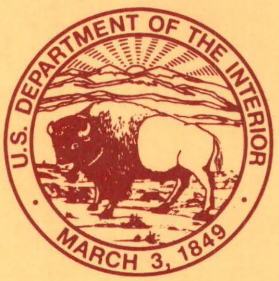
Thermodynamic Properties of Minerals and Related Substances at 298.15 K and 1 Bar (10^5 Pascals) Pressure and at Higher Temperatures

U.S. GEOLOGICAL SURVEY BULLETIN 2131



AVAILABILITY OF BOOKS AND MAPS OF THE U.S. GEOLOGICAL SURVEY

Instructions on ordering publications of the U.S. Geological Survey, along with prices of the last offerings, are given in the current-year issues of the monthly catalog "New Publications of the U.S. Geological Survey." Prices of available U.S. Geological Survey publications released prior to the current year are listed in the most recent annual "Price and Availability List." Publications that may be listed in various U.S. Geological Survey catalogs (**see back inside cover**) but not listed in the most recent annual "Price and Availability List" may be no longer available.

Order U.S. Geological Survey publications **by mail** or **over the counter** from the offices given below.

BY MAIL

Books

Professional Papers, Bulletins, Water-Supply Papers, Techniques of Water-Resources Investigations, Circulars, publications of general interest (such as leaflets, pamphlets, booklets), single copies of Earthquakes & Volcanoes, Preliminary Determination of Epicenters, and some miscellaneous reports, including some of the foregoing series that have gone out of print at the Superintendent of Documents, are obtainable by mail from

U.S. Geological Survey, Information Services
Box 25286, Federal Center, Denver, CO 80225

Subscriptions to periodicals (Earthquakes & Volcanoes and Preliminary Determination of Epicenters) can be obtained ONLY from the

Superintendent of Documents
Government Printing Office
Washington, DC 20402

(Check or money order must be payable to Superintendent of Documents.)

Maps

For maps, address mail orders to

U.S. Geological Survey, Information Services
Box 25286, Federal Center, Denver, CO 80225

Residents of Alaska may order maps from

U.S. Geological Survey, Earth Science Information Center
101 Twelfth Ave. - Box 12
Fairbanks, AK 99701

OVER THE COUNTER

Books and Maps

Books and maps of the U.S. Geological Survey are available over the counter at the following U.S. Geological Survey Earth Science Information Centers (ESIC), all of which are authorized agents of the Superintendent of Documents:

- **ANCHORAGE, Alaska**—Rm. 101, 4230 University Dr.
- **LAKEWOOD, Colorado**—Federal Center, Bldg. 810
- **MENLO PARK, California**—Bldg. 3, Rm. 3128, 345 Middlefield Rd.
- **RESTON, Virginia**—USGS National Center, Rm. 1C402, 12201 Sunrise Valley Dr.
- **SALT LAKE CITY, Utah**—Federal Bldg., Rm. 8105, 125 South State St.
- **SPOKANE, Washington**—U.S. Post Office Bldg., Rm. 135, West 904 Riverside Ave.
- **WASHINGTON, D.C.**—Main Interior Bldg., Rm. 2650, 18th and C Sts., NW.

Maps Only

Maps may be purchased over the counter at the following U.S. Geological Survey offices:

- **FAIRBANKS, Alaska**—New Federal Bldg., 101 Twelfth Ave.
- **ROLLA, Missouri**—1400 Independence Rd.
- **STENNIS SPACE CENTER, Mississippi**—Bldg. 3101

Thermodynamic Properties of Minerals and Related Substances at 298.15 K and 1 Bar (10^5 Pascals) Pressure and at Higher Temperatures

By Richard A. Robie and Bruce S. Hemingway

U. S. GEOLOGICAL SURVEY BULLETIN 2131

A summary of the thermodynamic data for minerals at 298.15 K *together with calculated values for the functions* $C^\circ_{p,T}$, $\Delta_f H^\circ_T$, $\Delta_f G^\circ_T$, S°_T, $(H^\circ_T - H^\circ_{298})T^{-1}$, *and* $(G^\circ_T - H^\circ_{298})T^{-1}$ *at temperatures up to* 1800 K

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1995

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
GORDON P. EATON, Director

For sale by U.S. Geological Survey, Information Services
Box 25286, Federal Center, Denver, CO 80225

Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Published in the Eastern Region, Reston, Va.
Manuscript approved for publication March 23, 1995.

Library of Congress Cataloging in Publication Data

Robie, Richard A., 1928-
Thermodynamic properties of minerals and related substances at 298.15 K and 1 bar (10 Pascals) pressure and at higher temperatures / by Richard A. Robie and Bruce S. Hemingway.
p. cm.— (Geological Survey bulletin ; 2131)
Includes bibliographical references and indexes.
Supt. of Docs. no. : I 19.3:B2131
1. Minerals—Tables. 2. Thermodynamics—Tables. I. Hemingway, Bruce S. II. Title. III. Series: U.S. Geological Survey bulletin ; 2131.
QE75.B9 no. 2131
[QE366.8]
557.3 s—dc20
[549'. 12] 95–19844
CIP

CONTENTS

Abstract 1
Introduction 1
Physical Constants and Atomic Weights 2
Reference States 3
Methods of Calculation 3
Additional Comments 4
Thermodynamic Properties at 298.15 K 5
    Elements 5
    Sulfides and Sulfosalts 11
    Oxides and Hydroxides 15
    Multiple Oxides 21
    Halides 23
    Carbonates and Nitrates 25
    Sulfates and Borates 28
    Phosphates, Molybdates, and Tungstates 30
    Ortho and Ring Structure Silicates 31
    Chain and Band Structure Silicates 34
    Framework Structure Silicates 36
    Sheet Structure Silicates 39
Coefficients for Heat Capacity Equations 41
    Elements 41
    Sulfides and Sulfosalts 45
    Oxides and Hydroxides 47
    Multiple Oxides 51
    Halides 53
    Carbonates and Nitrates 55
    Sulfates and Phosphates 56
    Ortho and Ring Structure Silicates 58
    Chain and Band Structure Silicates 61
    Framework Structure Silicates 63
    Sheet Structure Silicates 65
Thermodynamic Properties at High Temperature of Individual Phases 67
References Cited 397
Name Index 454
Formula Index 458

TABLE

1. Atomic weights of the elements for 1985 4

SYMBOLS, CONSTANTS, AND CONVERSION FACTORS

T	Temperature in Kelvins.
T_{trn}	Temperature of transition in Kelvins.
K	Kelvin, the unit of temperature. It is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.
J	Joule, the unit of energy (or work). One joule = 1/4.1840 thermochemical calories or 10 cm^3•bar.
mol	Mole, the amount of substance of a system that contains as many elementary entities as there are atoms in 0.012 kilograms of carbon 12. It is identical with the gfw (gram formula weight).
p	Pressure in bars. One bar = 10^5 Pascals or 0.1 MPa. The standard atmosphere is equal to 101325 Pascals. The kilogram•cm^{-2} is equal to 98065.5 Pascals.
°	Superscript indicates that the substance is in its standard state, 1 bar (10^5 Pascals) for a condensed phase.
$H^\circ_T - H^\circ_{298}$	Enthalpy at temperature T relative to 298.15 K in J•mol^{-1}, also called the heat content.
$(H^\circ_T - H^\circ_{298})T^{-1}$	Enthalpy function in J•mol^{-1}•K^{-1} (See note below).
S°_T	Entropy at temperature T, in J•mol^{-1}•K^{-1}.
$(G^\circ_T - H^\circ_{298})T^{-1}$	Gibbs energy function in J•mol^{-1}•K^{-1}.
C°_p	Heat capacity at constant pressure in J•mol^{-1}•K^{-1}.
V°_{298}	Volume of 1 mol of a substance at 1 bar pressure and at 298.15 K, in cm^3, or J•bar^{-1}.
$\Delta_{fus}H^\circ$	Enthalpy of melting at 1 bar pressure in J•mol^{-1}.
$\Delta_{trn}H^\circ$	Enthalpy of transition at 1 bar pressure in J•mol^{-1}.
$\Delta_{vap}H^\circ$	Enthalpy of vaporization to the ideal gas at 1 bar pressure at the normal boiling point in J•mol^{-1}.
$\Delta_f H^\circ$	Enthalpy of formation from the elements in their reference states in J•mol^{-1}.
$\Delta_f G^\circ$	Gibbs energy of formation from the elements in their reference states in J•mol^{-1}.
K_f	Equilibrium constant of formation.
R	Gas constant, 8.31451±0.00007 J•K^{-1}•mol^{-1}.
F	Faraday constant, 96,485.309±0.029 J•V^{-1}•mol^{-1}.
N_A	Avogadro constant, (6.0221367±0.0000036) x $10^{23}mol^{-1}$.
log	Common logarithm, base 10.
ln	Natural logarithm, base e = 2.71828...
atm	Standard atmosphere.
m=1	The standard state for an electrolyte in aqueous solution is the hypothetical ideal solution at unit activity and with the ions at infinite dilution.

When multiple units appear in the denominator of the symbol (for example, enthalpy function), the SI system does not recommend a particular order. For example, the units for entropy are given as J mol^{-1} K^{-1} in table 2.11 and as J K^{-1} mol^{-1} in table 3.5 of the Greenbook (278).

Thermodynamic Properties of Minerals and Related Substances at 298.15 K and 1 Bar (10^5 Pascals) Pressure and at Higher Temperatures

By Richard A. Robie and Bruce S. Hemingway

ABSTRACT

Selected values for the entropy (S°), molar volume (V°), and for the enthalpy and Gibbs energy of formation ($\Delta_f H°$ and $\Delta_f G°$) are given for 50 reference elements, 55 sulfides, 93 oxides and hydroxides, 141 silicates, and 154 other minerals and related substances at 298.15 K. For those minerals for which high-temperature heat-capacity or heat-content data are also available $(H^\circ_T - H^\circ_{298})T^{-1}$, S°_T, $(G^\circ_T - H^\circ_{298})T^{-1}$, C°_p, $\Delta_f H^\circ_T$, $\Delta_f G^\circ_T$ and log $K_{f,T}$ are tabulated at 100 K intervals for temperatures up to 1800 K.

INTRODUCTION

In the 17 years since the predecessor to this bulletin was published, an enormous body of new thermochemical and equilibrium measurements for minerals has been published, personal computers have become almost universally available, and a number of "internally consistent thermodynamic property databases" (ICTDB) have been published (37, 67, 117, 149, 150, 159, 187, 188, 374). (In this section, references are indicated by numbers in parentheses.) This report is an updated revision and expansion of U.S. Geological Survey (USGS) Bulletin 1452 (361) and entirely supersedes it. As an example of growth of the thermodynamic properties of mineral database, USGS Bulletin 1452 contained data for 58 silicate minerals whereas in the current set of tables this number has been increased to 141.

The purpose of these tables is to present a critical summary of the available thermodynamic data for minerals and related substances in a convenient form for the use of earth scientists. To make the tables as useful as possible, we have tried (1) to include enough auxiliary data so that a single set of tables would suffice for most calculations, (2) to ensure internal consistency, and (3) to provide the means for rapid revision and expansion as new data become available.

The tables in this compilation are divided into three sections. In the first section, values are given for the entropy (S°_{298}), molar volume (V°_{298}), enthalpy of formation ($\Delta_f H^\circ_{298}$), Gibbs energy of formation ($\Delta_f G^\circ_{298}$), and the logarithm of the equilibrium constant of formation (log $K_{f,298}$) for the reference elements, minerals, and other substances of geological interest (properties at 298.15 K and 1 bar). In the second section, coefficients for the polynomial used to represent the heat capacity at high temperature are tabulated together with the temperature limits of applicability. In the third section, values are given for the thermodynamic properties at 100 K intervals for temperatures up to 1800 K. The data are arranged in order of their conventional mineralogical groups. Within each group (for example, the oxides) the listing is by alphabetical order of the chemical symbol of the principal cation.

The data have been taken from the original literature, recent critical evaluations, or have been evaluated by the present authors and estimated uncertainties have been assigned to the thermodynamic properties at 298.15 K. The primary sources of data are indicated numerically in the thermodynamic table of properties at 298.15 K, as "S" for the reference to the data for the entropy, "H/G" for the reference to the formation properties, and "C" to references to measured heat capacities above 298.15 K. The references are listed in complete form following the tables. The entropy and heat-capacity values tabulated are based almost exclusively on calorimetric measurements whereas the values for the enthalpy or Gibbs energy of formation were obtained from both equilibrium and calorimetric measurements. The values for the thermodynamic properties of the reference elements have been taken from the JANAF tables (67), the CODATA (85) recommended values, or in the case of calcium, from measurement at the USGS (360). For those silicate glasses for which $S^\circ_T - S^\circ_0$ has been determined calorimetrically and for which the enthalpy of fusion of the crystalline equivalent could be evaluated, the residual entropy (that is, S°_0) of the glass has been evaluated and added to the calorimetric entropy to obtain the correct entropy for use in thermodynamic calculations. Glasses and other phases for which $S^\circ_T - S^\circ_0$ has been measured but for which the residual entropy has not been evaluated are indicated by a "+" sign and the user must be aware that the

value tabulated does not include the configurational entropy.

Although a number of different forms of equations for the representation of the heat capacity at high temperatures have been proposed over the past 10 years, for example Berman (37), Fei and Saxena (104), Richet and Fiquet (342), we have retained the form adopted in the previous version of these tables,

$$C_p = A_1 + A_2 \cdot T + A_3 \cdot T^{-2} + A_4 \cdot T^{-0.5} + A_5 \cdot T^2$$

This equation can not be extrapolated beyond its upper limit. Inasmuch as most users will have access to a personal computer, the conversion from one form of equation to an alternative form is possible and is left up to the individual user's preference. The entropies listed in the table of coefficients for the C_p° polynomials corresponds to the temperature at the lower limit of the temperature range for the polynomial. This is usually 298.15 K.

For several phases, the existence of multiple transitions at high temperature makes it impractical to provide a simple polynomial expression for the heat capacity. For such phases, for example Fe, $Cu_{1.9}S$, and several pyrrhotites, we have listed only the heat capacity at 298.15 K.

For these phases, one must go to the high-temperature table for the particular phase (if tabulated) to get the heat capacity (and entropy) above room temperature.

Internally consistent thermodynamic property data sets for silicate minerals have been published by Haas et al. (149), Holland and Powell (187, 188), Berman (37), Halbach and Chatterjee (150), and Saxena and Chatterjee (374) among others. Inasmuch as most of the authors relied on the same sources of calorimetric and equilibrium data to derive their adopted values, it is surprising that significant differences in their listed values for such important phases as grossular, anorthite, phlogopite and muscovite exist. For example, between the most frequently cited ICTDB, those of Berman (37) and Holland and Powell (188), the values of $\Delta_f G^\circ_{298}$ calculated from their listed values of S°_{298} and $\Delta_f H^\circ_{298}$ differ by 5.7, 3.7 and 3.7 kJ•mol^{-1} for grossular, anorthite, and muscovite, respectively, and for analbite and muscovite the tabulated entropies differ by 4.4 and 9.1 J•mol^{-1}•K^{-1}, respectively. The point is, of course, that internal consistency does not imply that the derived values are accurate.

The reason for these discrepancies is most likely in the assumptions that the individual compiler makes concerning the state of internal Al/Si order. For a 1:3 Al/Si compound such as the alkali feldspars or micas the complete random mixing of the 3 Si and 1 Al over the 4 tetrahedral sites leads to a contribution to the entropy of 18.7 J•mol^{-1}•K^{-1}. However, if the aluminum-avoidance model is valid, the configurational entropy will be considerably smaller and of the order of 13 to 14 J•mol^{-1}•K^{-1}. The aluminum-avoidance model has not been calculated exactly and only approximate values are available. The values for the configurational entropies that have been derived from phase equilibrium studies by Holland and Powell (188) and by Berman (37) are 12.6 and 17.0 J•mol^{-1}•K^{-1} for analbite and 16.0 and 15.1 J•mol^{-1}•K^{-1} for sanidine, respectively. It appears that these calculated values for the entropy of disorder do not unequivocally support the aluminum-avoidance model but rather tend to yield a configurational entropy that is greater than that estimated by the aluminum-avoidance value, but definitely less than the fully random model. Any value of ΔS greater than that calculated from aluminum-avoidance would presumably mean that this model was inapplicable at high temperatures; for example, at temperatures greater than 1300 K for analbite the disordering entropy would approach 18.7 J•mol^{-1}•K^{-1}. Moreover Goldsmith and Jenkins (123) have shown that the Al/Si disorder in $NaAlSi_3O_8$ is a continuous function of the temperature and that it occurs over a range of several hundred degrees (500–1050 K) and occurs without change in symmetry.

As a consequence of these points the question arises whether one can extract meaningful (unique) values for the entropy of the disordered phase of an alumino-silicate from phase equilibrium studies without having additional information on the Al/Si distribution. For this reason, we have adopted the fully random model for tabulating the high-temperature properties for the Al/Si disordered feldspars and micas. For an extended discussion of the contribution to the entropy of silicate minerals arising from Al/Si or magnetic spin disorder, see Ulbrich and Waldbaum (413).

The differences in the derived values for the thermodynamic properties of phases in the CASH system is due in part to the existence of two calorimetric values for the entropy of grossular which differ from one another by 4.6 J•mol^{-1}•K^{-1}. The value of Westrum et al. (438) was determined on a natural sample and involved a substantial correction for impurities. The value given by Haselton and Westrum (157) was derived from measurements on a synthetic sample. The heat capacity of the synthetic sample used by Haselton and Westrum (157) was later remeasured at the USGS by the present authors (359), who found an entropy $S^\circ(Ca_3Al_2Si_3O_{12}, 298.15\ K)$ of 259.9 J•mol^{-1}•K^{-1} which agrees with the Haselton and Westrum value to within 0.2 J•mol^{-1}•K^{-1} (0.08 percent). For this reason we have accepted the Haselton-Westrum value for the entropy of grossular in evaluating the thermodynamic properties of phases in the CASH system.

PHYSICAL CONSTANTS AND ATOMIC WEIGHTS

The symbols and constants used to prepare these tables are listed in the table of contents. The units adopted for reporting the thermodynamic properties are those of the International System of Units (SI). A formal description of

the SI system is given by Goldman and Bell (122). The recommended symbols and terminology used are those from the International Union of Pure and Applied Chemistry (IUPAC), "Quantities, Units and Symbols in Physical Chemistry", by Mills et al. (278) and commonly called the "Greenbook". The Greenbook is also a convenient source for the CODATA values of the fundamental physical constants, the 1985 atomic weights of the elements, and contains a detailed description of the SI system of units.

Values for the gas constant (R), the Faraday constant (F), and the Avogadro constant (A) used in the calculations are those adopted by the CODATA Task Group from the least squares evaluation of Cohen and Taylor (75). For convenience, we also give values for the atomic weights for 1985 (scale $C^{12} = 12.000$, Mills et al. (278)) in alphabetical order by their chemical symbol in table 1.

REFERENCE STATES

The reference pressure for the standard state adopted for these tables is 1 bar, that is 10^5 Pascals. For a gaseous phase, C_p°, $(H_T^\circ - H_{298}^\circ)T^{-1}$, and $\Delta_f H^\circ$ are independent of pressure, but the numerical values of S°, $(G_T^\circ - H_{298}^\circ)T^{-1}$, $\Delta_f G^\circ$ depend upon the choice of pressure. The change in pressure from p = 1 atm (1.0135 bar) to 1 bar yields $\Delta S = 0.11\ J \cdot mol^{-1} \cdot K^{-1}$. For a condensed phase (liquid or solid), it can be shown that the effect of changing the reference pressure from 1 atm to 1 bar has only a trivial effect upon all the thermodynamic properties tabulated in this report except for $\Delta_f G^\circ$, where a change will occur if one of the reference elements (usually oxygen) is a gas.

The standard states for the condensed elements are the most stable form at 1 bar pressure and the stated temperature. For gaseous elements, the standard state is the ideal gas at 1 bar pressure. Data are listed for the elements in their standard reference states, and for a few in nonstandard states; for example, S^2 gas and the diamond form of carbon. The reference state adopted for an element above its normal boiling or sublimation temperature is not necessarily its equilibrium state. Thus, at equilibrium, liquid sulfur boils at 1 bar pressure and approximately 716.9 K to a gas composed of S, S_2, S_4, S_6, S_8, etc., but for our reference table, we have assumed the gas phase to be only S_2. For the reference state table for sulfur we have followed the JANAF (67) tables procedure using 882.12 K as the fictive boiling temperature at which liquid sulfur is in equilibrium with S_2 gas at 1 bar pressure. Because of the convenience of using diatomic sulfur gas in calculations of sulfide mineral equilibria we have included a second set of high-temperature tables for which the reference state for calculating $\Delta_f G^\circ$, and $\Delta_f H^\circ$ and log K_f for the sulfide phase is S_2 gas. The user is cautioned not to intermix values from the two different reference states in their calculations. In other ambiguous cases, we have chosen either the dominant species in the gas or that species for which the best thermodynamic data are available as the reference state.

The reference states for $\Delta_f H^\circ$, $\Delta_f G^\circ$, and log K_f of the compounds are the elements in their standard states at 1 bar pressure and the stated temperature.

METHODS OF CALCULATION

Having chosen what we believe are the currently "best available" values for $H_T^\circ - H_{298}^\circ$, or C_p° (T), S_{298}° and either $\Delta_f H_{298}^\circ$ or $\Delta_f G_{298}^\circ$, we have calculated the Gibbs energy function, and the enthalpy, Gibbs energy, and the equilibrium constant of formation at 100 K intervals using the following relations:

$$(G_T^\circ - H_{298}^\circ)T^{-1} = (H_T^\circ - H_{298}^\circ)T^{-1} - S_T^\circ$$

$$\Delta_f H_T^\circ = \Delta_f H_{298}^\circ + \Delta(H_T^\circ - H_{298}^\circ)$$

$$\Delta_f G_T^\circ = \Delta_f H_{298}^\circ + T\Delta[(G_T^\circ - H_{298}^\circ)T^{-1}]$$

and

$$\log K_{f,T} = \Delta_f G_T^\circ (2.30258\ RT)^{-1} = -\Delta_f G_{298}^\circ (19.145T)^{-1}$$

These values together with C_p°, S_T° and $(H_T^\circ - H_{298}^\circ)T^{-1}$ are tabulated in the third section.

Transitions in heat capacity are treated in the standard manner: heat capacity curves are fit to the experimental values above and below the transition; values calculated from an extrapolation of the equation to the transition temperature are compared to the experimental values; and differences are summed to give an enthalpy of transition that is applied at the transition temperature.

The uncertainties assigned to the properties apply only to the values at 298.15 K. The principal source has been the original report of the experimental data. By convention, the uncertainty interval reported for calorimetric measurements is twice the standard deviation of the mean; that is,

$$\delta = 2[\Sigma (x_i - x_m)^2/n(n-1)]^{1/2}$$

where x_i is the value for an individual measurement, x_m is the arithmetic mean of all the measurements, and n is the number of measurements.

For generating the high-temperature tables, the input data supplied to the computer are the identifying name of the substance, the entropy, the enthalpy of formation at 298.15 K, the number of atoms of each element in the chemical formula, and the coefficients for the heat capacity equation. A commercial spreadsheet is used to compute the formula weight of the compound and values for S_T°, $\Delta_f H_T^\circ$, $\Delta_f G_T^\circ$, log $K_{f,T}$, C_p°, $(H_T^\circ - H_{298}^\circ)T^{-1}$, and $(G_T^\circ - H_{298}^\circ)\ T^{-1}$, at 100 K intervals up to 1800 K. Auxiliary data such as the melting and boiling points and enthalpies of melting and vaporization are also included. In addition, coefficients

from a regression performed on the calculated values of $\Delta_f G^\circ_T$ are included. The equation adopted is:

$$\Delta_f G^\circ_T = A + BT + CT^{-2}$$

The coefficients for the equations are listed, in scientific notation, at the bottom of the page for the individual high-temperature tables. The equations are given only for those minerals for which the regression yielded a fit of better than 1 percent.

ADDITIONAL COMMENTS

Small numbers of some groups are presented with other groups for convenience and economy. Examples include tellurides, selenides and arsenides that are included with sulfides and sulfosalts, and methane, cohenite, and ammonia that are included with the elements.

The data available in this publication are also available on diskette for a nominal fee through the Generic Mineral Technology Center for Pyrometallurgy at the University of Missouri at Rolla as a part of the FREED database. FREED is a thermodynamic database program for storing, retrieving, editing, and manipulating thermodynamic data on a computer. FREED was developed with support from the U.S. Department of Interior's Mineral Institute Program, administered by the U.S. Bureau of Mines, and the U.S. Department of Energy through the Westinghouse Savannah River Plant.

Table 1. Atomic weights of the elements for 1985.

Element	Symbol	Atomic Weight	Element	Symbol	Atomic Weight
Actinium	Ac	(227)	Sodium	Na	22.98977
Silver	Ag	107.8682	Niobium	Nb	92.90638
Aluminum	Al	26.98154	Neodymium	Nd	144.24
Americium	Am	(243)	Neon	Ne	20.1797
Argon	Ar	39.948	Nickel	Ni	58.69
Arsenic	As	74.92159	Neptunium	Np	(237)
Astatine	At	(210)	Oxygen	O	15.9994
Gold	Au	196.96654	Osmium	Os	190.2
Boron	B	10.811	Phosphorus	P	30.97376
Barium	Ba	137.327	Protactinium	Pa	231.03588
Beryllium	Be	9.01218	Lead	Pb	207.2
Bismuth	Bi	208.98037	Palladium	Pd	106.42
Bromine	Br	79.904	Polonium	Po	(209)
Carbon	C	12.011	Promethium	Pm	(145)
Calcium	Ca	40.078	Praseodymium	Pr	140.90765
Cadmium	Cd	112.411	Platinum	Pt	195.08
Cerium	Ce	140.115	Plutonium	Pu	(244)
Chlorine	Cl	35.4527	Radium	Ra	(266)
Cobalt	Co	58.9332	Rubidium	Rb	85.4678
Chromium	Cr	51.9961	Rhenium	Re	186.207
Cesium	Cs	132.90543	Rhodium	Rh	102.90550
Copper	Cu	63.546	Radon	Rn	(222)
Dysprosium	Dy	162.50	Ruthenium	Ru	101.07
Erbium	Er	167.26	Sulfur	S	32.066
Europium	Eu	151.965	Antimony	Sb	121.75
Fluorine	F	18.99840	Scandium	Sc	44.95591
Iron	Fe	55.847	Selenium	Se	78.96
Francium	Fr	(223)	Silicon	Si	28.0855
Gallium	Ga	69.723	Samarium	Sm	150.36
Gadolinium	Gd	157.25	Tin	Sn	118.710
Germanium	Ge	72.61	Strontium	Sr	87.62
Hydrogen	H	1.00794	Tantalum	Ta	180.9479
Helium	He	4.00260	Terbium	Tb	158.92534
Hafnium	Hf	178.49	Technetium	Tc	(98)
Mercury	Hg	200.59	Tellurium	Te	127.60
Holmium	Ho	164.93032	Thorium	Th	232.0381
Iodine	I	126.90447	Titanium	Ti	47.88
Indium	In	114.82	Thallium	Tl	204.3833
Iridium	Ir	192.22	Thulium	Tm	168.93421
Potassium	K	39.0983	Uranium	U	238.0289
Krypton	Kr	83.80	Vanadium	V	50.9415
Lanthanum	La	138.9055	Tungsten	W	183.85
Lithium	Li	6.941	Xenon	Xe	131.29
Lutetium	Lu	174.967	Yttrium	Y	88.90585
Magnesium	Mg	24.3050	Ytterbium	Yb	173.04
Manganese	Mn	54.93805	Zinc	Zn	65.39
Molybdenum	Mo	95.94	Zirconium	Zr	91.224
Nitrogen	N	14.00674			

THERMODYNAMIC PROPERTIES OF ELEMENTS IN THEIR REFERENCE STATE AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
SILVER (REFERENCE STATE)	107.868	42.55	10.272	0.0	0.0	0.00	85		85
Ag		0.21	0.002						
Ag^+ (AQUEOUS ION)	107.868	73.45		105.8	77.1	-13.50	85	85	
STD. STATE, m = 1		0.40		0.1	0.1	0.02			
ALUMINUM (REFERENCE STATE)	26.982	28.30	9.999	0.0	0.0	0.00	67		92
Al		0.08	0.001				92		67
Al^{3+} (AQUEOUS ION)	26.982	-332		-538.4	-489.4	86.11	85	85	
STD. STATE, m = 1		10		1.5	1.4	0.79	170	330	
ARSENIC (REFERENCE STATE)	74.922	35.69	12.963	0.0	0.0	0.00	361		361
As		0.84	0.020						
GOLD (REFERENCE STATE)	196.967	47.49	10.215	0.0	0.0	0.00	361		
Au		0.21	0.002						
BORON (REFERENCE STATE)	10.811	5.83	4.386	0.0	0.0	0.00	67		67
B		0.08	0.007				85		85
BARIUM (REFERENCE STATE)	137.327	62.42	38.21	0.0	0.0	0.00	361		361
Ba		0.84	0.02						
Ba^{2+} (AQUEOUS ION)	137.327	8.40		-532.5	-555.4	97.30	54	54	
STD. STATE, m = 1		0.50		1.0	1.0	0.18			
BERYLLIUM (REFERENCE STATE)	9.012	9.50	4.880	0.0	0.0	0.00	85		85
Be		0.08	0.002				67		67
BISMUTH (REFERENCE STATE)	208.980	56.74	21.31	0.0	0.0	0.00	361		361
Bi		0.42	0.01						127
BROMINE (REFERENCE STATE)	159.808	152.20	54.58	0.0	0.0	0.00	85		67
Br_2 (LIQUID)		0.30	0.20						
BROMINE (IDEAL GAS)	159.808	245.47	24789.7	30.9	3.1	-0.55	85	85	67
Br_2		0.05	0.2	0.1	0.3	0.05			
Br^- (AQUEOUS ION)	79.904	82.55		-121.4	-103.8	18.18	85	85	
STD. STATE, m = 1		0.20		0.2	0.2	0.04			
GRAPHITE (REFERENCE STATE)	12.011	5.74	5.298	0.0	0.0	0.00	85		85
C		0.10	0.001						
DIAMOND	12.011	2.38	3.417	1.9	2.9	-0.51	419	419	419
C		0.20	0.001	0.0	0.1	0.02			

THERMODYNAMIC PROPERTIES OF ELEMENTS IN THEIR REFERENCE STATE AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
CALCIUM (REFERENCE STATE)	40.078	42.90	26.19	0.0	0.0	0.00	360		117
Ca		0.10	0.04						
Ca^{2+} (AQUEOUS ION)	40.078	-56.2		-543.0	-553.6	96.99	85	85	
STD. STATE, m = 1		1.0		1.0				419	
CADMIUM (REFERENCE STATE)	112.411	51.80	13.005	0.0	0.0	0.00	85		85
Cd		0.15	0.003						
Cd^{2+} (AQUEOUS ION)	112.411	-72.8		-75.9	-77.6	-13.59	85	85	
STD. STATE, m = 1		1.5		0.6	0.6	0.11			
CERIUM (REFERENCE STATE)	140.115	72.0	20.77	0.0	0.0	0.00	419		361
Ce		4.0	0.02						
CHLORINE (REFERENCE STATE)	70.905	223.08	24789.7	0.0	0.0	0.00	67		67
Cl_2 (IDEAL GAS)		0.01	0.2				85		85
Cl^- (AQUEOUS ION)	35.453	56.60		-167.1	-131.2	22.99	85	85	
STD. STATE, m = 1		0.20		0.1	0.1				
COBALT (REFERENCE STATE)	58.933	30.04	6.670	0.0	0.0	0.00	361		361
Co		0.42	0.002						
CHROMIUM (REFERENCE STATE)	51.996	23.62	7.231	0.0	0.0	0.00	67		67
Cr		0.21	0.001						
CESIUM (REFERENCE STATE)	132.905	85.23	69.73	0.0	0.0	0.00	85		
Cs		0.40	0.40						
Cs^+ (AQUEOUS ION)	132.905	132.1		-258.0	-291.5	51.07	85	85	
STD. STATE, m = 1		0.5		0.5	1.0	0.18			
COPPER (REFERENCE STATE)	63.546	33.14	7.113	0.0	0.0	0.00	365		443
Cu		0.03	0.003						67
Cu^+ (AQUEOUS ION)	63.546	40.60		71.7	50.0	-8.76	419	419	
STD. STATE, m = 1		0.40		0.1	0.1	0.02			
Cu^{2+} (AQUEOUS ION)	63.546	-98.0		64.9	65.1	-11.40	85	85	
STD. STATE, m = 1		4.0		1.0	0.1	0.02			
FLUORINE (REFERENCE STATE)	37.997	202.79	24789.7	0.0	0.0	0.00	67		67
F_2 (IDEAL GAS)		0.02	0.2				85		85
F^- (AQUEOUS ION)	18.998	-13.8		-335.4	-281.5	49.32	85	85	
STD. STATE, m = 1		0.8		0.7	0.7	0.12			

THERMODYNAMIC PROPERTIES OF ELEMENTS IN THEIR REFERENCE STATE AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
IRON (REFERENCE STATE)	55.847	27.09	7.092	0.0	0.0	0.00	90		90
Fe		0.13	0.004				67		67
Fe^{2+} (AQUEOUS ION)	55.847	-107.1		-91.1	-90.0	15.77	411	411	
STD. STATE, m = 1		2.0		3.0	2.0	0.35			
Fe^{3+} (AQUEOUS ION)	55.847	-280.0		-49.9	-16.7	2.93	411	411	
STD. STATE, m = 1		13.0		5.0	2.0	0.35			
GERMANIUM (REFERENCE STATE)	72.61	31.09	13.630	0.0	0.0	0.00	85		361
Ge		0.15	0.005						
HYDROGEN (REFERENCE STATE)	2.016	130.68	24789.7	0.0	0.0	0.00	67		67
H_2 (IDEAL GAS)		0.02	0.2				85		85
H^+ (AQUEOUS ION)	1.008	0.00	0	0.0	0.0	0.00			
STD. STATE, m = 1									
MERCURY (REFERENCE STATE)	200.59	75.90	14.822	0.0	0.0	0.00	85		361
Hg (LIQUID)		0.12	0.002						
Hg^{2+} (AQUEOUS ION)	200.59	-36.2		170.2	163.5	-28.64	85	85	
STD. STATE, m = 1		0.8		0.2	0.2	0.04			
Hg_2^{2+} (AQUEOUS ION)	401.18	65.74		166.9	153.6	-26.91	85	85	
STD.STATE, m = 1		0.80		0.5	0.5	0.09			
IODINE (REFERENCE STATE)	253.809	116.14	51.29	0.0	0.0	0.00	85	67	67
I_2		0.30	0.06						
IODINE (IDEAL GAS)	253.809	260.69	24789.7	62.4	19.3	-3.39	67		67
I_2		0.02	0.2	0.1	0.1	0.01			
I^- (AQUEOUS ION)	126.904	106.45		-56.8	-51.7	9.06	85	85	
STD. STATE, m = 1		0.30		0.1	0.1	0.02			
POTASSIUM (REFERENCE STATE)	39.098	64.67	45.36	0.0	0.0	0.00	85		85
K		0.20	0.09				67		67
K^+ (AQUEOUS ION)	39.098	101.20		-252.1	-282.5	49.48	85	85	
STD. STATE, m = 1		0.20		0.1	0.1	0.01			
LITHIUM (REFERENCE STATE)	6.941	29.09	13.017	0.0	0.0	0.00	67		67
Li		0.20	0.007						85
Li^+ (AQUEOUS ION)	6.941	12.24		-278.5	-292.9	51.31	85	85	
STD. STATE, m = 1		0.15		0.1	0.1	0.01			

THERMODYNAMIC PROPERTIES OF ELEMENTS IN THEIR REFERENCE STATE AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
MAGNESIUM (REFERENCE STATE)	24.305	32.67	13.996	0.0	0.0	0.00	85		85
Mg		0.10	0.007				67		
Mg^{2+} (AQUEOUS ION)	24.305	-137.0		-467.0	-455.4	79.78	85	85	
STD. STATE, m = 1		4.0		0.6	0.6	0.11			
MANGANESE (REFERENCE STATE)	54.938	32.01	7.354	0.0	0.0	0.00	91		91
Mn		0.08	0.007						
Mn^{2+} (AQUEOUS ION)	54.938	-73.60		-220.8	-228.1	39.96	419	419	
STD. STATE, m = 1		1.00		0.5	0.5	0.09			
MOLYBDENUM (REFERENCE STATE)	95.94	28.66	9.387	0.0	0.0	0.00	91		91
Mo		0.21	0.005						
NITROGEN (REFERENCE STATE)	28.013	191.61	24789.7	0.0	0.0	0.00	67		67
N_2		0.02	0.2				85		85
SODIUM (REFERENCE STATE)	22.990	51.46	23.81	0.0	0.0	0.00	67		67
Na		0.20	0.01				85		85
Na^+ (AQUEOUS ION)	22.990	58.45		-240.3	-261.5	45.81	85	85	
STD. STATE, m = 1		0.15		0.1	0.1	0.01			
NICKEL (REFERENCE STATE)	58.69	29.87	6.588	0.0	0.0	0.00	67		67
Ni		0.08	0.003						
Ni^{2+} (AQUEOUS ION)	58.69	-128.9		-54.0	-45.6	7.99	419	419	
STD. STATE, m = 1		2.0		0.9	0.9	0.15			
OXYGEN (REFERENCE STATE)	31.999	205.15	24789.7	0.0	0.0	0.00	67		67
O_2 (IDEAL GAS)		0.02	0.2				85		85
PHOSPHORUS (REFERENCE STATE)	30.974	41.09	17.3	0.0	0.0	0.00	85		85
P (WHITE)		0.25	0.3						
LEAD (REFERENCE STATE)	207.2	64.8	18.267	0.0	0.0	0.00	67		67
Pb		0.5	0.006						
Pb^{2+} (AQUEOUS ION)	207.2	18.5		0.9	-24.2	4.24	85	85	
STD. STATE, m = 1		1.0		0.3	0.2	0.04			
PLATINUM (REFERENCE STATE)	195.08	41.63	9.091	0.0	0.0	0.00	361		361
Pt		0.21	0.004						
SULFUR (REFERENCE STATE)	32.066	32.05	15.511	0.0	0.0	0.00	67		67
S ORTHORHOMBIC		0.05	0.005				85		

THERMODYNAMIC PROPERTIES OF ELEMENTS IN THEIR REFERENCE STATE AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
SULFUR	32.066	33.03		0.3	0.0	0.00	67	419	67
S MONOCLINIC		0.05		0.1					
S^{2-} (AQUEOUS ION)	32.066	-14.6		33.1	85.8	-15.03	419	419	
STD. STATE, m = 1		1.0		1.0	1.0	0.18			
DIATOMIC SULFUR	64.132	228.17	24789.7	128.6	79.7	-13.96	67	67	67
S_2 (IDEAL GAS)		0.02	0.2	0.3	0.3	0.05			
ANTIMONY (REFERENCE STATE)	121.75	45.52	18.178	0.0	0.0	0.00	361		361
Sb		0.21	0.009						
SELENIUM (REFERENCE STATE)	78.96	42.27	16.42	0.0	0.0	0.00	62		126
Se		0.05	0.01						
SILICON (REFERENCE STATE)	28.086	18.81	12.056	0.0	0.0	0.00	67		67
Si		0.08	0.002				85		
$H_4SiO_4^\circ$ (AQUEOUS ION)	96.115	180.0		-1460.0	-1307.5	229.12		179	422
STD. STATE, m = 1		4.2		1.7	2.1	0.37		285	414
TIN (REFERENCE STATE)	118.710	51.18	16.29	0.0	0.0	0.00	85		85
Sn (WHITE, TET.)		0.08	0.01						
STRONTIUM (REFERENCE STATE)	87.62	55.69	33.92	0.0	0.0	0.00	39		67
Sr		0.20	0.02						
Sr^{2+} (AQUEOUS ION)	87.62	-31.5		-550.9	-563.8	98.78	55	55	
STD. STATE, m = 1		2.0		0.5	0.8	0.14			
TELLURIUM (REFERENCE STATE)	127.60	49.71	20.48	0.0	0.0	0.00	361		361
Te		0.20	0.01						
THORIUM (REFERENCE STATE)	232.038	51.83	19.79	0.0	0.0	0.00	319		319
Th		0.50	0.01						
TITANIUM (REFERENCE STATE)	47.88	30.76	10.63	0.0	0.0	0.00	67		67
Ti		0.10	0.01						
URANIUM (REFERENCE STATE)	238.029	50.2	12.50	0.0	0.0	0.00	85		85
U		0.2	0.02						
VANADIUM (REFERENCE STATE)	50.942	28.94	8.350	0.0	0.0	0.00	67		67
V		0.42	0.004						
TUNGSTEN (REFERENCE STATE)	183.85	32.65	9.545	0.0	0.0	0.00	67		67
W		0.10	0.004						

THERMODYNAMIC PROPERTIES OF ELEMENTS IN THEIR REFERENCE STATE AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
ZINC (REFERENCE STATE)	65.39	41.63	9.162	0.0	0.0	0.00	67		67
Zn		0.15	0.007				85		
Zn^{2+} (AQUEOUS ION)	65.39	-109.8		-153.4	-147.3	25.79	85	85	
STD. STATE, m = 1		0.5		0.2	0.2	0.04			
ZIRCONIUM (REFERENCE STATE)	91.224	38.87	14.016	0.0	0.0	0.00	67		67
Zr		0.20	0.007						
METHANE (IDEAL GAS)	16.043	186.26	24789.7	-74.8	-50.7	8.88	419	419	67
CH_4		0.21	0.2	0.3	0.4	0.07	67	67	
COHENITE	179.552	104.4	23.23	24.9	19.7	-3.45	361	361	361
Fe_3C		3.4	0.01	1.3	1.7	0.30			
AMMONIA (IDEAL GAS)	17.031	192.77	24789.7	-45.9	-16.4	2.87	67	67	67
NH_3		0.03	0.2	0.4	0.4	0.06			
NH_4^+ (AQUEOUS ION)	18.039	111.17		-133.3	-79.4	13.91	85	85	
STD. STATE, m = 1		0.40		0.3	0.3	0.05			

THERMODYNAMIC PROPERTIES OF SULFIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
ACANTHITE (ARGENTITE)	247.802	142.9	34.19	-32.0	-39.7	6.96	141	121	141
Ag_2S		0.3	0.04	1.0	1.0	0.18		52	306
REALGAR	106.988	63.5	29.80	-30.9	-29.6	5.19	429	419	270
AsS		0.6	0.24	5.0	5.0	0.88		270	
ORPIMENT	246.041	163.6	70.51	-91.6	-90.4	15.84	372	50	210
As_2S_3		1.6	0.25	4.2	4.2	0.74			
BISMUTHINITE	514.159	200.4	75.52	-135.2	-132.4	23.20	372	52	
Bi_2S_3		3.3	0.04	2.4	2.6	0.46			
TELLUROBISMUTHITE	800.761	261.1	101.85	-78.7	-78.2	13.71	201	279	
Bi_2Te_3		5.0	0.09	2.1	2.6	0.46			
OLDHAMITE	72.144	56.7	27.72	-474.9	-469.5	82.25	67	67	
CaS		1.3	0.09	2.1	2.1	0.37		279	
GREENOCKITE	144.477	72.2	29.93	-149.6	-146.1	25.60	38	3	38
CdS		0.3	0.02	1.3	1.3	0.23			
CATTIERITE	123.065	74.8	25.52	-150.9	-145.1	25.42	399	60	326
CoS_2		0.2	0.01	4.9	4.9	0.86		376	
LINNAEITE	305.064	176.0	62.55	-347.5	-334.9	58.66	399	60	
Co_3S_4		0.4	0.02	7.3	7.3	1.28		98	
COVELLITE	95.612	67.4	20.42	-54.6	-55.3	9.69	109	337	109
CuS		0.1	0.02	0.3	0.3	0.05	442		442
ANILITE	143.272	107.5	25.79	-73.3	-78.5	13.76	133	337	133
$Cu_{1.75}S$		0.2	0.02	0.3	0.3	0.05		140	
DIGENITE	146.449	109.6	25.63	-73.0	-78.3	13.72	133	337	133
$Cu_{1.80}S$		0.2	0.05	0.5	0.5	0.09			
DJURLEITE	155.981	114.8	26.89	-78.8	-84.2	14.75	394	337	394
$Cu_{1.95}S$		0.2	0.02	0.4	0.4	0.07			
CHALCOCITE	159.158	116.2	27.48	-83.9	-89.2	15.62	142	369	109
Cu_2S		0.2	0.02	1.1	1.1	0.19	109	48	142
CHALCOPYRITE	183.525	124.9	43.92	-194.9	-195.1	34.18	371	369	325
$CuFeS_2$		0.2	0.02	1.6	1.6	0.28		371	369
BORNITE	501.841	398.5	98.73	-371.6	-394.7	69.32	369	369	325
Cu_5FeS_4		0.8	0.05	2.1	2.1	0.37			369

THERMODYNAMIC PROPERTIES OF SULFIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
CUBANITE	271.438	205.0	67.44				388		280
$CuFe_2S_3$		0.8	0.06						
NUKUNDAMITE	613.779		278.0		-564.5	98.90		369	
$Cu_{5.5}FeS_{6.5}$			0.5		3.4	0.59			
TROILITE	87.913	60.3	18.20	-101.0	-101.3	17.75	143	69	79
FeS		0.2	0.03	1.5	1.5	0.26	347	3	131
PYRRHOTITE	80.932	60.7	17.49	-97.5	-98.9	17.33	143	131	131
$Fe_{.875}S$		0.2	0.05	2.0	2.0	0.35			
PYRRHOTITE	82.328	63.2	16.88	-97.6	-99.6	14.45	135	375	135
$Fe_{.90}S$		0.1	0.10	2.0	2.0	0.35			
PYRITE	119.979	52.9	23.94	-171.5	-160.1	28.05	138	409	79
FeS_2		0.1	0.01	1.7	1.7	0.30		67	
MARCASITE	119.979	53.9	24.58	-169.5	-158.4	27.75	139	139	139
FeS_2		0.1	0.02	2.1	2.1	0.37			
LOELLINGITE	205.690	80.1	27.51	-57.8	-52.3	9.17	332	25	
$FeAs_2$		0.7	0.02	5.0	5.0	0.88			
FERROSELITE	213.767	86.9	29.96				138		
$FeSe_2$		0.3	0.05						
FROHBERGITE	311.047	100.2	38.43	-72.4	-64.6	11.31	437	279	
$FeTe_2$		0.2	0.05	4.2	4.2	0.74			
HYDROGEN SULFIDE (IDEAL GAS)	34.082	205.8	24789.70	-20.6	-33.4	5.86	85	85	85
H_2S		0.2	0.20	0.6	0.6	0.11	67	67	67
HS^- (AQUEOUS ION)	33.074	67.0		16.3	44.8	-7.86	85	85	
STD. STATE, m = 1		0.9		0.2	0.3	0.05			
CINNABAR	232.656	82.5	28.42	-54.3	-40.7	7.13	233	326	
HgS		2.1	0.02	2.1	2.7	0.47		279	
METACINNABAR	232.656	96.2	30.17	-46.7	-43.3	7.59	217	120	
HgS		4.2	0.02	1.5	0.8	0.15			
MINIMGERITE	56.371	50.3	21.17	-345.7	-341.4	59.81	67	67	67
MgS		0.4	0.02	4.2	4.2	0.74			
ALABANDITE	87.004	80.3	21.46	-213.9	-218.7	38.31	279	3	79
MnS		0.8	0.01	0.8	0.9	0.17		375	203

THERMODYNAMIC PROPERTIES OF SULFIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
HAUERITE	119.070	99.9	34.20	-223.8	-224.6	39.35	441	279	
MnS_2		0.1	0.01	10.0	10.0	1.75			
MOLYBDENITE	160.072	62.6	32.02	-271.8	-262.8	46.04	275	305	114
MoS_2		0.2	0.02	4.9	4.9	0.86			
MILLERITE	90.756	53.0	16.89	-91.0	-63.9	14.97	429	58	271
NiS		0.4	0.01	3.0	3.0	0.53		271	98
HEAZLEWOODITE	240.202	133.2	40.95	-216.3	-210.2	36.83	395	58	107
Ni_3S_2		0.3	0.02	3.0	3.0	0.53		67	276
PENTLANDITE	771.944		155.40	-837.4				59	
$Ni_{4.5}Fe_{4.5}S_8$			0.20	14.6					
VIOLARITE	301.775		63.80	-378				59	
$(Ni_{.7}Fe_{.3})_3S_4$			0.30	11.8					
GALENA	239.266	91.7	31.49	-98.3	-96.8	16.96	67	397	67
PbS		0.7	0.01	2.0	2.0	0.35	326	245	326
CLAUSTHALITE	286.160	102.5	34.61	-100.1	-98.7	17.30	279	279	
PbSe		2.1	0.01	2.3	2.1	0.37			
ALTAITE	334.800	110.0	40.60	-70.7	-69.4	12.15	217	419	
PbTe		2.1	0.01	1.4	1.5	0.27			
COOPERITE	227.146	55.1	22.15	-82.4	-76.9	13.46	136	136	
PtS		0.1	0.01	3.4	3.4	0.59			
STIBNITE	339.698	182.0	73.41	-151.4	-149.9	26.26	234	382	211
Sb_2S_3		3.3	0.04	2.3	2.1	0.37		53	51
HERZENBERGITE	150.776	77.0	29.01	-106.5	-104.6	18.33	229	347	315
SnS		0.8	0.02	1.5	1.5	0.26			
BERNDTITE	182.842	87.5	40.96	-149.8	-141.5	24.79	229	326	315
SnS_2		0.2	0.02	5.0	5.0	0.88			
TUNGSTENITE	247.982	67.8	32.07	-241.6	-233.0	40.82	304	303	304
WS_2		0.3	0.02	2.5	2.5	0.44		304	
SPHALERITE	97.456	58.7	23.83	-204.1	-199.6	34.97	398	378	324
ZnS		0.2	0.01	1.5	1.5	0.26			
WURTZITE	97.456	58.8	23.85	-203.8	-199.3	34.92	398	338	324
ZnS		0.2	0.01	1.5	1.5	0.26			

THERMODYNAMIC PROPERTIES OF SULFIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
PROUSTITE	494.724	303.7	88.42				146		
Ag_3AsS_3		0.5	0.02						
SMITHITE	246.922	150.5	50.12				146		
$AgAsS_2$		0.2	0.30						
ENARGITE	393.824	257.6	88.24				381		
Cu_3AsS_4		0.6	0.12						
ARSENOPYRITE	166.263	68.8	26.42				331		
$FeAs_{1.08}S_{0.92}$		0.4	0.07						
LIVINGSTONITE	944.118	470.5	192.90	-373.2	-360.2	63.10	145	454	
$HgSb_4S_8$		1.5		6.5	6.5	1.14			
BERTHIERITE	427.611	245.0	92.22	-256.2	-255.8	44.82	97	382	382
$FeSb_2S_4$		1.0	0.20	6.5	6.5	1.14			
CHALCOSTIBITE	249.428	149.2	50.06	-130.8	-132.7	23.25	382	382	382
$CuSbS_2$		3.8	0.10	4.4	4.2	0.74			
Fe-TENNANTITE	1463.698	1024.2	332.10				380		
$Cu_{10}Fe_2As_4S_{13}$									
Fe-TETRAHEDRITE	1651.012	1061.0	336.70				380		
$Cu_{10}Fe_2Sb_4S_{13}$									
Zn-TENNANTITE	1482.784	1025.6	332.10				380		
$Cu_{10}Zn_2As_4S_{13}$									
Zn-TETRAHEDRITE	1670.098	1062.4	336.70				380		
$Cu_{10}Zn_2Sb_4S_{13}$									
PYRARGYRITE	541.553		92.56	-131.5				51	
Ag_3SbS_3			0.04	3					
MIARGYRITE	293.750		52.03	-95.8				51	
α-$AgSbS_2$			0.09	2.6					
MATILDITE	380.980		54.44	-165.3				52	
β-$AgBiS_2$			0.10	8					

THERMODYNAMIC PROPERTIES OF OXIDE AND HYDROXIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
CORUNDUM	101.961	50.9	25.58	-1675.7	-1582.3	277.20	93	268	94
Al_2O_3		0.1	0.01	1.3	1.3	0.23	94	85	57
BOEHMITE	59.988	37.2	19.54	-996.4	-918.4	160.90	176	176	
AlO(OH)		0.1	0.03	2.2	2.2	0.39		12	
DIASPORE	59.988	35.3	17.76	-1001.3	-922.7	161.53	334	12	
AlO(OH)		0.2	0.03	2.2	2.1	0.88	230	176	
GIBBSITE	78.004	68.4	31.96	-1293.1	-1154.9	202.33	178	171	178
$Al(OH)_3$		0.1	0.02	1.2	1.2	0.21		212	
ARSENOLITE	197.841	107.4	51.12	-657.0	-576.0	100.90	61	419	
As_2O_3		0.1	0.07	1.7	1.9	0.33			
CLAUDETITE	197.841	113.3	47.26	-654.8	-575.6	100.83	61		
As_2O_3		0.1	0.03	1.7	1.1	0.18			
DIBORON TRIOXIDE	69.620	54.0	27.26	-1273.5	-1194.4	209.24	85	85	67
B_2O_3		0.3	0.06	1.4	1.4	0.25		67	
BARIUM MONOXIDE	153.326	72.1	25.59	-548.1	-520.4	91.17	85	77	85
BaO		0.4	0.01	2.1	2.1	0.37		111	262
BROMELLITE	25.012	13.8	8.31	-609.4	-580.1	101.63	85	85	67
BeO		0.1	0.03	2.5	2.5	0.44			418
BISMITE	465.959	151.5	49.73	-573.9	-493.5	86.45	419	419	319
Bi_2O_3		2.1	0.06	1.3	1.5	0.26		269	
CARBON MONOXIDE	28.010	197.3	24789.70	-110.5	-137.1	24.01	67	67	67
CO (IDEAL GAS)		0.0	0.20	0.2	0.2	0.03	117	117	117
CARBON DIOXIDE	44.010	213.8	24789.70	-393.5	-394.4	69.09	67	67	67
CO_2 (IDEAL GAS)		0.0	0.20	0.1	0.2	0.03	117	117	117
CO_3^{--} (AQUEOUS ION)	60.009	-50.0		-675.2	-527.0	92.33	85	85	
STD. STATE, m = 1		1.0		0.1	0.3	0.05	36	36	
HCO_3^- (AQUEOUS ION)	61.017	98.4		-689.9	-586.8	102.81	85	85	
STD. STATE, m = 1		0.5		0.2	0.3	0.04	36	36	
H_2CO_3 (UN-IONIZED)	62.025	184.7		-699.7	-623.2	109.17	419	419	
STD. STATE, m = 1		0.9		0.1	0.1	0.02			
LIME	56.077	38.1	16.76	-635.1	-603.1	105.66	67	67	67
CaO		0.4	0.01	0.9	0.9	0.16	117	117	117

THERMODYNAMIC PROPERTIES OF OXIDE AND HYDROXIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
PORTLANDITE	74.093	83.4	33.06	-986.1	-898.0	157.33	67	67	67
$Ca(OH)_2$		0.4	0.02	1.3	1.3	0.23	158	158	117
MONTEPONITE	128.400	54.8	15.59	-258.4	-228.7	40.07	85	85	
CdO		1.5	0.01	0.4	0.6	0.11		267	
CERIANITE	172.114	62.3	23.85	-1088.7	-1025.4	179.64	436	14	227
CeO_2		0.1	0.03	1.5	1.9	0.34			
COBALT MONOXIDE	74.933	52.8	11.64	-237.9	-214.1	37.52	287	308	319
CoO		0.3	0.02	1.3	1.3	0.23		45	125
TRICOBALT TETRAOXIDE	240.797	109.3	39.77	-918.8	-802.2	140.54	222	319	319
Co_3O_4		0.3	0.02	2.0	2.0	0.35		307	
ESKOLAITE	151.990	81.2	29.09	-1134.7	-1053.1	184.49	67	67	67
Cr_2O_3		1.3	0.03	8.4	8.4	1.47		267	
DICESIUM MONOXIDE	281.810	146.9	59.62	-346.0	-308.4	54.02	112	384	112
Cs_2O		0.4	0.07	1.2	1.2	0.21			
TENORITE	79.545	42.6	12.22	-156.1	-128.3	22.48	67	67	272
CuO		0.2	0.03	2.0	2.0	0.35		272	
CUPRITE	143.091	92.4	23.44	-170.6	-147.8	25.89	67	190	272
Cu_2O		0.3	0.02	0.1	0.1	0.02	310	272	67
WUSTITE	68.887	56.6	12.04	-266.3	-244.9	42.91	67	198	83
$Fe_{.947}O$		0.4	0.04	0.8	0.8	0.14	132	148	67
FERROUS OXIDE (STOICHIOMETRIC)	71.846	60.6	12.00	-272.0	-251.4	44.05	67	67	67
FeO		1.7	0.05	2.1	2.2	0.38	132		
HEMATITE	159.692	87.4	30.27	-826.2	-744.4	130.41	137	161	83
Fe_2O_3		0.2	0.01	1.3	1.3	0.23	67	310	130
MAGNETITE	231.539	146.1	44.52	-1115.7	-1012.7	177.42	440	161	161
Fe_3O_4		0.4	0.01	2.1	2.1	0.37	22	310	134
GOETHITE	88.854	60.4	20.82	-562.6	-491.8	86.16	235	221	
FeO(OH)		0.6	0.04	2.1	2.1	0.12		18	
WATER	18.015	70.0	18.07	-285.8	-237.1	41.55	85	85	117
H_2O (LIQUID)		0.1	0.00	0.1	0.1	0.01			67
OH^- (AQUEOUS ION)	17.007	-10.7		-230.0	-157.3	27.56	85	85	
STD. STATE, m = 1		0.2		0.1	0.1	0.02			

THERMODYNAMIC PROPERTIES OF OXIDE AND HYDROXIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
STEAM	18.015	188.8	24789.70	-241.8	-228.6	40.05	85	85	67
H_2O (IDEAL GAS)		0.0	0.20	0.0	0.1	0.02			117
HAFNIUM DIOXIDE	210.489	59.3	20.82	-1117.6	-1061.1	185.90	319	256	319
HfO_2		0.4	0.01	1.3	1.3	0.23		319	
MONTROYDITE	216.589	70.3	19.32	-90.8	-58.5	10.25	85	85	67
HgO		0.3	0.02	0.1	0.1	0.01		415	
DIPOTASSIUM MONOXIDE	94.196	94.1	40.38	-363.2	-322.1	56.43	67	67	67
K_2O		6.3	0.20	2.1	2.8	0.49			
POTASSIUM HYDROXIDE	56.106	78.9	27.45	-424.7	-378.9	66.39	67	67	67
KOH		0.8	0.02	0.6	0.6	0.11		254	
DILITHIUM MONOXIDE	29.881	37.6	14.76	-597.9	-561.2	98.31	319	209	319
Li_2O		0.3	0.01	2.1	2.1	0.37	419	67	
PERICLASE	40.304	26.9	11.25	-601.6	-569.3	99.74	85	85	418
MgO		0.2	0.00	0.3	0.3	0.05	67	321	117
BRUCITE	58.320	63.2	24.63	-924.5	-833.5	146.02	419	419	228
$Mg(OH)_2$		0.1	0.07	0.4	0.4	0.07		193	
MANGANOSITE	70.937	59.7	13.22	-385.2	-362.9	63.58	319	419	391
MnO		0.4	0.00	0.5	0.5	0.09			319
PYROLUSITE	86.937	52.8	16.61	-520.0	-465.0	81.47	357	357	357
MnO_2		0.1	0.02	0.7	0.7	0.12			
BIXBYITE	157.874	113.7	31.37	-959.0	-882.1	154.53	357	357	357
Mn_2O_3		0.2	0.05	1.0	1.0	0.18			
HAUSMANNITE	228.812	164.1	46.95	-1384.5	-1282.5	224.68	357	357	357
Mn_3O_4		0.2	0.06	1.4	1.4	0.25			
BRAUNITE	604.645	416.4	125.08	-4260.0	-3944.7	691.08	367	367	367
Mn_7SiO_{12}		0.8	0.05	4.0	4.0	0.70			
MOLYBDITE	143.938	77.7	30.56	-745.2	-668.1	117.04	85	85	85
MoO_3		0.4	0.04	0.4	0.4	0.07			200
NITROGEN DIOXIDE	46.006	240.1	24789.70	33.1	51.2	-8.98	67	67	67
NO_2 (IDEAL GAS)		0.1	0.20	0.4	0.4	0.07			
NO_3^- (AQUEOUS ION)	62.005	146.7		-206.9	-110.8	19.42	85	85	
STD. STATE, m = 1		0.4		0.4	0.4	0.07			

THERMODYNAMIC PROPERTIES OF OXIDE AND HYDROXIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
DISODIUM MONOXIDE	61.979	75.3	25.88	-414.8	-376.0	65.87	67	302	67
Na_2O		0.8	0.08	0.3	0.4	0.07		419	115
SODIUM HYDROXIDE	39.997	64.4	18.78	-425.8	-379.6	66.50	67	67	67
NaOH		0.8	0.06	0.1	0.3	0.05		419	
BUNSENITE	74.689	38.0	10.97	-239.3	-211.1	36.99	271	161	161
NiO		0.2	0.02	0.4	0.4	0.07	419	191	319
PHOSPHORUS PENTOXIDE	141.945	114.4	59.40	-1504.9	-1361.6	238.54	319	319	
P_2O_5		0.4	0.20	0.5	0.5	0.10	67	67	
PO_4^{---} (AQUEOUS ION)	94.971	-222.0		-1259.6	-1001.6	175.47	419	419	
STD. STATE, m = 1		4.2		0.9	0.9	0.15			
LITHARGE (RED)	223.199	66.5	23.91	-219.0	-188.9	33.10	72	419	319
PbO		0.2	0.05	0.8	0.8	0.14	419		
MASSICOT (YELLOW)	223.199	68.7	23.15	-217.3	-187.9	32.92	419	15	319
PbO		0.2	0.03	0.3	0.3	0.06		419	
PLATTNERITE	239.199	71.8	25.01	-277.4	-218.3	38.25	319	419	319
PbO_2		0.4	0.01	2.9	2.9	0.51			
MINIUM	685.598	212.0	76.81	-718.7	-601.6	105.40	67	67	67
Pb_3O_4		6.7	0.09	6.3	6.6	1.16		419	
SULFUR DIOXIDE	64.065	248.2	24789.70	-296.8	-300.1	52.57	85	85	67
SO_2 (IDEAL GAS)		0.1	0.20	0.2	0.2	0.04			117
SULFUR TRIOXIDE	80.064	256.8	24789.70	-395.7	-371.0	64.99	419	419	67
SO_3 (IDEAL GAS)		0.8	0.20	0.7	0.7	0.12	67	67	
SO_3^{--} (AQUEOUS ION)	80.064	-29.0		-635.5	-486.5	85.23	419	419	
STD. STATE, m = 1		4.2		0.9	0.9	0.15			
SO_4^{--} (AQUEOUS ION)	96.064	18.5		-909.3	-744.0	130.34	85	85	
STD. STATE, m = 1		0.4		0.4	0.4	0.07			
VALENTINITE	291.498	123.0	50.01	-708.6	-626.4	109.75	319	419	
Sb_2O_3		2.5	0.05	2.9	3.0	0.53			
SILICON MONOXIDE	44.085	211.6	24789.70	-100.4	-127.3	22.30	67	67	67
SiO (IDEAL GAS)		0.8	0.20	8.4	8.4	1.47			
QUARTZ	60.084	41.5	22.69	-910.7	-856.3	150.01	435	444	160
SiO_2		0.1	0.00	1.0	1.0	0.18	317	419	341

THERMODYNAMIC PROPERTIES OF OXIDE AND HYDROXIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
H_4SiO_4 (UN-IONIZED)	96.115	180.0		-1460.0	-1307.8	229.12		179	422
STD. STATE, m = 1		4.2		1.7	2.1	0.37		285	414
CRISTOBALITE	60.084	43.4	25.74	-908.4	-854.6	149.71	435	67	286
SiO_2		0.1	0.03	2.1	2.1	0.37	404	341	341
TRIDYMITE	60.084	43.9	26.53	-907.5	-853.8	149.58	361		286
SiO_2		0.4	0.20	2.4	2.4	0.43			404
COESITE	60.084	38.5	20.64	-907.8	-852.5	149.35	6	6	361
SiO_2		1.0	0.01	2.1	2.1	0.37	189		423
STISHOVITE	60.084	27.8	14.01	-861.3	-802.8	140.65	6	189	361
SiO_2		0.4	0.01	2.1	2.1	0.37	189		
SILICALITE	60.084	46.3	33.29	-905.2	-852.2	149.30	213	213	
SiO_2		0.2	0.5	0.8	0.8	0.14			
SILICA GLASS	60.084	48.5	27.27	-901.6	-849.3	148.79	341	341	341
SiO_2		1.0	0.10	2.1	2.1	0.37	435	444	
CASSITERITE	150.709	49.0	21.55	-577.6	-515.8	90.36	449	85	85
SnO_2		0.2	0.03	0.2	0.2	0.04		16	
STRONTIUM OXIDE	103.619	55.5	20.69	-591.3	-560.7	98.22	67	46	67
SrO		0.4	0.01	1.0	1.0	0.18		77	262
TELLURITE	159.599	70.4	27.75	-319.7	-264.8	46.39	333	419	319
TeO_2		0.3	0.02	3.0	3.1	0.54		78	
THORIANITE	264.037	65.2	26.37	-1226.4	-1169.2	204.84	419	419	417
ThO_2		0.2	0.01	3.5	3.5	0.61			389
RUTILE	79.879	50.6	18.82	-944.0	-888.8	155.70	85	85	67
TiO_2		0.6	0.01	0.8	1.0	0.14	67	294	85
ANATASE	79.879	49.9	20.52	-938.7	-883.2	154.74	67	67	294
TiO_2		0.3	0.03	2.1	2.1	0.37		419	
DITITANIUM TRIOXIDE	143.758	77.3	31.43	-1520.9	-1433.9	251.21	67	67	67
Ti_2O_3		1.0	0.02	8.4	8.4	1.47			294
URANINITE	270.028	77.0	24.62	-1084.9	-1031.7	180.75	199	419	113
UO_2		0.2	0.01	1.0	1.0	0.18	248	248	128
KARELIANITE	149.881	98.1	29.85	-1218.8	-1139.0	199.55	67	67	76
V_2O_3		1.3	0.03	6.3	6.3	1.11			

THERMODYNAMIC PROPERTIES OF OXIDE AND HYDROXIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
TUNGSTEN DIOXIDE	215.849	50.6	20.03	-589.7	-533.9	93.53	67	67	67
WO_2		0.3	0.05	0.9	0.9	0.16			
TUNGSTEN TRIOXIDE	231.848	75.9	31.61	-842.9	-764.1	133.86	67	67	236
WO_3		1.3	0.10	0.8	0.9	0.16			
ZINCITE	81.389	43.2	14.34	-350.5	-320.4	56.12	352	85	352
ZnO		0.1	0.01	0.3	0.3	0.05			319
BADDELEYITE	123.223	50.4	21.15	-1100.6	-1042.9	182.70	319	196	82
ZrO_2		0.3	0.01	1.7	1.7	0.30	419	419	

THERMODYNAMIC PROPERTIES OF MULTIPLE OXIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
TIALITE	181.840	109.6	48.75				361		43
Al_2TiO_5		0.8	0.05						
CHRYSOBERYL	126.973	66.3	34.32	-2298.5	-2176.2	381.3	116	164	164
$BeAl_2O_4$		0.1	0.02	2.8	2.8	0.5	164		
CALCIUM FERRITE	215.770	145.4	44.98	-1520.3	-1412.4	247.4	419	419	42
$CaFe_2O_4$		0.8	0.05	0.2	0.2	0.0			
DICALCIUM FERRITE	271.847	188.8	67.18	-2138.3	-1999.9	350.4	419	419	42
$Ca_2Fe_2O_5$		1.3	0.10	0.9	0.9	0.2			
PEROVSKITE	135.956	93.6	33.63	-1660.6	-1574.8	275.9	419	419	295
$CaTiO_3$		0.4	0.01	1.7	1.8	0.3			
HERCYNITE	173.808	117.0	40.75	-1950.5	-1838.1	322.0	373	188	450
$FeAl_2O_4$		3.0	0.05	8.5	10.0	1.8	188		
CHROMITE	223.837	146.0	44.01	-1445.5	-1344.5	235.5	361	373	292
$FeCr_2O_4$		1.7	0.10	5.0	6.0	1.1			
ILMENITE	151.725	108.9	31.69	-1232.0	-1155.5	202.4	11	11	11
$FeTiO_3$		0.3	0.08	2.5	2.5	0.4			295
ULVOSPINEL	223.572	180.40	46.82	-1493.8	-1399.9	245.3	216	216	43
Fe_2TiO_4		2.5	0.05	2.0	2.1	0.4	312		
PSEUDOBROOKITE	239.571	156.5	54.53						43
Fe_2TiO_5		1.3	0.05						
SPINEL	142.266	88.7	39.71	-2299.1	-2176.6	381.3	67	67	44
$MgAl_2O_4$		4.0	0.03	2.0	2.3	0.4	37	64	386
MAGNESIOCHROMITE	192.295	106.0	43.56	-1783.6	-1669.1	292.4	373	373	292
$MgCr_2O_4$		0.8	0.05	0.9	0.9	0.1			
MAGNESIOFERRITE	199.997	121.8	44.57	-1441.5	-1329.6	232.9	290	373	42
$MgFe_2O_4$		2.0	0.05	3.0	3.1	0.5		249	
GEIKIELITE	120.183	74.6	30.86	-1572.8	-1484.4	260.1	352	425	352
$MgTiO_3$		0.2	0.07	1.2	1.2	0.2			295
PYROPHANITE	150.816	104.9	32.77	-1360.1	-1280.9	224.4	393	103	103
$MnTiO_3$		0.2	0.05	4.0	4.0	0.7		102	102
TREVORITE	234.382	140.9	43.65	-1070.5	-965.1	169.1	450	271	271
$NiFe_2O_4$		5.0	0.05	2.0	2.5	0.4		290	

THERMODYNAMIC PROPERTIES OF MULTIPLE OXIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
FRANKLINITE	241.082	150.7	44.94	-1188.1	-1082.1	189.6	439	290	21
$ZnFe_2O_4$		0.3	0.05	4.0	4.0	0.7			
HETAEROLITE	239.264	149.7	45.57	-1337.0	-1227.8	215.1	71	290	
$ZnMn_2O_4$		0.5	0.05	4.0	4.0	0.7			
ZINC TITANIUM SPINEL	242.658	143.1	45.58	-1652.1	-1538.4	269.5	406	290	43
Zn_2TiO_4		3.0	0.02	2.0	2.0	0.4			

THERMODYNAMIC PROPERTIES OF HALIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
BROMARGYRITE	187.772	107.1	28.99	-100.4	-97.0	16.99	419	419	361
AgBr		0.4	0.01	0.2	0.2	0.03		320	318
POTASSIUM BROMIDE	119.002	95.9	43.28	-393.8	-380.4	66.65	419	419	67
KBr		0.2	0.01	0.2	0.2	0.03			320
CHLORARGYRITE	143.321	96.2	25.73	-127.1	-109.8	19.24	85	85	361
AgCl		0.2	0.01	0.1	0.1	0.02		320	318
HYDROPHILITE	110.983	104.6	50.75	-795.8	-747.7	130.99	67	67	320
$CaCl_2$		1.3	0.01	0.7	0.8	0.14			284
NANTOKITE	98.999	86.2	23.92	-137.2	-119.9	21.01	419	419	
CuCl		2.0	0.04	10.0	10.0	1.75			
LAWRENCITE	126.752	118.0	39.46	-341.7	-302.2	52.95	67	67	284
$FeCl_2$		0.4	0.21	0.4	0.4	0.07		250	67
MOLYSITE	162.205	142.3	57.86	-399.5	-334.0	58.51	67	250	284
$FeCl_3$		0.4	0.10	0.4	0.4	0.07		419	
HYDROGEN CHLORIDE	36.461	186.9	24789.70	-92.3	-95.3	16.70	85	85	67
HCl (IDEAL GAS)		0.0	0.20	0.1	0.1	0.02	67	67	85
CALOMEL	236.043	95.8	32.94	-132.7	-105.2	18.43	85	85	
HgCl		0.4	0.08	0.2	0.2	0.04			
SYLVITE	74.551	82.6	37.52	-436.5	-408.6	71.58	117	117	117
KCl		0.2	0.00	0.2	0.2	0.04	85	85	67
CHLOROMAGNESITE	95.210	89.6	40.81	-641.3	-591.8	103.68	67	320	284
$MgCl_2$		0.8	0.10	0.7	0.7	0.13		85	
SCACCHITE	125.844	118.2	42.11	-481.3	-440.5	77.17	73	250	284
$MnCl_2$		0.2	0.17	0.8	0.8	0.14		419	
SALAMMONIAC	53.491	94.6	35.06	-314.4	-202.9	35.55	419	419	67
NH_4Cl		0.4	0.05	0.3	0.3	0.05	67		
HALITE	58.442	72.1	27.02	-411.3	-384.2	67.30	419	419	67
NaCl		0.2	0.00	0.1	0.1	0.02			320
NICKELOUS CHLORIDE	129.595	98.2	36.70	-304.9	-258.8	45.33	67	67	80
$NiCl_2$		0.2	0.07	2.0	2.0	0.35		419	
COTUNNITE	278.105	136.0	47.09	-359.4	-314.1	55.03	67	67	67
$PbCl_2$		2.1	0.05	0.3	0.7	0.12		419	320

THERMODYNAMIC PROPERTIES OF HALIDE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
FLUORITE	78.075	68.9	24.54	-1228.0	-1175.3	205.90	117	117	293
CaF_2		0.3	0.01	2.0	2.0	0.35		67	117
HYDROGEN FLUORIDE	20.006	173.8	24789.70	-273.3	-275.4	48.25	85	85	67
HF (IDEAL GAS)		0.0	0.20	0.7	0.7	0.12	67		
SELLAITE	62.302	57.2	19.61	-1124.2	-1071.1	187.64	117	117	117
MgF_2		0.5	0.01	1.2	1.2	0.21			
VILLIAUMITE	41.988	51.5	14.98	-573.6	-543.4	95.20	419	419	300
NaF		0.1	0.01	0.7	0.7	0.12			67
CRYOLITE	209.941	238.5	70.81	-3316.8	-3152.1	552.22	10	10	10
Na_3AlF_6		0.5	0.20	6.0	6.0	1.05		301	300
CHIOLITE	461.871	515.3	154.08	-7546.3	-7174.7	1256.95	400	400	400
$Na_5Al_3F_{14}$		0.8	0.10	20.0	20.0	3.50			
IODARGYRITE	234.773	115.5	41.30	-61.8	-66.2	11.60	419	419	320
AgI		1.7	0.04	1.7	1.8	0.31			
MARSHITE	190.450	96.6	33.35	-67.8	-69.4	12.16	320	320	108
CuI			0.02	5.0	5.0	0.88			
COCCINITE	454.399	180.0	71.84	-105.4	-101.7	17.82	419	419	67
HgI_2		6.3	0.10	1.7	2.6	0.45	67	67	

THERMODYNAMIC PROPERTIES OF CARBONATE AND NITRATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
WITHERITE	197.336	112.1	45.81	-1210.9	-1132.2	198.35	54	1	262
$BaCO_3$		2.1	0.06	2.2	2.2	0.39			
ARAGONITE	100.087	88.0	34.15	-1207.4	-1127.4	197.51	392	336	
$CaCO_3$		0.2	0.05	1.4	1.5	0.26			
CALCITE	100.087	91.7	36.93	-1207.4	-1128.5	197.70	392	246	202
$CaCO_3$		0.2	0.01	1.3	1.4	0.24		336	
VATERITE	100.087		37.63		-1125.5	197.19		336	
$CaCO_3$			0.40		1.5	0.26		412	
MONOHYDROCALCITE	118.102	131.1	48.70	-1498.3	-1361.6	238.54	197	197	
$CaCO_3 \cdot H_2O$		3.0	0.40	1.2	1.1	0.20			
IKAITE	208.179	370.0		-2954.1	-2540.9	445.15	273	273	273
$CaCO_3 \cdot 6H_2O$		5.0		5.0	5.0	0.88			
DOLOMITE	184.401	155.2	64.34	-2324.5	-2161.3	378.64	396	175	257
$CaMg(CO_3)_2$		0.3	0.03	1.5	1.7	0.29			
HUNTITE	353.030	299.5	122.58	-4529.6	-4203.1	736.34	168	169	
$CaMg_3(CO_3)_4$		0.9	0.10	1.6	1.6	0.29		253	
OTAVITE	172.419	92.5	34.30	-750.6	-669.4	117.28	63	419	
$CdCO_3$		5.5	0.02	2.5	2.6	0.46		63	
MALACHITE	221.116	166.3	54.86	-1054.0	-890.2	155.96	241	339	
$Cu_2(CO_3)(OH)_2$		2.5	0.08	2.1	2.2	0.39			
AZURITE	344.671	254.4	91.01	-1632.2	-1391.4	243.75	241	419	
$Cu_3(OH)_2(CO_3)_2$		3.8	0.13	2.0	2.2	0.39			
SIDERITE	115.856	95.5	29.38	-755.9	-682.8	119.63	351	351	351
$FeCO_3$		0.2	0.01	5.5	5.5	0.96			
MAGNESITE	84.314	65.1	28.02	-1113.3	-1029.5	180.36	178	347	359
$MgCO_3$		0.1	0.01	1.3	1.4	0.24			
NESQUEHONITE	138.360	195.6	75.47	-1977.3	-1723.8	301.99	353	354	
$MgCO_3 \cdot 3H_2O$		0.6	0.05	0.3	0.5	0.09			
HYDROMAGNESITE	467.638	503.7	211.10	-6514.9	-5864.2	1027.37	353	354	
$4MgCO_3 \cdot Mg(OH)_2 \cdot 4H_2O$		1.6	0.10	1.1	1.1	0.19			
ARTINITE	196.680	232.9	96.43	-2920.6	-2568.4	449.95	168	169	
$Mg_2(OH)_2CO_3 \cdot 3H_2O$		0.7	0.10	0.7	0.8	0.13			

THERMODYNAMIC PROPERTIES OF CARBONATE AND NITRATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
RHODOCHROSITE	114.947	98.0	31.07	-892.9	-819.1	143.50	351	351	283
$MnCO_3$		0.1	0.01	0.5	0.6	0.10			
NAHCOLITE	84.007	102.1	38.08	-949.0	-851.2	149.12	36	36	
$NaHCO_3$		1.7	0.25	0.2	0.6	0.10			
THERMONATRITE	124.004	168.1	54.99	-1429.7	-1286.1	225.32	424	36	129
$Na_2CO_3 \cdot H_2O$		0.8	0.27	0.4	0.5	0.09	36		
TRONA	226.026		107.00	-2682.1				416	
$Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$			0.50	0.4					
WEGSCHEIDERITE	358.010		153.30	-3984.0				416	
$Na_2CO_3 \cdot 3NaHCO_3$			0.80	0.8					
SODIUM CARBONATE	105.989	135.0	41.60	-1129.2	-1045.3	183.13	424	36	
Na_2CO_3		0.6		0.3	0.4	0.06	36		
DAWSONITE	143.995	132.0	59.30	-1964.0	-1786.0	312.89	110	110	110
$NaAlCO_3(OH)_2$		0.5	0.30	2.9	3.0	0.52			
GASPEITE	118.699	85.4	27.05				255		
$NiCO_3$		2.0	0.02						
CERUSSITE	267.209	131.0	40.59	-699.2	-625.5	109.58	217	419	
$PbCO_3$		3.4	0.06	1.2	1.6	0.27		4	
STRONTIANITE	147.629	97.1	39.01	-1218.7	-1137.6	199.29	55	55	262
$SrCO_3$		1.7	0.06	1.5	1.5	0.26			
SMITHSONITE	125.399	81.2	28.28	-817.0	-735.3	128.82	352	153	153
$ZnCO_3$		0.2	0.01	3.1	3.1	0.54			
NITROBARITE	261.337	213.8	80.58	-992.1	-796.6	139.55	419	419	361
$Ba(NO_3)_2$		0.9	2.10	2.5	0.4	0.08			
CALCIUM NITRATE	164.088	193.3	66.09	-938.4	-742.6	130.10	419	419	361
$Ca(NO_3)_2$		0.4	0.03	1.5	1.8	0.31			
NITER	101.103	133.1	48.04	-494.5	-394.6	69.13	419	419	361
KNO_3		0.7	0.06	0.4	0.5	0.08			
MAGNESIUM NITRATE	148.315	164.0	62.93	-790.6	-589.2	103.22	419	419	361
$Mg(NO_3)_2$		1.6	0.03	1.3	1.4	0.25			
AMMONIA-NITER	80.043	151.1	46.49	-365.6	-183.8	32.20	419	419	361
NH_4NO_3		0.2	0.10	0.8	0.9	0.15			

THERMODYNAMIC PROPERTIES OF CARBONATE AND NITRATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
SODA-NITER	84.995	116.5	37.60	-468.0	-367.1	64.32	419	419	361
$NaNO_3$		0.7	0.02	0.4	0.4	0.07			
STRONTIUM NITRATE	211.630	194.6	70.93	-978.2	-779.0	136.47	419	419	361
$Sr(NO_3)_2$		0.5	0.04	1.0	1.3	0.23			

THERMODYNAMIC PROPERTIES OF SULFATE AND BORATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
ALUMINUM SULFATE	342.154	239.3	73.41	-3441.8	-3100.6	543.20	88	88	88
$Al_2(SO_4)_3$		1.2	0.20	1.8	1.9	0.33			
BARITE	233.391	132.2	52.10	-1473.6	-1362.5	238.70	88	88	88
$BaSO_4$		0.8	0.06	1.0	1.3	0.23		419	
ANHYDRITE	136.142	107.4	46.01	-1434.4	-1321.8	231.57	368	88	368
$CaSO_4$		0.2	0.01	4.2	4.3	0.75		419	
GYPSUM	172.172	193.8	74.69	-2023.0	-1797.0	314.82	368	88	
$CaSO_4 \cdot 2H_2O$		0.3	0.22	4.3	4.4	0.77	88		
CHALCOCYANITE	159.610	109.5	40.88	-771.4	-662.3	116.03	106	4	106
$CuSO_4$		0.6	0.03	1.3	1.4	0.25	87	419	
CHALCANTHITE	249.686	301.2	108.97	-2279.7	-1880.0	329.36	87	87	
$CuSO_4 \cdot 5H_2O$		0.6	0.22	3.4	3.6	0.63		419	
BROCHANTITE	452.292		113.60		-1818.0	318.49		26	
$Cu_4(SO_4)(OH)_6$			0.20		2.5	0.44		419	
FERRIC SULFATE	399.885	282.8	130.80	-2581.9	-2254.4	394.96	328	19	328
$Fe_2(SO_4)_3$		0.9	0.20	2.9	3.0	0.52			
SZOMOLNOKITE	169.926		55.90	-1244.3			87	2	
$FeSO_4 \cdot H_2O$			0.40	0.5				87	
MELANTERITE	278.018	409.2	146.50	-3014.3	-2509.5	439.64	87	2	
$FeSO_4 \cdot 7H_2O$		1.3	0.30	0.6	1.3	0.23		87	
SULFURIC ACID (LIQUID)	98.080	156.9	53.57	-814.0	-690.0	120.88	419	419	
H_2SO_4		0.2	0.07	0.4	0.5	0.08		124	
ARCANITE	174.260	175.6	65.50	-1437.7	-1319.6	231.18	67	67	387
K_2SO_4		0.4	0.07	0.5	0.5	0.09			67
K-Al SULFATE	258.207	204.6	92.33	-2470.9	-2240.4	392.50	419	419	217
$KAl(SO_4)_2$		1.3	0.08	1.3	1.4	0.24			
ALUNITE	414.214	321.0	293.60	-5176.5	-4663.5	817.00	452	452	219
$KAl_3(OH)_6(SO_4)_2$		5.0	0.40	2.4	2.4	0.42		219	
LANGBEINITE	414.997	389.3	146.95	-4071.0	-3733.4	654.05	368	419	368
$K_2Mg_2(SO_4)_3$		1.0	0.04	3.0	3.0	0.52	40		
MAGNESIUM SULFATE	120.369	91.4		-1284.9	-1170.5	205.07	67	247	67
$MgSO_4$		0.8		0.6	0.8	0.14		88	

THERMODYNAMIC PROPERTIES OF SULFATE AND BORATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
EPSOMITE	246.476	372.0	146.80	-3388.7	-2871.2	503.01	419	419	88
$MgSO_4 \cdot 7H_2O$		4.0	0.20	0.1	0.9	0.15		88	
MANGANESE SULFATE	151.002	127.0	43.62	-1065.7	-962.1	168.56	450	87	87
$MnSO_4$		1.5	0.04	1.1	1.5	0.26		377	
MASCAGNITE	132.141	220.5	74.68	-1182.7	-903.5	158.29	419	88	387
$(NH_4)_2SO_4$		1.3	0.09	1.3	1.6	0.28	88	419	219
THENARDITE	142.043	149.6	53.33	-1387.8	-1269.8	222.46	88	88	81
Na_2SO_4		0.1	0.06	0.4	0.4	0.07	419	419	
MIRABILITE	322.196	591.9	219.80	-4327.3	-3645.8	638.71	47	47	
$Na_2SO_4 \cdot 10H_2O$		0.6	0.40	4.0	3.4	0.59		81	
NICKELOUS SULFATE	154.754	101.3	38.57	-873.2	-762.7	133.61	401	401	401
$NiSO_4$		0.3	0.03	1.0	1.0			4	
RETGERSITE (ALPHA, GREEN)	262.845	334.5	126.60	-2683.4	-2225.1	389.82	87	87	
$NiSO_4 \cdot 6H_2O$		0.4	0.20	0.5	0.5	0.09		419	
MORENOSITE	280.861	378.9	143.80	-2976.5	-2461.9	431.30	87	87	
$NiSO_4 \cdot 7H_2O$		0.4	0.50	0.5	0.5	0.09		419	
ANGLESITE	303.264	148.5	47.95	-920.0	-813.1	142.44	85	85	88
$PbSO_4$		0.6	0.06	0.4	0.5	0.09			
CELESTITE	183.684	117.0	46.25	-1453.2	-1339.6	234.69	419	419	
$SrSO_4$		4.2	0.06	4.2	4.4	0.77		129	
ZINKOSITE	161.454	110.5	41.57	-980.1	-868.7	152.20	87	87	87
$ZnSO_4$		1.3	0.07	0.8	0.9	0.16		4	192
BIANCHITE	269.545	363.6	130.20	-2777.8	-2324.6	407.26	87	87	
$ZnSO_4 \cdot 6H_2O$		1.3	0.50	1.0	1.0	0.18		419	
GOSLARITE	287.561	388.7	145.80	-3077.5	-2562.3	448.89	87	87	
$ZnSO_4 \cdot 7H_2O$		1.3	0.10	0.1	0.1	0.02		419	
BORAX	381.372	586.0	222.70	-6288.6	-5516.2	966.39	419	419	
$Na_2B_4O_7 \cdot 10H_2O$		2.3	0.20	8.5	8.5	1.49			

THERMODYNAMIC PROPERTIES OF PHOSPHATE, MOLYBDATE AND TUNGSTATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
BERLINITE	121.953	90.8	46.58	-1733.8	-1617.9	283.44	419	419	181
$AlPO_4$		0.2	0.10	5.0	5.0	0.88		181	
WHITLOCKITE	310.177	236.0	97.62	-4120.8	-3883.6	680.38	419	419	361
$Ca_3(PO_4)_2$		0.8	0.09	5.0	5.0	0.88			
FLUORAPATITE	504.302	387.9	157.56	-6872.0	-6489.7	1136.95	419	419	99
$Ca_5(PO_4)_3F$		1.7	0.12	5.0	5.0	0.88			
HYDROXYAPATITE	502.311	390.4	159.60	-6738.5	-6337.1	1110.22	419	419	99
$Ca_5(PO_4)_3OH$		1.7	0.20	5.0	5.0	0.88			
STRENGITE	186.849	171.3	64.50	-1888.2	-1657.5	290.37	100	419	100
$FePO_4 \cdot 2H_2O$		1.3	0.30	0.9	1.0	0.18			
POWELLITE	200.016	122.6	47.00	-1541.4	-1434.7	251.34	431	419	
$CaMoO_4$		0.8	0.09	0.9	0.9	0.15		12	
WULFENITE	367.138	166.1	53.86	-1051.9	-951.2	166.65	320	419	
$PbMoO_4$		2.1	0.10	0.9	1.2	0.20		89	
SCHEELITE	287.926	126.4	47.05	-1645.2	-1538.0	269.51	232	419	
$CaWO_4$		0.8	0.09	0.9	0.9	0.16		17	
FERBERITE	303.695	131.8	40.38	-1154.8	-1054.0	184.64	430	419	
$FeWO_4$		1.7	0.05	8.5	8.5	1.49	265	7	
HUEBNERITE	302.786	132.5	41.89	-1337.6	-1235.4	216.44	304	7	
$MnWO_4$		0.2	0.06	7.0	7.1	1.24			
STOLZITE	455.048	168.2	54.10	-1127.2	-1026.0	179.74	428	89	
$PbWO_4$		2.1	0.06	2.0	2.0	0.35			
SANMARTINITE	313.238	119.3	39.79	-1232.6	-1123.7	196.86	260	266	260
$ZnWO_4$		0.3	0.04	1.3	1.4	0.25			266

THERMODYNAMIC PROPERTIES OF ORTHO AND RING STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
TOPAZ	184.043	105.4	51.53	-3084.5	-2910.6	509.9	24	23	24
$Al_2SiO_4F_2$		0.2	0.03	4.7	4.7	0.8		24	
KYANITE	162.046	82.8	44.15	-2593.8	-2443.1	428.0	355	177	177
Al_2SiO_5		0.5	0.05	2.0	2.0	0.4	177	407	322
ANDALUSITE	162.046	91.4	51.52	-2589.9	-2441.8	427.8	355	177	177
Al_2SiO_5		0.5	0.05	2.0	2.0	0.4	177	407	322
SILLIMANITE	162.046	95.4	49.86	-2586.1	-2439.1	427.3	355	177	177
Al_2SiO_5		0.5	0.05	2.0	2.0	0.4	177	407	322
MULLITE	426.052	275.0	134.55	-6819.2	-6441.8	1128.6	67	67	67
$Al_6Si_2O_{13}$		5.0	0.07	10.0	10.0	1.8	329	86	329
DUMORTIERITE	565.938	334.9	168.4	-9109.0	-8568.2	1501.1	163	163	163
$Al_{6.75}[]_{0.25}Si_3BO_{17.25}(OH)_{.75}$		5.0	0.4	20.0	20.0	3.5			
EUCLASE	145.084	89.1	46.86	-2532.9	-2370.2	415.2	164	164	164
$BeAlSiO_4(OH)$		0.4	0.06	3.0	3.0	0.5		238	
PHENAKITE	110.107	63.4	37.18	-2143.1	-2028.4	355.4	164	164	164
Be_2SiO_4		0.3	0.02	4.0	4.0	0.7		379	
BERYL	537.502	346.7	203.3	-9006.6	-8500.5	1489.2	164	164	164
$Be_3Al_2(Si_6O_{18})$		4.7	0.1	7.0	6.4	1.1		238	
BERTRANDITE	238.230	172.1	91.8	-4580.5	-4295.1	752.5	164	164	164
$Be_4Si_2O_7(OH)_2$		0.8	0.1	5.5	5.5	1.0		238	
EPIDOTE	483.223	328.9	138.1				147		239
$Ca_2Al_2FeSi_3O_{12}(OH)$		2.5	0.6						243
LAWSONITE	314.238	230.0	101.32	-4869.0	-4512.9	790.6	335	68	335
$CaAl_2[Si_2O_7(OH)_2]H_2O$		2.1	0.12	2.1	2.1	0.4	68		
GEHLENITE	274.200	210.1	90.15	-3985.0	-3785.5	663.2	172	66	323
$Ca_2Al_2SiO_7$		0.6	0.02	5.0	5.0	0.9	420		
ZOISITE	454.357	295.9	136.5	-6901.1	-6504.5	1139.5	335	239	335
$Ca_2Al_3Si_3O_{12}(OH)$		0.6	0.4	3.3	3.3	0.6			
GROSSULAR	450.446	260.1	125.28	-6640.0	-6278.5	1099.9	157	68	258
$Ca_3Al_2Si_3O_{12}$		0.5	0.05	3.2	3.2	0.6	251	237	438
GLASS	450.446	329.2+	158.8				345		
$Ca_3Al_2Si_3O_{12}$			0.3						

THERMODYNAMIC PROPERTIES OF ORTHO AND RING STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
DATOLITE	159.979	110.2	53.32	-2477.8	-2318.1	406.1	448	383	274
$CaB(SiO_4)(OH)$		0.6	0.05	2.3	2.3	0.4			5
ILVAITE	408.793	292.3	101.07	-3692.8	-3437.0	602.1	349	349	349
$CaFe_2Fe(Si_2O_7)O(OH)$		0.6	0.10	5.0	5.0	0.9			
ANDRADITE	508.177	316.4	132.04	-5771.0	-5427.0	950.8	348	281	348
$Ca_3Fe_2Si_3O_{12}$		2.0	0.05	5.9	5.9	1.0		242	244
MONTICELLITE	156.466	108.1	51.3	-2251.0	-2132.8	373.6	385	49	385
$CaMgSiO_4$		0.3	0.1	3.0	3.1	0.5		385	
AKERMANITE	272.628	212.5	92.54	-3864.8	-3667.5	642.5	165	165	165
$Ca_2MgSi_2O_7$		0.4	0.02	2.0	2.0	0.4	427	49	323
MERWINITE	328.705	253.1	98.5	-4536.2	-4307.7	754.7	427	49	323
$Ca_3Mg(SiO_4)_2$		2.1	0.1	3.0	3.0	0.5			
TITANITE (SPHENE)	196.041	129.2	55.74	-2596.6	-2454.6	430.0	406	37	361
$CaTiSiO_5$		0.8	0.07	3.0	3.2	0.6		188	
LARNITE	172.239	127.6	51.60	-2306.7	-2191.2	383.9	225	149	84
α-Ca_2SiO_4		0.8	0.30	1.5	1.5	0.3			149
CALCIO-OLIVINE	172.239	120.5	58.01	-2316.5	-2198.9	385.2	149	149	149
γ-Ca_2SiO_4		0.8	0.04	2.5	2.5	0.4	405		84
HATURITE (ALITE)	228.317	168.6	72.74	-2933.1	-2786.5	488.2	149	410	149
Ca_3SiO_5		0.3	0.05	2.5	2.5	0.4	405		
RANKINITE	288.401	210.6	96.51	-3949.0	-3748.1	656.6	149	410	149
$Ca_3Si_2O_7$		2.9	0.05	10.0	10.0	1.8			
ROSENHAHNITE	366.500	281.8	126.46	-5198.1	-4882.1	855.3	68	68	68
$Ca_3Si_3O_8(OH)_2$		3.0	0.05	3.0	3.0	0.5			
SPURRITE	444.565	331.0	146.97	-5840.2	-5525.6	968.0	450	188	450
$Ca_5(SiO_4)_2CO_3$		2.0	0.30	5.7	5.9	1.0	188	410	
TILLEYITE	488.575	394.0	170.5	-6372.2	-6013.5	1053.5	450	188	450
$Ca_5Si_2O_7(CO_3)_2$		4.0	0.3	5.7	6.0	1.1		410	
COBALT-OLIVINE	209.950	142.6	44.49	-1412.0	-1308.7	229.3	364	215	363
Co_2SiO_4		0.2	0.01	2.0	2.0	0.3		308	
FAYALITE	203.777	151.0	46.31	-1478.2	-1379.1	241.6	350	350	350
Fe_2SiO_4		0.2	0.01	1.3	1.3	0.2		309	314

THERMODYNAMIC PROPERTIES OF ORTHO AND RING STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
ALMANDINE	497.753	342.6	115.32	-5264.7	-4942.0	865.8	9	69	447
$Fe_3Al_2Si_3O_{12}$		1.4	0.04	3.0	3.3	0.6	277	445	151
STAUROLITE	1703.727	985.0	445.9				172		172
$Fe_4Al_{18}Si_8O_{46}(OH)_2$		4.0	1.7						
OSUMILITE	1001.468		379.2						180
$KMg_2Al_3[Si_{10}Al_2O_{30}] \cdot H_2O$			0.3						
CORDIERITE	584.953	407.2	233.22	-9161.5	-8651.1	1515.6	427	297	323
$Mg_2Al_3(AlSi_5O_{18})$		3.8	0.22	5.9	5.9	1.0			
SAPPHIRINE	344.616	197.5	98.9				186		
$Mg_2Al_4O_6(SiO_4)$		2.0	0.7						
FORSTERITE	140.693	94.1	43.65	-2173.0	-2053.6	359.8	364	364	364
Mg_2SiO_4		0.1	0.03	2.0	2.0	0.4		240	119
PYROPE	403.127	266.3	113.12	-6285.0	-5934.5	1039.7	157	188	453
$Mg_3Al_2Si_3O_{12}$		0.8	0.15	4.0	4.0	0.7		298	
GLASS	403.127	346.3	146.1	-6163.0	-5836.3	1022.5	402	402	402
$Mg_3Al_2Si_3O_{12}$		12.0	0.2	15.0	15.0	2.6			
PYROPE-GROSSULAR ss.	422.055	268.3+	118.35				157	298	
$(Mg_{1.8}Ca_{1.2})Al_2Si_3O_{12}$		0.5	0.05						
GLASS	426.787	311.8+	152.5				345		
$(Mg_{1.5}Ca_{1.5})Al_2Si_3O_{12}$		0.6	0.2						
TEPHROITE	201.959	155.9	48.99	-1731.5	-1631.0	285.7	364	364	364
Mn_2SiO_4		0.5	0.03	3.0	3.0	0.5			
LIEBENBERGITE	209.463	128.1	42.57	-1396.5	-1288.9	225.8	363	363	363
Ni_2SiO_4		0.2	0.02	3.0	3.0	0.5		308	
Ni_2SiO_4-SPINEL	209.463	124.1	39.81	-1389.7	-1280.9	224.4	363	363	423
Ni_2SiO_4		0.4	0.01	3.5	3.5	0.6			
WILLEMITE	222.863	131.4	52.42	-1636.7	-1523.1	266.8	405	223	
Zn_2SiO_4		0.8	0.08	5.0	5.0	0.9			
ZIRCON	183.307	84.0	39.26	-2034.2	-1919.7	336.3	361	101	361
$ZrSiO_4$		1.3	0.07	3.1	3.1	0.5		379	

THERMODYNAMIC PROPERTIES OF CHAIN AND BAND STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
WOLLASTONITE	116.162	81.7	39.90	-1634.8	-1549.0	271.4	259	348	389
$CaSiO_3$		0.1	0.03	1.4	1.4	0.2	257	149	344
PSEUDOWOLLASTONITE	116.162	87.2	40.08	-1627.6	-1543.5	270.4	149	344	344
$CaSiO_3$		0.9	0.14	1.4	1.4	0.2	344	149	149
GLASS	116.162	94.8	40.13	-1608.7	-1526.8	267.5	344	344	344
$CaSiO_3$		3.0	0.15	3.0	3.0	0.5			
Ca-Al PYROXENE	218.123	141.0	63.57	-3306.3	-3129.6	548.3	154	68	154
$CaAl_2SiO_6$		2.0	0.01	2.5	2.6	0.5		65	403
GLASS	218.123	155.3+	78.13				154		
$CaAl_2SiO_6$		0.3	0.08						
FERROBUSTAMITE	248.092	180.5	73.00				156		156
$CaFeSi_2O_6$		0.3	0.02						
HEDENBERGITE	248.092	174.2	67.95	-2839.9	-2676.3	468.9	156	281	156
$CaFeSi_2O_6$		0.3	0.01	3.0	3.0	0.5		156	29
GLASS	248.092	185.7+					156		
$CaFeSi_2O_6$		0.4							
DIOPSIDE	216.550	142.7	66.09	-3201.5	-3026.8	530.3	259	165	257
$CaMgSi_2O_6$		0.3	0.10	2.0	2.0	0.4			
GLASS	216.550	166.0	76.09	-3156.1	-2988.4	523.5	343	340	343
$CaMgSi_2O_6$		3.0	0.20	5.0	5.1	0.9			340
FERROSILITE	131.931	94.6	33.00	-1195.2	-1118.0	195.9	41	41	188
$FeSiO_3$		0.3	0.02	3.0	3.0	0.5		291	423
α-SPODUMENE	186.090	129.3	58.37	-3053.5	-2880.2	504.6	327	171	327
$LiAlSi_2O_6$		0.8	0.02	2.8	3.0	0.5		20	28
β-SPODUMENE	186.090	154.4	78.25	-3025.3	-2859.5	501.0	327	171	327
$LiAlSi_2O_6$		1.2	0.04	2.8	3.0	0.5		20	
ENSTATITE	100.389	66.3	31.31	-1545.6	-1458.3	255.5	259	37	257
$MgSiO_3$		0.1	0.02	1.5	1.6	0.3		408	188
GLASS	100.389	74.1	36.60	-1542.5	-1457.5	255.3	345	345	
$MgSiO_3$		0.2	0.25	2.0	2.0	0.4			
CLINOENSTATITE	100.389	67.9	31.28	-1545.0	-1458.1	255.5	361	296	361
$MgSiO_3$		0.4	0.02	1.5	1.6	0.3		311	

THERMODYNAMIC PROPERTIES OF CHAIN AND BAND STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
$MgSiO_3$-PEROVSKITE	100.389	63.6	24.50	-1445.1	-1357.0	237.7	105	105	
$MgSiO_3$		3.0	0.05	5.0	5.0	0.9			
$MgSiO_3$-ILMENITE	100.389	60.4	26.36	-1486.6	-1397.5	244.8	105	13	13
$MgSiO_3$		3.0	0.02	5.0	5.0	0.9		288	
HYPERSTHENE	105.120	69.0	31.53				367		
$(Mg_{.85}Fe_{.15})SiO_3$		0.2	0.05						
RHODONITE	131.022	100.5	34.94	-1321.6	-1244.7	218.0	367	367	390
$MnSiO_3$		1.0	0.05	2.0	2.2	0.4		289	224
PYROXMANGITE	131.022	99.4	34.72	-1322.3	-1245.0	218.1	367	367	
$MnSiO_3$		2.0	0.02	2.0	2.4	0.4		32	
JADEITE	202.139	133.5	60.40	-3029.3	-2850.6	499.4	220	166	220
$NaAlSi_2O_6$		1.3	0.10	3.6	4.0	0.7		184	
GLASS	202.139	170.5					345		
$NaAlSi_2O_6$		0.4							
ACMITE	231.004	170.6	64.60	-2584.5	-2417.2	423.5	248	31	31
$NaFeSi_2O_6$		0.8	0.11	4.0	4.2	0.7	33	188	
TREMOLITE	812.366	548.9	272.90	-12303.0	-11574.6	2027.8	370	205	257
$Ca_2Mg_5Si_8O_{22}(OH)_2$		1.3	0.73	7.0	7.0	1.2		426	
GRUNERITE	1001.614	725.0	278.7	-9623.0	-8964.8	1570.6	264	264	252
$Fe_7Si_8O_{22}(OH)_2$		7.0	0.5	10.0	10.2	1.8	252	8	34
ANTHOPHYLLITE	780.820	534.5	265.4	-12070.0	-11343.4	1987.3	162	162	162
$Mg_7Si_8O_{22}(OH)_2$		3.5	0.4	8.0	8.5	1.5		70	
RIEBECKITE	935.900	691.0	274.7				450		
$Na_2Fe_3Fe_2Si_8O_{22}(OH)_2$		6.0	0.9						
GLAUCOPHANE	783.543	541.2	262.1	-11964.0	-11230.8	1967.6	362	188	185
$Na_2Mg_3Al_2Si_8O_{22}(OH)_2$		3.0	0.2	9.0	10.0	1.8			118
PARGASITE	835.825	582.0	272.0	-12719.8	-11981.5	2099.1	433	188	
$NaCa_2Mg_4Al(Al_2Si_6)O_{22}(OH)_2$		4.0	0.2	22.0	19.0	3.3	186	433	
FLUOR-PARGASITE	839.807	583.0	270.6	-12800.5	-12102.2	2120.2	450	434	
$NaCa_2Mg_4Al(Al_2Si_6)O_{22}F_2$		5.0	0.2	14.0	14.0	2.5	434		

THERMODYNAMIC PROPERTIES OF FRAMEWORK STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
EDINGTONITE (ordered)	489.586	434.8	180.40				27		
$BaAl_2Si_3O_{10} \cdot 3H_2O$		1.5	0.60						
ANORTHITE	278.207	199.3	100.79	-4234.0	-4007.9	702.2	366	150	446
$CaAl_2Si_2O_8$		0.3	0.05	2.0	2.0	0.4	56	68	258
HEXAGONAL ANORTHITE	278.207	214.8	99.85				231	171	
$CaAl_2Si_2O_8$		1.3	0.79						
$CaAl_2Si_2O_8$-glass	278.207	237.3	103.0	-4163.2	-3948.4	691.7	366	450	258
$CaAl_2Si_2O_8$		2.5	0.2	4.0	4.0	0.7			
STILBITE	714.893	805.9	333.4	-11038.0	-10146.0	1777.5	195	195	
$Ca_{1.02}Na_{0.14}K_{.01}(Al_{2.18}Si_{6.82}O_{18}) \cdot 7.33H_2O$		1.6	1.0	6.6	6.6	1.2	74		
HEULANDITE	707.942	767.2	317.6	-10594.6	-9779.0	1713.2	208	208	208
$Ca_{0.59}Sr_{0.18}Ba_{0.06}Na_{0.38}K_{0.13}Al_{2.16}Si_{6.84}O_{18} \cdot 6H_2O$		1.0	10.2	10.2	1.8			74	
WAIRAKITE	434.406	440.0	190.4				159		
$CaAl_2Si_4O_{12} \cdot 2H_2O$		10.0	0.5						
LAUMONTITE	470.437		211.3		-6772.0	1186.4		195	
$CaAl_2Si_4O_{12} \cdot 4H_2O$			1.0		7.0	1.2			
SCOLECITE	392.337	367.4	172.3	-6049.0	-5597.6	980.7	207	207	
$CaAl_2Si_3O_{10} \cdot 3H_2O$		0.7	0.5	5.0	5.0	0.9			
LEONHARDITE	922.859	922.2	409.3				231		
$Ca_2Al_4Si_8O_{24} \cdot 7H_2O$		10.9	2.0						
BICCHULITE	292.216	213.1	103.68	-4341.2	-4073.0	713.6	68	68	68
$Ca_2Al_2SiO_6(OH)_2$		5.0	0.10	5.0	5.0	0.9		144	
MEIONITE (Al/Si ordered)	934.709	715.2	340.36	-13881.4	-13131.8	2300.6	282	282	450
$Ca_4Al_6Si_6O_{24}CO_3$		1.0	0.08	6.2	6.2	1.1			
DANBURITE	245.866	155.3	82.20	-3902.8	-3677.0	644.2	448	383	5
$CaB_2Si_2O_8$		0.4	0.40	2.9	2.9	0.5	274		
CLINOPTILOLITE	2701.506	2872.3+	1267.6				173		
$(Na_{0.56}K_{0.98}Ca_{1.50}Mg_{1.23})(Al_{6.7}Fe_{0.3})Si_{29}O_{72} \cdot 22H_2O$			7.0				214		
POLLUCITE	245.488	207.2	83.0				30		
$(Cs_{.65}Na_{.19}Rb_{.03})Al_2Si_4O_{12} \cdot H_2O$		0.4	2.0						
MICROCLINE	278.332	214.2	108.72	-3974.6	-3749.3	656.8	313	166	167
$KAlSi_3O_8$		0.4	0.10	3.9	3.9	0.6			

THERMODYNAMIC PROPERTIES OF FRAMEWORK STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
SANIDINE	278.332	232.8	109.05	-3965.6	-3745.8	656.2	313	166	167
$KAlSi_3O_8$		0.5	0.10	4.1	4.1	0.7	155	194	
GLASS	278.332	261.6	116.50	-3920.8	-3709.6	649.9	366	166	258
$KAlSi_3O_8$		1.8	1.00	4.2	4.2	0.6		421	
KALIOPHILLITE (KALSILITE)	158.163	133.3	59.89	-2124.7	-2008.8	351.9	220	188	317
$KAlSiO_4$		1.2	0.05	3.1	3.1	0.5			
LEUCITE	218.247	200.2	88.27	-3037.8	-2875.1	503.7	220	188	317
$KAlSi_2O_6$		1.7	0.05	2.7	2.7	0.5			263
EUCRYPTITE	126.006	103.8	53.63	-2123.3	-2009.2	352.0	327	171	327
$LiAlSiO_4$		0.8	0.08	2.0	2.0	0.4		20	
PETALITE	306.259	233.2	128.40	-4886.5	-4610.7	807.8	180	180	180
$LiAlSi_4O_{10}$		0.6	0.50	6.3	6.3	1.1	35	28	35
ALBITE	262.223	207.4	100.07	-3935.0	-3711.6	650.2	313	166	167
$NaAlSi_3O_8$		0.4	0.13	2.6	2.6	0.5	123	171	220
ANALBITE	262.223	225.6	100.43	-3923.6	-3705.6	649.2	313	166	167
$NaAlSi_3O_8$		0.4	0.09	2.6	2.6	0.5	155	171	
GLASS	262.223	251.9	110.10	-3875.5	-3665.3	642.1	366	421	258
$NaAlSi_3O_8$		1.5	0.20	3.7	3.7	0.6			
NA-K FELDSPAR SS.	264.639	231.3	102.18	-3932.1	-3715.2	650.9	155	155	
$(Na_{0.85}K_{0.15})AlSi_3O_8$		0.4	0.10	4.0	4.0	0.7			
NA-K FELDSPAR SS.	269.472	237.0	105.22	-3945.1	-3728.7	653.2	155	155	
$(Na_{0.55}K_{0.45})AlSi_3O_8$		0.4	0.10	4.0	4.0	0.7			
NA-K FELDSPAR SS.	274.304	237.4	107.37	-3954.5	-3737.1	654.7	155	155	
$(Na_{0.25}K_{0.75})AlSi_3O_8$		0.4	0.10	4.0	4.0	0.7			
NEPHELINE	142.054	124.4	54.19	-2090.4	-1975.8	346.1	220	188	220
$NaAlSiO_4$		1.3	0.06	3.9	3.9	0.7			183
CARNEGIEITE	142.054	118.7	56.03	-2104.3	-1988.0	348.3	346	450	220
$NaAlSiO_4$		0.3	0.02	4.0	4.0	0.7			
GLASS	142.054	134.5	56.86	-2089.0	-1977.4	346.4	346	346	346
$NaAlSiO_4$		0.5	0.06	4.0	4.0	0.7			
ANALCIME	220.154	227.7	97.4	-3310.1	-3090.0	541.3	206	206	206
$NaAlSi_2O_6 \cdot H_2O$		0.3	0.2	3.3	3.3	0.6			

THERMODYNAMIC PROPERTIES OF FRAMEWORK STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
DEHYDRATED ANALCIME	202.139	172.5		-2983.1	-2816.0	493.4	206	206	317
$NaAlSi_2O_6$		0.2		3.5	3.5	0.6			206
NATROLITE	380.224	359.7	169.2	-5718.6	-5316.5	931.4	207	207	
$Na_2Al_2Si_3O_{10} \cdot 2H_2O$		0.7	0.2	5.0	5.0	0.9			
PHILLIPSITE	643.236	771.9+	303.0				173		
$(Na_{1.1}K_{0.8})Al_{1.9}Si_{6.1}O_{16} \cdot 6H_2O$		2.4	8.0						
MESOLITE	388.050	363.0+	171.1	-5947.1	-5512.7	965.8	207	207	
$Na_{0.68}Ca_{0.66}(Al_{1.99}Si_{3.01}O_{10}) \cdot 2.65H_2O$		2.0	0.4	5.4	6.0	1.1			
MORDENITE	441.880	486.5+	209.8	-6736.7	-6227.9	1091.1	212	212	
$Na_{0.36}Ca_{0.29}Al_{0.94}Si_{5.06}O_{12} \cdot 3.47H_2O$		1.0	1.2	4.5	4.5	0.8			
DEHYDRATED MORDENITE	379.367	299.1+		-5642.3	-5318.9	931.8	212	212	
$Na_{0.36}Ca_{0.29}Al_{0.94}Si_{5.06}O_{12}$		0.6		4.6	4.6	0.8			
MERLINOITE	239.967	282.4+	150.6	-3591.2	-3312.0	580.2	95	95	
$Na_{0.81}K_{0.19}AlSi_{1.94}O_{5.88} \cdot 2.13H_2O$		0.4	0.5	2.9	2.9	0.5		96	
MERLINOITE	244.028	276.6+	152.2	-3519.0	-3258.0	570.8	95	95	
$K_{0.80}Na_{0.20}AlSi_{1.94}O_{5.88} \cdot 1.81H_2O$		0.4	0.5	2.9	2.9	0.5		96	
MERLINOITE	245.088	274.3+	151.2	-3481.8	-3227.6	565.4	95	95	
$KAlSi_{1.94}O_{5.88} \cdot 1.69H_2O$		0.4	0.5	3.0	3.0	0.5		96	
MERLINOITE	233.057	274.6+	153.6	-3488.3	-3212.0	562.7	95	95	
$Na_{0.81}K_{0.19}AlSi_{1.81}O_{5.62} \cdot 2.18H_2O$		0.4	0.5	2.8	2.8	0.5		96	
MERLINOITE	237.629	260.5+	151.5	-3387.3	-3131.1	548.5	95	95	
$K_{0.91}Na_{0.09}AlSi_{1.81}O_{5.62} \cdot 1.79H_2O$		0.4	0.5	2.8	2.8	0.5		96	
MERLINOITE	237.277	259.7+	149.8	-3360.0	-3110.2	544.9	95	95	
$KAlSi_{1.81}O_{5.62} \cdot 1.69H_2O$		0.5	0.5	2.8	2.8	0.5		96	

THERMODYNAMIC PROPERTIES OF SHEET STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
DICKITE	258.160	197.1	98.56	-4118.5	-3796.0	665.0	230	171	149
$Al_2Si_2O_5(OH)_4$		1.3	0.04	2.0	2.1	0.4		149	
KAOLINITE	258.160	200.4	99.34	-4119.0	-3797.5	665.3	358	179	179
$Al_2Si_2O_5(OH)_4$		0.5	0.01	1.5	1.5	0.3	198	68	
HALLOYSITE	258.160	203.0		-4101.5	-3780.7	662.4	230	171	
$Al_2Si_2O_5(OH)_4$		1.3		10.0	10.0	1.8			
PYROPHYLLITE	360.314	239.4	128.10	-5640.0	-5266.2	922.6	365	258	258
$Al_2Si_4O_{10}(OH)_2$		0.4	0.08	1.5	1.5	0.3		68	
ILLITE	1553.665	1104.2	577.00				365		
$K_3(Al_7Mg)(Al_2Si_{14})O_{40}(OH)_8$		2.5	10.00						
MARGARITE	398.184	263.6	129.63	-6244.0	-5858.9	1026.4	335	68	335
$CaAl_2[Al_2Si_2O_{10}](OH)_2$		0.3	0.06	2.6	2.6	0.5			
PREHNITE	412.384	292.8	141.10	-6202.6	-5824.7	1020.4	335	68	335
$Ca_2Al[AlSi_3O_{10}](OH)_2$		0.7	0.10	2.0	2.0	0.4			
MUSCOVITE (Al/Si disordered)	398.308	306.4	140.81	-5974.8	-5598.8	980.9	365	166	258
$KAl_2[AlSi_3O_{10}](OH)_2$		0.6	0.10	4.9	4.9	0.9	432	152	316
MUSCOVITE (Al/Si ordered)	398.308	287.7	140.81	-5990.0	-5608.4	982.6	365	166	258
$KAl_2[AlSi_3O_{10}](OH)_2$		0.6	0.10	4.9	4.9	0.9	432	152	316
ANNITE	511.886	415.0	154.30	-5149.3	-4798.3	840.6	186	188	188
$KFe_3[AlSi_3O_{10}](OH)_2$		10.0	0.50	4.0	4.0	0.7	174		
PHLOGOPITE (Al/Si disordered)	417.260	334.6	149.65	-6226.0	-5846.0	1024.2	356	356	356
$KMg_3[AlSi_3O_{10}](OH)_2$		1.0	0.10	6.0	6.0	1.0			
PHLOGOPITE (Al/Si ordered)	417.260	315.9	149.65	-6246.0	-5860.5	1026.7	356	356	356
$KMg_3[AlSi_3O_{10}](OH)_2$		1.0	0.10	6.0	6.0	01.0			
FLUORPHLOGOPITE (Al/Si disorder)	421.242	336.3	146.52	-6355.5	-6015.7	1053.9	218	171	218
$KMg_3[AlSi_3O_{10}]F_2$		2.1	0.10	4.0	4.2	0.7		434	
FLUORPHLOGOPITE (Al/Si ordered)	421.242	317.6	146.52	-6375.5	-6030.1	1056.4	218	356	218
$KMg_3[AlSi_3O_{10}]F_2$		2.1	0.10	4.0	4.2	0.7			
TALC	379.266	260.8	136.20	-5900.0	-5520.2	967.1	370	162	257
$Mg_3Si_4O_{10}(OH)_2$		0.6	0.20	2.0	2.1	0.4			
CHRYSOTILE (ANTIGORITE)	277.112	221.3	107.50	-4360.0	-4032.4	706.4	226	171	226
$Mg_3Si_2O_5(OH)_4$		0.8	0.40	3.0	3.1	0.5			

THERMODYNAMIC PROPERTIES OF SHEET STRUCTURE SILICATE MINERALS AT 298.15 K

NAME AND FORMULA	WEIGHT	ENTROPY	VOLUME	ENTHALPY	FREE ENERGY	LOG(K)	REFERENCES		
		S°	V°	$\Delta_f H^\circ$	$\Delta_f G^\circ$				
	g	$J \cdot mol^{-1} \cdot K^{-1}$	cm^3	$kJ \cdot mol^{-1}$	$kJ \cdot mol^{-1}$		S	H/G	C
CLINOCHLORE	555.797	421.0	211.00	-8919.0	-8255.8	1446.3	180	182	182
$Mg_5Al(AlSi_3O_{10})(OH)_8$		15.0	0.50	20.0	20.0	3.5		204	
PARAGONITE (Al/Si disordered)	382.200	295.8	132.1	-5933.0	-5555.7	973.3	356	356	356
$NaAl_2[AlSi_3O_{10}](OH)_2$		0.9	0.1	3.8	3.9	0.7			
PARAGONITE (Al/Si ordered)	382.200	277.1	132.1	-5949.3	-5568.5	975.6	356	356	356
$NaAl_2[AlSi_3O_{10}](OH)_2$		0.9	0.1	3.8	3.9	0.7		37	

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SELECTED ELEMENTS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tn} K	$\Delta_{tn}H°$ $kJ \cdot mol^{-1}$
SILVER	42.55	1.126E+01	1.169E-02	-2.124E+05	2.253E+02		298	1234.9	11.95
Ag (crystal)	0.21						1235		
ALUMINUM	28.30	4.132E+01	-1.988E-02	-1.265E+05	-1.816E+02	1.93E-05	298	933.5	10.70
Al (crystal)	0.08						933.5		
ARSENIC	35.69	2.0845E+01	6.3265E-03	-9.8777E+04	5.2398E+01		298		
As	0.84						875		
GOLD	47.49	4.197E+01	-1.770E-02		-2.161E+02	1.123E-05	298	1337.3	12.36
Au (crystal)	0.21						1337.3		
BORON	5.83	4.758E+01	-5.227E-03	-5.903E+04	-5.899E+02	1.372E-06	298		
B (crystal)	0.08						2350		
BERYLLIUM	9.50	1.8735E+01	9.293E-03	-4.502E+05			298		
Be (crystal)	0.08						1550		
BISMUTH	56.74	2.6852E+01	-1.7289E-02			4.1802E-05	298		
Bi	0.42						544.52		
BROMINE	249.34	4.211E+01	-2.470E-03	-3.021E+04	-8.739E+01	9.370E-07	332.5		
Br_2 (ideal gas)	0.05						2200		
GRAPHITE	5.74	6.086E+01	-1.024E-02	7.139E+05	-9.922E+02	1.669E-06	298		
C (crystal)	0.10						2500		
DIAMOND	2.38	9.845E+01	-3.655E-02	1.217E+06	-1.659E+03	1.098E-05	298		
C (crystal)	0.20						1800		
CALCIUM	42.90	-2.659E+01	5.236E-02	-4.877E+05	7.442E+02	-9.772E-06	298		
Ca (α-crystal)	0.10						716		
CADMIUM	51.80		-3.8115E-02	-1.3402E+05	3.0044E+02	-1.4336E-05	298		
Cd (crystal)	0.15						594.18		
CERIUM	72.00	1.4017E+01	1.9292E-02	-1.0802E+05	1.4469E+02		298		
Ce (crystal)	4.00						999		
CHLORINE	223.08	4.591E+01	-3.699E-03	-4.094E+04	-1.811E+02	1.009E-06	298		
Cl_2 (ideal gas)	0.02						2500		
COBALT	30.04		4.1844E-02	-1.5646E+05	2.6875E+02	-1.6498E-05	298		
Co (crystal)	0.42						700		
CHROMIUM	23.62	-1.625E+01	2.293E-02	-1.222E+06	8.032E+02	1.232E-06	298		
Cr (crystal)	0.21						2100		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SELECTED ELEMENTS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
COPPER	33.14	6.084E+01	-2.875E-02	3.331E+05	-5.671E+02	1.420E-05	298	1357.8	13.14
Cu (crystal)	0.03						1357.8		
COPPER	83.95	3.280E+01					1357.8		
Cu (liquid)	0.50						2500		
FLUORINE	202.79	4.057E+01	1.792E-03	-1.004E+05	-1.489E+02	-4.836E-07	298		
F_2 (ideal gas)	0.02						2500		
GERMANIUM	31.09	2.4033E+01	3.049E-03	-1.5714E+05	0.84921E+00	-2.5E-08	298		
Ge (crystal)	0.15						1211.4		
HYDROGEN	130.68	4.783E+00	1.335E-02	-5.617E+05	4.583E+02	-1.825E-06	298		
H_2 (ideal gas)	0.02						2500		
MERCURY	75.90	1.6815E+01	3.623E-03	-7.956E+04	1.860E+02	2.168E-06	298		59.2
Hg (liquid)	0.12						629		
MERCURY	174.97	2.079E+01					298	629	
Hg (ideal gas)	0.02						1800		
IODINE	116.14	1.3122E+01	9.111E-03	-1.0131E+06	5.3419E+02	-1.5E-07	457.7		
I_2 (ideal gas)	0.30						1800		
MAGNESIUM	32.67		4.1345E-02	-2.7217E+05	3.1329E+02	-1.3745E-05	298	923	8.48
Mg (crystal)	0.10						923		
MAGNESIUM	73.23	3.431E+01					923		
Mg (liquid)	0.15						1366		
MAGNESIUM	148.65	2.079E+01					298		
Mg (ideal gas)	0.02						2000		
MANGANESE	32.01		4.1345E-02	-2.7217E+05	3.1329E+02	-1.3745E-05	298		
Mn (α-crystal)	0.08						980		
MOLYBDENUM	28.66	4.167E+01	-9.165E-03	1.082E+05	-2.882E+02	4.904E-06	298		
Mo (crystal)	0.21						2500		
NITROGEN	191.61	2.479E+01	9.648E-03	1.459E+05		-2.003E-06	298		
N_2 (ideal gas)	0.02						2500		
SODIUM	64.92	3.7482E+01	-1.9183E-02			1.0644E-05	371		
Na (liquid)	0.20						1170.5		
SODIUM	153.72	2.079E+01					298		
Na (ideal gas)	0.02						2500		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SELECTED ELEMENTS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
NICKEL	29.87	1.5121E+02	-2.049E-01		-1.3746E+03	1.742E-04	298		
Ni (crystal)	0.08						600		
OXYGEN	205.15	5.658E+01	-5.255E-03	6.856E+05	-5.780E+02	1.113E-06	298		
O_2 (ideal gas)	0.02						2500		
PHOSPHORUS	42.58	2.632E+01					317.3		
P (liquid)	0.25						1000		
LEAD	64.80	2.266E+01	1.0089E-01	-8.717E+04	4.0666E+01		298	600.6	4.81
Pb (crystal)	0.30						600.6		
PLATINUM	41.63	2.0046E+01	7.415E-03	-1.298E+05	8.738E+01	-4.798E-07	298		
Pt (crystal)	0.20						1800		
SULFUR	32.05	2.270E+01					298		
S (ortho-crystal)	0.05								
SULFUR	228.17	3.751E+01	2.173E-03	-1.645E+05	-6.575E+01	-7.275E-08	298		
S_2 (ideal gas)	0.02						2500		
ANTIMONY	45.52	5.2603E+01	-3.2904E-02	1.2617E+05	-3.6512E+02	2.4691E-05	298		
Sb (crystal)	0.21						904		
SILICON	18.81	2.431E+01	3.003E-03	-3.185E+05	-2.831E+01	2.330E-07	298	1685	50.02
Si (crystal)	0.08						1685		
SILICON	91.56	2.720E+01					1685		
Si (liquid)	0.5						2500		
TIN	51.18	-6.8705E+01	7.2961E-02	-1.2938E+06	1.53013E+03		298		
Sn (crystal)	0.08						505.1		
STRONTIUM	55.69	2.3369E+01	1.066E-02	2.233E+04			298		
Sr (crystal)	0.03						820		
TELLURIUM	49.71	1.9124E+01	2.2061E-02				298		
Te (crystal)	0.20						723		
Thorium	51.83	2.27467E+01	9.338E-03	-3.00023E+03	1.27357E+01	-9.09E-08	298		
TH (crystal)	0.50						1650		
TITANTIUM	30.76	2.01595E+02	-1.4675E-01	1.97328E+06	-2.7691E+03	6.28E-05	298		
Ti (α-crystal)	0.10						1166		
URANIUM	50.20	3.2944E+01	-7.800E-03		-9.500E+01	2.860E-05	298		
U (crystal)	0.20						942		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SELECTED ELEMENTS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
VANADIUM	28.94	3.440E+00	1.334E-02	-6.971E+05	4.369E+02	2.020E-07	298		
V (crystal)	0.42						2200		
TUNGSTEN	32.65	3.814E+01	-5.430E-03	2.183E+05	-2.568E+02	2.552E-06	298		
W (crystal)	0.10						2500		
ZINC	41.63	2.909E+01	-3.507E-03		-6.366E+01	1.161E-05	298	692.7	7.30
Zn (crystal)	0.15						692.7		
ZINC	75.16	3.138E+01					692.7		
Zn (liquid)	0.30						1180.2		
ZINC	160.99	2.079E+01					1180.2		
Zn (ideal gas)	0.03						2500		
ZIRCONIUM	38.87	-2.585E+01	3.6755E-02	-9.032E+05	8.778E+02	-6.585E-06	298	1135	4.02
Zr (α-crystal)	0.20						1135		
ZIRCONIUM	79.48	2.1943E+01	-6.37E-03	-1.1452E+06	2.7991E+02	4.81E-06	1135		
Zr (β-crystal)							2000		
METHANE	186.26	1.194E+02	2.055E-02	2.814E+06	-2.090E+03	-5.000E-06	298		
CH_4	0.04						1800		
COHENITE	104.40	1.073E+02	1.253E-02				298		
Fe_3C	3.40						1800		
AMMONIA	192.77	5.139E+01	2.660E-02	7.584E+05	-5.480E+02	-4.900E-06	298		
NH_3	0.03						1800		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SULFIDE AND SULFOSALT MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
ACANTHITE (ARGENTITE)	142.9	7.531E+01					298		
Ag_2S	0.3								
REALGAR	63.5	4.702E+01					298		
AsS	0.6								
GREENOCKITE	72.2	3.538E+01	1.503E-02	-5.333E+05	2.357E+02	-2.400E-06	298		
CdS	0.3						1100		
CATTIERITE	74.8	6.582E+01	3.032E-02	-5.870E+05			298		
CoS_2	0.2						1000		
COVELLITE	67.4	4.3049E+01	2.023E-02	-1.39938E-05	4.35838E-01		298		
CuS	0.2						780		
CHALCOCITE	116.2	7.684E+01					298		
Cu_2S	0.1								
CHALCOPYRITE	124.9	-5.8753E+02	3.7073E-01	-1.4721E+07	1.275E+04		298		
$CuFeS_2$	0.2						820		
ISS (intermediate ss)	250.5	-1.01845E+03	1.358E+00				820		
$CuFeS_2$							930		
BORNITE	398.5	2.429E+02					298		
Cu_5FeS_4	0.8								
TROILITE	60.3	5.049E+01					298		
FeS	0.2								
PYRRHOTITE	60.7	4.988E+01					298		
$Fe_{.875}S$	0.2								
PYRRHOTITE		5.084E+01					298		
$Fe_{.89}S$									
PYRRHOTITE	63.2	5.123E+01					298		
$Fe_{.90}S$	0.1								
PYRRHOTITE		5.095E+01					298		
$Fe_{.98}S$									
PYRITE	52.9	-2.032E+01	5.030E-02	-3.200E+06	1.787E+03		298		
FeS_2	0.1						1015		
MARCASITE	53.9	3.832E+02	-3.173E-01	1.676E+06	-4.488E+03	1.676E-04	298		
FeS_2	0.1						700		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SULFIDE AND SULFOSALT MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
HYDROGEN SULFIDE	205.8	2.636E+01	2.650E-02	2.660E+05	-4.356E+01	-6.024E-06	298		
H_2S (IDEAL GAS)	0.2						1800		
ALABANDITE	80.3	1.353E+02	-5.775E-02	1.169E+06	-1.435E+03	2.087E-05	298		
MnS	0.8						1800		
MOLYBDENITE	62.6	1.045E+02	-4.812E-03	-6.291E+03	-6.817E+02		298		
MoS_2	0.2						1200		
MILLERITE	53.0	4.711E+01					298		
NiS	0.4								
HEAZLEWOODITE	133.2	1.057E+03	-8.988E-01	8.139E+06	-1.388E+04	4.660E-04	298		
Ni_3S_2	0.3						840		
GALENA	91.7	4.460E+01	1.640E-02				298		
PbS	0.7						900		
STIBNITE	182.0	1.705E+02	-4.860E-03	7.539E+05	-9.978E+02		298		
Sb_2S_3	3.3						829		
HERZENBERGITE	77.0	-1.559E+02	1.219E-01	-3.548E+06	3.604E+03		298		
SnS	0.8						875		
HERZENBERGITE	135.1	2.672E+01	3.035E-02				875		
SnS	1.0						1153		
BERNDTITE	87.5	2.004E+01	3.823E-02	-9.602E+05	8.544E+02		298		
SnS_2	0.2						1000		
TUNGSTENITE	67.8	7.633E+01	5.561E-04	-1.137E+06		1.408E-06	298		
WS_2	0.3						1500		
SPHALERITE	58.7	6.151E+01	7.631E-04	-7.963E+04	-2.604E+02		298		
ZnS	0.8						1300		
WURTZITE	58.8	4.191E+01	7.619E-03	-6.603E+05	1.577E+02		298		
ZnS	0.2						1300		
BERTHIERITE	245.0	1.000E+01	7.930E-02	-6.416E+06	3.691E+03		298		
$FeSb_2S_4$	1.0						836		
CHALCOSTIBITE	149.2	8.810E+01	4.040E-02				298		
$CuSbS_2$	3.8						826		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR OXIDE AND HYDROXIDE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
CORUNDUM	50.9	1.612E+02	-1.352E-03	-1.815E+06	-1.059E+03	5.381E-07	298	2345	
Al_2O_3	0.1						2250		
BOEHMITE	37.2	2.057E+02	-3.492E-02	1.027E+06	-2.635E+03		298		
AlO(OH)	0.1						600		
DIASPORE	35.3	5.333E+01					298		
AlO(OH)	0.2								
GIBBSITE	68.4	9.170E+01					298		
$Al(OH)_3$	0.1								
DIBORON TRIOXIDE	54.0	1.847E+02	7.108E-03	6.441E+05	-2.270E+03		298		
B_2O_3	0.3						723		
DIBORON TRIOXIDE	160.9	1.297E+02					723		
B_2O_3 (liquid)	0.5						2200		
BARIUM MONOXIDE	72.1	5.722E+01	5.370E-03	-1.669E+05	-1.668E+02		298		
BaO	0.4						1800		
BROMELLITE	13.8	8.274E+01	-7.301E-03	-4.158E+05	-8.718E+02	1.845E-06	298		
BeO	0.2						2000		
BISMITE	151.5	1.036E+02	3.336E-02				298		
Bi_2O_3	2.1						800		
CARBON MONOXIDE	197.3	3.976E+01	3.188E-03	5.292E+05	-3.013E+02	-8.078E-07	298		
CO (ideal gas)	0.0						2500		
CARBON DIOXIDE	213.8	8.811E+01	-2.698E-03	7.232E+05	-1.007E+03		298		
CO_2 (ideal gas)	0						2200		
LIME	38.1	5.185E+01	2.444E-03	-9.340E+05			298		
CaO	0.4						2500		
PORTLANDITE	83.4	1.867E+02	-2.191E-02		-1.600E+03		298		
$Ca(OH)_2$	0.4						700		
CERIANITE	62.3	8.029E+01	5.699E-03	-7.294E+05	-2.099E+02		298		
CeO_2	0.1						1800		
COBALT MONOXIDE	52.8	-3.047E+01	2.946E-02	-4.166E+06	1.932E+03		298		
CoO	0.3						1800		
TRICOBALT TETROXIDE	109.3	1.316E+02	6.602E-02	-2.480E+06			298		
Co_3O_4	0.3						1000		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR OXIDE AND HYDROXIDE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H^{\circ}$ $kJ \cdot mol^{-1}$
ESKOLAITE	81.2	1.190E+02	9.496E-03	-1.442E+06	-3.405E+00		298		
Cr_2O_3	1.2						1800		
TENORITE	42.6	3.097E+01	1.374E-02	-1.258E+06	3.693E+02		298		
CuO	0.2						1400		
CUPRITE	92.4	4.260E+02	-2.508E-01	4.898E+06	-6.078E+03	9.244E-05	298		
Cu_2O	0.3						1500		
WUSTITE	56.6	-1.930E+01	3.017E-02	-2.533E+06	1.501E+03		298		
$Fe_{.947}O$	0.4						1652		
FERROUS OXIDE	60.6	3.908E+01	8.574E-03	-7.325E+05	2.466E+02		298		
FeO (fictive)	1.7						1800		
HEMATITE	87.4	1.50147E+03	-1.2146E+00	1.4123E+07	-2.1493E+04	5.690E-04	298	950	1.24
Fe_2O_3	0.2						950		
HEMATITE	243.8	-1.0957E+03	2.7267E-01	-1.0239E+08	3.396E+04		950		
Fe_2O_3	1.0						1800		
MAGNETITE	146.1	2.65911E+03	-2.5215E+00	2.0734E+07	-3.6455E+04	1.3677E-03	298		
Fe_3O_4	0.4						800		
MAGNETITE	369.1	9.6823E+01	5.2733E-02	5.6413E+07			900		
Fe_3O_4	0.6						1800		
STEAM	188.8	2.7057E+01	1.7584E-02	2.7696E+05	-2.7656E+01	-2.5097E-06	298		
H_2O (ideal gs)	0.04						2500		
DIPOTASSIUM MONOXIDE	94.1	7.450E+01	3.965E-02	-2.346E+05			298		
K_2O	6.3						2000		
DILITHIUM MONOXIDE	37.6	6.133E+01	3.568E-02	-1.168E+06	-7.050E+01	-7.318E-06	298		
Li_2O	0.8						2000		
PERICLASE	26.9	6.653E+01	-6.143E-03	-6.093E+05	-3.592E+02	2.451E-06	298		
MgO	0.2						2500		
BRUCITE	63.2	1.022E+02	1.511E-02	-2.617E+06			298		
$Mg(OH)_2$	0.1						900		
MANGANOSITE	59.7	6.028E+01	3.510E-03		-2.975E+02		298		
MnO	0.1						2000		
PYROLUSITE	52.8	2.904E+02	-1.442E-01	2.012E+06	-3.787E+03	4.541E-05	298		
MnO_2	0.1						850		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR OXIDE AND HYDROXIDE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
BIXBYITE	113.7	1.624E+02	1.211E-02	1.046E+06	-1.317E+03	3.462E-06	325		
Mn_2O_3	0.2						1400		
HAUSMANNITE	164.1	-7.432E+00	9.487E-02	-6.712E+06	3.396E+03		298		
Mn_3O_4	0.3						1400		
BRAUNITE	416.4	4.301E+02	1.110E-01	-7.325E+06			298		
Mn_7SiO_{12}	0.8						1500		
MOLYBDITE	77.7	6.433E+00	6.278E-02	-2.460E+06	1.337E+03		298	1074	
MoO_3	0.4						1074		
NITROGEN DIOXIDE	240.1	1.018E+02	-1.121E-02	1.218E+06	-1.300E+03	1.461E-06	298		
NO_2	0.1						2500		
DISODIUM MONOXIDE	75.3	1.1397E+02	7.4857E-03		-8.1335E+02		298		
Na_2O	0.8						1000		
BUNSENITE	38.0	4.1107E+03	-5.3024E+00	2.43067E+07	-5.3039E+04	3.5206E-03	298		
NiO	0.2						519		
BUNSENITE	67.7	-8.776E+00	4.223E-02	3.607E+06	7.873E+02	-7.526E-06	519		
NiO	0.5						1800		
LITHARGE	66.5	5.102E+01	1.027E-02	-7.387E+05			298		
PbO	0.2						1000		
PLATTNERITE	71.8	7.312E+01	7.484E-03	-1.261E+06			298		
PbO_2	0.4						1200		
MINIUM	212.0	1.779E+02	3.326E-02	-2.926E+06			298		
Pb_3O_4	6.7						1800		
SULFUR DIOXIDE	248.2	9.890E+01	-1.161E-02	8.465E+05	-1.127E+03	1.788E-06	298		
SO_2 (IDEAL GAS)	0.1						2500		
SULFUR TRIOXIDE	256.8	1.478E+02	-1.898E-02	1.079E+06	-1.794E+03	2.763E-06	298		
SO_3 (IDEAL GAS)	0.8						2500		
SILICON MONOXIDE	211.6	5.686E+01	-5.616E-03	4.922E+05	-5.335E+02	8.5943E-07	298		
SiO (IDEAL GAS)	0.8						2500		
QUARTZ	41.5	8.1145E+01	1.828E-02	-1.810E+05	-6.985E+02	5.406E-06	298		
SiO_2	0.1						844		
QUARTZ	104.6	5.796E+01	9.330E-03	1.835E+06			844		
SiO_2	0.2						1700		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR OXIDE AND HYDROXIDE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
CRISTOBALITE	43.4	-4.160E+03	2.548E+00	-6.286E+07	7.168E+04		298		
SiO_2	0.1						523		
CRISTOBALITE	76.3	7.275E+01	1.300E-03	-4.132E+06			523		
SiO_2	1.0						1800		
COESITE	38.5	2.331E+02	-7.777E-02	2.604E+06	-3.375E+03	1.924E-05	298		
SiO_2	1.0						1800		
STISHOVITE	27.8	1.474E+02	-4.027E-02	-2.834E+05	-1.559E+03	1.203E-05	298		
SiO_2	0.4						1800		
SILICA GLASS	48.5	7.464E+01	-7.259E-03	-3.114E+06		5.570E-06	298		
SiO_2	1.0						1700		
CASSITERITE	49.0	7.604E+01	7.364E-03	-2.224E+06			298		
SnO_2	0.1						1500		
STRONTIUM MONOXIDE	55.5	5.365E+01	5.982E-03	-3.666E+05	-1.019E+02		298		
SrO	0.4						2500		
THORIANITE	65.2	7.138E+01	7.556E-03	-1.053E+06			298		
ThO_2	0.2						1200		
RUTILE	50.6	8.462E+01	5.990E-04	-1.101E+06	-2.957E+02		298		
TiO_2	0.2						2100		
ANATASE	49.9	4.396E+01	1.374E-02	-2.595E+06	6.294E+02		298		
TiO_2	0.3						1300		
URANINITE	77.0	5.845E+01	1.606E-02	-1.867E+06	3.689E+02		298		
UO_2	0.2						1800		
KARELIANITE	98.1	5.799E+01	4.120E-02	-3.872E+06	1.351E+03		298		
V_2O_3	1.3						1800		
TUNGSTEN DIOXIDE	50.6	6.638E+01	1.326E-02	-1.294E+06			298		
WO_2	0.3						2500		
ZINCITE	43.2	4.350E+01	7.658E-03	-7.573E+05	5.456E+01		298		
ZnO	0.1						1800		
BADDELEYITE	50.4	1.073E+02	-5.011E-03	-2.203E+05	-8.141E+02		298	1478	8.08
ZrO_2	0.3						1478		
BADDELEYITE	167.1	7.448E+01					1478		
ZrO_2	1.5						2000		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR MULTIPLE OXIDE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
TIALITE	109.6	2.111E+02	1.461E-02	-3.625E+06	-6.610E+02		298		
Al_2TiO_5	0.8						1800		
CHRYSOBERYL	66.3	3.627E+02	-8.353E-02	-6.798E+04	-4.034E+03	2.248E-05	298		
$BeAl_2O_4$	0.1						1800		
CALCIUM FERRITE	145.4	9.588E+01	4.666E-02	-3.360E+06	1.410E+03		298		
$CaFe_2O_4$	0.8						1510		
DICALCIUM FERRITE	188.8	2.223E+02	9.728E-03	-5.661E+06	5.420E+02		298		
$Ca_2Fe_2O_5$	1.3						1750		
PEROVSKITE	93.6	1.250E+01	4.516E-02	-6.302E+06	2.462E+03		298		
$CaTiO_3$	0.4						1530		
HERCYNITE	116.0	2.247E+02	4.480E-03	-1.581E+06	-1.370E+03		298		
$FeAl_2O_4$	3.0						1200		
CHROMITE	146.0	3.018E+02	-4.157E-02	4.877E+05	-2.803E+03	1.147E-05	298		
$FeCr_2O_4$	1.7						1800		
ILMENITE	108.9	2.627E+02	-7.999E-02	3.827E+05	-2.538E+03	3.388E-05	298		
$FeTiO_3$	0.3						1000		
ULVOSPINEL	168.9	-1.026E+02	1.425E-01	-9.145E+06	5.271E+03		298		
Fe_2TiO_4	2.5						1800		
PSEUDOBROOKITE	156.5	2.136E+02	1.625E-02	-2.345E+06	-4.795E+02		298		
$Fe2TiO_5$	1.3						1800		
SPINEL	84.5	2.229E+02	6.127E-03	-1.686E+06	-1.551E+03		298		
$MgAl_2O_4$	0.04						1800		
MAGNESIOCHROMITE	106.0	1.961E+02	5.398E-03	-3.126E+06	-6.169E+02		298		
$MgCr_2O_4$	0.8						1800		
MAGNESIOFERRITE	123.8	1.782E+02	1.275E-02				665		
$MgFe_2O_4$	0.8						1230		
MAGNESIOFERRITE	379.2	1.066E+02	5.716E-02				1230		
$MgFe_2O_4$	3.0						1800		
GEIKIELITE	74.6	2.225E+02	-5.274E-02	-6.092E+05	-1.8746E+03	1.878E-05	298		
$MgTiO_3$	0.2						1800		
PYROPHANITE	104.9	1.217E+02	9.288E-03	-2.188E+06			298		
$MnTiO_3$	0.3						1600		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR MULTIPLE OXIDE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H^{\circ}$ $kJ \cdot mol^{-1}$
TREVORITE	165.0	9.559E+01	1.705E-01	3.9927E+04			298		
$NiFe_2O_4$	3.0						1000		
FRANKLINITE	150.7	1.995E+02	3.045E-02	-1.352E+06			298		
$ZnFe_2O_4$	0.3						600		
ZINC TITANIUM SPINEL	143.1	2.613E+02	-5.138E-03	-4.317E+05	-2.095E+03		298		
Zn_2TiO_4	0.3						1800		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR HALIDE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H^{\circ}$ $kJ \cdot mol^{-1}$
BROMARGYRITE	107.1	3.317E+01	6.443E-02				298		
AgBr	0.4						703		
POTASSIUM BROMIDE	95.9	-4.392E+01	5.855E-02	-1.839E+06	1.717E+03		298		
KBr	0.2						1000		
CHLORARGYRITE	96.2	5.996E+01	7.620E-03	-1.017E+06			298		
AgCl	0.2						728		
HYDROPHILITE	104.6	-4.725E+00	4.504E-02	-2.037E+06	1.503E+03		298	1045	28.54
$CaCl_2$	1.3						1045		
HYDROPHILITE	230.2	1.025E+02					1045		
$CaCl_2$ (liquid)	5.0						1800		
LAWRENCITE	118.0	-1.123E+02	8.951E-02	-5.115E+06	3.790E+03		298		
$FeCl_2$	0.4						950		
MOLYSITE	142.3	-2.56E+02	1.1755E+00	7.89E+06		-9.738E-04	298		
$FeCl_3$	0.4						577		
HYDROGEN CHLORIDE	186.9	1.738E+01	1.165E-02	-7.597E+03	1.477E+02	-2.052E-06	298		
HCl (ideal gas)	0.03						2500		
SYLVITE	82.6	-2.452E+01	4.852E-02	-1.605E+06	1.371E+03		298		
KCl	0.2						1043		
CHLOROMAGNESITE	89.6	7.690E+01	8.496E-03	-7.463E+05			298		
$MgCl_2$	0.8						987		
SCACCHITE	118.2	7.626E+01	1.191E-02	-6.048E+05			298		
$MnCl_2$	0.2						923		
SALAMMONIAC	95.0	8.410E+01					298		
NH_4Cl	0.4								
HALITE	72.1	4.515E+01	1.797E-02				298		
NaCl	0.2						1074		
HALITE	170.3	7.2008E+01	-3.2228E-03				1074		
NaCl (liquid)	2.2						1791		
NICKELOUS CHLORIDE	97.7	-5.078E+01	5.748E-02	-4.064E+06	2.608E+03		298		
$NiCl_2$	0.2						1303		
COTUNNITE	136.0	1.229E+02			-8.585E+02		298		
$PbCl_2$	2.1						768		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR HALIDE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H^{\circ}$ $kJ \cdot mol^{-1}$
FLUORITE	68.9	2.033E+03	-1.436E+00	2.988E+07	-3.312E+04	5.040E-04	298		
CaF_2	0.3						1400		
HYDROGEN FLUORIDE	173.8	6.845E+00	1.301E-02	-4.108E+05	4.007E+02	-1.911E-06	298		
HF (ideal gas)	0.04						2500		
SELLAITE	57.3	9.474E+01	1.595E-04	-7.328E+05	-4.322E+02		298	1536	58.16
MgF_2	0.4						1536		
VILLIAUMITE	51.5	-2.612E+00	3.347E-02	-1.402E+06	9.542E+02		298	1269	33.14
NaF	0.1						1269		
CRYOLITE	238.5	4.04227E+03	-3.8582E+00	3.4071E+07	-5.5876E+04	2.004E-03	298	836	8.20
Na_3AlF_6	0.5						836		
CRYOLITE	512.4	2.3669E+02	4.7986E-02				836	1153	1.8
Na_3AlF_6	2.5						1153		
CRYOLITE	605.5	3.0041E+02					1153	1290	113.75
Na_3AlF_6	2.5						1290		
CHIOLITE	515.3	5.099E+02	8.768E-02	-7.301E+06			298	1010	80.83
$Na_5Al_3F_{14}$	0.8						1010		
IODARGYRITE	115.5	2.4351E+01	1.0083E-02				298		
AgI	1.7						423		
MARSHITE	96.6	-1.6941E+03	1.0046E+00	-2.8543E+07	3.0558E+04		298		
CuI	0.5						643		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR CARBONATE AND NITRATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
WITHERITE	112.1	-9.936E+01	1.258E-01	-6.274E+06	3.760E+03		298		
$BaCO_3$	2.1						1079		
ARAGONITE	88.0	8.153E+01	4.567E-02	-1.141E+06			298		
$CaCO_3$	0.2						1000		
CALCITE	91.7	9.972E+01	2.692E-02	-2.158E+06			298		
$CaCO_3$	0.2						1200		
DOLOMITE	155.2	5.479E+02	-1.676E-01	2.840E+06	-6.548E+03	7.708E-05	298		
$CaMg(CO_3)_2$	0.3						1100		
SIDERITE	95.5	2.574E+02	-4.620E-02	1.523E+06	-3.082E+03		298		
$FeCO_3$	0.2						600		
MAGNESITE	65.1	8.112E+01	5.225E-02	-1.832E+06			298		
$MgCO_3$	0.1						1000		
RHODOCHROSITE	98.0	1.497E+02	1.876E-02	1.417E+05	-1.3142E+03		298		
$MnCO_3$	0.1						600		
THERMONATRITE	168.1	7.240E+01	2.607E-01	-1.258E+05			298		
$Na_2CO_3 \cdot H_2O$	0.8						380		
DAWSONITE	132.0	3.441E+01	3.347E-04	7.464E+02			298		
$NaAlCO_3(OH)_2$	0.5						500		
STRONTIANITE	97.1	-1.618E+02	1.2795E-01	-9.018E+06	5.294E+03		298	1197	18.82
$SrCO_3$	1.7						1197		
SMITHSONITE	81.2	1.4838E+02	2.835E-02	4.796E+05	-1.419E+03		298		
$ZnCO_3$	0.2						1200		
NITROBARITE	213.8	1.255E+02	1.497E-01	-1.670E+06			298		
$Ba(NO_3)_2$	0.8						800		
CALCIUM NITRATE	193.3	7.815E+01	1.734E-01	-2.778E+06	8.722E+02		298		
$Ca(NO_3)_2$	0.4						800		
MAGNESIUM NITRATE	164.0	5.8417E+01	2.7292E-01	1.8949E+05			298		
$Mg(NO_3)_2$	0.8						600		
SODA NITER	116.5	2.570E+01	2.237E-01		1.161E+01		298		
$NaNO_3$	0.7						549		
STRONTIUM NITRATE	194.6	1.3389E+03	-3.79E-01	2.5757E+07	-2.3582E+04		298		
$Sr(NO_3)_2$	0.5						900		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SULFATE AND PHOSPHATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
ALUMINUM SULFATE	239.3	7.877E+02	-9.899E-02		-8.615E+03		298		
$Al_2(SO_4)_3$	1.2						1100		
BARITE	132.2	1.412E+02			-3.507E+06		298		
$BaSO_4$	0.8						1300		
ANHYDRITE	107.4	3.728E+02	-1.574E-01	1.695E+06	-4.3308E+03	7.99E-05	298		
$CaSO_4$	0.2						1000		
CHALCOCYANITE	109.5	1.615E+02	4.796E-02	-3.192E+06			298		
$CuSO_4$	0.6						1200		
FERRIC SULFATE	282.8	2.553E+02	2.269E-01	-4.260E+06			298		
$Fe_2(SO_4)_3$	0.8						800		
ARCANITE	175.6	1.2037E+02	9.958E-02	-1.782E+06			298		
α-K_2SO_4	0.4						856		
ARCANITE	360.9	-8.445E+02	6.845E-01	3.499E+08			856		
β-K_2SO_4	1.0						1342		
K-Al SULFATE	204.6	2.370E+02	7.828E-02	-5.988E+06			298		
$KAl(SO_4)_2$	1.3						1000		
ALUNITE	321.0	5.145E+03	1.1375E-01	-1.5635E+07			298		
$KAl_3(OH)_6(SO_4)_2$	5.0						700		
LANGBEINITE	389.3	5.359E+02	1.101E-01	-1.020E+06	-4.040E+03	-4.909E-05	298		
$K_2Mg_2(SO_4)_3$	0.8						1000		
MAGNESIUM SULFATE	91.4	1.056E+02	4.717E-02	-2.129E+06			298		
$MgSO_4$	0.8						1400		
MANGANOUS SULFATE	127.0	1.203E+02	3.999E-02	-2.818E+06			298		
$MnSO_4$	2.0						1000		
MASCAGNITE	220.5	1.0436E+02	2.788E-01				298		
$(NH_4)_2SO_4$	1.3						600		
THENARDITE	239.7	1.2193E+02	8.141E-02				514		
Na_2SO_4 (hexagonal)	1.0						1155		
THENARDITE	424.6	2.011E+02	-3.941E-03				1155		
Na_2SO_4 (liquid)	2.0						1800		
NICKELOUS SULFATE	101.3	1.240E+02	3.062E-02	-3.150E+06			298		
$NiSO_4$	0.2						1200		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SULFATE AND PHOSPHATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
ANGLESITE	148.5	4.683E+01	1.278E-01	1.724E+06			298		
$PbSO_4$	0.6						1100		
ZINKOSITE	110.5	4.019E+01	1.243E-01	2.389E+06			298		
$ZnSO_4$	1.3						1100		
BERLINITE	90.8	1.9833E+03	-1.64948E+00	2.0607E+07	-2.93193E+04	7.72E-04	298		
$AlPO_4$	0.2						830		
WHITLOCKITE	236.0	1.929E+02	1.742E-01	-1.174E+06			298		
$Ca_3(PO_4)_2$	0.8						1373		
FLUORAPATITE	387.9	7.543E+02	-3.026E-02	-9.084E+05	-6.201E+03		298		
$Ca_5(PO_4)_3(F)$	1.7						1600		
HYDROXYAPATITE	390.4	3.878E+02	1.186E-01	-1.270E+07	1.811E+03		298		
$Ca_5(PO_4)_3(OH)$	1.7						1500		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR ORTHO AND RING STRUCTURE SILICATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
TOPAZ	105.4	4.714E+02	-8.165E-02	1.270E+06	-5.486E+03		298		
$Al_2SiO_4F_2$	0.2						1000		
KYANITE	82.8	2.794E+02	-7.124E-03	-2.056E+06	-2.289E+03		298		
Al_2SiO_5	0.5						2000		
ANDALUSITE	91.4	2.77306E+02	-6.588E-03	-1.9141E+06	-2.2656E+03		298		
Al_2SiO_5	0.1						2000		
SILLIMANITE	95.4	2.8019E+02	-6.900E-03	-1.376E+06	-2.399E+03		298		
Al_2SiO_5	0.6						2000		
MULLITE	275.0	7.546E+02	-2.943E-02	-3.454E+06	-6.576E+03		298		
$Al_6Si_2O_{13}$	5.0						1800		
DUMORTIERITE	334.9	1.43871E+03	-2.427E-01	3.860E+06	-1.682E+04	4.884E-05	298		
$Al_{6.75}\square_{.25}Si_3{}^{BO}{}_{17.25}(OH)_{.75}$	5.0						1800		
PHENAKITE	63.4	4.2849E+02	-9.958E-02	2.083E+06	-5.6705E+03	1.989E-05	298		
Be_2SiO_4	0.3						1800		
BERYL	346.7	1.625E+03	-4.252E-01	6.825E+06	-2.018E+04	1.203E-04	298		
$Be_3Al_2(Si_6O_{18})$	4.7						1800		
BERTRANDITE	172.1	8.253E+02	-9.965E-02	3.662E+06	-1.057E+04		298		
$Be_4Si_2O_7(OH)_2$	0.8						1400		
EUCLASE	89.1	5.329E+02	-1.507E-01	2.198E+06	-6.726E+03	4.122E-05	298		
$BeAlSiO_4(OH)$	0.4						1800		
EPIDOTE	328.9	3.676E+02					298		
$Ca_2Al_2Fe_2Si_3O_{12}(OH)$	2.5								
LAWSONITE	230.0	2.7732E+02	2.341E-01	-6.389E+06			298		
$CaAl_2Si_2O_7(OH)_2H_2O$	0.4						600		
GEHLENITE	210.1	4.057E+02	-7.099E-03	-1.188E+06	-3.174E+03		298		
$Ca_2Al_2SiO_7$	0.6						1800		
ZOISITE	295.9	1.134E+03	-4.523E-01		-1.157E+04	2.391E-04	298		
$Ca_2Al_3Si_3O_{12}(OH)$	0.3						750		
GROSSULAR	260.1	1.5293E+03	-6.990E-01	7.443E+06	-1.894E+04	2.530E-04	298		
$Ca_3Al_2Si_3O_{12}$	0.5						1200		
GLASS	329.9+	3.392E+02					298		
$Ca_3Al_2Si_3O_{12}$	0.7								

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR ORTHO AND RING STRUCTURE SILICATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
DATOLITE	110.2	1.9446E+02	1.8447E-01	4.0191E+05	-2.0305E+03	-1.01E-04	298		
$CaB(SiO_4)(OH)$	0.6						1000		
ILVAITE	292.3	8.569E+03	-5.2407E+00	9.6449E+07	-1.3456E+05		290		
$CaFe_3(Si_2O_7)O(OH)$	0.6						376		
ANDRADITE	316.4	8.092E+02	-7.025E-02	-6.789E+05	-7.403E+03		298		
$Ca_3Fe_2Si_3O_{12}$	2.0						1000		
MONTICELLITE	108.1	2.314E+02	-8.531E-04	-1.247E+06	-1.623E+03	-1.333E-06	298		
$CaMgSiO_4$	0.3						1000		
AKERMANITE	212.5	7.8146E+01	1.6573E-01	-6.7905E+06	2.8646E+03	-3.3437E-05	298	357.9	0.68
$Ca_2MgSi_2O_7$	0.4						1731		
MERWINITE	253.1	6.508E+02	-1.816E-01		-6.053E+03	7.036E-05	298		
$Ca_3Mg(SiO_4)_2$	2.1						1600		
TITANITE (Sphene)	129.2	1.767E+02	2.385E-02	-3.991E+06			298		
$CaTiSiO_5$	0.8						1670		
LARNITE	127.6	2.487E+02	-8.315E-04	-9.077E+04	-2.052E+03		298		
α-Ca_2SiO_4	0.8						970		
BREDIGITE	314.2	1.3456E+02	4.611E-02				970		
α'-Ca_2SiO_4	1.0						1710		
CALCIO-OLIVINE	120.5	1.327E+02	5.251E-02	-1.905E+06			298		
γ-Ca_2SiO_4	0.8						1200		
HATURITE (ALITE)	168.6	3.339E+02	-4.651E-03	-6.526E+04	-2.766E+03		298		
Ca_3SiO_5	0.3						1800		
RANKINITE	210.6	4.732E+02	-4.207E-02	3.397E+05	-4.319E+03		298		
$Ca_3Si_2O_7$	2.9						1400		
ROSENHAHNITE	281.8	3.650E+02	5.419E-02	-8.161E+06			298		
$Ca_3Si_3O_8(OH)_2$	3.0						1800		
SPURRITE	331.0	6.141E+02	-3.508E-03	-2.493E+06	-4.168E+03		298		
$Ca_5(SiO_4)_2CO_3$	2.0						1300		
TILLEYITE	394.0	7.417E+02	-5.345E-03	-1.435E+06	-5.879E+03		298		
$Ca_5Si_2O_7(CO_3)_2$	4.0						1200		
COBALT-OLIVINE	142.6	3.0583E+02	-3.195E-02	2.693E+05	-2.865E+03		298		
Co_2SiO_4	0.2						1100		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR ORTHO AND RING STRUCTURE SILICATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H^{\circ}$ $kJ \cdot mol^{-1}$
FAYALITE	151.0	1.7602E+02	-8.808E-03	-3.889E+06		2.471E-05	298	1490	
Fe_2SiO_4	0.2						1490		
ALMANDINE	342.6	8.629E+02	-8.288E-02	1.697E+06	-8.875E+03		298		
$Fe_3Al_2Si_3O_{12}$	1.4						1200		
STAUROLITE	985.0	2.798E+03	7.921E-02	-9.952E+06	-2.474E+04		298		
$Fe_4Al_{18}Si_8O_{46}(OH)_2$	4.0						1000		
OSUMILITE		5.842E+02	1.276E+00	-3.967E+06	-1.556E+03	-6.497E-04	298		
$KMg_2Al_3[Si_{10}Al_2O_{30}] \cdot H_2O$							1000		
CORDIERITE	407.2	8.123E+02	4.334E-02	-8.211E+06	-5.000E+03		298		
$Mg_2Al_3(AlSi_5O_{18})$	3.8						1700		
FORSTERITE	94.1	8.736E+01	8.717E-02	-3.699E+06	8.436E+02	-2.237E-05	298		
Mg_2SiO_4	0.1						1800		
PYROPE	266.3	8.730E+02	-1.374E-01	4.500E+03	-8.794E+03	3.341E-05	298	1570	241.0
$Mg_3Al_2Si_3O_{12}$	0.8						1570		
GLASS	346.3	5.138E+02	7.119E-02	-5.857E+05	-2.439E+03		298		
$Mg_3Al_2Si_3O_{12}$	12.0						1020		
GLASS		6.300E+02	3.50E-02				1083		
$Mg_3Al_2Si_3O_{12}$							1863		
PYROPE-GROSSULAR ss	268.3+	3.280E+02					298		
$(Mg_{1.8}Ca_{1.2})Al_2Si_3O_{12}$	0.5								
GLASS	311.8+	3.329E+02					298		
$(Mg_{1.5}Ca_{1.5})Al_2Si_3O_{12}$	0.6								
TEPHROITE	155.9	2.613E+02	-1.378E-02		-2.218E+03		298		
Mn_2SiO_4	0.5						1600		
LIEBENBERGITE	128.1	2.897E+02	-2.402E-02	1.310E+05	-2.779E+03		298		
Ni_2SiO_4	0.2						1300		
Ni_2SiO_4-SPINEL	124.1	1.654E+02	1.412E-02	-4.345E+06			350		
Ni_2SiO_4	0.4						800		
WILLEMITE	131.4	1.233E+02					298		
Zn_2SiO_4	0.8								
ZIRCON	84.0	2.370E+02	-1.788E-02	-1.496E+05	-2.268E+03		298		
$ZrSiO_4$	1.3						1600		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR CHAIN STRUCTURE SILICATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
WOLLASTONITE	81.7	2.0078E+02	-2.589E-02	-1.579E+05	-1.826E+03	7.434E-06	298	1398	5.93
$CaSiO_3$	0.1						1400		
PSEUDOWOLLASTONITE	87.2	1.578E+02	-1.045E-03	-6.396E+05	-1.077E+03		298	1821	57.30
$CaSiO_3$	0.9						1821		
GLASS	94.8	9.689E+01	3.425E-02	-1.804E+06			298		
$CaSiO_3$	3.0						1821		
Ca-Al PYROXENE	141.0	4.652E+02	-7.838E-02	6.729E+05	-4.941E+03	1.934E-05	298		
$CaAl_2SiO_6$	2.0						1000		
GLASS	155.3	1.661E+02					298		
$CaAl_2SiO_6$	0.3								
FERROBUSTAMITE	180.5	4.038E+02	-4.444E-02		-3.757E+03	1.597E-05	298		
$CaFeSi_2O_6$	0.3						1600		
HEDENBERGITE	174.2	3.1046E+02	1.257E-02	-1.846E+06	-2.040E+03		298		
$CaFeSi_2O_6$	0.3						1300		
GLASS	185.7+	1.732E+02					298		
$CaFeSi_2O_6$	0.4								
DIOPSIDE	142.7	4.7025E+02	-9.864E-02	2.454E+05	-4.823E+03	2.813E-05	298	1668	137.70
$CaMgSi_2O_6$	0.3						1700		
GLASS	166.0	1.041E+03	-6.358E-01	6.677E+06	-1.351E+04	2.724E-04	298		
$CaMgSi_2O_6$	3.0						1400		
FERROSILITE	94.6	1.243E+02	1.454E-02	-3.378E+06			298		
$FeSiO_3$	0.3						800		
α-SPODUMENE	129.3	4.212E+02	-2.401E-02	1.910E+06	-4.776E+03		298		
$LiAlSi_2O_6$	0.8						1200		
β-SPODUMENE	154.4	3.628E+02	-3.684E-03		-3.435E+03		298		
$LiAlSi_2O_6$	1.2						1700		
ENSTATITE	66.3	3.507E+02	-1.472E-01	1.769E+06	-4.296E+03	5.826E-05	298	1834	73.20
$MgSiO_3$	0.1						1000		
GLASS	74.1	8.205E+01					298		
$MgSiO_3$	0.2								
CLINOENSTATITE	67.9	2.056E+02	-1.280E-02	1.193E+06	-2.298E+03		298		
$MgSiO_3$	0.4						1600		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR CHAIN STRUCTURE SILICATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
$MgSiO_3$-ILMENITE	60.4	6.912E+01	7.330E-02	1.037E+06			298		
$MgSiO_3$	3.0						700		
HYPERSTHENE	69.0+	2.079E+02	-1.489E-02	1.921E+05	-2.135E+03		298		
$(Mg_{.85}Fe_{.15})SiO_3$	0.2						1000		
RHODONITE	100.5	9.904E+01	1.915E-02	-3.041E+06	2.745E+02		298		
$MnSiO_3$	1.0						1500		
JADEITE	133.5	3.011E+02	1.014E-02	-2.239E+06	-2.055E+03		298		
$NaAlSi_2O_6$	1.3						1300		
GLASS	170.5	1.663E+02					298		
$NaAlSi_2O_6$	0.4								
ACMITE	170.6	1.994E+02	6.197E-02	-4.267E+06			298		
$NaFeSi_2O_6$	0.8						1300		
TREMOLITE	548.9	6.131E+03	-4.189E+00	5.139E+07	-8.566E+04	1.757E-03	298		
$Ca_2Mg_5Si_8O_{22}(OH)_2$	1.3						1100		
GRUNERITE	725.0	7.555E+02	3.620E-01	-1.621E+07			298		
$Fe_7Si_8O_{22}(OH)_2$	7.0						900		
ANTHOPHILLITE	534.5	1.260E+03	1.888E-02	-1.164E+07	-8.127E+03		298		
$Mg_7Si_8O_{22}(OH)_2$	3.5						1200		
RIEBECKITE	691.0	7.721E+02	2.827E-01	-1.598E+07			298		
$Na_2Fe_3Fe_2Si_8O_{22}(OH)_2$	6.0						1000		
GLAUCOPHANE	541.2	1.718E+03	-1.211E-01	7.075E+06	-1.927E+04		298		
$Na_2Mg_3Al_2Si_8O_{22}(OH)_2$	3.0						1200		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR FRAMEWORK STRUCTURE SILICATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
EDINGTONITE (ordered)	434.8	4.220E+02					298		
$BaAl_2Si_3O_{10} \cdot 3H_2O$	1.5								
ANORTHITE	199.3	5.168E+02	-9.249E-02	-1.408E+06	-4.589E+03	4.188E-05	298		
$CaAl_2Si_2O_8$	0.3						1800		
$CaAl_2Si_2O_8$-glass	237.3	3.752E+02	3.197E-02	-2.815E+06	-2.459E+03		298	1830	133.0
$CaAl_2Si_2O_8$	2.5						1500		4.0
BICCHULITE	213.1	2.803E+02	8.204E-02	-5.679E+06			298		
$Ca_2Al_2SiO_6(OH)_2$	5.0						1800		
MEIONITE (ordered)	715.2	9.103E+02	1.9435E-01	-2.300E+07			298		
$Ca_4Al_6Si_6O_{24}CO_3$	1.0						1000		
DANBURITE	155.3	1.488E+02	2.173E-01	-3.280E+06			298		
$CaB_2Si_2O_8$	0.4						1000		
POLLUCITE	207.2	1.128E+02	1.876E-01	4.556E+05			298		
$(Cs_{.65}Na_{.19}Rb_{.03})Al_2Si_4O_{12} \cdot H_2O$	0.4						700		
MICROCLINE	214.2	7.595E+02	-2.171E-01	4.746E+06	-9.527E+03	6.433E-05	298		
$KAlSi_3O_8$	0.4						1400		
SANIDINE	232.8	6.934E+02	-1.717E-01	3.462E+06	-8.305E+03	4.919E-05	298	1500	54.0
$KAlSi_3O_8$	0.5						1400		
GLASS	261.6	6.295E+02	-1.084E-01	2.496E+06	-7.210E+03	-1.928E-05	298		
$KAlSi_3O_8$	1.8						1300		
KALIOPHILLITE	133.3	1.889E+02	5.519E-02		-1.479E+03		298	810	0.5
$KAlSiO_4$	1.2						810		
LEUCITE	200.2	1.4842E+02	1.343E-01	-2.165E+06			298		
$KAlSi_2O_6$	1.7						955		
LEUCITE	450.1	1.9647E+02	2.7666E-02	1.2261E+07			955		
$KAlSi_2O_6$	2.0						1800		
EUCRYPTITE	103.8	2.470E+02		-1.290E+06	-2.058E+03		298		
$LiAlSiO_4$	0.8						1300		
PETALITE	233.2	8.763E+02	-2.079E-01	4.033E+06	-1.069E+04	5.301E-05	298		
$LiAlSi_4O_{10}$	0.6						1300		
ALBITE	207.4	5.839E+02	-9.285E-02	1.678E+06	-6.424E+03	2.272E-05	298		
$NaAlSi_3O_8$	0.4						1400		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR FRAMEWORK STRUCTURE SILICATE MINERALS

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H^{\circ}$ $kJ \cdot mol^{-1}$
ANALBITE	225.6	6.714E+02	-1.467E-01	3.174E+06	-7.974E+03	3.659E-05	298	1393	64.5
$NaAlSi_3O_8$	0.4						1400		
GLASS	251.9	9.180E+02	-3.824E-01	5.280E+06	-1.151E+04	1.474E-04	298		
$NaAlSi_3O_8$	1.5						1200		
NEPHELINE	124.4	2.774E+01	2.954E-01				298		
$NaAlSiO_4$	1.3						457		
NEPHELINE		1.1209E+02	6.711E-02				457		
$NaAlSiO_4$							1180		
NEPHELINE	338.3	1.720E+02	5.520E-03				1180		
$NaAlSiO_4$	2.0						1525		
CARNEGIEITE	118.7	1.1613E+02	8.595E-02	-2.000E+06			273	966	8.5
$NaAlSiO_4$	0.3						966		
CARNEGIEITE	311.1	1.5232E+02	2.883E-02				966		
$NaAlSiO_4$	1.5						1700		
GLASS	134.5	3.171E+02	-4.320E-02	4.163E+05	-3.244E+03		272		
$NaAlSiO_4$	0.5						1033		
NEPHELINE		1.121E+02	6.711E-02				467		
$(Na_{.78}K_{.22})AlSiO_4$							1180		
ANALCIME	227.7	1.3438E+02	2.5415E-01	1.845E+05			298		
$NaAlSi_2O_6 \cdot H_2O$	0.3						700		
DEHYDRATED ANALCIME	172.5	1.9211E+02	8.0735E-02	-4.723E+06			298		
$NaAlSi_2O_6$	0.2						1000		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SHEET STRUCTURE SILICATES

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
DICKITE	197.1	9.084E+02	-2.113E-01	3.804E+06	-1.120E+04		298		
$Al_2Si_2O_5(OH)_4$	1.3						1000		
KAOLINITE	200.4	1.4303E+03	-7.885E-01	8.334E+06	-1.852E+04	3.034E-04	298		
$Al_2Si_2O_5(OH)_4$	0.5						800		
HALLOYSITE	203.0	2.463E+02					298		
$Al_2Si_2O_5(OH)_4$	1.3								
PYROPHYLLITE	239.4	7.468E+02	-5.345E-02		-7.578E+03	1.986E-05	298		
$Al_2Si_4O_{10}(OH)_2$	0.4						800		
ILLITE	1104.2	1.291E+03					298		
$K_3(Al_7Mg)(Al_2Si_{14})O_{40}(OH)_8$	2.5								
MARGARITE	263.6	8.265E+02	-5.040E-01		-8.7274E+03		298		
$CaAl_2[Al_2Si2O_{10}](OH)_2$	0.3						1200		
PREHNITE	292.8	9.460E+02	-1.1506E-01	2.755E+06	-1.056E+04		298		
$Ca_2Al[AlSi_3O_{10}](OH)_2$	0.7						1200		
MUSCOVITE (disordered)	306.4	9.177E+02	-8.111E-02	2.834E+06	-1.035E+04		298		
$KAl_2[AlSi_3O_{10}](OH)_2$	0.6						1000		
MUSCOVITE (ordered)	287.7	9.177E+02	-8.111E-02	2.834E+06	-1.035E+04		298		
$KAl_2[AlSi_3O_{10}](OH)_2$	0.6						1000		
ANNITE	415.0	6.366E+02	8.208E-02	-4.860E+06	-3.731E+03		298		
$KFe_3[AlSi_3O_{10}](OH)_2$	10.0						1000		
PHLOGOPITE (disordered)	334.6	8.639E+02	-7.6076E-02	3.5206E+05	-8.470E+03		298		
$KMg_3[AlSi_3O_{10}](OH)_2$	1.0						1000		
PHLOGOPITE (ordered)	315.9	8.639E+02	-7.6076E-02	3.5206E+05	-8.470E+03		298		
$KMg_3[AlSi_3O_{10}](OH)_2$	1.0						1000		
FLUORPHLOGOPITE (disordered)	336.3	4.9288E+02	4.910E-02	-6.599E+06	-1.569E+03		298		
$KMg_3[AlSi_3O_{10}]F_2$	2.1						1670		
FLUORPHLOGOPITE (ordered)	317.6	4.9288E+02	4.910E-02	-6.599E+06	-1.569E+03		298		
$KMg_3[AlSi_3O_{10}]F_2$	2.1						1670		
TALC	260.8	5.654E+03	-5.272E+00	4.021E+07	-7.693E+04	2.729E-03	298		
$Mg_3Si_4O_{10}(OH)_2$	0.6						800		
CHRYSOTILE	221.3	8.996E+02	-1.448E-01	4.500E+06	-1.093E+04		298		
$Mg_3Si_2O_5(OH)_4$	0.8						900		

COEFFICIENTS FOR HEAT CAPACITY EQUATIONS FOR SHEET STRUCTURE SILICATES

NAME AND FORMULA	ENTROPY $J \cdot mol^{-1} \cdot K^{-1}$	A1	A2 (T)	A3 (T^{-2})	A4 ($T^{-0.5}$)	A5 (T^{2})	T range K	T_{tm} K	$\Delta_{tm}H°$ $kJ \cdot mol^{-1}$
CLINOCHLORE	421.0	9.47951E+03	-7.8834E+00	8.31194E+07	-1.3594E+05	3.6206E-03	298		
$Mg_5Al(AlSi_3O_{10})(OH)_8$	15.0						800		
PARAGONITE (disordered)	295.8	6.6844E+02	3.627E-02	-1.860E+06	-5.816E+03		298		
$NaAl_2[AlSi_3O_{10}](OH)_2$	0.9						800		
PARAGONITE (ordered)	277.1	6.6844E+02	3.627E-02	-1.860E+06	-5.816E+03		298		
$NaAl_2[AlSi_3O_{10}](OH)_2$	0.9						800		

Thermodynamic Properties at High Temperature of Individual Phases

SILVER (REFERENCE STATE) **Formula wt 107.868**

Ag: Face-centered cubic crystals 298.15 to melting point 1234.9 K; liquid 1234.9 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.40	42.55	0.00	42.55	0.0	0.0	0.0
300	25.41	42.71	0.16	42.55	0.0	0.0	0.0
400	25.87	50.08	6.53	43.55	0.0	0.0	0.0
500	26.33	55.90	10.44	45.46	0.0	0.0	0.0
600	26.88	60.75	13.14	47.62	0.0	0.0	0.0
700	27.52	64.94	15.14	49.80	0.0	0.0	0.0
800	28.24	68.66	16.73	51.93	0.0	0.0	0.0
900	29.03	72.03	18.06	53.98	0.0	0.0	0.0
1000	29.86	75.14	19.19	55.94	0.0	0.0	0.0
1100	30.73	78.02	20.20	57.82	0.0	0.0	0.0
1200	31.64	80.73	21.12	59.62	0.0	0.0	0.0
1234.9	31.96	81.73	21.41	60.32	0.0	0.0	0.0
1234.9	33.47	90.88	30.57	60.31	0.0	0.0	0.0
1300	33.47	92.52	30.71	61.81	0.0	0.0	0.0
1400	33.47	95.00	30.91	64.09	0.0	0.0	0.0
1500	33.47	97.31	31.08	66.23	0.0	0.0	0.0
1600	33.47	99.47	31.23	68.24	0.0	0.0	0.0
1700	33.47	101.50	31.36	70.14	0.0	0.0	0.0
1800	33.47	103.41	31.48	71.93	0.0	0.0	0.0

Melting T 1234.9 K

$\Delta_{fus}H^\circ$ 11.94 kJ

$H_{298}^\circ-H_0^\circ$ 5.745 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.0272 $J\cdot bar^{-1}$

10.272 cm^3

6/18/92

ALUMINUM (REFERENCE STATE) **Formula wt 26.982**

Al: Face-centered cubic crystals 298.15 to melting point 933.5 K. Liquid 933.5 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	24.21	28.30	0.00	28.30	0.0	0.0	0.0
300	24.25	28.45	0.15	28.30	0.0	0.0	0.0
400	25.76	35.65	6.38	29.27	0.0	0.0	0.0
500	26.84	41.52	10.37	31.15	0.0	0.0	0.0
600	27.90	46.50	13.20	33.31	0.0	0.0	0.0
700	29.12	50.89	15.38	35.51	0.0	0.0	0.0
800	30.57	54.87	17.19	37.69	0.0	0.0	0.0
900	32.30	58.57	18.77	39.80	0.0	0.0	0.0
933.5	32.96	59.74	19.26	40.48	0.0	0.0	0.0
933.5	31.75	71.21	30.73	40.48	0.0	0.0	0.0
1000	31.75	73.40	30.81	42.59	0.0	0.0	0.0
1100	31.75	76.43	30.89	45.54	0.0	0.0	0.0
1200	31.75	79.19	30.96	48.23	0.0	0.0	0.0
1300	31.75	81.73	31.00	50.73	0.0	0.0	0.0
1400	31.75	84.08	31.08	53.00	0.0	0.0	0.0
1500	31.75	86.27	31.12	55.15	0.0	0.0	0.0
1600	31.75	88.32	31.16	57.16	0.0	0.0	0.0
1700	31.75	90.25	31.19	59.06	0.0	0.0	0.0
1800	31.75	92.06	31.23	60.83	0.0	0.0	0.0

Melting T	933.5 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	10.71 kJ		
		Molar Vol.	0.9999 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	4.565 kJ		9.999 cm^3

4/22/92

ARSENIC (REFERENCE STATE) **Formula wt 74.922**

As: Rhombohedral crystals 298.15 to sublimation point 875 K. Ideal tetratomic gas 875 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	24.65	35.69	0.00	35.69	0.0	0.0	0.0
300	24.67	35.84	0.15	35.69	0.0	0.0	0.0
400	25.38	43.04	6.37	36.66	0.0	0.0	0.0
500	25.96	48.77	10.23	38.54	0.0	0.0	0.0
600	26.51	53.55	12.90	40.65	0.0	0.0	0.0
700	27.05	57.68	14.88	42.80	0.0	0.0	0.0
800	27.60	61.33	16.43	44.89	0.0	0.0	0.0
875	28.03	63.82	17.31	46.51	0.0	0.0	0.0
875	20.60	103.62	57.11	46.51	0.0	0.0	0.0
900	20.61	104.14	56.14	48.00	0.0	0.0	0.0
1000	20.64	106.31	52.59	53.72	0.0	0.0	0.0
1100	20.67	108.28	49.68	58.59	0.0	0.0	0.0
1200	20.69	110.08	47.26	62.81	0.0	0.0	0.0

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 5.130 kJ

Boiling T 875 K

$\Delta_{vap}H^\circ$ 34.828 kJ

Molar Vol. 1.2963 $J\cdot bar^{-1}$

12.963 cm^3

6/10/92

GOLD (REFERENCE STATE) **Formula wt 196.967**

Au: Face-centered cubic crystals 298.15 to melting point 1336.15 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	25.18	47.49	0.00	47.49	0.0	0.0	0.0
300	25.19	47.65	0.16	47.49	0.0	0.0	0.0
400	25.88	55.00	6.51	48.49	0.0	0.0	0.0
500	26.26	60.82	10.43	50.39	0.0	0.0	0.0
600	26.57	65.63	13.09	52.54	0.0	0.0	0.0
700	26.91	69.76	15.04	54.71	0.0	0.0	0.0
800	27.36	73.38	16.55	56.83	0.0	0.0	0.0
900	27.93	76.63	17.78	58.85	0.0	0.0	0.0
1000	28.67	79.61	18.83	60.78	0.0	0.0	0.0
1100	29.57	82.38	19.77	62.62	0.0	0.0	0.0
1200	30.66	85.00	20.63	64.37	0.0	0.0	0.0
1300	31.95	87.51	21.45	66.06	0.0	0.0	0.0
1336.15	32.47	88.55	21.80	66.74	0.0	0.0	0.0
1336.15	33.54	97.94	31.20	66.74	0.0	0.0	0.0
1400	32.75	99.34	31.23	68.11	0.0	0.0	0.0
1500	31.49	101.54	31.28	70.26	0.0	0.0	0.0
1600	30.81	103.54	31.25	72.29	0.0	0.0	0.0
1700	30.81	105.39	31.21	74.18	0.0	0.0	0.0
1800	30.81	107.15	31.19	75.96	0.0	0.0	0.0

Melting T 1336.15 K

$\Delta_{fus}H^\circ$ 12.55 kJ

$H_{298}^\circ-H_0^\circ$ 6.017 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.0215 J·bar^{-1}

10.215 cm^3

01/07/93

BORON (REFERENCE STATE) **Formula wt 10.811**

B: Rhombohedral crystals 298.15 to melting point 2350 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	11.32	5.83	0.00	5.83	0.0	0.0	0.0
300	11.42	5.90	0.07	5.83	0.0	0.0	0.0
400	15.84	9.84	3.51	6.34	0.0	0.0	0.0
500	18.69	13.71	6.28	7.43	0.0	0.0	0.0
600	20.69	17.30	8.52	8.78	0.0	0.0	0.0
700	22.18	20.61	10.37	10.24	0.0	0.0	0.0
800	23.33	23.65	11.92	11.72	0.0	0.0	0.0
900	24.25	26.45	13.24	13.21	0.0	0.0	0.0
1000	25.01	29.05	14.38	14.66	0.0	0.0	0.0
1100	25.66	31.46	15.38	16.08	0.0	0.0	0.0
1200	26.21	33.72	16.26	17.46	0.0	0.0	0.0
1300	26.71	35.83	17.04	18.79	0.0	0.0	0.0
1400	27.16	37.83	17.75	20.08	0.0	0.0	0.0
1500	27.57	39.72	18.39	21.33	0.0	0.0	0.0
1600	27.96	41.51	18.98	22.53	0.0	0.0	0.0
1700	28.33	43.22	19.52	23.70	0.0	0.0	0.0
1800	28.69	44.85	20.02	24.83	0.0	0.0	0.0

Melting T	2350 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	22.55 kJ		
		Molar Vol.	0.4386 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	1.22 kJ		4.386 cm^3

BARIUM (REFERENCE STATE) **Formula wt 137.327**

Ba: α-crystals (body-centered cubic) 298.15 to lambda-anomaly in heat capacity at 582 K. β-crystals 582 to second-order lambda-anomaly in heat capacity at 768.13 K. γ-crystals 768.13 to melting point 1002 K. Liquid 1002 to boiling point 2169 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	28.09	62.42	0.00	62.42	0.0	0.0	0.0
300	28.14	62.59	0.17	62.42	0.0	0.0	0.0
400	33.23	71.24	7.68	63.56	0.0	0.0	0.0
500	43.74	79.72	13.78	65.94	0.0	0.0	0.0
582	54.43	86.71	18.19	68.52	0.0	0.0	0.0
582	32.47	87.13	18.61	68.52	0.0	0.0	0.0
600	33.94	88.16	19.18	68.97	0.0	0.0	0.0
700	42.36	94.02	21.89	72.13	0.0	0.0	0.0
768	48.10	98.02	23.64	74.38	0.0	0.0	0.0
768	39.07	98.34	23.96	74.38	0.0	0.0	0.0
800	39.07	99.81	24.56	75.24	0.0	0.0	0.0
900	39.07	104.41	26.17	78.24	0.0	0.0	0.0
1000	39.07	108.52	27.46	81.06	0.0	0.0	0.0
1002	39.07	109.34	27.87	81.46	0.0	0.0	0.0
1002	40.62	117.07	35.61	81.46	0.0	0.0	0.0
1100	40.37	120.60	36.13	84.48	0.0	0.0	0.0
1200	40.12	124.20	36.57	87.64	0.0	0.0	0.0
1300	39.86	127.44	36.86	90.58	0.0	0.0	0.0
1400	39.61	130.38	37.08	93.30	0.0	0.0	0.0
1500	39.36	133.08	37.20	95.88	0.0	0.0	0.0
1600	39.10	135.58	37.30	98.28	0.0	0.0	0.0
1700	38.85	137.92	37.37	100.55	0.0	0.0	0.0
1800	38.60	140.13	37.44	102.69	0.0	0.0	0.0

Melting T 1002 K

Boiling T K

$\Delta_{fus}H^\circ$ 7.749 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 6.912 kJ

Molar Vol. 3.821 $J\cdot bar^{-1}$

38.21 cm^3

6/12/92

BERYLLIUM (REFERENCE STATE) **Formula wt 9.012**

Be: Hexagonal close-packed crystals 298.15 to 1550 K; beta crystals 1550 to melting point 1560 K; liquid 1560 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$		$kJ\cdot mol^{-1}$		
298.15	16.44	9.50	0.00	9.50	0.0	0.0	0.0
300	16.52	9.60	0.10	9.50	0.0	0.0	0.0
400	19.64	14.83	4.64	10.19	0.0	0.0	0.0
500	21.58	19.43	7.84	11.59	0.0	0.0	0.0
600	23.06	23.50	10.26	13.24	0.0	0.0	0.0
700	24.32	27.15	12.18	14.97	0.0	0.0	0.0
800	25.47	30.47	13.77	16.71	0.0	0.0	0.0
900	26.54	33.54	15.13	18.41	0.0	0.0	0.0
1000	27.58	36.39	16.32	20.07	0.0	0.0	0.0
1100	28.59	39.06	17.39	21.67	0.0	0.0	0.0
1200	29.57	41.59	18.37	23.23	0.0	0.0	0.0
1300	30.55	44.00	19.27	24.73	0.0	0.0	0.0
1400	31.52	46.30	20.11	26.19	0.0	0.0	0.0
1500	32.47	48.51	20.90	27.61	0.0	0.0	0.0
1550	32.95	49.58	21.28	28.30	0.0	0.0	0.0
1550	30.00	50.94	22.64	28.30	0.0	0.0	0.0
1560	30.00	51.13	22.68	28.45	0.0	0.0	0.0
1560	30.00	59.20	30.76	28.44	0.0	0.0	0.0
1600	30.00	59.96	30.74	29.22	0.0	0.0	0.0
1700	30.00	61.78	30.70	31.08	0.0	0.0	0.0
1800	30.00	63.50	30.66	32.84	0.0	0.0	0.0

Melting T 1560 K

Boiling T K

$\Delta_{fus}H^\circ$ 12.21 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 1.95 kJ

Molar Vol. 0.488 $J\cdot bar^{-1}$

4.88 cm^3

6/18/92

BISMUTH (REFERENCE STATE) **Formula wt 208.980**

Bi: Rhombohedral crystals 298.15 to melting point 544.5 K. Liquid 544.5 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.41	56.74	0.00	56.74	0.0	0.0	0.0
300	25.43	56.90	0.16	56.74	0.0	0.0	0.0
400	26.62	64.36	6.61	57.75	0.0	0.0	0.0
500	28.66	70.50	10.80	59.70	0.0	0.0	0.0
544.52	29.83	73.40	12.39	61.01	0.0	0.0	0.0
544.52	30.48	94.15	33.14	61.01	0.0	0.0	0.0
600	29.61	96.64	32.76	63.88	0.0	0.0	0.0
700	28.61	101.13	32.24	68.89	0.0	0.0	0.0
800	28.02	104.90	31.74	73.16	0.0	0.0	0.0
900	27.67	108.18	31.31	76.87	0.0	0.0	0.0
1000	27.45	111.08	30.93	80.15	0.0	0.0	0.0
1100	27.31	113.69	30.61	83.08	0.0	0.0	0.0
1200	27.24	116.07	30.33	85.74	0.0	0.0	0.0
1300	27.19	118.25	30.09	88.16	0.0	0.0	0.0
1400	27.17	120.26	29.88	90.38	0.0	0.0	0.0
1500	27.17	122.13	29.70	92.43	0.0	0.0	0.0
1600	27.18	123.89	29.54	94.35	0.0	0.0	0.0
1700	27.19	125.54	29.41	96.14	0.0	0.0	0.0
1800	27.21	127.09	29.28	97.81	0.0	0.0	0.0

Melting T 544.52 K

$\Delta_{fus}H^\circ$ 11.299 kJ

$H_{298}^\circ-H_0^\circ$ 6.43 kJ

Boiling T 1835 K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.131 $J\cdot bar^{-1}$

21.31 cm^3

4/23/92

BROMINE (REFERENCE STATE) **Formula wt 159.808**

Br_2: Liquid 298.15 to boiling point 332.5 K; ideal diatomic gas, P = 1 bar, 332.5 to 2200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	75.67	152.20	0.00	152.20	0.0	0.0	0.0
300	75.60	152.67	0.47	152.20	0.0	0.0	0.0
332.5	75.30	160.43	7.79	152.64	0.0	0.0	0.0
332.5	36.33	249.34	96.70	152.64	0.0	0.0	0.0
400	36.71	256.09	86.55	169.54	0.0	0.0	0.0
500	37.08	264.33	76.62	187.71	0.0	0.0	0.0
600	37.31	271.11	70.05	201.06	0.0	0.0	0.0
700	37.48	276.87	65.39	211.49	0.0	0.0	0.0
800	37.60	281.89	61.91	219.98	0.0	0.0	0.0
900	37.70	286.32	59.21	227.11	0.0	0.0	0.0
1000	37.78	290.30	57.06	233.23	0.0	0.0	0.0
1100	37.87	293.90	55.31	238.59	0.0	0.0	0.0
1200	37.95	297.20	53.86	243.34	0.0	0.0	0.0
1300	38.04	300.24	52.64	247.60	0.0	0.0	0.0
1400	38.14	303.06	51.60	251.46	0.0	0.0	0.0
1500	38.24	305.70	50.71	254.99	0.0	0.0	0.0
1600	38.36	308.17	49.93	258.24	0.0	0.0	0.0
1700	38.49	310.50	49.26	261.24	0.0	0.0	0.0
1800	38.63	312.70	48.66	264.04	0.0	0.0	0.0

Melting T 265.9 K

$\Delta_{fus}H^\circ$ 10.57 kJ

$H_{298}^\circ-H_0^\circ$ 24.51 kJ

Boiling T 332.5 K

$\Delta_{vap}H^\circ$ 29.56 kJ

Molar Vol. 5.458 $J\cdot bar^{-1}$
54.58 cm^3

4/23/92

GRAPHITE (REFERENCE STATE) **Formula wt 12.011**

C: Hexagonal crystals 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	8.52	5.74	0.00	5.74	0.0	0.0	0.0
300	8.59	5.79	0.05	5.74	0.0	0.0	0.0
400	11.88	8.72	2.60	6.12	0.0	0.0	0.0
500	14.64	11.68	4.75	6.93	0.0	0.0	0.0
600	16.79	14.55	6.58	7.97	0.0	0.0	0.0
700	18.47	17.27	8.17	9.10	0.0	0.0	0.0
800	19.77	19.82	9.54	10.29	0.0	0.0	0.0
900	20.80	22.21	10.73	11.48	0.0	0.0	0.0
1000	21.63	24.45	11.78	12.67	0.0	0.0	0.0
1100	22.29	26.54	12.71	13.83	0.0	0.0	0.0
1200	22.83	28.51	13.53	14.98	0.0	0.0	0.0
1300	23.27	30.35	14.26	16.09	0.0	0.0	0.0
1400	23.64	32.09	14.92	17.17	0.0	0.0	0.0
1500	23.95	33.73	15.51	18.22	0.0	0.0	0.0
1600	24.22	35.29	16.05	19.24	0.0	0.0	0.0
1700	24.46	36.76	16.54	20.23	0.0	0.0	0.0
1800	24.67	38.17	16.98	21.18	0.0	0.0	0.0

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	0.5298 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	1.05 kJ		5.298 cm^3

4/23/92

DIAMOND **Formula wt 12.011**

C: Cubic crystals 298.15 to 1600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	6.14	2.38	0.00	2.38	1.9	2.9	-0.51
300	6.21	2.42	0.04	2.38	1.9	2.9	-0.51
400	10.24	4.76	2.09	2.67	1.7	3.3	-0.43
500	13.60	7.43	4.07	3.35	1.6	3.7	-0.38
600	16.12	10.14	5.88	4.26	1.5	4.1	-0.36
700	18.02	12.77	7.48	5.29	1.4	4.6	-0.34
800	19.48	15.28	8.90	6.38	1.4	5.0	-0.33
900	20.65	17.64	10.14	7.50	1.3	5.5	-0.32
1000	21.63	19.87	11.24	8.63	1.3	5.9	-0.31
1100	22.52	21.98	12.23	9.75	1.4	6.4	-0.30
1200	23.36	23.97	13.12	10.85	1.4	6.8	-0.30
1300	24.20	25.87	13.94	11.93	1.5	7.3	-0.29
1400	25.08	27.70	14.70	13.00	1.6	7.7	-0.29
1500	26.04	29.46	15.43	14.04	1.8	8.2	-0.28
1600	27.08	31.18	16.12	15.05	2.0	8.6	-0.28

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	0.3417 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	0.523 kJ		3.417 cm^3

A= 1.37E+00 B= 0.453E-02 C= 1.547E+04

11/18/92

CALCIUM (REFERENCE STATE) **Formula wt 40.078**

Ca: α-crystals (face-centered cubic) 298.15 to 716 K. β-crystals (body-centered cubic) 716 to melting point 1115 K. Liquid 1115 to boiling point 1755 K. Ideal monatomic gas, P = 1 bar, 1774 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.77	42.90	0.00	42.90	0.0	0.0	0.0
300	25.79	43.06	0.16	42.90	0.0	0.0	0.0
400	26.95	50.63	6.71	43.93	0.0	0.0	0.0
500	28.48	56.80	10.90	45.90	0.0	0.0	0.0
600	30.34	62.16	13.98	48.17	0.0	0.0	0.0
700	32.41	66.98	16.46	50.52	0.0	0.0	0.0
716	32.74	67.73	16.83	50.90	0.0	0.0	0.0
716	31.50	69.03	18.13	50.90	0.0	0.0	0.0
800	33.82	72.65	19.65	52.99	0.0	0.0	0.0
900	36.71	76.80	21.39	55.41	0.0	0.0	0.0
1000	39.71	80.82	23.07	57.75	0.0	0.0	0.0
1100	42.76	84.75	24.72	60.03	0.0	0.0	0.0
1115	43.23	85.33	24.96	60.37	0.0	0.0	0.0
1115	35.00	92.99	32.62	60.32	0.0	0.0	0.0
1200	35.00	95.55	32.79	62.76	0.0	0.0	0.0
1300	35.00	98.36	32.96	65.40	0.0	0.0	0.0
1400	35.00	100.95	33.11	67.84	0.0	0.0	0.0
1500	35.00	103.37	33.24	70.13	0.0	0.0	0.0
1600	35.00	105.63	33.35	72.28	0.0	0.0	0.0
1700	35.00	107.75	33.44	74.31	0.0	0.0	0.0
1774	35.00	109.23	33.50	75.73	0.0	0.0	0.0
1774	20.84	193.25	117.52	75.73	0.0	0.0	0.0
1800	20.84	193.55	116.12	77.43	0.0	0.0	0.0

Melting T 1115 K

$\Delta_{fus}H^\circ$ 8.54 kJ

$H_{298}^\circ-H_0^\circ$ 5.707 kJ

Boiling T 1774 K

$\Delta_{vap}H^\circ$ 330.915 kJ

Molar Vol. 2.619 $J\cdot bar^{-1}$

26.19 cm^3

CADMIUM (REFERENCE STATE) **Formula wt 112.411**

Cd: Hexagonal close packed crystals 298.15 to melting point 594.18 K. Liquid 594.18 to boiling point 1039 K. Ideal monatomic gas 1039 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.98	51.80	0.00	51.80	0.0	0.0	0.0
300	26.00	51.96	0.16	51.80	0.0	0.0	0.0
400	27.14	59.59	6.76	52.83	0.0	0.0	0.0
500	28.37	65.78	10.95	54.82	0.0	0.0	0.0
594.18	29.53	70.79	13.81	56.98	0.0	0.0	0.0
594.18	29.71	81.21	24.23	56.98	0.0	0.0	0.0
600	29.71	81.48	24.28	57.19	0.0	0.0	0.0
700	29.71	86.06	25.05	61.00	0.0	0.0	0.0
800	29.71	90.03	25.64	64.39	0.0	0.0	0.0
900	29.71	93.53	26.09	67.44	0.0	0.0	0.0
1000	29.71	96.66	26.45	70.21	0.0	0.0	0.0
1039	29.71	97.97	26.52	71.44	0.0	0.0	0.0
1039	20.79	193.90	122.45	71.44	0.0	0.0	0.0
1100	20.79	194.88	116.81	78.06	0.0	0.0	0.0
1200	20.79	196.69	108.81	87.88	0.0	0.0	0.0
1300	20.79	198.35	102.04	96.31	0.0	0.0	0.0
1400	20.79	199.89	96.23	103.65	0.0	0.0	0.0
1500	20.79	201.33	91.20	110.12	0.0	0.0	0.0
1600	20.79	202.67	86.80	115.86	0.0	0.0	0.0
1700	20.79	203.93	82.92	121.01	0.0	0.0	0.0
1800	20.79	205.12	79.47	125.65	0.0	0.0	0.0

Melting T 594.18 K

$\Delta_{fus}H^\circ$ 6.19 kJ

$H_{298}^\circ-H_0^\circ$ 6.25 kJ

Boiling T 1039 K

$\Delta_{vap}H^\circ$ 99.667 kJ

Molar Vol. 1.3005 $J\cdot bar^{-1}$
13.005 cm^3

CERIUM (REFERENCE STATE) **Formula wt 140.115**

Ce: α-crystals (face-centered cubic) 298.15 to 999 K. β-crystals 999 to melting point 1071 K. Liquid 1071 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	26.93	72.00	0.00	72.00	0.0	0.0	0.0
300	26.96	72.17	0.17	72.00	0.0	0.0	0.0
400	28.29	80.10	7.03	73.07	0.0	0.0	0.0
500	29.70	86.57	11.42	75.14	0.0	0.0	0.0
600	31.20	92.11	14.59	77.52	0.0	0.0	0.0
700	32.77	97.04	17.07	79.96	0.0	0.0	0.0
800	34.40	101.52	19.14	82.38	0.0	0.0	0.0
900	36.07	105.67	20.93	84.74	0.0	0.0	0.0
999	37.76	109.35	22.34	87.01	0.0	0.0	0.0
999	37.61	112.46	25.45	87.01	0.0	0.0	0.0
1000	37.61	112.55	25.52	87.03	0.0	0.0	0.0
1071	37.61	115.19	26.32	88.88	0.0	0.0	0.0
1071	37.70	120.29	31.41	88.88	0.0	0.0	0.0
1100	37.70	121.24	31.58	89.66	0.0	0.0	0.0
1200	37.70	124.52	32.09	92.43	0.0	0.0	0.0
1300	37.70	127.53	32.53	95.00	0.0	0.0	0.0
1400	37.70	130.33	32.89	97.44	0.0	0.0	0.0
1500	37.70	132.93	33.21	99.72	0.0	0.0	0.0
1600	37.70	135.36	33.49	101.87	0.0	0.0	0.0
1700	37.70	137.65	33.74	103.91	0.0	0.0	0.0
1800	37.70	139.80	33.96	105.84	0.0	0.0	0.0

Melting T 1071 K

$\Delta_{fus}H^\circ$ 5.46 kJ

$H_{298}^\circ-H_0^\circ$ 7.28 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.077 $J\cdot bar^{-1}$

20.77 cm^3

6/17/92

CHLORINE (REFERENCE STATE) **Formula wt 70.905**

Cl_2: Ideal diatomic gas 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	33.95	223.08	0.00	223.08	0.0	0.0	0.0
300	33.98	223.29	0.21	223.08	0.0	0.0	0.0
400	35.28	233.26	8.83	224.43	0.0	0.0	0.0
500	36.05	241.22	14.20	227.02	0.0	0.0	0.0
600	36.55	247.84	17.89	229.95	0.0	0.0	0.0
700	36.89	253.50	20.58	232.92	0.0	0.0	0.0
800	37.13	258.45	22.63	235.81	0.0	0.0	0.0
900	37.31	262.83	24.26	238.58	0.0	0.0	0.0
1000	37.45	266.77	25.57	241.20	0.0	0.0	0.0
1100	37.57	270.34	26.65	243.69	0.0	0.0	0.0
1200	37.67	273.62	27.57	246.05	0.0	0.0	0.0
1300	37.76	276.64	28.35	248.29	0.0	0.0	0.0
1400	37.85	279.44	29.02	250.41	0.0	0.0	0.0
1500	37.94	282.05	29.61	252.44	0.0	0.0	0.0
1600	38.03	284.50	30.14	254.37	0.0	0.0	0.0
1700	38.13	286.81	30.61	256.21	0.0	0.0	0.0
1800	38.24	288.99	31.03	257.97	0.0	0.0	0.0

Melting T 172.16 K

$\Delta_{fus}H^\circ$ 6.406 kJ

$H_{298}^\circ-H_0^\circ$ 9.18 kJ

Boiling T 239.1 K

$\Delta_{vap}H^\circ$ 20.41 kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

6/18/92

COBALT (REFERENCE STATE) **Formula wt 58.933**

Co: α-crystals (hexagonal close packed) 298.15 to 700 K. β-crystals (face-centered cubic) 700 to melting point 1768 K. Liquid 1768 to 1800 K. Curie point at 1394 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	24.81	30.04	0.00	30.04	0.0	0.0	0.0
300	24.85	30.19	0.15	30.04	0.0	0.0	0.0
400	26.56	37.58	6.54	31.04	0.0	0.0	0.0
500	28.19	43.68	10.71	32.97	0.0	0.0	0.0
600	29.70	48.96	13.75	35.21	0.0	0.0	0.0
700	31.05	53.64	16.13	37.51	0.0	0.0	0.0
700	30.51	54.27	16.78	37.49	0.0	0.0	0.0
800	32.58	58.50	18.63	39.88	0.0	0.0	0.0
900	34.55	62.45	20.28	42.17	0.0	0.0	0.0
1000	36.85	66.20	21.82	44.38	0.0	0.0	0.0
1100	39.77	69.84	23.31	46.53	0.0	0.0	0.0
1200	43.52	73.46	24.83	48.63	0.0	0.0	0.0
1300	48.26	77.12	26.45	50.67	0.0	0.0	0.0
1394	53.70	80.67	28.15	52.52	0.0	0.0	0.0
1400	44.22	80.88	28.24	52.64	0.0	0.0	0.0
1500	39.75	83.72	29.12	54.61	0.0	0.0	0.0
1600	38.28	86.23	29.73	56.50	0.0	0.0	0.0
1700	37.78	88.53	30.21	58.32	0.0	0.0	0.0
1768	37.74	90.00	30.50	59.50	0.0	0.0	0.0
1768	40.50	99.16	39.66	59.50	0.0	0.0	0.0
1800	40.50	99.98	39.68	60.30	0.0	0.0	0.0

Melting T 1768 K

$\Delta_{fus}H^\circ$ 16.19 kJ

$H_{298}^\circ-H_0^\circ$ 4.766 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 0.667 J·bar^{-1}
6.67 cm^3

CHROMIUM (REFERENCE STATE) **Formula wt 51.996**

Cr: Body-centered cubic crystals 298.15 to melting point 2130 K. Néel temperature 311.5 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	23.47	23.62	0.00	23.62	0.0	0.0	0.0
300	23.53	23.77	0.14	23.62	0.0	0.0	0.0
311.50	23.81	24.66	0.98	23.64	0.0	0.0	0.0
400	25.64	30.88	6.31	24.58	0.0	0.0	0.0
500	26.56	36.71	10.27	26.44	0.0	0.0	0.0
600	27.35	41.62	13.05	28.57	0.0	0.0	0.0
700	28.27	45.90	15.16	30.75	0.0	0.0	0.0
800	29.37	49.75	16.86	32.89	0.0	0.0	0.0
900	30.65	53.28	18.32	34.96	0.0	0.0	0.0
1000	32.09	56.58	19.63	36.96	0.0	0.0	0.0
1100	33.67	59.71	20.83	38.88	0.0	0.0	0.0
1200	35.38	62.71	21.97	40.75	0.0	0.0	0.0
1300	37.19	65.62	23.07	42.55	0.0	0.0	0.0
1400	39.11	68.44	24.15	44.30	0.0	0.0	0.0
1500	41.11	71.21	25.21	46.00	0.0	0.0	0.0
1600	43.19	73.93	26.27	47.66	0.0	0.0	0.0
1700	45.35	76.61	27.33	49.28	0.0	0.0	0.0
1800	47.57	79.27	28.39	50.88	0.0	0.0	0.0

Melting T 2130 K

$\Delta_{fus}H^\circ$ 16.933 kJ

$H_{298}^\circ-H_0^\circ$ 4.058 kJ

Boiling T 2945 K

$\Delta_{vap}H^\circ$ 344.31 kJ

Molar Vol. 0.7231 $J\cdot bar^{-1}$
7.231 cm^3

5/26/93

CESIUM (REFERENCE STATE) **Formula wt 132.905**

Cs: Body-centered cubic crystals 298.15 to melting point 301.55 K. Liquid 301.55 to boiling point 947.96 K. Ideal monatomic gas, P = 1 bar, 942 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	32.19	85.23	0.00	85.23	0.0	0.0	0.0
300	32.35	85.43	0.16	85.27	0.0	0.0	0.0
301.55	32.50	85.60	0.33	85.27	0.0	0.0	0.0
301.55	32.39	92.52	7.25	85.27	0.0	0.0	0.0
400	31.51	101.54	13.34	88.20	0.0	0.0	0.0
500	31.15	108.53	16.94	91.59	0.0	0.0	0.0
600	30.99	114.20	19.29	94.90	0.0	0.0	0.0
700	30.94	118.97	20.96	98.01	0.0	0.0	0.0
800	30.93	123.10	22.21	100.89	0.0	0.0	0.0
900	30.95	126.75	23.18	103.57	0.0	0.0	0.0
947.96	30.97	128.36	23.57	104.78	0.0	0.0	0.0
947.96	20.78	199.73	94.95	104.78	0.0	0.0	0.0
1000	20.78	200.84	91.09	109.75	0.0	0.0	0.0
1100	20.78	202.82	84.70	118.12	0.0	0.0	0.0
1200	20.79	204.63	79.37	125.26	0.0	0.0	0.0
1300	20.79	206.29	74.86	131.43	0.0	0.0	0.0
1400	20.81	207.84	71.00	136.83	0.0	0.0	0.0
1500	20.84	209.27	67.66	141.61	0.0	0.0	0.0
1600	20.88	210.62	64.73	145.88	0.0	0.0	0.0
1700	20.95	211.89	62.16	149.73	0.0	0.0	0.0
1800	21.04	213.09	59.87	153.22	0.0	0.0	0.0

Melting T 301.55 K

$\Delta_{fus}H^\circ$ 2.09 kJ

$H_{298}^\circ-H_0^\circ$ 7.71 kJ

Boiling T 942 K

$\Delta_{vap}H^\circ$ 67.71 kJ

Molar Vol. 6.973 $J\cdot bar^{-1}$

69.73 cm^3

6/11/92

COPPER (REFERENCE STATE) **Formula wt 63.546**

Cu: Face-centered cubic crystals 298.15 to melting point 1357.8 K. Liquid 1357.8 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	24.43	33.14	0.00	33.14	0.0	0.0	0.0
300	24.45	33.29	0.15	33.14	0.0	0.0	0.0
400	25.34	40.45	6.34	34.11	0.0	0.0	0.0
500	25.99	46.18	10.21	35.97	0.0	0.0	0.0
600	26.48	50.96	12.88	38.08	0.0	0.0	0.0
700	26.92	55.08	14.85	40.22	0.0	0.0	0.0
800	27.40	58.70	16.39	42.31	0.0	0.0	0.0
900	27.97	61.96	17.65	44.31	0.0	0.0	0.0
1000	28.69	64.94	18.71	46.23	0.0	0.0	0.0
1100	29.57	67.72	19.66	48.06	0.0	0.0	0.0
1200	30.65	70.34	20.53	49.81	0.0	0.0	0.0
1300	31.93	72.84	21.35	51.48	0.0	0.0	0.0
1357.8	32.77	74.25	21.82	52.43	0.0	0.0	0.0
1357.8	32.80	83.94	31.51	52.43	0.0	0.0	0.0
1400	32.80	84.95	31.55	53.40	0.0	0.0	0.0
1500	32.80	87.21	31.63	55.58	0.0	0.0	0.0
1600	32.80	89.32	31.70	57.62	0.0	0.0	0.0
1700	32.80	91.32	31.77	59.55	0.0	0.0	0.0
1800	32.80	93.19	31.82	61.37	0.0	0.0	0.0

Melting T	1357.8 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	13.14 kJ	Molar Vol.	0.7113J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	5.00 kJ		7.113 cm^3

5/28/93

FLUORINE (REFERENCE STATE) **Formula wt 37.997**

F_2: Ideal diatomic gas at P = 1 bar 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	31.31	202.79	0.00	202.79	0.0	0.0	0.0
300	31.35	202.98	0.19	202.79	0.0	0.0	0.0
400	33.14	212.27	8.23	204.04	0.0	0.0	0.0
500	34.28	219.80	13.33	206.47	0.0	0.0	0.0
600	35.11	226.12	16.89	209.23	0.0	0.0	0.0
700	35.75	231.59	19.54	212.04	0.0	0.0	0.0
800	36.27	236.40	21.60	214.79	0.0	0.0	0.0
900	36.70	240.69	23.26	217.43	0.0	0.0	0.0
1000	37.07	244.58	24.62	219.96	0.0	0.0	0.0
1100	37.38	248.13	25.77	222.36	0.0	0.0	0.0
1200	37.66	251.39	26.75	224.64	0.0	0.0	0.0
1300	37.89	254.42	27.60	226.82	0.0	0.0	0.0
1400	38.10	257.23	28.34	228.89	0.0	0.0	0.0
1500	38.28	259.87	29.00	230.87	0.0	0.0	0.0
1600	38.44	262.34	29.58	232.76	0.0	0.0	0.0
1700	38.57	264.68	30.11	234.57	0.0	0.0	0.0
1800	38.69	266.89	30.58	236.31	0.0	0.0	0.0

Melting T 53.48 K

$\Delta_{fus}H^\circ$ 0.51 kJ

$H_{298}^\circ-H_0^\circ$ 8.82 kJ

Boiling T 84.95 K

$\Delta_{vap}H^\circ$ 6.54 kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$
24789.7 cm^3

IRON (REFERENCE STATE) **Formula wt 55.847**

Fe: Body-centered cubic crystals 298.15 to 1185 K. Curie point 1043 K; face-centered cubic crystals 1185 to 1667 K; body-centered cubic crystals 1667 to melting point 1809 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.08	27.09	0.00	27.08	0.0	0.0	0.0
300	25.13	27.24	0.16	27.08	0.0	0.0	0.0
400	27.43	34.80	6.69	28.10	0.0	0.0	0.0
500	29.64	41.15	11.06	30.09	0.0	0.0	0.0
600	32.01	46.76	14.35	32.41	0.0	0.0	0.0
700	34.62	51.89	17.06	34.83	0.0	0.0	0.0
800	37.92	56.72	19.45	37.27	0.0	0.0	0.0
900	43.16	61.46	21.76	39.70	0.0	0.0	0.0
1000	54.46	66.50	24.39	42.11	0.0	0.0	0.0
1043	83.77	69.14	25.97	43.18	0.0	0.0	0.0
1100	44.35	71.91	27.31	44.60	0.0	0.0	0.0
1185	40.00	75.01	28.33	46.67	0.0	0.0	0.0
1185	33.78	75.77	29.10	46.67	0.0	0.0	0.0
1200	33.90	76.19	29.16	47.04	0.0	0.0	0.0
1300	34.81	78.94	29.56	49.38	0.0	0.0	0.0
1400	35.75	81.56	29.97	51.59	0.0	0.0	0.0
1500	36.69	84.06	30.38	53.67	0.0	0.0	0.0
1600	37.63	86.45	30.81	55.65	0.0	0.0	0.0
1667	38.26	88.01	31.09	56.92	0.0	0.0	0.0
1667	40.40	88.52	31.60	56.92	0.0	0.0	0.0
1700	41.45	89.32	31.78	57.54	0.0	0.0	0.0
1800	44.65	91.78	32.41	59.37	0.0	0.0	0.0

Melting T 1809 K

$\Delta_{fus}H^\circ$ 13.81 kJ

$H_{298}^\circ-H_0^\circ$ 4.51 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 0.7092 $J\cdot bar^{-1}$
7.092 cm^3

4/29/92

GERMANIUM (REFERENCE STATE) **Formula wt 72.61**

Ge: Face-centered cubic crystals (diamond structure) 298.15 to 1211.4 K. Liquid 1211.4 to boiling point 3107 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	23.22	31.09	0.00	31.09	0.0	0.0	0.0
300	23.25	31.23	0.14	31.09	0.0	0.0	0.0
400	24.31	38.08	6.06	32.02	0.0	0.0	0.0
500	24.96	43.58	9.78	33.80	0.0	0.0	0.0
600	25.45	48.18	12.36	35.82	0.0	0.0	0.0
700	25.87	52.13	14.26	37.88	0.0	0.0	0.0
800	26.24	55.61	15.73	39.88	0.0	0.0	0.0
900	26.59	58.72	16.92	41.80	0.0	0.0	0.0
1000	26.93	61.54	17.90	43.64	0.0	0.0	0.0
1100	27.25	64.12	18.74	45.39	0.0	0.0	0.0
1200	27.57	66.51	19.46	47.05	0.0	0.0	0.0
1211.4	27.61	66.77	19.54	47.23	0.0	0.0	0.0
1211.4	27.60	97.34	50.11	47.23	0.0	0.0	0.0
1300	27.60	99.29	48.57	50.72	0.0	0.0	0.0
1400	27.60	101.33	47.07	54.26	0.0	0.0	0.0
1500	27.60	103.24	45.78	57.46	0.0	0.0	0.0
1600	27.60	105.02	44.64	60.38	0.0	0.0	0.0
1700	27.60	106.69	43.64	63.05	0.0	0.0	0.0
1800	27.60	108.27	42.75	65.52	0.0	0.0	0.0

Melting T 1211.4 K

$\Delta_{fus}H^\circ$ 37.03 kJ

$H_{298}^\circ-H_0^\circ$ 4.64 kJ

Boiling T 3107 K

$\Delta_{vap}H^\circ$ 330.92 kJ

Molar Vol. 1.363 $J\cdot bar^{-1}$

13.63 cm^3

HYDROGEN (REFERENCE STATE) **Formula wt 2.016**

H_2: **Ideal diatomic gas at P = 1 bar 298.15 to 2500 K.**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	28.82	130.68	0.00	130.68	0.0	0.0	0.0
300	28.84	130.86	0.18	130.68	0.0	0.0	0.0
400	29.24	139.23	7.41	131.82	0.0	0.0	0.0
500	29.25	145.76	11.78	133.98	0.0	0.0	0.0
600	29.29	151.09	14.69	136.40	0.0	0.0	0.0
700	29.41	155.61	16.78	138.83	0.0	0.0	0.0
800	29.62	159.55	18.38	141.18	0.0	0.0	0.0
900	29.90	163.06	19.64	143.42	0.0	0.0	0.0
1000	30.24	166.23	20.68	145.54	0.0	0.0	0.0
1100	30.61	169.13	21.57	147.56	0.0	0.0	0.0
1200	31.01	171.81	22.34	149.47	0.0	0.0	0.0
1300	31.43	174.31	23.02	151.28	0.0	0.0	0.0
1400	31.86	176.65	23.64	153.01	0.0	0.0	0.0
1500	32.29	178.86	24.20	154.66	0.0	0.0	0.0
1600	32.71	180.96	24.72	156.24	0.0	0.0	0.0
17	33.12	182.96	25.20	157.75	0.0	0.0	0.0
1800	33.53	184.86	25.65	159.21	0.0	0.0	0.0

Melting T 13.80 K

Boiling T 20.27 K

$\Delta_{fus}H^\circ$ 0.117 kJ

$\Delta_{vap}H^\circ$ 0.904 kJ

$H_{298}^\circ-H_0^\circ$ 8.468 kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

4/29/92

MERCURY (REFERENCE STATE) **Formula wt 200.59**

Hg: Liquid 298.15 to boiling point 629.0 K. Ideal monatonic gas at P = 1 bar, 629.0 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	27.96	75.90	0.00	75.90	0.0	0.0	0.0
300	27.95	76.07	0.17	75.90	0.0	0.0	0.0
400	27.41	84.03	7.04	76.99	0.0	0.0	0.0
500	27.17	90.12	11.09	79.03	0.0	0.0	0.0
600	27.14	95.07	13.76	81.31	0.0	0.0	0.0
629.0	27.17	96.35	14.38	81.97	0.0	0.0	0.0
629.0	20.79	190.49	108.52	81.97	0.0	0.0	0.0
700	20.79	192.71	99.62	93.09	0.0	0.0	0.0
800	20.79	195.48	89.77	105.71	0.0	0.0	0.0
900	20.79	197.93	82.10	115.83	0.0	0.0	0.0
1000	20.79	200.12	75.97	124.15	0.0	0.0	0.0
1100	20.79	202.10	70.96	131.14	0.0	0.0	0.0
1200	20.79	203.91	66.78	137.14	0.0	0.0	0.0
1300	20.79	205.58	63.24	142.34	0.0	0.0	0.0
1400	20.79	207.12	60.21	146.91	0.0	0.0	0.0
1500	20.79	208.55	57.58	150.97	0.0	0.0	0.0
1600	20.79	209.89	55.28	154.61	0.0	0.0	0.0
1700	20.79	211.15	53.25	157.90	0.0	0.0	0.0
1800	20.79	212.34	51.45	160.89	0.0	0.0	0.0

Melting T 234.32 K

$\Delta_{fus}H^\circ$ 2.297 kJ

$H_{298}^\circ-H_0^\circ$ 9.343 kJ

Boiling T 629.0 K

$\Delta_{vap}H^\circ$ 59.214 kJ

Molar Vol. 1.4822 $J\cdot bar^{-1}$

14.822 cm^3

IODINE (REFERENCE STATE) **Formula wt 253.809**

I_2: Crystals 298.15 to melting point 386.8 K; liquid 386.8 to boiling point 457.7 K; ideal diatomic gas, P=1 bar, 457.7 to 2200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	54.44	116.14	0.00	116.14	0.0	0.0	0.0
300	54.51	116.48	0.34	116.14	0.0	0.0	0.0
386.8	63.54	131.22	13.32	117.90	0.0	0.0	0.0
386.8	80.67	171.34	53.44	117.90	0.0	0.0	0.0
400	80.67	174.06	54.35	119.71	0.0	0.0	0.0
457.7	80.67	184.93	57.67	127.26	0.0	0.0	0.0
457.7	37.39	276.61	149.35	127.26	0.0	0.0	0.0
500	37.48	279.93	139.88	140.06	0.0	0.0	0.0
600	37.53	286.77	122.82	163.96	0.0	0.0	0.0
700	37.55	292.56	110.63	181.93	0.0	0.0	0.0
800	37.62	297.58	101.50	196.08	0.0	0.0	0.0
900	37.76	302.01	94.41	207.61	0.0	0.0	0.0
1000	37.96	306.00	88.75	217.25	0.0	0.0	0.0
1100	38.23	309.63	84.15	225.48	0.0	0.0	0.0
1200	38.56	312.97	80.34	232.64	0.0	0.0	0.0
1300	38.93	316.07	77.14	238.94	0.0	0.0	0.0
1400	39.34	318.97	74.42	244.55	0.0	0.0	0.0
1500	39.79	321.70	72.10	249.61	0.0	0.0	0.0
1600	40.27	324.29	70.09	254.19	0.0	0.0	0.0
1700	40.78	326.74	68.35	258.39	0.0	0.0	0.0
1800	41.31	329.09	66.84	262.25	0.0	0.0	0.0

Melting T 386.8 K

Boiling T 457.7 K

$\Delta_{fus}H^\circ$ 15.52 kJ

$\Delta_{vap}H^\circ$ 41.96 kJ

$H_{298}^\circ-H_0^\circ$ 13.20 kJ

Molar Vol. 5.129 $J\cdot bar^{-1}$
51.29 cm^3

4/29/92

POTASSIUM (REFERENCE STATE) **Formula wt 39.098**

K: Crystals 298.15 to melting point 336.4 K; liquid 336.4 to boiling point 1039.5 K; ideal monatomic gas, P=1 bar, 1039.5 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	29.50	64.67	0.00	64.67	0.0	0.0	0.0
300	29.57	64.85	0.18	64.67	0.0	0.0	0.0
336.4	34.57	68.37	3.49	64.88	0.0	0.0	0.0
336.4	32.14	75.31	10.43	64.88	0.0	0.0	0.0
400	31.50	80.82	13.83	66.99	0.0	0.0	0.0
500	30.70	87.76	17.28	70.48	0.0	0.0	0.0
600	30.14	93.31	19.47	73.84	0.0	0.0	0.0
700	29.82	97.92	20.97	76.95	0.0	0.0	0.0
800	29.76	101.90	22.07	79.83	0.0	0.0	0.0
900	29.94	105.41	22.93	82.48	0.0	0.0	0.0
1000	30.36	108.59	23.65	84.94	0.0	0.0	0.0
1039.5	30.60	109.77	23.91	85.86	0.0	0.0	0.0
1039.5	20.79	186.30	100.44	85.86	0.0	0.0	0.0
1100	20.79	187.48	96.07	91.41	0.0	0.0	0.0
1200	20.79	189.28	89.78	99.50	0.0	0.0	0.0
1300	20.79	190.95	84.48	106.47	0.0	0.0	0.0
1400	20.79	192.49	79.93	112.56	0.0	0.0	0.0
1500	20.80	193.92	75.99	117.93	0.0	0.0	0.0
1600	20.81	195.27	72.54	122.73	0.0	0.0	0.0
1700	20.84	196.53	69.50	127.03	0.0	0.0	0.0
1800	20.87	197.72	66.80	130.92	0.0	0.0	0.0

Melting T 336.4 K

$\Delta_{fus}H^\circ$ 2.33 kJ

$H_{298}^\circ-H_0^\circ$ 7.09 kJ

Boiling T 1039.5 K

$\Delta_{vap}H^\circ$ 79.92 kJ

Molar Vol. 4.536 $J\cdot bar^{-1}$

45.36 cm^3

LITHIUM (REFERENCE STATE) **Formula wt 6.941**

Li: Crystals 298.15 to melting point 453.2 K; liquid 453.7 K to boiling point 1620 K; ideal monatomic gas, P=1 bar, 1620 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	24.62	29.09	0.00	29.09	0.0	0.0	0.0
300	24.67	29.24	0.15	29.08	0.0	0.0	0.0
400	27.61	36.70	6.62	30.08	0.0	0.0	0.0
453.7	29.39	40.29	9.21	31.08	0.0	0.0	0.0
453.7	30.39	46.90	15.82	31.08	0.0	0.0	0.0
500	30.13	49.84	17.16	32.69	0.0	0.0	0.0
600	29.54	55.28	19.27	36.01	0.0	0.0	0.0
700	28.99	59.79	20.70	39.10	0.0	0.0	0.0
800	28.94	63.66	21.73	41.93	0.0	0.0	0.0
900	28.89	67.07	22.53	44.54	0.0	0.0	0.0
1000	28.84	70.11	23.16	46.95	0.0	0.0	0.0
1100	28.79	72.85	23.67	49.18	0.0	0.0	0.0
1200	28.74	75.36	24.10	51.26	0.0	0.0	0.0
1300	28.70	77.66	24.45	53.20	0.0	0.0	0.0
1400	28.62	79.78	24.75	55.02	0.0	0.0	0.0
1500	28.54	81.75	25.01	56.74	0.0	0.0	0.0
1600	28.45	83.59	25.23	58.36	0.0	0.0	0.0
1620	28.43	83.95	25.27	58.68	0.0	0.0	0.0
1620	20.79	173.97	115.30	58.67	0.0	0.0	0.0
1700	20.80	174.97	110.85	64.12	0.0	0.0	0.0
1800	20.81	176.16	105.85	70.31	0.0	0.0	0.0

Melting T 453.2 K

$\Delta_{fus}H^\circ$ 3.00 kJ

$H_{298}^\circ-H_0^\circ$ 4.62 kJ

Boiling T 1620 K

$\Delta_{vap}H^\circ$ 145.84 kJ

Molar Vol. 1.3017 $J\cdot bar^{-1}$
13.017 cm^3

4/29/92

MAGNESIUM (REFERENCE STATE) **Formula wt 24.305**

Mg: Hexagonal close-packed crystals 298.15 to melting point 923 K. Liquid 923 to boiling point 1366.1 K. Ideal monotomic gas, P = 1 bar, 1366.1 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	24.87	32.67	0.00	32.67	0.0	0.0	0.0
300	24.90	32.82	0.15	32.67	0.0	0.0	0.0
400	26.14	40.17	6.50	33.66	0.0	0.0	0.0
500	27.18	46.11	10.54	35.58	0.0	0.0	0.0
600	28.20	51.16	13.39	37.76	0.0	0.0	0.0
700	29.29	55.58	15.59	40.00	0.0	0.0	0.0
800	30.51	59.57	17.37	42.20	0.0	0.0	0.0
900	31.90	63.25	18.91	44.34	0.0	0.0	0.0
923	32.24	64.05	19.23	44.82	0.0	0.0	0.0
923	34.31	73.23	28.42	44.82	0.0	0.0	0.0
1000	34.31	75.98	28.87	47.11	0.0	0.0	0.0
1100	34.31	79.25	29.36	49.89	0.0	0.0	0.0
1200	34.91	82.24	29.78	52.46	0.0	0.0	0.0
1300	34.31	84.98	30.12	54.86	0.0	0.0	0.0
1366.1	34.31	86.69	30.33	56.36	0.0	0.0	0.0
1366.1	20.79	180.29	123.93	56.36	0.0	0.0	0.0
1400	20.79	180.80	121.43	59.34	0.0	0.0	0.0
1500	20.79	182.23	114.72	67.49	0.0	0.0	0.0
1600	20.79	183.57	108.85	74.72	0.0	0.0	0.0
1700	20.79	184.83	103.67	81.16	0.0	0.0	0.0
1800	20.79	186.02	99.07	86.95	0.0	0.0	0.0

Melting T 923 K

$\Delta_{fus}H^\circ$ 8.477 kJ

$H_{298}^\circ-H_0^\circ$ 5.00 kJ

Boiling T 1361.1 K

$\Delta_{vap}H^\circ$ 127.87 kJ

Molar Vol. 1.3996 J·bar^{-1}
13.996 cm^3

4/29/92

MANGANESE (REFERENCE STATE) **Formula wt 54.938**

Mn: α-crystals 298.15 to 980 K. β-crystals 980 to 1360 K. γ-crystals 1360 to 1410 K. Δ-crystals 1410 to melting point 1517 K. Liquid 1517 to boiling point 2335 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	26.19	32.01	0.00	32.01	0.0	0.0	0.0
300	26.23	32.17	0.16	32.01	0.0	0.0	0.0
400	28.30	40.01	6.95	33.07	0.0	0.0	0.0
500	30.16	46.53	11.40	35.13	0.0	0.0	0.0
600	31.89	52.18	14.68	37.50	0.0	0.0	0.0
700	33.49	57.22	17.25	39.97	0.0	0.0	0.0
800	34.93	61.79	19.37	42.42	0.0	0.0	0.0
900	36.18	65.98	21.17	44.81	0.0	0.0	0.0
980	37.04	69.05	22.35	46.70	0.0	0.0	0.0
980	37.59	71.40	24.70	46.70	0.0	0.0	0.0
1000	37.68	72.12	24.96	47.16	0.0	0.0	0.0
1100	38.11	75.73	26.14	49.59	0.0	0.0	0.0
1200	38.54	79.07	27.15	51.92	0.0	0.0	0.0
1300	38.97	82.17	28.04	54.13	0.0	0.0	0.0
1360	39.15	84.01	28.52	55.49	0.0	0.0	0.0
1360	42.41	84.97	29.48	55.49	0.0	0.0	0.0
1400	43.43	86.75	30.47	56.28	0.0	0.0	0.0
1410	43.51	87.07	30.56	56.51	0.0	0.0	0.0
1410	45.23	88.41	31.89	56.52	0.0	0.0	0.0
1500	45.97	91.21	32.72	58.49	0.0	0.0	0.0
1517	46.11	91.86	32.87	59.00	0.0	0.0	0.0
1517	46.02	99.81	40.81	59.00	0.0	0.0	0.0
1600	46.02	102.13	41.08	61.05	0.0	0.0	0.0
1700	46.02	104.92	41.38	63.55	0.0	0.0	0.0
1800	46.02	107.55	41.63	65.92	0.0	0.0	0.0

Melting T 1517 K

Boiling T 2335 K

$\Delta_{fus}H^\circ$ 12.06 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 4.996 kJ

Molar Vol. 0.7354 $J\cdot bar^{-1}$
7.354 cm^3

1/31/92

MOLYBDENUM (REFERENCE STATE) **Formula wt 95.94**

Mo: Body-centered cubic crystals 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	23.90	28.66	0.00	28.66	0.0	0.0	0.0
300	23.92	28.81	0.15	28.66	0.0	0.0	0.0
400	25.05	35.86	6.24	29.61	0.0	0.0	0.0
500	25.86	41.54	10.09	31.45	0.0	0.0	0.0
600	26.47	46.31	12.77	33.54	0.0	0.0	0.0
700	26.99	50.43	14.76	35.66	0.0	0.0	0.0
800	27.46	54.06	16.32	37.74	0.0	0.0	0.0
900	27.92	57.32	17.58	39.74	0.0	0.0	0.0
1000	28.40	60.29	18.64	41.65	0.0	0.0	0.0
1100	28.92	63.02	19.55	43.47	0.0	0.0	0.0
1200	29.49	65.56	20.36	45.20	0.0	0.0	0.0
1300	30.11	67.95	21.08	46.86	0.0	0.0	0.0
1400	30.80	70.20	21.75	48.45	0.0	0.0	0.0
1500	31.56	72.35	22.38	49.97	0.0	0.0	0.0
1600	32.40	74.42	22.98	51.44	0.0	0.0	0.0
1700	33.31	76.41	23.56	52.85	0.0	0.0	0.0
1800	34.30	78.34	24.13	54.21	0.0	0.0	0.0

Melting T 2890 K

$\Delta_{fus}H^\circ$ 32.54 kJ

$H_{298}^\circ-H_0^\circ$ 4.594 kJ

Boiling T 4912 K

$\Delta_{vap}H^\circ$ 598.07 kJ

Molar Vol. 0.9387 J·bar^{-1}
9.387 cm^3

4/29/92

NITROGEN (REFERENCE STATE) **Formula wt 28.013**

N_2: Ideal diatomic gas at P = 1 bar 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$	——
298.15	29.13	191.61	0.00	191.61	0.0	0.0	0.0
300	29.13	191.79	0.18	191.61	0.0	0.0	0.0
400	29.24	200.17	7.42	192.75	0.0	0.0	0.0
500	29.70	206.74	11.83	194.92	0.0	0.0	0.0
600	30.26	212.21	14.85	197.35	0.0	0.0	0.0
700	30.86	216.91	17.09	199.82	0.0	0.0	0.0
800	31.45	221.07	18.85	202.22	0.0	0.0	0.0
900	32.03	224.81	20.29	204.53	0.0	0.0	0.0
1000	32.58	228.22	21.49	206.73	0.0	0.0	0.0
1100	33.10	231.35	22.52	208.83	0.0	0.0	0.0
1200	33.58	234.25	23.42	210.83	0.0	0.0	0.0
1300	34.03	236.95	24.22	212.73	0.0	0.0	0.0
1400	34.45	239.49	24.94	214.55	0.0	0.0	0.0
1500	34.82	241.88	25.58	216.30	0.0	0.0	0.0
1600	35.16	244.14	26.17	217.97	0.0	0.0	0.0
1700	35.45	246.28	26.71	219.57	0.0	0.0	0.0
1800	35.71	248.31	27.20	221.11	0.0	0.0	0.0

Melting T 63.14 K

Boiling T 77.35 K

$\Delta_{fus}H^\circ$ 0.720 kJ

$\Delta_{vap}H^\circ$ 5.586 kJ

$H_{298}^\circ-H_0^\circ$ 8.669 kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

6/19/92

SODIUM (REFERENCE STATE) **Formula wt 22.990**

Na: Body-centered cubic crystals 298.15 to melting point 371 K; liquid 371 to fictive boiling point 1170.5 K. Ideal monotomic gas, P=1 bar, 1170.5 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	28.15	51.46	0.00	51.46	0.0	0.0	0.0
300	28.20	51.63	0.17	51.46	0.0	0.0	0.0
371	31.83	57.90	5.80	52.10	0.0	0.0	0.0
371	31.83	64.92	12.82	52.10	0.0	0.0	0.0
400	31.51	67.30	14.18	53.12	0.0	0.0	0.0
500	30.55	74.22	17.54	56.68	0.0	0.0	0.0
600	29.81	79.73	19.66	60.07	0.0	0.0	0.0
700	29.27	84.28	21.06	63.22	0.0	0.0	0.0
800	28.94	88.16	22.06	66.10	0.0	0.0	0.0
900	28.84	91.56	22.82	68.74	0.0	0.0	0.0
1000	28.94	94.61	23.43	71.18	0.0	0.0	0.0
1100	29.26	97.38	23.94	73.44	0.0	0.0	0.0
1170.5	29.61	99.21	24.28	74.93	0.0	0.0	0.0
1170.5	20.79	182.09	107.16	74.93	0.0	0.0	0.0
1200	20.79	182.61	105.04	77.57	0.0	0.0	0.0
1300	20.79	184.28	98.56	85.72	0.0	0.0	0.0
1400	20.79	185.82	93.01	92.81	0.0	0.0	0.0
1500	20.79	187.25	88.19	99.06	0.0	0.0	0.0
1600	20.79	188.59	83.97	104.62	0.0	0.0	0.0
1700	20.79	189.85	80.26	109.59	0.0	0.0	0.0
1800	20.79	191.04	76.96	114.08	0.0	0.0	0.0

Melting T 371 K

$\Delta_{fus}H^\circ$ 2.598 kJ

$H_{298}^\circ-H_0^\circ$ 6.460 kJ

Boiling T 1170.5 K

$\Delta_{vap}H^\circ$ 97.610 kJ

Molar Vol. 2.381 $J\cdot bar^{-1}$

23.81 cm^3

4/29/92

NICKEL (REFERENCE STATE) **Formula wt 58.69**

Ni: Face-centered cubic crystals (magnetic) to Curie point 631 K; nonmagnetic 631 to melting point 1728 K; liquid 1728 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.99	29.87	0.00	29.87	0.0	0.0	0.0
300	26.05	30.03	0.16	29.87	0.0	0.0	0.0
400	28.38	37.87	6.95	30.92	0.0	0.0	0.0
500	30.82	44.45	11.46	32.99	0.0	0.0	0.0
600	34.85	50.39	15.00	35.40	0.0	0.0	0.0
631	39.83	52.26	16.08	36.19	0.0	0.0	0.0
700	30.79	55.58	17.63	37.94	0.0	0.0	0.0
800	31.00	59.10	19.29	39.81	0.0	0.0	0.0
900	31.59	63.38	20.62	42.76	0.0	0.0	0.0
1000	32.22	66.74	21.75	44.99	0.0	0.0	0.0
1100	32.93	69.85	22.73	47.11	0.0	0.0	0.0
1200	33.68	72.74	23.61	49.13	0.0	0.0	0.0
1300	34.52	75.47	24.42	51.05	0.0	0.0	0.0
1400	35.40	78.06	25.17	52.89	0.0	0.0	0.0
1500	36.32	80.53	25.88	54.65	0.0	0.0	0.0
1600	37.28	82.91	26.57	56.34	0.0	0.0	0.0
1700	38.28	85.20	27.23	57.97	0.0	0.0	0.0
1728	38.54	85.83	27.41	58.42	0.0	0.0	0.0
1728	38.91	95.75	37.34	58.42	0.0	0.0	0.0
1800	38.91	97.34	37.40	59.94	0.0	0.0	0.0

Melting T 1728 K

$\Delta_{fus}H^\circ$ 17.16 kJ

$H_{298}^\circ-H_0^\circ$ 4.79 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 0.6588 $J\cdot bar^{-1}$
6.588 cm^3

4/29/92

OXYGEN (REFERENCE STATE) **Formula wt 31.999**

O_2: Ideal diatomic gas at P = 1 bar 298.15 to 2500 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	29.35	205.15	0.00	205.15	0.0	0.0	0.0
300	29.35	205.33	0.18	205.15	0.0	0.0	0.0
400	30.04	213.85	7.54	206.31	0.0	0.0	0.0
500	31.12	220.67	12.15	208.52	0.0	0.0	0.0
600	32.14	226.43	15.40	211.04	0.0	0.0	0.0
700	33.00	231.45	17.85	213.60	0.0	0.0	0.0
800	33.72	235.91	19.79	216.12	0.0	0.0	0.0
900	34.33	239.92	21.37	218.54	0.0	0.0	0.0
1000	34.85	243.56	22.70	220.86	0.0	0.0	0.0
1100	35.29	246.90	23.82	223.08	0.0	0.0	0.0
1200	35.67	249.99	24.79	225.20	0.0	0.0	0.0
1300	36.00	252.86	25.64	227.22	0.0	0.0	0.0
1400	36.31	255.54	26.39	229.14	0.0	0.0	0.0
1500	36.58	258.05	27.06	230.99	0.0	0.0	0.0
1600	36.84	260.42	27.67	232.75	0.0	0.0	0.0
1700	37.08	262.66	28.21	234.45	0.0	0.0	0.0
1800	37.32	264.79	28.71	236.08	0.0	0.0	0.0

Melting T 54.35 K

$\Delta_{fus}H^\circ$ 0.444 kJ

$H_{298}^\circ-H_0^\circ$ 8.682 kJ

Boiling T 90.18 K

$\Delta_{vap}H^\circ$ 6.816 kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

4/29/92

PHOSPHORUS (REFERENCE STATE) **Formula wt 30.974**

P: Crystals (white, α) 298.15 to melting point 317.3 K. Liquid 317.3 to sublimation point 1180 K. Ideal diatomic gas 1180 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	23.82	41.09	0.00	41.08	0.0	0.0	0.0
300	23.87	41.22	0.14	41.08	0.0	0.0	0.0
317.3	24.35	42.57	1.45	41.12	0.0	0.0	0.0
317.3	26.32	44.65	3.53	41.12	0.0	0.0	0.0
400	26.32	50.75	8.24	42.51	0.0	0.0	0.0
500	26.32	56.62	11.86	44.76	0.0	0.0	0.0
600	26.32	61.42	14.27	47.15	0.0	0.0	0.0
700	26.32	65.48	15.99	49.49	0.0	0.0	0.0
800	26.32	68.99	17.28	51.71	0.0	0.0	0.0
900	26.32	72.09	18.29	53.80	0.0	0.0	0.0
1000	26.32	74.87	19.09	55.78	0.0	0.0	0.0
1100	26.32	77.38	19.75	57.63	0.0	0.0	0.0
1180	26.32	79.22	20.19	59.03	0.0	0.0	0.0
1180	18.54	133.23	74.20	59.03	0.0	0.0	0.0
1200	18.55	133.54	73.27	60.27	0.0	0.0	0.0
1300	18.60	135.03	69.07	65.96	0.0	0.0	0.0
1400	18.64	136.41	65.46	70.95	0.0	0.0	0.0
1500	18.68	137.70	62.34	75.36	0.0	0.0	0.0
1600	18.72	138.91	59.62	79.29	0.0	0.0	0.0
1700	18.75	140.04	57.21	82.83	0.0	0.0	0.0
1800	18.77	141.11	55.08	86.03	0.0	0.0	0.0

Melting T 317.3 K

$\Delta_{fus}H^\circ$ 0.659 kJ

$H_{298}^\circ-H_0^\circ$ 5.36 kJ

Boiling T 1180 K

$\Delta_{vap}H^\circ$ 63.84 kJ

Molar Vol. 1.73 $J\cdot bar^{-1}$
17.3 cm^3

6/18/92

LEAD (REFERENCE STATE) **Formula wt 207.2**

Pb: Face-centered cubic crystals 298.15 to melting point 600.6 K. Liquid 600.6 to boiling point 2021 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	26.65	64.80	0.00	64.80	0.0	0.0	0.0
300	26.67	64.96	0.16	64.80	0.0	0.0	0.0
400	27.79	72.80	6.94	65.86	0.0	0.0	0.0
500	28.78	79.10	11.21	67.89	0.0	0.0	0.0
600	29.74	84.44	14.22	70.22	0.0	0.0	0.0
600.6	29.74	84.47	14.23	70.24	0.0	0.0	0.0
600.6	30.63	92.48	22.24	70.24	0.0	0.0	0.0
700	30.31	97.15	23.41	73.74	0.0	0.0	0.0
800	29.98	101.17	24.25	76.92	0.0	0.0	0.0
900	29.66	104.68	24.87	79.81	0.0	0.0	0.0
1000	29.37	107.79	25.34	82.45	0.0	0.0	0.0
1100	29.17	110.58	25.69	84.89	0.0	0.0	0.0
1200	28.90	113.10	25.97	87.13	0.0	0.0	0.0
1300	28.73	115.41	26.19	89.22	0.0	0.0	0.0
1400	28.60	117.54	26.36	91.18	0.0	0.0	0.0
1500	28.51	119.50	26.51	92.99	0.0	0.0	0.0
1600	28.46	121.34	26.63	94.71	0.0	0.0	0.0
1700	28.45	123.07	26.74	96.33	0.0	0.0	0.0
1800	28.48	124.70	26.84	97.86	0.0	0.0	0.0

Melting T 600.65 K

$\Delta_{fus}H^\circ$ 4.81 kJ

$H_{298}^\circ-H_0^\circ$ 6.870 kJ

Boiling T 2021 K

$\Delta_{vap}H^\circ$ 177.7 kJ

Molar Vol. 1.8267 $J\cdot bar^{-1}$

18.267 cm^3

6/17/92

PLATINUM (REFERENCE STATE) **Formula wt 195.08**

Pt: Face-centered cubic crystals 298.15 to melting point 2042 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.81	41.63	0.00	41.63	0.0	0.0	0.0
300	25.83	41.79	0.16	41.63	0.0	0.0	0.0
400	26.49	49.32	6.67	42.65	0.0	0.0	0.0
500	27.02	55.29	10.68	44.60	0.0	0.0	0.0
600	27.53	60.26	13.45	46.81	0.0	0.0	0.0
700	28.04	64.54	15.50	49.04	0.0	0.0	0.0
800	28.56	68.32	17.10	51.22	0.0	0.0	0.0
900	29.08	71.71	18.40	53.31	0.0	0.0	0.0
1000	29.61	74.80	19.49	55.31	0.0	0.0	0.0
1100	30.15	77.65	20.44	57.21	0.0	0.0	0.0
1200	30.69	80.30	21.27	59.03	0.0	0.0	0.0
1300	31.22	82.78	22.02	60.76	0.0	0.0	0.0
1400	31.76	85.11	22.69	62.42	0.0	0.0	0.0
1500	32.29	87.32	23.31	64.00	0.0	0.0	0.0
1600	32.82	89.42	23.89	65.53	0.0	0.0	0.0
1700	33.34	91.42	24.43	66.99	0.0	0.0	0.0
1800	33.86	93.34	24.94	68.40	0.0	0.0	0.0

Melting T 2042 K

Boiling T K

$\Delta_{fus}H^\circ$ 19.648 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 5.724 kJ

Molar Vol. 0.9091 $J\cdot bar^{-1}$
9.091 cm^3

01/07/93

SULFUR (REFERENCE STATE) **Formula wt 32.066**

S: Orthorhombic crystals 298.15 to 368.3 K; monoclinic crystals 368.3 to melting point 388.36 K; liquid 388.36 K to fictive boiling point 882.1 K. Ideal diatomic gas, P=1 bar, 882.1 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	22.70	32.05	0.00	32.05	0.0	0.0	0.0
300	22.74	32.19	0.14	32.05	0.0	0.0	0.0
368.3	24.24	37.01	4.47	32.54	0.0	0.0	0.0
368.3	24.77	38.10	5.56	32.54	0.0	0.0	0.0
388.36	25.17	39.43	6.57	32.86	0.0	0.0	0.0
388.36	31.06	43.86	11.00	32.86	0.0	0.0	0.0
400	32.16	44.79	11.60	33.19	0.0	0.0	0.0
500	37.98	53.53	17.13	36.40	0.0	0.0	0.0
600	34.31	60.08	20.25	39.82	0.0	0.0	0.0
700	32.68	65.24	22.14	43.10	0.0	0.0	0.0
800	31.70	69.53	23.39	46.14	0.0	0.0	0.0
882.1	31.66	72.62	24.16	48.47	0.0	0.0	0.0
882.1	18.47	133.08	84.61	48.47	0.0	0.0	0.0
900	18.51	133.45	83.29	50.16	0.0	0.0	0.0
1000	18.68	135.41	76.82	58.59	0.0	0.0	0.0
1100	18.85	137.20	71.55	65.65	0.0	0.0	0.0
1200	19.00	138.85	67.16	71.69	0.0	0.0	0.0
1300	19.15	140.37	63.46	76.91	0.0	0.0	0.0
1400	19.28	141.80	60.30	81.50	0.0	0.0	0.0
1500	19.42	143.13	57.57	85.56	0.0	0.0	0.0
1600	19.55	144.39	55.19	89.20	0.0	0.0	0.0
1700	19.67	145.58	53.10	92.48	0.0	0.0	0.0
1800	19.79	146.71	51.24	95.46	0.0	0.0	0.0

Melting T	388.36 K	Boiling T	882.1 K
		$\Delta_{vap}H^\circ$	53.32 kJ
$\Delta_{fus}H^\circ$	1.72 kJ	Molar Vol.	1.5511 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	4.412 kJ		15.511 cm^3

S_2 (gas) Formula wt 64.132

S_2: Ideal diatomic gas, P = 1 bar, 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	32.49	228.17	0.00	228.17	128.6	79.7	-13.96
300	32.53	228.37	0.20	228.17	128.6	79.4	-13.82
400	34.05	237.96	8.49	229.47	122.7	63.4	-8.27
500	34.98	245.66	13.70	231.96	118.3	49.0	-5.12
600	35.65	252.10	17.31	234.80	114.7	35.5	-3.09
700	36.17	257.64	19.97	237.67	111.6	22.6	-1.68
800	36.62	262.50	22.02	240.48	108.8	10.0	-0.66
900	37.01	266.84	23.66	243.17	0.0	0.0	0.0
1000	37.37	270.75	25.02	245.74	0.0	0.0	0.0
1100	37.69	274.33	26.16	248.18	0.0	0.0	0.0
1200	38.00	277.62	27.13	250.49	0.0	0.0	0.0
1300	38.29	280.68	27.98	252.70	0.0	0.0	0.0
1400	38.57	283.53	28.72	254.80	0.0	0.0	0.0
1500	38.84	286.20	29.39	256.81	0.0	0.0	0.0
1600	39.09	288.71	29.99	258.72	0.0	0.0	0.0
1700	39.34	291.09	30.53	260.56	0.0	0.0	0.0
1800	39.59	293.34	31.03	262.32	0.0	0.0	0.0

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 9.124 kJ 24789.7 cm^3

11/18/92

ANTIMONY (REFERENCE STATE) **Formula wt 121.75**

Sb: Rhombohedral crystals 298.15 to melting point 904 K. Liquid 904 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.25	45.52	0.00	45.52	0.0	0.0	0.0
300	25.27	45.69	0.16	45.52	0.0	0.0	0.0
400	25.91	53.04	6.52	46.52	0.0	0.0	0.0
500	26.48	58.88	10.45	48.43	0.0	0.0	0.0
600	27.17	63.77	13.18	50.59	0.0	0.0	0.0
700	28.09	68.02	15.24	52.78	0.0	0.0	0.0
800	29.32	71.85	16.92	54.93	0.0	0.0	0.0
900	30.92	75.39	18.38	57.01	0.0	0.0	0.0
904	30.99	75.54	18.41	57.11	0.0	0.0	0.0
904	31.38	97.53	40.42	57.11	0.0	0.0	0.0
1000	31.38	100.68	39.55	61.12	0.0	0.0	0.0
1100	31.38	103.67	38.81	64.86	0.0	0.0	0.0
1200	31.38	106.40	38.19	68.21	0.0	0.0	0.0
1300	31.38	108.91	37.66	71.24	0.0	0.0	0.0
1400	31.38	111.24	37.22	74.02	0.0	0.0	0.0
1500	31.38	113.40	36.83	76.57	0.0	0.0	0.0
1600	31.38	115.41	36.49	78.94	0.0	0.0	0.0
1700	31.38	117.33	36.18	81.14	0.0	0.0	0.0
1800	31.38	119.12	35.92	83.20	0.0	0.0	0.0

Melting T 904 K

$\Delta_{fus}H^\circ$ 19.874 kJ

$H_{298}^\circ-H_0^\circ$ 5.870 kJ

Boiling T 1860 K

$\Delta_{vap}H^\circ$ 86.525 kJ

Molar Vol. 1.8178 $J\cdot bar^{-1}$

18.178 cm^3

6/10/92

SELENIUM (REFERENCE STATE) **Formula wt 78.96**

Se: Crystals 298.15 to melting point 494 K. Liquid 494 to boiling point 957 K. Ideal diatomic gas 957 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.06	42.27	0.00	42.27	0.0	0.0	0.0
300	25.06	42.42	0.15	42.27	0.0	0.0	0.0
400	26.44	49.83	6.56	43.27	0.0	0.0	0.0
494	27.30	55.51	10.45	45.06	0.0	0.0	0.0
494	35.95	67.97	22.91	45.06	0.0	0.0	0.0
500	35.85	68.38	23.06	45.32	0.0	0.0	0.0
600	34.37	74.79	25.07	49.72	0.0	0.0	0.0
700	33.54	80.03	26.34	53.69	0.0	0.0	0.0
800	33.29	84.48	27.21	57.27	0.0	0.0	0.0
900	33.93	88.43	27.92	60.51	0.0	0.0	0.0
957	34.78	90.50	28.30	62.19	0.0	0.0	0.0
957	19.27	146.44	84.28	62.19	0.0	0.0	0.0
1000	19.31	147.29	81.48	65.81	0.0	0.0	0.0
1100	19.41	149.13	75.83	73.30	0.0	0.0	0.0
1200	19.52	150.82	71.14	79.68	0.0	0.0	0.0
1300	19.62	162.39	67.17	85.22	0.0	0.0	0.0
1400	19.73	153.84	63.78	90.06	0.0	0.0	0.0
1500	19.83	155.21	60.84	94.37	0.0	0.0	0.0
1600	19.94	156.49	58.28	98.21	0.0	0.0	0.0
1700	20.04	157.70	56.03	101.67	0.0	0.0	0.0
1800	20.15	158.85	54.03	104.82	0.0	0.0	0.0

Melting T 494 K

$\Delta_{fus}H^\circ$ 6.16 kJ

$H_{298}^\circ-H_0^\circ$ 5.52 kJ

Boiling T 957 K

$\Delta_{vap}H^\circ$ 53.57 kJ

Molar Vol. 1.642 $J\cdot bar^{-1}$
16.42 cm^3

12/14/92

SILICON (REFERENCE STATE) **Formula wt 28.086**

Si: Cubic crystals 298.15 to melting point 1685 K; liquid 1685 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	20.00	18.81	0.00	18.81	0.0	0.0	0.0
300	20.06	18.93	0.12	18.81	0.0	0.0	0.0
400	22.14	25.02	5.40	19.63	0.0	0.0	0.0
500	23.33	30.10	8.87	21.23	0.0	0.0	0.0
600	24.16	34.43	11.36	23.08	0.0	0.0	0.0
700	24.81	38.21	13.23	24.97	0.0	0.0	0.0
800	25.36	41.56	14.71	26.84	0.0	0.0	0.0
900	25.86	44.57	15.93	28.65	0.0	0.0	0.0
1000	26.33	47.32	16.94	30.38	0.0	0.0	0.0
1100	26.78	49.85	17.82	32.04	0.0	0.0	0.0
1200	27.21	52.20	18.58	33.62	0.0	0.0	0.0
1300	27.63	54.40	19.26	35.13	0.0	0.0	0.0
1400	28.05	56.46	19.87	36.58	0.0	0.0	0.0
1500	28.47	58.41	20.43	37.98	0.0	0.0	0.0
1600	28.88	60.26	20.95	39.31	0.0	0.0	0.0
1685	29.22	61.75	21.35	40.40	0.0	0.0	0.0
1685	27.20	91.55	51.15	40.40	0.0	0.0	0.0
1700	27.20	91.79	50.94	40.85	0.0	0.0	0.0
1800	27.20	93.35	49.62	43.73	0.0	0.0	0.0

Melting T	1685 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	50.2 kJ		
		Molar Vol.	1.2056 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	3.218 kJ		12.056 cm^3

TIN (REFERENCE STATE) **Formula wt 118.710**

Sn: Crystals 298.15 to melting point 505.1 K. Liquid 501 to 1800 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J \cdot mol^{-1} \cdot K^{-1}$			$kJ \cdot mol^{-1}$	
298.15	27.11	51.18	0.00	51.18	0.0	0.0	0.0
300	27.15	51.35	0.17	51.18	0.0	0.0	0.0
400	28.90	59.40	7.13	52.27	0.0	0.0	0.0
500	31.03	66.06	11.69	54.37	0.0	0.0	0.0
505.1	31.16	66.38	11.88	54.50	0.0	0.0	0.0
505.1	29.42	80.63	26.13	54.50	0.0	0.0	0.0
600	28.66	85.62	26.58	59.04	0.0	0.0	0.0
700	28.25	90.00	26.85	63.15	0.0	0.0	0.0
800	28.04	93.76	27.01	66.75	0.0	0.0	0.0
900	27.96	97.06	27.12	69.94	0.0	0.0	0.0
1000	27.95	100.00	27.20	72.80	0.0	0.0	0.0
1100	27.98	102.67	27.27	75.40	0.0	0.0	0.0
1200	28.04	105.10	27.33	77.77	0.0	0.0	0.0
1300	28.13	107.35	27.39	79.96	0.0	0.0	0.0
1400	28.23	109.44	27.44	82.00	0.0	0.0	0.0
1500	28.34	111.39	27.50	83.89	0.0	0.0	0.0
1600	28.46	113.22	27.56	85.66	0.0	0.0	0.0
1700	28.58	114.95	27.61	87.34	0.0	0.0	0.0
1800	28.70	116.59	27.67	88.92	0.0	0.0	0.0

Melting T 505.1 K

$\Delta_{fus}H^\circ$ 7.195 kJ

$H_{298}^\circ-H_0^\circ$ 6.323 kJ

Boiling T 2876 K

$\Delta_{vap}H^\circ$ 295.77 kJ

Molar Vol. 1.629 $J \cdot bar^{-1}$
16.29 cm^3

6/17/92

STRONTIUM (REFERENCE STATE) **Formula wt 87.62**

Sr: α-crystals (face-centered cubic) 298.15 to 820 K; γ-crystals (body-centere cubic) 820 to melting point 1050 K; liquid 1050 to boiling point 1685.5 K; ideal monatomic gas, P=1 bar, 1685.5 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	26.79	55.69	0.00	55.69	0.0	0.0	0.0
300	26.81	55.86	0.17	55.69	0.0	0.0	0.0
400	27.77	63.70	6.94	56.75	0.0	0.0	0.0
500	28.78	70.00	11.21	58.79	0.0	0.0	0.0
600	29.82	75.34	14.23	61.12	0.0	0.0	0.0
700	30.87	80.02	16.53	63.49	0.0	0.0	0.0
800	31.93	84.21	18.39	65.82	0.0	0.0	0.0
820	32.15	85.01	18.72	66.28	0.0	0.0	0.0
820	29.79	86.03	19.74	66.29	0.0	0.0	0.0
900	30.13	88.81	20.65	68.17	0.0	0.0	0.0
1000	30.45	92.01	21.62	70.39	0.0	0.0	0.0
1050	30.75	93.51	22.05	71.46	0.0	0.0	0.0
1050	39.46	100.58	29.12	71.46	0.0	0.0	0.0
1100	39.46	102.42	29.59	72.82	0.0	0.0	0.0
1200	39.46	105.85	30.42	75.44	0.0	0.0	0.0
1300	39.46	109.01	31.11	77.90	0.0	0.0	0.0
1400	39.46	111.94	31.71	80.23	0.0	0.0	0.0
1500	39.46	114.66	32.23	82.43	0.0	0.0	0.0
1600	39.46	117.20	32.68	84.53	0.0	0.0	0.0
1685.5	39.46	119.26	33.02	86.24	0.0	0.0	0.0
1685.5	20.84	200.65	114.41	86.24	0.0	0.0	0.0
1700	20.84	200.83	113.62	87.21	0.0	0.0	0.0
1800	20.88	202.02	108.46	93.56	0.0	0.0	0.0

Melting T	1050 K	Boiling T	1685 K
		$\Delta_{vap}H^\circ$	137.18 kJ
$\Delta_{fus}H^\circ$	7.42 kJ		
		Molar Vol.	3.392 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	6.36 kJ		33.92 cm^3

6/19/92

TELLURIUM (REFERENCE STATE) **Formula wt 127.600**

Te: Crystals 298.15 to melting point 723 K. Liquid 723 to boiling point 1261 K. Ideal diatomic gas 1261 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$		$kJ\cdot mol^{-1}$		
298.15	25.70	49.71	0.00	49.71	0.0	0.0	0.0
300	25.74	49.87	0.16	49.71	0.0	0.0	0.0
400	27.95	57.58	6.83	50.75	0.0	0.0	0.0
500	30.15	64.05	11.27	52.78	0.0	0.0	0.0
600	32.36	69.74	14.60	55.14	0.0	0.0	0.0
700	34.57	74.90	17.30	57.60	0.0	0.0	0.0
723	35.07	76.43	17.86	58.57	0.0	0.0	0.0
723	37.66	100.62	42.05	58.57	0.0	0.0	0.0
800	37.66	104.04	41.63	62.41	0.0	0.0	0.0
900	37.66	108.48	41.19	67.29	0.0	0.0	0.0
1000	37.66	112.44	40.83	71.60	0.0	0.0	0.0
1100	37.66	116.03	40.54	75.48	0.0	0.0	0.0
1200	37.66	119.31	40.30	79.01	0.0	0.0	0.0
1261	37.66	121.18	40.18	81.00	0.0	0.0	0.0
1261	18.66	161.10	80.10	81.00	0.0	0.0	0.0
1300	18.66	161.67	78.25	83.41	0.0	0.0	0.0

Melting T 723 K

$\Delta_{fus}H^\circ$ 17.489 kJ

$H_{298}^\circ-H_0^\circ$ 6.121 kJ

Boiling T 1261 K

$\Delta_{vap}H^\circ$ 50.341 kJ

Molar Vol. 2.048 $J\cdot bar^{-1}$
20.48 cm^3

6/17/92

THORIUM (REFERENCE STATE) **Formula wt 232.038**

Th: α-crystals (face-centered cubic) 298.15 to 1650 K. β-crystals (body-centered cubic) 1650 to melting point 2023 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	26.23	51.80	0.00	51.83	0.0	0.0	0.0
300	26.24	51.99	0.16	51.83	0.0	0.0	0.0
400	27.09	59.66	6.79	52.87	0.0	0.0	0.0
500	27.95	65.79	10.93	54.86	0.0	0.0	0.0
600	28.83	70.97	13.84	57.12	0.0	0.0	0.0
700	29.71	75.48	16.05	59.43	0.0	0.0	0.0
800	30.60	79.50	17.81	61.69	0.0	0.0	0.0
900	31.50	83.16	19.28	63.88	0.0	0.0	0.0
1000	32.39	86.52	20.55	65.98	0.0	0.0	0.0
1100	33.29	89.65	21.67	67.99	0.0	0.0	0.0
1200	34.19	92.59	22.67	69.92	0.0	0.0	0.0
1300	35.08	95.36	23.59	71.77	0.0	0.0	0.0
1400	35.98	97.99	24.44	73.55	0.0	0.0	0.0
1500	36.88	100.51	25.24	75.26	0.0	0.0	0.0
1600	37.77	102.91	25.99	76.92	0.0	0.0	0.0
1650	38.20	104.08	26.35	77.73	0.0	0.0	0.0
1650	35.42	106.21	28.48	77.73	0.0	0.0	0.0
1700	36.02	107.27	28.69	78.58	0.0	0.0	0.0
1800	37.21	109.36	29.13	80.23	0.0	0.0	0.0

Melting T 2023 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 6.350 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.979 $J\cdot bar^{-1}$
19.79 cm^3

6/12/92

TITANIUM (REFERENCE STATE) **Formula wt 47.88**

Ti: α-crystals (hexagonal close packed) 298.15 to 1166 K. β-crystals (body-centered cubic) 1166 to melting point 1939.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.25	30.76	0.00	30.76	0.0	0.0	0.0
300	25.27	30.92	0.16	30.76	0.0	0.0	0.0
400	26.82	38.39	6.62	31.77	0.0	0.0	0.0
500	27.98	44.51	10.79	33.72	0.0	0.0	0.0
600	28.59	49.67	13.71	35.96	0.0	0.0	0.0
700	29.01	54.11	15.87	38.25	0.0	0.0	0.0
800	29.57	58.02	17.54	40.48	0.0	0.0	0.0
900	30.52	61.55	18.92	42.63	0.0	0.0	0.0
1000	32.05	64.84	20.16	44.69	0.0	0.0	0.0
1100	34.30	68.00	21.33	46.66	0.0	0.0	0.0
1166	36.22	70.06	22.12	47.94	0.0	0.0	0.0
1166	29.24	73.64	25.70	47.94	0.0	0.0	0.0
1200	29.46	74.48	25.80	48.68	0.0	0.0	0.0
1300	30.18	76.86	26.10	50.76	0.0	0.0	0.0
1400	31.02	79.13	26.43	52.70	0.0	0.0	0.0
1500	32.00	81.30	26.76	54.54	0.0	0.0	0.0
1600	33.12	83.40	27.12	56.28	0.0	0.0	0.0
1700	34.36	85.45	27.52	57.93	0.0	0.0	0.0
1800	35.74	87.45	27.93	59.52	0.0	0.0	0.0

Melting T 1939 K

Boiling T K

$\Delta_{fus}H^\circ$ 14.15 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 4.83 kJ

Molar Vol. 1.063 $J\cdot bar^{-1}$
10.63 cm^3

6/17/92

URANIUM (REFERENCE STATE) **Formula wt 238.029**

U: α-crystals (orthorhombic) 298.15 to 942 K. β-crystals (tetragonal) 942 to 1049 K. γ-crystals (body-centered cubic) 1049 to melting point 1408 K. Liquid 1408 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	27.66	50.20	0.00	50.20	0.0	0.0	0.0
300	27.69	50.37	0.17	50.20	0.0	0.0	0.0
400	29.65	58.60	7.29	51.31	0.0	0.0	0.0
500	31.95	65.46	11.99	53.47	0.0	0.0	0.0
600	34.68	71.51	15.53	55.98	0.0	0.0	0.0
700	37.91	77.10	18.49	58.60	0.0	0.0	0.0
800	41.65	82.40	21.15	61.25	0.0	0.0	0.0
900	45.92	87.54	23.66	63.88	0.0	0.0	0.0
942	47.88	89.69	24.69	65.00	0.0	0.0	0.0
942	42.40	92.64	27.64	65.00	0.0	0.0	0.0
1000	42.40	95.17	28.50	66.67	0.0	0.0	0.0
1049	42.40	97.20	29.15	68.05	0.0	0.0	0.0
1049	38.30	101.71	33.66	68.05	0.0	0.0	0.0
1100	38.30	103.52	33.87	69.65	0.0	0.0	0.0
1200	38.30	106.86	34.24	72.62	0.0	0.0	0.0
1300	38.30	109.92	34.55	75.37	0.0	0.0	0.0
1400	38.30	112.76	34.82	77.94	0.0	0.0	0.0
1408	38.30	112.98	34.84	78.14	0.0	0.0	0.0
1408	47.74	119.17	41.03	78.14	0.0	0.0	0.0
1500	47.91	122.20	41.45	80.75	0.0	0.0	0.0
1600	48.12	125.30	41.86	83.44	0.0	0.0	0.0
1700	48.36	128.22	42.23	85.99	0.0	0.0	0.0
1800	48.60	130.99	42.58	88.41	0.0	0.0	0.0

Melting T 1408 K

$\Delta_{fus}H^\circ$ 8.720 kJ

$H_{298}^\circ-H_0^\circ$ 6.364 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.250 J·bar^{-1}
12.50 cm^3

6/11/92

VANADIUM (REFERENCE STATE) **Formula wt 50.942**

V: Body-centered cubic crystals 298.15 to 2175 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	24.90	28.94	0.00	28.94	0.0	0.0	0.0
300	24.94	29.09	0.15	28.94	0.0	0.0	0.0
400	26.30	36.49	6.55	29.94	0.0	0.0	0.0
500	26.91	42.43	10.57	31.86	0.0	0.0	0.0
600	27.42	47.38	13.33	34.05	0.0	0.0	0.0
700	27.97	51.65	15.38	36.26	0.0	0.0	0.0
800	28.60	55.42	16.99	38.43	0.0	0.0	0.0
900	29.31	58.83	18.32	40.51	0.0	0.0	0.0
1000	30.10	61.96	19.46	42.50	0.0	0.0	0.0
1100	30.96	64.87	20.47	44.40	0.0	0.0	0.0
1200	31.87	67.60	21.38	46.22	0.0	0.0	0.0
1300	32.83	70.19	22.22	47.97	0.0	0.0	0.0
1400	33.83	72.66	23.01	49.64	0.0	0.0	0.0
1500	34.88	75.03	23.77	51.26	0.0	0.0	0.0
1600	35.95	77.31	24.50	52.81	0.0	0.0	0.0
1700	37.06	79.52	25.20	54.32	0.0	0.0	0.0
1800	38.19	81.67	25.89	55.78	0.0	0.0	0.0

Melting T 2175 K

Boiling T K

$\Delta_{fus}H^\circ$ 20.928 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 4.64 kJ

Molar Vol. 0.835 $J\cdot bar^{-1}$
8.35 cm^3

TUNGSTEN (REFERENCE STATE) **Formula wt 183.85**

W: Body-centered cubic crystals 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	24.33	32.65	0.00	32.65	0.0	0.0	0.0
300	24.34	32.80	0.15	32.65	0.0	0.0	0.0
400	24.90	39.88	6.27	33.61	0.0	0.0	0.0
500	25.45	45.49	10.05	35.45	0.0	0.0	0.0
600	25.92	50.18	12.66	37.52	0.0	0.0	0.0
700	26.33	54.20	14.58	39.62	0.0	0.0	0.0
800	26.69	57.74	16.07	41.67	0.0	0.0	0.0
900	27.03	60.91	17.27	43.64	0.0	0.0	0.0
1000	27.36	63.77	18.26	45.51	0.0	0.0	0.0
1100	27.69	66.39	19.11	47.29	0.0	0.0	0.0
1200	28.04	68.82	19.84	48.98	0.0	0.0	0.0
1300	28.40	71.08	20.48	50.60	0.0	0.0	0.0
1400	28.79	73.20	21.06	52.14	0.0	0.0	0.0
1500	29.20	75.20	21.59	53.61	0.0	0.0	0.0
1600	29.65	77.10	22.08	55.02	0.0	0.0	0.0
1700	30.13	78.91	22.54	56.37	0.0	0.0	0.0
1800	30.65	80.64	22.97	57.67	0.0	0.0	0.0

Melting T 3680 K

Boiling T K

$\Delta_{fus}H^\circ$ 35.397 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 4.979 kJ

Molar Vol. 0.9545 J·bar^{-1}
9.545 cm^3

ZINC (REFERENCE STATE) **Formula wt 65.390**

Zn: Hexagonal close-packed crystals 298.15 to melting point 692.7 K. Liquid 692.7 to boiling point 1180.2 K. Ideal monatomic gas 1180.2 to 2000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.39	41.63	0.00	41.63	0.0	0.0	0.0
300	25.41	41.79	0.16	41.63	0.0	0.0	0.0
400	26.36	49.23	6.59	42.64	0.0	0.0	0.0
500	27.39	55.22	10.64	44.57	0.0	0.0	0.0
600	28.57	60.31	13.53	46.78	0.0	0.0	0.0
692.7	29.81	64.50	15.62	48.88	0.0	0.0	0.0
692.7	31.38	75.07	26.19	48.88	0.0	0.0	0.0
700	31.38	75.40	26.24	49.16	0.0	0.0	0.0
800	31.38	79.59	26.89	52.70	0.0	0.0	0.0
900	31.38	83.29	27.39	55.90	0.0	0.0	0.0
1000	31.38	86.59	27.78	58.81	0.0	0.0	0.0
1100	31.38	89.58	28.11	61.47	0.0	0.0	0.0
1180.2	31.38	91.79	28.33	63.46	0.0	0.0	0.0
1180.2	20.79	189.50	126.04	63.46	0.0	0.0	0.0
1200	20.79	189.84	124.29	65.55	0.0	0.0	0.0
1300	20.79	191.51	116.33	75.18	0.0	0.0	0.0
1400	20.79	193.05	109.51	83.54	0.0	0.0	0.0
1500	20.79	194.48	103.59	90.89	0.0	0.0	0.0
1600	20.79	195.82	98.41	97.41	0.0	0.0	0.0
1700	20.79	197.08	93.85	103.23	0.0	0.0	0.0
1800	20.79	198.27	89.79	108.48	0.0	0.0	0.0

Melting T K

$\Delta_{fus}H^\circ$ 7.32 kJ

$H_{298}^\circ-H_0^\circ$ 5.648 kJ

Boiling T 1080.2 K

$\Delta_{vap}H^\circ$ 115.30 kJ

Molar Vol. 0.9162 $J\cdot bar^{-1}$

9.162 cm^3

4/30/92

ZIRCONIUM (REFERENCE STATE) Formula wt 91.224

Zr: α-crystals (hexagonal close packed) 298.15 to 1135 K. β-crystals (body-centered cubic) 1135 to melting point 2125 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	25.20	38.87	0.00	38.87	0.0	0.0	0.0
300	25.23	39.03	0.16	38.87	0.0	0.0	0.0
400	26.04	46.42	6.55	39.87	0.0	0.0	0.0
500	26.52	52.28	10.49	41.79	0.0	0.0	0.0
600	27.16	57.17	13.21	43.96	0.0	0.0	0.0
700	27.99	61.42	15.26	46.15	0.0	0.0	0.0
800	28.96	65.22	16.91	48.30	0.0	0.0	0.0
900	30.04	68.69	18.31	50.38	0.0	0.0	0.0
1000	31.18	71.91	19.54	52.37	0.0	0.0	0.0
1100	32.33	74.93	20.65	54.29	0.0	0.0	0.0
1135	32.74	75.94	21.02	54.92	0.0	0.0	0.0
1135	28.33	79.48	24.56	54.92	0.0	0.0	0.0
1200	28.51	81.06	24.76	56.30	0.0	0.0	0.0
1300	28.88	83.36	25.07	58.29	0.0	0.0	0.0
1400	29.35	85.51	25.35	60.16	0.0	0.0	0.0
1500	29.93	87.56	25.64	61.92	0.0	0.0	0.0
1600	30.62	89.51	25.93	63.58	0.0	0.0	0.0
1700	31.41	91.39	26.23	65.16	0.0	0.0	0.0
1800	32.31	93.21	26.54	66.67	0.0	0.0	0.0

Melting T 2125 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 5.497 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.4016 J·bar^{-1}
14.016 cm^3

11/30/92

METHANE **Formula wt 16.043**

CH_4: Ideal gas, P = 1 bar, 298.15 to 1800 K

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	35.70	186.26	0.00	186.26	-74.8	-50.7	8.88
300	35.72	186.48	0.22	186.26	-74.9	-50.6	8.80
400	39.91	197.22	9.52	187.70	-78.0	-42.0	5.48
500	46.21	206.79	16.22	190.57	-80.8	-32.7	3.41
600	52.42	215.77	21.74	194.03	-83.3	-22.8	1.98
700	58.08	224.29	26.54	197.75	-85.4	-12.5	0.93
800	63.14	232.38	30.80	201.58	-87.2	-2.0	0.13
900	67.65	240.08	34.65	205.43	-88.6	8.8	-0.51
1000	71.67	247.42	38.16	209.27	-89.8	19.7	-1.03
1100	75.26	254.43	41.37	213.05	-90.7	30.7	-1.45
1200	78.48	261.11	44.33	216.78	-91.5	41.7	-1.82
1300	81.36	267.51	47.07	220.44	-92.0	52.9	-2.12
1400	83.95	273.64	49.61	224.02	-92.4	64.0	-2.39
1500	86.26	279.51	51.98	227.53	-92.7	75.2	-2.62
1600	88.33	285.14	54.19	230.95	-92.9	86.4	-2.82
1700	90.17	290.56	56.25	234.30	-92.9	97.6	-3.00
1800	91.80	295.76	58.18	237.57	-93.0	108.8	-3.16

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 10.025 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

2/25/94

COHENITE **Formula wt 179.552**

Fe_3C: Orthorhombic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	111.04	104.40	0.00	104.40	24.9	19.7	-3.45
300	111.06	105.09	0.68	104.40	24.9	19.7	-3.43
400	112.31	137.21	28.43	108.77	27.2	17.6	-2.29
500	113.57	162.40	45.34	117.07	28.6	15.0	-1.56
600	114.82	183.22	56.81	126.41	29.2	12.2	-1.06
700	116.07	201.01	65.19	135.83	29.0	9.3	-0.70
800	117.32	216.59	71.63	144.97	27.9	6.6	-0.43
900	118.58	230.49	76.77	153.71	25.6	4.1	-0.24
1000	119.83	243.04	81.02	162.03	21.0	1.9	-0.10
1100	121.08	254.52	84.60	169.92	13.8	0.4	-0.02
1200	122.34	265.11	87.69	177.42	8.9	-0.7	0.03
1300	123.59	274.95	90.41	184.55	8.6	-1.5	0.06
1400	124.84	284.16	92.82	191.34	8.1	-2.3	0.08
1500	126.10	292.82	95.00	197.82	7.4	-3.0	0.10
1600	127.35	300.99	96.98	204.01	6.5	-3.6	0.12
1700	128.60	308.75	98.80	209.95	2.7	-4.2	0.13
1800	129.85	316.14	100.49	215.64	0.2	-4.5	0.13

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.323 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	kJ		23.23 cm^3

01/06/93

AMMONIA **Formula wt 17.031**

NH_3: Ideal gas, P = 1 bar, 298.15 to 1800 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	35.68	192.77	0.00	192.77	-45.9	-16.4	2.87
300	35.72	192.99	0.22	192.77	-45.9	-16.2	2.82
400	38.59	203.63	9.43	194.20	-48.1	-5.9	0.78
500	41.99	212.60	15.60	197.01	-49.9	4.8	-0.50
600	45.32	220.56	20.28	200.28	-51.4	15.9	-1.38
700	48.44	227.78	24.08	203.70	-52.6	27.2	-2.03
800	51.34	234.44	27.31	207.13	-53.6	38.7	-2.53
900	54.03	240.65	30.13	210.51	-54.4	50.3	-2.92
1000	56.52	246.47	32.65	213.82	-55.0	61.9	-3.24
1100	58.82	251.96	34.92	217.04	-55.4	73.7	-3.50
1200	60.96	257.18	37.01	220.17	-55.8	85.4	-3.72
1300	62.94	262.13	38.93	223.21	-55.9	97.2	-3.91
1400	64.77	266.87	40.71	226.16	-56.0	109.0	-4.07
1500	66.45	271.39	42.37	229.03	-56.0	120.8	-4.21
1600	68.00	275.73	43.92	231.81	-55.9	132.5	-4.33
1700	69.42	279.90	45.38	234.52	-55.7	144.3	-4.43
1800	70.71	283.90	46.75	237.15	-55.5	156.1	-4.53

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 10.045 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

11/18/92

ACANTHITE (ARGENTITE) **Formula wt 247.802**

Ag_2S: Monoclinic crystals 298.15 to 451.3 K; cubic crystals (argentite) 451.3 to 865 K. γ phase 865 to 1000 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	75.31	142.89	0.00	142.89	-32.0	-39.7	6.95
300	75.39	143.35	0.46	142.89	-32.0	-39.7	6.92
400	80.47	165.67	19.78	145.89	-34.0	-42.2	5.52
500	87.26	193.79	41.08	152.71	-30.5	-44.7	4.67
600	86.03	209.59	48.67	160.92	-30.7	-47.5	4.14
700	84.80	222.75	53.91	168.84	-31.0	-50.3	3.75
800	84.69	234.05	57.75	176.30	-31.3	-53.0	3.46
900	80.38	244.84	61.53	183.31	-84.1	-54.7	3.17
1000	80.57	253.28	63.38	189.90	-83.8	-51.5	2.69

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	3.419 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	17.132 kJ		34.19 cm^3

9/30/92

REALGAR **Formula wt 106.988**

AsS: Monoclinic crystals 298.15 to melting point 580 K; liquid 580 to 800 K.
Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	47.02	63.50	0.00	63.50	-30.9	-29.6	5.19
300	47.08	63.80	0.29	63.51	-30.9	-29.6	5.16
400	49.32	77.68	12.29	65.39	-33.2	-29.1	3.80
500	51.18	88.88	19.88	69.00	-34.6	-27.9	2.92
600	67.12	110.35	36.84	73.51	-28.7	-26.7	2.33
700	71.48	121.00	41.46	79.54	-27.8	-26.4	1.97
800	77.50	130.90	45.57	85.33	-26.3	-26.3	1.72

Melting T 580 K

Boiling T K

$\Delta_{fus}H^\circ$ 6.668 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Molar Vol. 2.980 $J\cdot bar^{-1}$
29.80 cm^3

9/30/92

GREENOCKITE **Formula wt 144.477**

CdS: Cubic crystals 298.15 to 1100 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	47.30	72.18	0.00	72.18	-149.6	-146.1	25.60
300	47.36	72.47	0.29	72.18	-149.6	-146.1	25.44
400	49.46	86.42	12.35	74.07	-152.0	-144.8	18.91
500	50.70	97.60	19.90	77.69	-153.7	-142.8	14.92
600	51.68	106.93	25.12	81.81	-161.2	-140.5	12.23
700	52.55	114.96	28.98	85.99	-162.3	-136.9	10.22
800	53.37	122.03	31.98	90.06	-163.2	-133.2	8.70
900	54.16	128.37	34.40	93.97	-217.1	-128.4	7.45
1000	54.93	134.11	36.41	97.70	-216.5	-118.5	6.19
1100	55.67	139.38	38.13	101.25	-314.8	-102.9	4.89

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.993 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	8.818 kJ		29.93 cm^3

9/30/92

CATTIERITE **Formula wt 123.065**

CoS_2: Cubic crystals 298.15 to 1000 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	68.26	74.80	0.00	74.80	-150.9	-145.1	25.42
300	68.39	75.22	0.42	74.80	-150.9	-145.1	25.26
400	74.28	95.76	18.20	77.56	-155.5	-143.0	18.67
500	78.63	112.82	29.87	82.96	-158.5	-139.5	14.57
600	82.38	127.50	38.31	89.18	-160.5	-135.5	11.80
700	85.85	140.46	44.86	95.60	-161.8	-131.2	9.79
800	89.16	152.14	50.19	101.95	-163.1	-126.7	8.27
900	92.38	162.83	54.70	108.13	-269.8	-120.0	6.97
1000	95.55	172.72	58.63	114.10	-267.7	-103.5	5.41

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	2.552 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	12.301 kJ		25.52 cm^3

9/30/92

COVELLITE **Formula wt 95.612**

CuS: Hexagonal crystals 298.15 to 800 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	47.53	67.40	0.00	67.40	-54.6	-55.3	9.68
300	47.59	67.69	0.29	67.40	-54.6	-55.3	9.62
400	50.29	81.77	12.47	69.30	-56.8	-55.4	7.23
500	52.62	93.24	20.27	72.98	-58.1	-54.9	5.74
600	54.82	103.03	25.84	77.19	-59.0	-54.2	4.72
700	56.94	111.64	30.14	81.51	-59.4	-53.3	3.98
800	59.03	119.38	33.62	85.77	-59.5	-52.4	3.42

Melting T	780i K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	2.042 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	9.45 kJ		20.42 cm^3

9/30/92

CHALCOCITE **Formula wt 159.158**

Cu_2S: Orthorhombic crystals 298.15 to 376 K; hexagonal crystals 376 to 710 K; cubic crystals 710 to melting point 1403 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	76.84	116.20	0.00	116.20	-83.9	-89.2	15.62
300	77.01	116.67	0.47	116.20	-83.9	-89.2	15.53
400	98.83	151.07	31.14	119.93	-81.1	-91.3	11.92
500	95.31	172.84	44.33	128.51	-80.5	-93.9	9.81
600	92.30	189.93	52.56	137.37	-79.9	-96.7	8.42
700	89.79	203.97	58.06	145.91	-79.5	-99.5	7.43
800	82.76	216.94	62.85	154.09	-78.5	-102.5	6.69
900	82.50	226.66	65.04	161.62	-132.1	-104.5	6.06
1000	85.02	235.65	67.02	168.63	-131.1	-101.5	5.30
1100	85.02	243.77	68.68	175.09	-130.3	-98.6	4.68
1200	85.02	251.17	70.03	181.14	-129.7	-95.7	4.17
1300	85.02	257.95	71.71	186.24	-128.7	-92.2	3.71
1400	85.02	264.23	72.15	192.08	-155.6	-89.2	3.33

Melting T	1403 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.748 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	15.80 kJ		27.48 cm^3

9/30/92

CHALCOPYRITE **Formula wt 183.525**

$CuFeS_2$: Tetragonal crystals 298.15 to 820 K; tetragonal crystals 820 to 930 K; cubic crystals 930 to 1200 K. Reference state for sulfur is orthorhombic sulfur. Above 820 K, the phase is called ISS (intermediate solid solution).

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	95.80	124.90	0.00	124.90	-194.9	-195.1	34.18
300	96.24	125.49	0.59	124.90	-194.9	-195.1	33.97
400	106.26	155.01	26.15	128.86	-199.0	-195.0	25.47
500	109.15	179.02	42.45	136.57	-201.5	-193.8	20.24
600	114.53	199.34	53.97	145.38	-203.2	-192.1	16.72
700	123.84	217.64	63.24	154.41	-204.0	-190.1	14.19
800	136.83	234.99	71.59	163.40	-203.8	-188.2	12.29
900	203.75	264.70	91.48	173.22	-298.0	-185.0	10.74
1000	172.49	285.00	101.42	183.58	-290.2	-173.0	9.04
1100	172.49	301.44	107.88	193.56	-285.3	-161.5	7.67
1200	172.49	316.45	113.27	203.18	-279.8	-150.6	6.55

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	4.392 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	18.34 kJ		43.92 cm^3

9/30/92

BORNITE **Formula wt 501.841**

Cu_5FeS_4: Orthorhombic crystals 298.15 to 470 K; cubic crystals 470 to 535 K; cubic crystals 535 to 1200 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	242.90	398.50	0.00	398.50	-371.6	-394.7	69.15
300	243.20	400.00	1.50	398.50	-371.6	-394.8	68.75
400	260.60	472.40	64.09	408.31	-379.9	-402.3	52.54
500	369.45	549.41	121.22	428.19	-376.3	-407.9	42.62
600	327.89	615.63	161.33	454.30	-370.6	-414.9	36.12
700	323.50	665.90	184.73	481.17	-368.2	-422.6	31.53
800	325.20	709.20	202.19	507.01	-365.8	-430.5	28.11
900	327.30	747.53	215.89	531.64	-576.1	-434.4	25.21
1000	332.90	782.29	227.29	555.00	-569.5	-419.1	21.89
1100	340.00	814.34	237.21	577.13	-563.5	-404.3	19.20
1200	348.30	844.27	246.12	598.15	-556.7	-390.1	16.98

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 53.011 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 9.873 J·bar^{-1}

98.73 cm^3

9/30/92

TROILITE **Formula wt 87.913**

FeS: Hexagonal crystals (NiAs structure) 298.15 to a complex transition at 411 K and a Néel temperature at 590 K; paramagnetic 590 to melting point at 1468 K; liquid 1468 to 1800 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	50.49	60.30	0.00	60.30	-102.6	-102.9	18.03
300	50.64	60.62	0.31	60.31	-102.6	-102.9	17.92
400	70.02	76.87	14.44	62.43	-104.1	-103.0	13.46
500	72.06	102.86	34.29	68.57	-99.5	-103.6	10.83
600	67.33	116.98	41.52	75.46	-98.4	-104.5	9.10
700	58.13	126.32	44.23	82.09	-99.1	-105.5	7.87
800	57.73	134.00	45.90	88.10	-100.1	-106.3	6.94
900	58.65	140.86	47.27	93.59	-154.6	-106.0	6.15
1000	60.64	147.13	48.49	98.64	-155.3	-100.6	5.25
1100	62.00	152.82	49.52	103.30	-156.8	-95.0	4.51
1200	62.99	158.17	50.52	107.65	-157.5	-89.3	3.89
1300	63.99	163.32	51.56	111.76	-156.5	-83.7	3.36
1400	64.99	168.22	52.60	115.62	-155.3	-78.2	2.92
1500	71.13	194.95	75.20	119.75	-121.7	-73.4	2.56
1600	71.13	199.51	74.94	124.57	-120.3	-70.2	2.29
1700	71.13	203.82	74.72	129.10	-119.8	-67.1	2.06
1800	71.13	207.88	74.52	133.36	-119.0	-64.0	1.86

Melting T	1468 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	32.34 kJ		
		Molar Vol.	1.820 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	9.351 kJ		18.20 cm^3

PYRRHOTITE **Formula wt 80.932**

$Fe_{.875}S$: Monoclinic crystals 298.15 to combined structural and magnetic transition at 590 K; hexagonal crystals (Ni-As-type) 590 to 1000 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	49.88	60.70	0.00	60.70	-97.5	-98.9	17.33
300	50.01	60.70	0.31	60.39	-97.4	-98.8	17.21
400	56.24	76.28	13.53	62.75	-99.0	-99.4	12.98
500	63.56	89.57	22.76	66.81	-99.5	-99.5	10.39
600	67.35	104.51	32.47	72.04	-97.7	-99.8	8.69
700	65.30	114.53	37.37	77.16	-97.2	-100.0	7.46
800	57.42	122.64	40.28	82.36	-97.6	-100.3	6.55
900	57.19	129.39	42.17	87.22	-151.6	-99.6	5.78
1000	58.38	135.46	43.71	91.75	-151.9	-93.8	4.90

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 9.21 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.749 $J\cdot bar^{-1}$
17.49 cm^3

1/13/93

PYRITE **Formula wt 119.979**

FeS_2: Cubic crystals 298.15 to 1000 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	62.17	52.90	0.00	52.90	-171.5	-160.1	28.05
300	62.39	53.29	0.38	52.90	-171.6	-160.1	27.87
400	69.15	72.34	16.88	55.45	-176.7	-155.9	20.36
500	71.95	88.10	27.64	60.45	-180.4	-150.3	15.70
600	73.93	101.39	35.20	66.20	-183.3	-144.0	12.54
700	75.90	112.94	40.87	72.07	-185.9	-137.3	10.24
800	78.10	123.21	45.38	77.83	-188.2	-130.2	8.50
900	80.57	132.55	49.15	83.40	-296.8	-120.6	7.00
1000	83.29	141.18	52.43	88.75	-297.1	-101.1	5.28

Melting T	1015i K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.394 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	9.63 kJ		23.94 cm^3

9/30/92

MARCASITE **Formula wt 119.979**

FeS_2: Orthorhombic crystals 298.15 to 700 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	62.43	53.90	0.00	53.90	-169.5	-158.4	27.75
300	62.60	54.29	0.39	53.90	-169.5	-158.3	27.56
400	69.17	73.31	16.86	56.45	-174.7	-154.3	20.15
500	72.44	89.13	27.68	61.45	-178.3	-148.8	15.54
600	74.59	102.53	35.32	67.21	-181.2	-142.6	12.41
700	77.00	114.20	41.10	73.11	-183.7	-136.0	10.14

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	2.458 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	9.74 kJ		24.58 cm^3

3/6/92

HYDROGEN SULFIDE **Formula wt 34.082**

H_2S: Ideal gas at p = 1 bar, 298.15 to 1800 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	34.20	205.80	0.00	205.80	-20.6	-33.4	5.86
300	34.21	206.01	0.21	205.80	-20.6	-33.5	5.84
400	35.48	216.01	8.85	207.15	-24.7	-37.5	4.89
500	37.22	224.11	14.35	209.76	-27.9	-40.3	4.21
600	39.05	231.05	18.31	212.74	-30.6	-42.5	3.70
700	40.85	237.21	21.40	215.81	-32.9	-44.3	3.31
800	42.58	242.78	23.94	218.83	-34.9	-45.8	2.99
900	44.21	247.89	26.11	221.78	-89.7	-46.0	2.67
1000	45.72	252.63	27.99	224.63	-90.1	-41.1	2.15
1100	47.13	257.05	29.67	227.38	-90.4	-36.2	1.72
1200	48.41	261.21	31.18	230.03	-90.6	-31.3	1.36
1300	49.58	265.13	32.55	232.58	-90.7	-26.3	1.06
1400	50.62	268.84	33.80	235.04	-90.8	-21.4	0.80
1500	51.55	272.37	34.96	237.41	-90.8	-16.4	0.57
1600	52.35	275.72	36.02	239.70	-90.8	-11.5	0.37
1700	53.04	278.92	37.00	241.91	-90.8	-6.5	0.20
1800	53.60	281.96	37.91	244.06	-90.7	-1.6	0.05

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 9.96 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

9/30/92

ALABANDITE **Formula wt 87.004**

MnS: Cubic crystals 298.15 to 1800 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	49.98	80.30	0.00	80.30	-213.9	-218.7	38.32
300	49.99	80.61	0.31	80.30	-213.9	-218.8	38.09
400	51.10	95.13	12.86	82.27	-216.2	-220.3	28.77
500	52.14	106.65	20.62	86.04	-217.9	-221.2	23.10
600	52.83	116.22	25.93	90.29	-219.3	-221.7	19.30
700	53.25	124.40	29.81	94.59	-220.6	-222.0	16.56
800	53.55	131.53	32.76	98.78	-221.9	-222.1	14.50
900	53.84	137.85	35.08	102.77	-276.3	-220.9	12.82
1000	54.21	143.55	36.98	106.57	-278.7	-214.7	11.22
1100	54.73	148.74	38.56	110.17	-278.9	-208.3	9.89
1200	55.44	153.53	39.94	113.59	-279.1	-201.9	8.79
1300	56.39	158.00	41.17	116.83	-279.3	-195.5	7.85
1400	57.60	162.22	42.30	119.93	-281.7	-188.9	7.05
1500	59.10	166.24	43.36	122.88	-284.2	-182.2	6.34
1600	60.91	170.11	44.40	125.71	-296.9	-174.7	5.70
1700	63.04	173.87	45.43	128.43	-297.3	-167.0	5.13
1800	65.51	177.54	46.48	131.06	-297.4	-159.4	4.62

Melting T K Boiling T K

$\Delta_{vap}H^\circ$ kJ

$\Delta_{fus}H^\circ$ kJ Molar Vol. 2.146 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 21.46 cm^3

9/30/92

MOLYBDENITE **Formula wt 160.072**

MoS_2: Hexagonal crystals 298.15 to 1200 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	63.51	62.60	0.00	62.60	-271.8	-262.8	46.04
300	63.63	62.99	0.39	62.60	-271.8	-262.7	45.75
400	68.45	82.01	16.85	65.16	-276.8	-259.5	33.88
500	71.58	97.65	27.50	70.14	-280.2	-254.7	26.61
600	73.77	110.90	35.04	75.86	-282.7	-249.4	21.71
700	75.35	122.40	40.69	81.70	-284.6	-243.7	18.18
800	76.54	132.54	45.10	87.44	-286.2	-237.7	15.52
900	77.44	141.61	48.65	92.96	-393.7	-229.5	13.32
1000	78.12	149.81	51.56	98.24	-392.5	-211.3	11.03
1100	78.65	157.28	54.00	103.28	-391.3	-193.2	9.17
1200	79.04	164.14	56.07	108.07	-390.1	-175.3	7.63

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	3.202 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	8.82 kJ		32.02 cm^3

9/30/92

MILLERITE **Formula wt 90.756**

NiS: Rhombohedral crystals 298.15 to 623 K; hexagonal crystals 623 to melting point 1066 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	47.11	52.97	0.00	52.97	-91.0	-88.3	15.47
300	47.24	53.26	0.29	52.97	-91.0	-88.3	15.38
400	50.79	67.36	12.55	54.81	-93.4	-87.3	11.40
500	53.68	79.04	20.42	58.62	-95.1	-85.6	8.94
600	56.27	89.04	26.22	62.82	-96.4	-83.6	7.27
700	59.45	102.68	34.91	67.77	-94.4	-81.7	6.10
800	62.55	110.79	38.18	72.61	-94.6	-80.3	5.24
900	65.65	118.37	41.05	77.32	-147.6	-77.0	4.47
1000	68.74	125.44	43.68	81.76	-145.9	-69.2	3.61
1100	71.13	159.58	72.73	86.85	-114.7	-62.5	2.97

Melting T 1066 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 8.47 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.689 $J\cdot bar^{-1}$

16.89 cm^3

9/30/92

HEAZLEWOODITE **Formula wt 240.202**

Ni_3S_2: Hexagonal crystals 298.15 to 834 K; cubic crystals 834 K to incongruent melting point 1064 K; liquid 1064 to 1400 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	118.24	133.20	0.00	133.20	-216.3	-210.2	36.82
300	118.45	133.93	0.73	133.20	-216.3	-210.1	36.59
400	129.01	169.52	31.54	137.98	-221.3	-207.8	27.14
500	136.05	199.12	51.79	147.34	-224.7	-204.1	21.32
600	141.59	224.42	66.29	158.12	-227.8	-199.7	17.38
700	148.35	246.72	77.51	169.22	-230.1	-194.8	14.53
800	158.39	267.14	86.95	180.20	-230.5	-191.1	12.48
900	189.15	355.52	159.38	196.14	-278.4	-187.1	10.86
1000	191.81	375.52	162.41	213.11	-272.8	-177.3	9.26
1100	189.12	411.84	182.56	229.28	-247.9	-168.7	8.01
1200	189.12	428.28	183.11	245.17	-242.7	-161.7	7.03
1300	189.12	443.42	183.57	259.85	-237.9	-155.1	6.23
1400	189.12	457.44	183.97	273.47	-233.3	-148.9	5.56

Melting T	1064 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	19.66 kJ		
		Molar Vol.	4.095 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	21.50 kJ		40.95 cm^3

9/30/92

GALENA **Formula wt 239.266**

PbS: Cubic crystals 298.15 to 900 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	49.49	91.70	0.00	91.70	-98.3	-96.8	16.95
300	49.52	92.01	0.31	91.70	-98.3	-96.8	16.85
400	51.16	106.48	12.81	93.66	-100.6	-96.1	12.55
500	52.80	118.07	20.65	97.42	-102.1	-94.9	9.91
600	54.44	127.84	26.14	101.70	-103.3	-93.3	8.12
700	56.08	136.36	30.30	106.05	-109.0	-90.8	6.77
800	57.72	143.95	33.63	110.32	-109.5	-88.1	5.75
900	59.36	150.84	36.40	114.45	-162.9	-84.3	4.90

Melting T	1400 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
H (fusion)	kJ		
		Molar Vol.	3.149 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	11.51 kJ		31.49 cm^3

9/30/92

STIBNITE **Formula wt 339.698**

Sb_2S_3: Orthorhombic crystals 298.15 to 900 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	119.75	182.00	0.00	182.00	-151.4	-149.8	26.25
300	119.81	182.74	0.74	182.00	-151.4	-149.8	26.09
400	123.38	217.70	30.96	186.74	-158.1	-149.0	19.46
500	126.46	245.58	49.76	195.82	-162.7	-146.3	15.28
600	128.94	268.86	62.76	206.10	-166.0	-142.7	12.42
700	130.92	288.89	72.36	216.53	-168.6	-138.6	10.34
800	132.51	306.48	79.78	226.70	-170.8	-134.1	8.76
900	133.80	322.17	85.72	236.45	-332.2	-126.2	7.33

Melting T 829 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 7.341 $J\cdot bar^{-1}$

73.41 cm^3

10/1/92

HERZENBERGITE **Formula wt 150.776**

SnS: Orthorhombic crystals 298.15 to 875 K; cubic crystals 875 to melting point 1153 K. Liquid 1153 to 1300 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	49.25	77.00	0.00	77.00	-106.5	-104.6	18.33
300	49.32	77.30	0.30	77.00	-106.5	-104.6	18.22
400	50.87	91.76	12.81	78.95	-108.9	-103.9	13.57
500	52.02	103.22	20.52	82.70	-110.6	-102.5	10.70
600	54.51	112.91	25.96	86.95	-119.0	-99.3	8.65
700	58.40	121.50	30.30	91.20	-119.6	-96.0	7.16
800	63.50	129.71	34.12	95.59	-119.5	-92.7	6.05
900	54.04	137.47	37.81	99.66	-171.8	-88.1	5.11
1000	57.07	143.32	39.59	103.73	-170.9	-78.9	4.12
1100	60.11	148.90	41.32	107.58	-169.7	-69.7	3.31
1200	75.61	181.98	69.64	112.34	-136.3	-62.0	2.70
1300	75.61	188.03	70.10	117.93	-133.5	-55.9	2.25

Melting T 1153 K

$\Delta_{fus}H^\circ$ 31.59 kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.901 $J\cdot bar^{-1}$
29.01 cm^3

10/1/92

BERNDTITE **Formula wt 182.842**

SnS_2: Hexagonal crystals 298.15 to 1000 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	70.12	87.50	0.00	87.50	-149.8	-141.5	24.79
300	70.17	87.93	0.43	87.50	-149.8	-141.5	24.63
400	72.05	108.41	18.13	90.28	-154.7	-138.4	18.08
500	73.52	124.64	29.06	95.58	-158.2	-134.0	14.00
600	75.19	138.19	36.60	101.59	-168.1	-127.5	11.10
700	77.13	149.92	42.25	107.67	-170.0	-120.6	9.00
800	79.33	160.36	46.75	113.61	-171.4	-113.5	7.41
900	81.74	169.84	50.50	119.34	-278.6	-104.0	6.04
1000	84.33	178.59	53.75	124.84	-276.9	-84.7	4.42

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	4.096 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	kJ		40.96 cm^3

10/1/92

TUNGSTENITE **Formula wt 247.982**

WS_2: Hexagonal crystals 298.15 to 1500 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	63.83	67.80	0.00	67.80	-241.6	-233.0	40.81
300	63.99	68.20	0.39	67.80	-241.6	-232.9	40.55
400	69.67	87.50	17.10	70.39	-246.5	-229.8	30.00
500	72.41	103.37	27.92	75.45	-249.8	-225.2	23.53
600	74.01	116.72	35.48	81.25	-252.2	-220.0	19.16
700	75.09	128.22	41.06	87.15	-254.1	-214.5	16.01
800	75.90	138.30	45.37	92.93	-255.6	-208.8	13.63
900	76.57	147.28	48.80	98.48	-363.1	-200.7	11.65
1000	77.16	155.38	51.61	103.77	-361.9	-182.7	9.54
1100	77.71	162.76	53.95	108.80	-360.6	-164.9	7.83
1200	78.24	169.54	55.96	113.58	-359.4	-147.1	6.40
1300	78.76	175.82	57.69	118.13	-358.2	-129.5	5.20
1400	79.29	181.68	59.21	122.47	-357.0	-111.9	4.18
1500	79.83	187.17	60.57	126.60	-355.8	-94.5	3.29

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circs-H_0^\circ$ 11.01 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.207 J·bar^{-1}
32.07 cm^3

10/1/92

SPHALERITE **Formula wt 97.456**

ZnS: Cubic crystals 298.15 K to 1300 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	45.76	58.70	0.00	58.70	-204.1	-199.6	34.97
300	45.82	58.98	0.28	58.70	-204.1	-199.6	34.75
400	48.30	72.53	12.00	60.53	-206.6	-198.0	25.85
500	49.93	83.50	19.43	64.06	-208.3	-195.6	20.44
600	51.12	92.71	24.62	68.09	-209.6	-193.0	16.80
700	52.04	100.66	28.47	72.19	-218.0	-190.1	14.18
800	52.79	107.66	31.47	76.19	-219.1	-186.0	12.14
900	53.42	113.92	33.87	80.04	-273.2	-180.7	10.49
1000	53.96	119.57	35.85	83.72	-272.8	-170.4	8.90
1100	54.43	124.74	37.52	87.22	-272.4	-160.2	7.61
1200	54.85	129.49	38.95	90.54	-387.1	-148.1	6.45
1300	55.23	133.90	40.19	93.71	-385.6	-128.2	5.15

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.383 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	8.82 kJ		23.83 cm^3

10/1/92

WURTZITE **Formula wt 97.456**

ZnS: Hexagonal crystals 298.15 to 1300 K. Reference state for sulfur is orthorhombic sulfur.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	45.89	58.80	0.00	58.80	-203.8	-199.4	34.93
300	45.96	59.08	0.28	58.80	-203.8	-199.3	34.71
400	48.72	72.74	12.09	60.64	-206.2	-197.7	25.82
500	50.13	83.77	19.57	64.20	-207.9	-195.4	20.41
600	51.09	93.00	24.75	68.25	-209.2	-192.8	16.78
700	51.86	100.94	28.57	72.37	-217.7	-189.8	14.17
800	52.55	107.91	31.52	76.38	-218.8	-185.8	12.13
900	53.21	114.13	33.90	80.24	-272.9	-180.6	10.48
1000	53.86	119.77	35.86	83.91	-272.5	-170.3	8.90
1100	54.50	124.94	37.52	87.41	-272.1	-160.1	7.60
1200	55.15	129.71	38.97	90.74	-386.8	-148.0	6.44
1300	55.80	134.15	40.24	93.91	-385.2	-128.2	5.15

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.385 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	8.85 kJ		23.85 cm^3

10/1/92

BERTHIERITE **Formula wt 427.611**

$FeSb_2S_4$: Orthorhombic crystals 298.15 to 836 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	175.23	245.00	0.00	245.00	-256.2	-255.8	44.81
300	175.60	246.09	1.08	245.00	-256.2	-255.8	44.54
400	186.17	298.40	46.33	252.06	-264.1	-255.4	33.36
500	189.05	340.31	74.64	265.67	-269.1	-252.8	26.40
600	190.44	374.90	93.83	281.07	-272.9	-249.1	21.69
700	191.92	404.37	107.73	296.63	-276.0	-244.9	18.27
800	193.91	430.12	118.37	311.74	-279.0	-240.2	15.68
900	196.48	453.10	126.91	326.20	-494.4	-230.9	13.40

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	9.222 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		92.22 cm^3

2/17/93

CHALCOSTIBITE **Formula wt 249.428**

$CuSbS_2$: Orthorhombic crystals 298.15 t0 826 K. Reference state for sulfur is orthorhombic sulfur.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	100.15	149.20	0.00	149.20	-130.8	-132.7	23.25
300	100.22	149.82	0.62	149.20	-130.8	-132.7	23.11
400	104.26	179.20	26.02	153.18	-134.8	-133.3	17.40
500	108.30	202.90	42.07	160.83	-137.2	-132.6	13.85
600	112.34	223.01	53.45	169.56	-138.7	-131.5	11.45
700	116.38	240.63	62.15	178.48	-139.3	-130.3	9.72
800	120.42	256.43	69.18	187.25	-139.5	-129.0	8.42
900	124.46	270.85	75.10	195.75	-245.5	-125.5	7.29

Melting T	826 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	5.006 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	kJ		50.06 cm^3

2/17/93

ACANTHITE (ARGENTITE) **Formula wt 247.802**

Ag_2S: Monoclinic crystals 298.15 to 451.3 K; cubic crystals (argentite) 451.3 to 865 K. γ phase 865 to 1000 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	75.31	142.89	0.00	142.89	-96.3	-79.5	13.93
300	75.39	143.35	0.46	142.89	-96.3	-79.4	13.83
400	80.47	165.67	19.78	145.89	-95.3	-73.9	9.65
500	87.26	193.79	41.08	152.71	-89.6	-69.2	7.23
600	86.03	209.59	48.67	160.92	-88.1	-65.3	5.68
700	84.80	222.75	53.91	168.84	-86.7	-61.6	4.60
800	84.69	234.05	57.75	176.30	-85.7	-58.1	3.79
900	80.38	244.84	61.53	183.31	-84.1	-54.7	3.17
1000	80.57	253.28	63.38	189.90	-83.8	-51.5	2.69

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	3.419 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	17.132 kJ		34.19 cm^3

A= -8.355E+01 B= 3.273E-02 C= -5.14E+05

9/24/92

REALGAR **Formula wt 106.988**

AsS: Monoclinic crystals 298.15 to melting point 580 K; liquid 580 to 800 K.
Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$		$kJ\cdot mol^{-1}$		
298.15	47.02	63.50	0.00	63.50	-95.2	-69.5	12.17
300	47.08	63.80	0.29	63.51	-95.2	-69.3	12.07
400	49.32	77.68	12.29	65.39	-94.5	-60.8	7.94
500	51.18	88.88	19.88	69.00	-93.8	-52.4	5.48
600	67.12	110.35	36.84	73.51	-86.0	-44.5	3.87
700	71.48	121.00	41.46	79.54	-83.6	-37.7	2.82
800	77.50	130.90	45.57	85.33	-80.7	-31.4	2.05

Melting T 580 K

$\Delta_{fus}H^\circ$ 6.668 kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.980 $J\cdot bar^{-1}$
29.80 cm^3

A= -84.07 B= 0.06734 C= -4.98E+05

3/25/92

GREENOCKITE **Formula wt 144.477**

CdS: Cubic crystals 298.15 to 1100 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	47.30	72.18	0.00	72.18	-213.9	-186.0	32.58
300	47.36	72.47	0.29	72.18	-213.9	-185.8	32.35
400	49.46	86.42	12.35	74.07	-213.4	-176.5	23.05
500	50.70	97.60	19.91	77.69	-212.8	-167.4	17.48
600	51.68	106.93	25.12	81.81	-218.6	-158.2	13.78
700	52.55	114.96	28.98	85.99	-218.1	-148.2	11.06
800	53.37	122.03	31.98	90.06	-217.6	-138.3	9.03
900	54.16	128.37	34.40	93.97	-217.1	-128.4	7.45
1000	54.93	134.11	36.41	97.70	-216.5	-118.5	6.19
1100	55.67	139.38	38.13	101.25	-314.8	-102.9	4.89

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	2.993 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	8.81 kJ		29.93 cm^3

A= -2.177E+02 B= 9.880E-02 C= 2.109E+05

9/24/92

CATTIERITE **Formula wt 123.065**

CoS_2: Cubic crystals 298.15 to 1000 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	68.26	74.80	0.00	74.80	-279.5	-224.8	39.38
300	68.39	75.22	0.42	74.80	-279.5	-224.5	39.08
400	74.28	95.76	18.20	77.56	-278.2	-206.3	26.94
500	78.63	112.82	29.87	82.96	-276.8	-188.5	19.69
600	82.38	127.50	38.31	89.18	-275.1	-171.0	14.89
700	85.85	140.46	44.86	95.60	-273.4	-153.8	11.48
800	89.16	152.14	50.19	101.95	-271.9	-136.8	8.93
900	92.38	162.83	54.70	108.13	-269.8	-120.0	6.97
1000	95.55	172.72	58.63	114.10	-267.7	-103.5	5.41

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 12.30 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.552 $J\cdot bar^{-1}$

25.52 cm^3

A= -2.710E+02 B= 1.682E-01 C= -3.57E+05

3/26/92

COVELLITE **Formula wt 95.612**

CuS: Hexagonal crystals 298.15 to 800 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	47.53	67.40	0.00	67.40	-118.9	-95.1	16.66
300	47.59	67.69	0.29	67.40	-118.9	-95.0	16.53
400	50.29	81.77	12.47	69.30	-118.1	-87.1	11.37
500	52.62	93.24	20.27	72.98	-117.3	-79.4	8.30
600	54.82	103.03	25.84	77.19	-116.3	-71.9	6.26
700	56.94	111.64	30.14	81.51	-115.2	-64.6	4.82
800	59.03	119.38	33.62	85.77	-113.9	-57.5	3.75

Melting T	780i K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	2.042 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	9.45 kJ		20.42 cm^3

A= -1.148E+02 B= 7.208E-02 C= -1.60E+05

3/26/92

CHALCOCITE **Formula wt 159.158**

Cu_2S: Orthorhombic crystals 298.15 to 376 K; hexagonal crystals 376 to 710 K; cubic crystals 710 to melting point 1403 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	76.84	116.20	0.00	116.20	-148.2	-129.1	22.61
300	77.01	116.67	0.47	116.20	-148.2	-129.0	22.45
400	98.83	151.07	31.14	119.93	-142.5	-123.0	16.06
500	95.31	172.84	44.33	128.51	-139.7	-118.5	12.38
600	92.30	189.93	52.56	137.37	-137.3	-114.5	9.97
700	89.79	203.97	58.06	145.91	-135.3	-110.8	8.27
800	82.76	216.94	62.85	154.09	-132.9	-107.6	7.02
900	82.50	226.66	65.04	161.62	-132.1	-104.5	6.06
1000	85.02	235.65	67.02	168.63	-131.1	-101.5	5.30
1100	85.02	243.77	68.68	175.09	-130.3	-98.6	4.68
1200	85.02	251.17	70.03	181.14	-129.7	-95.7	4.17
1300	85.02	257.95	71.71	186.24	-128.7	-92.2	3.71
1400	85.02	264.23	72.15	192.08	-155.6	-89.2	3.33

Melting T	1403 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	2.748 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	15.80 kJ		27.48 cm^3

A= -1.304E+02 B= 2.957E-02 C= -6.73E+05

01/13/93

CHALCOPYRITE **Formula wt 183.525**

$CuFeS_2$: Tetragonal crystals 298.15 to 820 K; tetragonal crystals 820 to 930 K; cubic crystals 930 to 1200 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar. Above 820 K, phase is called ISS (intermediate solid solution).

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	95.80	124.90	0.00	124.90	-323.5	-274.8	48.14
300	96.24	125.49	0.59	124.90	-323.5	-274.5	47.79
400	106.26	155.01	26.15	128.86	-321.7	-258.4	33.74
500	109.15	179.02	42.45	136.57	-319.8	-242.8	25.37
600	114.53	199.34	53.97	145.38	-317.9	-227.6	19.81
700	123.84	217.64	63.24	154.41	-315.6	-212.7	15.87
800	136.83	234.99	71.59	163.40	-312.6	-198.2	12.94
900	203.75	264.70	91.48	173.22	-298.0	-185.0	10.74
1000	172.49	285.00	101.42	183.58	-290.2	-173.0	9.04
1100	172.49	301.44	107.88	193.56	-285.3	-161.5	7.67
1200	172.49	316.45	113.27	203.18	-279.8	-150.6	6.55

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 18.34 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.392 J·bar^{-1}

43.92 cm^3

A= -2.9995E+02 B= 1.2712E-01 C= -1.19E+06

3/26/92

BORNITE **Formula wt 501.841**

Cu_5FeS_4: Orthorhombic crystals 298.15 to 470 K; cubic crystals 470 to 535 K; cubic crystals 535 to 1200 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	242.90	398.50	0.00	398.50	-628.8	-554.1	97.07
300	243.20	400.00	1.50	398.50	-628.7	-553.6	96.39
400	260.60	472.40	64.09	408.31	-625.3	-529.1	69.09
500	369.45	549.41	121.22	428.19	-612.9	-506.0	52.86
600	327.89	615.63	161.33	454.30	-600.0	-485.9	42.30
700	323.50	665.90	184.73	481.17	-591.4	-467.7	34.90
800	325.20	709.20	202.19	507.01	-583.4	-450.6	29.42
900	327.30	747.53	215.89	531.64	-576.1	-434.4	25.21
1000	332.90	782.29	227.29	555.00	-569.5	-419.1	21.89
1100	340.00	814.34	237.21	577.13	-563.5	-404.3	19.20
1200	348.30	844.27	246.12	598.15	-556.7	-390.1	16.98

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 53.01 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 9.873 $J\cdot bar^{-1}$

98.73 cm^3

A= -5.714E+02 B= 1.542E-01 C= -2.625E+06

3/26/92

TROILITE **Formula wt 87.913**

FeS: Hexagonal crystals (NiAs structure) 298.15 to a complex transition at 411 K and a Néel temperature at 590 K; paramagnetic 590 to melting point at 1468 K; liquid 1468 to 1800 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	50.49	60.30	0.00	60.30	-166.9	-142.8	25.01
300	50.64	60.62	0.31	60.31	-166.9	-142.6	24.83
400	70.02	76.87	14.44	62.43	-165.5	-134.7	17.59
500	72.06	102.86	34.29	68.57	-158.7	-128.1	13.39
600	67.33	116.98	41.52	75.46	-155.8	-122.3	10.65
700	58.13	126.32	44.23	82.09	-154.9	-116.8	8.71
800	57.73	134.00	45.90	88.10	-154.5	-111.4	7.27
900	58.65	140.86	47.27	93.59	-154.6	-106.0	6.15
1000	60.64	147.13	48.49	98.64	-155.3	-100.6	5.25
1100	62.00	152.82	49.52	103.30	-156.8	-95.0	4.51
1200	62.99	158.17	50.52	107.65	-157.5	-89.3	3.89
1300	63.99	163.32	51.56	111.76	-156.5	-83.7	3.36
1400	64.99	168.22	52.60	115.62	-155.3	-78.2	2.92
1500	71.13	194.95	75.20	119.75	-121.7	-73.4	2.56
1600	71.13	199.51	74.94	124.57	-120.3	-70.2	2.29
1700	71.13	203.82	74.72	129.10	-119.8	-67.1	2.06
1800	71.13	207.88	74.52	133.36	-119.0	-64.0	1.86

Melting T	1468 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	32.34 kJ		
		Molar Vol. 1.820	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	9.351 kJ	18.20	cm^3

A= -1.488E+02 B= 4.910E-02 C= -8.05E+05

2/17/93

PYRRHOTITE **Formula wt 80.932**

$Fe_{.875}S$: Monoclinic crystals 298.15 to combined structural and magnetic transition at 590 K; hexagonal crystal (NiAs-type) 590 to 1000 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	49.88	60.70	0.00	60.70	-161.8	-138.8	24.31
300	50.01	60.70	0.31	60.39	-161.7	-138.5	24.12
400	56.24	76.28	13.53	62.75	-160.4	-131.1	17.12
500	63.56	89.57	22.76	66.81	-158.6	-124.0	12.95
600	67.35	104.51	32.47	72.04	-155.0	-117.5	10.23
700	65.30	114.53	37.37	77.16	-153.0	-111.2	8.30
800	57.42	122.64	40.28	82.36	-151.9	-105.4	6.88
900	57.19	129.39	42.17	87.22	-151.6	-99.6	5.78
1000	58.38	135.46	43.71	91.75	-151.9	-93.8	4.90

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	1.749 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	9.21 kJ		17.49 cm^3

A= -1.513E+02 B= 5.811E-02 C= -4.30E+05

01/13/93

PYRITE **Formula wt 119.979**

FeS_2: Cubic crystals 298.15 to 1000 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	62.17	52.90	0.00	52.90	-300.1	-239.8	42.01
300	62.39	53.29	0.38	52.90	-300.1	-239.4	41.69
400	69.15	72.34	16.88	55.45	-299.5	-219.3	28.64
500	71.95	88.10	27.64	60.45	-298.7	-199.3	20.82
600	73.93	101.39	35.20	66.20	-298.0	-179.5	15.63
700	75.90	112.94	40.87	72.07	-297.4	-159.8	11.93
800	78.10	123.21	45.38	77.83	-297.0	-140.2	9.15
900	80.57	132.55	49.15	83.40	-296.8	-120.6	7.00
1000	83.29	141.18	52.43	88.75	-297.1	-101.1	5.28

Melting T	1015i K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	2.394 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	9.63 kJ		23.94 cm^3

A= -2.967E+02 B= 1.958E-01 C= -1.36E-05

9/25/92

MARCASITE **Formula wt 119.979**

FeS_2: Orthorhombic crystals 298.15 to 700 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	62.43	53.90	0.00	53.90	-298.1	-238.1	41.71
300	62.60	54.29	0.39	53.90	-298.1	-237.7	41.39
400	69.17	73.31	16.86	56.45	-297.4	-217.7	28.42
500	72.44	89.13	27.68	61.45	-296.6	-197.8	20.66
600	74.59	102.53	35.32	67.21	-295.9	-178.1	15.50
700	77.00	114.20	41.10	73.11	-295.2	-158.5	11.83

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	2.458 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	9.74 kJ		24.58 cm^3

A= -2.952E+02 B= 1.955E-01 C= -1.08E+05

9/25/92

HYDROGEN SULFIDE **Formula wt 34.082**

H_2S: Ideal gas at p = 1 bar, 298.15 to 1800 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	34.20	205.80	0.00	205.80	-84.9	-73.3	12.84
300	34.21	206.01	0.21	205.80	-84.9	-73.2	12.75
400	35.48	216.01	8.85	207.15	-86.0	-69.1	9.03
500	37.22	224.11	14.35	209.76	-87.0	-64.8	6.77
600	39.05	231.05	18.31	212.74	-87.9	-60.3	5.25
700	40.85	237.21	21.40	215.81	-88.7	-55.6	4.15
800	42.58	242.78	23.94	218.83	-89.2	-50.8	3.32
900	44.21	247.89	26.11	221.78	-89.7	-46.0	2.67
1000	45.72	252.63	27.99	224.63	-90.1	-41.1	2.15
1100	47.13	257.05	29.67	227.38	-90.4	-36.2	1.72
1200	48.41	261.21	31.18	230.03	-90.6	-31.3	1.36
1300	49.58	265.13	32.55	232.58	-90.7	-26.3	1.06
1400	50.62	268.84	33.80	235.04	-90.8	-21.4	0.80
1500	51.55	272.37	34.96	237.41	-90.8	-16.4	0.57
1600	52.35	275.72	36.02	239.70	-90.8	-11.5	0.37
1700	53.04	278.92	37.00	241.91	-90.8	-6.5	0.20
1800	53.60	281.96	37.91	244.06	-90.7	-1.6	0.05

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 9.96 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

A= -9.067E+01 B= 4.942E-02 C= 2.447E+05

3/26/92

ALABANDITE **Formula wt 87.004**

MnS: Cubic crystals 298.15 to 1800 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	49.98	80.30	0.00	80.30	-278.2	-258.6	45.30
300	49.99	80.61	0.31	80.30	-278.2	-258.5	45.00
400	51.10	95.13	12.86	82.27	-277.5	-252.0	32.91
500	52.14	106.65	20.62	86.04	-277.0	-245.7	25.66
600	52.83	116.22	25.93	90.29	-276.6	-239.4	20.84
700	53.25	124.40	29.81	94.59	-276.4	-231.3	17.41
800	53.55	131.53	32.76	98.78	-276.3	-227.1	14.83
900	53.84	137.85	35.08	102.77	-276.3	-220.9	12.82
1000	54.21	143.55	36.98	106.57	-278.7	-214.7	11.22
1100	54.73	148.74	38.56	110.17	-278.9	-208.3	9.89
1200	55.44	153.53	39.94	113.59	-279.1	-201.9	8.79
1300	56.39	158.00	41.17	116.83	-279.3	-195.5	7.85
1400	57.60	162.22	42.30	119.93	-281.7	-188.9	7.05
1500	59.10	166.24	43.36	122.88	-284.2	-182.2	6.34
1600	60.91	170.11	44.40	125.71	-296.9	-174.7	5.70
1700	63.04	173.87	45.43	128.43	-297.3	-167.0	5.13
1800	65.51	177.54	46.48	131.06	-297.4	-159.4	4.62

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.146 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 21.46 cm^3

A= -2.807E+02 B= 6.621E-02 C= 2.459E+05

3/26/92

MOLYBDENITE **Formula wt 160.072**

MoS_2: Hexagonal crystals 298.15 to 1200 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	63.51	62.60	0.00	62.60	-400.4	-342.5	60.00
300	63.63	62.99	0.39	62.60	-400.4	-342.1	59.57
400	68.45	82.01	16.85	65.16	-399.6	-322.8	42.16
500	71.58	97.65	27.50	70.14	-398.5	-303.8	31.73
600	73.77	110.90	35.04	75.86	-397.4	-284.9	24.80
700	75.35	122.40	40.69	81.70	-396.2	-266.3	19.87
800	76.54	132.54	45.10	87.44	-395.0	-247.8	16.18
900	77.44	141.61	48.65	92.96	-393.7	-229.5	13.32
1000	78.12	149.81	51.56	98.24	-392.5	-211.3	11.04
1100	78.65	157.28	54.00	103.28	-391.3	-193.2	9.17
1200	79.04	164.14	56.07	108.07	-390.1	-175.3	7.63

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 8.818 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.202 $J\cdot bar^{-1}$

32.02 cm^3

A= -3.933E+02 B= 1.822E-01 C= -3.21E+05

3/26/92

MILLERITE **Formula wt 90.756**

NiS: Rhombohedral crystals 298.15 to 623 K; hexagonal crystals 623 to melting point at 1066 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	47.11	52.97	0.00	52.97	-155.3	-128.2	22.45
300	47.24	53.26	0.29	52.97	-155.3	-128.0	22.29
400	50.79	67.36	12.55	54.81	-154.8	-119.0	15.53
500	53.68	79.04	20.42	58.62	-154.2	-110.1	11.50
600	56.27	89.04	26.22	62.82	-153.8	-101.3	8.82
700	59.45	102.68	34.91	67.77	-150.2	-93.0	6.94
800	62.55	110.79	38.18	72.61	-149.0	-85.4	5.57
900	65.65	118.37	41.05	77.32	-147.6	-77.0	4.47
1000	68.74	125.44	43.68	81.76	-145.9	-69.2	3.61
1100	71.13	159.58	72.73	86.85	-114.7	-62.5	2.97

Melting T	1066 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	1.689 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	53.01 kJ		16.89 cm^3

A= -1.434E+02 B= 7.351E-02 C= -6.29E+05

4/1/92

HEAZLEWOODITE **Formula wt 240.202**

Ni_3S_2: Hexagonal crystals 298.15 to 834 K; cubic crystals 834 K to incongruent melting point 1064 K; liquid 1064 to 1400 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	118.24	133.20	0.00	133.20	-344.9	-289.9	50.78
300	118.45	133.93	0.73	133.20	-344.9	-289.5	50.41
400	129.01	169.52	31.54	137.98	-344.0	-271.2	35.41
500	136.05	199.12	51.79	147.34	-343.0	-253.1	26.44
600	141.59	224.42	66.29	158.12	-342.5	-235.2	20.47
700	148.35	246.72	77.51	169.22	-341.7	-217.3	16.22
800	158.39	267.14	86.95	180.20	-339.3	-201.1	13.13
900	189.15	355.52	159.38	196.14	-278.4	-187.1	10.86
1000	191.81	375.52	162.41	213.11	-272.8	-177.3	9.26
1100	189.12	411.84	182.56	229.28	-247.9	-168.7	8.01
1200	189.12	428.28	183.11	245.17	-242.7	-161.7	7.04
1300	189.12	443.42	183.57	259.85	-237.9	-155.1	6.23
1400	189.12	457.44	183.97	273.47	-233.3	-148.9	5.56

Melting T	1064 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	19.66 kJ		
		Molar Vol.	4.095 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	21.501 kJ		40.95 cm^3

A= -2.815E+02 B= 1.016E-01 C= -3.71E+06

4/1/92

GALENA **Formula wt 239.266**

PbS: Cubic crystals 298.15 to 900 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	49.49	91.70	0.00	91.70	-162.6	-136.6	23.93
300	49.52	92.01	0.31	91.70	-162.6	-136.4	23.76
400	51.16	106.48	12.81	93.66	-161.9	-127.8	16.69
500	52.80	118.07	20.65	97.42	-161.3	-119.4	12.47
600	54.44	127.84	26.14	101.70	-160.6	-111.0	9.67
700	56.08	136.36	30.30	106.05	-164.8	-102.0	7.61
800	57.72	143.95	33.63	110.32	-163.9	-93.1	6.08
900	59.36	150.84	36.40	114.45	-162.9	-84.3	4.90

Melting T 1400 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.149 $J\cdot bar^{-1}$

31.49 cm^3

A= -1.640E+02 B= 8.830E-02 C= 9.946E+04

9/25/92

STIBNITE **Formula wt 339.698**

Sb_2S_3: Orthorhombic crystals 298.15 to 900 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	119.75	182.00	0.00	182.00	-344.3	-269.4	47.19
300	119.81	182.74	0.74	182.00	-344.3	-269.8	46.82
400	123.38	217.70	30.96	186.74	-342.2	-244.1	31.88
500	126.46	245.58	49.76	195.82	-340.1	-219.8	22.96
600	128.94	268.86	62.76	206.10	-338.0	-195.9	17.06
700	130.92	288.89	72.36	216.53	-335.9	-172.4	12.87
800	132.51	306.48	79.78	226.70	-334.0	-149.2	9.74
900	133.80	322.17	85.72	236.45	-332.2	-126.2	7.33

Melting T 829 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 7.341 $J\cdot bar^{-1}$

73.41 cm^3

A = -3.338E+02 B = 2.315E-01 C = -4.19E+05

4/1/92

HERZENBERGITE **Formula wt 150.776**

SnS: Orthorhombic crystals 298.15 to 875 K; cubic crystals 875 to melting point 1153 K. Liquid 1153 to 1300 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	49.25	77.00	0.00	77.00	-170.8	-144.5	25.31
300	49.32	77.30	0.30	77.00	-170.8	-144.3	25.13
400	50.89	91.76	12.81	78.96	-170.2	-135.6	17.71
500	52.03	103.22	20.52	82.70	-169.8	-127.0	13.26
600	54.52	112.91	25.96	86.95	-176.4	-117.1	10.19
700	58.41	121.50	30.30	91.20	-175.4	-107.3	8.00
800	63.50	129.71	34.12	95.59	-173.9	-97.7	6.38
900	54.04	137.47	37.81	99.66	-171.8	-88.1	5.11
1000	57.07	143.32	39.59	103.73	-170.9	-78.9	4.12
1100	60.11	148.90	41.32	107.58	-169.7	-69.7	3.31
1200	75.61	181.98	69.64	112.34	-136.3	-62.0	2.70
1300	75.61	188.03	70.10	117.93	-133.5	-55.9	2.25

Melting T 1153 K

Boiling T K

$\Delta_{fus}H^\circ$ 31.59 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Molar Vol. 2.901 $J\cdot bar^{-1}$

29.01 cm^3

A= -1.696E+02 B= 8.941E-02 C= -1.74E+05

4/1/92

BERNDTITE **Formula wt 182.842**

SnS_2: Hexagonal crystals 298.15 to 1000 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	70.12	87.50	0.00	87.50	-278.4	-221.2	38.75
300	70.17	87.93	0.43	87.50	-278.4	-220.8	38.45
400	72.05	108.41	18.13	90.28	-277.4	-201.8	26.35
500	73.52	124.64	29.06	95.58	-276.6	-183.0	19.12
600	75.19	138.19	36.60	101.59	-282.8	-163.1	14.19
700	77.13	149.92	42.25	107.67	-281.6	-143.2	10.69
800	79.33	160.36	46.75	113.61	-280.2	-123.5	8.06
900	81.74	169.84	50.50	119.34	-278.6	-104.0	6.04
1000	84.33	178.59	53.75	124.84	-276.9	-84.7	4.42

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	4.096 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		40.96 cm^3

A= -2.818E+02 B= 1.973E-01 C= 1.613E+05

4/1/92

TUNGSTENITE **Formula wt 247.982**

WS_2: Hexagonal crystals 298.15 to 1500 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	63.83	67.80	0.00	67.80	-370.2	-312.7	54.77
300	63.99	68.20	0.39	67.80	-370.2	-312.3	54.37
400	69.67	87.50	17.10	70.39	-369.3	-293.1	38.28
500	72.41	103.37	27.92	75.45	-368.1	-274.2	28.65
600	74.01	116.72	35.48	81.25	-366.9	-255.6	22.25
700	75.09	128.22	41.06	87.15	-365.6	-237.1	17.69
800	75.90	138.30	45.37	92.93	-364.4	-218.8	14.29
900	76.57	147.28	48.80	98.48	-363.1	-200.7	11.65
1000	77.16	155.38	51.61	103.77	-361.9	-182.7	9.54
1100	77.71	162.76	53.95	108.80	-360.6	-164.9	7.83
1200	78.24	169.54	55.96	113.58	-359.4	-147.1	6.40
1300	78.76	175.82	57.69	118.13	-358.2	-129.5	5.20
1400	79.29	181.68	59.21	122.47	-357.0	-111.9	4.18
1500	79.83	187.17	60.57	126.60	-355.8	-94.5	3.29

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 11.01 kJ

Boiling T 239.1 K

$\Delta_{vap}H^\circ$ 20.41 kJ

Molar Vol. 3.207 $J\cdot bar^{-1}$

32.07 cm3

A= -3.610E+02 B= 1.782E-01 C= -4.51E+05

4/1/92

SPHALERITE **Formula wt 97.456**

ZnS: Cubic crystals to 1300 K. Wurtzite is the stable form of ZnS above 1300 K.
Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	45.76	58.70	0.00	58.70	-268.4	-239.5	41.95
300	45.82	58.98	0.28	58.70	-268.4	-239.3	41.66
400	48.30	72.53	12.00	60.53	-267.9	-229.7	29.99
500	49.93	83.50	19.43	64.06	-267.4	-220.2	23.00
600	51.12	92.71	24.62	68.09	-266.9	-210.7	18.35
700	52.04	100.66	28.47	72.19	-273.8	-201.3	15.02
800	52.79	107.66	31.47	76.19	-273.5	-191.0	12.47
900	53.42	113.92	33.87	80.04	-273.2	-180.7	10.49
1000	53.96	119.57	35.85	83.72	-272.8	-170.4	8.90
1100	54.43	124.74	37.52	87.22	-272.4	-160.2	7.61
1200	54.85	129.49	38.95	90.54	-387.1	-148.1	6.45
1300	55.23	133.90	40.19	93.71	-385.6	-128.2	5.15

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.383 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	8.82 kJ		23.83 cm^3

A= -2.821E+02 B= 1.131E-01 C= 8.609E+05

01/06/93

WURTZITE **Formula wt 97.456**

ZnS: Hexagonal crystals 298.15 to 1300 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	45.89	58.80	0.00	58.80	-268.1	-239.2	41.91
300	45.96	59.08	0.28	58.80	-268.1	-239.0	41.62
400	48.72	72.74	12.09	60.64	-267.6	-229.4	29.96
500	50.13	83.77	19.57	64.20	-267.1	-219.9	22.97
600	51.09	93.00	24.75	68.25	-266.6	-210.5	18.33
700	51.86	100.94	28.57	72.37	-273.5	-201.2	15.01
800	52.55	107.91	31.52	76.38	-273.2	-190.9	12.46
900	53.21	114.13	33.90	80.24	-272.9	-180.6	10.48
1000	53.86	119.77	35.86	83.91	-272.5	-170.3	8.90
1100	54.50	124.94	37.52	87.41	-272.1	-160.1	7.60
1200	55.15	129.71	38.97	90.74	-386.8	-148.0	6.44
1300	55.80	134.15	40.24	93.91	-385.2	-128.2	5.15

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.385 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 8.85 kJ 23.85 cm^3

A= -2.8172E+02 B= 1.1284E-01 C= 8.613E+06

01/06/93

BERTHIERITE **Formula wt 427.611**

$FeSb_2S_4$: Orthorhombic crystals 298.15 to 836 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	175.23	245.00	0.00	245.00	-513.4	-415.2	72.75
300	175.60	246.09	1.08	245.00	-513.3	-414.6	72.18
400	186.17	298.40	46.33	252.06	-509.5	-382.2	49.91
500	189.05	340.31	74.64	265.67	-505.8	-350.8	36.65
600	190.44	374.90	93.83	281.07	-502.3	-320.1	27.87
700	191.92	404.37	107.73	296.63	-499.2	-290.0	21.64
800	193.91	430.12	118.37	311.74	-496.6	-260.3	17.00
900	196.48	453.10	126.91	326.20	-494.4	-230.9	13.40

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 9.222 $J\cdot bar^{-1}$

92.22 cm^3

A= -4.957E+02 B= 2.954E-01 C= -6.84E+05

2/17/93

CHALCOSTIBITE **Formula wt 249.428**

$CuSbS_2$: Orthorhombic crystals 298.15 t0 826 K. Reference state for sulfur is ideal S_2 gas at p = 1 bar.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	100.15	149.20	0.00	149.20	-259.4	-212.4	37.21
300	100.22	149.82	0.62	149.20	-259.4	-212.1	36.93
400	104.26	179.20	26.02	153.18	-257.5	-196.6	25.68
500	108.30	202.90	42.07	160.83	-255.5	-181.6	18.97
600	112.34	223.01	53.45	169.56	-253.3	-167.0	14.54
700	116.38	240.63	62.15	178.48	-250.9	-152.9	11.41
800	120.42	256.43	69.18	187.25	-248.3	-139.0	9.08
900	124.46	270.85	75.10	195.75	-245.5	-125.5	7.29

Melting T 826 K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ Molar Vol. 5.006 $J\cdot bar^{-1}$
50.06 cm^3

A= -2.486E+02 B= 1.377E-01 C= -4.38E+05

2/17/93

CORUNDUM **Formula wt 101.961**

Al_2O_3: Rhombohedral crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	79.10	50.92	0.00	50.92	-1675.7	-1582.3	277.20
300	79.53	51.41	0.49	50.92	-1675.7	-1581.7	275.39
400	96.45	76.87	22.60	54.28	-1676.3	-1550.2	202.43
500	106.04	99.51	38.40	61.11	-1676.0	-1518.7	158.66
600	112.31	119.43	50.23	69.21	-1675.3	-1487.3	129.48
700	116.79	137.10	59.43	77.67	-1674.4	-1456.1	108.65
800	120.19	152.93	66.82	86.10	-1673.5	-1424.9	93.04
900	122.88	167.24	72.91	94.34	-1672.7	-1393.9	80.90
1000	125.08	180.31	78.02	102.29	-1693.4	-1361.5	71.12
1100	126.93	192.32	82.38	109.93	-1692.3	-1328.3	63.08
1200	128.52	203.43	86.16	117.27	-1691.2	-1295.3	56.38
1300	129.91	213.78	89.48	124.30	-1690.0	-1262.3	50.72
1400	131.13	223.45	92.41	131.04	-1688.8	-1229.5	45.87
1500	132.23	232.53	95.03	137.51	-1687.4	-1196.8	41.67
1600	133.23	241.10	97.39	143.72	-1686.0	-1164.1	38.00
1700	134.14	249.21	99.52	149.68	-1684.5	-1131.5	34.77
1800	134.99	256.90	101.47	155.43	-1683.0	-1099.0	31.89

Melting T 2345 K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 10.016 kJ Molar Vol. 2.558 J·bar^{-1} 25.58 cm^3

A= -1.686E+03 B= 3.257E-01 C= 6.538E+05

4/4/92

BOEHMITE **Formula wt 59.988**

AlO(OH): Orthorhombic crystals 298.15 to 600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	54.24	37.20	0.00	37.20	-996.4	-918.4	160.90
300	54.50	37.54	0.34	37.20	-996.4	-917.9	159.82
400	66.40	54.95	15.46	39.49	-997.3	-891.6	116.43
500	74.51	70.70	26.51	44.19	-997.3	-865.2	90.38
600	80.03	84.80	35.00	49.80	-997.0	-838.8	73.02

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	1.954 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	8.83 kJ		19.54 cm^3

A= -9.976E+02 B= 2.646E-01 C= 2.644E+04

8/27/92

DIBORON TRIOXIDE **Formula wt 69.620**

B_2O_3: Hexagonal crystals 298.15 to melting point 723 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	62.60	54.00	0.00	54.00	-1273.5	-1194.4	209.24
300	62.93	54.39	0.39	54.00	-1273.5	-1193.9	207.87
400	78.07	74.68	18.02	56.67	-1273.6	-1167.3	152.43
500	89.31	93.37	31.20	62.17	-1273.3	-1140.8	119.17
600	98.08	110.46	41.65	68.81	-1272.6	-1114.3	97.01
700	105.19	126.13	50.23	75.90	-1271.6	-1088.0	81.19
800	129.70	175.88	89.55	86.33	-1244.7	-1064.5	69.50
900	129.70	191.16	94.02	97.14	-1241.6	-1042.1	60.48
1000	129.70	204.83	97.58	107.25	-1238.7	-1020.1	53.28
1100	129.70	217.19	100.51	116.68	-1236.1	-998.4	47.41
1200	129.70	228.47	102.94	125.53	-1233.6	-976.9	42.52
1300	129.70	238.86	105.00	133.86	-1231.3	-955.6	38.39
1400	129.70	248.47	106.76	141.71	-1229.2	-934.5	34.86
1500	129.70	257.42	108.29	149.13	-1227.1	-913.5	31.81
1600	129.70	265.79	109.63	156.16	-1225.2	-892.6	29.14
1700	129.70	273.65	110.81	162.84	-1223.5	-871.9	26.79
1800	129.70	281.06	111.86	169.20	-1221.8	-851.2	24.70

Melting T 723 K Boiling T K

$\Delta_{fus}H^\circ$ 24.07 kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.722 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 9.30 kJ 27.22 cm^3

A= -1.240E+03 B= 2.148E-01 C= -2.28E+06

9/9/92

BARIUM MONOXIDE **Formula wt 153.326**

BaO: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	47.28	72.07	0.00	72.07	-548.1	-520.4	91.17
300	47.35	72.36	0.29	72.07	-548.1	-520.2	90.58
400	49.98	86.37	12.41	73.96	-547.7	-511.0	66.73
500	51.78	97.73	20.11	77.62	-548.0	-501.8	52.42
600	53.17	107.30	25.51	81.79	-548.9	-492.5	42.87
700	54.33	115.58	29.55	86.04	-549.0	-483.1	36.05
800	55.36	122.91	32.71	90.20	-549.5	-473.6	30.92
900	56.29	129.48	35.28	94.20	-549.5	-464.1	26.94
1000	57.15	135.46	37.42	98.03	-549.5	-454.6	23.75
1100	57.96	140.94	39.25	101.69	-557.8	-444.3	21.10
1200	58.73	146.02	40.85	105.17	-557.8	-434.0	18.89
1300	59.48	150.75	42.25	108.50	-557.8	-423.7	17.02
1400	60.19	155.18	43.51	111.68	-557.6	-413.4	15.42
1500	60.89	159.36	44.64	114.72	-557.2	-403.1	14.04
1600	61.58	163.31	45.68	117.63	-556.8	-392.9	12.83
1700	62.25	167.07	46.63	120.43	-556.3	-382.6	11.76
1800	62.90	170.64	47.52	123.12	-555.8	-372.4	10.81

Melting T 2286 K

Boiling T K

$\Delta_{fus}H^\circ$ kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 9.98 kJ

Molar Vol. 2.559 J·bar^{-1}
25.59 cm^3

A= -5.518E+02 B= 9.893E-02 C= 2.781E-01

8/27/92

BROMELLITE **Formula wt 25.012**

BeO: Hexagonal crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	25.56	13.77	0.00	13.77	-609.4	-580.1	101.63
300	25.76	13.93	0.16	13.77	-609.4	-579.9	100.97
400	33.93	22.57	7.68	14.89	-609.7	-570.0	74.44
500	38.90	30.71	13.46	17.25	-609.6	-560.1	58.51
600	42.28	38.12	18.00	20.12	-609.4	-550.2	47.90
700	44.73	44.83	21.65	23.18	-609.0	-540.4	40.32
800	46.61	50.93	24.66	26.28	-608.6	-530.6	34.64
900	48.09	56.51	27.18	29.33	-608.2	-520.9	30.23
1000	49.30	61.64	29.33	32.31	-607.7	-511.2	26.70
1100	50.31	66.39	31.20	35.19	-607.3	-501.6	23.82
1200	51.18	70.81	32.83	37.98	-606.9	-492.0	21.41
1300	51.94	74.93	34.27	40.66	-606.6	-482.4	19.38
1400	52.62	78.81	35.55	43.25	-606.3	-472.9	17.64
1500	53.24	82.46	36.71	45.75	-606.0	-463.4	16.14
1600	53.82	85.91	37.77	48.15	-620.3	-453.5	14.80
1700	54.37	89.19	38.73	50.47	-619.7	-443.1	13.61
1800	54.90	92.32	39.61	52.71	-619.1	-432.7	12.56

Melting T 2681 K

Boiling T K

$\Delta_{fus}H^\circ$ kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 2.88 kJ

Molar Vol. 0.8309 $J\cdot bar^{-1}$

8.309 cm^3

A= -6.089E+02 B= 9.754E-02 C= -4.08E-02

8/27/92

BISMITE **Formula wt 465.959**

Bi_2O_3: Monoclinic crystals 298.15 to melting point 1098 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	113.55	151.50	0.00	151.50	-573.9	-493.5	86.45
300	113.61	152.20	0.70	151.50	-573.9	-493.0	85.83
400	116.94	185.34	29.34	156.00	-572.0	-466.3	60.89
500	120.28	211.80	47.20	164.60	-570.2	-440.1	45.98
600	123.62	234.02	59.66	174.36	-591.3	-411.9	35.86
700	126.95	253.33	69.03	184.30	-589.5	-382.2	28.52
800	130.29	270.50	76.48	194.02	-587.3	-352.7	23.03
900	133.62	286.03	82.64	203.39	-584.7	-323.5	18.78
1000	136.96	300.29	87.91	212.38	-581.9	-294.7	15.39

Melting T 1098 K

Boiling T K

$\Delta_{fus}H^\circ$ kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Molar Vol. 4.973 $J\cdot bar^{-1}$

49.73 cm^3

A= -5.909E+02 B= 2.957E-01 C= 8.426E+05

8/27/92

CARBON MONOXIDE **Formula wt 28.010**

CO: Ideal gas at p = 1 bar, 298.15 to 2200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	29.14	197.27	0.00	197.27	-110.5	-137.1	24.01
300	29.13	197.45	0.18	197.27	-110.5	-137.2	23.89
400	29.15	205.80	7.39	198.41	-110.1	-146.2	19.09
500	29.79	212.37	11.81	200.57	-110.0	-155.2	16.22
600	30.55	217.87	14.87	203.00	-110.2	-164.2	14.30
700	31.29	222.64	17.16	205.48	-110.5	-173.2	12.93
800	31.97	226.86	18.97	207.89	-110.9	-182.2	11.89
900	32.58	230.66	20.45	210.21	-111.4	-191.0	11.09
1000	33.14	234.12	21.69	212.43	-112.0	-199.9	10.44
1100	33.64	237.31	22.75	214.55	-112.6	-208.6	9.91
1200	34.09	240.25	23.68	216.57	-113.2	-217.3	9.46
1300	34.50	243.00	24.50	218.50	-113.9	-226.0	9.08
1400	34.86	245.57	25.22	220.34	-114.6	-234.6	8.75
1500	35.18	247.98	25.88	222.11	-115.3	-243.1	8.47
1600	35.47	250.26	26.47	223.80	-116.0	-251.6	8.21
1700	35.72	252.42	27.01	225.42	-116.7	-260.1	7.99
1800	35.94	254.47	27.50	226.97	-117.4	-268.5	7.79

Melting T 68.05 K

Boiling T K

$\Delta_{fus}H^\circ$ 0.837 kJ

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 J·bar^{-1}

$H_{298}^\circ-H_0^\circ$ 8.67 kJ

24789.7 cm^3

A= -1.131E+02 B= -8.667E-02 C= 1.858E+05

4/4/92

CARBON DIOXIDE **Formula wt 44.010**

CO_2: Ideal gas at p = 1 bar, 298.15 to 2200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	37.12	213.79	0.00	213.79	-393.5	-394.4	69.09
300	37.20	214.02	0.23	213.79	-393.5	-394.4	68.67
400	41.20	225.28	9.98	215.30	-393.6	-394.7	51.54
500	44.62	234.85	16.58	218.28	-393.7	-394.9	41.26
600	47.39	243.24	21.49	221.75	-393.8	-395.2	34.40
700	49.64	250.72	25.36	225.37	-394.0	-395.4	29.50
800	51.48	257.47	28.51	228.96	-394.2	-395.6	25.83
900	53.01	263.63	31.15	232.48	-394.4	-395.7	22.97
1000	54.29	269.28	33.40	235.88	-394.6	-395.9	20.68
1100	55.38	274.51	35.35	239.16	-394.8	-396.0	18.80
1200	56.31	279.37	37.06	242.31	-395.0	-396.1	17.24
1300	57.10	283.90	38.57	245.34	-395.2	-396.1	15.92
1400	57.79	288.16	39.92	248.25	-395.5	-396.2	14.78
1500	58.38	292.17	41.13	251.04	-395.7	-396.3	13.80
1600	58.90	295.95	42.23	253.73	-395.9	-396.3	12.94
1700	59.35	299.54	43.22	256.32	-396.1	-396.3	12.18
1800	59.74	302.94	44.13	258.82	-396.3	-396.3	11.50

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 9.36 kJ 24789.7 cm^3

A= -3.944E+02 B= -1.248E-03 C= 5.480E-02

12/17/91

LIME **Formula wt 56.077**

CaO: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	42.07	38.10	0.00	38.10	-635.1	-603.1	105.66
300	42.21	38.36	0.26	38.10	-635.1	-602.9	104.97
400	46.99	51.25	11.43	39.83	-634.7	-592.2	77.33
500	49.34	62.01	18.80	43.22	-634.2	-581.6	60.76
600	50.72	71.14	24.01	47.13	-633.7	-571.2	49.72
700	51.65	79.03	27.90	51.14	-633.4	-560.8	41.84
800	52.35	85.98	30.91	55.07	-634.0	-550.3	35.93
900	52.90	92.18	33.32	58.85	-634.0	-539.9	31.33
1000	53.36	97.78	35.31	62.47	-634.2	-529.4	27.65
1100	53.77	102.88	36.97	65.91	-634.7	-518.9	24.64
1200	54.13	107.58	38.38	69.19	-643.3	-507.7	22.10
1300	54.47	111.92	39.61	72.32	-643.1	-496.4	19.95
1400	54.80	115.97	40.68	75.29	-643.0	-485.1	18.10
1500	55.10	119.76	41.63	78.13	-642.8	-473.8	16.50
1600	55.40	123.33	42.48	80.84	-642.6	-462.6	15.10
1700	55.68	126.69	43.25	83.44	-642.4	-451.3	13.87
1800	55.96	129.88	43.95	85.94	-790.9	-437.9	12.71

Melting T 3200 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 6.75 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.676 $J\cdot bar^{-1}$

16.76 cm^3

A= -6.395E+02 B= 1.105E-01 C= 3.497E+05

8/27/92

PORTLANDITE **Formula wt 74.093**

$Ca(OH)_2$: Hexagonal crystals 298.15 to 700 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	87.51	83.40	0.00	83.40	-986.1	-898.0	157.33
300	87.75	83.94	0.54	83.40	-986.1	-897.5	156.27
400	97.94	110.71	23.73	86.98	-985.3	-868.1	113.36
500	104.19	133.29	39.24	94.05	-983.9	-838.9	87.64
600	108.23	152.67	50.43	102.24	-982.3	-810.1	70.52
700	110.89	169.57	58.89	110.68	-980.7	-781.5	58.32

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	3.306 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	14.16 kJ		33.06 cm^3

A= -9.810E+02 B= 2.857E-01 C= -1.98E+05

4/8/92

CERIANITE **Formula wt 172.114**

CeO_2: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	61.63	62.30	0.00	62.30	-1088.7	-1024.6	179.51
300	61.78	62.68	0.38	62.30	-1088.7	-1024.2	178.33
400	67.52	81.33	16.52	64.80	-1087.9	-1002.9	130.96
500	70.83	96.78	27.08	69.70	-1086.9	-981.7	102.56
600	73.11	109.91	34.57	75.33	-1085.9	-960.7	83.64
700	74.86	121.31	40.21	81.11	-1085.0	-940.0	70.14
800	76.29	131.40	44.63	86.77	-1084.1	-919.3	60.02
900	77.52	140.46	48.22	92.25	-1083.4	-898.7	52.16
1000	78.62	148.69	51.20	97.48	-1085.7	-878.3	45.87
1100	79.63	156.23	53.74	102.49	-1090.5	-857.4	40.71
1200	80.56	163.20	55.94	107.26	-1089.8	-836.2	36.40
1300	81.45	169.68	57.87	111.81	-1089.1	-815.2	32.75
1400	82.29	175.75	59.58	116.17	-1088.3	-794.1	29.63
1500	83.09	181.45	61.12	120.33	-1087.4	-773.1	26.92
1600	83.88	186.84	62.52	124.32	-1086.5	-752.2	24.56
1700	84.64	191.95	63.80	128.15	-1085.6	-731.3	22.47
1800	85.38	196.81	64.98	131.83	-1084.5	-710.5	20.62

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.385 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 10.37 kJ 23.85 cm^3

A= -1.0865E+03 B= 2.088E-01 C= -5.536E-02

8/27/92

COBALT MONOXIDE **Formula wt 74.933**

CoO: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	43.34	52.83	0.00	52.83	-237.9	-214.1	37.51
300	43.62	53.10	0.27	52.83	-237.9	-214.0	37.25
400	51.88	67.04	12.37	54.68	-237.1	-206.1	26.91
500	54.00	78.90	20.53	58.37	-236.0	-198.5	20.73
600	54.51	88.80	26.16	62.64	-235.1	-191.0	16.63
700	54.67	97.22	30.22	66.99	-234.3	-183.8	13.71
800	54.90	104.53	33.29	71.24	-234.1	-176.5	11.53
900	55.30	111.02	35.71	75.30	-233.6	-169.4	9.83
1000	55.92	116.87	37.70	79.17	-233.4	-162.3	8.48
1100	56.75	122.24	39.39	82.85	-233.3	-155.2	7.37
1200	57.76	127.22	40.88	86.34	-233.5	-148.0	6.44
1300	58.95	131.89	42.22	89.67	-234.1	-140.9	5.66
1400	60.28	136.30	43.46	92.84	-235.1	-133.8	4.99
1500	61.75	140.51	44.63	95.88	-234.9	-126.6	4.41
1600	63.34	144.55	45.75	98.80	-234.4	-119.4	3.90
1700	65.03	148.44	46.84	101.60	-233.6	-112.2	3.45
1800	66.81	152.21	47.90	104.31	-249.0	-104.6	3.04

Melting T 2078 K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.164 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 9.45 kJ 11.64 cm^3

A= -2.336E+02 B= 7.152E-02 C= -1.63E+05

9/9/92

TRICOBALT TETROXIDE **Formula wt 240.797**

Co_3O_4: Cubic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	123.39	109.30	0.00	109.30	-918.8	-802.2	140.54
300	123.85	110.06	0.76	109.30	-918.8	-801.5	139.54
400	142.51	148.50	34.08	114.42	-919.0	-762.3	99.54
500	154.69	181.68	57.05	124.63	-918.5	-723.1	75.54
600	164.32	210.76	74.15	136.61	-917.5	-684.1	59.56
700	172.75	236.73	87.64	149.09	-916.3	-645.4	48.16
800	180.54	260.31	98.77	161.54	-916.2	-606.5	39.60
900	187.96	282.01	108.27	173.74	-914.6	-567.9	32.96
1000	195.14	302.18	116.60	185.58	-913.1	-529.5	27.66

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	3.977 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	18.13 kJ		39.77 cm^3

A= -9.157E+02 B= 3.866E-01 C= -1.61E+05

9/9/92

ESKOLAITE **Formula wt 151.990**

Cr_2O_3: Rhombohedral crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	105.41	81.20	0.00	81.20	-1134.7	-1053.1	184.49
300	105.63	81.85	0.65	81.20	-1134.7	-1052.6	183.26
400	113.62	113.48	28.02	85.46	-1133.1	-1025.4	133.90
500	117.83	139.32	45.60	93.73	-1131.3	-998.7	104.33
600	120.55	161.06	57.87	103.19	-1129.5	-972.4	84.65
700	122.58	179.80	66.98	112.82	-1127.8	-946.3	70.62
800	124.22	196.28	74.03	122.25	-1126.2	-920.5	60.10
900	125.65	211.00	79.69	131.31	-1124.8	-894.9	51.94
1000	126.95	224.30	84.35	139.95	-1123.7	-869.4	45.41
1100	128.15	236.46	88.28	148.18	-1122.7	-844.1	40.08
1200	129.30	247.66	91.65	156.01	-1122.1	-818.7	35.64
1300	130.40	258.05	94.59	163.46	-1121.7	-793.5	31.88
1400	131.47	267.76	97.19	170.57	-1121.7	-768.2	28.66
1500	132.52	276.86	99.51	177.36	-1122.0	-743.0	25.87
1600	133.55	285.45	101.60	183.85	-1122.6	-717.7	23.43
1700	134.56	293.58	103.51	190.06	-1123.6	-692.4	21.27
1800	135.57	301.29	105.26	196.03	-1125.0	-666.9	19.35

Melting T	2603 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
$H_{298}^\circ-H_0^\circ$	9.45 kJ	Molar Vol.	2.909 $J\cdot bar^{-1}$
			29.09 cm^3

A= -1.1225E+03 B= 2.533E-01 C= -5.635E-01

10/1/92

TENORITE **Formula wt 79.545**

CuO: Monoclinic crystals 298.15 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	42.30	42.60	0.00	42.60	-156.1	-128.3	22.48
300	42.44	42.86	0.26	42.60	-156.1	-128.2	22.32
400	47.07	55.80	11.47	44.33	-155.6	-118.9	15.53
500	49.32	66.57	18.83	47.74	-154.8	-109.9	11.48
600	50.80	75.70	24.04	51.65	-154.0	-100.9	8.79
700	51.98	83.62	27.95	55.67	-153.2	-92.2	6.88
800	53.05	90.63	31.02	59.61	-152.3	-83.5	5.45
900	54.09	96.94	33.53	63.41	-151.4	-74.9	4.35
1000	55.13	102.69	35.64	67.06	-150.5	-66.5	3.47
1100	56.18	108.00	37.46	70.54	-149.6	-58.1	2.76
1200	57.25	112.93	39.06	73.87	-148.7	-49.9	2.17
1300	58.33	117.56	40.50	77.05	-147.9	-41.7	1.67
1400	59.43	121.92	41.81	80.10	-160.2	-33.1	1.23

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	1.222 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	7.10 kJ		12.22 cm^3

A= -1.506E+02 B= 8.412E-02 C= -2.64E+05

8/28/92

CUPRITE **Formula wt 143.091**

Cu_2O: Cubic crystals 298.15 to 1509 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	62.54	92.40	0.00	92.40	-170.6	-147.8	25.89
300	62.59	92.79	0.39	92.40	-170.6	-147.7	25.71
400	67.18	111.37	16.47	94.90	-170.6	-140.0	18.28
500	71.49	126.85	27.07	99.79	-170.3	-132.4	13.83
600	74.27	140.16	34.72	105.43	-169.8	-124.9	10.87
700	76.00	151.74	40.50	111.24	-169.3	-117.4	8.76
800	77.28	161.98	45.02	116.95	-168.7	-110.0	7.18
900	78.60	171.15	48.68	122.48	-168.2	-102.7	5.96
1000	80.33	179.52	51.75	127.77	-167.6	-95.5	4.99
1100	82.76	187.29	54.46	132.83	-167.0	-88.3	4.19
1200	86.10	194.62	56.95	137.68	-166.4	-81.2	3.53
1300	90.51	201.68	59.35	142.33	-165.6	-74.1	2.98
1400	96.12	208.59	61.77	146.82	-191.0	-66.2	2.47
1500	103.03	215.45	64.28	151.16	-189.4	-57.4	2.00

Melting T 1509 K

Boiling T K

$\Delta_{fus}H^\circ$ kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Molar Vol. 2.344 $J\cdot bar^{-1}$
23.44 cm^3

A= -1.690E+02 B= 7.367E-02 C= -6.26E+04

8/26/92

WUSTITE **Formula wt 68.887**

$Fe_{.947}O$: Rhombohedral crystals 298.15 to melting point 1652 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	48.13	56.60	0.00	56.60	-266.3	-244.9	42.91
300	48.27	56.90	0.30	56.60	-266.3	-244.8	42.62
400	51.99	71.43	12.87	58.56	-265.2	-237.8	31.05
500	52.78	83.13	20.79	62.34	-264.2	-231.1	24.14
600	53.04	92.78	26.15	66.64	-263.4	-224.6	19.55
700	53.38	100.98	30.01	70.97	-262.8	-218.1	16.28
800	53.95	108.14	32.97	75.18	-262.6	-211.8	13.83
900	54.76	114.54	35.34	79.20	-262.7	-205.4	11.92
1000	55.80	120.36	37.33	83.03	-263.4	-199.0	10.40
1100	57.05	125.74	39.07	86.67	-264.9	-192.5	9.14
1200	58.48	130.76	40.62	90.14	-265.6	-185.9	8.09
1300	60.05	135.51	42.06	93.45	-264.7	-179.3	7.20
1400	61.76	140.02	43.40	96.62	-263.7	-172.8	6.45
1500	63.58	144.34	44.69	99.65	-262.7	-166.3	5.79
1600	65.51	148.50	45.93	102.58	-261.6	-159.9	5.22

Melting T	1652 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	1.204 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	kJ		12.04 cm^3

A= -2.632E+02 B= 6.455E-02 C= -8.06E+04

2/5/93

FERROUS OXIDE (Fictive) **Formula wt 71.846**

FeO: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	47.68	60.60	0.00	60.60	-272.0	-251.4	44.05
300	47.75	60.90	0.29	60.60	-272.0	-251.3	43.75
400	50.26	75.03	12.52	62.51	-271.2	-244.5	31.93
500	51.47	86.39	20.20	66.19	-270.5	-237.9	24.85
600	52.26	95.84	25.48	70.36	-269.9	-231.5	20.15
700	52.91	103.95	29.35	74.60	-269.6	-225.1	16.79
800	53.51	111.05	32.33	78.72	-269.6	-218.7	14.28
900	54.11	117.39	34.72	82.67	-270.0	-212.3	12.32
1000	54.72	123.12	36.69	86.43	-271.0	-205.9	10.75
1100	55.34	128.37	38.36	90.01	-273.0	-199.3	9.46
1200	55.98	133.21	39.80	93.41	-274.1	-192.5	8.38
1300	56.63	137.72	41.07	96.65	-273.7	-185.7	7.46
1400	57.30	141.94	42.20	99.73	-273.3	-179.0	6.68
1500	57.98	145.91	43.23	102.68	-273.0	-172.3	6.00
1600	58.68	149.68	44.18	105.50	-272.7	-165.6	5.40
1700	59.38	153.26	45.05	108.21	-273.4	-158.8	4.88
1800	60.10	156.67	45.87	110.81	-273.6	-152.1	4.41

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.200 $J\cdot bar^{-1}$

12.00 cm^3

A= -2.719E+02 B= 6.634E-02 C= 7.599E+04

2/24/94

HEMATITE **Formula wt 159.692**

Fe_2O_3: Rhombohedral crystal 298.15 to Neél temperature 950 K. Hexagonal crystals 950 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	104.05	87.40	0.00	87.40	-826.2	-744.4	130.41
300	104.32	88.04	0.64	87.40	-826.2	-743.9	129.51
400	120.29	120.27	28.59	91.68	-824.6	-716.6	93.58
500	131.72	148.44	48.16	100.28	-822.3	-689.9	72.07
600	139.33	173.16	62.75	110.41	-819.6	-663.6	57.77
700	146.52	195.17	74.19	120.98	-816.9	-637.8	47.59
800	156.12	215.32	83.79	131.53	-814.0	-612.4	39.99
900	170.22	234.47	92.57	141.90	-810.9	-587.4	34.09
950	179.45	243.91	96.89	147.03	-809.3	-575.3	31.65
950	151.69	244.58	97.54	147.03	-807.9	-575.3	31.65
1000	148.49	252.27	100.16	152.11	-808.9	-562.8	29.40
1100	143.55	266.18	104.32	161.86	-810.8	-538.0	25.55
1200	140.74	278.53	107.45	171.08	-811.9	-513.2	22.34
1300	140.07	289.76	109.98	179.78	-810.1	-488.4	19.62
1400	141.42	300.18	112.16	188.02	-808.5	-463.8	17.30
1500	144.64	310.03	114.21	195.82	-806.9	-439.2	15.29
1600	149.58	319.52	116.26	203.26	-805.2	-414.7	13.54
1700	156.06	328.77	118.40	210.37	-804.9	-390.3	11.99
1800	163.95	337.91	120.71	217.20	-803.1	-366.0	10.62

Melting T 1895 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 65.10 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.027 $J\cdot bar^{-1}$

30.27 cm^3

A= -8.089E+02 B= 2.466E-01 C= -8.423E+05

9/9/92

MAGNETITE **Formula wt 231.539**

Fe_3O_4: Cubic (ferrimagnetic) crystals 298.15 to Neél temperature 845.5 K. Cubic crystals (paramagnetic) 845.5 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	150.90	146.14	0.00	146.14	-1115.7	-1012.7	177.42
300	151.40	147.07	0.93	146.14	-1114.6	-1012.1	176.21
400	176.18	194.21	41.81	152.40	-1113.0	-977.9	127.70
500	192.90	235.43	70.45	164.98	-1109.2	-944.5	98.67
600	207.91	271.89	92.08	179.81	-1104.8	-912.0	79.40
700	228.68	305.38	110.00	195.38	-1099.5	-880.3	65.69
800	260.76	337.86	126.70	211.16	-1092.7	-849.4	55.46
845.5	330.50	354.00	135.66	218.34	-1087.8	-835.3	51.60
900	213.93	369.13	142.05	227.08	-1085.1	-819.5	47.56
1000	205.97	391.22	148.81	242.41	-1085.5	-790.0	41.27
1100	201.45	410.62	153.78	256.84	-1089.1	-760.3	36.10
1200	199.28	428.04	157.65	270.39	-1091.0	-730.4	31.79
1300	198.76	443.96	160.82	283.14	-1088.6	-700.4	28.14
1400	199.43	458.71	163.55	295.16	-1086.5	-670.6	25.02
1500	201.00	472.52	165.99	306.53	-1084.6	-641.0	22.32
1600	203.23	485.56	168.24	317.32	-1082.9	-611.5	19.96
1700	205.99	497.96	170.38	327.58	-1084.1	-582.0	17.88
1800	209.15	509.82	172.45	337.37	-1083.7	-552.4	16.03

Melting T	1870 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	4.452 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	102.80 kJ		44.52 cm^3

A= -1.086E+03 B= 2.969E-01 c+ -1.437E+06

9/9/92

STEAM **Formula wt 18.015**

H_2O: Ideal gas at p = 1 bar, 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	33.59	188.84	0.00	188.84	-241.8	-228.6	40.05
300	33.59	189.05	0.21	188.84	-241.8	-228.5	39.79
400	34.04	198.75	8.59	190.16	-242.9	-223.9	29.24
500	35.09	206.45	13.78	192.67	-243.9	-219.0	22.88
600	36.34	212.96	17.43	195.52	-244.8	-214.0	18.63
700	37.66	218.66	20.23	198.43	-245.7	-208.8	15.58
800	38.97	223.77	22.49	201.28	-246.5	-203.5	13.28
900	40.27	228.44	24.39	204.05	-247.2	-198.0	11.49
1000	41.53	232.75	26.04	206.70	-247.8	-192.6	10.06
1100	42.76	236.76	27.51	209.26	-248.4	-187.0	8.88
1200	43.94	240.53	28.83	211.71	-248.9	-181.4	7.90
1300	45.07	244.10	30.03	214.06	-249.4	-175.7	7.06
1400	46.15	247.48	31.15	216.33	-249.8	-170.1	6.35
1500	47.19	250.70	32.18	218.51	-250.2	-164.4	5.72
1600	48.18	253.77	33.15	220.62	-250.5	-158.6	5.18
1700	49.12	256.72	34.06	222.66	-250.7	-152.9	4.70
1800	50.01	259.56	34.93	224.63	-251.0	-147.1	4.27

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

A= -2.4896E+02 B= 5.632E-02 C= 3.354E+05

8/26/92

DIPOTASSIUM MONOXIDE **Formula wt 94.196**

K_2O: Cubic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	83.68	94.10	0.00	94.10	-363.2	-322.1	56.43
300	83.79	94.62	0.52	94.10	-363.2	-321.9	56.04
400	88.89	119.45	21.99	97.45	-367.0	-307.3	40.13
500	93.39	139.77	35.83	103.94	-365.6	-292.6	30.56
600	97.64	157.17	45.78	111.40	-363.7	-278.1	24.21
700	101.78	172.54	53.48	119.05	-361.4	-264.0	19.70
800	105.85	186.39	59.77	126.62	-358.6	-250.3	16.34
900	109.90	199.10	65.12	133.98	-355.5	-237.0	13.75
1000	113.92	210.88	69.80	141.08	-352.0	-224.0	11.70
1100	117.92	221.93	73.99	147.94	-506.2	-202.1	9.60
1200	121.92	232.36	77.82	154.54	-500.2	-174.7	7.61

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.038 $J\cdot bar^{-1}$
40.38 cm^3

A= -3.816E+02 B= 1.640E-01 C= 1.032E+06

5/20/93

DILITHIUM MONOXIDE **Formula wt 29.881**

Li_2O: Cubic crystals 298.15 to melting point 1700 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	54.10	37.60	0.00	37.60	-597.9	-561.2	98.31
300	54.33	37.94	0.33	37.60	-597.9	-561.0	97.67
400	63.61	54.96	15.10	39.86	-598.7	-548.5	71.63
500	69.52	69.83	25.43	44.40	-605.4	-535.3	55.92
600	73.98	82.91	33.16	49.75	-605.7	-521.2	45.38
700	77.67	94.60	39.26	55.34	-605.6	-507.1	37.84
800	80.87	105.19	44.27	60.92	-605.2	-493.1	32.20
900	83.72	114.88	48.50	66.38	-604.4	-479.1	27.81
1000	86.29	123.83	52.15	71.68	-603.4	-465.3	24.30
1100	88.63	132.17	55.36	76.81	-602.2	-451.5	21.44
1200	90.76	139.98	58.22	81.75	-600.7	-437.9	19.06
1300	92.70	147.32	60.80	86.51	-599.1	-424.4	17.05
1400	94.46	154.25	63.15	91.11	-597.3	-411.0	15.33
1500	96.05	160.83	65.29	95.54	-595.3	-397.7	13.85
1600	97.47	167.07	67.25	99.82	-593.2	-384.6	12.56
1700	98.72	173.02	69.07	103.95	-881.4	-357.3	10.98

Melting T 1700 K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.476 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 14.76 cm^3

A= -6.086E+02 B= 1.425E-01 C= 4.563E+06

12/7/92

PERICLASE **Formula wt 40.304**

MgO: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	37.26	26.90	0.00	26.90	-601.6	-569.3	99.74
300	37.40	27.13	0.23	26.90	-601.6	-569.1	99.09
400	42.70	38.70	10.26	28.44	-601.6	-558.3	72.90
500	45.57	48.57	17.06	31.51	-601.4	-547.4	57.19
600	47.37	57.05	21.97	35.07	-601.1	-536.7	46.72
700	48.61	64.45	25.69	38.75	-600.8	-526.0	39.25
800	49.53	71.00	28.62	42.38	-600.5	-515.3	33.64
900	50.26	76.88	30.98	45.89	-600.4	-504.7	29.29
1000	50.87	82.21	32.94	49.26	-608.9	-493.3	25.77
1100	51.40	87.08	34.60	52.48	-608.9	-481.8	22.88
1200	51.90	91.57	36.02	55.56	-609.0	-470.2	20.47
1300	52.36	95.75	37.26	58.49	-609.0	-458.6	18.43
1400	52.82	99.64	38.35	61.29	-736.4	-443.9	16.56
1500	53.28	103.30	39.33	63.97	-735.0	-423.1	14.73
1600	53.76	106.76	40.22	66.54	-733.5	-402.3	13.13
1700	54.25	110.03	41.03	69.00	-732.1	-381.7	11.73
1800	54.76	113.15	41.78	71.37	-730.6	-361.1	10.48

Melting T 3125 K

Boiling T K

$\Delta_{fus}H^\circ$ kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 5.17 kJ

Molar Vol. 1.125 $J\cdot bar^{-1}$

11.25 cm^3

A= -6.373E+02 B= 1.449E-01 C= 2.512E+06

8/26/92

BRUCITE **Formula wt 58.320**

$Mg(OH)_2$: Hexagonal crystals 298.15 to 900 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	77.27	63.20	0.00	63.20	-924.5	-833.5	146.02
300	77.66	63.68	0.48	63.20	-924.5	-832.9	145.02
400	91.89	88.23	21.78	66.45	-924.4	-802.4	104.78
500	99.29	109.60	36.61	73.00	-923.4	-772.0	80.64
600	104.00	128.15	47.47	80.68	-922.1	-741.8	64.58
700	107.44	144.45	55.80	88.65	-920.6	-711.9	53.12
800	110.20	158.98	62.43	96.55	-919.0	-682.1	44.54
900	112.57	172.10	67.87	104.23	-917.3	-652.6	37.88

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.463 J·bar^{-1}

$H_{298}^\circ-H_0^\circ$ 11.40 kJ 24.63 cm^3

A= -9.195E+02 B= 2.971E-01 C= -2.30E+05

4/9/92

MANGANOSITE **Formula wt 70.937**

MnO: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	44.10	59.71	0.00	59.71	-385.2	-362.9	63.58
300	44.16	59.98	0.27	59.71	-385.2	-362.8	63.16
400	46.81	73.07	11.60	61.48	-384.9	-355.3	46.40
500	48.73	83.74	18.84	64.90	-384.5	-348.0	36.35
600	50.24	92.76	23.95	68.81	-384.3	-340.7	29.66
700	51.49	100.60	27.80	72.80	-384.1	-333.4	24.88
800	52.57	107.55	30.83	76.72	-384.0	-326.2	21.30
900	53.52	113.80	33.30	80.50	-383.9	-319.0	18.51
1000	54.38	119.48	35.37	84.12	-386.2	-311.7	16.28
1100	55.17	124.70	37.13	87.57	-386.2	-304.3	14.45
1200	55.91	129.53	38.67	90.87	-386.3	-296.8	12.92
1300	56.59	134.04	40.02	94.02	-386.3	-289.4	11.63
1400	57.24	138.26	41.23	97.03	-388.6	-281.9	10.52
1500	57.87	142.23	42.31	99.91	-391.1	-274.1	9.54
1600	58.46	145.98	43.31	102.67	-403.8	-265.6	8.67
1700	59.03	149.54	44.21	105.33	-404.4	-256.9	7.89
1800	59.59	152.93	45.05	107.88	-404.9	-248.3	7.20

Melting T 2054 K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.322 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 13.22 cm^3

A= -3.880E+02 B= 7.651E-02 C= 2.398E+05

4/9/92

PYROLUSITE **Formula wt 86.937**

MnO_2: Crystals 298.15 to 850 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	54.76	52.75	0.00	52.75	-520.0	-465.0	81.47
300	54.94	53.09	0.34	52.75	-520.0	-464.7	80.91
400	63.21	70.11	15.09	55.01	-519.8	-446.3	58.27
500	68.34	84.81	25.27	59.54	-519.1	-427.9	44.71
600	71.21	97.56	32.72	64.84	-518.4	-409.8	35.67
700	72.68	108.66	38.33	70.32	-517.7	-391.7	29.23
800	73.36	118.41	42.67	75.74	-517.2	-373.8	24.40
900	73.65	127.07	46.10	80.97	-516.8	-355.9	20.65

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	1.661 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		16.61 cm^3

A= -5.172E+02 B= 1.795E-01 C= -1.20E+05

8/26/92

BIXBYITE **Formula wt 157.874**

Mn_2O_3: Cubic crystals 298.15 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	101.81	113.70	0.00	113.70	-959.0	-882.1	154.53
300	101.93	114.33	0.63	113.70	-959.0	-881.6	153.49
400	108.49	144.55	26.77	117.78	-958.4	-855.9	111.76
500	114.61	169.43	43.74	125.69	-957.6	-830.3	86.74
600	120.05	190.81	56.01	134.80	-956.9	-804.9	70.08
700	124.93	209.69	65.52	144.18	-956.0	-779.7	58.18
800	129.38	226.67	73.22	153.45	-955.2	-754.5	49.27
900	133.49	242.15	79.69	162.45	-954.2	-729.5	42.34
1000	137.37	256.42	85.27	171.15	-957.7	-704.5	36.80
1100	141.07	269.68	90.18	179.51	-956.6	-679.3	32.26
1200	144.63	282.11	94.57	187.55	-955.3	-654.1	28.47
1300	148.09	293.82	98.55	195.27	-953.8	-629.0	25.27
1400	151.47	304.92	102.21	202.71	-956.7	-604.0	22.54

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	3.137 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	17.56 kJ		31.37 cm^3

A= -9.550E+02 B= 2.508E-01 C= -1.645E+05

8/27/92

HAUSMANNITE **Formula wt 228.812**

Mn_3O_4: Tetragonal crystals 298.15 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	142.02	164.10	0.00	164.10	-1384.5	-1282.5	224.68
300	142.52	164.98	0.88	164.10	-1384.5	-1281.8	223.18
400	158.37	208.55	38.62	169.94	-1383.4	-1247.7	162.93
500	165.03	244.68	63.30	181.38	-1382.1	-1214.0	126.82
600	169.49	275.18	80.64	194.54	-1381.0	-1180.5	102.77
700	173.64	301.61	93.63	207.99	-1380.2	-1147.1	85.60
800	178.04	325.08	103.90	221.18	-1379.5	-1113.8	72.73
900	182.86	346.33	112.40	233.93	-1379.0	-1080.7	62.72
1000	188.12	365.86	119.71	246.16	-1385.1	-1047.4	54.71
1100	193.77	384.05	126.18	257.87	-1384.4	-1013.7	48.14
1200	199.78	401.17	132.06	269.11	-1383.3	-980.0	42.66
1300	206.12	417.41	137.51	279.90	-1381.8	-946.5	38.03
1400	212.72	432.92	142.65	290.28	-1386.7	-912.9	34.06

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	4.695 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	24.78 kJ		46.95 cm^3

A= -1.3809E+03 B= 3.3405E-01 C= -9.874E+05

4/10/92

BRAUNITE **Formula wt 604.645**

Mn_7SiO_{12}: Tetragonal crystals 298.15 to 1500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	380.79	416.40	0.00	416.40	-4260.0	-3944.7	691.09
300	382.01	418.76	2.35	416.41	-4260.0	-3942.8	686.48
400	428.72	535.79	103.74	432.05	-4258.2	-3837.2	501.08
500	456.30	634.62	171.68	462.94	-4254.9	-3732.3	389.91
600	476.35	719.66	220.85	498.81	-4251.4	-3628.2	315.86
700	492.85	794.36	258.56	535.80	-4247.8	-3524.6	263.00
800	507.45	861.14	288.78	572.37	-4244.2	-3421.5	223.40
900	520.96	921.70	313.83	607.87	-4240.7	-3318.8	192.62
1000	533.78	977.26	335.19	642.07	-4252.6	-3216.4	168.00
1100	546.15	1028.71	353.81	674.91	-4248.9	-3112.9	147.82
1200	558.21	1076.75	370.34	706.41	-4244.5	-3009.8	131.01
1300	570.07	1121.90	385.25	736.65	-4239.4	-2907.1	116.81
1400	581.76	1164.58	398.87	765.71	-4249.7	-2804.4	104.63
1500	593.34	1205.11	411.45	793.66	-4260.6	-2700.4	94.04

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 65.68 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 12.508 $J\cdot bar^{-1}$

125.08 cm^3

A= -4.2437E+03 B= 1.0286E+00 C= -6.946E+05

02/24/94

MOLYBDITE **Formula wt 143.938**

MoO_3: Orthorhombic crystals 298.15 to melting point 1074 K; liquid 1074 to 1500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	74.91	77.70	0.00	77.70	-745.2	-668.1	117.04
300	75.13	78.16	0.46	77.70	-745.2	-667.6	116.24
400	83.02	101.00	20.24	80.76	-744.1	-641.9	83.82
500	87.78	120.06	33.29	86.77	-742.7	-616.5	64.40
600	91.85	136.42	42.71	93.71	-741.1	-591.4	51.48
700	95.89	150.89	50.02	100.87	-739.3	-566.6	42.28
800	100.08	163.96	56.01	107.95	-737.2	-542.0	35.39
900	104.46	176.00	61.15	114.85	-734.8	-517.8	30.05
1000	109.03	187.24	65.71	121.53	-732.2	-493.8	25.79
1100	126.95	197.87	69.85	128.02	-729.2	-470.1	22.32
1200	126.95	207.97	73.71	134.26	-725.8	-446.7	19.44
1300	126.95	217.67	77.36	140.31	-722.0	-423.6	17.02
1400	126.95	227.02	80.85	146.17	-717.9	-400.8	14.95
1500	126.95	236.09	84.22	151.87	-713.3	-378.3	13.17

Melting T	1074 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	48.91 kJ		
		Molar Vol.	3.056 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	12.59 kJ		30.56 cm^3

A= -7.299E+02 B= 2.358E-01 C= -8.02E+05

8/27/92

NITROGEN DIOXIDE **Formula wt 46.006**

NO_2: Ideal gas at p = 1 bar, 298.15 to 1800 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	37.00	240.10	0.00	240.10	33.1	51.2	-8.98
300	37.05	240.33	0.23	240.10	33.1	51.4	-8.94
400	40.16	251.39	9.81	241.59	32.5	57.5	-7.51
500	43.29	260.70	16.20	244.50	32.2	63.8	-6.67
600	45.91	268.83	20.94	247.89	32.0	70.2	-6.11
700	48.02	276.08	24.66	251.41	31.9	76.6	-5.71
800	49.71	282.60	27.69	254.91	31.9	83.0	-5.42
900	51.06	288.54	30.22	258.32	31.9	89.3	-5.18
1000	52.16	293.98	32.36	261.62	32.0	95.7	-5.00
1100	53.05	298.99	34.20	264.79	32.1	102.1	-4.85
1200	53.77	303.64	35.80	267.84	32.3	108.4	-4.72
1300	54.36	307.97	37.21	270.76	32.4	114.8	-4.61
1400	54.85	312.01	38.45	273.56	32.5	121.1	-4.52
1500	55.25	315.81	39.56	276.26	32.6	127.4	-4.44
1600	55.58	319.39	40.55	278.84	32.8	133.7	-4.37
1700	55.86	322.77	41.44	281.33	32.9	140.1	-4.30
1800	56.09	325.97	42.25	283.72	33.0	146.4	-4.25

Melting T K Boiling T K

$\Delta_{vap}H^\circ$ kJ

$\Delta_{fus}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 24789.7 cm^3

A= 3.210E+01 B= 6.353E-02 C= 1.451E+04

5/06/93

DISODIUM MONOXIDE **Formula wt 61.979**

Na_2O: Cubic crystals 298.15 to melting point 1193 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	69.10	75.30	0.00	75.30	-414.8	-376.0	65.87
300	69.26	75.73	0.43	75.30	-414.8	-375.7	65.42
400	76.30	96.68	18.57	78.11	-420.2	-362.3	47.31
500	81.34	114.27	30.64	83.63	-420.1	-347.8	36.33
600	85.26	129.46	39.43	90.03	-419.3	-333.4	29.03
700	88.47	142.85	46.21	96.64	-418.2	-319.2	23.82
800	91.20	154.85	51.67	103.18	-416.7	-305.1	19.92
900	93.60	165.73	56.20	109.53	-414.9	-291.3	16.91
1000	95.74	175.71	60.05	115.66	-413.0	-277.7	14.50

Melting T	1193 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	2.588 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	12.40 kJ		25.88 cm^3

A= -4.180E+02 B= 1.407E-01 C= -5.93E+03

9/10/92

BUNSENITE **Formula wt 74.689**

NiO: Rhombohedral (distorted cubic) crystals 298.15 to Néel temperature 519 K. Cubic crystals 519 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	44.49	37.99	0.00	37.99	-239.3	-211.1	36.99
300	44.70	38.27	0.28	37.99	-239.3	-211.0	36.73
400	53.00	52.38	12.52	39.86	-238.6	-201.6	26.33
500	64.90	65.25	21.59	43.66	-237.3	-192.5	20.11
519	69.15	67.74	23.25	44.49	-236.8	-190.9	19.21
600	56.01	76.07	27.86	48.21	-236.2	-183.6	15.99
700	54.22	84.55	31.73	52.82	-235.6	-175.0	13.05
800	53.66	91.74	34.50	57.24	-235.1	-166.8	10.89
900	53.83	98.06	36.63	61.43	-234.5	-157.8	9.16
1000	54.43	103.76	38.38	65.38	-234.0	-149.3	7.80
1100	55.29	108.99	39.88	69.11	-233.5	-140.8	6.69
1200	56.29	113.84	41.20	72.64	-233.1	-132.4	5.76
1300	57.37	118.39	42.40	75.99	-232.6	-124.0	4.98
1400	58.48	122.68	43.51	79.17	-232.1	-115.7	4.32
1500	59.57	126.76	44.55	82.21	-231.6	-107.4	3.74
1600	60.62	130.63	45.52	85.11	-231.1	-99.1	3.24
1700	61.61	134.34	46.44	87.90	-230.6	-90.9	2.79
1800	62.52	137.89	47.30	90.59	-247.3	-82.0	2.38

Melting T 2257 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 6.69 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.097 $J\cdot bar^{-1}$

10.97 cm^3

A= -2.331E+02 B= 8.392E-02 C= -2.85E+05

9/9/92

LITHARGE **Formula wt 223.199**

PbO: Tetragonal crystals (red) 298.15 to 1000 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	45.77	66.50	0.00	66.50	-219.0	-188.9	33.10
300	45.89	66.78	0.28	66.50	-219.0	-188.7	32.86
400	50.51	80.69	12.33	68.37	-218.4	-178.7	23.34
500	53.20	92.27	20.25	72.02	-217.5	-168.9	17.65
600	55.13	102.15	25.91	76.24	-216.6	-159.3	13.87
700	56.70	110.77	30.20	80.57	-220.5	-149.0	11.12
800	58.08	118.43	33.60	84.83	-219.4	-138.9	9.07
900	59.35	125.35	36.39	88.96	-218.3	-128.9	7.48
1000	60.55	131.66	38.75	92.92	-216.9	-119.0	6.22

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.391 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 23.91 cm^3

A= -2.194E+02 B= 1.004E-01 C= 4.877E+04

9/9/92

PLATTNERITE **Formula wt 239.199**

PbO_2: Tetragonal crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	61.17	71.80	0.00	71.80	-277.4	-218.3	38.25
300	61.35	72.18	0.38	71.80	-277.4	-218.0	37.95
400	68.23	90.90	16.59	74.31	-276.6	-198.3	25.89
500	71.82	106.54	27.31	79.23	-275.4	-178.8	18.68
600	74.11	119.85	34.93	84.92	-274.2	-159.6	13.89
700	75.79	131.41	40.65	90.76	-277.8	-139.8	10.43
800	77.14	141.62	45.13	96.49	-276.5	-120.2	7.85
900	78.30	150.77	48.75	102.02	-275.1	-100.7	5.84
1000	79.34	159.08	51.76	107.32	-273.7	-81.4	4.25
1100	80.31	166.69	54.31	112.37	-272.1	-62.2	2.96
1200	81.23	173.71	56.52	117.20	-270.5	-43.2	1.88

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	2.501 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	36.78 kJ		25.01 cm^3

A= -2.752E+02 B= 1.937E-01 C= -7.72E+04

9/9/92

MINIUM **Formula wt 685.598**

Pb_3O_4: Tetragonal crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	154.90	212.00	0.00	212.00	-718.7	-601.6	105.40
300	155.37	212.96	0.96	212.00	-718.7	-600.9	104.62
400	172.92	260.35	42.01	218.35	-716.3	-562.0	73.38
500	182.83	300.08	69.25	230.83	-713.0	-523.7	54.71
600	189.73	334.06	88.78	245.27	-709.5	-486.2	42.33
700	195.21	363.73	103.61	260.12	-720.3	-446.9	33.35
800	199.94	390.11	115.36	274.75	-716.3	-408.1	26.65
900	204.22	413.91	125.00	288.91	-711.8	-369.8	21.46
1000	208.23	435.64	133.12	302.51	-707.0	-332.1	17.35
1100	212.07	455.66	140.13	315.54	-701.8	-294.9	14.00
1200	215.78	474.28	146.28	328.00	-696.2	-258.1	11.24
1300	219.41	491.69	151.76	339.93	-690.2	-221.9	8.91
1400	222.97	508.08	156.72	351.36	-683.9	-186.1	6.94
1500	226.49	523.59	161.26	362.33	-677.3	-150.7	5.25
1600	229.97	538.31	165.44	372.87	-670.4	-115.8	3.78
1700	233.43	552.36	169.34	383.02	-663.1	-81.4	2.50
1800	236.86	565.80	173.00	392.80	-655.6	-47.4	1.37

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 7.681 J·bar^{-1}

$H_{298}^\circ-H_0^\circ$ kJ 76.81 cm^3

A= -6.975E+02 B= 3.642E-01 C= -1.26E+06

8/21/92

SULFUR DIOXIDE **Formula wt 64.065**

SO_2: Ideal gas at p = 1 bar, 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	39.85	248.20	0.00	248.20	-296.8	-300.1	52.57
300	39.92	248.45	0.25	248.20	-296.8	-300.1	52.25
400	43.48	260.42	10.61	249.81	-300.2	-300.9	39.30
500	46.53	270.47	17.50	252.96	-302.7	-300.8	31.43
600	48.92	279.17	22.55	256.62	-304.7	-300.3	26.14
700	50.78	286.86	26.45	260.40	-306.3	-299.4	22.34
800	52.23	293.74	29.59	264.15	-307.7	-298.3	19.48
900	53.38	299.96	32.17	267.78	-362.1	-296.0	17.18
1000	54.29	305.63	34.34	271.29	-362.0	-288.6	15.08
1100	55.01	310.84	36.19	274.65	-361.9	-281.3	13.36
1200	55.60	315.65	37.78	277.87	-361.8	-274.0	11.93
1300	56.07	320.12	39.17	280.95	-361.7	-266.7	10.71
1400	56.46	324.29	40.39	283.90	-361.6	-259.3	9.68
1500	56.79	328.20	41.47	286.72	-361.5	-252.1	8.78
1600	57.06	331.87	42.44	289.43	-361.5	-244.8	7.99
1700	57.29	335.34	43.31	292.03	-361.4	-237.4	7.30
1800	57.49	338.62	44.09	294.53	-361.4	-230.2	6.68

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 10.55 kJ 24789.7 cm^3

A= -3.536E+02 B= 6.628E-02 C= 3.246E+06

9/9/92

SULFUR TRIOXIDE **Formula wt 80.064**

SO_3: Ideal gas at p = 1 bar, 298.15 to 2200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	50.63	256.80	0.00	256.80	-395.7	-371.0	64.99
300	50.77	257.11	0.31	256.80	-395.7	-370.8	64.56
400	57.69	272.70	13.82	258.88	-399.3	-362.2	47.30
500	63.09	286.18	23.16	263.02	-401.8	-352.6	36.84
600	67.16	298.06	30.17	267.89	-403.6	-342.6	29.83
700	70.26	308.66	35.69	272.97	-405.0	-332.3	24.80
800	72.64	318.20	40.16	278.04	-406.0	-321.9	21.02
900	74.49	326.87	43.88	282.99	-460.0	-310.2	18.00
1000	75.93	334.80	47.02	287.78	-459.6	-293.6	15.34
1100	77.07	342.09	49.70	292.39	-459.0	-277.0	13.15
1200	77.96	348.83	52.02	296.82	-458.5	-260.5	11.34
1300	78.68	355.10	54.04	301.06	-458.0	-244.0	9.80
1400	79.25	360.96	55.82	305.13	-457.4	-227.6	8.49
1500	79.71	366.44	57.40	309.04	-456.9	-211.2	7.35
1600	80.08	371.60	58.81	312.79	-456.3	-194.8	6.36
1700	80.38	376.46	60.07	316.39	-455.8	-178.5	5.48
1800	80.64	381.06	61.20	319.86	-455.3	-162.2	4.71

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circs-H_0^\circs$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

A= -4.504E+02 B= 1.580E-01 C= 3.103E+06

4/9/92

SILICON MONOXIDE **Formula wt 44.085**

SiO: Ideal gas at p = 1 bar, 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	29.90	211.60	0.00	211.60	-100.4	-127.3	22.30
300	29.92	211.79	0.18	211.60	-100.4	-127.5	22.19
400	31.15	220.55	7.77	212.79	-101.0	-136.4	17.81
500	32.38	227.64	12.57	215.07	-101.6	-145.2	15.17
600	33.39	233.64	15.96	217.68	-102.3	-153.8	13.39
700	34.19	238.85	18.51	220.34	-103.0	-162.4	12.12
800	34.82	243.45	20.51	222.95	-103.7	-170.8	11.15
900	35.33	247.59	22.13	225.46	-104.4	-179.2	10.40
1000	35.72	251.33	23.47	227.86	-105.2	-187.4	9.79
1100	36.04	254.75	24.60	230.15	-106.0	-195.6	9.29
1200	36.30	257.90	25.56	232.33	-106.9	-203.7	8.87
1300	36.51	260.81	26.40	234.41	-107.8	-211.8	8.51
1400	36.67	263.52	27.13	236.40	-108.7	-219.7	8.20
1500	36.81	266.06	27.77	238.29	-109.7	-227.6	7.93
1600	36.93	268.44	28.34	240.10	-110.7	-235.5	7.69
1700	37.03	270.68	28.84	241.84	-162.0	-242.8	7.46
1800	37.11	272.80	29.30	243.50	-162.8	-247.5	7.18

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 8.71 kJ 24789.7 cm^3

A= -1.084E+02 B= -7.908E-02 C= 4.562E+05

4/10/92

QUARTZ **Formula wt 60.084**

SiO_2: Trigonal crystals 298.15 to α-β transition at 844 K. β-crystals 844 to 1700. The melting point is estimated to be 1700 K. Liquid 1700 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	44.59	41.46	0.00	41.46	-910.7	-856.3	150.01
300	44.78	41.74	0.28	41.46	-910.7	-855.9	149.03
400	53.27	55.85	12.52	43.33	-910.9	-837.7	109.38
500	59.68	68.45	21.34	47.11	-910.5	-819.4	85.60
600	65.04	79.82	28.18	51.64	-909.8	-801.2	69.75
700	69.82	90.21	33.80	56.41	-908.8	-783.2	58.44
800	74.25	99.83	38.58	61.25	-907.4	-765.3	49.97
900	68.62	109.00	42.93	66.07	-905.6	-747.7	43.39
1000	69.12	116.25	45.52	70.73	-904.8	-730.2	38.14
1100	69.74	122.87	47.69	75.18	-904.1	-712.8	33.85
1200	70.43	128.96	49.56	79.40	-903.3	-695.4	30.27
1300	71.17	134.63	51.19	83.44	-902.5	-678.1	27.25
1400	71.96	139.93	52.65	87.28	-901.8	-660.9	24.66
1500	72.77	144.92	53.96	90.96	-901.0	-643.7	22.41
1600	73.60	149.65	55.16	94.49	-900.2	-626.6	20.46
1700	74.45	154.14	56.27	97.87	-949.6	-609.0	18.71
1800	81.37	164.31	62.89	101.42	-938.5	-589.6	17.11

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.269 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	6.916 kJ		22.69 cm^3

A= -9.047E+02 B= 1.744E-01 C= -3.39E+05

01/06/93

CRISTOBALITE **Formula wt 60.084**

SiO_2: Tetragonal crystals, α, 298.15 to 523 K. Cubic crystals, β, 523 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	44.95	43.40	0.00	43.40	-908.4	-854.6	149.71
300	45.15	43.70	0.28	43.42	-908.4	-854.2	148.73
400	50.73	57.93	12.63	45.31	-908.5	-836.1	109.19
500	68.59	70.56	21.48	49.08	-908.2	-818.1	85.46
600	62.06	84.60	29.96	54.64	-906.5	-800.7	69.71
700	65.23	94.42	34.78	59.64	-905.8	-783.1	58.44
800	67.34	103.28	38.73	64.55	-905.0	-765.7	49.99
900	68.82	111.30	41.99	69.31	-904.2	-748.3	43.43
1000	69.92	118.61	44.74	73.87	-903.3	-731.0	38.18
1100	70.77	125.32	47.07	78.26	-902.4	-713.8	33.90
1200	71.44	131.50	49.07	82.43	-901.6	-696.7	30.33
1300	72.00	137.24	50.81	86.43	-900.7	-679.7	27.31
1400	72.47	142.60	52.34	90.26	-899.9	-662.7	24.73
1500	72.87	147.61	53.70	93.91	-899.1	-645.8	22.49
1600	73.22	152.32	54.91	97.41	-898.3	-628.9	20.53
1700	73.53	156.77	55.99	100.78	-947.8	-611.7	18.79
1800	73.82	160.98	56.98	104.00	-946.8	-591.9	17.18

Melting T 1996 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 7.04 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.574 $J\cdot bar^{-1}$

25.74 cm^3

A= -9.029E+02 B= 1.719E-01 C= -2.62E+05

01/06/93

COESITE **Formula wt 60.084**

SiO_2: Monoclinic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	45.46	38.50	0.00	38.50	-907.8	-852.5	149.35
300	45.58	38.78	0.28	38.50	-907.8	-852.2	148.37
400	52.60	52.85	12.48	40.37	-908.0	-833.6	108.85
500	58.51	65.26	21.12	44.13	-907.7	-815.0	85.14
600	62.81	76.33	27.73	48.59	-907.2	-796.5	69.34
700	65.84	86.25	32.97	53.28	-906.5	-778.1	58.06
800	67.94	95.19	37.22	57.97	-905.6	-759.8	49.61
900	69.41	103.28	40.72	62.56	-904.7	-741.6	43.04
1000	70.45	110.65	43.64	67.01	-903.8	-723.6	37.79
1100	71.23	117.40	46.12	71.28	-902.9	-705.6	33.50
1200	71.86	123.63	48.24	75.39	-902.0	-687.7	29.93
1300	72.45	129.40	50.08	79.33	-901.1	-669.9	26.91
1400	73.06	134.79	51.70	83.10	-900.2	-652.1	24.33
1500	73.75	139.86	53.14	86.71	-899.3	-634.4	22.09
1600	74.56	144.64	54.46	90.19	-898.5	-616.8	20.14
1700	75.54	149.19	55.67	93.52	-947.7	-598.8	18.40
1800	76.71	153.54	56.80	96.74	-946.6	-578.2	16.78

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.064 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 6.89 kJ 20.64 cm^3

A= -9.036E+02 B= 1.799E-01 C= -2.39E+05

8/28/92

STISHOVITE **Formula wt 60.084**

SiO_2: Tetragonal crystals 298.15 to 1800 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	42.99	27.78	0.00	27.78	-861.3	-802.8	140.65
300	43.24	28.05	0.27	27.78	-861.3	-802.4	139.72
400	53.50	42.04	12.42	29.62	-861.5	-782.8	102.22
500	59.42	54.67	21.28	33.39	-861.2	-763.1	79.72
600	63.14	65.85	27.97	37.89	-860.6	-743.6	64.73
700	65.60	75.78	33.18	42.61	-859.8	-724.1	54.03
800	67.32	84.66	37.34	47.32	-859.0	-704.8	46.02
900	68.58	92.67	40.75	51.92	-858.2	-685.6	39.79
1000	69.58	99.95	43.58	56.36	-857.4	-666.4	34.81
1100	70.42	106.62	45.99	60.63	-856.5	-647.4	30.74
1200	71.20	112.78	48.05	64.72	-855.7	-628.4	27.35
1300	71.97	118.51	49.86	68.64	-854.9	-609.5	24.49
1400	72.79	123.87	51.47	72.40	-854.0	-590.6	22.04
1500	73.68	128.92	52.92	76.00	-853.2	-571.8	19.91
1600	74.68	133.71	54.25	79.46	-852.3	-553.1	18.06
1700	75.80	138.27	55.48	82.79	-901.6	-534.0	16.41
1800	77.06	142.64	56.65	85.99	-900.3	-512.4	14.87

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 7.74 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.4014 $J\cdot bar^{-1}$

14.014 cm^3

A= -8.572E+02 B= 1.907E-01 C= -2.28E+05

12/17/91

SILICA GLASS **Formula wt 60.084**

SiO_2: Glass 298.15 to estimated melting point 1700 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	37.94	48.50	0.00	48.50	-901.6	-849.3	148.79
300	38.36	48.74	0.24	48.50	-901.6	-849.0	147.81
400	53.17	62.11	11.89	50.22	-902.0	-831.3	108.56
500	59.95	74.79	20.90	53.89	-901.7	-813.7	85.00
600	63.64	86.07	27.74	58.33	-901.0	-796.1	69.31
700	65.93	96.07	33.04	63.02	-900.2	-778.7	58.11
800	67.53	104.98	37.26	67.72	-899.4	-761.4	49.71
900	68.77	113.01	40.69	72.31	-898.6	-744.2	43.19
1000	69.84	120.31	43.56	76.75	-897.7	-727.1	37.98
1100	70.82	127.01	45.99	81.02	-896.8	-710.1	33.72
1200	71.79	133.22	48.10	85.12	-895.9	-693.2	30.17
1300	72.77	139.00	49.96	89.04	-895.0	-676.3	27.17
1400	73.81	144.43	51.63	92.81	-894.1	-659.5	24.61
1500	74.90	149.56	53.14	96.42	-893.1	-642.8	22.38
1600	76.07	154.43	54.54	99.90	-892.1	-626.1	20.44
1700	77.32	159.08	55.84	103.24	-941.2	-609.1	18.71

Melting T	1700 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	2.727 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	6.998 kJ		27.27 cm^3

A= -8.966E+02 B= 1.694E-01 C= -3.06E+05

2/25/93

CASSITERITE **Formula wt 150.709**

SnO_2: Tetragonal crystals 298.15 to 1903 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	53.22	49.02	0.00	49.02	-577.6	-515.8	90.36
300	53.54	49.35	0.33	49.02	-577.6	-515.4	89.74
400	65.09	66.56	15.27	51.29	-577.4	-494.7	64.60
500	70.83	81.76	25.86	55.90	-576.6	-474.1	49.53
600	74.28	95.00	33.66	61.34	-582.6	-452.3	39.38
700	76.66	106.64	39.64	66.99	-581.1	-430.8	32.14
800	78.46	117.00	44.39	72.61	-579.5	-409.4	26.73
900	79.92	126.32	48.26	78.07	-577.8	-388.2	22.53
1000	81.18	134.81	51.49	83.32	-576.0	-367.3	19.18
1100	82.30	142.60	54.24	88.36	-574.1	-346.5	16.45
1200	83.33	149.81	56.62	93.19	-572.2	-325.9	14.18
1300	84.30	156.52	58.71	97.80	-570.2	-305.4	12.27
1400	85.21	162.80	60.57	102.22	-568.2	-285.1	10.64
1500	86.10	168.71	62.25	106.46	-566.1	-265.0	9.23

Melting T 1903 K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.155 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 8.38 kJ 21.55 cm^3

A= -5.763E+02 B= 2.084E-01 C= -1.755E+05

6/11/93

STRONTIUM MONOXIDE **Formula wt 103.619**

SrO: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	45.41	55.52	0.00	55.52	-591.3	-560.7	98.22
300	45.49	55.80	0.28	55.52	-591.3	-560.5	97.59
400	48.66	69.37	12.02	57.35	-590.8	-550.3	71.86
500	50.62	80.45	19.55	60.89	-590.2	-540.2	56.43
600	52.06	89.81	24.86	64.95	-589.5	-530.3	46.16
700	53.24	97.93	28.83	69.10	-588.9	-520.5	38.84
800	54.26	105.10	31.95	73.16	-588.4	-510.7	33.35
900	55.19	111.55	34.48	77.07	-588.5	-501.0	29.07
1000	56.04	117.41	36.59	80.82	-587.7	-491.3	25.66
1100	56.86	122.79	38.40	84.39	-594.7	-481.3	22.86
1200	57.63	127.77	39.97	87.80	-594.7	-471.0	20.50
1300	58.38	132.41	41.36	91.06	-594.7	-460.7	18.51
1400	59.11	136.76	42.60	94.17	-594.5	-450.4	16.80
1500	59.83	140.87	43.72	97.14	-594.4	-440.1	15.33
1600	60.53	144.75	44.75	100.00	-594.1	-429.8	14.03
1700	61.22	148.44	45.70	102.74	-730.7	-418.4	12.86
1800	61.90	151.96	46.58	105.38	-728.5	-400.1	11.61

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.069 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	8.675 kJ		20.69 cm3

A= -5.956E+02 B= 1.047E-01 C= 3.940E+05

10/2/92

THORIANITE Formula wt 264.037

ThO_2: Cubic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	61.79	65.20	0.00	65.20	-1226.4	-1169.2	204.84
300	61.95	65.58	0.38	65.20	-1226.4	-1168.9	203.51
400	67.82	84.31	16.60	67.72	-1225.5	-1149.8	150.15
500	70.95	99.81	27.18	72.63	-1224.4	-1131.0	118.15
600	72.99	112.94	34.66	78.28	-1223.2	-1112.5	96.85
700	74.52	124.31	40.25	84.06	-1222.0	-1094.1	81.64
800	75.78	134.34	44.61	89.73	-1220.8	-1075.9	70.25
900	76.88	143.34	48.14	95.20	-1219.7	-1057.9	61.40
1000	77.88	151.49	51.06	100.43	-1218.6	-1040.0	54.32
1100	78.82	158.96	53.54	105.41	-1217.5	-1022.2	48.54
1200	79.72	165.85	55.69	110.17	-1216.5	-1004.5	43.72

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.637 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 10.56 kJ 26.37 cm^3

A= -1.219E+03 B= 1.794E-01 C= -3.21E+05

9/10/92

RUTILE **Formula wt 79.879**

TiO_2: Tetragonal crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	55.29	50.62	0.00	50.62	-944.0	-888.8	155.70
300	55.49	50.96	0.34	50.62	-944.0	-888.4	154.68
400	63.19	68.12	15.21	52.91	-943.6	-869.9	113.60
500	67.29	82.70	25.25	57.45	-942.8	-851.6	88.96
600	69.85	95.21	32.49	62.72	-942.0	-833.4	72.56
700	71.62	106.12	37.96	68.16	-941.0	-815.4	60.85
800	72.92	115.77	42.25	73.52	-940.1	-797.5	52.07
900	73.94	124.42	45.72	78.70	-939.1	-779.8	45.26
1000	74.77	132.25	48.58	83.67	-938.3	-762.1	39.81
1100	75.45	139.41	50.99	88.42	-937.6	-744.5	35.35
1200	76.04	146.00	53.06	92.95	-941.0	-726.9	31.64
1300	76.55	152.11	54.85	97.26	-940.0	-709.1	28.49
1400	76.99	157.80	56.41	101.39	-939.0	-691.4	25.79
1500	77.39	163.13	57.80	105.33	-938.0	-673.7	23.46
1600	77.76	168.13	59.03	109.10	-937.2	-656.1	21.42
1700	78.09	172.86	60.14	112.71	-936.5	-638.5	19.62
1800	78.39	177.33	61.15	116.18	-935.9	-621.0	18.02

Melting T 2103 K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.882 J·bar^{-1}

$H_{298}^\circ-H_0^\circ$ 8.67 kJ 18.82 cm^3

A= -9.385E+02 B= 1.766E-01 C= -2.66E+05

4/5/93

ANATASE **Formula wt 79.879**

TiO_2: **Tetragonal crystals 298.15 to 1300 K.**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	55.32	49.90	0.00	49.90	-938.7	-883.2	154.74
300	55.59	50.24	0.34	49.90	-938.7	-882.9	153.72
400	64.71	67.69	15.47	52.22	-938.2	-864.4	112.87
500	68.60	82.60	25.76	56.85	-937.3	-846.0	88.38
600	70.69	95.31	33.09	62.22	-936.3	-827.8	72.07
700	72.07	106.32	38.56	67.75	-935.3	-809.8	60.43
800	73.15	116.01	42.82	73.19	-934.3	-792.0	51.71
900	74.10	124.68	46.24	78.44	-933.3	-774.2	44.93
1000	75.01	132.54	49.07	83.46	-932.5	-756.6	39.52
1100	75.91	139.73	51.47	88.26	-931.8	-739.1	35.09
1200	76.82	146.37	53.55	92.83	-935.2	-721.4	31.40
1300	77.74	152.56	55.37	97.19	-934.0	-703.7	28.27

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.052 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 20.52 cm^3

A= -9.331E+02 B= 1.767E-01 C= -2.60E+05

9/10/92

URANINITE **Formula wt 270.028**

UO_2: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	63.60	77.03	0.00	77.03	-1084.9	-1031.7	180.75
300	63.82	77.42	0.39	77.03	-1084.9	-1031.4	179.58
400	71.65	97.01	17.37	79.65	-1083.9	-1013.7	132.38
500	75.51	113.46	28.64	84.81	-1082.7	-996.3	104.08
600	77.96	127.45	36.67	90.78	-1081.5	-979.2	85.24
700	79.82	139.62	42.71	96.91	-1080.5	-962.2	71.80
800	81.42	150.38	47.45	102.93	-1079.7	-945.4	61.72
900	82.90	160.06	51.31	108.75	-1079.3	-928.6	53.89
1000	84.31	168.87	54.54	114.33	-1081.6	-911.7	47.62
1100	85.70	176.97	57.31	119.66	-1085.3	-894.5	42.48
1200	87.07	184.48	59.73	124.75	-1084.1	-877.2	38.18
1300	88.45	191.51	61.89	129.62	-1082.7	-860.0	34.56
1400	89.84	198.11	63.83	134.28	-1081.2	-843.0	31.45
1500	91.24	204.36	65.61	138.74	-1089.3	-825.4	28.74
1600	92.64	210.29	67.26	143.03	-1088.5	-807.8	26.37
1700	94.05	215.95	68.79	147.16	-1087.7	-790.3	24.28
1800	95.48	221.37	70.24	151.13	-1086.8	-772.8	22.43

Melting T	3151 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.4618 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	11.28 kJ		24.618 cm^3

A= -1.083E+03 B= 1.718E-01 C= 1.932E+04

12/17/91

KARELIANITE **Formula wt 149.881**

V_2O_3: Rhombohedral crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	104.96	98.10	0.00	98.10	-1218.8	-1139.0	199.55
300	105.33	98.75	0.65	98.10	-1218.8	-1138.6	198.23
400	117.82	131.04	28.62	102.42	-1217.1	-1112.0	145.21
500	123.52	158.01	47.09	110.92	-1214.9	-1086.0	113.45
600	127.11	180.86	60.14	120.72	-1212.6	-1060.4	92.32
700	129.99	200.68	69.92	130.76	-1210.1	-1035.3	77.25
800	132.67	218.21	77.60	140.62	-1207.7	-1010.5	65.97
900	135.32	233.99	83.86	150.13	-1205.2	-986.0	57.22
1000	138.04	248.39	89.14	159.25	-1202.6	-961.7	50.24
1100	140.84	261.68	93.72	167.96	-1200.1	-937.8	44.53
1200	143.74	274.05	97.76	176.29	-1197.4	-914.1	39.79
1300	146.73	285.68	101.41	184.26	-1194.7	-890.5	35.78
1400	149.80	296.66	104.76	191.90	-1192.0	-866.3	32.36
1500	152.95	307.11	107.87	199.24	-1189.2	-844.1	29.39
1600	156.17	317.08	110.79	206.29	-1186.2	-821.3	26.81
1700	159.46	326.65	113.55	213.09	-1183.4	-798.5	24.53
1800	162.80	335.85	116.19	219.66	-1180.4	-775.9	22.52

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.985 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 29.85 cm^3

A= -1.197E+03 B= 2.355E-01 C= -1.14E+06

6/11/93

TUNGSTEN DIOXIDE **Formula wt 215.849**

WO_2: Monoclinic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	55.78	50.60	0.00	50.60	-589.7	-533.9	93.53
300	55.98	50.95	0.34	50.60	-589.7	-533.5	92.89
400	63.60	68.22	15.32	52.90	-589.1	-514.9	67.24
500	67.83	82.91	25.43	57.48	-588.1	-496.4	51.86
600	70.74	95.54	32.75	62.79	-586.9	-478.2	41.63
700	73.02	106.62	38.35	68.28	-585.6	-460.2	34.34
800	74.97	116.51	42.81	73.70	-584.1	-442.4	28.89
900	76.72	125.44	46.48	78.96	-582.6	-424.8	24.65
1000	78.35	133.61	49.58	84.02	-581.1	-407.3	21.28
1100	79.90	141.15	52.27	88.88	-579.4	-390.0	18.52
1200	81.39	148.16	54.63	93.53	-577.7	-372.9	16.23
1300	82.85	154.74	56.75	97.99	-575.9	-355.9	14.30
1400	84.28	160.93	58.66	102.26	-574.0	-339.1	12.65
1500	85.69	166.79	60.42	106.37	-572.0	-322.3	11.22
1600	87.09	172.37	62.04	110.32	-570.0	-305.8	9.98
1700	88.47	177.69	63.56	114.13	-567.9	-289.3	8.89
1800	89.85	182.78	64.98	117.80	-565.8	-273.0	7.92

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.003 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 20.03 cm^3

A= -5.776E+02 B= 1.702E-01 C= -6.726E+05

9/10/92

ZINCITE **Formula wt 81.389**

ZnO: Hexagonal crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	40.42	43.20	0.00	43.20	-350.5	-320.4	56.12
300	40.53	43.45	0.25	43.20	-350.5	-320.2	55.75
400	44.56	55.73	10.89	44.85	-350.3	-310.1	40.49
500	46.74	65.93	17.86	48.07	-349.9	-300.1	31.35
600	48.22	74.59	22.80	51.79	-349.6	-290.2	25.26
700	49.38	82.11	26.52	55.60	-356.6	-280.2	20.91
800	50.37	88.77	29.44	59.34	-356.4	-269.4	17.59
900	51.28	94.76	31.81	62.94	-356.1	-258.5	15.00
1000	52.13	100.20	33.80	66.40	-355.8	-247.7	12.94
1100	52.94	105.21	35.51	69.71	-355.5	-236.9	11.25
1200	53.74	109.85	36.99	72.86	-470.2	-224.2	9.75
1300	54.52	114.18	38.31	75.87	-468.6	-203.7	8.18
1400	55.29	118.25	39.50	78.76	-467.0	-183.4	6.84
1500	56.06	122.09	40.57	81.52	-465.3	-163.1	5.68
1600	56.82	125.74	41.57	84.17	-463.6	-143.0	4.67
1700	57.58	129.20	42.49	86.72	-461.8	-123.0	3.78
1800	58.34	132.52	43.35	89.17	-460.0	-103.3	3.00

Melting T 2242 K

Boiling T K

$\Delta_{fus}H^\circ$ kJ

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.434 J·bar^{-1}

$H_{298}^\circ-H_0^\circ$ 6.93 kJ

14.34 cm^3

10/7/92

BADDELEYITE **Formula wt 123.223**

ZrO_2: Monoclinic crystals 298.15 to 1478 K. Tetragonal crystals 1478 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	56.18	50.40	0.00	50.40	-1100.6	-1042.9	182.70
300	56.35	50.75	0.35	50.40	-1100.6	-1042.5	181.51
400	63.21	67.99	15.28	52.70	-1100.1	-1023.2	133.61
500	67.51	82.59	25.33	57.26	-1099.2	-1004.1	104.89
600	70.45	95.17	32.62	62.55	-1098.2	-985.1	85.76
700	72.57	106.20	38.18	68.02	-1097.1	-966.4	72.11
800	74.16	116.00	42.58	73.41	-1095.9	-947.8	61.88
900	75.38	124.80	46.16	78.64	-1094.8	-929.4	53.94
1000	76.32	132.80	49.13	83.66	-1093.7	-911.0	47.59
1100	77.06	140.11	51.64	88.47	-1092.7	-892.8	42.40
1200	77.63	146.84	53.78	93.05	-1095.5	-874.5	38.06
1300	78.08	153.07	55.64	97.43	-1094.2	-856.1	34.40
1400	78.41	158.87	57.25	101.62	-1092.9	-837.8	31.26
1478	78.62	163.13	58.37	104.75	-1092.2	-822.5	29.07
1500	74.48	168.28	62.60	105.68	-1085.8	-819.8	28.55
1600	74.48	173.09	63.34	109.75	-1085.0	-802.1	26.18
1700	74.48	177.60	64.00	113.60	-1084.4	-784.4	24.10
1800	74.48	181.86	64.58	117.28	-1083.8	-766.7	22.25

Melting T	3123 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	2.115 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	8.75 kJ		21.15 cm^3

A= -1.0934E+03 B= 1.81734E-01 C= -4.273.01E+05

9/9/92

CHRYSOBERYL Formula wt 126.973

$BeAl_2O_4$: Orthorhombic crystals 298.15 to 1800 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	105.40	66.26	0.00	66.26	-2298.5	-2176.2	381.26
300	106.01	66.91	0.65	66.26	-2298.5	-2175.5	378.78
400	130.76	101.12	30.36	70.76	-2299.3	-2134.3	278.71
500	145.88	132.05	52.07	79.98	-2298.9	-2093.0	218.66
600	155.80	159.58	68.58	91.00	-2297.8	-2051.9	178.64
700	162.63	184.14	81.57	102.58	-2296.5	-2011.1	150.07
800	167.53	206.19	92.01	114.18	-2295.1	-1970.4	128.65
900	171.18	226.15	100.62	125.53	-2293.8	-1929.9	112.01
1000	174.02	244.33	107.82	136.51	-2314.0	-1888.0	98.62
1100	176.33	261.03	113.95	147.09	-2312.7	-1845.5	87.63
1200	178.34	276.46	119.23	157.23	-2311.3	-1803.1	78.48
1300	180.18	290.81	123.85	166.96	-2309.8	-1760.7	70.75
1400	181.97	304.23	127.94	176.29	-2308.5	-1718.6	64.12
1500	183.80	316.85	131.60	185.25	-2307.0	-1676.5	58.38
1600	185.72	328.77	134.92	193.85	-2320.1	-1634.2	53.34
1700	187.80	340.09	137.97	202.12	-2318.1	-1591.3	48.89
1800	190.08	350.89	140.80	210.09	-2316.1	-1548.6	44.94

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 13.09 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.432 $J\cdot bar^{-1}$

34.32 cm^3

A= -2.308E+03 B= 4.208E-01 C= 5.946E+05

7/17/92

CALCIUM FERRITE **Formula wt 215.770**

$CaFe_2O_4$: Orthorhombic crystals 298.15 to melting point 1510 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	153.65	145.40	0.00	145.40	-1520.3	-1412.4	247.44
300	153.95	146.35	0.95	145.40	-1520.3	-1411.7	245.79
400	164.04	192.25	40.65	151.59	-1518.1	-1375.8	179.66
500	168.83	229.41	65.85	163.56	-1516.0	-1340.5	140.04
600	172.11	260.50	83.30	177.20	-1514.4	-1305.6	113.66
700	174.98	287.24	96.19	191.05	-1513.4	-1270.9	94.83
800	177.81	310.79	106.22	204.58	-1513.8	-1236.1	80.71
900	180.73	331.90	114.33	217.57	-1514.3	-1201.4	69.73
1000	183.77	351.10	121.12	229.98	-1516.4	-1166.6	60.93
1100	186.94	368.76	126.96	241.80	-1520.3	-1131.4	53.72
1200	190.24	385.17	132.10	253.07	-1530.6	-1095.3	47.68
1300	193.66	400.53	136.70	263.83	-1529.0	-1059.1	42.55
1400	197.17	415.01	140.89	274.12	-1527.2	-1023.0	38.17
1500	200.78	428.74	144.77	283.97	-1525.4	-987.1	34.37

Melting T	1510 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	108.2 kJ	Molar Vol.	4.498 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	25.42 kJ		44.98 cm^3

A= -1.519E+03 B= 3.537E-01 C= 1.473E+05

5/15/92

DICALCIUM FERRITE **Formula wt 271.847**

$Ca_2Fe_2O_5$: Orthorhombic crystals 298.15 to melting point 1750 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	192.91	188.80	0.00	188.80	-2138.3	-1999.9	350.37
300	193.61	190.00	1.19	188.80	-2138.3	-1999.1	348.06
400	217.91	249.55	52.79	196.76	-2135.4	-1953.1	255.04
500	228.76	299.48	87.02	212.45	-2131.9	-1907.9	199.31
600	234.54	341.74	111.17	230.57	-2128.7	-1863.4	162.22
700	238.04	378.18	129.06	249.12	-2126.1	-1819.4	135.76
800	240.40	410.13	142.84	267.29	-2126.2	-1775.5	115.92
900	242.13	438.55	153.78	284.77	-2125.7	-1731.7	100.50
1000	243.51	464.13	162.69	301.45	-2127.3	-1687.8	88.16
1100	244.66	487.40	170.09	317.31	-2131.2	-1643.7	78.05
1200	245.69	508.73	176.35	332.38	-2149.8	-1598.0	69.56
1300	246.63	528.44	181.72	346.72	-2148.0	-1552.1	62.36
1400	247.52	546.74	186.39	360.36	-2146.4	-1506.4	56.20
1500	248.37	563.85	190.49	373.36	-2144.9	-1460.7	50.86
1600	249.20	579.91	194.13	385.77	-2143.7	-1415.1	46.20
1700	250.02	595.04	197.40	397.64	-2144.4	-1369.5	42.08

Melting T 1750 K

Boiling T K

$\Delta_{fus}H^\circ$ 31.65 kJ

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 6.718 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 25.42 kJ

67.18 cm^3

A= -2.135E+03 B= 4.491E-01 C= 1.854E+05

7/22/92

PEROVSKITE **Formula wt 135.956**

$CaTiO_3$: Orthorhombic crystals 1530 K; cubic crystals 1530 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			J·mol^{-1}·K^{-1}			kJ·mol^{-1}	
298.15	97.65	93.64	0.00	93.64	-1660.6	-1574.8	275.89
300	98.17	94.25	0.60	93.64	-1660.6	-1574.3	274.10
400	114.28	125.13	27.38	97.74	-1659.5	-1545.6	201.83
500	119.98	151.34	45.42	105.92	-1657.8	-1517.4	158.51
600	122.60	173.47	58.09	115.38	-1656.2	-1489.4	129.66
700	124.31	192.50	67.43	125.07	-1654.8	-1461.7	109.07
800	125.83	209.20	74.63	134.56	-1654.4	-1434.1	93.64
900	127.43	224.11	80.41	143.70	-1653.4	-1406.7	81.64
1000	129.21	237.62	85.20	152.43	-1652.7	-1379.3	72.04
1100	131.20	250.03	89.29	160.74	-1652.4	-1352.0	64.20
1200	133.39	261.54	92.87	168.67	-1664.1	-1323.9	57.63
1300	135.76	272.31	96.08	176.23	-1662.5	-1295.6	52.06
1400	138.31	282.46	99.00	183.46	-1660.8	-1267.5	47.29
1500	141.01	292.10	101.71	190.38	-1658.9	-1239.4	43.16
1600	134.01	302.46	105.26	197.20	-1655.3	-1211.8	39.56
1700	134.01	310.58	106.95	203.63	-1654.4	-1184.1	36.38
1800	134.01	318.28	108.47	209.81	-1802.2	-1154.3	33.50

Melting T 2188 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.363 J·bar^{-1}

33.63 cm^3

A= -1.657E+03 B= 2.783E-01 C= -4.73E+04

5/15/92

HERCYNITE **Formula wt 173.808**

$FeAl_2O_4$: Cubic crystals 298.15 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	128.91	117.00	0.00	117.00	-1950.5	-1838.1	322.03
300	129.38	117.80	0.80	117.00	-1950.5	-1837.4	319.92
400	148.11	157.85	35.52	122.34	-1950.1	-1799.7	235.02
500	159.35	192.20	59.24	132.96	-1948.9	-1762.3	184.10
600	167.07	221.97	76.60	145.37	-1947.5	-1725.1	150.18
700	172.83	248.18	89.95	158.22	-1946.0	-1688.1	125.97
800	177.38	271.56	100.61	170.95	-1944.7	-1651.4	107.82
900	181.11	292.68	109.35	183.33	-1943.9	-1614.7	93.71
1000	184.28	311.93	116.69	195.24	-1965.2	-1576.7	82.36
1100	187.01	329.62	122.96	206.66	-1965.7	-1537.8	73.02
1200	189.43	346.00	128.40	217.60	-1965.2	-1498.9	65.25
1300	191.59	361.25	133.18	228.07	-1963.1	-1460.1	58.67
1400	193.55	375.52	137.42	238.10	-1961.0	-1421.6	53.04

Melting T	K	Boiling T	K
			kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	4.075 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		40.75 cm^3

A= -1.955E+03 B= 3.799E-01 C= 3.842E+05

7/17/92

CHROMITE Formula wt 223.837

$FeCr_2O_4$: Cubic crystals 298.15 to 1800 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	133.58	146.00	0.00	146.00	-1445.5	-1344.5	235.55
300	133.95	146.83	0.82	146.00	-1445.5	-1343.9	233.99
400	149.91	187.72	36.25	151.47	-1444.7	-1310.1	171.08
500	160.48	222.38	60.10	162.27	-1443.4	-1276.6	133.36
600	167.91	252.33	77.49	174.84	-1441.7	-1243.4	108.25
700	173.37	278.64	90.81	187.83	-1440.1	-1210.5	90.33
800	177.55	302.08	101.40	200.67	-1438.6	-1177.8	76.90
900	180.85	323.19	110.05	213.13	-1437.5	-1145.3	66.47
1000	183.55	342.39	117.27	225.11	-1437.3	-1112.8	58.13
1100	185.84	359.99	123.40	236.59	-1438.0	-1080.4	51.30
1200	187.86	376.25	128.69	247.56	-1438.3	-1047.8	45.62
1300	189.69	391.36	133.32	258.04	-1437.3	-1015.3	40.80
1400	191.42	405.48	137.40	268.08	-1436.6	-982.9	36.67
1500	193.10	418.74	141.06	277.68	-1436.3	-950.5	33.10
1600	194.77	431.26	144.37	286.89	-1436.4	-918.1	29.97
1700	196.47	443.12	147.38	295.74	-1437.8	-885.7	27.21
1800	198.22	454.40	150.16	304.24	-1439.1	-853.2	24.76

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.401 $J\cdot bar^{-1}$

44.01 cm^3

A= -1.437E+03 B= 3.242E-01 C= -4.01E+05

5/15/92

ILMENITE Formula wt 151.725

$FeTiO_3$: Rhombohedral crystals 298.15 to 1640 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	99.18	108.90	0.00	108.90	-1232.0	-1155.0	202.43
300	99.47	109.51	0.61	108.90	-1232.0	-1155.0	201.10
400	111.62	139.94	26.97	112.97	-1231.1	-1129.5	147.49
500	119.20	165.72	44.72	121.01	-1229.7	-1104.2	115.35
600	124.35	187.94	57.58	130.36	-1228.1	-1079.2	93.95
700	128.16	207.41	67.41	140.00	-1226.6	-1054.6	78.69
800	131.26	224.73	75.20	149.53	-1225.2	-1030.1	67.26
900	134.02	240.35	81.58	158.77	-1224.1	-1005.8	58.37
1000	136.71	254.61	86.96	167.65	-1223.6	-981.5	51.27
1100	139.50	267.77	91.61	176.16	-1224.1	-957.3	45.46
1200	142.50	280.03	95.72	184.31	-1227.7	-933.0	40.61
1300	145.81	291.57	99.45	192.12	-1225.1	-908.5	36.50
1400	149.48	302.51	102.89	199.62	-1222.3	-884.2	32.99
1500	153.58	312.96	106.13	206.83	-1219.4	-860.2	29.95
1600	158.15	323.01	109.23	213.78	-1216.3	-836.3	27.30

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.169 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 16.992 kJ 31.69 cm^3

A= -1.224E+03 B= 2.424E-01 C= -3.82E-01

5/15/92

ULVOSPINEL **Formula wt 223.572**

Fe_2TiO_4: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	142.27	180.40	0.00	180.40	-1493.8	-1399.9	245.26
300	142.86	181.28	0.88	180.40	-1493.8	-1399.4	243.64
400	160.79	225.33	39.04	186.29	-1492.2	-1368.1	178.65
500	167.80	262.05	64.17	197.88	-1490.3	-1337.3	139.70
600	172.68	293.08	81.85	211.22	-1488.6	-1306.8	113.77
700	177.71	320.07	95.18	224.89	-1487.2	-1276.6	95.26
800	183.47	344.16	105.85	238.32	-1485.9	-1246.6	81.40
900	190.06	366.15	114.83	251.31	-1485.1	-1216.8	70.62
1000	197.44	386.55	122.72	263.83	-1485.4	-1187.0	62.00
1100	205.52	405.74	129.87	275.87	-1486.9	-1157.0	54.94
1200	214.21	423.99	136.53	287.45	-1490.4	-1127.0	49.05
1300	223.43	441.50	142.86	298.63	-1485.5	-1096.9	44.07
1400	233.11	458.41	148.96	309.45	-1480.1	-1067.2	39.82
1500	243.18	474.83	154.90	319.93	-1473.9	-1037.9	36.14
1600	253.60	490.86	160.74	330.11	-1467.1	-1009.0	32.94
1700	264.33	506.55	166.52	340.03	-1461.5	-980.6	30.13
1800	275.32	521.97	172.26	349.71	-1454.1	-952.5	27.64

Melting T K Boiling T K

$\Delta_{vap}H^\circ$ kJ

$\Delta_{fus}H^\circ$ kJ Molar Vol. 4.682 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 46.82 cm^3

A= -1.482E+03 B= 2.956E-01 C= -5.73E+05

5/26/93

SPINEL **Formula wt 142.266**

$MgAl_2O_4$: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	115.94	88.70	0.00	88.70	-2299.1	-2176.6	381.32
300	116.46	89.42	0.72	88.70	-2299.1	-2175.9	378.84
400	137.26	126.06	32.51	93.56	-2299.8	-2134.6	278.74
500	149.86	158.14	54.81	103.34	-2299.5	-2093.3	218.68
600	158.57	186.28	71.41	114.87	-2298.6	-2052.1	178.65
700	165.13	211.24	84.35	126.89	-2297.5	-2011.2	150.07
800	170.33	233.64	94.78	138.85	-2296.5	-1970.3	128.65
900	174.63	253.96	103.42	150.53	-2295.3	-1929.7	111.99
1000	178.29	272.55	110.73	161.82	-2324.3	-1886.9	98.56
1100	181.48	289.70	117.02	172.67	-2323.0	-1843.2	87.52
1200	184.31	305.61	122.51	183.10	-2321.6	-1799.7	78.33
1300	186.85	320.46	127.37	193.10	-2320.0	-1756.1	70.56
1400	189.17	334.40	131.70	202.70	-2445.7	-1709.8	63.79
1500	191.29	347.52	135.60	211.92	-2442.3	-1657.3	57.71
1600	193.27	359.93	139.15	220.79	-2438.9	-1605.1	52.40
1700	195.12	371.70	142.38	229.32	-2435.3	-1553.0	47.72
1800	196.85	382.91	145.36	237.54	-2431.6	-1501.2	43.56

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.971 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 15.41 kJ 39.71 cm^3

A= -2.3446E+03 B= 4.598E-01 C= 3.114E+06

5/21/93

MAGNESIOCHROMITE (picrochromite) **Formula wt 192.295**

$MgCr_2O_4$: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	126.82	106.00	0.00	106.00	-1783.6	-1669.1	292.41
300	127.37	106.79	0.78	106.00	-1783.6	-1668.4	290.48
400	147.88	146.60	35.31	111.29	-1783.2	-1630.0	212.85
500	158.71	180.87	59.00	121.87	-1781.8	-1591.8	166.29
600	165.47	210.44	76.22	134.22	-1780.1	-1554.0	135.28
700	170.18	236.32	89.32	147.00	-1778.2	-1516.4	113.16
800	173.72	259.29	99.66	159.63	-1776.5	-1479.2	96.58
900	176.54	279.92	108.05	171.87	-1774.9	-1442.1	83.70
1000	178.86	298.64	115.02	183.62	-1782.1	-1404.5	73.36
1100	180.85	315.79	120.92	194.87	-1781.2	-1366.8	64.90
1200	182.60	331.60	125.99	205.61	-1780.4	-1329.1	57.85
1300	184.16	346.28	130.40	215.87	-1779.9	-1291.6	51.89
1400	185.57	359.98	134.29	225.68	-1907.2	-1250.9	46.67
1500	186.88	372.83	137.76	235.07	-1905.9	-1204.0	41.93
1600	188.09	384.93	140.86	244.06	-1905.0	-1157.2	37.78
1700	189.23	396.36	143.68	252.69	-1904.5	-1110.5	34.12
1800	190.31	407.21	146.24	260.97	-1904.3	-1063.8	30.87

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.356 J·bar^{-1}

43.56 cm^3

A= -1.7945E+03 B= 3.960E-01 C= 1.0556E+00

5/20/92

MAGNESIOFERRITE **Formula wt 199.997**

$MgFe_2O_4$: Cubic (α) crystals 298.15 to 665 K. Cubic (β) crystals 665 to 1230 K. γ-crystals 1230 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	143.72	121.80	0.00	121.80	-1441.5	-1329.6	232.93
300	144.10	122.62	0.71	121.91	-1441.5	-1328.9	231.38
400	164.30	167.06	39.35	127.71	-1439.7	-1291.6	168.66
500	180.83	205.54	66.02	139.52	-1437.0	-1254.9	131.09
600	196.01	239.86	86.43	153.43	-1433.4	-1218.8	106.10
700	187.13	269.98	102.86	167.12	-1429.3	-1182.7	88.25
800	188.40	295.05	113.47	181.58	-1427.4	-1147.6	74.93
900	189.68	317.31	121.87	195.44	-1426.5	-1112.7	64.58
1000	190.95	337.36	128.71	208.65	-1435.8	-1077.1	56.26
1100	192.23	355.62	134.43	221.19	-1438.4	-1041.0	49.43
1200	193.50	372.40	139.30	233.10	-1439.6	-1004.9	43.74
1300	180.93	388.05	143.60	244.45	-1437.5	-968.8	38.93
1400	186.64	401.67	146.47	255.20	-1564.3	-929.6	34.68
1500	192.36	414.74	149.34	265.40	-1561.9	-884.4	30.80
1600	198.07	427.34	152.21	275.13	-1559.3	-839.3	27.40
1700	203.79	439.52	155.07	284.45	-1558.1	-794.3	24.40
1800	209.50	451.33	157.94	293.39	-1555.6	-749.4	21.75

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.457 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 44.57 cm^3

A= -1.464E+03 B= 3.886E-01 C= 1.938E+06

5/20/93

GEIKIELITE **Formula wt 120.183**

$MgTiO_3$: Rhombohedral crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	93.03	74.64	0.00	74.64	-1572.8	-1484.4	260.05
300	93.37	75.22	0.57	74.64	-1572.8	-1483.8	258.35
400	106.87	104.13	25.64	78.49	-1572.3	-1454.2	189.90
500	114.55	128.87	42.72	86.16	-1571.2	-1424.8	148.85
600	119.39	150.22	55.12	95.10	-1569.8	-1395.7	121.50
700	122.69	168.88	64.55	104.33	-1568.4	-1366.8	101.99
800	125.10	185.43	71.98	113.46	-1566.9	-1338.1	87.37
900	127.01	200.28	77.99	122.29	-1565.5	-1309.6	76.00
1000	128.65	213.75	82.97	130.77	-1572.9	-1280.5	66.88
1100	130.19	226.08	87.20	138.89	-1572.0	-1251.3	59.42
1200	131.72	237.47	90.84	146.63	-1575.1	-1222.0	53.19
1300	133.32	248.08	94.05	154.03	-1573.7	-1192.7	47.92
1400	135.06	258.02	96.91	161.11	-1699.6	-1160.3	43.29
1500	136.97	267.41	99.52	167.89	-1696.7	-1121.9	39.07
1600	139.09	276.31	101.93	174.39	-1693.7	-1083.6	35.38
1700	141.44	284.81	104.18	180.63	-1690.7	-1045.5	32.12
1800	144.04	292.97	106.32	186.65	-1687.6	-1007.7	29.24

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.086 $J\cdot bar^{-1}$

30.86 cm^3

$H_{298}^\circ-H_0^\circ$ 13.64 kJ

A= -1.601E+03 B= 3.214E-01 C= 2.118E+06

5/20/92

PYROPHANITE **Formula wt 150.816**

$MnTiO_3$: Rhombohedral crystals 298.15 to 1600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	99.86	104.90	0.00	104.90	-1360.1	-1280.9	224.41
300	100.18	105.52	0.62	104.90	-1360.1	-1280.4	222.94
400	111.74	136.14	27.14	109.00	-1359.2	-1254.0	163.75
500	117.59	161.76	44.70	117.06	-1358.0	-1227.8	128.27
600	121.20	183.54	57.17	126.37	-1356.7	-1201.9	104.63
700	123.74	202.43	66.51	135.92	-1355.5	-1176.2	87.77
800	125.71	219.08	73.79	145.29	-1354.3	-1150.7	75.13
900	127.36	233.99	79.65	154.34	-1353.4	-1125.3	65.31
1000	128.80	247.48	84.50	162.99	-1354.8	-1099.9	57.45
1100	130.11	259.82	88.58	171.24	-1354.2	-1074.5	51.02
1200	131.33	271.19	92.10	179.10	-1357.8	-1048.9	45.66
1300	132.48	281.75	95.16	186.59	-1356.8	-1023.2	41.11
1400	133.59	291.61	97.86	193.75	-1358.2	-997.6	37.22
1500	134.66	300.86	100.28	200.58	-1359.8	-971.7	33.84
1600	135.71	309.59	102.46	207.13	-1371.7	-945.2	30.86

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	3.277 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	16.69 kJ		32.77 cm^3

A= -1.355E+03 B= 2.557E-01 C= -1.72E+05

2/24/94

TREVORITE **Formula wt 234.382**

$NiFe_2O_4$: Cubic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	146.87	140.90	0.00	140.90	-1070.5	-965.1	169.08
300	147.18	141.81	0.91	140.90	-1070.5	-964.5	167.93
400	164.04	186.46	39.58	146.88	-1068.8	-929.4	121.36
500	181.00	224.88	66.17	158.71	-1066.4	-894.8	93.47
600	198.00	259.38	86.72	172.66	-1063.2	-860.7	74.93
700	215.02	291.18	103.83	187.35	-1059.0	-827.3	61.73
800	232.05	321.01	118.80	202.21	-1053.7	-795.0	51.91
900	249.09	349.32	132.33	217.00	-1047.6	-762.5	44.25
1000	266.13	376.45	144.86	231.59	-1041.6	-731.1	38.19

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	4.365 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		43.65 cm^3

A= -1.053E+03 B= 3.232E-01 C= -8.04E+05

5/26/93

FRANKLINITE **Formula wt 241.082**

$ZnFe_2O_4$: Tetragonal crystals 298.15 to 600 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	193.37	150.70	0.00	150.70	-1188.1	-1082.1	189.58
300	193.61	151.90	1.19	150.70	-1188.0	-1081.5	188.30
400	203.23	209.05	50.62	158.43	-1181.9	-1046.9	136.71
500	209.32	255.09	81.78	173.31	-1175.7	-1013.9	105.91
600	214.01	293.68	103.44	190.24	-1169.9	-982.0	85.49

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.494 $J\cdot bar^{-1}$
44.94 cm^3

A= -1.167E+03 B= 3.112E-01 C= -7.364E+05

2/24/94

ZINC TITANIUM SPINEL **Formula wt 242.658**

Zn_2TiO_4: Tetragonal crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	133.58	143.10	0.00	143.10	-1652.1	-1538.4	269.52
300	134.01	143.93	0.83	143.10	-1652.1	-1537.7	267.74
400	151.80	185.13	36.53	148.60	-1651.4	-1499.7	195.83
500	163.31	220.32	60.81	159.51	-1649.9	-1461.9	152.72
600	171.49	250.85	78.61	172.25	-1647.9	-1424.5	124.01
700	177.64	277.77	92.33	185.44	-1660.3	-1387.3	103.52
800	182.45	301.82	103.31	198.51	-1658.2	-1348.4	88.04
900	186.31	323.54	112.32	211.21	-1655.8	-1309.8	76.02
1000	189.48	343.34	119.89	223.45	-1653.3	-1271.5	66.42
1100	192.12	361.52	126.34	235.19	-1650.9	-1233.5	58.57
1200	194.36	378.34	131.91	246.42	-1882.6	-1191.6	51.87
1300	196.26	393.97	136.79	257.18	-1877.3	-1134.2	45.57
1400	197.90	408.58	141.10	267.48	-1872.1	-1077.3	40.19
1500	199.31	422.28	144.93	277.35	-1866.8	-1020.7	35.54
1600	200.54	435.18	148.37	286.81	-1861.6	-964.4	31.48
1700	201.60	447.37	151.47	295.90	-1856.4	-908.5	27.91
1800	202.54	458.93	154.28	304.64	-1851.3	-852.9	24.75

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.558 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 45.58 cm^3

A= -1.751E+03 B= 4.850E-01 C= 6.790E+06

9/11/92

BROMARGYRITE **Formula wt 187.772**

AgBr: Cubic crystals 298.15 to melting point 703 K. Liquid 703 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	52.38	107.10	0.00	107.10	-100.4	-97.0	16.99
300	52.50	107.42	0.32	107.10	-100.4	-96.9	16.88
400	58.94	123.41	14.17	109.24	-114.6	-92.8	12.11
500	65.39	137.25	23.77	113.48	-112.9	-87.5	9.14
600	71.83	149.75	31.24	118.50	-110.5	-82.6	7.19
700	78.27	161.30	37.50	123.80	-107.6	-78.2	5.83
703	78.46	162.63	37.70	124.93	-107.5	-78.3	5.82
800	62.34	182.76	52.14	130.62	-96.8	-75.4	4.92
900	62.34	190.08	53.28	136.80	-95.3	-72.7	4.22
1000	62.34	196.65	54.18	142.47	-93.9	-70.3	3.67

Melting T 703 K

Boiling T K

$\Delta_{fus}H^\circ$ 9.16 kJ

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.899 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ

28.99 cm^3

A= -1.0054E+02 B= 3.173E-02 C= -5.577E+05

5/20/93

POTASSIUM BROMIDE **Formula wt 119.002**

KBr: Cubic crystals 298.15 to melting point 1007 K. Liquid 1007 to boiling point 1671 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	52.29	95.90	0.00	95.90	-393.8	-380.4	66.65
300	52.34	96.22	0.32	95.90	-393.8	-380.3	66.22
400	53.86	111.54	13.56	97.98	-411.2	-372.3	48.61
500	54.79	123.65	21.71	101.94	-410.7	-362.6	37.88
600	56.20	133.75	27.33	106.42	-410.1	-353.0	30.73
700	58.21	142.56	31.59	110.97	-409.2	-343.6	25.64
800	60.75	150.49	35.07	115.42	-408.2	-334.3	21.83
900	63.74	157.82	38.09	119.73	-406.8	-325.1	18.87
1000	67.09	164.70	40.82	123.89	-405.2	-316.1	16.51
1100	69.87	196.66	66.62	130.04	-456.6	-305.1	14.49
1200	69.87	202.73	66.89	135.84	-453.6	-291.4	12.68
1300	69.87	208.32	67.12	141.20	-450.6	-278.0	11.17
1400	69.87	213.50	67.32	146.18	-447.6	-264.9	9.88
1500	69.87	218.32	67.49	150.83	-444.6	-251.9	8.77
1600	69.87	222.83	67.64	155.19	-441.6	-239.2	7.81

Melting T	1007 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	25.5 kJ		
		Molar Vol. 4.328	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	12.21 kJ	43.28	cm^3

A= -4.330E+02 B= 1.198E-01 C= 1.642E+06

4/8/93

CHLORARGYRITE **Formula wt 143.321**

AgCl: Cubic crystals 298.15 to melting point 728 K; liquid 728 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	50.79	96.23	0.00	96.23	-127.1	-109.8	19.24
300	50.95	96.54	0.31	96.23	-127.1	-109.7	19.10
400	56.65	112.08	13.77	98.31	-125.9	-104.1	13.59
500	59.70	125.08	22.68	102.40	-124.5	-98.8	10.32
600	61.71	136.15	29.03	107.13	-122.9	-93.8	8.17
700	63.22	145.78	33.81	111.98	-121.2	-89.1	6.65
728	63.81	148.97	34.93	114.04	-120.7	-88.3	6.33
800	66.94	172.34	53.92	118.42	-106.4	-85.9	5.61
900	66.94	180.20	55.37	124.83	-104.4	-83.5	4.84
1000	66.94	187.27	56.52	130.75	-102.5	-81.3	4.25

Melting T	728 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	1289 kJ	Molar Vol.	2.573 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	12.033 kJ		25.73 cm^3

A= -1.102E+02 B= 3.084E-02 C= -8.08E+05

5/20/92

HYDROPHILITE **Formula wt 110.983**

$CaCl_2$: Orthorhombic crystals 298.15 to 1045 K. Liquid 1045 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	72.83	104.60	0.00	104.60	-795.8	-747.7	130.99
300	72.93	105.05	0.45	104.60	-795.8	-747.4	130.13
400	75.71	126.50	18.99	107.51	-794.4	-731.5	95.52
500	76.86	143.52	30.46	113.07	-793.1	-715.9	74.78
600	78.00	157.63	38.28	119.35	-792.0	-700.5	60.99
700	79.45	169.76	44.06	125.71	-790.9	-685.4	51.14
800	81.26	180.48	48.59	131.89	-790.8	-670.3	43.76
900	83.40	190.18	52.34	137.84	-789.8	-655.3	38.03
1000	85.81	199.09	55.56	143.53	-788.9	-640.4	33.45
1100	102.53	235.46	85.12	150.34	-758.7	-627.1	29.78
1200	102.53	244.37	86.57	157.80	-764.4	-614.6	26.75
1300	102.53	252.58	87.80	164.78	-761.4	-602.2	24.20
1400	102.53	260.17	88.85	171.32	-758.4	-590.1	22.02
1500	102.53	267.24	89.76	177.48	-755.4	-578.2	20.13
1600	102.53	273.86	90.56	183.30	-752.5	-566.4	18.49
1700	102.53	280.07	91.26	188.81	-749.5	-554.9	17.05
1800	102.53	285.93	91.89	194.04	-895.3	-541.4	15.71

Melting T	1045 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	28.54 kJ		
		Molar Vol. 5.075	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	15.27 kJ	50.75	cm^3

A= -7.714E+02 B= 1.293E-01 C= -1.447E+06

3/04/94

LAWRENCITE **Formula wt 126.752**

$FeCl_2$: Rhombohedral crystals 298.15 to 950 K; liquid 950 to 1300 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	76.34	117.95	0.00	117.95	-341.7	-302.2	52.95
300	76.54	118.42	0.47	117.95	-341.6	-302.0	52.58
400	81.04	141.27	20.23	121.04	-339.8	-289.1	37.75
500	81.49	159.42	32.45	126.96	-338.1	-276.6	28.89
600	81.92	174.30	40.65	133.65	-336.6	-264.4	23.02
700	83.17	187.01	46.63	140.39	-335.4	-252.5	18.84
800	85.31	198.25	51.32	146.93	-334.3	-240.7	15.72
900	88.28	208.46	55.25	153.21	-333.3	-229.1	13.30
1000	102.17	263.64	102.17	161.47	-289.4	-219.8	11.48
1100	102.17	273.34	102.16	171.18	-288.6	-212.8	10.11
1200	102.17	282.21	102.16	180.05	-287.1	-206.0	8.97
1300	102.17	290.41	102.15	188.26	-284.1	-199.4	8.01

Melting T	950 K	Boiling T	1347 K
		$\Delta_{vap}H^\circ$	124.81 kJ
$\Delta_{fus}H^\circ$	43.01 kJ	Molar Vol.	3.946 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	16.27 kJ		39.46 cm^3

A= -3.136E+02 B= 9.168E-02 C= -1.52E+06

3/26/93

MOLYSITE **Formula wt 162.205**

$FeCl_3$: Crystals 298.15 to melting point 577 K; liquid 577 to boiling point 605 K; Ideal gas (dimer) 605 to 700 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	96.67	142.26	0.00	142.26	-399.2	-333.8	58.47
300	96.67	142.86	0.60	142.26	-359.4	-333.4	58.04
400	107.70	171.86	25.72	146.14	-396.9	-311.8	40.71
500	119.86	197.34	43.46	153.88	-393.7	-290.8	30.38
600	133.89	294.42	128.55	165.87	-346.8	-272.3	23.71
700	71.13	344.71	154.70	190.01	-324.5	-263.3	19.64

Melting T	577 K	Boiling T	605 K
		$\Delta_{vap}H^\circ$	21.88 kJ
$\Delta_{fus}H^\circ$	43.10 kJ	Molar Vol.	5.786 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	19.71 kJ		57.86 cm^3

A= -3.455E+02 B= 1.274E-01 C= -2.375E+06

5/21/92

HYDROGEN CHLORIDE **Formula wt 36.461**

HCl: Ideal gas at p = 1 bar, 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	29.14	186.90	0.00	186.90	-92.3	-95.3	16.70
300	29.13	187.08	0.18	186.90	-92.3	-95.3	16.60
400	29.05	195.44	7.40	188.04	-92.6	-96.3	12.57
500	29.27	201.94	11.75	190.19	-92.9	-97.2	10.15
600	29.64	207.31	14.70	192.61	-93.3	-98.0	8.53
700	30.10	211.91	16.86	195.05	-93.6	-98.7	7.37
800	30.60	215.96	18.55	197.41	-93.9	-99.4	6.49
900	31.12	219.60	19.92	199.68	-94.1	-100.1	5.81
1000	31.64	222.90	21.06	201.84	-94.4	-100.8	5.26
1100	32.16	225.94	22.05	203.89	-94.6	-101.4	4.82
1200	32.66	228.76	22.91	205.85	-94.8	-102.0	4.44
1300	33.15	231.40	23.68	207.72	-94.9	-102.6	4.12
1400	33.61	233.87	24.37	209.50	-95.0	-103.2	3.85
1500	34.05	236.20	25.00	211.20	-95.2	-103.8	3.61
1600	34.46	238.41	25.58	212.83	-95.3	-104.4	3.41
1700	34.83	240.51	26.12	214.40	-95.3	-104.9	3.22
1800	35.17	242.52	26.61	215.90	-95.4	-105.5	3.06

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 8.64 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

24789.7 cm^3

A= -9.476E+01 B= -6.043E-03 C= 1.185E+05

3/04/93

SYLVITE **Formula wt 74.551**

KCl: Cubic crystals 298.15 to 1043 K, melting point; liquid 1043 to fictive boiling point 1475 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	51.29	82.59	0.00	82.59	-436.5	-408.6	71.58
300	51.36	82.91	0.32	82.59	-436.5	-408.4	71.10
400	53.41	98.01	13.38	84.64	-438.4	-398.6	52.06
500	54.63	110.06	21.51	88.56	-437.9	-388.8	40.61
600	56.10	120.15	27.14	93.00	-437.2	-379.0	32.99
700	57.99	128.93	31.41	97.52	-436.4	-369.3	27.56
800	60.26	136.82	34.87	101.95	-435.3	-359.8	23.49
900	62.87	144.07	37.83	106.23	-434.0	-350.5	20.34
1000	65.75	150.84	40.48	110.36	-432.4	-341.3	17.83
1100	66.94	182.80	67.19	115.61	-482.9	-329.1	15.63
1200	66.94	189.20	67.72	121.48	-479.5	-315.2	13.72
1300	66.94	195.10	68.18	126.92	-476.1	-301.7	12.12
1400	66.94	200.54	68.56	131.98	-472.7	-288.4	10.76

Melting T 1043 K

Boiling T 1750 K

$\Delta_{fus}H^\circ$ 26.28 kJ

$\Delta_{vap}H^\circ$ 155.39 kJ

$H_{298}^\circ-H_0^\circ$ 11.37 kJ

Molar Vol. 3.752 J·bar^{-1}
37.52 cm^3

A= -4.584E+02 B= 1.207E-01 C= 1.373E+06

3/26/93

CHLORMAGNESITE **Formula wt 95.210**

$MgCl_2$: Rhombohedral crystals 298.15 to melting point 987 K. Liquid 987 to boiling point 1710 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	71.04	89.60	0.00	89.60	-641.3	-591.8	103.68
300	71.16	90.04	0.44	89.60	-641.3	-591.5	102.98
400	75.63	111.20	18.74	92.46	-639.9	-575.0	75.09
500	78.16	128.37	30.39	97.98	-638.5	-559.0	58.40
600	79.92	142.78	38.51	104.27	-637.0	-543.2	47.29
700	81.32	155.21	44.53	110.68	-635.4	-527.7	39.38
800	82.53	166.15	49.20	116.95	-633.9	-512.4	33.46
900	83.63	175.94	52.97	122.97	-632.5	-497.3	28.86
1000	92.47	228.82	99.37	129.45	-596.4	-482.4	25.20
1100	92.47	237.65	98.74	138.28	-594.3	-470.5	22.34
1200	92.47	245.68	98.22	146.94	-592.3	-459.4	20.00
1300	92.47	253.09	97.78	154.87	-590.2	-448.5	18.02
1400	92.47	259.91	97.40	162.13	-715.6	-434.6	16.22
1500	92.47	266.31	97.07	168.91	-712.2	-414.8	14.44
1600	92.47	272.29	96.78	175.22	-708.8	-395.1	12.90
1700	92.47	277.90	96.53	181.12	-705.5	-375.7	11.54

Melting T 987 K

$\Delta_{fus}H^\circ$ 43.1 kJ

$H_{298}^\circ-H_0^\circ$ 13.76 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.081 $J\cdot bar^{-1}$

40.81 cm^3

A= -6.293E+02 B= 1.445E-01 C= -4.868E+05

4/23/93

SCACCHITE **Formula wt 125.844**

$MnCl_2$: Rhombohedral crystals 298.15 to 923 K; liquid 923 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	73.01	118.24	0.00	118.24	-481.3	-440.5	77.17
300	73.11	118.69	0.45	118.24	-481.3	-440.2	76.65
400	77.24	140.35	19.19	121.17	-479.9	-426.8	55.73
500	79.80	157.88	31.07	126.81	-478.6	-413.6	43.21
600	81.73	172.60	39.36	133.25	-477.2	-400.8	34.89
700	83.36	185.33	45.53	139.80	-475.9	-388.1	28.96
800	84.84	196.56	50.35	146.21	-474.6	-375.7	24.53
900	86.23	206.63	54.26	152.37	-473.3	-363.4	21.09
1000	94.56	257.19	95.73	161.46	-436.1	-354.4	18.51
1100	94.56	266.19	95.62	170.57	-434.2	-346.3	16.44
1200	94.56	274.43	95.54	178.89	-432.3	-338.4	14.73
1300	94.56	282.00	95.46	186.54	-430.5	-330.6	13.29
1400	94.56	288.99	95.40	193.59	-431.0	-322.9	12.05

Melting T	923 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	37.53 kJ		
		Molar Vol.	4.211 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	15.071 kJ		42.11 cm^3

A= -4.505E+02 B= 9.437E-02 C= -1.734E+06

3/26/93

HALITE **Formula wt 58.442**

NaCl: Cubic crystals 298.15 to 1073.8 K; liquid 1073.8 to fictive boiling point 1791 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	50.51	72.12	0.00	72.12	-411.3	-384.2	67.30
300	50.54	72.43	0.31	72.12	-411.2	-384.0	66.86
400	52.34	87.22	13.09	74.12	-413.5	-374.8	48.94
500	54.14	99.09	21.12	77.97	-413.0	-365.2	38.15
600	55.93	109.12	26.77	82.35	-412.4	-355.6	30.96
700	57.73	117.88	31.07	86.81	-411.5	-346.3	25.84
800	59.53	125.70	34.51	91.19	-410.4	-337.0	22.00
900	61.32	132.82	37.39	95.43	-409.1	-327.9	19.03
1000	63.12	139.37	39.87	99.50	-407.6	-319.0	16.66
1100	68.46	171.89	67.93	103.96	-377.5	-310.8	14.76
1200	68.14	177.83	67.96	109.87	-472.3	-302.4	13.16
1300	67.82	183.27	67.96	115.31	-469.5	-288.3	11.59
1400	67.50	188.29	67.94	120.35	-466.7	-274.5	10.24
1500	67.17	192.93	67.90	125.03	-463.9	-260.9	9.08
1600	66.85	197.26	67.85	129.41	-461.2	-247.4	8.08
1700	66.53	201.30	67.78	133.52	-458.5	-234.2	7.19

Melting T 1074 K

$\Delta_{fus}H^\circ$ 28.16 kJ

$H_{298}^\circ-H_0^\circ$ 10.61 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.702 J·bar^{-1}
27.02 cm^3

A= -4.283E+02 B= 1.1044E-01 C= 1.132E+06

5/21/92

NICKELOUS CHLORIDE **Formula wt 129.595**

$NiCl_2$: Rhombohedral crystals 298.15 to melting point.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	71.68	98.20	0.00	98.20	-304.9	-258.8	45.33
300	71.88	98.64	0.44	98.20	-304.9	-258.5	45.00
400	77.21	120.25	19.14	101.11	-303.6	-243.2	31.76
500	78.34	137.63	30.89	106.74	-302.3	-228.3	23.85
600	78.89	151.96	38.84	113.12	-301.3	-213.6	18.59
700	79.74	164.18	44.62	119.56	-300.4	-199.0	14.85
800	81.06	174.91	49.09	125.82	-299.2	-184.6	12.05
900	82.87	184.55	52.74	131.82	-297.8	-170.3	9.89
1000	85.11	193.40	55.86	137.54	-296.4	-156.2	8.16
1100	87.72	201.63	58.63	143.00	-294.7	-142.3	6.76
1200	90.66	209.39	61.18	148.21	-292.9	-128.5	5.59
1300	93.87	216.77	63.57	153.20	-290.9	-114.9	4.62

Melting T	1303 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	77.17 kJ		
		Molar Vol.	3.670 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	14.43 kJ		36.70 cm^3

A = -2.965E+02 B = 1.403E-01 C = -3.75E+05

4/8/93

COTUNNITE **Formula wt 278.105**

$PbCl_2$: Orthorhombic crystals 298.15 to 768 K; liquid 768 to 1000 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	73.18	136.00	0.00	136.00	-359.4	-314.1	55.03
300	73.33	136.45	0.45	136.00	-359.4	-313.8	54.64
400	79.98	158.53	19.56	138.97	-357.9	-298.9	39.03
500	84.51	176.89	32.12	144.77	-356.0	-284.3	29.70
600	87.85	192.61	41.15	151.46	-354.0	-270.2	23.52
700	90.45	206.35	48.01	158.34	-356.6	-255.6	19.07
768	91.89	215.09	51.72	163.37	-355.0	-246.2	16.74
800	113.80	250.41	83.99	166.42	-329.7	-242.4	15.82
900	113.80	263.80	87.31	176.49	-325.0	-231.7	13.45
1000	113.80	275.77	89.96	185.81	-320.3	-221.5	11.57

Melting T	768 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	23.85 kJ		
		Molar Vol.	4.709 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	16.94 kJ		47.09 cm^3

A= -3.405E+02 B= 1.218E-01 C= -9.24E+05

5/21/92

FLUORITE **Formula wt 78.075**

CaF_2: Cubic crystals 298.15 K to transition at 1424 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	67.68	68.90	0.00	68.90	-1228.0	-1175.3	205.90
300	67.38	69.32	0.42	68.90	-1228.0	-1175.0	204.57
400	69.99	88.47	16.98	71.49	-1227.2	-1157.4	151.14
500	79.35	105.16	28.58	76.58	-1225.8	-1140.1	119.10
600	83.72	120.09	37.48	82.62	-1224.0	-1123.1	97.77
700	83.92	133.05	44.13	88.92	-1222.3	-1106.5	82.56
800	82.48	144.17	49.02	95.15	-1221.8	-1089.9	71.16
900	81.73	153.82	52.68	101.14	-1220.8	-1073.5	62.30
1000	83.53	162.50	55.65	106.85	-1220.0	-1057.1	55.22
1100	89.33	170.70	58.41	112.29	-1219.3	-1040.9	49.43
1200	100.22	178.90	61.40	117.49	-1225.8	-1024.1	44.58
1300	117.06	187.54	65.00	122.54	-1222.2	-1007.4	40.48
1400	140.52	197.03	69.51	127.52	-1216.7	-991.1	36.98

Melting T	1691 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	2.454 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	11.64 kJ		24.54 cm^3

A= -1.221E+03 B= 1.643E-01 C= -2.93E+05

11/25/92

HYDROGEN FLUORIDE Formula wt 20.006

HF: Ideal gas at p = 1 bar, 298.15 to 2500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	29.14	173.78	0.00	173.78	-273.3	-275.4	48.25
300	29.15	173.96	0.18	173.78	-273.3	-275.4	47.95
400	29.21	182.36	7.44	174.93	-273.5	-276.1	36.05
500	29.15	188.87	11.79	177.09	-273.7	-276.7	28.91
600	29.18	194.19	14.68	179.51	-274.0	-277.3	24.14
700	29.32	198.70	16.76	181.94	-274.3	-277.9	20.73
800	29.55	202.63	18.34	184.28	-274.6	-278.3	18.17
900	29.86	206.13	19.61	186.52	-275.0	-278.8	16.18
1000	30.20	209.29	20.65	188.64	-275.3	-279.2	14.58
1100	30.59	212.18	21.53	190.65	-275.6	-279.6	13.28
1200	30.99	214.86	22.31	192.56	-276.0	-279.9	12.18
1300	31.40	217.36	22.99	194.37	-276.3	-280.2	11.26
1400	31.81	219.70	23.60	196.10	-276.6	-280.5	10.47
1500	32.22	221.91	24.17	197.75	-276.9	-280.8	9.78
1600	32.63	224.00	24.68	199.32	-277.2	-281.0	9.17
1700	33.02	225.99	25.16	200.83	-277.5	-281.2	8.64
1800	33.39	227.89	25.61	202.28	-277.8	-281.5	8.17

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 2478.97 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 8.599 kJ 24789.7 cm^3

A= -2.759E+02 B= -3.234E-03 C= 1.443E+05

11/19/92

SELLAITE **Formula wt 62.302**

MgF_2: Tetragonal crystals 298.15 to melting point 1536 K. Liquid 1536 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	61.51	57.20	0.00	57.20	-1124.2	-1071.1	187.64
300	61.69	57.58	0.38	57.20	-1124.2	-1070.7	186.42
400	68.61	76.38	16.67	59.72	-1123.4	-1053.0	137.51
500	72.56	92.15	27.48	64.67	-1122.4	-1035.5	108.18
600	75.16	105.63	35.22	70.40	-1121.2	-1018.2	88.64
700	77.02	117.36	41.07	76.29	-1120.0	-1001.2	74.71
800	78.44	127.74	45.66	82.09	-1118.9	-984.3	64.27
900	79.57	137.05	49.36	87.68	-1117.7	-967.5	56.15
1000	80.50	145.48	52.43	93.05	-1125.3	-950.2	49.63
1100	81.28	153.19	55.02	98.17	-1124.3	-932.7	44.29
1200	81.95	160.29	57.24	103.06	-1123.3	-915.3	39.84
1300	82.53	166.88	59.16	107.71	-1122.3	-898.0	36.08
1400	83.04	173.01	60.85	112.16	-1248.7	-877.7	32.75
1500	83.49	178.75	62.34	116.41	-1246.3	-851.3	29.64
1600	94.56	222.46	100.45	122.01	-1185.0	-827.5	27.01
1700	94.56	228.19	100.10	128.09	-1181.4	-805.2	24.74
1800	94.56	233.59	99.80	133.79	-1177.9	-783.2	22.73

Melting T 1536 K

$\Delta_{fus}H^\circ$ 58.69 kJ

$H_{298}^\circ-H_0^\circ$ 9.914 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.961 $J\cdot bar^{-1}$
19.61 cm^3

A= -1.145E+03 B= 1.963E-01 C= 1.628E+06

11/19/92

VILLIAUMITE **Formula wt 41.988**

NaF: Cubic crystals 298.15 to melting point 1269 K. Liquid 1269 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	46.86	51.50	0.00	51.50	-573.6	-543.4	95.20
300	46.94	51.79	0.29	51.50	-573.6	-543.2	94.58
400	49.72	65.74	12.36	53.38	-576.0	-532.9	69.59
500	51.19	77.00	19.98	57.02	-575.7	-522.2	54.55
600	52.53	86.45	25.29	61.16	-575.3	-511.5	44.53
700	54.02	94.66	29.29	65.37	-574.7	-500.9	37.38
800	55.71	101.98	32.48	69.49	-573.9	-490.4	32.02
900	57.59	108.65	35.17	73.48	-573.0	-480.0	27.86
1000	59.63	114.82	37.51	77.31	-571.8	-469.8	24.54
1100	61.82	120.60	39.62	80.98	-570.5	-459.6	21.82
1200	64.12	126.08	41.56	84.52	-665.8	-447.1	19.46
1300	68.51	157.48	69.57	87.91	-629.2	-429.0	17.24
1400	68.51	162.55	69.49	93.06	-626.4	-413.7	15.44
1500	68.51	167.28	69.43	97.85	-623.5	-398.6	13.88
1600	68.51	171.70	69.37	102.33	-620.6	-383.7	12.53
1700	68.51	175.85	69.32	106.53	-617.8	-369.0	11.34
1800	68.51	179.76	69.27	110.49	-615.0	-354.5	10.29

Melting T 1269 K

$\Delta_{fus}H^\circ$ 33.14 kJ

$H_{298}^\circ-H_0^\circ$ 8.49 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 1.498 $J\cdot bar^{-1}$
14.98 cm^3

A= -6.018E+02 B= 1.344E-01 C= 1.835E+06

11/19/92

CRYOLITE **Formula wt 209.941**

Na_3AlF_6: Monoclinic (α) crystals 298.15 to 836 K transition to cubic (β) crystals. Cubic crystals 836 to 1153 K. γ crystals 1153 to melting point 1290 K. Liquid 1290 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	217.37	238.50	0.00	238.50	-3316.8	-3152.1	552.22
300	217.73	239.85	1.34	238.50	-3316.8	-3151.0	548.63
400	238.77	305.46	58.16	247.31	-3323.0	-3095.4	404.21
500	251.60	360.26	95.69	264.57	-3320.4	-3038.8	317.45
600	262.30	407.03	122.52	284.51	-3317.0	-2982.8	259.67
700	281.11	448.71	143.68	305.03	-3312.3	-2927.4	218.44
800	315.99	488.31	162.84	325.47	-3305.1	-2872.9	187.58
900	279.88	532.93	186.63	346.30	-3290.1	-2820.0	163.66
1000	284.68	562.66	196.20	366.46	-3295.5	-2767.3	144.54
1100	289.47	590.02	204.46	385.56	-3289.9	-2714.7	128.91
1200	300.41	617.49	213.76	403.73	-3571.9	-2655.4	115.58
1300	396.91	730.45	308.67	421.78	-3447.8	-2580.3	103.67
1400	396.91	759.86	314.97	444.89	-3429.0	-2514.3	93.81
1500	396.91	787.23	320.43	466.80	-3410.1	-2449.6	85.30
1600	396.91	812.84	325.21	487.63	-3391.4	-2386.2	77.90
1700	396.91	836.89	329.43	507.46	-3372.6	-2323.9	71.40
1800	396.91	859.57	333.18	526.39	-3354.0	-2262.7	65.66

Melting T 1290 K

$\Delta_{fus}H^\circ$ 113.75 kJ

$H_{298}^\circ-H_0^\circ$ 38.223 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 7.081 $J\cdot bar^{-1}$

70.81 cm^3

A= -3.370E+03 B= 6.097E-01 C= -3.62E+06

11/19/92

CHIOLITE **Formula wt 461.871**

$Na_5Al_3F_{14}$: Tetragonal crystals 298.15 to melting point 1010 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	453.91	515.30	0.00	515.30	-7546.3	-7174.7	1256.95
300	455.08	518.11	2.80	515.31	-7546.3	-7172.4	1248.79
400	499.34	655.82	122.04	533.78	-7556.5	-7047.1	920.24
500	524.54	770.16	200.20	569.96	-7552.3	-6920.2	722.94
600	542.23	867.43	255.80	611.63	-7546.5	-6794.3	591.49
700	556.38	952.11	297.76	654.35	-7539.6	-6669.5	497.67
800	568.64	1027.22	330.87	696.35	-7532.1	-6545.7	427.38
900	579.80	1094.85	357.91	736.94	-7524.1	-6422.9	372.77
1000	590.28	1156.48	380.63	775.85	-7547.6	-6298.8	329.01

Melting T	1010 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	80.831 kJ		
		Molar Vol.	15.408 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	38.223 kJ		154.08 cm^3

A= -7.5366E+03 B= 1.239E+00 C= -7.07E+05

11/20/92

IODARGYITE **Formula wt 234.773**

AgI: Hexagonal crystals 298.15 to 423 K; cubic crystals 423 to 831 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	54.41	115.48	0.00	115.48	-61.8	-66.3	11.61
300	54.60	115.82	0.34	115.48	-61.8	-66.3	11.54
400	64.68	132.91	15.16	117.74	-69.3	-67.6	8.82
500	56.48	160.54	36.15	124.39	-84.0	-66.3	6.93
600	56.48	170.88	39.54	131.34	-82.8	-62.9	5.47
700	56.48	179.54	41.96	137.58	-81.8	-59.6	4.45
800	56.48	187.07	43.78	143.29	-80.8	-56.5	3.69

Melting T	831 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
$H_{298}^\circ-H_0^\circ$	kJ	Molar Vol.	4.130 $J\cdot bar^{-1}$ 41.30 cm^3

A= -9.280E+01 B= 4.399E-02 C= 1.196E+06

11/19/92

MARSHITE **Formula wt 190.450**

CuI: Cubic crystals 298.15 to transition point at 643 K. There is a second transition at 679 K. CuI melts at 868 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	54.06	96.60	0.00	96.60	-67.8	-69.4	12.16
300	54.14	96.93	0.33	96.60	-67.8	-69.4	12.09
400	57.20	112.92	14.17	98.75	-75.5	-69.7	9.10
500	60.59	125.89	22.98	102.91	-96.4	-66.3	6.92
600	76.90	137.85	30.12	107.73	-94.3	-60.4	5.26
700	68.62	163.05	49.32	113.73	-82.4	-55.6	4.15
800	68.62	172.22	51.74	120.48	-80.1	-51.9	3.39
900	65.75	189.35	62.33	127.02	-70.1	-48.8	2.83
1000	63.45	196.15	62.56	133.59	-68.3	-46.5	2.43
1100	61.43	202.11	62.55	139.56	-66.9	-44.4	2.11
1200	59.68	207.38	62.38	145.00	-65.8	-42.5	1.85
1300	58.20	212.09	62.11	149.98	-65.0	-40.5	1.63
1400	56.99	216.36	61.79	154.57	-77.6	-38.3	1.43

Melting T 868 K

Boiling T K

$\Delta_{fus}H^\circ$ 7.93 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Molar Vol. 3.335 $J\cdot bar^{-1}$
33.35 cm^3

A= -7.665E+01 B= 2.882E-02 C= -2.219E+05

11/19/92

WITHERITE **Formula wt 197.336**

$BaCO_3$: Orthorhombic crystals 298.15 to 1079 K; tetragonal crystals 1079 to 1241 K; cubic crystals 1241 to 1600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	85.32	112.13	0.00	112.13	-1210.9	-1132.2	198.35
300	85.75	112.66	0.53	112.13	-1210.8	-1131.7	197.05
400	99.75	139.57	23.87	115.71	-1209.9	-1105.5	144.36
500	106.60	162.62	39.77	122.84	-1209.3	-1079.4	112.77
600	112.19	182.55	51.38	131.17	-1209.3	-1053.5	91.71
700	118.01	200.28	60.48	139.80	-1208.3	-1027.6	76.68
800	124.41	216.45	68.06	148.38	-1207.4	-1001.8	65.41
900	131.45	231.50	74.71	156.79	-1205.7	-976.2	56.65
1000	139.07	245.74	80.76	164.98	-1203.4	-950.8	49.66
1100	154.81	275.81	102.47	173.34	-1191.2	-925.3	43.94
1200	154.81	289.28	106.83	182.45	-1187.4	-901.3	39.23
1300	158.98	304.39	113.13	191.26	-1180.3	-877.7	35.27
1400	158.98	316.17	116.40	199.77	-1176.1	-854.7	31.89
1500	158.98	327.13	119.24	207.89	-1172.0	-831.8	28.97
1600	158.98	337.39	121.73	215.66	-1167.8	-809.3	26.42

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.581 $J\cdot bar^{-1}$

45.81 cm^3

A= -1.196E+03 B= 2.438E-01 C= -9.15E+05

9/11/92

ARAGONITE **Formula wt 100.087**

$CaCO_3$: Orthorhombic crystals 298.15 to 1000 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	82.31	87.99	0.00	87.99	-1207.4	-1127.4	197.51
300	82.55	88.50	0.51	87.99	-1207.4	-1126.9	196.21
400	92.67	113.75	22.38	91.37	-1206.7	-1100.2	143.66
500	99.80	135.22	37.18	98.04	-1205.8	-1073.6	112.16
600	105.76	153.96	48.13	105.83	-1204.8	-1047.3	91.17
700	111.17	170.67	56.75	113.92	-1203.7	-1021.2	76.20
800	116.28	185.85	63.87	121.98	-1203.4	-995.0	64.97
900	121.22	199.84	69.97	129.86	-1202.2	-969.1	56.24
1000	126.06	212.86	75.34	137.52	-1201.0	-943.2	49.27

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	3.415 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	14.31 kJ		34.15 cm^3

A= -1.203E+03 B= 2.598E-01 C= -1.96E+05

9/18/92

CALCITE **Formula wt 100.087**

$CaCO_3$: Rhombohedral crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	83.47	91.71	0.00	91.71	-1207.4	-1128.5	197.70
300	83.82	92.23	0.52	91.71	-1207.4	-1128.0	196.39
400	97.00	118.36	23.18	95.19	-1206.3	-1101.6	143.86
500	104.55	140.88	38.75	102.13	-1204.9	-1075.6	112.37
600	109.88	160.43	50.18	110.25	-1203.5	-1049.9	91.40
700	114.16	177.70	59.02	118.68	-1202.0	-1024.4	76.44
800	117.88	193.19	66.15	127.04	-1201.6	-999.0	65.23
900	121.28	207.28	72.09	135.18	-1200.3	-973.8	56.52
1000	124.48	220.22	77.17	143.05	-1199.1	-948.7	49.55
1100	127.55	232.23	81.61	150.62	-1198.1	-923.7	43.86
1200	130.53	243.46	85.57	157.89	-1204.9	-898.2	39.10

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	3.693 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	14.48 kJ		36.93 cm^3

A= -1.200E+03 B= 2.518E-01 C= -3.036E+05

10/14/92

DOLOMITE **Formula wt 184.401**

$CaMg(CO_3)_2$: Rhombohedral crystals 298.15 to 1100 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	157.51	155.18	0.00	155.18	-2324.5	-2161.3	378.64
300	158.06	156.16	0.97	155.18	-2324.5	-2160.3	376.13
400	183.54	205.32	43.61	161.71	-2323.4	-2105.7	274.97
500	201.89	248.35	73.52	174.83	-2321.4	-2051.4	214.31
600	215.66	286.43	96.12	190.32	-2318.8	-1997.7	173.91
700	226.65	320.53	114.00	206.53	-2316.0	-1944.4	145.09
800	236.08	351.42	128.69	222.74	-2313.9	-1891.4	123.47
900	244.73	379.73	141.10	238.63	-2310.8	-1838.7	106.72
1000	253.15	405.96	151.89	254.07	-2316.2	-1785.7	93.28
1100	261.72	430.48	161.48	269.00	-2312.9	-1732.9	82.28

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 25.98 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 6.434 $J\cdot bar^{-1}$

64.34 cm^3

A= -2.314E+03 B= 5.283E-01 C= -4.81E+05

5/22/92

SIDERITE **Formula wt 115.856**

$FeCO_3$: Rhombohedral crystals 298.15 to 600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	82.27	95.47	0.00	95.47	-755.9	-682.8	119.63
300	82.52	95.98	0.51	95.47	-755.9	-682.4	118.81
400	94.34	121.43	22.57	98.86	-755.1	-658.0	85.92
500	102.56	143.43	37.80	105.63	-754.0	-633.8	66.21
600	108.09	162.65	49.08	113.56	-752.9	-609.9	53.09

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.938 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	14.59 kJ		29.38 cm^3

A= -7.525E+02 B= 2.383E-01 C= -1.23E+05

5/22/92

MAGNESITE **Formula wt 84.314**

$MgCO_3$: Rhombohedral crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	76.09	65.09	0.00	65.09	-1113.3	-1029.5	180.36
300	76.44	65.56	0.47	65.09	-1113.3	-1029.0	179.15
400	90.57	89.67	21.39	68.28	-1112.9	-1000.9	130.70
500	99.92	110.94	36.20	74.73	-1111.9	-973.0	101.65
600	107.38	129.83	47.46	82.37	-1110.6	-945.3	82.30
700	113.96	146.89	56.50	90.39	-1109.1	-917.9	68.49
800	120.06	162.51	64.07	98.44	-1107.3	-890.7	58.16
900	125.88	176.98	70.61	106.37	-1105.3	-863.7	50.13
1000	131.54	190.54	76.42	114.12	-1111.6	-836.3	43.68

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	2.802 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	11.63 kJ		28.02 cm^3

A= -1.108E+03 B= 2.718E-01 C= -2.42E+05

5/22/92

RHODOCHROSITE **Formula wt 114.947**

$MnCO_3$: Rhombohedral crystals 298.15 to 600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	80.78	98.03	0.00	98.03	-892.9	-819.1	143.50
300	81.03	98.53	0.50	98.03	-892.9	-818.7	142.54
400	92.38	123.49	22.13	101.36	-892.4	-794.0	103.68
500	100.87	145.05	37.06	107.99	-891.6	-769.5	80.38
600	107.70	164.07	48.29	115.78	-890.6	-745.2	64.87

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol. 3.107	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	14.12 kJ	31.07	cm^3

A= -8.894E+02 B= 2.425E-01 C= -9.44E+04

5/22/92

DAWSONITE **Formula wt 143.995**

$NaAlCO_3(OH)_2$: Orthorhombic crystals 298.15 to 500 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	34.52	132.00	0.00	132.00	-1964.0	-1786.0	312.89
300	34.52	132.21	0.21	132.00	-1964.2	-1784.9	310.77
400	34.55	142.15	8.79	133.35	-1980.2	-1722.9	224.98
500	34.58	149.86	13.95	135.91	-1994.4	-1656.9	173.09

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	5.93 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	22.17 kJ		59.3 cm^3

A= -2.010E+03 B= 6.937E-01 C= 1.518E+06

7/17/92

STRONTIANITE **Formula wt 147.629**

$SrCO_3$: Orthorhombic crystals 298.15 to 1197 K; hexagonal crystals 1197 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	81.50	97.07	0.00	97.07	-1218.7	-1137.6	199.29
300	82.03	97.58	0.50	97.07	-1218.7	-1137.1	197.97
400	97.72	123.80	23.26	100.54	-1217.7	-1110.0	144.94
500	102.86	146.24	38.74	107.50	-1216.4	-1083.2	113.16
600	106.05	165.28	49.69	115.58	-1215.2	-1056.6	91.99
700	109.46	181.87	57.98	123.89	-1214.1	-1030.3	76.88
800	113.64	196.75	64.67	132.09	-1213.0	-1004.1	65.56
900	118.69	210.42	70.38	140.04	-1212.4	-978.0	56.76
1000	124.54	223.22	75.50	147.72	-1210.6	-952.0	49.73
1100	131.11	235.40	80.25	155.15	-1216.3	-925.9	43.97
1200	144.77	262.84	100.48	162.36	-1195.5	-899.7	39.16
1300	144.77	274.42	103.89	170.53	-1192.6	-875.1	35.16
1400	144.77	285.15	106.81	178.34	-1189.9	-850.8	31.74

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	3.901 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		39.01 cm^3

A = -1.210E+03 B = 2.577E-01 C = -4.37E+05

7/17/92

SMITHSONITE **Formula wt 125.399**

$ZnCO_3$: Rhombohedral crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	80.05	81.19	0.00	81.19	-817.0	-735.3	128.82
300	80.29	81.69	0.49	81.19	-817.0	-734.8	127.94
400	91.77	106.42	21.93	84.49	-816.4	-707.5	92.39
500	101.01	127.92	36.86	91.07	-815.4	-680.4	71.08
600	108.79	147.05	48.21	98.83	-814.0	-653.5	56.89
700	115.57	164.34	57.36	106.98	-819.7	-626.8	46.77
800	121.64	180.17	65.02	115.15	-817.9	-599.4	39.13
900	127.19	194.82	71.63	123.20	-815.7	-572.2	33.21
1000	132.34	208.49	77.44	131.05	-813.2	-545.3	28.48
1100	137.18	221.34	82.66	138.68	-810.3	-518.6	24.63
1200	141.77	233.47	87.39	146.08	-922.2	-490.3	21.34

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 13.49 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 2.828 $J\cdot bar^{-1}$

28.28 cm^3

A= -8.163E+02 B= 2.711E-01 C= 1.690E+04

5/22/92

NITROBARITE **Formula wt 261.337**

$Ba(NO_3)_2$: Cubic crystals 298.15 to 800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	151.35	213.80	0.00	213.80	-992.1	-796.6	139.55
300	151.85	214.74	0.93	213.80	-992.1	-795.4	138.48
400	174.94	261.75	41.70	220.06	-990.5	-730.0	95.33
500	193.67	302.85	70.26	232.59	-988.0	-665.2	69.49
600	210.68	339.68	92.26	247.42	-984.9	-600.9	52.31
700	226.88	373.38	110.34	263.04	-979.6	-537.3	40.09
800	242.65	404.71	125.90	278.81	-973.6	-474.4	30.98

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol. 8.058	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ	80.58	cm^3

A= -9.791E+02 B= 6.323E-01 C= -5.41E+05

5/22/92

CALCIUM NITRATE **Formula wt 164.088**

$Ca(NO_3)_2$: Cubic crystals 298.15 to 800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	149.11	193.30	0.00	193.30	-938.4	-742.6	130.10
300	149.66	194.22	0.92	193.30	-938.4	-741.4	129.08
400	173.76	240.79	41.30	199.49	-936.6	-675.9	88.27
500	192.74	281.65	69.73	211.92	-933.1	-611.2	63.85
600	210.08	318.34	91.69	226.64	-928.4	-547.2	47.64
700	226.83	351.98	109.81	242.18	-922.5	-484.1	36.12
800	243.37	383.35	125.47	257.88	-916.3	-421.8	27.54

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 6.609 $J\cdot bar^{-1}$

66.09 cm^3

A= -9.217E+02 B= 6.267E-01 C= -6.975+05

5/22/92

NITER **Formula wt 101.103**

KNO_3: Orthorhombic crystals 298.15 to 401 K; Rhombohedral crystals 401 to 610 K; liquid 610 to 700 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	96.27	133.09	0.00	133.09	-494.5	-394.5	69.12
300	96.27	133.69	0.60	133.09	-494.4	-393.9	68.59
400	108.41	163.09	26.05	137.05	-495.6	-360.1	47.03
500	120.50	204.68	56.74	147.94	-486.8	-328.1	34.27
600	120.50	226.64	67.36	159.28	-484.0	-296.6	25.82
700	123.43	262.08	89.73	172.35	-471.1	-267.0	19.92

Melting T	610 K		Boiling T	K
$\Delta_{fus}H^\circ$	10.10 kJ		$\Delta_{vap}H^\circ$	kJ
$H_{298}^\circ-H_0^\circ$	kJ		Molar Vol.	4.804 $J\cdot bar^{-1}$
				48.04 cm^3

A= -4.736E+02 B= 2.981E-01 C= -8.83E+05

5/22/92

MAGNESIUM NITRATE **Formula wt 148.315**

$Mg(NO_3)_2$: Cubic crystals 298.15 to 600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	141.92	164.01	0.00	164.01	-790.7	-589.2	103.22
300	142.40	164.89	0.88	164.01	-790.6	-587.9	102.37
400	168.77	209.45	39.54	169.91	-789.5	-520.5	67.97
500	195.63	249.99	68.07	181.92	-786.0	-453.6	47.38
600	222.70	288.05	91.58	196.47	-780.4	-387.6	33.74

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol. 6.293	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ	62.93	cm^3

A= -7.811E+02 B= 6.577E-01 C= -3.732+05

5/22/92

AMMONIA-NITER **Formula wt 80.043**

NH_4NO_3: Ammonia-niter undergoes phase changes at 305.3, 357.4, 398.4 K. It melts at 442.8 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	139.37	151.08	0.00	151.08	-365.6	-183.8	32.20
300	139.37	151.94	0.86	151.08	-365.6	-182.7	31.81
400	190.79	208.94	51.26	157.68	-358.5	-122.3	15.97
500	161.08	260.24	86.69	173.55	-349.1	-64.5	6.74

Melting T	442.8 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	5.44 kJ	Molar Vol.	4.649 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		46.49 cm^3

A= -3.384E+02 B= 5.556E-01 C= -9.90E+05

5/22/92

SODA NITER **Formula wt 84.995**

$NaNO_3$: α-crystals 298.15 to 549.2 K. β-crystals 549.2 to 583.2 K. Liquid 583.2 to 700 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	93.07	116.52	0.00	116.52	-468.0	-367.1	64.32
300	93.48	117.10	0.58	116.52	-468.0	-366.5	63.81
400	115.76	147.04	26.59	120.45	-469.1	-332.6	43.43
500	138.07	175.27	46.56	128.62	-465.5	-298.9	31.22
600	154.81	234.63	94.82	139.81	-441.2	-266.7	23.22
700	154.81	258.48	103.39	155.09	-435.1	-238.1	17.77

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol. 3.76	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ	37.6	cm^3

A= -4.447E+02 B= 2.995E-01 C= -1.05E+06

5/22/92

STRONTIUM NITRATE **Formula wt 211.630**

$Sr(NO_3)_2$: Crystals 298.15 to 900 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	149.93	194.56	0.00	213.80	-978.2	-779.0	136.47
300	149.88	195.49	0.92	213.80	-978.2	-777.8	135.42
400	169.18	240.55	39.98	220.06	-977.0	-711.1	92.86
500	197.81	281.44	68.73	232.59	-973.6	-644.9	67.37
600	220.32	319.61	92.23	247.42	-968.0	-579.7	50.47
700	234.85	354.76	111.66	263.04	-961.1	-515.5	38.47
800	242.20	386.68	127.58	278.81	-953.4	-452.4	29.54
900	243.53	415.33	140.44	274.89	-946.4	-390.1	22.64

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol. 7.093	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ	70.93	cm^3

A= -9.566E+02 B= 6.317E-01 C= -9.810+05

5/22/92

ALUMINUM SULFATE **Formula wt 342.154**

$Al_2(SO_4)_3$: Orthorhombic crystals 298.15 to 1100 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	259.26	239.30	0.00	239.30	-3441.8	-3100.6	543.20
300	260.62	240.91	1.60	239.30	-3441.9	-3098.5	539.48
400	317.35	324.34	74.05	250.30	-3449.3	-2983.5	389.60
500	352.93	399.26	126.52	272.74	-3451.1	-2866.9	299.49
600	376.60	465.84	166.35	299.49	-3449.7	-2750.1	239.41
700	392.79	525.19	197.62	327.57	-3446.5	-2633.7	196.53
800	403.92	578.41	222.75	355.66	-3442.2	-2517.9	164.40
900	411.44	626.45	243.33	383.12	-3596.9	-2399.4	139.25
1000	416.28	670.07	260.40	409.67	-3609.7	-2265.3	118.32
1100	419.06	709.89	274.71	435.18	-3600.9	-2131.3	101.20

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	7.341 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	40.22 kJ		73.41 cm^3

A= -3.501E+03 B= 1.233E+00 C= 3.117E+06

6/10/93

BARITE **Formula wt 233.391**

$BaSO_4$: Orthorhombic crystals 298.15 to 1300 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	101.75	132.21	0.00	132.21	-1473.6	-1362.5	238.70
300	102.23	132.84	0.63	132.21	-1473.6	-1361.8	237.11
400	119.28	164.94	28.47	136.47	-1476.0	-1324.4	172.95
500	127.17	192.50	47.51	144.99	-1477.5	-1286.4	134.39
600	131.46	216.10	61.17	154.93	-1479.0	-1248.0	108.65
700	134.04	236.57	71.41	165.16	-1479.4	-1209.5	90.25
800	135.72	254.59	79.35	175.24	-1480.1	-1170.9	76.45
900	136.87	270.65	85.68	184.96	-1533.5	-1131.1	65.65
1000	137.69	285.11	90.85	194.27	-1532.4	-1086.5	56.75
1100	138.30	298.27	95.13	203.13	-1539.8	-1041.1	49.44
1200	138.76	310.32	98.75	211.57	-1539.1	-995.8	43.35
1300	139.12	321.44	101.84	219.60	-1538.3	-950.6	38.19

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol. 5.21	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ	52.10	cm^3

A= -7.496E+01 B= -9.007E-02 C= 4.067E-01

5/22/92

ANHYDRITE **Formula wt 136.142**

$CaSO_4$: Orthorhombic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	101.23	107.40	0.00	107.40	-1434.4	-1321.8	231.57
300	101.57	108.03	0.63	107.40	-1434.5	-1321.1	230.02
400	116.68	139.45	27.87	111.58	-1436.6	-1283.2	167.56
500	127.18	166.68	46.74	119.94	-1437.2	-1244.7	130.03
600	135.03	190.59	60.83	129.77	-1437.0	-1206.3	105.01
700	141.54	211.91	71.90	140.01	-1436.1	-1167.9	87.15
800	147.55	231.20	80.98	150.22	-1435.8	-1129.5	73.75
900	153.59	248.93	88.71	160.21	-1487.3	-1090.2	63.27
1000	160.04	265.44	95.52	169.92	-1484.2	-1046.3	54.65

Melting T	1723 K	Boiling T	K
$\Delta_{fus}H^\circ$	28.03 kJ	$\Delta_{vap}H^\circ$	kJ
$H_{298}^\circ-H_0^\circ$	17.30 kJ	Molar Vol.	4.601 $J\cdot bar^{-1}$
			46.01 cm^3

A= -1.4465E+02 B= 3.971E-01 C= 5.860E+05

9/16/92

CHALCOCYANITE **Formula wt 159.610**

$CuSO_4$: Crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	139.89	109.50	0.00	109.50	-771.4	-662.3	116.03
300	140.42	110.37	0.86	109.50	-771.3	-661.6	115.19
400	160.73	153.87	38.57	115.30	-769.2	-625.5	81.69
500	172.71	191.11	64.28	126.83	-765.1	-590.1	61.65
600	181.41	223.40	83.11	140.29	-759.9	-555.6	48.37
700	188.56	251.91	97.67	154.24	-753.9	-522.0	38.95
800	194.88	277.51	109.44	168.08	-747.3	-489.3	31.95
900	200.72	300.81	119.26	181.55	-793.4	-456.4	26.49
1000	206.27	322.24	127.68	194.56	-784.6	-419.4	21.91
1100	211.62	342.15	135.07	207.08	-775.6	-383.3	18.20
1200	216.84	360.79	141.67	219.12	-766.1	-348.1	15.15

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	4.088 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	16.87 kJ		40.88 cm^3

A= -7.631E+02 B= 3.445E-01 C= -1.35E+05

11/25/92

FERRIC SULFATE **Formula wt 399.885**

$Fe_2(SO_4)_3$: Orthorhombic crystals 298.15 to 800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	275.03	282.80	0.00	282.80	-2581.9	-2254.4	394.96
300	276.04	284.50	1.70	282.81	-2581.9	-2252.4	392.16
400	319.44	370.29	76.08	294.21	-2588.8	-2142.1	279.73
500	351.71	445.15	128.08	317.07	-2591.1	-2030.2	212.09
600	379.61	511.78	167.72	344.07	-2590.4	-1918.0	166.98
700	405.44	572.26	199.85	372.41	-2587.4	-1806.2	134.78
800	430.16	628.02	227.10	400.92	-2582.5	-1694.9	110.66

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	13.08 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		130.80 cm^3

A= -2.592E+03 B= 1.121E+00 C= 2.722E+05

6/10/93

ARCANITE **Formula wt 174.260**

K_2SO_4: Orthorhombic crystals (α) 298.15 to 856 K. Hexagonal crystals (β) 856 to melting point 1342 K. Liquid 1342 to 1700 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	130.01	175.56	0.00	175.56	-1437.7	-1319.6	231.18
300	130.44	176.37	0.80	175.56	-1437.7	-1318.9	229.63
400	149.06	216.62	35.70	180.93	-1445.2	-1278.2	166.91
500	163.03	251.43	59.81	191.62	-1445.8	-1236.3	129.15
600	175.17	282.25	78.04	204.21	-1444.9	-1194.5	103.99
700	186.44	310.11	92.73	217.38	-1442.6	-1152.9	86.03
800	197.25	335.71	105.12	230.59	-1439.3	-1111.7	72.59
900	203.55	368.88	125.49	243.39	-1479.5	-1069.8	62.09
1000	189.91	389.40	132.41	256.99	-1474.8	-1024.5	53.51
1100	197.63	407.72	137.86	269.86	-1628.5	-970.4	46.08
1200	219.88	425.78	143.69	282.09	-1620.8	-910.9	39.65
1300	252.38	444.61	150.77	293.84	-1610.5	-852.1	34.24
1400	197.61	485.93	180.08	305.85	-1567.7	-795.0	29.66
1500	197.61	499.57	181.25	318.32	-1561.4	-740.1	25.77
1600	197.61	512.32	182.28	330.04	-1555.0	-685.5	22.38
1700	197.61	524.30	183.18	341.12	-1548.8	-631.3	19.40

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	6.550 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	25.43 kJ		65.50 cm^3

A= -1.541E+03 B= 5.285E-02 C= 6.26776E+06

5/27/92

K-Al SULFATE **Formula wt 258.207**

$KAl(SO_4)_2$: Hexagonal crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	192.98	204.60	0.00	204.60	-2470.9	-2240.4	392.50
300	193.95	205.80	1.19	204.60	-2470.9	-2239.0	389.83
400	230.89	267.25	54.52	212.73	-2478.5	-2160.8	282.17
500	252.19	321.23	92.07	229.16	-2480.1	-2081.2	217.42
600	267.33	368.61	120.08	248.53	-2479.7	-2001.4	174.24
700	279.58	410.76	142.01	268.75	-2477.9	-1921.9	143.41
800	290.27	448.80	159.89	288.92	-2475.2	-1842.6	120.31
900	300.06	483.57	174.92	308.64	-2577.9	-1761.6	102.24
1000	309.29	515.66	187.90	327.76	-2581.9	-1670.5	87.25

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	9.233 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	32.22 kJ		92.33 cm^3

A= -2.499E+03 B= 8.218E-01 C= 1.235E+06

5/27/92

ALUNITE **Formula wt 414.214**

$KAl_3(OH)_6(SO_4)_2$: Crystals 298.15 to 700 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	372.53	321.00	0.00	321.00	-5176.5	-4663.5	817.00
300	374.90	323.31	2.30	321.01	-5176.6	-4660.3	811.41
400	462.28	444.70	107.73	336.96	-5185.9	-4487.0	585.92
500	508.84	553.29	183.69	369.60	-5186.2	-4312.1	450.48
600	539.32	648.92	240.57	408.35	-5183.0	-4137.6	360.20
700	562.22	733.84	284.94	448.90	-5177.7	-3963.8	295.77

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	29.360 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		293.60 cm^3

A= -5.116E+03 B= 1.594E+00 C= -2.065E+06

11/25/92

LANGBEINITE **Formula wt 414.997**

$K_2Mg_2(SO_4)_3$: Cubic crystals 298.15 to 1203 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	318.92	389.30	0.00	389.30	-4071.0	-3733.4	654.05
300	319.93	391.28	1.97	389.31	-4071.1	-3731.3	649.66
400	363.71	489.76	87.32	402.44	-4084.4	-3616.5	472.25
500	393.92	574.34	145.78	428.56	-4088.1	-3499.1	365.54
600	416.52	648.25	189.10	459.15	-4088.9	-3381.1	294.35
700	434.14	713.84	222.90	490.93	-4087.6	-3263.3	243.50
800	448.13	772.75	250.21	522.54	-4085.1	-3145.7	205.39
900	459.30	826.21	272.85	553.36	-4241.1	-3025.2	175.57
1000	468.13	875.08	291.95	583.12	-4250.8	-2889.0	150.90
1100	474.96	920.03	308.29	611.73	-4401.2	-2744.0	130.30
1200	480.00	961.58	322.40	639.18	-4391.4	-2593.8	112.90

Melting T	1203 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	14.695 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	57.066 kJ		146.95 cm^3

A= -4.191E+03 B= 1.309E+00 C= 6.392E+06

11/25/92

MAGNESIUM SULFATE **Formula wt 120.369**

$MgSO_4$: Crystals 298.15 to 1400 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	95.71	91.40	0.00	91.40	-1284.9	-1170.5	205.07
300	96.10	91.99	0.59	91.40	-1284.9	-1169.8	203.68
400	111.16	121.91	26.54	95.38	-1287.6	-1131.3	147.72
500	120.67	147.80	44.46	103.34	-1288.7	-1092.1	114.08
600	127.99	170.47	57.80	112.67	-1288.9	-1052.7	91.64
700	134.27	190.68	68.28	122.40	-1288.5	-1013.4	75.62
800	140.01	208.99	76.89	132.10	-1287.7	-974.1	63.60
900	145.42	225.80	84.21	141.59	-1339.6	-933.9	54.20
1000	150.64	241.39	90.59	150.80	-1345.4	-888.3	46.40
1100	155.73	255.99	96.28	159.70	-1342.4	-842.7	40.02
1200	160.73	269.75	101.45	168.30	-1339.0	-797.4	34.71
1300	165.66	282.81	106.20	176.61	-1335.2	-752.4	30.23
1400	170.55	295.27	110.62	184.65	-1458.4	-704.6	26.29

Melting T	1400 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	$J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	1539 kJ		cm^3

A= -1.325E+03 B= 4.385E-01 C= 2.288E+06

11/25/92

MANGANESE SULFATE **Formula wt 151.002**

$MnSO_4$: Orthorhombic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	100.52	127.00	0.00	127.00	-1065.7	-962.1	168.56
300	100.99	127.62	0.62	127.00	-1065.7	-961.5	167.40
400	118.68	159.38	28.17	131.21	-1067.9	-926.6	120.99
500	129.02	187.05	47.38	139.68	-1068.4	-891.3	93.10
600	136.47	211.26	61.63	149.63	-1068.2	-855.8	74.49
700	142.54	232.77	72.77	160.00	-1067.3	-820.5	61.21
800	147.89	252.16	81.83	170.33	-1066.1	-785.3	51.26
900	152.81	269.86	89.45	180.42	-1117.7	-749.2	43.47
1000	157.47	286.21	96.02	190.19	-1116.9	-708.4	36.99

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	4.362 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		43.62 cm^3

A= -1.077E+03 B= 3.657E-01 C= 5.563E+05

6/10/93

MASCAGNITE **Formula wt 132.141**

$(NH4)_2SO_4$: Orthorhombic crystals 298.15 to 600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	187.48	220.50	0.00	220.50	-1182.7	-903.5	158.29
300	188.00	221.66	1.16	220.50	-1182.7	-901.8	157.01
400	215.88	279.56	51.35	228.21	-1187.6	-807.6	105.46
500	243.76	330.73	87.05	243.68	-1189.3	-712.4	74.42
600	271.64	377.64	115.49	262.15	-1188.2	-617.0	53.72

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 7.468 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 74.68 cm^3

A= -1.193E+03 B= 9.583E-01 C= 3.227E+05

3/24/93

THENARDITE **Formula wt 142.043**

Na_2SO_4: Orthorhombic crystals (V) 298.15 to 450 K. Orthorhombic crystals (III) 450 to 514 K. Hexagonal crystals (I) 514 to 1155 K. Liquid 1155 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	127.28	149.60	0.00	149.60	-1387.8	-1269.8	222.46
300	127.63	150.35	0.79	149.56	-1387.8	-1269.1	220.96
400	146.82	191.96	36.81	155.15	-1395.1	-1229.0	160.49
500	173.30	234.89	68.03	166.86	-1392.0	-1187.8	124.09
600	170.78	279.30	96.29	183.01	-1384.2	-1148.4	99.97
700	178.92	306.23	107.51	198.72	-1382.5	-1109.2	82.77
800	187.06	330.66	116.95	213.71	-1379.9	-1070.3	69.88
900	195.20	353.16	125.19	227.97	-1429.6	-1030.7	59.82
1000	203.34	374.15	132.60	241.55	-1424.3	-986.7	51.54
1100	211.48	393.91	139.40	254.51	-1418.2	-943.2	44.79
1200	196.37	431.72	165.14	266.58	-1581.8	-895.0	38.96
1300	195.98	447.42	167.53	279.89	-1575.4	-838.0	33.67
1400	195.58	461.93	169.54	292.39	-1569.2	-781.5	29.16
1500	195.19	475.41	171.27	304.14	-1563.0	-725.5	25.26
1600	194.80	487.99	172.75	315.24	-1557.0	-669.9	21.87
1700	194.40	499.79	174.04	325.75	-1551.0	-614.6	18.88
1800	194.01	510.89	175.16	335.73	-1545.2	-559.6	16.24

Melting T	1155 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	5.333 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	23.22 kJ		53.33 cm^3

A= -1.482E+03 B= 5.020E-01 C= 6.251E+06

2/5/92

NICKELOUS SULFATE **Formula wt 154.754**

$NiSO_4$: Orthorhombic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	97.69	101.30	0.00	101.30	-873.2	-762.7	133.61
300	98.19	101.91	0.60	101.30	-873.3	-762.0	132.67
400	116.56	132.98	27.57	105.41	-875.7	-724.7	94.64
500	126.71	160.17	46.46	113.71	-876.5	-686.9	71.76
600	133.62	183.92	60.44	123.48	-876.6	-648.9	56.49
700	139.01	204.93	71.29	133.64	-876.2	-611.0	45.59
800	143.57	223.80	80.05	143.75	-875.0	-573.7	37.46
900	147.67	240.95	87.34	153.61	-926.6	-534.5	31.02
1000	151.47	256.71	93.56	163.14	-923.7	-491.1	25.65
1100	155.08	271.31	98.99	172.32	-920.5	-448.0	21.27
1200	158.56	284.96	103.81	181.15	-917.1	-405.2	17.64

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	3.857 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	15.94 kJ		38.57 cm^3

A= -8.988E+02 B= 4.077E-01 C= 1.381E+06

2/5/93

ANGLESITE **Formula wt 303.264**

$PbSO_4$: Orthorhombic crystals 298.15 to 1100 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	104.33	148.50	0.00	148.50	-920.0	-813.1	142.44
300	104.33	149.15	0.64	148.50	-920.0	-812.4	141.45
400	108.73	179.59	26.96	152.62	-922.7	-776.4	101.38
500	117.63	204.76	44.16	160.59	-924.2	-739.6	77.27
600	128.30	227.13	57.28	169.85	-924.8	-702.6	61.17
700	139.81	247.76	68.24	179.52	-929.1	-664.8	49.61
800	151.76	267.21	77.93	189.28	-927.4	-627.2	40.95
900	163.98	285.79	86.81	198.98	-977.7	-588.7	34.17
1000	176.35	303.70	95.15	208.56	-972.4	-545.8	28.51
1100	188.83	321.10	103.09	218.00	-966.0	-503.4	23.90

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	4.795 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	20.05 kJ		47.95 cm^3

A= -9.455E+02 B= 3.981E-01 C= 1.275E+06

11/25/92

ZINKOSITE **Formula wt 161.454**

$ZnSO_4$: Orthorhombic crystals 298.15 to 1100 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	104.12	110.50	0.00	110.50	-980.1	-868.7	152.20
300	104.02	111.14	0.64	110.50	-980.1	-868.1	151.14
400	104.84	140.94	26.38	114.56	-982.9	-830.5	108.46
500	111.90	165.03	42.72	122.31	-984.8	-792.2	82.76
600	121.41	186.25	55.02	131.23	-985.8	-753.6	65.61
700	132.08	205.75	65.26	140.50	-993.3	-714.8	53.34
800	143.36	224.12	74.31	149.81	-992.5	-675.1	44.08
900	155.01	241.67	82.63	159.05	-1043.8	-634.4	36.82
1000	166.88	258.62	90.46	168.16	-1039.6	-589.1	30.77
1100	178.89	275.09	97.95	177.14	-1034.4	-544.3	25.85

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	4.157 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	17.24 kJ		41.57 cm^3

A= -1.010E+03 B= 4.187E-01 C= 1.501E+06

11/25/92

BERLINITE **Formula wt 121.953**

$AlPO_4$: Rhombohedral crystals 298.15 to α-β transition at 855 K. β-crystals 855 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	93.96	90.80	0.00	90.80	-1733.8	-1617.9	283.44
300	94.15	91.38	0.58	90.80	-1733.8	-1617.1	281.56
400	109.86	120.53	25.86	94.67	-1735.3	-1577.9	206.05
500	122.79	146.53	44.04	102.49	-1735.0	-1538.6	160.73
600	131.82	169.75	57.95	111.80	-1734.0	-1499.4	130.53
700	140.83	190.72	69.12	121.60	-1732.4	-1460.4	108.97
800	153.40	210.29	78.82	131.47	-1730.0	-1421.7	92.82
900	140.70	229.96	88.62	141.34	-1725.9	-1383.4	80.29
1000	142.50	244.88	93.92	150.96	-1735.2	-1344.7	70.24

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	4.658 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	14.76 kJ		46.58 cm^3

A= -1.731E+03 B= 3.866E-01 C= -2.087E+05

11/25/92

WHITLOCKITE **Formula wt 310.177**

$Ca_3(PO_4)_2$: Rhombohedral crystals 298.15 to 1373 K. Monoclinic crystals 1373 to 1600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	231.63	236.00	0.00	236.00	-4120.8	-3883.6	680.38
300	232.12	237.43	1.43	236.00	-4120.8	-3882.2	675.93
400	255.24	307.49	62.09	245.40	-4122.7	-3802.1	496.50
500	275.30	366.64	102.76	263.88	-4121.9	-3722.1	388.83
600	294.16	418.51	133.10	285.41	-4120.2	-3642.3	317.08
700	312.44	465.23	157.42	307.82	-4117.6	-3562.8	265.85
800	330.43	508.13	177.92	330.21	-4116.6	-3483.5	227.44
900	348.23	548.08	195.86	352.22	-4112.2	-3404.6	197.59
1000	365.93	585.69	211.98	373.70	-4107.0	-3326.2	173.74
1100	383.55	621.39	226.78	394.61	-4101.2	-3248.4	154.25
1200	401.12	655.52	240.57	414.94	-4245.0	-3167.2	137.86
1300	418.67	688.32	253.60	434.72	-4232.6	-3077.8	123.67
1400	330.54	729.26	275.09	454.17	-4205.8	-2989.8	111.55
1500	330.54	752.05	278.79	473.26	-4201.6	-2903.0	101.09
1600	330.54	773.38	282.02	491.36	-4197.5	-2816.6	91.95

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 9.762 J·bar^{-1}

$H_{298}^\circ-H_0^\circ$ kJ 97.62 cm^3

A= -4.148E+03 B= 8.253E-01 C= 1.823E+06

11/25/92

FLUORAPATITE **Formula wt 504.302**

$Ca_5(PO_4)_3F$: Hexagonal crystals 298.15 to 1600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	375.94	387.90	0.00	387.90	-6872.0	-6489.7	1136.95
300	377.11	390.23	2.32	387.91	-6872.0	-6487.4	1129.52
400	426.47	506.06	102.70	403.37	-6874.0	-6358.5	830.32
500	458.22	604.87	170.83	434.03	-6871.4	-6229.9	650.82
600	480.47	690.49	220.68	469.80	-6867.7	-6102.0	531.21
700	496.89	765.84	259.02	506.82	-6863.7	-5974.7	445.83
800	509.43	833.05	289.57	543.47	-6864.1	-5847.4	381.79
900	519.24	893.64	314.57	579.07	-6860.4	-5720.6	332.00
1000	527.04	948.77	335.44	613.33	-6857.7	-5594.1	292.20
1100	533.30	999.30	353.15	646.15	-6856.1	-5467.8	259.64
1200	538.35	1045.93	368.38	677.55	-7085.0	-5335.3	232.23
1300	542.44	1089.19	381.62	707.57	-7077.5	-5189.8	208.52
1400	545.74	1129.51	393.23	736.28	-7069.7	-5044.8	188.22
1500	548.40	1167.26	403.49	763.77	-7061.9	-4900.4	170.64
1600	550.50	1202.72	412.62	790.11	-7054.1	-4756.6	155.28

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 15.756 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 63.47 kJ 157.56 cm^3

A= -6.931E+03 B= 1.344E+00 C= 4.048E+06

11/25/92

HYDROXYAPATITE **Formula wt 502.311**

$Ca_5(PO_4)_3(OH)$: Hexagonal crystals 298.15 to 1500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			J·mol^{-1}·K^{-1}			kJ·mol^{-1}	
298.15	385.17	390.40	0.00	390.40	-6738.5	-6337.1	1110.22
300	386.83	392.79	2.38	390.41	-6738.5	-6334.7	1102.94
400	446.42	513.36	106.92	406.44	-6740.1	-6199.4	809.55
500	477.29	616.59	178.17	438.42	-6736.9	-6064.6	633.55
600	497.62	705.50	229.81	475.70	-6732.7	-5930.6	516.29
700	513.35	783.43	269.23	514.21	-6728.4	-5797.2	432.58
800	526.86	852.88	300.60	552.28	-6728.4	-5663.9	369.81
900	539.23	915.66	326.44	589.22	-6724.2	-5531.1	321.01
1000	550.97	973.08	348.31	624.77	-6720.7	-5398.8	282.00
1100	562.37	1026.13	367.25	658.88	-6717.9	-5266.7	250.09
1200	573.58	1075.54	383.98	691.57	-6945.1	-5128.6	223.24
1300	584.69	1121.90	398.99	722.90	-6935.1	-4977.6	200.00
1400	595.76	1165.63	412.65	752.98	-6924.2	-4827.4	180.11
1500	606.82	1207.11	425.23	781.88	-6912.5	-4678.0	162.90

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	15.960 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	64.24 kJ		159.60 cm^3

A= -6.777E+03 B= 1.386E+00 C= 2.726E+06

11/25/92

TOPAZ **Formula wt 184.043**

$Al_2SiO_4F_2$: Orthorhombic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	143.63	105.40	0.00	105.40	-3084.5	-2910.6	509.92
300	144.28	106.29	0.89	105.40	-3084.5	-2909.6	506.59
400	172.38	151.96	40.52	111.44	-3084.9	-2851.1	372.31
500	190.31	192.49	68.81	123.68	-3083.7	-2792.8	291.76
600	201.97	228.30	90.10	138.19	-3081.7	-2734.8	238.08
700	209.49	260.04	106.66	153.38	-3079.3	-2677.2	199.77
800	214.10	288.34	119.83	168.51	-3076.9	-2619.9	171.06
900	216.62	313.72	130.46	183.26	-3074.6	-2562.9	148.75
1000	217.54	336.61	139.13	197.47	-3093.9	-2504.7	130.83

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ kJ

Molar Vol. 5.153 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 19.77 kJ 51.53 cm^3

A= -3.079E+03 B= 5.740E-01 C= -2.85E+05

7/23/92

KYANITE **Formula wt 162.046**

Al_2SiO_5: Triclinic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	121.58	82.80	0.00	82.80	-2593.8	-2443.1	428.01
300	122.26	83.55	0.75	82.80	-2593.8	-2442.2	425.21
400	149.25	122.81	34.84	87.97	-2594.7	-2391.4	312.28
500	165.25	157.97	59.44	98.53	-2594.1	-2340.6	244.52
600	175.97	189.10	78.02	111.08	-2592.7	-2290.1	199.36
700	183.70	216.84	92.59	124.24	-2591.0	-2239.8	167.13
800	189.56	241.77	104.36	137.40	-2589.2	-2189.7	142.97
900	194.15	264.37	114.09	150.27	-2587.3	-2139.9	124.19
1000	197.84	285.02	122.29	162.73	-2606.8	-2088.8	109.11
1100	200.85	304.02	129.30	174.72	-2604.6	-2037.1	96.73
1200	203.35	321.61	135.37	186.24	-2602.3	-1985.6	86.43
1300	205.44	337.97	140.68	197.29	-2599.9	-1934.2	77.72
1400	207.20	353.26	145.37	207.89	-2597.5	-1883.2	70.26
1500	208.70	367.61	149.54	218.06	-2595.0	-1832.2	63.80
1600	209.97	381.12	153.28	227.84	-2592.5	-1781.5	58.16
1700	211.06	393.88	156.65	237.23	-2640.1	-1730.4	53.17
1800	211.99	405.97	159.70	246.27	-2637.3	-1677.0	48.66

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circs-H_0^\circs$ 15.86 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.415 J·bar^{-1}
44.15 cm^3

A= -2.599E+03 B= 5.109E-01 C= 3.358E+05

7/29/92

ANDALUSITE **Formula wt 162.046**

Al_2SiO_5: Orthorhombic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	122.60	91.39	0.00	91.39	-2589.9	-2441.8	427.77
300	123.26	92.15	0.76	91.39	-2589.9	-2440.8	424.98
400	149.43	131.57	34.98	96.59	-2590.7	-2391.0	312.22
500	165.03	166.71	59.54	107.17	-2590.1	-2341.1	244.56
600	175.54	197.79	78.05	119.74	-2588.8	-2291.4	199.48
700	183.16	225.45	92.55	132.90	-2587.2	-2241.9	167.29
800	188.94	250.30	104.25	146.05	-2585.4	-2192.7	143.17
900	193.49	272.83	113.92	158.90	-2583.6	-2143.8	124.42
1000	197.16	293.41	122.07	171.34	-2603.1	-2093.5	109.35
1100	200.16	312.35	129.04	183.31	-2601.0	-2042.6	96.99
1200	202.67	329.88	135.07	194.80	-2598.8	-1992.0	86.71
1300	204.77	346.18	140.36	205.83	-2596.4	-1941.4	78.01
1400	206.56	361.43	145.02	216.40	-2594.1	-1891.2	70.56
1500	208.08	375.73	149.18	226.55	-2591.6	-1841.1	64.11
1600	209.38	389.20	152.90	236.30	-2589.2	-1791.1	58.47
1700	210.50	401.93	156.26	245.67	-2636.8	-1740.8	53.49
1800	211.46	413.99	159.30	254.69	-2634.1	-1688.2	48.99

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 16.90 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 5.152 $J\cdot bar^{-1}$

51.52 cm^3

A= -2.595E+03 B= 5.027E-01 C= 3.590E+05

7/29/92

SILLIMANITE **Formula wt 162.046**

Al_2SiO_5: **Orthorhombic crystals 298.15 to 1800 K.**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	123.72	95.40	0.00	95.40	-2586.1	-2439.1	427.32
300	124.33	96.17	0.76	95.40	-2586.1	-2438.2	424.52
400	148.88	135.63	35.01	100.62	-2586.9	-2388.8	311.93
500	163.95	170.58	59.40	111.91	-2586.4	-2339.3	244.38
600	174.29	201.44	77.73	123.71	-2585.2	-2289.9	199.35
700	181.88	228.91	92.09	136.81	-2583.7	-2240.9	167.21
800	187.70	253.59	103.70	149.89	-2582.0	-2192.0	143.12
900	192.31	275.97	113.29	162.68	-2580.4	-2143.4	124.39
1000	196.05	296.44	121.39	175.05	-2598.0	-2093.4	109.35
1100	199.13	315.27	128.32	186.95	-2598.0	-2042.8	97.00
1200	201.70	332.71	134.33	198.38	-2595.9	-1992.5	86.73
1300	203.87	348.94	139.60	209.34	-2593.6	-1942.2	78.04
1400	205.71	364.12	144.26	219.86	-2591.4	-1892.3	70.60
1500	207.29	378.37	148.41	229.96	-2589.0	-1842.3	64.16
1600	208.64	391.79	152.13	239.66	-2586.6	-1792.7	58.52
1700	209.80	404.47	155.49	248.98	-2634.3	-1742.6	53.54
1800	210.80	416.50	158.54	257.96	-2631.7	-1690.3	49.05

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 17.44 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.986 $J\cdot bar^{-1}$

49.86 cm^3

A= -2.592E+03 B= 4.998E-01 C= 4.086E+05

7/29/92

MULLITE **Formula wt 426.052**

$Al_6Si_2O_{13}$: **Orthorhombic crystals 298.15 to 1800 K.**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	326.13	275.00	0.00	275.00	-6819.2	-6441.8	1128.55
300	327.73	277.02	2.02	275.01	-6819.3	-6439.4	1121.18
400	392.44	381.04	92.29	288.75	-6821.5	-6312.3	824.29
500	431.98	473.17	156.55	316.62	-6820.4	-6185.1	646.14
600	458.88	554.45	204.83	349.62	-6817.5	-6058.3	527.41
700	478.40	626.72	242.59	384.14	-6813.7	-5932.1	442.65
800	493.16	691.61	273.03	418.59	-6809.8	-5806.4	379.11
900	504.65	750.39	298.15	452.24	-6806.0	-5681.2	329.72
1000	513.76	804.05	319.27	484.78	-6866.2	-5552.0	290.00
1100	521.10	853.37	337.30	516.07	-6861.6	-5420.8	257.40
1200	527.05	898.98	352.87	546.11	-6856.7	-5290.0	230.26
1300	531.91	941.36	366.46	574.90	-6851.4	-5159.5	207.31
1400	535.88	980.93	378.43	602.51	-6846.3	-5029.8	187.66
1500	539.13	1018.02	389.04	628.98	-6840.9	-4900.2	170.64
1600	541.76	1052.90	398.50	654.40	-6835.6	-4771.0	155.75
1700	543.88	1085.81	406.99	678.82	-6930.5	-4641.0	142.60
1800	545.56	1116.95	414.65	702.30	-6924.8	-4506.7	130.78

Melting T 2123 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 46.07 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 13.46 $J\cdot bar^{-1}$

134.6 cm^3

A= -6.844E+03 B= 1.295E+00 C= 1.613E+06

5/4/92

DUMORTIERITE **Formula wt 565.938**

$[Al_{6.75}][\ ]_{.25}Si_3BO_{17.25}(OH)_{.75}$: Orthorhombic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	440.00	334.90	0.00	334.90	-9109.0	-8568.2	1501.08
300	442.08	337.63	2.72	334.91	-9109.1	-8564.9	1491.24
400	532.57	478.13	124.68	353.45	-9112.5	-8382.8	1094.65
500	592.80	603.87	212.67	391.20	-9111.0	-8200.4	856.67
600	634.72	715.87	279.71	436.16	-9106.7	-8018.7	698.07
700	664.89	816.10	332.70	483.41	-9100.7	-7837.8	584.85
800	687.16	906.41	375.68	530.73	-9094.2	-7657.9	499.99
900	703.94	988.36	411.26	577.10	-9087.6	-7478.7	434.04
1000	716.81	1063.23	441.20	622.02	-9153.0	-7295.3	381.06
1100	726.88	1132.04	466.73	665.30	-9145.4	-7109.9	337.61
1200	734.93	1195.64	488.76	706.88	-9137.5	-6925.2	301.44
1300	741.52	1254.74	507.96	746.78	-9129.2	-6741.0	270.85
1400	747.09	1309.90	524.85	785.05	-9121.2	-6557.9	244.67
1500	751.98	1361.61	539.83	821.78	-9112.9	-6375.0	221.99
1600	756.43	1410.29	553.23	857.06	-9104.6	-6192.7	202.17
1700	760.66	1456.27	565.31	890.97	-9246.7	-6009.4	184.64
1800	764.83	1499.87	576.27	923.59	-9237.7	-5819.4	168.87

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 16.84 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 59.84 kJ 168.4 cm^3

A= -9.125E+03 B= 1.833E+00 C= 1.061E+06

7/22/92

EUCLASE **Formula wt 145.084**

$BeAlSiO_4(OH)$: **Crystals 298.15 to 1800 K.**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	126.83	89.10	0.00	89.10	-2532.9	-2370.2	415.24
300	127.50	89.89	0.78	89.10	-2532.9	-2369.2	412.50
400	156.65	130.86	36.37	94.49	-2533.9	-2314.4	302.22
500	175.85	168.02	62.47	105.55	-2533.3	-2259.5	236.05
600	188.84	201.30	82.52	118.78	-2531.8	-2204.9	191.95
700	197.87	231.13	98.39	132.74	-2529.7	-2150.6	160.48
800	204.36	258.00	111.25	146.75	-2527.4	-2096.6	136.89
900	209.17	282.36	121.88	160.48	-2525.0	-2042.9	118.56
1000	212.92	304.60	130.80	173.80	-2533.3	-1988.7	103.88
1100	216.03	325.04	138.41	186.63	-2530.7	-1934.4	91.85
1200	218.78	343.96	145.00	198.96	-2528.2	-1880.3	81.84
1300	221.41	361.57	150.77	210.80	-2525.6	-1826.4	73.38
1400	224.07	378.08	155.91	222.17	-2523.0	-1772.7	66.14
1500	226.91	393.63	160.55	233.08	-2520.4	-1719.2	59.87
1600	230.01	408.38	164.79	243.58	-2532.2	-1665.5	54.37
1700	233.47	422.42	168.73	253.69	-2579.2	-1610.9	49.50
1800	237.34	435.87	172.43	263.44	-2575.6	-1554.1	45.10

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 16.83 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 4.686 $J\cdot bar^{-1}$

46.86 cm^3

A= -2.529E+03 B= 5.403E-01 C= -2.31E+05

7/23/92

PHENAKITE **Formula wt 110.107**

Be_2SiO_4: Hexagonal crystals 298.15 to 1800 K. Decomposes to BeO and SiO_2 above 1833 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	95.60	63.37	0.00	63.37	-2143.1	-2028.4	355.36
300	96.16	63.96	0.59	63.37	-2143.1	-2027.7	353.04
400	121.33	95.31	27.84	67.47	-2143.9	-1989.0	259.74
500	138.41	124.34	48.35	75.99	-2143.3	-1950.4	203.75
600	150.19	150.68	64.40	86.28	-2142.1	-1911.9	166.44
700	158.46	174.49	77.28	97.21	-2140.3	-1873.7	139.81
800	164.33	196.06	87.82	108.24	-2138.3	-1835.7	119.86
900	168.53	215.67	96.56	119.10	-2136.2	-1798.0	104.35
1000	171.57	233.59	103.92	129.67	-2134.2	-1760.5	91.96
1100	173.77	250.05	110.18	139.87	-2132.2	-1723.3	81.83
1200	175.39	265.24	115.55	149.70	-2130.3	-1686.2	73.39
1300	176.61	279.33	120.20	159.13	-2128.7	-1649.2	66.27
1400	177.57	292.46	124.26	168.19	-2127.2	-1612.4	60.16
1500	178.39	304.74	127.85	176.89	-2125.9	-1575.7	54.87
1600	179.13	316.27	131.03	185.25	-2153.9	-1538.3	50.22
1700	179.88	327.15	133.88	193.28	-2202.4	-1499.4	46.07
1800	180.68	337.46	136.46	201.00	-2200.6	-1458.0	42.31

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 12.16 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.718 $J\cdot bar^{-1}$

37.18 cm^3

A= -2.135E+03 B= 3.744E-01 C= -4.46E+05

7/22/92

BERYL **Formula wt 537.502**

$Be_3Al_2(Si_6O_{18})$: **Hexagonal crystals 298.15 to 1800 K.**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	417.00	346.70	0.00	346.71	-9006.6	-8500.5	1489.21
300	419.01	349.29	2.58	346.71	-9006.7	-8497.3	1479.48
400	507.82	482.86	118.55	364.32	-9010.0	-8326.9	1087.35
500	567.30	603.00	202.73	400.26	-9008.6	-8156.2	852.05
600	608.30	710.27	267.11	443.16	-9004.7	-7986.0	695.23
700	637.50	806.36	318.05	488.31	-8999.1	-7816.7	583.27
800	659.03	892.96	359.39	533.56	-8992.8	-7648.1	499.36
900	675.52	971.57	393.64	577.93	-8986.1	-7480.5	434.14
1000	688.78	1043.45	422.51	620.94	-9000.6	-7312.1	381.93
1100	700.03	1109.64	447.24	662.40	-8993.5	-7143.5	339.21
1200	710.19	1170.99	468.73	702.26	-8986.1	-6975.7	303.64
1300	719.89	1228.22	487.68	740.54	-8978.7	-6808.5	273.56
1400	729.66	1281.93	504.61	777.31	-8971.1	-6641.9	247.81
1500	739.86	1332.61	519.95	812.66	-8963.4	-6475.7	225.50
1600	750.81	1380.71	534.04	846.67	-8999.0	-6309.0	205.96
1700	762.75	1426.58	547.13	879.44	-9290.5	-6138.4	188.60
1800	775.87	1470.54	559.47	911.07	-9278.7	-5953.2	172.75

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 64.43 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 20.33 $J\cdot bar^{-1}$

203.3 cm^3

A= -8.995E+03 B= 1.683E+00 C= -6.74E+05

7/22/92

BERTRANDITE **Formula wt 238.230**

$Be_4Si_2O_7(OH)_2$: Crystals 298.15 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	224.64	172.10	0.00	172.10	-4580.5	-4295.1	752.46
300	225.83	173.49	1.39	172.10	-4580.6	-4293.3	747.51
400	279.83	246.33	64.67	181.67	-4582.9	-4197.1	548.07
500	317.42	313.06	111.68	201.38	-4582.4	-4100.6	428.38
600	344.16	373.43	148.32	225.11	-4580.2	-4004.5	348.61
700	363.51	428.01	177.75	250.26	-4576.7	-3908.8	291.67
800	377.60	477.52	201.90	275.63	-4572.5	-3813.6	249.00
900	387.80	522.62	222.02	300.60	-4568.1	-3719.0	215.84
1000	395.06	563.88	238.98	324.90	-4563.5	-3624.9	189.34
1100	400.01	601.78	253.41	348.37	-4559.1	-3531.3	167.68
1200	403.13	636.73	265.77	370.96	-4555.0	-3438.0	149.65
1300	404.76	669.07	276.41	392.67	-4551.4	-3345.1	134.41
1400	405.16	699.09	285.60	413.49	-4548.3	-3252.4	121.35

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	9.179 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	31.04 kJ		91.79 cm^3

A= -4.564E+03 B= 9.388E-01 C= -1.03E+06

7/29/92

LAWSONITE **Formula wt 314.238**

$CaAl_2Si_2O_7(OH)_2 \cdot H_2O$: Crystals 298.15 to 600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J \cdot mol^{-1} \cdot K^{-1}$			$kJ \cdot mol^{-1}$	
298.15	275.24	230.00	0.00	230.00	-4869.0	-4512.9	790.63
300	276.56	231.71	1.70	230.01	-4869.1	-4510.7	785.37
400	331.03	319.37	77.78	241.59	-4871.0	-4390.9	573.38
500	368.81	397.47	132.37	265.10	-4869.7	-4270.9	446.17
600	400.03	467.54	174.43	293.10	-4866.0	-4151.5	361.41

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 41.36 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 10.132 $J \cdot bar^{-1}$

101.32 cm^3

A= -4.869E+03 B= 1.196E+00 C= -7.02E+04

7/29/92

GEHLENITE **Formula wt 274.200**

$Ca_2Al_2SiO_7$: Tetragonal crystals 298.15 to incongruent melting point at 1866 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	206.40	210.10	0.00	210.10	-3985.0	-3785.5	663.19
300	207.12	211.38	1.28	210.10	-3985.0	-3784.3	658.88
400	236.74	275.39	56.76	218.63	-3985.5	-3717.2	485.41
500	255.45	330.37	94.75	235.62	-3984.6	-3650.2	381.33
600	268.56	378.16	122.69	255.48	-3983.2	-3583.5	311.96
700	278.34	420.33	144.25	276.08	-3981.6	-3517.0	262.44
800	285.95	458.01	161.51	296.50	-3981.9	-3450.5	225.29
900	292.04	492.06	175.69	316.37	-3980.8	-3384.2	196.41
1000	297.04	523.09	187.58	335.52	-4001.6	-3316.4	173.23
1100	301.21	551.61	197.73	353.88	-4001.2	-3247.9	154.23
1200	304.73	577.97	206.50	371.47	-4016.6	-3178.2	138.34
1300	307.74	602.48	214.17	388.31	-4014.6	-3108.3	124.89
1400	310.33	625.39	220.95	404.43	-4012.6	-3038.8	113.38
1500	312.57	646.88	226.99	419.89	-4010.3	-2969.3	103.40
1600	314.53	667.11	232.40	434.71	-4008.1	-2900.0	94.67
1700	316.24	686.23	237.28	448.95	-4055.9	-2830.3	86.96
1800	317.74	704.35	241.71	462.64	-4350.6	-2753.9	79.91

Melting T 1866 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 33.21 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 9.015 $J\cdot bar^{-1}$

90.15 cm^3

A= -4.005E+03 B= 6.909E-01 C= 1.392E+06

7/22/92

ZOISITE Formula wt 454.357

$Ca_2Al_3Si_3O_{12}(OH)$: Orthorhombic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	350.34	295.85	0.00	295.85	-6901.1	-6504.5	1139.54
300	351.83	298.02	2.17	295.86	-6901.2	-6502.1	1132.08
400	412.84	408.40	97.91	310.49	-6902.5	-6368.7	831.65
500	450.20	504.83	164.89	339.94	-6900.8	-6235.4	651.39
600	476.35	589.34	214.73	374.61	-6897.7	-6102.6	531.27
700	497.24	664.38	253.63	410.74	-6893.8	-5970.4	445.51
800	516.12	732.02	285.28	446.74	-6891.2	-5838.5	381.21
900	534.93	793.89	311.96	481.93	-6886.4	-5707.2	331.23
1000	554.92	851.27	335.25	516.02	-6913.1	-5574.3	291.16
1100	576.93	905.17	356.20	548.97	-6906.3	-5440.7	258.35
1200	601.55	956.41	375.60	580.81	-6914.2	-5306.5	230.98

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 13.65 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 52.07 kJ 136.5 cm^3

A= -6.898E+03 B= 1.325E+00 C= -1.37E+05

7/22/92

GROSSULAR Formula wt 450.446

$Ca_3Al_2Si_3O_{12}$: Cubic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	330.22	260.12	0.00	260.12	-6640.0	-6278.5	1099.94
300	331.57	262.17	2.04	260.13	-6640.1	-6276.2	1092.77
400	389.70	366.16	92.25	273.91	-6640.8	-6154.7	803.71
500	425.80	457.32	155.64	301.68	-6638.6	-6033.4	630.29
600	448.43	537.11	202.69	334.41	-6635.3	-5912.7	514.73
700	463.30	607.42	238.93	368.49	-6631.6	-5792.6	432.24
800	474.02	670.02	267.67	402.34	-6630.9	-5672.6	370.37
900	482.99	726.37	291.11	435.27	-6628.0	-5553.0	322.28
1000	491.81	777.71	310.73	466.98	-6647.1	-5432.2	283.74
1100	501.62	825.04	327.63	497.41	-6645.2	-5310.8	252.18
1200	513.24	869.17	342.60	526.57	-6666.7	-5187.7	225.81

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 47.66 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 12.528 $J\cdot bar^{-1}$

125.28 cm^3

A= -6.637E+03 B= 1.206E+00 C= -1.07E+05

7/22/92

DATOLITE **Formula wt 159.979**

$CaB(Si_4)OH$: Crystals 298.15 to 1000 K. Datolite decomposes in air at about 970 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	127.41	110.20	0.00	110.20	-2477.8	-2318.1	406.12
300	127.95	110.99	0.79	110.20	-2477.8	-2317.1	403.44
400	153.07	151.41	35.87	115.54	-2478.7	-2263.4	295.56
500	172.25	187.72	61.31	126.41	-2478.3	-2209.6	230.83
600	187.00	220.49	81.08	139.41	-2477.0	-2155.9	187.69
700	198.17	250.20	97.05	153.14	-2475.0	-2102.6	156.89
800	206.23	277.22	110.23	166.99	-2473.6	-2049.4	133.81
900	211.49	301.84	121.21	180.63	-2471.1	-1996.6	115.87
1000	214.12	324.28	130.39	193.89	-2468.9	-1944.0	101.54

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	5.332 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	19.25 kJ		53.32 cm^3

A= -2.473E+03 B= 5.301E-01 C= -2.53E+05

7/22/92

ILVAITE **Formula wt 408.793**

$CaFe_3Si_2O_7O(OH)$: Monoclinic crystals 298.15 to 900 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	298.90	292.30	0.00	292.30	-3692.8	-3437.0	602.13
300	299.90	294.20	1.85	292.35	-3692.8	-3435.4	598.15
400	343.40	387.70	83.02	304.68	-3689.7	-3350.0	437.45
500	362.50	466.50	137.00	329.50	-3685.5	-3265.6	341.14
600	380.90	534.20	176.10	358.10	-3681.0	-3182.0	277.01
700	398.50	594.30	206.70	387.60	-3676.1	-3099.2	231.26
800	408.10	648.10	213.20	434.90	-3686.8	-3031.4	197.93
900	417.80	696.70	251.40	445.30	-3668.6	-2935.3	170.36

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	10.107 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	48.09 kJ		101.07 cm^3

A= -3.664E+03 B= 8.052E-01 C= -1.20E+06

3/5/93

ANDRADITE **Formula wt 508.177**

$Ca_3Fe_2Si_3O_{12}$: Cubic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	351.88	316.40	0.00	316.40	-5771.0	-5427.0	950.77
300	353.17	318.58	2.17	316.41	-5771.0	-5424.9	944.53
400	406.71	428.17	97.19	330.99	-5770.1	-5309.5	693.33
500	440.29	522.80	162.68	360.11	-5766.8	-5194.7	542.67
600	462.94	605.20	210.95	394.24	-5762.7	-5080.7	442.30
700	478.83	677.82	248.15	429.67	-5758.5	-4967.3	370.66
800	490.20	742.55	277.74	464.81	-5757.4	-4854.2	316.94
900	498.37	800.78	301.82	498.96	-5754.7	-4741.5	275.18
1000	504.17	853.61	321.78	531.83	-5754.2	-4629.0	241.79

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 53.49 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 13.204 $J\cdot bar^{-1}$

132.04 cm^3

A= -5.756E+03 B= 1.128E+00 C= -6.85E+05

7/22/92

MONTICELLITE **Formula wt 156.466**

$CaMgSiO_4$: Orthorhombic crystals 298.15 to 1100 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	123.00	108.10	0.00	108.10	-2251.0	-2132.8	373.64
300	123.46	108.86	0.76	108.10	-2251.0	-2132.0	371.21
400	141.90	147.16	33.96	113.20	-2250.9	-2092.3	273.23
500	153.07	180.11	56.75	123.37	-2249.9	-2052.8	214.45
600	160.69	208.73	73.47	135.26	-2248.6	-2013.5	175.29
700	166.26	233.94	86.35	147.60	-2247.3	-1974.4	147.33
800	170.53	256.44	96.61	159.82	-2246.8	-1935.4	126.37
900	173.91	276.72	105.02	171.70	-2245.6	-1896.6	110.07
1000	176.64	295.19	112.05	183.14	-2253.2	-1857.2	97.01
1100	178.88	312.14	118.03	194.11	-2252.7	-1817.6	86.31

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	5.13 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	18.76 kJ		51.3 cm^3

A= -2.248E+03 B= 3.910E-01 C= -1.25E+05

7/22/92

AKERMANITE **Formula wt 272.628**

$Ca_2MgSi_2O_7$: Tetragonal crystals 298.15 to melting point at 1731 K. A small transition at 357.9 K has an enthalpy of 0.68 kJ.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	214.10	212.50	0.00	212.50	-3864.8	-3667.5	642.52
300	214.79	213.83	1.32	212.50	-3864.8	-3666.3	638.35
400	239.88	281.42	58.23	223.19	-3864.4	-3600.9	470.22
500	253.60	336.53	96.03	240.50	-3863.1	-3535.2	369.31
600	263.63	383.69	123.16	260.53	-3861.7	-3469.8	302.06
700	272.19	424.98	143.85	281.13	-3860.3	-3404.6	254.05
800	280.00	461.84	160.38	301.46	-3860.8	-3339.3	218.03
900	287.32	495.25	174.08	321.16	-3859.7	-3274.2	190.03
1000	294.24	525.88	185.76	340.12	-3867.4	-3208.5	167.59
1100	300.75	554.23	195.92	358.32	-3866.9	-3142.6	149.23
1200	306.85	580.67	204.91	375.76	-3882.1	-3075.6	133.87
1300	312.52	605.46	212.97	392.48	-3879.6	-3008.5	120.88
1400	317.73	628.81	220.27	408.54	-4004.1	-2938.5	109.63
1500	322.45	650.84	226.93	423.96	-3999.6	-2862.5	99.68
1600	326.68	671.84	233.03	438.81	-3994.8	-2786.8	90.98
1700	330.38	691.76	238.65	453.11	-4090.1	-2710.5	83.28
1800	382.00	784.60	315.23	469.37	-4253.3	-2629.6	76.31

Melting T 1731 K

Boiling T K

$\Delta_{fus}H^\circ$ 124.5 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 34.91 kJ

Molar Vol. 9.254 $J\cdot bar^{-1}$
92.54 cm^3

A= -3.904E+03 B= 6.968E-01 C= 2.903E+06

7/22/92

MERWINITE **Formula wt 328.705**

$Ca_3Mg(SiO_4)_2$: Monoclinic crystals 298.15 to 1600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	252.36	253.10	0.00	253.10	-4536.2	-4307.7	754.67
300	253.18	254.66	1.56	253.10	-4536.2	-4306.2	749.77
400	286.77	332.55	69.05	263.50	-4535.6	-4229.6	552.32
500	306.89	398.87	114.76	284.11	-4533.6	-4153.3	433.89
600	320.06	456.07	147.95	308.12	-4531.2	-4077.5	354.97
700	329.37	506.14	173.24	332.90	-4528.9	-4002.1	298.63
800	336.54	550.61	193.22	357.39	-4529.6	-3926.6	256.38
900	342.58	590.60	209.49	381.12	-4528.1	-3851.4	223.52
1000	348.15	626.99	223.08	403.91	-4535.9	-3775.5	197.21
1100	353.67	660.43	234.70	425.73	-4535.9	-3699.5	175.67
1200	359.46	691.45	244.85	446.60	-4559.8	-3621.6	157.64
1300	365.75	720.46	253.90	466.56	-4557.3	-3543.5	142.38
1400	372.69	747.82	262.14	485.68	-4681.7	-3462.5	129.18
1500	380.42	773.79	269.76	504.03	-4676.9	-3375.5	117.54
1600	389.04	798.61	276.94	521.67	-4671.4	-3288.9	107.37

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 9.85 $J\cdot bar^{-1}$

98.5 cm^3

A= -4.557E+03 B= 7.840E-01 C= 1.573E+06

7/22/92

TITANITE (SPHENE) **Formula wt 196.041**

$CaTiSiO_5$: Monoclinic crystals 298.15 to 1670 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	138.91	129.20	0.00	129.20	-2596.6	-2454.6	430.03
300	139.51	130.06	0.86	129.20	-2596.6	-2453.8	427.23
400	161.30	173.58	38.59	134.99	-2596.2	-2406.2	314.20
500	172.66	210.90	64.37	146.54	-2594.9	-2358.8	246.42
600	179.92	243.07	83.06	160.01	-2593.3	-2311.7	201.25
700	185.25	271.22	97.29	173.93	-2591.6	-2264.9	169.01
800	189.54	296.24	108.56	187.68	-2590.9	-2218.3	144.83
900	193.24	318.79	117.77	201.02	-2589.3	-2171.8	126.04
1000	196.56	339.32	125.49	213.83	-2588.0	-2125.4	111.02
1100	199.64	358.20	132.09	226.11	-2587.1	-2079.2	98.73
1200	202.55	375.70	137.84	237.86	-2598.2	-2032.3	88.46
1300	205.34	392.02	142.93	249.10	-2596.0	-1985.3	79.77
1400	208.05	407.34	147.48	259.86	-2593.7	-1938.4	72.32
1500	210.70	421.78	151.61	270.17	-2591.3	-1891.7	65.87
1600	213.30	435.47	155.38	280.08	-2588.9	-1845.1	60.23

Melting T 1670 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 5.574 $J\cdot bar^{-1}$

55.74 cm^3

A= -2.591E+03 B= 4.661E-01 C= -2.27E+05

7/22/92

LARNITE **Formula wt 172.239**

α-Ca_2SiO_4: Monoclinic crystals 298.15 to 1000 K. Bredigite (α') is the stable modification of Ca_2SiO_4 between 970 and 1710 K. α-crystals 1710 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	128.59	127.60	0.00	127.60	-2306.7	-2191.2	383.88
300	128.97	128.40	0.79	127.60	-2306.7	-2190.5	381.39
400	145.20	167.89	35.02	132.88	-2306.3	-2151.8	280.99
500	156.15	201.54	58.21	143.33	-2305.1	-2113.3	220.77
600	164.18	230.76	75.24	155.52	-2303.6	-2075.1	180.65
700	170.37	256.55	88.40	168.15	-2302.1	-2037.1	152.01
800	175.34	279.63	98.97	180.66	-2302.4	-1999.2	130.53
900	179.44	300.53	107.69	192.84	-2301.1	-1961.4	113.83
1000	180.66	319.64	115.05	204.59	-2300.1	-1923.7	100.48
1100	185.28	337.21	121.35	215.86	-2299.6	-1886.1	89.56
1200	189.89	353.50	126.84	226.66	-2315.0	-1847.2	80.41
1300	194.50	368.67	131.66	237.01	-2313.0	-1808.3	72.66
1400	199.11	382.87	135.95	246.92	-2310.8	-1769.6	66.02
1500	203.72	396.23	139.79	256.44	-2308.6	-1731.0	60.28
1600	208.33	408.83	143.26	265.57	-2306.3	-1692.6	55.26
1700	212.94	420.76	146.41	274.35	-2354.1	-1653.8	50.81
1800	205.02	444.84	160.60	284.24	-2628.4	-1610.9	46.75

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 5.16 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 51.6 cm^3

A= -2.308E+03 B= 3.850E-01 C= 2.243E+05

7/22/92

CALCIO-OLIVINE **Formula wt 172.239**

γ-Ca_2SiO_4: Orthorhombic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	126.93	120.50	0.00	120.50	-2316.5	-2198.9	385.23
300	127.29	121.29	0.78	120.50	-2316.5	-2198.2	382.73
400	141.80	160.08	34.39	125.69	-2316.3	-2158.7	281.90
500	151.34	192.80	56.87	135.93	-2315.5	-2119.4	221.41
600	158.91	221.08	73.26	147.82	-2314.6	-2080.3	181.10
700	165.57	246.09	85.98	160.10	-2313.6	-2041.3	152.32
800	171.73	268.60	96.32	172.28	-2314.3	-2002.3	130.73
900	177.61	289.17	105.03	184.14	-2313.3	-1963.3	113.95
1000	183.31	308.18	112.57	195.61	-2312.4	-1924.5	100.52
1100	188.89	325.91	119.26	206.66	-2311.7	-1885.7	89.54
1200	194.39	342.58	125.29	217.30	-2326.7	-1845.8	80.34

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 5.801 $J\cdot bar^{-1}$

58.01 cm^3

A= -2.314E+03 B= 3.898E-01 C= -9.84E+04

7/22/92

HATURITE (ALITE) **Formula wt 228.317**

Ca_3SiO_5: Triclinic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	171.59	168.60	0.00	168.60	-2933.1	-2786.5	488.17
300	172.08	169.66	1.06	168.60	-2933.1	-2785.6	485.00
400	193.33	222.31	46.67	175.64	-2932.2	-2736.5	357.34
500	207.61	267.07	77.51	189.56	-2930.3	-2687.8	280.78
600	218.01	305.89	100.10	205.79	-2928.1	-2639.5	229.78
700	225.97	340.12	117.54	222.58	-2925.9	-2591.5	193.38
800	232.28	370.72	131.50	239.22	-2926.4	-2543.6	166.07
900	237.43	398.39	143.00	255.39	-2924.6	-2495.8	144.85
1000	241.72	423.63	152.66	270.97	-2923.3	-2448.3	127.88
1100	245.33	446.84	160.92	285.92	-2922.8	-2400.8	114.00
1200	248.43	468.33	168.09	300.24	-2946.1	-2351.5	102.35
1300	251.10	488.32	174.38	313.94	-2943.4	-2302.0	92.50
1400	253.43	507.01	179.94	327.07	-2940.4	-2252.8	84.05
1500	255.48	524.57	184.91	339.66	-2937.4	-2203.8	76.74
1600	257.28	541.12	189.38	351.74	-2934.4	-2155.0	70.35
1700	258.89	556.76	193.42	363.34	-2981.4	-2105.9	64.70
1800	260.31	571.60	197.10	374.51	-3424.0	-2048.0	59.43

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 7.274 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 72.74 cm^3

A= -2.936E+03 B= 4.891E-01 C= 4.480E+05

7/22/92

RANKINITE **Formula wt 288.401**

$Ca_3Si_2O_7$: Monoclinic crystals 298.15 to 1400 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	214.35	210.60	0.00	210.60	-3949.0	-3748.1	656.64
300	215.00	211.93	1.32	210.60	-3949.0	-3746.9	652.37
400	242.55	277.86	58.46	219.41	-3948.5	-3679.5	480.48
500	260.37	334.03	97.17	236.86	-3946.9	-3612.4	377.38
600	272.58	382.65	125.45	257.20	-3944.9	-3545.7	308.68
700	281.20	425.35	147.12	278.23	-3942.9	-3479.4	259.63
800	287.38	463.33	164.29	299.04	-3943.7	-3413.0	222.84
900	291.79	497.44	178.22	319.22	-3942.4	-3346.7	194.23
1000	294.89	528.36	189.74	338.61	-3941.8	-3280.6	171.36
1100	296.98	556.57	199.41	357.16	-3942.2	-3214.4	152.64
1200	298.27	582.47	207.60	374.88	-3966.7	-3146.4	136.95
1300	298.92	606.38	214.60	391.78	-3965.3	-3078.1	123.68
1400	299.05	628.54	220.63	407.91	-3964.2	-3009.9	112.30

Melting T 1633 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 9.651 $J\cdot bar^{-1}$
96.51 cm^3

A= -3.948E+03 B= 6.684E-01 C= 5.979E+04

7/22/92

ROSENHAHNITE **Formula wt 366.500**

$Ca_3Si_3O_8(OH)_2$: Triclinic crystals 298.15 to 1800 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	289.35	281.80	0.00	281.80	-5198.1	-4882.1	855.31
300	290.58	283.59	1.79	281.81	-5198.1	-4880.2	849.69
400	335.67	374.18	80.33	293.85	-5198.5	-4774.0	623.41
500	359.45	451.87	133.98	317.89	-5197.0	-4668.1	487.66
600	374.84	518.85	172.92	345.93	-5195.0	-4562.4	397.19
700	386.28	577.52	202.61	374.91	-5192.9	-4457.2	332.59
800	395.60	629.73	226.17	403.56	-5193.5	-4351.9	284.14
900	403.70	676.80	245.45	431.35	-5191.8	-4246.8	246.47
1000	411.03	719.72	261.65	458.07	-5190.7	-4141.9	216.35
1100	417.86	759.22	275.54	483.67	-5190.1	-4037.0	191.70
1200	424.36	795.86	287.68	508.18	-5213.4	-3930.4	171.08
1300	430.62	830.07	298.43	531.64	-5210.4	-3823.6	153.63
1400	436.70	862.21	308.09	554.12	-5207.2	-3717.0	138.68
1500	442.66	892.54	316.87	575.68	-5203.6	-3610.7	125.73
1600	448.52	921.30	324.91	596.39	-5199.8	-3504.6	114.41
1700	454.30	948.66	332.35	616.31	-5346.2	-3397.4	104.39
1800	460.02	974.79	339.29	635.50	-5787.1	-3276.3	95.07

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 12.646 $J\cdot bar^{-1}$

126.46 cm^3

A= -5.206E+03 B= 1.065E+00 C= 6.937E+05

7/22/92

SPURRITE **Formula wt 444.565**

$Ca_5(SiO_4)_2CO_3$: Crystals 298.15 to 1300 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	343.62	331.00	0.00	331.00	-5840.2	-5525.6	968.04
300	344.71	333.13	2.12	331.01	-5840.2	-5523.6	961.73
400	388.72	438.91	93.78	345.13	-5838.1	-5418.4	707.55
500	415.98	528.78	155.67	373.11	-5834.3	-5313.9	555.12
600	434.91	606.39	200.72	405.67	-5830.1	-5210.2	453.58
700	449.02	674.54	235.23	439.31	-5826.2	-5107.2	381.09
800	460.04	735.24	262.67	472.57	-5826.9	-5004.2	326.73
900	468.93	789.96	285.11	504.85	-5824.0	-4901.5	284.47
1000	476.30	839.76	303.87	535.89	-5822.2	-4799.1	250.68
1100	482.51	885.45	319.84	565.62	-5821.7	-4696.9	223.03
1200	487.84	927.67	333.62	594.05	-5861.1	-4591.5	199.86
1300	492.46	966.91	345.66	621.24	-5857.1	-4485.9	180.24

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 14.697 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 146.97 cm^3

A= -5.829E+03 B= 1.031E+00 C= -3.84E+05

7/23/92

TILLEYITE **Formula wt 488.575**

$Ca_5Si_2O_7(CO_3)_2$: Monoclinic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	383.49	394.00	0.00	394.00	-6372.2	-6013.5	1053.52
300	384.73	396.38	2.37	394.01	-6372.2	-6011.3	1046.63
400	436.64	514.78	104.98	409.80	-6369.6	-5891.3	769.30
500	470.37	616.07	174.89	441.17	-6365.1	-5772.2	603.00
600	494.50	704.07	226.25	477.82	-6360.0	-5654.1	492.22
700	512.82	781.73	265.94	515.80	-6354.9	-5536.8	413.15
800	527.33	851.19	297.74	553.46	-6354.4	-5419.8	353.87
900	539.15	914.01	323.92	590.08	-6350.0	-5303.2	307.78
1000	549.01	971.34	345.95	625.38	-6346.6	-5187.1	270.94
1100	557.38	1024.07	364.80	659.26	-6344.4	-5071.3	240.81
1200	564.58	1072.88	381.16	691.72	-6382.0	-4952.5	215.57

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	17.050 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		170.50 cm^3

A= -6.351E+03 B= 1.165E+00 C= -8.90E+05

01/07/93

COBALT-OLIVINE **Formula wt 209.950**

Co_2SiO_4: Orthorhombic crystals 298.15 to 1300 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	133.41	142.60	0.00	142.60	-1412.0	-1308.7	229.27
300	133.83	143.43	0.82	142.60	-1412.0	-1308.0	227.74
400	151.48	184.55	36.46	148.09	-1410.8	-1273.5	166.30
500	162.81	219.65	60.67	158.98	-1409.0	-1239.4	129.47
600	170.44	250.05	78.37	171.68	-1406.8	-1205.7	104.96
700	175.73	276.75	91.92	184.82	-1404.5	-1172.4	87.48
800	179.40	300.47	102.64	197.83	-1403.1	-1139.2	74.38
900	181.91	321.75	111.32	210.43	-1401.1	-1106.3	64.21
1000	183.55	341.01	118.47	222.54	-1399.5	-1073.7	56.08
1100	184.52	358.56	124.43	234.12	-1398.4	-1041.1	49.44

Melting T	1693 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	4.449 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	22.52 kJ		44.49 cm^3

A= -1.401E+03 B= 3.282E-01 C= -4.72E+05

7/22/92

FAYALITE **Formula wt 203.777**

Fe_2SiO_4: Orthorhombic crystals 298.15 to 1490 K. Fayalite melts incongruently at 1490 K. Liquid 1490 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	131.84	151.00	0.00	151.00	-1478.2	-1379.1	241.61
300	132.39	151.82	0.81	151.00	-1478.2	-1378.5	240.02
400	152.14	192.99	36.51	156.48	-1477.1	-1345.4	175.69
500	162.24	228.12	60.73	167.39	-1475.5	-1312.7	137.13
600	168.83	258.31	78.23	180.09	-1473.8	-1280.3	111.45
700	174.03	284.74	91.55	193.19	-1472.3	-1248.1	93.14
800	178.71	308.29	102.16	206.13	-1471.0	-1216.2	79.41
900	183.31	329.60	110.92	218.68	-1470.4	-1184.4	68.74
1000	188.03	349.16	118.39	230.77	-1470.9	-1152.6	60.21
1100	193.02	367.31	124.95	242.36	-1472.9	-1120.7	53.21
1200	198.33	384.33	130.84	253.49	-1473.0	-1088.7	47.39
1300	204.03	400.43	136.25	264.18	-1469.6	-1056.8	42.46
1400	210.14	415.77	141.30	274.46	-1466.0	-1025.2	38.25
1500	240.60	490.58	205.80	284.78	-1372.5	-994.4	34.63
1600	240.60	506.10	207.98	298.12	-1366.1	-969.4	31.65
1700	240.60	520.68	209.89	310.79	-1412.0	-944.3	29.01
1800	240.60	534.43	211.60	322.83	-1406.7	-916.9	26.61

Melting T	1490 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	89.3 kJ		
		Molar Vol.	4.631 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	22.49 kJ		46.31 cm3

A= -1.457E+03 B= 3.049E-01 C= -1.30E+06

7/22/92

ALMANDINE **Formula wt 497.753**

$Fe_3Al_2Si_3O_{12}$: Cubic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	343.29	342.60	0.00	342.60	-5264.7	-4941.9	865.79
300	344.49	344.73	2.12	342.61	-5264.7	-4939.9	860.10
400	396.60	451.51	94.70	356.81	-5264.5	-4831.6	630.93
500	431.35	543.98	158.77	385.21	-5262.0	-4723.6	493.46
600	455.57	624.89	206.33	418.56	-5258.5	-4616.2	401.87
700	472.90	696.49	243.24	453.25	-5254.6	-4509.5	336.50
800	485.47	760.51	272.78	487.73	-5251.0	-4403.3	287.50
900	494.57	818.24	296.94	521.30	-5248.4	-4297.5	249.42
1000	501.06	870.71	317.05	553.66	-5269.5	-4190.5	218.88
1100	505.54	918.69	334.00	584.69	-5271.4	-4082.4	193.85
1200	508.42	962.81	348.42	614.39	-5271.3	-3974.4	173.00

Melting T	1683 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	11.532 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	52.74 kJ		115.32 cm^3

A= -5.257E+03 B= 1.068E+00 C= -3.13E+05

4/6/93

CORDIERITE **Formula wt 584.953**

$Mg_2Al_3(AlSi_5O_{18})$: Orthorhombic crystals 298.15 to 1700 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	443.28	407.20	0.00	407.20	-9161.5	-8651.1	1515.61
300	445.39	409.95	2.74	407.21	-9161.6	-8648.0	1505.71
400	528.32	550.66	124.83	425.83	-9164.9	-8476.1	1106.84
500	577.52	674.23	210.80	463.43	-9164.2	-8303.9	867.48
600	611.37	782.68	274.89	507.79	-9161.6	-8132.1	707.94
700	636.90	878.92	324.86	554.06	-9157.8	-7960.8	594.03
800	657.37	965.35	365.18	600.16	-9153.5	-7790.1	508.63
900	674.50	1043.79	398.63	645.16	-9149.2	-7619.9	442.24
1000	689.32	1115.64	426.97	688.67	-9204.5	-7445.9	388.92
1100	702.43	1181.97	451.43	730.54	-9199.3	-7270.2	345.22
1200	714.27	1243.60	472.84	770.76	-9193.4	-7095.1	308.83
1300	725.11	1301.21	491.84	809.37	-9186.9	-6920.4	278.06
1400	735.16	1355.32	508.86	846.45	-9434.8	-6740.2	251.48
1500	744.56	1406.36	524.27	882.09	-9424.6	-6548.0	228.02
1600	753.44	1454.70	538.31	916.38	-9414.0	-6356.6	207.52
1700	761.87	1500.63	551.22	949.41	-9653.8	-6163.4	189.37

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ Molar Vol. 23.322 $J\cdot bar^{-1}$ 233.22 cm^3

A= -9.227E+03 B= 1.785E+00 C= 4.350E+06

7/22/92

FORSTERITE **Formula wt 140.693**

Mg_2SiO_4: **Orthorhombic crystals 298.15 to 1800 K.**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	118.61	94.11	0.00	94.11	-2173.0	-2053.6	359.78
300	119.10	94.85	0.73	94.11	-2173.0	-2052.9	357.43
400	137.71	131.97	32.92	99.05	-2173.2	-2012.8	262.84
500	148.28	163.92	55.01	108.91	-2172.6	-1972.7	206.09
600	155.77	191.65	71.21	120.44	-2171.6	-1932.9	168.27
700	161.75	216.12	83.73	132.39	-2170.5	-1893.2	141.27
800	166.83	238.06	93.81	144.25	-2169.2	-1853.6	121.03
900	171.25	257.97	102.17	155.80	-2167.9	-1814.2	105.29
1000	175.14	276.22	109.28	166.94	-2183.8	-1773.6	92.64
1100	178.56	293.08	115.42	177.65	-2182.7	-1732.6	82.27
1200	181.54	308.74	120.81	187.93	-2181.3	-1691.8	73.64
1300	184.08	323.38	125.58	197.79	-2179.8	-1651.1	66.34
1400	186.21	337.10	129.84	207.26	-2433.0	-1604.2	59.85
1500	187.92	350.01	133.66	216.35	-2428.5	-1545.1	53.80
1600	189.21	362.18	137.09	225.09	-2424.0	-1486.3	48.52
1700	190.08	373.68	140.19	233.49	-2469.7	-1427.4	43.86
1800	190.53	384.56	142.97	241.59	-2465.0	-1366.2	39.64

Melting T	2163 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	4.365 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	17.22 kJ		43.65 cm^3

A= -2.240E+03 B= 4.675E-01 C= 4.724E+06

7/22/92

PYROPE **Formula wt 403.127**

$Mg_3Al_2Si_3O_{12}$: Cubic crystals 298.15 to 1570 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	325.76	266.27	0.00	266.27	-6285.0	-5934.5	1039.67
300	327.12	268.29	2.01	266.28	-6285.1	-5932.3	1032.88
400	383.71	370.83	90.96	279.87	-6286.1	-5814.4	759.27
500	419.39	460.56	153.33	307.24	-6284.3	-5696.7	595.12
600	443.59	539.30	199.81	339.49	-6280.9	-5579.5	485.72
700	460.82	609.04	235.93	373.11	-6276.9	-5462.9	407.64
800	473.55	671.45	264.87	406.57	-6272.6	-5346.9	349.11
900	483.27	727.81	288.62	439.19	-6268.5	-5231.4	303.62
1000	490.92	779.14	308.49	470.65	-6311.8	-5112.8	267.06
1100	497.14	826.23	325.36	500.87	-6308.0	-4993.0	237.09
1200	502.37	869.72	339.90	529.82	-6304.0	-4873.7	212.14
1300	506.94	910.11	352.58	557.54	-6299.9	-4754.6	191.04
1400	511.10	947.84	363.75	584.08	-6678.0	-4626.6	172.62
1500	515.01	983.23	373.71	609.52	-6669.6	-4480.3	156.01

Melting T 1570 K

Boiling T K

$\Delta_{fus}H^\circ$ 241.0 kJ

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 11.312 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 47.85 kJ

113.12 cm^3

A= -6.316E+03 B= 1.208E+00 C= 2.167E+06

7/22/92

GLASS Formula wt 403.127

$Mg_3Al_2Si_3O_{12}$: Glass 298.15 to glass transition 1020 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	387.18	346.30	0.00	346.3	-6163.0	-5836.3	1022.48
300	387.83	348.70	2.39	346.3	-6162.9	-5834.3	1015.82
400	416.67	464.47	102.57	361.9	-6159.5	-5725.2	747.62
500	437.98	559.83	167.61	392.2	-6155.1	-5617.2	586.81
600	455.32	641.26	214.16	427.1	-6150.3	-5510.0	479.68
700	470.25	712.60	249.70	462.9	-6145.2	-5403.7	403.22
800	483.61	776.28	278.12	498.2	-6140.0	-5298.2	345.93
900	495.85	833.95	301.64	532.3	-6134.8	-5193.2	301.40
1000	507.28	886.79	321.64	565.2	-6176.6	-5085.3	265.62

Melting T 1570 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 50.09 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 14.61 $J\cdot bar^{-1}$

146.1 cm^3

A= -6.143E+03 B= 1.058E+00 C= -7.88E+05

10/15/92

TEPHROITE **Formula wt 201.959**

Mn_2SiO_4: Orthorhombic crystals 298.15 to 1524 K. Tephroite melts incongruently at 1524 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	128.74	155.90	0.00	155.90	-1731.5	-1631.0	285.73
300	129.11	156.70	0.80	155.90	-1731.5	-1630.3	283.86
400	144.89	196.18	35.00	161.18	-1731.3	-1596.6	208.49
500	155.22	229.69	58.08	171.62	-1730.4	-1563.0	163.29
600	162.48	258.67	74.90	183.76	-1729.5	-1529.7	133.17
700	167.82	284.14	87.82	196.32	-1728.4	-1496.4	111.66
800	171.86	306.82	98.08	208.74	-1727.5	-1463.4	95.55
900	174.96	327.25	106.46	220.79	-1726.6	-1430.4	83.02
1000	177.38	345.82	113.43	232.38	-1730.3	-1397.4	72.99
1100	179.27	362.81	119.34	243.48	-1729.8	-1364.2	64.78
1200	180.74	378.48	124.39	254.08	-1729.2	-1331.0	57.93
1300	181.87	392.99	128.77	264.22	-1728.7	-1297.8	52.15
1400	182.73	406.50	132.60	273.90	-1732.9	-1264.6	47.18
1500	183.36	419.13	135.96	283.17	-1737.6	-1230.8	42.86

Melting T	1524 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	4.899 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	22.35 kJ		48.99 cm^3

A= -1.730E+03 B= 3.321E-01 C= -3.65E+04

7/22/92

LIEBENBERGITE **Formula wt 209.463**

Ni_2SiO_4: Orthorhombic crystals 298.15 to 1300 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	123.07	128.10	0.00	128.10	-1396.5	-1288.9	225.81
300	123.50	128.86	0.76	128.10	-1396.5	-1288.3	224.30
400	141.96	167.13	33.93	133.19	-1396.7	-1252.1	163.51
500	153.93	200.18	56.82	143.36	-1396.1	-1216.1	127.04
600	162.20	229.02	73.73	155.29	-1395.6	-1180.1	102.73
700	168.12	254.49	86.81	167.68	-1394.7	-1144.2	85.38
800	172.44	277.24	97.26	179.98	-1393.0	-1109.5	72.44
900	175.61	297.74	105.80	191.94	-1391.2	-1073.1	62.28
1000	177.93	316.37	112.90	203.47	-1389.4	-1037.9	54.21
1100	179.60	333.41	118.89	214.52	-1387.7	-1002.8	47.62
1200	180.74	349.09	124.00	225.09	-1386.2	-967.9	42.13
1300	181.48	363.59	128.40	235.19	-1384.8	-933.1	37.49

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	4.257 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	19.72 kJ		42.57 cm^3

A= -1.391E+03 B= 3.528E-01 C= -3.04E+05

7/22/92

Ni_2SiO_4-SPINEL Formula wt 209.463

Ni_2SiO_4: Cubic crystals 298.15 to 800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	120.73	124.10	0.00	124.10	-1389.7	-1280.9	224.41
300	121.36	124.85	0.75	124.10	-1389.7	-1280.3	222.91
400	143.89	163.28	34.09	129.19	-1389.8	-1243.7	162.41
500	155.08	196.71	57.28	139.43	-1389.1	-1207.3	126.12
600	161.80	225.63	74.18	151.45	-1388.5	-1171.0	101.94
700	166.42	250.93	87.05	163.89	-1387.7	-1134.8	84.68
800	169.91	273.39	97.19	176.20	-1386.2	-1099.7	71.80

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	3.981 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		39.81 cm^3

A= -1.385E+03 B= 3.578E-01 C= -2.19E+05

7/29/92

ZIRCON Formula wt 183.307

$ZrSiO_4$: Tetragonal crystals 298.15 to 1600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	98.64	84.03	0.00	84.03	-2034.2	-1919.7	336.32
300	99.03	84.64	0.61	84.03	-2034.2	-1919.0	334.12
400	115.51	115.58	27.45	88.14	-2034.0	-1880.6	245.58
500	126.03	142.57	46.18	96.39	-2032.9	-1842.4	192.47
600	133.27	166.23	60.13	106.10	-2031.3	-1804.4	157.08
700	138.46	187.18	70.97	116.21	-2029.5	-1766.7	131.83
800	142.28	205.93	79.65	126.28	-2027.4	-1729.3	112.91
900	145.12	222.86	86.78	136.08	-2025.4	-1692.2	98.21
1000	147.25	238.27	92.72	145.54	-2023.4	-1655.3	86.46
1100	148.83	252.38	97.76	154.62	-2021.4	-1618.5	76.86
1200	149.97	265.38	102.06	163.32	-2023.2	-1581.8	68.85
1300	150.76	277.42	105.78	171.64	-2021.0	-1545.1	62.08
1400	151.28	288.61	109.01	179.60	-2018.8	-1508.6	56.28
1500	151.55	299.06	111.84	187.22	-2016.7	-1472.2	51.27
1600	151.63	308.84	114.33	194.52	-2014.8	-1436.0	46.88

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.926 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 39.26 cm^3

A= -2.023E+03 B= 3.674E-01 C= -6.21E+05

7/23/92

WOLLASTONITE **Formula wt 116.162**

$CaSiO_3$: Triclinic crystals 298.15 to 1400 K. Pseudowollastonite is stable above 1398 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	86.19	81.69	0.00	81.69	-1634.8	-1549.0	271.37
300	86.50	82.22	0.53	81.69	-1634.8	-1548.5	269.61
400	99.33	109.02	23.77	85.26	-1634.7	-1519.7	198.45
500	107.40	132.12	39.74	92.38	-1633.9	-1491.0	155.76
600	112.94	152.22	51.50	100.71	-1633.0	-1462.5	127.32
700	116.96	169.94	60.58	109.36	-1631.9	-1434.2	107.02
800	120.02	185.77	67.83	117.94	-1631.8	-1405.9	91.80
900	122.44	200.05	73.77	126.28	-1630.9	-1377.8	79.96
1000	124.42	213.06	78.74	134.32	-1630.1	-1349.7	70.50
1100	126.11	225.00	82.97	142.03	-1629.6	-1321.7	62.76
1200	127.60	236.03	86.63	149.41	-1637.1	-1293.1	56.28
1300	128.95	246.30	89.83	156.47	-1635.9	-1264.4	50.80
1400	130.22	255.90	92.67	163.23	-1634.7	-1235.9	46.11

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 13.84 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.990 $J\cdot bar^{-1}$

39.90 cm^3

A= -1.632E+03 B= 2.827E-01 C= -1.12E+05

7/31/92

PSEUDOWOLLASTONITE **Formula wt 116.162**

$CaSiO_3$: Triclinic crystals 298.15 to melting point 1821 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	87.92	87.20	0.00	87.20	-1627.6	-1543.5	270.40
300	88.20	87.74	0.54	87.20	-1627.6	-1542.9	268.64
400	99.53	114.82	24.00	90.82	-1627.4	-1514.7	197.80
500	106.55	137.84	39.86	97.98	-1626.7	-1486.6	155.30
600	111.43	157.72	51.40	106.32	-1625.8	-1458.7	126.99
700	115.06	175.18	60.25	114.93	-1625.0	-1430.9	106.77
800	117.89	190.74	67.28	123.45	-1625.0	-1403.2	91.61
900	120.17	204.76	73.04	131.72	-1624.3	-1375.5	79.83
1000	122.06	217.52	77.85	139.67	-1623.8	-1347.8	70.40
1100	123.65	229.23	81.94	147.29	-1623.6	-1320.3	62.69
1200	125.01	240.05	85.48	154.57	-1631.3	-1292.1	56.24
1300	126.19	250.10	88.56	161.54	-1630.4	-1263.8	50.78
1400	127.23	259.49	91.29	168.21	-1629.4	-1235.7	46.10
1500	128.14	268.30	93.72	174.59	-1628.4	-1207.6	42.05
1600	128.95	276.60	95.89	180.71	-1627.5	-1179.6	38.51
1700	129.68	284.44	97.86	186.58	-1676.7	-1145.1	35.37
1800	130.34	291.87	99.65	192.23	-1824.1	-1118.1	32.44

Melting T 1821 K — Boiling T K

$\Delta_{fus}H^\circ$ 57.3 kJ — $\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ — Molar Vol. 4.008 $J\cdot bar^{-1}$ / 40.08 cm^3

A= -1.629E+03 B= 2.815E-01 C= 1.853E+05

7/31/92

$CaSiO_3$ glass **Formula wt 116.162**

$CaSiO_3$: Glass 298.15 to 1821 K, melting point of pseudowollastonite.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	86.81	94.80	0.00	94.80	-1608.7	-1526.8	267.49
300	87.12	95.34	0.54	94.80	-1608.7	-1526.3	265.75
400	99.31	122.25	23.86	98.39	-1608.5	-1498.8	195.72
500	106.80	145.27	39.75	105.52	-1607.8	-1471.5	153.72
600	112.43	165.26	51.41	113.85	-1606.9	-1444.3	125.74
700	117.18	182.95	60.47	122.48	-1605.9	-1417.3	105.76
800	121.47	198.88	67.83	131.05	-1605.7	-1390.3	90.78
900	125.49	213.42	74.02	139.41	-1604.5	-1363.5	79.13
1000	129.34	226.85	79.36	147.49	-1603.4	-1336.8	69.82
1100	133.07	239.35	84.07	155.28	-1602.3	-1310.1	62.21
1200	136.74	251.09	88.31	162.78	-1609.0	-1283.0	55.85
1300	140.35	262.17	92.17	170.00	-1606.8	-1255.9	50.46
1400	143.92	272.70	95.74	176.96	-1604.3	-1229.0	45.85
1500	147.46	282.76	99.07	183.68	-1601.5	-1202.3	41.87
1600	150.99	292.38	102.21	190.18	-1598.5	-1175.8	38.39
1700	154.49	301.64	105.18	196.46	-1645.3	-1149.0	35.30
1800	157.98	310.57	108.02	202.56	-1790.2	-1117.8	32.44

Melting T	1821 K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
$H_{298}^\circ-H_0^\circ$	14.20 kJ	Molar Vol.	4.013 $J\cdot bar^{-1}$
			40.13 cm^3

A= -1.606E+03 B= 2.698E-01 C= -6.93E+04

7/31/92

Ca-Al PYROXENE **Formula wt 218.123**

$CaAl_2SiO_6$: Monoclinic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	164.97	141.00	0.00	141.00	-3306.3	-3129.6	548.27
300	165.63	142.02	1.02	141.00	-3306.3	-3128.5	544.70
400	194.10	193.89	46.01	147.88	-3306.9	-3069.0	400.77
500	212.57	239.32	77.59	161.73	-3306.0	-3009.7	314.41
600	225.29	279.27	101.21	178.06	-3304.3	-2950.5	256.86
700	234.43	314.72	119.62	195.10	-3302.4	-2891.7	215.78
800	241.23	346.49	134.42	212.07	-3301.3	-2833.1	184.98
900	246.45	375.22	146.59	228.63	-3299.5	-2774.7	161.04
1000	250.58	401.40	156.79	244.61	-3319.2	-2715.0	141.81

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	6.357 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	24.40 kJ		63.57 cm^3

A= -3.303E+03 B= 5.877E-01 C= -1.73E+05

04/30/93

HEDENBERGITE **Formula wt 248.092**

$CaFeSi_2O_6$: Monoclinic crystals 298.15 to 1300 K. Decomposes at 1238 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	175.30	174.20	0.00	174.20	-2839.9	-2676.3	468.86
300	175.94	175.29	1.08	174.20	-2839.9	-2675.2	465.79
400	201.95	229.81	48.35	181.46	-2839.3	-2620.4	342.18
500	218.13	276.73	80.79	195.94	-2837.6	-2565.9	268.05
600	229.59	317.57	104.69	212.88	-2835.4	-2511.7	218.66
700	238.39	353.65	123.18	230.46	-2833.2	-2457.9	183.41
800	245.51	385.96	138.04	247.92	-2831.8	-2404.4	156.99
900	251.49	415.23	150.32	264.90	-2829.8	-2351.1	136.45
1000	256.67	442.00	160.71	281.29	-2828.6	-2298.0	120.03
1100	261.25	466.68	169.64	297.04	-2828.4	-2244.9	106.60
1200	265.37	489.59	177.45	312.14	-2835.2	-2191.3	95.38
1300	269.13	510.99	184.36	326.63	-2831.6	-2137.6	85.90

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	6.795 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	28.23 kJ		67.95 cm^3

A= -2.830E+03 B= 5.328E-01 C= -4.43E+05

7/31/92

DIOPSIDE **Formula wt 216.550**

$CaMgSi_2O_6$: Monoclinic crystals 298.15 to incongruent melting point at 1668 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	166.78	142.70	0.00	142.70	-3201.5	-3026.8	530.27
300	167.46	143.73	1.03	142.70	-3201.5	-3025.7	526.81
400	195.68	196.12	46.47	149.65	-3201.6	-2967.1	387.45
500	213.25	241.81	78.19	163.62	-3200.2	-2908.6	303.85
600	224.98	281.80	101.74	180.06	-3198.2	-2850.4	248.14
700	233.19	317.13	119.97	197.17	-3196.0	-2792.6	208.38
800	239.21	348.68	134.51	214.17	-3194.6	-2735.0	178.58
900	243.80	377.13	146.41	230.72	-3192.4	-2677.7	155.41
1000	247.47	403.02	156.34	246.68	-3199.1	-2619.9	136.85
1100	250.57	426.75	164.77	261.98	-3197.6	-2562.1	121.66
1200	253.33	448.67	172.03	276.64	-3204.0	-2503.8	108.98
1300	255.94	469.05	178.39	290.66	-3201.7	-2445.5	98.26
1400	258.51	488.11	184.02	304.09	-3326.7	-2384.3	88.96
1500	261.16	506.04	189.07	316.97	-3322.9	-2317.1	80.69
1600	263.96	522.98	193.67	329.32	-3319.0	-2250.2	73.46

Melting T 1668 K

$\Delta_{fus}H^\circ$ 137.7 kJ

$H_{298}^\circ-H_0^\circ$ 25.24 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 6.609 $J\cdot bar^{-1}$

66.09 cm^3

A= -3.213E+03 B= 5.949E-01 C= 9.377E+05

7/31/92

$CaMgSi_2O_6$ GLASS Formula wt 216.550

$CaMgSi_2O_6$: Glass 298.15 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	168.31	166.00	0.00	166.00	-3156.1	-2988.3	523.53
300	168.93	167.04	1.04	166.00	-3156.1	-2987.3	520.12
400	196.43	219.69	46.69	172.99	-3156.1	-2931.0	382.74
500	213.62	265.52	78.50	187.02	-3154.7	-2874.9	300.33
600	224.44	305.50	101.99	203.51	-3152.7	-2819.1	245.42
700	232.22	340.70	120.06	220.65	-3150.5	-2763.7	206.22
800	239.22	372.17	134.51	237.65	-3149.2	-2708.4	176.84
900	247.01	400.78	146.57	254.21	-3146.8	-2653.5	154.00
1000	256.65	427.28	157.07	270.21	-3152.9	-2598.1	135.71
1100	268.92	452.30	166.66	285.63	-3150.1	-2542.7	120.74
1200	284.36	476.33	175.80	300.53	-3154.1	-2487.0	108.26
1300	303.39	499.82	184.86	314.96	-3147.9	-2431.7	97.71
1400	326.34	523.12	194.12	328.99	-3267.2	-2373.8	88.56

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 26.94 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 7.609 $J\cdot bar^{-1}$

76.09 cm^3

A= -3.152E+03 B= 5.546E-01 C= -1.44E+05

10/15/92

FERROSILITE **Formula wt 131.931**

$FeSiO_3$: Orthorhombic crystals 298.15 to 800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	90.63	94.60	0.00	94.60	-1195.2	-1118.0	195.86
300	91.13	95.16	0.56	94.60	-1195.2	-1117.5	194.57
400	109.00	124.16	25.73	98.43	-1194.3	-1091.7	142.56
500	118.06	149.56	43.37	106.18	-1192.6	-1066.2	111.39
600	123.64	171.61	56.32	115.29	-1190.7	-1041.1	90.64
700	127.58	190.98	66.23	124.75	-1188.8	-1016.4	75.84
800	130.65	208.22	74.10	134.12	-1187.0	-991.9	64.76

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	3.300 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	kJ		33.00 cm^3

A= -1.188E+03 B= 2.460E-01 C= -2.90E+05

05/07/93

α-SPODUMENE **Formula wt 186.090**

$LiAlSi_2O_6$: Monoclinic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	158.93	129.30	0.00	129.30	-3053.5	-2880.2	504.59
300	159.48	130.28	0.98	129.30	-3053.5	-2879.2	501.29
400	184.73	179.81	43.93	135.88	-3054.5	-2820.8	368.36
500	203.25	223.13	74.03	149.09	-3057.3	-2762.1	288.55
600	217.12	261.47	96.78	164.69	-3056.3	-2703.2	235.33
700	227.78	295.77	114.76	181.01	-3054.4	-2644.5	197.33
800	236.12	326.75	129.43	197.32	-3052.1	-2586.0	168.85
900	242.75	354.96	141.67	213.29	-3049.6	-2527.9	146.71
1000	248.07	380.82	152.05	228.77	-3057.4	-2469.4	128.98
1100	252.37	404.68	160.98	243.69	-3054.3	-2410.7	114.47
1200	255.84	426.79	168.75	258.04	-3050.9	-2352.3	102.39

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	5.837 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		58.37 cm^3

A= -3.054E+03 B= 5.849E-01 C= -5.34E+04

9/18/92

β-SPODUMENE **Formula wt 186.090**

$LiAlSi_2O_6$: Tetragonal crystals 298.15 to 1700 K. Melting point is 1696 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	162.77	154.40	0.00	154.40	-3025.3	-2859.5	500.96
300	163.37	155.41	1.01	154.40	-3025.3	-2858.5	497.69
400	189.58	206.27	45.11	161.16	-3025.8	-2802.7	365.99
500	207.34	250.60	75.88	174.71	-3028.2	-2746.7	286.94
600	220.36	289.60	98.93	190.68	-3026.8	-2690.5	234.23
700	230.39	324.36	117.02	207.34	-3024.7	-2634.7	196.60
800	238.41	355.66	131.71	223.95	-3022.1	-2579.1	168.40
900	244.98	384.14	143.94	240.19	-3019.3	-2523.9	146.48
1000	250.49	410.24	154.33	255.91	-3026.9	-2468.3	128.93
1100	255.18	434.34	163.29	271.05	-3023.5	-2412.6	114.56
1200	259.22	456.72	171.12	285.60	-3019.9	-2357.2	102.60
1300	262.74	477.61	178.03	299.58	-3016.0	-2302.1	92.50
1400	265.84	497.20	184.20	313.00	-3012.1	-2247.4	83.85
1500	268.58	515.63	189.73	325.90	-3008.0	-2192.9	76.36
1600	271.03	533.05	194.74	338.31	-3003.8	-2138.7	69.82
1700	273.23	549.55	199.29	350.25	-3245.1	-2076.7	63.81

Melting T 1696 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 7.825 $J\cdot bar^{-1}$

78.25 cm^3

A= -3.023E+03 B= 5.543E-01 C= -2.00E+05

10/16/92

ENSTATITE **Formula wt 100.389**

$MgSiO_3$: Orthorhombic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	83.09	66.27	0.00	66.27	-1545.6	-1458.3	255.48
300	83.41	66.78	0.51	66.27	-1545.6	-1457.7	253.81
400	97.40	92.83	23.11	69.73	-1545.6	-1428.4	186.52
500	106.62	115.63	38.95	76.68	-1544.9	-1399.1	146.16
600	112.88	135.66	50.78	84.87	-1543.8	-1370.1	119.27
700	117.44	153.41	59.99	93.42	-1542.5	-1341.2	100.08
800	121.10	169.34	67.41	101.93	-1541.1	-1312.6	85.70
900	124.39	183.80	73.56	110.24	-1539.6	-1284.1	74.52
1000	127.68	197.07	78.81	118.27	-1546.7	-1255.1	65.56

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	3.131 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	11.99 kJ		31.31 cm^3

A= -1.542E+03 B= 2.869E-01 C= -1.78E+05

7/31/92

CLINOENSTATITE **Formula wt 100.389**

$MgSiO_3$: Crystals 298.15 to melting point at 1830 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	82.12	67.86	0.00	67.86	-1545.0	-1458.1	255.45
300	82.34	68.37	0.51	67.86	-1545.0	-1457.6	253.78
400	93.04	93.59	22.36	71.23	-1545.3	-1428.4	186.52
500	101.20	115.27	37.35	77.92	-1545.1	-1399.2	146.17
600	107.42	134.29	48.53	85.76	-1544.6	-1370.0	119.27
700	112.22	151.23	57.30	93.92	-1543.8	-1341.0	100.06
800	115.98	166.47	64.41	102.06	-1542.9	-1312.1	85.67
900	118.95	180.30	70.31	109.99	-1541.9	-1283.3	74.48
1000	121.32	192.96	75.30	117.67	-1549.6	-1253.9	65.49
1100	123.22	204.62	79.57	125.05	-1548.7	-1224.3	58.14
1200	124.73	215.41	83.27	132.13	-1547.7	-1194.9	52.01
1300	125.93	225.44	86.51	138.93	-1546.7	-1165.5	46.83
1400	126.87	234.81	89.36	145.45	-1673.1	-1133.1	42.28
1500	127.60	243.59	91.89	151.70	-1670.8	-1094.6	38.12
1600	128.14	251.84	94.14	157.71	-1668.5	-1056.3	34.48

Melting T 1830 K

$\Delta_{fus}H^\circ$ 61.50 kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 3.128 $J\cdot bar^{-1}$

31.28 cm^3

A= -1.562E+03 B= 3.088E-01 C= 1.138E+06

10/16/92

$MgSiO_3$-ILMENITE

Formula wt 100.389

$MgSiO_3$: Ilmenite structure form stable only at high pressure 298.15 to 700 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	102.64	60.40	0.00	60.40	-1486.6	-1397.5	244.83
300	102.63	61.03	0.63	60.40	-1486.6	-1397.0	243.23
400	104.92	90.77	26.33	64.44	-1485.4	-1367.3	178.54
500	109.92	114.69	42.52	72.17	-1484.2	-1337.9	139.77
600	115.98	135.26	54.25	81.01	-1482.8	-1308.8	113.94
700	122.55	153.62	63.53	90.09	-1481.0	-1279.9	95.51

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	2.636 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		26.36 cm^3

A= -1.481E+03 B= 2.885E-01 C= -1.88E+05

12/9/92

RHODONITE **Formula wt 131.022**

$MnSiO_3$: Triclinic crystals 298.15 to 1600 K. Melts incongruently at 1564 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	86.44	100.50	0.00	100.50	-1321.6	-1244.7	218.05
300	86.84	101.04	0.53	100.50	-1321.6	-1244.2	216.63
400	101.42	128.30	24.18	104.12	-1321.4	-1218.4	159.10
500	108.73	151.79	40.43	111.37	-1320.6	-1192.7	124.60
600	113.29	172.04	52.21	119.83	-1319.8	-1167.2	101.61
700	116.61	189.77	61.19	128.58	-1318.9	-1141.9	85.21
800	119.31	205.52	68.29	137.23	-1318.0	-1116.6	72.91
900	121.67	219.71	74.09	145.62	-1317.2	-1091.5	63.35
1000	123.83	232.64	78.96	153.69	-1318.6	-1066.4	55.70
1100	125.87	244.54	83.13	161.41	-1317.8	-1041.3	49.44
1200	127.83	255.58	86.77	168.81	-1317.0	-1016.2	44.23
1300	129.75	265.89	90.01	175.88	-1316.1	-991.1	39.82
1400	131.63	275.57	92.91	182.66	-1317.4	-966.1	36.05
1500	133.50	284.72	95.56	189.16	-1318.9	-940.9	32.76
1600	135.35	293.39	97.99	195.41	-1330.5	-915.1	29.87

Melting T	1564 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	3.494 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	14.55 kJ		34.94 cm^3

A= -1.318E+03 B= 2.513E-01 C= -1.87E+05

4/5/93

JADEITE **Formula wt 202.139**

$NaAlSi_2O_6$: Monoclinic crystals 298.15 to 1300 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	159.92	133.50	0.00	133.50	-3029.3	-2850.6	499.40
300	160.62	134.49	0.99	133.50	-3029.3	-2849.5	496.13
400	188.41	184.89	44.71	140.19	-3033.0	-2789.1	364.22
500	205.31	228.88	75.25	153.63	-3032.7	-2728.2	285.01
600	217.07	267.41	97.96	169.45	-3031.6	-2667.4	232.21
700	225.96	301.57	115.64	185.93	-3029.9	-2606.8	194.52
800	233.06	332.22	129.89	202.33	-3027.8	-2546.5	166.27
900	238.96	360.02	141.69	218.33	-3025.6	-2486.5	144.31
1000	244.02	385.46	151.67	233.79	-3033.8	-2426.0	126.72
1100	248.44	408.93	160.27	248.66	-3031.1	-2365.3	112.32
1200	252.39	430.72	167.79	262.94	-3125.0	-2302.4	100.22
1300	255.96	451.07	174.44	276.63	-3121.1	-2234.0	89.76

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	6.040 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	kJ		60.40 cm^3

A= -3.039E+03 B= 6.146E-01 C= 4.741E+05

7/31/92

ACMITE **Formula wt 231.004**

$NaFeSi_2O_6$: Monoclinic crystals 298.15 to 1300 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	169.88	170.57	0.00	170.57	-2584.5	-2417.2	423.48
300	170.58	171.62	1.05	170.57	-2584.5	-2416.2	420.69
400	197.52	224.81	47.17	177.64	-2587.4	-2359.8	308.15
500	213.32	270.70	78.93	191.78	-2586.4	-2303.0	240.59
600	224.73	310.65	102.32	208.33	-2584.9	-2246.4	195.57
700	234.07	346.01	120.49	225.52	-2582.9	-2190.2	163.43
800	242.31	377.81	135.21	242.60	-2580.6	-2134.3	139.35
900	249.91	406.80	147.54	259.26	-2578.2	-2078.6	120.64
1000	257.10	433.50	158.13	275.37	-2576.2	-2023.2	105.68
1100	264.04	458.33	167.45	290.88	-2574.5	-1968.0	93.45
1200	270.80	481.60	175.78	305.82	-2668.5	-1910.5	83.16
1300	277.44	503.54	183.35	320.19	-2662.8	-1847.6	74.24

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circs-H_0^\circ$ 26.94 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 6.460 $J\cdot bar^{-1}$
64.60 cm^3

A= -2.587E+03 B= 5.648E-01 C= 9.860E+04

7/31/92

TREMOLITE **Formula wt 812.366**

$Ca_2Mg_5Si_8O_{22}(OH)_2$: Monoclinic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	655.44	548.90	0.00	548.90	-12303.0	-11574.6	2027.77
300	657.85	552.96	4.05	548.91	-12303.1	-11570.0	2014.47
400	774.71	759.08	182.86	576.22	-12304.7	-11325.2	1478.89
500	850.48	940.81	309.46	631.36	-12299.8	-11080.8	1157.59
600	895.82	1100.21	403.71	696.50	-12292.0	-10837.7	943.48
700	926.86	1240.73	476.31	764.42	-12283.0	-10596.1	790.67
800	956.04	1366.36	534.42	831.94	-12275.3	-10355.5	676.13
900	992.18	1480.95	583.18	897.77	-12265.0	-10116.1	587.11
1000	1041.58	1587.91	626.42	961.49	-12295.7	-9874.4	515.78

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 27.290 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 97.63 kJ 272.90 cm^3

A= -1.228E+04 B= 2.405E+00 C= -1.24E+06

7/31/92

GRUNERITE **Formula wt 1001.614**

$Fe_7Si_8O_{22}(OH)_2$: Monoclinic crystals 298.15 to 900 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	681.08	725.00	0.00	725.00	-9623.0	-8964.8	1570.56
300	683.99	729.22	4.21	725.01	-9623.1	-8960.7	1560.17
400	798.99	943.37	189.94	753.43	-9622.2	-8739.9	1141.28
500	871.66	1129.92	319.42	810.50	-9616.4	-8519.9	890.05
600	927.67	1293.95	416.28	877.68	-9607.7	-8301.4	722.68
700	975.82	1440.64	492.84	947.80	-9597.4	-8084.5	603.26
800	1019.77	1573.85	555.99	1017.86	-9586.0	-7869.1	513.79
900	1061.29	1696.37	609.84	1086.53	-9574.5	-7655.1	444.28

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	27.870 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		278.70 cm^3

A= -9.590E+03 B= 2.154E+00 C= -1.52E+06

9/18/92

ANTHOPHYLLITE **Formula wt 780.820**

$Mg_7Si_8O_{22}(OH)_2$: Monoclinic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	664.02	534.50	0.00	534.50	-12070.0	-11343.4	1987.26
300	667.12	538.62	4.10	534.51	-12070.1	-11338.8	1974.22
400	788.45	748.97	186.60	562.37	-12070.0	-11094.9	1448.81
500	859.43	933.12	314.60	618.53	-12063.8	-10851.7	1133.64
600	907.21	1094.29	409.61	684.68	-12054.7	-10610.1	923.67
700	942.29	1236.89	483.32	753.58	-12043.9	-10370.2	773.82
800	969.58	1364.57	542.46	822.11	-12032.2	-10131.9	661.53
900	991.72	1480.09	591.19	888.90	-12020.3	-9895.0	574.28
1000	1010.24	1585.56	632.19	953.37	-12068.5	-9654.6	504.29
1100	1026.11	1682.61	667.30	1015.31	-12057.1	-9413.7	447.01
1200	1039.97	1772.50	697.79	1074.71	-12045.0	-9174.0	399.32

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 96.78 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 26.540 $J\cdot bar^{-1}$

265.40 cm^3

A= -1.204E+04 B= 2.389E+00 C= -1.29E+06

4/5/93

GLAUCOPHANE **Formula wt 783.543**

$Na_2Mg_3Al_2Si_8O_{22}(OH)_2$: Monoclinic crystals 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	645.48	541.20	0.00	541.20	-11964.0	-11230.8	1967.54
300	647.73	545.20	3.99	541.21	-11964.1	-11226.2	1954.61
400	750.28	746.42	178.46	567.95	-11973.3	-10979.0	1433.68
500	823.97	922.19	300.59	621.60	-11971.7	-10730.6	1120.99
600	878.30	1077.46	392.56	684.89	-11966.2	-10482.8	912.59
700	919.33	1216.07	465.02	751.05	-11958.0	-10236.2	763.82
800	950.88	1340.98	523.86	817.12	-11948.3	-9990.9	652.32
900	975.41	1454.45	572.73	881.73	-11937.7	-9746.8	565.68
1000	994.60	1558.26	613.99	944.26	-11973.7	-9500.4	496.24
1100	1009.62	1653.79	649.31	1004.48	-11962.3	-9253.5	439.40
1200	1021.32	1742.16	679.84	1062.32	-12144.0	-9003.0	391.88

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	26.210 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	95.62 kJ		262.10 cm^3

A= -1.196E+04 B= 2.462E+00 C= -4.11E+05

8/5/92

ANORTHITE **Formula wt 278.207**

$CaAl_2Si_2O_8$: Triclinic ($P\bar{1}$) crystals 298.15 to 510 K: triclinic ($I\bar{1}$) crystals 510 to melting point 1830 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	211.34	199.30	0.00	199.30	-4234.0	-4007.9	702.15
300	212.23	200.61	1.31	199.30	-4234.0	-4006.5	697.57
400	248.25	267.09	58.96	208.12	-4234.6	-3930.5	513.25
500	270.17	325.01	99.17	225.84	-4233.4	-3854.5	402.67
600	285.13	375.67	128.98	246.68	-4231.4	-3778.9	328.98
700	296.26	420.49	152.12	268.37	-4229.1	-3703.7	276.37
800	305.17	460.65	170.71	289.94	-4227.5	-3628.7	236.93
900	312.78	497.04	186.08	310.96	-4225.2	-3554.0	206.27
1000	319.67	530.36	199.10	331.26	-4244.3	-3478.1	181.67
1100	326.21	561.13	210.36	350.78	-4241.8	-3401.6	161.52
1200	332.67	589.80	220.28	369.51	-4246.9	-3324.7	144.72
1300	339.23	616.68	229.18	387.50	-4243.0	-3248.0	130.50
1400	346.03	642.07	237.28	404.79	-4238.6	-3171.7	118.33
1500	353.18	666.18	244.77	421.42	-4233.8	-3095.6	107.79
1600	360.75	689.22	251.78	437.44	-4228.4	-3019.9	98.59
1700	368.81	711.33	258.42	452.90	-4322.7	-2943.6	90.44
1800	377.41	732.65	264.79	467.86	-4464.2	-2860.5	83.01

Melting T 1830 K

Boiling T K

$\Delta_{fus}H^\circ$ 133.0 kJ

$\Delta_{vap}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 33.33 kJ

Molar Vol. 10.079 $J\cdot bar^{-1}$

100.79 cm^3

A= -4.240E+03 B= 7.634E-01 C= 4.945E+05

7/30/92

$CaAl_2Si_2O_8$-GLASS Formula wt 278.207

$CaAl_2Si_2O_8$: Glass 298.15 to 1500 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	210.65	237.30	0.00	237.30	-4163.2	-3948.4	691.73
300	211.54	238.61	1.30	237.30	-4163.2	-3947.1	687.23
400	247.44	304.86	58.76	246.09	-4163.9	-3874.9	505.99
500	269.96	362.65	98.89	263.76	-4162.7	-3802.7	397.26
600	286.17	413.37	128.82	284.55	-4160.7	-3730.9	324.79
700	298.89	458.48	152.24	306.24	-4158.2	-3659.4	273.06
800	309.44	499.09	171.25	327.85	-4156.3	-3588.3	234.28
900	318.53	536.08	187.12	348.96	-4153.5	-3517.4	204.14
1000	326.59	570.06	200.67	369.39	-4171.9	-3445.4	179.97
1100	333.90	601.54	212.45	389.08	-4168.7	-3372.9	160.16
1200	340.62	630.88	222.86	408.03	-4173.0	-3300.1	143.65
1300	346.89	658.40	232.16	426.24	-4168.3	-3227.5	129.68
1400	352.80	684.33	240.57	443.76	-4163.2	-3155.4	117.73
1500	358.41	708.86	248.24	460.62	-4157.8	-3083.6	107.38

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 33.15 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 10.30 $J\cdot bar^{-1}$

103.0 cm^3

A= -4.164E+03 B= 7.199E-01 C= 1.207E+05

9/16/92

BICCHULITE **Formula wt 292.216**

$Ca_2Al_2SiO_6(OH)_2$: Cubic crystals 298.15 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	240.87	213.10	0.00	213.10	-4341.2	-4073.0	713.56
300	241.81	214.59	1.49	213.10	-4341.2	-4071.4	708.87
400	277.62	289.63	66.54	223.09	-4342.2	-3981.2	519.88
500	298.60	353.99	111.00	243.00	-4341.6	-3891.0	406.48
600	313.75	409.83	143.58	266.25	-4340.3	-3801.0	330.90
700	326.14	459.15	168.80	290.36	-4338.6	-3711.3	276.93
800	337.06	503.43	189.16	314.27	-4338.6	-3621.5	236.46
900	347.12	543.71	206.16	337.56	-4336.9	-3532.0	204.99
1000	356.66	580.78	220.73	360.05	-4356.6	-3441.2	179.74
1100	365.85	615.21	233.51	381.70	-4354.8	-3349.7	159.06
1200	374.80	647.43	244.91	402.52	-4368.4	-3257.2	141.78
1300	383.59	677.78	255.24	422.53	-4364.0	-3164.7	127.16
1400	392.26	706.52	264.72	441.80	-4359.1	-3072.7	114.64
1500	400.84	733.88	273.51	460.37	-4353.3	-2981.0	103.80
1600	409.35	760.02	281.73	478.29	-4347.0	-2889.7	94.34
1700	417.80	785.09	289.49	495.60	-4390.2	-2798.3	85.98
1800	426.22	809.21	296.85	512.36	-4679.6	-2700.6	78.37

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 10.368 $J\cdot bar^{-1}$

103.68 cm^3

A= -4.356E+03 B= 9.167E-01 C= 9.910E+05

7/30/92

MEIONITE (Al/Si ORDERED) **Formula wt 934.709**

$Ca_4Al_6Si_6O_{24}CO_3$: **Tetragonal crystals 298.15 to 1200 K.**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	709.51	715.20	0.00	715.20	-13881.4	-13131.8	2300.58
300	713.05	719.60	4.39	715.21	-13881.5	-13127.1	2285.58
400	844.29	945.01	199.95	745.06	-13882.2	-12875.3	1681.30
500	915.47	1141.70	336.51	805.18	-13877.0	-12624.1	1318.80
600	963.02	1313.04	437.18	875.86	-13869.8	-12374.1	1077.24
700	999.41	1464.33	514.99	949.33	-13861.6	-12125.5	904.80
800	1029.84	1599.81	577.49	1022.32	-13856.8	-11877.6	775.51
900	1056.82	1722.70	629.28	1093.42	-13848.8	-11630.7	675.01
1000	1081.65	1835.34	673.29	1162.05	-13905.1	-11380.3	594.43
1100	1105.08	1939.54	711.49	1228.06	-13896.8	-11128.1	528.42
1200	1127.55	2036.67	745.23	1291.44	-13919.2	-10874.3	473.33

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 34.036 $J\cdot bar^{-1}$
340.36 cm^3

A= -1.387E+04 B= 2.495E+00 C= -2.94E+05

7/30/92

MICROCLINE **Formula wt 278.332**

$KAlSi_3O_8$: Triclinic crystals 298.15 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	202.13	214.20	0.00	214.20	-3974.6	-3749.3	656.84
300	202.85	215.45	1.25	214.20	-3974.7	-3747.9	652.54
400	236.27	278.64	56.05	222.59	-3978.8	-3671.5	479.44
500	259.96	334.06	94.60	239.46	-3978.7	-3594.6	375.52
600	276.64	383.02	123.63	259.39	-3977.4	-3517.9	306.25
700	288.65	426.62	146.39	280.22	-3975.3	-3441.5	256.80
800	297.58	465.77	164.76	301.01	-3972.8	-3365.4	219.73
900	304.51	501.23	179.91	321.32	-3970.2	-3289.6	190.92
1000	310.21	533.62	192.67	340.95	-3978.0	-3213.4	167.85
1100	315.20	563.42	203.58	359.84	-4054.0	-3132.5	148.74
1200	319.89	591.05	213.08	377.97	-4049.7	-3048.9	132.71
1300	324.56	616.84	221.48	395.37	-4045.3	-2965.7	119.16
1400	329.45	641.07	229.01	412.06	-4040.7	-2882.8	107.56

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	10.872 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	33.99 kJ		108.72 cm^3

A= -4.002E+03 B= 7.941E-01 C= 1.562E+06

7/30/92

SANIDINE **Formula wt 278.332**

$KAlSi_3O_8$: Monoclinic crystals 298.15 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	204.55	232.80	0.00	232.80	-3965.6	-3745.8	656.23
300	205.29	234.07	1.26	232.80	-3965.6	-3744.4	651.95
400	238.98	298.03	56.74	241.30	-3969.5	-3670.0	479.24
500	262.28	354.02	95.66	258.36	-3969.2	-3595.1	375.57
600	278.65	403.37	124.87	278.50	-3967.7	-3520.4	306.47
700	290.48	447.26	147.73	299.54	-3965.4	-3446.0	257.14
800	299.30	486.65	166.15	320.51	-3962.7	-3372.0	220.16
900	306.15	522.32	181.34	340.98	-3959.9	-3298.3	191.42
1000	311.72	554.87	194.11	360.76	-3967.6	-3224.2	168.41
1100	316.51	584.81	205.02	379.79	-4043.4	-3145.4	149.36
1200	320.85	612.54	214.49	398.04	-4039.0	-3064.0	133.37
1300	325.03	638.39	222.84	415.55	-4034.5	-2982.9	119.85
1400	329.24	662.63	230.29	432.34	-4029.9	-2902.2	108.28

Melting T	1473 K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	10.905 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	34.02 kJ		109.05 cm^3

A= -3.991E+03 B= 7.728E-01 C= 1.497E+06

5/12/93

$KAlSi_3O_8$-GLASS Formula wt 278.332

$KAlSi_3O_8$: Glass 298.15 to 1300 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	209.41	261.60	0.00	261.60	-3920.8	-3709.6	649.89
300	210.18	262.90	1.29	261.60	-3920.8	-3708.3	645.65
400	244.32	328.36	58.06	270.30	-3924.2	-3636.8	474.90
500	267.66	385.54	97.79	287.75	-3923.3	-3565.0	372.42
600	283.99	435.87	127.54	308.33	-3921.3	-3493.5	304.13
700	295.65	480.57	150.77	329.81	-3918.5	-3422.4	255.38
800	304.11	520.63	169.43	351.20	-3915.3	-3351.7	218.84
900	310.30	556.83	184.76	372.07	-3912.0	-3281.5	190.45
1000	314.88	589.77	197.55	392.22	-3919.3	-3210.9	167.72
1100	318.26	619.95	208.38	411.57	-3994.9	-3135.6	148.89
1200	320.78	647.75	217.65	430.11	-3990.4	-3057.7	133.09
1300	322.67	673.51	225.66	447.85	-3986.0	-2980.1	119.74

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 34.88 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 11.650 $J\cdot bar^{-1}$
116.50 cm^3

A= -3.937E+03 B= 7.307E-01 C= 9.138E+05

9/16/92

KALIOPHILLITE (KALSILITE) **Formula wt 158.163**

$KAlSiO_4$: Hexagonal crystals 298.15 to 810 K. High kaliophillite 810 to 1800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	119.70	133.26	0.00	133.26	-2124.7	-2008.8	351.92
300	120.07	134.00	0.74	133.26	-2124.7	-2008.1	349.62
400	137.03	170.98	32.79	138.19	-2127.9	-1968.6	257.06
500	150.35	203.04	55.02	148.02	-2127.6	-1928.8	201.49
600	161.63	231.47	71.87	159.61	-2126.5	-1889.1	164.46
700	171.63	257.15	85.42	171.74	-2124.6	-1849.7	138.02
800	180.76	280.68	96.77	183.90	-2122.1	-1810.5	118.21
900	177.65	303.87	106.26	197.61	-2119.4	-1773.3	102.92
1000	177.65	322.58	113.39	209.19	-2128.1	-1734.2	90.59
1100	177.65	339.52	119.23	220.29	-2205.2	-1690.3	80.27
1200	177.65	354.97	124.10	230.87	-2202.5	-1643.6	71.54
1300	177.65	369.19	128.22	240.97	-2199.9	-1597.2	64.17
1400	177.65	382.36	131.75	250.61	-2197.4	-1550.9	57.87
1500	177.65	394.61	134.81	259.80	-2195.0	-1504.8	52.40
1600	177.65	406.08	137.49	268.59	-2192.7	-1458.9	47.63
1700	177.65	416.85	139.85	277.00	-2240.7	-1412.6	43.40
1800	177.65	427.00	141.95	285.05	-2238.3	-1364.0	39.58

Melting T K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 5.959 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ kJ 59.89 cm^3

A= -2.170E+03 B= 4.426E-01 C= 2.954E+06

1/12/94

LEUCITE **Formula wt 218.247**

$KAlSi_2O_6$: Tetragonal crystals 298.15 to 955 K. Cubic crystals 955 to melting point 1959 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	164.11	200.20	0.00	200.20	-3037.8	-2875.1	503.69
300	164.65	201.22	1.01	200.20	-3037.8	-2874.0	500.40
400	188.61	252.08	45.11	206.98	-3041.2	-2818.8	368.09
500	206.91	296.20	75.69	220.50	-3040.9	-2763.2	288.67
600	222.99	335.36	98.92	236.44	-3039.4	-2707.8	235.73
700	238.01	370.87	117.73	253.15	-3036.8	-2652.8	197.95
800	252.48	403.61	133.67	269.93	-3033.3	-2598.1	169.63
900	266.62	434.16	147.66	286.50	-3028.8	-2544.0	147.64
1000	236.40	462.95	160.23	302.72	-3034.0	-2489.6	130.04
1100	237.04	484.04	165.82	318.22	-3112.9	-2430.5	115.41
1200	238.18	504.71	171.80	332.91	-3110.4	-2368.6	103.10
1300	239.69	523.83	176.96	346.87	-3108.0	-2306.9	92.69
1400	241.46	541.66	181.51	360.15	-3105.6	-2245.4	83.77
1500	243.42	558.39	185.57	372.82	-3103.2	-2184.0	76.05
1600	245.53	574.16	189.25	384.91	-3100.8	-2122.8	69.30
1700	247.74	589.11	192.62	396.49	-3198.6	-2060.8	63.32
1800	250.05	603.34	195.75	407.59	-3195.6	-1994.0	57.86

Melting T 1959 K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 8.827 J·bar^{-1}

$H_{298}^\circ-H_0^\circ$ kJ 88.27 cm^3

A= -3.082E+03 B= 5.979E-01 C= 2.833E+06

1/12/94

EUCRYPTITE **Formula wt 126.006**

$LiAlSiO_4$: α-eucryptite 298.15 to 1300 K. β-eucryptite 1300 to 1600 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	$J\cdot mol^{-1}\cdot K^{-1}$				$kJ\cdot mol^{-1}$		
298.15	113.30	103.80	0.00	103.80	-2123.3	-2009.2	352.00
300	113.85	104.50	0.70	103.80	-2123.3	-2008.5	349.70
400	136.04	140.59	32.02	108.57	-2123.9	-1970.1	257.26
500	149.80	172.53	54.29	118.24	-2126.5	-1931.4	201.76
600	159.40	200.73	71.05	129.68	-2125.4	-1892.4	164.75
700	166.58	225.87	84.21	141.66	-2123.9	-1853.7	138.32
800	172.22	248.49	94.87	153.62	-2122.0	-1815.2	118.52
900	176.81	269.05	103.73	165.32	-2119.9	-1777.0	103.13
1000	180.63	287.88	111.23	176.65	-2128.4	-1738.3	90.80
1100	183.88	305.26	117.69	187.56	-2125.9	-1699.4	80.70
1200	186.69	321.38	123.33	198.05	-2123.2	-1660.7	72.29
1300	189.16	336.42	128.30	208.12	-2120.3	-1622.3	65.18
1400	191.34	350.52	132.73	217.80	-2117.4	-1584.2	59.10
1500	193.29	363.79	136.70	227.09	-2114.3	-1546.2	53.84
1600	195.05	376.32	140.29	236.03	-2111.1	-1508.4	49.24

Melting T 1670 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 5.363 $J\cdot bar^{-1}$

53.63 cm^3

A= -2.123E+03 B= 3.846E-01 C= -1.10E+05

9/16/92

PETALITE **Formula wt 306.259**

$LiAlSi_4O_{10}$: Monoclinic crystals 298.15 to 1300 K. Petalite decomposes above about 1100 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	245.30	233.20	0.00	233.20	-4886.5	-4610.7	807.75
300	246.32	234.72	1.52	233.20	-4886.6	-4608.9	802.47
400	292.33	312.31	68.84	243.47	-4887.9	-4516.1	589.73
500	323.66	381.13	116.87	264.26	-4889.9	-4422.9	462.05
600	345.43	442.18	153.25	288.92	-4887.5	-4329.8	376.93
700	360.93	496.65	181.87	314.78	-4884.0	-4237.1	316.17
800	372.26	545.63	205.00	340.63	-4879.9	-4144.9	270.63
900	380.77	589.99	224.08	365.91	-4875.5	-4053.3	235.24
1000	387.40	630.46	240.09	390.37	-4881.6	-3961.5	206.92
1100	392.77	667.64	253.73	413.91	-4876.8	-3869.7	183.75
1200	397.36	702.02	265.52	436.50	-4871.9	-3778.3	164.46
1300	401.52	733.99	275.82	458.17	-4866.9	-3687.4	148.16

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 38.31 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 12.840 $J\cdot bar^{-1}$

128.40 cm^3

A= -4.879E+03 B= 9.174E-01 C= -5.17E+05

8/7/92

ALBITE **Formula wt 262.223**

$NaAlSi_3O_8$: Triclinic crystals 298.15 to 1400 K.

Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	FORMATION FROM THE ELEMENTS $\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	205.07	207.40	0.00	207.40	-3935.0	-3711.6	650.24
300	205.84	208.67	1.27	207.40	-3935.0	-3710.2	645.98
400	239.68	272.86	56.93	215.93	-3939.0	-3634.8	474.64
500	262.58	328.96	95.91	233.05	-3938.6	-3558.7	371.77
600	278.77	378.34	125.11	253.23	-3937.1	-3482.9	303.20
700	290.66	422.25	147.95	274.30	-3934.7	-3407.4	254.26
800	299.66	461.68	166.38	295.30	-3931.9	-3332.2	217.57
900	306.68	497.39	181.59	315.80	-3929.0	-3257.4	189.05
1000	312.30	530.01	194.39	335.61	-3936.5	-3182.2	166.22
1100	316.95	560.00	205.33	354.67	-3933.1	-3107.0	147.53
1200	320.92	587.75	214.80	372.95	-4026.3	-3029.6	131.87
1300	324.41	613.58	223.10	390.48	-4021.9	-2946.7	118.40
1400	327.61	637.74	230.45	407.28	-4017.4	-2864.2	106.86

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 33.45 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 10.007 $J\cdot bar^{-1}$
100.07 cm^3

A= -3.949E+03 B= 7.694E-01 C= 7.970E+05

8/7/92

ANALBITE **Formula wt 262.223**

$NaAlSi_3O_8$: Triclinic crystals 298.15 to 1400 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	204.81	225.60	0.00	225.60	-3923.6	-3705.6	649.19
300	205.57	226.87	1.27	225.60	-3923.6	-3704.2	644.95
400	239.71	290.99	56.87	234.11	-3927.6	-3630.6	474.10
500	263.29	347.17	95.94	251.23	-3927.2	-3556.4	371.53
600	279.83	396.72	125.29	271.43	-3925.5	-3482.4	303.16
700	291.73	440.80	148.26	292.54	-3923.1	-3408.7	254.36
800	300.49	480.35	166.77	313.58	-3920.2	-3335.4	217.78
900	307.13	516.15	182.01	334.13	-3917.2	-3262.5	189.35
1000	312.30	548.78	194.79	353.99	-3924.7	-3189.2	166.58
1100	316.50	578.75	205.67	373.08	-3921.3	-3115.8	147.95
1200	320.06	606.45	215.06	391.39	-4014.6	-3040.3	132.34
1300	323.25	632.19	223.26	408.93	-4010.3	-2959.3	118.90
1400	326.24	656.26	230.51	425.75	-4005.9	-2878.6	107.40

Melting T 1391 K Boiling T K

$\Delta_{fus}H^\circ$ kJ $\Delta_{vap}H^\circ$ kJ

Molar Vol. 10.043 $J\cdot bar^{-1}$

$H_{298}^\circ-H_0^\circ$ 33.42 kJ 100.43 cm^3

A= -3.937E+03 B= 7.507E-01 C= 7.781E+05

8/7/92

$NaAlSi_3O_8$-GLASS Formula wt 262.223

$NaAlSi_3O_8$: Glass 298.15 to 1200 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	209.90	251.90	0.00	251.90	-3875.5	-3665.3	642.14
300	210.68	253.20	1.30	251.90	-3875.5	-3664.0	637.95
400	246.12	318.98	58.35	260.63	-3878.9	-3593.1	469.21
500	270.03	376.65	98.45	278.19	-3877.8	-3521.8	367.91
600	286.40	427.42	128.49	298.92	-3875.5	-3450.8	300.41
700	298.28	472.50	151.94	320.56	-3872.4	-3380.3	252.23
800	307.73	512.96	170.84	342.12	-3868.9	-3310.2	216.13
900	316.09	549.70	186.52	363.18	-3865.0	-3240.6	188.07
1000	324.30	583.42	199.89	383.54	-3871.5	-3170.7	165.61
1100	333.04	614.74	211.59	403.15	-3866.7	-3100.8	147.24
1200	342.78	644.12	222.11	422.02	-3958.1	-3029.0	131.84

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 34.17 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 11.010 $J\cdot bar^{-1}$

110.10 cm^3

A= -3.871E+03 B= 7.012E-01 C= -3.14E+05

12/9/92

NEPHELINE **Formula wt 142.054**

$NaAlSiO_4$: Orthorhombic(?) crystals 298.15 to 467 K. Hexagonal crystals 467 to 1180 K. Orthorhombic crystals 1180 to 1521 K. Carnegieite is the stable phase of $NaAlSiO_4$ between 1521 and 1799 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	115.81	124.35	0.00	124.35	-2090.4	-1975.8	346.14
300	116.36	125.12	0.72	124.40	-2090.4	-1975.0	343.88
400	145.90	161.59	32.37	129.22	-2093.5	-1936.3	252.84
500	145.64	196.36	52.55	143.81	-2094.7	-1899.3	198.41
600	152.36	223.80	72.66	151.14	-2091.8	-1858.0	161.75
700	159.07	247.82	84.58	163.24	-2091.0	-1819.0	135.73
800	165.78	269.33	94.14	175.19	-2089.9	-1780.3	116.24
900	172.49	288.91	102.13	186.77	-2088.7	-1741.6	101.08
1000	179.20	306.86	108.99	197.86	-2098.0	-1702.4	88.92
1100	185.91	324.09	115.51	208.58	-2095.7	-1662.9	78.96
1200	178.62	341.12	122.21	218.92	-2188.8	-1621.3	70.57
1300	179.18	355.47	126.58	228.89	-2186.0	-1574.1	63.25
1400	179.73	368.78	130.36	238.42	-2183.4	-1527.2	56.98
1500	180.28	381.20	133.66	247.54	-2180.7	-1480.4	51.55

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	5.419 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		54.19 cm^3

A= -2.118E+03 B= 4.188E-01 C= 1.718E+06

8/7/92

CARNEGIEITE **Formula wt 142.054**

$NaAlSiO_4$: Triclinic crystals 298.15 to 966 K; cubic crystals 966 to melting point 1799 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	119.26	118.70	0.00	118.70	-2089.3	-1973.0	345.65
300	119.69	119.44	0.74	118.70	-2089.3	-1972.2	343.39
400	138.01	156.58	32.94	123.64	-2092.5	-1932.9	252.41
500	151.11	188.84	55.31	133.53	-2092.2	-1893.0	197.76
600	162.14	217.39	72.22	145.17	-2091.0	-1853.3	161.34
700	172.21	243.15	85.79	157.36	-2089.0	-1813.8	135.35
800	181.77	266.77	97.19	169.58	-2086.4	-1774.7	115.87
900	191.02	288.71	107.11	181.60	-2083.1	-1735.9	100.75
1000	181.15	317.40	123.78	193.62	-2082.1	-1697.0	88.64
1100	184.03	334.80	129.13	205.67	-2079.6	-1658.6	78.76
1200	186.92	350.94	133.82	217.12	-2173.7	-1618.1	70.43
1300	189.80	366.01	138.02	227.99	-2170.0	-1571.9	63.16
1400	192.68	380.18	141.82	238.36	-2166.2	-1526.0	56.94
1500	195.57	393.57	145.31	248.26	-2162.1	-1480.4	51.55
1600	198.45	406.29	148.54	257.75	-2157.9	-1435.1	46.85
1700	201.33	418.40	151.56	266.84	-2203.7	-1389.6	42.70
1800	204.21	429.99	154.40	275.59	-2198.8	-1341.9	38.94

Melting T 1799 K

$\Delta_{fus}H^\circ$ 21.7 kJ

$H_{298}^\circ-H_0^\circ$ 19.45 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 5.603 $J\cdot bar^{-1}$

56.03 cm^3

A= -2.122E+03 B= 4.276E-01 C= 2.200E+06

1/12/94

$NaAlSiO_4$-GLASS **Formula wt 142.054**

$NaAlSiO_4$: Glass-liquid 298.15 to glass transition 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	121.03	134.50	0.00	134.50	-2089.0	-1977.4	346.42
300	121.47	135.25	0.75	134.50	-2089.0	-1976.7	344.17
400	140.22	172.98	33.46	139.52	-2092.0	-1939.0	253.20
500	152.09	205.64	56.09	149.55	-2091.5	-1900.7	198.56
600	159.90	234.11	72.78	161.33	-2090.3	-1862.7	162.16
700	165.10	259.17	85.62	173.55	-2088.8	-1824.9	136.17
800	168.50	281.46	95.79	185.67	-2087.2	-1787.2	116.69
900	170.60	301.44	103.99	197.45	-2085.7	-1749.8	101.56
1000	171.73	319.48	110.72	208.76	-2094.9	-1711.9	89.42

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	5.686 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	19.99 kJ		56.86 cm^3

A= -2.089E+03 B= 3.771E-01 C= -9.27E+04

9/16/92

ANALCIME **Formula wt 220.154**

$NaAlSi_2O_6 \cdot H_2O$: Cubic crystals 298.15 to 800 K. Analcime starts to lose H_2O above 500 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J \cdot mol^{-1} \cdot K^{-1}$			$kJ \cdot mol^{-1}$	
298.15	212.23	227.70	0.00	227.70	-3310.1	-3090.0	541.33
300	212.68	229.01	1.31	227.70	-3310.1	-3088.6	537.76
400	237.19	293.54	57.20	236.34	-3313.3	-3014.4	393.63
500	262.19	349.14	95.69	253.45	-3312.2	-2939.8	307.11
600	287.38	399.17	125.54	273.63	-3309.3	-2865.5	249.46
700	312.66	445.37	150.47	294.90	-3304.3	-2792.0	208.33
800	337.99	488.77	172.32	316.45	-3297.3	-2719.2	177.54

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 35.74 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 9.680 $J \cdot bar^{-1}$

96.80 cm^3

A= -3.306E+03 B= 7.344E-01 C= -2.83E+05

5/12/93

DEHYDRATED ANALCIME **Formula wt 202.139**

$NaAlSi_2O_6$: Cubic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———		$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	163.05	172.50	0.00	172.50	-2983.1	-2816.0	493.35
300	163.85	173.51	1.01	172.50	-2983.1	-2815.0	490.12
400	194.89	225.37	46.01	179.36	-2986.3	-2758.6	360.23
500	213.59	271.00	77.77	193.23	-2985.3	-2701.8	282.25
600	227.43	311.21	101.60	209.61	-2983.2	-2645.3	230.29
700	238.99	347.16	120.42	226.74	-2980.3	-2589.2	193.20
800	249.32	379.76	135.90	243.86	-2976.8	-2533.5	165.42
900	258.94	409.68	149.04	260.64	-2972.8	-2478.3	143.84
1000	268.12	437.44	160.49	276.95	-2978.8	-2422.9	126.56

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	$J\cdot bar^{-1}$ cm^3
$H_{298}^\circ-H_0^\circ$	27.18 kJ		

A= -2.978E+03 B= 5.560E-01 C= -3.36E+05

5/12/93

DICKITE **Formula wt 258.160**

$Al_2Si_2O_5(OH)_2$: **Triclinic crystals 298.15 to 900 K**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	239.56	197.10	0.00	197.10	-4118.5	-3796.0	665.04
300	240.64	198.59	1.48	197.10	-4118.6	-3794.0	660.58
400	287.65	274.77	67.60	207.17	-4120.4	-3685.5	481.26
500	317.09	342.38	114.78	227.59	-4119.5	-3576.8	373.66
600	334.95	401.91	150.12	251.79	-4117.2	-3468.5	301.95
700	344.93	454.38	177.32	277.06	-4114.4	-3360.6	250.76
800	349.32	500.78	198.59	302.19	-4111.7	-3253.1	212.40
900	349.59	541.97	215.39	326.58	-4109.5	-3145.9	182.58

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 9.856 $J\cdot bar^{-1}$
98.56 cm^3

A= -4.113E+03 B= 1.075E+00 C= -3.31E+05

7/29/92

KAOLINITE **Formula wt 258.160**

$Al_2Si_2O_5(OH)_2$: **Triclinic crystals 298.15 to 800 K**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	243.37	200.40	0.00	200.40	-4119.0	-3797.5	665.29
300	244.40	201.91	1.50	200.40	-4119.1	-3795.5	660.84
400	289.53	278.90	68.31	210.59	-4120.6	-3687.3	481.50
500	317.00	346.72	115.53	231.19	-4119.6	-3579.1	373.89
600	333.50	406.10	150.60	255.50	-4117.3	-3471.1	302.18
700	344.03	458.35	177.53	280.82	-4114.5	-3363.7	251.00
800	351.92	504.82	198.85	305.97	-4111.6	-3256.6	212.63

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	9.934 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	35.75 kJ		99.34 cm^3

A= -4.115E+03 B= 1.074E+00 C= -2.43E+05

7/29/92

PYROPHYLLITE **Formula wt 360.314**

$Al_2Si_4O_{10}(OH)_2$: **Monoclinic crystals 298.15 to 800 K**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	——	$kJ\cdot mol^{-1}$ ——	
298.15	293.76	239.40	0.00	239.40	-5640.0	-5266.1	922.58
300	295.04	241.22	1.82	239.41	-5640.1	-5263.8	916.49
400	349.70	334.18	82.47	251.71	-5641.8	-5138.0	670.94
500	386.14	416.37	139.78	276.59	-5640.6	-5012.1	523.60
600	412.51	489.22	183.14	306.08	-5637.5	-4886.7	425.42
700	432.69	554.39	217.41	336.98	-5633.1	-4761.9	355.33
800	448.83	613.25	245.36	367.89	-5628.0	-4637.8	302.81

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	12.81 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	42.70 kJ		128.1 cm^3

A= -5.634E+03 B= 1.246E+00 C= -3.54E+05

7/29/92

MARGARITE **Formula wt 398.184**

$CaAl_2[Al_2Si_2]O_{10}(OH)_2$: **Monoclinic crystals 298.15 to 1200 K**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	323.41	263.60	0.00	263.60	-6244.0	-5858.9	1026.43
300	324.82	265.60	2.00	263.61	-6244.1	-5856.5	1019.68
400	384.97	367.96	90.81	277.15	-6245.9	-5726.9	747.84
500	424.42	458.38	153.83	304.55	-6244.5	-5597.2	584.73
600	452.21	538.35	201.37	336.98	-6241.1	-5468.1	476.03
700	472.69	609.68	238.74	370.94	-6236.7	-5339.6	398.44
800	488.23	673.86	269.00	404.86	-6232.8	-5211.6	340.28
900	500.23	732.08	294.05	438.03	-6228.0	-5084.3	295.08
1000	509.60	785.29	315.16	470.14	-6265.9	-4954.5	258.79
1100	516.96	834.22	333.18	501.04	-6260.8	-4823.6	229.05
1200	522.74	879.46	348.75	530.71	-6263.4	-4692.5	204.26

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 48.14 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 12.963 $J\cdot bar^{-1}$

129.63 cm^3

A= -6.243E+03 B= 1.291E+00 C= 6.216E+02

7/29/92

PREHNITE **Formula wt 412.384**

$Ca_2Al[AlSi_3O_{10}](OH)_2$: Orthorhombic crystals 298.15 to 1200 K

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	331.12	292.80	0.00	292.80	-6202.6	-5824.7	1020.43
300	332.41	294.85	2.05	292.81	-6202.7	-5822.3	1013.73
400	389.19	398.83	92.23	306.60	-6203.7	-5695.3	743.71
500	427.23	490.03	155.67	334.36	-6201.7	-5568.3	581.71
600	453.51	570.39	203.25	367.14	-6198.0	-5442.0	473.76
700	471.95	641.76	240.39	401.37	-6193.4	-5316.4	396.70
800	484.90	705.68	270.20	435.48	-6190.4	-5191.2	338.94
900	493.85	763.34	294.58	468.76	-6185.9	-5066.5	294.05
1000	499.76	815.71	314.83	500.88	-6203.2	-4940.9	258.08
1100	503.31	863.52	331.82	531.71	-6199.7	-4814.8	228.63
1200	505.00	907.40	346.19	561.21	-6212.4	-4687.7	204.05

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ 50.66 kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 14.110 $J\cdot bar^{-1}$

141.10 cm^3

A= -6.194E+03 B= 1.255E+00 C= -3.99E+05

5/14/92

MUSCOVITE (Al/Si disordered) **Formula wt 398.308**

$KAl_2[AlSi_3O_{10}](OH)_2$: Crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	325.99	306.40	0.00	306.40	-5974.8	-5598.8	980.86
300	327.30	308.42	2.01	306.41	-5974.9	-5596.4	974.40
400	385.47	411.09	91.08	320.01	-5979.1	-5469.5	714.22
500	425.61	501.68	154.21	347.47	-5977.5	-5342.2	558.08
600	454.37	581.96	201.96	379.99	-5973.8	-5215.4	454.03
700	475.51	653.67	239.61	414.06	-5968.6	-5089.5	379.77
800	491.31	718.24	270.13	448.11	-5962.6	-4964.2	324.12
900	503.20	776.83	295.40	481.43	-5956.4	-4839.8	280.89
1000	512.13	830.33	316.64	513.69	-5981.9	-4713.9	246.22

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	14.081 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	49.41 kJ		140.81 cm^3

A= -5.966E+03 B= 1.253E+00 C= -5.87E+05

7/15/92

MUSCOVITE (Al/Si ordered) **Formula wt 398.308**

$KAl_2[AlSi_3O_{10}](OH)_2$: Monoclinic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	325.99	287.70	0.00	287.70	-5990.0	-5608.4	982.55
300	327.30	289.72	2.01	287.71	-5990.1	-5606.0	976.07
400	385.47	392.39	91.08	301.31	-5994.3	-5477.2	715.23
500	425.61	482.98	154.21	328.77	-5992.7	-5348.0	558.69
600	454.37	563.26	201.96	361.29	-5989.0	-5219.4	454.38
700	475.51	634.97	239.61	395.36	-5983.8	-5091.6	379.93
800	491.31	699.54	270.13	429.41	-5977.8	-4964.5	324.14
900	503.20	758.13	295.40	462.73	-5971.6	-4838.2	280.79
1000	512.13	811.63	316.64	494.99	-5997.1	-4710.4	246.04

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	14.081 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	49.41 kJ		140.81 cm^3

A= -5.981E+03 B= 1.271E+00 C= -5.87E+05

3/5/93

ANNITE **Formula wt 511.886**

$KFe_3[AlSi_3O_{10}](OH)_2$: **Crystals 298.15 to 1000 K**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	390.32	415.00	0.00	415.00	-5149.3	-4798.3	840.62
300	391.81	417.42	2.41	415.01	-5149.3	-4796.1	835.06
400	452.51	539.23	108.03	431.20	-5149.7	-4678.2	610.89
500	491.34	644.64	181.04	463.60	-5144.8	-4560.7	476.45
600	520.03	736.87	235.25	501.62	-5138.3	-4444.5	386.92
700	543.12	818.82	277.63	541.19	-5130.7	-4329.5	323.06
800	562.76	892.65	312.07	580.58	-5122.7	-4215.6	275.24
900	580.11	959.96	340.91	619.05	-5114.9	-4102.6	238.10
1000	595.84	1021.90	365.63	656.28	-5119.0	-3989.8	208.40

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	15.43 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	kJ		154.3 cm^3

A= -5.122E+03 B= 1.135E+00 C= -1.31E+06

7/29/92

PHLOGOPITE (Al/Si Disordered) **Formula wt 417.260**

$KMg_3[AlSi_3O_{10}](OH)_2$: **Crystals 298.15 to 1000 K**

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	354.65	334.60	0.00	334.60	-6226.0	-5846.0	1024.18
300	355.97	336.80	2.19	334.61	-6226.1	-5843.7	1017.45
400	412.17	447.54	98.22	349.32	-6230.1	-5715.4	746.74
500	448.48	543.69	164.88	378.80	-6228.8	-5586.8	583.64
600	473.45	627.79	214.35	413.44	-6225.8	-5458.7	475.21
700	491.23	702.19	252.70	449.48	-6221.8	-5331.2	397.81
800	504.13	768.67	283.37	485.30	-6217.4	-5204.2	339.79
900	513.53	828.62	308.45	520.17	-6213.1	-5077.8	294.70
1000	520.33	883.10	329.31	553.78	-6245.5	-4949.0	258.50

Melting T	K	Boiling T	K
$\Delta_{fus}H^\circ$	kJ	$\Delta_{vap}H^\circ$	kJ
		Molar Vol.	14.965 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	54.08 kJ		149.65 cm^3

A= -6.222E+03 B= 1.273E+00 C= -3.45E+05

7/29/92

PHLOGOPITE (Al/Si ordered) **Formula wt 417.260**

$KMg_3[AlSi_3O_{10}](OH)_2$: Monoclinic crystals 298.15 to 1000 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	354.65	315.90	0.00	315.90	-6246.0	-5860.5	1026.71
300	355.97	318.10	2.19	315.91	-6246.1	-5858.1	1019.96
400	412.17	428.84	98.22	330.62	-6250.1	-5727.9	747.97
500	448.48	524.99	164.88	360.10	-6248.8	-5597.5	584.75
600	473.45	609.09	214.35	394.74	-6245.8	-5467.5	475.97
700	491.23	683.49	252.70	430.78	-6241.8	-5338.1	398.32
800	504.13	749.97	283.37	466.60	-6237.4	-5209.2	340.12
900	513.53	809.92	308.45	501.47	-6233.1	-5081.0	294.89
1000	520.33	814.40	329.31	535.08	-6265.5	-4950.3	258.57

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 14.962 $J\cdot bar^{-1}$
149.62 cm^3

A= -6.242E+03 B= 1.291E+00 C= -3.45E+05

FLUORPHLOGOPITE (Al/Si disordered) **Formula wt 421.242**

$KMg_3[AlSi_3O_{10}]F_2$: Crystals 298.15 to 1700 K. Approximate melting point 1670 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	342.42	336.30	0.00	336.30	-6355.5	-6015.7	1053.90
300	343.70	338.42	2.12	336.31	-6355.5	-6013.6	1047.04
400	392.83	444.81	94.33	350.48	-6358.5	-5899.0	770.31
500	420.87	535.72	157.05	378.67	-6356.9	-5784.3	604.26
600	439.96	614.23	202.69	411.54	-6354.4	-5670.0	493.60
700	454.48	683.18	237.66	445.52	-6351.3	-5556.2	414.60
800	466.38	744.67	265.53	479.14	-6347.9	-5442.8	355.37
900	476.62	800.21	288.43	511.78	-6344.6	-5329.8	309.33
1000	485.76	850.90	307.71	543.19	-6377.8	-5214.4	272.37
1100	494.13	897.60	324.28	573.32	-6453.5	-5093.6	241.87
1200	501.92	940.93	338.77	602.17	-6448.8	-4970.2	216.34
1300	509.29	981.40	351.60	629.80	-6443.7	-4847.1	194.76
1400	516.32	1019.40	363.12	656.28	-6820.5	-4715.2	175.92
1500	523.09	1055.26	373.56	681.70	-6810.5	-4565.1	158.97
1600	529.64	1089.23	383.11	706.12	-6800.2	-4415.6	144.15
1700	536.01	1121.53	391.92	729.61	-6940.0	-4265.5	131.06

Melting T 1670 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 14.652 $J\cdot bar^{-1}$

146.52 cm^3

A= -6.476E+03 B= 1.272E+00 C= 8.177E+06

01/14/93

FLUORPHLOGOPITE (Al/Si ordered) **Formula wt 421.242**

$KMg_3[AlSi_3O_{10}]F_2$: Crystals 298.15 to 1700 K. Approximate melting point 1670 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	342.42	336.30	0.00	336.30	-6375.5	-6030.1	1056.43
300	343.70	338.42	2.12	336.31	-6375.5	-6028.0	1049.54
400	392.83	444.81	94.33	350.48	-6378.5	-5911.5	771.95
500	420.87	535.72	157.05	378.67	-6376.9	-5794.9	605.38
600	439.96	614.23	202.69	411.54	-6374.4	-5678.7	494.37
700	454.48	683.18	237.66	445.52	-6371.3	-5563.1	415.11
800	466.38	744.67	265.53	479.14	-6367.9	-5447.8	355.70
900	476.62	800.21	288.43	511.78	-6364.6	-5333.0	309.51
1000	485.76	850.90	307.71	543.19	-6397.8	-5215.7	272.43
1100	494.13	897.60	324.28	573.32	-6473.5	-5093.0	241.84
1200	501.92	940.93	338.77	602.17	-6468.8	-4967.7	216.23
1300	509.29	981.40	351.60	629.80	-6463.7	-4842.8	194.58
1400	516.32	1019.40	363.12	656.28	-6840.5	-4709.0	175.69
1500	523.09	1055.26	373.56	681.70	-6830.5	-4557.0	158.69
1600	529.64	1089.23	383.11	706.12	-6820.2	-4405.7	143.83
1700	536.01	1121.53	391.92	729.61	-6960.0	-4253.7	130.70

Melting T 1670 K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 14.652 $J\cdot bar^{-1}$

146.52 cm^3

A= -6.496E+03 B= 1.291E+00 C= 8.177E+06

01/14/93

TALC **Formula wt 379.266**

$Mg_3Si_4O_{10}(OH)_2$: Monoclinic crystals 298.15 to 800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	321.77	260.80	0.00	260.80	-5900.0	-5520.1	967.08
300	323.23	262.79	1.99	260.81	-5900.1	-5517.8	960.71
400	386.65	365.29	90.94	274.35	-5901.1	-5390.1	703.85
500	420.68	455.61	153.83	301.78	-5899.0	-5262.5	549.76
600	444.28	534.40	200.28	334.12	-5895.5	-5135.5	447.08
700	475.19	605.03	237.17	367.85	-5890.5	-5009.3	373.79
800	525.90	671.51	269.84	401.68	-5882.6	-4883.9	318.88

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	13.625 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	46.88 kJ		136.25 cm^3

A= -5.890E+03 B= 1.260E+00 C= -4.84E+05

7/29/92

CHRYSOTILE (Antigorite) **Formula wt 277.112**

$Mg_3Si_2O5(OH)_4$: Monoclinic crystals 298.15 to 900 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K			$J\cdot mol^{-1}\cdot K^{-1}$			$kJ\cdot mol^{-1}$	
298.15	274.05	221.30	0.00	221.30	-4360.0	-4032.4	706.44
300	275.12	223.00	1.69	221.31	-4360.1	-4030.3	701.73
400	323.31	309.17	76.44	232.73	-4361.0	-3920.2	511.91
500	356.40	385.10	129.33	255.77	-4359.1	-3810.1	398.03
600	379.00	452.21	169.18	283.03	-4355.4	-3700.7	322.16
700	394.31	511.86	200.32	311.54	-4350.8	-3591.9	268.03
800	404.36	565.22	225.24	339.97	-4345.7	-3483.8	227.47
900	410.50	613.23	245.52	367.71	-4340.7	-3376.4	195.96

Melting T K

$\Delta_{fus}H^\circ$ kJ

$H_{298}^\circ-H_0^\circ$ kJ

Boiling T K

$\Delta_{vap}H^\circ$ kJ

Molar Vol. 10.75 $J\cdot bar^{-1}$

107.5 cm^3

A= -4.348E+03 B= 1.081E+00 C= -6.03E+05

5/14/92

PARAGONITE (Al/Si disordered) **Formula wt 382.200**

$NaAl_2[AlSi_3O_{10}](OH)_2$: Monoclinic crystals 298.15 to 800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	———	———	$J\cdot mol^{-1}\cdot K^{-1}$	———	———	$kJ\cdot mol^{-1}$ ———	
298.15	321.50	288.80	0.00	288.80	-5933.0	-5555.7	973.31
300	322.86	290.79	1.99	288.81	-5933.1	-5553.3	966.90
400	380.52	392.22	89.98	302.24	-5937.9	-5426.1	708.56
500	419.03	481.51	152.15	329.36	-5936.9	-5298.2	553.49
600	447.59	560.55	199.12	361.43	-5933.8	-5170.7	450.14
700	470.21	631.30	236.29	395.02	-5929.2	-5043.9	376.37
800	488.92	695.35	266.73	428.62	-5923.5	-4917.8	321.09

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ	Molar Vol.	13.211 $J\cdot bar^{-1}$
$H_{298}^\circ-H_0^\circ$	48.12 kJ		132.11 cm^3

A= -5.931E+03 B= 1.268E+00 C= -2.33E+05

5/14/92

PARAGONITE (Al/Si ordered) **Formula wt 382.200**

$NaAl_2[AlSi_3O_{10}](OH)_2$: Monoclinic crystals 298.15 to 800 K.

					FORMATION FROM THE ELEMENTS		
Temp.	C_p°	S_T°	$(H_T^\circ-H_{298}^\circ)/T$	$-(G_T^\circ-H_{298}^\circ)/T$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
K	J·mol^{-1}·K^{-1}				kJ·mol^{-1}		
298.15	321.50	277.10	0.00	277.10	-5949.3	-5568.5	975.55
300	322.87	279.09	1.99	277.11	-5949.4	-5566.1	969.12
400	380.52	380.52	89.98	290.54	-5954.2	-5437.7	710.08
500	419.04	469.81	152.16	317.66	-5953.2	-5308.7	554.58
600	447.60	548.85	199.12	349.73	-5950.1	-5180.0	450.95
700	470.21	619.61	236.29	383.32	-5945.5	-5052.0	376.98
800	488.92	683.65	266.73	416.92	-5939.8	-4924.8	321.55

Melting T	K	Boiling T	K
		$\Delta_{vap}H^\circ$	kJ
$\Delta_{fus}H^\circ$	kJ		
		Molar Vol.	13.211 J·bar^{-1}
$H_{298}^\circ-H_0^\circ$	48.12 kJ		132.11 cm^3

A= -5.947E+03 B= 1.279E+00 C= -2.34E+05

12/9/92

REFERENCES CITED

1. Adami, L. H., and Conway, K. C., 1966, Heats and free energies of formation of anhydrous carbonates of barium, strontium, and lead: U.S. Bur. Mines Rept. Inv. 6822, 7 p.

2. Adami, L. H., and Kelley, K. K., 1963, Heats of formation of two crystalline hydrates of ferrous sulfate: U. S. Bur. Mines Rept. Inv. 6260, 7 p.

3. Adami, L. H., and King, E. G., 1964, Heats and free energies of formation of sulfides of manganese, iron, zinc, and cadmium: U.S. Bur. Mines Rept. Inv. 6495, 10 p.

4. Adami, L. H., and King, E. G., 1965, Heats of formation of anhydrous sulfates of cadmium, cobalt, copper, nickel, and zinc: U. S. Bur. Mines Rept. Inv. 6617, 10 p.

5. Agoshkov, V. M., Semenov, Yu. V. Malinko, S. V., and Khodakovskiy, I. L., 1977, Enthalpies of datolite and danburite between 298.15 and 973.15 K: Geochemistry International, v. 14(6), p. 142-147.

6. Akaogi, M., and Navrotsky, A., 1984, The quartz-cosite-stishovite transformations: new calorimetric measurements and calculations of phase diagrams: Physics of the Earth and Planetary Interiors, v. 36, p. 124-134.

7. Amosee, J. and Mathieu, J.C., 1980, The enthalpies of formation of $FeWO_4$, $MnWO_4$, and their solid solutions: Jour. Chem. Thermodynamics, v. 12, p. 683-689.

8. Anovitz, L. M., Essene, E. J., Hemingway, B. S., Komada, N. L., and Westrum, E. F., Jr., 1988, The heat-capacities of grunerite and deerite: phase equilibria in the system Fe-Si-C-O-H and implications for the metamorphism of the banded iron formations: EOS, v. 69, p. 515.

9. Anovitz, L. M., Essene, E. J., Metz, G. W., Bohlen, S. R., Westrum, E. F., Jr., and Hemingway, B. S., 1993, Heat capacity and phase equilibria of almandine, $Fe_3Al_2Si_3O_{12}$: Geochim. Cosmochim. Acta, v. 57, p. 4191-4204.

10. Anovitz, L. M., Hemingway, B. S., Westrum, E. F., Jr., Metz, G. W., and Essene, E. J., 1987, Heat capacity measurements for cryolite (Na_3AlF_6) and reactions in the system Na-Fe-Al-Si-O-F: Geochim. Cosmochim. Acta, v. 51, p. 3087-3103.

11. Anovitz, L. M., Treiman, A. H., Essene, E. J., Hemingway, B. S., Westrum, E. F., Jr., Wall, V. J., Burriel, R., and Bohlen, S. R., 1985, The heat-capacity of ilmenite and phase equilibria in the system Fe-Ti-O: Geochim. Cosmochim. Acta, v. 49, p. 2027-2040.

12. Apps, J. A., Neil, J. M., and Jan, C.-H., 1988, Thermochemical properties of gibbsite, bayerite, boehmite, diaspore, and the aluminate ion between 0 and 350°C: University of California Lawrence Berkeley Rept., LBL-21482.

13. Ashida, T., Kume, S., Ito, E., and Navrotsky, A., 1988, $MgSiO_3$ ilmenite: heat capacity, thermal expansivity, and enthalpy of transformation: Phys. Chem. Minerals, v. 16, p. 239-245.

14. Baker, F. B., Huber, E. J., Jr., Holley, C. E., Jr., and Krikorian, N. H., 1971, Enthalpies of formation of cerium dioxide, cerium sesquicarbide, and cerium dicarbide: Jour. Chem. Thermodynamics, v. 3, p. 77-84.

15. Bannister, M. J., 1984, The standard molar Gibbs free energy of formation of PbO. Oxygen concentration cell measurements at low temperatures: Jour. Chem. Thermodynamics, v. 16, p. 787-792.

16. Bannister, M. J., 1986, Oxygen concentration-cell determination of the standard molar Gibbs free energy of formation of SnO_2: Jour. Chem. Thermodynamics, v. 18, p. 455-463.

17. Barany, R., 1962, Heats and free energies of formation of calcium tungstate, calcium molybdate, and magnesium molybdate: U.S. Bur. Mines Rept. Inv. 6143, 11 p.

18. Barany, R., 1965, Heats of formation of goethite, ferrous vanadate, and manganese molybdate: U.S. Bur. Mines Rept. Inv. 6618, 10 p.

19. Barany, R., and Adami, L. H., 1965, Heats of formation of anhydrous ferric sulfate and indium sulfate: U. S. Bur. Mines Rept. Inv. 6687, 8 p.

20. Barany, R., and Adami L. H., 1966, Heats of formation of lithium sulfate and five potassium- and lithium-aluminum silicates: U.S. Bur. Mines Rept. Inv. 6873, 18 p.

21. Bartel, J.J. and Westrum, E.F., Jr., 1975, Heat capacities of Fe_3O_4 and $ZnFe_2O_4$ from 300 to 500 K: Jour. Chem. Thermodynamics, v. 7, p. 706-708.

22. Bartel, J.J. and Westrum, E. F., Jr., 1976, Thermodynamics of Fe(II) Fe(III) oxide systems. II zinc and cadmium-doped Fe_3O_4 and crystalline magnetite: Jour. Chem. Thermodynamics, v. 8, p. 583-600.

23. Barton, M. D., 1982, The thermodynamic properties of topaz solid solutions and some petrologic applications: Am. Mineralogist, v. 67, p. 956-974.

24. Barton, M. D., Haselton, H. T., Jr., Hemingway, B. S., Kleppa, O. J., and Robie, R. A., 1982, The thermodynamic properties of fluor-topaz: Am. Mineralogist, v. 67, p. 350-355.

25. Barton, P. B., Jr., 1969, Thermochemical study of the system Fe-As-S: Geochim. Cosmochim. Acta, v. 33, p. 841-857.

26. Barton, P. B., Jr., and Bethke, P. M., 1960, Thermodynamic properties of some synthetic zinc and copper minerals: Am. Jour. Sci., v. 258-A, (Bradley volume), p. 21-34.

27. Belitskiy, I. A., Gabunda, S. P., Drebushchak, V. A., Naumov, V. N., and Nogteva, V. V., 1984, The specific heat of edingtonite at 5-316 K and the entropy and enthalpy under standard conditions: Geochemistry International, v. 21(3), p. 21-23.

28. Bennington, K. O., 1982, Stability relationships between petalite ($LiAlSi_4O_{10}$) and spodumene ($LiAlSi_2O_6$): U.S. Bur. Mines Rept. Inv. 8719, 15 p.

29. Bennington, K. O., Beyer, R. P., and Brown, R. R., 1984, Thermodynamic properties of hedenbergite, a complex silicate of Ca, Fe, Mn, and Mg: U.S. Bur. Mines Rept Inv. 8873, 19 p.

30. Bennington, K. O., Beyer, R. P., and Johnson, G. K., 1983, Thermodynamic properties of pollucite (a cesium-aluminum silicate): U.S. Bur. Mines Rept. Inv. 8779, 18 p.

31. Bennington, K. O., and Brown, R. R., 1982, Thermodynamic properties of synthetic acmite ($NaFe^{3+}Si_2O_6$): U.S. Bur. Mines Rept Inv. 8621, 12 p.

32. Bennington, K. O., Brown, R. R., Bell, H. E., and Beyer, R. P., 1987, Thermodynamic properties of two manganese silicates, pyroxmangite and fowlerite: U.S. Bur. Mines Rept Inv. 9064, 22 p.

33. Bennington, K. O., Brown, R. R., and Beyer, R. P., 1984, Thermodynamic properties of aegirine: U.S. Bur. Mines Rept. Inv. 8912, v. 16, p.

34. Bennington, K. O., Ferrante, M. J., and Stuve, J. M., 1978, Thermodynamic data on the amphibole asbestos minerals amosite and crocidolite: U.S. Bur. Mines Rept. Inv. 8265, 30 p.

35. Bennington, K. O., Stuve, J. M., and Ferrante, M. J., 1980, Thermodynamic properties of petalite ($Li_2Al_2Si_8O_{20}$): U.S. U.S. Bur. Mines Rept. Inv. 8451, 20 p.

36. Berg, R. L., and Vanderzee, C. E., 1978, Thermodynamics of carbon dioxide and carbonic acid: (a) the standard enthalpies of solution of $Na_2CO_3(s)$, $NaHCO_3(s)$, and $CO_2(g)$ in water at 298.15 K; (b) the standard enthalpies of formation, standard Gibbs energies of formation, and standard entropies of $CO_2(aq)$, $HCO_3^-(aq)$, $CO_3^{2-}(aq)$, $NaHCO_3(s)$, $Na_2CO_3(s)$, $Na_2CO_3 \cdot H_2O(s)$, and $Na_2CO_3 \cdot 10H_2O(s)$: Jour. Chem. Thermodynamics, v. 10, p. 1113-1136.

37. Berman, R. G., 1988, Internally consistent thermodynamic data for minerals in the system Na_2O-K_2O-CaO-MgO-FeO-Fe_2O_3-Al_2O_3-SiO_2-TiO_2-H_2O-CO_2: Jour. Petrology, v. 29 pt. 2, p. 445-522.

38. Beyer, R. P., Ferrante, M. J., and Mrazek, R. V., 1983, An automated calorimeter for heat-capacity measurements from 5 to 300 K. The heat capacity of cadmium sulfide from 5.37 to 301.8 K and the relative enthalpy to 1103.4 K: Jour. Chem. Thermodynamics, v. 15, p. 827-834.

39. Boerio, J. and Westrum, E.F., Jr., 1978, Heat capacity and thermodynamic properties of strontium from 5 to 350 K: Jour. Chem. Thermodynamics, v. 10, p. 1-7.

40. Boerio-Goates, J., Artman, J. I., and Woodfield, B. F., 1990, Heat capacity studies of phase transition in langbeinites II. $K_2Mg_4(SO_4)_3$: Phys. Chem. Minerals, v. 17, p. 173-178.

41. Bohlen, S. R., Metz, G. W., Essene, E. J., Anovitz, L. M., Westrum, E. F., Jr., and Wall, V. J., 1983, Thermodynamics and phase equilibrium of ferrosilite: potential oxygen barometer in mantle rocks: EOS, v. 64, p. 350.

42. Bonnickson, K. R., 1954, High-temperature heat contents of calcium and magnesium ferrites: Am. Chem. Soc. Jour., v. 76, p. 1480-1482.

43. Bonnickson, K. R., 1955, High-temperature heat contents of some titanates of aluminum, iron, and zinc: Am. Chem. Soc. Jour., v. 77, p. 2152-2154.

44. Bonnickson, K. R., 1955, High-temperature heat contents of aluminates of calcium and magnesium: Jour. Phys. Chemistry, v. 59, p. 221-221.

45. Boyle, B. J., King, E. G., and Conway, K. C., 1954, Heats of formation of nickel and cobalt oxides (NiO and CoO) by combustion calorimetry: Am. Chem. Soc. Jour., v. 76, p. 3835-3837.

46. Brink, I. J., and Holley, C. E., Jr., 1978, The enthalpy of formation of strontium monoxide: Jour. Chem. Thermodynamics, v. 10, p. 259-266.

47. Brodale, G., and Giauque, W. F., 1958, The heat of hydration of sodium sulfate. Low temperature heat capacity and entropy of sodium sulfate decahydrate: Am. Chem. Soc. Jour., v. 80, p. 2042-2044.

48. Brooks, A. A., 1953, A thermodynamic study of the equilibrium $2Cu(s) + H_2S(g) = Cu_2S(\gamma) + H_2(g)$: Am. Chem. Soc. Jour., v. 75, p. 2464-2467.

49. Brousse, C., Newton, R. C., and Kleppa, O. J., 1984, Enthalpy of formation of forsterite, enstatite, akermanite, monticellite and merwinite at 1073 K by alkali borate solution calorimetry: Geochim. Cosmochim. Acta, v. 48, p. 1081-1088.

50. Bryndzia, L. T., and Kleppa, O. J., 1988, Standard molar enthalpies of formation of realgar (α-AsS) and orpiment (As_2S_3) by high-temperature direct-synthesis calorimetry: Jour. Chem. Thermodynamics, v. 20, p. 755-764.

51. Bryndzia, L. T., and Kleppa, O. J., 1988, High-temperature reaction calorimetry of solid and liquid phases in the quasi-binary system Ag_2S-Sb_2S_3: Geochim. Cosmochim. Acta, v. 52, p. 167-176.

52. Bryndzia, L.T., and Kleppa, O.J., 1988, Standard enthalpies of formation of sulfides and sulfosalts in the Ag-Bi-S system by high-temperature, direct synthisis calorimetry: Economic Geology, v. 83, p. 174-181.

53. Bryndzia, L.T., and Kleppa, O.J., 1988, High-temperature reaction calorimetry of solid and liquid phases in part of the quasi-binary system Cu_2S-Sb_2S_3: Am. Mineralogist, v. 73, p. 707-713.

54. Busenberg, E., and Plummer, L. N., 1986, The solubility of $BaCO_3$(cr)(witherite) in CO_2-H_2O solutions between 0 and 90°C, evaluation of the association constants of $BaHCO_3^+$(aq) and $BaCO_3^\circ$(aq) between 5 and 80°C, and a preliminary evaluation of the thermodynamic properties of Ba^{2+}(aq): Geochim. Cosmochim. Acta, v. 50, p. 2225-2233.

55. Busenberg, E., Plummer, L. N., and Parker, V. B., 1984, The solubility of strontianite ($SrCO_3$) in CO_2-H_2O solutions between 2 and 91°C, the association constants of $SrHCO_3^+$(aq) and $SrCO_3$(aq)° between 5 and 80°C, and an evaluation of the thermodynamic properties of Sr^{2+}(aq) and $SrCO_3$(cr) at 25°C and 1 atm total pressure: Geochim. Cosmochim. Acta, v. 48, p. 2021-2035.

56. Carpenter, M. A., McConnell, J. D. C., and Navrotsky, A., 1985, Enthalpies of ordering in the plagioclase feldspar solid solution: Geochim. Cosmochim. Acta, v. 49, p. 947-966.

57. Castanet, Robert, 1984, Selected data on the thermodynamic properties of alpha-alumina: High Temperatures - High Pressures, v. 16, p. 449-457.

58. Cemic, L., and Kleppa, O. J., 1986, High temperature calorimetry of sulfide systems. I. Thermochemistry of liquid and solid phases of Ni+S: Geochim. Cosmochim. Acta, v. 50, p. 1633-1641.

59. Cemic, L., and Kleppa, O. J., 1987, High temperature calorimetry of sulfide systems II. Standard enthalpies of formation of pentlandite and violarite: Phys. Chem. Minerals, v. 14, p. 52-57.

60. Cemic, L., and Kleppa, O. J., 1988, High temperature calorimetry of sulfide systems III. Standard enthalpies of formation of phases in the systems Fe-Cu-S and Co-S: Phys. Chem. Minerals, v. 16, p. 172-179.

61. Chang, S. S., and Bestul, A. B., 1971, Heat capacities of cubic, monoclinic, and vitreous arsenious oxide from 5 to 360 K: Jour. Chem. Physics, v. 55, p. 933-946.

62. Chang, S.S., and Bestul, A.B., 1974, Heat capacities of selenium crystal (trigonal), glass, and liquid from 5 to 360 K: Jour. Chem. Thermodynamics, v. 6, p. 325-344.

63. Chang, Y. A., and Ahmad, N., 1982, Thermodynamic Data on Metal Carbonates and Related Oxides, (Metallurgical Society of AIME Publ.), 235 p.

64. Charlu, T. V., Newton, R. C., and Kleppa, O. J., 1975, Enthalpies of formation at 970 K of compounds in the system MgO-Al_2O_3-SiO_2 from high temperature solution calorimetry: Geochim. Cosmochim. Acta, v. 39, p. 1487-1497.

65. Charlu, T. V., Newton, R. C., and Kleppa, O. J., 1978, Enthalpy of formation of some lime silicates by high-temperature solution calorimetry, with discussion of high pressure phase equilibria: Geochim. Cosmochim. Acta, v. 42, p. 367-375.

66. Charlu, T. V., Newton, R. C., and Kleppa, O. J., 1981, Thermochemistry of synthetic $Ca_2Al_2SiO_7$ (gehlenite) $Ca_2MgSi_2O_7$ (akermanite) melilites: Geochim. Cosmochim. Acta, v. 45, p. 1609-1617.

67. Chase, M. W., Jr., Davies, C. A., Downey, J. R., Jr., Frurip, D. J., McDonald, R. A., and Syverud, A. N.,1985, JANAF Thermochemical Tables Third Edition, Part I, Al-Co; Part II, Cr-Zr: Jour. Phys. Chem. Ref. Data, v. 14, Supplement no. 1, p. 1-1856.

68. Chatterjee, N. D., Johannes, Wilhelm, and Leistner, Hans, 1984, The system $CaO-Al_2O_3-SiO_2-H_2O$: new phase equilibrium data, some calculated phase relations, and their petrological applications: Contributions to Mineralogy and Petrology, v. 88, p. 1-13.

69. Chattilon-Colinet, C., Kleppa, O. J., Newton, R. C., and Perkins, D., 1983, Enthalpy of formation of $Fe_3Al_2Si_3O_{12}$ (almandine) by high temperature alkali borate solution calorimetry: Geochim. Cosmochim. Acta, v. 47, p. 439-444.

70. Chernosky, J. V., Jr., and Autio, L. K., 1979, The stability of anthophyllite in the presence of quartz: Am. Mineralogist, v. 64, p. 294-303.

71. Chhor, K., Bocquet, J. F., Pommier, C., and Chardon, B., 1986, Heat capacity and thermodynamic behavior of Mn_3O_4 and $ZnMn_2O_4$ at low temperatures. Jour. Chem. Thermodynamics, v. 18, p. 88-99.

72. Chhor, K., Pommier, C., Gariner, P. and Abello, L., 1991, Low temperature behavior of α-PbO and $Pb_{1-x}Ti_{1+x}$ oxides from calorimetric spectroscopic and neutron diffraction studies: Jour. Phys. Chem. Solids, v. 52, p. 895-902.

73. Chisholm, R. C., and Stout, J. W., 1962, Heat capacity and entropy of $CoCl_2$ and $MnCl_2$ from 11° to 300° K. Thermal anomaly associated with antiferromagnetic ordering in $CoCl_2$: Jour. Chem. Physics. v. 36, p. 972-979.

74. Cho, M., Maruyama, S., and Liou, J.G., 1987, An experimental investigation of heulandite-laumontite equilibrium at 1000 to 2000 bar P_{fluid}. Contributions to Mineralogy Petrology, v. 97, p. 43-50.

75. Cohen, E. R., and Taylor, B. N., 1987, The 1986 CODATA recommended values of the fundamental physical constants: U.S. Nat. Bur. Standards, Jour. Research v. 92, p. 85-95.

76. Cook, O. A., 1947, High-temperature heat contents of V_2O_3, V_2O_4, and V_2O_5: Am. Chem. Soc. Jour., v. 69, p. 331-333.

77. Cordfunke, E. H. P., Konings, R. J. M., and Ouweltjes, W., 1990, The standard enthalpies of formation of MO(s), MCl_2(s), and M_{+2}(aq,∞) (M = Ba, Sr): Jour. Chem. Thermodynamics, v. 22, p. 991-996.

78. Cordfunke, E. H. P., Ouweltjes, W., and Prins, G., 1987, Standard enthalpies of formation of Tellurium compounds. I. Tellurium dioxide: Jour. Chem. Thermodynamics, v. 19, p. 369-375.

79. Coughlin, J. P., 1950, High-temperature heat contents of manganous sulfide, ferrous sulfide, and pyrite: Am. Chem. Soc. Jour., v. 72, p. 5445-5448.

80. Coughlin, J. P., 1951, High-temperature heat contents of nickel chloride: Am. Chem. Soc. Jour., v. 73, p. 5314-5315.

81. Coughlin, J. P., 1955, High-temperature heat contents, heats of transition, and heat of fusion of anhydrous sodium sulfate: Am. Chem. Soc. Jour., v. 77, p. 868-870.

82. Coughlin, J. P., and King, E. G., 1950, High-temperature heat contents of some zirconium-containing substances: Am. Chem. Soc. Jour., v. 72, p. 2262-2265.

83. Coughlin, J. P., King, E. G., and Bonnickson, K. R., 1951, High-temperature heat contents of ferrous oxide, magnetite and ferric oxide: Am. Chem. Soc. Jour., v. 73, p. 3891-3893.

84. Coughlin, J. P., and O'Brien, C. J., 1957, High temperature heat content of calcium orthosilicate: Jour. Phys. Chemistry., v. 61, p. 767-769.

85. Cox, J. D., Wagman, D. D., and Medvedev, V. A., 1989, CODATA key values for thermodynamics: Hemisphere, New York, 271 p.

86. Dayal, R. R., Johnson, R. E., and Muan, A., 1967, Stability of mullite derived from equilibria in the system CaO-Al_2O_3-SiO_2: Am. Chem. Soc. Jour., v. 50, p. 537-540.

87. DeKock, C. W., 1982, Thermodynamic properties of selected transition metal sulfates and their hydrates: U. S. Bur. Mines Information Circular 8910, 45 p.

88. DeKock, C. W., 1986, Thermodynamic properties of selected metal sulfates and their hydrates: U. S. Bur. Mines Information Circular 9081, 59 p.

89. Dellien, I., McCurdy, K. G, and Hepler, L. G., 1976, Enthalpies of formation of lead chromate, lead molybdate, and lead tungstate, and the entropy of aqueous tungstate ion: Jour. Chem. Thermodynamics, v. 8, p. 203-207.

90. Desai, P. D., 1986, Thermodynamic properties of iron and silicon: Jour. Phys. Chem. Ref. Data, v. 15, p. 967-983.

91. Desai, P. D., 1987, Thermodynamic properties of manganese and molybdenum: Jour. Phys. Chem. Reference Data, v. 16, p. 91-108.

92. Desai, P. D., 1987, Thermodynamic properties of aluminum: Int. Jour. Thermophysics, v. 8, p. 621-638.

93. Ditmars, P. D., and Douglas, T. B., 1971, Measurement of the relative enthalpy of pure α-Al_2O_3 (NBS heat capacity and enthalpy standard reference material no. 720) from 273 to 1173 K: U. S. Natl. Bur. Standards Jour. Research, v. 75A, p. 401-420.

94. Ditmars, D. A., Isihara, S., Chang, S. S., Bernstein, G., and West, E. D., 1982, Enthalpy and heat-capacity standard reference material: synthetic sapphire (γ-Al_2O_3) from 10 to 2250 K: U.S. Natl. Bur. Standards Jour. Research, v. 87, p. 159-163.

95. Donahoe, R. J., Hemingway, B. S., and Liou, J. G., 1990, Thermochemical data for merlinoite: 1. Low-temperature heat capacities, entropies, and enthalpies of formation at 298.15 K of six synthetic samples having various Si/Al and Na/(Na + K) ratios: Am. Mineralogist, v. 75, 188-200

96. Donahoe, R. J., Liou, J. G., and Hemingway, B. S., 1990, Thermochemical data for merlinoite: 2. Free energies of formation at 298.15 K of six synthetic samples having various Si/Al and Na/(Na + K) ratios and application to saline, alkaline lakes: Am. Mineralogist, v. 75, 201-208

97. Dzhabbarov, A.I., 1985, Heat capacity of the anisotropic antiferromagnetic semiconductor iron antimony sulfide ($FeSb_2S_4$) at low temperature: Zhur. Fiz. Khim., v. 59, p. 202-204.

98. Egami, Akira, Nagakawa, T., Oishi, T., Ono, K., and Moriyama, J., 1986, A thermodynamic study of the systems Ni-S and Co-S by CaF_2 solid electrolyte galvanic cell technique: Trans. Japan Institute of Metals, v. 27, p. 890-897.

99. Egan, E. P., Jr., Wakefield, Z. T., and Elmore, K. L., 1950, High-temperature heat content of hydroxyapatite: Am. Chem. Soc. Jour., v. 72, p. 2418-2421.

100. Egan, E. P., Jr., Wakefield, Z. T., and Luff, B. B., 1961, Low temperature heat capacity, entropy and heat of formation of crystalline and colloidal ferric phosphate dihydrate: Jour. Phys. Chemistry, v. 65, p. 1265-1270.

101. Ellison, A.J.G., and Navrotsky, A. 1992, Enthalpy of formation of zircon. Jour. Am. Ceramic Soc., v. 75, p. 1430-1433.

102. Eriksson, G. and Pelton, A. D., 1993, Critical evaluation and optimization of the thermodynamic properties and phase diagrams of the MnO-TiO_2, MgO-TiO_2, FeO-TiO_2, Ti_2O_3-TiO_2, Na_2O-TiO_2, and K_2O-TiO_2 systems: Metallurgical Transactions, v. 24B, p. 795-805.

103. Evans, L. G. and Muan, A., 1971, Activity-composition relations of solid solutions and stabilities of manganese and nickel titanates at 1250° C as derived from equilibria in the systems MnO-CoO-TiO_2 and MnO-NiO-TiO_2: Thermochimica Acta, v. 2, p. 277-292.

104. Fei, Y., and Saxena, S. K., 1987, An equation for the heat capacity of solids: Geochim. Cosmochim. Acta, v. 51, p. 251-254.

105. Fei, Y., Saxena, S.K. and Navrotsky, A., 1990, Internally consistent thermodynamic data and equilibrium phase relations in the system MgO-SiO_2 at high pressure and high temperature: Jour. Geophys. Research, v. 95B, p. 6915-6928.

106. Ferrante, M. J., 1972, Enthalpies above 298.15 K for copper sulfate and copper oxysulfate: U. S. Bur. Mines Rept. Inv. 7600, 8 p.

107. Ferrante, M. J., and Gokcen, N. A., 1982, Relative enthalpies of Ni_3S_2: U. S. Bur. Mines Rept. Inv., no. 8745, 8 p.

108. Ferrante, M.J., Mrazek, R.V., and Brown, R.R., 1987, High-temperature relative enthalpies and related thermodynamic properties of CuI: U.S. Bur. Mines Rept. Inv. 9074, 10 p.

109. Ferrante, M. J., Stuve, J. M., Daut, G. E., and Pankratz, L. B., 1978, Low-temperature heat capacities and high-temperature enthalpies of cuprous and cupric sulfides: U.S. Bur. of Mines Rept. Inv. 8305, p. 1-22. See also High Temp Science, v. 14, p. 77-90.

110. Ferrante, M. J., Stuve, J. M., and Richardson, D.W., 1976, Thermodynamic data for synthetic dawsonite: U.S. Bur. Mines Rept. Inv. 8129, 13 p.

111. Fitzgibbon, G. C., Huber, E. J., Jr., and Holley, C. E., Jr., 1973, Enthalpy of formation of barium monoxide: Jour. Chem. Thermodynamics, v. 5, p. 577-582.

112. Flotow, H. E., and Osborne, D. W., 1974, The heat capacity of dicesium monoxide (Cs_2O) from 5 to 350 K and the Gibbs energy of formation to 763 K: Jour. Chem. Thermodynamics, v. 6, p. 135-140.

113. Fredrickson, D. R., and Chasanov, M. G., 1970, Enthalpy of uranium dioxide and sapphire to 1500 K by drop calorimetry: Jour. Chem. Thermodynamics, v. 2, p. 623-630.

114. Fredrickson, D. R., and Chasanov, M. G., 1971, The enthalpy of molybdenum disulfide to 1200° K by drop calorimetry: Jour. Chem. Thermodynamics, v. 3, p. 693-696.

115. Fredrickson, D. R., and Chasanov, M. G., 1973, The enthalpy of sodium oxide Na_2O to 1300 K by drop calorimetry: Jour. Chem. Thermodynamics, v. 5, p. 485-490.

116. Furukawa, G. T., and Saba, W. G., 1965, Heat capacity and thermodynamic properties of beryllium aluminate (chrysoberyl), $BeO \cdot Al_2O_3$, from 16 to 380°K: U. S. Natl. Bur. Standards Jour. Research., v. 65, p. 13-18.

117. Garvin, D., Parker, V. B., and White, H. J., 1987, CODATA thermodynamic tables. Selections for some compounds of calcium and related mixtures: A prototype set of tables. Hemisphere, New York, 356 p.

118. Gillet, P., Reynard, B., and Tequi, C., 1989, Thermodynamic properties of glaucophane: new data from calorimetric and spectroscopic measurements: Phys. Chem. Minerals, v. 16, p. 659-667.

119. Gillet, P., Richet, P., Guyot, F. and Fiquet, G., 1991, High temperature thermodynamic properties of forsterite: Jour. Geophys. Research, v. 96, p. 11805-11816.

120. Goates, J. R., Cole, A. G., and Gray, E. L., 1951, Free energy of formation and solubility product constant of mercuric sulfide: Amer. Chem. Soc. Jour., v. 73, p. 3596-3597.

121. Goates, J. R., Cole, A. G., Gray, E. L., and Faux, N. D., 1951, Thermodynamic properties of silver sulfide: Am. Chem. Soc. Jour., v. 73, p. 707-708.

122. Goldman, D. T., and Bell, R. J., 1986, The international system of units (SI): U.S. Natl. Bur. Standards Special Publication 330, 51 p.

123. Goldsmith, J. R., and Jenkins, D. M., 1985, The high-low albite relations revealed by reversal of degree of order at high pressures: Am. Mineralogist, v. 70, p. 911-923.

124. Good, W. D., Lacina, J. L., and McCullough, J. P., 1960, Sulfuric acid: heat of formation of aqueous solutions by rotating bomb calorimetry: Am. Chem. Soc. Jour., v. 82, p. 5589-5591.

125. Grimsey, E.J. and Reynolds, K.A., 1986, Equilibrium oxygen pressure of (Co_3O_4 + CoO) from 1173 to 1228K. Jour. Chem Thermodynamics, v. 18, p. 473-476.

126. Gronvold, F., 1973, Heat capacities and thermodynamic properties of hexagonal and liquid selenium in the range 298 to 1000 K. Enthalpy and temperature of fusion: Jour. Chem. Thermodynamics, v. 5, p. 525-531.

127. Gronvold, F., 1975, Heat capacity and thermodynamic properties of bismuth in the range 300 to 950 K. Fusion characteristics: Acta Chem. Scandinavica, v. 29A, p. 945-955.

128. Gronvold, F., Kveseth, N. J., Sveen, A., and Tichy, J., 1970, Thermodynamics of the UO_{2+x} phase 1. Heat capacities of $UO_{2.017}$ and $UO_{2.254}$ from 300 to 1000 K and electronic contributions: Jour. Chem. Thermodynamics, v. 2, p. 665-680.

129. Gronvold, F., and Meisingset, K. K., 1983, Thermodynamic properties and phase transitions of salt hydrates between 270 and 400 K. II. $Na_2CO_3 \cdot H_2O$ and $Na_2CO_3 \cdot 10H_2O$: Jour. Chem. Thermodynamics, v. 15, p. 881-889.

130. Gronvold, F. and Samuelsen, E.J., 1975, Heat capacity and thermodynamic properties of α-Fe_2O_3 in the region 300-1050 K. Antiferromagnetic transition: Jour. Phys. Chem. Solids, v. 36, p. 249-256.

131. Gronvold, F., and Stolen, S., 1992, Thermodynamics of iron sulfides II. Heat capacity and thermodynamic properties of FeS and of $Fe_{0.875}S$ at temperatures from 298.15 K to 1000K, of $Fe_{0.98}S$ from 298.15 K to 800 K and of $Fe_{0.89}S$ from 298.15 K to about 650 K. Thermodynamics of formation: Jour. Chem. Thermodynamics, v. 24, p. 913-916.

132. Grønvold, F., Stølen, S., Tolmach, P. and Westrum, E. F., Jr., 1993, Heat capacities of the wüstites $Fe_{0.9379}O$ and $Fe_{0.9254}O$ at temperatures T from 5 K to 350 K. Thermodynamics of the reaction xFe(s) + (1/4)Fe_3O_4(s) = $Fe_{(0.7500 + x)}O$(s) = $Fe_{1-y}O$(s) at ≈ 850 K, and properties of $Fe_{1-y}O$(s) to T = 1000 K. Thermodynamics of formation of wüstite: Jour. Chem. Thermodynamics, v. 25, p. 1089-1117.

133. Gronvold, F. Stolen, S., Westrum, E. F., Jr., and Galeas, C. G., 1987, Thermodynamics of copper sulfides III. Heat capacities and thermodynamic properties of $Cu_{1.75}S$, $Cu_{1.80}S$ and $Cu_{1.85}S$ from 5 to about 700 K: Jour. Chem. Thermodynamics, v. 19, p. 1305-1324.

134. Gronvold, F., and Sveen, A., 1974, Heat capacity and thermodynamic properties of synthetic magnetite (Fe_3O_4) from 300 to 1050 K. Ferrimagnetic transition and zero-point entropy: Jour. Chem. Thermodynamics, v. 6, p. 859-872.

135. Gronvold, F., Svein, S., Labban, A. K., and Westrum, E. F., Jr., 1991, Thermodynamics of iron sulfides I. Heat capacity and thermodynamic properties of Fe_9S_{10} at temperatures from 5 K to 740 K: Jour. Chem. Thermodynamics, v. 23, p. 261-272.

136. Gronvold, F., Thurmann-Moe, T., and Westrum, E. F., Jr., and Chang, E., 1961, Low-temperature heat capacities and thermodynamic functions of some platinum group chalcogenides. I. Monochalcogenides: PtS, PtTe and PdTe: Jour. Chem. Physics, 35, p. 1665-1669.

137. Gronvold, F. and Westrum, E.F., Jr., 1959, α-ferric oxide: low temperature heat capacity and thermodynamic functions. Am. Chem. Soc. Jour., v. 81, p. 1780-1783.

138. Gronvold, F., and Westrum, E. F., Jr., 1962, Heat capacities and thermodynamic functions of iron disulfide (pyrite), iron-diselenide, and nickel diselenide from 5 to 350°K. The estimation of standard entropies of transition metal chalcogenides: Inorganic Chemistry, v. 1, p. 36-48.

139. Gronvold, F., and Westrum, E. F., Jr., 1976, Heat capacities of iron disulfides. Thermodynamics of marcasite from 5 to to 700 K, pyrite from 350 to 770 K, and the transformation of marcasite to pyrite: Jour. Chem. Thermodynamics, v. 8, 1039-1048.

140. Gronvold, F., and Westrum, E. F., Jr., 1980, The anilite/ low-digenite transition: Am. Mineralogist, v. 65, p. 574-575.

141. Gronvold, F., and Westrum, E. F., Jr., 1986, Silver(I) sulfide: Ag_2S. Heat capacity from 5 to 1000 K, thermodynamic properties, and transitions: Jour. Chem. Thermodynamics, v. 18, p. 381-401.

142. Gronvold, F., and Westrum, E. F., 1987, Thermodynamics of copper sulfides. I. Heat capacity and thermodynamic properties of copper (I) sulfide, Cu_2S, from 5 to 950 K: Jour. Chem. Thermodynamics, v. 19, p. 1183-1198.

143. Gronvold, F., Westrum, E. F., Jr., and Chou, C., 1959, Heat capacities and thermodynamic properties of the pyrrhotites FeS and $Fe_{0.877}S$ from 5 to 350°K: Jour. Chem. Physics, v. 30, p. 528-531.

144. Gupta, A., and Chatterjee, N. D., 1978, Synthesis, composition, thermal stability and thermodynamic properties of bicchulite, $Ca_2[Al_2SiO_6](OH)_2$: Am. Mineralogist, v. 63, p. 58-65.

145. Gurevich, V.M., Gorbunov, V.E., Gavrichev, K.S., and Khodakovskii, I.L., 1988, The low-temperature heat capacity of livingstonite ($HgSb_4S_8$): Russ. Jour. Phys. Chemistry, v. 62, p. 699-700.

146. Gurevich, V. M., Gorbunov, V. E., Gavrichev, K. S., and Khodakovsky, I. L., 1989, Low-temperature heat capacity of proustite Ag_3AsS_3 and smithite $AgAsS_2$: Geokhimiia, p. 132-139.

147. Gurevich, V. M., Semenov, Yu. V., Sidorov, Yu. I., Gorbunov, V. E., Gavrichev, K. S., Zhananov, V. M., Turdakin, V. A., and Khodakovsky, I. L., 1990, Low-temperature specific heat of epidote $Ca_2FeAl_2Si_3O_{12}(OH)$. Geochemistry International 27(8), p.111-114.

148. Haas, J. L., Jr., and Hemingway, B. S., 1992, Recommended standard electrochemical potentials and fugacities of oxygen for the solid buffers and thermodynamic data in the systems iron-silicon-oxygen, nickel-oxygen, and copper-oxygen / by John L. Hass, Jr with comments and additions by Bruce S. Hemingway: U.S. Geological Survey Open-file Report 92-267.

149. Haas, J. L., Jr., Robinson, G. R., Jr., and Hemingway, B. S., 1981, Thermodynamic tabulations for selected phases in the system $CaO-Al_2O_3-SiO_2-H_2O$ at 101.325 kPa (1 atm) between 273.15 K and 1800 K: Jour. Phys. Chem. Ref. Data, v. 10, p. 575-669.

150. Halbach, H., and Chatterjee, N. D., 1984, An internally consistent set of thermodynamic data for twenty-one $CaO-Al_2O_3-SiO_2-H_2O$ phases by linear parametric programming: Contributions to Mineralogy and Petrology, v. 88, p. 14-23.

151. Harlov, D.E., and Newton, R.C., 1992, Experimental determination of the reaction 2 magnetite + 2 kyanite + 4 quartz = 2 almandine + O_2 at high pressure on the magnetite-hematite buffer: Am. Mineralogist, v. 77, p. 558-564.

152. Haselton, H. T., Jr., Cygan, G. L., and Jenkins, D. M., 1994, Experimental study of muscovite stability in pure H_2O and 1 molal KCl-HCl solutions: (unpublished report).

153. Haselton, H. T., and Goldsmith, J. R., 1987, The decarbonation and heat capacity of $ZnCO_3$: Geochim. Cosmochim. Acta, v. 51, p. 261-265.

154. Haselton, H. T., Jr., Hemingway, B. S., and Robie, R. A., 1984, Low-temperature heat capacities of $CaAl_2SiO_6$ glass and pyroxene and thermal expansion of $CaAl_2SiO_6$ pyroxene: Am. Mineralogist, v. 69, p. 481-489.

155. Haselton, H. T., Jr., Hovis, G. L., Hemingway, B. S., and Robie, R. A., 1983, Calorimetric investigation of the excess entropy of mixing in analbite-sanidine solid solutions: Lack of evidence for Na, K short-range order and implications for two-feldspar thermometry: Am. Mineralogist, v. 68, p. 398-413.

156. Haselton, H. R., Jr., Robie, R. A., and Hemingway, B. S., 1987, Heat capacities of synthetic hedenbergite, ferrobustamite, and $CaFeSi_2O_6$ glasses: Geochim. Cosmochim. Acta, v. 51, p. 2211-2217.

157. Haselton, H. T., Jr., and Westrum, E. F., Jr., 1980, Low-temperature heat capacities of synthetic pyrope, grossular, and $pyrope_{60}$ $grossular_{40}$: Geochim. Cosmochim. Acta, v. 44, p. 701-709.

158. Hatton, W. E., Hildenbrand, D. L., Sinke, G. C., and Stull, D. R., 1959, The chemical thermodynamic properties of calcium hydroxide: Am. Chem. Soc. Jour., v. 81, p. 5028-5030.

159. Helgeson, H. C., Delany, J. M., Nesbitt, H. W., and Bird, D. K., 1978, Summary and critique of the thermodynamic properties of rock-forming minerals: Am. Jour. Science, v.278-A, 220 p.

160. Hemingway, B. S., 1987, Quartz: Heat capacities from 340 to 1000 K and revised values for the thermodynamic properties: Am. Mineralogist, v. 72, p. 273-279.

161. Hemingway, B. S., 1990, Thermodynamic properties for bunsenite, NiO, magnetite, Fe_3O_4, and hematite, Fe_2O_3 with comments on selected oxygen buffers: Am. Mineralogist, v. 75, p. 781-790.

162. Hemingway, B. S., 1991, Thermodynamic properties for anthophyllite and talc: Corrections and discussion of calorimetric data: Am. Mineralogist, v. 76, p. 1589-1596.

163. Hemingway, B. S., Anovitz, L. M., and Robie, R. A., 1990, Thermodynamic properties of dumortierite $(Si_3B(Al_{6.75}[\ ]_{0.25}O_{17.25}(OH)_{0.75}$: Am. Mineralogist, v. 75, 1370-1375.

164. Hemingway, B. S., Barton, M. D., Robie, R. A., and Haselton, H. T., Jr., 1986, Heat capacities and thermodynamic functions for beryl, $Be_3Al_2Si_6O_{18}$, phenakite, Be_2SiO_4, euclase, $BeAlSiO_4(OH)$, bertrandite, $Be_4Si_2O_7(OH)_2$, and chrysoberyl, $BeAl_2O_4$: Am. Mineralogist, v. 71, p. 557-568.

165. Hemingway, B. S., Evans, H. T., Jr., Nord, G. L., Haselton, H. T., Jr., Robie, R. A., and McGee, J. J., 1987, Akermanite: phase transitions in heat capacity and thermal expansion, and revised thermodynamic data: Canadian Mineralogist, v. 24, p. 425-434.

166. Hemingway, B. S. and Haselton, H. T., Jr., 1994, A reevaluation of the calorimetric data for the enthalpy of formation of some K- and Na-bearing silicate minerals: U. S. Geological Survey Open-file Report 94-576, 33 p.

167. Hemingway, B. S., Krupka, K. M., and Robie, R. A., 1981, Heat capacities of the alkali feldspars between 350 and 1000 K by differential scanning calorimetry. The thermodynamic functions of the alkali feldspars from 298.15 to 1400 K, and the reaction quartz + jadeite = analbite: Am. Mineralogist, v. 66, p. 1202-1215.70 p.

168. Hemingway, B. S., and Robie, R. A., 1972, The heat capacities at low temperatures and entropies at 298.15 K of huntite, $CaMg_3(CO_3)_4$, and artinite, $Mg_2(OH)_2CO_3 \cdot 3H_2O$: Am. Mineralogist, v. 57, p. 1754-1767.

169. Hemingway, B. S., and Robie, R. A., 1973, A calorimetric determination of the standard enthalpies of formation of huntite, $CaMg_3(CO_3)_4$, and artinite, $Mg_2(OH)_2CO_3 \cdot 3H_2O$ and their standard Gibbs free energies of formation: U.S. Geol. Survey Jour. Research, v. 1, p. 535-541.

170. Hemingway, B. S., and Robie, R. A., 1977, The entropy and Gibbs free energy of formation of the aluminum ion: Geochim. Cosmochim. Acta, v. 41, p. 1402-1404.

171. Hemingway, B. S., and Robie, R. A., 1977, Enthalpies of formation of low albite ($NaAlSi_3O_8$), gibbsite ($Al(OH)_3$), and $NaAlO_2$; revised values for $\Delta H^\circ_{f,298}$ and $\Delta G_{f,298}$ of alumino-silicates: U.S. Geol. Survey Jour. Research, v. 5, p. 413-429.

172. Hemingway, B. S., and Robie, R. A., 1984, Heat capacity and thermodynamic functions for gehlenite and staurolite: Comments on the Schottky anomaly in staurolite: Am. Mineralogist, v. 69, p. 307-318.

173. Hemingway, B. S., and Robie, R. A., 1984, Thermodynamic properties of zeolites: low temperature heat capacities and thermodynamic functions for phillipsite and clinoptilolite. Estimates of the thermochemical properties of zeolitic water at low temperatures: Am. Mineralogist, v. 69, p. 692-700.

174. Hemingway, B. S., and Robie, R. A., 1990, Heat capacities and thermodynamic properties of annite (aluminous iron biotite): Am. Mineralogist, v. 75, p. 183-187

175. Hemingway, B. S. and Robie, R. A., 1994, Enthalpy and Gibbs energy of formation of dolomite, $CaMg(CO_3)_2$, at 298.15 K from HCl solution calorimetry: U. S. Geological Survey Open-File Report 94-575, 12 p.

176. Hemingway, B. S., Robie, R. A., and Apps, J. A., 1991, Revised values for the thermodynamic properties of boehmite, AlO(OH), and comments on the relative stabilities of the aluminum hydroxide and oxyhydroxide phases: Am. Mineralogist, v. 76, p. 445-457.

177. Hemingway, B. S., Robie, R. A., Evans, H. T., Jr., and Kerrick, D. M., 1991, Heat capacities and entropies of sillimanite, fibrolite, andalusite, kyanite, and quartz and the Al_2SiO_5 phase diagram. Am. Mineralogist, v. 76, p. 1597-1613.

178. Hemingway, B. S., Robie, R. A., Fisher, J. R., and Wilson, W. H., 1977, The heat capacities of gibbsite, $Al(OH)_3$, between 13 and 480 K and magnesite, $MgCO_3$, between 13 and 380 K and their standard entropies at 298.15 K, and the heat capacities of Calorimetry Conference benzoic acid between 12 and 316 K: U.S. Geol. Survey Jour. Research, v. 5, p. 797-806.

179. Hemingway, B. S., Robie, R. A., and Kittrick, J. A., 1978, Revised values for the Gibbs free energy of formation of $[Al(OH)^-_{4aq}]$, diaspore, boehmite and bayerite at 298.15 K and I bar, the thermodynamic properties of kaolinite to 800 K, and the heats of solution of several gibbsite samples: Geochim. Cosmochim. Acta, v. 42, p. 1533-1543.

180. Hemingway, B. S., Robie, R. A., Kittrick, J. A., Grew, E. S., Nelen, J. A., and London, D., 1984, The heat capacities of osumilite from 298.15 to 1000 K, the thermodynamics properties of two natural chlorites to 500 K, and the thermodynamic properties of petalite to 1800 K: Am. Mineralogist, v. 69, p. 701-710.

181. Hemingway, B. S., Robie, R. A., and Krupka, K. M., 1992, Thermodynamic properties for berlinite, $AlPO_4$: U.S. Geol. Survey Open-File Rept. 92-510, 8 p.

182. Henderson, C. E., Essene, E. J., Anovitz, L. M., Westrum, E. F., Jr., Hemingway, B. S., and Bowman, J. R., 1983, Thermodynamics and phase equilibria of clinochlore $(Mg_5Al)(Si_3Al)O_{10}(OH)_8$: EOS, v. 64, p. 466. Final term for C_p equation is missing, the value is + $1.4955x10^5T^{-2}$.

183. Henderson, C.M.B., and Thompson, A.B., 1980, The low-temperature inversion in sub-potassic nephelines: Am. Mineralogist, v. 65, p. 970-980.

184. Holland,T.J.B., 1980, The reaction albite = jadeite + quartz determined experimentally in the range 600 - 1200°C: Am. Mineral., v. 65, p. 129-134.

185. Holland, T. J. B., 1988, Preliminary phase relations involving glaucophane and applications to high pressure petrology: new heat capacity and thermodynamic data: Contributions to Mineralogy and Petrology, v. 99, p. 134-142.

186. Holland, T. J. B., 1989, Dependence of entropy on volume for silicate and oxide minerals: A review and a predictive model: Am. Mineralogist, v. 74, p. 5-13.

187. Holland, T. J. B., and Powell, R., 1985, An internally consistent thermodynamic dataset with uncertainties and correlations: 2. Data and results: Jour. Metamorphic Geology, v. 3, p. 343-370.

188. Holland, T. J. B. and Powell, R., 1990, An enlarged and updated internally consistent thermodynamic dataset with uncertainties and correlation: the system K_2O-Na_2O-CaO-MgO-MnO-FeO-Fe_2O_3-Al_2O_3-TiO_2-SiO_2-C-H_2-O_2: Jour. Metamorphic Geology. v. 8, p. 89-124.

189. Holm, J. L., Kleppa, O. J., and Westrum, E. F., Jr., 1967, Thermodynamics of polymorphic transformations in silica. Thermal properties from 5 to 1070°K and P-T stability fields for coesite and stishovite: Geochim. Cosmochim. Acta, v. 31, p. 2289-2307.

190. Holmes, R. D., Kersting, A. B., and Arculus, R. J., 1989, Standard molar Gibbs free energy of formation for Cu_2O: high-resolution electrochemical measurements from 900 to 1300 K: Jour. Chem. Thermodynamics, v. 21, p. 351-361.

191. Holmes, R.D., O'Neill, H.St.C., and Arculus, R.J., 1986, Standard Gibbs free energy of formation for Cu_2O, NiO, CoO, and Fe_xO: High resolution electrochemical measurements using zirconia solid electrolytes from 900-1400 K: Geochim. Cosmochim. Acta, v. 50, p. 2439-2452.

192. Hosmer, P. K., and Krikorian, O. H., 1980, The high-temperature enthalpies of zinc sulfate and zinc oxysulfate: High Temperatures-High Pressures, v. 12, p. 281-290.

193. Hostetler, P. B., 1963, The stability and surface energy of brucite in water at 25°C: Am. Jour. Sci., v. 21, p. 238-258.

194. Hovis, G. L., 1988, Enthalpies and volumes related to K-Na mixing and Al-Si disorder in alkali feldspars: Jour. Petrology, v. 29, p. 731-763

195. Howell, D. A., Johnson, G. K., Tasker, I. R., O'Hare, P. A. G., and Wise, W. S., 1990, Thermodynamic properties of the zeolite stilbite: Zeolites, v. 10, p. 525-531.

196. Huber, E. J., Jr., Head, E. L., and Holley, C. E., Jr., 1964, The heats of formation of zirconium diboride and dioxide: Jour. Phys. Chemistry, v. 689, p. 3040-3042.

197. Hull, H., and Turnbull, A. G., 1973, A thermochemical study of monohydrocalcite: Geochim. Cosmochim. Acta, v. 37, p. 685-694.

198. Humphrey, G. L., King. E. G., and Kelley, K. K., 1952, Some thermodynamic values for ferrous oxide: U. S. Bur. Mines Rept. Inv. 4870, 16 p.

199. Huntzicker, J. J., and Westrum, E. F., Jr., 1971, The magnetic transition, heat capacity, and thermodynamic properties of uranium dioxide from 5 to 350 K: Jour. Chem. Thermodynamics, v. 3, p. 61-76.

200. Inaba, H., Miyahara, K., and Naito, K., 1984, Measurements of the molar heat capacities of MoO_2 and MoO_3 from 350 to 950K. Jour. Chem. Thermodynamics, v. 16, p. 643-651.

201. Itskevich, Ye. S., 1961, Thermodynamic investigations at low temperatures. XII. Specific heat of bismuth telluride between 1.4 and 65° K. Enthalpy and entropy of Bi_2Te_3 at 298.15 K: Zhur. Fizicheskoi Khimii, v. 35, no. 8, p. 1813-1815.

202. Jacobs, G. K., Kerrick, D. M., and Krupka, K. M., 1981, The high-temperature heat capacity of natural calcite ($CaCO_3$): Phys. Chem. Minerals, v. 7, p. 55-59.

203. Jeffes, J. H. E., Richardson, F. S., and Pearson, J., 1954, The heats of formation of manganous orthosilicate and manganous sulfide: Faraday Society Transactions, v. 50, p. 364-370.

204. Jenkins, D. M., and Chernosky, J. V., 1986, Phase equilibrium and crystallochemical properties of Mg-chlorite: Am. Mineralogist, v. 71, p. 924-936.

205. Jenkins, D.M., Holland, T.J.B., and Clarke, A., 1991, Experimental determination of the pressure stability and thermochemical properties of synthetic tremolite: Am. Mineralogist, v. 76, p. 458-469.

206. Johnson, G. K., Flotow, H. E., O'Hare, P. A. G., and Wise, W. S., 1982, Thermodynamic studies of zeolites: analcime and dehydrated analcime: Am. Mineralogist, v. 67, p. 736-748.

207. Johnson, G. K., Flotow, H. E., O'Hare, P. A. G., and Wise, W. S., 1983, Thermodynamic studies of zeolites: natrolite, mesolite, and scolecite: Am. Mineralogist, v. 68, p. 1134-1145.

208. Johnson, G. K., Flotow, H. E., O'Hare, P. A. G., and Wise, W. S., 1985, Thermodynamic studies of zeolites: Heulandite: Am. Mineralogist, v. 70, p. 1065-1071.

209. Johnson, G.K., Grow, R.T. and Hubbard, W.N., 1975, The enthalpy of formation of lithium oxide (Li_2O): Jour. Chem. Thermodynamics, v. 7, p. 781-786.

210. Johnson, G. K., Papatheodorou, G. N., and Johnson, C. E., 1980, The enthalpies of formation and high-temperature thermodynamic functions of As_4S_4 and As_2S_3: Jour. Chem. Thermodynamics, v. 12, no. 6, p. 545-558.

211. Johnson, G. K., Papatheodorou, G. N., and Johnson, C. E., 1981, The enthalpies of formation of SbF_5(l) and Sb_2S_3(c) and the high-temperature thermodynamic functions of Sb_2S_3(c) and Sb_2S_3(l): Jour. Chem. Thermodynamics, v. 13, p. 745-754.

212. Johnson, G. K., Tasker, I. R., Flotow, H. E., and Wise, W. S., 1992, Thermodynamic studies of mordenite, dehydrated mordenite, and gibbsite: Am. Mineralogist, v. 77, p. 85-93. Note that quartz was taken as the reference phase for silica instead of silicalite.

213. Johnson, G. K., Tasker, I. R., Howell, D. A., and Smith, J. V., 1987, Thermodynamic properties of silicalite: Jour. Chemical Thermodynamics, v. 19, p. 617-632.

214. Johnson, G.K., Tasker, I.R., Jurgens, R., and O'Hare, P.A.G., 1991, Thermodynamic studies of zeolites, Clinoptilolite. Jour. Chem. Thermodynamics, v. 23, p. 475-484.

215. Kale, G. M. and Jacob, K. T., 1989, Gibbs energy of formation of Co_2SiO_4 and phase relations in the system Co-Si-O: Trans. Instn. Min. Metallurgy. Sect. C: Mineral. Process. Extr. Metall., v. 98, p. C117-122.

216. Kale, G.M. and Jacob, K.T., 1992, Chemical potential of oxygen for iron-rutile-ilmenite and iron-ilmenite-ulvospinel equilibria: Metal. Transactions, v. 23B, p. 57-64.

217. Kelley, K. K., 1960, Contributions to the data on theoretical metallurgy. XIII. High-temperature heat-capacity, and entropy data for the elements and inorganic compounds: U. S. Bureau of Mines Bulletin 584, 232 p.

218. Kelley, K. K., Barany, R., King, E. G., and Christensen, A. U., 1959, Some thermodynamic properties of fluorphlogopite mica: U.S. Bur. Mines Rept. Inv. 5436, 16 p.

219. Kelley, K. K., Shomate, C. H., Young, F. E., Naylor, B. F., Salo, A. E., and Huffman, E. H., 1946, Thermodynamic properties of ammonium and potassium alums and related substances, with reference to extraction of alumina from clay and alunite: U. S. Bur. Mines Tech. Paper 688, 104 p.

220. Kelley, K. K., Todd, S. S., Or, R. L., King, E. G., and Bonnickson, K. R., 1953, Thermodynamic properties of sodium-aluminum and potassium-aluminum silicates: U.S. Bur. Mines Rept. Inv. 4955, 21 p.

221. Khodakovsky, I. L. written communication in 1993.

222. Khriplovich, L. M., Oppermann, H., and Paukov, I. E., 1979, The heat capacity of cobalt oxide (Co_3O_4) in the range 5.1 - 307.34 K: Zuhr. Fiz Khimii, v. 53, p. 1608-1610.

223. King, E. G., 1951, Heats of formation of crystalline calcium orthosilicate, tricalcium silicate and zinc orthosilicate: Am. Chem. Soc. Jour., v. 73, p. 656-658.

224. King, E. G., 1952, Heats of formation of manganous metasilicate (rhodonite) and ferrous orthosilicate (fayalite): Am. Chem. Soc. Jour., v. 74, p. 4446-4448.

225. King, E.G., 1957, Low-temperature heat capacities and entropies at 298.15° K. of some crystalline silicates containing calcium. Am. Chem. Soc. Jour., v. 79, p. 5437-5438.

226. King, E. G., Barany, R., Weller, W. W., and Pankratz, L. B., 1967, Thermodynamic properties of forsterite and serpentine: U.S. Bur. Mines Rept. Inv. 6962, 19 p.

227. King, E. G., and Christensen, A. U., 1961, High-temperature heat contents and entropies of cerium dioxide and columbium dioxide: U. S. Bur. Mines Rept. Inv. 5789, 6 p.

228. King, E. G., Ferrante, M. J., and Pankratz, L. B., 1975, Thermodynamic data for $Mg(OH)_2$ (brucite): U. S. Bur. Mines Rept. Inv. 8041, 13 p.

229. King, E.G., and Todd, S.S., 1953, Heat capacities at low-temperature and entropies at 298.16° K of stannic and stannus sulfides: Am. Chem. Soc. Jour., v. 75, p. 3023-3029.

230. King, E. G., and Weller, W. W., 1961, Low-temperature heat capacities and entropies at 298.15°K of diaspore, kaolinite, dickite and halloysite: U.S. Bur. Mines Rept. Inv. 5810, 6 p.

231. King, E. G., and Weller, W. W., 1961, Low temperature heat capacities and entropies at 298.15°K of some sodium- and calcium-aluminum silicates: U.S. Bur. Mines Rept. Inv. 5855, 8 p.

232. King, E. G. and Weller, W. W., 1961, Low-temperature heat capacities and entropies at 298.15°K of monotungstates of sodium, magnesium, and calcium: U.S. Bur. Mines Rept. Inv. 5791, 6 p.

233. King, E. G., and Weller, W. W., 1962, Low-temperature heat capacity and entropy at 298.15°K of red mercuric sulfide: U.S. Bur. Mines Rept. Inv. 6001, 4 p.

234. King, E. G., and Weller, W. W., 1962, Low-temperature heat capacities and entropies at 298.15°K of antimony and indium sulfides: U.S. Bur. mines Rept. Inv. 6040, 5 p.

235. King, E. G., and Weller, W. W., 1970, Low-temperature heat capacities and entropies at 298.15°K of goethite and pyrophyllite: U.S. Bur. Mines Rept. Inv. 7369, 6 p.

236. King, E. G., Weller, W. W., and Christensen, A. U., 1960, Thermodynamics of some oxides of molybdenum and tungsten: U. S. Bur. Mines Rept. Inv. 5664, 29 p.

237. Kiseleva, I. A., 1984, The enthalpy of formation of grossular: Geochemistry International, v. 21(5), p. 138-141.

238. Kiseleva, I. A., Mel'chakova, L. V., and Ogorodnikova, L. P., 1986, Thermodynamical properties of beryllium minerals: chrysoberyl, beryl, euclase, and bertrandite: Geokhimiya, n. 5, p. 716-729.

239. Kiseleva, I. A., and Ogorodnikova, L. P., 1986, Calorimetric data on the thermodynamics of epidote, clinozoisite, and zoisite: Geokhimiia, n. 6, p. 846-853.

240. Kiseleva, I. A., Ogorodnikova, L. P., Topor, N. D., and Chigareva, O. G.,1980, A thermochemical study of the CaO-MgO-SiO_2 system: Geochemistry International, v. 16(6), p. 122-134

241. Kiseleva, I.A., Ogorodova, L.P., Melchakova, L.V., Bisengalieva, M.R., and Becturganov, N.S., 1992, Thermodynamic properties of copper carbonates-malachite $Cu_2(OH)_2CO_3$ and azurite $Cu_3(OH)_2(CO_3)_2$: Phys. Chem. Minerals, v. 19, p. 322-333.

242. Kiseleva,, I. A., Ogorodova, L. P., and Sokolova, E. L., 1989, Enthalpy of formation of andradite: Geokhimiia, n. 1, p. 125-131.

243. Kiseleva, I. A., Topor, N. D., and Andreyenko, E. D., 1974, Thermodynamic parameters of minerals of the epidote group: Geochemistry International, v. 11, p. 389-398.

244. Kiseleva, I. A., Topor, N. D., and Melchakova, L. V., 1972, Experimental determination of heat content and heat capacity of andradite and pyrope: Geokhimiia, n. 11, p. 1372-1379.

245. Kiukkola, K., and Wagner, C., 1957, Measurements on galvanic cells involving solid electrolytes: Jour. Electrochem. Soc., v. 104, p. 379-387.

246. Ko, H. C., Ahmad, N., and Chang, Y. A., 1982, Thermodynamics of calcination of calcite: U.S. Bur. Mines Rept. Inv. 8647, 9 p.

247. Ko, H. C., and Daut, G. E., 1980, Enthalpies of formation of α- and β-magnesium sulfate and magnesium sulfate monohydrate: U. S. Bur. Mines Rept. Inv. 8409, 8p.

248. Ko, H. C., Ferrante, M. J., and Stuve, J. M., 1977, Thermophysical properties of acmite: Proceedings of the Seventh Symposium on Thermophysical Properties, (Am. Soc. Mech. Eng.), p. 392-395.

249. Koehler, M. F., Barany, R., and Kelley, K. K., 1961, Heats and free energies of formation of ferrites and aluminates of calcium, magnesium, sodium, and lithium: U. S. Bur. Mines Rept. Inv. 5711, 14 p.

250. Koehler, M. F., and Coughlin, J. P., 1959, Heats of formation of ferrous chloride, ferric chloride and manganous chloride: Jour. Phys. Chemistry, v. 63, p. 605-608.

251. Kolesnik, Yu. N., Nogteva, V. V., Arkhipenko, D. K., Orekhov, B. A., and Ye, I., 1979, Thermodynamics of pyrope-grossular solid solutions and the specific heat of grossular at 13-300 K: Geokhimiia, n. 5, p. 713-721.

252. Komada, N., Westrum, E. F., Jr., and Hemingway, B. S., 1994, Thermodynamic properties of two iron silicates: heat capacities of deerite from 10 to 700 K and grunerite from 10 to 1000 K: Jour. Chem. Thermodynamics, (in press).

253. Konigsberger, E., and Gamsjager, H., 1987, Solid-solute phase equilibrium in aqueous solution: I solubility constant and free enthalpy of formation of huntite: Ber. Buns. Phys. Chemie., v. 91, p. 785-790.

254. Konings, R. J. M., Cordfunke, E. H. P., and Ouweltjes, W., 1988, The standard enthalpies of formation of hydroxides. II. The alkali hydroxides CsOH and KOH: Jour. Chem. Thermodynamics, v. 20, p. 777-780.

255. Kostryakov, V. N., and Kalinkina, I. N., 1964, Heat capacity and entropy for manganese, iron, cobalt, and nickel carbonates at low temperatures: Zhur. Fizicheskoi Khimii, v. 38, p 780-78.

256. Kornilov, A.N., Ushakova, I.M., Huber, E.T., Jr., and Holley, C.E., Jr., 1975, The enthalpy of formation of hafnium dioxide: Jour. Chem. Thermodynamics, v. 7, p. 21-26.

257. Krupka, K. M., Hemingway, B. S., Robie, R. A., and Kerrick, D. M., 1985, High-temperature heat capacities and derived thermodynamic properties of anthophyllite, diopside, dolomite, enstatite, bronzite, talc, tremolite, and wollastonite: Am. Mineralogist, v. 70, p. 261-271.

258. Krupka, K. M., Robie, R. A., and Hemingway, B. S., 1979, The heat capacities of corundum, periclase, anorthite, $CaAl_2Si_2O_8$ glass, muscovite, pyrophyllite, $KAlSi_3O_8$ glass, grossular, and $NaAlSi_3O_8$ glass: Am. Mineralogist, v. 64, p. 86-101.

259. Krupka, K. M., Robie, R. A., Hemingway, B. S., Kerrick, D. M., and Ito, Jun, 1985, Low-temperature heat capacities and derived thermodynamic properties of anthophyllite, diopside, enstatite, and wollastonite: Am. Mineralogist, v. 70, p. 249-260.

260. Landee, C. P., and Westrum, E. F., Jr., 1975, Thermophysical measurements on transition-metal tungstates. I. Heat capacity of zinc tungstate from 5 to 550 K: Jour. Chem. Thermodynamics, v. 7, p. 973-976.

261. Landee, C. P., and Westrum, E. F., Jr., 1976, Thermophysical measurements on transition metal tungstates. III. Heat capacity of antiferromagnetic manganese tungstate: Jour. Chem. Thermodynamics, v. 8, p. 663-674.

262. Lander, J. J., 1951, Experimental heat contents of SrO, BaO, CaO, $BaCO_3$ and $SrCO_3$ at high temperatures. Dissociation pressures of $BaCO_3$ and $SrCO_3$: Am. Chem. Soc. Jour., v. 73, p. 5794-5797.

263. Lange, R. A., Carmichael, I. S. E., and Stebbins, J. F., 1986, Phase transitions in leucite ($KAlSi_2O_6$), orthorhombic $KAlSiO_4$, and their iron analogues: Am. Mineralogist, v. 71, p. 937-945.

264. Lattard, D. and Evans, B.W., 1992, New experiments on the stability of grunerite: Euro., Jour. Mineralogy, v. 4, p. 219-238.

265. Lyon, W. G., and Westrum, E. F., Jr., 1974, Heat capacities of zinc tungstate and ferrous tungstate from 5 to 550°K: Jour. Chem. Thermodynamics, v. 6, p. 763-80.

266. Lyon, W. G., and Westrum, E. F., Jr., 1974, High temperature thermal functions and the thermochemistry of zinc tungstate: Jour. Chem. Thermodynamics, v. 6, p. 781-786.

267. Mah, A. D., 1954, Heats of formation of chromium oxide and cadmium oxide from combustion calorimetry: Am. Chem. Soc. Jour., v. 76, p. 3363-3365.

268. Mah, A. D., 1957, Heats of formation of alumina, molybdenum trioxide, and molybenum dioxide: Jour. Phys. Chemistry, v. 61, p. 1572-1573.

269. Mah, A. D., 1961, Heats of formation of cerium sesquioxide and bismuth sesquioxide by combustion calorimetry: U. S. Bur. Mines Rept. Inv. 5676, 7 p.

270. Mah, A. D., 1982, Thermodynamic data for arsenic sulfide reactions: U.S. Bur. Mines Rept. Inv. 8671, 85 p.

271. Mah, A. D., and Pankratz, L. B., 1976, Contributions to the data on theoretical metallurgy. XVI. Thermodynamic properties of nickel and its inorganic compounds: U.S. Bur. Mines Bull. 668, 125 p.

272. Mah, A. D., Pankratz, L. B., Weller, W. W., and King. E. G., 1967, Thermodynamic data for cuprous and cupric oxides: U. S. Bur. Mines Rept. Inv. 7026, 20 p.

273. Marland, G., 1975, The stability of $CaCO_3 \cdot 6H_2O$ (ikaite). Geochem. Cosmochim. Acta., v. 39, p. 83-91.

274. Mazdab, F. K., Anovitz, L. M., Hemingway, B. S., Robie, R. A., and Navrotsky, A., 1992, Thermodynamic properties of some boron-bearing minerals: Abstracts with Program, 1992, Geological Society of America, p A258.

275. McBride, J. J., and Westrum, E. F., Jr., 1976, Low-temperature heat capacity of anisotropic crystals. Lamellar molybdenum disulfide: Jour. Chem. Thermodynamics, v. 8, p. 37-44.

276. Mehrotra, G. M., Tare, V. B., and Wagner, J. B., Jr., 1985, The Standard Gibbs Energy of Formation of $Ni_{3+x}S_2$: Jour. Electrochem. Soc., v. 132, p. 247-250.

277. Metz, G. W., Anovitz, L. M., Essene, E. J., Bohlen, S. R., Westrum, E. F., and Wall, V. J., 1983, The heat capacity and phase equilibria of almandine: EOS v. 64, p. 346-347.

278. Mills, I., Cuitas, T., Homann, K., Kalloy, N., and Kuchitsu, K., 1988, Quantities, units and symbols in physical chemistry: Blackwell, Oxford, 134 p.

279. Mills, K.C., 1974, Thermodynamic data for inorganic sulfides, selenides and tellurides, Butterworths, London, 845 p.

280. Mizota, T., Tanada, H., Fujii, Y., and Koto, K., 1985, The heat capacity of cubanite and the anomaly in cubic $CuFe_2S_3$: Canadian Mineralogist, v. 23, p. 77-82.

281. Moecher, D. P., and Chou, I-Ming, 1990, Experimental investigation of andradite and hedenbergite equilibria employing the hydrogen sensor technique, with revised estimates of $\Delta_f G^{\circ}_{m,298}$ for andradite and hedenbergite: Am. Mineralogist, v. 75, p. 1327-1341.

282. Moecher, D. P., and Essene, E. J., 1990, Phase equilibria for calcic scapolite and implications of variable Al-Si disorder for P-T, T-X_{CO_2} and a-X relations. Jour. Petrology, v. 31, 997-1024.

283. Moore, G. E., 1943, Heat content of manganese dioxide and carbonate at high temperatures: Am. Chem. Soc. Jour., v. 65, p. 1398-1399.

284. Moore, G. E., 1943, Heat contents at high temperatures of the anhydrous chlorides of calcium, iron, magnesium, and manganese: Am. Chem. Soc. Jour., v. 65, p. 1700-1703.

285. Morey, G. W., Fournier, R. O., and Rowe, J. J., 1962, Solubility of quartz in water in the temperature interval from 25° to 300°C: Geochim. Cosmochim. Acta, v. 26, p. 1029-1043.

286. Mosesman, M. A., and Pitzer, K. S., 1941, Thermodynamic properties of the crystalline forms of silica: Am. Chem. Soc. Jour., v. 63, p. 2348-2356.

287. Nabutouskaya, O.A., Opperman, H., Paukov, I.E., and Khriplovich, L.M., 1985, Thermodynamic properties of cobalt monoxide at 5-328 K: Zhur. Fiz. Khim; v. 59, p. 1253-1254.

288. Navrotsky, Alexandra, 1989, Thermochemistry of perovskites in Navrotsky, Alexandra and Weidner, D.J. (eds.), Perovskite: A structure of great interest to geophysics and materials science: AGU Geophysical Monograph 45, p. 67-80.

289. Navrotsky, Alexandra, and Coons, W. E., 1976, Thermochemistry of some pyroxenes and related compounds: Geochim. Cosmochim. Acta, v. 40, p. 1281-1288.

290. Navrotsky, Alexandra, and Kleppa, O.J., 1968, Thermodynamics of formation of simple spinels: Jour. Inorg. Nucl. Chemistry, v. 30, p. 479-498.

291. Navrotsky, Alexandra, Pintchovski, F. S., and Akimoto, S. I., 1979, Calorimetric study of the stability of high pressure phases in the systems CoO-SiO_2 and "FeO"-SiO_2, and calculation of phase diagrams in MO-SiO_2 systems: Physics of the Earth and Planetary Interiors, v. 19, p. 275-292.

292. Naylor, B. F., 1944, High-temperature heat contents of ferrous and magnesium chromites: Ind. Eng. Chemistry, v. 36, p. 933-934.

293. Naylor, B. F, 1945, Heat contents at high temperatures of magnesium and calcium fluorides: Am. Chem. Soc. Jour., v. 67, p. 150-152.

294. Naylor, B. F., 1946, High-temperature heat contents of TiO, Ti_2O_3, Ti_3O_5, and TiO_2: Am. Chem. Soc. Jour. v. 68, p. 1077-1080.

295. Naylor, B. F., and Cook, O. A., 1946, High-temperature heat contents of the metatitanates of calcium, iron, and magnesium: Am. Chem. Soc. Jour., v. 68, p. 1003-1005.

296. Newton, R. C., Charlu, T. V., Anderson, P. A. M., and Kleppa, O. J., 1979, Thermochemistry of synthetic clinopyroxenes on the join $CaMgSi_2O_6$-$Mg_2Si_2O_6$: Geochim. Cosmochim. Acta, v. 43, p. 55-60.

297. Newton, R. C., Charlu, T. V., and Kleppa, O. J., 1974, A calorimetric investigation of the stability of anhydrous magnesium cordierite with application to granulite facies metamorphism: Contribution to Mineralogy and Petrology, v. 44, p. 295-311.

298. Newton, R. C., Charlu, T. V., and Kleppa, O. J., 1977, Thermochemistry of high-pressure garnets and clinopyroxenes in the system CaO-MgO-Al_2O_3-SiO_2: Geochim. Cosmochim. Acta, v. 41, p. 369-377.

299. Newton, R. C., Thompson, A. B., and Krupka, K. M., 1977, Heat capacity of synthetic $Mg_3Al_2SiO_3O_{12}$ from 350 to 1,000 K and the entropy of pyrope: EOS Trans. Am. Geophys. Union, v. 58, p. 523.

300. O'Brien, C. J., and Kelley, K. K., 1957, High temperature heat contents of cryolite, anhydrous aluminum fluoride and sodium fluoride: Am. Chem. Soc. Jour., v. 79, p. 5616-5618.

301. Ogorodova, L. N., Kiseleva, I. A., and Shuriga, T. N., 1989, Enthalpies of formation and phase transformation of cryolite: Geokhimiia, N. 8, p. 1180-1183.

302. O'Hare, P.A.G., 1972, Thermochemical and theoretical investigations of the sodium-oxygen system, Part I. The standard enthalpy of formation of sodium oxide (Na_2O): Jour. Chem. Phys., v. 56, p. 4513-4516.

303. O'Hare, P. A. G., 1987, Inorganic chalcogenides: high-tech materials, low-tech thermodynamics: Jour. Chem. Thermodynamics, v. 19, p. 675-701.

304. O'Hare, P. A. G., Hubbard, W. N., Johnson,G. K., and Flotow, H. E., 1984, Calorimetric mesurements of the low-temperature heat capacity, standard molar enthalpy of formation at 298.15 K, and high-temperature molar enthalpy increments relative to 298.15 K of tungsten disulfide (WS_2), and the thermodynamic properties to 1500 K: Jour. Chem. Thermodynamics, v. 16, p. 45-59.

305. O'Hare, P. A. G., Lewis, B. M., and Parkinson, B. A., 1988, Standard molar enthalpy of formation by fluorine-combustion calorimetry of tungsten diselenide (WSe_2). Thermodynamics of the high-temperature vaporization of WSe_2. Revised value of the standard molar enthalpy of formation of molybdenite (MoS_2): Jour. Chem. Thermodynamics, v. 20, p. 681-691.

306. Okazaki, H. and Takano, A., 1985, The specific heat of Ag_2S in alpha-phase: Zeit. Naturforsch., v. 40a, p. 986-988.

307. O'Neill, H. St. C., 1985, Thermodynamics of Co_3O_4: A possible electron spin unpairing transition in Co^{3+}: Phys. Chem. Minerals, v. 12, p. 149-154.

308. O'Neill, H. St. C., 1987, Free energies of formation of NiO, CoO, Ni_2SiO_4, and Co_2SiO_4: Am. Mineralogist, v. 72, p. 280-291.

309. O'Neill, H. St. C., 1987, Quartz-fayalite-iron and quartz-fayalite-magnetite equilibria and the free energy of formation of fayalite (Fe_2SiO_4) and magnetite (Fe_3O_4): Am. Mineralogist, v. 72, p. 67-75.

310. O'Neill, H. St. C., 1988, Systems Fe-O and Cu-O: Thermodynamic data for the equilibria Fe-"FeO," Fe-Fe_3O_4, "FeO"-Fe_3O_4, Fe_3O_4-Fe_2O_3, Cu-Cu_2O, and Cu_2O-CuO from emf measurements: Am. Mineralogist, v. 73, p. 470-486.

311. O'Neill, H. St. C., and Navrotsky, A., 1980, The thermodynamics of the clinopyroxene to pyroxenoid phase transition in the systems CaO-MnO-SiO_2: EOS, v. 61, p. 1147.

312. O'Neill, Hugh St. C., Pownceby, M. I., and Wall, V. J., 1988, Ilmenite-rutile-iron and ulvospinel-ilmenite-iron equilibria and the thermochemistry of ilmenite ($FeTiO_3$) and ulvospinel (Fe_2TiO_4): Geochim. Cosmochim. Acta, v. 52, p. 2065-2072.

313. Openshaw, R. E., Hemingway, B. S., Robie, R. A., Waldbaum, D. R., and Krupka, K. M., 1976, The heat capacities at low temperatures and entropies at 298.15 K of low albite, analbite, microcline, and high sanidine: U.S. Geol. Survey Jour. Research, v. 4, p. 195-204.

314. Orr, R. L., 1953, High temperature heat contents of magnesium orthosilicate and ferrous orthosilicate: Am. Chem. Soc. Jour., v. 75, p. 528-529.

315. Orr, R. L. and Christensen, A. U., 1958, High temperature heat contents of stannous and stannic sulfides: Jour. Phys. Chemistry, v. 62, p. 124-125.

316. Pankratz, L. B., 1964, High temperature heat contents and entropies of muscovite and dehydrated muscovite: U.S. Bur. Mines Rept. Inv. 6371, 6 p.

317. Pankratz, L. B., 1968, High-temperature heat contents and entropies of dehydrated analcite, kaliophilite, and leucite: U.S. Bur. Mines Rept. Inv. 7073, 8 p.

318. Pankratz, L. B., 1970, Thermodynamic data for silver chloride and silver bromide: U. S. Bur. Mines Rept. Inv. 7430, 12 p.

319. Pankratz, L. B., 1982, Thermodynamic properties of elements and oxides: U. S. Bur. Mines Bull. 672, 509 p.

320. Pankratz, L. B., 1984, Thermodynamic properties of halides: U. S. Bur. Mines Bull. 674, 826 p.

321. Pankratz, L. B., and Kelley, K. K., 1963, Thermodynamic data for magnesium oxide (periclase): U. S. Bur. Mines Rept. Inv. 6295, 5 p.

322. Pankratz, L. B., and Kelley, K. K., 1964, High-temperature heat contents and entropies of andalusite, kyanite, and sillimanite: U.S. Bur. Mines Rept. Inv. 6370, 7 p.

323. Pankratz, L. B., and Kelley, K. K., 1964, High-temperature heat contents and entropies of akermanite, cordierite, gehlenite, and merwinite: U.S. Bur. Mines Rept. Inv. 6555, 7 p.

324. Pankratz, L. B., and King, E. G., 1965, High-temperature heat contents and entropies of two zinc sulfides and four solid solutions of zinc and iron sulfides: U.S. Bur. Mines Rept. Inv. 6708, 8 p.

325. Pankratz, L. B., and King, E. G., 1970, High-temperature enthalpies and entropies of chalcopyrite and bornite: U.S. Bur. Mines Rept. Inv. 7435, 10 p.

326. Pankratz, L. B., Mah, A. D., and Watson, S. W., 1987, Thermodynamic properties of sulfides: U.S. Bur. Mines Bull., 689, 427 p.

327. Pankratz, L. B., and Weller, W. W., 1967, Thermodynamic properties of three lithium-aluminum silicates: U.S. Bur. Mines Rept. Inv. 7001, 13 p.

328. Pankratz, L. B., and Weller, W. W., 1969, Thermodynamic data for ferric sulfate and indium sulfate: U. S. Bur. Mines Rept. Inv. 7280, 8 p.

329. Pankratz, L. B., Weller, W. W., and Kelley, K. K., 1963, Low-temperature heat capacity and high-temperature heat content of mullite: U.S. Bur.Mines Rept. Inv. 6287, 7 p.

330. Parks, G. A., 1972, Free energies of formation and aqueous solubilities of aluminum hydroxides and oxide hydroxides at 25 °C: Am. Mineralogist, v. 57, p. 1163-1189.

331. Pashinkin, A.C., Muratova, V.A., Antyukhov, A.M., and Moiseyev, N.V., 1989, Heat capacity and thermodynamic functions of arsenopyrite (in Russian): Izv. Akad. Nauk. SSSR, Neorg. Mater., v. 25, p. 225-227.

332. Pashinkin, A.C., Muratova, V.A., Moiseyev, N.V. and Bazhenov, J.V., 1991, Heat capacity and thermodynamic functions of iron diarsenide in the temperature range 5 K to 300 K: Jour. Chem. Thermodynamics, v. 23, p. 827-830.

333. Pashinkin, A. S., Rabinovich, I. B., Sheiman, M. S., Nistratov, V. P., and Vorobjova, O. I., 1985, Heat capacity and thermodynamic functions of tellurium dioxide in the range 5 to 300 K: Jour. Chem. Thermodynamics, v. 17, p. 43-47.

334. Perkins, D., III, Essene, E. J., Westrum, E. F., Jr., and Wall, V. J., 1979, New thermodynamic data for diaspore and their implications to the system Al_2O_3-SiO_2-H_2O: Am. Mineralogist, v. 64, p. 1080-1090.

335. Perkins, D., III, Westrum, E. F., Jr., and Essene, E. J., 1980, The thermodynamic properties and phase relations of some minerals in the system CaO-Al_2O_3-SiO_2-H_2O: Geochim. Cosmochim. Acta, v. 44, p. 61-84.

336. Plummer, L. N., and Busenberg, E., 1982, The solubilities of calcite, aragonite and vaterite in CO_2-H_2O solutions between 0 and 90°C, and an evaluation of the aqueous model for the system $CaCO_3$-CO_2-H_2O: Geochim. Cosmochim. Acta, v. 46, p. 1011-1040.

337. Potter, R.W. II, 1977, An electrochemical investigation of the system copper-sulfur: Economic Geology, v. 72, p. 1524-1542.

338. Richards, A. W., 1959, The heats of formation and dissociation of zinc sulfide: Jour. Appl. Chemistry, v. 9, p. 142-145.

339. Richardson, D. W., and Brown, R. R., 1974, Enthalpy of formation of malachite [$Cu_2(CO_3)(OH)_2$]: U.S. Bur. Mines Rept. Inv. 7851, 5 p.

340. Richet, P., and Bottinga, Y., 1984, Anorthite, andesine, wollastonite, diopside, cordierite and pyrope: thermodynamics of melting, glass transitions, and properties of the amorphous phases: Earth and Planetary Science Letters, v. 67, p. 415-432.

341. Richet, P., Bottingia, Y., Denielou, L., Petitet, J.P., and Tequi, C., 1982, Thermodynamic properties of quartz, cristobalite and amorphous SiO_2: drop calorimetry measurements between 1000 and 1800 K and a review from 0 to 2000 K. Geochim. Cosmochim. Acta., v. 46, p. 2639-2658.

342. Richet, P., and Fiquet, G., 1991, High-temperature heat capacity and premelting of minerals in the system MgO-CaO-Al_2O_3-SiO_2: Jour. Geophys. Research, v. 96, No. B1, p. 445-456.

343. Richet, P., Robie, R. A., and Hemingway, B. S., 1987, Low-temperature heat capacity of diopside glass ($CaMgSi_2O_6$): A calorimetric test of the configurational-entropy theory applied to the viscosity of liquid silicates: Geochm. Cosmochim. Acta, v. 50, p. 1521-1533.

344. Richet, P., Robie, R. A., and Hemingway, B. S., 1991, Thermodynamic properties of wollastonite, pseudowollastonite and $CaSiO_3$ glass and liquid: Europ. Jour. Mineralogy, v. 3, p. 475-484.

445. Richet, P., Robie, R.A., and Hemingway, B.S., 1993, Entropy and structure of silicate glasses and melts: Geochim. Cosmochim. Acta, v. 57, p. 2751-2766.

346. Richet, P., Robie, R. A., Rogez, J., Hemingway, B. S., Courtial, P., and Tequi, C., 1990, Thermodynamics of open networks: ordering and entropy in $NaAlSiO_4$ glass, liquid, and polymorphs: Phys. Chem. Minerals, v. 17, p. 385-394.

347. Robie, R. A., 1965, Heats and free energies of formation of troilite, herzenbergite, magnesite, and rhodochrosite calculated from equilibrium data: U.S. Geol. Survey Prof. Paper 525-D, p. 65-72.

348. Robie, R. A., Bin, Zhao, Hemingway, B. S., and Barton, M. D., 1987, Heat capacity and thermodynamic properties of andradite garnet, $Ca_3Fe_2Si_3O_{12}$, between 10 and 1000 K and revised values for $\Delta_f G^\circ_m$ (298.15 K) of hedenbergite and wollastonite: Geochim. Cosmochim. Acta, v. 51, p. 2219-2224.

349. Robie, R. A., Evans, H. T., Jr., and Hemingway, B. S., 1988, Thermophysical properties of ilvaite $CaFe^{2+}_2Fe^{3+}Si_2O_7(OH)$: heat capacity from 7 to 920 K and thermal expansion between 298 and 856 K: Phys. Chem. Minerals, v. 15, p. 390-397.

350. Robie, R. A., Finch, C. B., and Hemingway, B. S., 1982, Heat capacity and entropy of fayalite (Fe_2SiO_4) between 5.1 and 383 K: comparison of calorimetric and equilibrium values for the QFM buffer reaction: Am. Mineralogist, v. 67, p. 463-469.

351. Robie, R. A., Haselton, H. T., Jr., and Hemingway, B. S., 1984, Heat capacities and entropies of rhodochrosite ($MnCO_3$) and siderite ($FeCO_3$) between 5 and 600 K: Am. Mineralogist, v. 69, p. 349-357.

352. Robie, R. A., Haselton, H. T., Jr., and Hemingway, B. S., 1989, Heat capacities and entropies at 298.15 K of $MgTiO_3$ (geikielite), ZnO (zincite), and $ZnCO_3$ (smithsonite): Jour. Chem. Thermodynamics, v. 21, p. 743-749.

353. Robie, R. A., and Hemingway, B. S., 1972, The heat capacities at low-temperatures and entropies at 298.15 K of nesquehonite, $MgCO_3 \cdot H_2O$, and hydromagnesite: Am. Mineralogist, v. 57, p. 1768-1781.

354. Robie, R. A., and Hemingway, B. S., 1973, The enthalpies of formation of nesquehonite, $MgCO_3 \cdot 3H_2O$, and hydromagnesite, $5MgO \cdot 4CO_2 \cdot 5H_2O$: U.S. Geol. Survey Jour. Research, v. 1, p. 543-547.

355. Robie, R. A., and Hemingway, B. S., 1984, Entropies of kyanite, andalusite, and sillimanite: additional constraints on the pressure and temperature of the Al_2SiO_5 triple point: Am. Mineralogist, v. 69, p. 298-306.

356. Robie, R. A., and Hemingway, B. S., 1984, Heat capacities and entropies of phlogopite ($KMg_3[AlSi_3O_{10}](OH)_2$) and paragonite ($NaAl_2[AlSi_3O_{10}](OH_2)$ between 5 and 900 K and estimates of the enthalpies and Gibbs free energies of formation: Am. Mineralogist, v. 69, p. 858-868.

357. Robie, R. A., and Hemingway, B. S., 1985, Low-temperature molar heat capacities and entropies of MnO_2 (pyrolusite), Mn_3O_4 (hausmannite) and Mn_2O_3 (bixbyite): Jour. Chem. Thermodynamics, v. 17, p. 165-181.

358. Robie, R. A., and Hemingway, B. S., 1991, Heat capacities of kaolinite from 7 to 380 K and of DMSO intercalated kaolinite from 20 to 310 K. The entropy of kaolinite $Al_2Si_2O_5(OH)_4$: Clays and Clay Minerals, v. 39, p. 362-386.

359. Robie, R. A. and Hemingway, B. S., 1994, Heat capacities of synthetic grossular ($Ca_3Al_2Si_3O_{12}$), macrocrystals of magnesite ($(Mg_{0.991}Fe_{0.005}Ca_{0.003}Mn_{0.001})CO_3$), high-temperature superconductors $YBa_2Cu_3O_{6+x}$ and $BiCaSrCu_2O_{6+x}$, and type 321 stainless steel: U. S. Geological Survey Open-File Report 94-223, 12 p.

360. Robie, R. A., Hemingway, B. S., and Ditmars, D.A., unpublished data on C_p between 10 and 360 K for calcium metal.

361. Robie, R. A., Hemingway, B. S., and Fisher, J. R., 1978, Thermodynamic properties of minerals and related substances at 298.15 K and 1 bar (10^5 pascals) pressure and at higher temperatures: U.S. Geol. Survey Bull. 1452, 456 p.

362. Robie, R. A., Hemingway, B. S., Gillet, P., and Reynard, B., 1991, On the entropy of glaucophane $Na_2Mg_3Al_2Si_8O_{22}(OH)_2$: Contributions to Mineralogy and Petrology, v. 107, p. 484-486.

363. Robie, R. A., Hemingway, B. S., Ito, J., and Krupka, K. M., 1984, Heat capacity and entropy of Ni_2SiO_4-olivine from 5 to 1000 K and of Co_2SiO_4 from 360 to 1000 K: Am. Mineralogist, v. 69, p. 1096-1101.

364. Robie, R. A., Hemingway, B. S., and Takei, H., 1982, Heat capacities and entropies of Mg_2SiO_4, Mn_2SiO_4, and Co_2SiO_4 between 5 and 380 K: Am. Mineralogist, v. 67, p. 470-482.

365. Robie, R. A., Hemingway, B. S., and Wilson, W. H., 1976, The heat capacities of Calorimetry Conference copper and muscovite $KAl_2(AlSi_3)O_{10}(OH)_2$, pyrophyllite $Al_2Si_4O_{10}(OH)_2$, and illite $K_3(Al_7Mg)(Si_{14}Al_2)O_{40}(OH)_8$ between 15 and 375 K and their standard entropies at 298.15 K: U.S. Geol. Survey Jour. Research, v. 4, p. 631-644.

366. Robie, R. A., Hemingway, B. S., and Wilson, W. H., 1978, Low-temperature heat capacities and entropies of $KAlSi_3O_8$, $NaAlSi_3O_8$, and $CaAl_2Si_2O_8$ glasses and of anorthite: Am. Mineralogist, v. 63, p. 110-123.

367. Robie, R.A., Huebner, J.S., and Hemingway, B.S., 1993, Heat capacities and thermodynamic properties of braunite (Mn_7SiO_{12}) and rhodonite ($MnSiO_3$): (unpublished report).

368. Robie, R. A., Russell-Robinson, S., and Hemingway, B. S., 1989, Heat capacities and entropies from 8 to 1000 K of langbeinite ($K_2Mg_2(SO_4)_3$), anhydrite ($CaSO_4$) and of gypsum ($CaSO_4 \cdot 2H_2O$) to 325 K: Thermochimica Acta, v. 139, p. 67-81.

369. Robie, R. A., Seal, R. R., II, and Hemingway, B. S., 1994, Heat Capacity and entropy of bornite (Cu_5FeS_4) between 6 and 760 K and the thermodynamic properties of phases in the Cu-Fe-S: Canadian Mineralogist, v. 32, 945-956.

370. Robie, R. A., and Stout, J. W., 1963, Heat capacity from 12 to 305°K and entropy of talc and tremolite: Jour. Phys. Chemistry., v. 67, p. 2252-2256.

371. Robie, R. A., Wiggins, L. B., Barton, P. B., Jr., and Hemingway, B. S., 1985, Low-temperture heat capacity and entropy of chalcopyrite ($CuFeS_2$): estimates of the standard molar enthalpy and Gibbs free energy of formation of chalcopyrite and bornite (Cu_5FeS_4): Jour. Chem. Thermodynamics, v. 17, p. 481-488.

372. Romanovskii, V. A., and Tarasov, V. V., 1960, Heat capacity of the trisulfides of arsenic, antimony, and bismuth in connection with their structural and physical-chemical properties: Sov. Phys.-Solid State, v. 2, p. 1170-1175.

373. Sack, R.O. and Ghiorso, M.S., 1991, Chromium spinels as petrogenetic indicators: Thermodynamics and petrological applications: Am. Mineralogist, v. 76, p. 827-847.

374. Saxena, S. K., and Chatterjee, N., 1986, Thermochemical data on mineral phases: the system $CaO\text{-}MgO\text{-}Al_2O_3\text{-}SiO_2$: Jour. Petrology, v. 27, p. 827-842.

375. Schaefer, S. C., 1980, Electrochemical determination of Gibbs energies of formation of MnS and $Fe_{0.9}S$: U.S. Bur. Mines Rept. Inv., 8486, 17 p.

376. Schaefer, S. C., 1981, Electrochemical determination of Gibbs energies of formation of cobalt and nickel sulfides: U.S. Bur. Mines Rept. Inv., 8588, 18 p.

377. Schaefer, S. C., 1983, Electrochemical determination of thermodynamic properties of manganese sulfate and cadmium oxysulfate: U. S. Bur. Mines Rept. Inv. 8809, 20 p.

378. Schaefer, S. C., and Gokcen, N. A., 1982, Electrochemical determination of the thermodynamic properties of sphalerite, ZnS (beta): High Temperature Science, v. 15, p. 225-237.

379. Schuiling, R. D., Vergouwen, L., and Van der Rijst, J., 1976, Gibbs energies of formation of zircon ($ZrSiO_4$), thorite ($ThSiO_4$), and phenacite (Be_2SiO_4): Am. Mineralogist, v. 61, p. 161-168.

380. Seal, R.R., II, Essene, E.J. and Kelley, W.C., 1990, Tetrahedrite and tennantite: evaluation of thermodynamic data and phase equilibria: Canadian Mineralogist, v. 28, p. 725-738.

381. Seal, R. R., II, Robie, R. A., and Hemingway, B. S., 1991, Unpublished entropy and C_p data for enargite.

382. Seal, R. R., II, Robie, R. A., Hemingway, B. S., and Barton, P. B., Jr., 1992, Superambient heat capacities of synthetic stibnite, berthierite and chalcostibite: Revised thermodynamic properties and implications for phase equilibria: Economic Geology, v. 87, p. 1911-1918.

383. Semenov, Yu. V., Malinko, S. V., Kiseleva, I. A., and Khodakovsky, I. L., 1987, The formation conditions of endogenous calcium borates and borosilicates: Geokhimiya, No. 8, p. 1182-1190.

384. Settle, J. L., Johnson, G. K., and Hubbard, W. N., 1974, The enthalpy of formation of dicesium monoxide (Cs_2O): Jour. Chem. Thermodynamics, v. 6, p. 263-269.

385. Sharp, Z. D., Essene, E. J., Anovitz, L. M., Metz, G. W., Westrum, E. F., Hemingway, B. S., and Valley, J. W., 1983, The heat capacity of natural monticellite and phase equilibria in the system CaO-MgO-SiO_2-CO_2: Geochim. Cosmochim. Acta, v. 50, p. 1475-1484.

386. Shearer, J. A., and Kleppa, O. J., 1973, The enthalpies of formation of $MgAl_2O_4$, $MgSiO_3$, Mg_2SiO_4 and Al_2SiO_5 by oxide melt solution calorimetry: Jour. Inorg. Nuc. Chemistry, v. 35, p. 1073-1078.

387. Shomate, C. H., and Naylor, B. B., 1945, High-temperature heat contents of aluminum oxide, aluminum sulfate, potassium sulfate, ammonium sulfate and ammonium bisulfate: Am. Chem. Soc. Jour., v. 67, p. 72-75.

388. Sirota, N. N., Lubyannikov, E. P., Novikov, V. V., and Sidorov, A. A., 1985, Low-temperture thermodynamic properties of cubic cubanite at temperatures of 5-300 K: Soviet Physics Doklady, v. 30, p. 789-791.

389. Southard, J. C., 1941, A modified calorimeter for high temperatures. The heat content of silica, wollastonite and thorium dioxide above 25°: Am. Chem. Soc. Jour., v. 63, p. 3142-3150.

390. Southard, J. C., and Moore, G. E., 1942, High-temperature heat content of Mn_3O_4, $MnSiO_3$ and Mn_3C: Am. Chem. Soc. Jour., v. 64, p. 1769-1770.

391. Southard, J. C., and Shomate, C. H., 1942, Heat of formation and high-temperature heat content of manganous oxide and manganous sulfate. High-temperature heat content of manganese: Am. Chem. Soc. Jour., v. 64, p. 1770-1774.

392. Staveley, L. A. K., and Linford, R. G., 1969, The heat capacity and entropy of calcite and aragonite and their interpretation: Jour. Chem. Thermodynamics, v. 1, p. 1-11.

393. Stephenson, C. C., and Smith, D., 1968, Heat capacity of manganese titanate from 30° to 300°K: Jour. Chem. Physics, v. 49, p. 1814-1818.

394. Stolen, S., Gronvold, F., and Westrum, E. F., Jr., 1990, Thermodynamics of copper sulfides. IV. Heat capacity and thermodynamic properties of $Cu_{1.90}S$ from 5 K to 750 K, $Cu_{1.95}S$ from 5 K to 1000 K, $Cu_{1.98}S$ from 300 K to 750 K: Jour. Chem. Thermodynamics, v. 22, p. 1035-1057.

395. Stolen, S., Gronvold, F., Westrum, E. F., Jr., and Kolonin, G. R., 1991, Heat capacities and thermodynamic properties of synthetic heazlewoodite, Ni_3S_2, and of the high-temperature phase $Ni_{3\pm x}S_2$: Jour. Chem. Thermodynamics, v. 23, p. 77-93.

396. Stout, J. W., and Robie, R. A., 1963, Heat capacity from 11 to 300°K. Entropy and heat of formation of dolomite: Jour. Phys. Chemistry, v. 67, p. 2248-2252.

397. Stubbles, J. R., and Birchenall, C. E., 1959, Redetermination of the lead-lead sulfide equilibrium between 585 and 920°C K: Trans. Metal. Soc. AIME., v. 215, p. 535-539.

398. Stuve, J. M., 1974, Low-temperture heat capacities of sphalerite and wurtzite: U.S. Bur. Mines Rept. Inv., 7940, 8 p.

399. Stuve, J. M., Beyer, R. P., and Brown, R. R., 1985, Thermodynamic properties of $CoS_{0.89}$, $CoS_{1.33}$, and CoS_2: U.S. Bur. Mines Rept. Inv., 8994, 11 p.

400. Stuve, J. M., and Ferrante, M. J., 1980, Low-temperature heat capacities and high-temperature enthalpies of chiolite ($Na_5Al_3F_{14}$): U. S. Bur. Mines Rept. Inv. 8442, 8 p.

401. Stuve, J. M., Ferrante, M. J., and Ko, H. C., 1978, Thermodynamic properties of $NiBr_2$ and $NiSO_4$ from 10 to 1,200 K: U.S. Bur. Mines Rept. Inv. 8271, 15 p.

402. Tequi, C., Robie, R. A., Hemingway, B. S., Neuville, D., and Richet, P., 1991, Melting and thermodynamic properties of pyrope ($Mg_3Al_2Si_3O_{12}$): Geochim. Cosmochim. Acta, v. 55, p. 1005-1010.

403. Thompson, A. B., Perkins, D. III, Sonderegger, U., and Newton, R. C., 1978, Heat capacities of synthetic $CaAl_2SiO_6$-$CaMgSi_2O_6$-$Mg_2Si_2O_6$ pyroxenes: EOS Transactions, v. 59, p. 395.

404. Thompson, A. B., and Wennemer, M., 1979, Heat capacities and inversions in tridymite, cristobalite, and tridymite-cristobalite mixed phases: Am. Mineralogist, v. 64, p. 1018-1026.

405. Todd, S. S., 1951, Low-temperature heat capacities and entropies at 298.16°K of crystalline calcium orthosilicate, zinc orthosilicate and tricalcium silicate: Am. Chem. Soc. Jour., v. 73, p. 3277-3278.

406. Todd, S. S., and Kelley, K. K., 1956, Heat and free-energy data for tricalcium dititanate, sphene, lithium metatitanate, and zinc-titanium spinel: U.S. Bur. Mines Rept. Inv. 5193, 18 p.

407. Topor, L., Kleppa, O. J., Newton, R. C., and Kerrick, D. M., 1989, Molten salt calorimetry of Al_2SiO_5 polymorphs at 1000 K. EOS Transactions (Amer. Geophys. Union), v. 70, p. 493.

408. Torgeson, D. R., and Sahama, T. G., 1948, A hydrofluoric acid solution calorimeter and the determination of the heats of formation of Mg_2SiO_4, $MgSiO_3$, and $CaSiO_3$: Am. Chem. Soc. Jour., v. 70, p. 2156-2160.

409. Toulmin, P., III, and Barton, P. B., Jr., 1964, Thermodynamic study of pyrite and pyrrhotite: Geochim. Cosmochim. Acta, v. 28, p. 641-671.

410. Treiman, A. H., and Essene, E. J., 1983, Phase equilibria in the system CaO-SiO_2-H_2O: Am. Jour. Science, v. 283-A, p. 97-120.

411. Tremaine, P.R. and LeBlanc, J.C., 1980, The solubility of magnetite and the hydrolysis and oxidation of Fe^{2+} in water to 300°C: Jour. Sol. Chemistry, v. 9, p. 415-442.

412. Turnbull, A. G., 1973, A thermochemical study of vaterite: Geochim. Cosmochim. Acta, v. 37, p. 1593-1601.

413. Ulbrich, H. H., and Waldbaum, D., R., 1976, Structural and other contributions to the third-law entropies of silicates: Geochim. Cosmochim. Acta, v. 40, p. 1-24.

414. van Lier, J. A., de Bruyn, P. L., and Overbeek, J. Th. G., 1960, The solubility of quartz: Jour. Phys. Chemistry, v. 64, p. 1675-1682.

415. Vanderzee, C. E., Rodenburg, L. N., and Berg, R. L., 1974, Thermochemical studies on red and yellow orthorhombic and on red hexagonal mercuric oxide: Jour. Chem. Thermodynamics, v. 6, p. 17-33.

416. Vanderzee, C. E., and Wigg, D. A., 1981, The standard enthalpies of solution and formation of Wegscheider's salt: $Na_2CO_3 \cdot 3NaHCO_3(s)$ and of trona: $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O(s)$ at 298.15 K: Jour. Chem. Thermodynamics, v. 13, p. 573-583.

417. Victor, A. C., and Douglas, T. B., 1961, Thermodynamic properties of thorium dioxide from 298 to 1,200°K: U. S. Natl. Bur. Standards Jour. Research, v. 65A, p. 105-111.

418. Victor, A. C., and Douglas, T. B., 1963, Thermodynamic properties of magnesium oxide and beryllium oxide from 298 to 1200°K: U. S. Natl. Bur. Standards Jour. Research, v. 67A, p. 325-329.

419. Wagman, D. D., Evans, W. H., Parker, V. B., Schumm, R. H., Halow, I., Bailey, S. M., Churney, K. L., and Nuttal, R. L., 1982, The NBS tables of chemical thermodynamic properties. Selected values for inorganic and C_1 and C_2 organic substances in SI units: Jour. Phys. Chem. Ref. Data, v. 11, supplement no. 2, 392 p.

420. Waldbaum, D. R., 1973, The configurational entropies of $Ca_2MgSi_2O_7$-$Ca_2SiAl_2O_7$ melilites and related minerals: Contributions to Mineralogy and Petrology, v. 39, p. 33-54.

421. Waldbaum, D. R., and Robie, R. A., 1971, Calorimetric investigation of Na-K mixing and polymorphism in the alkali feldspars: Zeit. Kristallographie, v. 184, p. 381-420.

422. Walther, J. V., and Helgeson, H. C., 1977, Calculation of the thermodynamic properties of aqueous silica and the solubility of quartz and its polymorphs at high pressures and temperatures: Am. Jour. Sci., v. 227, p. 1315-1351.

423. Watanabe, H., 1982, Thermochemical properties of synthetic high pressure compounds relevant to the earth's mantle. In Akimoto, S., and Manghnani, M. H., eds. High-Pressure Research In Geophysics, p. 441-464, Reidel, Dordrecht.

424. Waterfield, C. G., Linford, R. G., Goalby, B. B., Bates, T. R., Elyard, C. A., and Staveley, L. A. K., 1968, Thermodynamic investigation of disorder in the hydrates of sodium carbonate: Faraday Soc. Trans., v. 69, p. 868-874.

425. Wechsler, B.A., and Navrotsky, A., 1984, Thermodynamics and structural chemistry of compounds in the system MgO-TiO_2: Jour. Solid State Chemistry, v. 55, p. 165-180.

426. Welch, M.D., and Pawley, A.R., 1991, Tremolite: New enthalpy and entropy data from a phase equilibrium study of the reaction tremolite = 2 diopside + 1.5 ortho enstatite + β-quartz + H_2O: Am. Mineralogist, v. 76, p. 1931-1939.

427. Weller, W. W., and Kelley, K. K., 1963, Low-temperature heat capacities and entropies at 298.15°K of akermanite, cordierite, gehlenite, and merwinite: U.S. Bur. Mines Rept. Inv. 6343, 7 p.

428. Weller, W. W., and Kelley, K. K., 1964, Low-temperature heat capacities and entropies at 298.15°K of lead molybdate and lead tungstates: U.S. Bur. Mines Rept. Inv. 6357, 5 p.

429. Weller, W. W., and Kelley, K. K., 1964, Low-temperature heat capacities and entropies at 298.15°K of sulfides of arsenic, germanium and nickel: U.S. Bur. Mines Rept. Inv. 6511, 7 p.

430. Weller, W. W., and Kelley, K. K., 1966, Low-temperature heat capacities and entropies at 298.15°K of ferrous molybdate and ferrous tungstate: U.S. Bur. Mines Rept. Inv. 6782, 5 p.

431. Weller, W. W., and King, E. G., 1963, Low-temperature heat capacities and entropies at 298.15°K of monomolybdates of sodium, magnesium, and calcium: U.S. Bur. Mines Rept. Inv. 6147, 6 p.

432. Weller, W. W., and King, E. G., 1963, Low-temperature heat capacity and entropy at 298.15°K of muscovite: U.S. Bur. Mines Rept. Inv. 6281, 4 p.

433. Westrich, H. R., and Holloway, J. R., 1981, Experimental dehydration of pargasite and calculation of its entropy and Gibbs energy: Am. Jour. Science, v. 281, p. 922-934.

434. Westrich, H. R., and Navrotsky, A., 1981, Some thermodynamic properties of fluorapatite, fluorpargasite, and fluorphlogopite: Am. Jour. Science, v. 281, p. 1091-1103.

435. Westrum, E. F., Jr., written communication, September, 1959.

436. Westrum, E.F., Jr., and Beale, A.F., Jr., 1961, Heat capacities and chemical thermodynamics of cerium (III) fluoride and of cerium (IV) oxide from 5 to 300° K: Jour. Phys. Chemistry, v. 65, p. 353-355.

437. Westrum, E. F., Jr., Chou, C., and Gronvold, F., 1959, Heat capacities and thermodynamic properties of the iron tellurides $Fe_{1.11}Te$ and $FeTe_2$ from 5 to 350° K: Jour. Chem. Physics, v. 30, p. 761-764.

438. Westrum, E. F., Jr., Essene, E. J., and Perkins, D., III, 1977, Thermophysical properties of the garnet, grossular ($Ca_3Al_2Si_3O_{12}$): Jour. Chem. Thermodynamics, v. 11, p. 57-166.

439. Westrum, E.F., Jr., and Grimes, D.M., 1957, Low temperature heat capacities and thermodynamic properties of zinc ferrite: Jour. Phys. Chem. Solids, v. 3, p. 44-49.

440. Westrum, E.F., Jr., and Gronvold, F., 1969, Magnetite (Fe_3O_4) heat capacity and thermodynamic properties from 5 to 350° K low-temperature transition: Jour. Chem. Thermodynamics, v. 1, p. 543-557.

441. Westrum, E. F., Jr., and Gronvold, F., 1970, Manganese disulfide (hauerite) and manganese ditelluride. Thermal properties from 5 to 350° K and antiferromagnetic transitions: Jour. Phys. Chem., v. 52, p. 3820-3826.

442. Westrum, E. F., Jr., Stolen, S., and Gronvold, F., 1987, Thermodynamics of copper sulfides II. Heat capacity and thermodynamic properties of synthetic covellite, CuS, from 5 to 780.5 K. Enthalpy of decomposition: Jour. Chem. Thermodynamics, v. 19, p. 1199-1208.

443. White, G. K., and Collocott, S. J., 1984, Heat capacity of reference materials: Cu and W: Jour. Phys. Chem. Ref. Data, v. 13, p. 1251-1257.

444. Wise, S. S., Margrave, J. L., Feder, H. M., and Hubbard, W. N., 1963, Fluorine bomb calorimetry. V. The heats of formation of silicon tetrafluoride and silica: Jour. Phys. Chemistry, v. 67, p. 815-821.

445. Woodland, A. B., and Wood, B. J., 1989, Electrochemical measurement of the free energy of almandine ($Fe_3Al_2Si_3O_{12}$) garnet: Geochem. Cosmochim. Acta, v. 53, p. 2277-2282.

446. Wruck, B., 1987, Thermodynamic behavior of the P$\bar{1}$ - I$\bar{1}$ phase transition in anorthite (abs): Programme Physical Properties and Thermodynamic Behavior of Minerals (NATO), Cambridge.

447. Yakovlev, B. G., and Vozianova, O. V., 1983, Thermodynamical properties of almandine: Geokimiia, n. 1, p. 64-75.

448. Zhdanov, V. M., Turdakin, V. A., Arutyunov, V. S., Semenov, Yu. V., Malinko, S. V., and Kodakovsky, I. L., 1977, Low-temperature specific heat, standard entropy, and elastic parameters of datolite and danburyite: Geochemistry International, 14(6), p. 135-141.

449. Zhogin, D. Yu., Kosarukina, E. A., and Kolesov, V. P., 1980, Heat capacity in the 10-300 K range and thermodynamic functions of tetragonal tin dioxide: Zhur. Fiz. Khimii, v. 54(4), p. 916-920.

450. Heat capacity of hercynite estimated as $C_P(FeAl_2O_4) = \sum C_P(FeO) + C_P(Al_2O_3)$ by Robie. Entropy of $MnSO_4$ and other values estimated by Robie.

451. Enthalpies of solution of members of the nepheline-kalsilite series were reported by Hovis and Roux (Hovis, G.L. and Roux, J., 1993, Thermodynamic mixing properties of nepheline-kalsilite crystalline solutions: Am. Jour. Sci., v. 293, p. 1108-1127.). Using enthalpy of solution values calculated from their equations 4 and 5, ancillary data from (166, tables 1-4), and unpublished enthalpy of solution data for KCl from Hemingway ($\Delta H(soln) = 6.045 - 0.0189t(°C)$), we calculate $\Delta_f H$ = -2090.4 ± 2.5 and -2124.7 ± 2.5 kJ • mol^{-1}, respectively, for nepheline and kalsilite. These results are in good agreement with values given in (361) of -2092.1 ± 2.4 and -2121.9 ± 1.4 kJ • mol^{-1}, respectively, but based on less pure samples (20, 171). These results are significantly less negative than the formation properties calculated by (188) from a limited number of phase equilibrium experiments. The calorimetrically determined value of -3037.8 ± 2.8 kJ • mol^{-1} for leucite (171, 20) is preferred to that derived by (188) from a limited number of phase equilibrium data (-3020.0 ± 2.7 kJ • mol^{-1}).

452. Heat capacity measurements on a synthetic alunite are combined with earlier results by Kelley et al. (219) to estimate the entropy at 298.15 K. The reaction scheme used by Kelley et al. (219) is recalculated using modern values for the enthalpy of formation of the reference phases. See, Hemingway, B.S. and Robie, R.A., 1994, Heat capacity and enthalpy of formation of synthetic alunite: U.S. Geological Survey Open-file Report 94-688, 8 p.

453. High temperature heat capacities are derived from 244, 299, 402.

454. The Gibbs energy of livingstonite at 298.15 K is estimated from the study of (Sorokin, V.I., Dadze, T.P., and Pokronskiy, V.A., 1988, The Gibbs free energy of formation of livingstonite: Geokhimiya, No. 6, 897-900).

INDEX OF NAMES

	page
Acanthite (argentite)	11 45 122 148
Acmite	35 62 357
Akermanite	32 59 321
Alabandite	12 46 135 161
Albite	37 63 373
Almandine	33 60 333
Altaite	13 61 308
Aluminum	5 41 68
Aluminum ion	5
Aluminum sulfate	28 56 283
Alunite	28 56 290
Ammonia	10 44 121
Ammonia-niter	26 280
Ammonium ion	10
Analbite	2 37 64 374
Analcime	37 64 379
Anatase	19 50 223
Andalusite	31 58 305
Andradite	32 59 319
Anglesite	29 57 297
Anhydrite	28 56 285
Anilite	11
Annite	39 65 388
Anorthite	2 36 63 362
Anthophyllite	35 62 360
Antimony	9 43 106
Aragonite	25 55 267
Arcanite	28 56 288
Arsenic	5 41 69
Arsenolite	15
Arsenopyrite	14
Artinite	25
Azurite	25
Baddeleyite	20 50 228
Barite	28 56 284
Barium	5 72
Barium ion	5
Barium monoxide	15 47 177
Berlinite	30 57 299
Berndtite	13 46 142 168
Berthierite	14 46 146 172
Bertrandite	31 58 312
Beryllium	5 41 73
Beryl	31 58 311
Bianchite	29
Bicarbonate ion	15
Bicchulite	36 63 364
Bismite	15 47 179
Bismuth	5 41 74
Bismuthinite	11
Bixbyite	17 49 201
Boehmite	15 47 175
Borax	29
Boric oxide	16 176
Bornite	11 45 129 155
Boron	5 41 71
Braunite	17 49 203
Bredigite	32 59
Brochantite	28
Bromargyrite	23 53 245
Bromellite	15 47 178
Bromide ion	5
Bromine	5 41 75
Bromine (ideal gas)	5 41 4
Brucite	17 48 198
Bunsenite	18 49 207
Ca-Al pyroxene	34 61 345
$CaAl_2SiO_6$ glass	34 61
$CaAl_2Si_2O_8$ glass	36 63 363
$CaFeSi_2O_6$ glass	34 61
$CaMgSi_2O_6$ glass	34 61 348
$CaSiO_3$ glass	34 61 344
$Ca_3Al_2Si_3O_{12}$ glass	31 58
Cadmium	6 41 79
Cadmium ion	6
Calcio-olivine	32 59 325
Calcite	25 55 268
Calcium	6 41 78
Calcium ferrite	21 51 230
Calcium ion	6
Calcium nitrate	26 55 277
Calomel	23
Carbon dioxide	15 47 181
Carbon monoxide	15 47 180
Carbonate ion	15
Carbonic acid (aqueous)	15
Carnegieite	37 64 377
Cassiterite	19 50 219
Cattierrite	11 45 125 151
Celestite	29
Cerianite	16 47 184
Cerium	6 41 80
Cerussite	26
Cesium	6 84
Cesium ion	6
Chalcanthite	28
Chalcocite	11 45 127 153
Chalcocyanite	28 56 286
Chalcopyrite	11 45 128 154
Chalcostibite	14 46 147 173
Chiolite	24 54 263
Chlorargyrite	23 53 247
Chloride ion	6
Chlorine	6 41 81
Chloromagnesite	23 53 253
Chromite	21 51 234
Chromium	6 41 83
Chrysoberyl	21 51 229
Chrysotile (Antigorite)	39 65 394
Cinnabar	12
Claudetite	15
Clausthalite	13
Clinochlore	40
Clinoenstatite	34 61 353
Clinoptilolite	36
Cobalt	6 41 82
Cobalt monoxide	16 47 185
Cobalt-olivine	32 59 331
Coccinite	24
Coesite	19 50 216
Cohenite	10 44 120
Cooperite	13
Copper	6 42 85
Copper ion	6
Cordierite	33 60 334
Corundum	15 47 174
Cotunnite	23 53 257
Covellite	11 45 126 152
Cristobalite	19 50 215
Cryolite	24 54 262
Cubanite	12
Cupric ion	6
Cuprite	16 48 189
Cuprous ion	6

	page
Danburite	36 63
Datolite	32 59 317
Dawsonite	26 55 273
Dehydrated analcime	38 64 380
Dehydrated mordenite	33
Diamond	5 41 77
Diaspore	15 47
Diboron trioxide	15 47 176
Dicalcium ferrite	21 51 231
Dicesium monoxide	16
Dickite	39 65 381
Digenite	11
Dilithium monoxide	17 48 196
Diopside	34 61 347
Dipotassium monoxide	17 48 195
Disodium monoxide	18 49 206
Dititanium trioxide	19
Djurleite	11
Dolomite	25 55 269
Dumortierite	31 58 308
Edingtonite	36 63
Enargite	14
Enstatite	34 61 352
Epidote	31 58
Epsomite	29
Eskolaite	16 48 187
Euclase	31 58 309
Eucryptite	37 63 371
Fayalite	32 60 332
Ferberite	30
Ferric ion	7
Ferric sulfate	28 56 287
Ferrobustamite	34 61
Ferroselite	12
Ferrosilite	34 61 349
Ferrous ion	7
Ferrous oxide	16 48 191
Fluorapatite	30 57 301
Fluoride ion	6
Fluorine	6 42 86
Fluorite	24 54 258
Fluor-pargasite	35
Fluorphlogopite (Al/Si disordered)	39 65 391
Fluorphlogopite (Al/Si ordered)	39 65 392
Forsterite	33 60 335
Franklinite	22 52 243
Frohbergite	12
Galena	13 46 139 165
Gaspeite	26
Gehlenite	31 58 314
Geikielite	21 51 240
Germanium	7 42 88
Gibbsite	15 47
Glaucophane	35 62 361
Goethite	16
Gold	5 41 70
Goslarite	29
Graphite	5 41 76
Greenockite	11 45 124 150
Grossular	2 31 58 316
Grunerite	35 62 359
Gypsum	28
Hafnium dioxide	17
Halite	23 53 255
Halloysite	39 65
Haturite	32 59 326
Hauerite	13
Hausmannite	17 49 202
Heazlewoodite	13 46 138 164
Hedenbergite	34 61 346
Hematite	16 48 192
Hercynite	21 51 233
Herzenbergite	13 46 141 167
Hetaerolite	22
Heulandite	36
Hexagonal anorthite	36
Huebnerite	30
Huntite	25
Hydrogen	7 42 89
Hydrogen chloride	23 53 251
Hydrogen fluoride	24 54 259
Hydrogen ion	7
Hydrogen sulfide	12 46 134 160
Hydrogen sulfide ion	12
Hydromagnesite	25
Hydrophilite	23 53 248
Hydroxide ion	16
Hydroxyapatite	30 57 302
Hypersthene	35 62
Ikaite	25
Illite	39 65
Ilmenite	21 51 235
Ilvaite	32 59 318
Iodargyrite	24 54 264
Iodide ion	7
Iodine	7 42 91
Iodine (ideal gas)	7
Iron	2 7 87
Iron ion	7
Iron tennantite	14
Iron tetrahedrite	14
Jadeite	35 62 356
K-Al sulfate	28 56 289
$KAlSi_3O_8$ glass	37 63 368
Kaliophillite (Kalsilite)	37 63 369
Kaolinite	39 65 382
Karelianite	19 50 225
Kyanite	31 58 304
Langbeinite	28 56 291
Larnite (bredigite)	31 58 324
Laumontite	36
Lawrencite	23 53 249
Lawsonite	31 58 313
Lead	8 43 102
Lead ion	8
Leonhardite	36
Leucite	37 63 370
Liebenbergite	33 60 339
Lime	15 47 182
Linnaeite	11
Litharge	18 49 208
Lithium	7 93
Lithium ion	7
Livingstonite	14
Loellingite	12
Magnesiochromite	21 51 238
Magnesioferrite	21 51 239
Magnesite	25 55 271
Magnesium	8 42 94
Magnesium ion	8
Magnesium nitrate	26 55 279
Magnesium sulfate	28 56 292
Magnetite	16 48 193
Malachite	25
Manganese	8 42 95

	page
Manganese ion	8
Manganese sulfate	29 56 293
Manganosite	17 48 199
Marcasite	12 45 133 159
Margarite	39 65 384
Marshite	24 54 265
Mascagnite	29 56 294
Massicot	19
Matildite	14
Meionite (Al-Si ordered)	36 63 365
Melanterite	28
Mercuric ion	7
Mercurous ion	7
Mercury	7 42 90
Merlinoite	38
Merwinite	32 59 322
Mesolite	38
Metacinnabar	12
Methane	10 44 119
$MgSiO_3$ glass	34 61
$MgSiO_3$-Ilmenite	35 62 354
$MgSiO_3$-Perovskite	35
$Mg_3Al_2Si_3O_{12}$ glass	33 60 337
$(Mg_{1.5}Ca_{1.5})Al_2Si_3O_{12}$ glass	33 60
$(Mg_{1.8}Ca_{1.2})Al_2Si_3O_{12}$ glass	33 60
Miargyrite	14
Microcline	36 63 366
Millerite	13 46 137 163
Minium	18 49 210
Mirabilite	29
Molybdenite	13 46 136 162
Molybdenum	8 42 96
Molybdite	17 49 204
Molysite	23 53 250
Monohydrocalcite	25
Monteponite	16
Monticellite	32 59 320
Montroydite	17
Mordenite	38
Morenosite	29
Mullite	31 58 307
Muscovite (Al/Si disordered)	2 39 65 386
Muscovite (Al/Si ordered)	2 39 65 387
$NaAlSiO_4$ glass	37 64 378
$NaAlSi_2O_6$ glass	35 62
$NaAlSi_3O_8$ glass	37 64 375
$Na_{.25}K_{.75}$ feldspar	37
$Na_{.55}K_{.45}$ feldspar	37
$Na_{.85}K_{.15}$ feldspar	37
Nahcolite	26
Nantokite	23
Natrolite	38
Nepheline-$Na_{.78}K_{.22}AlSiO_4$	32 64
Nepheline	37 64 376
Nesquehonite	25
NH_4^+	10
Nickel	8 43 99
Nickelous chloride	23 53 256
Nickelous ion	8
Nickelous sulfate	29 56 289
Niningerite	12
Ni_2SiO_4-spinel	33 60 340
Nifer	26 278
Nitrate ion	17
Nitrobarite	26 55 276
Nitrogen	8 42 97
Nitrogen dioxide	17 49 205
Nukundamite	12
Oldhamite	11
Orpiment	11
Osumilite	33 60
Otavite	25
Oxygen	8 42 100
Paragonite (Al/Si disordered)	40 66 395
Paragonite (Al/Si ordered)	40 66 396
Pargasite (Al/Si ordered)	35
Pentlandite	13
Periclase	17 48 197
Perovskite	21 51 232
Petalite	37 63 372
Phenakite	31 58 310
Phillipsite	38
Phlogopite (Al/Si disordered)	2 39 65 389
Phlogopite (Al/Si ordered)	2 39 65 390
Phosphate ion	18
Phosphorus	8 43 101
Phosphorus pentoxide	18
Platinum	8 43 103
Plattnerite	18 49 209
Pollucite	36 63
Portlandite	16 47 183
Potassium	7 42 92
Potassium aluminum sulfate	28 56 289
Potassium bromide	23 53 246
Potassium hydroxide	17
Potassium ion	7
Powellite	30
Prehnite	39 65 385
Proustite	14
Pseudobrookite	21 51
Pseudowollastonite	34 61 343
Pyrargyrite	14
Pyrite	12 45 132 158
Pyrolusite	17 48 200
Pyrope	33 60 336
Pyrope-grossular	33 60
Pyrophanite	21 51 241
Pyrophyllite	39 65 383
Pyroxmangite	35
Pyrrhotite	12 45 131 157
Quartz	18 49 214
Rankinite	32 59 327
Realgar	11 45 123 149
Retgersite	29
Rhodochrosite	26 55 272
Rhodonite	35 62 355
Riebeckite	35 62
Rosenhahnite	32 59 328
Rutile	19 50 222
Salammoniac	23 53
Sanidine	2 37 63 367
Sanmartinite	30
Sapphirine	33
Scacchite	23 53 254
Scheelite	30
Scolecite	36
Selenium	9 43 107
Sellaite	24 54 260
Siderite	25 55 270
Silica glass	19 50 218
Silicalite	19
Silicic acid (aqueous)	9 19
Silicon	9 43 108
Silicon monoxide	18 49 213
Sillimanite	31 58 306
Silver	5 41 67
Silver ion	5
Smithite	14

	page
Smithsonite	26 55 275
Soda-niter	27 55 281
Sodium	8 42 98
Sodium carbonate	26
Sodium hydroxide	18
Sodium ion	8
Sphalerite	13 46 144 170
Spinel	21 51 237
α-spodumene	34 61 350
β-spodumene	34 61 351
Spurrite	32 59 329
Staurolite	33 60
Steam	17 48 194
Stibnite	13 46 140 166
Stilbite	36
Stishovite	19 50 217
Stolzite	30
Strengite	30
Strontianite	26 55 274
Strontium	9 43 110
Strontium ion	9
Strontium monoxide	19 50 220
Strontium nitrate	27 55 282
Sulfate ion	18
Sulfide ion	9
Sulfite ion	18
Sulfur	3 8 43 104
Sulfur (monoclinic)	9
Sulfur (ideal gas)	3 9 43 105
Sulfur dioxide	18 49 211
Sulfur trioxide	18 49 212
Sulfuric acid	28
Sylvite	23 53 252
Szomolnokite	28
Talc	39 65 393
Tellurite	19
Tellurium	9 43 111
Tellurobismuthite	11
Tenorite	16 48 188
Tephroite	33 60 338
Thenardite	29 56 295
Thermonatrite	26 55
Thorianite	19 50 221
Thorium	9 43 112
Tialite	21 51
Tilleyite	32 59 330
Tin	9 43 109
Titanite (sphene)	32 59 323
Titanium	9 43 113
Topaz	31 58 303
Tremolite	35 62 358
Trevorite	21 52 242
Tricobalt tetraoxide	16 47 186
Tridymite	19
Troilite	12 45 130 156
Trona	26
Tungsten	9 44 116
Tungsten dioxide	20 50 226
Tungstenite	13 46 143 169
Tungsten trioxide	20
Ulvospinel	21 51 236
Uraninite	19 50 224
Uranium	9 43 114
Valentinite	18
Vanadium	9 44 115
Vaterite	25
Villiaumite	24 54 261
Violarite	13
Wairakite	36
Water	16
Wegscheiderite	26
Whitlockite	30 57 300
Willemite	33 60
Witherite	25 55 266
Wollastonite	34 61 342
Wulfenite	30
Wurtzite	13 46 145 171
Wustite	16 48 190
Zinc	10 44 117
Zinc ion	10
Zinc tennantite	14
Zinc tetrahedrite	14
Zinc titanium spinel	22 52 244
Zincite	20 50 227
Zinkosite	29 57 298
Zircon	33 60 341
Zirconium	10 44 118
Zoisite	31 58 315

INDEX OF FORMULAS

	page
Ag	5 41 67
Ag^+	5
$AgAsS_2$	14
β-AgBiS2	14
AgBr	23 53 245
AgCl	23 53 247
AgI	24 54 264
α-$AgSbS_2$	14
Ag_2S	11 45 122 148
Ag_3AsS_3	14
Ag_3SbS_3	14
Al	5 41 68
Al^{3+}	5
$Al(OH)_3$	15 47
AlO(OH)	15 47
$AlPO_4$	30 57 299
Al_2O_3	15 47 174
$Al_2(SO_4)_3$	28 56 283
$Al_2SiO_4F_2$	31 58 303
Al_2SiO_5	31 58 304 305 306
$Al_2Si_2O_5(OH)_4$	39 65 381 382
$Al_2Si_4O_{10}(OH)_2$	39 65 383
Al_2TiO_5	21 51
$Al_6Si_2O_{13}$	31 58 307
$Al_{6.75}[]_{0.25}{}^{B}Si_3O_{17.25}(OH)_{0.75}$	31 58 308
As	5 41 69
AsS	11 45 123 149
As_2O_3	15
As_2S_3	11
Au	5 41 70
B	5 41 71
B_2O_3	15 47 176
Ba	5 72
Ba^{2+}	5
$BaAl_2Si_3O_{10}\cdot 3H_2O$	36 63
$BaCO_3$	25 55 266
$Ba(NO_3)_2$	26 55 276
BaO	15 47 177
$BaSO_4$	28 56 284
Be	5 41 73
$BeAlSiO_4(OH)$	31 58 309
$BeAl_2O_4$	21 51 229
BeO	15 47 178
Be_2SiO_4	31 58 310
$Be_3Al_2(Si_6O_{18})$	31 58 311
$Be_4Si_2O_7(OH)_2$	31 58 312
Bi	5 41 74
Bi_2O_3	15 47 179
Bi_2S_3	11
Bi_2Te_3	11
Br	5
Br_2	5 41 75
C	5 41 76 77
CH_4	10 44 119
CO	15 47 180
CO_2	15 47 181
CO_3^{2-}	15
$Ca_{0.59}{}^{Sr}0.18{}^{Ba}0.06{}^{Na}0.38{}^{K}0.13{}^{Al}2.16{}^{Si}6.84{}^{O}18\cdot 6H_2O$	36
Ca	6 41 78
Ca^{2+}	6
$CaAl_2[Al_2Si_2O_{10}](OH)_2$	39 65 384
$CaAl_2SiO_6$	34 61 345
$CaAl_2[Si_2O_7(OH)_2]\cdot H_2O$	31 58 313
$CaAl_2Si_2O_8$	36 63 362 363
$CaAl_2Si_3O_{10}\cdot 3H_2O$	36
$CaAl_2Si_4O_{12}\cdot 2H_2O$	36
$CaAl_2Si_4O_{12}\cdot 4H_2O$	36
$CaB(SiO_4)(OH)$	32 59 317
$CaB_2Si_2O_8$	36 63
$CaCO_3$	25 55 267 268
$CaCO_3\cdot H_2O$	25
$CaCO_3\cdot 6H_2O$	25
$CaCl_2$	23 53 248
CaF_2	24 54 258
$CaFeSi_2O_6$	34 61 346
$CaFe_2O_4$	21 51 230
$CaFe_3(Si_2O_7)O(OH)$	32 59 318
$CaMg(CO_3)_2$	25 55 269
$CaMgSiO_4$	32 59 320
$CaMgSi_2O_6$	34 61 347 348
$CaMg_3(CO_3)_4$	25
$CaMoO_4$	30
CaO	15 47 182
$Ca(OH)_2$	16 47 183
CaS	11
$CaSO_4$	28 56 285
$CaSO_4\cdot 2H_2O$	28
$CaSiO_3$	34 61 342 343 344
$CaTiO_3$	21 51 232
$CaTiSiO_5$	32 59 323
$CaWO_4$	30
$Ca_{1.02}{}^{Na}0.14{}^{K}.01(Al_{2.18}{}^{Si}6.82{}^{O}18)\cdot 7.33H_2O$	36
$Ca_2Al[AlSi_3O_{10}](OH)_2$	39 65 385
$Ca_2Al_2FeSi_3O_{12}(OH)$	31 58
$Ca_2Al_2SiO_6(OH)_2$	36 63 364
$Ca_2Al_2SiO_7$	31 58 314
$Ca_2Al_3Si_3O_{12}(OH)$	31 58 315
$Ca_2Al_4Si_8O_{24}\cdot 7H_2O$	36
$Ca_2Fe_2O_5$	21 51 231
$Ca_2MgSi_2O_7$	32 59 321
$Ca_2Mg_5(Si_8O_{22})(OH)_2$	35 62 358
α-Ca2SiO4	31 58 324
β-Ca_2SiO_4	31 58 324
γ-Ca_2SiO_4	32 59 325
$Ca_3Al_2Si_3O_{12}$	2 31 58 316
$Ca_3Fe_2Si_3O_{12}$	32 59 319
$Ca_3Mg(SiO_4)_2$	32 59 322
$Ca_3(PO_4)_2$	30 57 300
Ca_3SiO_5	32 59 326

	page
$Ca_3Si_2O_7$	32 59 327
$Ca_3Si_3O_8(OH)_2$	32 59 328
$Ca_4Al_6Si_6O_{24}CO_3$	36 63 365
$Ca_5(PO_4)_3F$	30 57 301
$Ca_5(PO_4)_3OH$	30 57 302
$Ca_5(SiO_4)_2CO_3$	32 59 329
$Ca_5Si_2O_7(CO_3)_2$	32 59 330
Cd	6 41 79
Cd^{2+}	6
$CdCO_3$	25
CdO	16
CdS	11 45 124 150
Ce	6 41 80
CeO_2	16 47 184
Cl^-	6
Cl_2	6 41 81
Co	6 41 82
CoO	16 47 185
CoS_2	11 45 125 151
Co_2SiO_4	32 59 331
Co_3O_4	16 47 186
Co_3S_4	11
Cr	6 41 83
Cr_2O_3	16 48 187
$(Cs_{.65}Na_{.19}Rb_{.03})Al_2Si_4O_{12}\cdot H_2O$	36 63
Cs	6 84
Cs^+	6
Cs_2O	16
Cu	6 42 85
Cu^+	6
Cu^{2+}	6
CuCl	23
$CuFeS_2$	11 45 128 154
$CuFe_2S_3$	12
CuI	24 54 265
CuO	16 48 188
CuS	11 45 126 152
$CuSbS_2$	14 46 147 173
$CuSO_4$	28 56 286
$CuSO_4\cdot 5H_2O$	28
$Cu_{1.75}S$	11
$Cu_{1.80}S$	11
$Cu_{1.95}S$	11
$Cu_2(CO_3)(OH)_2$	25
Cu_2O	16 48 189
Cu_2S	11 45 127 153
Cu_3AsS_4	14
$Cu_3(OH)_2(CO_3)_2$	25
$Cu_4(SO_4)(OH)_6$	28
Cu_5FeS_4	11 45 129 155
$Cu_{10}Fe_2As_4S_{13}$	14
$Cu_{10}Fe_2Sb_4S_{13}$	14
$Cu_{10}Zn_2As_4S_{13}$	14
$Cu_{10}Zn_2Sb_4S_{13}$	14
F^-	6
F_2	6 42 86
$Fe_{.875}S$	12 45 131 157
$Fe_{.90}S$	12 45
$Fe_{.947}O$	16 48 190
Fe	2 7 87
Fe^{2+}	7
Fe^{3+}	7
$FeAl_2O_4$	21 51 233
$FeAs_{1.08}S_{0.92}$	14
$FeAs_2$	12
$FeCO_3$	25 55 270
$FeCl_2$	23 53 249
$FeCl_3$	23 53 250
$FeCr_2O_4$	21 51 234
FeO	16 48 191
FeO(OH)	12 45 130 156
$Fe(PO_4)\cdot 2H_2O$	30
FeS	12 45 130 156
$FeSO_4\cdot H_2O$	28
$FeSO_4\cdot 7H_2O$	28
FeS_2	12 45 132 133 158 159
$FeSb_2S_4$	14 46 146 172
$FeSe_2$	12
$FeSiO_3$	34 61 349
$FeTe_2$	12
$FeTiO_3$	21 51 235
$FeWO_4$	30
Fe_2O_3	16 48 192
$Fe_2(SO_4)_3$	28 56 287
Fe_2SiO_4	32 60 332
Fe_2TiO_4	21 51 236
Fe_2TiO_5	21 51
$Fe_3Al_2Si_3O_{12}$	33 60 333
Fe_3C	10 44 120
Fe_3O_4	16 48 193
$Fe_4Al_{18}Si_8O_{46}(OH)_2$	33 60
$Fe_7Si_8O_{22}(OH)_2$	35 62 359
Ge	7 42 88
H^+	7
HCO_3^-	15
HCl	23 53 251
HF	24 54 259
HS^-	12
H_2	7 42 89
H_2CO_3	15
H_2O	16 17 48 194
H_2S	12 46 134 160
H_2SO_4	28
H_4SiO_4	9 19
HfO_2	17
Hg	7 42 90
Hg^{2+}	7
HgCl	23
HgI_2	24
HgO	17
HgS	12
$HgSb_4S_8$	14
Hg_2^{2+}	7
I^-	7
I_2	7 42 91

	page
$K_{0.80}Na_{0.20}AlSi_{1.94}O_{5.88}\cdot 1.81H_2O$	38
$K_{0.91}Na_{0.09}AlSi_{1.81}O_{5.62}\cdot 1.79H_2O$	38
K	7 42 92
K^+	7
$KAl(SO_4)_2$	28 56 289
$KAlSiO_4$	37 63 369
$KAlSi_{1.81}O_{5.62}\cdot 1.69H_2O$	38
$KAlSi_{1.94}O_{5.88}\cdot 1.69H_2O$	38
$KAlSi_2O_6$	37 63 370
$KAlSi_3O_8$	2 36 37 63 366 367
$KAl_2[AlSi_3O_{10}](OH)_2$	39 65 386 387
$KAl_3(OH)_6(SO_4)_2$	28 56 290
KBr	23 53 246
KCl	23 53 252
$KFe_3[AlSi_3O_{10}](OH)_2$	39 65 388
$KMg_2Al_3[Si_{10}Al_2O_{30}]\cdot H_2O$	33 60
$KMg_3[AlSi_3O_{10}]F_2$	39 65 391 392
$KMg_3[AlSi_3O_{10}](OH)_2$	39 65 389 390
KNO_3	26 278
KOH	17
$K_2Mg_2(SO_4)_3$	28 56 291
K_2O	17 48 195
K_2SO_4	28 56 288
$K_3(Al_7Mg)(Al_2Si_{14})O_{40}(OH)_8$	39 65
Li	7 93
Li^+	7
$LiAlSiO_4$	37 63 371
$LiAlSi_2O_6$	34 61 350 351
$LiAlSi_4O_{10}$	37 63 372
Li_2O	17 48 196
$(Mg_{.85}Fe_{.15})SiO_3$	35 62
Mg	8 42 94
Mg^{2+}	8
$MgAl_2O_4$	21 51 237
$MgCO_3$	25 55 271
$MgCO_3\cdot 3H_2O$	25
$MgCl_2$	23 53 253
$MgCr_2O_4$	21 51 238
MgF_2	24 54 260
$MgFe_2O_4$	21 51 239
$Mg(NO_3)_2$	26 55 279
MgO	17 48 197
$Mg(OH)_2$	17 48 198
MgS	12
β-$MgSO_4$	28 56 292
$MgSO_4\cdot 7H_2O$	29
$MgSiO_3$	34 61 352 353 35 62 354
$MgTiO_3$	21 51 240
$(Mg_{1.5}Ca_{1.5})Al_2Si_3O_{12}$	33 60
$(Mg_{1.8}Ca_{1.2})Al_2Si_3O_{12}$	33 60
$Mg_2Al_3(AlSi_5O_{18})$	33 60 334
$Mg_2Al_4O_6(SiO_4)$	33
$Mg_2(OH)_2CO_3\cdot 3H_2O$	25
Mg_2SiO_4	33 60 335
$Mg_3Al_2Si_3O_{12}$	33 60 336 337
$Mg_3Si_2O_5(OH)_4$	39 65 394
$Mg_3Si_4O_{10}(OH)_2$	39 65 393
$Mg_5Al(AlSi_3O_{10})(OH)_8$	40
$4MgCO_3\cdot Mg(OH)_2\cdot 4H_2O$	25
$Mg_7Si_8O_{22}(OH)_2$	35 62 360
Mn	8 42 95
Mn^{2+}	8
$MnCO_3$	26 55 272
$MnCl_2$	23 53 254
MnO	17 48 199
MnO_2	17 48 200
MnS	12 45 135 161
$MnSO_4$	29 56 293
MnS_2	13
$MnSiO_3$	35 62 355
$MnTiO_3$	21 51 241
$MnWO_4$	30
Mn_2O_3	17 49 201
Mn_2SiO_4	33 60 338
Mn_3O_4	17 49 202
Mn_7SiO_{12}	17 49 203
Mo	8 42 96
MoO_3	17 49 204
MoS_2	13 46 136 162
NH_3	10 44 121
NH_4^+	10
NH_4Cl	23 53
NH_4NO_3	26 280
$(NH_4)_2SO_4$	29 56 294
NO_2^-	17 49 205
NO_3^-	17
N_2	8 42 97
$(Na_{0.25}K_{0.75})AlSi_3O_8$	37
$Na_{0.36}Ca_{0.29}Al_{0.94}Si_{5.06}O_{12}$	38
$Na_{0.36}Ca_{0.29}Al_{0.94}Si_{5.06}O_{12}\cdot 3.47H_2$	38
$(Na_{0.55}K_{0.45})AlSi_3O_8$	37
$Na_{0.68}Ca_{0.66}(Al_{1.99}Si_{3.01}O_{10})\cdot 2.64H_2O$	38
$(Na_{0.78}K_{0.22})AlSiO_4$	32 64
$Na_{0.81}K_{0.19}AlSi_{1.81}O_{5.62}\cdot 2.18H_2O$	38
$Na_{0.81}K_{0.19}AlSi_{1.94}O_{5.88}\cdot 2.13H_2O$	38
$(Na_{0.85}K_{0.15})AlSi_3O_8$	37
Na	8 42 98
Na^+	8
$NaAlCO_3(OH)_2$	26 55 273
$NaAlSiO_4$	37 64 376 377 378
$NaAlSi_2O_6$	35 62 356 380
$NaAlSi_2O_6\cdot H_2O$	37 64 379
$NaAlSi_3O_8$	2 37 63 64 373 374
$NaAl_2[AlSi_3O_{10}](OH)_2$	40 66 395 396
$NaCa_2Mg_4Al(Al_2Si_6)O_{22}F_2$	35
$NaCa_2Mg_4Al(Al_2Si_6)O_{22}(OH)_2$	35

	page
$NaCl$	23 53 255
NaF	24 54 261
$NaFeSi_2O_6$	35 62 357
$NaHCO_3$	26
$NaNO_3$	27 55 281
$NaOH$	18
$(Na_{1.1}K_{.8})Al_{1.9}Si_{6.1}\cdot 6H_2O$	38
$Na_2Al_2Si_3O_{10}\cdot 2H_2O$	38
$Na_2B_4O_7\cdot 10H_2O$	29
Na_2CO_3	26
$Na_2CO_3\cdot H_2O$	26 55
$Na_2CO_3\cdot NaHCO_3\cdot 2H_2O$	26
$Na_2Fe_3Fe_2Si_8O_{22}(OH)_2$	35 62
$Na_2Mg_3Al_2Si_8O_{22}(OH)_2$	35 62 361
$Na_2CO_3\cdot 3NaHCO_3$	26
Na_2O	18 49 206
Na_2SO_4	29 56 295
$Na_2SO_4\cdot 10H_2O$	29
Na_3AlF_6	24 54 262
$Na_5Al_3F_{14}$	24 54 263
Ni	8 43 99
Ni^{2+}	8
$NiCl_2$	23 53 256
$NiCO_3$	26
$NiFe_2O_4$	21 52 242
NiO	18 49 207
NiS	13 46 137 163
$NiSO_4$	29 56 289
$NiSO_4\cdot 6H_2O$	29
$NiSO_4\cdot 7H_2O$	29
$(Ni_{.7}Fe_{.3})_3S_4$	13
Ni_2SiO_4	33 60 339 340
Ni_3S_2	13 46 138 164
$Ni_{4.5}Fe_{4.5}S_8$	13
OH^-	16
O_2	8 42 100
P	8 43 101
PO_4^{3-}	18
P_2O_5	18
Pb	8 43 102
Pb^{2+}	8
$PbCO_3$	26
$PbCl_2$	23 53 257
$PbMoO_4$	30
PbO	18 49 208
PbO_2	18 49 209
PbS	13 46 139 165
$PbSO_4$	29 57 297
$PbSe$	13
$PbTe$	13 61 308
$PbWO_4$	30
Pb_3O_4	18 49 210
Pt	8 43 103
PtS	13
S	3 8 43 104
S^{2-}	09
SO_2	18 49 211
SO_3^{2-}	18 49 212
SO_3^{2-}	18
SO_4^{2-}	18
S_2	3 9 43 105
Sb	9 43 106
Sb_2O_3	18
Sb_2S_3	13 46 140 166
Se	9 43 107
Si	9 43 108
SiO	18 49 213
SiO_2	18 19 49 50 214 215 216 217 218
Sn	9 43 109
SnO_2	19 50 219
SnS	13 46 141 167
SnS_2	13 46 142 168
Sr	9 43 110
Sr^{2+}	9
$SrCO_3$	26 55 274
$Sr(NO_3)_2$	27 55 282
SrO	19 50 220
$SrSO_4$	29
Te	9 43 111
TeO_2	19
Th	9 43 112
ThO_2	19 50 221
Ti	9 43 113
TiO_2	19 50 222 223
Ti_2O_3	19
U	9 43 114
UO_2	19 50 224
V	9 44 115
V_2O_3	19 50 225
W	9 44 116
WO_2	20 50 226
WO_3	20
WS_2	13 46 143 169
Zn	10 44 117
Zn^{2+}	10
$ZnCO_3$	26 55 275
$ZnFe_2O_4$	22 52 243
$ZnMn_2O_4$	22
ZnO	20 50 227
ZnS	13 46 144 145 170 171
$ZnSO_4$	29 57 298
$ZnSO_4\cdot 6H_2O$	29
$ZnSO_4\cdot 7H_2O$	29
$ZnWO_4$	30
Zn_2SiO_4	33 60
Zn_2TiO_4	22 52 244
Zr	10 44 118
ZrO_2	20 50 228
$ZrSiO_4$	33 60 341

*U.S. G.P.O.:1995-380-070:89