A COMMENT ON THE TIME-DEPENDANT EVOLUTION OF INITIAL STRONTIUM ISOTOPIC RATIO OF UPPER-CRETACEOUS AND CENOZOIC GRANITOIDS FROM CENTRAL PERU.

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In the Andes of Central Peru, one of the more striking characteristic of andean orogenesis, which starts in upper-Albian times in this area, is the importance of associated mantle-derived, I-type, medium- to high-K calk-alkaline granitoids. During this period, however, magmatic activity is not completely continuous [(1),(2),(3)], although subduction of the oceanic Nazca (Farallon)-plate appears to have been continuous at least since Albian times.

The present paper deals with the evolution of initial $^{87}Sr/^{86}Sr$ (Sri) of these granitoids, on the basis of published data [(4),(5)] and original unpublished data (6). We consider here only the granitoids of the coastal region and the lower Pacific slope of the Western Cordillera, that is to say at the level of the inner front of magmatism (its first apparition towards the trench), in the Lima area. The problem of transversal W-E variations of Sri will be discussed elsewhere (6).

From the beginning of the setting of the Coastal Batholith in the Upper-Albian to the ceasing of magmatic activity in central Peru during the Pliocene (3), Sri shows a complex evolutionnary pattern both in each individual pluton and with time :

- we show that a great number of the studied granitoids are isotopically heterogeneous; this heterogeneity accounts for most of the poorly defined Rb-Sr isochrons (5).
- we demonstrate the existence of a series of six relatively long (10-25 M.a.) periods (I to VI in the figure) during which Sri increases progressively, with different gradients according to the periods, for example, from 0.7033 to 0.7055 during period I, from 0.704 to 0.7042 during period IV. These periods of increasing Sri are separated by shorter episodes (<1 to 5 M.a.) during which Sri decreases, sometimes abruptly, for example from 0.7055 to 0.704 between 84 and 82 M.a..

The isotopic heterogeneity of individual plutons cannot be interpreted in terms of crustal contamination of the magmas during their ascent "en route" to the surface. No correlation appears between Sri and degree of differentiation, except in a few cases of evolved plutons, as the Sayan and Puscao monzogranites (5) or the Rupay granitic dyke (6).

For most of the studied granitoids, the lack of mixing trends makes the hypothesis of an heterogeneous mantellic source the more convincing, although in a few cases - the "Linga super-unit " of the Coastal Batholith (5) for example - a model of magma mixing seems to give the best fit with the data. Conceivably, the principal phenomenon accounting for the heterogeneity of source-region is the transformation of the mantle wedge by metasomatic fluids and/or melts extracted from the slab + sediments by metamorphism and /or fusion. This transformation is supposed to be a metasomatic vein-lyke one. An additionnal phenomenon (7) would be the trapping and freezing of the part of the primary melts previously produced which could not escape upward and the subsequent downward transport along the slab of the so-produced melt-veined peridotite.

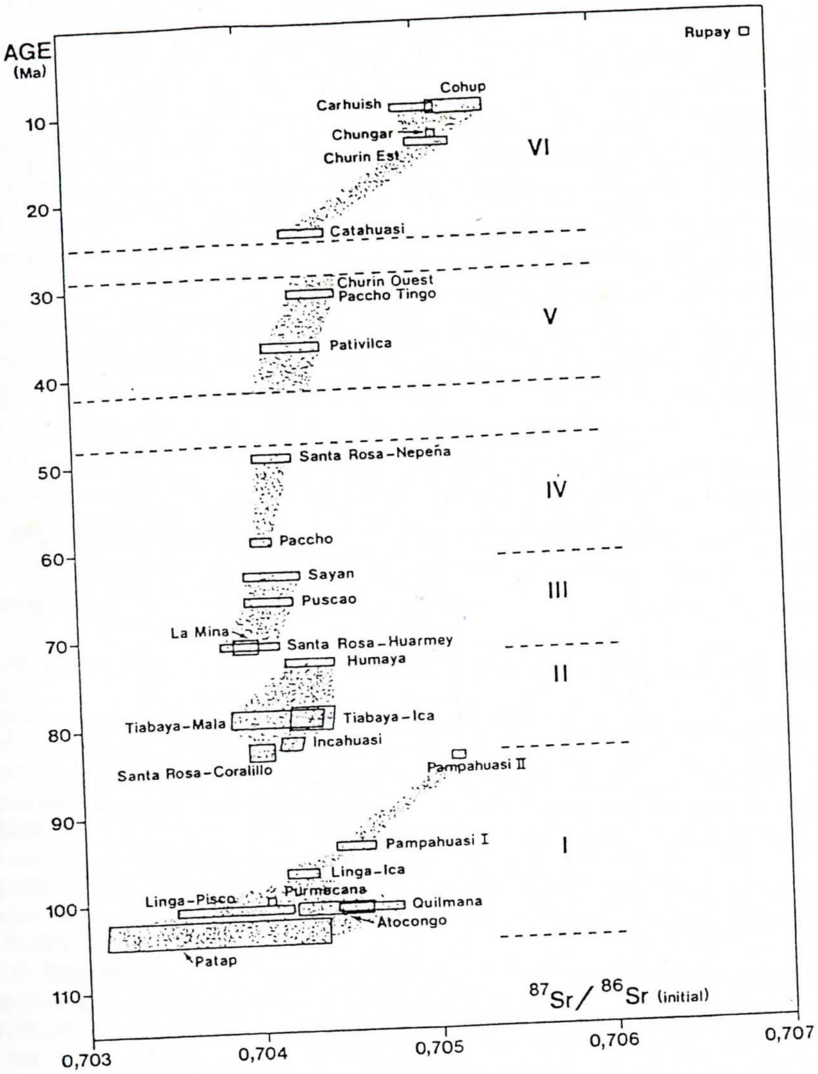

Figure : Sri versus age for upper-Cretaceous and Cenozoic granitoids from Central Peru - Data from (4), (5) and (6).

The plutons which show the greatest Sri heterogeneity are those from period I, during which continental crust is comparatively the thinnest. This, and the fact that period I is characterized by comparatively high Sri, are interpreted as the result of trapping along the Benioff-Wadati zone of abundant crustal material in the first stage of Coastal Batholith formation. We consider it as the result of the frontal erosion of an accretionnary prism formed during the Lower-Cretaceous, epoch characterized by a distensive tectonic regime and a weak coupling between both plates. Our interpretation also accounts for the Pb-isotopic composition of period I granitoids (8). The involved sediments are demonstrated to have isotopic characteristics near to those of the present-day Barbados Ridge (9), that is to say proceeding from archean Guyana shield -

lyke terrains.

This sediments may be considered as lateral equivalents of deltaic Goyllarizquizga group of central Peru.

The limit between periods I and II corresponds aproximatively with the end of the very high subduction rate period of Upper Cretaceous and may correlate with the complete resorption of the accretionnary prism.

For the periods II to V , the data are consistent with a mixing process involving a crustal component near to the present-day pacific sediments and a mantellic OIB-type one.

The cyclic evolution during these times may be interpreted in terms of a competition between subduction related alteration of the mantle wedge, which leads to both higher Sri and heterogeneity as previously noted, and mantle wedge convection which tends to insure the renewal of "normal", low Sri, more homogeneous sub-continental asthenosphère. In a context of continuous subduction, the first process is generally dominant, although during slow subduction rate or distensive episodes the second one may become temporally dominant, açcounting for the decrease of Sri, as clearly noted between I and II, between II and III (this seems to correlate with the setting of the main dyke-swarm of the Coastal Batholith (2) in a distensive tectonic regime) and between III and IV (this correlates with the end of the setting of the ring-complexes).

The increase of Sri during the most recent period is partly a transversal W-E evolution (6) but has to be correlated also with a period of high subduction rate and strong coupling between both plates which insure an ample and continuous domination of subduction-related alteration process of the mantle wedge over the mantle wedge convection process.

(1) COBBING, E.J. et al., 1981, The geology of the Western Cordillera of Northern Peru. Overseas Memoir 5, Londres, 143 p.

(2) PITCHER, W.S., ATHERTON, M.P., COBBING, E.J. et BCKINSALE, R.D.,(editors), 1985, Magmatism at a plate edge; the Peruvian Andes. Blackie, Glasgow, 323 p.

(3) SOLER P., this symposium, Chronology and spacial distribution of magmatic activity during Upper-Cretaceous and Cenozoic in Central Peruvian Andes - A plate dynamics interpretative scheme.

(4) STEWART,J.W., EVERNDEN, J.F. et SNELLING, N.J., 1974, Ade determinations from andean Peru : a reconnaissance survey. Geol. Soc. Amer. Bull., 85, p. 1107-1116.

(5) BECKINSALE, R.D., SANCHEZ F., A.W. et al., 1985, Rb-Sr whole-rock isochron and K-Ar age determinations for the Coastal Batholith of Peru. in Magmatism at a plate edge : the Peruvian Andes (W. Pitcher et al., éditeurs), Blackie, p.

(6) ROTACH-TOULHOAT N. and SOLER P., in preparation, Sr-, Nd-, and Pb-isotopic geochemistry of Cenozoic intrusive stocks from a transect of Central Peruvian Andes.

(7) ARCULUS, R.J. et POWELL, R., 1986, Source component mixing in the regions of arc magma generation. Jour. Geophys. Res., v. 91, p. 5913-5926.

(8) MUKASA, S.B., 1986, Common Pb isotopic compositions of the Lima, Arequipa and Toquepala segments in the Coastal Batholith, Peru : implications for magmagenesis. Geoch. Cosmoch. Acta, vol. 50, p. 771-782.

(9) WHITE, W.M., DUPRE, B. and VIDAL, Ph., 1985, Isotope and trace element geochemistry of sediments from the Barbados Ridge - Demerara Plain region, Atlantic ocean. Geoch. Cosmoch. Acta, vol. 49, p. 1875-1886.