# Analysis of the evolution and rank distribution of coals from the Oyon basin (Upper Jurassic) of Peru

## *Análisis de la evolución y distribución del rango de los carbones de la Cuenca de Oyón (Jurásico Superior) en Perú*

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ABSTRACT

*The Oyon Coal Basin (Upper Jurassic) is located in the central part of Peru and it is centered around two nuclei of very faulted and strongly tectonized anticlines. The middleupper part of the Oyon Formation which is representative of the sedimentary registry of this Basin contains the coal productive series. This series is formed by sandstones and clay sediments among which 5 very faulted coal seams are interlayered. Coals from this Basin are humic and they are mainly composed of vitrinite (85-97% vol.) with a relative to moderate mineral matter content (ash: 6-36%). Their degree of evolution was determined from vitrinite reflectance measurements and carbon content. The coal rank into this Basin shows a definite distribution which is successively represented by low volatile bituminous coals, semi-anthracites, anthracites and metaanthracites. The high degree of evolution reached by these coals is due to the high thermal gradient resulting from the location of important intrusive stocks (belonging to the Coast Batholit) and the subsequent volcanic activity of the different phases of the Andean Orogeny, consequence of the collision ad subduction processes of the Nazca Plate under South American lithospheric Plate.*

**Key words:** *Peru, Oyon Basin, Coal, Rank, Upper Jurassic, Andean orogeny.*

RESUMEN

*La Cuenca Carbonífera de Oyón (Jurásico Superior) se localiza en la parte central de Perú y está centrada alrededor de los nucleos de dos anticlinales fallados y fuertemente tectonizados. La parte media-superior de la Formación Oyón, representativa del resgistro sedimentario de esta Cuenca, contiene la serie productiva y se encuentra formada por areniscas y sedimentos arcillosos entre los cuales se intercalan 5 capas de carbón. Los carbones de esta cuenca son húmicos y están formados mayoritariamente por vitrinita (85-97% vol.) con un relativo a moderadamente alto contenido en materia mineral (cenizas:6-36%). Su grado de evolución fue determinado a partir de las medidas de reflectancia de la vitrinita y del contenido en carbono. Así, la distribución del rango en esta cuenca muestra una zonación definida que está sucesivamente representada por los estadios de evolución correspondientes al rango de los carbones bituminosos de bajos volátiles, semiantracitas, antracitas y meta-antracitas. La conclusión más importante es que el elevado grado de evolución alcanzado por estos carbones es debido al alto gradiente térmico provocado por los stocks intrusivos de dimensiones kilométricas del Borde Este del Batolito de la Costa así como por la actividad volcánica de las diferentes fases de la Orogenia Andina como consecuencia de la colisión y subducción de la Placa Nazca bajo la Placa Suramericana.*

**Palabras clave:** *Perú, Cuenca de Oyón, Carbón, Rango, Jurásico Superior, Orogenia Andina.*

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### Introduction and objetive

The Oyon Coal Basin is located in the central part of Peru in the Lima Department (Fig.1). Its age is Upper Jurassic (Cobbing, 1973) and according to geographical and geological criteria it is subdivided into two sectors: Gazuna in the Northwest part of the Basin and Pampahuay in the Southern part. Both sectors are centered around two nuclei of very faulted and strongly tectonized anticlines.

The Oyon Formation which is representative of the sedimentary registry of this Basin has an estimated thickness (Núñez del Prado, 1989) of 400-500 m and its middle-upper part contains the productive coal series. This series has a thickness (Kópex MineroPerú, 1973) of 250-270 m and it is formed by sandstones and clay sediments among which 5 very faulted coal seams with a thickness varying between 0,8 and 2,5 m (exceptionally 10 m) are interlayered. In general, these coals are unknown therefore, the objective of the present work was to determine the main features of Jurassic coals in the Oyon Basin and their rank distribution.

### Analytical Procedures

A petrographic study was carried out on these coals by means of reflected white light using oil immersion objectives (32x) for reflectance measurements and maceral analyses. Chemical characterization related to the ash, carbon and

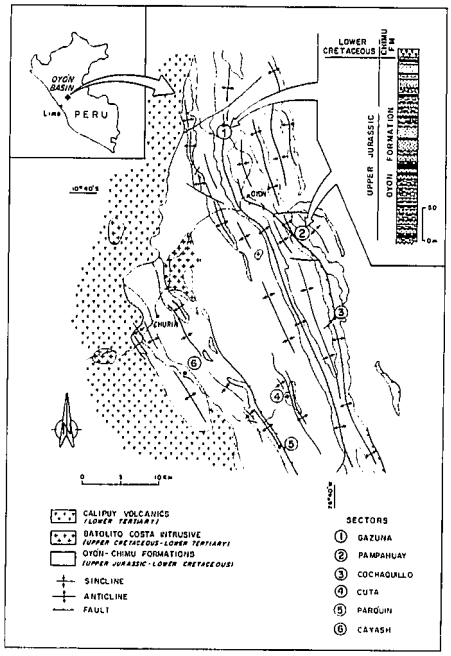


**Fig.1.- Geographical location and geological setting of the Oyon Basin (Peru).**

*Fig.1.- Situación geográfica y geológica de la Cuenca de Oyón (Perú).*

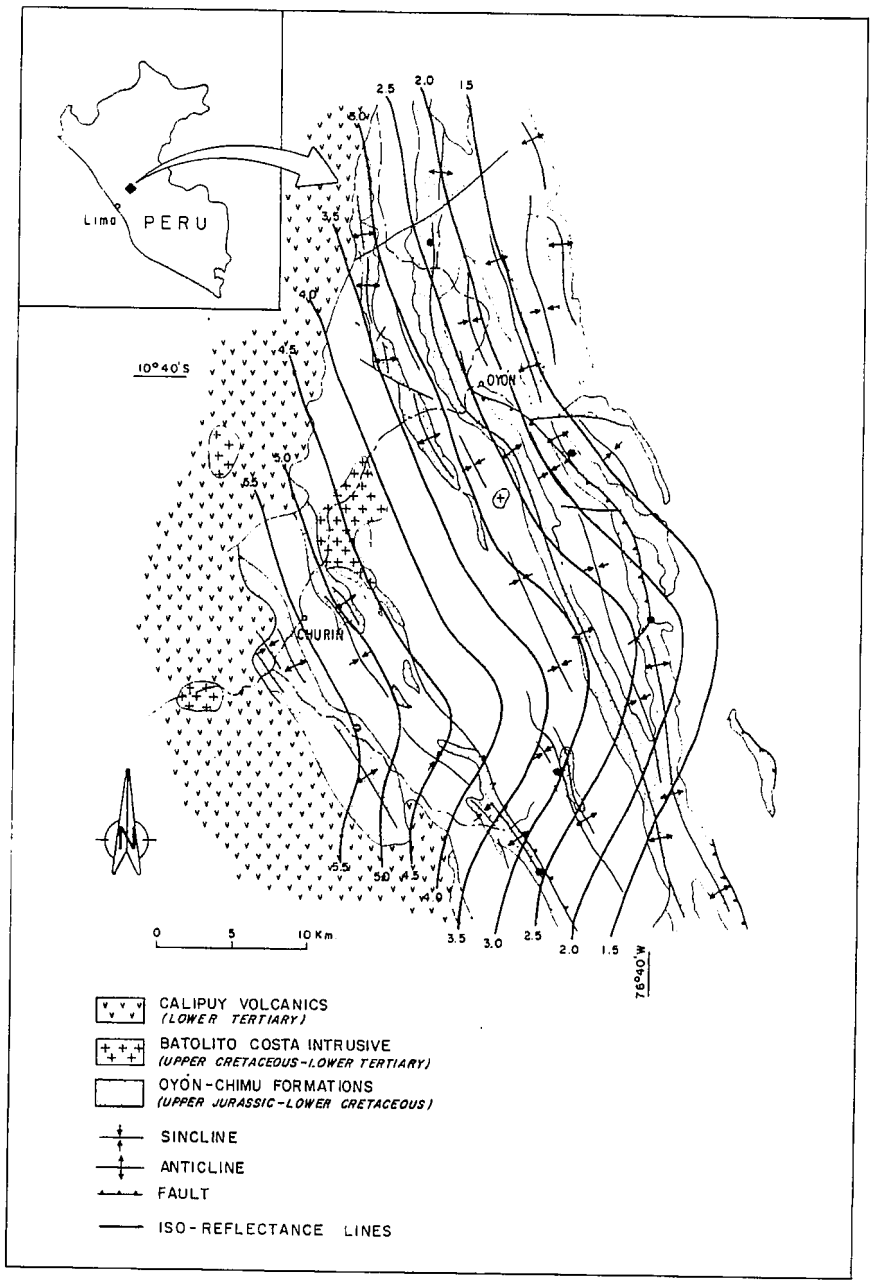


**Fig.2.- Distribution of iso-reflectance values.**

*Fig.2.- Distribución de los valores de iso-reflectancia.*

volatile matter contents was carried out in accordance with International Standard Procedures as were petrographic analyses.

## Results and Discussion

In general, coals from this Basin are humic, banded and they are mainly composed of clarain and vitrain lithotypes. Their color is bright black with a greasy luster and they were generated in a coastal marsh sedimentary environment. Their mineral matter content is variable (ash content: (6-36%) although exceptionally in some areas, ash content can reach 50-70%.As for maceral composition, vitrinite is predominant constituting as much as 97% (vol.mmf) of the total identified organic compounds for the Gazuna Sector (NW part of the Basin). Liptinite (mainly resinite and sporinite) is very scarce (<2% vol.mmf) for coals from the Pampahuay sector (SE part of the Basin) while it is rare appearing in vitrinized form in coals from the Gazuna area. Inertinite is slightly more abundant (3-13% vol.mmf) in coals from the Pampahuay sector. In addition, coals from the other areas located in the SW part of the Basin such as Cochaquillo, Cuta, Parquin and Cayash were analyzed. In all cases they show a similar composition to that described for coals from the other two sectors (Gazuna and Pampahuay).

The coal rank distribution for this Basin is calculated from the iso-values of the mean random vitrinite reflectance (%) and carbon content (% daf) as shown in Fig.2 and in Fig.3. Coals from the Pampahuay sector have reached an evolutionary stage corresponding to the low volatile bituminous coal rank (phase of wet gas generation in the catagenesis stage) with reflectances of between 1,6 and 2,0%, carbon content of between 86-92% (daf) and volatile matter of 21-13% (daf). The increase in reflectance values in some specific coals from this sector is directly related to the presence of an inverse fault of regional character which cuts across all the coal productive series (Fig.2).

Coals from the Gazuna sector in the NW part of the Basin (Fig.2 and 3) are more evolved. They are anthracites with weak anisotropy (phase of dry gas generation in the metagenesis stage) presenting random reflectance values of

between 2,24 - 2,52%, carbon contents of 85-93% (daf) and volatile matter values of 12-8% (daf). The increase in rank observed at the bottom of the productive series in the sector coincides with the proximity of the nucleus of the anticline structure (Fig. 2 and 3). In addition, andesitic dikes which affect coal beds have contributed to an increase in the degree of evolution in this zone. The presence of the vitrinized liptinitic compounds also indicates rapid heatings.

The data obtained from coals belonging to the two main sectors as well as the data from coals sampled in the SW part of the Basin (Cochaquillo, Cuta, Parquin and Cayash) show that the rank variation has a clearly defined zonal distribution. Thus, a lateral increase in coal rank (Fig.2 and 3) from East to West is observed. This zonal distribution is successively represented by the evolutionary stages corresponding to the low volatile bituminous coal rank (Pampahuay), semianthracite rank (Gazuna and Cochaquillo), anthracites (Parquin and Cuta) and meta-anthracites (Cayash). The increase in rank in the Western part of the Basin is due to the higher thermal gradient resulting from the location in this area of intrusive stocks that belong to the eastern border of the Coast Batholit (introduced during the Upper Cretaceous - Lower Tertiary) and the subsequent volcanic activity of the Lower Tertiary represented by the so-called Calipuy Volcanics (Fig. 1).

## Conclusions

The higher rank reached by the Jurassic coals of the Oyon Coal Basin is due to the influence of the different phases of the Andean Orogeny. The latter were a consequence of the collision and the subsequent subduction processes of the Nazca Plate under the South American lithospheric plate. This event has generated a magmatism which has given rise to an abnormal and rapid increase in thermal gradient in this part of Peru. As a result all the coal seams in the Oyon Basin, have been affected and their rank has increased significantly.

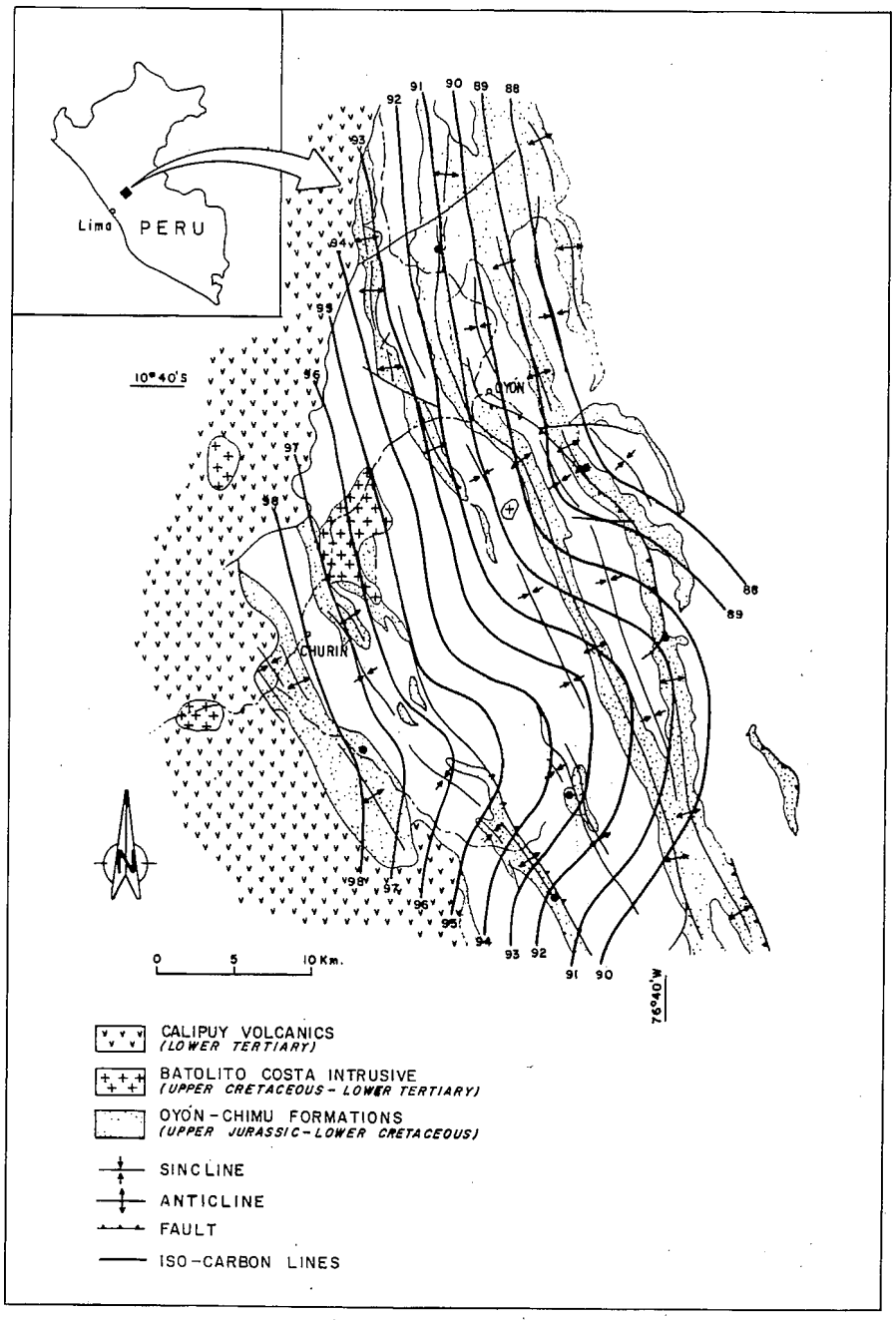


**Fig. 3.- Distribution of iso-carbon values.**

***Fig. 3.- Distribución de los valores de iso-carbono.***

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