

## **Characterization of coals from the El Mulato and La Rica mountain ranges, Ojinaga sub-basin (Upper Cretaceous), Chihuahua, Mexico.**

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The Ojinaga sub-basin is located in the south-east of the sedimentary Chihuahua Basin. The area is characterized by mountain ranges, made up mainly of sedimentary rocks of Upper Cretaceous age and volcanic rocks of Tertiary age. Among the mountain ranges of El Mulato and La Rica, in the Ojinaga sub-basin, there is a lithological sequence of shaly sandstone, carbonaceous shale, black shale, and sandy shale with an interbedded coal seam and coal beds with a varying thickness of less than 0.5 m. The coal seam appear at the top of the lithological sequence that constitutes the so-called Aguja Marina Formation of Upper Cretaceous age (Lower Campanian) (Adkins, 1932, Maxwell and Dietrich, 1965; Vaughan, 1900; Wolleben, 1965, Cabrera et al., 1984), which is correlated with the San Carlos Formation. The Aguja Marina Formation presents a deeper facies than the San Carlos Formation. Some authors like Wolleben (1965) and Cabrera et al. (1984), limit the stratigraphic range of the San Carlos Formation, and consider that the

coal beds are located underneath the Picachos Formation (Upper Campanian) of western Chihuahua (Vivar, 1925). Alcantara-Diaz and Camacho-Vazquez (1977) consider that the coal seam and beds are underneath the Aguja Continental Formation (Upper Campanian) (Adkins, 1932, Maxwell and Dietrich, 1965; Vaughan, 1900; Wolleben, 1965, Cabrera et al., 1984).

To carry out this study, coals and carbonaceous rocks were collected from the El Mulato and La Rica mountains, with the aim of making a petrological and geochemical study of these materials and assessing their economic potential as an energy source for northern Mexico. During the sampling, a variation was observed in the depositional environments (open sea to delta) in where the coal was formed. The lithological sequences are conformities and have transitional contacts both at the base and at the top. In the vicinity of the sampled area, igneous intrusions were detected.

The vitrinite reflectance of the studied coals varies between 0.4 and 1.65%, indicating that the organic matter is predominantly located in the oil-gas window. Consequently the coal samples can be classified as sub-bituminous to low-volatile bituminous coals. Some carbonaceous rocks showed alterations in their organic fraction, probably related to hydrothermal phenomena. The Rock-Eval pyrolysis results from the coals and carbonaceous rocks taken from the Ojinaga sub-basin, show variable  $T_{max}$  (~ 434 ° C to 517 ° C) values, consistent with the petrographic data, indicating thermally mature to overmature organic matter. The TOC and HI values for the coal samples exhibit two groups, one of which shows a potential for hydrocarbon (gas) generation, while the other shows signs of hydrocarbon depletion.

The petrographic and geochemical characteristics of the studied samples indicate that the organic matter of the coals and carbonaceous rocks of the El Mulato and La Rica Sierras in the Ojinaga sub-basin suggest different conditions of deposition. This influenced the preserved type of organic matter and consequently its potential properties for generating hydrocarbons (mainly gas). Further studies with biomarkers will provide more information and the results may be useful for an economic evaluation of the coal seam and beds in this area of the Ojinaga sub-basin.

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