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THE APPLICATIONS OF HRTEM AND AEM TO THE STUDY OF CLAY MINERALS AND THE DIAGENESIS - METAMORPHISM TRANSITIONAL FIELD

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A judicious use of the various modes of Transmission Electron Microscopy (TEM), i.e. high resolution transmission electron microscopy (HRTEM), analytical electron microscopy (AEM) and selected area electron diffraction (SAD), which makes it possible to observe areas as small as 3Å-5Å and thus clear up hitherto unresolvable problems, renders it an invaluable tool to the geologist, especially the mineralogist and petrologist (1). The aim of this communication is serve as a guide to describe some of its applications to the study of clay minerals and also diagenetic-metamorphic transformations.

TEM-AEM APPLIED TO CLAY MINERALS

Morphology and genesis. A study of the morphology of smectites, illites and chlorites and of their geochemistry allows us to establish various different origins for marine sediments such as proximal and subaerial volcanic, transitional from volcanic to diagenetic, marine diagenetic, and detrital (2).

Microanalysis and reconstruction of the palaeoenvironment. Statistical and microanalytical studies of the smectites, illites, palygorskites and zeolites in black-shale-type sediments in the Betic Cordillera suggest that the halmiolytic alteration of the Atlantic and/or tethyan volcanic rocks generated a large quantity of smectites, which were carried by bottom currents to the betic domains. Palygorskite and zeolites were formed during early diagenetic transformations (3).

Selected-area electron diffraction permits the rapid distinction between phyllosilicates of similar chemical composition and the measure of the crystalline parameters.

HRTEM-AEM APPLIED TO THE DIAGENESIS-METAMORPHISM TRANSITIONAL FIELD

Traditional XRD studies and their related parameters (illite "crystallinity" index and smectite proportion in mixed-layer I/S) have proved to be insufficient when studying the degree of evolution of shales and slates from diagenesis to green-schist facies (4,5). HRTEM together with EDX permits the direct observation of the microstructural relationships at unit cell level and the microanalysis of packets down to 10 phyllosilicate layers. This high spatial and analytical resolution makes it possible to establish, for example: a) the exact physico-chemical mechanisms during the evolution of Sm — I+Chl — Mi+Chl and the true nature of the mixed-layers (4); b) the evolution in the composition of the phyllosilicates and the existence of various textural models according to the diagenetic-metamorphic grade (4,6); c) the evolution of the polytypes in the micas and the true physical meaning of the term "crystallinity" (6,7); d) lastly, the definition of three zones, I-Chl-Bi, from lower to greater grade according to the above-mentioned characteristics (8).

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REFERENCES