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Correlation of the clay mineral distributions in the sedimentary rocks of south and western Zagros, Iran

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Introduction

Clay minerals of calcareous sedimentary rocks of south (Fars and Kuhgiluyeh Boyer-ahmad Provinces) and western Iran (Kurdestan Province) as a part of the old Tethys area were investigated in order to compare their origin and distribution in the different geological formations and different areas, and to reconstruct the paleoclimate of the area. Chemical analysis, XRD, TEM, SEM, and thin section studies were performed on the twenty major sedimentary rocks. The studied samples represent a complete succession of the Late Mesozoic-Cenozoic sediments.

The whole study region is a part of the Zagros orogenic area. The Zagros mountain ranges, with a northwest to southeast direction, are extended towards the whole parts of the study area. According to Zahedi (1976), the Zagros area underwent a relatively moderate orogenic phase (attenuated Laramian phase) near the end of Cretaceous and the beginning of Eocene, characterized by folding, emergence and erosion. The laramian movements were succeeded by a shallow marine transgression. A later regression of the sea eastward resulted in the formation of intermontane lakes in the Middle Tertiary, which may have produced an environment conducive for the formation of fibrous clay minerals. Therefore the study area is a part of the Post-Tethyan Sea environment rich in the evaporites (salts and gypsum) in most of the southern and south-western parts.

Results

Chlorite, illite, smectite, palygorskite, kaolinite and interstratified illite-smectite are

the major clay minerals of the studied rocks. The relative abundances of the clay minerals were in accordance with their CEC values. Kaolinite is present in the Cretaceous sedimentary rocks of the three studied areas with a higher occurrence in Lower Cretaceous compared to the Upper Cretaceous ones. Smectite is absent in the Lower Cretaceous rocks and appears in the Upper Cretaceous, late Paleocene and all other Tertiary and Quaternary rocks. Unlike kaolinite, palygorskite occurs only in Eocene and all other younger sediments and is absent in Cretaceous and Late Paleocene rocks. The highest abundance of this fibrous clay mineral is observed in Oligo-Miocene sample. Illite and chlorite are almost present in all rocks. Few interstratified illite-smectite is seen in some samples.

Discussion and conclusions

Origin of clay minerals in rocks: According to Chamley (1998) the thickness of the Tertiary limestone deposits of Tethys area in Arabian Peninsula does not exceed 1500 m, indicating that sediments have not suffered deep burial diagenesis. The following evidences reported by Bolle & Adatte (2001) and Chamley (1998) were also found for the southern and western Iran: (a) the almost constant but variable presence of smectite; (b) the co-existence of smectite with high kaolinite in Upper Cretaceous and early Paleocene samples and with palygorskite in other samples; and (c) the scarcity of mixed layer illite-smectite. According to these findings, distributions of the clay minerals in different sediments of the study area could indicate an inherited (detrital) origin for kaolinite, smectite, illite and chlorite (Sanguesa *et al*., 2000).

Presence of large amounts of highly crystalline elongated palygorskite as confirmed by sharp peak of XRD graph can be an indication of *in situ* neoformation during the Tertiary shallow saline and alkaline environment. Shallow water and high temperature increase the pH and consequently enhance Si solubility (Khormali and Abtahi, 2003).

Reconstruction of the paleoclimate of south and western Iran: The climatic evolution of the Tethys in south and western Iran, as inferred from clay mineralogy of parent rocks revealed that the study area had almost the same climatic trend as reported by Bolle & Adatte (2001) and Adatte *et al*., (2002) for south-eastern Tethys. Presence of high kaolinite and the absence or little occurrence of chlorite, smectite, palygorskite and illite in the Lower Cretaceous sediments is in accordance with warm and humid climate of that period. However, lower amounts of kaolinite and the occurrence of smectite in the Upper Cretaceous sediments indicate a gradual shift from warm and humid to more seasonal climate. Kaolinite disappearance and presence of some palygorskite and smectite in the late Paleocene sediments indicate the increase in aridity which continues to the present time (Krinsley, 1970). The maximum amount of palygrskite (65%) detected in the studied sediments of Oligo-Miocene confirms the

presence of the former shallow lakes, a suitable environment for the formation of fibrous clay minerals. The same results were also reported for central Iran (Khademi and Mermut, 1998).

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