Alteration of Silicic Vitric Tuffs Interbedded in Volcaniclastic Deposits of the Southern Basin and Range Province, Mexico: Evidences for Hydrothermal Reactions

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Abstract: In Northwestern Mexico, the Miocene basins that disrupted the Sierra Madre Occidental Province are filled with sandstones and conglomerates (the Báucarit Formation) cemented mainly by zeolites of the heulandite-clinoptilolite group. Few volcanic tuffs are intercalated in the sediments for which four different groups of samples have been defined. These groups correspond to a gradation in the alteration of the glassy matrix. Group 1 is characterized by the preservation of the glassy matrix and the presence of disseminated patches of clay minerals with a continuous variation between aluminous Al-montmorillonite and ferric smectite end-members. Heulandite-group zeolites and opal C-T are also present. Group 2 is characterized by a nearly complete replacement of volcanic glass by a more homogeneous Almontmorillonite. In some samples, heulandite-group zeolites are present as clusters on clay minerals. The primary vitroclastic texture is generally preserved and relict glass is present in small amounts. In group 3, the secondary assemblage is dominated by heulandite-group zeolite crystals as pseudomorphs of shards and pumiceous fragments. Discrete illite is present in all samples. Textures are exceptionally well-preserved. Group 4 is characterized by the presence of heulandite and clay minerals in which the Mg-Fe smectite end-member is more magnesian than in other groups. The original texture is not preserved.

The following are deduced from the mass-balance calculations: the alteration of the tuffs leads to a strong Mg- and Ca- and, to a lesser degree, Fe-enrichment, and to Na and K depletion. Zeolites account for Ca-enrichment and clay minerals are host for Fe and Mg. As a consequence, alteration may have occurred under open system conditions and the most likely source for the high Ca and Mg gains is a fluid circulating through the underlying volcaniclastic sediments and underlying mid-Tertiary volcanics of the bimodal (basaltic-rhyolitic) sequence. However, those fluids may have been rather dilute and weakly alkaline.

As estimated temperatures are between 85 and 125 ° C and as there is only a low burial, it is proposed that hot fluids are responsible for the alteration of volcanic glass. A decrease with time in the initial permeability of the tuffs is consistent with the observed evolution of the changing Al-smectite toward a more magnesian composition.

Key Words: Basin and Range • Hydrothermal alteration • Mass-balance calculations • Mexico • Smectites • Transmission electron microscopy • Volcanic tuffs • Zeolites

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