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Brine evolution and paleoclimate reconstruction in Khemisset Triassic potash-bearing evaporites: Evidence from fluid-inclusion petrography and microthermometry

FATIMA-EZZAHRAE NAJIB[1], MUHAMMAD OUABID[1], OTMANE RAJI[1], OUSSAMA KHADIRI YAZAMI[2], FATIMA ZAHRA EL FRIEKH[2], ABDELHAKIM ASMANE[3] AND MOSTAFA BENZAAZOUA[1]

[1]Geology & Sustainable Mining Institute, Mohammed VI Polytechnic University, 43150, Benguerir, Morocco

[2]SBU minging, OCP, Avenue Hassan II, Khouribga 25000, Morocco

[3]Mining Operations Lab (MOL), Mohammed VI Polytechnic University (UM6P), 43150, Benguerir, Morocco

Evaporite deposits, typically dominated by rock salts derived from brines, host significant potassium resources that are critical for fertilizer production and food security. Understanding their genesis, which is controlled by brine source, temperature, and precipitation pathways, is therefore of both scientific and economic importance. The Triassic Khemisset basin in Morocco is a promising site for potash evaporites; however, its geology remains poorly constrained, with limited knowledge of brine origin, paleotemperatures, and mineral precipitation. In this study, bedded halite and associated potash layers of Khemisset basin from a systematically sampled drill core were analysed to reconstruct paleoclimate conditions and brine evolution. Two complementary approaches were employed: (i) halite petrography, focusing on growth fabrics and fluid-inclusion petrofacies, and (ii) fluid-inclusion microthermometry to estimate paleo-brine temperatures. Petrographic observations reveal chevron and cumulate halite characterized by alternating fluid inclusion-rich and inclusion-poor bands, recording crystallization both at the basin floor and at the air–brine interface. Primary inclusions are predominantly cubic, single-phase liquids, with minor two- and multi-phase inclusions. Secondary inclusions occur along healed fractures or as isolated pockets. Occasional solid inclusions with orthorhombic morphology, interpreted as carnallite daughter crystals, are confined to K-rich intervals. Microthermometry yields homogenization temperatures of 10–50 °C, consistent with late Triassic air temperatures and comparable to modern and ancient evaporitic environments. Chevron halite reflects bottom growth under moderate conditions, whereas cumulate textures indicate stronger surface evaporation. The presence of carnallite daughter minerals documents progressive Mg–K enrichment of residual brines culminating in potash saturation. These results support a multi-stage depositional model for potash mineralization in the studied Khemisset basin, refine its genetic framework, and provide guidance for future exploration.