



Lead and sulfur isotopes of Guarn Halfaya and Bou Grine deposits associated to salt dome cap rocks (Diapirs zone, Northern Tunisia): sources of metals and genetic model

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The Pb-Zn ores districts at Guarn Halfaya and Bou Grine are hosted mainly by the dolostones in the contact breccias between Triassic and Upper Cretaceous and by Upper Cretaceous limestones. The mineralization occurs as lenticular, impregnations, substitutions, replacements, stratiform, vein, dissemination, and stockwork. A complex polymetallic sulfide assemblage typifies the main ore stage, dominated by sphalerite and galena, pyrite with minor chalcopyrite, arsenopyrite, and sulfosalt (grey copper). Limestone, barite and celestite dominate the gangue, with lesser calcite. Barite and celestite intergrown with main ore-stage sulfides of Oum Edeboua has $\delta^{34}\text{S}$ values of 12.7 to 15.0 ‰ consistent with the derivation of sulfate from Triassic evaporites from the study area ($12.8 < \delta^{34}\text{S} < 14.0$ ‰). The $\delta^{34}\text{S}$ values for sulfides of the both study area range from 2.6 to 9.5 ‰. These positive $\delta^{34}\text{S}$ values are likely due to abiotic thermally-driven abiotic sulfate reduction (TSR) of Triassic sulfates at depth. However, the presence of bacterial relics suggests involvement of bacterially-mediated sulfate reduction (BSR). The lead isotope composition is homogeneous with $^{206}\text{Pb}/^{204}\text{Pb}$, $^{207}\text{Pb}/^{204}\text{Pb}$, and $^{208}\text{Pb}/^{204}\text{Pb}$ ratio ranging between from 18.723 to 18.783, 15.667 to 15.685, and 38.806 to 38.889, respectively, and plot between the upper crust and orogene curves of Zartman and Doe (1981) which imply involvement of a well-mixed multi-source reservoir of Pb at depth. The syn-diagenetic mineralization in the Bahloul Formation and the calculate of model age suggest a Late Cretaceous age, correspond to a NE–SW to ENE–WSS regional extensional tectonic events, which likely favored migration of mineralizing fluids and eventual deposition at Guarn Halfaya and Bou Grine.