Two contrasting sources for base-metal mineralization in northeast Algeria: Evidence from fluid inclusion and stable isotope studies

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Base-metal mineralization, mainly Pb-Zn-Ba, is widely distributed in northeast Algeria, regardless to the geological petrological and structural complexity of the region. In this part of the country, the northern area belongs to the Maghreban chain which is composed mainly of Neoproterozoic-Paleozoic metamorphic complex and Middle Mesozoic-Cenozoic terrigenous nappes that are intruded by Miocene igneous rocks. The southern area, however, is structurally more stable and consists of Mesozoic-Cenozoic mainly marine sedimentary lithologies.

In the northern area, it is believed that the Miocene igneous activity is responsible for the emplacement of many base-metal deposits, such as those of Oued Amizour giant Zn ores and El Aouana and Ain Barbar Pb-Zn deposits. In the southern area, the Eastern Saharan Atlas, the halokinesis of the Triassic evaporitic sediments that intruded the Cretaceous to Quaternay carbonate-clay sediments is responsible for the emplacement of base-metal (Pb-Zn-Ba-F) and Fe mineralization. This is observed in several localities, such as Mesloula, Hameimat, Djebissa, and the giant Ouenza-Boukhadra iron deposit.

Fluid inclusion and stable isotope studies carried out on the northeast Algerian deposits show two different mineralizing fluid. In the northern area, the fluids are generally hot and saline, with homogenization temperatures (Th) greater than 160°C and can reach 500°C, and salinities between 20 and 25% eq.NaCl. $\delta^{34}S$ of sulphide mineralization varies between -7‰ and +5‰ (n=57 samples). These values reflect the major influence of magmatic fluid for the origin the sulphide mineralization. Magmatic fluid is also reflected when observing $\delta^{18}O_{V\text{-}SMOW}$ and $\delta^{13}C_{V\text{-}PDB}$ data of gangue calcite (+11.2‰ to +20.2‰ and -3.7‰ to -11.0‰ respectively) for Oued Amizour. $\delta^{34}S$ of sulphates (anhydrite) from Oued Amizour Zn-mineralization show heavier values ranging from +13.2‰ to +20.6‰ (n = 10; mean = +16.3‰) which reflect marine sulphates, more likely Miocene seawater sulphates. The isotopic data indicate that the majority of the ore deposits related to the Tertiary igneous rocks of northeast Algeria were deposited from mineralized magmatic fluids within seawater environment.

In the Eastern Saharan Atlas, fluid inclusion and stable isotope data show that the fluids are still hot but less than those of the northern area, with Th between 100 and 160°C and salinities varying between 10 and 30% eq.NaCl. $\delta^{34}S$ of sulphide mineralization varies between -2‰ and +10‰ (n=54 samples); that of the gangue sulphates (barite and celestine) varies between 18 and 32‰ (n=15 samples); and that of the Triassic sulphates (gypsum) range from 14 to 16‰ (n=17 samples). These data coupled with the O- and C-isotope results of gangue calcite indicate that these brines, originating from the compaction and development of deep sedimentary basins associated with Atlasic tectonic events, could have leached metallic cations from post-Triassic sedimentary formations in the basin or even the Triassic rocks.

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