Evaporites, U–Pb Dating, and Fluid Inclusions: Insights into the Formation of Carbonate-Hosted Copper Mineralization in the Anti-Atlas, Morocco.

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Résumé

To meet the challenges of the energy transition and the growing demand for strategic raw materials such as copper (Cu), it is crucial to intensify research efforts aimed at understanding mineral systems, in order to identify new resources. After porphyry Cu deposits, sediment-hosted stratiform deposits represent a significant global source of Cu. The Morocco's Anti-Atlas Mountains host numerous Cu occurrences within the carbonate deposits of Ediacaran-early Cambrian age (Adoudou formation). Characterizing this formation which host numerous stratabound occurences, therefore plays a central role in understanding the genesis of these mineral deposits. This study aims to enhance the understanding of such stratabound Cu deposits by focusing on the sedimentary factors and scales that governed their formation through a holistic approach, supported by high-resolution sedimentological facies analysis, U-Pb carbonate dating and fluid inclusion analysis. The study highlights the presence of vanished evaporites, with evidence from facies associations, collapse breccias, and bipyramidal quartz with sulfate inclusions. These evaporites may acted as a major source of sulfur and chlorine for the formation of Cu-bearing metal complexes. These facies and lithologies are encountered in specific stratigraphic levels within Adoudou formation and may have controlled the stratabound distribution.

Several diagenetic phases, both carbonate and siliceous, have been identified based on textural and mineralogical criteria. The resulting paragenesis reflects the evolution of the sediment from primary deposition through early to burial diagenesis and makes it possible to constrain the context of the different phases of Cu precipation/remobilisation. Petrographic observations suggest an association between primary sulfide mineralization (bornite, chalcopyrite) and a microcrystalline dolomite interpreted as an early diagenetic phase that yielded an age of 500 ± 29 Ma (U–Pb dating). Fluid inclusion analyses conducted on one of several carbonate diagenetic phases indicate the circulation of high-temperature brines (25–37 wt% NaCl)

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exceeding 150∘C. Further analysis should define detailed nature and origine of theses fluids. These new data, consistent with field observations, provide insights into the genetic model of stratabound copper mineralization. The Lower Cambrian primary sediment (microbialites and evaporites) may have undergone both diagenetic replacement (dolomitization and silicification), attributed to the circulation of metal-bearing, high-temperature brines.

Mots-Clés: Evaporites, Carbonate diagenesis, Copper mineralization, Fluid Inclusions, AntiAtlas