Atacamite and Nantokite in Qimantag area: Evidence for Cenozoic climate evolution of the Qaidam Basin

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Using mineralogy method to reflect climate evolution is a new approach to research Cenozoic environmental progression of Qaidam Basin. In this paper, we present the chemical composition and crystallographic parameter of atacamite, nantokite and tenorite in cryptocrystalline aggregates from the Kaerqueka copper deposit of Qimantag metallogenic belt by means of electron microprobe and in-situ X-ray diffraction analyses. Atacamite and nantokite occur in an intimate intergrowth as the secondary precipitation of chalcopyrite and bornite filling in the interstitial space of andradite in the Kaerqueka copper deposit, with an average composition of Cl: 12.38 %, Cu: 63.76 %, O: 21.46 %. X-ray microdiffraction shows that the intergrowth conatins nantokite with a cubic unitcell a=5.403(2) Å and atacamite with an orthorhombic unitcell a=6.030(3), b=6.883(2), c=9.114(1) Å. XRD quantitative calculation shows that the nanometric aggregate contains 36.07% tenorite, 18.41% atacamite and 45.52% nantokite. The presence of nantokite and atacamite requires saline solutions for its formation and hyperarid climate conditions for its preservation. Combined with the data of salt lakes and the pollen sequence of western China, we suggest that during the uplift of Tibetan Plateau and the retreat of the Paratethys, saline water was forced to the surface through a basal fracture zone. In the hyperarid climate of the Qaidam Basin, the recharge of groundwater by direct precipitation is negligible, and groundwater is derived from inflow from the salt lakes. Thus, atacamite is preserved. In addition, spertiniite in the edge and fractures of atacamite and nantokite may represent wetter climate after the formation of atacamite and nantokite. The uplift of Tibetan Plateau made both the Asian High (Siberia High) and the Asian Low (India Low) strengthened, which consequently intensified the winter and summer monsoons, giving rise to much drier and colder glacial climate and much wetter and warmer interglacial climate in the East Asian monsoon region.