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Characterization and modeling of illite crystal particles and growth mechanisms in a zoned hydrothermal deposit, Lake City, Colorado

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ABSTRACT

Mean thickness measurements and crystal-thickness distributions (CTDs) of illite particles vary systematically with changes in hydrothermal alteration type, fracture density, and attendant mineralization in a large acid-sulfate/Mo-porphyry hydrothermal system at Red Mountain, near Lake City, Colorado. The hydrothermal illites characterize an extensive zone of quartz-sericite-pyrite alteration beneath two deeply rooted bodies of magmatic-related, quartz-alunite altered rock.

Nineteen illites from a 3000 ft vertical drill hole were analyzed by XRD using the PVP-10 intercalation method and the computer program MudMaster (Bertaut-Warren-Averbach technique). Mean crystallite thicknesses, as determined from 001 reflections, range from 5–7 nanometers (nm) at depths from 0–1700 ft, then sharply increase to 10–16 nm at depths between 1800–2100 ft, and decrease again to 4–5 nm below this level. The interval of largest particle thickness correlates strongly with the zone of most intense quartz-sericite-pyrite alteration (QSP) and attendant high-density stockwork fracturing, and with the highest concentrations of Mo within the drill core. CTD shapes for the illite particles fall into two main categories: asymptotic and lognormal. The shapes of the CTDs are dependent on conditions of illite formation. The asymptotic CTDs correspond to a nucleation and growth mechanism, whereas surface-controlled growth was the dominant mechanism for the lognormal CTDs. Lognormal CTDs coincide with major through-going fractures or stockwork zones, whereas asymptotic CTDs are present in wallrock distal to these intense fracture zones.

The increase in illite particle size and the associated zone of intense QSP alteration and stockwork veining was related by proximity to the dacitic magma(s), which supplied both reactants and heat to the hydrothermal system. However, no changes in illite polytype, which in other studies reflect temperature transitions, were observed within this interval.