

Element Fluxes During Alteration in High-Sulfidation Epithermal Systems: A Case Study from the Pueblo Viejo Au-Ag(-Cu) Deposit, Dominican Republic

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The alteration of rocks associated with hydrothermal ore deposits reflects a large-scale and complex migration of chemical elements, which may be added into the system by externally-derived fluids or mobilised from one alteration facies to another, following hydrothermal dissolution of minerals in the precursor rock and subsequent reprecipitation as new minerals elsewhere. Understanding chemical and mineralogical changes that occur during alteration and mineralisation provides an insight into the nature of ore-forming fluids and the changes in their physico-chemical properties during intense fluid-rock interaction.

To investigate the behaviour of elements and key mineral breakdown and reprecipitation reactions that occurred during alteration at the Pueblo Viejo Au-Ag(-Cu) high-sulfidation epithermal deposit, Dominican Republic, a whole-rock elemental mass transfer analysis was integrated with automated mineralogy (SEM-EDX) and mineral chemistry (EPMA and LA-ICP-MS). To assess spatial variations in elemental behaviour, multiple samples of andesite belonging to three alteration facies (chlorite-carbonate-illite, quartz-pyrophyllite, and quartz-alunite) were considered.

Elements conserved during alteration—REEs for chlorite-carbonate-illite alteration and LREEs for quartz-pyrophyllite and quartz-alunite alteration—were used to remove the effect of bulk mass change for the mass transfer analysis. Although epidote, an important host of REEs in the protolith, was destroyed during chlorite-carbonate-illite alteration, REEs were locally reprecipitated in newly formed carbonates. During quartz-pyrophyllite and quartz-alunite alteration, LREEs were preferentially incorporated on a local scale into newly formed alunite and APS minerals, following the dissolution of REE-bearing minerals (apatite, carbonates, epidote, and titanite).

Based on their behaviour both within and between each alteration facies, the 64 elemental components considered can be divided into seven groups. Elements such as Ti and Zr, typically considered to be immobile in hydrothermal systems, were mobilised during intense acid alteration. The changes in several chemical species (including Fe, Ca, C, S, Li, Zn, Se, and Te) were spatially systematic, which has important implications for geochemical exploration.