

Pre-nucleation clustering of noble metals in high-temperature magmatic liquids

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The conventional view is that magmatic trace minerals nucleate and grow by assembling cationic and anionic species from the melt. Experiments reported here suggest that this view may be simplistic. We have investigated on the nanometer-scale the distribution of Pt in Fe-Cu-S sulfide matrix. When ligands like arsenic are added to the sulfide, Pt and As self-organize to Pt-As molecules, non-crystalline (Pt-As)_n clusters, PtAs₂ nanoparticles, and at very high temperature to nanometer-sized droplets of Pt-rich Fe-As melt. With the addition of As, the partitioning of Pt among sulfide phases is shifted relative to simple (As-free) systems by at least an order of magnitude. Similar to minerals crystallizing from aqueous solutions, magmatic trace minerals may grow by oriented attachment of nanoparticles and nanophases when they crystallize from magmatic solutions. This explains how noble trace elements could form discrete mineral phases in subsolidus range although their concentrations in magmatic melts do not exceed tens of ppb to few ppm. Pre-nucleation clustering should be considered when highly siderophile elements (HSE) partition coefficients determined by simple system experimentation are used to model HSE fractionations among chemically more diverse reservoirs of the Earth

[1] Tredoux *et al* (1995). *South African Journal Geol* **98**, 157–167.

Dolomite reaction rim growth under non-isostatic stress

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Reaction rims of dolomite (CaMg[CO₃]₂) were produced by solid-state reactions of oriented calcite (CaCO₃) and magnesite (MgCO₃) single crystals using a gas-deformation apparatus at 400 MPa confining pressure, 750 °C, and run durations ranging from 4 to 76 h. In addition, we applied a differential stress up to 40 MPa perpendicular to the contact interface.

The resulting dolomite reaction rims consist of two different textural domains. Granular dolomite grains (2.2–5 μm grain size) grew next to calcite, while elongated palisade-shaped grains (2.2–5.2 μm diameter) grew perpendicular to the magnesite interface. The thickness of the granular dolomite layer is 2.9–11.2 μm, smaller than the palisade-like layer (5.2 to 13.2 μm). Platinum markers show that the initial interface is located between granular and palisade-forming dolomite, indicating that rim growth occurred by counter diffusion of MgO and CaO.

As expected, rim thickness increased with increasing run duration. The effect of the applied load is not systematic and causes a maximum variation in rim thickness of less than 11% at fixed time.

Diffusion of MgO across the dolomite reaction rim into calcite produced newly formed magnesio-calcite grains with an average diameter of 20.7 to 34.8 μm. Grain size of magnesio-calcite grains increased with increasing distance to the dolomite boundary. The magnesio-calcite layer increased from 29.1 to 63.3 μm with time, but was also not affected by the differential stress conditions.

The experiments indicate that differential stresses up to 40 MPa do not significantly change the kinetics of reaction rim growth in the carbonate system. Possibly this is because volume diffusion is the dominant transport mechanism, which presumably is less strongly affected by deformation than grain boundary diffusion.