

High T carbonate volcanic melts with new phase relations

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Melting of anhydrous calcite at high T (~1225°C) was long seen to conflict with the low T characteristics of carbonatite intrusions, until experimental hydrous melting (~650°C) opened new possibilities. In 2003 only 50 carbonate volcanoes were known, but now several new provinces, with hundreds of vents, call for new appraisal, with essentially dry, high T (~1200°C) melts, carrying mantle debris. These are diatreme pyroclastic eruptions, comprising either carbonate alone or mingled with silicate melts that are often glassy. From one centre, single eruption events may form dolomite or calcite tuffs (and tuffisites) or more rarely carry these two carbonates in mixtures of separate fragments. No eruptions composed of any intermediate carbonates have been found. High T is recorded in the platy habit of carbonate crystals, Ti magnetite phenocrysts, and carbonate globules and phenocrysts in silicate glass. High P is signalled in chromite phenocrysts, and by magnesite phenocrysts in silicate glass. Previously unreported phase relations include: multiphase melt immiscibility, with dolomite, calcite, phosphate and sulphide phases in silicate glass; xenocrysts of olivine and clinopyroxene with carbonate and/or glass inclusions in a range of forms; single crystal intergrowths of carbonate and clinopyroxene; K-Al-Si residua in dolomite and calcite melts (no Na). Some of the separate calcitic or dolomitic eruptions could have different source depths. But some calcite melts come from >70 km (below decarbonation boundary) calling for different protoliths or melt mechanisms from those giving dolomite. Below 70 km dolomite is considered to be the stable carbonate: sub-lithosphere calcite sources do not fit in the simple PT experimental picture, but then neither do calcite kimberlites. No single petrogenesis scheme may apply, with different depths and melting regimes being among the key variables. Bimodality extends to carbonate mineralogy, with only calcite or dolomite, even in the multiphase immiscibility and phenocrysts. Neither carbonate melts, nor crystals, of intermediate composition are found: carbonate solid solutions seem not to be stable phases. Calcite-dolomite eutectic melting can be ruled out because this would lead to far more intermediate than end member compositions. Liquid immiscibility of carbonates is the most likely cause of bimodality, as witnessed in separate dolomite and calcite globules in silicate glass. Other examples, where the two carbonates co-exist in the same eruption, are also best explicable by liquid immiscibility. All these high T carbonate phenomena hold new challenges for experimental and mantle petrology.

Geochemical transport in intra-oceanic subduction: Numerical predictions

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Our approach of understanding subduction-related processes consists in coupled geochemical-petrological-thermomechanical numerical geodynamic modelling of subduction zones. With this method we can simulate and visualize the evolution of various fields such as temperature, pressure, melt production etc. Furthermore we extend this tool for 2D and 3D modelling of the evolution of various geochemical signatures in subduction zones.

Implementation of geochemical signatures in numerical models is based on marker-in-cell method and allows capturing influences of various key processes such as mechanical mixing of crustal and mantle rocks, fluid release, transport and consuming and melt generation and extraction. Concerning the isotopic signatures, we focus on a limited number of elements: Pb, Hf, Sr and Nd. Transported by aqueous fluids and/or melts through the mantle wedge these incompatible elements capture geochemical interactions between the mantle wedge and the slab which is analyzed numerically based on moving and interacting rock- fluid- and melt- markers. At this first stage we focus on intra-oceanic subduction setting and numerical modelling predictions are compared to natural geochemical data from various modern and fossil subduction zones.