

Magma chamber processes beneath a fast-spreading mid-ocean ridge

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During cruise JC-21 (Jan-Feb 2008) a comprehensive suite of samples of fast-spread lower oceanic crust was obtained from Hess Deep (Equatorial Pacific), using ROV *Isis*. The sampled section comprises several fault blocks, which represent different stratigraphic levels. The gabbroic rocks recovered span a large range in composition from primitive to highly evolved, and record a range of magmatic processes operating in the lower crustal crystal mush beneath the fast-spreading East Pacific Rise.

Major- and trace element data show that gabbros representing deep stratigraphic levels are characterized by relatively primitive compositions, whereas the highest levels are evolved. Constituent minerals commonly show complicated zoning patterns, with both reverse and normal zoning occurring throughout the section, and often in individual grains. Extensive normal zoning (>40 mole%) occurs at the highest levels. Minerals within individual samples may show contrasting growth histories and compositions, indicative of a complex crystallization history. Within normally zoned grains, the degree of enrichment of highly incompatible elements relative to moderately incompatible ones is more than predicted from fractional crystallization, with the degree of over-enrichment correlating negatively with partition coefficients. In addition, interstitial Fe-Ti oxides are abundant. This is consistent with a scenario in which crystal accumulation was followed by the migration of incompatible element-enriched, oxide-saturated melts. Taken together, the complicated zoning patterns, contrasting growth histories and late-stage migration of melt indicate open system processes are common in the lower crustal crystal mush beneath fast-spreading ridges.

Eclogite-carbonate-chloride system at 7.0-16.5 GPa: Implications to diamond and mantle fluids

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Recent studies of fluid inclusions in diamonds and other mantle minerals indicate that chloride can be important in the mantle fluids. Melting phase relations have been determined in a model chloride-carbonate-bearing eclogite at 7.0, 10.5, and 16.5 GPa and 1200-1800°C using multianvil technique. Starting composition was simplified Mid-Ocean-Ridge basalt in the system SiO₂-Al₂O₃-MgO-CaO. 4 wt.% CO₂ was added in the form of MgCO₃ and CaCO₃ and 3.56 wt.% Cl was added as NaCl and KCl.

The typical phase assemblage coexisting with partial melts at 7.0-10.5 GPa is garnet-clinopyroxene-kyanite-stishovite. At 16.5 GPa kyanite and clinopyroxene were not stable. Unknown Cl-free Al-rich phase was detected at 16.5 GPa. It has an approximate formula calculated to one carbon atom Mg_{0.3}Al_{3.0}Si_{0.7}O₅CO₃. KCl and NaCl crystals were stable in low temperature runs coexisting with magnesite and Ca- and Mg-bearing carbonatite melt. Melting of chloride produces chloride-carbonate melt immiscible with carbonatite. High temperature runs at 1600-1800°C reveal homogenous Si-rich carbonate-chloride partial melts. At 7 GPa and 1550°C melt composition was (wt.%): SiO₂=50.3, Al₂O₃=8.5, MgO=3.7, CaO=10.6, Na₂O=1.5, K₂O=4.0, CO₂=17.5, Cl=4.9, O^(c)=0.9. This composition correspond to Si-rich endmember of silicate-carbonate-bearing sequence of fluid inclusions in diamonds at Si,Al (silicate)-Mg,Fe,Ca (carbonate) - Na,K (chloride) triangle.

Chlorides were stable 100-200°C above the solidus. This fact may indicate that melt composition in chloride-carbonate peridotite can be effectively controlled by the presence of water. In the anhydrous environments a low-fraction of 'dry' Cl- and alkali-poor Ca-Mg-rich carbonatite melts can be formed and migrate from the source, whereas under the hydrous conditions, chloride can be dissolved into water to form alkali-rich chloride-carbonate brine-like melts. At higher temperatures (1400-1600°C) two immiscible carbonatite and chloride-carbonate liquids may coexist. The composition of carbonatite and chloride-carbonate melts is consistent with that of melt inclusions in fibrous/cloudy diamonds. The results are also applicable for carbonate and chloride stability and mantle dynamics during deep subduction.