Diffusion profiles of Li in plagioclase/clinopyroxene and plagioclase/olivine intergrowths

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Diffusion in magmatic systems occurs during crystal growth, magma mixing and ascent. In some magmatic crystals diffusion profiles are preserved. These profiles provide information about the timescales of magmatic processes. It is known that Li diffuses very rapidly in plagioclase and clinopyroxene (Giletti and Shanahan 1997, Coogan *et al.* 2005, Parkinson *et al.* 2007) and that Li diffuses in plagioclase two to three times faster than in clinopyroxene (Coogan *et al.* 2005)

This study is focused on the diffusion of Li between intergrown plagioclase/clinopyroxene and plagioclase/olivine. These intergrowths are observed in andesitic and dacitic rocks from the volcanic island Nisyros (Greece). Plagioclase phenocrysts in the andesitic lavas are cloudy zoned with slightly higher An content in the cores, while olivine and clinopyroxene phenocrysts are not zoned. In the dacitic lavas plagioclase phenocysts have complexely zoned ('splotchy') cores and low An rims, while clinopyroxene phenocrysts show nearly no zoning. Both intergrowths of phenocrysts were analysed for Li concentration. Concentration profiles across the minerals were measured using a Cameca ims3f ionprobe with ~ 5 µm lateral resolution.

Li concentration in the dacitic sample jumps at the border of the intergrowth from 10 µg/g in the plagioclase to 44 µg/g in the clinopyroxene and then drops steadily over a distance of 100 µm to 5 µg/g in the clinopyroxene core. Similar patterns are observed for plagioclase/clinopyroxene pairs in other dacitic and andesitic samples. In intergrowths of plagioclase and olivine in andesitic samples, the same Li increase on the border of the crystals is found (7 µg/g in the plagioclase to 13 µg/g in the olivine rim and a slow decrease to 5 µg/g in the core). Preliminary Li isotope measurements reveal negative δ^{7Li} values (~ –26‰) in clinopyroxene rims to zero values in the core. Isotope and concentration profiles are estimated to be caused by diffusion at ~ 1000°C and on timescale of only hours.

References

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Jadeitite, lawsonite eclogite, and related rocks, Guatemala: Fluid-rock histories from a cold subduction zone

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Jadeitite (jadeite rock) occurs rarely in a few serpentinite bodies from worldwide subduction complexes. Geochemical and CL-textural data show that much jadeitite crystallizes directly from multiply sourced Na-, Al, and Si-bearing fluids. Both jadeitite and lawsonite eclogite occur together in a few serpentinite-matrix mélanges of Guatemala. Also a rare rock, lawsonite eclogite forms under wet, extreme P/T conditions.

Each rock type shows complex fluid-rock interactions. Relationships of jadeitite-forming fluids and host rocks are all but unknown—such contacts are rarely preserved. In the Sierra de las Minas, a 3 m-wide pit exposes such a contact, with jadeitite and serpentinite respectively altered to albitite and meta-ultramafic rocks. At the paleocontact, Zr, U, Hf, Pb, Ba, Sr, Y and Cs are greatly enriched in albitite relative to the other rocks. Enrichments coincide with the appearance of and/or increase in abundance and/or grain size of zircon, titanite, celsian and REE-rich epidote in albitite. All contain albite inclusions—many appear poikiloblastic—suggesting nucleation/growth of "trace-element-rich grains in albitite.

Lawsonite eclogite records another fluid-rock system. For example, sample 2-14 (Jalapa dept.) is LREE-rich, with La 50× and Sm 30× Chondrite. It contains lawsonite grains as: 1) 50-100µm, subidiomorphic inclusions in cores of 3-5 mm $garnet_1$; 2) 200-400 µm, irregular grains in $garnet_1$ rims; 3) 100-300 µm idiomorphic matrix, partly consumed by amoeboid titanite; 4) 100-300 µm, idiomorphic matrix, with 100-200 µm $garnet_2$; and 5) 300-600 µm idiomorphic late veins. Each textural type shows distinct LREE abundances and fractionations, as well as Sr contents and zoning (all by LA-ICPMS). Mass balance suggests only lawsonite (1) reflects "protolith" LREE values. The others manifest LREE redistribution, or deposition of exotic REE.

These data show that Guatemalan serpentinite-matrix mélanges yield field examples of the mobility of "immobile" elements under low-T (300-450^{o}C), high to very high-P (~8-~23 kbar) conditions, in chemically distinct fluids.