Geochemical evidence for multistage melt percolation in mantle keel beneath Wyoming craton.

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Results

Garnet and clinopyroxenes from concentrate KL-1 pipe Front Range kimberlite group Colorado display several trends (3) varying in Ti and Na contents. Cr-Ca trends in lherzolite fields (Sobolev, 1977) is less then for Iron Mt kimberlite (Hausel, 1998). In L-Ti groups Ga and Cpx both have strong U peaks correlating with La/Yb_n ratio for Cpx and parental melts. Some Cpx and other minerals show small Eu minima. Spinels reveal joint Al-Ti enrichment. Ilmenites display several descending Ti-Al-Mg and Mn (up to 12%) trends. The most Cr-rich garnets (to 12%) and ilmenites (to 8% Cr_2O_3) were found in harzburgites. Clinopyroxene thermobarometry (Nimis, Taylor, 2000; Ashchepkov, 2002) suggest heating for deformed L-Ti intergrowths of Cpx and Ga comparing with the separate Cpx grains.

Discussion

Several pulses of melt percolation suggest long history for mantle evolution with the participation of subduction related eclogites and possibly sea flour (Mn) sediments in melt generation region at the last stages. Ti-low pyroxenes were associated with deformations caused by deep subduction.

Conclusion

Mantle column beneath KL-kimberlite pipe was modified by Ti rich plum- related and then by melts contaminated in subducted material. Grants RBRF 05-99-65688 05-00-65288.

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Melt migration vs. isentropic decompression melting, more or less

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Decompression melting of the asthenospheric mantle is routinely modelled as an isentropic process, but as thermodynamic models evolve to the point where this constraint can be rigorously (and perhaps accurately) imposed, it becomes important to test the quality of this assumption. In particular, as McKenzie (1984) recognised, when melt migration occurs the upwelling is neither adiabatic nor reversible due to advection of heat by the melt and gravitational dissipation. McKenzie estimated that these effects were negligible relative to the rather large uncertainties in his melting parameters, but concluded that *melt migration leads to excess melting* above that generated in the isentropic case, by at most 60%. However, relative movement of melt and solids has another first-order effect — the possibility of introducing chemical disequilibrium, or something akin to fractional melting. It is well known that fractional melting processes are less productive in general than equilibrium melting, so this raises the possibility that *melt migration leads to substantially less melting* and crustal production than the isentropic equilibrium case. In order to settle which of these effects is dominant and to bound the magnitude of both effects, I construct an energy equation similar to McKenzie's that allows for chemical and thermal disequilibrium between migrating melts and residues and perform a series of one-dimensional MELTS calculations that show the net melt production of various cases.

For normal oceanic potential temperatures (sufficient to generate 3-9 km of crust), *the extra crustal thickness generated by gravitational dissipation is no more than ~100 m*. This number is much smaller than McKenzie's estimate for two reasons: the effective limitation of melt production by clinopyroxene exhaustion and low melt productivity near the solidus (Asimow et al., 1997). In the absence of steep melting or freezing fronts dissipation due to viscous solid compaction is negligible, but I have not treated dissipation due to shear of the matrix. The possibility that migrating melts may escape hotter than the melting adiabat is in fact a way to *reduce* crust production by ~100 m, not a source of excess melt relative to the isentropic case. Most importantly, *disequilibrium flow decreases crustal production by 1-2 km relative to batch melting*. In short, if melt migration leads to chemical isolation it strongly suppresses melting but the isentropic model remains an excellent approximation of equilibrium flow and the incrementally isentropic model an excellent approximation of disequilibrium flow.

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