EXPERIMENTAL CALIBRATION OF GEOTHERMOBAROMETERS IN NATURAL LHERZOLITIC SYSTEMS AT HIGH PRESSURE

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Important informations about the constitution of the continental lithosphere may be obtained from garnet lherzolite xenoliths sampled by kimberlites. In particular P,T distributions within the deep lithosphere give constraints and boundary conditions for the modelling of the dynamic behaviour of the earth's interior.

The basis of the widely used two-pyroxene thermometer is the exchange of the enstatite component between ortho- and clinopyroxene, well known in the system CaO - MgO - SiO₂ (CMS) up to 60 kb. The direct application to more complex systems may be misleading because of the uncertainties introduced by other important constituents of pyroxenes, but non-idealities may cancel each other in the complex natural system and very simple empirical thermometers and barometers (e.g. Finnerty and Boyd 1984; Brey et al., 1986) may be applicable. The arguments for successful application are however debatable and thus it is necessary to have experimental data to verify or falsify the use of such empirical geothermobarometers.

We thus performed experiments with complex, natural compositions typical for the upper mantle in the range $800 - 1500^{\circ}$ C, 25 - 50 kb. Experiments in Fe-bearing systems are problematic because of possible loss or gain of Fe to or from the sample container and the need to demonstrate equilibrium values in systems with several degrees of compositional freedom. In our approach we use single crystal olivines of a composition near equilibrium with the charge and accordingly they do not react with the samples. Within this single crystal olivine we subject starting materials of strongly differing mineralogy/mineral chemistry (natural spinel and garnet lherzolite, synthetic mineral and oxide mixes) to the same P,T condition. For the most important chemical parameters for geothermobarometry (i.e. Al- and Ca-content of pyroxenes) the direction and the coincidence of the approached equilibrium value can be demonstrated.

The obtained data set together with some data from the literature allows to evaluate not only two-pyroxene thermometry and Al-in-orthopyroxene barometry, but also other thermobarometric reactions (e.g. Fe/Mg exchanges garnet-olivine or garnet-orthopyroxene or Cr-solubility in orthopyroxene). The various thermobarometers are currently revised but the preliminary evaluation suggests that pressure-temperature estimates with almost acceptable systematic errors are obtained using the Nickel and Green (1985) barometer in combination with the Wells (1977) thermometer.

Application of these two methods defines groups of low-temperature xenoliths (T <1100°C) in accord with conductive heat flow geotherms and contrasting groups of hightemperature xenoliths, recording a range of temperatures at near-isobaric conditions. The level of this isobaric 'temperature discontinuity' is different for the different suites/provinces and is interpreted as an expression of the movement of 'kiel-shaped' continents over heat sources (such as upwelling streams of convection cells), resulting in (repeated?) processes of:

- a) lithospheric thinning by thermal erosion involving the generation of magmas and, hence, causing differentiation processes both within the lithosphere and the convecting mantle below and
- magmatic underplating, when the continent rests over cooler regions of the convecting mantle and thickens again.

REFERENCES

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