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Geodynamics and magma genesis

G1
THE ROLE OF KIMBERLITE IN MANTLE EVOLUTION

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Kimberlite (KIMB) appears to play a role in mantle evolution similar to KREEP in the Moon. It is enriched in all the trace elements except for those which are retained by garnet and clinopyroxene. Enriched magmas can be viewed as a mixture of MORB plus KIMB. KIMB may be a late stage residual fluid of a crystallizing eclogite cumulate. The ratio of trace element concentrations in MORB to those in KIMB equals the solid/liquid partition coefficient for an eclogite residue, implying that the MORB source was depleted by removal of a kimberlite-like fluid. A primitive mantle pattern can be approximated by a mix of 25 MORB: 1 KIMB. This gives a flat terrestrial pattern for the LIL and an enrichment of about 10. This implies that the depleted and enriched reservoirs (including continental crust) result from about 10% melting of primitive mantle. The melt forms a series of cumulate layers. KIMB forms from the final 4% melt fraction of the eclogite cumulate.

If MORB is formed by extensive melting of eclogite, diapirs must be able to ascend from great depth without appreciable fractionation. The physics of diapiric ascent is reviewed.

G2
DIAPIRISM AND MAGMA GENESIS : AN INSTABILITY ANALYSIS.

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Among the different hypotheses proposed for magma generation, the mantle diapir certainly is one of the most popular (and may be the most plausible).

We have investigated the problem of the behavior of a piece of mantle subject to partial melting. The problem can be described by two coupled non linear equations. One for the heat budjet, one for the momentum.

The discussion of the momentum equation shows the need of a process which lowers the viscosity around the diapir by a factor 10^5 to obtain a rising effect. We adopt the hypothesis of Anderson's halos.

Using this effect as a working hypothesis, we discuss the differential system in a phase space (velocity, temperature difference with surrounding).

The discussion shows clearly the existence of a zone where the diapir is stable and a zone where both velocity and degree of partial melting increase with time.

A more complex case which involves gaz bubbles is also discussed.

G3
MECHANICAL ASPECTS OF CONTINENTAL RIFTING

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Continental rifting is associated with characteristic shallow features like extension, vertical movements and deep seated phenomena as thinning of the lithosphere and upwelling of mantel material. This findes expression in anomalous data of : heat flow, gravity, seismic wave velocities as well as the occurence of volcanic activity.

Several attempts of concepts for mechanisms of rifting are discussed on the base of quantitative models. In particular plate collision as well as plate bending at hot spots fail to serve as a self supporting mechanism of rifting, because it is unlikely on mechanical grounds to transmit the necessary energy over the required distances. Lithospheric stretching has been reported to be a nonsufficient mechanism on the base of geothermal arguments.

Models on a mantle diapir concept are considered in detail according to the initial and diapir phase of development and the induced stress regime in the subsurface region in addition. Thereafter the typical wavelength across continental rifts requires the existence of a distinct crustal layer. Even at low amplitude level the developing ascent of mantle material affects the topic layer of diapiric