PERIDOTITE XENOLITHS AND THE DYNAMICS OF KIMBERLITE INTRUSION.

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Mean olivine subgrain-sizes and grain-sizes resulting respectively from syntectonic (dynamic) recovery and recrystallization are inverse functions of the differential stress applied during deformation. During primary annealing recrystallization, tablet-shaped olivine neoblasts are characterized by a constant growth-rate proportional to the annealing temperature (pyroxene geothermometry) and to the strain energy stored in the paleoblasts, this energy being itself proportional to the stress immediately prior to annealing. The time for the xenoliths to reach the surface and the kimberlite average intrusion velocity (depth from pyroxene geobarometry) are then derived from the growth-rate for annealing calculated on the basis of experimental data and from maximum annealed olivine-tablet sizes in blastogranular peridotites, with some corrections for heating by the kimberlite and supercooling at shallow depths and, eventually, for the distance of the sample studied from the xenolith surface.

Experimentally determined flow laws for dry olivine are used to derive strain-rates from the stress and temperature data. Rough estimates of the late-deformation duration are then obtained whenever strain can be appreciated from internal deformation of olivine (blastolaminar samples) or recrystallized enstatite laminae (PHN-1611-type textures). As these estimates range from a few hours to a few tens of years, the deformations cannot be related to major tectonic phenomena such as the ascent of large diapirs or convection-related flow, a conclusion in accord with the unrealistic velocity estimates (3 to 30 km/yr) implied by such models. These deformations are therefore ascribed to kimberlite-conduit formation and the longest times are regarded as artifacts possibly due to superplastic behavior of the deepest samples. Strain-rates prior to sampling and velocities of intrusion are ultimately combined for estimating the diameter of the zone mechanically perturbed by the kimberlite ascent, the initial force which initiated the intrusion and the related energy involved.