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Textural and compositional characteristics of mantle xenoliths from southeastern Libya: Evidence of mantle refertilization processes

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The study presents the very first data on mantle xenoliths of the Wādi Eghei area, southeastern Libya. These dm- to cm-sized xenoliths are found in a small volcanic cone of Pliocene basalts, which is situated on the northeastern slopes of the Tibesti Mountains. The host basalts originated from near primary magmas derived by melting of an enriched and garnet-bearing mantle source in within-plate geotectonic settings.

Generally, the Wādi Eghei xenoliths can be divided into two texturally different groups: i) well-equilibrated, undeformed protogranular xenoliths, and ii) moderately/strongly sheared, porphyroclastic/equigranular types. Despite their textural diversity, all xenoliths are anhydrous clinopyroxene (cpx)-rich lherzolites, except one protogranular sample (V-5) that can be classified as cpx-poor lherzolite or harzburgite (≈5% of modal cpx). In terms of mineral chemistry, the protogranular xenoliths display only slightly more depleted compositions compared to sheared xenoliths, with sample V-5 as always the most depleted of the whole suite. Fo contents in olivine from protogranular and sheared xenoliths range 90.5-91.0 (V-5∼91.5). Orthopyroxene (opx) from protogranular samples has higher Mg#(Mg#=100*Mg/[Mg+Fetot]mol%) from 90.5 to 91.2 (91.8 for V-5 opx), than those from deformed xenoliths (Mg#=89.5-90.5). The composition of spinel also correlates with the texture of the xenoliths. Spinel from the undeformed samples has Cr#s(Cr#=100*Cr/[Cr+Al]mol%) mostly ranging 12-14 (V-5∼16), whereas Cr# in spinel occurring in sheared xenoliths is always <10. The variations in cpx composition do not show discernible textural dependences. They display a wide compositional range: En=45.5-50.2; Fs=3.7-5.7; Wo=42.0-50.1. The contents of $Al2O_3$, Na2O and TiO_2 range from 2.32-7.75 wt.%, 0.96-1.79 wt.%, and 0.2-0.84 wt.%, respectively. Calculated temperatures indicate that the undeformed types of xenoliths equilibrated at slightly higher temperatures (with minimal and maximal temperatures ranging from 850-950°C, and from 1000 to 1130 °C, respectively), than deformed types (757-923°C and 900-980°C). In addition, among the protogranular xenoliths, a clear dependence of degree of fertility and calculated temperatures is established, with the most fertile samples having the highest equilibrium temperatures.

The first data on modal and mineral chemistry compositions of mantle xenoliths from the Wādi Eghei area indicate that this mantle segment underneath southeastern Libya is too fertile to represent a 'normal' subcontinental mantle. The enrichment is most probably related to mafic metasomatisic processes, i.e. to percolations of mafic alkaline magma, similar in composition to the host basalts. The effects of similar mafic metasomatism are also recorded in mantle xenoliths from other localities in Libya. Further analyses, including whole rock, trace element and isotope compositions are in progress and will provide more details about these refertilization processes.