MINOR ELEMENT CONTENT OF OLIVINE AND ORTHOPYROXENE IN UPPER-MANTLE XENOLITHS.

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Highly-sensitive electron microprobe analyses for Na,Al,Ca,Ti,Cr and Ni are reported for olivine and orthopyroxene from 10 lherzolite and 8 harzburgite xenoliths from Lashaine (Tanzania) and Bultfontein, Dutoitspan, Monastery and Newlands (S. Africa). [The term lherzolite is used if a Ca-rich clinopyroxene grain was found, irrespective of the modal abundance of cpx.] The harzburgites contain more modal orthopyroxene than the lherzolites. On the basis of trace elements we recognize 2 lherzolite groups. Group I (1 each from Bultfontein and Letseng) has minerals richer in Fe than those in Group II (7 from Lashaine, 1 from Mothae). The harzburgites also fall into 2 groups: Group III (2 from Bultfontein, 1 each from Dutoitspan and Newlands) with high-Ca orthopyroxene and Group IV (Bultfontein 2, Monastery 1 (with amphibole), Liqhobong 1) with low-Ca opx.

Figs. 1-3. Group I olivines contain higher Al,Cr and Ca than II olivines, whose distinctive feature is higher Ti. Groups III and IV olivines have similar amounts of Al,Ca,Ti and Cr. Olivines from lherzolites contain 30-130ppmw Na_2O, while those from harzburgites have no detectable Na.

Figs. 4-6. Group I orthopyroxenes contain higher Ca,Na,Ni and Cr than II opx. The high-Ca III orthopyroxenes have more Na,Al,Cr than IV opx while Ni and Ti are similar. These high-Ca orthopyroxenes contain roughly twice as much Ca,Al and Cr as orthopyroxenes in "normal" Group I lherzolites.

Fig. 7. Ca is distributed nearly linearly between ol and opx, except for the high-Ca III harzburgites. If the lherzolites equilibrated at temperatures ranging over ~225°C and pressures ranging over ~10-20kb, as indicated by the pyroxene compositions, the Ca partitioning is essentially independent of these pressure and temperature variations.

Fig. 8. Cr partitioning between ol and opx is complex with no obvious pattern, though the harzburgites and lherzolites are separated. Lherzolite 1544 has clean opx grains with lower Cr than a remnant of an altered grain.

Fig. 9. K_DNi[= Ni(ol)/Ni(opx)] ranges as follows:
I lherzolite 3.6-4.1, II lherzolite 4.2 and 4.6, III harzburgite 4.4-5.9, IV harzburgite 4.6-5.3.

We draw attention to the Group III harzburgites whose high Al,Ca and Cr allow them to be described as "fertile harzburgites" because exsolution at high pressure and temperature would cause them to transform into garnet lherzolite [defined as containing gt,cpx,opx,ol without specification of the mode]. Such exsolution has been documented, e.g. Ext. Abstr. Int. Conf. Kimberlites, 1973, 81-82. O'Hara, Saunders and Mercy (Phys. Chem. Earth 9, 571, 1975) described a model of partial melting followed by solid-state exsolution which provides possible mechanisms for producing "fertile" and "barren" harzburgites; however, quantitative modeling of the trace-element distribution as a function of temperature, pressure and the bulk composition of coexisting partial melt will not be possible until appropriate experimental data are forthcoming on the distribution coefficients between individual minerals and melt.

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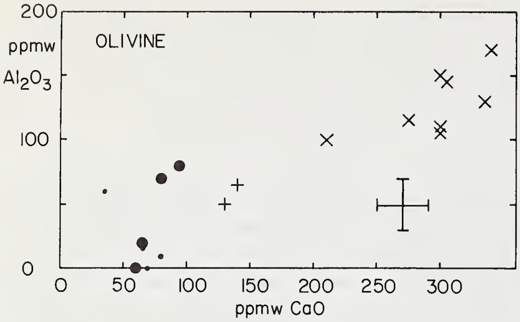

Fig. 1

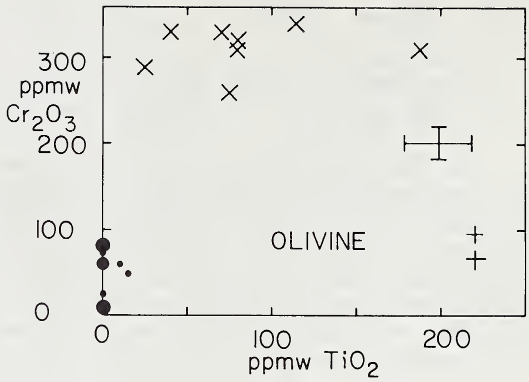

Fig. 2

Horizontal cross: group I lherzolite
Inclined cross: group II lherzolite
Large dot: group III harzburgite
Small dot: group IV harzburgite

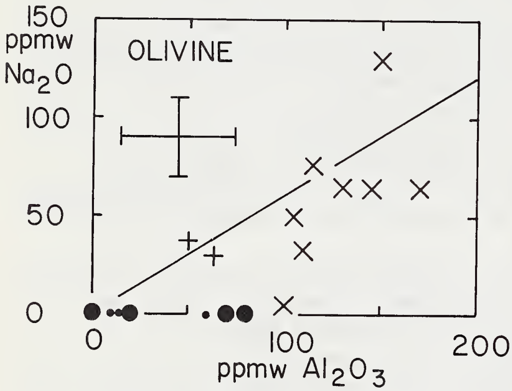

Fig. 3

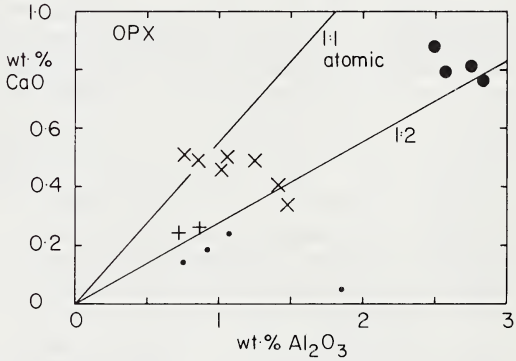

Fig. 4

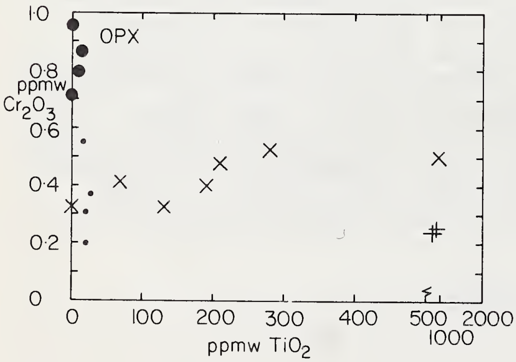

Fig. 5

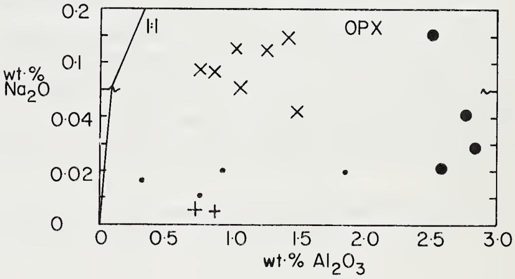

Fig. 6

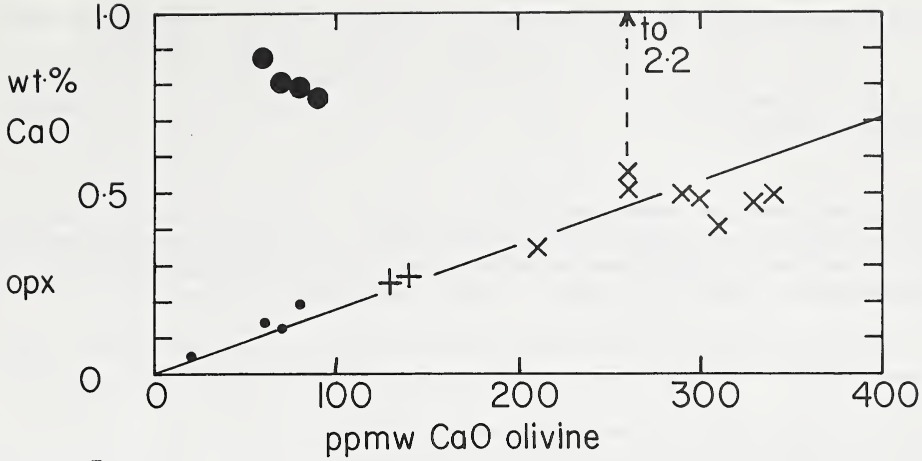

Fig. 7

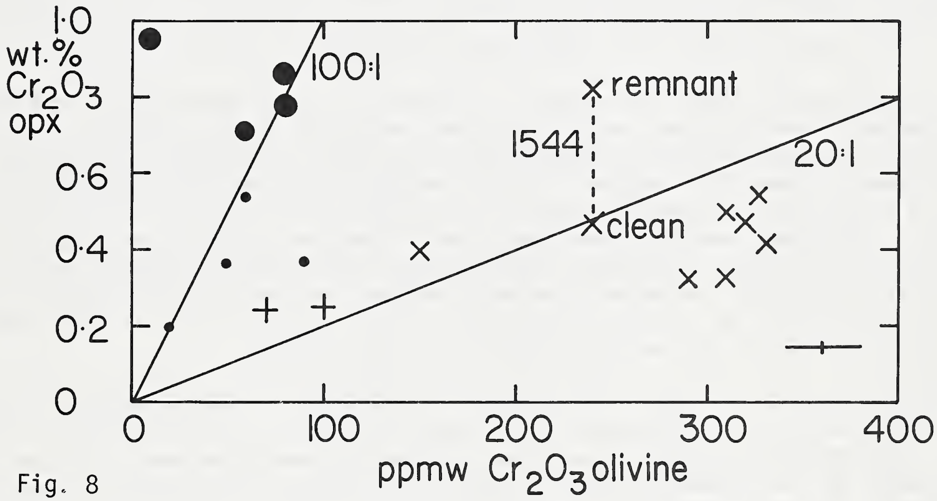

Fig. 8

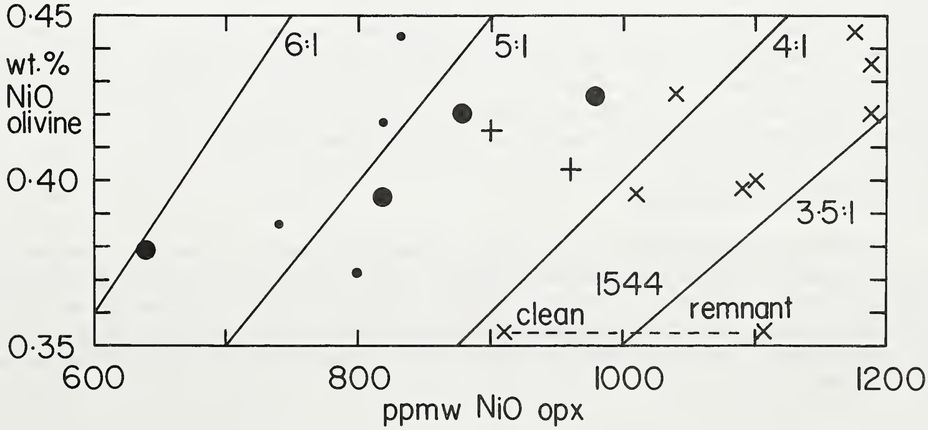

Fig. 9