SULPHIDE-OXIDE AND SILICATE-OXIDE INTERGROWTHS IN XENOLITHS OF UPPER-MANTLE PERIDOTITE

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Pentlandite-magnetite intergrowths occur as globules, altered to various degrees in a nodule of spinel lherzolite (BD1197) from the De Beers mine. The freshest intergrowth consists of (i) pentlandite free of magnetite, and (ii) pentlandite-magnetite intergrowth. The phases were identified by single-crystal X-ray study and found not to be crystallographically orientated. Electron microprobe analysis gave: pentlandite Fe 26.6 - 27.7, Co 0.8, Ni 37.5 - 40.5, S 32.6 - 33.8; magnetite Fe 67.5, Ni 1.0, S 0.1 wt.%. The intergrowth might result either from (i) a eutectic in the Fe-Ni-S-O system (ii) oxidation of a pentlandite-pyrrhotite precursor (iii) exsolution of an oxide-sulphide single-phase. Possibly (i) is preferred tentatively, but the others cannot be ruled out without further studies. Coexisting silicates are olivine (Fo_{94}), orthopyroxene (not analysed), Cr-diopside (Na_2O 2.9, Al_2O_3 1.0, Cr_2O_3 4.6, FeO 1.6, CaO 19.1, MgO 16.1), secondary phlogopite (TiO_2 0.16, Cr_2O_3 0.76, FeO 2.0, MgO 26.5, NiO 0.25). The coexisting spinel is a picrochromite (SiO_2 0.10, TiO_2 0.27, Al_2O_3 2.55, Cr_2O_3 68.7, FeO 16.6, MnO 0.30, MgO 12.5, NiO 0.12 wt.%).

Intergrowth textures resembling fingerprints occur between chromite on the one hand and olivine, orthopyroxene, diopside and chromic pargasitic hornblende on the other hand. The dactylic chromite may be intergrown with just a single silicate or more than one silicate. The intergrowths tend to occur at multiple junctions but some occur in thin section apparently totally enclosed in a single silicate grain. The silicate of the intergrowth frequently occurs in thin section with parallel optical extinction to a neighbouring grain of the same type of silicate (often the silicate is seen to be physically continuous). Some intergrowths involve several silicate grains, and some intergrowths appear to be completely independent. A sequence of textures can be traced from euhedral isolated chromite grains, through irregular graphic intergrowths with silicates, to fine-scale vermicular intergrowths.

Electron-microprobe analyses of the following intergrowths revealed essentially similar compositions for euhedral and intergrowth chromites and for the silicates both inside and outside the symplectites: chromite-orthopyroxene (spinel harzburgite, Newlands Mine); chromite orthopyroxene and chromite-diopside (spinel lherzolite, Bultfontein Mine); chromite-chromic pargasitic hornblende (spinel amphibole harzburgite, Monastery Mine). Actually very slight differences in the composition of some intergrowth silicates do occur. The main bulk-rock orthopyroxene in the Bultfontein specimen contains more CaO (0.6 - 0.8 wt.%) and Al_2O_3 (2.6 - 2.9 wt.%) than the intergrowth orthopyroxene (0.3 - 0.4 and 2.1 - 2.3), consistent with adjustment to a lower T and P of the latter, and in the amphibole harzburgite the intergrowth amphibole contains very slightly higher amounts of chromium. The composition of the olivines, orthopyroxenes and clinopyroxenes in the investigated xenoliths is similar to that of these phases in other upper-mantle peridotite, though the amphibole differs from other upper-mantle pargasites in being more potassic; in this aspect it lies intermediate between the pargasites and the potassic richterite reported from the Wesselton Mine (Table 1).

Earlier models for these fingerprint textures involved (i) replacement (HOLMES, 1936) and (ii) reaction between original garnet and chromian diopside to form pargasite and chromite (BOYD, 1971). We suggest that at least some intergrowths form by simultaneous crystallization, possibly as a result of pressure-induced recrystallization of original chromite and surrounding silicate. Others might involve simultaneous crystallization of primary phases.

A symplectite of euhedral olivine and euhedral chromite occurs in a spinel lherzolite from Lashaine volcano. A resemblance to coronas around garnets might imply breakdown of an earlier phase of bulk composition XY_2O_4, perhaps of spinel structure.

References

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TABLE 1

	1	2	3	4
SiO_2	44.73	45.5	54.3	44.2 - 44.8
TiO_2	0.29	<0.01	0.59	0.00- 0.01
Al_2O_3	12.58	11.1	1.24	11.0 - 11.2
Cr_2O_3	2.43	1.67	0.06	2.07- 2.34
Fe_2O_3	1.10	n.d.	n.d.	n.d.
FeO	2.37	3.18*	4.30	2.68- 2.75*
MnO	0.11	0.06	0.07	0.18- 0.19
MgO	19.17	20.0	21.2	20.1 - 20.5
NiO	n.d.	0.10	n.d.	0.34- 0.37
CaO	10.95	10.6	7.12	10.7 - 11.3
Na_2O	3.84	3.79	3.25	3.16- 3.31
K_2O	0.43	0.60	4.72	1.33- 1.35

* Total iron reported as FeO

1. Chromic pargasite in lherzolite xenolith, Kirsh Volcano Aden (VARNE, 1970).
2. Pargasite in amphibole/spinel symplectite, in harzburgite, Wesselton Mine (BOYD, 1971).
3. Average of 3 analyses of potassic richterites in mica-pyroxenite xenolith, Wesselton Mine (ERLANK, 1970).
4. Range of composition of chromic pargasitic hornblende, both intergrown with spinel and isolated grains in harzburgite BD 1368, Monastery Mine.