ENSTATITE XENOCRYST CONTAINING COEXISTING Cr-POOR AND Cr-RICH GARNET, WELTEVREDEN FLOORS, SOUTH AFRICA.

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The genesis and depth of origin of the large xenocrysts of garnet, ilmenite, diopside and enstatite that occur in kimberlite is still a major problem with respect to petrologic models of the upper mantle. The relation of these xenocrysts to other kimberlitic minerals and the constituents of the ultramafic xenoliths is unknown. Of particular interest in this context was the discovery of a large (~20 cm) single crystal of enstatite (En_{88}) containing abundant Mg-ilmenite (MgO~12 wt.%) and rarer polyphase garnet inclusions. This xenocryst was obtained from Weltevreden Floors near the present Frank Smith Mine, South Africa.

The polyphase garnet inclusions are unique in that they consist of two chemically distinct suites of minerals - one Cr-rich and one Cr-poor. The major garnet phase is orange in color and is predominantly pyrope-almandine ($Py_{71}Al_{21}Gr_{8}$) (Table 1,4) whereas inside this garnet is a second one that is pink and Cr-rich ($CrPy_{33}Py_{28}Al_{19}Gr_{20}$) (Table, 5). This inner chrome-pyrope garnet itself contains Cr-diopside, (Table 1,6) chromite (Table 1,9) and ilmenite. The enclosing orange almandine-pyrope contains rounded Mg-ilmenites (Table 1,3) at the boundary with the Cr-pyrope as well as elongated strings of both olivine (Fo_{86}) (Table 1,8) and another diopside (Table 1,7). The assemblage described above is shown diagrammatically in fig. 1. Within the enstatite host and in close association with polyphase garnet assemblage are calcite, Ti-phlogopite, and serpentine. These three phases are considered to be later than the original formation of the enstatite host.

The compositionsof the host enstatite (Table 1,1) and the major ilmenite inclusions (Table 1,2) are comparable with similar minerals from xenocrysts at Frank Smith Mine (1). Interestingly, the association of this ilmenite with the host enstatite varies from irregularly dispersed blobs to crystallographically controlled lamellar intergrowths (2). Enstatite/ilmenite ratio is about 73:25 with polyphase garnet accounting for the remaining 2%. Using these values plus chemical composition and X-ray cell parameters (3) the density of this specimen is 3.61 ± 0.09 gm/cm^3. This is important in as much as a value exceeds that of the ultramafic and eclogitic xenoliths and will have important geophysical implications with respect to seismic velocities. Furthermore, the relatively widespread occurrence of ilmenite-silicate xenocrysts should be now contrasted with the occurrences of eclogite in kimberlite.

Most of the minerals in the polyphase garnet inclusions can be matched compositionally with other minerals either from Frank Smith or other localities. Of interest, however, is the resemblance of the Cr-pyrope garnet and Cr-diopside with some mineral inclusions in diamond. This resemblance adds crecedence to the idea that diamond did not form in kimberlite as presently known but in an igneous process associated with some precursor of kimberlite whose chemistry is uncertain. It must be stressed that we are not here concerned with the eclogitic environment in which some diamonds are known to have formed.

Although it is likely the Cr-rich garnet and related suite represent the remnant of an earlier pre-existing rock that underwent considerable partial melting it must also be considered that the outer orange garnet may be metamorphic. However, irrespective of the origin, based on orthopyroxene geothermometry (1) and Al_2O_3 content (4) possible pressure and temperature of equilibration are in the region of 60 kb and 1200°C.

References

1. Boyd and Nixon (1973). "Lesotho Kimberlites", p. 254-268.

2. McCallister, Meyer and Brookins (1975). Phys. Chem. Earth, 9, 287-293.

3. Boyd and McCallister (1976). Geophys. Res. Letts., 3, 509-512.

4. MacGregor (1974). Am. Mineral., 59, 110-119.

Table 1. Average analyses of minerals in enstatite xenocryst, Weltevreden Floors (See text for numbers)

	1	2	3	4	5	6	7	8	9
SiO_2	56.7	0.15	0.29	41.8	40.7	54.5	55.4	39.7	0.34
TiO_2	0.23	53.5	49.8	0.96	0.71	0.33	0.40	0.05	7.70
Al_2O_3	0.82	0.32	1.07	21.5	15.5	2.13	1.84	0.04	10.7
Cr_2O_3	0.02	0.19	1.89	0.33	9.96	2.50	0.36	0.06	35.5
FeO	8.09	33.5	35.1	10.6	7.72	3.20	4.39	13.1	30.5
MnO	0.16	0.35	0.28	0.32	0.38	0.08	0.11	0.12	0.38
MgO	33.2	12.4	10.8	20.2	17.3	17.0	17.4	47.5	13.4
CaO	0.93	0.06	0.09	4.05	8.36	17.8	18.2	0.05	0.09
NiO	0.02	-	<0.01	<0.01	<0.01	0.06	0.02	0.07	<0.01
Na_2O	0.16	-	<0.01	0.12	0.10	2.06	1.82	0.03	<0.01
K_2O	0.01	-	<0.01	<0.01	<0.01	0.05	0.06	<0.01	<0.01
	100.3	100.4	99.3	99.9	100.6	99.7	100.0	100.7	98.6

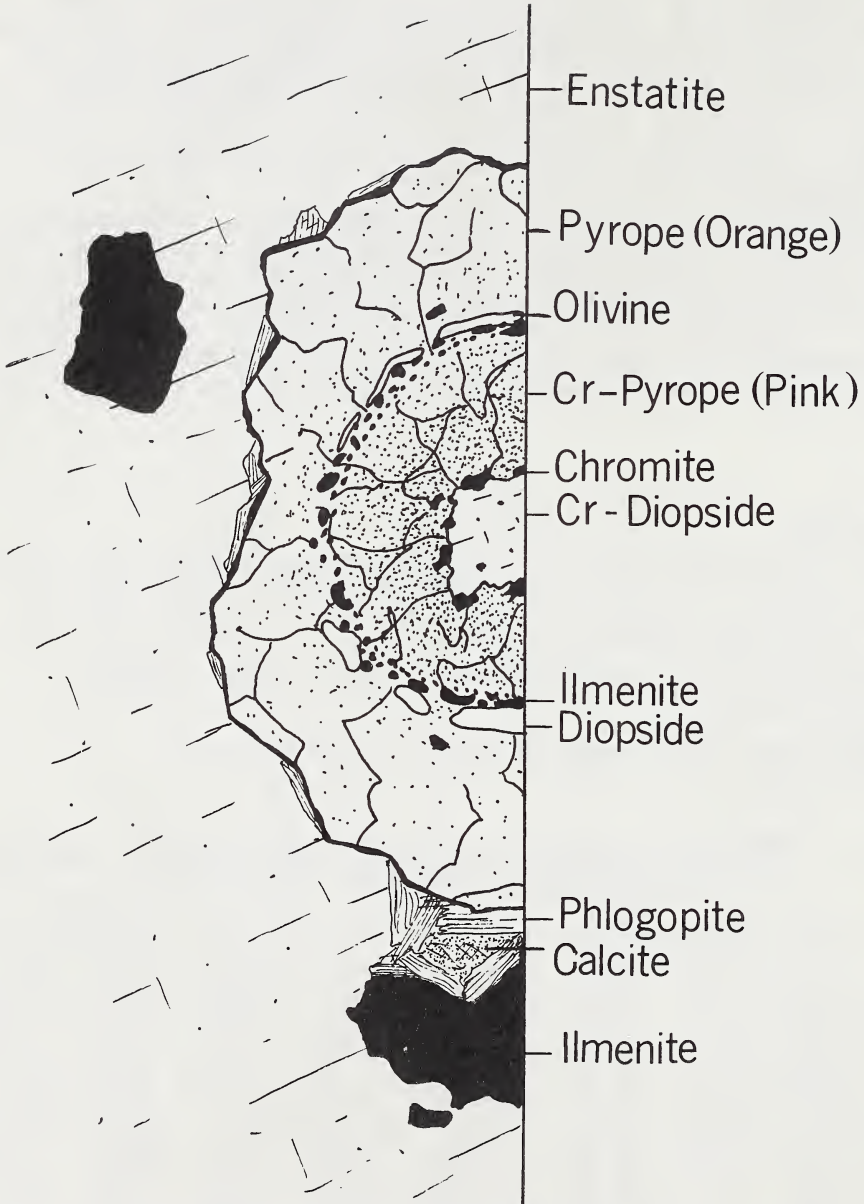

Figure 1. Garnet polyphase assemblage in enstatite xenocryst, Weltevreden Floors.