Notes on Rock-forming Minerals (26) Enstatite from a Garnet-Peridotite Inclusion in Kimberlite

by

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Introduction and acknowledgement

Many chemical analyses have been published on enstatites from peridotites and granulites, but no reliable one has been published on that from eclogite or garnet-peridotite. We are interested in the composition of enstatites from eclogite or garnet-peridotite inclusion in kimberlite, for they were probably derived from the mantle of the earth and such enstatites in equilibrium with garnet would be expected to be saturated with alumina.

In this paper, we intend to give the chemical composition of an enstatite from a garnet-peridotite inclusion in kimberlite together with some petrogenetic discussion on its genesis.

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Description of rock and minerals

The garnet-peridotite in question is an inclusion in kimberlite. It was brought from Ward's Natural Science Establishment in Rochester, U. S. A., and is labelled "eclogite in kimberlite, Kimberley". The rock consists of olivine, enstatite, serpentine, diopside, chromite, garnet, biotite, and white mica in the order of decreasing amount. Among these minerals, the serpentine and white mica appear to be secondary in origin. The former occurs replacing the olivine and enstatite and the latter occurs forming an armour around the garnet. The amount of garnet in the rock is subordinate and it may be more reasonably called garnet-peridotite instead of eclogite. The enstatite was separated from the rock by means of the isodynamic separator and methylene iodide. The sample obtained for analysis is almost free from impurity. The chemical analysis was made by MATSUI and the result is shown in Table 1. The atomic ratio $\text{Mg} : \text{Fe}^{+2}$ is 94 : 6. The optic properties of the enstatite and the associated olivine are shown in Table 2. Refractive index γ of the white mica is lower than 1.62, and hence it is not margarite.

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Table 1. Chemical composition of enstatite

Wt. %		Atomic ratio for o=6	
SiO ₂	57.79	Si	1.977
TiO ₂	< 0.007	Al ^{IV}	0.023
Al ₂ O ₃	0.79	Al ^{VI}	0.009
FeO	3.96*	Cr	0.006
MnO	0.10	Fe	0.113
MgO	36.36**	Mn	0.003
CaO	0.53	Mg	1.834
Na ₂ O	n.d.	Ca	0.019
K ₂ O	n.d.		
P ₂ O ₅	n.d.	* Total Fe as FeO	
Cr ₂ O ₃	0.23	** Ni present	
H ₂ O ⁻	0.04	*** Not accurate	
H ₂ O ⁺	0.32***	**** Excluding TiO ₂	
Total	100.12****		

Table 2. Optic properties of constituent minerals.

Enstatite : $\alpha = 1.656$, $\beta = 1.661$, $\gamma = 1.665$, 2V over Z = 62°.
Olivine : $\alpha = 1.645$ $\gamma = 1.682$.
White mica : γ is smaller than 1.62.

Analytical method

The contents of SiO₂ and H₂O were determined gravimetrically after the conventional method. Determination of Al₂O₃, total Fe, TiO₂, MnO and Cr₂O₃ was made colorimetrically; Al₂O₃ was determined by 8-hydroxyquinoline-chloroform extraction method (CLASSEN, BASTINGS and VISSER, 1956); total Fe with 1,10-phenanthroline; MnO as permanganate; and Cr₂O₃ with diphenylcarbazide. Determination of MgO+CaO and CaO was made chelatometrically (MATSUI, 1961; PATTON and REEDER, 1956). FeO was not analyzed because of unusual difficulty in the decomposition of the sample.

Discussion

The maximum possible content of Al₂O₃ in enstatite is determined by the equilibrium in the system MgO-Al₂O₃-SiO₂. Enstatite should have a maximum Al₂O₃ content when it is in equilibrium with cordierite+spinel or with pyrope. Under sufficiently high pressures, enstatite would occur in equilibrium with pyrope as was suggested by BOYD and ENGLAND (1960). The enstatite described in this paper is associated with garnet that may be Mg-rich pyralspite as suggested by the richness in MgO of the associated olivine and enstatite. Therefore, the enstatite may be considered to have maximum possible Al₂O₃ content under the conditions of its formation.

ROSS, FOSTER and MYERS (1954) showed that enstatites from peridotite inclusions in alkali basalts contain 2-5 wt. % of Al₂O₃. These enstatites are not associated with garnet, and hence it may be considered that the maximum possible Al₂O₃ content of the enstatites under the conditions of their formation would be larger than their actual Al₂O₃ contents. The Al₂O₃ content of the enstatite described in this paper is 0.8 wt. % and it is much smaller than those of enstatites described by ROSS, FOSTER and MYERS.

Therefore, it may be considered that the physical conditions of the formation of the enstatite described in this paper on the one hand and those of described by ROSS, FOSTER and MYERS on the other, were different from each other. Probably the difference in physical conditions may be due to a difference in the depth of the mantle of the earth, from which the host rocks of the analyzed enstatites were brought up.

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造岩鉱物ノート (26) キンバレイ岩中にとりこまれたざくろ石かんらん岩の頑火輝石

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(要 旨)

記載した岩石の頑火輝石は、ざくろ石と共存するにもかかわらず、0.8 wt. % の Al_2O_3 を含むのみである。これはこの岩石が普通のアルカリ玄武岩中に含まれるかんらん岩ノジュールとは、生成の物理的条件が異つていたことを示し、両種の岩石はマントルの異つた深さの所から運ばれてきたことを示す。ざくろ石と共存する頑火輝石の Al_2O_3 の量は、生成の圧力の指示者として用いることは理論的に可能であるのみでなく実際にも可能であることを示した。