PETROLOGY OF PERIDOTITE NODULES FROM THE NDONYUO OLNCHORO, SAMBURU DISTRICT, CENTRAL KENYA

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The sodic alkaline volcanic rocks were extruded in enormous volumes repeatedly from Miocene times onwards in Kenya, eastern Uganda and northern Tanzania. The Miocene and Pliocene basaltic volcanism was closely controlled by the developing rift valley.

Around the Ndonyuo Olnchoro, 37°46'E, 1°22'N, there occurs Pliocene olivine nephelinite, in which many ejected blocks of a suite of ultramafic nodules are enclosed. This is the first detailed paper of the peridotite nodules in the Gregory Rift Valley of Kenya.

<u>Petrochemistry</u>:

Chemical composition and norms of the olivine nephelinite are shown in Table 1. It belongs to Group C of Mantle norm.

The peridotite nodules are divisible into two groups.

Table 1. Chemical composition and norms of the host rock(Olivine nephelinite)

	No.14	C.I.P.W.Norm				Mantle Norm	
SiO_2	38.59						
TiO_2	2.62		an	1.36	28.64 sal (an+lc+ne)	$NaFeSi_2O_6$	20.20
Al_2O_3	9.20		lc	8.73		$NaAlSi_2O_6$	12.34
Cr_2O_3	0.16		ne	18.55		$CaTiAl_2O_6$	7.73
Fe_2O_3	8.52					$CaAl_2SiO_6$	5.75
FeO	8.23	di	wo	18.79	72.03 fem (wo through ap)	$CaSiO_3$	15.50
MnO	0.22	di	en	14.84		$MgSiO_3$	9.82
NiO	0.01	di	fs	1.83		$FeSiO_3$	4.70
CaO	10.88	ol	fo	12.39		Mg_2SiO_4	15.71
MgO	13.06	ol	fa	1.68		Fe_2SiO_4	8.25
Na_2O	4.05		cs	0.35		Total	100.00
K_2O	1.88		mt	12.36			
P_2O_5	0.99		cm	2.46			
$H_2O(+)$	1.65		il	4.98			
$H_2O(-)$	0.24		ap	2.35			
Total	100.30						

The first group contains rocks consisting of varying combinations of magnesian olivine, orthopyroxene, and small amount of chromian spinel and clinopyroxene. Harzburgite and lherzolite belong to the first group and occupy about 90 per cent of the peridotite nodules by volume. The other group of ultramafic nodules comprises of websterite consisting of orthopyroxene, clinopyroxene and small amount of chromian spinel and occupies about 10 per cent of the nodules by volume.

Chemical compositions of the peridotite nodules are shown in Table 2.

The continental lherzolite such as those of Ndonyuo Olnchoro($MgO/\Sigma FeO$=7.63~6.96) and Lashaine, northern Tanzania ($MgO/\Sigma FeO$=6.97~5.49)(Dawson et al, 1970) show a tendency to have higher $MgO/\Sigma FeO$ and therefore to be more enriched in the higher melting components, than the oceanic lherzolites. This might imply that the continental upper mantle has been more depleted of the material that formed the crust.

The nodules from kimberlite are higher in $MgO/\Sigma FeO$(7.65 ~ 5.36) than most lherzolite nodules from basalts(6.57~2.28). Of considerable interest is the fact that the $MgO/\Sigma FeO$ ratios (7.63~5.49) of the lherzolite nodules from Ndonyuo Olnchoro and Lashaine fall within the limit of variation of nodules from kimberlite.

Table 2. Chemical composition of the peridotite nodules

	Harzburgite		Lherzolite		Websterite
	No.17	No.18	No.13	No.16	No.12
SiO_2	43.16	43.28	43.16	40.59	52.24
TiO_2	0.01	0.01	tr	tr	tr
Al_2O_3	1.79	1.61	1.47	0.92	2.14
Cr_2O_3	0.04	0.23	0.29	0.41	3.42
Fe_2O_3	2.07	1.60	2.55	3.83	2.95
FeO	4.61	4.74	4.31	3.59	5.39
MnO	0.21	0.19	0.18	0.16	0.35
NiO	0.18	0.17	0.15	0.20	0.08
MgO	46.57	47.14	46.57	48.99	30.08
CaO	0.28	0.33	0.49	0.39	2.58
Na_2O	0.04	0.33	0.07	0.12	0.09
K_2O	0.02	0.01	0.06	0.02	0.07
P_2O_5	0.06	tr	0.05	0.07	0.03
$H_2O(+)$	0.61	0.75	0.81	0.38	1.12
$H_2O(-)$	0.04	0.04	0.05	0.03	0.02
Total	99.69	100.13	100.21	99.70	100.56
$MgO/\Sigma FeO$	7.20	7.63	7.05	6.96	3.74

The variation trends of some oxides in websterite-pyroxenite nodules including the websterite nodule from Ndonyuo Olnchoro are different from those in the lherzolite nodules(Kuno and Aoki, 1970). These two types of nodules are of different origin, as is also suggested by the difference in pyroxene compositions. The websterite-pyroxenite variation is very similar to the eclogite variation, suggesting their similar origin. There may be a petrogenetical relationship between the eclogite nodule from Chunya Hill,southern Kenya(Saggerson, 1968) and the websterite nodule from Ndonyuo Olnchoro.

Mineralogy:

Nineteen olivines, twenty two orthopyroxenes, three clinopyroxenes and eighteen spinels from the harzburgite and lherzolite nodules and seven orthopyroxenes, three clinopyroxenes and four spinels from the websterite nodule are analysed with an EPMA chiefly, and only FeO is analysed by wet method.

The contents of forsterite molecule of olivines from harzburgite and lherzolite nodules are homogeneous(Fo 92.8~91.9) from rock to rock, from grain to grain, and even in the grain.

The ratios of Mg:Fe^{2+}:Ca of orthopyroxenes from harzburgite and lherzolite nodules are homogeneous(91.9:7.1:1.0~92.7:6.5:0.8), and those of orthopyroxenes from websterite nodule are also homogeneous(89.4:9.7:0.8~89.7:9.5:0.8). Al_2O_3 contents of orthopyroxenes are 1.86~2.94 wt% for the harzburgite and lherzolite nodules and are 3.12~3.27 wt% for the websterite nodule. Cr_2O_3 contents of orthopyroxenes are 0.41~0.51 wt% for all peridotite nodules.

The ratios of Mg:Fe^{2+}:Ca of clinopyroxenes from lherzolite nodules are 53.3:4.0:42.6~57.3:3.9:38.8, and those of clinopyroxenes from websterite nodule are 48.9:2.7:48.4~49.2:2.7:48.1. Al_2O_3 contents of clinopyroxenes are 1.84~3.03 wt% for lherzolite nodules and are 3.19~3.43 wt% for websterite nodule. Cr_2O_3 contents of clinopyroxenes are 0.96~1.07 wt% for lherzolite nodules and are 0.75~0.80 wt% for websterite nodule.

The Al_2O_3 contents and Ca/Ca + Mg ratios of the clinopyroxenes from lherzolite nodules indicate more affinities with those in mantle-derived rocks rather than with peridotites derived by accumulation from a basaltic melt.

Various methods are used to estimate the temperature of formation of the olivine-pyroxene assemblage within the rock, these methods being Fe^{2+} : Mg partition between coexisting pyroxenes(Bartholomé, 1962; Kretz, 1963), Fe^{2+}: Mg partition between olivine and orthopyroxene(Bartholomé, 1962). For harzburgite and lherzolite equilibrium temperatures are more than 1500°C and for websterite these are 500°~620°C.

Using the phase relations $CaMgSi_2O_6 - Mg_2Si_2O_6$ at 30kb (Davis and Boyd, 1966), temperatures 1060°~ 1190°C for lherzolites and 880°C for websterite are obtained. The temperature and pressure of formation obtained by plotting the clinopyroxene and compositions on the grid drawn up by O'Hara(1967) are 1210°C/36kb~1340°C/38kb for the lherzolites.

However, no garnet is found in the peridotite nodules from Ndonyuo Olnchoro. Symplektites of chromian spinel and orthopyroxene are found in the peridotite nodules. Chemistry of chromian spinel is not so homogeneous from rock to rock and from grain to grain. The symplektites may be derived from the original garnet according to the reaction forsterite + pyrope ⟶ 4 enstatite + spinel. From the present compositions of forsterite, enstatite and spinel in harzburgite, the composition of garnet is inferred to be pyrope molecule 55~60%, knorringite molecule 30~35%, almandine molecule 10% and andradite molecule 1%.

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