COEXISTING OLIVINE AND PYROXENES FROM THE ACOJE ULTRAMAFICS, PHILIPPINES

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Three selected peridotites, their olivines and pyroxenes from the Acoje mine, Philippines were chemically studied. From the data based on the pyroxene grid the Acoje peridotites seem to be recrystallized under conditions prevailing in the plagioclase peridotite field, and this estimation is not inconsistent with the suggestions from the distribution coefficient data of $\text{Fe}^{+2}\text{-Mg}$ between the coexisting silicates in the peridotites.

INTRODUCTION

The Zambales Range in Luzon Island, Philippines, stretches southward from the western coast of the Lingayen Gulf to the Bataan Peninsula, occupying an area about 180×35 square km. The Zambales Range is mainly composed of the ultramafic complex of which the age of emplacement is estimated to be Cretaceous. On the west of the Range, along the coast, the ultramafic belt is covered with unconformity by Miocene limestone, conglomerate, sandstone and marl, and on the east and south it is covered by volcanic rocks of Tertiary to Quarternary age. The Zambales ultramafic complex consists of dunite, peridotite and pyroxenite, which have suffered more or less serpentinization, together with gabbroic rocks.

The Zambales region is well known as the most productive area of chrome and nickel ores in the Philippines. The Acoje and Coto mines are being worked in this region. In the Acoje mine district ultrama-

fic rocks are composed of dunite, peridotite,

Fig. 1. Distribution of the Zambales ultramafic complex, Luzon Island, Philippines.

pyroxenite and a small amount of gabbroic rocks. The ore deposits of chrome and nickel in these mines occur mainly in the dunite and peridotite. So far, the metallic minerals identified in the Acoje mine are chromite, pentlandite, troilite, pyrite, chalcopyrite, awaruite, magnetite, hematite, violarite, native copper and goethite.

In this paper the chemistry of three selected peridotites, their olivines and co-existing pyroxenes from the Acoje mine is described, and some petrological discussions are given.

PETROGRAPHY

Three selected specimens, each considerably serpentinized, but still retain sufficient amounts of primary constituents so that the original texture can be identified. Olivine is the most intensely altered, orthopyroxene is next and clinopyroxene usually remain intact. The modal compositions were obtained by point-counter analyses in which discrimination of the serpentine replacing olivine from that replacing orthopyroxene was carefully carried out. Rock nomenclature is used in accordance with the classification of Jackson (1968).

1) Serpentinized harzburgite (Specimen No. D-5-a).

The rock had originally an allotriomorphic-granular texture, with a maximum size up to 3 mm in length. It is primarily composed of olivine ($N_z=1.672$), orthopyroxene ($N_y=1.667-1.688$, $2V_z=85^\circ-87^\circ$), clinopyroxene ($N_y=1.678-1.679$, $2V_z=54^\circ-56^\circ$) and a little amount of yellowish brown chromite. Olivine shows sporadic development of undulose extinction. Orthopyroxene and clinopyroxene have very thin exsolution lamellae parallel to the (100) plane of the host crystal. The lamellae could not be identified, but may be Ca-rich and Ca-

poor pyroxenes in the orthopyroxene and clinopyroxene, respectively. The primary modal composition (volume per cent), approximate because of the uncertainty of the presence of serpentine, is as follows: olivine 86, orthopyroxene 10, clinopyroxene 3 and chromite 1.

2) Serpentinized lherzolite (Sp. No. F-14).

The rocks is allotriomorphic-granular in texture with crystals less than 4 mm in size. Its primary constituents are olivine ($N_z=1.672$), orthopyroxene ($N_y=1.665$, $2V_z=87^\circ$), clinopyroxene ($N_y=1.679$, $2V_z=54^\circ$) and some yellowish brown chromite. Olivine sometimes display wavy extinction and weak translation lamellae. Both pyroxenes contain very thin lamellae. The approximate modal analysis of the original rock is olivine 83 per cent, orthopyroxene 9 per cent, clinopyroxene 7 per cent and chromite 1 per cent in volume.

Table 1. Chemical compositions of the ultramafic rocks from the Acoje mine.

	1 D-5-a	2 F-14	3 L-1
SiO ₂	39.63	39.74	47.47
TiO ₂	0.14	0.19	0.19
Al ₂ O ₃	2.03	1.42	1.26
Cr ₂ O ₃	0.29	0.24	0.28
Fe ₂ O ₃	5.67	5.19	2.61
FeO	2.82	3.32	2.73
MnO	0.12	0.12	0.11
NiO	0.34	0.32	0.12
MgO	38.62	38.53	23.96
CaO	0.37	1.50	15.06
Na ₂ O	0.01	0.01	0.18
K ₂ O	tr.	tr.	0.01
H ₂ O ⁺	9.42	8.20	5.49
H ₂ O ⁻	0.32	1.05	0.64
P ₂ O ₅	tr.	tr.	tr.
Total	99.78	99.82	100.14
M*	89.6	89.5	89.2

*M = (Mg + Ni) × 100 / (Mg + Ni + Fe²⁺ + Fe³⁺ + Mn)
(Analyst: H. Onuki)

3) Serpentinized wehrlite (Sp. No. L-1).

This shows a typically hypidiomorphic-granular texture, ranging 5 to 1 mm in diameter. The primary minerals are clinopyroxene ($Ny=1.680$, $2Vz=53^\circ$), olivine ($Nz=1.675$), orthopyroxene ($Ny=1.669$, $2Vz=88^\circ$) and a little amount of yellowish brown chromite. Olivine and both pyroxenes sporadically show undulating extinction. Exsolution lamellae of clinopyroxene and orthopyroxene in orthopyroxene and clinopyroxene, respectively, are developed along (100) the host crystal. The volumetric percentage of the original constituent minerals in this rock are clinopyroxene 68, olivine 27 and orthopyroxene 5.

BULK ROCK CHEMISTRY AND SERPENTINIZATION

The bulk chemical compositions of three serpentinized peridotites are presented in Table 1. If, as the first approximation, the serpentinization in the Acoje ultramafics have proceeded by the simple addition of

water without leaching of any oxides, the estimation of the modal composition concerning olivine and pyroxenes could be possible from the $(Mg+Ni+Fe^{+2}+Fe^{+3}+Mn)/Si$ ratio of the host rock, because these ratios of the olivine and pyroxenes from the ultramafic intrusive rocks are almost two and unit, respectively. The computed modal compositions (volume per cent) based on this method are as follows:

D-5-a olivine 64, pyroxenes 36.

F-14 olivine 66, pyroxenes 34.

L-1 olivine 34, pyroxenes 66.

Even though the uncertainty of the observed modal analysis is taken into consideration, it can be said that comparison between the observed and calculated modal compositions shows considerable discrepancy. In addition, Al_2O_3 content of each of the analysed rocks is not consistent with the assumed amount of Al_2O_3 by means and either of the two modal analyses noted already. These evidences may show the chemical complexity of the serpentinization

Table 2. Olivine analyses.

	Weight per cent				Atomic ratios, when O = 4		
	1 D-5-a	2 F-14	3 L-1		1 D-5-a	2 F-14	3 L-1
SiO_2	40.74	40.62	40.26	Si	0.999	1.000	0.997
TiO_2	0.01	0.02	0.03	Al	0.001	-	0.001
Al_2O_3	0.05	tr.	0.02	Ti	-	-	0.001
Cr_2O_3	0.03	0.01	0.01	Cr	0.001	-	-
Fe_2O_3	0.24	0.15	0.14	Fe^{+3}	0.004	0.003	0.003
FeO	9.59	10.14	10.75	Fe^{+2}	0.197	0.209	0.222
MnO	0.12	0.15	0.14	Mn	0.003	0.003	0.003
NiO	0.39	0.37	0.30	Ni	0.008	0.007	0.006
MgO	48.78	48.42	47.91	Mg	1.783	1.775	1.767
CaO	0.06	0.04	0.03	Ca	0.002	0.001	0.001
Na_2O	tr.	n.d.	n.d.	Na	-	-	-
K_2O	tr.	n.d.	n.d.	K	-	-	-
H_2O^+	0.07	0.03	0.06	Total	2.998	2.998	3.001
H_2O^-	0.05	0.02	0.03				
Total	100.17	99.97	99.72	M*	89.8	89.3	88.6

*M = $(Mg+Ni) \times 100 / (Mg+Ni+Fe^{+2}+Mn)$.

(Analyst: H. Onuki)

of the ultramafics. It may be not really useful to compare the analyses of the ultramafics from different geologic environments with different degree of serpentinization. Compelled by the circumstance which Alpine type ultramafics are commonly partially or completely serpentinized, we usually carry out such a comparison. Practically it has some utility values. If the serpentinization of the ultramafic rocks is accompanied by minimal changes in the ratio of $(\text{Mg}+\text{Ni}) \times 100 / (\text{Mg}+\text{Ni}+\text{Fe}^{+2}+\text{Fe}^{+3}+\text{Mn})$, a comparison of the ratio can be made for various ultramafic intrusives. There is a small difference in the $(\text{Mg}+\text{Ni}) \times 100 / (\text{Mg}+\text{Ni}+\text{Fe}^{+2}+\text{Fe}^{+3}+\text{Mn})$ ratio, ranging from 89.6 to 89.2 of the analysed rocks. These values are rather lower than those of the rocks from the Horoman (Onuki, 1965; Nagasaki, 1966) and Burro Mountain (Loney *et al.*, 1971) ultramafic bodies, but are comparative with those from the Lizard peridotites (Green, 1964).

MINERAL CHEMISTRY

1) Olivine

The chemical composition and structural formula of the olivine from the serpentinized harzburgite, lherzolite and wehrlite are listed in Table 2. Their compositions are restricted to Fo values, $(\text{Mg}+\text{Ni}) \times 100 / (\text{Mg}+\text{Ni}+\text{Fe}^{+2}+\text{Fe}^{+3}+\text{Mn})$, from 89.8 to 88.6. The Fo contents of the olivines from the Acoje peridotites are similar, in general, to those from many Alpine-peridotites and peridotite inclusions in basaltic rocks. But these values fall within the less magnesian part of the range of olivines from Alpine-peridotites and olivine nodules.

Forbes and Banno (1966) suggested that the Ni-Fe ratio of olivine differs according to their mode of occurrence. Nakamura (1971) has also shown that the olivines from the Toba ultramafic complex (Nakamura, 1971) and dunite-wehrlite series inclusions in Hawaii (White, 1966) have different NiO-

Table 3. Orthopyroxene analyses.

	Weight per cent				Atomic ratios, when O = 6		
	1 D-5-a	2 F-14	3 L-1		1 D-5-a	2 F-14	3 L-1
SiO ₂	55.99	55.74	55.49	Si	1.938	1.936	1.929
TiO ₂	0.15	0.19	0.21	Al ^{IV}	0.062	0.064	0.071
Al ₂ O ₃	2.81	2.92	3.27	Al ^{VI}	0.053	0.055	0.063
Cr ₂ O ₃	0.50	0.25	0.24	Ti	0.004	0.005	0.005
Fe ₂ O ₃	0.39	0.43	0.34	Cr	0.014	0.008	0.007
FeO	6.01	6.31	6.55	Fe ⁺³	0.010	0.011	0.009
MnO	0.14	0.14	0.15	Fe ⁺²	0.174	0.183	0.190
NiO	0.10	0.08	0.08	Mn	0.004	0.004	0.004
MgO	32.98	32.68	32.61	Ni	0.003	0.002	0.002
CaO	0.74	0.78	0.48	Mg	1.701	1.691	1.689
Na ₂ O	0.02	0.03	0.07	Ca	0.027	0.029	0.018
K ₂ O	tr.	tr.	tr.	Na	0.001	0.002	0.005
H ₂ O+	0.05	0.07	0.07	K	-	-	-
H ₂ O-	0.10	0.05	0.05	Total	3.991	3.990	3.992
Total	99.98	99.67	99.61	M*	90.1	89.5	89.3

$$*M = (\text{Mg}+\text{Ni}) \times 100 / (\text{Mg}+\text{Ni}+\text{Fe}^{+2}+\text{Fe}^{+3}+\text{Mn})$$

(Analyst: H. Onuki)

($\text{Fe} \times 100 / \text{Mg} + \text{Fe}$) ratio from those from other ultramafic intrusions in orogenic belts. The former group is interpreted to have accumulated from a basaltic magma in genesis (White, 1966; Nakamura, 1971). Analysed olivines from the Acoje ultramafics fall within the range of olivines from ultramafic intrusions in orogenic belts.

2) Orthopyroxene

The chemical analyses and calculated atomic ratios of the orthopyroxenes from three Acoje peridotites are given in Table 3. The orthopyroxenes have a range of 90.1 to 89.3 in $(\text{Mg} + \text{Ni}) \times 100 / (\text{Mg} + \text{Ni} + \text{Fe}^{+2} + \text{Mn})$

pyroxenes is not dependant on pressure differences, but on the varying availability of Al_2O_3 . The CaO contents of the orthopyroxenes ranges from 0.45 to 0.78 weight per cent, which is much lower than values for orthopyroxenes from many other ultramafic intrusives (Green, 1964; Onuki, 1965; Nagasaki, 1966; Loney *et al.*, 1971; Medaris, 1972), though they have very thin exsolution lamellae of Ca-rich pyroxene.

Molecular proportions calculated by the method after Kushiro (1962), and Onuki and Tiba (1965) are shown in Table 4. Mg-Tschermak's molecules show a relatively small range (4.3–5.7 per cent). The values are slightly higher than those of the Horoman ultramafics (Onuki, 1965; Nagasaki, 1966) and lower than those of the Lizard peridotite (Green, 1964).

3) Clinopyroxene

The three clinopyroxenes coexisting with the analysed olivine and orthopyroxene were also analysed by the wet chemical method (Table 5). They fall close to the boundary between endiopside and diopside in the system $\text{CaMgSi}_2\text{O}_6$ – $\text{CaFeSi}_2\text{O}_6$ – $\text{Mg}_2\text{Si}_2\text{O}_6$ – $\text{Fe}_2\text{Si}_2\text{O}_6$. The Cr_2O_3 content of the clinopyroxene is always higher than that of the coexisting orthopyroxene. In the analysed clinopyroxenes, Al_2O_3 , TiO_2 , MnO and Na_2O tend to increase with decreasing $(\text{Mg} + \text{Ni}) \times 100 / (\text{Mg} + \text{Ni} + \text{Fe}^{+2} + \text{Fe}^{+3} + \text{Mn})$ ratio, but the Cr_2O_3 content shows just the reverse trend.

The amounts of Al_2O_3 (2.91–3.28 weight per cent) in them are higher than those from Dawros (Rothstein, 1958), Hayachine (Onuki, 1963), Kanto Mountains (Tazaki, 1967) and Burro Mountain (Loney *et al.*, 1971) peridotites, and are lower than those of the primary peridotites from Lizard (Green, 1964) and of the peridotites from Horoman (Onuki, 1965; Nagasaki, 1966)

Table 4. Molecular proportions of orthopyroxenes.

	1 D-5-a	2 F-14	3 L-1
$\text{NaCrSi}_2\text{O}_6$	0.1	0.2	0.5
$\text{CaTiAl}_2\text{O}_6$	0.4	0.5	0.5
MgCrAlSiO_6	1.3	0.6	0.4
$\text{MgFe}^{+3}\text{AlSiO}_6$	1.0	1.1	1.0
$\text{MgAl}_2\text{SiO}_6$	4.3	4.7	5.7
MgSiO_3	82.7	82.2	82.4
CaSiO_3	1.2	1.2	0.7
FeSiO_3	9.0	9.5	8.8

ratio. Al_2O_3 ranges from 2.81 to 3.27 weight per cent. The Al_2O_3 contents of the Acoje orthopyroxenes are similar to those from the New Zealand peridotites (Challis, 1965) and are higher than those of the Burro Mountain peridotites (Loney *et al.*, 1971), but lower than those of the ultramafics from the Lizard (Green, 1964), Horoman (Onuki, 1965; Nagasaki, 1966) and typical peridotites in southwestern Oregon (Medaris, 1972).

Because the orthopyroxenes from the Acoje peridotites have relatively lower Al_2O_3 contents, the analysis in detail on the role of Al_2O_3 in them may be not significant. It can be pointed out, however, that the variation of Al_2O_3 contents in these ortho-

Table 5. Clinopyroxene analyses.

	Weight per cent				Atomic ratios, when O = 6		
	1 D-5-a	2 F-14	3 L-1		1 D-5-a	2 F-14	3 L-1
SiO ₂	52.31	52.50	52.65	Si	1.907	1.900	1.916
TiO ₂	0.15	0.17	0.18	Al ^{IV}	0.093	0.100	0.084
Al ₂ O ₃	2.91	3.06	3.28	Al ^{VI}	0.032	0.030	0.057
Cr ₂ O ₃	1.03	0.39	0.39	Ti	0.004	0.005	0.005
Fe ₂ O ₃	1.03	1.12	0.99	Cr	0.030	0.011	0.011
FeO	2.15	2.31	2.21	Fe ⁺³	0.028	0.030	0.027
MnO	0.08	0.09	0.09	Fe ⁺²	0.064	0.070	0.067
MgO	17.56	18.46	17.07	Mn	0.002	0.003	0.003
CaO	22.41	22.06	22.64	Mg	0.954	0.995	0.925
Na ₂ O	0.16	0.25	0.34	Ca	0.875	0.855	0.882
K ₂ O	tr.	0.02	0.02	Na	0.011	0.017	0.024
H ₂ O+	0.05	tr.	0.05	K	-	0.001	0.001
H ₂ O-	0.11	0.05	0.07	Total	4.000	4.017	4.002
Total	99.98	100.08	99.98	Ca	45.5	43.8	46.3
M*	90.9	90.6	90.4	Mg	49.5	50.9	48.6
				Fe**	5.0	5.3	5.1

*M=Mg×100/(Mg+Fe⁺²+Fe⁺³+Mn), **Fe=Fe⁺²+Fe⁺³+Mn
(Analyst: H. Onuki)

Table 6. Molecular proportions of clinopyroxenes.

	1 D-5-a	2 F-14	3 L-1
NaCrSi ₂ O ₆	1.1	1.1	1.1
NaFe ⁺³ Si ₂ O ₆	-	0.7	1.4
CaCrAlSiO ₆	1.9	-	-
CaTiAl ₂ O ₆	0.4	0.5	0.5
CaFe ⁺³ AlSiO ₆	2.8	2.3	1.3
CaAl ₂ SiO ₆	3.5	4.7	5.9
CaSiO ₃	39.6	38.3	40.1
MgSiO ₃	47.4	48.8	46.2
FeSiO ₃	3.3	3.6	3.5

and southwestern Oregon (Medaris, 1972). This range of Al₂O₃ contents of the clinopyroxenes is comparable with those of peridotites from New Zealand (Challis, 1966) and of recrystallized peridotites in the Lizard area (Green, 1964).

Molecular proportions calculated based on the method after Kushiro (1962) of the analysed clinopyroxenes from the Acoje ultramafics are shown in Table 6. The

jadeite molecule is absent in them, but the CaAl₂SiO₆ component ranges from 3.5 to 5.9 per cent.

DISTRIBUTION OF Fe⁺²-Mg BETWEEN COEXISTING SILICATES

The distribution of Fe⁺² and Mg between the coexisting mineral pairs, olivine-orthopyroxene, olivine-clinopyroxene and orthopyroxene-clinopyroxene from the Acoje peridotites is examined here.

1) Olivine-orthopyroxene

Recently Nafziger and Muan (1967), Larimer (1968) and Medaris (1969) studied experimentally the Fe⁺²-Mg distribution between olivine and orthopyroxene. The distribution coefficient, (Fe⁺²/Mg)_{ol}/(Fe⁺²/Mg)_{opx}, is not so sensitive to change in temperature over the range 700° to 1300°C (Larimer, 1968; Medaris, 1969). Olivine-orthopyroxene pairs of the Acoje peridotites yield the

distribution function of 1.08–1.11 and plot on the high temperature side of the distribution curve determined experimentally at 900°C and 500 bars pressure (Medaris, 1969).

Nafziger and Muan (1967) have shown that olivine solid solution has a moderate deviation from ideality, whereas the pyroxene solid solution is practically ideal in its activity-composition relation. Using activity coefficient data at 1200°C determined by Nafziger and Muan (1967), and the following equation,

$$K = \frac{[\text{Fe}^{+2}/(\text{Mg} + \text{Fe}^{+2})]_{\text{ol}} \cdot \gamma_{\text{Fe}^{+2}\text{ol}}}{[\text{Mg}/(\text{Mg} + \text{Fe}^{+2})]_{\text{ol}} \cdot \gamma_{\text{Mg}^{\text{ol}}}} \cdot \frac{[\text{Mg}/(\text{Mg} + \text{Fe}^{+2})]_{\text{opx}} \cdot \gamma_{\text{Mg}^{\text{opx}}}}{[\text{Fe}^{+2}/(\text{Mg} + \text{Fe}^{+2})]_{\text{opx}} \cdot \gamma_{\text{Fe}^{+2}\text{opx}}}$$

where the γ values with appropriate subscripts and super scripts are the activity coefficients. The K values around 1.55 ± 0.05 of three pairs from the Acoje peridotites are obtained.

Williams and Eugster (1969), however, have demonstrated that the distribution of iron and magnesium between these two minerals is not dependant of temperature. If it is so, the distribution coefficient of Fe^{+2} and Mg can not used as a geothermometer.

2) Olivine-clinopyroxene

The distribution coefficient of Fe^{+2} and Mg , that is, $K = (\text{Fe}^{+2}/\text{Mg})_{\text{ol}}/(\text{Fe}^{+2}/\text{Mg})_{\text{cpx}}$, between the coexisting olivine and clinopyroxene from the Acoje peridotites ranges from 1.65 to 1.73. These values are similar to those from the Miyamori ultramafic complex (Onuki, 1965), but slightly higher than the Lizard ultramafic complex (Green, 1964) and Horoman ultramafic mass (Onuki, 1965; Nagasaki, 1966) and the high-pressure type peridotites in southwestern Oregon (Medaris, 1972).

3) Orthopyroxene-clinopyroxene

The coexisting pyroxenes from the Aco-

Fig. 2. P-T conditions for the Acoje peridotites based on O'Hara's pyroxene grid. Lizard PR.: Primary peridotites from Lizard (Green, 1964). SE.: Secondary (recrystallized) peridotites from Lizard (Green, 1964).

je peridotites have K values, namely $K = (\text{Fe}^{+2}/\text{Mg})_{\text{opx}}/(\text{Fe}^{+2}/\text{Mg})_{\text{cpx}}$, that ranges from 1.52 to 1.55, which is within analytical error. Kretz (1961), Bartholomé (1962) have shown that K is about 1.4 in igneous rocks and 1.8 in metamorphic rocks. The obtained values from the Acoje peridotites are comparable with those of igneous origin, but these values suggest that the peridotites were formed at relatively lower temperatures.

PETROGENETIC GRID BASED ON CLINOPYROXENE COMPOSITION

Green and Ringwood (1967) have indicated that natural peridotites with sufficient Al_2O_3 occur in three distinct mineral facies under anhydrous conditions, that is, 1) plagioclase peridotite, 2) spinel peridotite and 3) garnet peridotite. O'Hara (1967) has proposed a provisional P-T projection and their bounding equilibria for natural aluminous four-phase peridotites, using the chemical properties of clinopyroxene. Fig. 2 shows the pressure-temperature conditions for the Acoje peridotites based on O'Hara's

pyroxene grid. Clinopyroxene compositions from the Acoje peridotites plot in the plagioclase peridotite field and their host rocks appear to have equilibrated under conditions within the range from 2 to 4 kb around 1100°–1200°C. These inferred conditions of equilibrium suggest that Acoje peridotites were recrystallized at a high temperature within the plagioclase peridotite field.

CONCLUSION

The bulk and mineral chemistries do not directly give good ground for the discussion on the genesis of the Acoje peridotites. As regards the chemical nature of the pyroxenes, however, it can be said that these peridotites were not formed under the conditions of higher pressures. The interpretation of distribution coefficient between Fe^{+2} and Mg for the coexisting silicate minerals used here includes many uncertainties, and it is too qualitative at present. Thus, O'Hara's pyroxene grid is a tool only useful for the estimation of the physical condition where the Acoje peridotites were crystallized or recrystallized.

From the data based on the pyroxene grid the Acoje peridotites seem to be recrystallized under conditions prevailing in the plagioclase peridotite field, and this estimation is not inconsistent with the suggestions from the distribution coefficient data of Fe^{+2} and Mg between the coexisting silicates in the peridotites. If it is so, the diapiric movement of the Acoje peridotites from deep in the crust or the upper mantle to a shallower level in the crust could have occurred. It is uncertain whether partial melting of the peridotites occurred during hot diapiric movement. No plagioclase in the present recrystallized peridotites should depend on their chemical character poor in Al_2O_3 .

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フィリッピン, Acoje かんらん岩類に共存するかんらん石と輝石類

武田 晃幸・大貫 仁

フィリッピン群島, ルソン島に広く分布する Zambales 超苦鉄質岩体のうち, Acoje 鉱山付近より, 3種のかんらん岩類をえらび, 岩石の記載を行なったのち, 総化学組成, モード組成とともに, かんらん石, 斜方輝石および単斜輝石の化学組成を報告した。造岩鉱物の化学的性質, Fe^{+2} -Mg 分配などから, これらのかんらん岩類が地殻浅所で比較的高温の条件下で再結晶した可能性を指摘した。