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Amygdale Chlorite (Diabantite) in a Trachyandesite from Yaizu, Shizuoka Prefecture

By

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Introduction

Although the mineral group of chlorite is ubiquitous as a minor rock-forming mineral and sometimes even as a member of the major constituent minerals in extrusive and shallow intrusive rocks, little investigations have been made on the mineral in igneous rocks.

The present paper gives a result of the chemical and X-ray studies of a chlorite in a trachyandesite lava from the Takakusayama district, Shizuoka Prefecture. In this district, Neogene alkaline rocks form lava flows and shallow intrusive bodies in the sedimentary rocks of the Setogawa and Ooigawa Groups (TIBA, 1966). The rocks range from alkali olivine basalt to trachyte in composition. Almost all of the alkaline rocks of this district carry chlorite in various amounts.

Trachyandesite

The amygdale chlorite-bearing trachyandesite (NSM-101777) is taken at a quarry near Noaki, Yaizu City, Shizuoka Prefecture. Close occurrence between chlorite-bearing trachyandesite and pumpellyite-bearing trachybasalts is observed here.

The trachyandesite consists of pale greenish gray matrix and oval or lenticular amygdales (1 mm–1 cm across) of dark green chlorite (Fig. 1). Under the microscope, the rock shows fine-grained subtrachytic texture made of plagioclase laths (up to 0.15 mm long), minute prisms of clinopyroxene and minor kaersutite, and aggregates of chlorite and/or calcite. Clinopyroxene (salite) occurs rarely as phenocrysts (1.5 mm long). Aggregates of fine scaly crystals of chlorite fill amygdales, fine veinlets and angular interstices.

Chlorite scales are grown as radial aggregates (Fig. 2) on walls of amygdales, veinlets and interstices, forming carpets (generally 0.28 mm thick). In most cases, amygdales are constructed by multifold layer of such carpets leaving a hollow center. Amygdales filled with fragmentary carpets of chlorite and calcite are sometimes observed.

Chemical analysis of the bulk rock is given in Table 1, together with the CIPW norm. The rock is rather high in Na_2O and low in K_2O content as well as the most of basic and intermediate members of this district (TIBA, 1966).

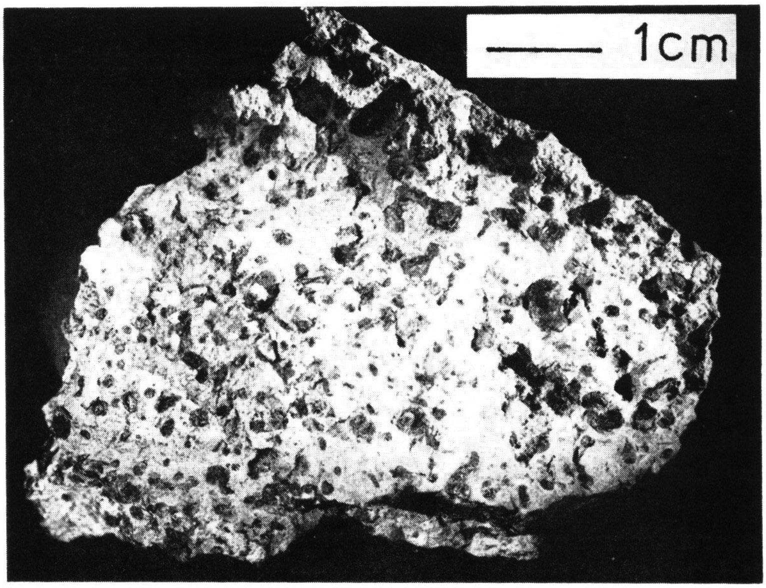

Fig. 1. Amydgale chlorite-bearing trachyandesite

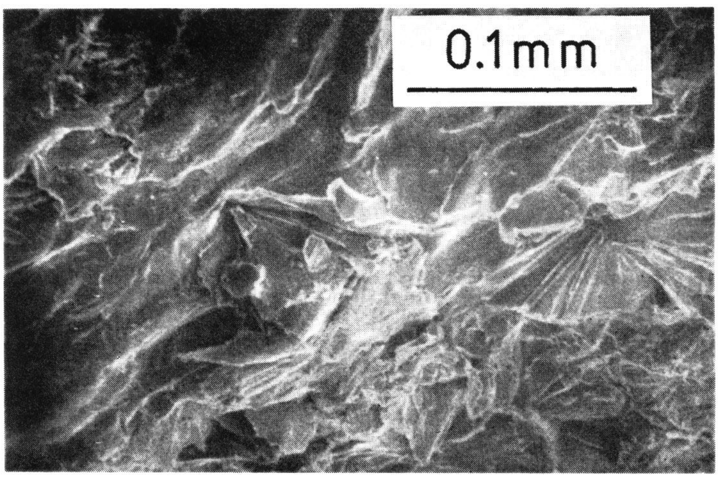

Fig. 2. Scanning electron micrograph of radial aggregates of chlorite

Chlorite

Chlorite shows parallel extinction. It presents variation of pleochroism from X′=pale straw yellow and Z′=green or brownish green at the basal part of a single carpet to X′=colorless and Z′=pale green at the upper part, implying compositional zoning during its growth.

Tables 2 and 3 are X-ray powder data and chemical analysis of hand-picked ag-

Table 1. Chemical analysis and CIPW norm of amygdale chlorite-bearing trachyandesite (NSM-101777).

SiO_2	52.66		or	13.75
TiO_2	1.64		ab	48.18
Al_2O_3	16.87		an	13.60
Fe_2O_3	4.38	di	wo	2.12
FeO	4.46		en	1.48
MnO	0.16		fs	0.45
MgO	2.88	hy	en	1.36
CaO	4.09		fs	0.41
Na_2O	5.70	ol	fo	3.04
K_2O	2.33		fa	1.02
H_2O+	3.16		mt	6.34
H_2O-	1.44		il	3.11
P_2O_5	0.26		ap	0.61
total	100.03			96.28

gregates of chlorite, respectively. This chlorite is fairly rich in silica and iron, and poor in alumina. Provided appreciable amounts of TiO_2, CaO, Na_2O and K_2O are essential, structural formula of the mineral is given as $(Na_{0.17}K_{0.08})$ $(Ca_{0.37}Mg_{3.39}Mn_{0.10}Fe^{2+}_{4.46}Ti_{0.12}Fe^{3+}_{0.71}Al_{2.01})$ $(Si_{6.51}Al_{1.49})$ O_{20} $(OH)_{16}$. In this formula, the number of octahedral trivalent cations is greater than the tetrahedral Al, while the sum of the octahedral cations is less than 12.00. This suggests that the excess octahedral trivalent cations replaced octahedral divalent cations in a ratio of 2: 3 as stated by FOSTER (1962). According to FOSTER's classification on Fe^{2+}/R^{2+} ratio and Si number (FOSTER, 1962), this chlorite can be plotted in the diabantite field.

As to the major element chemistry, the present chlorite quite resembles the chlorite in the ophitic alkali gabbro from the same district (TIBA, 1966). Relatively iron-rich chlorite (brunsvigite) is found in spilite of Great Island, New Zealand (BATTEY, 1958). It remains, however, to be proved whether such iron-rich chlorites in basic and intermediate igneous rocks resulted from iron-rich residual liquids or iron-rich hydrothermal solutions, since the information of chlorites in igneous rocks is so limited.

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Table 2. X-ray powder data for amygdale chlorite.
(Fe/Mn radiation, b = broad)

d (Å)	I	Qobs	Qcal	hkl
14.6	85	0.0047	0.0048	001
7.22	100	0.0192	0.0192	002
4.810	25	0.0432	0.0436	003
4.652	10	0.0462	0.0462	020
3.593	40	0.0775	0.0774	004
2.876	8	0.1209	0.1210	005
2.697	5	0.1375	0.1379	$20\bar{1}$
2.677	8	0.1395	0.1395	200
			0.1389	130
			0.1405	$13\bar{1}$
2.610	10b	0.1468	0.1461	$20\bar{2}$
			0.1469	131
2.467	20b	0.1643	0.1647	132
			0.1639	$20\bar{3}$
2.407	10	0.1726	0.1717	202
			0.1729	$13\bar{3}$
2.288	5	0.1910	0.1913	$20\bar{4}$
			0.1921	133
2.033	5b	0.2419	0.2425	204
1.904	5b	0.2758	0.2753	$20\bar{6}$
			0.2759	135
1.550	20	0.4162	0.4162	060
			0.4131	$33\bar{1}$
			0.4181	$33\bar{2}$
1.519	5b	0.4334	0.4323	331
			0.4327	$33\bar{3}$
1.515	10b	0.4357	0.4356	062
1.474	5b	0.4603	0.4598	063

a_0 5.39 Å β 97.0°
b_0 9.30 Å
c_0 14.40 Å

Table 3. Chemical analysis of amygdale chlorite.

		atomic ratios on anhydrous basis of O = 28	
SiO_2	30.60	Si	6.513
TiO_2	0.74	Al^{IV}	1.487
Al_2O_3	13.92	Al^{VI}	2.005
Fe_2O_3	4.41	Fe^{3+}	0.706
FeO	25.05	Ti	0.119
MnO	0.56	Fe^{2+}	4.457
MgO	10.70	Mn	0.101
CaO	1.61	Mg	3.393
Na_2O	0.40	Ca	0.367
K_2O	0.28	Na	0.166
H_2O+	10.05	K	0.077
H_2O-	2.10		
total	100.42		

α_{min} 1.607 X′ pale straw yellow ~ colorless
γ_{max} 1.623 Z′ green or brownish green ~ pale green elongation positive