MICROPROBE STUDY OF ZONED EPIDOTE IN THE SANBAGAWA METAMORPHIC ROCKS FROM THE KANTO MOUNTAINS

—NOTES ON ROCK-FORMING MINERALS(37)—

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Introduction

Epidote widely occurs in the regional metamorphic rocks of basic, pelitic and psammitic compositions. MIYASHIRO and SEKI (1958) indicated that the range of Al-Fe-Mn substitution in epidote is enlarged with increasing metamorphic grade. STRENS (1965) and HOLDAWAY (1965) suggested the existence of a solvus between clinozoisite and pistacite; however, BROWN (1967) reported many epidotes of intermediate compositions which fall in the proposed immiscibility from the greenschist facies rocks from Eastern Otago, New Zealand. He also reported that iron-rich epidote consists of two distinct parts, iron-rich core and iron-poor mantle with sharp contact.

This paper describes the compositional variations of zoned epidote in the Sanbagawa metamorphic rocks from the Kanto Mountains, Central Japan, and discusses its genesis in some detail.

Host Rocks and Epidote

The metamorphic terrane of the studied area is classified into two zones, zone A and zone B. A sketch map showing the distribution of those zones and the localities of the analysed rocks is shown in Fig. 1. Actinolite, chlorite, pumpellyite, epidote, albite, magnesioriebeckite and quartz are common constituent minerals in the basic rocks of zone A, while those of zone B contain actinolite, barrosite, epidote, porphyroblastic albite and quartz. The mineral assemblages of the studied specimens(a-g) are listed in Table 1.

Zone A corresponds to the glaucophane schist facies, and zone B to the greenschist facies(SEKI, 1958).

Epidote and other metamorphic minerals in these zones are often zoned. Two types of zoned epidote are recognized in thin section. One is a simple zoning in which the core part is pale

Fig. 1. Localities of the analysed specimens. The letters refer those in Tables 1 and 2.

greenish yellow and the rim part is colourless, whereas the other is complex zoning in which simple zoned grain is mantled with pale greenish yellow epidote with sharp boundary.

Complex-zoned epidotes are recognized in all sections of twenty-three basic rock specimens in the zone B, while none of them are observed in 95 sections of the basic rocks in the zone A. It is noteworthy that the epidote enclosed in part by porphyroblastic albite is simply zoned in the enclosed parts, while in the unenclosed parts zoning is complex. The sketches of some complex-zoned epidotes are shown in Fig. 2.

Simple-zoned epidote is observed in the basic rocks of zones, A and B. Epidote included by porphyroblastic albite is simply zoned. In 35 sections of pelitic and psammitic rocks of zones, A and B, only simple-zoned epidote has been found.

Barrositic amphibole coexisting with complex-zoned epidote is almost always mantled with pale green to colourless actinolite in the zone B. In the zone A magnesioriebeckite coexists with actinolite.

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Table 1. Mineral assemblages of analysed samples.

		actinolite	riebeckite	barroisite	epidote	albite	quartz	chlorite	mica
zone B	a	+		+	+	+	+	+	
	b	+		+	+	+	+	+	+
zone A	c	+			+	+	+	+	
	d	+			+	+	+	+	
	e	+	+		+	+	+	+	+
	f	+	+		+	+	+	+	+
	g	+			+	+	+	+	+

+; mineral present.

Fig. 2. Sketches of complex-zoned epidotes in the zone B.
Shaded and unshaded parts indicate the mantle and the core, respectively.

Analytical Results and Discussion

The zoning patterns of selected epidotes in regard to Fe and Al are given in Fig. 3. These patterns were obtained from records by scanning the electron beam on specimens. The electron probe microanalyzer Model JXA-5 of J.E.O.L. was used throughout. The analytical procedures are the same as those described by NAKAMURA and KUSHIRO (1970).

In the complex-zoned epidotes the Fe content decreases slightly from the center to the margin of the core, and it increases abruptly across the core-mantle boundary and remains at high value with the mantle. On the other hand, the Fe content of simple-zoned epidote gradually decreases from

core to rim (Fig. 3, c1-c2, d1-d2).

The selected partial analyses of the core and the mantle of the zoned epidotes are listed in Table 2. The grains a and b are the complex-zoned porphyroblastic epidotes in the zone B. The a1 and b1 are the core, and the a2 and b2 are the mantle of the complex-zoned epidote. The subsidiary numbers 1 and 2 of specimens(c-d) indicates the core and the rim of the simple-zoned epidote, respectively. The grains e, f, and g are slightly zoned, and their cores were analysed.

Continuous change of Fe_2O_3 content ranging from 6.8 to 16.2 wt% are common, and this conflicts with the solvus model proposed by STRENS (1965) and HOLDAWAY (1965). Further the Fe_2O_3 content of the mantle is about 7 wt% higher than that of the core in the complex-zoned epidote.

Fig. 3. The results of scanning by $AlK\alpha$ and $FeK\alpha$ emissions on the complex- and simple-zoned epidotes.

Table 2 Chemical composition of epidote.

	a-1	a-2	b-1	b-2	c-1	c-2
SiO_2	36.30	36.33	38.19	37.40	37.02	37.46
Al_2O_3	25.61	23.05	27.90	22.96	24.57	26.36
$Fe_2O_3^*$	10.04	13.83	6.89	13.62	10.51	8.77
$Mn_2O_3^*$	0.31	0.13	0.13	0.17	0.44	0.38
CaO	22.97	22.87	23.44	23.05	23.10	23.66
Total	95.23	96.21	96.55	97.20	96.64	96.63

Number of ions on the basis of 12.5 oxygens.

	a-1	a-2	b-1	b-2	c-1	c-2
Si	2.91	2.94	2.99	2.98	2.98	2.97
Al	2.42	2.19	2.58	2.15	2.33	2.46
Mn	0.02	0.01	0.01	0.01	0.03	0.02
Fe	0.66	0.89	0.43	0.86	0.67	0.50
Ca	1.97	1.98	1.97	1.97	1.99	2.00

	c'-1	c'-2	d-1	d-2	e	f	g
SiO_2	37.93	38.20	37.44	39.00	37.58	36.12	37.13
Al_2O_3	24.39	26.50	21.00	26.93	24.03	22.24	22.54
$Fe_2O_3^*$	10.61	8.16	16.19	7.94	12.60	15.68	14.96
$Mn_2O_3^*$	0.45	0.39	0.09	0.14	0.03	0.08	0.06
CaO	23.08	23.36	23.18	23.38	23.22	22.52	23.07
Total	96.46	96.61	97.90	97.39	97.46	96.64	97.76

Number of ions on the basis of 12.5 oxygens.

	c'-1	c'-2	d-1	d-2	e	f	g
Si	3.00	3.00	2.99	3.00	3.08	3.05	3.08
Al	2.29	2.48	2.98	2.45	2.32	2.21	2.20
Mn	0.03	0.03	0.01	0.01	0.00	0.00	0.00
Fe	0.67	0.49	1.04	0.55	0.78	1.01	0.95
Ca	1.97	1.98	1.99	1.97	2.04	2.04	2.05

* All Fe and Mn are expressed as Fe_2O_3 and Mn_2O_3 .

ERNST *et al.* (1970) indicated Al-enrichment in epidote with increasing metamorphic grade on the Franciscan metamorphic terrane. Therefore, simple zoning can be explained by the progressive metamorphism, and thus the formation of the mantle in the complex-zoned epidote may be derived from the retrogressive as suggested by MIYASHIRO and SEKI (1958).

However, it is noteworthy that the occurrence of the iron-rich mantle are restricted in the basic rocks of the zone B, suggesting that the formation of the complex zoning could be due to the expense of barroisitic amphibole.

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関東山地，三波川変成岩に含まれる緑レン石

——造岩鉱物ノート (37)——

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(要 旨)

関東山地の三波川変成岩には，帯状構造をもつ緑レン石が広く分布している。この帯状構造には二つのタイプがあり，単純型と複合型と呼んだ。後者は， Fe_2O_3 含有量が中心から外へ少くなり，さらに最外側で急に増加す

る。前者は中心から外へ連続的に Fe_2O_3 が少くなる。複合型は変成度の高い塩基性変成岩にのみ見られる。従ってこれは，下降変成作用によって出来たものと考えられる。