COMPOSITIONAL RANGE OF α AND β ZOISITES

MASAKI ENAMI* and SHOHEI BANNO*

Introduction

The relationships among the optic orientation, optic axial dispersion and chemistry of zoisite described in textbooks are somewhat confusing. We have confirmed that the relationships described by MYER (1966) are correct and further pin-pointed the chemical composition of zoisite at α - β transition of optic plane.

Optical properties and chemical composition

We have selected three zoisite-bearing metagabbros, one from the Iratsu and two from the Fujiwara masses, of the Sanbagawa metamorphic terrain in central Shikoku. The symmetry of zoisites in three specimens was

Table 1. Chemical compositions of α and β zoisites.

	7055b		F-10a		F-10b	
	α -zo.	β -zo.	α -zo.	β -zo.	α -zo.	β -zo.
SiO ₂	39.88	40.22	39.78	39.81	39.99	39.40
TiO ₂	0.03	0.03	0.00	0.04	0.01	0.02
Al ₂ O ₃	31.63	32.69	31.92	32.47	31.94	32.73
Fe ₂ O ₃ *	2.48	1.09	2.06	1.37	2.11	1.27
MnO	0.05	0.03	0.06	0.02	0.04	0.03
MgO					0.19	0.16
CaO	24.06	24.26	23.98	24.00	24.35	24.71
Na ₂ O					0.11	0.16
K ₂ O					0.00	0.00
Total	98.12	98.33	97.81	97.71	98.76	98.43
Atomic ratios (O=12.5, anhydrous basis)						
Si	3.033	3.037	3.032	3.028	3.023	2.986
Al ^{IV}						0.014
Al ^{VI}	2.836	2.909	2.866	2.910	2.846	2.899
Ti	0.002	0.002	0.000	0.002	0.001	0.001
Fe ³⁺	0.142	0.062	0.118	0.079	0.120	0.073
Mn	0.003	0.002	0.004	0.001	0.003	0.002
Mg					0.022	0.018
Ca	1.960	1.963	1.957	1.956	1.972	2.006
Na					0.016	0.015
K					0.000	0.000
X _{Fe}	0.048	0.021	0.040	0.026	0.041	0.025

Fe₂O₃*: Total Fe is treated as total Fe₂O₃.

Localities

Fujiwara mass: F-10a, F-10b.

Iratsu mass: 7055b.

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* Department of Earth Sciences, Kanazawa University, Kanazawa, 920 Japan.

confirmed by X-ray powder pattern following the criteria given by SEKI (1959). On one sample, it was confirmed by Weissenberg photograph that zoisite is elongated parallel to crystallographic b axis (morphological c). The optic orientations, optic axial dispersion and optic axial angle were determined on U-stage with orthoscopic setting. Chemical compositions were determined by microprobe. Selected analyses are shown in Table 1.

Chemistry and optic orientation Following TERMIER (1898), zoisite with optic plane normal to crystallographic a axis is called α zoisite and that with optic plane normal to crystallographic b is called β zoisite. The relationship between the optic orientation and chemistry is shown in Fig. 1. The chemical compositions were determined by microprobe and hence Fe is treated as Fe₂O₃, although wet chemical analyses of zoisite reported in literatures (cf. DEER *et al.*, 1963; BANNO, 1964; MYER, 1966) contain appreciable amount of FeO in comparison with Fe₂O₃. No attempt was made to examine the effect of oxidation state of Fe on optics, but there is no need to take that effect into account unless the ac-

Fig. 1. Relationship between optic orientation and chemical composition. The amount of Fe and Al are on anhydrous basis O=12.5.

Fig. 2. Micro-probe scanning feature of (001) section which described by ENAMI (1977, Fig. 3-3). α and β denote the boundary determined by the dispersion.

Fig. 3. Relationship between optic axial angle and the composition of zoisite.

curacy of data is significantly improved. The boundary between α and β zoisites is located at $X_{Fe}=0.030$, where $X_{Fe}=Fe^{3+}/(Fe^{3+}+Al)$. Further, as shown in Fig. 2, scanning of a sector-zoned zoisite described by ENAMI (1977, Fig. 3-3) by microprobe showed that the change from α to β orientations takes place at $X_{Fe}=0.030$. Because of strong axial dispersion, the boundary between α and β zoisites can be located very accurately on thin section cut normal to c axis.

The relationships between $2V_z$ and chemistry is shown in Fig. 3. The $2V_z$ - X_{Fe} curve is smoothed to pass a point with $2V_z=0$ and $X_{Fe}=0.030$ where the curve is vertical as proven by Tsuboi (1959, p. 308). These data show that α zoisite is richer in Fe than β zoisite.

Optic axial dispersion Fig. 4 shows the relationships between $2V_z$, optic orientation and wavelength of transmitted light. For light sources, Cd, Na and Hg lamps, with appropriate filters for Cd and Hg, were used. The data of GAME (1954) are also plotted in the figure. For this measurement, homogeneous zoisites from the Iratsu mass were

Fig. 4. Optic axial dispersion of α and β zoisites.

Table 2. Summary of optic properties and chemistry.

Optic plane	Termier's nomenclature	Fe contents	Dispersion
(010)	β	$X_{Fe}<0.030$	$r>v$
(100)	α	$X_{Fe}>0.030$	$r<v$

used. The figure clearly indicates that the sign of optic axial dispersion is $r<v$ for α zoisite and $r>v$ for β zoisite.

Concluding remarks

The relationships between optic orientation, optic axial angle, dispersion and chemistry are summarized in Table 2. The optic axial dispersion was correctly described by TERMIER (1898) and WINCHELL & WINCHELL (1953). Confusion in some recent textbooks might have arisen from FRANCIS (1958). As pointed out by DEER *et al.* (1963), the available data before MYER (1966) were too scarce to decide which of α and β zoisites is richer in Fe.

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