原 著 論 文

On the Radial Arrangement of Joint-prisms and the Fluidal Structure observed in the Hôzanji Volcanic Knoll, Nara Pref., Japan

By

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abstract

The Eruptive-tectonics of the Hôzanji Andesite Knoll was worked out. Joint-prisms of the knoll are radiating from the center. Hypersthènes and plagioclases generally tend to be oriented to the vertical direction. From these facts the andesite mass may be presumed to be a volcanic neck in the real sense of the term.

I. Brief Geology and topography (NAKAMURA, 1926) - Fig. 1 -

Just behind the Hôzanji Temple on the eastern slope of Mt. Ikoma in the Central Kinki District, Japan, there exists a famous volcanic knoll, small but rather conspicuous. This volcanic knoll, a part of the Setouchi Volcanic Zone, consists of aphanitic augite-hypersthene-andesite (WEIN-SCHENK, 1891; YOSIZAWA, 1932, - Table 1 -) and its base rock is granite. The geologic age of the andesite mass is quite unknown. At the dome-

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shaped summit of Mt. Ikoma basic rocks (YOSIZAWA, 1949) such as diorite and gabbro are exposed, resisting to erosion.

Table I. Petrography of Hôzanji Andesite

megascopically: greyish-black, aphanitic, not lustrous, rarely porous, sometimes glassy, with plentiful xenoliths and xenocrysts of base-rocks.		
phenocrysts	hypersthene	abundant, long prismatic (ca. 0.5 mm in max. length), colorless, $2V = (-) 76^{\circ} \sim 82^{\circ}$, $r(\text{max.}) = 1.695$, sometimes with corona of monoclinic pyroxenes.
	augite	very rare, colorless, $c \wedge Z = 43^{\circ}$, $2V = (+) 44^{\circ}$, β (indet.)
	hornblende	extremely rare, dark-brown, corroded, with opacite margin.
ground-mass	plagioclase (An $60 \pm$, thin lamellae parallel to 010), pyroxenes rhombic and monoclinic, iron-ore, cristobalite, glass	

Jirô MAKIYAMA (cited in MURAKAMI, 1950) has recently ascribed the formation of Ikoma Mountain-range to the upfolding of basal granite, which is accompanied with several thrust faults from north to south on the steep hill-sides. Along one of the thrusts, a small basalt dyke is said to have intruded at the western foot of Mt. Ikoma.

The Hôzanji Andesite Mass is ellipsoidal in plan, about 100 m. from east to west and about 60 m. from north to south, projecting sharply on the eastern slope of Mt. Ikoma, about 40 m. up from its base. Only from the topographical view-point this andesite mass has long been conceived as a volcanic neck without any other satisfactory proofs.

II. Radial arrangement of joint-pillars

A) Elongated direction of joint-prisms and its measuring method

The Hôzanji Andesite Mass has many cracks such as columnar, scaly and tabular joints. The latter two are local, while the columnar joint, composed of irregular pentagonal or quadrangular prisms, is highly dominant.

V.P.: vertical plane, H.P.: horizontal plane, J.S.: one of the joint surfaces, AB: the edge now in question, BC: strike of the joint surface (ABC)

Fig. 2. Factors determining the direction of an edge of joint-pillars.

In order to clarify the regularity of this columnar joint system, the writer measured the elongated direction of the joint-columns, instead of measuring the attitudes of the joint surfaces as many authors ever did.

The direction of an edge of a joint-column was regarded to be approximately equal to its elongated direction. If the following four factors are given, the special position of an edge will be uniquely determined (Fig. 2):

- a: Locality of the edge on a topographical map (The position of point B on a map).

b: Strike of the vertical plane (ABD) containing the edge (AB) (The direction of BD).

c: Sense of the strike BD $(\overrightarrow{BD})$.

d: Dip angle of the edge on the vertical plane (ABD).

$\angle\theta = \overrightarrow{BD} \wedge \overrightarrow{BA}$, $\angle\theta$ is marked +, if A is above the horizontal plane and -, if A is below it.

However, the second factor is pretty difficult to be measured in practice. By means of the following method, fairly accurate results could be easily gained:

Table 2. Results of measurements of the elongated directions of joint-columns in each part (numerals with degree unit).

part	attitudes measured
A	(S 54.5E, -20) (S 51.5E, -30) (S 46.5E, -15)
B	(S 26.5E, +30) (S 26.5E, +15) (S 26.5E, +12) (S 26.5E, +30) (S 44.5E, +10) (S 51.5E, +10) (S 46.5E, 0)
C	(S 3.5W, +10) (S 3.5W, +20) (S 11.5W, +20) (S 13.5W, +20)
D	(W 51.5S, +30) (W 71.5S, +20) (W 68.5S, +20) (W 68.5S, +23) (W 48.5S, +10) (W 36.5S, +20) (W 46.5S, +5)
E	(W 16.5S, +4) (W 16.5S, +5) (W 21.5S, +10) (W 15.5S, +10) (W 14.5S, +12) (W 16.5S, +4) (W 8.5S, +10) (W 14.5S, +5) (W 6.5S, 0)
F	(S 39.5E, -30) (S 46.5E, -20) (S 51.5E, -20) (S 51.5E, -12)
G	(W 66.5S, +20) (W 56.5S, +20) (W 51.5S, +15) (W 56.5S, +20) (W 44.5S, +20) (W 48.5S, +8) (W 46.5S, +10) (W 46.5S, +15)
H	(W 2.5N, +5) (W 6.5S, +20) (W 6.5S, +10) (W 16.5S, +10) (W 6.5S, +8)
I	(N 48.5W, -10) (N 41.5W, -10) (N 46.5W, -10)
J	(N 28.5W, +3) (N 36.5W, -10) (N 28.5W, -10)
K	(N 3.5E, 0) (N 3.5E, 0) (N 11.5E, -10) (N 8.5E, -20) (N 3.5E, -20) (N 13.5E, -10) (N 5.5E, -10) (N 6.5W, -8)
L	(N 53.5E, -20) (N 61.5E, -20) (N 61.5E, -20) (N 33.5E, +10) (N 48.5E, +5)
M	(S 24.5E, +10) (S 44.5E, 0) (S 6.5E, +12) (S 16.5E, +10) (S 26.5E, +5) (S 34.5E, +3) (S 46.5E, 0) (S 24.5E, +8)
N	(S 51.5E, +20) (S 41.5E, +12) (S 54.5E, +10) (S 56.5E, +5) (S 66.5E, +5) (S 46.5E, +9)
O	(S 26.5E, +10) (S 26.5E, +15) (S 31.5E, +15) (S 26.5E, +10) (S 12.5E, +12) (S 24.5E, +5) (S 14.5E, -5) (S 24.5E, +5) (S 19.5E, +20) (S 19.5E, +10) (S 18.5E, +12) (S 21.5E, +10) (S 26.5E, +12) (S 24.5E, +10)
P	(W 46.5S, 0) (W 46.5S, +10) (W 46.5S, +10) (W 46.5S, +10) (W 46.5S, +12) (W 46.5S, 0) (W 46.5S, 0)
Q	(W 2.5S, +10) (W 4.5S, +10) (W 11.5S, +12) (W 4.5S, +10) (W 6.5S, 0)
R	(S 66.5E, +8) (S 74.5E, +8) (S 66.5E, 0) (S 56.5E, +8) (S 74.5E, +8) (S 64.5E, -5) (S 66.5E, 0) (S 76.5E, -10) (S 76.5E, +6) (S 86.5E, +8) (S 58.5E, 0) (S 61.5E, +10)

Put one brim (PQ) of a clinometer on the edge (AB) now in question and keep the surface of the clinometer horizontal, seeing a levelling bubble. Then bring the brim (PQ) to the position where (PQ) coincides with (AB) when observing from above, and read the direction of the strike.

B) Results of measurements

The surface of the knoll was divided into forty parts with radial lines and contours and in each part the direction is measured. Unfortunately exposures being poor only eighteen parts could be measured (Parts A, B, —, R in Fig. 3). The results are tabulated in Table 2. In these measurements, the sense of the strike of the vertical plane containing the edge of a joint-column is taken outwards from the center of the knoll. And the values of bearing are corrected into the geophysical azimuth.

C) Some discussions

Mean attitudes of elongated directions of joint-prisms in the eighteen parts are tabulated in Table 3 and illustrated in Fig. 3.

Table 3. Mean attitudes of the elongated directions of joint-columns at each part (numerals with degree unit)

altitude	eastern side	southern side				western side	northern side			
	A	B	—	C	D	E	—	—	—	—
430 m.	S50.8E -21.7	S35.5E +15.3	—	S 8.0W +17.5	W55.9S +18.2	W12.3S + 6.7	—	—	—	—
420 m.	F	—	—	—	G	H	I	J	K	L
	S47.3E -20.5	—	—	—	W52.1S +16.0	W 6.7S +10.6	N45.5W -10.0	N31.2W - 5.7	N 5.4E - 9.3	N51.7E - 9.0
410 m.	M	—	N	O	P	Q	—	—	—	—
	S28.0E + 6.0	—	S52.8E +10.2	S22.4E +10.1	W46.5S + 6.0	W 5.9S + 8.4	—	—	—	—
400 m.	—	R	—	—	—	—	—	—	—	—
	—	S69.1E + 3.4	—	—	—	—	—	—	—	—

Fig. 3. Directions to which joint-prisms are elongated.

A : andesite, G : granite
Arrow marks show the elongated directions of the joint-columns.
The position of this longitudinal section is shown in Fig. 3.

Fig. 4. Profile of the Hôzanji Knoll.

The joint-prisms are developed radially from the center of the knoll except the eastern parts, where columnar joint is obscure and tabular or irregular cracks are prevailing instead. In the eastern parts, moreover, the petrography is sometimes a little different, being more glassy in its ground-mass.

In the northern parts dip angles are marked—, that is, the joint-prisms are elongated downwards below the horizontal plane, as illustrated in Fig. 4.

Assuming that joint-prisms occur perpendicularly to the isothermal planes when lava is cooling, the next presumption concerning the true shape of the andesite mass may be reasonable:

The Hôzanji Andesite Knoll is a volcanic neck which has a cylindrical form, inclining northward a little (Fig. 4).

This presumption will become still more probable when the flow structure is examined as expressed below.

III. Fluidal structure

Many oriented sections were examined in order to investigate the fluidal structure displayed by the subparallel alignment of long prismatic hypersthene and lath-shaped plagioclases.

One example at the part H in Fig. 3. will be shown below: Three oriented sections a, b and c perpendicular to one another were made in case of the joint-prism shown in Photo 3. of Plate. The sections a and c are almost vertical and b is nearly horizontal, and the section c is in the tangential plane to the cylindrical surface of the volcanic knoll. In each slice hypersthene and plagioclases are observed as tabulated in Table 4. (Photos 6, 7 and 8 of Plate). Each mineral has a tendency to be arranged in a nearly vertical direction. Such a trend is, more or less, observed at every place of the knoll.

Table 4. Alignment and crystal form of two constituent minerals in each oriented section

slice	hypersthene	plagioclase
a	prismatic, usually arranged in a vertical direction.	lath-shaped, usually arranged in a vertical direction. albite-twins to be observed.
b	cross-sections mostly to be observed.	lath-shaped, arranged in a tangential direction to the surface of the knoll.
c	prismatic, usually arranged in a vertical direction. the most conspicuous of the three.	tabular, flattened on 010, albite twins not to be seen.

This fact is quite conducive to the presumption that the true shape of the Hôzanji Andesite Mass is a volcanic neck.

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ホーザン
宝山寺火丘の放射状柱状節理と流理構造

粉 川 昭 平

(要 約)

柱状節理が放射状に発達していることと、紫蘇輝石と斜長石が鉛直方向に並んでいる傾向のあることとによつて、奈良県宝山寺安山岩丘の真の型体は火山岩類であろうと推定した。