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## Fission-Track Age of Pumices Included in the Gigante Formation, North of Neiva, Colombia

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### INTRODUCTION

To estimate the age of fossil horizon, radiometric age determinations are necessary. Fortunately, volcanoclastic deposits preserved in the Upper Magdalena Basin during the late Cenozoic time (Van Houten, 1976).

Fission-track age determination was carried out on the pumices included in the Gigante Formation, north of Neiva, Colombia. The Gigante Formation unconformably covers the Honda Group which has yielded fossils of a middle to late Miocene vertebrate fauna.

### FISSION-TRACK AGE DETERMINATION

Age determination of volcanic samples was carried out using the fission-track method.

The fission-track age,  $T$  years, can be represented by the following equation (Price and Walker, 1963).

$$T = \frac{1}{\lambda} \ln \left( 1 + \frac{\lambda}{\lambda_f} \cdot \frac{\rho_s}{\rho_i} \cdot \frac{\phi \sigma}{\eta} \right) \quad \dots\dots(1)$$

where  $\rho_s$  is the fossil fission-track density ( $\text{cm}^{-2}$ ),  $\rho_i$  is the induced fission-track density ( $\text{cm}^{-2}$ ),  $\lambda$  is the total decay constant for  $^{238}\text{U}$ ,  $\lambda_f$  is the fission decay constant for  $^{238}\text{U}$  ( $7.03 \times 10^{-17} \text{ yr}^{-1}$ ),  $\sigma$  is the thermal neutron cross section for fission of  $^{235}\text{U}$  ( $\text{cm}^2$ ),  $\phi$  is the thermal neutron dose ( $\text{cm}^{-2}$ ), and  $\eta$  is the isotope ratio  $^{235}\text{U}/^{238}\text{U}$ . If  $T$  is smaller than  $10^9$  yr., the equation (1) can be written as follows.

$$T = 5.96 \times 10^{-8} \phi \frac{\rho_s}{\rho_i} \quad \dots\dots(2)$$

Both the fossil and induced fission-track densities are counted on the same external surface of the same grain. The procedure of the age determination was performed according to the method of Nishimura and Yokoyama (1973) and Yokoyama et al. (1980).

### SAMPLE

Sampling locality is located about 18 km north of Neiva, at the outcrop along the road from Neiva to Villavieja. Locality No. is NV 4 of Takemura (1982).

Sampling horizon is included in the Gigante Formation which consists of irregular alternating beds of gravels (pebble with cobble, sandy and tuffaceous matrix) and volcanic deposits (volcanic sand, volcanic ash and pumices).

Samples are pumices included in the part of volcanic deposits. About 5 kg of pumices were crushed and washed by water, and heavy minerals were concentrated by panning. This sample includes heavy minerals such as green hornblende, brown hornblende, zircon and orthorhombic pyroxene. Zircon crystals were gathered for the fission-track age determination.

## RESULT AND CONSIDERATION

Age determination was carried out using grain by grain re-etching method of fission-track method. At first, after counting fossil and induced fission-track densities on the same external surface of the same grain, age of each zircon crystal was calculated (Table 1), and its result is represented as shown in Fig. 1. As shown in Table 1, fossil fission-track number of

Table 1. Fission-track ages of individual grains of zircon crystals included in pumices of the Gigante Formation. A and B indicate the component of Groups A and B.

						$\phi = 3.80 \pm 0.11 \times 10^{14}/\text{cm}^2$					
Number	Ts	$\rho_s$ ( $\times 10^4$ $\text{cm}^2$ )	Ti	$\rho_i$ ( $\times 10^6$ $\text{cm}^2$ )	Fission-track age	Number	Ts	$\rho_s$ ( $\times 10^4$ $\text{cm}^2$ )	Ti	$\rho_i$ ( $\times 10^6$ $\text{cm}^2$ )	Fission-track age
1	25	49.8	46	0.92	12.3	19	12	44.1	25	0.92	10.9
2	16	64.5	40	1.61	9.1 B	20	15	30.2	48	0.97	7.1 A B
3	21	25.6	68	0.83	7.0 A B	21	11	42.8	28	1.12	8.9 B
4	11	32.6	34	1.01	7.3 A B	22	19	40.3	45	0.96	9.6 B
5	6	14.5	—	—	—	23	8	28.3	21	0.74	8.6 B
6	14	46.8	24	0.80	13.2	24	7	22.0	18	0.57	8.8 B
7	19	40.9	38	0.82	11.3	25	6	28.7	16	0.77	8.5 B
8	24	18.2	65	0.49	8.4 B	26	12	35.3	43	1.26	6.3 A B
9	28	53.0	75	1.42	8.5 B	27	7	12.2	24	0.42	6.6 A B
10	15	30.8	42	0.86	8.1 B	28	20	51.4	43	1.11	10.5
11	19	30.9	—	—	—	29	19	23.2	39	0.48	11.0
12	20	28.1	68	0.96	6.7 A B	30	24	25.0	61	0.64	8.9 B
13	10	27.3	32	0.87	7.1 A B	31	23	47.5	71	1.47	7.3 A B
14	15	58.6	20	0.78	17.0	32	15	40.4	27	0.73	12.6
15	22	24.7	42	0.47	11.9	33	27	38.4	—	—	—
16	20	41.6	60	1.25	7.5 A B	34	10	18.0	31	0.56	7.3 A B
17	7	26.3	18	0.68	8.8 B						
18	13	35.1	40	1.08	7.4 A B						

$H = 7.03 \times 10^{-17} \text{y}^{-1}$

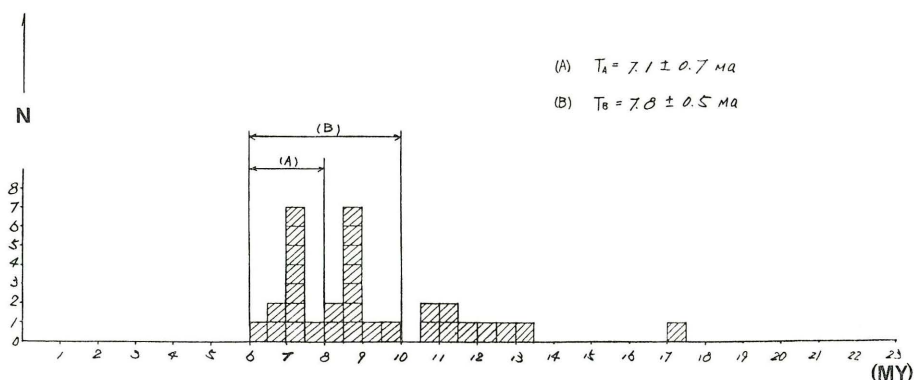


Fig. 1. Distribution of fission-track ages on individual grains of zircon crystal included in pumices of the Gigante Formation.

each grain ranges from 6–28, and induced fission-track number ranges from 16–75. These data are comparatively large in number, and it is considered that age indicated by each zircon crystals is reliable and that the age of the sample is the mean value of zircon crystals which occupy the peak indicating the youngest age.

The age of each grain ranges between 6 m.y. and 17 m.y. From the frequency pattern (Fig. 1), the result is divided into three groups. One is the group which is composed of 22 grains ranging between 6 and 10 m.y., and second is the group which consists of 8 grains ranging between 10.5 and 13.5 m.y., and isolated one grain indicates 17 m.y.

The group indicating the youngest age was subdivided into two groups. One ranges between 6 and 8 m.y., the other ranges between 8 and 10 m.y. Zircon crystals indicating the ages between 6 and 8 m.y. are named Group A, and those indicating the ages between 6 and 10 m.y. are named Group B. The total numbers of fossil and induced tracks of Group A are 162 and 519 respectively, and the age of this Group is calculated  $7.1 \pm 0.7$  m.y. The total numbers of fossil and induced tracks of Group B are 327 and 948 respectively, and the age is calculated  $7.8 \pm 0.5$  m.y. Difference between two groups could not be recognized. So, the author considers that the age of this pumice sample is the  $7.8 \pm 0.5$  m.y. calculated using zircon crystals whose ages range between 6 and 10 m.y. This age indicates that the volcanic materials of the Gigante Formation were deduced by the late Miocene volcanic activity, and is concordant with the age of the Gigante Formation ( $8.5 \pm 0.4$  m.y.) reported by Van Houten (1976) using the K-Ar method.

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