FISSION-TRACK AGES OF THE METALLOGENIC EPOCH OF THE IKUNO-AKENOBE PROVINCE IN JAPAN

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The igneous rock specimens taken from Ikuno-Akenobe province in Japan were dated by the fission-track technique. Ages of pre-ore dikes, ranging from 72 to 65 my, are younger than ages of Ariga granite and Yakuno metamorphic rocks in this province, which are 75 and 115 my, respectively. Being obvious from the ages of post-ore dikes, ranging from 55 to 51 my, none of the post-ore dikes in this province is younger than the Miocene time.

INTRODUCTION

Polymetallic vein-type deposits of tin, tungsten, copper, zinc, lead, silver and gold are found at Akenobe and Ikuno. These are among the best-known of Japanese deposits and have been cited as type examples of a xenothermal deposits. The ore-deposits at Akenobe, Nakase and Ikuno mines are quite similar in the assemblage of vein-forming minerals but differ in their host rocks. The host rocks at the Akenobe and Nakase are Permo-Carboniferous sedimentary rocks and Triassic rocks of the Yakuno mafic complex, while the host rocks at the Ikuno deposits are Cretaceous rhyolitic pyroclastic rocks of the Ikuno Group. The ages of granitic rocks, which are found very close to these deposits, are not younger than host rocks. A number of dikes, basaltic and rhyolitic in composition, have intruded before and after the mineralization.

The ages of these dikes have been obtained by Ishihara and Shibata using K-Ar method (1972). For the re-examination of metallogenic epoch of this province, the

rock specimens have been dating collected.

ANALYTICAL PROCEDURE

Zircons were separated with an isodynamic separator and heavy liquid after crushing, sieving and washing of the rock samples. Zircon is suitable for the application of fission-track dating, because of the high uranium impurities and its high temperature stability.

The method depends on the spontaneous fission of ^{238}U atoms in mineral, taking place at a constant rate and leaving fission-tracks. Once formed, the fission tracks disappear if the material is heated above a critical temperature. The fission track age, T yr, can be represented by the following equation (Fleisher and Price, 1964).

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

where ρ_s is the fossil fission track density (cm^{-2}), ρ_i is the induced track density by bombardment with the thermal neutrons (cm^{-2}), λ is the total decay constant for uranium (yr^{-1}), λ_f is the fission decay constant for ^{238}U (we used 6.85×10^{-17}

Table 1 Fission-track ages of Ikuno-Akenobe province

Sample	Spontaneous fission-track density (cm ⁻²)	Induced fission-track density (cm ⁻²)	Thermal neutron dose (cm ⁻²)	Fission-track age (my)
Ikuno				
Andesite dike, post-ore	6.3×10^6	8.2×10^6	1.1×10^{15}	52
Rhyolite dike, pre-ore	8.5×10^6	7.8×10^6	1.1×10^{15}	70
Ariga				
Granite	9.6×10^6	8.9×10^6	1.1×10^{15}	75
Fudo-no Taki, Haga				
Yakuno metamorphic rock	1.3×10^7	7.5×10^6	1.1×10^{15}	115
Nakase				
Quartz porphyry	7.9×10^6	7.8×10^6	1.05×10^{15}	65
Quartz diorite	1.0×10^7	8.9×10^6	1.05×10^{15}	72
Akenobe				
Felsite dike, post-ore	6.7×10^6	8.5×10^6	1.05×10^{15}	51
Felsite dike, post-ore	8.9×10^6	9.2×10^6	0.88×10^{15}	52
Porphyritic andesite	8.5×10^6	8.8×10^6	0.88×10^{15}	52
Andesite	8.0×10^6	7.8×10^6	0.88×10^{15}	55

Table 2 The ages of minerals and rocks in the metallogenic province

Name of ore deposits	Rocks	Age	Reference
Post-ore			
Ikuno	Andesite dike	52 ^{my}	This work
Akenobe	Felsite dike	52.6	Ishihara and Shibata, 1972
Akenobe	Felsite dike	57.8	" " "
Akenobe	Felsite dike	51	This work
Akenobe	Felsite dike	52	"
Akenobe	Porphyritic andesite dike	52	"
Akenobe	Andesite dike	55	"
Pre-ore			
Ikuno	Felsite dike	72.8	Ishihara and Shibata, 1972
Ikuno	Felsite dike	70	This work
Nakase	Quartz porphyry	65	"
Nakase	Quartz diorite	72	"
Miyazu	Granite	55-68	Kawano and Ueda, 1973
Ariga	Granite	75	This work
Ohtani	Granodiorite	93.0	Shibata and Ishihara, 1974
Ohtani	Muscovite, alter envelope	90.0	" " "
Ohtani	Muscovite, vein	91.4	" " "
Yakuno	Metamorphic rock	115	This work

yr⁻¹); Nishimiura, 1975), σ is the thermal neutron cross section for fission ²³⁵U (cm⁻²), ϕ is the thermal neutron dose (cm⁻²), and η is the isotope ratio ²³⁵U/²³⁸U. If T were smaller than 10⁻⁹yr, equation (1) can be written

$$T = 6.12 \times 10^{-8} \phi \frac{\rho_s}{\rho_i}$$

Zircon required two hours at 180°C in 1:1 55% HF and Conc. H₂SO₄ using stainless capsul and teflon inner capsul.

ANALYZED SPECIMENS AND RESULTS

Localities of the analyzed specimens and results are listed in Table 1.

Ikuno: The pre-ore dikes are rhyolite, andesite and basalt. The fission-track age of rhyolite dikes was obtained as 70 my (Table 1).

The andesite and sandstone like liparite dikes are found as post-ore dikes. The age of andesite dike was also obtained as 52 my.

Nakase: The rock specimens of pre-ore dikes were collected from Nakase mine for fission-track dating and obtained as 65 and 72 my.

Akenobe: At the Akenobe mine, the post-ore felsite dikes were dated as 51 and 52 my, and surrounding andesite were also obtained as 52 and 55 my.

The specimens from the host rocks of these mines were also collected from Ariga granite and Yakuno metamorphic rocks and obtained as 75 and 115 my, respectively.

DISCUSSION

The dates of these rocks were obtained by Kawano and Ueda (1966), Ishihara and

Shibata (1972) and Shibata and Ishihara (1974) as shown in Table 2.

From these data, the age of tungsten, tin and molybdenum deposits in this province were ranging from 70 to 90 my with plutonic rocks, that of polymetallic vein type deposits were 70 to 55 my with plutonic and subvolcanic activities and then gold and silver ore are deposited with subvolcanism.

ACKNOWLEDGMENTS

Grateful thanks are due to the staffs of all mines visited for the guidance during our field studies and also Profs. T. Nakamura and T. Kasama of University of Osaka City and Prof. K. Wadatsumi of Himeji Technical College for helpful comments on this studies. I wish also to express our appreciation to Prof. S. Iwata and the members of the Research Reactor Institute of Kyoto University for the use of their facilities in neutron irradiation.

REFERENCES

- Fleischer, R.L. and Price, P.B. (1964), Techniques for geological dating of minerals by chemical etching of fission fragment tracks, *Geochim. Cosmochim. Acta*, **28**, 1705-1714.
- Ishihara, S. and Shibata, K. (1972) Re-examination of the Metallogenic epoch of the Ikuno-Akenobe province, in Japan, *Mining Geol.*, **22**, 67-75.
- Kawano, Y. and Ueda, Y. (1966), K-Ar dating on the igneous rocks in Japan (I) - Granitic rocks in Southwestern Japan, *Jap. Assoc. Min. Petr. Econ. Geol. Jour.*, **56**, 191-211.
- Nishimura, S. (1975), On the value of the decay constant for spontaneous fission of uranium-238, *Mem. Fac. Sci., Kyoto Univ., Ser. Geol. Min.*, **41**, 15-19.
- Shibata, K. and Ishihara, S. (1974), K-Ar ages of the major Tungsten and Molybdenum deposits in Japan, *Econ. Geol.*, **69**, 1207-1214.

生野・明延鉾床の鉾化時代のフィッショントラックによる年代決定

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フィッショントラック法を生野・明延鉾床の火成岩について適用した。その結果、鉾化前の岩脈について 72~65 my を得た。この値はこの地域の 75 my を示す有賀花崗岩体や 115 my を示す夜久野変成岩体よりも若い。鉾床生成後に貫入した岩脈の年代は 51~55 my であって、中生代よりも若い岩脈のないことがわかった。

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