A Rb-Sr GEOCHRONOLOGICAL STUDY ON TATEHIRA GRANODIORITE, OSHIMA PENINSULA, SOUTHWEST HOKKAIDO, JAPAN

SHIGERU IIZUMI*, HIDEO KOBAYASHI* and MINORU TOYODA**

Introduction

The Tatehira granodiorite is one of the pre-Miocene stocks occurring sporadically in southwest Hokkaido and has been known as the pluton related to formation of kanoite, a manganoan clinopyroxene (KOBAYASHI, 1977a; 1977b). Cretaceous K-Ar ages have been reported for some of these plutons (KAWANO & UEDA, 1966; SHIBATA & YAMADA, 1978), but the radiometric age of the Tatehira granodiorite still remains unknown.

Initial Sr isotopic ratios of the granitoids in this district have not yet been determined by isochron method, though the ratios have been calculated for two granodioritic plutons using the known K-Ar ages (SHIBATA & ISHIHARA, 1979). In this report the authors present the Rb-Sr whole rock-mineral isochron age and the initial Sr isotopic ratio for the Tatehira granodiorite.

Geological setting and sample descriptions

The Tatehira granodiorite intrudes discordantly into Late Paleozoic or Early Mesozoic Matsumae Group (KOBAYASHI, 1977b; SAWAMURA & HATA, 1981) composed mainly of slate, sandstone and chert. The Tatehira granodiorite is unconformably overlain by the Miocene Usubetsu Formation, which is composed mainly of andesitic to basaltic lavas and pyroclastics. The Tatehira granodiorite apparently occurs as several separated small plutons (Fig. 1).

The sample used for Rb-Sr analysis was collected from the southern part of one of the plutons (Fig. 1). The sample is a medium-grained massive hornblende-biotite granodiorite, and is somewhat heterogeneous in modal contents of mafic minerals. The mafic mineral-rich and poor-parts are tentatively called here melanocratic and leucocratic parts, respectively.

The rock is composed mainly of hornblende, biotite, plagioclase, quartz, zircon, sphene, apatite and opaque minerals. Hornblende occurs as euhedral crystals with the maximum length of 3 mm. The axial color shows X=yellow, Y=yellowish green, Z=green, and $C\wedge Z$ is 21° . Biotite, higher in modal content than hornblende, occurs as euhedral to subhedral grains with the axial color of X=pale yellow, Y=Z=brown. Plagioclase is usually subhedral and is zoned from An_{45} to An_{25} . Quartz and K-feldspar occur as interstitial phases. Graphic intergrowth of albitic plagioclase and K-feldspar often develops along the plagioclase rim contacted with K-feldspar. Opaque minerals are usually included in mafic minerals.

The melanocratic(WRM) and leucocratic (WRL) parts of the sample were separately powdered and chemically analysed by X-ray fluorescence according to the methods described by KOBAYASHI *et al* (1981). They have similar chemical compositions to each other, with slight difference in $FeO+Fe_2O_3$, CaO and K_2O contents (Table 1).

Result and discussion

Sr isotopic ratios were determined using a MAT 261 mass spectrometer equipped at Institute for Thermal Spring Research, Okayama University. Rb and Sr concentrations were measured by isotopic dilution method.

Received March 31, 1984. Accepted July 9, 1984.

* Department of Geology, Shimane University, Matsue, 690 Japan.

** Aratani Construction Consultant Corporation, Hiroshima, 733 Japan.

Table 1. Chemical compositions and norms of the Tatchira granodiorites.

WRM : melanocratic part.
WRL : leucocratic part.

	WRM	WRL
SiO ₂	64.30	64.50
TiO ₂	0.75	0.68
Al ₂ O ₃	15.74	15.59
Fe ₂ O ₃	2.15	2.01
FeO	3.82	3.43
MnO	0.10	0.10
MgO	2.63	2.40
CaO	4.70	4.23
Na ₂ O	2.75	2.90
K ₂ O	2.14	2.97
P ₂ O ₅	0.15	0.14
H ₂ O ⁺	0.43	0.50
H ₂ O ⁻	0.24	0.23
Total	99.90	99.68
Q	24.64	22.33
Or	12.65	17.55
Ab	23.27	24.54
An	22.34	20.07
C	0.71	0.25
En	6.55	5.98
Hy	4.19	3.70
Fs		
Mt	3.12	2.91
Il	1.42	1.29
Ap	0.35	0.32

Fig. 1. Geological map of the Tatchira district.

1 : Alluvium, 2 : andesitic to basaltic lavas and pyroclastics (Usubetsu Formation), 3 : hornblende-biotite granodiorite (Tatchira granodiorite), 4 : slate, sandstone and chert (Matsumae Group), T : Tatchira, K : locality of kanoite, G : locality of the sample.

Index map shows distribution of granitic rocks in Northeast Japan. AP : Abukuma granitic province, KP : Kitakami granitic province, O : Okushiri Island, T : Tatchira, S : Setana, I : Imagane

The experimental procedures were previously described by KAGAMI *et al* (1982). Isotopic data presented in this report were statistically analysed by the least squares regression method of YORK (1969). Sixty times replicate analyses of the Standard Sample, NBS-987, gave an $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of 0.710239 ± 0.000007 at the 95 per cent confidence level. The measured Sr isotopic ratios were normalized to $^{86}\text{Sr}/^{88}\text{Sr} = 0.1194$. The age has been calculated using $\lambda = 1.42 \times 10^{-11} \text{y}^{-1}$ for the decay constant of ^{87}Rb (STEIGER & JÄGER, 1977).

Rb and Sr concentrations and Sr isotopic ratios were determined for WRM and WRL,

and for plagioclase-rich and biotite-rich fractions separated from the WRL. The plagioclase-rich fraction (PRF) is composed mainly of plagioclase with small amount of quartz and K-feldspar, and the biotite-rich fraction (BRF) contains hornblende about 5 per cent. The results of the analysis are listed in Table 2. They are plotted on a well-defined isochron, which yields an age of $102.5 \pm 0.3 \text{ Ma}$ with an initial ratio of 0.70538 ± 0.00001 (2σ) (Fig. 2).

K-Ar ages have been determined for some pre-Miocene granitoids in southwest Hokkaido. KAWANO & UEDA (1966) have reported the

Sample	Rb _{ppm}	Sr _{ppm}	$^{87}\text{Rb}/^{86}\text{Sr}$	$^{87}\text{Sr}/^{86}\text{Sr}$
1 WRM	97.07	276.5	1.016 ± 0.002	0.70681 ± 0.00007
2 WRF	102.6	285.7	1.039 ± 0.009	0.70689 ± 0.00004
3 PRF	42.82	332.1	0.399 ± 0.001	0.70602 ± 0.00005
4 BRF	360.5	21.47	48.91 ± 0.12	0.77662 ± 0.00008

Table 2. Rb and Sr concentrations and Sr isotopic ratios. WRM: melanocratic part of the whole rock sample, WRL: leucocratic part of the whole rock sample, PRF: plagioclase rich fraction from WRL, BRF: biotite rich-fraction from WRL.

Fig. 2. Isochron diagram for the Tatehira granodiorite (see Table 2 for abbreviations).

ages of 127 Ma and 114 Ma for two granodioritic plutons, Imagane and Setana plutons, in Oshima Peninsula respectively. SHIBATA & YAMADA (1978) have determined a K-Ar biotite age of a granodiorite from Okushiri Island, which gives a younger age of 95.8 ± 3.1 Ma. Similarly the Tatehira granodiorite has a rather young age among the granitoids in southwest Hokkaido.

Initial Sr isotopic ratios of the granodiorite from Okushiri Island and the Setana granodiorite, which were calculated based on the known K-Ar ages, are 0.7053 and 0.7044 respectively (SHIBATA & ISHIHARA, 1979). The Tatehira granodiorite has a comparable

ratio to the granodiorite from Okushiri Island.

The pre-Miocene granitoids in southwest Hokkaido have been considered to be correlated to those of Kitakami or Abukuma granitic provinces in northeast Honshu (TSUCHIYA, 1981; NOZAWA, 1983). The granitoids in the Kitakami granitic province, characterized by their low initial Sr isotopic ratios ranging from 0.7043 to 0.7049 (SHIBATA & ISHIHARA, 1979), have a limited range of K-Ar ages around 120 Ma. The granitoids in the Abukuma granitic province, on the other hand, show a range of younger K-Ar ages around 95 Ma and have a little higher ini-

tial Sr isotopic ratios ranging from 0.7047 to 0.7058 (UENO, 1977; MARUYAMA, 1978; SHIBATA & ISHIHARA, 1979). In view of the age and the initial Sr isotopic ratio, the Tatehira granodiorite as well as the granodiorite from Okushiri Island (SHIBATA & YAMADA, 1978) should be correlated to the granitoids in Abukuma granitic province.

Acknowledgements The authors wish to thank to Dr. H. HONMA of Institute for Thermal Spring Research, Okayama University for allowing them to use the mass spectrometer and for valuable suggestions on the isotopic analysis. The authors are greatfull to Mr. Y. OKAMOTO of Kyushu University for assistance in this study, and to Drs. Y. YAMAGUCHI and T. WATANABE of Shimane University for reviewing the manuscript.

References

- KAGAMI, H., OKANO, O., SUDO, H. and HONMA, H., 1982 : Isotopic analysis of Rb and Sr using a full automatic thermal ionization mass spectrometer. *Papers Inst. Therm. Spr. Res. Okayama Univ.*, **52** 51–70. (in Japanese with English abstract).
- KAWANO, Y. and UEDA, Y., 1966 : K–Ar dating on the igneous rocks in Japan (IV)—Granitic rocks in northeastern Japan—. *Jour. Japan. Assoc. Min. Petr. Econ. Geol.*, **56**, 41–55. (in Japanese with English abstract).
- KOBAYASHI, H., 1977a : Kanoite, $(\text{Mn}^{2+}, \text{Mg})_2\text{Si}_2\text{O}_6$, a new clinopyroxene in the metamorphic rock from Tatehira, Oshima Peninsula, Hokkaido, Japan. *Jour. Geol. Soc. Japan*, **83**, 537–542.
- , 1977b : The metamorphic rock of Tatehira, Southwest Hokkaido, Japan (II). Parageneses of Kanoite. *Mem. Fac. Lit. & Sci., Shimane Univ.*, **11**, 89–95. (in Japanese).
- , WATANABE, T. and IZUMI, S., 1981 : A full-automatic analysis of silicate rocks by X-ray fluorescence method. *Mem. Fac. Sci. Shimane Univ.*, **15**, 115–124. (in Japanese).
- MARUYAMA, T., 1978 : Geochronological studies on granitic rocks distributed in the Gosaisho—Takanuki district, southern Abukuma plateau, Japan. *Jour. Min. Coll. Akita Univ.*, Ser. A, **5**, 53–102.
- NOZAWA, T., 1983 : Felsic plutonism in Japan. *Geol. Soc. Amer. Mem.*, **159**, 105–122.
- SAWAMURA, K. and HATA, M., 1981 : Geology of the Ainuma district. Quadrangle Series, Scale 1 : 50,000. *Geol. Surv. Japan*, 48p. (in Japanese with English abstract).
- SHIBATA, K. and ISHIHARA, S., 1979 : Initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of plutonic rocks from Japan. *Contrib. Mineral. Petrol.*, **70**, 381–390.
- and YAMADA, N., 1978 : K–Ar age of a granodiorite from Okushiri Island, Hokkaido. *Bull. Geol. Surv. Japan*, **29**, 611–613. (in Japanese).
- STEIGER, R. H. and JÄGER, E., 1977 : Subcommission on Geochronology : convention on the use of decay constants in geo- and cosmo-chronology. *Earth Planet. Sci. Lett.*, **36**, 359–362.
- TSUCHIYA, N., 1982 : Petrology of the Matsumae plutonic complex, southwestern Hokkaido, Japan. Part I, Petrography and petrochemistry. *Jour. Japan. Assoc. Min. Petr. Econ. Geol.*, **77**, 322–344.
- UENO, N., 1977 : Rb–Sr and K–Ar isotopic investigations of granodiorites and the associated metamorphic rocks in the Abukuma plateau, Japan. *Earth Sci.*, **31**, 49–54.
- YORK, D., 1969 : Least-squares filling of a straight line with correlated errors. *Earth Planet. Sci. Lett.*, **5**, 320–324.

地名・地層名の日本語訳

Tatehira : 館平, Imagane : 今金, Setana : 瀬棚,
Okushiri Island : 奥尻島, Matsumae Group : 松前
層群