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# Rb-Sr AGE OF THE YURAPPU-DAKE PLUTONIC COMPLEX IN SOUTHWESTERN HOKKAIDO

*by*

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(with 3 text-figures and 1 table)

*Abstract*

A Rb-Sr whole-rock age and two whole rock-mineral ages of the Yurappu-dake Plutonic Complex in southwestern Hokkaido were determined. The Rb-Sr whole-rock age is 115 ± 9 Ma with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7057 ± 0.0001, whereas the whole rock-mineral ages are 70 ± 7 and 74 ±3 Ma. It is suggested that the Yurappu-dake Plutonic Complex had a Sr isotopic heterogeneity when the whole-rock system was closed.

## Introduction

There are several granitic rock bodies regarded as products of plutonic activity during Cretaceous time in southwestern Hokkaido. Among them two K-Ar biotite ages have been reported by Kawano and Ueda (1966), which are 124 Ma for the Imagane body and 111 Ma for the Setana body. In this paper the Yurappu-dake Plutonic Complex was taken for Rb-Sr dating and its genesis is discussed based on its initial $^{87}Sr/^{86}Sr$ ratios.

## Geological Setting

The Yurappu-dake Plutonic Complex has effected contact metamorphism on the Paleozoic sedimentary rocks, and both are covered with Tertiary sediments (Text-fig. 1). This pluton is exposed in an area of about 8 x 10 km and separated into two bodies. The northern body consists mainly of gabbro, whereas the southern body is composed mostly of granodiorite which extends for a larger area than the former. On the basis of intrusive relations and modal compositions of constituent minerals, the gabbroic body can be classified into 5 rock types and the granodioritic body into 4 rock types as follows: the gabbroic body = coarse gabbro, fine quartz gabbro, coarse quartz gabbro, medium tonalite, and porphyritic granodiorite; the granodioritic body = tonalite, granodiorite I, granodiorite II, and granite (Hashimoto, 1980).

## Analytical Methods

Whole rock samples, 0.5–1kg, were crushed and pulverized. Mineral samples were picked up by hand from coarse crushed rocks. Plagioclase samples contained a little amount of K-feldspar, and biotite samples, especially No. b6, included some felsic minerals.

After pulverization, splits of 100 to 300mg were decomposed with HF and $HClO_4$ on a hot plate and evaporated to dryness. The residue was dissolved in 2N HCl and was

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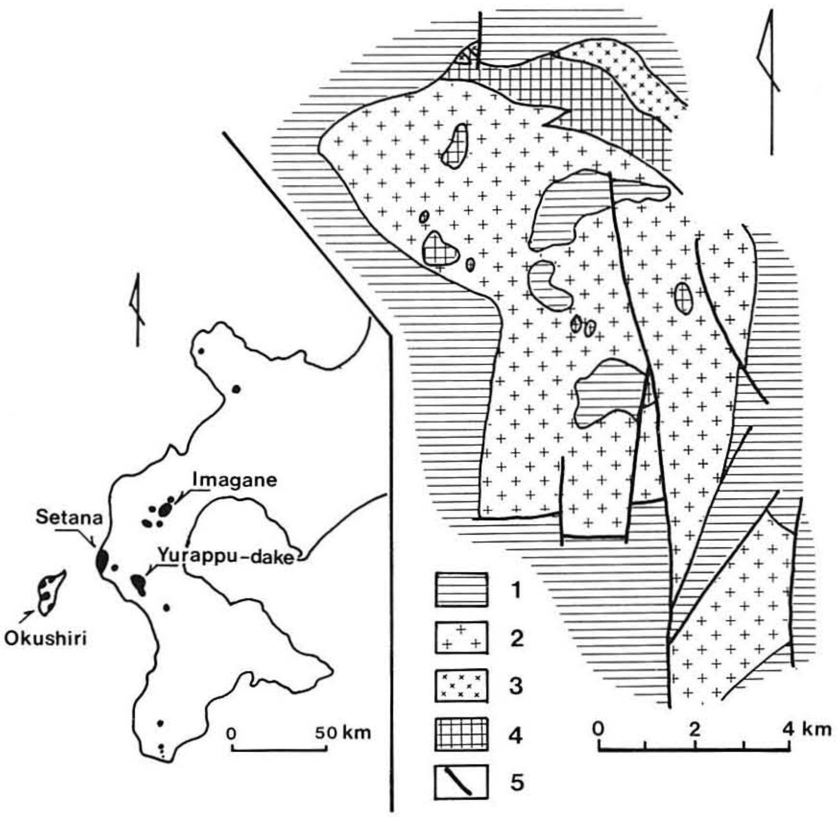



**Text-figure 1** Index map of Cretaceous granites in southwestern Hokkaido and simplified geological map of Yurappu-dake area.
1. Tertiary sediments, 2. Granodioritic body, 3. Gabbroic body, 4. Paleozoic sedimentary rocks affected by contact metamorphism, and 5. Fault.

centrifuged. Sr was separated from it by ion exchange techniques using Dowex 50W-X8 resin.

Sr isotopic ratios were determined on a 30cm radius, 90° sector mass spectrometer (JEOL-JMS 05RB) equipped with tripple filaments (Re for center and Ta for side), using Faraday cup, vibrating reed electrometer and digital output.

Values for $^{87}Sr/^{86}Sr$ on NBS SRM 987 were $0.7102 \pm 0.0002$ ($2\sigma$) on the basis of an average of 8 analyses made over the period of this study. All $^{87}Sr/^{86}Sr$ ratios were normalized to $^{86}Sr/^{88}Sr = 0.1194$ and adjusted to NBS SRM 987 = 0.71022. Rb and Sr contents were determined by isotope dilution method. Analytical errors on $^{87}Rb/^{86}Sr$ are estimated at 2%. The isochron age and initial $^{87}Sr/^{86}Sr$ ratio were calculated with least squares method of York (1969) using a value of $\lambda = 1.42 \times 10^{-11}\ yr^{-1}$ for decay constant of $^{87}Rb$ (Steiger and Jäger, 1977) and were given at $\pm 2\sigma$.

## Results and Discussion

The analytical results for eleven whole-rock samples, two plagioclase and two biotite samples are given in Table 1. $^{87}Rb/^{86}Sr$ ratios of the main rock types (gabbro – granodiorite) are generally low. A whole-rock age calculated using all samples including one granite and two aplite samples is 115 ± 9 Ma (initial $^{87}Sr/^{86}Sr$ ratio = 0.7057 ± 0.0001) (Text-fig. 2). The whole rock-mineral age of a medium tonalite (No. b6) of the gabbroic body, which can be regarded as a biotite mineral age, is 70 ±7 Ma, and that of granodiorite II (No. BN10) is 74 ± 3 Ma.

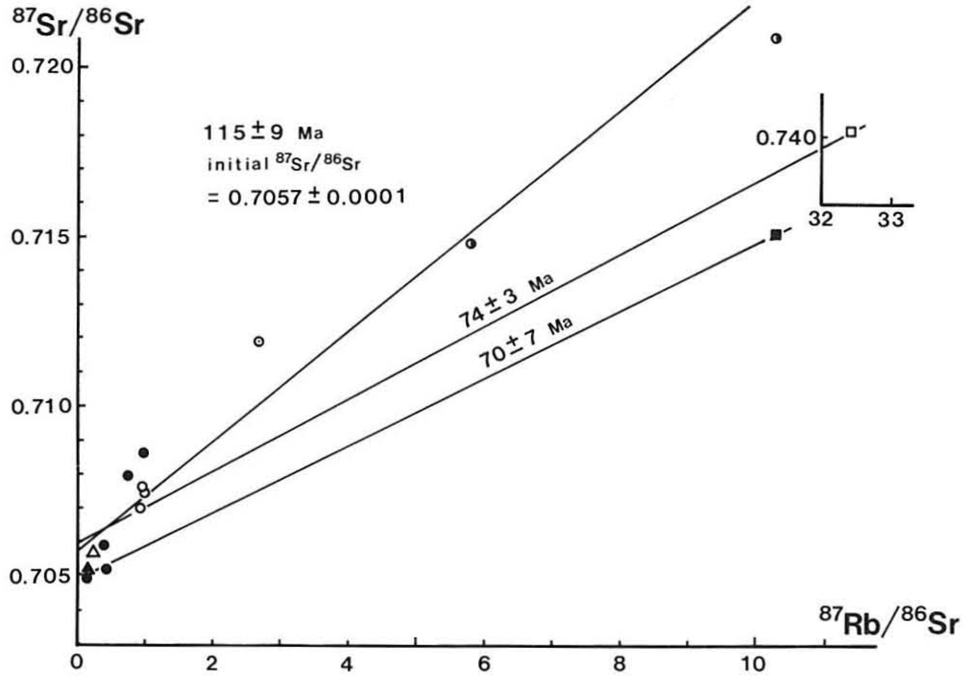
**Table 1** Analytical data for whole rock and mineral samples.

| Sample No. | (Rock name) | Rb (ppm) | Sr (ppm) | $^{87}Rb/^{86}Sr$ | $^{87}Sr/^{86}Sr$ | error (2σ) |
|---|---|---|---|---|---|---|
| H59 | (coarse gabbro) | 15.5 | 311 | 0.144 | 0.7049 | 0.0006 |
| H25 | (fine quartz gabbro) | 42.5 | 307 | 0.400 | 0.7059 | 0.0011 |
| b6 | (medium tonalite) | 53.5 | 378 | 0.409 | 0.7052 | 0.0003 |
| d16 | (coarse quartz gabbro) | 69.0 | 269 | 0.742 | 0,7079 | 0.0004 |
| t3 | (porphyritic granodiorite) | 89.1 | 266 | 0.969 | 0.7086 | 0.0006 |
| DXL | (granodiorite II) | 95.3 | 298 | 0.925 | 0.7070 | 0.0006 |
| BN10 | (granodiorite II) | 93.8 | 291 | 0.933 | 0.7076 | 0.0006 |
| BL11 | (granodiorite I) | 107 | 317 | 0.977 | 0.7074 | 0.0007 |
| BQ25 | (granite) | 164 | 178 | 2.67 | 0.7119 | 0.0007 |
| H22 | (aplite) | 176 | 87.9 | 5.80 | 0.7148 | 0.0006 |
| AC20 | (aplite) | 181 | 50.9 | 10.3 | 0.7209 | 0.0011 |
| b6 | plagioclase | 31.4 | 606 | 0.150 | 0.7052 | 0.0007 |
| b6 | biotite | 186 | 52.2 | 10.3 | 0.7151 | 0.0005 |
| BN10 | plagioclase | 44.6 | 534 | 0.242 | 0.7057 | 0.0006 |
| BN10 | biotite | 275 | 24.6 | 32.4 | 0.7401 | 0.0006 |

$^{87}Sr/^{86}Sr$: normalized to $^{86}Sr/^{88}Sr$ = 0.1194 and adjusted to $^{87}Sr/^{86}Sr$ = 0.71022 for NBS SRM 987.

The above whole-rock age, 115 Ma, can not be compared directly with the K-Ar biotite ages of the Imagane and Setana bodies, 124 and 111 Ma, respectively (Kawano and Ueda, 1966), because of different methods of dating. However these ages are not so different with each other. Rb-Sr whole-rock ages for most granitic rocks are slightly older than the corresponding K-Ar biotite ages (Shibata and Ishihara, 1979a). Accordingly, if the Cretaceous granodioritic rocks in southwestern Hokkaido have almost the same age, this age (115 Ma) might be somewhat young. This may be ascribed to the aplites (Nos. H22 and AC20) and the granite (No. BQ25) which are small bodies late intruded in the Yurappu-dake Complex. On the other hand, an isochron drawn by limited data excluding the aplites and the granite would become extremely old (more than 300 Ma), which is unlikely inferred from the young whole rock-mineral ages (70 and 74 Ma). In short, the age of 115 Ma is regarded to be a reasonable Rb-Sr whole-rock age.

The difference between above Rb-Sr whole-rock age and mineral age is somewhat large

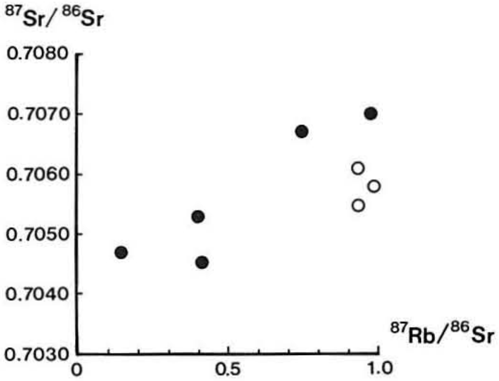



**Text-figure 2** Rb-Sr isochron diagram for the Yurappu-dake Plutonic Complex. solid circle: gabbroic body, open circle: granodioritic body, double circle: granite, half solid circle: aplite, solid triangle: plagioclase of BN10, solid square: biotite of b6, and open square: biotite of BN10.

as compared with another examples (Yanagi, 1975), which may indicate that the cooling rate of the plutonic complex might have been considerably low.

As for initial $^{87}Sr/^{86}Sr$ ratios, Shibata and Ishihara (1979b) reported many data of plutonic rocks from Japan, including two initial $^{87}Sr/^{86}Sr$ ratios of Cretaceous granitic rocks from southwestern Hokkaido, i.e. 0.7053 (Okushiri) and 0.7044 (Setana). The value (0.7057) obtained in the present study is nearly equal or slightly high compared with them.

As shown in Text-fig. 2, deviation of each plot from the isochron is slightly large. Using the age of 115 Ma, the initial $^{87}Sr/^{86}Sr$ ratios were recalculated for each value of the main rock types. The resultant ratios range from 0.7045 to 0.7070 (Text-fig. 3). This may suggest that there was a strontium isotopic heterogeneity when the whole-rock system was closed. It may be possible that there was a slight difference in Rb/Sr ratio between the source material of the gabbroic body and that of the granodioritic body. However two samples from the gabbroic body have higher initial $^{87}Sr/^{86}Sr$ ratios than those of the granodioritic body (Text-fig. 3). If the source material of the gabbroic magma had a slightly lower Rb/Sr ratio, some high Rb/Sr (high $^{87}Sr/^{86}Sr$) materials might have been incorporated into a part of the gabbroic body which has high $^{87}Rb/^{86}Sr$ ratios. Although it is difficult to ascertain the above process at present, it is unlikely that this plutonic complex has been derived from a homogeneous magma through a simple fractional crystallization within a short time.




**Text-figure 3** Recalculated initial $^{87}Sr/^{86}Sr$ ratios assuming the age of 115 Ma. solid circle: gabbroic body, and open circle: granodioritic body

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