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Potassium-Argon Ages of Granitic Rocks from the Kitakami Highlands

by
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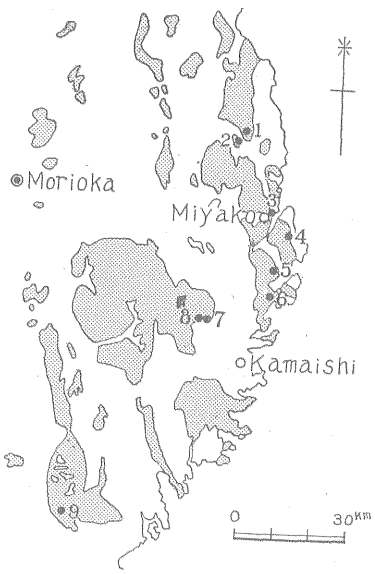
In the Kitakami Highlands of northeastern Japan there are a number of granitic rocks which cannot be assigned an age on geological evidence with certainty. Only the Miyako and Taro masses are known to have been intruded in Lower Cretaceous times[4]. Except in a few of the cases, the age of intrusion of the Kitakami granitic rocks is thought by most geologists to be the same as that of the Miyako and Taro masses. Imai[2] et al. obtained a U-Pb age of about 100 million years from a uraninite from an ore deposit which was formed during the later stages of intrusion of the Miyako granite.

Age determinations were carried out using the potassium-argon method on biotites separated from nine samples of granitic rock from the area. Localities of the samples are shown in Fig. 1 and descriptions given at the foot of Table 1.

Sample No. 3 was given by Mr. H. Yoshida of the Geological Survey of Japan and is known from geological evidence to have been emplaced at a time between the Neocomian and Aptian stages of the Lower Cretaceous. Other samples were given by Prof. Y. Kawano of Tohoku University.



1. Otomo 2. Takashizu 3. Miyako
4. Omoé 5. Yamaya 6. Origasa
7. Nakamura 8. Hashino
9. Sammaya

Fig. 1 Map of the Kitakami Highlands showing sample localities and distribution of granitic rocks

Separation of the biotites was undertaken at the Geological Survey of Japan and the age determinations were made at the Department of Geodesy and Geophysics, Cambridge. Samples 2, 3, 4, 7 and 8 were measured using the total volume method[3] and the remainder by the technique of isotope dilution.

In the former method, the volume of argon is measured directly using a calibrated McLeod gauge. In the latter a known volume of enriched argon-38 of known isotopic composition is mixed with the gases evolved upon fusion of the mineral sample. This mixture is subjected to treatment with red hot titanium in order to remove all gaseous impurities from the argon with the exception of hydrogen. Hydrogen is removed by pumping on the remaining mixture while it is absorbed on active charcoal at the temperature of liquid nitrogen (−197°C). From the

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A^{40}/A^{36}, A^{36}/A^{38} and A^{38}/A^{40} ratios the volume of radiogenic argon is calculated.

The potassium oxide content of the minerals was estimated using a flame photometer.

From comparison with standards it is considered that in dealing with rocks of the order of 100 million years old, the combined error caused by uncertainties in the potassium oxide content and volume is $\pm 5(\delta t)$ for the total volume and $\pm 4(\delta t)$ for the isotope dilution method. δt is defined as the error in age in millions of years due to a one per cent error in the proportion of potassium oxide or volume of radiogenic argon, and is calculated together with the age using the Cambridge electronic computor Edsac II.

Table 1 Results of Potassium-Argon Dating

No.	Sample	Method	Atmospheric contamination (%)	K_2O (%)	Age in million of years
1	Otomo	Isotope dilution	11.0	6.00	107±3
2	Takashizu	Total volume	4.8	7.53	114±6
3	Miyako	〃	12.3	7.33	123±6
4	Omoé	〃	6.0	6.63	122±6
5	Yamaya	Isotope dilution	12.3	5.26	106±6
6	Origasa	〃	5.8	6.35	110±5
7	Nakamura	Total volume	28.2	5.98	129±6
			20.0	5.98	126±6
8	Hashino	〃	13.7	6.39	115±6
9	Semmaya	Isotope dilution	5.7	5.82	119±5

Decay constants: $\lambda\beta = 4.72\times10^{-10}\ yr^{-1}$, $\lambda e = 0.584\times10^{-10}\ yr^{-1}$

No.	Name of rock	Name of rock mass	Locality
1.	Biotite granodiorite	Tanohata	1.5km S of Otomo, Iwaizumi-cho
2.	Garnet bearing hornblende-biotite granodiorite	Takashizu	1km ENE of Takashizu, Iwaizumi-cho
3.	Biotite granodiorite	Miyako	Kuwagasaki, Miyako-shi
4.	Hornblende-biotite granodiorite	Taro	2km W of Omoé, Miyako-shi
5.	Hornblende-biotite granodiorite	Miyako	3.5km N of Osawa, Yamada-cho
6.	Hornblende-biotite granodiorite	Miyako	2.5km S of Origasa, Yamada-cho
7.	Quartz diorite	Kurihashi	1.5km WNW of Nakamura, Kamaishi-shi
8.	Quartz diorite	Kurihashi	2km W of Sawa, Kamaishi-shi
9.	Quartz diorite	Semmaya	2.5km SW of Semmaya

Results are given in Table 1. The ages range from 106 to 129 million years with an average of 117 million years. Though this range exceeds the limit of the experimental error, it does not take into account any loss of argon which would give rise to a spurious age. As the samples of biotite used were fresh it is probable that this factor is negligible. It would therefore seem that the granitic rocks of the Kitakami Highlands represent different stages of a period of acid intrusion which took place in Lower Cretaceous times[1]. This result is in support of the geological postulate.

The K-A age of 123±6 million years for the Miyako granodiorite is in good agreement with the date given by geological evidence.

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