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K-Ar Ages of the Ryoke Metamorphic Rocks of the Komagane District, Nagano Prefecture, Central Japan

By

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Abstract

K-Ar age measurements were made on three biotites of the Ryoke metamorphic rocks from the Komagane district, Nagano prefecture, Central Japan (Fig. 1). The ages are 58, 59, and 64 m. y., respectively and agree fairly with those of the younger group of the Ryoke granitic rocks of Central Japan.

Geological setting

In the Ryoke metamorphic belt of the Komagane district (Fig. 2, Fig. 3), metamorphic rocks are exposed extensively in the northwestern part of the district, while granitic rocks occupy the southeastern part. The granitic rocks are divided into two groups from their field relations: the older and the younger. The older granitic rocks consist of banded quartz-diorite to granodiorite and are discordant to the general trend of the metamorphic rocks in the northern part of the district but are subconcordant in the southern part. The younger granitic rocks are quartz-diorite and granite. The older granitic rocks show generally gneissose structure but the younger does not. Both groups of rocks were intruded, roughly speaking, in intimate connection with the Ryoke regional metamorphism and the younger rocks show no effective polymetsmorphism.

The metamorphic rocks have been derived mainly from pelitic and psammitic sediments, but some basic volcanics as well as calcareous and siliceous rocks are also associated. Metamorphic grade becomes higher from the north-west to the south-east, namely, toward the older granitic bodies. Based on the index minerals in the pelitic rocks, the metamorphic terrain is divided into the following four succesive zones: the biotite zone, the cordierite zone, the first sillimanite zone and the second sillimanite zone. The biotite zone continues far to the north over the northern limit of the district.

The biotite zone is characterized by the association of biotite-muscovite and the absence of cordierite. In the lower grade part of the zone, the rocks contain a small amount of chlorite. In the rocks derived from highly aluminous sediment, andalusite is stable. The cordierite zone is characterized by the general entrance of cordierite to the rocks derived from pelitic sediment. This zone corresponds probably to the zone

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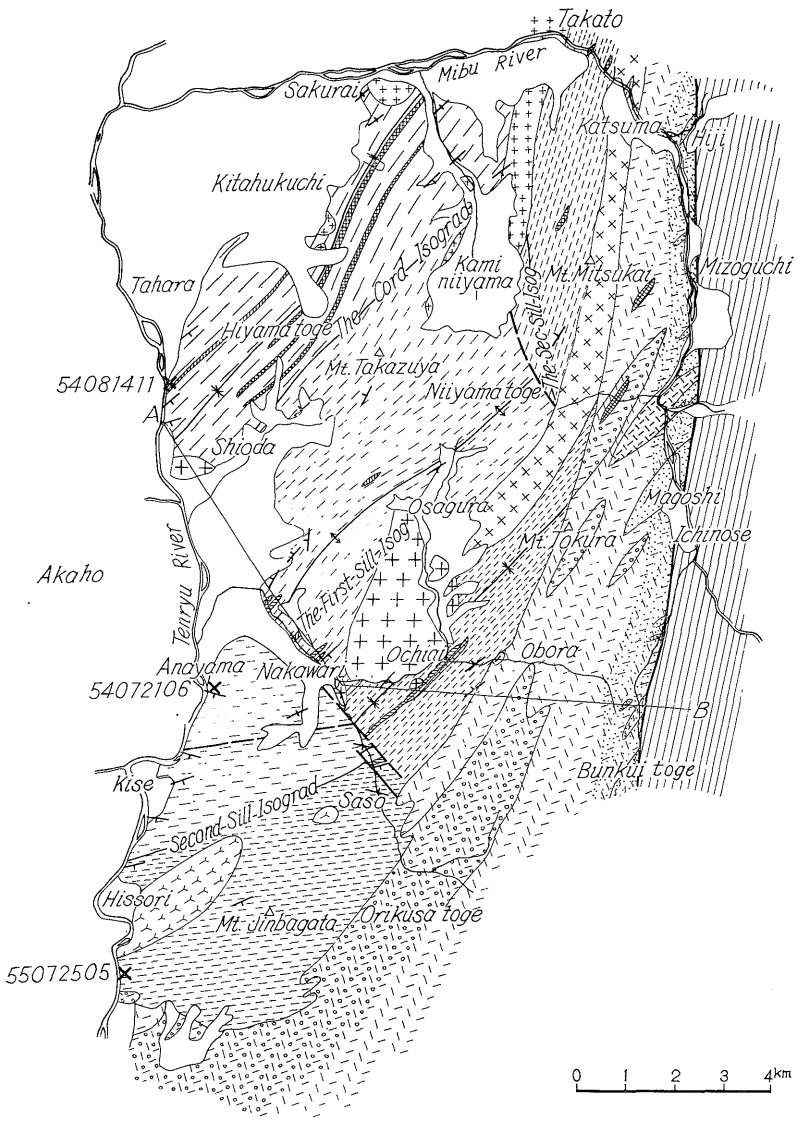

Figure 1 Index to Komagane

of schistose hornfels by KOIDE (1958). The entrance of sillimanite to highly aluminous rocks is characteristic to the first sillimanite zone, in which sillimanite has been converted from andalusite and then it is not fibrolite but is represented by large crystals with andalusite core of unstable relic. The second sillimanite zone is characterized by the general entrance of fibrolite to pelitic rocks. In this grade of metamorphism, muscovite begins to dissociate into sillimanite and potash-feldspar. The first and the second sillimanite zones. correspond probably to the zones of transitional rock and of banded gneiss by KOIDE (HAYAMA, 1960).

Recently, many age-measurements were made on the Ryoke granitic rocks by the K-Ar method and their ages range from 60 m. y. to 100 m. y. (MILLER, et al.,

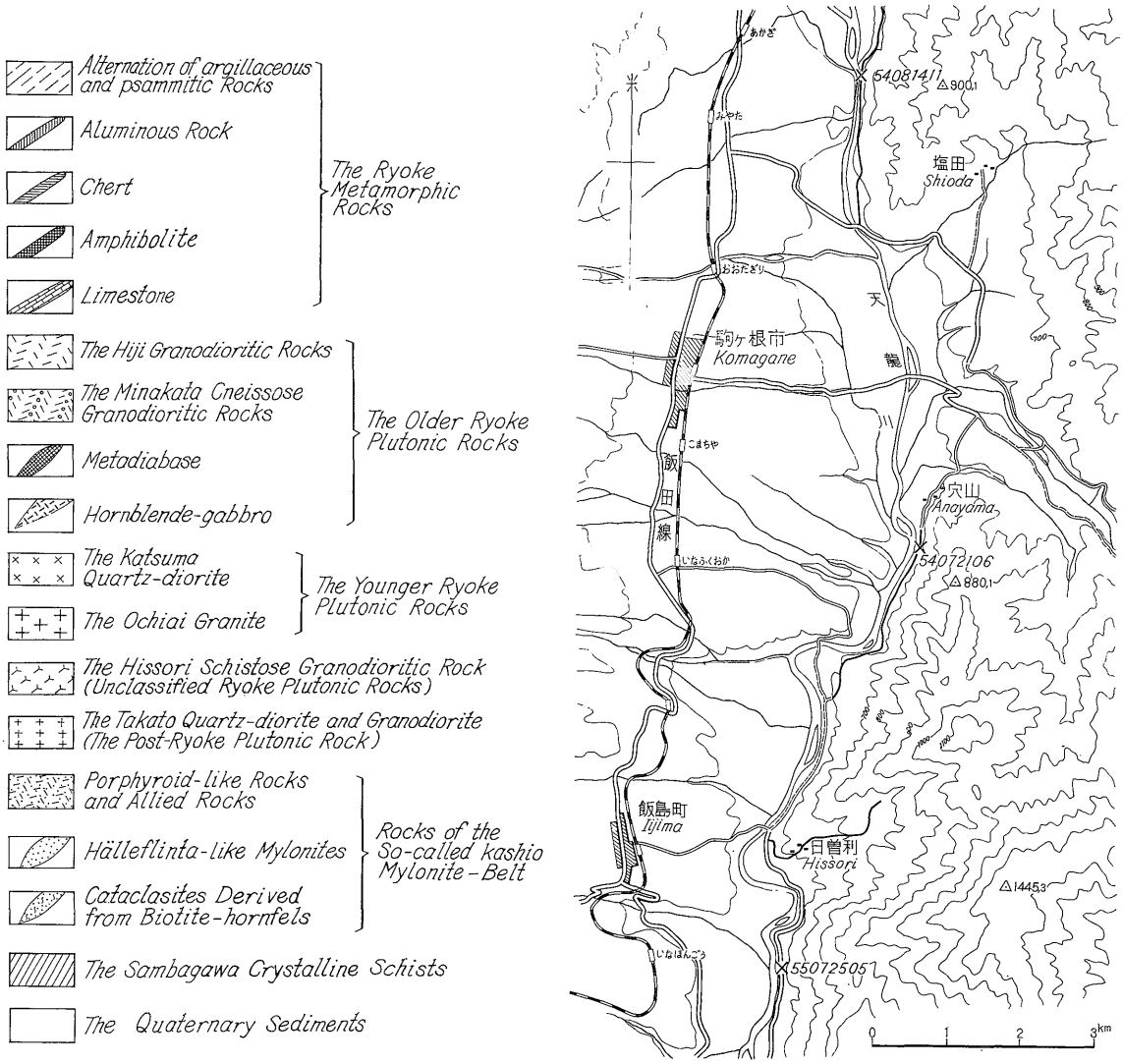

Figure 2 Geologic Map of the Eastern Part of Komagane City, Nagano Prefecture, Japan (HAYAMA, 1960)

District

1961 ; BANNO, et al., 1961 ; SHIBATA, et al., 1966 ; KAWANO, et al., 1967). These figures were very contradictory to the geologic age of the Ryoke metamorphic belt, accepted by many Japanese geologists, and then the data have been desired on the metamorphic rocks. The present data are the first on them.

Description of the determined samples

(1) Biotite-muscovite-microcline schist (54081411)
Shioda, Komagane-shi, Nagano pref.

This rock was sampled from the north of Shioda (Fig. 2). The rock belongs to

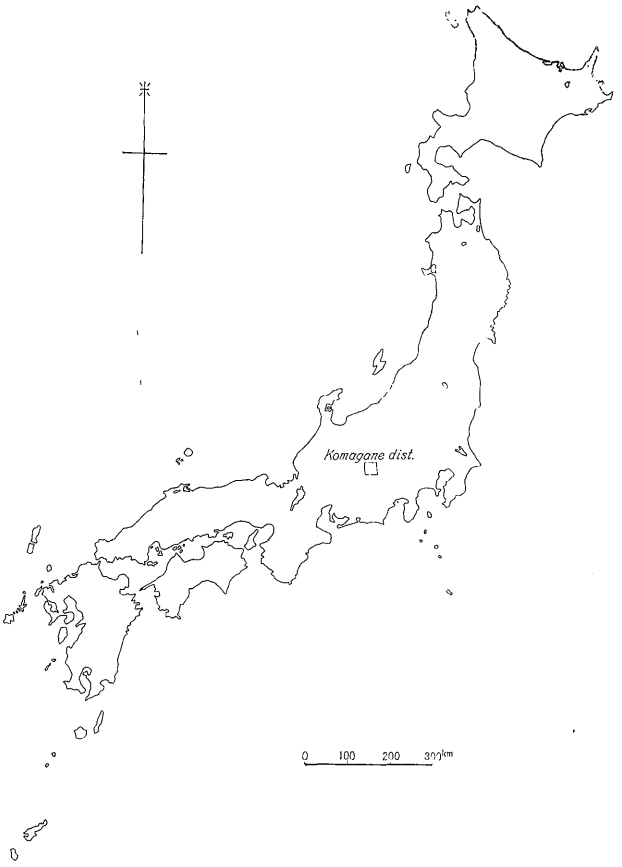

Figure 3 Localities on the 1/50,000 topographic map

the higher grade part of the biotite zone. It is fine-grained, schistose rock and is composed of quartz, microcline, acid plagioclase, muscovite and biotite in order of abundance, with subordinately tourmaline and graphite. Under the microscope, biotite and muscovite arrange linearly in the mosaic base of felsic minerals. Biotite is very fine-grained (0.05~0.1 mm) and is pleochroic with X = brownish yellow and Y=Z = reddish brown. Biotite was analysed by H. HARAMURA, as follow ; SiO_2=35.38, Al_2O_3=19.49, TiO_2=2.61, Fe_2O_3=1.19, FeO=17.89, MgO=8.50, MnO=0.06, CaO =0.16, Na_2O=0.25, K_2O=8.92, F=0.22, H_2O+=4.52, H_2O-=0.29, C=0.44, Total=99.92 (HAYAMA, 1964).

(2) Biotite-muscovite-microcline gneiss (54072106)
Anayama, Komagane-shi Nagano pref.

This rock was sampled from Anayama (Fig. 2). The rock belongs to the cordierite zone. It is medium-grained, massive rock and is composed of quartz (very abundant), microcline, acid plagioclase (very small amount), biotite and muscovite with accessory tourmaline and opaque minerals. Under the microscope, muscovite

and biotite show slightly preferred orientation in the mosaic base of felsic minerals. Biotite is 0.05 to 0.5 mm in flake length. Pleochroism is as follows ; X=yellow and Y = Z = reddish brown. This biotite was analysed by H. HARAMURA, as follows ; SiO_2=33.60, Al_2O_3=19.08, TiO_2=2.12, Fe_2O_3=2.40, FeO=18.53, MgO=9.39, MnO =0.36, CaO=0.02, Na_2O=0.18, K_2O =9.15, F=0.24, H_2O+=3.91, H_2O-=0.88, C=0.15, P_2O_5=0.19, Total=99.96 (HAYAMA, 1964).

(3) Biotite-muscovite-cordierite-microcline gneiss (55072505)
Hissori, Nakagawa-mura, Kamiina-gun, Nagano pref.

This rock swas ampled from the south of Hissori (Fig. 2). The rock belongs to the second sillimanite zone. It is coarse-grained, massive gneiss and is composed of quartz, oligoclase, microcline (very abundant), biotite, muscovite and cordierite with accessory apatite, zircon, opaque minerals. Under the microscope, the rock is granoblastic, with no parallelism in both felsic and mafic minerals. Felsic minerals are generally 1.0 to 2.0 mm in grain size and biotite is 0.5 to 1.0 mm. Pleochroism is as follows ; X=pale yellow and Y= Z=deep reddish brown. This biotite was analysed by H. HARAMURA, as follows ; SiO_2=33.73, Al_2O_3=20.21, TiO_2=2.89, Fe_2O_3 =1.57, FeO=19.70, MgO=8.05, MnO=0.18, CaO=0.00, Na_2O=0.11, K_2O=8.82, F=0.38, H_2O+=4.21, H_2O-=0.30, C=0.15, P_2O_5=0.03, Total=99.97 (HAYAMA, 1964).

Experimental procedure

Biotite was separated with isodynamic separator and Clerici solution after crushing and sieving of rock samples.

Argon was extracted and purified in the pyrex high vacuum system. Each sample was fused in a molybdenum crucible at about 1300°C for 30 minutes with an induction heater. The Ar^{38} spike was added during fusion and argon was purified from other gases with hot titanium sponge. Isotopic ratios of argon were measured by the static operation on the Mitsubishi MS-315G mass spectrometer, which is a Reynolds-type with 15 cm-radius 60°-sector analyzer.

Potassium was determined by flame photometry. Each sample was digested with hydrofluoric acid and hydrochloric acid, the residue was dissolved in hydrochloric acid, diluted to a standard volume, and the potassium content of the solution was measured with the Hitachi EPU-2 flame photometer.

Table 1 Results of K-Ar age measurements

Sample No.	Rock	Mineral	K_2O (%)	Atom. Contam. (%)	Age & Error (m. y.)
54081411	Biot-musc-microcl-sch.	biotite	9.54	13.8	58±3
54072106	Biot-musc-microcl-gn.	biotite	9.46	13.1	59±3
55072505	Biot-musc-cord-microcl-gn.	biotite	8.84	39.9	64±3

The constants used in the calculations are as follows ; $\lambda_\beta = 4.72 \times 10^{-10}$ yr^{-1}, $\lambda_e = 0.584 \times 10^{-10}$yr^{-1} and $K^{40}/K = 0.0119\%$.

A comment on the result

The K-Ar ages of the Ryoke granitic rocks in Central Japan range from 60 m. y. to 100 m. y., with two maxima in 60～70 m. y. and in 90～100 m. y. Though the granite younger in the K-Ar age does not always agree with the granite younger in postulation from the field relation, the granite of 60～70 m. y. may be actually younger and those of 90～100 m. y. may be older. The results of the present measurements of the Ryoke metamorphic rocks are shown in Table 1. These figures agree well with the ages of the younger group of granite. This fact suggests the following two cases ; 1) The K-Ar ages of the rocks of the Ryoke metamorphic belt had been renewed by the younger granite, with accidental relic age ; 2) The K-Ar ages are not the actual age of the formation of the Ryoke metamorphic belt, but are the age of its upheaval to the shallower horizon. The age, 90～100 m. y., corresponds to the upheaval rather sooner after the formation and the age, 60～70 m. y., to the upheaval after long time. In connection with this, it is suggestive that the granite of 90～100 m. y. is mainly located nearer to the Median Tectonic Line, by which the Ryoke metamorphic belt formed a tilted block.

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駒ケ根地域の領家変成岩の K-Ar 年令

柴田　賢・端山　好和

要　旨

長野県駒ケ根地域の領家変成岩の 3 コの黒雲母について，K-Ar 年令を測定した。それらは，58，59および 64 m. y. で，中部日本の新期領家花崗岩にほぼ相当する。