550.93 : 552.4 (551.53+551.82)

K-Ar Ages of Hida Metamorphic Rocks, Amo-Tsunokawa Area and Oki Area, Japan

By

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Abstract

The K-Ar ages on three biotites separated from the Hida metamorphic rocks are 175 and 174 m. y. for the Amo-Tsunokawa area, and 169 m. y. for the Oki area, similar to each other and also to the K-Ar biotite ages of the Hida metamorphic rocks in other localities. Thus, the Oki gneiss is ascertained to belong to the Hida metamorphic belt.

Geological setting

The Hida metamorphic belt is one of the oldest basement rocks in the Japanese Islands. It is the northernmost zone in the zonal arrangement of basement rocks in Southwest Japan and is exposed mainly in the Hida mountains. Rocks exposed there are gneiss, schist and granitic rocks. Most of the granitic rocks belong to the Funatsu granitic rocks which are intruded into Paleozoic formation and are covered by Jurassic conglomerate. K-Ar age of the Funatsu granitic rocks is late Triassic or early Jurassic. So, the age of the Funatsu granitic rocks is undoubtedly early Mesozoic. While, as to the age of the Hida metamorphic rocks, controversy has been continued for these two decades and is not yet settled. Some

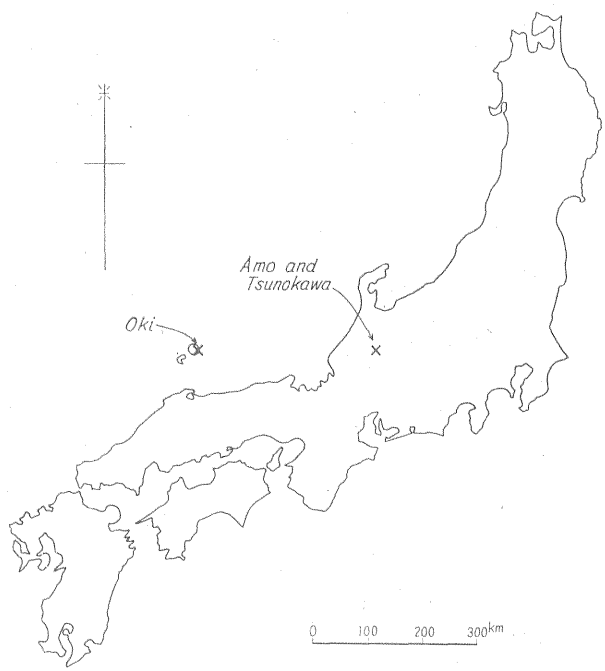

Fig. 1 Index to the Amo-Tsunokawa area and the Oki area

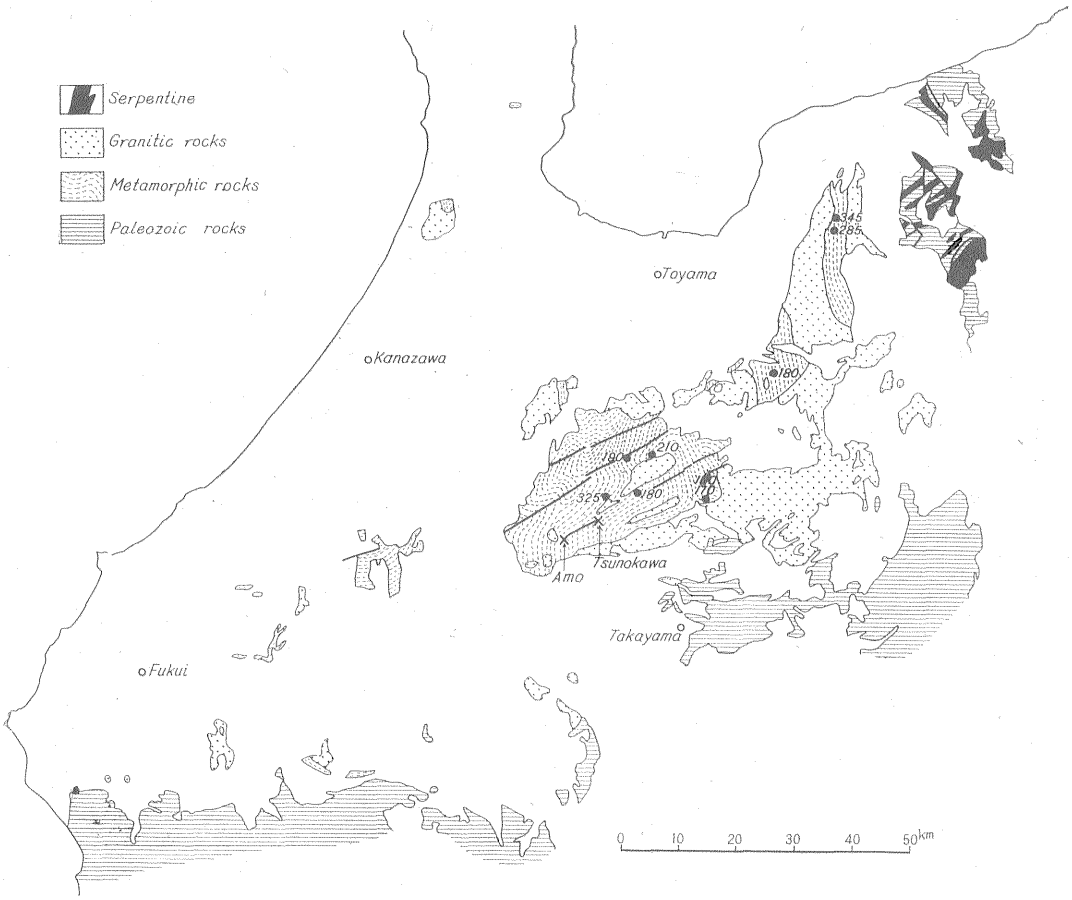

Fig. 2 Distribution of metamorphic rocks in the Hida metamorphic belt
(Figures are previous data on their isotopic ages, in million years.)

authors believe it Precambrian and some others do it early Mesozoic. K-Ar age of the Hida metamorphic rocks on biotite is early Mesozoic, nearly the same as that of the Funatsu granitic rocks (KUNO, H. et al., 1960). However, K-Ar age on hornblende is a little different, giving two ages; one is early Mesozoic similar to biotite age and the other is older, late Carboniferous or early Permian (OHMOTO, H., 1964).

1) Amo-Tsunokawa area

The largest mass of the Hida metamorphic rocks is exposed in the Hida mountains. The Amo-Tsunokawa area lies near its southern periphery, along the Odori river. There is exposed a formation composed mainly of biotite gneiss, biotite hornblende gneiss and biotite-bearing quartzo-feldspathic gneiss. The structure of this gneiss formation runs from NEE to SWW in general, but near the Amo mine, it changes abruptly to nearly NS direction.

Samples for the present study were taken from this formation.

A part of the Funatsu granitic rocks is exposed close near but the gneisses are entirely free from contact effect of the granitic rocks.

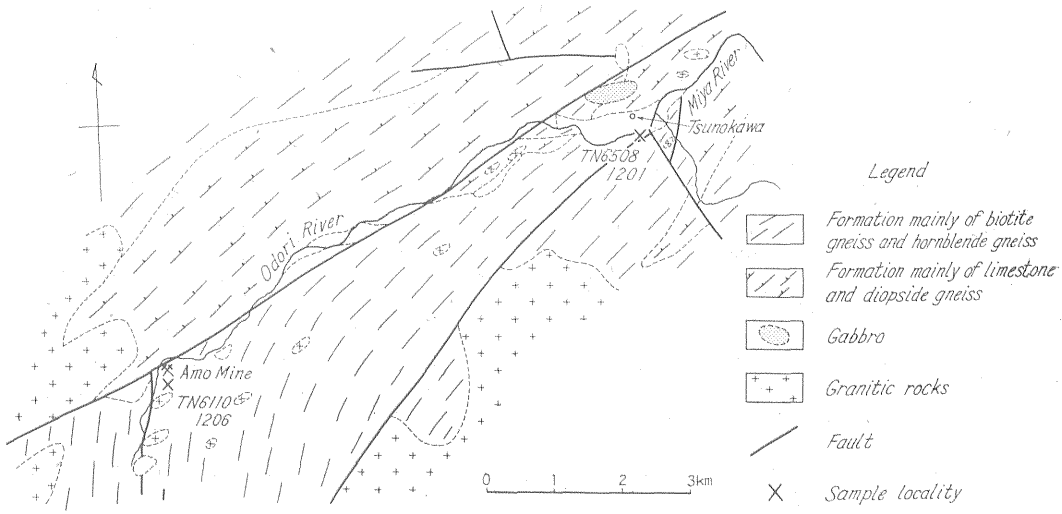

Fig. 3 Geologic map of the Amo-Tsunokawa area, Hida mountains

2) Oki area

The Oki Islands lie in the Japan Sea about 350 km west of the Hida mountains. There is exposed "Oki gneiss", a complex of gneiss and granitic rocks in a small area. The Oki gneiss is commonly believed to belong to the Hida metamorphic belt, because it is quite

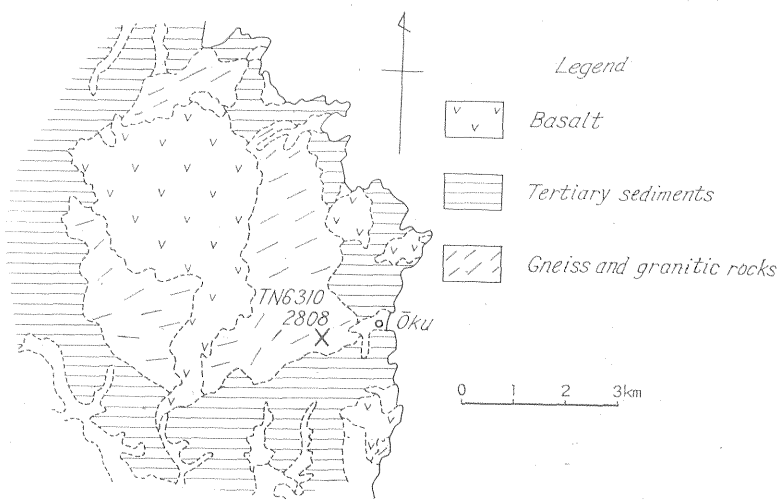

Fig. 4 Geologic map of the Oki area
(Compiled from Ohta's (1963), modified and simplified by the writers.)

similar to the Hida metamorphic rocks petrographically and is nearly on the probable extension of the Hida metemorphic belt, though there is no available geological evidence except that it is covered by the Tertiary sediments. The Oki gneiss is composed mainly of biotite gneiss, hornblende gneiss, crystalline limestone, diopside gneiss and granitic rocks, such as biotite granodiorite, muscovite granite and mylonite including "augen gneiss". The granitic rocks are quite similar to some of the Funatsu granitic rocks in the Hida mountains.

A sample for the present study was taken from a biotite gneiss formation in the Oki

gneiss.

The gneisses are entirely free from contact effect of the granitic rocks nearby.

Description of the determined samples

(1) Hornblende biotite quartz plagioclase gneiss (TN 61101206)

Amo mine, Genda, Kawai-mura, Yoshiki-gun, Gifu pref. (Hida Mountains)

It is fine-grained, dark-colored, strongly gneissose and banded irregularly with hornblende-rich band and biotite-rich band. Under the microscope, it is composed mainly of biotite, hornblende, plagioclase and quartz. Small quantities of iron ore and sphene are contained, too. Biotite is flaky, 0.3–0.6 mm across, with pleochroism, X: colorless or pale brown, Y, Z: brown. Biotite is remarkably fresh. Hornblende is hypidiomorphic or allotriomorphic, 0.3–0.8

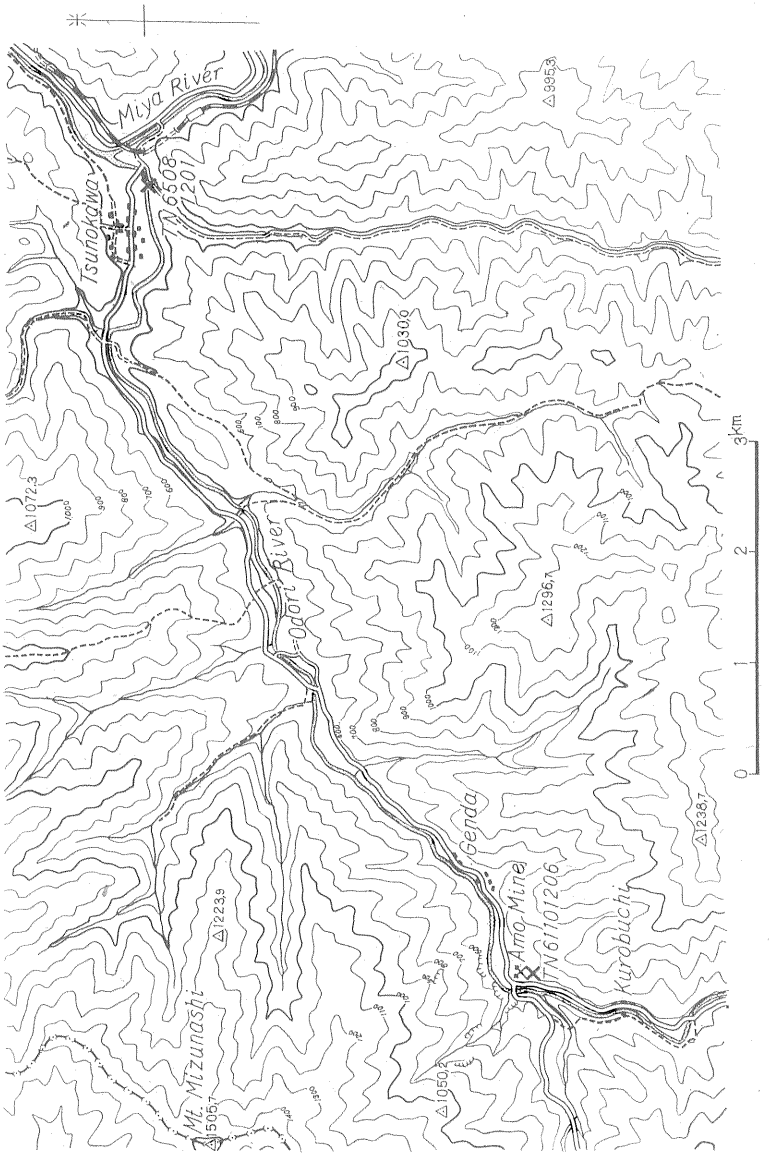

Fig. 5 Sample localities on the 1/50,000 topographic map, Hidafurukawa

mm across, with pleochroism, X: nearly colorless, Y, Z: grass green, often giving sieve structure. Plagioclase is hypidiomorphic, 0.1–0.7 mm across, relatively fresh and is nearly oligoclase in composition. Quartz is allotriomorphic, 0.1–0.4 mm across, with abundant cracks in every crystal.

(2) Garnet hornblende biotite quartz plagioclase gneiss (TN 65081201)

Tsunokawa, Kawai-mura, Yoshiki-gun, Gifu pref. (Hida Mountains)

It is coarse-grained, relatively light-colored, gneissose and heterogeneously banded. Under the microscope, parallel structure is strong only for biotite but is weak for quartz and plagioclase. It is composed mainly of biotite, hornblende, garnet, plagioclase and quartz. Small quantities of iron ore, apatite and zircon are contained, too. Biotite is hypidiomorphic,

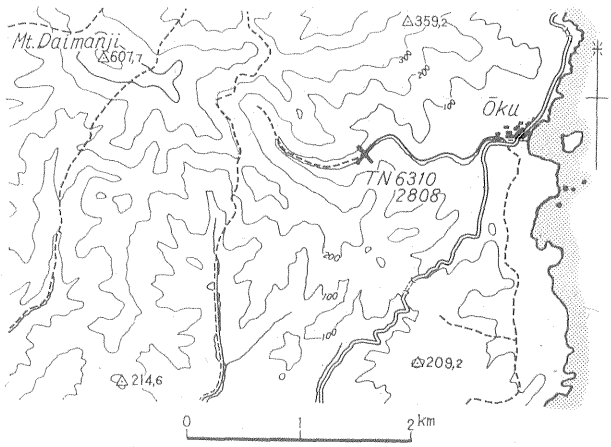

Fig. 6 Sample locality on the 1/50,000 topographic map, Saigo

1–3 mm across, with pleochroism, X: colorless, Y, Z: pale reddish brown. Biotite is relatively fresh but is a little altered, yielding chlorite and prehnite. Hornblende is hypidiomorphic, 2–3 mm across, often with sieve structure, giving pleochroism, X: pale brownish yellow, Y, Z: grass green. There are some pseudomorphs, angular in shape, 3–7 mm across, now composed of fine-grained aggregate of biotite, 0.1–0.2 mm across, accompanying a small quantity of hornblende. Garnet is porphyroblastic, large, rounded, idiomorphic, 1–3 cm across, and poikilitically includes all other minerals. Plagioclase is allotriomorphic, 0.2–1.0 cm, always altered a little and its composition is nearly oligoclase. Quartz is relatively small in quantity and is only interstitial.

(3) Graphite biotite microcline plagioclase quartz gneiss (TN 63102808)

Ōku, Saigo-cho, Suki-gun, Shimane pref. (Oki Islands)

It is medium-grained, dark-colored, strongly gneissose and irregularly banded. Under the microscope, parallel structure is strong only for biotite but is weak for quartz and feldspar. It is composed mainly of biotite, graphite, quartz, plagioclase and microcline. Small quantities of muscovite, iron ore and sphene are contained. Besides, calcite veinlets are included, too. Biotite is flaky, 1–2 mm across, often curved, with pleochroism, X: colorless to pale brown, Y, Z: brown. Biotite is nearly fresh. Graphite is flaky, 0.5–2.0 mm across, commonly accompanied by biotite. Quartz is allotriomorphic, 1–2 mm across, with abundant cracks in

every crystal. Plagioclase is hypidiomorphic, 0.5–1.5 mm across, nearly oligoclase in composition and is altered a little. Some of the plagioclase crystals suffer microclinization. Microcline is relatively small in quantity, interstitial and allotriomorphic, 0.5–2.0 mm across, often with myrmekitic intergrowth. Muscovite, 0.5–1.0 mm across, is accompanied by biotite.

Experimental procedures

K-Ar age determinations were made on the biotites separated from the rock samples, using the isotope dilution technique.

Separation of biotite was carried out with an isodynamic separator after crushing and sieving. Potassium determination was made by the flame photometry. Biotite was digested with HF and HCl, the residue was dissolved in HCl and diluted to a standard volume, and potassium content was measured with the Hitachi EPU-2 flame photometer.

Argon extraction and purification were made in the pyrex high vacuum system. The biotite in a molybdenum crucible was fused at about 1300°C for 30 minutes with an induction heater. The Ar^{38} spike was added during fusion, and evolved gases were purified by hot titanium sponge and CuO. The isotopic ratios of argon on sample Nos. TN 61101206 and TN 63102808 were measured with the Hitachi RMU-5B mass spectrometer by the flow method, whereas argon ratios of sample No. TN 65081201 were measured with the Mitsubishi MS-315 mass spectrometer by the static method.

The results of K-Ar age determinations are given in Table 1.

Table 1 Results of K-Ar age determinations

Sample No.	Area	Mineral	K_2O (%)	Atmospheric contamination (%)	Age and error (million years)
TN 61101206	Amo	biotite	5.28	9.4	175±11
TN 65081201	Tsunokawa	biotite	2.06	21.6	174± 9
TN 63102808	Oki	biotite	7.97	13.3	165±12
				13.7	173±12

$\lambda\beta = 4.72 \times 10^{-10}$ yr.$^{-1}$, $\lambda_e = 0.584 \times 10^{-10}$ yr.$^{-1}$

Geological meaning of the results

The results, 175, 174 and 169 (average of two daterminations) million years are correlated to early Jurassic age, all alike. It is a remarkable fact that these results coincide to almost one age, in despite of long distance between one sample locality and the other two, about 350 km. Furthermore, they are quite similar to the K-Ar ages on biotite of the metamorphic rocks from different localities in the Hida metamorphic belt.

Even though the age problem of the Hida metamorphic belt is not yet settled, it should not be denied that, in the Hida metamorphic belt, there was an event in early Mesozoic age, on "regional scale" throughout the Hida metamorphic belt including the Oki Islands, giving recrystallization of biotite.

By the way, the Oki gneiss is ascertained again by this result to belong to the Hida metamorphic belt.

Acknowledgement

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天生・角川地域および隠岐地域の飛騨変成岩の K-Ar 年代

柴田 賢　野沢 保

要 旨

飛騨山地天生・角川地域の飛騨変成岩の K-Ar 年代は 175, 174×10^6 年，隠岐地域のそれは 169×10^6 年で両者ほぼ同じであり，隠岐の変成岩は飛騨変成帯に属するという地質学的資料をうらづけるものである。またこれらの年代は他の地域の飛騨変成岩の年代ともほぼ等しい。