

## Age of granitic cobbles from the Koshiki Knoll, sea-off southwestern Kyushu, Japan

Shunso ISHIHARA\* and Atsuyuki MIZUNO\*\*

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### INTRODUCTION

A number of cobbles and pebbles of granitic composition were dredged from a site, GSK 70-232 at a water depth of 310 meters on a summit area of the Koshiki Knoll (formerly called Magoshichi Knoll; 31°34.9'N, 129°19.7'E) through R/V Tokaidaigaku-Marui II cruise conducted by the Geological Survey of Japan in 1970. The Koshiki Knoll with relative height of about 400 meters is located in the northern part of the Okinawa Trough, approximately 30 kilometers to the west from the southern extremity of Shimokoshiki Island surrounded by the sea floor of 700 to 750 meters deep (Fig. 1). The granitic cobbles and pebbles were thought to have been derived from acoustic basement which comprises a larger part of the knoll and have been suspected to have intruded into surrounding Neogene sedimentary layers, based on interpretation of seismic reflection profile (MIZUNO & Res. Group, Marine Geology Survey, 1971; KIMURA *et al.*, 1975). From the results of their detailed optical and chemical study, KIM *et al.* (1975) concluded that the granitic cobbles and pebbles are mineralogically and chemically similar to the onshore granitoids of Shimokoshiki granitoids with K-Ar age of 13 Ma.

(MILLER *et al.*, 1962). Thus, the Koshiki Knoll granitoids have been thought to have a Miocene age.

Reconnaissance study made on the granitic cobbles, however, indicates that the Koshiki Knoll granitoids are I type but have ilmenite-series characteristics of ISHIHARA (1977). Since two types of granitoids, namely the ilmenite series and magnetite series, occur in specific geotectonic units continuously (ISHIHARA, 1979), the above difference is thought important for further understanding of the Koshiki Knoll granitoids. Thus one cobble was dated and the result will be discussed with some petrographical data in this short note.

### SAMPLES AND RESULT

The studied cobble has dimensions of 10 cm and 12 cm. It is a medium grained rock with some fine grained phase. Under the microscope, it consists of plagioclase, green and brown amphiboles, biotite (generally altered to chlorite), quartz and potassium feldspar in the order of abundance; hence this rock may be plotted between tonalite and granodiorite field in modal quartz-feldspars' diagram. KIM *et al.* (1975) classified the Koshiki Knoll granitoids into i) micro-quartz-gabbro, ii) micro-quartz-diorite, iii) micro-granodiorite, and reported abundant biotite in the latter two rocks. Thus the studied tonalite may be similar

\* Mineral Deposit Department, Geological Survey of Japan

\*\* Faculty of Science, Yamaguchi University

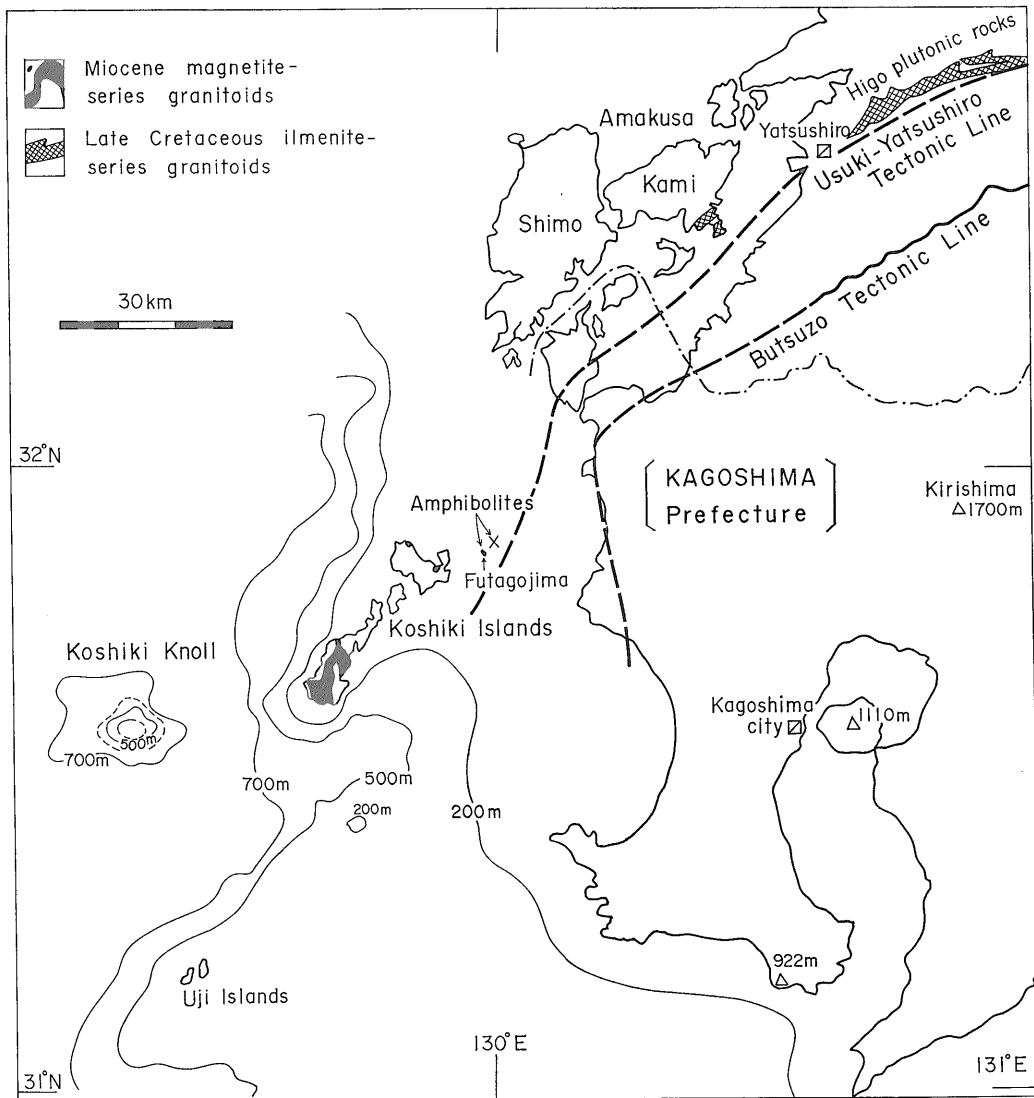


Fig. 1 Index map of the Koshiki Knoll and southwestern Kyushu.

one to the micro-quartz-diorite, but our sample is much coarse grained.

Plagioclase of the studied rock is moderately sericitized. Amphiboles are relatively fresh, although two or more generations of the amphiboles are seen. Biotite is severely decomposed to chlorite and aggregates of sphene,  $TiO_2$  minerals and ilmenite. Epidote minerals of secondary origin occur associated with biotite. Neither magnetite nor its pseudomorph is observed. Z-color of biotite is bright brown, which is more akin to typical

color of the ilmenite series than that of the magnetite series.

Mineral separation and K-Ar dating were carried out at the Teledyne Isotopes. Separation of biotite is not successful, possibly due to the severe alteration. The biotite fraction and hornblende fraction gave only little difference on their K content. Thus the hornblende fraction was analyzed and the result was  $84.5 \pm 5.5$  Ma (Table 1). The dated sample could be mixture of amphibole and chloritized biotite. It may give a minimum

age for the tonalite. The 84.4 Ma is old enough to rule out Miocene age for the Koshiki Knoll granitoids.

## DISCUSSION

Miocene granitoids occurring in the Inner zone (marginal sea side) of Southwest Japan have generally mafic composition similar to that of the Koshiki Knoll. The other characteristic is that they contain magnetite and belong to the magnetite-series, at least from the Sanin District to Shimokoshiki Island along and behind the Quaternary volcanic front (ISHIHARA, 1979). Among the other Miocene plutons occurring in small islands in the northwestern sea-off Kyushu Island, KITAI (1969) reported more than 1 volume percent of magnetite in very small plutonic bodies having composition from gabbro to granodiorite. KIM *et al.* (1975), indeed, correlated magmatism of the Koshiki Knoll granitoids with that of these small plutons. Recently, granodiorite from Futagojima of the Koshiki Islands have been found to have a Miocene age (7.5 Ma) and I-type magnetite-series characteristics (ISHIHARA *et al.*, 1984).

Although KIM *et al.* (1975) noted some magnetite in micro-quartz-diorite, majority of the Koshiki Knoll granitoids seems to be the ilmenite series in judging from their bulk ferric/ferrous ratios given in their Table 2. This is in accord with our observation. Then question arises where we have magnetite-free granitoids having mafic composition. The Outer Zone granitoids of Southwest Japan can be ruled out in this context, because they are magnetite free but salic in composition.

In the southwestern-most part of Kumamoto Prefecture, there occur granitoids of tonalite-granodiorite composition, which are called Higo plutonic rocks (YAMAMOTO, 1962). ISHIHARA (1979) points out predominance of the ilmenite-

series granitoids in this area. KAWANO and UEDA (1966) reported 80 and 97 Ma ages on biotite from these plutonic rocks. Thus the Koshiki Knoll granitoids have similar K-Ar age and opaque oxide assemblage to those of the Higo plutonic rocks.

Westward extension of the Cretaceous igneous rocks of the Inner Zone of Southwest Japan was often discussed in the early 1960s. Foliated tonalite and amphibolite of Futagojima (ISHIHARA and KAWACHI, 1961) are somewhat unusual as rock unit of the Outer Zone of Southwest Japan. The amphibolite occurs in several reefs distributed northeastward from the Koshiki Islands (Fig. 1) and its schistosity trends generally northeast. KAWACHI *et al.* (1964) concluded from the metamorphic grade and chemical data that the amphibolites were the westernmost equivalent of the Ryoike metamorphic rocks. ISHIHARA *et al.* (1984) also correlate the foliated tonalite to the Higo granitoids. The Koshiki Knoll is located to the southwest of these older metamorphic and plutonic rocks (Fig. 1). Thus correlation of Koshiki Knoll granitoids to the Higo granitoids is reasonable geologically. The northeasterly Cretaceous basement appears to be reactivated during Miocene and intruded by magnetite-series magmatism, and thus two stages of the granitoids occur in the Futagojima-Koshiki Knoll area.

## CONCLUSION

The granitoids occurring at the Koshiki Knoll are found to have a late Cretaceous age and I-type ilmenite-series characteristics. The knoll is therefore considered a fragmental block of the Cretaceous basement which belongs to the Inner Zone constituents of Southwest Japan.

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南西九州海域、甌海丘における花崗岩質礫の年代

石原 三・水野篤行

要 旨

甌海丘に産する花崗岩質礫は甌列島の中新世花崗岩類に対比させて中新世と考えられていたが、K-Ar年代(84.8 Ma)とチタン鉄鉱系に属する性質から白亜紀花崗岩類に属することが判明した。甌海丘は肥後深成岩類、双子島片状花崗岩類の南西方に位置し、西南日本内帯の岩石区に属し、海底堆積物に対する基盤を構成するものと考えられる。

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