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On the Significance of the Gneissic Rocks Found as Xenoliths in Andesite on the Sangun Metamorphic Belt of Yamaguchi Prefecture

By

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with 1 Text-figure and 1 Plate

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ABSTRACT: Gneissic rocks are found as xenoliths in the andesite of Mitakésan (Kimpôzan), 15 km to the north-northeast of Tokuyama City, Yamaguchi Prefecture. The xenoliths consist mainly of gneisses derived from basic rocks, containing hornblende, biotite, and plagioclase, in some specimens with clinopyroxene. Quartzo-feldspathic gneisses, consisting of biotite, plagioclase, and quartz, sometimes with garnet, pelitic gneiss, and non-foliated magmatites are also included. Judged from their rock association and mineral assemblage, they cannot be correlated to the gneisses either of the Ryôké or the Sangun metamorphic complex. The occurrence of gneiss xenoliths testifies to the presence of sialic layer, underlying the Sangun crystalline schists, which are characterized by the nature of the glaucophanitic metamorphism.

I. DESCRIPTIONS

Gneiss xenoliths are found included in hornblende-andesite of Mitakésan (Kimpôzan),[1] about 15 km to the north-northeast of Tokuyama City, Yamaguchi Pref. The andesite was erupted amid the Sangun metamorphic terrain, presumably in the Pleistocene. The same kinds of andesites are distributed in this district, e.g. at Shikumagadaké and Dakéyama to the northwest of Tokuyama City. They are similar in petrographic characters to the andesitic volcanoes in the San'in province, which belong to the so-called Daisén volcanic zone.

The andesite consists of phenocrysts of hornblende, plagioclase, and a little biotite, which sometimes grows into large plates, and groundmass feldspar, iron ore, and glass. Hornblende is marginally opacitized. The volcano of Mitakésan is largely composed of andesite blocks, and no stratified structure is observed. The volcano would have been formed by an explosion of relatively short duration.

The xenoliths of gneissic rocks were collected on the eastern flank of Mitakésan (Fig.1). The size of the xenoliths ranges from several to 20 centimeters in diameter, and their shape is angular to subangular. Petrographically, the xenoliths can be divided into the following four categories; i.e. 1) gneisses of basic rocks origin, 2) pelitic gneiss, 3) quartzo-feldspathic gneisses, and 4) non-foliated magmatites.

1. Gneisses of basic rocks origin

Rocks of this category occupy the majority of the xenoliths. They comprise amphibolite and its anatectic derivatives, such as porphyroblastic gneiss, metatectic gneiss, and permeation gneiss.

1) 山口県都濃郡鹿野町・都濃町金峰山

The amphibolite consists of equigranular hornblende and plagioclase, accompanied by biotite, and sometimes by clinopyroxene. The porphyroblastic gneiss is characterized by the growth of plagioclase porphyroblast, and the grain size becomes larger than the amphibolite. Its mineral assemblage is the same as the amphibolite, except for the sporadic occurrence of quartz. The metatectic gneiss shows banded structure. The rock consists of hornblende, biotite, plagioclase, and quartz, rarely with clinopyroxene. In the leucocratic layer, the grain size becomes larger and quartz tends to be enriched. In some specimens, the rock shows migmatitic appearance. The permeation gneiss appears rather homogeneous, owing probably to the growth of constituent minerals *en masse*. It consists of hornblende, biotite, and plagioclase, accompanied often by quartz, rarely by clinopyroxene and epidote.

The rocks show various features of alteration affected by the andesite magma. The alteration is most conspicuous in hornblende, which is more or less changed to opacite aggregate of minute iron ore and clinopyroxene marginally, with reddish or dark brown, oxydized core of hornblende.[1] When both hornblende and biotite are present in the same specimen, hornblende is more altered than biotite, the unusually dark axial colour of which may indicate oxydation. Clinopyroxene[2] does not show any effect of alteration, except for slight brownish tint on the margin. Plagioclase appears dusty. Colourless glass is formed along the intergranular space.

2. *Pelitic gneiss*

This type of rock was found only in a single specimen. This is a kind of metatectic to migmatitic gneiss, probably of pelitic rock origin. The main constituents are biotite, plagioclase, K-feldspar, and quartz. It is noticed that, at the contact with K-feldspar, biotite is changed to fibrolitic aggregates, accompanied occasionally by spinel. Whether the fibrolitic mineral is sillimanite or mullite is not determined, but, judged from the fact that no growth of fibrolitic mineral is detected in the other biotite of the gneisses, the fibrolitic mineral would indicate the presence of sillimanite in the original gneiss.

In the K-feldspar crystal,[3] chessboard structure develops (Plate 23). Each square of the chessboard has a rectangular shape, and the sides of the rectangles run parallel to each other. It seems that the longer and shorter sides are parallel to (001) and (010) respectively. The interstitial space between squares is occupied by glass. The chessboard structure would have been developed together with melting of the host crystal along the cleavage plane.

3. *Quartzo-feldspathic gneisses*

They consist of biotite, plagioclase, and quartz, accompanied by garnet. They would have been derived from quartz-diorite through regional metamorphism.

4. *Non-foliated magmatites*

Among non-foliated rocks, biotite-quartz-diorite, with or without garnet, mylonitic garnet-bearing aplite, and quartz vein are detected.

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1) For hornblende in a porphyroblastic gneiss, $2V_X=64\pm1°$.
2) For clinopyroxene in a permeation gneiss, $2V_Z=53°$.
3) $2V_X=85+1°$. Triclinicity index 0.041.

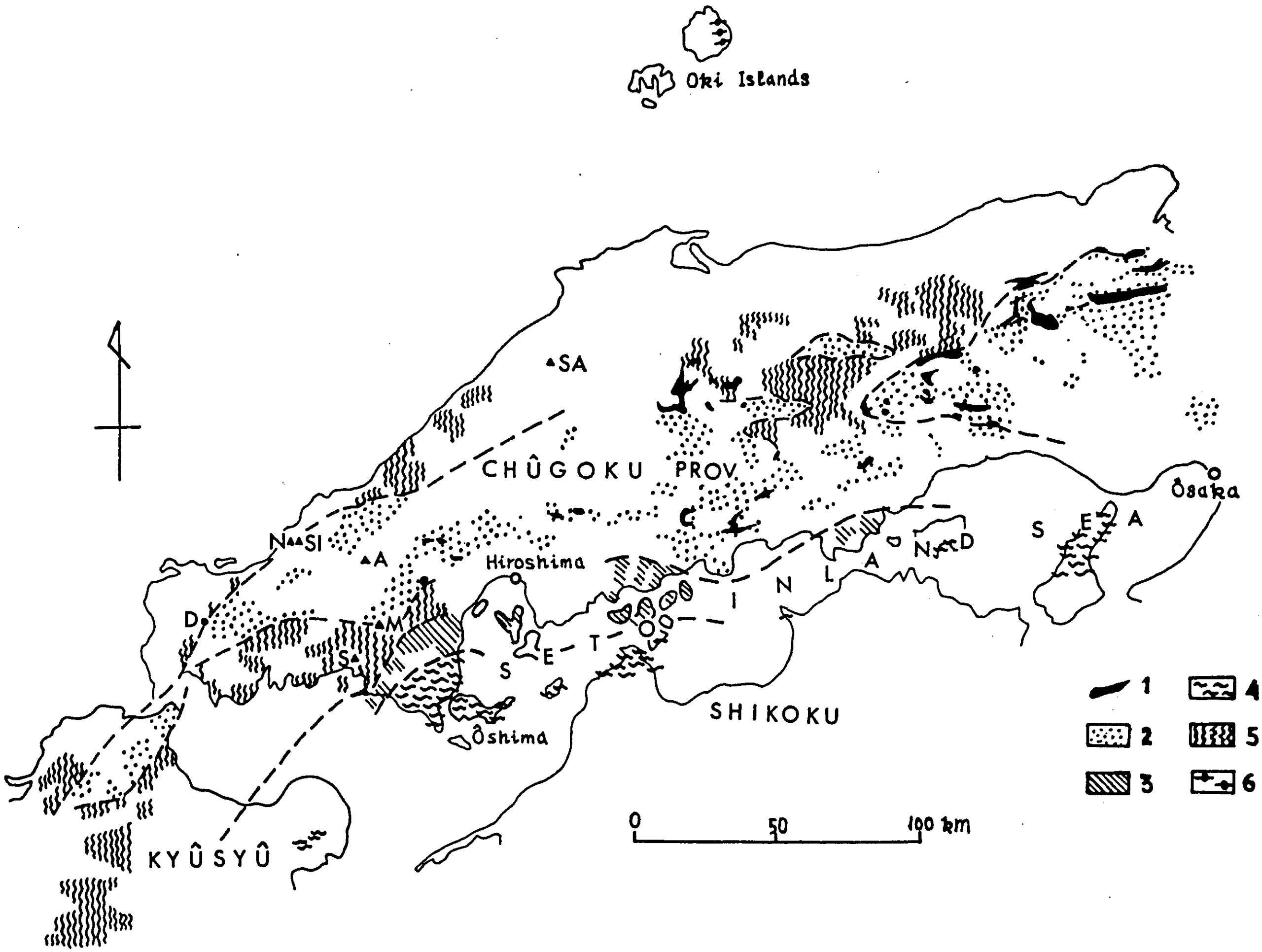

FIG. 1. Geological map showing distribution of the Palaeozoic formations in Southwest Japan (after A. HASE, partly modified by the authors). The localities of hornblende-andesite in the Chûgoku province from which xenoliths of granitic to gabbroic rocks have been reported by some authors are also shown on the map.

1 Yakuno intrusive rocks, 2 Non-metamorphic, or partly metamorphosed in a lower grade, Palaeozoic formations (Central non-metamorphic zone, Maizuru zone, Tamba zone, and others), 3 Non-metamorphic Palaeozoic formations (Intermediate non-metamorphic zone and others), 4 Ryôké metamorphic rocks, along with granitic rocks, 5 Sangun metamorphic rocks, 6 Hida metamorphic rocks

A Aono-yama, D Dai, M Mitakésan, N Nanaé, S Shikumagadaké, SA Sambésan, SI Shibuki

II. Discussions

Gneissic or granitic xenoliths have been so far reported from several parts of the Chûgoku province. TANEDA and YAMAGUCHI (1950) described hornblende-biotite-quartz-diorite and granitic rocks, occurring as xenoliths in the hornblende-andesite of the Aono volcano group. MURAKAMI (1954) reported the occurrence of biotite granite, gneissic gabbro, and foliated aplite as xenoliths in a basalt flow, about 25 km to the north-northeast of Yamaguchi City. The gneissic gabbro consists of plagioclase, clino-pyroxene, hypersthene, hornblende, and quartz, showing weak compositional banding. MURAKAMI suggested its nature of hybrid origin. The foliated aplite consists of quartz, K-feldspar, and plagioclase. KARAKIDA (1963) also reported granitic xenoliths in the basalt at Shibuki and in the andesite at Nanae, on the north of Yamaguchi Pref., and coarse-grained granodioritic rock and banded gneiss in the Aono volcano group.

In the Chûgoku province, there are distributed granitic rocks, ranging from quartz-diorite or monzonite to granite, related to the Late-Mesozoic igneous activity, while gneissic rocks are restricted within the Ryôké belt, running east-west along the Seto Inland Sea, and in the Oki Islands. Accordingly, the occurrence of gneiss xenoliths from the inland part of the Chûgoku province suggests the nature of the basement rocks underlying the Palaeozoic formations, but the single occurrence of granitic rocks as xenoliths cannot necessarily be taken as derived from the Pre-Mesozoic basement. In this respect, the gneissic xenoliths in question are of utmost importance in clarifying the nature of the Palaeozoic basement.

The xenoliths of the Mitakésan volcano consist largely of derivatives of basic rocks, accompanied by quartzo-feldspathic gneisses, pelitic gneiss, and non-foliated magmatites. They are commonly characterized by various features of anatexis, such as formation of porphyroblast, permeation, metatexis, and migmatization. It is most unlikely that these gneisses could have been derived from the Ryôké metamorphic complex, because the axis of the highest grade in the Ryôké belt, consisting of anatectic rocks, runs about 30 km to the south of Mitakésan, and furthermore, the metamorphic rocks of the Ryôké belt are mainly represented by pelitic and siliceous derivatives, and basic anatexites are confined only to a narrow zone (KOJIMA and OKAMURA, 1968). In North Kyûshû, the western extension of the Sangun metamorphic belt, amphibolites are distributed, e.g. in the Seburi Mountainland and the Sasaguri district of the Sangun Mountainland, but the occurrence of anatexites is very restricted and no quartzo-feldspathic gneiss is found. The gneissic rocks in the Oki Islands are believed by most geologists to represent the western extension of the belt of Hida gneiss complex. In the Islands, pelitic, basic, and calcareous gneisses are exposed along with granitic rocks, either massive or mylonitic. The gneisses of the Mitakésan xenolith have certain resemblance to the Hida gneiss complex in that basic anatexites are predominating and that quartzo-feldspathic gneisses are contained, but neither calc-silicate rocks nor crystalline limestone, that are predominating in the Hida belt, have been collected. Anyway, together with the occurrence of gneissic rocks as xenoliths in the volcanic rocks of Aono and other localities in Yamaguchi Pref., the gneissic xenoliths of the Mitakésan volcano suggest the nature of the basement rocks underlying the Palaeozoic formations.

In this connection, it should be noticed that KAWANO, UEDA, and MURAKAMI (1966) reported recently the presence of a granitic rock, garnet-bearing muscovite gneissic granodiorite,[1] showing 424 m.y. by the K-A method, from Dai near Miné City, Yamaguchi Pref. It occurs, along with other types of granodiorite or quartz-diorite, included in serpentinite in a fault belt, named the Nagato Tectonic Zone. They considered these granitic rocks as derived from the Pre-Palaeozoic basement by tectonic movement. All these data suggest the presence of sialic basement under the Sangun metamorphic belt, which is characterized by the nature of glaucophanitic metamorphism.

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1) Prof. MURAKAMI of the Yamaguchi University has kindly offered the senior author a specimen of the analysed one. It shows clearly defined foliation surface, marked by the preferred orientation of mica, on which lineation can be observed. The rock must be a product of regional metamorphism derived from a granitic rock, and does not seem to have been affected by anatexis. Other types of crystalline schists should be expected to occur in the vicinity.

Explanation of Plate XXIII

A: Microphotograph of K-feldspar in a pelitic gneiss xenolith. Chessboard structure develops all over the grain of K-feldspar, the outer margin of which is surrounded by thin film of glass. Black parts in the grain are also glass. Crossed nicols.

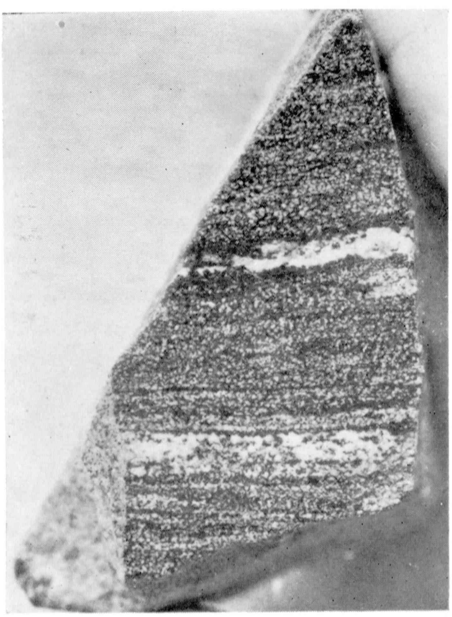
B: Photograph of a pelitic gneiss xenolith. This is a kind of metatectic to migmatitic gneiss.

C: An example of gneiss xenolith of basic rock origin. This is a metatectic amphibolite, accompanied by biotite and sometimes by clinopyroxene.

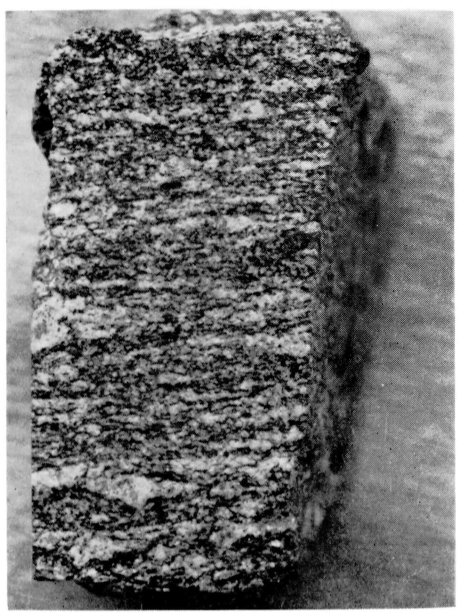
D: Photograph of a quartzo-feldspathic gneiss xenolith. Gneissic structure is conspicuous and augen structure can be seen.

A 0.5 mm

B 1.5 cm



C 1.5 cm



D 1.5 cm