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Geology and Petrography of the Hira Granite, and Mutual Relations between Granites in the Northeastern Kinki District, Japan

By

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Abstract

In the first part of the present paper, are outlined the geology and petrography of the granite of Mt. Hira, and in the second part, are discussed the mutual ralations between the granites in this area, as summarized below.

In the inner zone of Southwest Japan, several arc structures are formed, mainly consisting of the Palaeozoic strata, one of which, the Kinki arc, is observed in the Kinki district. The granites of Hira, Hiei, Mikumo, Tanokami and Suzuka, inject into the eastern part of the arc. Although these granites are generally considerad to be of nearly contemporaneous injection (perhaps, in the Cretaceous period), they can be classified into two groups, the Hira granite group and the Hiei granite group, judging from their modes of occurrence, their rock textures and their mineralogical characters, and may be correlated to the Nôhi rhyolite and allied granites in the Mino arc which is standing on the east of the Kinki arc.

Introduction

The present paper includes the field and petrographical study of the Hira granite, done mainly by M. KAWAHARA, the microscopical re-examination of the rocks by K. KANEKO, a consideration of the relations between this granite and the other granites nearly located, and the correlation to the late Cretaceous acid igneous rocks, the Nôhi rhyolite and allied granites, by H. YOSHIZAWA and K. ISHIZAKA.

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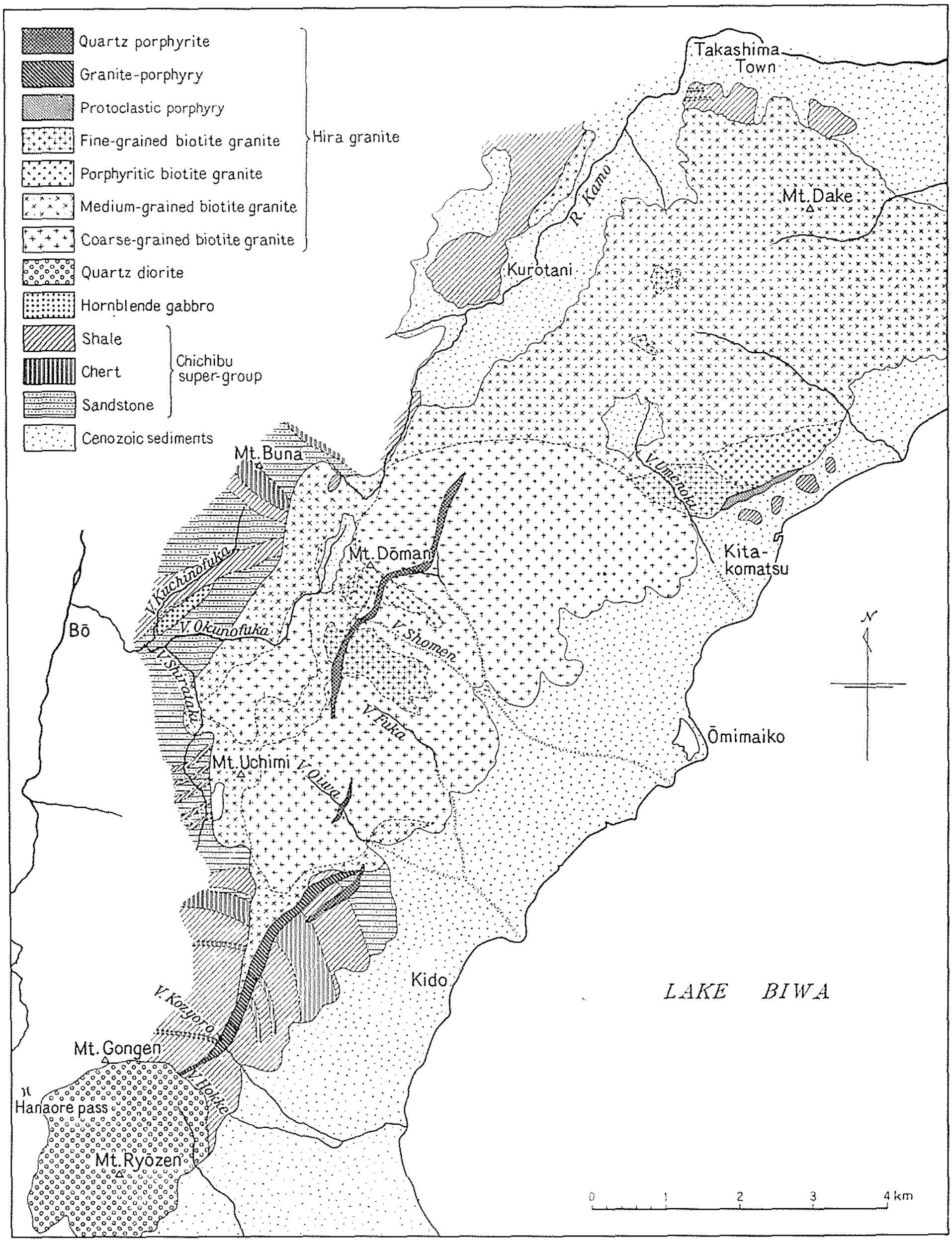


Fig. 1 Geological map of the Hira granite

Topography and Geology of the Hira Granite

The Hira mountain system runs generally in the NNE-SSW trend along the western shore of Lake Biwa, and branches in its northern half so that the arrangement of Mt. Buna (1214m.) and many other summits is "Y"-shaped. This mountain chain is a horst which has faults both on the eastern and western sides : The Hira fault group is in the NNE trend on the eastern side, and the Hanase fault, in the same trend, runs across the Palaeozoic strata on the western side.

As shown in the geological map (Fig. 1), the quartz diorite stock and the gabbro dyke* are found in the area, besides the Hira granite. But these two rocks will not be referred to in the present paper, because in the wirters' opinion they are different from the Hira granite in the geological conditions.

The Hira granite intrudes into the Palaeozoic strata which are ubiquitous in this area and have the general E-W strike. The contact of both kinds of rocks is NNE in general trend: In the western part, the Palaeozoic strata have a thermal aureole of 1 km. wide, and alter to hornfels, and in the eastern part, in spite of the fact that the granite mass is overlain extensively by the Cenozoic sediments of the western shore of Lake Biwa, in some places, there are found contacts between both rocks. For instance, in the northwest of Kido, the granite contacts obviously with the Palaeozoic strata with a surface trending towards NNE, and in the north of Kitakomatsu, the former also contacts with the latter, and a kind of quartz porphyry with protoclastic texture intrudes in between.

Consequently, it becomes clear that the granite is a distinctly discordant body in the Palaeozoic strata, the injection of which is accompanied mainly by the formation of the NNE trending fissures in the Palaeozoic strata, though the presence of some folding movements of the strata at the time of the magmatic injection can not be denied. Textures of this granite are very changeable and one rock facies is generally transitional with other facies.

The rock in the side contact part adjacent to the Palaeozoic strata, generally consists of medium-grained biotite granite, and partly of fine-grained biotite granite. Moreover, in the roof part of the granite, there occur porphyritic biotite granite and fine-grained biotite granite, the latter of which resembles that of the side contact mentioned above. Porphyritic granite and fine-grained granite represent the marginal facies of the Hira granite. In the

* These bosses and dykes of rather basic rooks were probably formed before the granite injection, though these two kinds of rocks may be comagmatic.

interior of the body, it is represented by coarse-grained biotite granite having pegmatite, and generally speaking, granurality of the granite increases on a higher horizon, i. e. on ridges and decreases on a lower horizon, i. e. in valleys. All these rock facies in this body generally grade into each other, but the coarse-grained facies often injects into the porphyritic or the fine-grained facies in the summit area : It shows the re-injection of the yet unconsolidated inner magma part into the already solidified marginal rock facies. The arrangement of these facies is shown in Fig. 1 and Fig. 2.

Judging from these mechanisms of intrusion and arrangement of rock facies, it is considered that the Hira granite represents the top part of a shallow-emplaced mass, the crystallization of the marginal part of the magma generally precedes that of the inner part and the unsolidified residual magma in the interior intrudes into the already solidified rock facies just under the

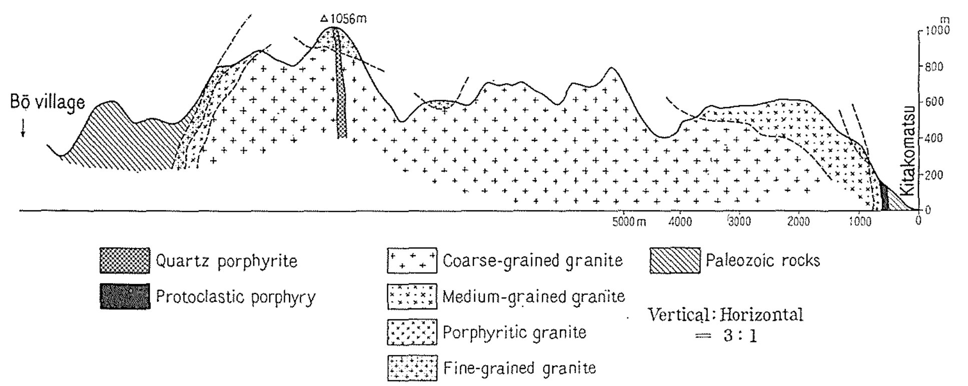


Fig. 2 Inner structure of the Hira granite

roof. These facts on the aspects of the magmatic consolidation are consistent with the natures of the chief constituents contained in various rock facies.

After the main granitic injection, quartz porphyry and quartz porphyrite dykes are injected in parallel, in the NNE trend, into the granite and neighbouring Palaeozoic strata. Judging from this fact, it is, also, clear that crustal movements, mainly faulting, are continued from the time preceding the granitic injection to that of the magmatic solidification.

Petrography of the Hira Granite

1) Coarse-grained ~ medium-grained biotite granite

The rock, assuming pink color, occurs in the inner part of the large intrusion body.

Essential minerals; quartz, microperthite, plagioclase and biotite.

Accessory minerals; allanite, zircon, titanite and magnetite.

Quartz, generally, is interstitially crystallized. As a shearing strain, the mineral shows undulatory extinction and infrequently has an optically biaxial character. The optical angle of the K-feldspar phase in the microperthite is (−)63° ±3° and the plagioclase phase is no doubt albite. These two phases in the perthite are common in (010) and C-axis, according to the observation by the universal stage. Plagioclase is frequently zoned, the composition range of which is $An_{8\sim23}$ ($2V_z$=83°∼102°). Biotite is of a dark brown variety.

2) Porphyritic biotite granite

The rock is similar to the coarse-grained ∼ medium-grained granite in its mineral assemblage.

Phenocrysts: Quartz, microperthite, plagioclase and biotite.
quartz; weakly undulatory extinction.
microperthite; 2V of the K-feldspar phase = (−)60°
Bending of the crystal by stress is found under the microscope.
plagioclase; An_{27} in the core and $An_{18\sim24}$ in the margin.

Groundmass: Fine-grained and granitic texture.

3) Fine-grained biotite granite.

Essential minerals; quartz, microperthite, plagioclase and biotite.

Accessory minerals; apatite, allanite, sphene, magnetite and epidote.

Quartz, generally, shows undulatory extinction and forms a graphic texture together with alkali-feldspar. Perthite, sometimes, has cryptoperthite texture. 2V of the K-feldspar phase in it is (−)53°. Biotite is of a brown variety.

4) Granite-porphyry

a) Normal type

This rock is bluish or pinkish, and porphyritic.

Phenocrysts: Microperthite, plagioclase, quartz and biotite. Quartz is euhedral, and has undulatory extinction. 2V of the K-feldspar phase in the microperthite is (−)56°. The chemical composition of zoned plagloclase crystal is An_{24} in its core and An_{18} in its mantle.

Groundmass: Aggregates of subhedral quartz, microperthite, plagioclase and biotite. Due to the secondary crystallization of chlorites, groundmass shows bluish tinge.

b) Protoclastic type

This rock occurs in the form of dyke in the north of Kitakomatsu. This is generally characterized by subhedral quartz, microperthite, plagioclase and biotite, similarly as the normal rock type. Phenocrysts of quartz, microperthite and plagioclase are rich in crack filled with groundmass minerals, rotated and strained. Microperthite and plagioclase are mainly altered to sericite. Biotite is mostly altered to chlorite and epidote. Groundmass is stained by iron-oxide.

5) Pegmatite

This rock mainly occurs in the southern part of the coarse-grained biotite granite.

Essential minerals; quartz, microperthite, biotite, muscovite and fayalite ($2V=(-)65°, Fo_{20}Fa_{80}$)

6) Quartz porphyrite

This rock injects into the granite and neighbouring Palaeozoic strata in the form of dyke trending NNE, i. e. the same direction as the elongation of the granite body. It contains phenocrysts of plagioclase and subordinate biotite, in a bluish microcrystalline groundmass which is similar to the granite-porphyry in its mineral assemblage.

Phenocrysts: Plagioclase is labradorite ($An_{52}\sim An_{60}$) with replaced periphery and veinlets of An_{20}, therefore very heterogeneous under the microscope, and sometimes alters to an aggregate of sericite or epidote. This plagioclase may be a kind of autolith, judging from the texture of its body and the compositional discrepancy between the groundmass and this phenocryst. Quartz is usually corroded. Biotite alters completely to chlorite.

Groundmass: K-feldspar, quartz and brown biotite.

As to the groundmass, judging from its mineral composition, this rock should belong to quartz porphyry.

7) Palaeozoic formation

This formation consists mainly of shale, sandstone and chert. It is observed that, around the areas of Shirataki Valley and Mt. Buna, sandstone is dominant, and around the areas of Kinpira Valley and Kozyorō Valley, shale is dominant. Near the contact to the granite, these sedimentary rock turn into hornfels.

Sandy hornfels : Main constituent minerals……… quartz, feldspars, biotite and graphite.

Shaly hornfels : Main constituent minerals……… quartz, biotite, feldspars, chlorite, and sericite probably altered from cordierite.

Chert: Many round quartz and small amounts of feldspars are scattered in the siliceous glass.

Relation between the Hira granite and the other granites developed in the northeastern Kinki district, and the Nôhi Rhyolite and allied granites in the western Chūbu district

As already mentioned, the Hira granite is an intrusive body trending toward NNE which has a discordant form in the Palaeozoic strata striking to the E-W direction. On the contrary, the Hiei (Daimonji) granite, found in the south of the Hira granite, occurs as a stock with the E-W trend, in an axial zone of a fold-structure of the Palaeozoic strata having the strike of the same direction, and therefore the writers consider that the Hiei granite is in a little more concordant position with the strata than the Hira granite. Compared with the Hira granite, moreover, the Hiei granite is much simpler in its rock facies, and has smaller numbers of pegmatite and a higher percentage of plagioclase, the last of which is richer in An-component. From these geological and petrographical points of view, it is inferred that the Hira granite is a more shallow-emplaced body, and solidified at a later stage, than the Hiei granite, if both granites are of a comagmatic origin*.

The Mikumo granite, found in the east of the Hiei granite, may be an extending part of the latter, considering its topographic situation, and also its rock facies and its intrusive relation with the Palaeozoic strata.

Furthermore, as to the Tanokami granite, contacting with the Mikumo granite, its relation with the latter is now uncertain, but it has been recently corraborated by two of the writers and another** that a small mass similar to the Tanokami granite intrudes into the Mikumo granite. The Tanokami rock is changeable in its rock facies, contains many pegmatites and is leucocratic as a whole. In these points, the Tanokami rock is similar to the Hira granite rather than to the Hiei granite.

In the further eastern part of this Kinki district, there is another occurrence of the granite, the Suzuka granite, which is distributed along the ridge of the Suzuka mountain-range running in the NNE-SSW direction and intrudes into the Palaeozoic strata having generally the E-W strike. This granite has many similarities to the Hira granite with regard to the geological structure of the surrounding Palaeozoic strata and also to its internal structure and petrographical character, judging from the study of M. OGATA.

Considering all these facts, especially the geological structure and petrography of these granites, most granites of this area adjacent to the north of the

*This deduction is, the writers consider, proper.

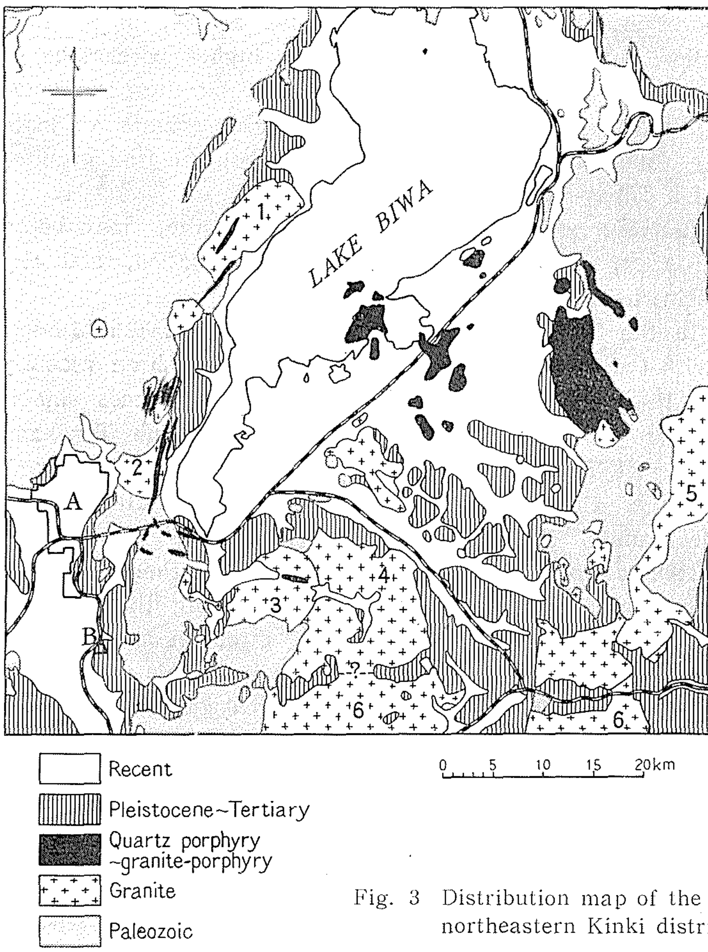
** H. YOSHIZAWA, K. ISHIZAKA and Waichi NAKAJIMA.

Ryōke Metamorphic zone, can be classified into the following two groups.

(1) The Hira granite group, including the Hira-, the Tanokami-, the Suzuka- and other granites.

(2) The Hiei granite group, including the Hiei-, the Mikumo- and other granites.

It is assumed that the former group intruded up to a more shallow depth at a more or less later stage, in comparison with the latter group, although the depth-difference and the intrusion-time-gap may be small. Furthermore, considerably large numbers of granite-prophyry and quartz prophyry in small mass are found in and near these granites.



1. Hira
2. Hiei
3. Tanokami
4. Mikumo
5. Suzuka
6. Ryoke

A. Kyoto city
B. Uji city

from Geol. Map (1/500,000) of Geol. Survey, Japan, modified by the writers

Fig. 3 Distribution map of the granites in the northeastern Kinki district

As these small masses in dyke or apophyse are very similar in their occurrences and rock facies, it is considered that they are cognate and formed at an almost similar stage: This kind of rocks is formed after the consolidation of the Hira granite group, but, these dykes on Mt. Hira, are closely related to the granite itself in the point of their mutual arrangement and distribution.

From their trends and arrangement, as shown in Fig. 3, these dykes can be classified into two groups, in the west and south area of Lake Biwa. One runs from the Hira granite in the north through the Hiei granite to the Palaeozoic strata: It is intermittently found and has the NNE~NS strike. The other runs from the Tanokami granite in the east to the Palaeozoic strata on the west, and has the E-W strike. These two dyke groups seem to join each other in the area about 5 km. NNE of City Uji. In the opinion of the writers, these injection trends of the dyke groups together with those of the Hira granite group, suggest the geological tectonics, especially the fissure system, in the time of the movement of the granitic magma.

The summary of the discussion mentioned above, is as follows.

(1) The granites of the Hiei group intruded in a rather less discordant rerlation with the fold structure of the Palaeozoic strata, than those of the Hira group.

(2) After the intrusion of the Hiei group, the intrusion of the Hira group succeeded in a state of a more discordant relation with the structure of the Palaeozoic strata.

(3) At the latest stage, i. e. the stage of the residual magmatic activity, the granite-porphyries and quartz prophyries intruded in a remarkably discordant relation with the geological structure of that time. Namely, at least, the Hira granite group, and the porphyries are of fissure injection not directly dependent on the original arc structure of the Palaeozoic strata before their occurrences.

(4) All these granitic rocks, probably, are of comagmatic origin: From the geochronological data, the Hiei granite is considered to be formed in the Cretaceous period. *

In the Mino arc adjacent to the east of the Kinki arc, the acid rocks, the Nôhi rhyolite and allied granites, are formed in the late Cretaceous period and have been surveying carefully by K. Kawada and others**. The granitic rocks, mentioned above, of the northeastern Kinki district, can, in the writers' opinion, be compared with the Nôhi rhyolite and allied granites, although

*T. Matsumoto also considers that all granites of this area are of the Crètaceous period.

volcanic facies are absent in the former: Whether or not volcanic facies exist, depends probably on tectonic differences in each arc.

Mutual relations between these granites under discussion, the granites of the Ryoke metamorphic zone*** and the Hiroshima granite in the Chûgoku region will be studied in future.

Acknowledgments

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** According to T. KOBAYASHI, in the Inner zone of Southwest Japan, there are formed several arc structures mainly consisting of the palaeozoic system of the early Mesozoic Era, one of which, the Kinki arc, is observed in the Kinki district. Furthermore, he states that between this arc and the Mino arc adjacent to the east, there occurs a structure zone. i.e. the "Neo syntaxis". In the late Mesozoic Era, injections of acid magma, represented by the Shirakawa granite, occurred in the weak zone of the Mino arc induced by this syntaxis.

Recent studies of the Hida metamorphic zone, representing the north part of the Mino arc, by H. FUJIMOTO, and others, state that the formation of these arcs starts in the deposition stage of the Palaeozoic strata in the late Palaeozoic Era. After the orogenic movement in the late palaeozoic Era, geoanticlinal movement occurs in the Mino arc. Along fissures induced by this movement, areal extrusions of acid magma succeeded by intrusions of the same, form the Nôhi Rhyolite and allied granites in the late Cretaceous period.

*** ASAYAMA et al. say that the Mikumo granite may belong to the Ryoke granite, judging from their radioactive data.

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