121. Stratigraphical Evidences for the Pre-Silurian Age of the Granites in the Kitakami Massif, Northeast Japan

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The Silurian System, the oldest of the fossiliferous sediments in the Japanese Islands, is distributed sporadically in the Kitakami and the Hida massifs and along the Kurosegawa Tectonic Zone in the Kii Peninsula, Shikoku and Kyushu. Many of the granitic and metamorphic rocks distributed in areas adjacent to the Silurian formations, have been emphasized to be pre-Silurian or Pre-Cambrian in age by many authors on the basis of their petrographical characters and age dating. However, the stratigraphical relation between the Silurian strata and the pre-Silurian “basement rocks” was not known except for the fault contact at some localities, and sediments which suggest derivation from the basement rocks have not been found in the Silurian formations.

The Hikami Granites in the Kitakami Massif, one of the older granites in Japan, is characterized by the rich contents of alkali-feldspars, and by the distinct gneissose or protoclastic textures. It was intruded and metamorphosed by the Early Cretaceous (110-120 m.y.) granite. The age of the Hikami Granites had been assigned to the Late Permian or Triassic, because it was believed that the granites intruded the rocks older than the Permian in age. Recently, Murata et al. (1974) and Okami and Murata (1975) pointed out that the Hikami Granites constitute a basement complex of the Silurian System in the Kitakami Massif, the view being upheld by the stratigraphical and petrographical evidences, though the radiometric dating of the granites was Devonian or Early Carboniferous in age.

The Hikami Granites, form an oval shaped mass of $7 \text{ km} \times 14 \text{ km}$ in east-west and north-south directions respectively, and are situated between Ofunato and Rikuzentakada Cities, Iwate Prefecture. The Hikami is composed of a complex of granitic and metamorphic rocks, that was divided by Ishii et al. (1960) into two types of granite, i.e., the Hinokami-yama Type and the Ono Type, and the Tsubonosawa

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The Hinokami-yama Type granite, distributed in the central and southern parts of the mass, shows remarkable gneissosity, which indicates the character of late-kinematic intrusion under a stress condition, and is surrounded by a large amount of biotite-gneiss of the Tsubonosawa Metamorphics as large xenolithic lenses. The Ono Type granite, distributed in the northern and eastern parts of the Hikami Granites, consists mainly of non-schistose granodiorite with comparatively abundant K-feldspars. It originated from a hydrous and low-temperature magma and intruded into the shallow zone during the post-kinematic stage.

The K-Ar ages of biotite, hornblende and orthoclase of the Hikami Granites varied distinctly by localities and the minerals dated from 114 to 355 m.y. (Kawano & Ueda, 1964; Shibata, 1973; Murata et al., 1947), however, these data were the values influenced by the Cretaceous granites. Recently, Shibata (1975) published the Rb-Sr ages of the Hikami Granites by the whole-rock method. According to him (1975), the Rb-Sr analytical date-points of the Hinokami-yama Type and the Ono Type granites lay on the 339±12 m.y. isochron, and had no difference in initial $^{87}$Sr/$^{86}$Sr ratio of 0.7079±0.0003. Thus, he (1975) considered the Hikami Granites to be one of the Middle Paleozoic plutonic rocks in the Japanese Islands. However, only the Tsubonosawa Metamorphics were considered to be Pre-Cambrian in age, based on the 334±18 m.y. isochron and initial ratio of 0.7129±0.0003.
Two stratigraphical evidences indicate distinctly the subsistence of the pre-Silurian basement of granites in the Kitakami Massif in spite of the results of radiometric dating. One of them is that the basal sandstone of the Silurian Kawauchi Formation lies on the Hikami Granites, and the other is the slumping beds of granite pebbles and breccia in the Lower Devonian Ono Formation.

The basal sandstone of the Silurian Kawauchi Formation crops out conspicuously at Higuchizawa, Kusayamizawa, Gyoninzawa and west of Ono in the Hikoroichi area, Ofunato City, Iwate Prefecture. This sandstone has been mistaken megascopically for mylonite, aplite or quartz-porphyry which is exposed at the granite margin. However, Murata et al. (1974) and Okami and Murata (1975) showed that the arkose sandstone originated from granite and forms the basal sandstone of the Kawauchi Formation. This view was upon their detailed stratigraphical and sedimentological studies, as follows:

The sandstone, about five meters in thickness so far as observed, covers the Ono Type granite of the Hikami Granites with unconformity originally, but is in contact with the faults observed at Gyoninzawa and Ono. The rock consists of angular coarse grains (−1.0 to 0.3 φ) of quartz, feldspars and fragments of granite with subrounded pebbles (5 to 0.4 cm) of granites and quartz. These grains are cemented by a little amount of clayey materials and secondary quartz, however, at the top of the sandstone bed, the clayey matrix increases rapidly and changes gradually upwards to the overlying black slate. The sandstone sequence seems to be a massive bed in the outcrops, however, the sequence of grain size distribution and mineral composition of the sandstone at Kusayamizawa shows distinct cycles of grading as shown in Text-fig. 2. Sorting, Skewness and Kurtosis indicate that the sandstone was deposited under a non-marine environment, as would be expected from the grade of abrasion, at the area adjacent to the source. The mineral composition of the sandstone changes with the grain size distribution, which shows two cycles of grading. In particular the content ratio of quartz and rock fragments of granite are related closely. It is considered that the products of deep weathering may have been supplied during the early depositional stage; the unweathered materials increase towards the later stage, as shown in Text-fig. 3. The optical characters of the feldspars in the sandstone, i.e., perthitic K-feldspar, 2Vx=64°–69° and a small amount of albite (An 5) include “chess-board albite” or “chequer albite”, are in common with the Ono Type granite of the Hikami Granites.

Many lenses of slumping beds that consist mainly of pebbles and breccias of granite are developed in the lower part of the Lower
Devonian Ono Formation, which had been considered to be a cataclastic dyke of granite by many authors, and that was the major evidence of intrusion of the Hikami Granites. However, many fragments of limestone and siliceous slate which yielded well preserved corals and radiolarians were found in the breccia beds of granite as soft rock pebbles. Fine fragments of granite also occurred from the lower part of the Ono Formation forming a graded lamination with the siliceous slate matrix. Based on those evidences, Murata et al. (1974) concluded that the lenses of granite breccia are clastic sediments that formed the slumping bed with soft rock pebbles of limestone and siliceous slate. The optical characters of the granite from this breccia beds of Ono Formation also coincides with the Ono Type Granite.

As mentioned above, the results of the stratigraphical and petrographical studies show distinctly that a part of the Hikami Granites in the Kitakami Massif is the basement complex of the Silurian formation. Namely, the Ono Type granite of the Hikami Granites is covered by the basal sandstone of the Silurian Kawauchi Formation with blended unconformity. After the shallow marine sedimentation of the Kawauchi Formation, abrupt subsidence of the sedimentary basin with acidic volcanism may have been responsible for forming the slumping beds of granite breccia.

Shibata (1975) presented the Rb-Sr analytical data for arkose sandstone from the basal sandstone of the Silurian Kawauchi Forma-
tion and the granite boulders from the lower part of the Lower Devoonian Ono Formation as 264 m.y. This age is contradictory to the geological evidences. The present writers construe that the results of radiometric dating of the Hikami Granites and clastic materials from the Silurian and Devonian formations are the values influenced or resulting from the intrusion by the Cretaceous granite and tectonic movements of the basement blocks, because many dykes of the Cretaceous granite are distributed in the Hikoroichi area.

The existence of the basement complex of granites in the Kitakami Massif is a new page on the historical geology of the Japanese Islands.

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