**189. *On a Conglomerate Schist from Iya Valley
in Shikoku.***

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A conglomerate schist, recently found by the writer in the crystalline schist system of Shikoku, is a member of the Ôboké series of the Sambagawa formation.¹⁾ It is well exposed along the eastern bank of Iya valley, 1 km. north of Itchu on the south wing of the so-called Ôboké anticlinal axis. From the geological point of view this Iya valley is considered to be an antecedent valley, similar to the Ôboké valley. The conglomerate schist occurs as interstratified layer, 30 m. or more in thickness in the Ôboké gneiss, showing usually well foliated planes of stratification. It consists of numerous pebbles of lenticular forms, regularly arranged in plane of schistosity and imbedded in the matrix of a remarkable schistose texture. Average lengths of the major and minor diameters of the pebbles, cut perpendicular to the plane of schistosity of the rock, are 10 cm. and 2 cm. respectively. The surface of the pebbles is usually smooth and round, giving the evidence that they were perfectly water-worn. From these facts there is no reason to consider that this conglomerate schist is a modified type of fault breccia or friction breccia, but the rock of real sedimentary origin. These pebbles are petrographically classified into three types, on which a short description is given as follows:

Type A. — A rather remarkably porphyritic rock, containing phenocrysts of quartz and feldspar in a fine grained groundmass, in which the schistosity developed slightly owing to the parallel arrangement of granulated or recrystallized minerals. The phenocrysts of quartz are

1) B. KOTÔ: On the so called Crystalline Schists of Chichibu. Joun. Coll. Sci. Imp. Univ. Tokyo, Vol. II, No. 1. 1887. T. OGAWA: Kochi Sheet. Geol. Surv. Japan. 1901.

The Sambagawa formation is composed of the oldest metamorphic rocks in Japan. As no fossils have yet been met with in any of the strata of this formation, its age is still uncertain. It is simply considered to be pre-Carboniferous. The formation in the central part of Shikoku is generally divided into Besshi and Oboke series.

Conglomerate schist

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generally 1 mm. or more in diameter having well defined idiomorphic form, though some of them have been distorted and often make undulatory extinction between crossed Nicols. Sometimes they have a corroded outline. Most of the phenocrysts of orthoclase and plagioclase make perfect crystal forms with twinning or zonal structure, though they are partly decomposed in general. Obviously these phenocrysts of quartz and feldspar are the relics of those in the original igneous rocks. The groundmass is composed of fine grains of quartz, feldspar, actinolite, biotite and sericite. Most of them are the recrystallized product under the dynamo-metamorphism, while some of quartz and feldspar are original materials partly granulated. Those recrystallized grains of quartz and feldspar are characterized by their fresh appearance and a considerable admixture of actinolite and micas. The chemical analyses of a pebble of the type A are as follows: SiO_2 76.12, Al_2O_3 14.16, Fe_2O_3 0.62, FeO 1.12, MgO 1.04, CaO 1.32, Na_2O 2.23, K_2O 3.17, Total 99.79 (Analyst: Takezo Kato) The mineral components, chemical composition and the texture of this pebble show that it has been derived from an acidic rock with a porphyritic texture.

Type B.—A hard compact rock chiefly composed of microcrystalline minerals with well shaped phenocrysts of feldspar, which are quite difficult, however, to determine their optical properties owing to

their extreme decomposition. The groundmass is made of subparallel bands of the brightly polarizing aggregation of fine crystals of quartz and feldspar, accompanying a considerable amount of actinolite and mica. Though the chemical composition is still undetermined, the lithological characters indicate that these pebbles are derived also from some acidic volcanic rocks.

Type C.—The pebbles of this type are more or less angular in form and are composed of very fine grains of quartz, feldspar and graphitic matters. They show more schistosity than those of other two types, and are closely resembling to the black phyllite of the underlying Ôboké gneiss series in general appearances.

Matrix.—The material, by which the pebbles are cemented, is a heterogeneous mixture of particles of quartz, feldspar, biotite, actinolite and limonitic matters. It forms thin distinct subparallel foliations, as a result of the rearrangement of the recrystallized products, though a few of its original components occurs unaltered. It is remarkable that the alteration as the effects of pressure is generally more distinct in the matrix than in the pebbles, as the similar relation exists between the groundmass and phenocrysts of the pebbles.

Geological meanings of the conglomerate schists: As already mentioned it is clear that the pebbles of A and B types are the denudation products of some acidic volcanic rocks, though their origin is still in question. Only rocks which occur near the conglomerate schist are the underlying Ôboké gneiss and black phyllite. Now a special attention must be paid to the so-called Ôboké gneiss. It has an appearance very similar to that of acidic volcanic rocks, and consists principally of fine grains of quartz, feldspar, actinolite, epidote, allunitite accompanying phenocrastic relics of quartz and feldspar, which indicate that the rock has suffered a severe deformation, though it has not yet lost its identity to the properties of an acidic rock with porphyritic texture. The Ôboké gneiss is usually schistose and crystalline rather than granular, but sometimes it is easily mistaken for the pebbles of A or B type under the microscope. Besides these similarities, the chemical composition of this gneiss gives another data to explain the relation between this rock and some volcanics. The analysis of the typical Ôboké gneiss, collected from the anticlinal core, is as follows: SiO_2 75.92, Al_2O_3 12.38, Fe_2O_3 0.21, FeO 2.13, MgO 0.62, CaO 1.04, Na_2O 3.08, K_2O 3.08, H_2O (+) 1.23, H_2O (—) 0.02, TiO_2 0.28, P_2O_5 0.04, MnO 0.03, Total 100.06 (Analyst: Senzaburo Tanaka) In short it may be said that the Ôboké gneiss is identical with the pebbles of A and B types

in its petrographical characters, and it is most probable to say that they were derived from the same original rocks. If this consideration be correct the Ôboké gneiss is not equivalent of graywacke sandstone, as it has been believed by many geologists, and may be regarded as a metamorphosed form of a complex of acidic lavas and their tuffs, produced by a moderate pressure at a certain depth.

It is very remarkable that this conglomerate schist does not contain any piece of pebbles of green schists, such as chlorite schist, amphibole schist, etc., which form the essential part in the Besshi series of this district. The stratigraphical relation between the Besshi and Ôboké series has been left as an open question among our geologists for a long time, but this fact favours the consideration, already expressed by Prof. T. Ogawa, that the present position of these series in the field is in natural order and that the Besshi series comes above the Ôboké series.

In Japan proper many conglomerate layers have been found in the Mesozoic and Cainozoic formations, but they are seen rarely in the Chichibu formation of Permo-Carboniferous. Moreover any trace of that rock has never been found in the Mikabu and Sambagawa formations which are to be pre-Carboniferous. So the recent occurrence of the thick conglomerate schist in the Sambagawa formation of this district in Shikoku attracts our profound attention, as an important factor of the old Palaeozoic geology of Japan. Especially the presence of the pebbles of A and B types in this rock indicates an important fact that a notable igneous activity of acidic rocks took place before the Carboniferous age in Japan.¹⁾ The igneous activities of basic rocks in that age have been often reported, but those of the acidic rocks have never been mentioned until recently,²⁾

1) Concerning the periods of igneous activity in Japan, various opinions are found in the works of Harada, Iddings, Kato and in publications of the Imperial Geological Survey of Japan. T. Harada: *Die japanischen Inseln. Eine topographisch-geologische Uebersicht.* Imp. Geol. Surv. Japan., J. Iddings: *Igneous Rocks* Vol. II (1913) pp. 603-612. T. Kato: *The Periods of Igneous Activity in Japan with special Reference to Metallogeny.* Proceedings of the Second Pan-Pacific Science Conference (Australia) 1923, and *Journ. Geol. Soc. Tokyo*, Vol. XXXI (1924) 1-13. *The Geology and Mineral Resources of the Japanese Empire.* Imp. Geol. Surv. Japan (1926.)

2) The so-called Gneiss system in Japan proper was believed as the oldest intrusives forming the foundation of the Sambagawa formation, but modern geologists are inclined to consider that the period of their intrusion is more young.

According to the latest personal communication of Professors S. Kozu and M. Watanabe of Tohoku Imperial University, the Palaeozoic conglomerate layers which are conformable under the Fusulina limestone at Usuginu, Prov. Rikuzen, contain the pebbles of granite, aplite, pegmatite and hornstone. Both conglomerate layers at Usuginu and Iya-valley give the most interesting data to explain the ancient igneous activities of acidic rocks in Japan.