14. *Igneous Activities prior to the Deposition of the Chichibu System.*

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(Read March 17, 1953.—Received March 20, 1953.)

Introduction.

The Chichibu System has been well investigated stratigraphically, because it is widely distributed in Japan and contains abundant marine fossils in various horizons. Petrographically speaking, however, this system has been almost neglected concerning the determination of the mineral composition, although such investigation is very necessary from various geological standpoints.

In the sedimentary peterography of the Chichibu System, it would be very interesting to confirm the problem whether there were igneous activities prior to its deposition or not. With regard to such geological subjects, the Usuginu conglomerate was discussed some years ago. This conglomerate has many granite pebbles, large or small, and is supposed by T. Kobayashi[1] to have been accumulated as a delta deposit. The thin sections of these pebbles were examined by H. Yamada[2] under the microscope. According to his opinion, they are normal types of granite which are quite different from those younger than the Chichibu System, but it is still unknown from where such pebbles were supplied.

From February of 1952, one of present writers (T. Ichimura) started his peterographical work on the specimens of sandstone collected from several horizons of the Chichibu System exposed extensively in the Hannō-Agano-Shōmaru district, and another writer (H. Matsubayashi) co-operated in his laboratory work. The same area was already investigated stratigraphically by R. Morikawa[3] and Huzimoto,[4] and all specimens were

1) T. KOBAYASHI, "Nihonchihōchishitsushi" (General remarks), (1951), 39.
2) H. YAMADA, *Jour. Geol. Soc.*, **45** (1938), 688-693.
3) R. MORIKAWA and R. ENDŌ, *Jour. Geol. Soc.*, **56** (1950), 291.
,, ,, , *Jour. Geol. Soc.*, **58** (1952), 187-190.
4) H. HUZIMOTO, *Sc. Rept. T. B. D., Sect.* C, **1** (1936), No. 4, 172-178.

obtained from the beds assigned by them to the Permian. From the microscopical investigations of thin sections cut from sandstones and

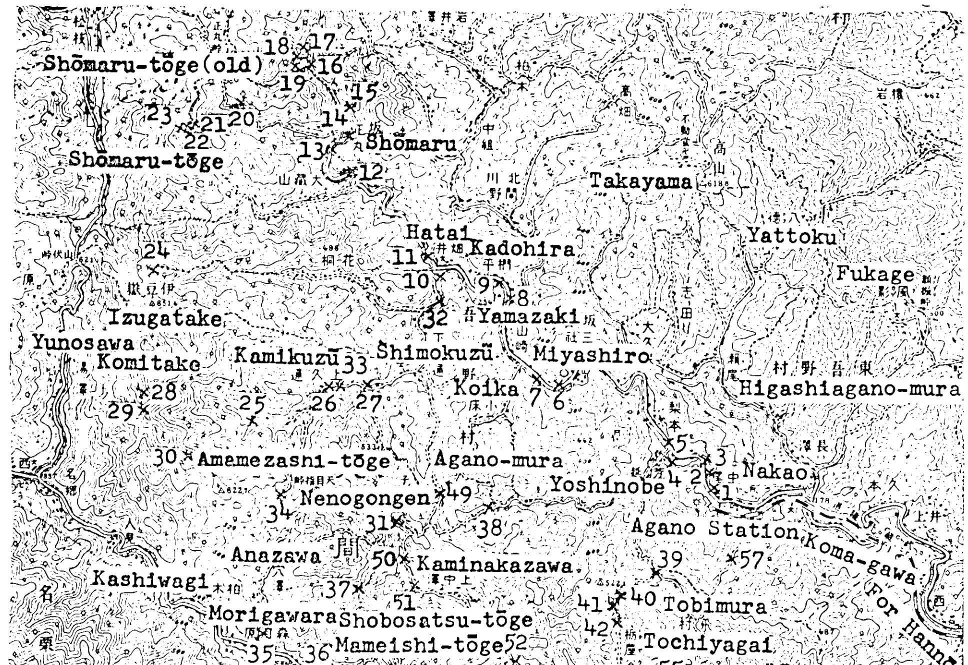

Fig. 1. Map showing the location where the specimens of sandstones were collected.

heavy minerals separated by their mechanical analyses, it was proved that igneous activities also took place before the deposition of the Chichibu System in this district. They are partly represented by granitic intrusions similar to those shown by the Usuginu conglomerate.

The writers are deeply indebted to Mr. R. Morikawa for his many useful suggestions during their field and laboratory works.

General Features.

It is necessary to give a short description of the area where sandstones were collectcd before the writers explain the various characters of these specimens. The district under consideration is interposed between the Koma-gawa and Nakuri-gawa and is easily accessible from Agano or Hannō of the Musashino Railway Line. It is a mountainous area extending from northwest to southeast along the backbone ridge passing through Shōmaru Pass, Izugatake, Komitake, Amamezashi Pass, Nenogongen, Mameishi Pass, etc. The highest peak here is called Izugatake, about two kilometers to the south of Shōmaru Pass, and rises up to 851.4 meters above sea-level. One of the characteristic topographical features of this area is the abundance of steep ridges due to the predominance of siliceous sediments. This is indicated clearly by Izugadake, Komitake and others (Figs. 1–2).

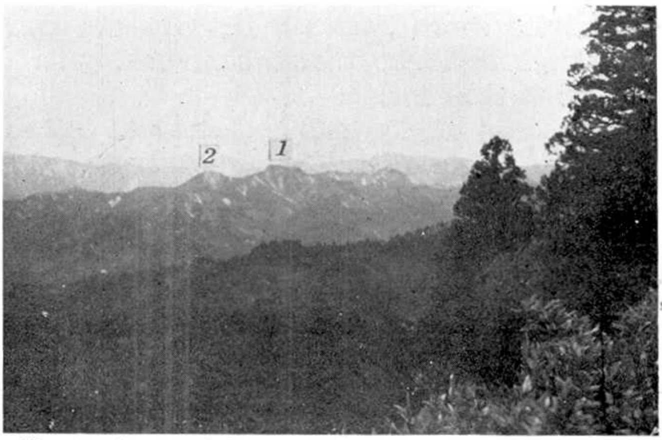

Fig. 2. A part of the mountainous area under consideration viewed from Takayama. 1=Izugadake, 2=Komitake.

The Chichibu system exposed here is composed of chert, schalstein, clayslate, shale, sandstone, limestone and conglomerate. The beds of these rocks were subjected to intense folding and faulting and show varying strikes and dips from place to place. Such a feature is commonly seen in chert beds here and there. They have, however, a general strike of N 40°–60° W and are repeatedly folded with large anticlinal or synclinal structures.

Of these sediments, chert is most extensively exposed in close association with schalstein and limestone. They are frequently intercalated by sandstone and clayslate or shale. Sandstone seems to occur in several horizons and is occasionally found together with clayslate or shale, but the same bed has a tendency to be not traceable for a long distance. Ample exposures of this rock may be seen along the bus road between Agano and Shōmaru Pass as well as in the area including Izugadake, Amamezashi Pass, Nenogongen, Kaminakazawa, etc. In these cases, some sandstone beds are 150 meters or more in the thickest part. The occurrence of limestone is also known in many places, assuming mostly a lenticular form in alternated beds of chert and schalstein. The largest mass is now mined on the ridge behind the Agano Station for the purpose of cement industry. It is very noteworthy that the limestone of this area contains *Schwagerina*, *Neoschwagerina*, *Pseudoschwagerina* and *Yabeina*. Such *Fusulina*-bearing limestones are divided by Morikawa[5] into five zones, viz., (i) *Yebeina* zone (Kamikuzū, Yoshinobe, Tennō-zan, Nitayama Pass, etc.), (ii) *Neoschwagerina* zone (Asamido), (iii) *Schwagerina tschernyschewi* —*S. kraffti* zone (Nakao, Nenogongen, etc.), (iv) *Schwagerina vulgaris* zone (Koika, Shōmaru Pass, Shimokuzū, Tobimura, etc.) and (v) *Pseudoschwagerina* zone (Kamikuzū, Old Shōmaru Pass, etc.). From such a paleontrogical evidence, the sandstone-bearing formation of this district is assigned to the Permian.

Moreover, conglomerate is exposed on the river bed of Shimokuzū, 1 kilometer south of Hatai. It consists of abundant limestone pebbles and schalstein-like matrix. Morikawa[6] obtained many fossils from these pebbles with a greyish white or black color. They are *Pseudoschwagerina* sp., *Schwagerina vulgaris*, *S. tschernyschewi* *S. kraffti*, *Parafusulina japonica* var. *hayasakai*, *P. kairimizuensis*, *Nagatoella fujimotoi*, *Mizza velebitana* and *Pleurotomaria* sp.

Distribution and Structure of Sandstone Beds.

The Chichibu System of this district is intensely folded and repeats anticline or syncline whose axis extends from northwest to southeast or west-northwest to east-southeast. The distribution of sandstone beds here depends upon such geological structure, and the same beds are repeatedly exposed.

One of these beds is traceable along the axis of anticline which seems to pass through Yunosawa, Amamezashi Pass, Kaminakazawa and

5) Personal communication by R. MORIKAWA.

6) R. MORIKAWA, *op. cit.*, 1952, 187-190.

Shimonakazawa. It appears on each wing and respectively show a steep inclination northeastwards.

By proceeding eastwards, there is also found a remarkable sandstone bed almost parallel to the exposures mentioned above. It can sporadically be followed from Kamikuzū to Tobimura and is supposed to be of a more upper horizon.

Such sandstone bed reappear along the Komā-gawa beyond the axis of syncline which stretches from Kamikuzū to Yoshinobe. This can be confirmed by the distribution of *Fusulina*-bearing limestones in this area. They are amply exposed on the bed of the Koma-gawa and the cutting of the bus road between Agano and Shōmaru Pass, forming here an anticline which again passes into a syncline in the adjacent area.

Moreover, minor exposures are observed here and there at Morigawara, Nittachi, Tochiyagai, Nakauchi, Arata, Mameishi Pass, etc.

Megascopical Characters of Sandstones.

Sandstone is one of predominant sediments of the Chichibu System in this district. It is generally represented by fine or medium-grained sandstone with a gray or black color in fresh specimens. The sandstone here is so hard and compact that it can not easily be crushed by a hammer.

Megascopically, most of the specimens are rich in quartz and feldspar, containing small fragments of black clayslate with or without regular arrangement. There are also some specimens intercalated with thin layers of clayslate and traversed by calcite veinlets. Through weathering, such sandstones obtain a yellowish brown color and is frequently stained with iron oxides.

Mineral Components and Rock-fragments in Sandstones.

Fifty seven specimens of sandstone (Fig. 1) were mechanically analysed to find out how many kinds of heavy minerals are contained in them. Moreover, each of these specimens was examined under the microscope by using thin sections. Both microscopical investigations and mechanical analyses indicate that the sandstone of the Chichibu System consists of quartz, orthoclase, microcline, plagioclase, biotite, calcite, glauconite, muscovite, sericite, allanite, anatase, augite, epidote, garnet, hornblende, hypersthene, ilmenite, limonite, magnetite, pyrite, pyrrhotite, rutile, titanite, zircon and zoisite.

Of these minerals, quartz is alway present abundantly, occurring as angular pieces, large or small, which occasionally show a wavy extinction.

They are filled up by arenaceous substances, and there are some grains penetrated by calcite veinlets.

The next predominant components are feldspars represented by orthoclase, microcline and plagioclase. So far as is known at present, orthoclase is found in almost all specimens examined by the writers, but is found with less frequency as compared with plagioclase. It is characterized by the abundance of perthite.

Microcline is partly microcline-perthite and usually occurs in a minor amount. It is absent in some specimens.

Plagioclase is, on the other hand, to be seen in all thin sections and ranges from albite to labradorite.

In these cases, feldspars have mostly a fresh appearance, although they are sometimes sericitized and invaded by calcite.

One of the important minerals is indicated by biotite whose occurrence is confirmed in all thin sections and by mechanical analyses. It is strongly pleochroic from light yellow (X) to dark brown (Y and Z) or light yellow (X) to reddish brown (Y and Z). The crystal is generally twisted and often takes an irregular form. Chlorite is an alteration product of this mineral.

Calcite is a secondary mineral derived from plagioclase or other calcareous sources. It is particularly abundant in the specimens collected at Shimonakazawa.

Glauconite is a very rare component found only in the sandstone which is exposed at Miyashiro and Kadohira. It has a bright green color and reveals an aggregate polarization.

Sericite flakes are contained in feldspars and feldspathic matrix and are more conspicuous than platey muscovite. Muscovite is commonly seen in the specimens from Shōmaru, Shōmaru Pass, Nenogongen, Nittachi, Arata, Tochiyagai, etc.

Allanite is rarely found in the sandstones exposed at Yoshinobe, Miyashiro, Kadohira, Hatai, Shōmaru, etc. It takes an irregular form and is strongly pleochroic from light brown to dark brown or dark reddish brown.

Anatase is only known in the specimens from Miyashiro, Kadohira and Hatai. The mineral has an indigo-blue color and is weakly pleochroic.

Augite is also rare and occurs in a prismatic or irregular form. It has a light green color and weak pleochroism. The crystal is noticed in the specimens from Shōmaru Pass, Amamezashi Pass, Morigawara, Kunehana, etc.

Epidote is a noteworthy mineral with a yellow or greenish yellow color. It is weakly pleochroic and indicates a bright interference color. The crystal shows high frequency in the specimens from Nakao, Miyashiro, Hatai, Shōmaru, Morigawara, Nittachi, Nenogongen, Tochiyagai, Shimo-nakazawa, Nakauchi, etc.

Besides epidote, one of the important heavy minerals is garnet. The most pre-dominant is colorless or of a pink variety. There is also another kind of this mineral with a light reddish brown or a reddish brown color. Such different types of garnet are almost free of optical anomaly. In all specimens, garnet usually occurs as rounded or angular grains, but beautiful rhombic dodecahedron or combination of icositetrahedron and rhombic dodecahedron is respectively shown in the specimens from the ridge between Shōbosatsu Pass and Nenogongen as well as from Miyashiro.

Hornblende and hypersthene are unimportant components. The former is a green variety with a somewhat bluish shade, showing such a pleochroic scheme as light yellow (X), green or yellowish green (Y) and bluish green (Z), whereas the latter is pleochroic from yellow (X) to brownish yellow (Y) or greyish green (Z). Both minerals have a prismatic or irregular form.

Magnetite and ilmenite are generally associated together, the latter being more abundant than the former. In this case, ilmenite passes into leucoxene on its surface. Hematite is very scarce, but limonite is an abundant secondary mineral.

Pyrite is present in most specimens. It is found in oolitic aggregates or single grains and is exceedingly plentiful in some specimens. This mineral is supposed to have been in close association with the deposition of sandstones. Pyrrhotite is, on the other hand, contained scantily only in two specimens.

Rutile is not widely distributed, but it is occasionaly seen in the specimens from Hatai and the ridge between Komitake and Amamezashi Pass. Mostly, the mineral occurs as rounded grains or angular fragments, although there are some prismatic crystals. Rutile has a reddish brown or yellowish brown or light yellow color and is weakly pleochroic, being characterized by the high index of refraction and adamantine luster.

Titanite is a common mineral in most specimens. It is, however, always found in low frequency, and there are some varieties different in color, ranging from nearly colorless to light brown or brownish yellow under the microscope. Of these, the brownish varieties are weakly pleochroic from colorless to light yellowish brown. The crystal generally has an irregular form. Moreover, it is very high in its index of refraction and birefringence.

The presence of tourmaline is known in many specimens. It is particularly noticeable in those collected from Shōmaru, the ridge between Komitake and Amamezashi Pass, Amamezashi Pass, Nenogongen, Kaminakazawa, Shimonakazawa, Agano, Kunehana and Arata. The crystal takes mostly a granular or fragmental form, although some of it has a stout prismatic habit. The mineral is strongly pleochroic with varying absorption color., (i) X=light brown, Z=brown: (ii) X=light blue, Z=blue: (iii) X=light bluish grey, Z=greyish blue: (iv) X=reddish brown, Z=dark brown: (v) X=yellowish brown, Z=dark brown, etc.

Zircon is an important heavy mineral with a prismatic or granular form. It is represented by the colorless or purple variety. The former is more abundant than the latter. When the crystal is well preserved, zircon has a stout or slender prismatic form, occurring usually in such

Table I. Mineral components and

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Quartz	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Microcline			×			×	×	×			×	×	×	×	×	×	×	×	×	×	×		×	×
Orthoclase	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Plagioclase	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Biotite				×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Calcite	×	×	×	×			×		×	×														
Chlorite	×			×	×	×			×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Glauconite						×		?	×															
Sericite (muscovite)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Allanite				×	×	×	×	?	×		×				×						×			
Anatase						×		×			×													
Augite																					×		×	
Epidote	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	×	×
Colorless garnet	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Light reddish brown or reddish brown garnet			×	×	×	×	×	×		×	×		×	×		×	×		×	×	×	×	×	×
Pink garnet	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×
Hornblende					×																			
Hypersthene		×		×						×				×				×			×	×	×	
Limonite	×		×		×	×	×	×	×		×	×	×			×	×	×	×	×	×	×		×
Magnetite (ilmenite, hematite)	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	×		×	×
Pyrite	×	×	×	×	×		×		×	×	×			×					×	×				×
Pyrrhotite					×	×					×													
Rutile			×											×		×					×			
Titanite	×	×	×	×	×	×	×	×	×		×	×	×	×		×	×		×	×	×	×	×	×
Tourmaline				×	×	×	×		×		×			×	×	×	×	×	×		×	×		×
Colorless zircon	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Purple zircon		×	×	×	×	×	×	×	×	?	×	×	×	×	×	×	×	×	×	×	×	×		
Zoisite		×												×										
Chert	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Schalstein	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Clayslate	×	×		×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Crystalline schist								×										×						×

combinations as (100), (110); (111), (110), (100); and (110), (111), (100), (311). Among these combinations, the first two are commonly observed. Purple zircon is commonly rounded except that contained in the specimen of Shōmaru. Sometimes, it encloses small prismatic or granular crystals with indistinct characters. Zoisite is a negligible component.

Besides component minerals mentioned above, the sandstones of the Chichibu System contain many angular pieces of schalstein, chert, clayslate and crystalline schist. Of these, the most abundant is black clayslate of a microscopical or megascopical size. Exclusive of such crystalline schists as graphite schist, graphite quartz schist, quartz schist, sericite schist, etc., they are found in almost all specimens investigated by the writers.

Mineral components and rock-fragments contained in sandstone under consideration are summarized in the following table.

rock-fragments in sandstones.

(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)	(55)	(56)	(57)
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Localities of sandstones in the preceeding table.

		Village	District	Prefecture
(1)	Nakao,	Agano-mura,	Iruma-gun	Saitama
(2)	〃 ,	〃	〃	〃
(3)	〃 ,	〃	〃	〃
(4)	Yoshinobe,	〃	〃	〃
(5)	〃 ,	〃	〃	〃
(6)	Miyashiro,	〃	〃	〃
(7)	〃 ,	〃	〃	〃
(8)	Kadohira,	〃	〃	〃
(9)	〃 ,	〃	〃	〃
(10)	Hatai,	〃	〃	〃
(11)	〃 ,	〃	〃	〃
(12)	Shōmaru,	〃	〃	〃
(13)	〃 ,	〃	〃	〃
(14)	〃 ,	〃	〃	〃
(15)	〃 ,	〃	〃	〃
(16)	Shōmaru—Shōmaru Pass,	〃	〃	〃
(17)	〃 ,	〃	〃	〃
(18)	〃 ,	〃	〃	〃
(19)	〃 ,	〃	〃	〃
(20)	〃 ,	〃	〃	〃
(21)	〃 ,	〃	〃	〃
(22)	〃 ,	〃	〃	〃
(23)	〃 ,	〃	〃	〃
(24)	Izugatake,	Agano-mura—Nakuri-mura	〃	〃
(25)	Kamikuzū,	Agano-mura	〃	〃
(26)	〃 ,	〃	〃	〃
(27)	〃 ,	〃	〃	〃
(28)	Izugatake—Amamezashi Pass,	Agano-mura—Nakuri-mura	〃	〃
(29)	〃	〃	〃	〃
(30)	〃	〃	〃	〃
(31)	Nenogongen,	Agano-mura	〃	〃
(32)	Hatai,	〃	〃	〃
(33)	Kamikuzū,	〃	〃	〃
(34)	Amamezashi Pass,	Agano-mura—Nakuri-mura	〃	〃
(35)	Morigawara,	Nakuri-mura	〃	〃
(36)	Nittachi,	〃	〃	〃
(37)	Shōbosatsu Pass—Nenogongen,	Agano-mura	〃	〃
(38)	Nenogongen—Yoshinobe,	〃	〃	〃
(39)	Yoshinobe—Tochiyagai,	〃	〃	〃
(40)	Tochiyagai,	〃	〃	〃
(41)	〃 ,	〃	〃	〃
(42)	〃 ,	〃	〃	〃
(43)	Shimokuzū—Nakauchi,	Agano-mura—Furuichiba-mura	〃	〃
(44)	Nakauchi,	Furuichiba-mura	〃	〃
(45)	Kunehara,	〃	〃	〃
(46)	Arata,	〃	〃	〃
(47)	〃 ,	〃	〃	〃
(48)	Koika—Nenogongen,	Agano-mura	〃	〃
(49)	Nenogongen—Kaminakazawa,	〃	〃	〃
(50)	Kaminakazawa,	〃	〃	〃
(51)	Kaminakazawa—Shimonakazawa,	〃	〃	〃
(52)	Kaminakazawa—Shimonakazawa,	〃	〃	〃
(53)	Shimonakazawa,	〃	〃	〃
(54)	Tochiyagai,	〃	〃	〃
(55)	〃 ,	〃	〃	〃
(56)	Shimonakazawa,	〃	〃	〃
(57)	Agano,	〃	〃	〃

Sources of Mineral Components.

So far as is known at present, sandstones of this area have various mineral components, differing somewhat from place to place. There is, however, no characteristic mineral which is stratigraphically important to distinguish minerallogically the horizons of sandstone beds.

Of several kinds of light mineral, feldspars are found in almost the same frequency as quartz grains. On of the striking features indicated by thin sections is the abundance of perthite. This intergrowth can be seen even in microcline crystals, suggesting that they were supplied from granitic rocks together with some plagioclase and other microcline crystals. Moreover, this fact is proved by the occurrence of many fragments with a micropegmatitic or micrographic texture and biotite flakes as well as of titanite and allanite. Quartz is believed to have derived partly from such siliceous rocks as granite, granodiorite, granite porphyry and quartz porphyry. It is also noteworthy that there are rounded quartz grains subjected to magmatic corrosion. Some of the rock-fragments evidently resemble intrusive feldspathic rocks. Among various heavy minerals, anatase may have its source in quartz porphyry.

As to garnet, it is represented by several varieties with different colors and it is not clear what kinds of rock they were originally contained in. It is, however, conceivable that there are some garnets drived from the contact aureole between calcareous rocks and granites, because epidote crystals are always found together with them in almost all specimens of sandstone. Similarly, clayslate, shale and sandstone within the contact aureole may be the source of tourmaline crystals, although it is likely to occur in granite and its pegmatite as well as in granitic contamination rocks.

As to hornblende, it is uncertain whether this mineral was furnished from igneous rocks or not, but hypersthene has occasionally well-defined crystal forms and is supposed to have been an ingredient of such volcanic rocks as andesite.

Rutile seems, on the other hand, to have been supplied from metamorphic rocks. On this point, the presence of garnet affords an important clue to the source of rutile.

Possibilities of Igneous Activities prior to the deposition of the Chichibu System.

The sandstones exposed here mostly indicate a high frequency of mineral components which are commonly seen in granitic rocks, suggesting that there were some granitic intrusions before the sedimentation of the Chichibu System of this district.

The distribution of such plutonic rocks is, however, quite unknown in any part of present Japan, as has been already stated by Yamada[7] on the sources of granite pebbles contained in the Usuginu conglomerate. Moreover, all kinds of granitic rock in Japan are now believed to be younger than the Chichibu System, but it is conceivable that older granitic rocks had once been exposed somewhere in the area which disappeared later by folding and faulting. The angularity and fresh appearance of mineral components mentioned above may be an evidence that the exposures of granitic rocks were not very far from the geosyncline where the deposition of the Chichibu System took place. From such evidences, it is also inferrable that these granitic rocks subsided to the bottom of the Japan Sea. Yamada[2], however, formerly attributed their sources to granitic rocks of the continent.

The possibility of igneous activities are, furthermore, supported by the presence of corroded quartz and hypersthene as well as of augite. They are likely to have been contained in such igneous rocks as quartz porphyry, liparite, dacite and andesite. The frequent occurrence of schalstein-fragments in sandstone is also an important evidence of volcanic activities.

Summary.

1) The Chichibu System exposed in this area is composed of chert, schalstein, limestone, conglomerate, sandstone, shale and clayslate. Of these, the most predominant are chert and schalstein.

The Chichibu System here was intensely subjected to folding and faulting. It has, however, a general strike of N 40°–60° W, repeating large anticlinal or synclinal structures.

2) For the purpose of ascertaining the mineral components of sandstone, many specimens of this rock were collected from various places of the area including Hannō, Agano and Shōmaru Pass. They were determined by microscopical investigations of thin sections and heavy minerals separated by mechanical analyses.

3) So far as is known at present, these sandstones contain such minerals as quartz, orthoclase, microcline, plagioclase, biotite, calcite, glauconite, allanite, anatase, augite, epidote, garnet, hornblende, hyper-

7) H. YAMADA, *op. cit.*, 692–693.
8) ,, *op. cit.*, 693.

sthene, ilmenite, limonite, magnetite, pyrite, pyrrhotite, rutile, sericite (muscovite), titanite, zircon and zoisite.

4) Such mineral components are characterized by the frequent occurrence of orthoclase (abundant in perthite), microcline, microcline-perthite and fragments with a micropegmatitic or micrographic texture, as well as of titanite and allanite. These minerals are supposed to have been supplied from granitic rocks.

5) The sources of corroded quartz grains, hypersthene and augite may be quartz porphyry, liparite, dacite and andesite.

6) It is also noteworthy that most of the sandstones are frequently rich in angular pieces of schalstein.

7) Judging from these evidences, it is quite possible that there were granitic intrusions and other volcanic activities prior to the deposition of the Chichibu System of this district. The angularity and fresh appearance of mineral components seem, furthermore, to suggest that their sources had not been very far from the geosyncline where the sedimentation of the Chichibu System took place. It is, however, still obscure whether such sources existed really in Japan or in the area now covered by the Japan Sea or elsewhere. This is an important problem awaiting solution.

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14. 秩父系堆積前の火成活動

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飯能から吾野及正丸峠に跨る山岳地域には，チャート，輝緑凝灰岩，石灰岩，粘板岩，頁岩など丶共に砂岩を伴う秩父系が広く露出している．これ等の中，各産地から採取した砂岩に就き，薄片及機械分析によって分離した重鉱物の顯微鏡的研究を行った結果，火成岩に根源を有する種々の鉱物を含むことが分った．殊にパーサイト，マイクロクライソパーサイト，微ペグマタイト狀或は微文象狀組織を有する破片，黒雲母，榍石，褐廉石などを屢々含むことは，砂岩の材料が花崗岩及花崗閃緑岩の如き酸性深成岩及その関係岩類から供給されたことの証據であり，又融蝕された石英の結晶，形態の整つた紫蘇輝石などの存在は，前者が石英斑岩，石英粗面岩，石英安山岩などの何れかの斑晶であったこと丶，後者が安山岩の如き火山岩の鉱物成分だったことを物語るものである．

以上の事実から判断して，此地域に露出する秩父系の堆積以前には火成活動，特に花崗岩質深成岩の貫入があったことが想像されるし，更に他方では石英斑岩，石英粗面岩，石英安山岩の様な石英斑晶を有する火成岩や安山岩などが露出していたことも，輝緑凝灰岩が示す如き火山活動も考えられる．然も各鉱物が比較的新鮮であり，且つ甚しく角立っている点は，秩父系が堆積した地向斜から余り遠くなかった処からこれ等の材料が供給された場合を暗示する様に思われる．たゞし斯る材料の根源が日本の何処にあったか，それとも今日の日本海によって占められる丶地域にあったかに就ては，未だに不明な点が多く，それらは今後詳細な研究を要する重要な問題である．