Conglomerate of the Karaumedate Formation in the Kitakami Massif, Northeast Japan

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Abstract

The gravels contained in the Karaumedate Formation (Carboniferous) are described and discussed as to depositional environment and stratigraphical value.

INTRODUCTION AND ACKNOWLEDGMENTS

A large dome structure, named the Motai Dome, is developed at the northwestern margin of the southern part of the Kitakami Massif. The core of the dome consists of low-grade metamorphic rocks of the Motai Group. Non-metamorphosed Paleozoic formations, ranging from Late Devonian to Late Permian in age, are developed successively southward of the Motai Group. Many problems on the stratigraphy still remain concerning these Paleozoic formations. Among the problems, the "pre-Karaumedate unconformity" and the conglomerate of the Lower Carboniferous Karaumedate Formation are important for the Carboniferous stratigraphy and tectonics in the Kitakami Massif. Recently, the writers had the opportunity to study the Karaumedate Formation stratigraphically and sedimentologically. In the present article, the results of stratigraphical study on the Karaumedate Formation and observations on the petrography and sedimentology of the conglomerate in the formation are described. As the result, the Karaumedate Formation may be considered to be composed of deltaic sediments which were supplied from the north.

Before going further, the writers offer their cordial thanks to Professor Kotora Hatai of the Institute of Geology and Paleontology, Tohoku University, for his kind guidance and suggestions during the course of the present work. They are indebted to Dr. Yoshio Onuki of the Hase Geological Survey Office, and Mr. Minoru Sumita, Chief Prospecting Engineer of the Akagane Mining Station of the Dowa Mining Co. Ltd., for their kind suggestions on the stratigraphy of the Paleozoic formations in the Nagasaka District. Acknowledgments are due to Messrs. Kimiji Kumagai, Akio Ishikawa, Shohei Ohtomo and Masa-aki Shishido, and Mrs. Kimiko Shibuya of the Institute of Geology and Paleontology, Tohoku University, for their help during the present work.

STRATIGRAPHY OF THE KARAUMEDATE FORMATION

The stratigraphy of the Paleozoic formations distributed in the Nagasaka District was studied by Noda (1934), Tachibana (1952a, b) and Onuki *et al.* (1962), and summarized by Onuki (1969) as follows: –

Permian	Toyoma Formation Yamazaki Conglomerate Rodai Formation Nishikori Formation

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	~~ Unconformity ~~~~~~
Middle Carboniferous	Takezawa Group
	~~ Unconformity ~~~~~~
Lower Carboniferous	Karaumedate Formation
	~~ Unconformity ~~~~~~
Upper Devonian	Tobigamori Formation
	~~ Unconformity ~~~~~~
Pre-Upper Devonian	Motai Group

TOBIGAMORI FORMATION (Noda, 1934)

The Tobigamori Formation is distributed in the northern margin of the Nagasaka District, and consists mainly of dark gray slate. This formation attains about 800 to 1800 meters in thickness, but the exact thickness is unknown because of the obscure stratification. Thin lenses of andesitic tuff and tuffaceous conglomerate, named the Natsuyama Conglomerate (Tachibana, 1952a) or Natsuyama-type Pseudoconglomerate (Kano and Takahashi, 1958; Kano, 1960) are intercalated in several horizons of this formation.

The age of the Tobigamori Formation was first determined paleontologically by the occurrence of *Cyrtospirifer yabei* Noda and Tachibana, which was reported by Yabe and Noda (1933) as *Spirifer verneuili* Murchison. Including *Cyrtospirifer*, this formation yielded abundant brachiopods, pelecypods and plants. The geological age of this formation is now considered by Hayasaka and Minato (1954) and Tachibana (1955) to be Frasnian -Famennian (Upper Devonian).

KARAUMEDATE FORMATION (Tachibana, 1952a)

This formation is developed along the southern margin of the Tobigamori Formation. The Karaumedate Formation is composed of medium to coarse grained tuffaceous sandstone and sandy slate intercalated with lenticular pebbly conglomerates, and measures nearly 550 meters in thickness.

The Karaumedate Formation yielded abundant brachiopods, pelecypods and plant fossils, including *Kitakamithyris*, *Syringothyris* and *Lepidodendoron*. On the basis of the fauna and flora, Tachibana (1952b, 1956) considered the geological age of this formation to be Lower Carboniferous.

The stratigraphical relation between the Tobigamori and the Karaumedate formations has been disputed by some authors. Okubo (1951) maintained an angular unconformity on the basis of the basal conglomerate and the difference of bedding, the Karaumedate Formation being N10°E, 50°NW at about one kilometer northwest of Natsuyama, Higashiyama-cho, Higashi-Iwai-gun, Iwate Prefecture, and that of the Tobigamori Formation, N60°W-N70°E, 38°–68°S. His opinion was accepted by Minato (1965) and Onuki (1969), however, Tachibana (1952a) doubted the pre-Karaumedate unconformity because the basal conglomerate of Okubo (1951) was a lenticular conglomerate between them. This problem will be discussed because many evidences of this study deny Okubo's (1951) opinion.

The Karaumedate Formation is covered by the Takezawa Group of Tachibana (1952), which consists of calcareous black slate and thick limestone with tuff layers. The Takezawa Group corresponds from paleontological evidence to the Viséan-Namurian in age. The stratigraphical relation between the Karaumedate Formation and the Takezawa Group is also subjected to question, but being out of scope of the present article, remarks will be reserved for another opportunity.

CONGLOMERATE OF THE KARAUMEDATE FORMATION

Stratigraphical Position and Occurrence

The lenticular conglomerate of the Karaumedate Formation is developed conspicuously in the Nanatsumori Area, about three kilometers northeast of Sarusawa, Daito-cho, Higashi-Iwai-gun, Iwate Prefecture, as shown in Figs. 1, 2. The Karaumedate Formation in this area is intercalated with more than five horizons of lenticular conglomerates. The thickness of the lenticular conglomerates is from 25 to 1.5 meters and decreases upwards from the base. The size of the pebbles is about one to three centimeters in general, the largest one measured about four centimeters in diameter. The diameter of the pebbles shows a slight decrease by horizon from the base upwards in good correspondence with the upward decay in thickness.

The conglomerates become thin to the east and westwards rapidly, and occur sporadically at Toriumi in the east of Sarusawa Area, and Karaumedate and Natsuyama

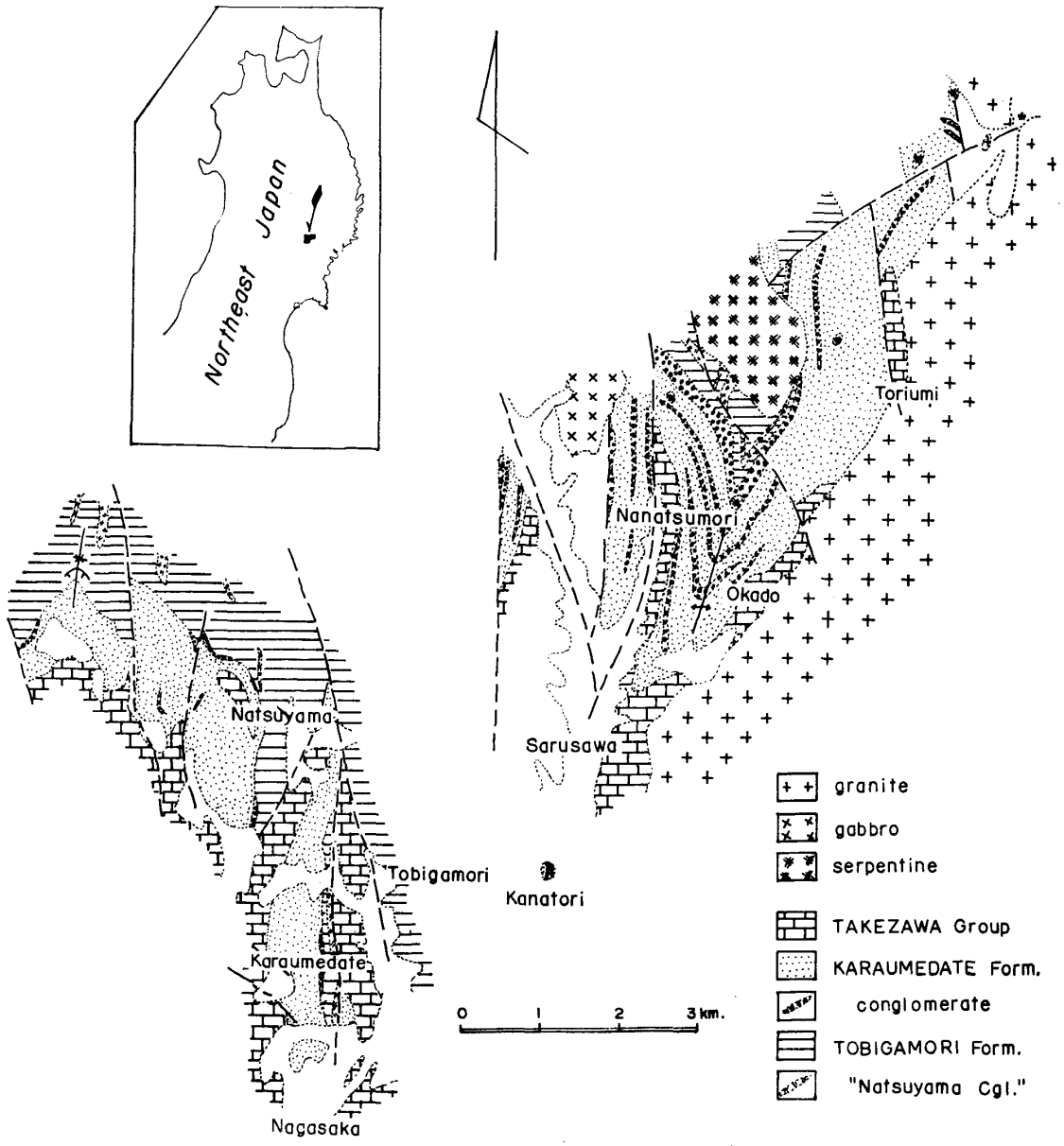

Fig. 1. Distribution of the Karaumedate Formation.

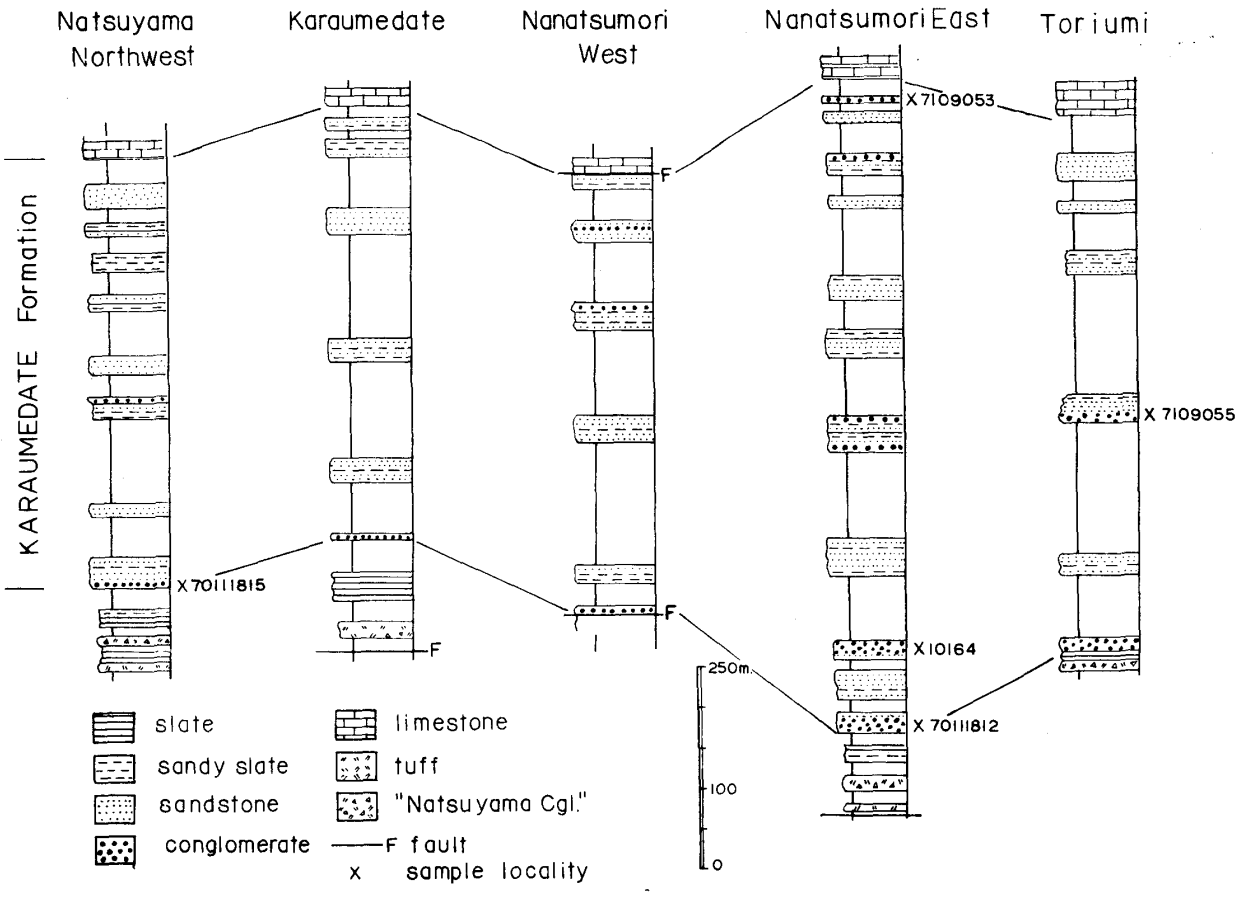

Fig. 2. Columnar sections of the Karaumedate Formation.

in the west of the Nagasaka District. The conglomerate, which was considered to the basal conglomerate of the Karaumedate Formation by Okubo (1951) at the northwest of Natsuyama, is one of the lenticular conglomerates, about seven meters thick and 60 meters in length, as pointed out by Tachibana (1952b). Cross stratification is well developed in the lenticular conglomerates and a coarse grained sandstone of this formation, as shown in Plate 54, figs. 1–3.

Texture and composition

The materials treated in this article were collected in west to east, direction from the northwest of Natsuyama in Higashiyama-cho, Kanetori, east of Nanatsumori, Okado and at Toriumi in Daito-cho, Higashi-Iwai-gun, Iwate Prefecture. They are from different horizons extending from the base to the uppermost part of the Karaumedate Formation. Five to ten thin sections of each sample were examined microscopically. The textural and compositional analysis were followed according to Krumbein (1935), Cailleux (1947) and Friedman (1958).

The size of the pebbles in the conglomerate is less than 40 mm in diameter, $-1.5\,\phi$ in mean size, and not sorted, the sorting being 1.3. Most of the pebbles are not in contact with each other. The pebbles are well rounded, but some of them are of subrounded shape (Powers, 1953). The estimated roundness ranges from 0.45 to 0.60 (Cailleux, 1947). Many pebbles are spheroidal, but some are elongated by subsequent compression.

The pebbles of the Karaumedate Formation consist of quartzite, chert (including meta-tuff), porphyroidal rocks, orthoquartzite, granitic rocks, andesite, slate and

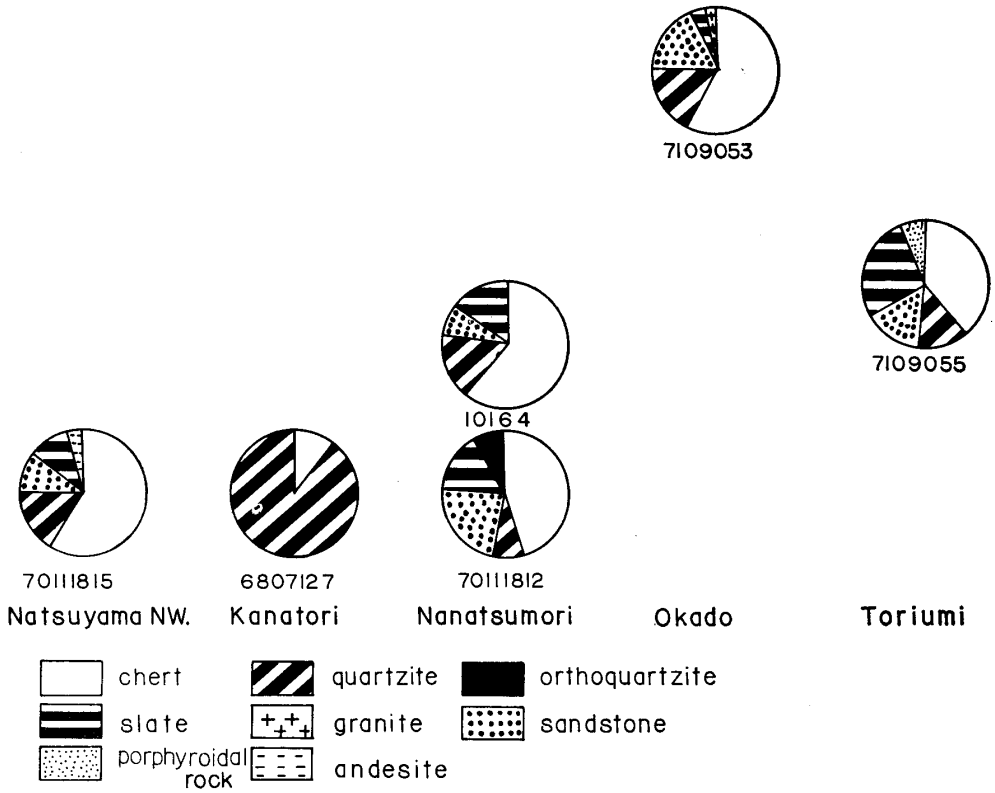

Fig. 3. Composition of pebbles of the Karaumedate Formation.

sandstone. Brief descriptions are as follows;

Quartzite: – Equigranular coarse grained quartz, 0.6–0.5 mm in size, sub-anhedral shape, plane contact, fresh and possessing vacuoles. The quartzite may have originated from a sandstone and/or chert by thermal metamorphism. Quartzite pebbles are common in all of the samples.

Chert: – Microcrystalline and amorphous quartz with a small amount of clay minerals in a pore space, as the clayey microcrystalline quartz of Shoji (1967). No lamination. The chert may be considered to be derived from altered acidic tuff. Chert pebbles are most abundant in the conglomerate of the Karaumedate Formation.

Porphyroidal rocks: – Phenocryst of quartz and feldspars, about 0.5 to 0.8 mm in size, matrix of microcrystalline quartz and a small amount of clay minerals. This rock is considered to be derived from altered clastic sediments. Porphyroidal rocks were collected only from the upper part of the Karaumedate Formation at the northwest of Natsuyama, Higashiyama-cho, Higashi-Iwai-gun, Iwate Prefecture (Pl. 55, fig. 6).

Orthoquartzite: – Detrital quartz essentially, mean size nearly 1.2 ϕ, and cemented by secondary quartz. The original quartz grains are fringed by a dust ring. Pebbles of orthoquartzite were found only in the basal part of the formation at the east of Nanatsumori, Daito-cho, Higashi-Iwai-gun, Iwate Prefecture (Pl. 55, figs. 1, 2).

Granite: – Quartz, feldspars and biotite of equigranular texture. Quartz monocrystalline, dominantly non-undulatory extinction, but contains some weakly undulatory extinction ones. No polycrystal quartz. Feldspars are albite with perthite texture. The pebbles of granite are found very rarely and of small in size, measuring about 8 mm in diameter (Pl. 54, fig. 4).

Andesite: – Pyroxene andesite, not preserved in detail. Andesite was collected from the lower part of the formation at the west of Toriumi only (Pl. 55, fig. 5).

Sandstone and slate: – More or less suffered by thermal effect, but the original texture is well preserved. Pebbles of both rocks are found regularly in all lenses of conglomerate, but in small amount.

The compositions of the conglomerate are characterized by the small amount of igneous rocks, no schistose rocks and dominated by quartzose rocks, as quartzite and chert. Chert pebbles are contained in about 50% at the localities. Quartzite is about 15%. The concentration ratio of the sandstone and slate pebbles is varied, ranging from 1 to 27%, and in average about 12%.

Table 1. Composition of the pebbles of the Karaumedate Formation.
(percentage is based upon number of pebbles per one square meter quadrant)

	Natsuyama NW	Kanetori	Nanatsumori		Okado	Torinoumi
			(701118–12)	(1916–4)		
Chert	59.2%	10.1%	46.1%	61.3%	58.9%	37.2%
Quartzite	17.0	89.8	7.7	15.4	17.6	12.8
Sandstone	10.1	-	23.0	7.7	17.6	15.4
Slate	10.1	-	15.4	15.4	3.9	26.9
Granite	-	-	-	-	1.8	-
Orthoquartzite	-	-	7.7	-	-	-
Andesite	-	-	-	-	-	7.7
Unknown	3.5	-	-	-	-	-
	N=59	N=36	N=13	N=13	N=59	N=39

The matrix of the conglomerates is of medium grained arkosic sandstone and partly slaty. Grains of sandstone are quartz, feldspars mica and fragments of chert, slate, quartzite and clayey rocks and opaque minerals, being subangular to subrounded in shape (Powers, 1953). Parameters of their grain size distribution are estimated as the mean size 2.3 ϕ, sorting 1.4. Composition of the matrix of sandstone is quartz 15.8%, feldspars 40.0%, others 26.0% and matrix (under 5 ϕ) (Okada, 1968) 18.0%. (Pl. 55, fig. 3).

CONSIDERATIONS ON THE CONGLOMERATE

The depositional environment of the conglomerates in the Karaumedate Formation may be considered to be deltaic based on texture, lenticular shape, and their stratigraphical and geographical distributions. The occurrence of many plant fragments from the sub- and superjacent strata of the conglomerates may support this consideration. Although complete restoration of the depositional basin of the Karaumedate Formation is impossible, the stratigraphical and geographical developments of the conglomerates suggest that the sediments may have been supplied from an area north of Nanatsumori.

The pebble of the orthoquartzite found in the Karaumedate Formation is a new datum on the stratigraphy of the Kitakami Massif. Recently, many pebbles of orthoquartzite have been recorded from different geological ages by Tokuoka (1967, 1970), Kishu Shimanto Research Group (1968), Adachi 1971, Shibata *et al.* (1971) and Okami (1973), who consider that the pebbles may be derived from the Pre-Cambrian or pre-Silurian rocks, because no orthoquartzite has been found from the sediments younger than the Silurian in Japanese Islands. If it is ture, a Pre-Cambrian terrain may have been exposed in the hinterland of the Karaumedate Formation during the deposition as the provenance.

The composition of the pebble assemblage of the Karaumedate Formation differs from that of the "Natsuyama Conglomerate" of the Tobigamori Formation. The "Natsuyama Conglomerate" is a basaltic volcanic conglomerate with pebbles of hornblende quartz schist, epidote hornblende quartz schist, epidote chlorite schist, diabase schist, epischalstein, mylonite, chert, sandstone, diabase, porphyrite and porphyroid (Suzuki and Minato, 1946; Kano and Takahashi, 1958). Some problems on the origin of these schistose pebbles still remain, however, the source of the "Natsuyama Conglomerate" is quite different from that of the conglomerates of the Karaumedate Formation.

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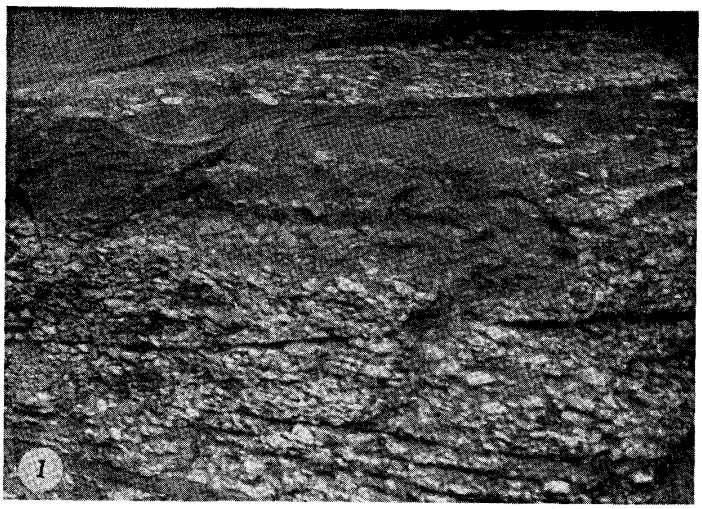
Plate 54

Figs. 1–3. Cross stratification in the conglomerate of the Karaumedate Formation at Nanatsumori, Daito-cho, Higashi-Iwai-gun, Iwate Prefecture.

Fig. 4. Enlarged view of a sample, no. 71090503, × 1.5, collected from the upper part of the Karaumedate Formation at Okado, Daito-cho, Higashi-Iwai-gun, Iwate Prefecture.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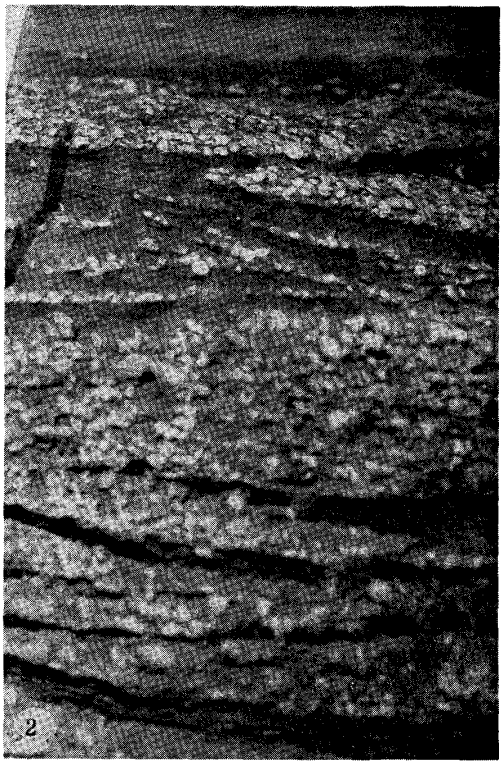
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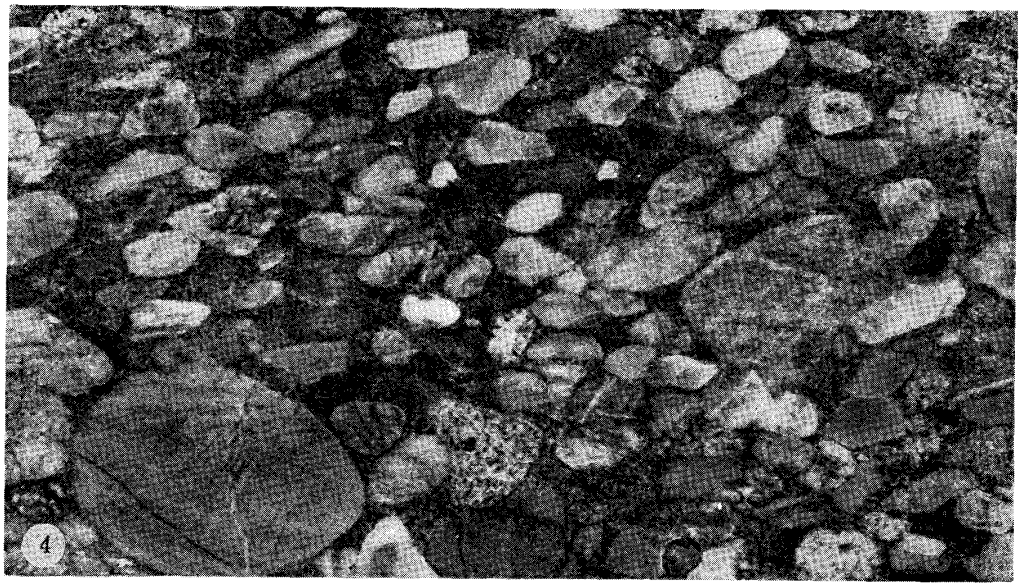
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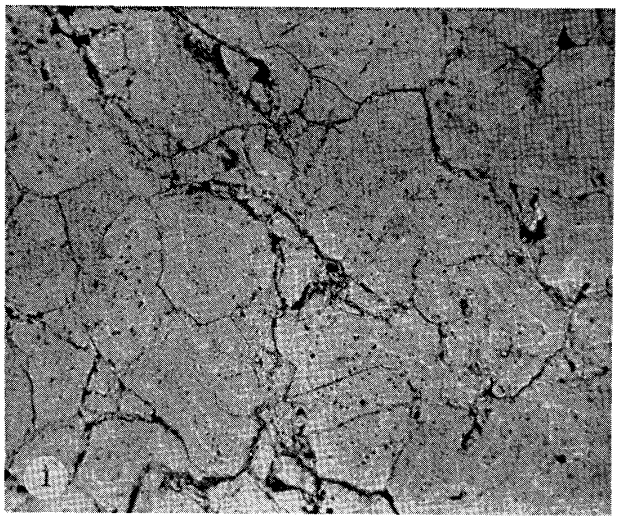
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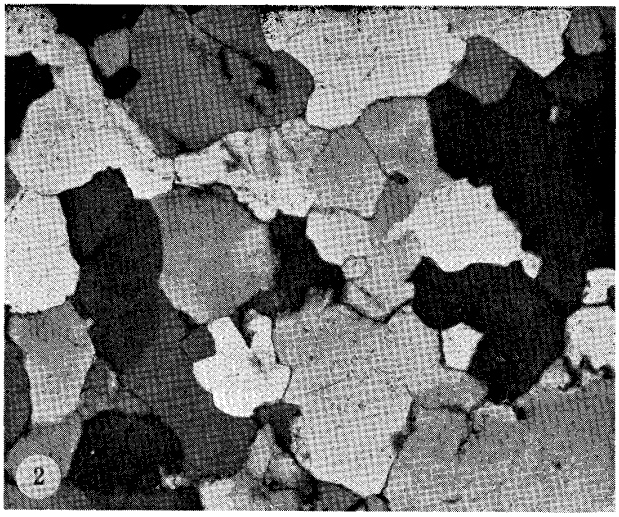
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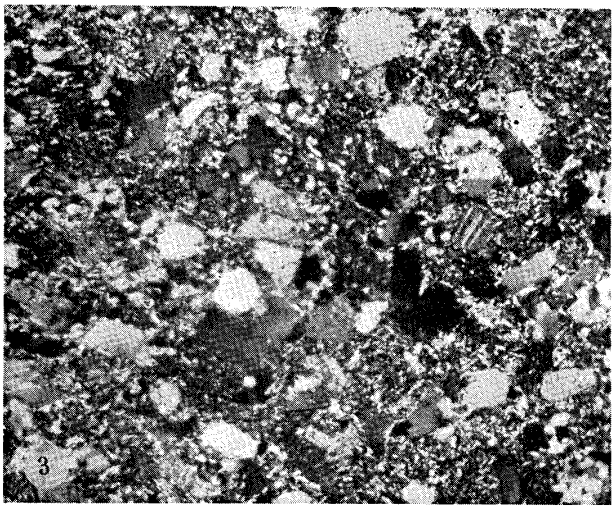
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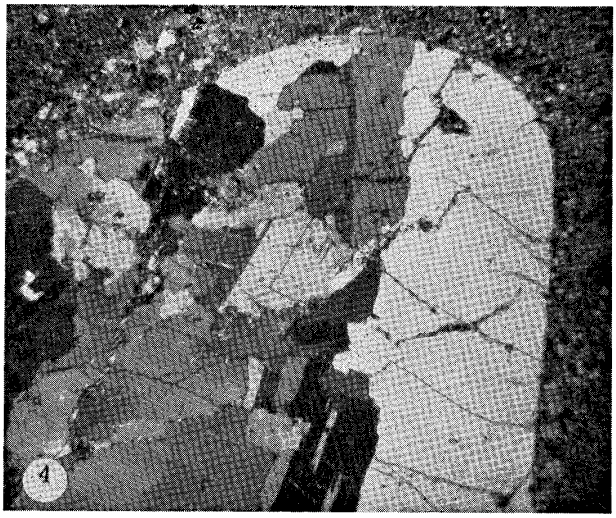
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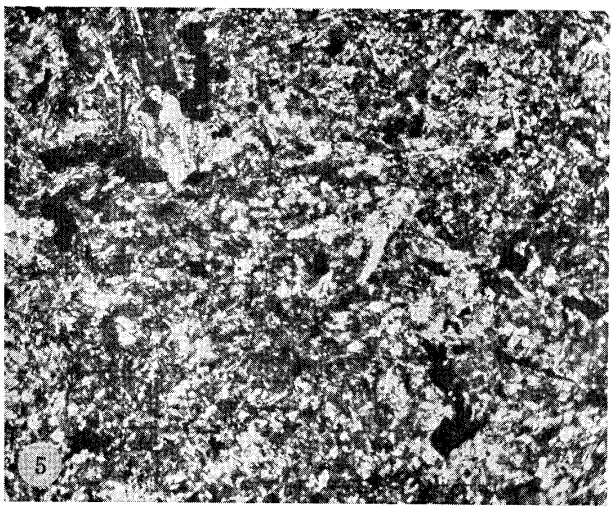
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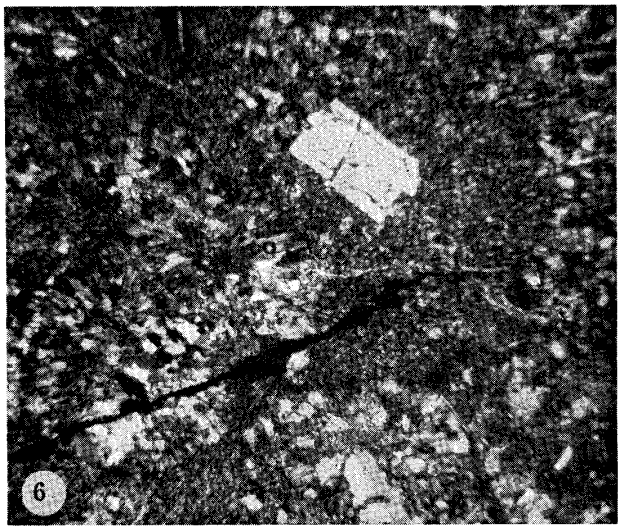
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Plate 55

Figs. 1, 2. Orthoquartzite.
1-Orthoquartzite pebble, sample no. 70111812, × 50, opened nicols collected from the basal part of the Karaumedate Formation at Nanatsumori, Daito-cho, Higashi-Iwai-gun, Iwate Prefecture.
2-Same specimen, crossed nicols.

Fig. 3. Sandstone.
Matrix of the conglomerate in the Karaumedate Formation, at Okado, Daito-cho, Higashi-Iwai-gun, Iwate Prefecture, ×50.

Fig. 4. Granite.
Same sample as Plate 55, fig. 3, × 20.

Fig. 5. Andesite.
Sample no. 7109055, collected from the lower part of the Karaumedate Formation, west of Toriumi, Daito-cho, Higashi-Iwai-gun, Iwate Prefecture, × 50.

Fig. 6. Porphyroidal rock.
Sample no. 70111815, collected from the basal part of the Karaumedate Formation, northwest of Natsuyama, Higashiyama-cho, Higashi-Iwai-gun, Iwate Prefecture, × 20.