Find of Nummulites and Orthoquartzitic Pebbles From Eocene Turbidites in Shimajiri Belt, Okinawa

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Find of *Nummulites* and Orthoquartzitic Pebbles from the Eocene Turbidites in Shimajiri Belt, Okinawa

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Abstract Discoveries of an Eocene form of *Nummulites* (a benthic large foraminifer) and of orthoquartzitic pebbles are recorded from turbiditic sequences of the Kayo Formation hitherto assigned to Cretaceous, in the Shimajiri Belt of northern Okinawa-jima, Ryukyu Islands. The important bearing of this revision is outlined in terms of paleotectonic framework of the islands and their adjacency.

This interim report deals with an addition to our knowledge on the Paleogene geosynclinal sediments in the Ryukyu Islands. It is founded with the discovery of an Eocene benthic foraminifer, *Nummulites* sp. from the Kayo Formation of Okinawa-jima and resulted in success of the southward tracing of the Paleogene (inclusive basal Miocene) turbiditic facies from Amami-oshima to Okinawa, as advocated by KONISHI (1963, 1965). Importance of orthoquartzite pebbles found from the same formation is briefly discussed together. A part of this paper was orally presented at the 11th Pacific Science Congress (KONISHI *et al.*, 1966).

We are indebted to Dr. H. OKADA of Kagoshima University for his valuable comments on sandstone petrography, and to Dr. C. BOWIN of the Woods Hole Oceanographic Institution for giving access to two unpublished papers on the Philippine Ridge. Our thanks are also extended to Mr. K. NAKAMURA of our department for drafting line drawings used in this paper.

The pre-Miocene basement complex of the Ryukyu Islands was stratigraphically revised and a zonal distribution of stratigraphic units, which is similar to that of the Outer Zone of Southwest Japan was vindicated, through our areal mapping during the last decade (KONISHI, 1963, 1964, 1965; KONISHI *et al.*, 1966; ISHIBASHI, 1968, 1969;

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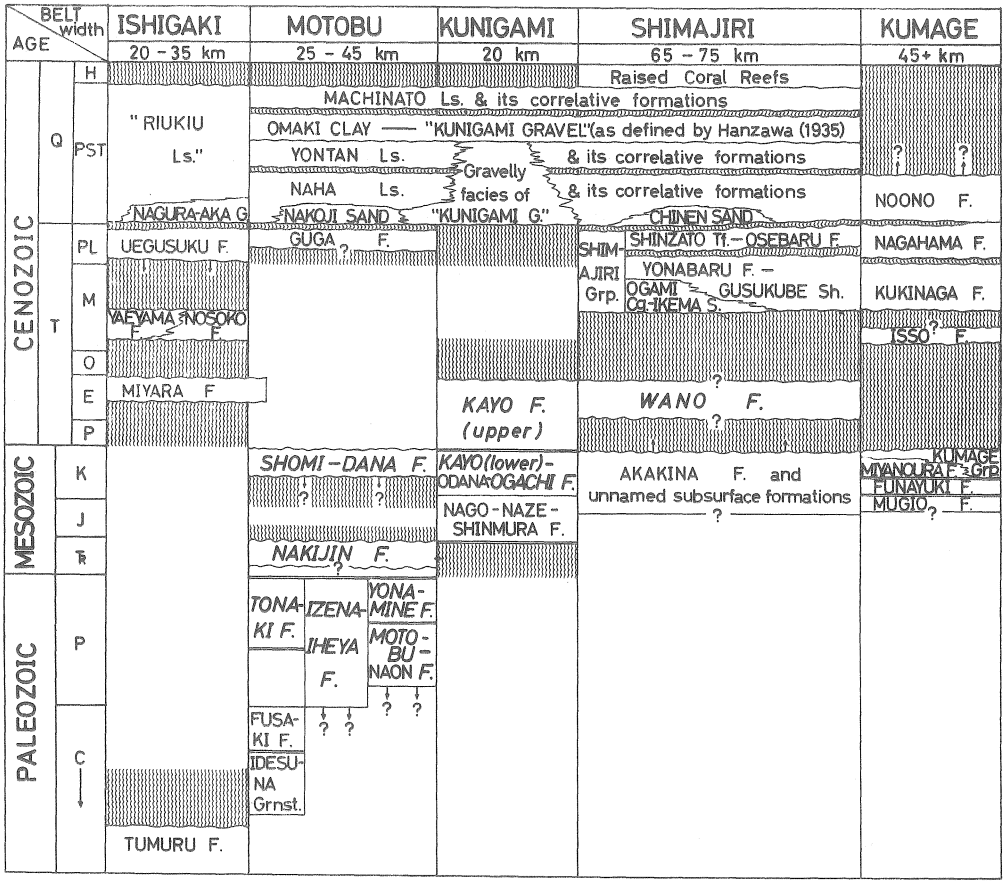
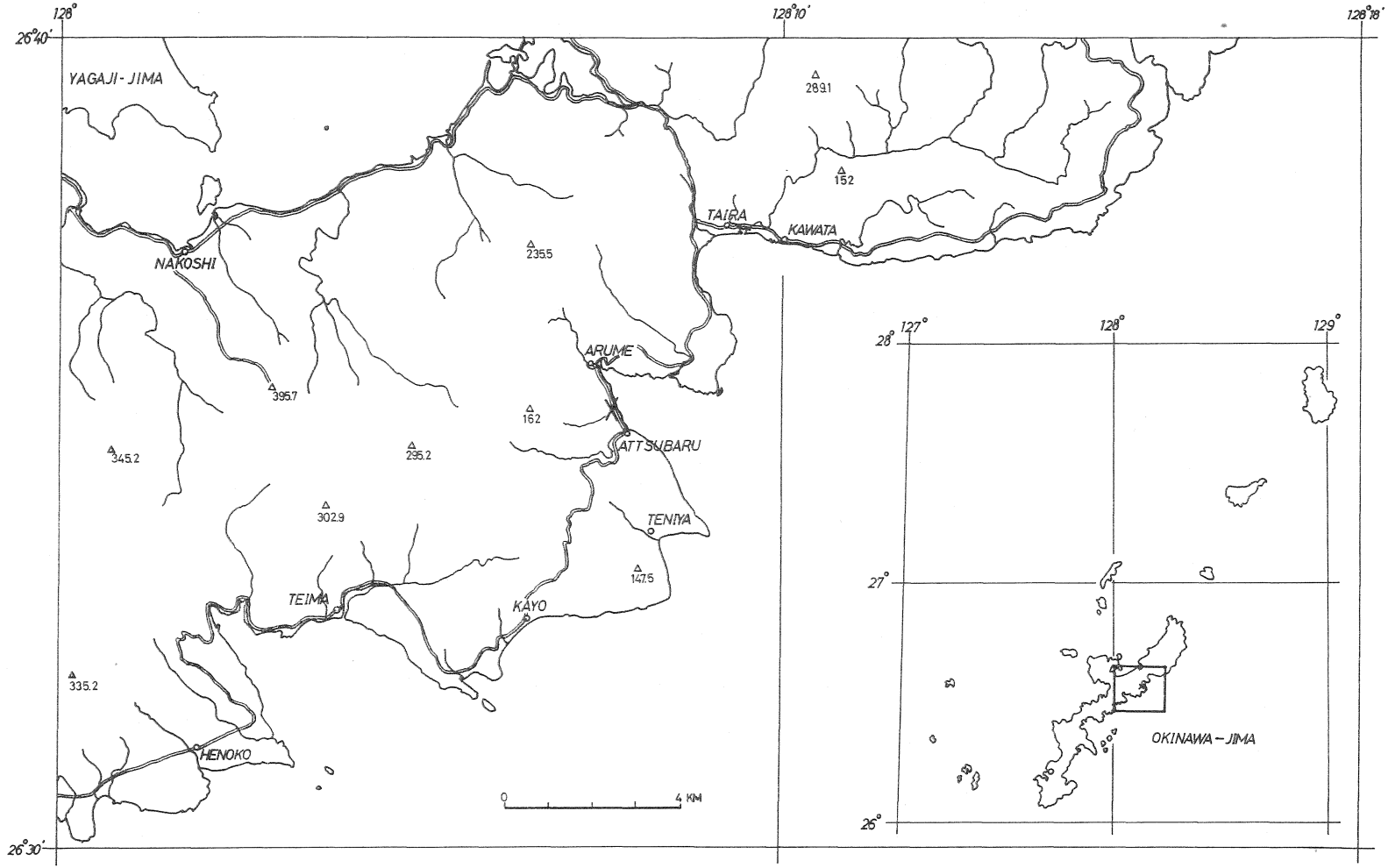


Text-figure 1 Nomenclature and correlation of the major stratigraphic units in the Ryukyu Islands.

ISHIDA, 1969 and others). Besides the eugeosynclinal Middle Permian and sublittoral to neritic Paleogene (Eocene) formations previously established (HANZAWA, 1956), Lower and Upper Permian, Upper Triassic, Cretaceous and bathyal facies of Paleogene (Eocene) have been added to the stratigraphic column of the islands (Text-fig. 1).

The discovery of *Nummulites* sp. was made in the summer of 1965, at an outcrop of the Kayo Formation (FLINT *et al.*, 1959) near the mouth of a streamlet, Yamato-gawa, 400m northwest of the type locality of the Attsu Conglomerate Lentil, that is located 500m north of Attsubaru (Text-fig. 2). The foraminifers occur rather sparsely, though crudely aligning along certain layers within poorly sorted silty sandstone, which alternates with thick beds of arkosic conglomeratic sandstone, a representative lithology of the upper part of the Kayo Formation (FLINT *et al.*, 1959; KONISHI, 1963). Tests of *Nummulites* sp. on hand are usually preserved dissolved, thus leaving only their molds, but some are still retaining chalky calcitic matter. Therefore, several specimens could be identified to be conspecific with the Eocene form which was identified by HANZAWA and reported from the Wano Formation at Kasari Peninsula of Amami-oshima (ISHIDA, 1969, Pl. I, Fig. 6).



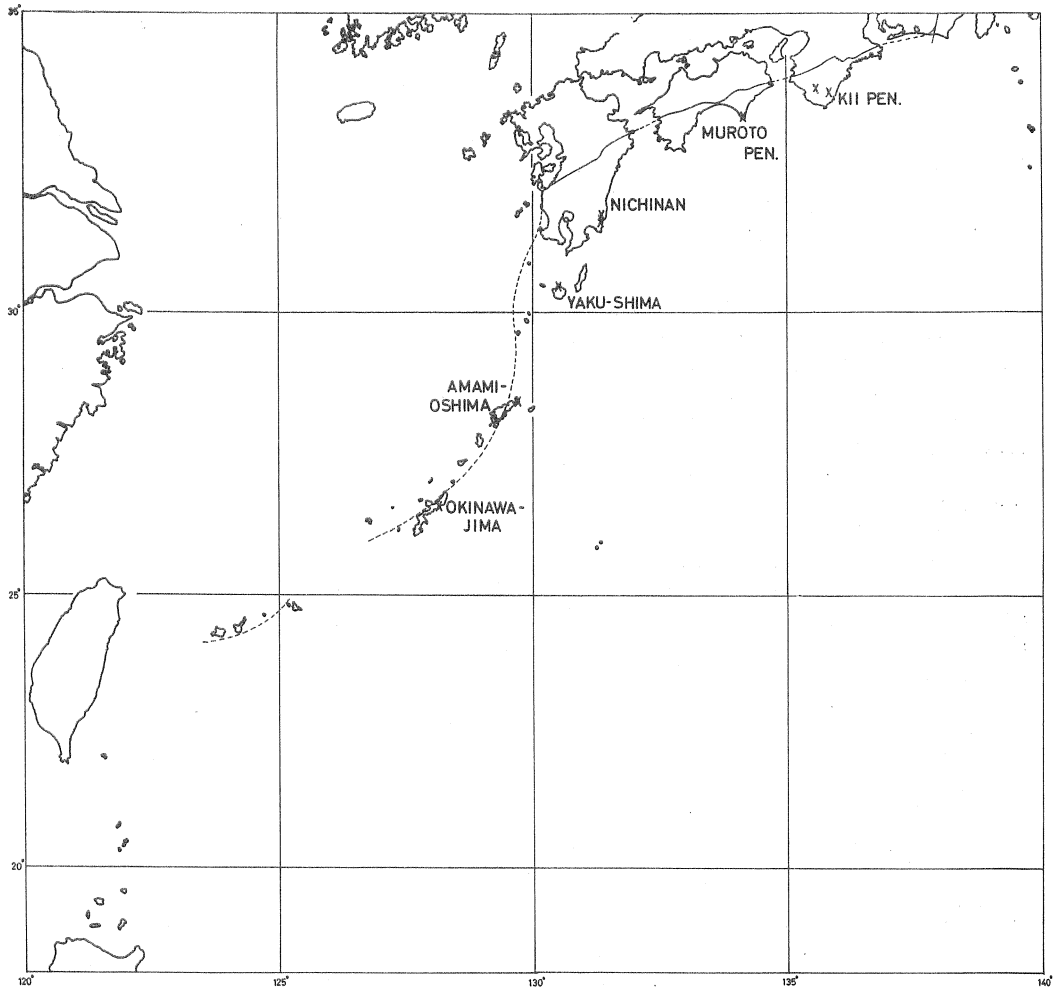
Text-figure 2 Map showing the locality of the Eocene *Nummulites* sp., north of Attsubaru, and that of orthoquartzite pebbles, south of Kawata, both in the Kayo Formation of northern Okinawa-jima. The distribution of the formation was shown in Text-fig. 2 of KONISHI (1963).

The Kayo Formation was hitherto assigned to Cretaceous (KONISHI,1963, 1965) based on both palynological data of a coaly stringer and the Late Mesozoic reefy flora and fauna in limestone gravels, which were interpreted to be a kind of allodapic limestone. With the find of *Nummulites* sp., the stratigraphic range of the formation should extend up to the Eocene, and that verifies the southerly extension of the Eocene turbiditic facies in the Shimajiri Belt from Amami-oshima to Okinawa. The Eocene portion of the Kayo Formation is to represent a bathyal counterpart of the nearshore Miyara Formation in the Ishigaki Belt, a relation exactly comparable with that between the nearshore Kuma Group in the Sanbagawa terrain and bathyal Muroto-hanto Group in the Shimanto (Nakamura) terrain of Shikoku.

Occurrence of *Nummulites* sp. in the Kayo Formation prompted us to reexamine a set of gravel samples, which were collected from various localities of the conglomerate beds in the formation. Although the work is still in the initial stage, our preliminary result confirmed that two pebbles which were collected from an intraformational conglomerate, just south of Kawata (Text-fig. 2) and previously identified as quartzite are actually orthoquartzite, *i. e.* sedimentary quartz arenite severely cemented by secondary quartz, in which rounded quartz grains attain 95% or more of the detrital fraction. Ubiquitous occurrence of this type of sandstone among the gravels of the conglomerates appears to characterize Paleogene turbiditic sequences in the Shimanto and northern Shimajiri Belts (HARATA *et al.*, 1970, 1970a: Text-fig. 3).

Under microscope, the quartz grains with medium size of 0.29mm demonstrate tightly interlocking mosaic with suture boundaries, and their original grain outlines are usually indistinct. The gross texture appears to resemble the lithology type-2 of TOKUOKA (1970). However, their subrounded to rounded detrital cores are sometimes separable from surrounding secondary overgrowth with a careful tracing of dust-like ring (Figs. 3 and 4 of Pl.2). A good proportion of the grains is strain monocrystalline quartz, and some are polycrystalline. Besides the quartz, few percentage of the grains are sporadically represented with sericitized felsic fragments probably of altered feldspars (microcline?). Euhedral sphenes and other stable minerals together with abundance of dusty particles occur as inclusions in the quartz grains. The sandstone may be referred to first-cycle orthoquartzite, because of its high concentration of undulatory subrounded monocrystalline quartz grains (BLATT,1967) and of the occasional retainment of feldsparthic grains.

Inasmuch as orthoquartzite tends to occur principally on the craton or its margins rather than in the geosynclines, and also mostly in the Precambrian to Early Paleozoic (especially Cambrian) sediments, the provenance of the orthoquartzite gravels now so ubiquitous in the Paleogene (inclusive basal Miocene) of the Shimanto-Shimajiri terrains has been sought outside of the Japanese Islands, of which geohistorical development has been typically of mobile geosynclinal belt. With introducing an intriguing hypothesis of "Southern Former-Land" (HARATA *et al.*, 1970; TOKUOKA, 1970), further investigations have been proposed by many workers in order to examine whether such a land has been buried beneath the arc-trench gap along the Nankai-Ryukyu Trench,



Text-figure 3 Map showing localities (marked with X) of orthoquartzite gravels from the Paleogene geosynclinal turbidites in the Shimanto-Shimajiri terrains. The line either solid or broken, running across the islands indicates the Butsuzo-Hedo Tectonic Line defining the northern or northwestern border of the terrains against the Chichibu-Motobu terrains.

or its remnant can be traced, beyond the trench, to either one of the three inactive ridges (=remnant arcs of KARIG, 1972), Okidaito, Daito and Amami, running parallel to the Philippine Ridge (BEN-AVRAHAM *et al.*, 1973;=Central Basin Fault of HESS, 1948), an extinct Cretaceous(?) mid-oceanic ridge. In fact, the geomorphological relations of the ridge system in the Philippine Sea suggest that the development of these three ridges may have predated the generation of the Kyushu-Palau Ridge.

As the Shimajiri terrain of the Ryukyu Islands has shared an intimate history of sedimentary and tectonic development in common with the Shimanto terrain of the Southwest Japan within the same tectonic framework, until the end of the Paleogene, the Kyushu-Palau Ridge may have formed after or possibly synchronously with the fragmentation of the folded mountain systems and the subsequent southward drifting of its western wing (KONISHI and SUDO, 1972), which probably began in Middle to Late

Miocene and should be closely related with the generation of the new ridge system.

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Explanation of Plates

Nummulites sp.

(× 10)

Fig. 1 Lateral view.

Fig. 2 Oblique section, nearly sagittal.

All the specimens were collected from an outcrop, north of Attsubaru, North Okinawa.

Microphotographs of Orthoquartzite

(All figures were taken under crossed nicols)

Figs. 3 and 4 Secondarily enlarged rounded grains of quartz, of which detrital cores are easily distinguished from secondary overgrowth with dust rings.

Fig. 5 Gross texture of the orthoquartzite, characterized with interlocking sutured quartz mosaic.

The specimen was collected from an intraformational conglomerate, south of Kawsta, North Okinawa (Slide No. KK60090305) .

Plate 2