78. *Radiocarbon Ages of "Exposed Reef" at Minamitori-shima (Marcus Island), Central Pacific*

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Among the Japanese islands, Minamitori-shima (Marcus Island: 24°17′N; 153°59′E) occupies a geotectonically unique position, as the sole island lying on the Pacific Plate, about 1150 km east of the Ogasawara (=Bonin) Trench, and, together with Wake atoll and many guyots, constitutes the Marcus-Wake Seamounts aligning west-north-westwards (Fig. 1).

Minamitori-shima has been referred to a typical elevated atoll in the Central Pacific, uplift of which was ascribed to either "lithospheric bulge" related to subduction (Wilson, 1963) or "riding over asthenospheric bump" (Menard, 1973; McNutt and Menard, 1978). These interpretations were founded on the classic report by Bryan (1903): (1) A topographic depression suggesting an abandoned lagoon in the center of the island; (2) six bench-like steps referable to uplifted terraces; (3) an "exposed" or "elevated reef" cropping out "probably seven feet above the water line"; and (4) the maximum altitude attaining 70 feet (=23 m) above the present sea level.

Even after the maximum elevation was corrected (33 feet; Yoshida, 1902; Akimoto, 1902: 5 m; Kagawa, 1937: 7 m; Sakagami, 1961: and 9 m; Geographical Survey of Japan, 1979), the stratigraphic assignment of both "exposed reef" and "bench-like steps" should draw a keen interest to geoscientists, whether they represent a remnant of the Last Interglacial reef on the uplifted atolls (Veeh, 1966; Thomson and Walton, 1972; Konishi *et al.*, 1978; Marshall and Launay, 1978; Konishi, 1984) or the partially emerged Holocene reef due to Postglacial isostatic rebound (Walcott, 1972; Clark *et al.*, 1978) or some other causes.

It is our purpose to document and discuss the result of our observation on both the "bench-like steps" and "exposed reef" on the coast of Minamitori-shima. Field work was done by Konishi and Omura in May of 1979; radiocarbon assay was carried out by Tanaka; and the paper was written by Konishi. We thank to authorities of Self Defence Agency for their logistic assistance, and to Dr. Bun-ichi Toyota, former president of Kanazawa University and Prof. Emeritus T. Kobayashi, M. J. A., for their encouragement of this study.

One glance at the bench-like steps along the northern part of the eastern coast, which were documented by Bryan (1903), proves that they are nothing but a very narrow berm-origin microtopography formed by storm on a windward steep slope of the unconsolidated rampart. This feature very common along the windward rampart may be retained only ephemerally until next storm attacks.

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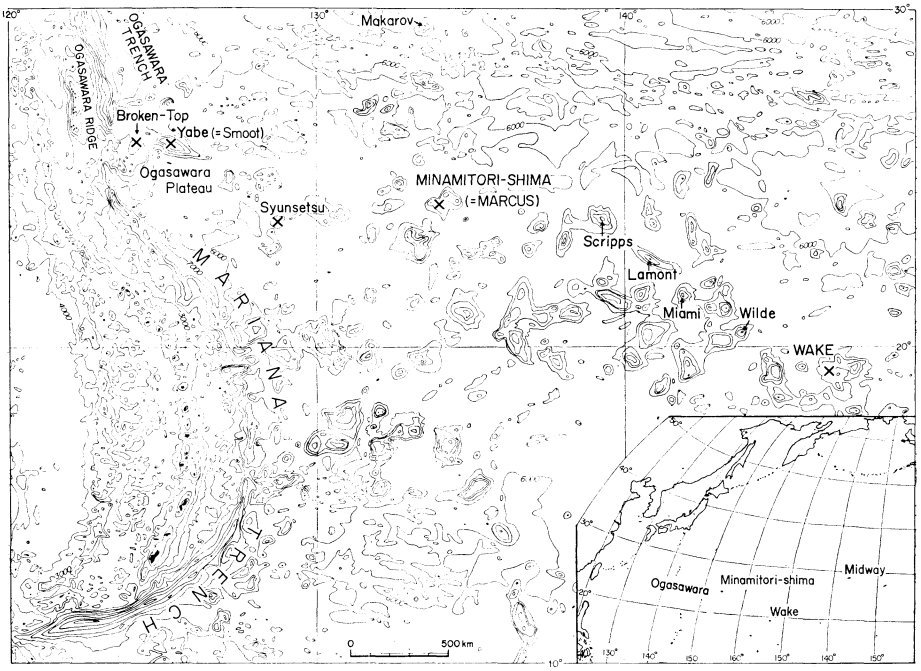

Fig. 1. Map showing two islands (Minamitori-shima and Wake) and some guyots of the Marcus-Wake Seamounts.

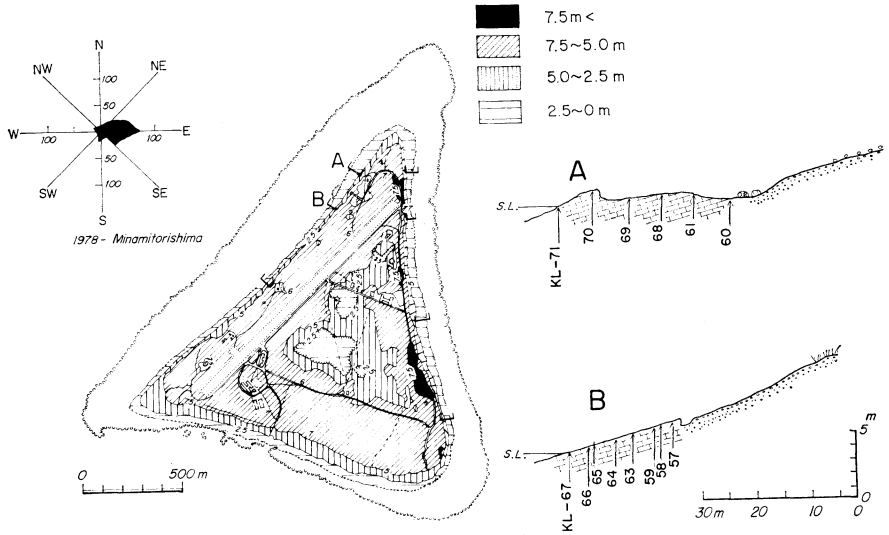

Fig. 2. Topography of Minamitori-shima (data from Geographical Survey of Japan, 1979) with rose-diagram showing prevailing wind directions (daily) in 1978 (data from Meterological Agency of Japan, MS). Two cross-sections across the "exposed reef" (=beach conglomerate) indicate sites of radiocarbon-dated coralline cobbles (KL-57~-71).

In May of 1979, only four steps were traced along the wide gravel beach of the southern coast.

Bryan's "exposed reef", which was later described as "old, already mineralized reef' by Sakagami (1961), crops out at the northern corner of the western beach in contact with the moat of the present reef. Its maximum elevation stands at least 1.0 m above the high tide. The "exposed reef" is the misnomer (Konishi, 1980) and should be referred to beach conglomerate, a coarse-grained member of beachrock, which preserves inclined-stratification, and is composed of round to subround coralline cobbles of allochthonous origin, with occasional inclusion of molluscan shells (*Tridacna* and *Turbo*). It characteristically lacks both encrusting coralline algae and autochthonous corals. Matrix of the beach conglomerate consists of foraminiferal tests and fragmental debris of other reef-dwelling organisms, all of which are well cemented by aragonite and Mg-calcite.

Across the northern part of the western coast, two transects, A and B, were selected to be perpendicular to strandline, and cobble-size fossils of corals (mostly *Favia* and *Favites*, with few *Porites*) were collected from the beach conglomerate for radiometric dating at six and eight sites, respectively, along each transect (Fig. 2). The result of radiocarbon dating is summarized in Table I. Except

Table I. Radiocarbon age of corals, Minamitori-shima

	Sample no.	^{14}C		^{14}C date (y.B.P.)	
		NCM/g C_6H_6	$\frac{A_{sample}}{A_{std.}\times 0.95}$	$T_{1/2}$ (5730 y.)	$T_{1/2}$ (5568 y.)
TRAVERSE A	79051417 (KL-60)	6.221	0.8360	1480±110	1440±110
	1418 (KL-61)	5.120	0.6881	3090±120	3000±120
	1419 (KL-68)	5.218	0.7012	2930±120	2850±110
	1420 (KL-69)	5.356	0.7198	2720±110	2640±110
	1421 (KL-70)	4.991	0.6707	3300±100	3210±90
	1422 (KL-71)	5.067	0.6810	3180±130	3090±120
TRAVERSE B	79051404 (KL-57)	5.500	0.7391	2500±110	2430±110
	1405 (KL-58)	5.175	0.6955	3000±110	2920±110
	1406 (KL-59)	5.375	0.7223	2690±120	2610±120
	1407 (KL-63)	5.331	0.7164	2760±110	2680±110
	1408 (KL-64)	5.293	0.7113	2820±100	2740±100
	1409 (KL-65)	5.178	0.6959	3000±110	2910±100
	1410 (KL-66)	5.139	0.6906	3060±100	2970±100
	1411 (KL-67)	5.216	0.7010	2940±100	2850±100
REEF CREST	79051306 (GaK-8477)	—	—		2130±100
	1307 (GaK-8478)	—	—		2880±140
REEF FLAT	79051302 (GaK-8475)	—	—		540±140
	1303 (GaK-8476)	—	—		1280±120

one specimen (79051417) from a dent on the Transect A, all the corals occur in the narrow range between 2430 and 3210 y.B.P., which is averaged to be 2838±206 y.B.P. for thirteen samples. Besides, the radiocarbon dates of two *in situ* fossil *Acropora* at reef crest and two *Acropora* of reef flat were included

in the table for comparison. These four dates were measured at Radiocarbon Laboratory of Gakushuin University under the supervision of Prof. K. Kigoshi.

The radiocarbon ages of the coral rubbles confirm Late Holocene, but not the Last Interglacial (Late Pleistocene) for the beach conglomerate. There are scores of reports on the beach conglomerate of the similar ages and occurrences elsewhere in the Central Pacific (*e.g.* Newell and Bloom, 1970). The origin of such "elevated" beachrock has been in dispute. While some students attribute it to a short-termed highstand of sea level slightly above the present one, the other alternative has claimed that the sea level was then kept at almost the same with that of the present, and the beach conglomerate merely represents a tempestite deposited above mean sea level through stormy high tide. Both the nature of carbonate cement and a narrow range of the radiocarbon dates are equivocal. The localized occurrence of the "elevated" beach conglomerate which lacks to merge with reef flat may tend to favor the latter interpretation. Elevated reef flat was observed nowhere in the island. With the result of our observation, the wide-spread argument that Minamitori-shima is a typical elevated atoll in the Central Pacific can no longer be valid.

As evidenced with the Middle Cretaceous reefoid cap at Syunsetsu (Konishi, 1973), Yabe (Shiba, 1979; =Smoot, Smoot, 1983) and Broken-Top (Smoot, 1983; =KH84-1, Konishi, 1985), the Mercus-Wake Seamounts lying on the ocean floor of the Jurassic Magnetic Quiet Zone (older than 150 Ma) represents one of the oldest west-north-west trending chains of guyots as old as 100 Ma or even older (probably formed by the Middle Cretaceous (110-95 Ma) or Early Cretaceous (before 110 Ma) volcanism then intensive in the Pacific: Winterer, 1976; Hilde *et al.*, 1977; Tokuyama, 1980; Schlanger *et al.*, 1981; Rea and Vallier, 1983).

Although the neotectonic uplift of Minamitori-shima for the last 125 Ka is now rejected, epirogenic record wrought in the carbonate buildup from Cretaceous to Quaternary here should depict an invaluable insight into the local tectonic subsidence-uplift history as well as eustatic sea level change of this part of the Pacific (Crough, 1984), where not only a depth anomaly for ocean floor and seamount summits against the "Sclater's rule", but also a collision tectonics among plateau, seamount and island arc has been mentioned. Minamitori-shima is one of the most desirable candidates for deep drilling in the Pacific.

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