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Distribution of Protodolomite in Minami-daito-jima, Okinawa

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Abstract

Beautiful protodolomite is widely distributed in Daito-jima Islands. However, protodolomite has not been found in the leeward side (the west side) of Minami-daito-jima. In this paper the authors clearly show the boundary between the distribution of protodolomite and that of calcite at the west coast of the island. It should suggest to provide a key for the protodolomite formation in the atoll environment.

1. Introduction

One of the most interesting problems in carbonate geochemistry is to elucidate the mechanism of the formation of protodolomite in coral reef islands. The authors have studied on sedimentary protodolomite which may provide a key to the solution of the dolomite problem. In order to estimate the conditions of the protodolomite formation, two approaches have been used : (1) field observation (Ohde, 1976 ; Ohde and Kitano, 1981a), and (2) laboratory experiment chiefly on synthesis (Kitano, 1956 ; Kitano and Furutsu, 1959 ; Kitano and Kanamori, 1966 ; Ohde and Kitano, 1978 ; 1980 ; 1981b).

The distribution and chemical composition of protodolomite in Minami-daito-jima were already reported (Ohde, 1976 ; Ohde and Kitano, 1981a). And the authors showed the absence of protodolomite at the western part of the island. But the authors could not show the clear boundary line between the distribution of protodolomite and that of calcite (limestone).

In order to solve such a protodolomite problem, it has been needed to make more detailed survey of the distribution of protodolomite in the island. This paper shows the detailed and exact distribution area of protodolomite in Minami-daito-jima.

2. Experimental

Sampling sites : Figure 1 shows the location of Minami-daito-jima which is 370 km to the east of Okinawa and separated by the Ryukyu Trench. Carbonate rock samples were collected at the west side of the island as shown in Figs. 2(a) and (b).

Analytical method : Mineral species including protodolomite were identified by X-ray diffraction powder method (Murata et al., 1972 ; Milliman, 1974). Calcium and magnesium in carbonate rock were determined by the EDTA titration and also by

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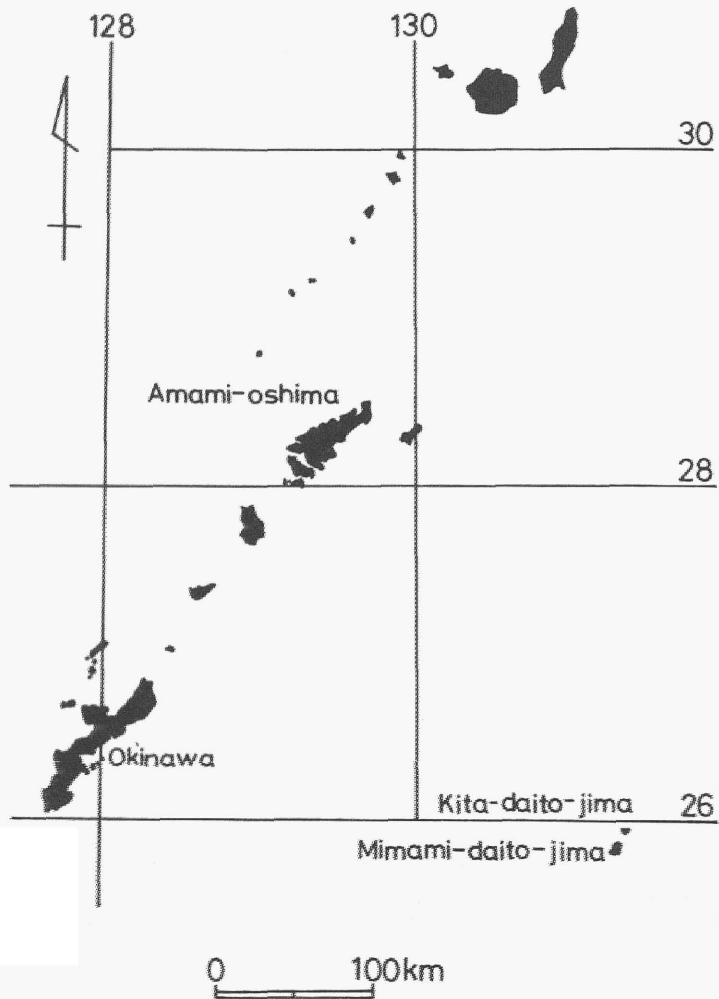


Fig. 1 Location of Minami-daito-jima.

3. Results and Discussion

Distribution of protodolomite : Figures 2(a) and (b) show the mineralogical composition of carbonate rocks in the west side of Minami-daito-jima. These figures clearly indicate the distribution area of protodolomite at the western coast line of the island. In Nishiminato-Yagimichi line, protodolomite could be found only at the sampling sites of Ni-Ya 15, 16 and 17. And in Nishiminato-Shioya line, it was found at the sites of Ni-Shi 10 to 22 as seen from Fig. 2.

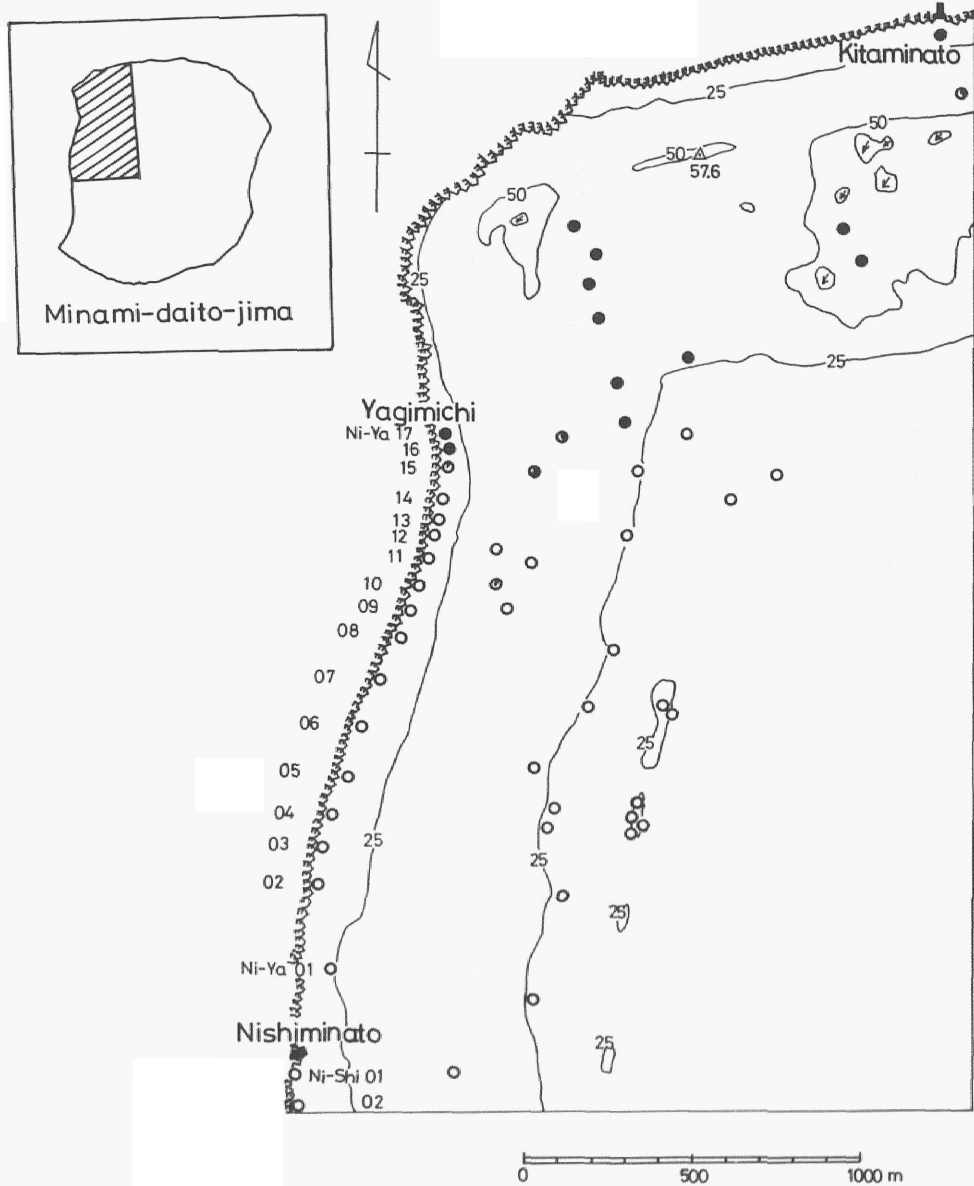


Fig. 2(a) Distribution of protodolomite(●) and calcite(○) in the western north part of Minami-daito-jima. (Contour lines, 25 and 50 m, are shown.)

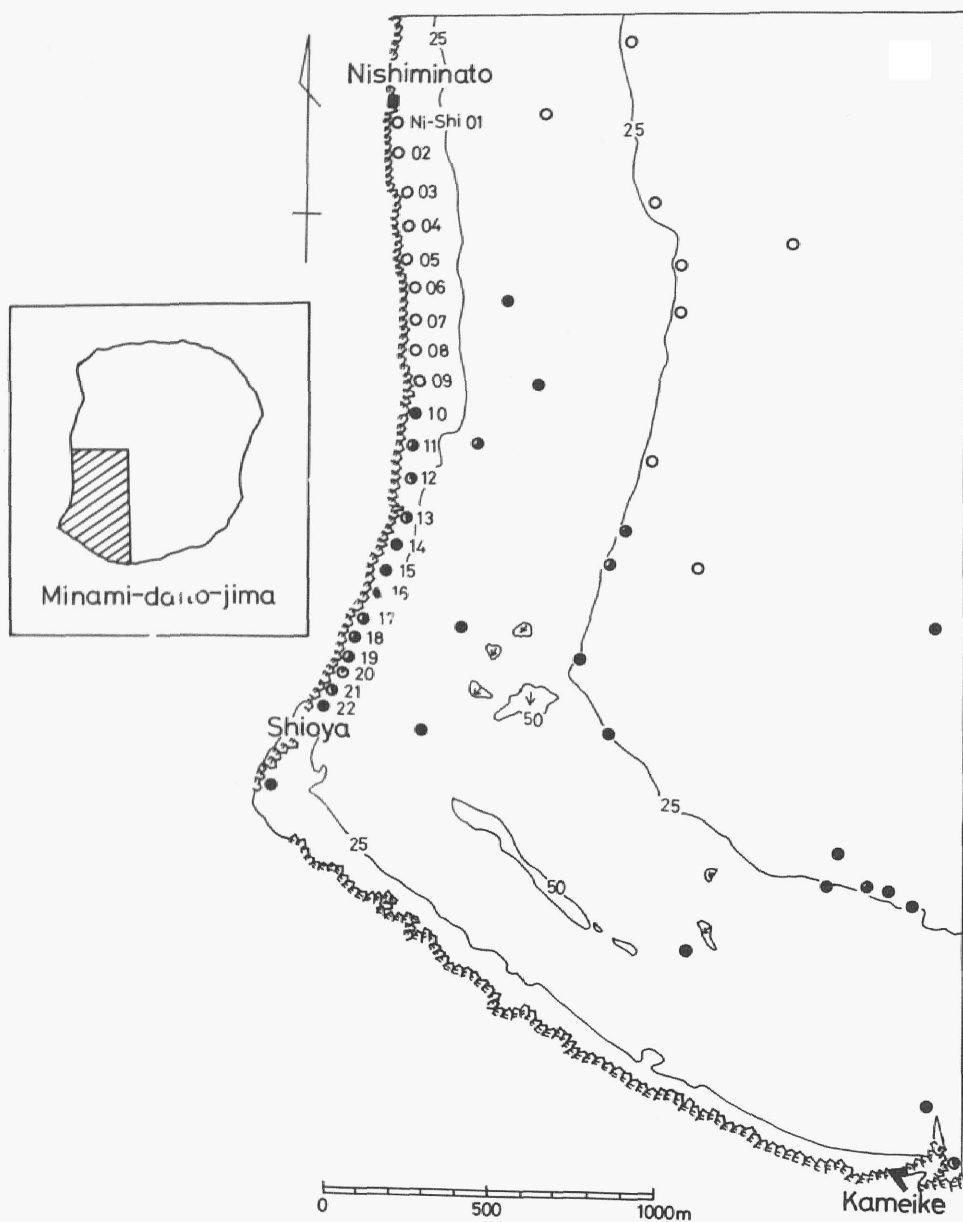


Fig. 2(b) Distribution of protodolomite(●) and calcite(○) in the western south part of Minami-daito-jima.

Figure 3 shows the distribution area of protodolomite in the island. As evident from Fig. 3, protodolomite is not found at the central part of the west coast. Figure 3 is based on Fig. 2, and the previous observations by the authors (Ohde, 1976 ; Ohde and Kitano, 1981a).

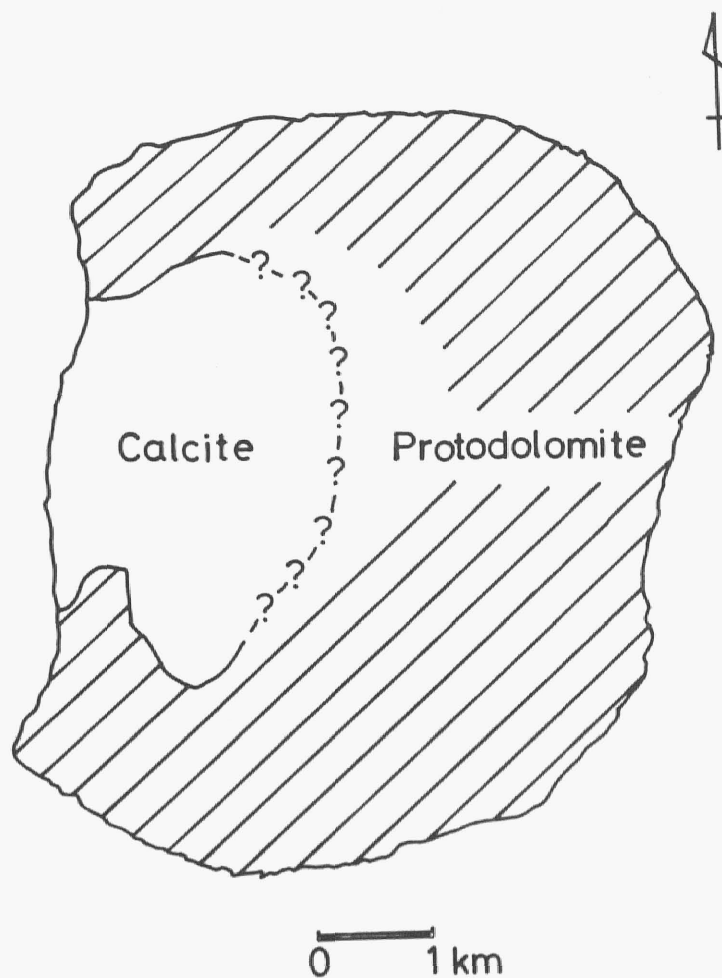


Fig. 3 Distribution of protodolomite and calcite in Minami-daito-jima.

Reason why protodolomite has not been found in the west side of the island : The authors already reported that protodolomite is considered to be formed from aqueous solution (Ohde, 1976 ; Ohde and Kitano, 1978 ; 1981a). Thus, it is considered to be formed before the elevation of the island but not after the elevation. In order to explain the characteristic distribution of protodolomite, the environmental

conditions under which the island was surrounded before the elevation must be considered. To estimate the conditions at the time of the atoll formation in Daito-jima, the authors refer to the water circulation of Bikini atoll, which has been studied by Von Arx (1954). He observed the currents in the lagoon of Bikini atoll as shown in Fig. 4. The oceanic water flows into lagoon through windward reef, and leaves lagoon from leeward reef. The surface water in the lagoon flows to the leeward and partly sinks down the bottom. The bottom water then spreads to all directions except the leeward.

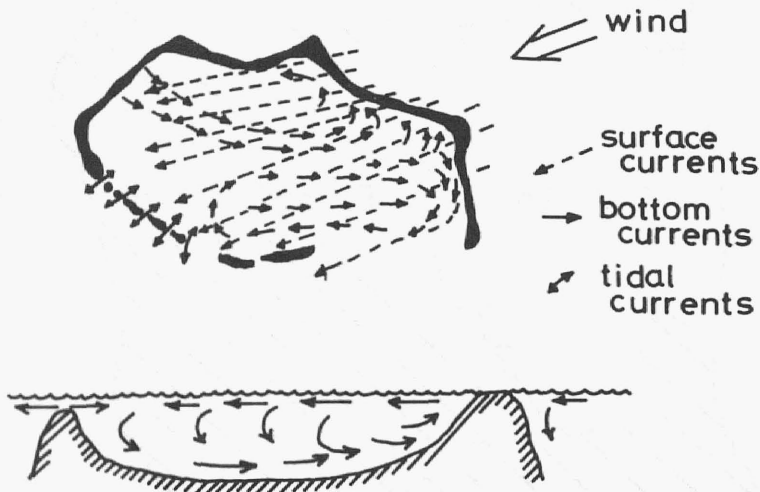


Fig. 4 Currents in Bikini lagoon observed by Von Arx (1954).

Since Bikini and Daito-jima are considered to be atolls of the Pacific formed in similar environments, the water circulation in Daito-jima lagoon before the elevation of the island is expected to have been similar to that in Bikini lagoon. If oceanic water is concentrated by intensive evaporation in a shallow lagoon before the complete elevation of the island, the concentrated brine water might have spread to all directions except leeward through the bottom of the lagoon, as that in Bikini lagoon. The leeward of Minami-daito-jima is the west side of the island (Minami-daito Local Meteor. Observatory, 1975). And the reef is poorly developed in the west coast of the island. Thus it is presumed that the direction of the leeward has not been changed since the time of the atoll formation. Therefore, concentrated brine in the lagoon has not flowed to the west side of the island. If protodolomite

is formed from brine in the lagoon, the absence of protodolomite in the west part of the island can at least partly be explained in the light of such an assumption. This idea is supported by the successful synthesis of protodolomite from magnesium-rich brine (Ohde and Kitano, 1978).

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