

Reexamination of the “Phosphate Rocks” collected from the Northwestern Part of the Philippine Sea—with Special Reference to the Samples obtained by GDP Cruises (1972–1977)—

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Introduction

Abundant bottom materials were collected from Kyushu-Palau Ridge, Amami Plateau, Daito Ridge, Oki-Daito Ridge and from the vicinity of the northwestern part of the Philippine Sea during the GDP cruises operated from 1972 to 1977. Among these bottom materials, semi-consolidated, grey-brown sediments, many of which compose the nuclei of the manganese nodules, were considered to be phosphatic. But the identification was purely tentative, and mineralogical analysis remains to be performed. In fact, during the research program of GDP it was suggested that some of the “phosphate rocks” are zeolitic ones (R.M. GDP-21, 1977).

The authors will take advantage of this occasion to reexamine the composition of these semi-consolidated sediments. In this paper they will revise the composition of those previously reported as “phosphate rocks” and make a brief discussion.

Analytical results

The representative 34 semi-consolidated sediments of 19 locations are analyzed by X-ray diffractometer. Precise locations and depth of those samples are listed in previous reports (see SHIKI, T., 1985 in this volume). Their mineral compositions are listed in Table 1. The results can be summarized as follows.

1. Most of the semi-consolidated sediments collected from Daito Ridge and Oki-Daito Ridge are not phosphate rocks, but zeolitic rocks. Zeolitic sediments are also found in other areas. Zeolite is identified mainly as phillipsite, and some nuclei sediments of Amami Plateau and Daito Ridge contain analcime. In these cases the sediments are more or less tuffaceous.

2. Phosphate is also included in many sediments, but is not so common in those of Daito and Oki-Daito Ridges.

3. Ferromanganese oxide coatings are thick on phosphatic and zeolitic rocks or semi-consolidated sediments, and thin or lack on carbonate-bearing sediments.

4. Clay minerals of the sediments are mainly smectite and illite. Smectite is considered to be included in tuffaceous sediments.

Considering on these results, the authors have revised the names of the rock types of the initial description; the revised names are listed in Table 2.

Table 1. Mineral composition of the "carbonate and phosphate rocks" collected from the Northwestern Philippine Sea (GDP cruises).

Kinan Smt Chain	8- 4*	-		Ar	P		770- 925m
Kyushu-Palau Ridge	8- 7- 10	+	+	C			975-1165
	8-12- 14	+			I	+	2250-2280
	-285	+	+		P	S	+
	-290	+	+		P	S	
	-291	+			P	S	+
	11- 2- 1			C,D			535- 550
	11- 3- 3			C			620-1350
Amami Plateau	11- 8- 73	+	+		P		1580-1690
	11- 9			C			1350-1410
	- 1	+	+		P		
	- 1	+	+		A	S	
	- 30	+	+				
	11-17- 1	+			P	I	1800-2110
	- 20	+			P	I	
Daito Ridge	15- 2- 43	+			P,A	S	2440-2505
	-135	+	+		P	S	
	15- 3-404	-	+		P		2375-2450
	-424	-		C	P	S	
	15- 4- 11	+			P	S,I	1160-1245
	-F13			C			
	-F22			C			
	15- 7- 16	+			P,A		2190-2580
	15- 8	-			P	I	3200-3400
	21-15			C		S,I	2918-3029
	24-13			C			2550-2625
seamount	15-15- 9	+				S,I	2640-3000
	- 10	+	+		P	S	
Oki-Daito	15-11- 2	+			P		2880-3700
	- 12	+			P	S	
	- 16	+			P	S	
	21- 5- 2B	+			P	S,I	2730-2735
	-12B	+			P	I	
	21- 6- 4	+	+				1970-1980

+ : common - : rare

* including Mg-Al-sulphate hydrate mineral

Ar: aragonite D: dolomite C: calcite

P: phillipsite A: analcite

S: smectite I: illite

Discussion

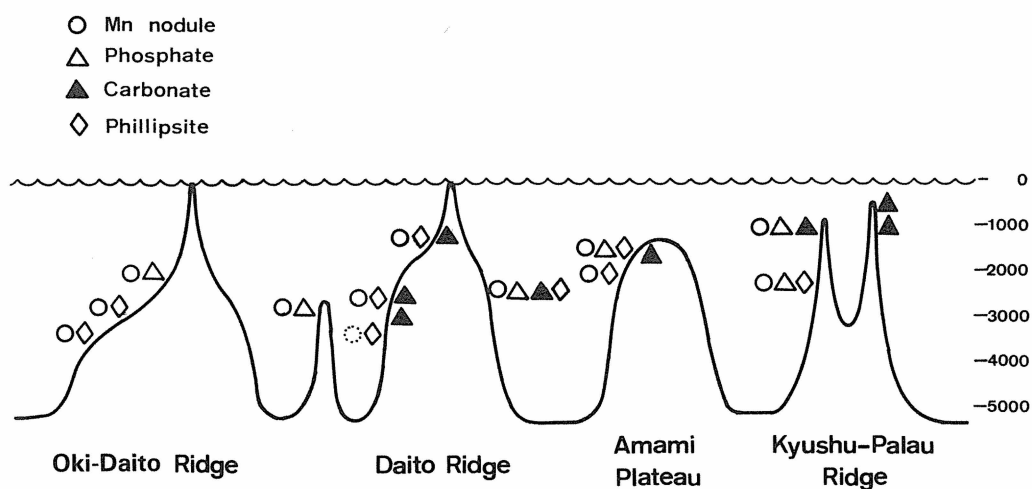
The sedimentary cover of the plateau and ridges of the Philippine Sea is partly composed of intermediate and basic pyroclastics. Therefore phillipsite and smectite included in those sediments may have been altered from volcanic materials.

Dolomitic limestone is found in the bottom samples of the Komahashi Seamount of Kyushu-Palau Ridge. Sampling depth was between - 535m to - 550m. It suggests that once the sea level was 500m lower than the present level, or that subsidence of Komahashi Seamount of about 500m took place.

Phosphate in oceanic sediments is generally considered to be generated under particular conditions and/or often replaces pre-existing carbonate. This phosphorous enrichment by upwelling water and decay of organic substances occurs in slightly reducing condition, and when pH value is below 7.5 under which condition carbonate would be generally unstable but phosphate still stable.

Table 2. Revision of the carbonate and phosphate rocks collected from the Northwestern Philippine Sea (GDP Cruises)

ORIGINAL DESCRIPTION	REVISED ROCK TYPE	AGE
Kyushu-Palau Ridge		
11- 2 ls	*dol.l.s	
11- 3 ls	ls	Mioc.
8- 7 phos.ls	phos.ls	Mioc.
8-12	phos.zeol.tuff.ms	
Amami Plateau		
11- 8 phos.r.	phos.zeol.ms	
11- 9 ls	ls	Eoc.
11-17 phos.r.(mtx)	phos.r.	Eoc.
11-17 phos.r.(mtx)	*zeol.ms	
Daito Ridge		
15- 2 phos.r.	(phos.)zeol.ms	
15- 3	(phos.)calc.zeol.ms	
15- 4 ls	ls	Eoc.
15- 7 phos.r.	*zeol.ms	
15- 8 phos.r.	*zeol.ms	
21-15 (pebble)	calc.ms	
24-13 calc.ms	calc.ms	Oligoc.
seamount		
15-15 phos.r.	(phos.zeol.)ms	
Oki-Daito Ridge		
15-11 phos.r.	*zeol.ms	Eoc. & Mioc.
21- 5 phos.r.	*zeol.ms	Eoc.
21- 6 ls & phos.r.	(calc.)phos.r.	Eoc.& Plioc.

**Fig. 1.** Schematic illustration of the occurrence of marine authigenic minerals in the Northwestern Philippine Sea.

Ferromanganese oxide coatings are closely co-existing with phosphate in the Philippine Sea. But the condition of phosphate production is not favorable to the precipitation of coatings. Therefore the environmental change from phosphate production to ferromanganese oxide precipitation must have occurred in the Philippine Sea. In the Kyushu-Palau Ridge, phosphorization of Miocene carbonate rocks was confirmed. Therefore, the environmental change may have occurred after Miocene. This event may be closely related to the development of the Philippine Sea.

References

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- RESEARCH MEMBERS OF THE GDP-21 CRUISE, 1977: Development of the geological study on the Daito Ridge Group Region (Report of the GDP-21 Cruise), *Marine Sciences/Monthly*, 9, 704–710, 773–783. (in Japanese with English abstract)