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IX. RELATIONSHIP BETWEEN LOCAL VARIATION OF NODULE FACIES AND ACOUSTIC STRATIGRAPHY IN THE GH81-4 AREA

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The growth of manganese nodules may be related to changes of sea-floor geological conditions as recorded in the substrates. Our knowledge of relationships of nodule characteristics to stratigraphy of sediments is much limited. Some comparative studies of nodule distribution with acoustic stratigraphy have pointed out evidences of relationship to substrates (TAMAKI *et al.*, 1977; CALVERT *et al.*, 1978; MIZUNO *et al.*, 1980). We made an attempt to find a rule of local variation of nodule facies in terms of 3.5 kHz SBP records in order to accumulate basic data on nodule genesis and mineral exploration. The seismic profiles of air gun was less available for nodule filed mapping because of less resolution, though the uppermost reflectors were consistently correlated to each other on both profiles.

According to the previous stratigraphic correlations to DSDP cores (sites 165, 166 and 170) established by TAMAKI (1977) in the northern Central Pacific Basin, the substrates of this area are composed of acoustic units: Unit I (uppermost transparent layer sometimes with internal weak reflectors), Unit II (semi-opaque layer) and acoustic basement (opaque). Unit I has three variable acoustic features: type A (entirely transparent), type B (generally transparent with concordant reflectors), and type C (generally transparent with flat turbidite beds). They have pointed out an abundant occurrence of nodules in the type A which is correlated to the Oligocene to Recent ooze and clay sequences. Nodule abundance is inversely related to thickness of Unit I of type A.

In the GH81-4 area, the sequence is identified to type A throughout, although underlain opaque layers may be variable (TANAHASHI, this cruise report). A marked correlation between nodule facies and acoustic stratigraphy was found around the abyssal hills. The local variation of nodule facies is again closely related to the thickness of transparent layer of Unit I as well as in the northern Central Pacific Basin. The thickness is variable ranging from zero to more than 300 meters (Table IX-1 and Fig. IX-1). The area of very thick transparent layer (thicker than ca. 80 meters) yields scarce nodules in the flat-floor basins. The great abundance is encountered only in the area of thin transparent layers (thinner than ca. 70 meters). However, it seems that the thickness of transparent layers is not always a unique factor controlling nodule abundance, because the abundance is quite variable at a given thickness between 10 to 70 meters (Fig. IX-1).

Another important rule on nodule facies and acoustic stratigraphy in detailed survey areas is that nodule type is clearly related to the development of Unit I (Area I in Fig. IX-2; Area II in Fig. IX-3). Nodules of type s are preferentially distributed in the area of no or scarce development of Unit I, whereas r-type nodules are related to the moderate development of Unit I. Apparent outcrops of older opaque layers are related

Table IX-1 Occurrence of manganese nodules and the thickness of acoustic transparent layer (TL).

Stat. No.	Sample No.	Abundance (kg/m^2)	Type	TL Thickness (m)
2576	FG310-1	0	-	160
	FG310-2	0	-	160
2577	FG313	0.1	Sr	80
2578	FG314	0.1	Sr	70
2579	P218	-	-	120
	FG315	0.1	Sr	120
2580	FG322-1	12.8	IDs•r, ISs•r, Ds•r	0
	FG322-2	0.4	IDs•r	0
2581	FG311	0.2	IDs•r	150
2582	FG312	0.8	Sr	80
2583	P220	-	Sr	10
	FG327	4.5	Sr	<5
2584	FG326	0	-	170
2585	FG323	0	-	140
2586	P219	0	-	30-60
	FG321	-	-	0?
2587	FG318	0	-	120
2588	FG317	0.1	Sr	110
2589	FG324	0	-	140
2590	FG325	0	-	160
2591	P221	0	-	140
	FG333	0	-	140
2592	FG320	0	-	140
2593	FG319	0	-	140
2594	FG316-1	0.1	Sr, Dr	15-30
	FG316-2	2.1	IDr, IDPr	10-25
2595	FG332	0	-	>80
2596	P223	0	-	70
	FG342	0.4	Sr	80
2597	FG341-1	0.3	Sr	80
	FG341-2	0.1	Sr	100
2598	FG329	0.8	Sr	40
2599	FG328-1	0	-	150
	FG328-2	0	-	150
2600	P222	0	-	50
	FG340	0	-	40-50
2601	FG339	0	-	130
2602	FG330	0	-	150
2603	FG331	0	-	40

Table IX-1 (continued)

Stat. No.	Sample No.	Abundance (kg/m2)	Type	TL Thickness (m)
2604	FG336	0	-	140
2605	FG335	12.6	DPs•r, Ts•r, Fs•r, Ds•r	0
2606	FG334	0.3	Sr	60
2607	FG337	0	-	150
2608	FG338	4.9	Sr	40
2609	FG343	1.3	Sr	20
2610	FG344	0.1	Sr	80
2611	FG345	0.1	Sr	100
2612	FG346	0	-	20
2613	B57	0.1	Vr	20
2614	FG347	0.1	Vr	140
2615	FG348	0	-	160
2616	FG349	0	-	140
2617	FG350	0.1	(Dr)	140
2618	B58	0.1	Sr	140
2619	FG351	2.8	Sr, Dr	60
2620	FG352	9.6	Sr, Dr	100
2621	FG353	15.6	ISPs, IDPs, IDs, Is	0
2622	B59	15.7	IDPs, DPs	0
2623	FG354	0	-	0
2624	FG355	5.2	Sr, Dr	30
2625	FG356	11.4	Sr, Dr	40
2626	FG357	5.9	Sr	60
2627	FG358	5.8	Sr	70
2628	B60	8.8	Sr	0-30
2629	FG359	-	-	0
2630	FG360	0.3	Sr	50
2631	FG361	0.2	Sr	30
2632	FG362	9.9	IDs, IDPs	0
2633	FG363	15.1	IDs, IDPs	0
2634	B61	14.6	IDs, IDPs, Fs	10?
2635	FG364	10.2	IDs, IDPs, Is	0
2636	FG365	3.0	Sr	50
2637	FG366	0.6	Sr	70
2638	FG367	1.3	Sr	30
2639	B62	-	-	-
2640	FG368	14.8	Ds, DPs, IDs	0
2641	FG369	1.7	Sr	20
2642	FG370	0.2	Sr	30-40

Table IX-1 (continued)

Stat. No.	Sample No.	Abundance (kg/m^2)	Type	TL Thickness (m)
2643	FG371	0	-	100
2644	FG372	0.1	Sr	50
2645	B63	12.0	-	0?
2646	FG373	4.9	IDr, IDPr, Fr	0
2647	FG374	tr	(IDr)	0
2648	FG375	10.2	Sr, Dr	40
2649	FG376	10.4	Sr, Dr	0
2650	FG377	8.1	IDs•r, Ss•r, Ts•r	0
2651	P224	-	Ss	0?
2652	FG378	9.5	IDs, IDPs	0
2653	FG379	4.0	IDs	0
2654	FG380	15.1	IDs, IDPs	0
2655	FG381	18.0	Ss•r, Ds•r, Fs•r, IDs•r	0
2656	FG382	0.5	Sr	20
2657	B64	1.1	Sr	60
2658	FG383	tr	Vs	40
2659	FG384	8.9	IDs, Ts	0
2660	FG385	13.0	IDs, ISs, Vs	0
2661	FG386	10.5	Ss•r, Ds•r	0-20
2662	FG387	0.8	Sr	10
2663	P225	-	Ds•r	<5
2664	FG388	tr	Vs	80
2665	FG389	0	-	60
2666	FG390	tr	Dr	70
2667	FG391	0.3	Sr	80
2668	FG392	0.9	Sr	40
2669	B65	0.4	Sr	40-60
2670	FG424	3.3	Sr	0-20
2671	FG425	tr	Dr	120
2672	FG426	tr	Fr	330
2673	FG427	0	Vr	360
2674	FG428	0	-	360
2675	P230	0	-	360
2676	P226	0	-	150
	FG393-1	0	-	150
	FG393-2	0	-	150
2677	FG394	0.4	Sr	60
2678	FG395	0.1	Sr	80
2679	FG396	0.1	Sr	90

Table IX-1 (continued)

Stat. No.	Sample No.	Abundance (kg/m2)	Type	TL Thickness (m)
2680	FG397	0.1	Sr	90
2681	B66	0.1	Sr	110
2682	FG398	0	-	110
2683	FG399	0	-	60?
2684	FG400	tr	Sr	<5
2685	FG401	0	-	<5
2686	FG402	8.6	Dr, SEr, IDr, Fr	<5
2687	FG403	15.1	IDr, Dr	<5
2688	P227	0	-	110
2689	FG404	0	-	120
2690	FG405	tr	Sr	80
2691	FG406	0	-	0
2692	FG407	7.6	IDr, Fr	0
2693	FG408	5.7	Sr, Fr	10
2694	FG409	0	-	40
2695	B67	3.3	IDr, Fr	<5
2696	FG410	0.1	Sr	170
2697	FG411	0	-	120
2698	FG412	tr	Dr	110
2699	FG413	tr	Dr	90
2700	P228	0	-	110
2701	FG414	0	-	110
2702	FG415	tr	Vr	120
2703	FG416	0	-	120
2704	FG417	0	-	130
2705	B68	tr	Sr	120
2706	FG418	0.1	Sr	90
2707	FG419	0	-	<5
2708	FG420	0	-	<5
2709	FG421	0	-	<5
2710	FG422	0.2	Dr, IDr	<5
2711	FG423	9.6	IDr, IDPr	<5
2712	P229	-	IDr, IDPr	10
2713	D496	-	Sr, Dr, IDs	-

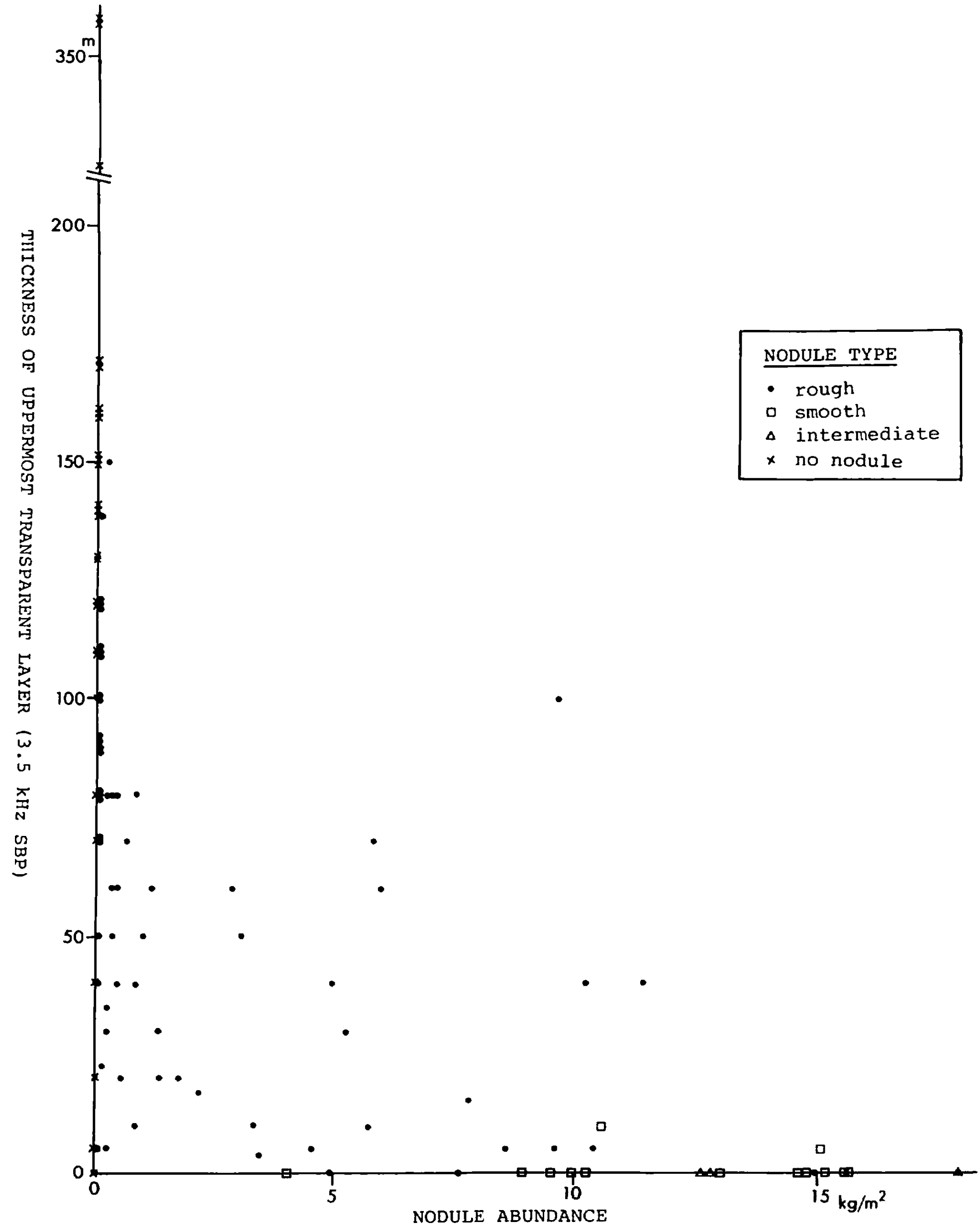

Fig. IX-1 Relationship between nodule abundance and thickness of the uppermost transparent layer (Unit I) on 3.5 kHz sub-bottom profiler records. Smooth surface nodules occur in the area of no transparent layer, rough surface nodules with transparent layers, and very thick transparent layers yield no nodule. Several anomalous plots may be due to positioning uncertainty during detailed sampling.

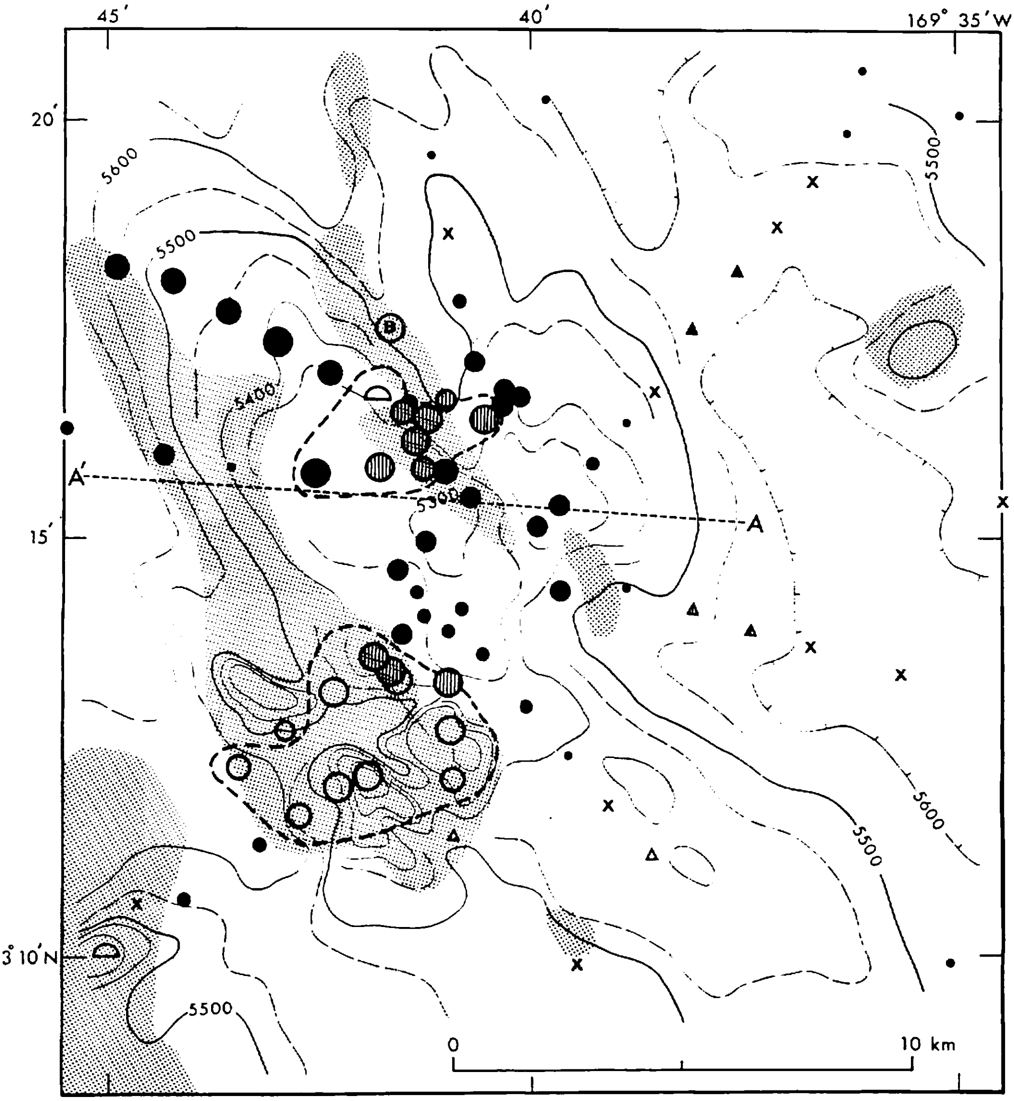

Fig. IX-2 Distributions of manganese nodules and outcrop of lower opaque layers (shadowed area on the map) in detailed survey area I. Thick dashed lines indicate high nodule coverage greater than 5%. Line A-A': approximate survey line of Fig. IX-4.

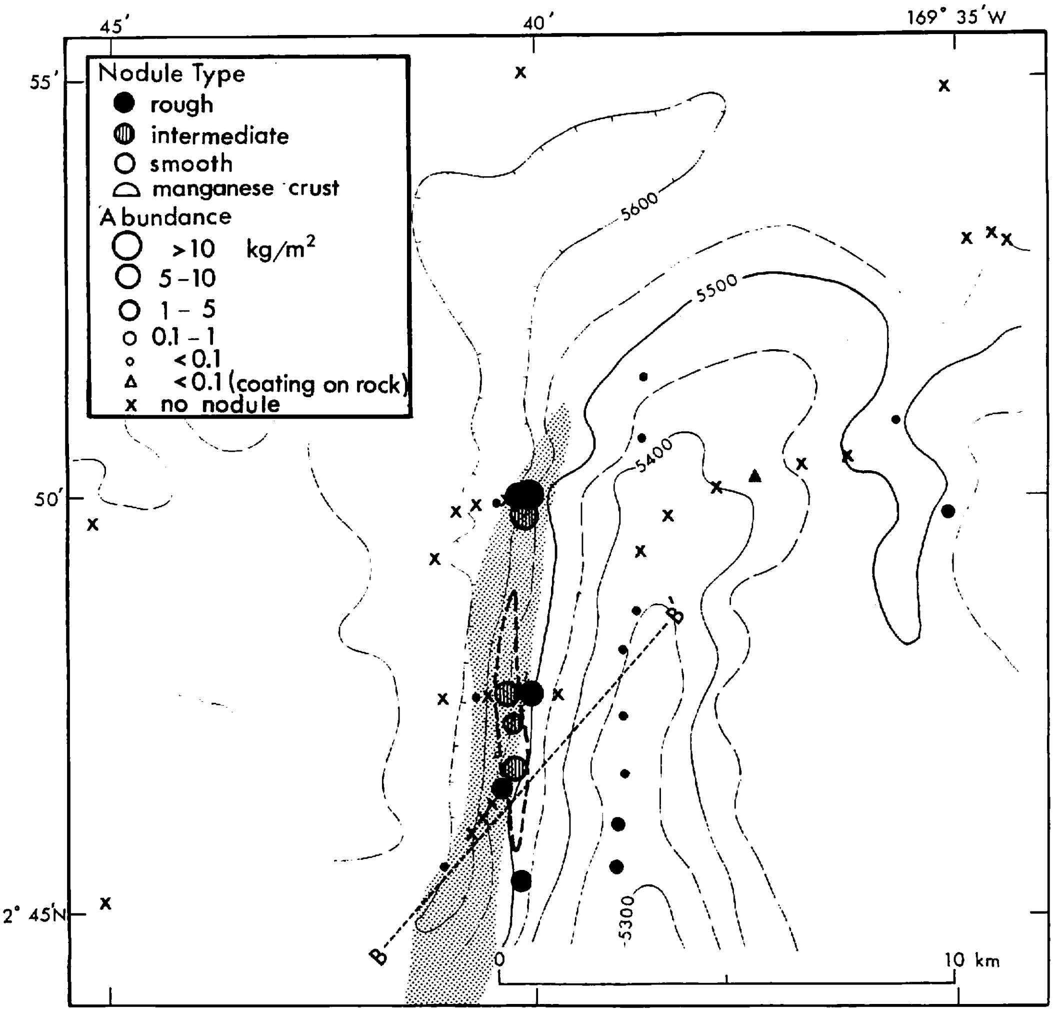

Fig. IX-3 Distributions of manganese nodules and apparent outcrop of lower opaque layers (shadowed area on the map) in detailed survey area II. Thick dashed lines indicate high nodule coverage greater than 5%. Line B-B′: approximate survey line of Fig. IX-5.

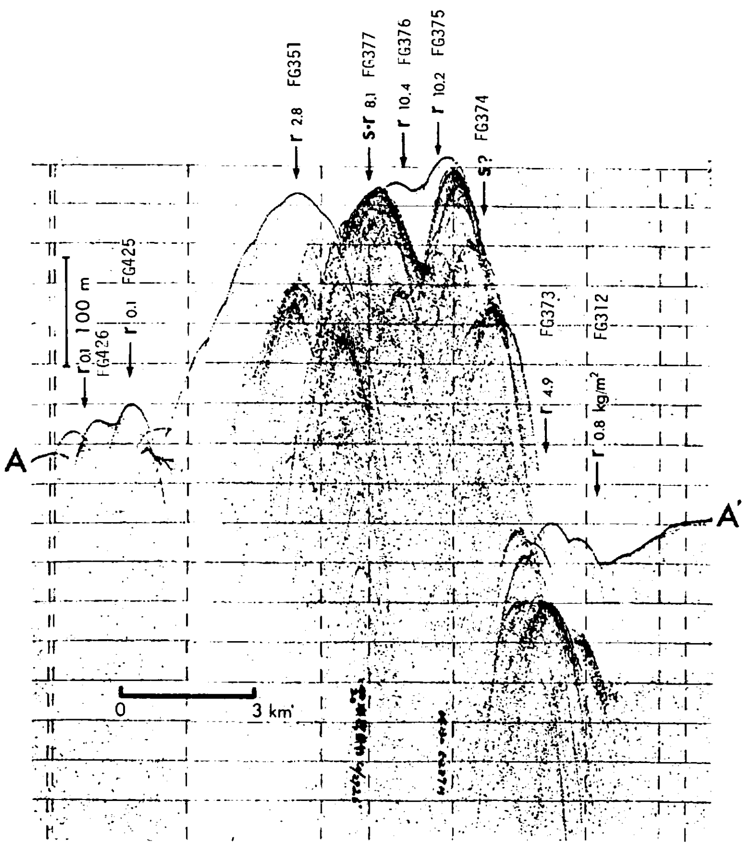

Fig. IX-4 Typical SBP profiles and nodule distribution in the area I. Sample number, nodule surface structure, and abundances are shown on each station (arrows).

to abundant distribution of type s, and developments of transparent layers to type r (Figs. IX-4 and IX-5). This clear relationship is consistent with the two supply route model for nodule formation; type s is composed of hydrogenous components derived from normal sea water and type r is of diagenetic components from unconsolidated biogenous sediments (USUI, 1979; HALBACH and ÖZKARA, 1979). No or scarce sedimentation appear to be a requisite for an abundant deposition of s-type nodules, while sedimention of siliceous sediments for the development of r-type nodules.

This relationship found in the GH81-4 area is generally similar to those found in the GH76-1, GH77-1, and GH79-1 areas, regionally in the northern Central Pacific Basin (MIZUNO *et al.*, 1980) and on the Wake-Tahiti Transect (USUI, 1982). Present and past variations of sedimentary conditions, which are probably caused by Antarctic bottom current, productivity of organic materials, movement of the Pacific plate, may have controlled this relationships. Detailed correlations of nodule variabilities to sediment stratigraphy should be discussed at each site, on the basis of nodule and sediment chronological data. Future comparative studies may elucidate some unsolved pro-

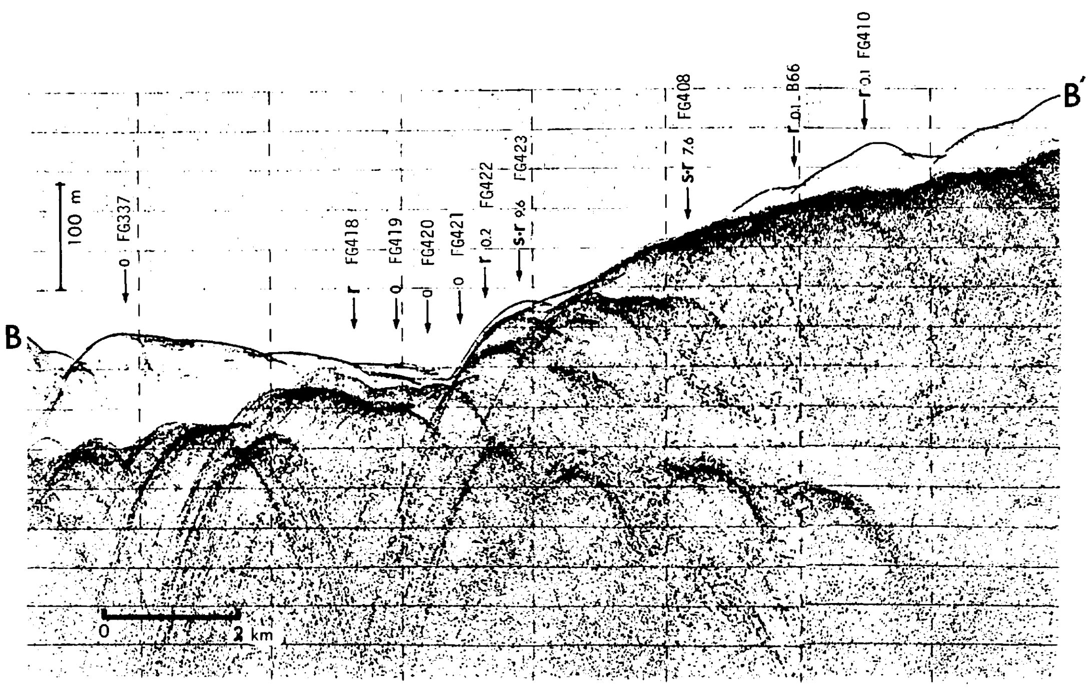

Fig. IX-5 Typical SBP profiles and nodule distribution in the area II.

blems; what are preferential conditions for s- and r-type nodules and to what extent upward lifting of nodules on sediment columns could take place.

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