IV. SUBSTRATE PROFILES BY 3.5kHz PDR

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Acoustic profiles of the substrates were obtained along all the tracks in the survey area by means of a Raytheon 3.5kHz PDR (subbottom profiler) with nine transducers and a correlation processor. This aimed at obtaining fundamental data on the correlation between manganese nodule distribution and the surficial sediment sequence and structure deduced from the 3.5kHz records in a joint consideration with continuous seismic reflection records simultaneously obtained. The present article is concerned only with the 3.5kHz records obtained, and their relation with nodule occurrences is discussed in another chapter (Chap. XVII).

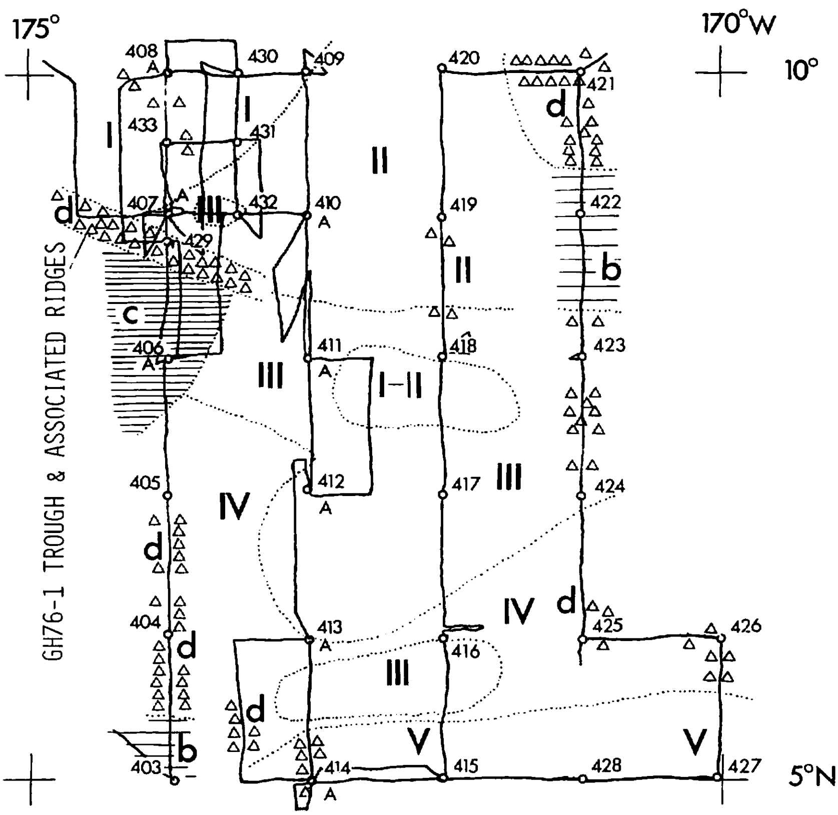

Fig. IV-1 Distribution of 3.5 kHz substrate types and of transparent layer thickness of Type *a* in GH76-1 area. *Substrate types*: b (coarsely hatched), Type *b*; c (finely hatched), Type *c*; d (with triangle), Type *d*; and the other area (with the symbols, I-V), Type *a*. *Thickness class of transparent layer of Type a*: I, less than 20 m; II, 20-50 m; III, 50-100 m; IV, 100-150 m; V, more than 150 m.

Results

Some 3.5 kHz layers can be discriminated in the GH76–1 area, and their acoustic pattern makes it possible to classify the substrate sequence into the following types: *a*) consisting of transparent and opaque layers, occupying the upper and lower portions of the profile respectively; *b*) intercalated with an irregularly layered opaque part within the transparent layer of Type *a*; *c*) the lower part of the transparent layer of Type *a* is substituted by a horizontally layered opaque part; and *d*) consisting only of an opaque layer. Among four types, *a*, *b*, and *c* may be roughly correlated with the seismic reflection types, A, B, and C of Unit I, respectively.

The areal distribution of the four types is shown in Fig. IV-1, together with the thickness distribution of the transparent layer of Type *a*.

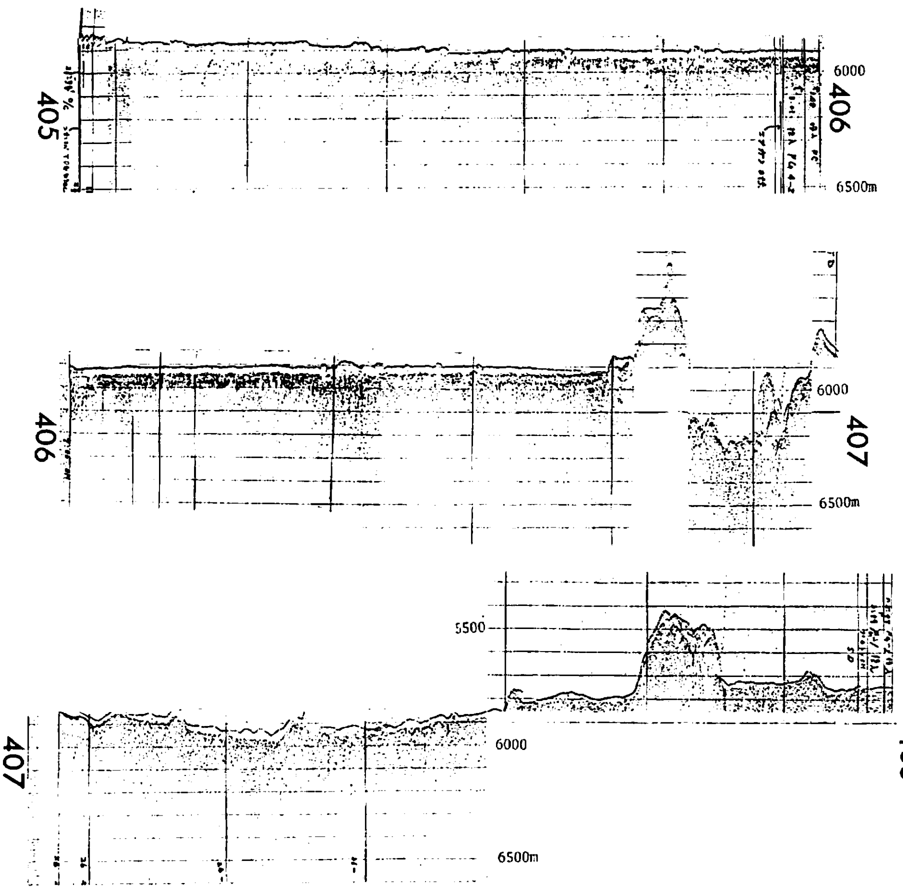

Fig. IV-2 3.5 kHz records along the meridian 174° (Sts. 405-406-407-408).
Type *a* with a rather thin transparent layer is distributed in the southern half of 405-406 and the whole track of 407-408. Type *d* is located within the GH76-1 Trough and on the abyssal hills north of the trough. The remaining parts, north and south of St. 406 are occupied by the Type *c* sequence.

Type a is most widely developed over the whole area. The sequence is composed of a transparent layer beneath the sea bottom and an underlying opaque layer. The boundary of both layers is typically clear, but in some cases it becomes obscure, and the bottom of the opaque layer can not be detected. In some profiles, a reflective layer is observed within the opaque layer. The thickness of the transparent layer ranges from less than 10 m to more than 150 m, and in some cases it abruptly varies from place to place. However, in many cases, particularly where there is a relatively thin transparent layer, the thickness tends to be rather constant over long distance.

As a whole, the transparent layer of Type *a* is thinner in the northern part of the survey area, generally less than 50 m thick, and less than 20 m in the northwestern part of the area (Fig. IV-2, 407–408). The thickness gradually increases southwards, and attains thickness of between 50–100 m in the medial part (Fig. IV-3, around 417–around 418), to 100–150 m in the southern part, and reaches more than 150 m in the southern extremity of the area (Fig. IV-4).

This general thickness distribution shows no definite relationship with bottom topography. However, as described later (Chap. VII), it is related to some extent with that of Type A of Unit I of the seismic reflection records, although the base of the 3.5kHz transparent layer probably represents a chert bed which might be expected in the lower part of the seismic reflection transparent layer. Also, it is likely that the 3.5kHz

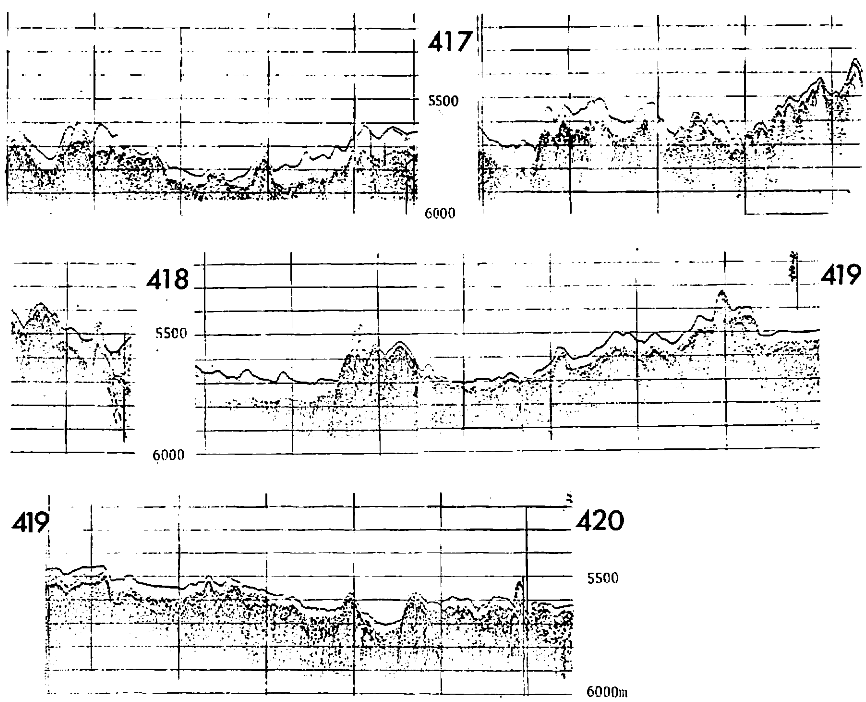

Fig. IV-3 3.5 kHz records along the meridian 172° (south of 417-418-419-420), showing the general tendency of northward thinning of the transparent layer of the Type *a* sequence.

transparent layer of Type *a* is largely composed of clay and/or ooze, from the DSDP results in Holes 166 and 170 after WINTERER, EWING, *et al.* (1973). According to our piston core sampling data (Chap. X), the uppermost part of the transparent layer consists of deep sea clay, so far as the northwestern area is concerned.

The opaque layer may be composed of various sediments of Paleogene–Cretaceous and basement basalt, but the discrimination of constituent sediments and rocks is impossible on the profiles.

Type b, found only at a part of northeastern area, is characterized by rather irregularly layered transparent and opaque parts on the 3.5kHz record. As seen in Fig. IV-5 at the environs of St. 422, the 3.5kHz record shows the existence of strikingly dark colored opaque layer beneath the transparent layer of several to 50m thick. The opaque layer continues to the topographic high which crops out to the north, and is underlain by a semi-transparent layer which irregularly covers the lowest opaque layer to the south. From consideration of this data with the seismic reflection records (see Figs. VII-8c and VII-9, around St. 422), layers other than a part of the lowest opaque layer seem to substitute for the whole transparent layer of Type *a*. Geological interpretation of this type is still very difficult, because to lack of sample evidence.

Type c is only locally developed in the western abyssal plain district. The sequence consists of a rather thin transparent layer and underlying upper and lower opaque

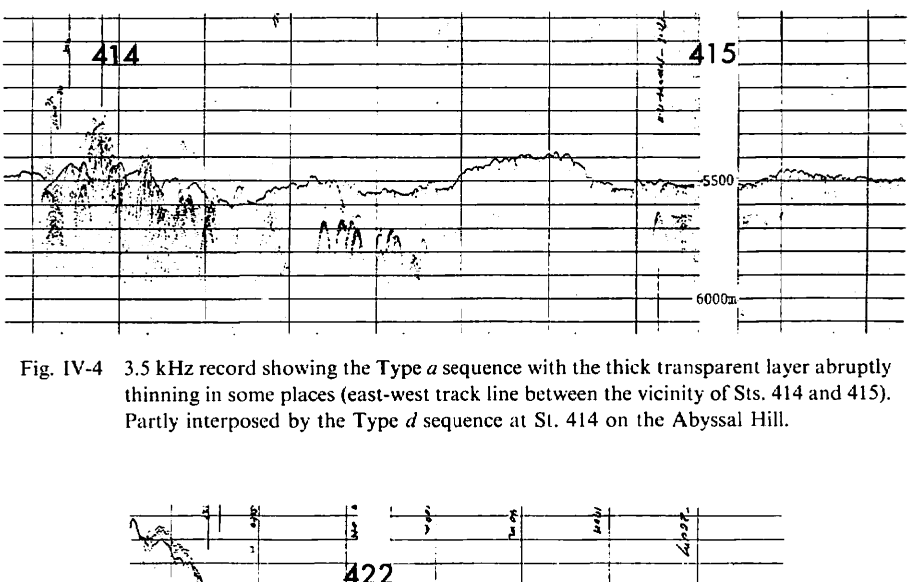

Fig. IV-4 3.5 kHz record showing the Type *a* sequence with the thick transparent layer abruptly thinning in some places (east-west track line between the vicinity of Sts. 414 and 415). Partly interposed by the Type *d* sequence at St. 414 on the Abyssal Hill.

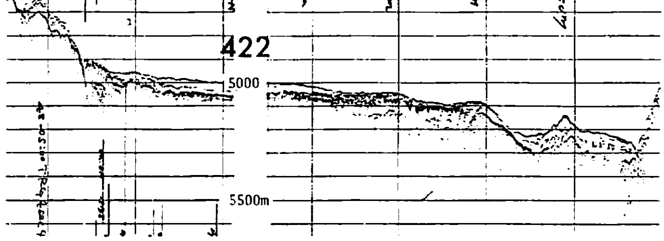

Fig. IV-5 3.5 kHz record near St. 422, showing the acoustic feature of the Type *b* sequence.

layers. A marked feature is the presence of the an opaque layer which seems to change laterally from the lower part of the transparent layer of Type *a* (Fig. IV-2. 405–406).

The upper opaque layer is characterized by the accumulation of very densely stratified thin layers of about 50–60 m in total thickness, which form horizontal layers on the records, clearly and evenly defined from the overlying transparent layer which is 30 m thick and gradually merges with the underlying lower opaque layer. The upper opaque layer abuts on to the ridge at the southern side of the GH76-1 Trough (Fig. IV-2, 406–407). A comparative examination with seismic reflection records shows that the upper opaque layer most likely represents a turbidite, although we have no drilling or sampling evidence to confirm this.

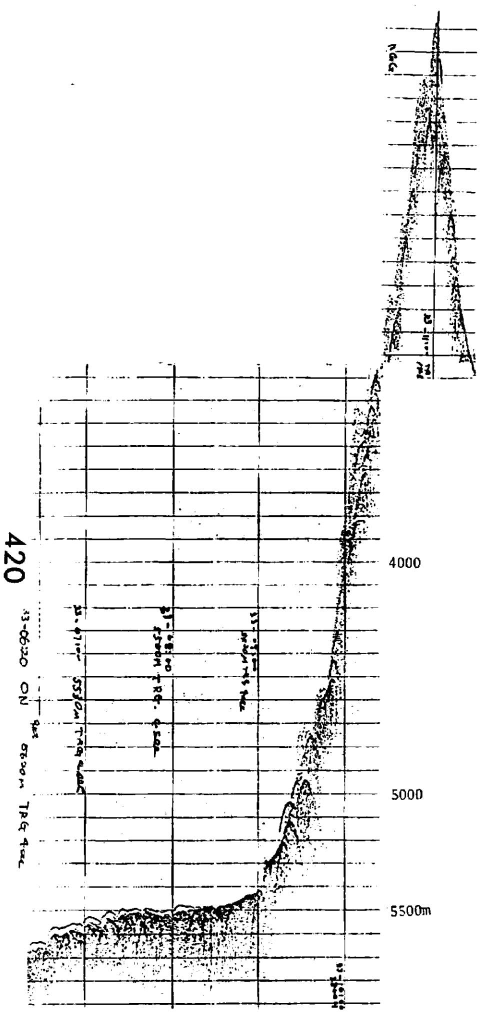

Fig. IV-6 3.5 kHz record showing Types *d* and *a* at the northeastern seamount district (east of St. 420). The Type *d* sequence is developed east of the vicinity of 33-09: 00 and the remaining area is represented by the Type *a* sequence.

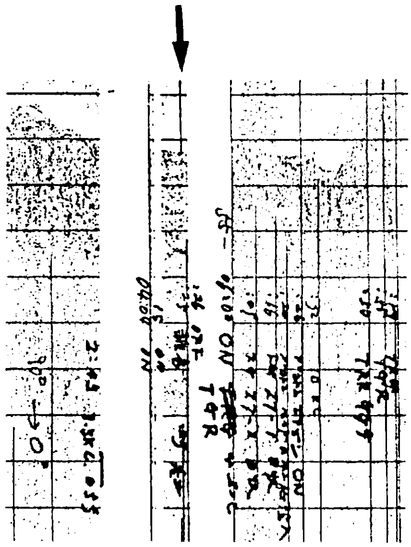

Fig. IV-7 3.5 kHz record at St. 429 in the GH76-1 Trough. Solid arrow shows the position of piston coring.

Type d, consisting only of opaque layer, is distributed on the seamount slopes and summits of the southwestern and northeastern seamount areas (Fig. IV-6), and also, on abyssal hills scattered in the deep sea basin districts (Figs. IV-2, south of 408; IV-4, around 414). It is noteworthy that many troughs in other areas, particularly in the eastern hill-trough district, are not characterized by this type on the 3.5kHz records. According to seismic reflection records, Type *d*, particularly at topographic highs, seems represent the outcrops of basement basalt or chert in most cases. However, a piston core sample from St. 429 (Chap. X) indicates that the uppermost 1 m thick part of the opaque layer of Type *d* consists of deep sea clay which is probably of Mid-Tertiary age at the GH76–1 Trough bottom.

In summary, the 3.5kHz substrate sequence is mostly represented by the Type *a* sequence consisting of two layers of transparent (upper) and opaque (lower) strata throughout the present area, and the transparent layer increases toward the south from less than 20 m to more than 150 m. However, this increase in thickness is disturbed near or at topographic highs by the Type *d* sequence which only consists of the opaque layer largely of basement basalt, in the western abyssal plain area by the Type *c* sequence which is a turbidite facies which substitutes the lower part of the transparent layer of Type *a*, and in a part of northeastern and southwestern areas by the Type *b* sequence which comprises on irregular opaque layer in the transparent layer. The geological interpretation of the substrate sequence is still difficult in most cases because lack of any direct sampling.

Reference

WINTERER, E. L., EWING, J. I., *et al.* (1973) *Initial Reports of the Deep Sea Drilling Project*, vol. 17, Washington (U. S. Government Printing Office), xx+930p.