

### **III. SUBSURFACE ACOUSTIC STRATIGRAPHY ON 3.5 kHz SBP RECORDS IN THE PENRHYN BASIN, SOUTH PACIFIC (GH83-3 AREA)**

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#### **Introduction**

Acoustic stratigraphy on 3.5 kHz subbottom profiling (SBP) records has been studied in order to clarify the distribution and structures of surficial sediments and is discussed in relation to lithologic units in core sequences and distribution of manganese nodules. The SBP acoustic survey proved very useful in understanding subsurface stratigraphy of the pelagic sedimentation in the Central Pacific Basin and has revealed the relation between thickness of uppermost transparent layers and manganese nodule abundance (Tamaki *et al.*, 1977; Usui and Tanahashi, 1992).

The SBP system, manufactured by Raytheon Co. Ltd., consists of nine transducers (TR75A), a transceiver (PTR 105A), a correlation processor (CESP II), and a graphic recorder (LSR 1811).

A 100-msec long acoustic pulse was transmitted every 6 seconds, and the ship speed during the survey was about 10 knots, and therefore, the trace interval (record spacing) is about 30 m on ship tracks. The reflected signal was recorded in 2-second range with a line density of 80 lines / inch. The thickness of unit is shown in meter assuming a sound velocity of 1500 m / sec in the sediments.

#### **Acoustic stratigraphy in 3.5 kHz SBP records**

The SBP survey was carried out along grid survey lines arranged in the N-S and E-W directions and at 30-mile intervals in the whole survey area (Fig. III-1) and at 3-mile intervals in the detailed survey area.

The following three acoustic units were recognized on the SBP records. The characteristics of the units are shown in Table III-1 and several examples of SBP records are shown in Figure III-2.

*Unit I* : The uppermost layer of acoustic unit is easily characterized by its transparency. The upper surface of this unit forms a strong reflector from sea bed. No internal structures and reflectors are observed.

*Unit II* : The semi-opaque layer below Unit I is distinguished as Unit II. This unit is sometimes exposed to the seafloor as a semi-transparent layer without overlying Unit I. The upper reflector of this unit is sharp but the lower boundary of this unit is relatively obscure. Rarely, the boundary between

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Keywords: sub-bottom profile, deep-sea sediment, acoustic stratigraphy, Manihiki Plateau, Hakurei-Maru, Penrhyn Basin



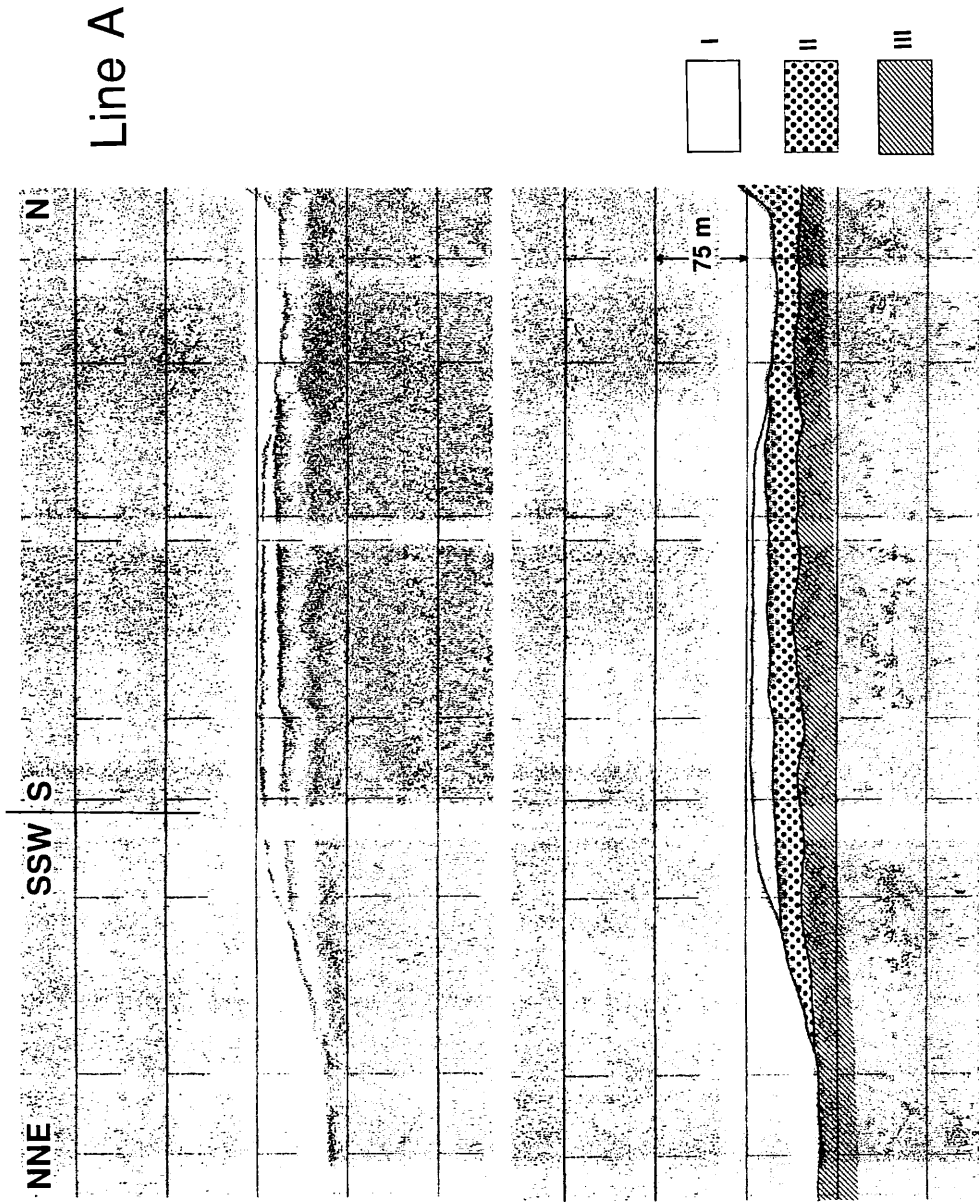


Fig. III-2 Typical 3.5 kHz SBP records (upper) and interpretation (lower), in the survey area of the Penrhyn Basin. The positions of the survey lines are shown in Figure III-3. I, II, and III denote acoustic Units.



Line C



Fig. III-2 (continued)

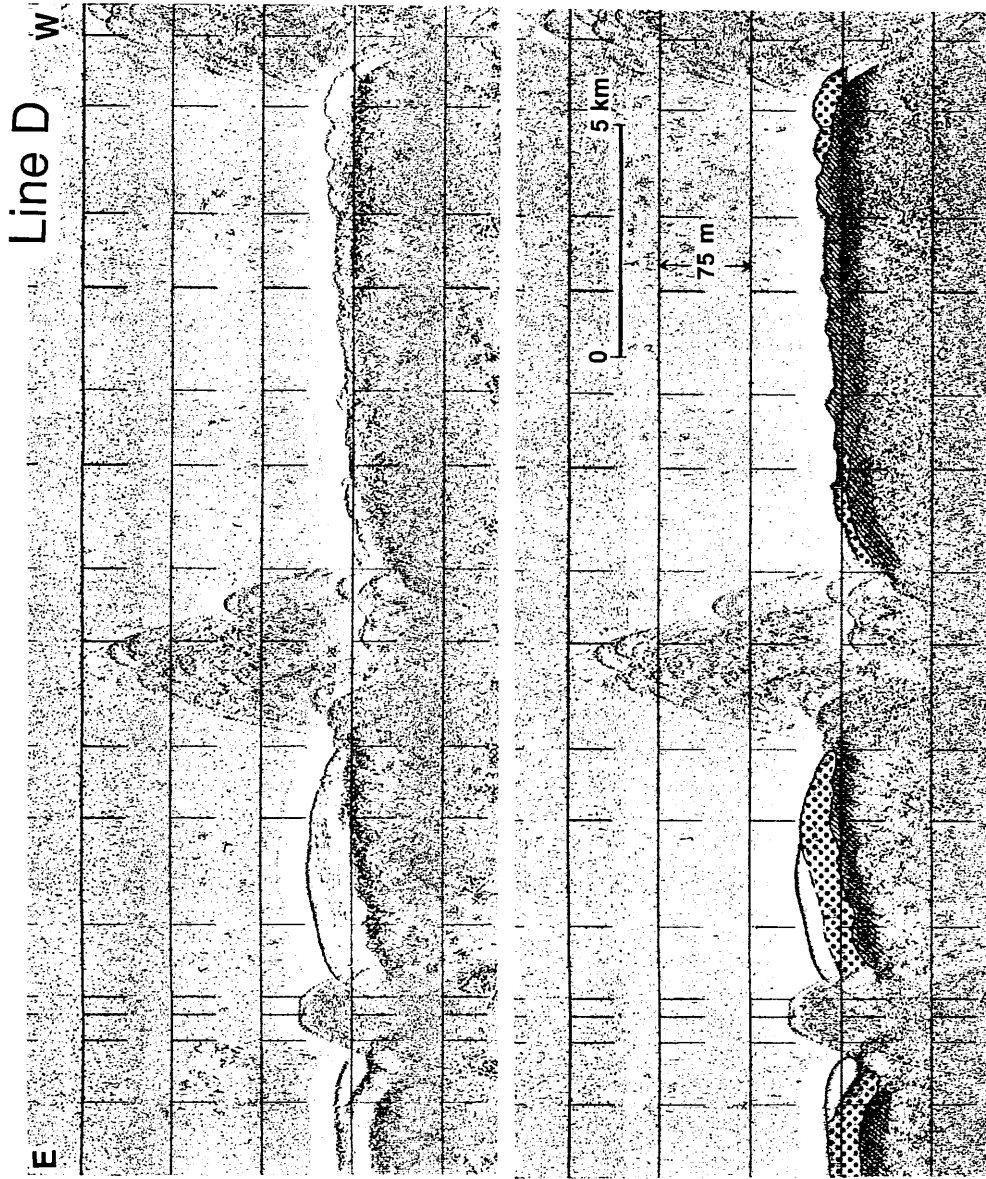


Fig. III-2 (continued)

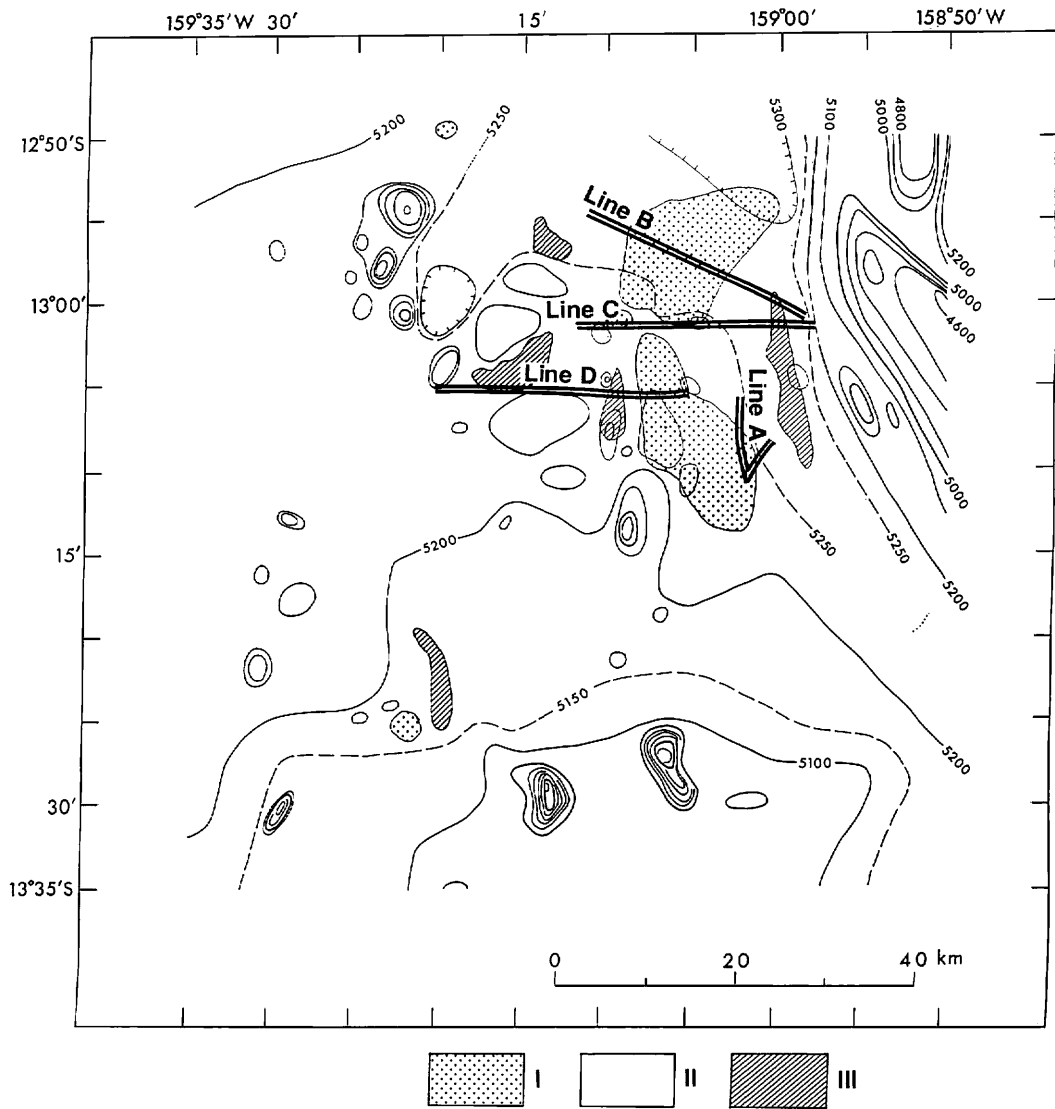


Fig. III-3 Distribution of acoustic units in the detailed survey area of the Penrhyn Basin. I: distribution of Unit I, II: outcropping of Unit II including outcropping of Unit III on the topographic highs with dense contours, and III: outcropping of Unit III.

Unit I and this unit is obscure and is recognized as a weak inner reflector in the continuous acoustic unit (central right part of Line C in Fig. III-2).

*Unit III* : This unit is an acoustic basement on SBP records. This unit is dark under the upper layers mentioned above and is sometimes exposed to the seafloor on and around topographic highs.

The boundary between Units I and II is clear but sometimes obscure with thick overlying Unit I. The boundary between Units II and III shows no sharp reflector but

is easily distinguished by the contrast of their transparency. The thickness of Unit I ranges from 0 to 35 m, and that of Unit II is rather uniform and usually around 15 m.

The distribution of the acoustic units mentioned above are mapped with topography in the detailed survey area (Fig. III-3).

Unit I of the air-gun seismic survey includes Units I and II of SBP and Unit II of the seismic stratigraphy is correlative to Unit III of SBP and underlying sedimentary sequences (Okuda, this cruise report).

### Correlation of acoustic stratigraphic units to lithologic units in core sequences

Sediment cores were recovered by a piston core and the core sequences are divided into three lithologic units (Nishimura and Saito, Chapter IV of this volume). Generally speaking, these units in the sediment cores are correlative to the SBP acoustic units based on coincidence of the core locations and the distribution of acoustic unit. The brief description of the lithologic units in cores are as follows.

*Lithologic unit I*: Unconsolidated dark reddish brown to dark brown pelagic clay and zeolitic clay.

*Lithologic unit II*: Consolidated dark brown to dark reddish brown pelagic clay.

*Lithologic unit III*: Alternation of yellowish brown claystone (siltstone) and semi-consolidated dark reddish brown pelagic clay.

The boundary between Lithologic units I and II is thought to be a hiatus in the core sequences, because the lithologic change is distinct and manganese crust or coat are sometimes observed at the boundary. There is no evidence for presence of hiatuses between Lithologic units II and III, which suggests continuous sedimentation.

The correlation between the acoustic stratigraphic units and the lithologic units are shown in Table I. The resolution of the SBP record is no less than a few meters. The Lithologic unit I was present at all sampling stations although Unit I is lacked on SBP records. But, underlain Lithologic units II and III were observed at sampling

Table III-1 The acoustic units of the surveyed area in the Penrhyn Basin on 3.5 kHz SBP records.

UNIT	3.5 kHz SEISMIC PROFILING RECORD	LITHOLOGY IN CORE SECTIONS	AGE
I	Transparent layer	Unconsolidated dark reddish brown zeolitic clay - pelagic clay	Recent - Oligocene
II	Semi-transparent layer (outcropped) Semi-opaque layer (below layer I)	consolidated dark brown to dark reddish brown pelagic clay	Eocene -
III	Opaque layer	Alternation of yellowish brown claystone (siltstone) and semi-consolidated dark reddish brown pelagic clay	Cretaceous



sites without Unit I on SBP records.

The age of the lithologic units are assigned by ichthyolith biostratigraphy (Nishimura and Saito, Chapter IV of this volume). The acoustic Unit I is assigned to the Oligocene age to Recent, and underlying Units II and III is to the Oligocene and older ages.

#### **Relation between acoustic stratigraphy and manganese nodule distribution**

In the northern Central Pacific Basin, the thickness of transparent layers of the uppermost acoustic unit has an inverse relationship to abundance of manganese nodules (Usui and Tanahashi, 1986). In this survey area, the uppermost Unit I is distributed at some restricted areas and the thickness of Unit I is rather uniform within the areas. The areas of low or no abundance of manganese nodules roughly coincides with the distribution of Unit I. The more details are discussed in chapter VIII (Usui, this volume).

#### **References**

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