ISSN 0110-5205

NZOI OCEANOGRAPHIC FIELD REPORT

No. 16 January 1981

SEABED INVESTIGATIONS, PORT TARANAKI

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Distributed on exchange

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INTRODUCTION

Dredging of the main shipping channel and entrance to Port Taranaki has been hampered in the past by the presence of boulders and, probably, rocky outcrops that presumably are submarine expressions of the laharic debris surrounding Mount Egmont (c.f. Lewis and Eade 1974). In view of the proposal to deepen the harbour floor a geophysical survey was undertaken to evaluate sediment distribution and stratigraphy with particular emphasis on the mapping of submarine outcrops and gravel deposits.

Port Taranaki occupies a broad embayment near New Plymouth on the coast north of Cape Egmont (Fig. 1). The port is protected by the main and lee breakwaters which are separated by the 0.55 km wide entrance. The three main wharves (Moturoa, Newton King and Blyde) are approached along a broad, northeast-southwest trending channel that is currently dredged to a maintenance depth of approximately 9 m.

Field work was carried out from the 6 m long, NZOI survey boat *Taraiti*. Bathymetric and continuous seismic profiles were made with a Raytheon profiling system (model DE 719B-RTT) equipped with 200 kHz, 7 kHz and 3.5 kHz transducers. Profiles extended along predetermined lines and the boat's positions were periodically fixed by sextant (Fig. 2). Profiles were examined for sub-bottom information and for morphological features of dimensions too small for portrayal on the bathymetric chart.

The area was also surveyed with a Klein side-scan sonar (model 400) which was run 5 m above the harbour floor along transects approximately 100 m apart (Fig.4). Positions along transects were fixed using shore-based theodolites. The instrument scanned 150 m either side of the towfish which produced considerable overlap between transects. This range proved useful in compiling a physiographic and sediment map of the harbour and in checking the validity of sonograph features, e.g., some "features" may be artifacts produced by electronic noise, reflections from the boat's wake, wave action etc. The width-exaggerated sonographs were converted to a 1 : 1 scale and sediment boundaries and other features were transferred to a base map (Fig. 4). Sonograph distortion, resulting from boat speed and towfish height above the harbour floor, was minimal as speed was only about 5 km h^{-1} and towfish height < 5 m. The estimated error of boundary location is ±15 m. Interpretation of sediment patches displayed on sonographs was aided by several grab (LaFond and Dietz 1948) and pipe-dredge samples.

BATHYMETRY

The harbour floor is essentially a broad, 8.5 -9.6 m deep trough that merges with the inner continental margin beyond the harbour entrance (Fig. 3). The northern side of the trough is cut by a 3 m deep, narrow trench that runs almost continuously along the base of the main breakwater (Fig. 3). The trench floor is irregular, being broken by pinnacles and/or ridges. Similarly, the main floor of the adjacent trough has an irregular morphology (Fig. 3) being roughly divided along its axis by a subdued ridge with up to 1.3 m relief. The northern half of the trough is broken by small banks and basins in contrast to the southern half where the relief is quite subdued. The southern limit of the trough has a steep wall that plunges directly to its floor near the harbour entrance, whereas near the wharf area the wall changes in slope at 8-9 m depth and descends at a gentler declination.

The seafloor beyond the confines of the harbour descends to the north at a slope of just over 1°. The bottom is locally rugged with up to 2 m of relief.

SEDIMENTS AND THEIR DISTRIBUTION

The sonographs reveal two distinct types of seabed with markedly different reflectivity characteristics (Figs 5-7). Zones of low reflectivity are mantled by moderate to well-sorted, fine sand with the following properties (based on analysis of five samples) -

textural class	fine sand [98.4% sand, 1.6% silt]
mean grain size	2.2 - 2.6 ϕ
sorting	0.57 - 0.73 ϕ
skewness	0.11 - 0.15

By contrast, highly reflective zones appear to be covered with gravel. Clasts, particularly boulders (> 256 mm diameter), are readily identifiable. The presence of gravelly deposits on the shore platform and intertidal areas marginal to the harbour tend to support this interpretation. Despite eight attempts to collect sediment with a pipe dredge, the only sample was a solitary, well-rounded cobble (90 mm maximum diameter) of andesite encrusted with bryozoans and serpulid worm tubes. Some zones of particularly high and dense reflectivity may be exposures of lithified laharic debris similar to that on the platform along the southern shore of the port. Such an interpretation, however, must be tested by sampling. For this report

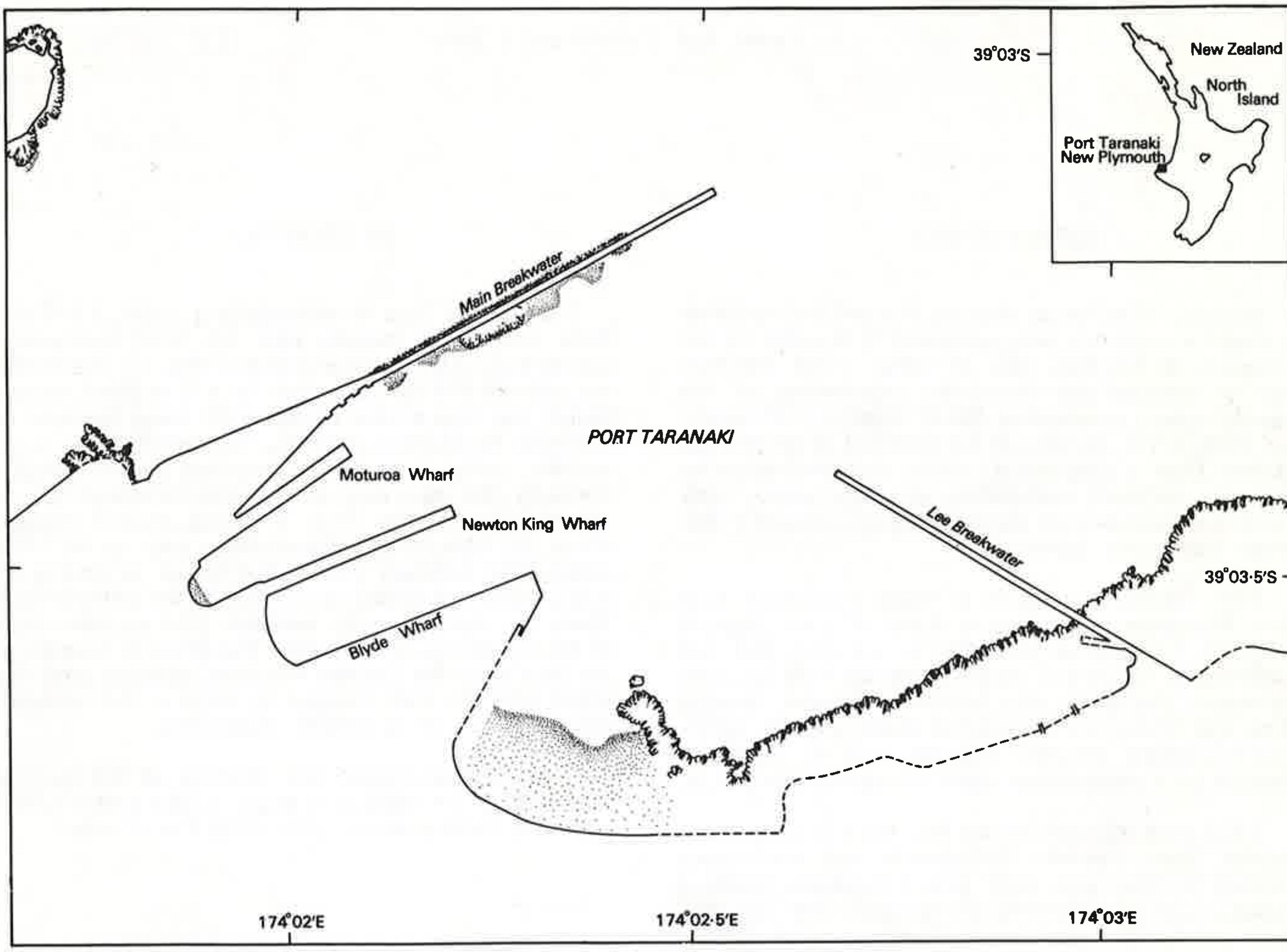

Fig. 1. Locality map; adapted from Hydrographic Office (1978); stipple represents nearshore sand and hatch represents rocky shore platform.

highly reflective zones are interpreted as patches of gravel while bearing in mind that some patches may be partly or wholly composed of bedrock.

(a) Main Channel and Entrance

The largest gravel patches are concentrated in a broad band that extends north-eastwards along the shallow, southerly reaches of Port Taranaki and north-north-eastwards beyond the lee breakwater, i.e., it approximates the trend of the shore platform (Fig. 5). Within the main channel, gravel patches are smaller and markedly fewer in number, the prevailing sediment being sand. Near the wharf area is a large, lobate patch of mixed sand and gravel which extends from the southern reaches of the main channel into the entrances of the two main berthage areas (Fig. 4).

The patches of gravel are generally irregular in outline and without distinct orientation (Figs 4-6). Boundaries with sand are usually sharp, which may be attributed to the slightly higher relief and/or rougher topography of the gravel patches. As previously noted from sounding records the gravelly areas have a rough, irregular morphology with patches standing up to 1 m above the general level of the sandy harbour floor which has a smooth featureless morphology. Nevertheless, the sand appears to be capable of covering the gravel, at least temporarily, as implied from

(i) lobate incursions of sand on to gravel patches; the inferred direction of incursion being the same as the known direction of sediment transport (south-westwards) and

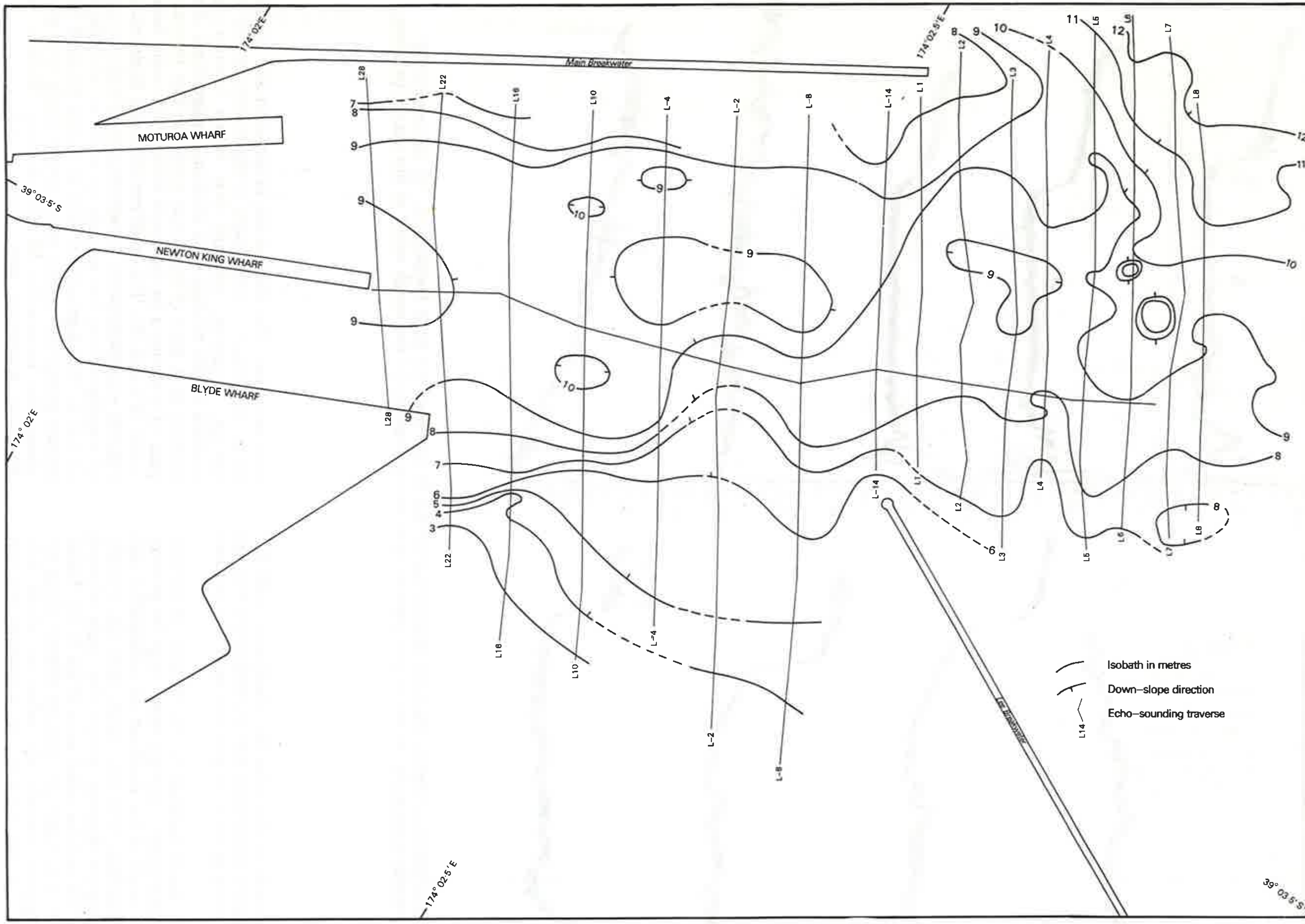

Fig. 2. Bathymetry of Port Taranaki with isobaths drawn at 1 m intervals.

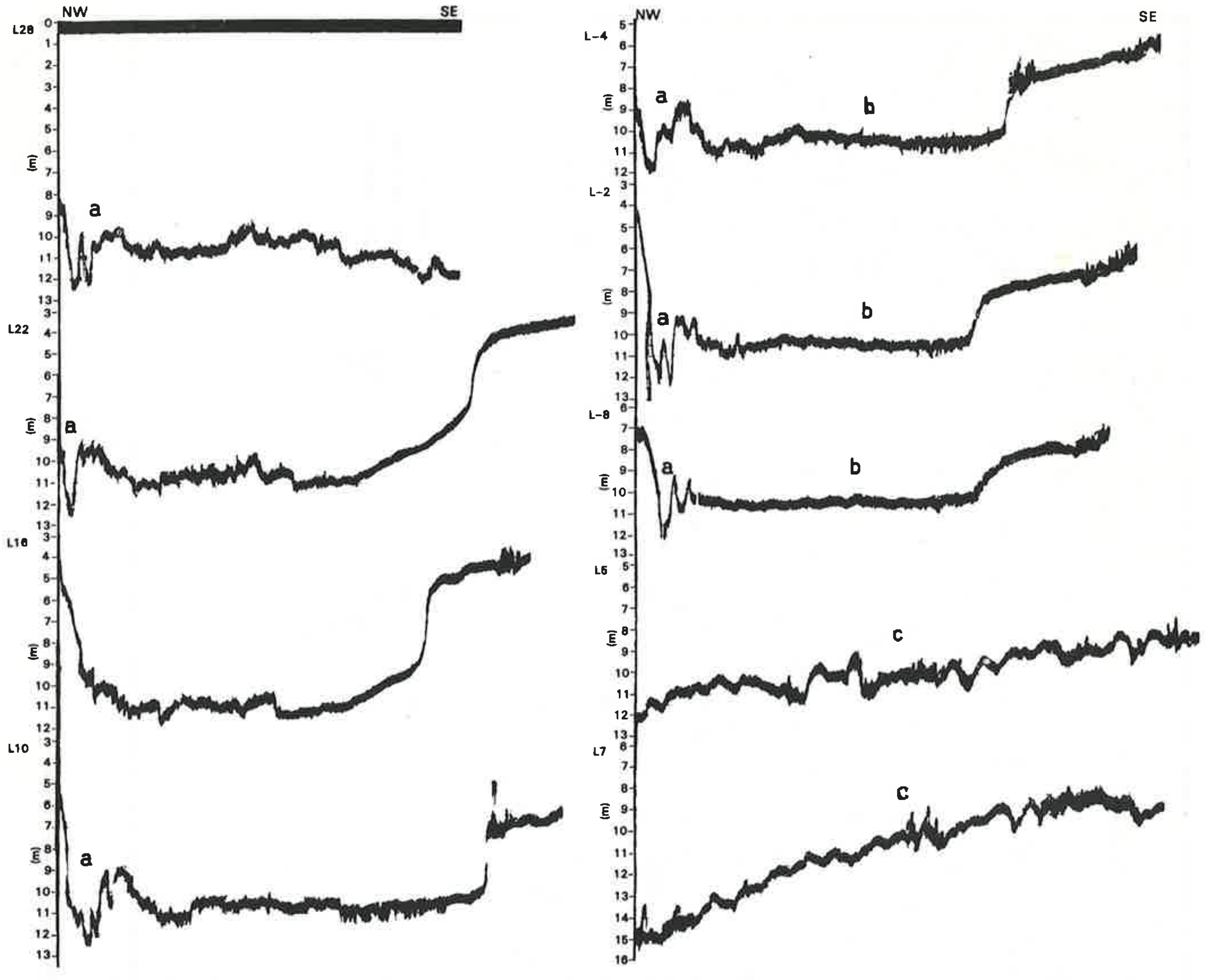

Fig. 3. Selected bathymetric profiles displaying (a) the trough near the main breakwater, (b) the relatively smooth topography of the sandy harbour floor as opposed to (c) the rough relief of the gravel patches.

(ii) patches, such as that near the wharf area, with diffuse sand/gravel boundaries and reflectivities that are lower than reflectivities of patches near the harbour entrance.

The sand itself appears to be devoid of natural sedimentary bed-forms although some may be present that are too small to be resolved on sonographs and bathymetric profiles. The side-scan, however, readily detected numerous furrows within the main channel between line L8 and the wharf area (Figs 5, 6). These features are 1-2 m wide and usually extend along the the main channel towards the wharves where they curve around and end, pointing back towards the harbour entrance. The dimensions, orientation and location of the furrows and observation of the movements of the dredge, *Ngamotu*, indicate that these features are suction trails produced by dredging operations. Also present is a tract of hummocky seafloor that follows a path of the trench on the south side of the main breakwater (Figs 3, 6). The most conspicuous features are roughly equidimensional depressions with axial lengths of usually 2-5 m, but ranging up to 10 m, with depths of 2-3 m. The depressions have probably resulted from bucket dredge operations which periodically take place along the breakwater (G. Greenstreet, Wallace and Partners, Auckland, pers. comm. 1980).

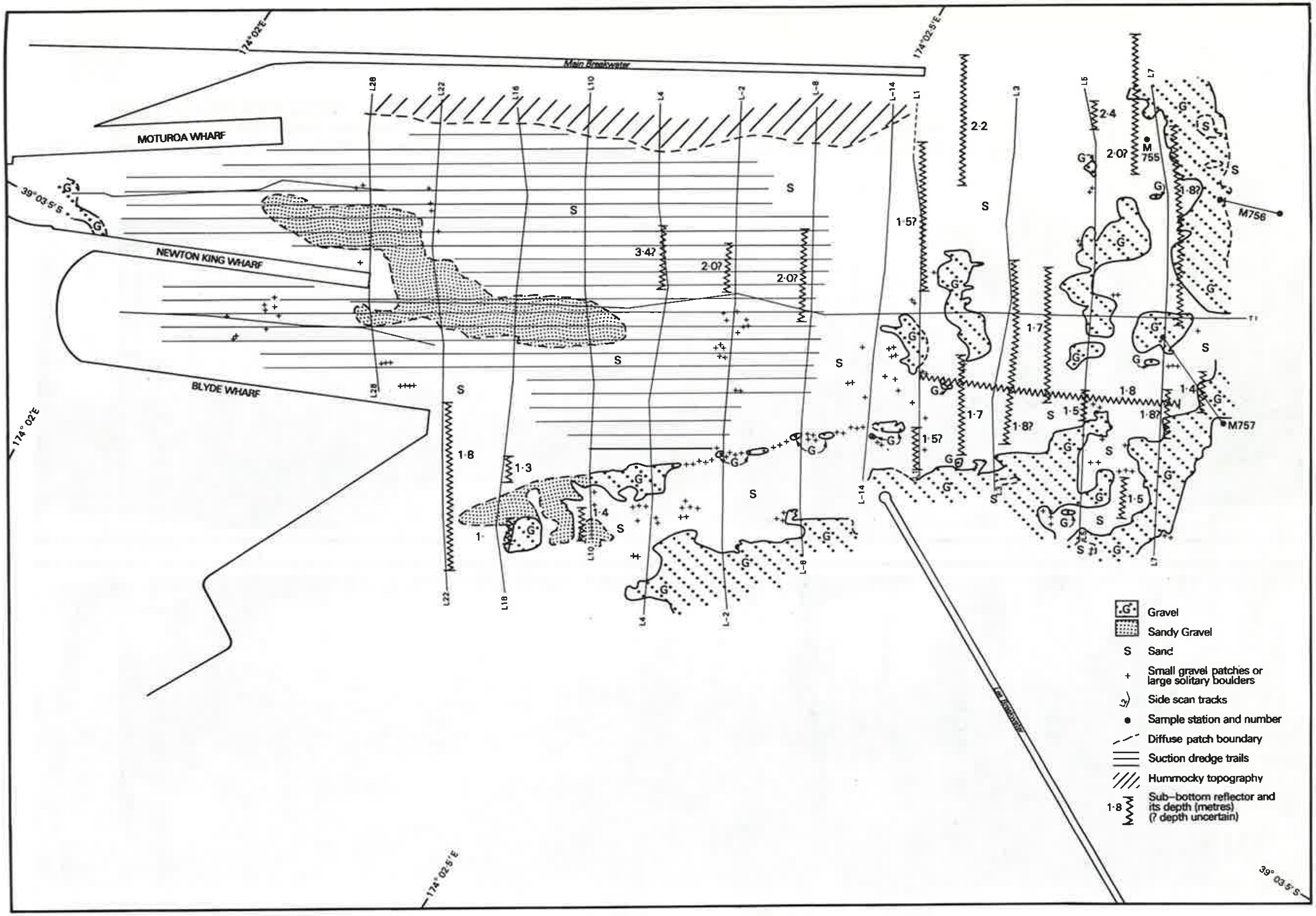

Fig. 4. Distribution of sand, gravel, individual boulders and prominent structures on the seabed as revealed by side-scan sonar. Also shown are the distribution and depth of subsurface reflectors as determined from seismic profiles.

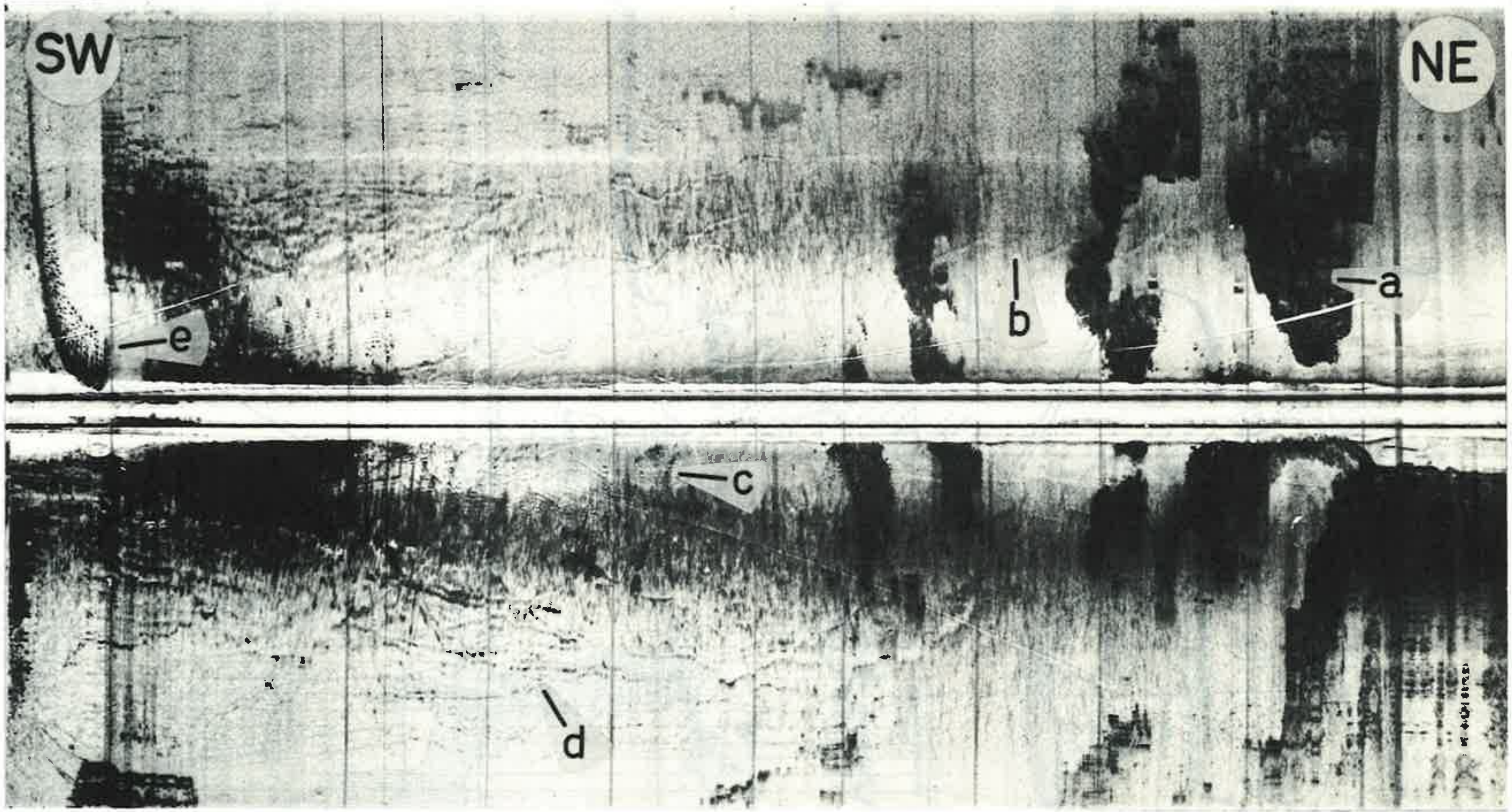

Fig. 5. Sonograph of line T_1, along the length of the shipping channel, displaying (a) gravel patches; (b) sand, (c) individual boulders; (d) trails produced by the suction dredge *Ngamotu*; (e) the end of Newton King Wharf.

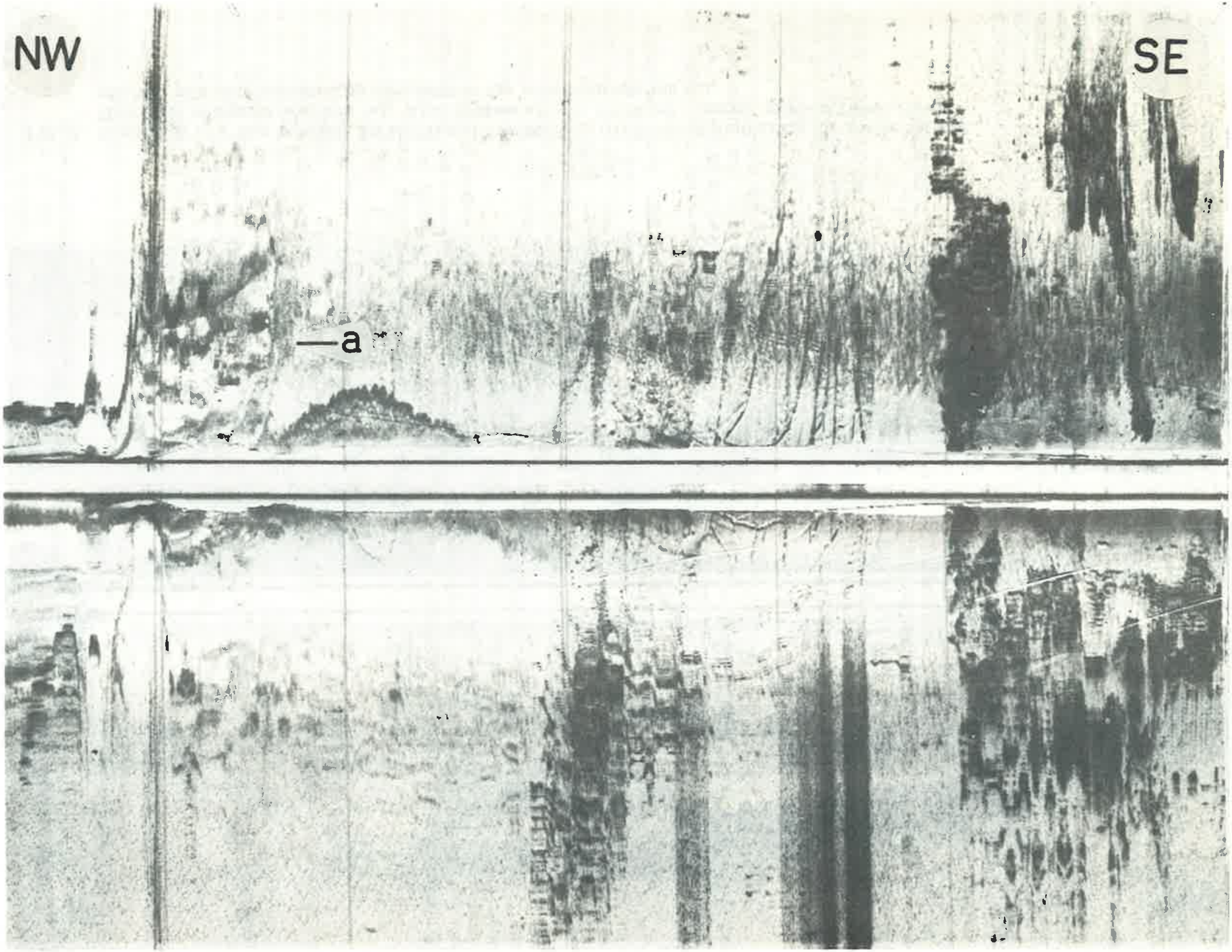

Fig. 6. Sonograph of line L10, across the main channel with gravel patches separated by sand which is locally scoured by dredge trails. Of note is the zone of hummocky topography (a) which coincides with the trough near the main breakwater.

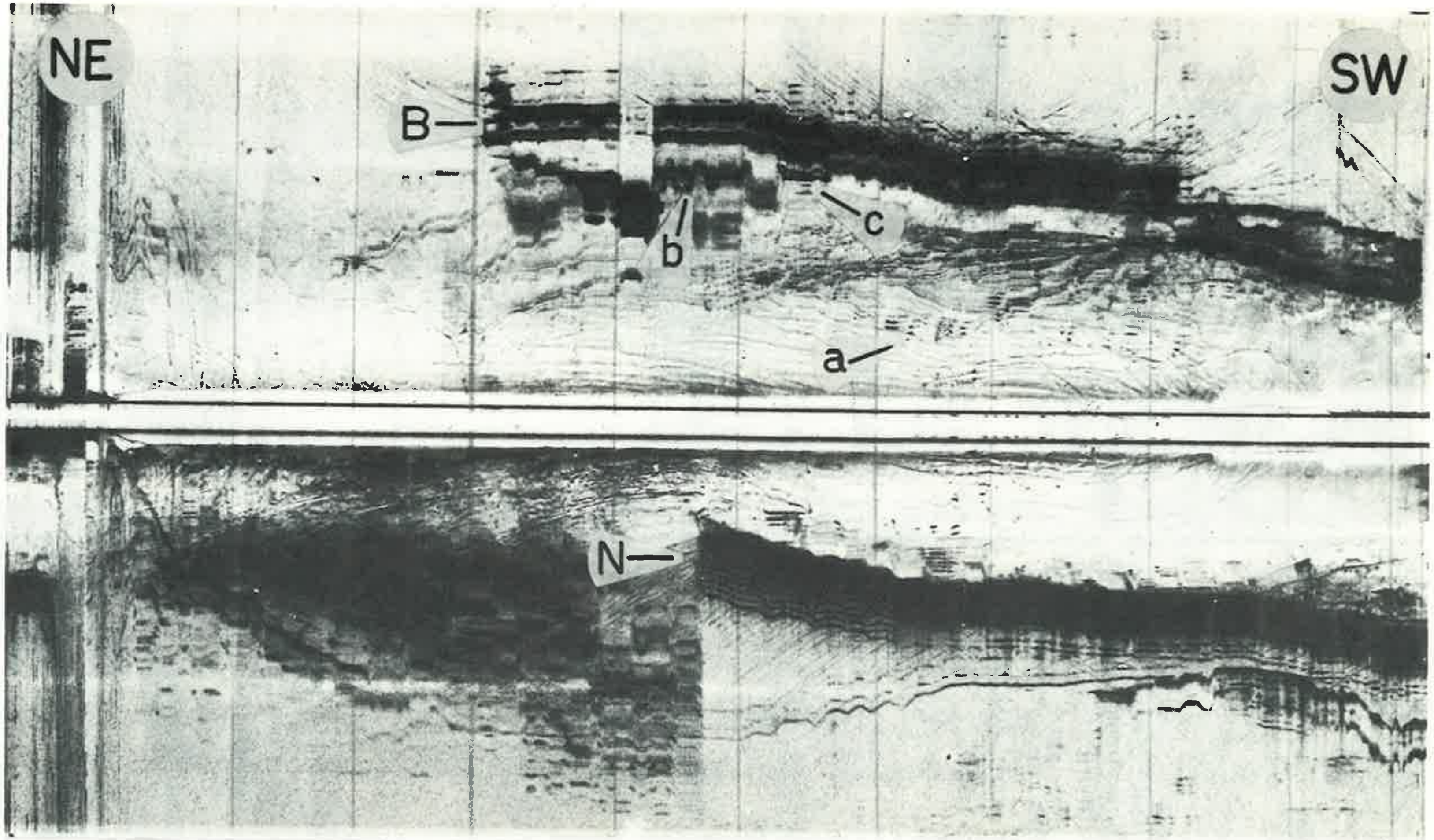

Fig. 7. Sonograph of a line between Blyde (B) and Newton King (N) Wharves displaying the sandy harbour floor with scattered boulders (a). Also evident are the V-shaped concrete piles of Blyde (b) and the hull of a ship distorted by movement of the side-scan towfish (c).

(b) Wharf Area

Side-scan sonar transects between the three main wharves reveal a predominantly sandy harbour floor with numerous suction dredge trails (Figs 4, 6). Apart from the sand-gravel sediment near the seaward end of Newton King Wharf the only other significant concentration of gravel is located near the shore of the basin bounded by Newton King and Moturoa Wharves. Elsewhere, gravel clasts of boulder size (maximum diameter measured 0.6 m) are thinly scattered throughout the wharf area. Approximate locations of large boulders are presented in Fig. 4.

SUBSURFACE SEDIMENTS

Over much of the harbour sub-bottom, seismic reflectors are not evident (Fig. 4). Those reflectors which are present have a patchy distribution with the majority concentrated around the harbour periphery especially in the vicinity of the lee breakwater and the entrance. Within the harbour only two small areas with reflectors are evident, viz. northwest of the wharves on the margins of the dredged zone and in the main channel just inside the harbour entrance.

Reflectors have similar characteristics, despite their patchy distribution, suggesting they are part of a widespread and continuous horizon; e.g., reflectors are parallel and usually 1.4-2.4 m beneath the harbour floor and commonly have an uneven surface with up to 1 m of relief over short distances of 5-10 m. In places they merge with the surface trace and may reach the the harbour floor.

Compilation of surface sediment distribution (from sonographs) and the subsurface reflectors enable some interpretation of the subsurface reflectors to be made. There is no seismic penetration over strongly reflective, gravelly areas. Shallow subsurface reflectors underlie the sand, particularly where it abuts against patches of gravel. The irregular morphology of the reflectors (similar to that of the exposed gravel patches) and their distribution suggest that the reflectors are subsurface extensions of these patches. [The results from the seismic survey should be treated with caution. While the reflectors are probably gravel and/or bedrock surfaces, the absence of reflectors in the main harbour basin does not necessarily mean there is no subsurface gravel or bedrock in these areas.]

Intertidal Platforms and the Shallow Sub-bottom Reflectors

Intertidal shore platforms have been cut in the agglomerate north of the lee breakwater. An echo-sounding traverse across the platform at high tide shows a low slope (1.0-1.4°) with a rough, irregular morphology. A change of slope occurs at approximately low water level, the rough morphology continuing down a steeper slope towards the gravel patches, mapped from the sonographs, north of the lee breakwater.

In a recent review of intertidal platform morphology Kirk (1977) notes that actively eroding platforms grade down to mean or low water level where they commonly terminate in a cliff. The change of slope around low water level at New Plymouth is probably the outer edge of the actively eroding platform. Shore platforms inherit much of their terrace-like morphology from planation at higher and lower sea levels (Kirk 1977). Thus, the gravel patches mapped from the sonographs are probably the surface expression of an older platform planed at a lower sea level. Much of this surface has been modified by sand brought into the harbour by the predominant littoral drift. Where this sediment cover is thin, particularly near the boundaries between sand and gravel patches, the profiles show that the platform extends under the sand.

CONCLUSIONS

1. The floor of Port Taranaki is mantled primarily by fine sand interspersed with irregular patches of either gravel or bedrock or both. The exact nature of these patches is uncertain but their morphology, their distribution with respect to the present shore platform, and a solitary sample of gravel suggest strongly that they are seaward extensions of the shore platform which consists of lahar-deposited, volcanic agglomerate with a patchy veneer of gravel.

2. Seismic profiles suggest that the gravel-bedrock horizon extends below the sand to a general depth range of 1.5-2.0 m. These, and evidence from side-scan sonographs, confirm that sand is actively covering the gravel-bedrock, especially in the main shipping channel.

ACKNOWLEDGMENTS

We wish to thank P.J. Hill for preparation of the side-scan sonar, Helen Battersby for draughting diagrams and D.P. Gordon and Mrs R.M. Thompson for editorial services.

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(Received for publication – 22 September 1980)