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SURVEY OF MARINE SAND DEPOSITS IN REMOTE AREAS OF LAGOON OFFSHORE NORTHERN TONGATAPU, KINGDOM OF TONGA

14-21 February 1984

by

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INTRODUCTION AND BACKGROUND

Prior to this 1984 survey, UNDP staff had completed four surveys for construction-grade sand offshore northern Tongatapu (Eade et al., 1978; Gauss, 1980; Gauss and Carter, 1982; Gauss, 1983). These surveys located two sand deposits containing an estimated 105, 000 m 3 of sand, most of which "would appear to be suitable for use as fine aggregate in concrete making" (Gauss, 1983). This volume of sand, used at the estimated rate of 8000 tons/year (Duphorn, 1981) would last for approximately 22 years. * Gauss (1983) recommended a trial dredging programme accompanied by environmental monitoring.

The present survey to locate additional sand bodies was conducted at the request of the Government of the Kingdom of Tonga as part of the CCOP /SOPAC work prograrrme element CCSP /TG. 6: Study of coastal, beach and near shore sand deposits to determine nature of known deposits and to locate new deposits suitable for construction, roading, landfill and other purposes.

OBJECTIVES

The offshore areas closest to Nuku'alofa were surveyed by the four previous studies. The present work was designed to extend the survey into more remote regions. Following the approach of the previous work, the

*This calculation assumes a sand density of 1. 7 tons/m^3 , as was reported by the New Zealand Concrete Research Association (NZCRA) for the sand samples collected in 1984.

first survey planned in the remote areas was reconnaissance side-scan sonar, with bottom sampling and diver observations at selected sites. Any extensive sandy areas, if present, would be resurveyed later by geophysics, vibrocoring and/or air jetting.

PERSONNEL PARTICIPATING

The following personnel participated on board the survey vessel:

Rubin	UNDP Marine Geologist (Engineering)
E. Saphore	UNDP Electronics Technician
S. Soakai	Trainee Geologist, Ministry of Lands, Survey and Natural Resources, Kingdom of Tonga.

Additional personnel of the Ministry of Lands, Survey and Natural Resources including Dave Tappin helped with logistical support. The crew of the vessel chartered for the work (the Robin) \lVere exceptionally helpful throughout the survey.

EQUIPMENT AND METHODS

The UNDP office provided the following equipment:

Klein 100 kHz side-scan sonar system
Trisponder radio positioning system
Inflatable dinghy with outboard engine
Diving equipment
Generators

The Ministry of Lands, Survey and Natural Resources arranged for charter of the vessel and crew. Transport of equipment was sanetimes by Government vehicle and sanetimes by public taxi.

Side-scan sonar surveying was conducted fran a chartered fishing boat. Positioning was by an electronic range-range dual transponder system and, when that system was observed to fail, by two horizontal sextant angles.

Sand samples were collected by SCUBA divers from the inflatable dinghy. Samples were analyzed for suitability as fine concrete aggregate by the NZCRA.

RESULTS

Side-scan sonar was used for reconnaissance surveying along the track lines shown in Figure 1. Throughout the region surveyed, the side-scan images show patches of sediment between reefs or rock outcrops. The sediment patches range in size from tens of square metres in predominantly rocky areas (Fig. 2) to tens of thousands of square metres containing only isolated reefs or rock outcrops (Fig. 3).

The large sand body in Maria Bay is partially covered with ripples having a wave length of approximately 1 ID. This large wave length suggests that the ripples are in a sand coarser than 0.6 rrm in mean diameter (Clifton, 1976). Diver investigation at two non-rippled sites on the Maria Bay sand body confirmed the side-scan interpretations -- no rock outcrops or patch reefs could be seen on the sea floor. Three samples collected at the two dive sites were sent to the NZCRA to evaluate their suitability for fine aggregate in concrete. 'IWo samples were too fine to be used in concrete. The third sample was found to be acceptable provided that the stockpiled sand is not allowed to become excessively dry (APPENDIX).

The total volume of useable sand in the Maria Bay sand body is unknown because the distribution and relative abundance of the different sand tyPes can not be determined from the limited samples. Neither is the thickness of the sand sheet known. At the request of the Government of the Kingdom of Tonga, no other samples were collected so that more side-scan records could be obtained. Consequently, nothing is known about the grain size of the other sediment bodies that we located.

CONCLUSIONS

Along the survey track lines the sea floor in the more remote areas of the Nuku'alofa Lagoon consists of patches of sediment between reefs or rock outcrops. Small sediment patches are present throughout the survey area.

Transects across larger sediment patches are shown in Figure 1.

One relatively large sand body occurs in Maria Bay. Sane of the sand there can be used to make concrete; some sand there is too fine. The distribution of useable sand there and in the other sediment bodies that were located will have to be determined by additional sampling.

FUTURE WORK

Before sand resources in these more remote regions of the Nuku'alofa Lagoon can be evaluated, a detailed grab-sampling programme is required. The most promising areas (i.e. the largest sediment patches) are shown in Figure 1. The Ministry of Lands, Survey and Natural Resources has requested that they conduct a sampling programme. If surficial samples are promising, sub-bottom sarrpling will have to be done by vibrocore or air jet.

These additional studies are of immediate use, however, only if a dredging site 10-20 kIn from Nuku'alofa is preferable to the previously identified sites which are as close as 2 kIn. A more direct solution to the sand-resource problem appears to be the pilot dredging programme discussed by Gauss (1983). Additional sampling in the more remote areas could proceed simultaneously, if still deemed necessary.

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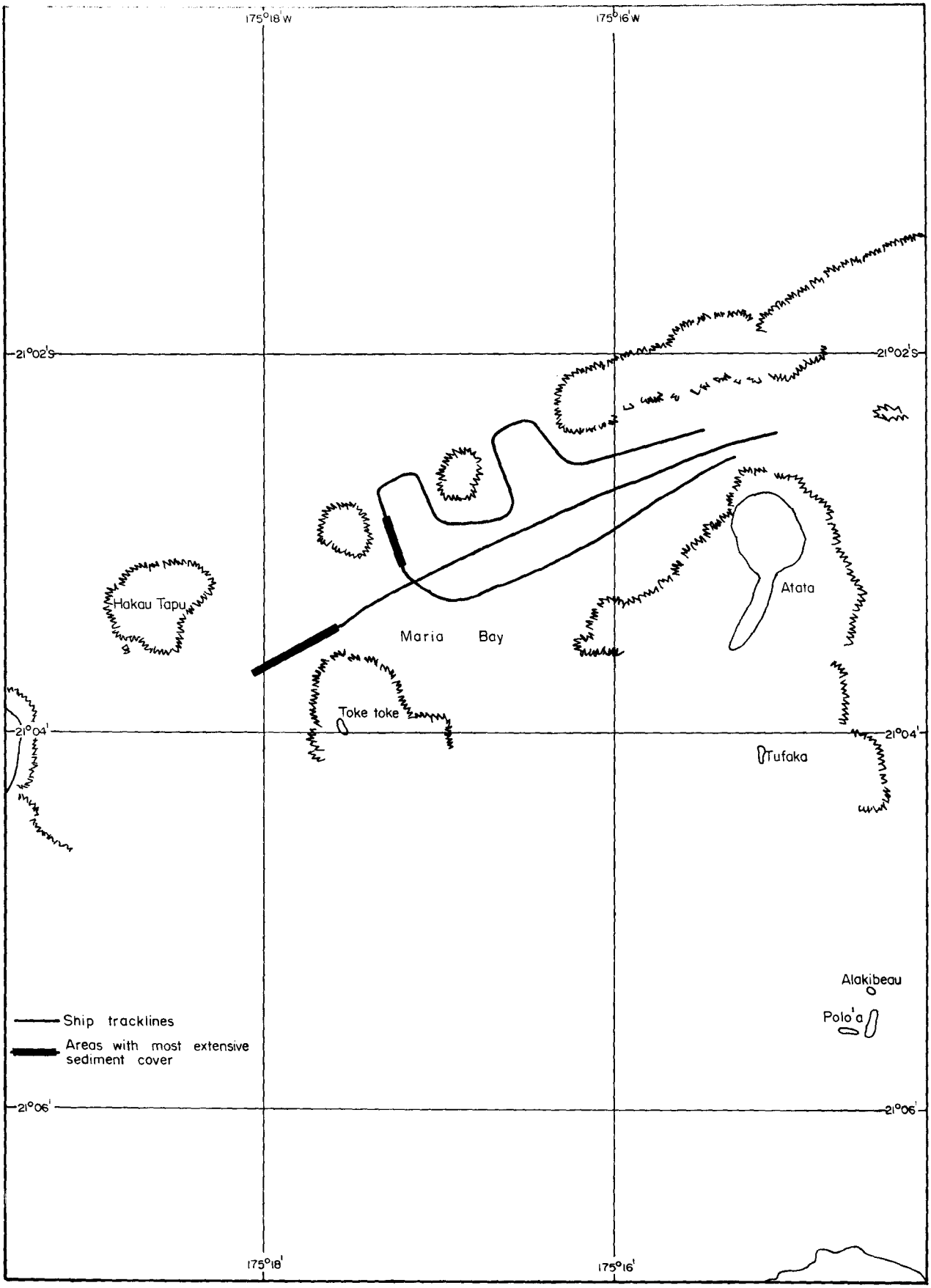


Figure 1A. Ship tracklines and locations of largest sediment-floored areas in Maria Bay.

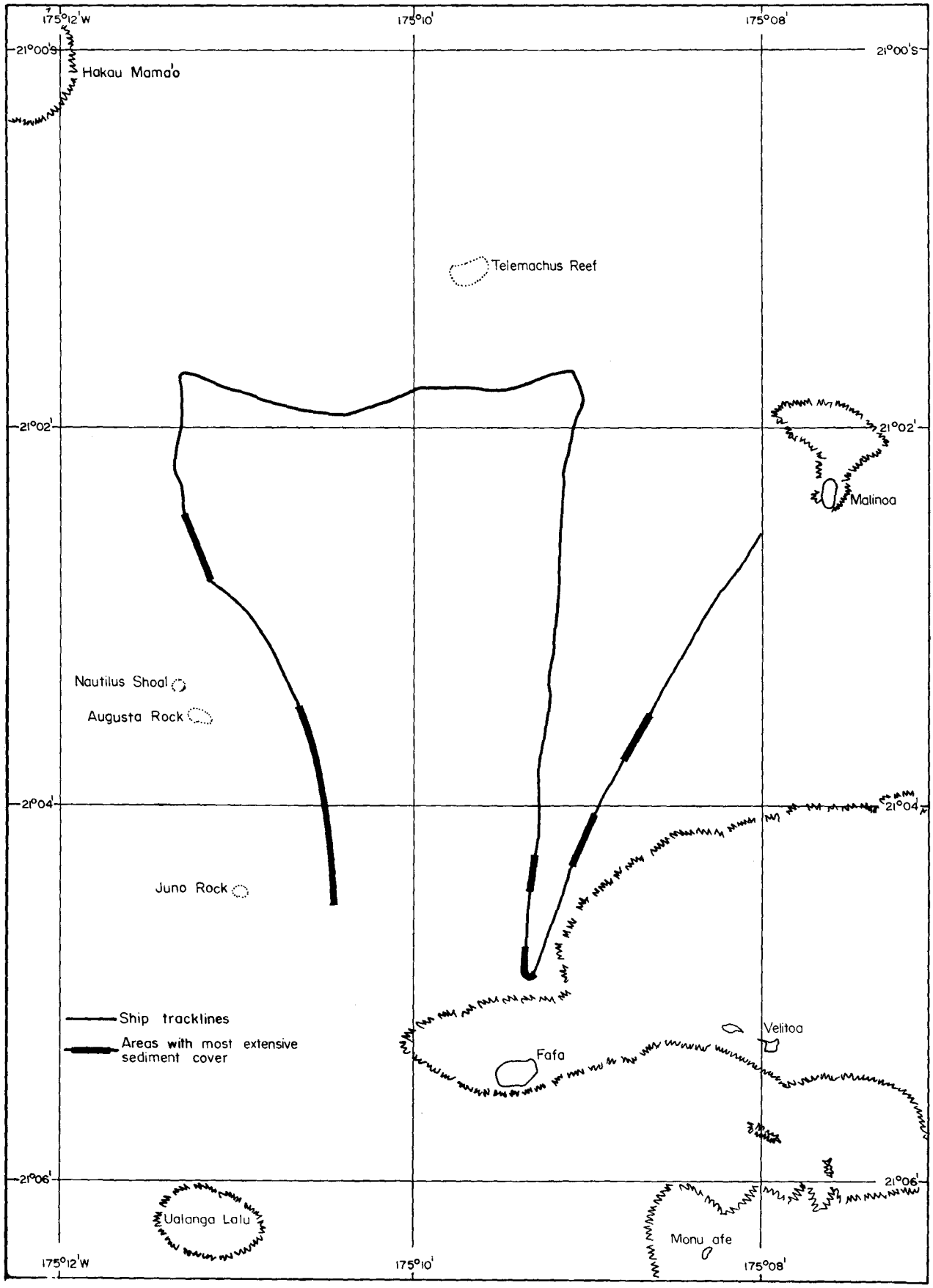


Figure 1B. Ship tracklines and locations of largest sediment-floored areas north of Fafa.

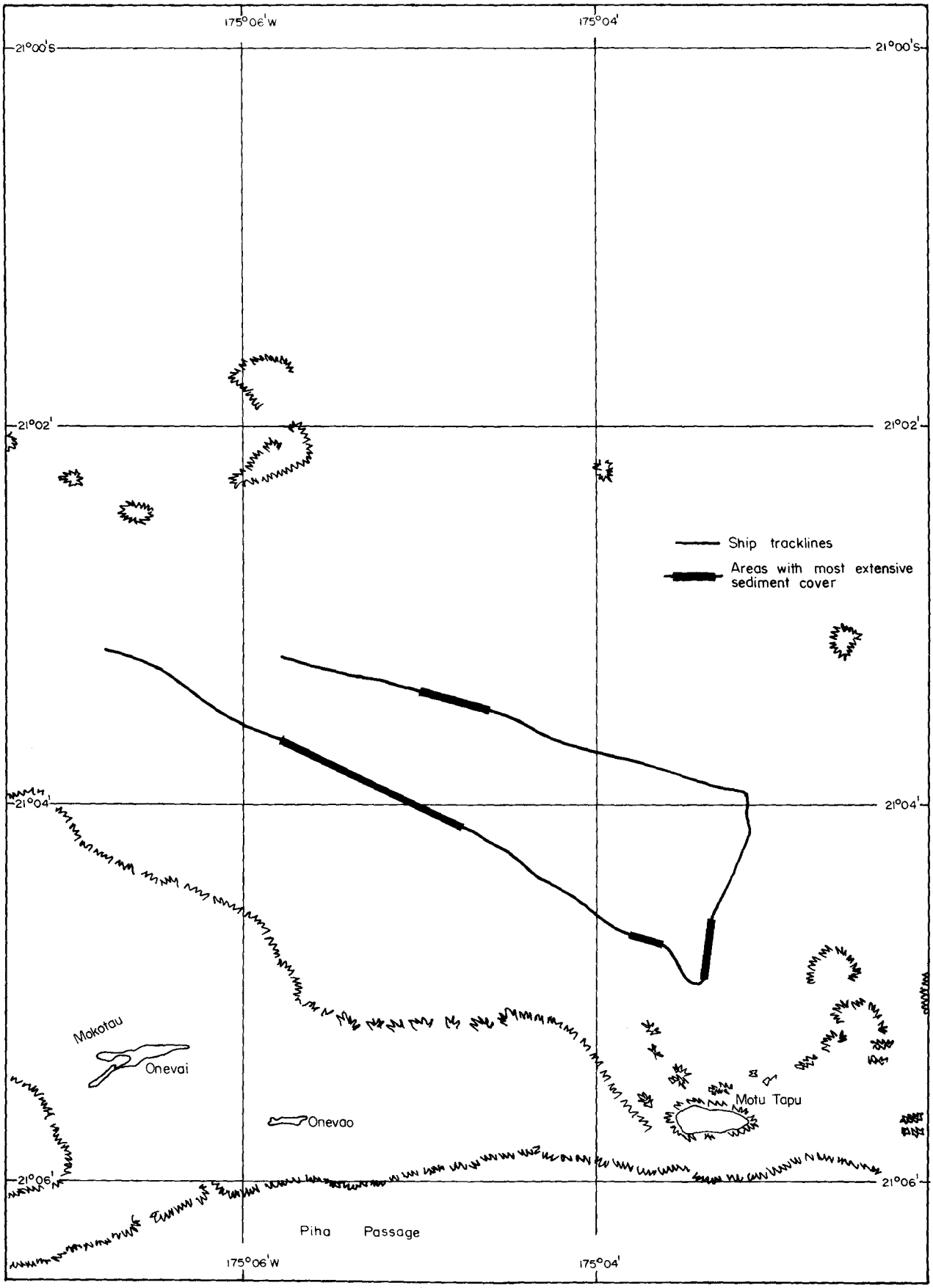


Figure 1C. Ship tracklines and locations of largest sediment-floored areas north of Onevai and Motu Tapu.

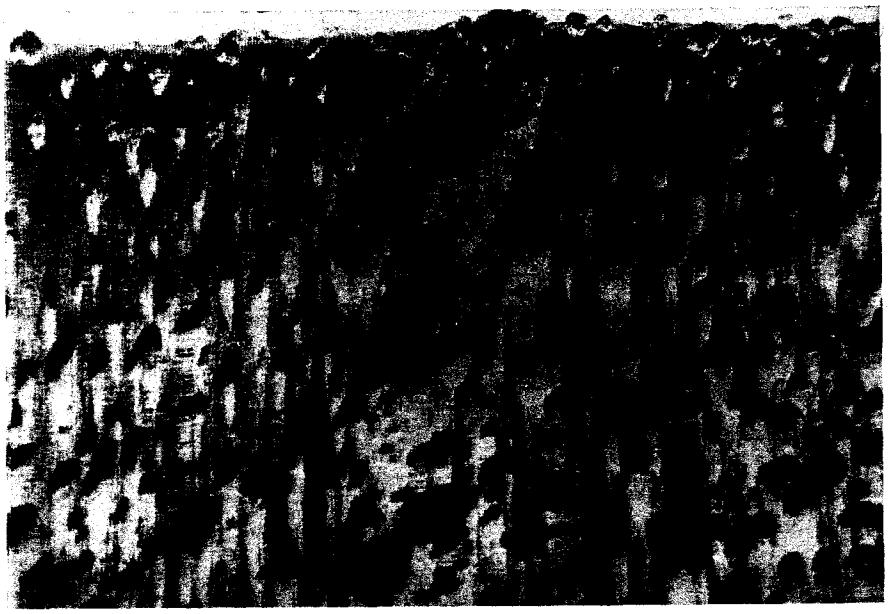


Figure 2. Side-scan sonograph showing patch reefs or rock outcrops (black with white acoustic shadows) and small sediment-covered areas (uniform grey shading). Area of seafloor shown is 100 m (top-to-bottom) by 400 m (across).

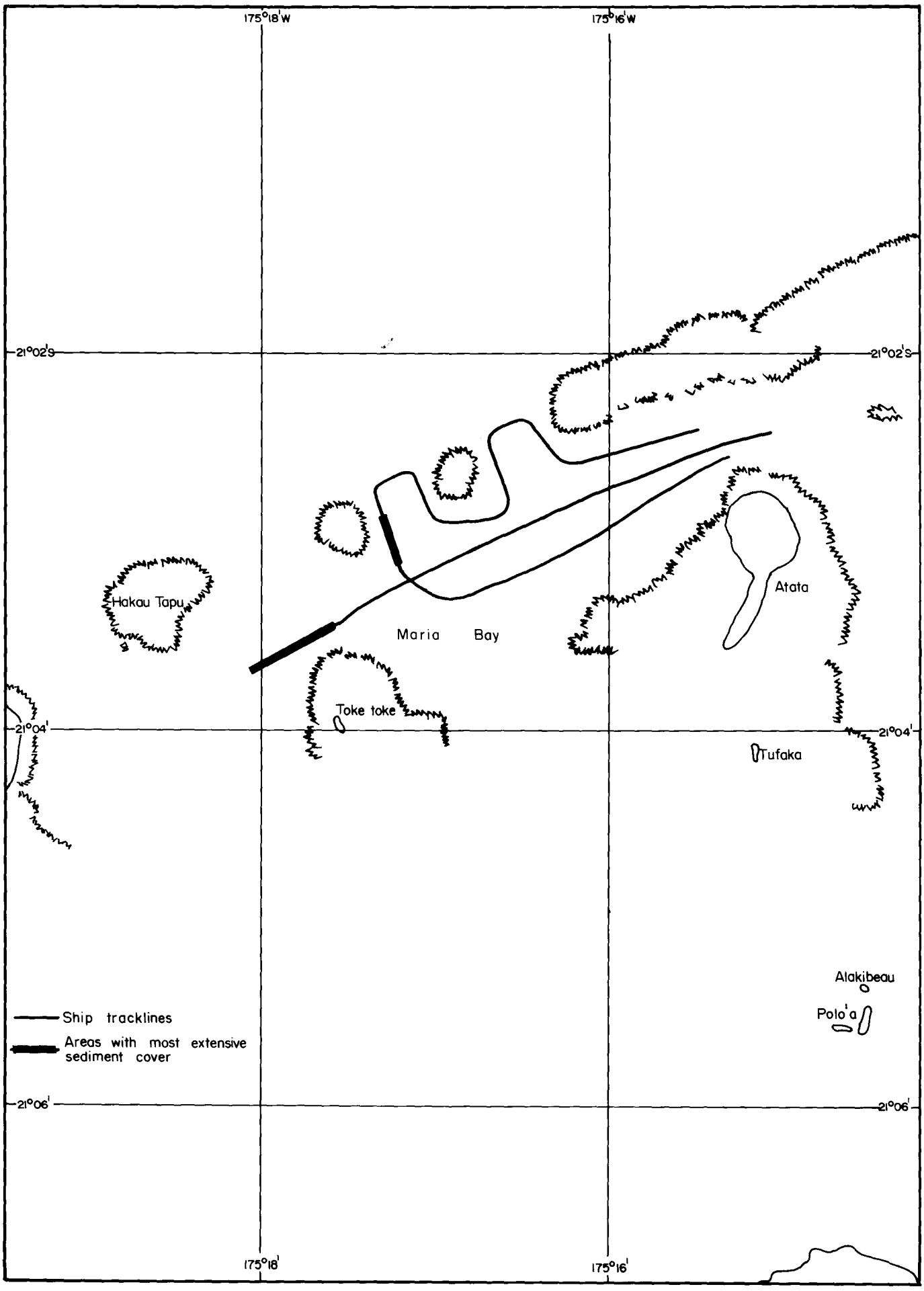
Figure 3. Side-scan sonograph showing an extensive sediment-covered area with isolated outcropping rocks or patch reefs. Area shown is 125 m (top-to-bottom) by 500 m (across).

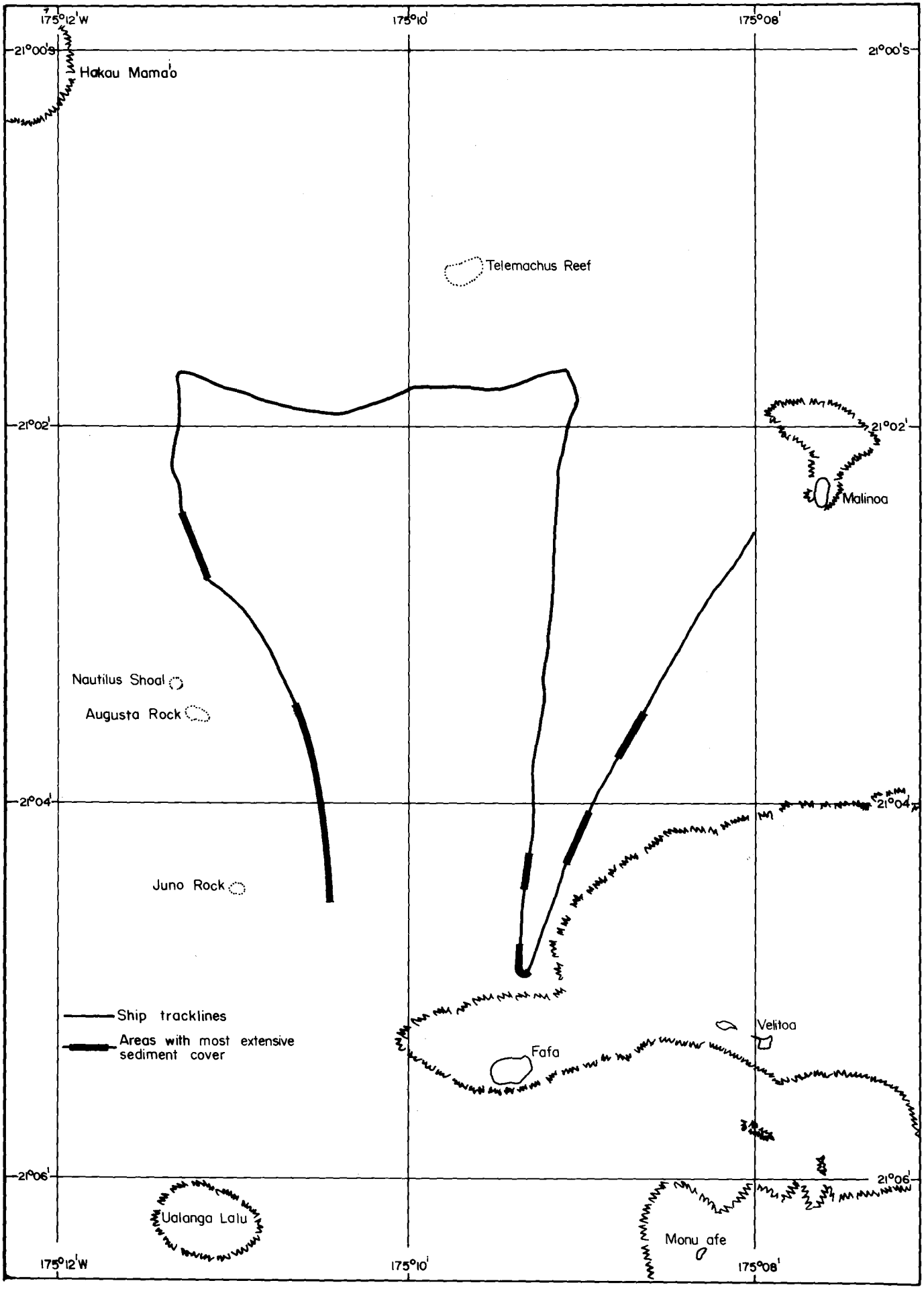
APPENDIX

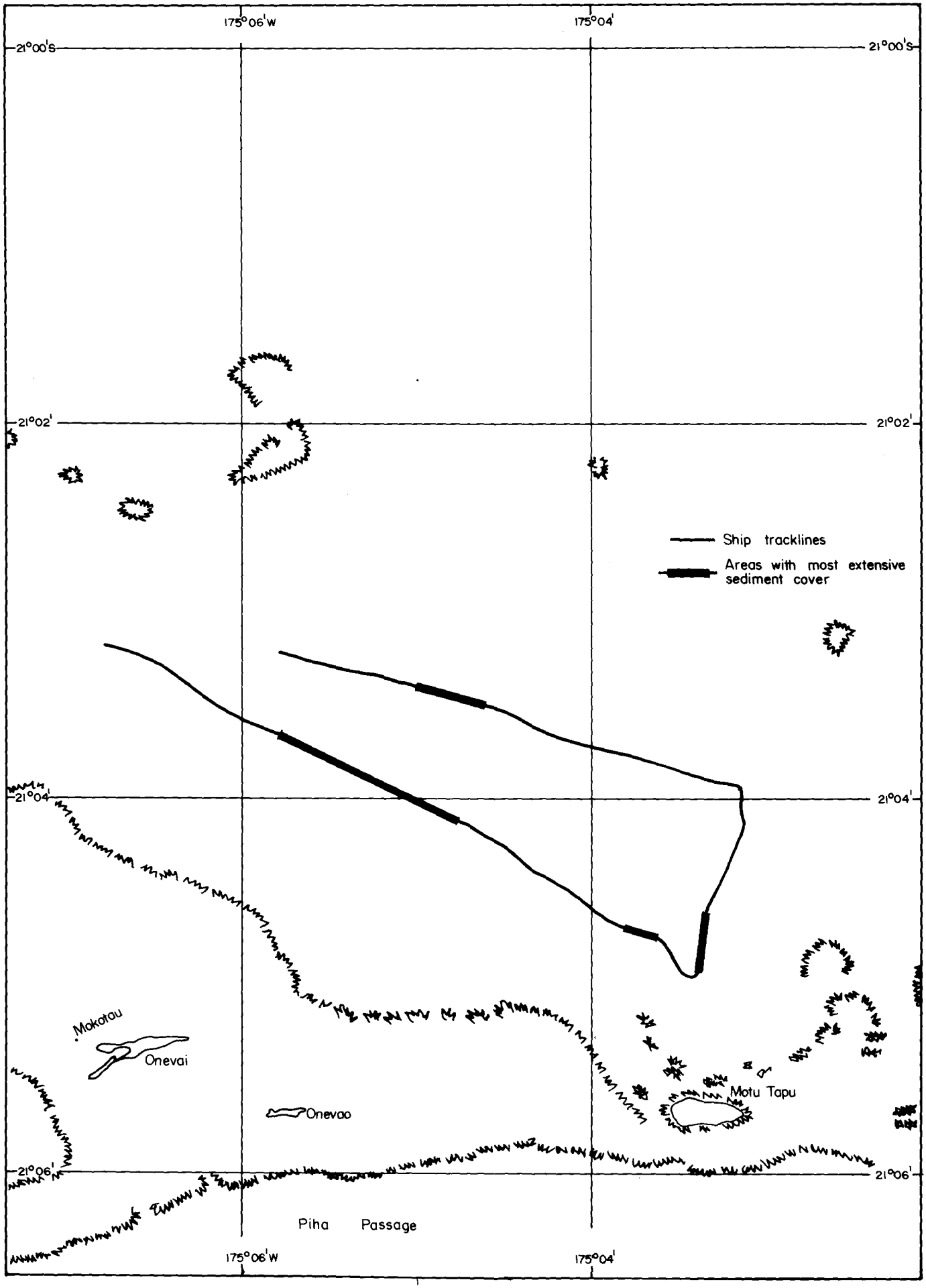
Size Distributions of Sands fram Maria Bay
(Western-most Sediment Patch Shown in Figure lA)
Determined by the New Zealand Concrete Research Association

Cumulative Percentage Finer Than

Size (nun)	Sample 1	Sample 2	Sample 3
4.75	100	100	100
2.36	98	100	99
1.18	92	99	98
0.600	70	95	93
0.300	23	77	70
0.150	9	32	35
0.075	5	2	14
Pan	0	0	0
Density (dry basis)	1710 kg/m 3	1680 kg/m 3	1780 kg/m 3
Suitable for concrete	Yes	No	No


175°18'W
175°16'W
21°02'S
21°04'
21°06'
Hakau Tapu
Maria Bay
Toke toke
Atata
Tufaka
Alakibeau
Polo'a
Ship tracklines
Areas with most extensive sediment cover


175°12'W
175°10'
175°08'
21°00'S
Hakau Mamaʻo
Telemachus Reef
21°02'
Malinoa
Nautilus Shoal
Augusta Rock
21°04'
Juno Rock
Ship tracklines
Areas with most extensive sediment cover
Velitoa
Fafa
21°06'
Ualanga Lalu
Monu afe


175°06'W
175°04'
21°00'S
21°02'
21°04'
21°06'
Ship tracklines
Areas with most extensive sediment cover
Makatau
Onevai
Onevao
Motu Tapu
Piha Passage