Hawaii National Marine Renewable Energy Center (HINMREC)

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Task 1: Management

Kāne‘ohe Wave Energy Test Site: Sub-Bottom Profiler Survey

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KANEOHE WAVE ENERGY TEST SITE

SUB-BOTTOM PROFILER SURVEY
OAHU, HI

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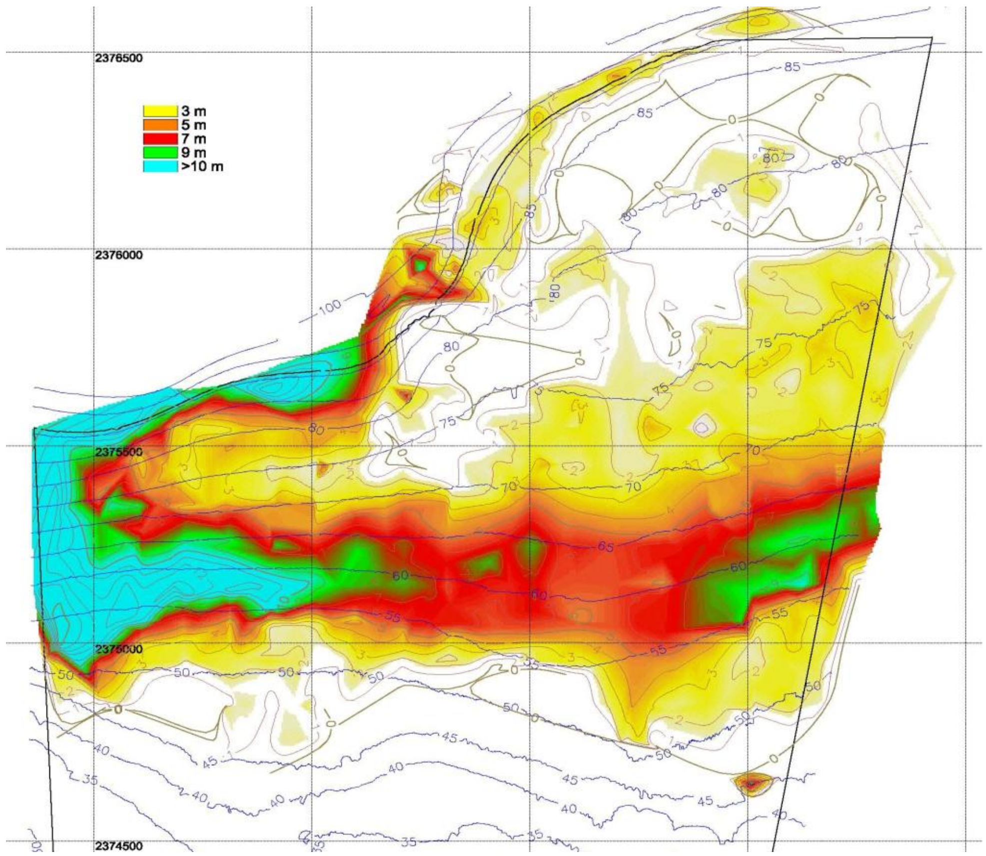

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TABLE OF CONTENTS

1. INTRODUCTION 2

2. METHODOLOGY 4

2.1 SURVEY SCHEDULE 4
2.2 UNITS AND COORDINATE SYSTEM 4
2.3 NAVIGATION AND POSITIONING 4
2.4 SUB-BOTTOM PROFILING METHODS 4

3. SURVEY RESULTS 6

3.1 SUB-BOTTOM PROFILER SURVEY 6

LIST OF FIGURES

FIGURE 1-1. PROJECT LOCATION. 2
FIGURE 1-2. AERIAL IMAGE OF PROJECT SITE (FROM GOOGLE EARTH). 3
FIGURE 2-1. WAVE ENERGY TEST SITE SUB-BOTTOM TRACK LINES. 5
FIGURE 3-1. SUB-BOTTOM PROFILE ALONG LINE 1. 7
FIGURE 3-2. SUB-BOTTOM PROFILE ALONG LINE 5. 8
FIGURE 3-3. SUB-BOTTOM PROFILE ALONG LINE 9. 9
FIGURE 3-4. SUB-BOTTOM PROFILE ALONG LINE 13. 9
FIGURE 3-5. SUB-BOTTOM PROFILE ALONG LINE 17. 10
FIGURE 3-6. SUB-BOTTOM PROFILE ALONG CROSS LINE 14. 11
FIGURE 3-7. SUB-BOTTOM PROFILE ALONG CROSS LINE 20. 12
FIGURE 3-8. SUB-BOTTOM PROFILE ALONG CROSS LINE 24. 13
FIGURE 3-9. SEDIMENT THICKNESS IN PROJECT AREA. BROWN LINES INDICATE SEDIMENT THICKNESS, BLUE LINES INDICATE WATER DEPTH. 14
FIGURE 3-10. COLOR REPRESENTATION OF SEDIMENT THICKNESS IN THE PROJECT AREA. 15

1. INTRODUCTION

The area north of the Mokapu Peninsula, adjacent to Kaneohe Marine Corps Base Hawaii (MCBH), has been utilized by the U.S. Navy and Ocean Power Technologies, Inc. (OPT) for wave energy research since 2002. A prototype OPT PowerBuoy is presently deployed at the 30 m water depth offshore of North Beach at the MCBH. The Hawaii National Marine Renewable Energy Center (HNMREC) at the University of Hawaii, under contract with Department of Energy, desires to expand the present test site to water depths of 100 m to allow for the testing of other wave energy devices.

Sea Engineering has been contracted by the HNMREC to conduct site investigations in support of the development of the expanded test site. This report presents the results of the sub-bottom profiler survey of the site. Sub-bottom profilers are sonar systems designed to provide information on sedimentary layers below the seafloor.

The project location is shown in Figure 1-1. An aerial image of the 4.4 km^2 proposed test site is shown in Figure 1-2. The test site is 1600 to 2000 m wide and extends approximately 2600 m offshore from the 30 m depth contour to the approximate 100 m depth contour.

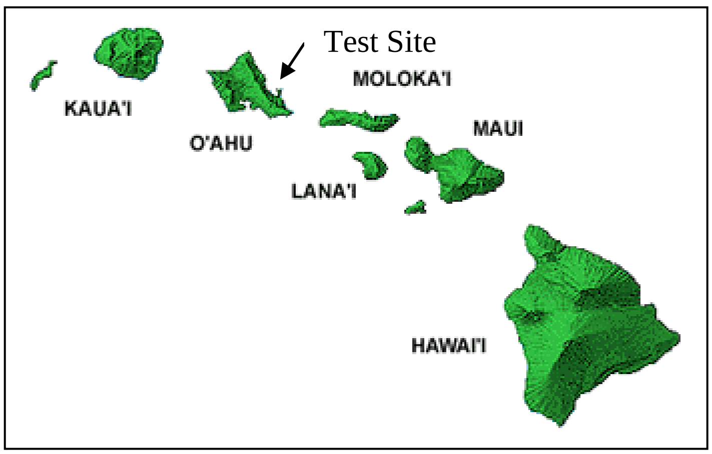

Figure 1-1. Project location.

Figure 1-2. Aerial image of project site (from Google Earth).

2. METHODOLOGY

2.1 Survey Schedule

Sea Engineering conducted the sub-bottom survey on November 17 and 18, 2011.

2.2 Units and Coordinate System

The project coordinate system is the Universal Transverse Mercator (UTM), Zone 4, meters.

2.3 Navigation and Positioning

A differential GPS (DGPS) receiver was used for horizontal positioning.

Hypack survey software was used for navigation of the survey vessel.

2.4 Sub-bottom Profiling Methods

Geophysical sub-bottom profiling systems are essentially echo-sounders that use lower acoustic frequencies to penetrate into the substrate. A sub-bottom system transmits an acoustic signal directly below the towfish. A portion of the acoustic signal is reflected back from the seafloor while a portion penetrates the sediment layer. A receiver records the signals that are reflected back from the seafloor and underlying substrate. The time delay between the signal returns allows for the differentiation of sediment layers. Where common echo-sounders may use an acoustic frequency in the vicinity of 200 kHz, sub-bottom system frequencies are typically between 500 Hz and 20 kHz. The term sub-bottom refers to a generally hard layer of sediment or rock that underlies recent soft sediment deposition. The lower the acoustic frequency, the deeper into the bottom the system can penetrate.

For this survey, an EdgeTech 0512i “chirp” sub-bottom profiler was used with an EdgeTech 3200XS processing system. The EdgeTech 0512i system is a specialized system for use in coarse sand environments. The chirp processors use signal processing to shape the acoustic wavelets used to image the substrate. They provide significantly greater image resolution than traditional impulsive systems such as boomers and sparkers. Different signal pulses are available with the system for use in different terrains. The optimal pulses for substrates in Hawaii have been found to be 500 Hz to 7 kHz and 700 Hz to 12.0 kHz. This is a low frequency range, but necessary for penetration into the coralline limestone sands and gravels found in Hawaii. The 500 Hz to 7 kHz pulse was used for this survey.

Survey tracklines were spaced 100 m apart, oriented both parallel and perpendicular to shore, as shown in Figure 2.1.

The sub-bottom data were reviewed with EdgeTech software and sub-bottom horizons were digitized for processing. Sediment thickness data were contoured using Digital Terrain Model (DTM) software, and final charts created using AutoCAD.

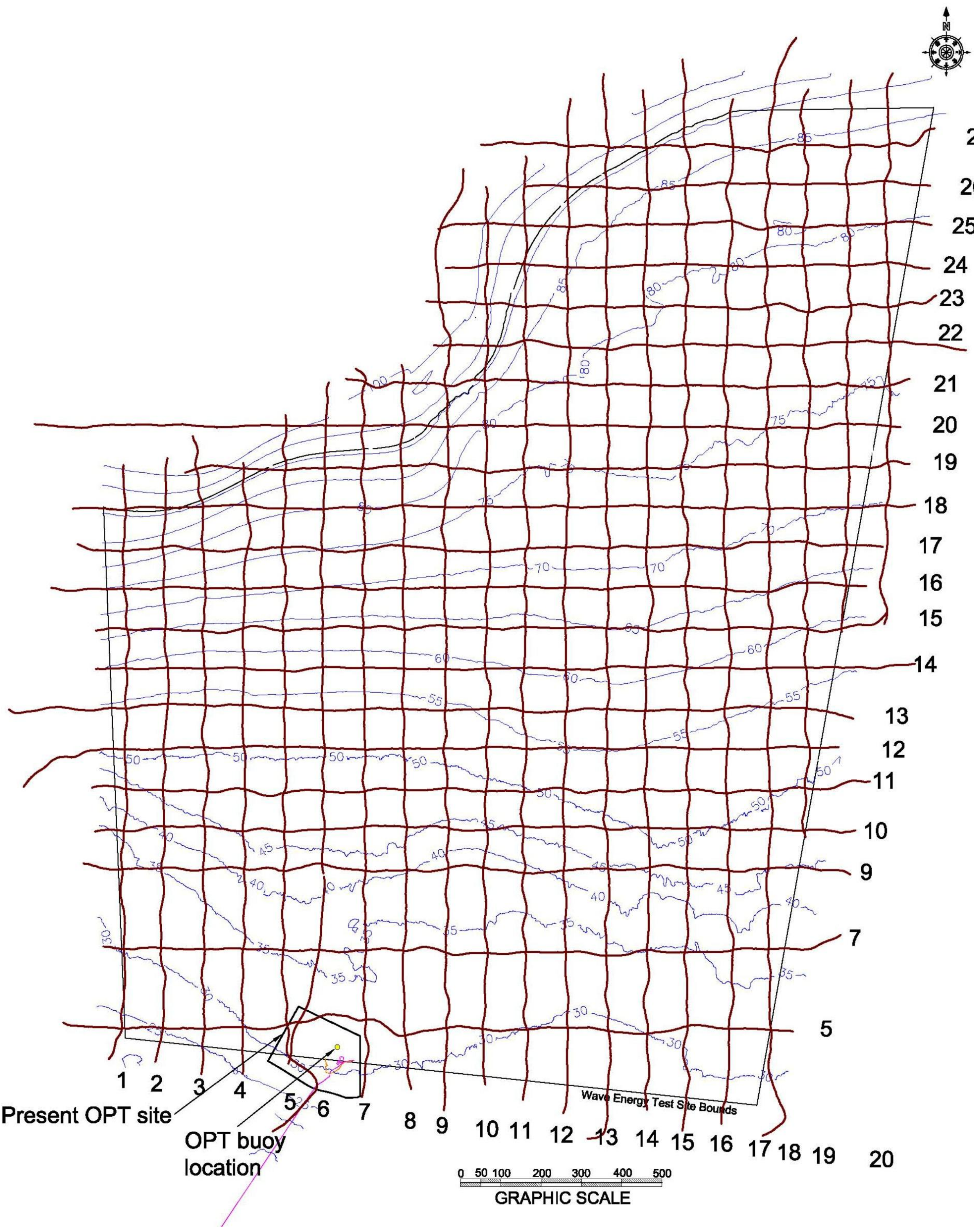

Figure 2-1. Wave energy test site sub-bottom track lines.

3. SURVEY RESULTS

3.1 Sub-bottom Profiler Survey

The subbottom survey showed an offshore morphology consisting of a series of terraces, or shelves formed during ancient low sea level stands by wave-induced erosion of the reef limestone. The terraces form a stair-step appearance, with the wide, gently sloping surfaces separated by steeper slopes or scarps. The terrace surfaces are often buried by wedge-like deposits of sediment, typically sand. This morphology is common in the Hawaiian Islands.

Figures 3-1 to 3-8 present representative sub-bottom profile images. Figures 3-1 to 3-5 present profiles measure in the north-south (inshore-offshore) direction, while Figures 3-6 to 3-7 present profiles measured in the east-west direction. Tick marks on the images are spaced 10 m apart vertically, and 100 m apart horizontally. The vertical scale represents distance in meters below the sub-bottom towfish. The sub-bottom towfish was towed approximately 3 m below the water surface, therefore addition of 3 m to the vertical scale in the images is required to determine seafloor or sediment horizon depths referenced to sea level.

The sub-bottom images indicate that hard substrate composed of reef limestone extends from shallow water to the approximate 50 m water depth. Seaward of this, the reef limestone slopes steeply downward to a wide, gently sloping terrace at the approximate 65 to 70 m water depth. This terrace is buried by up to 10 m of sediment.

Figures 3-9 to 3-10 present contour charts of the measured sediment thickness. Sediment thickness is greatest along the west side of the project area and in a band 200 to 300 m wide along the 60 m depth contour. With the exception of the steeply sloping west side of the project site, the sediment thins or pinches out at the 70 to 75 m water depth.

Key findings of the sub-bottom survey include the following:

- Reef limestone hard bottom is prevalent inshore of the 50 meter depth contour
- A band of sediment, 5 to 12 meters thick and approximately 250 meters wide, is present at water depths of 55 to 65 meters.
- One to 2 meters of sand is typical from the 65 to 75 meter water depths.
- Minimal sand is present in the eastern part of the project area seaward of the 75 meter contour.
- The barchan dunes in the northeastern corner of the site are only 1-2 meters thick.

The discussion above is based on interpretations of the characteristics of the side scan, bathymetric and sub-bottom survey work conducted to-date. Additional work to be conducted at the site includes a remotely operated vehicle video survey. The video survey will provide valuable visual confirmation of the sub-bottom, side scan, and multibeam interpretations.

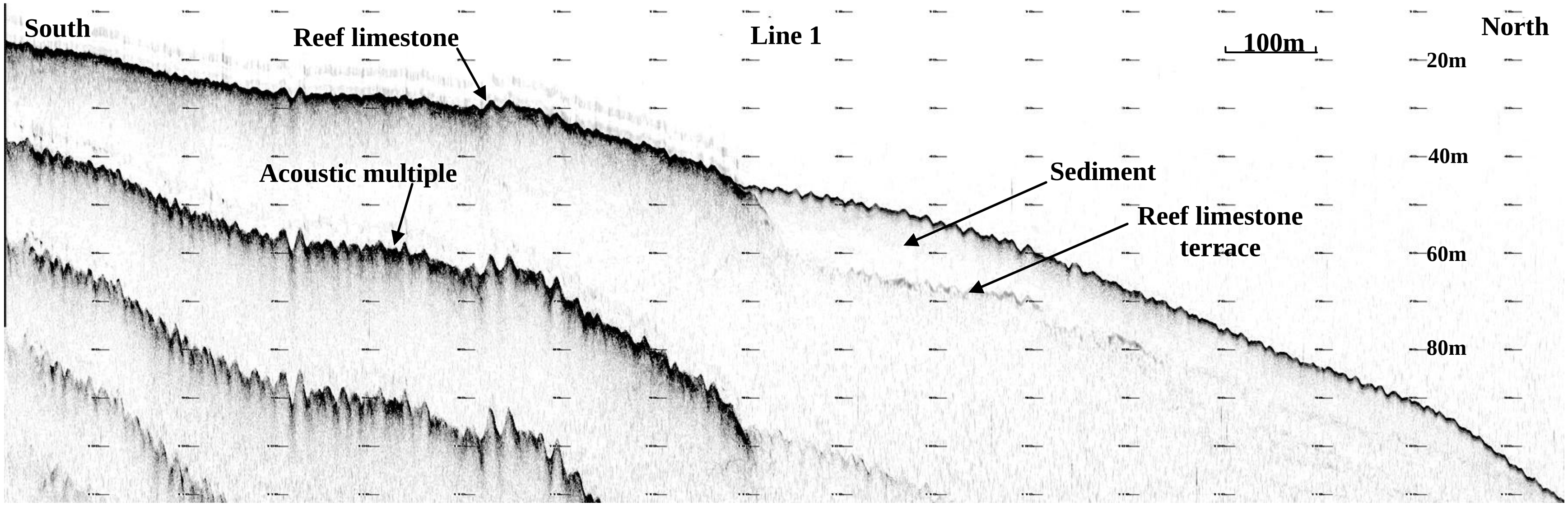

Figure 3-1. Sub-bottom profile along Line 1.

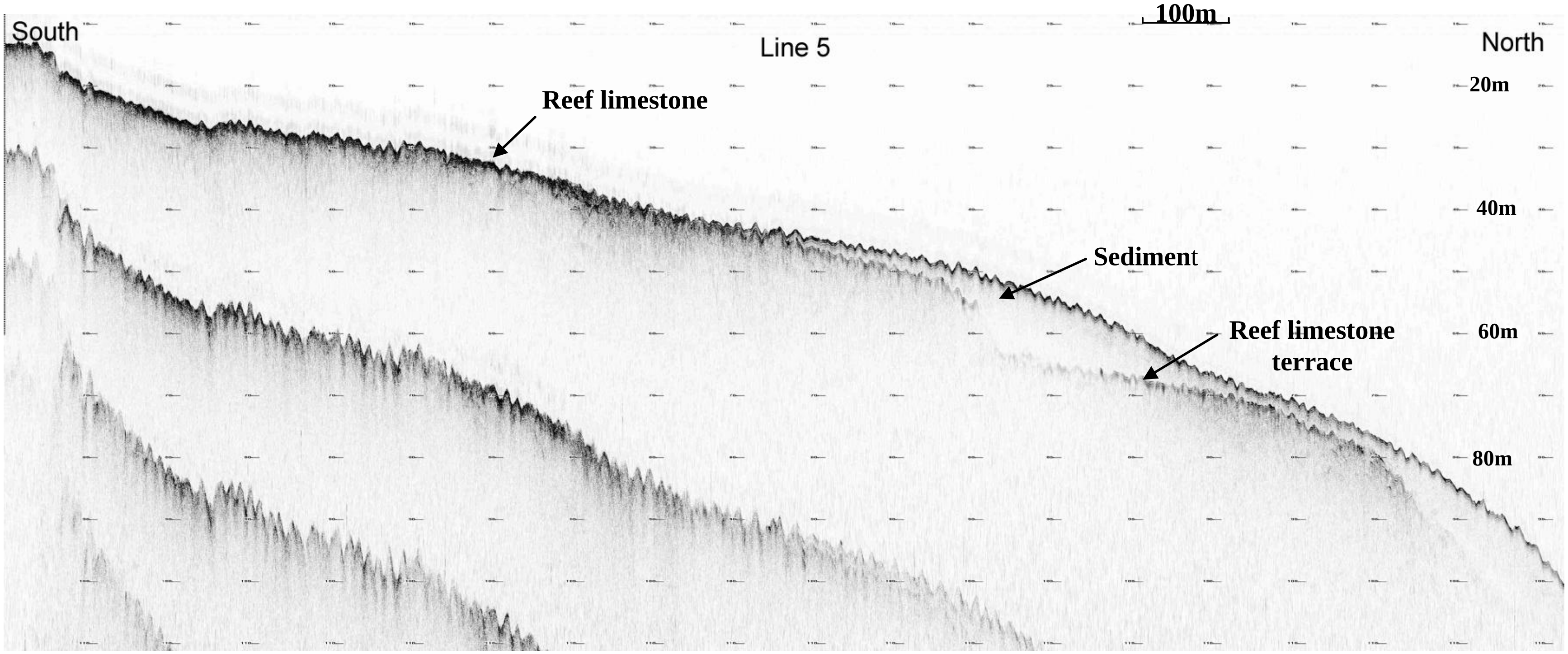

Figure 3-2. Sub-bottom profile along Line 5.

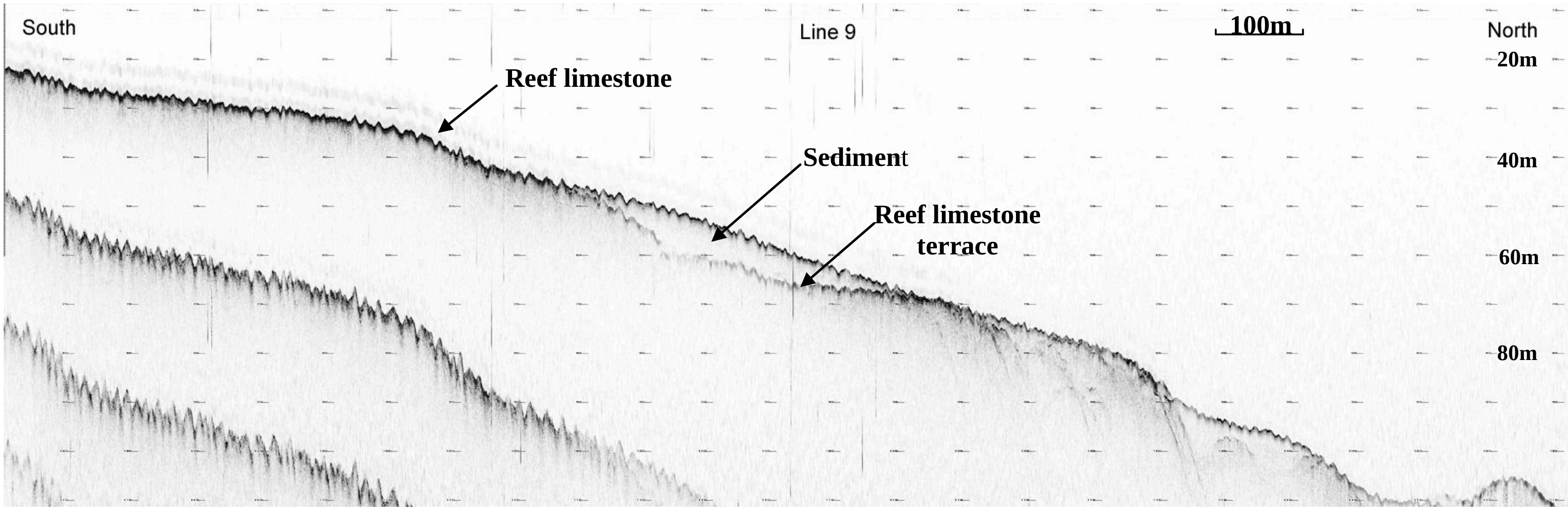

Figure 3-3. Sub-bottom profile along Line 9.

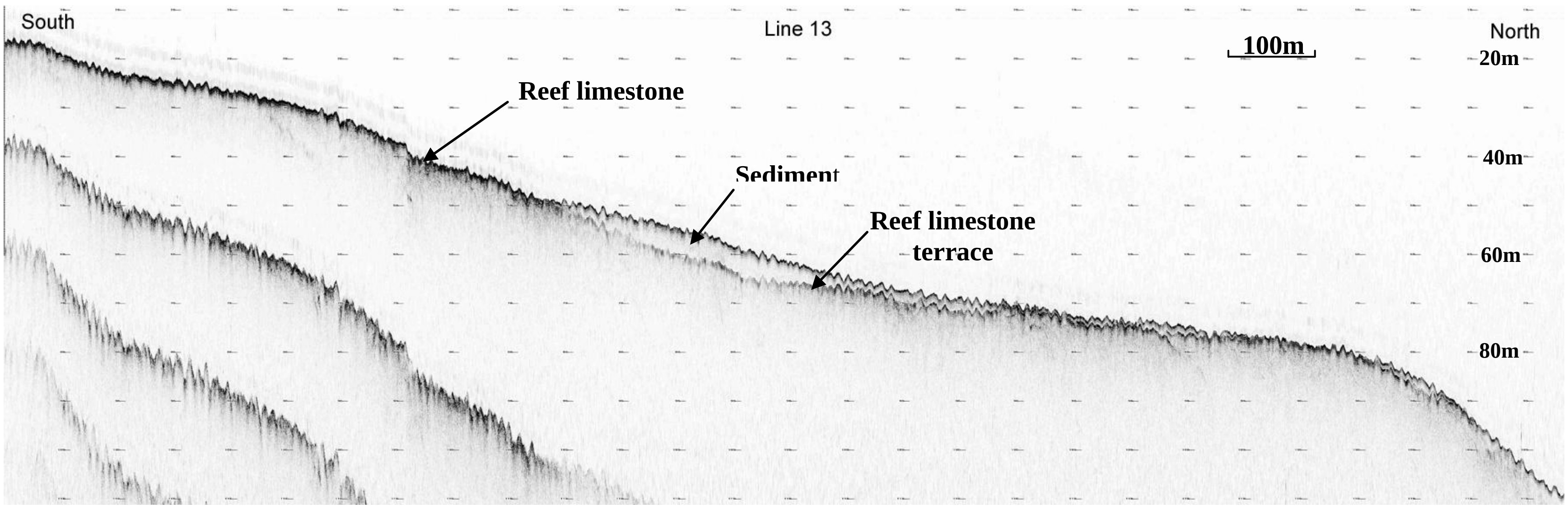

Figure 3-4. Sub-bottom profile along Line 13.

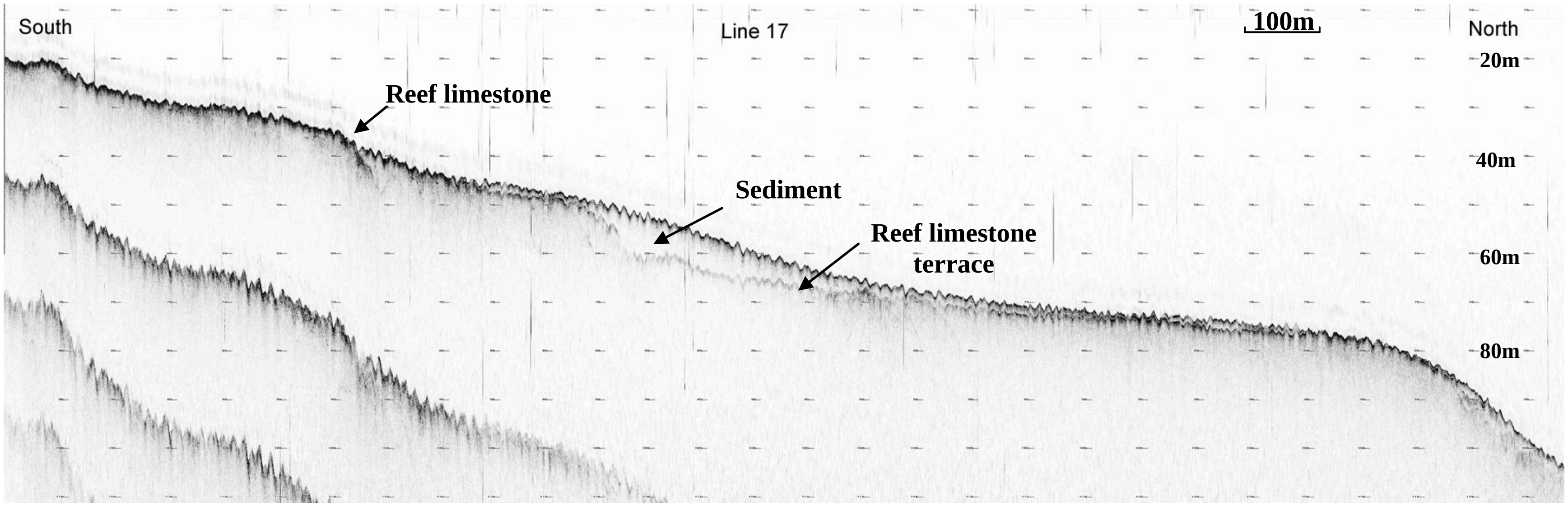

Figure 3-5. Sub-bottom profile along Line 17.

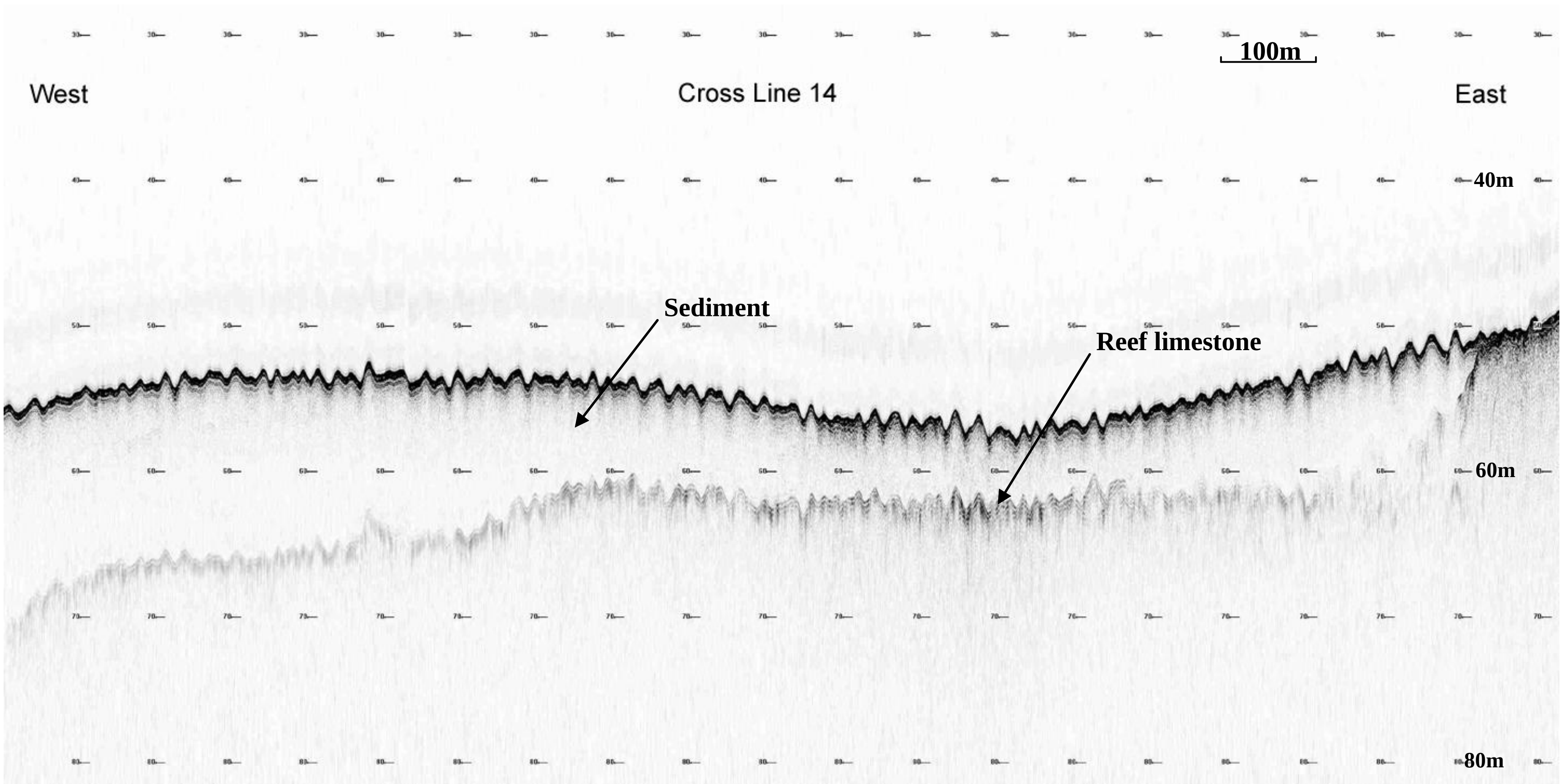

Figure 3-6. Sub-bottom profile along Cross Line 14.

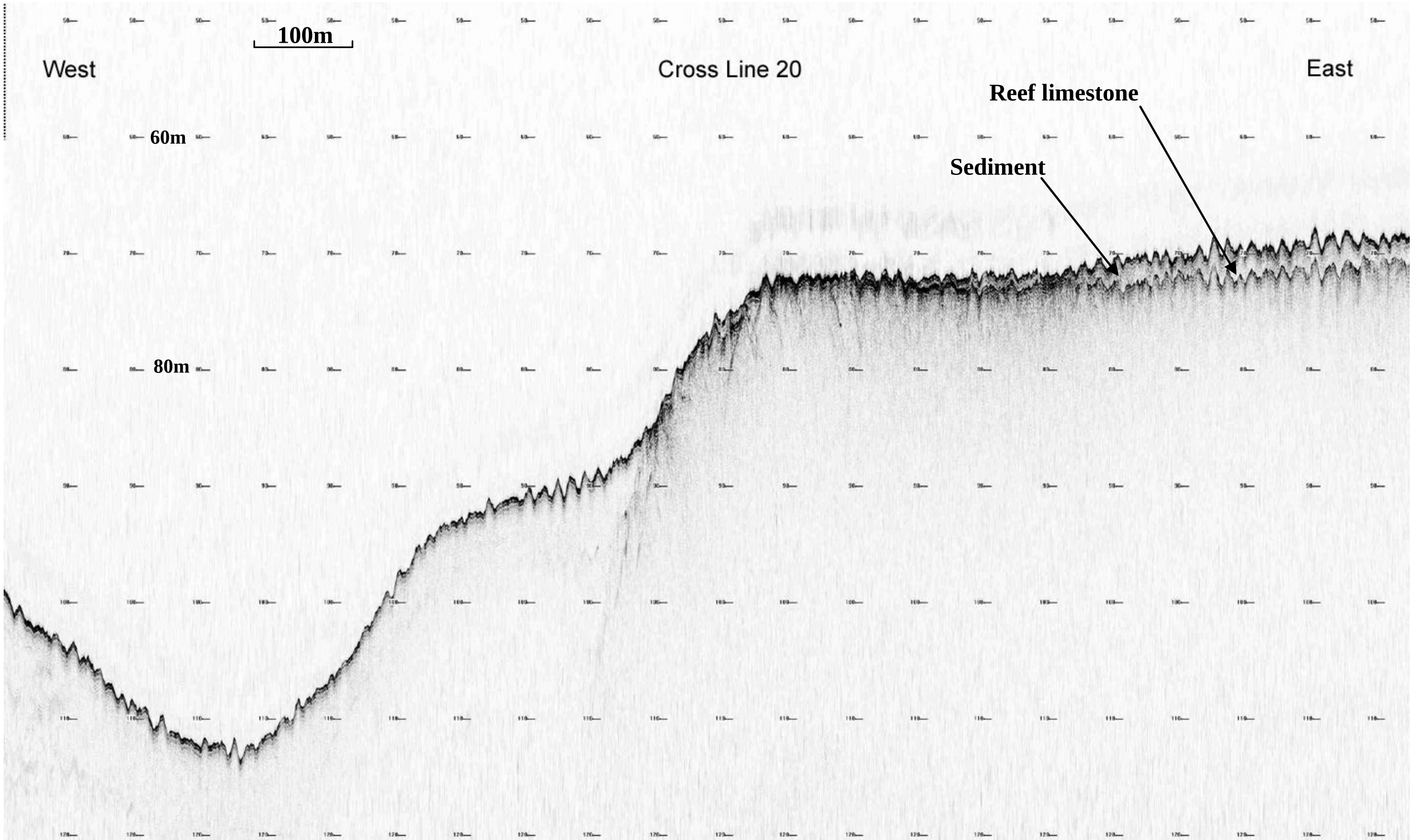

Figure 3-7. Sub-bottom profile along Cross Line 20.

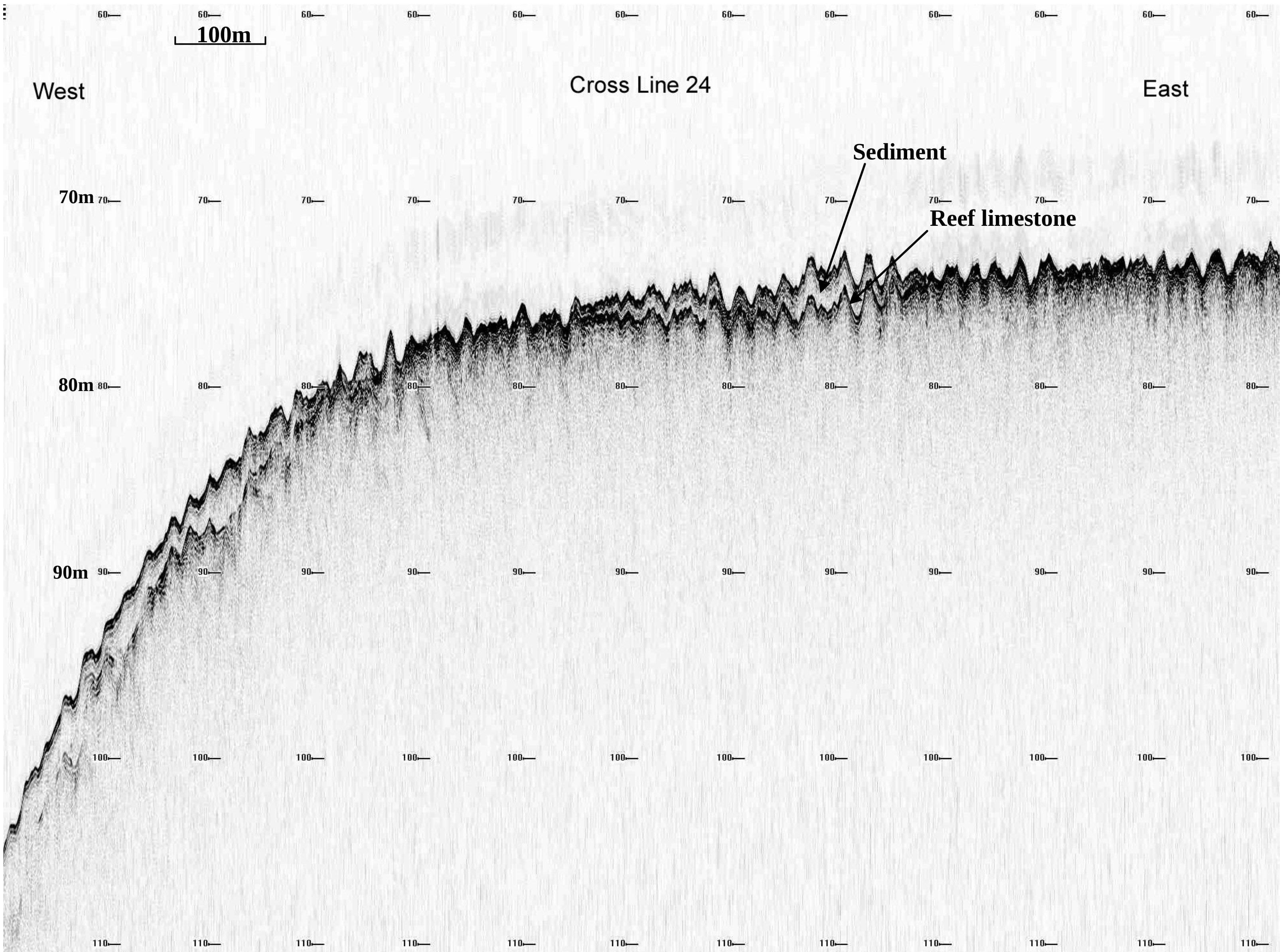

Figure 3-8. Sub-bottom profile along Cross Line 24.

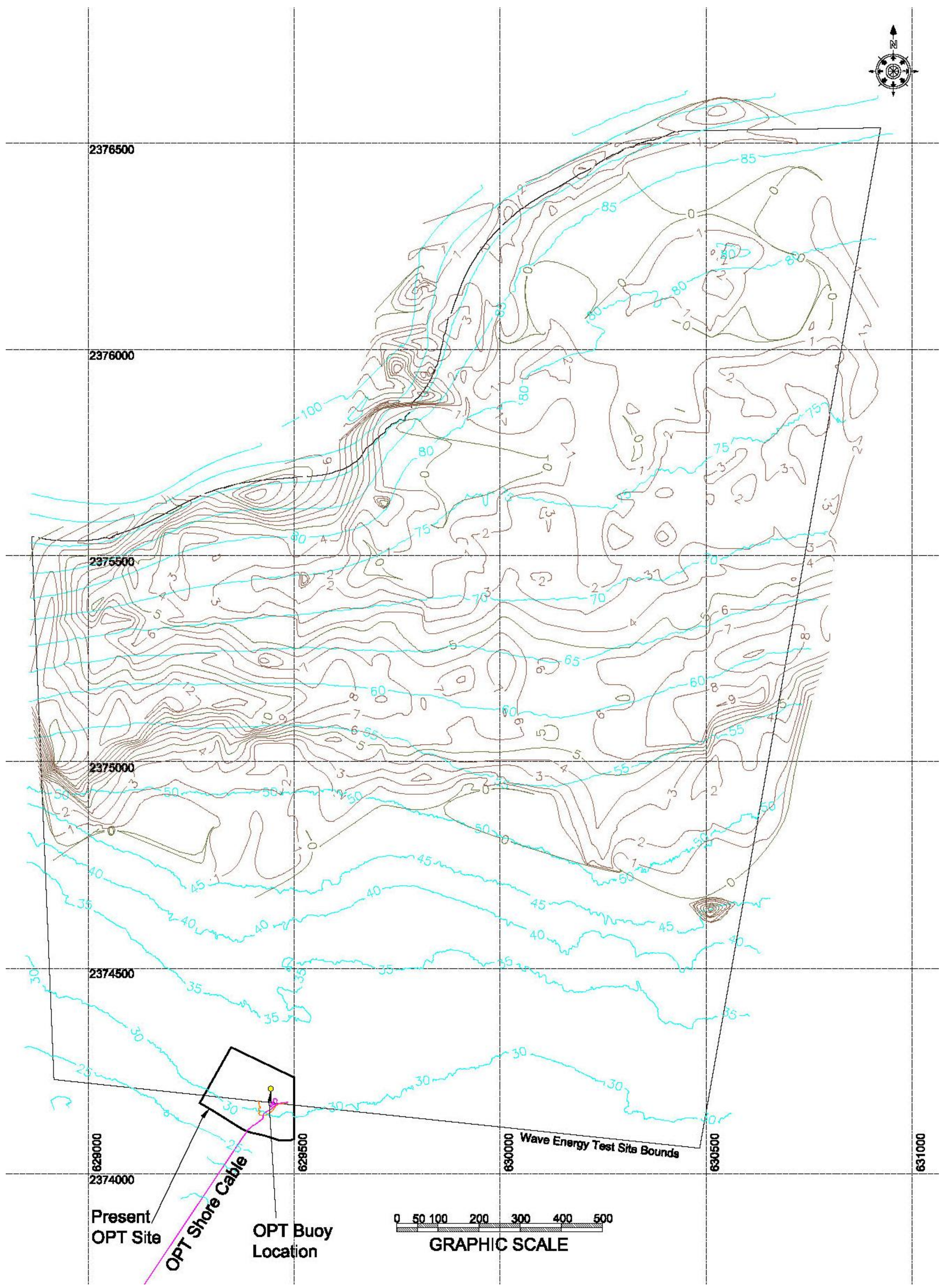

Figure 3-9. Sediment thickness in project area. Brown lines indicate sediment thickness, blue lines indicate water depth.

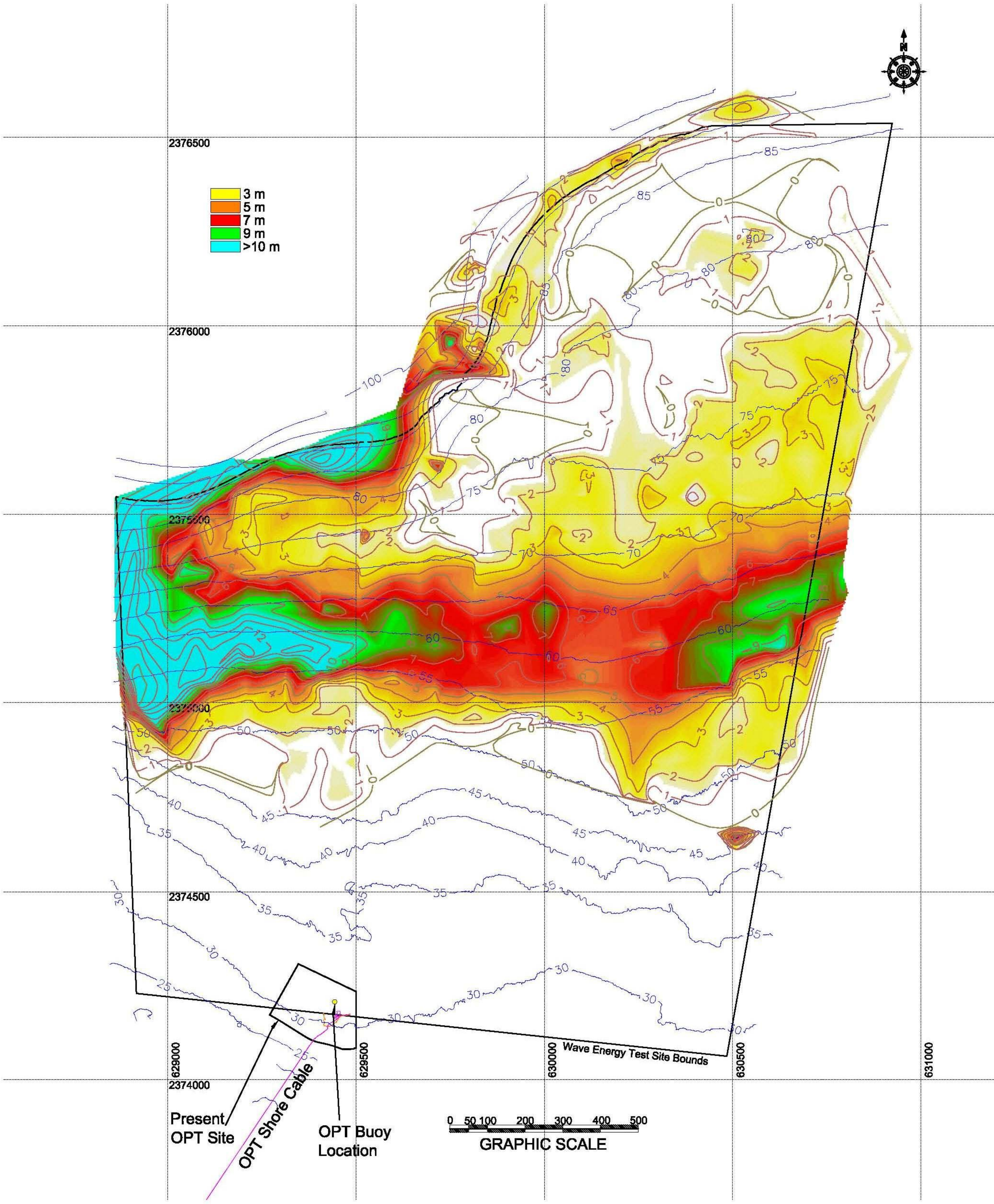

Figure 3-10. Color representation of sediment thickness in the project area.