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Task 1: Management

Kāneʻohe Wave Energy Test Site: Multibeam Bathymetry Survey

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KANEOHE WAVE ENERGY TEST SITE

MULTIBEAM BATHYMETRY SURVEY
OAHU, HI

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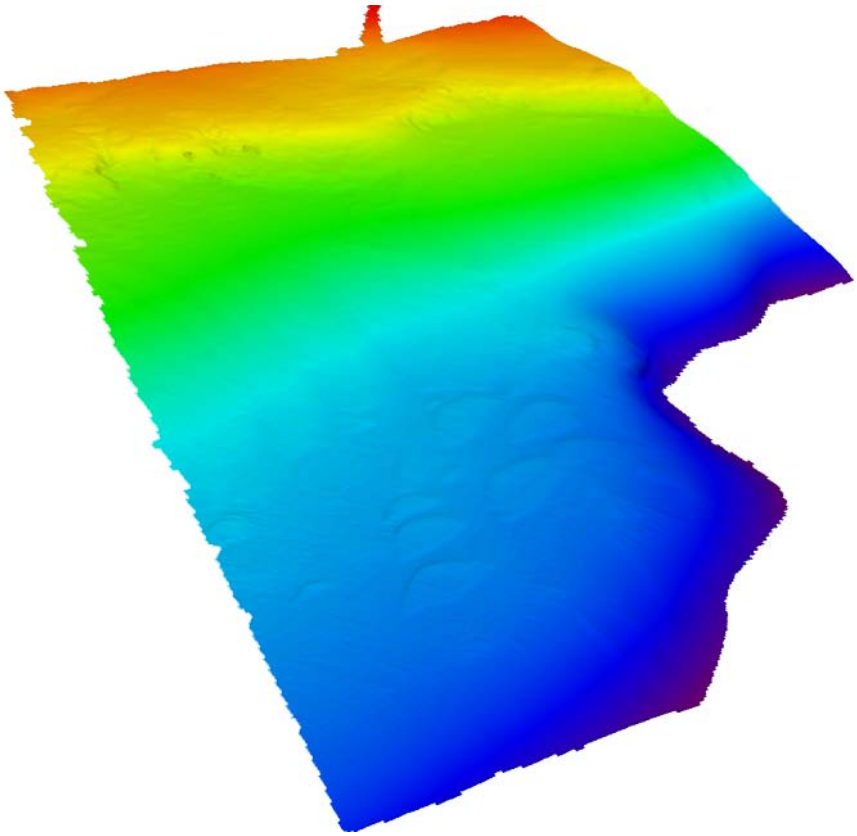

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1. INTRODUCTION

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 multibeam sonar bathymetric survey of the site.

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 100 m depth contour.

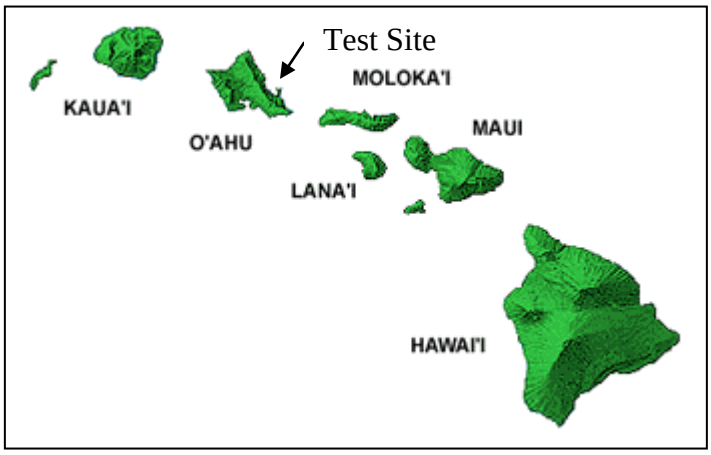

Figure 1-1. Project location.

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

2. METHODOLOGY

2.1 Survey Schedule

SEI, in conjunction with SOLMAR Hydrographics, conducted the multibeam survey on September 6 to 9, 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 C&C Technologies C-Nav 2000 10-channel dual frequency precision differential GPS (DGPS) receiver was used for horizontal positioning. The C-Nav system is accurate to 0.1 m. C-Nav positions are based upon the International Terrestrial Reference Frame (ITRF) 2000 datum, which contains a small offset from the WGS84 datum. RTCM position corrections from the C-Nav were fed into an Applanix POS/MV for sensor positioning.

Hypack survey software was used to integrate the DGPS positions with the survey data.

2.4 Multibeam Sonar Methods

An R2Sonics 2024 multibeam echosounder system was utilized for the bathymetry survey. The multibeam was operated at 200 kHz with 256 beams and a 90 degree swath The system was compensated for boat motion (heave, pitch, roll, and yaw) using an Applanix POS/MV Wavemaster. Numerous quality control and quality assurance procedures are used to calibrate the multibeam system and ensure system accuracy.

2.4.1 Tide Corrections

Multibeam data were corrected to the MLLW datum using tidal data from the NOAA Mokuoloe tide gage (#1612480) in Kaneohe Bay.

2.4.2 System Draft Correction

The distance of the multibeam transducer head below the water surface is called the draft. The draft was measured on installation and checked using a standard hydrographic survey technique known as a “bar check”. The bar check consist of lowering a calibration plate a short distance below the multibeam transducer head.

2.4.3 Sound Velocity

The velocity of sound is a critical component for hydrographic survey measurement. Sound velocity changes with water temperature and salinity variations. Sound velocity at the water surface was measured directly using a sound velocity probe while surveying (Valeport Mini SVS) and also indirectly using the bar check method. Sound velocity casts to 90 m were periodically taken with an AML Oceanographic SV Plus sound velocity probe to measure sound

velocity with depth in the water column. Sound velocity casts are useful for recording the presence of a thermocline, or changes in temperature, in the water column.

2.4.4 Patch Test

The patch test procedure is a standard operational test to determine the installation configuration of the multibeam transducer head. The procedure consists of collecting data over short line segments at various speeds, offsets, and directions. Comparison of the data within the processing software allows calculation of the following parameters:

- System latency – the processing time lag in the GPS navigation device
- Multibeam pitch – the fore and aft angle of the multibeam head
- Multibeam roll - the port and starboard angle of the multibeam head
- Multibeam yaw- the angle of the multibeam with respect to boat heading.

2.4.5 Multibeam processing

The multibeam data were processed using CARIS hydrographic survey software. The software incorporates the system correction from the patch test results, as well as the transient corrections for heave, pitch, roll, and heading from the system motion sensors. Data spikes and other errors are edited from the data set. The edited data set is further reduced by dividing the survey area into a grid of cells, and averaging the data within those cells.

The data for this survey were averaged within 2 meter cells for depths shallower than 50 meters and 4 meter cells for depths greater than 50 meters.

3. SURVEY RESULTS

3.1 Multibeam Bathymetry Survey

Results of the multibeam survey are presented in Figure 3-1 to Figure 3-4: Figure 3-1 presents the bathymetry of the entire area with 1-meter contour intervals; Figure 3-2 illustrates the bathymetry contours overlain on the side scan image of the site; Figure 3-3 presents a larger scale chart of the northern half of the project area, from the 50-meter depth to the 100-m depth, using a 0.5 meter contour interval and overlain on the side scan image; and Figure 3-4 presents a color-shaded relief perspective image of the results with 3x vertical exaggeration.

Key features of the seafloor in the area include the following:

- The nearshore portion of the project area, between depths of 30 to 35 meters is relatively featureless and flat, with slopes ranging from 1V:34H to 1V:54H.
- A steeply sloping, irregular bottom is present at water depths between 35 and 45 meters. Slopes as steep as 1V:8H occur between 40 and 45 meter water depths.
- Between depths of 50 to 75 meters, the seafloor appears featureless, with little vertical relief, and typical slopes of 1V:25H. Linear grooves are present in the eastern portion of this zone, and may be indicative of hard bottom.
- Between depths of 75 and 85 meters in the northeastern corner of the project site, the bottom is relatively flat (1V:65H), and has barchan bedform features. The multibeam results indicate that the barchans are approximately 1.5 m high, 150 to 200 m long, and up to 100 m wide. They do not appear to be connected. Barchans are arcuate, isolated dune forms, characteristic of an environment with a limited supply of sand.
- At water depths deeper than 90 meters, the seafloor slopes steeply to the northwest into a pronounced marine canyon. Slopes of 1V:10H to 1V:7H are typical in this zone.

The discussion above is based on interpretations of the characteristics of the side scan image and multibeam data and should not be considered definitive. Additional work to be conducted at the site includes a sub-bottom profiler survey and a remotely operated vehicle video survey. The video survey will provide valuable visual confirmation of the side scan and multibeam interpretations.

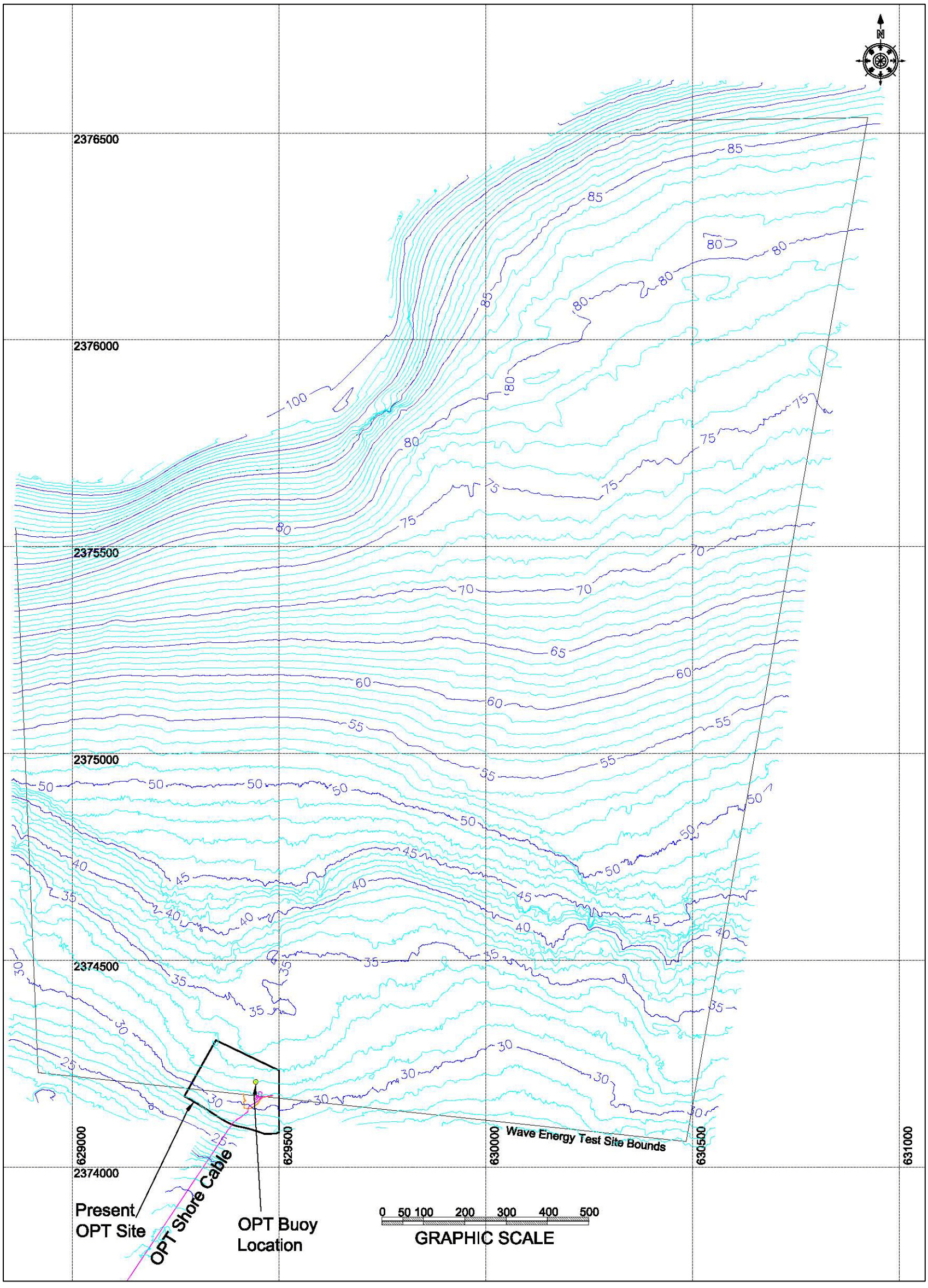

Figure 3-1. Wave energy test site bathymetry (1 m contour interval).

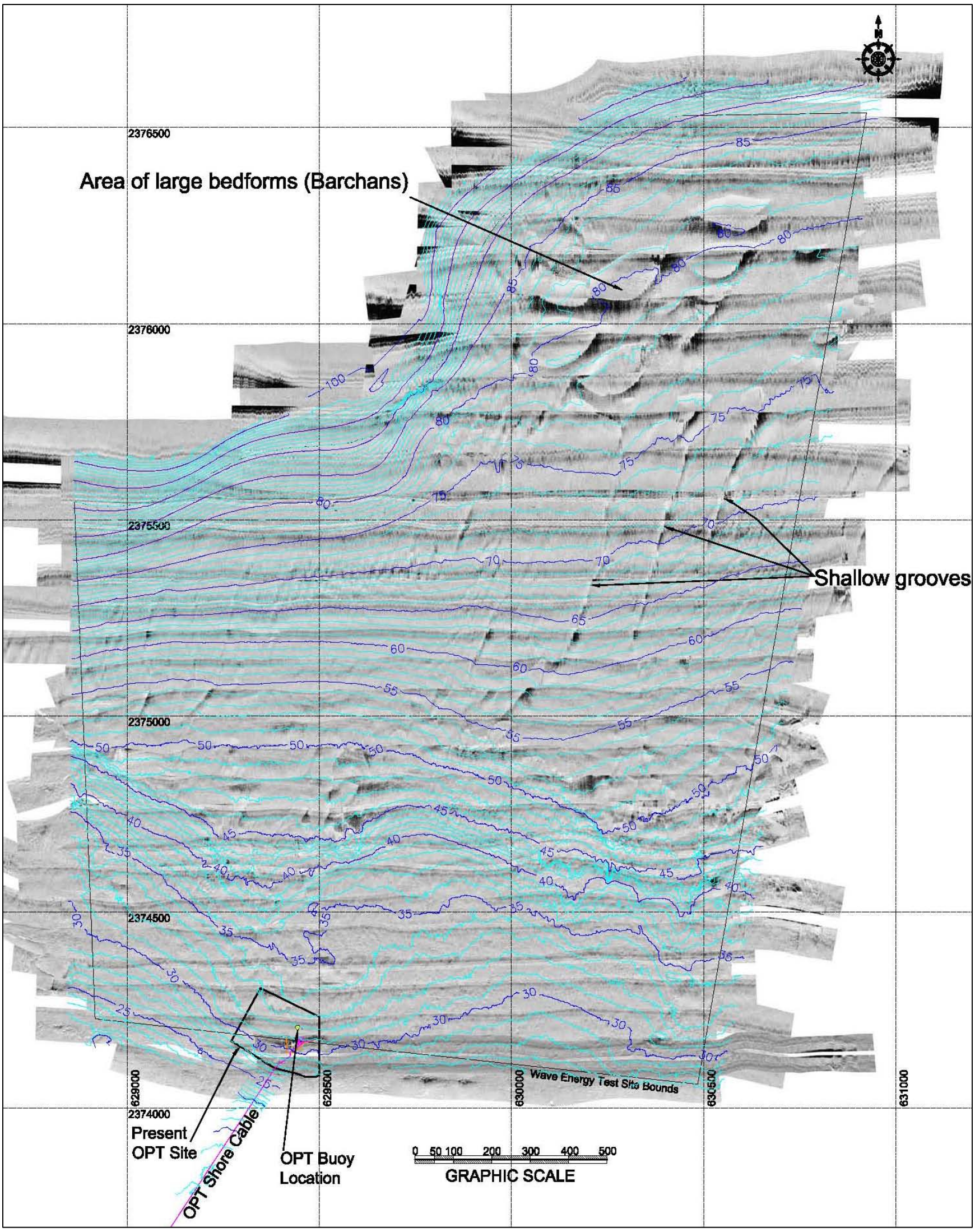

Figure 3-2. Wave energy test site side scan image with 1 m depth contours.

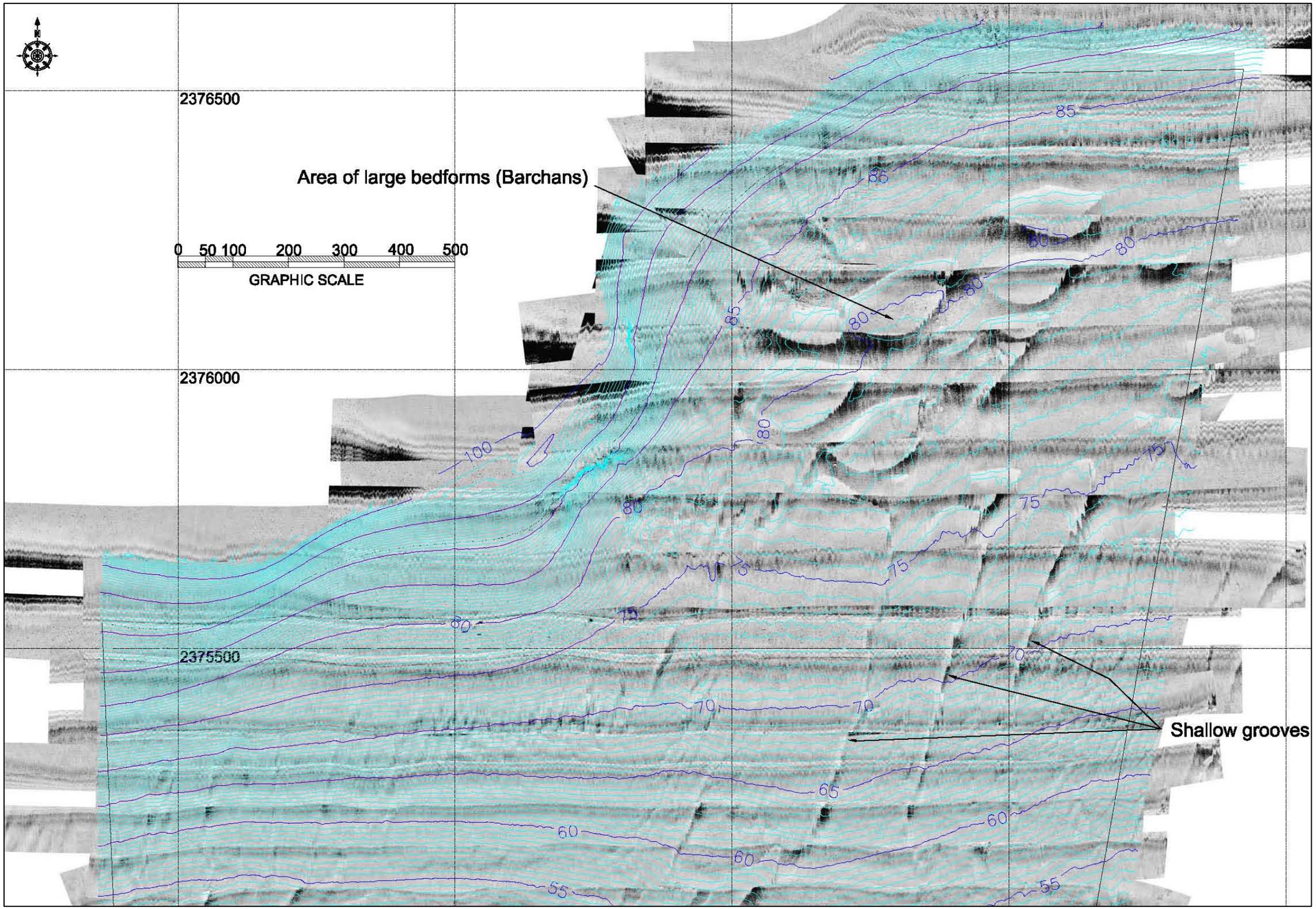

Figure 3-3. Side scan image of northern half of test site with 0.5 m depth contours.

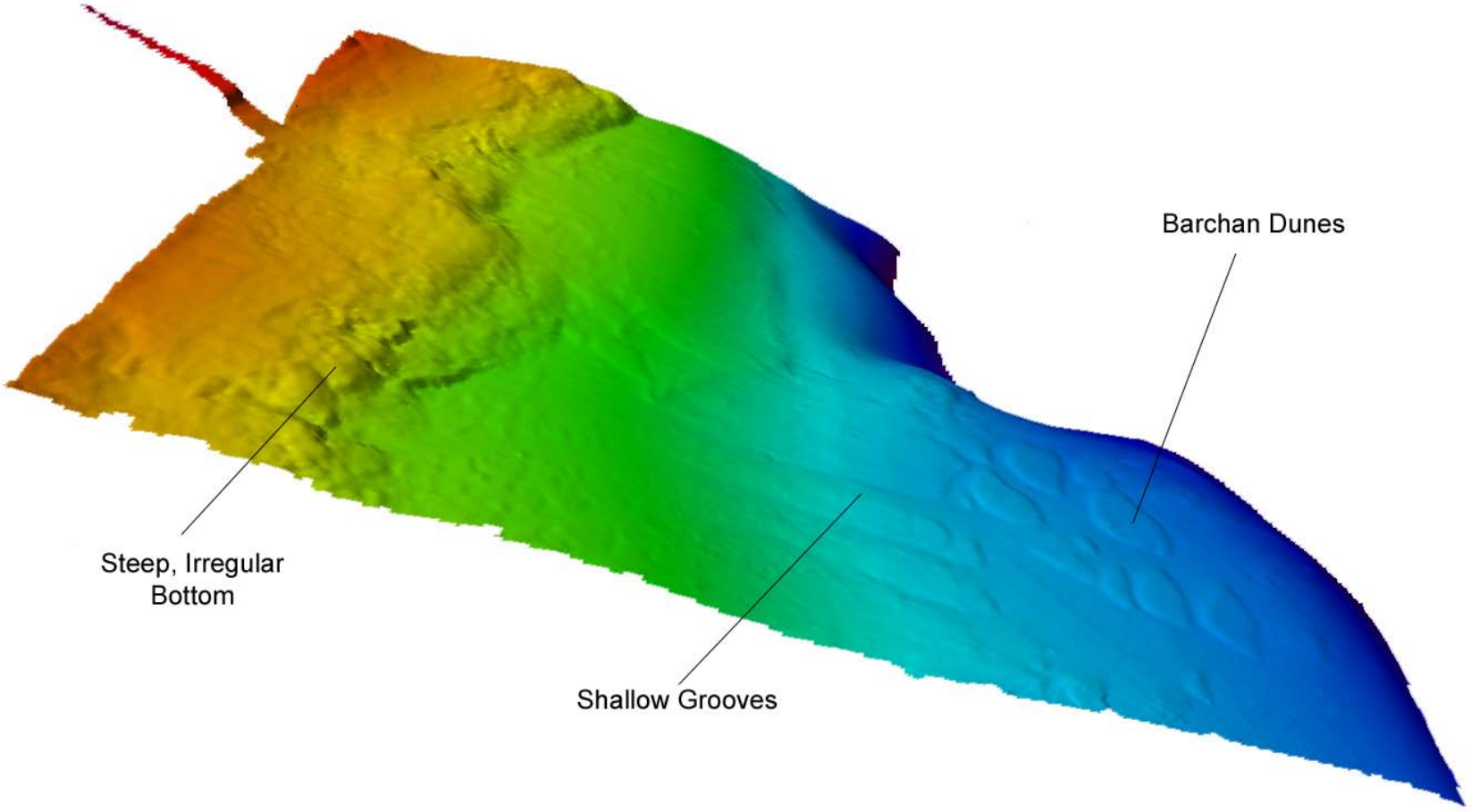

Figure 3-4. Color-shaded relief perspective of the survey area