Pacific Marine Energy Center
South Energy Test Site

Near Waldport, Oregon

<u>DATA REPORT:</u>

Results of Geophysical Exploration

By: Siemens & Associates
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Prepared for: Oregon State University

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RE: Pacific Marine Energy Center South Energy Test Site: Geophysical Exploration
Near Waldport, Oregon

Hello Dan,

Siemens & Associates is pleased to present the results of the geophysical exploration.
The geophysical interpretations incorporate the results of an area geologic reconnaissance which strongly influences our interpretation. A draft of this document has been reviewed by OSU and 3U Technologies and comments have been incorporated.

Data were gathered and processed for three geophysical methods: Electrical Resistivity (ER), Seismic Refraction (SR) and Seismic Refraction Microtremor (ReMi). The results are presented to describe continuous, 2D profiles. The interpretations suggest a complicated system of sediments and sedimentary rock through the proposed HDD alignment currently at ~ 50 foot depth. Through this zone, heterogeneous materials of variable strength are expected to dominate. The more homogeneous Alsea Formation is interpreted at lower elevations.

The independent geophysical methods describe similar geologic features in terms of thickness and character of stratification. As described in the report, several factors are judged to be responsible for apparent discrepancies and the results must be interpreted with care.

Siemens & Associates expresses sincere appreciation for the opportunity to conduct this exploration and as new challenges, discoveries and questions arise, we are standing by to offer our assistance.

Prepared by,
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1. Introduction

1.1. Purpose

Siemens & Associates (SA), in conjunction with Optim and John Thompson Associates (JTA), have completed terrestrial geophysical services to support geotechnical evaluations associated with improvements proposed at Driftwood Beach State Recreation Site. The information is intended to provide a first look at geotechnical conditions that can be related to the distribution and strength of shallow, unconsolidated soil and sediment as well as depth to hard rock.

1.2. Methods

Three geophysical methods were used:

- Electrical Resistivity (ER) in 2D
- Seismic Refraction (SR) in 2D
- Seismic Refraction Microtremor (ReMi) in 2D

Details concerning the procedures, the equipment used and results are presented later in this report.

1.3. Project Description

It is understood that Driftwood Beach State Recreation Site is proposed as the entry point for a series of horizontal direction drillings (HDDs) that will extend west below the surf zone providing conduits for communication, control and power distribution to the grid from the test site to be located at sea. The HDDs will extend roughly 3500 feet beyond the west end of the parking lot and will extend to depths approaching 50 feet. Currently, five HDDs are scheduled with diameters on the order of 5 inches.

1.4. Scope

Working under contract with OSU, the SA team completed geophysical measurement throughout the terrestrial portion of the HDD corridor using three independent geophysical methods. Guidelines for the work were outlined in the agreement executed on March 20, 2017, prepared by OSU Capital Planning and Facilities Services. The original work scope as described in the agreement was modified to facilitate permitting and resulted in a an extra mobilization, 18% additional ER survey, 50% additional SR survey and 20% additional ReMi survey in order to limit the need to clear vegetation through the originally proposed geophysical routes. The completed scope is summarized as follows:

- ER, SR and ReMi surveys on four different lines
- SR only, on two additional lines
- Geologic reconnaissance

- Onsite mapping and establishment of permanent survey monuments
- Survey data including locations of geophysical traverses uploaded to GIS database

1.5. Location

The project is located on the Pacific Ocean within the property lines of Driftwood Beach State Recreation Site managed by Oregon Parks and Recreation Department. Twenty four hour access to the site is provided off Highway 101 about two miles north of Waldport, Oregon. Specifically, the project is at Latitude 44.464313°N and Longitude -124.080387°W.

1.6. Limitations

This report has been prepared for the exclusive use of OSU for specific application to the project known as Pacific Marine Energy Center South Energy Test Site. This report has been prepared in accordance with generally accepted geophysical practice consistent with similar work done near Waldport, Oregon, by geophysical practitioners at this time. No other warranty, express or implied, is made.

The information contained in this report is based on data obtained from the field explorations described in Section 4 of this report. The explorations indicate geophysical conditions only at specific locations and times, and only to the depths penetrated. They do not necessarily reflect variations that may exist between exploration locations. The subsurface at other locations may differ from conditions interpreted at these explored locations. Also, the passage of time may result in a change in conditions. If any changes in the nature, design or location of the project are implemented, the information contained in this report should not be considered valid unless the changes are reviewed by SA to address the implications and benefit of enhancing the work as necessary. SA is not responsible for any claims, damages or liability associated with outside interpretation of these results, or for the reuse of the information presented in this report for other projects.

2. Geologic Setting

The project site lies along the Pacific shoreline of Oregon, approximately two miles north of the mouth of the Alsea River and the town of Waldport. The site lies west of the relatively steep, north-south-trending Coast Range, on the coastal margin at Driftwood Beach State Recreation Site. The shoreline area at the project site consists of a relatively flat parking area on a terrace surface approximately 30 feet above the active shoreline. In the vicinity of the site, the shoreline is characterized by a relatively steep, 20- to 40-foot high, steep bluff formed by wave-cut erosion at the toe of the slope. At the project area, the slope from the parking area to the beach is relatively subdued and modified with paths and minor fill.

Based on our literature review and site reconnaissance, the units encountered at the site, from youngest to oldest, consist of Holocene (recent) surficial deposits of unconsolidated fine- to medium-grained dune and beach sand, recent alluvium; Pleistocene marine terrace deposits; and Tertiary siltstone, claystone, and fine sandstone. The recent dune deposits are principally located in the periphery of the parking lot and to areas north, south, and east. The base of the dune sand may exhibit some consolidation. In addition to the recent dune sand deposits along the uplands, active shoreline processes are reworking the older, fine to medium grained terrace sand. Other recent deposits observed near the site include stream alluvium at the mouths of small drainages located north and south of the site. The alluvium consists of sand, gravel and cobbles composed predominantly of erosionally-resistant basalt. The thickness of the recent (Holocene) deposits varies between 0 and tens of feet-thick.

Flat-lying marine terrace deposits underlie the unconsolidated recent deposits in the project vicinity. These semi-consolidated terrace soils are remnants of older beach deposits. The marine terrace deposits are exposed in the shoreline bluffs along most of the Lincoln County shoreline, including the project area. The semi-consolidated, Pleistocene marine terrace deposits form steep bluffs along the shoreline and extend inland as much as a mile. The terrace deposits directly overlie the wave-cut benches formed on westward-tilted, Tertiary marine siltstone and fine sandstone of the Alsea Formation. The base of the marine terrace deposit may contain a lag deposit of coarse sand, gravel and cobbles that formed as a lag deposit at the shoreline transgressed to the east, prior to the deposition of the Pleistocene beach deposit. The Pleistocene marine terrace deposits range in thickness between 0 and 50 feet or more (Schlicker, et. al., 1973).

Tertiary (middle to late Oligocene), dark gray, marine siltstone and fine sandstone (Alsea Formation) underlie the marine terrace deposit. The contact between the Alsea Fm. and the Plio-Pleistocene terrace deposit is unconformable, with the underlying Alsea interbedded claystone, siltstone and fine sandstone inclined westward at dips ranging between 5 and 30 degrees, based on exposures along the Alsea River embayment and east of the project site. Thicknesses of individual interbeds of siltstone versus fine sandstone are unknown at the project site as this unit is not exposed at the surface in the project vicinity. The erosional contact between the Plio-Pleistocene terrace deposits and the underlying Oligocene siltstone and sandstone is regionally flat, however locally may be irregular due to variable erosional resistance between the siltstone, claystone and sandstone. Additionally, due to the unfavorable dip towards the west and active shoreline erosion, bedding plane failures (landslides) within the Alsea Formation exists and displaces the overlying Plio-Pleistocene through Holocene-aged deposits. The thickness of the Tertiary marine Alsea Formation ranges in thickness between 150 and 3,500 feet (Snavely, et. al., 1975).

3. Executive Summary: Conditions Encountered

The data from the various geophysical methods are processed to present the results as “tomograms”; a word derived from the Greek “tomo” meaning to cut or slice. Data were collected to illustrate subsurface conditions a distance of roughly 1200 feet along the westerly route of the proposed HDD corridor as illustrated by Figure 100 (Geophysical Exploration Plan). The tomograms are annotated to communicate our interpretation of the various types of soil and rock believed to be identified by each geophysical method.

As described in the previous section (Geologic Setting), the SA team has identified three distinct strata that dominate the materials to be encountered through this section of the HDD corridor. Stratification is simplified as follows:

- Beach Sand: The recent beach sand consists of unconsolidated, cohesionless, fine- to medium-grained sand derived from the reworking of the older, underlying marine terrace deposits. The sand ranges in density between loose and medium dense, and ranges in moisture between moist and saturated. The thickness of the beach sand varies between approximately 10 and 30 feet in the study area. Geophysical properties are summarized as follows:
  - ER: Wide variations in electrical properties were encountered mostly due to variable moisture content and moisture characteristics. When saturated by salt water, the sand offers a very low electrical resistivity, on the order of 1 Ohm-m. At higher elevations, the sand is moist and the connate water is fresh; the apparent electrical resistivity is on the order of 1,000 Ohm-m. This variation within the same strata promotes difficulty distinguishing the beach sand based on electrical resistivity alone.
  - SR: Unsaturated P-wave velocity was only measured through the higher elevations of the parking lot. Here the beach sand is characterized by P-wave velocity ranging from about 500 to 2000 f/s. In the saturated environment, the P-wave velocity will be similar to the compression wave propagation speed through water: about 4700 f/s.
  - ReMi: S-wave velocity is considered to be an excellent means of distinguishing the extents of the beach sand and the contact with stronger, underlying units. S-wave velocity is valid in both the saturated and unsaturated environment and SA interprets the S-wave velocity of the beach sand to vary from about 300 f/s to around 1000 f/s with these velocities identifying loose to dense characteristics, respectively.
- Marine Terrace Deposits: The Pleistocene terrace deposits consist of orange-brown, fine to medium-grained sand, with abundant organic fragments. Scattered, thin (1- to 2-inch) seams of sandy silt exist within the unit. Previous borings performed in this unit exhibit densities ranging between medium dense and dense. Subsurface information for the proximal area is sparse, however based on observations from the field, the terrace deposit ranges in thickness between 25 and 35 feet in the vicinity of the parking lot and to between 20 and 50 feet in the near shore area investigated in this study. Geophysical properties are summarized as follows:

  - ER: Again, the ER interpretation is challenged by a wide range of electrical resistivity mostly driven by the character of the connate water. However, within each ER tomogram, electrical contrast exists to help define the upper and lower boundary of the marine terrace deposits.
  - SR: P-wave refraction is an ineffective method to define the character and thickness of this stratum. SA suggests that this is due to numerous, thin layers offering variable P-wave velocity. When a high velocity layer is situated at a higher elevation than a lower velocity layer, the first arrival P-waves are carried by the higher elevation layer and the lower layers are not sampled properly. Thus, limited sampling of the marine terrace has been accomplished by SR. This blind zone leads to problems associated with defining the marine terrace thickness and position of lower strata.
  - ReMi: The ReMi method provides clear definition of the marine terrace layers and identifies numerous velocity reversals, heterogeneity and a reasonable estimate regarding thickness, and strength. SA interprets S-wave velocity ranging from about 800 f/s to roughly 2200 f/s represent the marine terrace. This suggests a wide range of strength and texture.

- <u>Tertiary Alsea Formation</u>: The fine grained marine Alsea Formation is an indurated, interbedded, gray, siltstone, claystone, and fine sandstone. Based on previous explorations within this formation elsewhere in the region, the Alsea is hard/very dense and exhibits refusal standard penetration tests (SPTs). As described above, the top of the Alsea is a former shoreline and may exhibit an undulating erosional surface due to the variability in erosional resistance between the siltstone and sandstone interbeds. The thickness of the individual interbeds of siltstone and sandstone are unknown at the site, but outcrop evidence suggests a range between inches and tens of feet. Geophysical properties are summarized as follows:

  - ER: The ER results suggest that the Alsea Formation offers a low resistivity layer and the formation is well defined in both the saltwater and freshwater environment. The Resistivity varies widely based on the character of the connate water. In the higher elevations a strong electrical contrast exists that defines the depth to the Alsea that closely correlates with the depth defined by both SR and ReMi.
  - SR: Where thick deposits of the marine terrace deposits exist, the SR method is not considered to be an effective geophysical method to reliably define the depth and P-wave velocity of the Alsea.
  - ReMi: In each tomogram, the Alsea is clearly defined by an increase in S-wave velocity. SA interprets an S-wave velocity on the order of 2200 f/s and higher to represent the Alsea Formation. The contact with the overlying marine terrace is typically abrupt and S-wave velocity as high as about 3800 f/s are interpreted.

4. Geophysical Data Acquisition: Terrestrial

The three geophysical methods were designed to explore the geotechnical conditions to depths of 100 feet and beyond. Data were procured in a manner to extend the exploration as far west as possible by scheduling operations to coincide with low tide. In order to facilitate permitting with Oregon Parks and Recreation Department, the lines on the beach were terminated below the parking lot to prevent the need to clear vegetation. Exploration was continued at the higher elevation of the parking lot with the survey locations selected to avoid vegetation removal and limit damage to the parking lot pavement. Line locations are illustrated by Figure 100 (Geophysical Exploration Plan).

In this section, the geophysical methods, equipment, challenges, and quality are described.

4.1. Geophysical Methods and Equipment

4.1.1. Electrical Resistivity (ER)

How it works: Two-dimensional (2D) electrical resistivity tomography is a geophysical method to illustrate the electrical characteristics of the subsurface by taking measurements on land or in a marine setting. These measurements are then interpreted to provide a 2D electrical resistivity profile which is, in turn, related to the likely distribution of geologic or cultural features known to offer similar electrical properties. Measurement in an electrical survey involves injecting DC current though two current-carrying electrodes and measuring the resulting voltage difference at two or more potential electrodes. The apparent resistivity is calculated using the value of the injected current, the voltage measured and a geometric factor related to

the arrangement of the four electrodes.

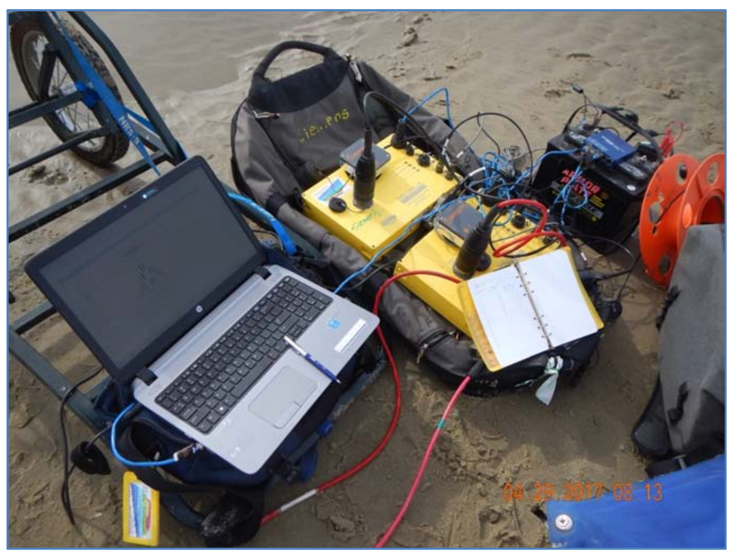
The investigation depth of any particular measurement is related to the spacing between the electrodes that inject current. Therefore, sampling at different depths can be done by changing the spacing between the electrodes. Measurements are repeated along a survey line with various combinations of electrodes and spacing to produce an apparent resistivity cross-section (tomogram). In this case, SA used both Wenner and Dipole-Dipole arrays with electrode spacing ranging from 3 to 4 m along overlapping lines composed of 56 electrode take-outs built into the cable.

ER lines were set to coincide with low tide and continue from the surf zone to the toe of the brushy slope west of the parking lot. Additional lines were extended north to south both near the toe and crest of slope near the west end of the parking lot. Line length varies from 540 feet to 1141 feet with depth of exploration as great as 160 feet. Figure 100 (Geophysical Exploration Plan) illustrates the location of each line.

Electrical resistivity data were recorded using an R-8 SuperSting manufactured by Advanced Geosciences, Inc., Austin, Texas, USA. The instrument is an eight channel, automated system capable of completing over 1600 measurements in about one hour. For this project, the measurement sequence was configured for a high density data set and data were subsequently filtered during the processing stage.

4.1.2. Seismic Refraction (SR)

Seismic refraction (SR) is an active seismic method utilizing geophone receivers set along a straight line gathering data from signals induced by a small explosive charge (8 gauge, 400 grain black powder shell detonated using a Betsy Seisgun). Data were processed using forward modeling software developed by Optim known as SeisOpt@2D; the models developed are considered questionable due to velocity reversal "blind zones" as described in Section 5. SR provides a 2D profile illustrating P-wave velocity with depth. Lower P-wave velocity is related to unconsolidated materials while heavily consolidated materials and rock are illustrated by higher P-wave velocity.



How it works: When the explosive charge detonates, the receivers are triggered and the wavelet energy is recorded. The P-wave is the fastest of the various seismic waves that are generated and only the time of the first arrival wave form at the receiver is considered in the SR method. These "first arrivals" are picked for each record. As the energy travels through the ground, the waves are refracted and the arrival time, combined with distance from the source is related to both the velocity and distance to the layers promoting refraction. This distance is not necessarily vertical depth; rather the nearest refractor and the image can be skewed when oriented along a dipping refractor.

In this case, the soils on the beach are saturated promoting P-wave travel through and velocity measurement of the fluid rather than the soil. This means that P-wave velocity lower than about 4700 f/s (speed through water) will not be measured by seismic refraction.

Data were recorded using a networked pair of DAQ III seismographs manufactured by Seismic Source in Ponca City, Oklahoma, USA, connected to a HP laptop computer.

4.1.3. Seismic Refraction Microtremor (ReMi)

The refraction microtremor, known as ReMi is a passive, surface-wave analysis method for obtaining near surface shear-wave velocity models to constrain strength and position of shallow geologic boundaries. These analyses provide information about land and marine soil and rock properties that are very difficult to obtain through alternative methods. SA recorded passive ambient vibrations (background noise) augmented by an active seismic source (un-timed plate and hammer) operated near the array.

On land, surface wave analysis is performed using Rayleigh waves because they can be detected on an air-ground interface (earth surface) using geophones. However, the Scholte wave, which is a similar type of seismic surface wave propagating along the interface between a fluid layer and an underlying solid (the seabed), dominate in marine work. Hence, the Scholte wave is capitalized in marine work and measured with hydrophones set

at the water-seabed interface to record ambient vibrations. Both hydrophones and geophones measure the vertical component of the surface wave (Scholte or Rayleigh) and the results are considered a reasonable estimate of the vertical distance (depth) to layers below the receivers.

How it works: The ReMi analysis develops the shear-wave velocity/depth profile using an engineering seismograph, low frequency receivers (geophones or hydrophones) and straight line array aperture (Louie, 2001). Ambient surface wave energy is recorded using relatively long sample window (30 seconds) recording the ambient wavefield. At this site, quality low frequency signals were consistently recorded from waves crashing on the beach, nearby highway traffic (trucks) and SA enhanced the mid-range frequency (about 15 Hz. to 50 Hz.) using a plate and hammer.

The microtremor records are transformed as a simple, two-dimensional slowness-frequency (p-f) plot where the ray parameter "p" is the horizontal component of slowness (inverse velocity) along the array and "f" is the corresponding frequency (inverse of period). The p-f analysis produces a record of the total spectral power in all records from the site, which plots within the chosen p-f axes. The trend within these axes, where a coherent phase has significant power is "picked". Then the slowness-frequency picks are transformed to a typical period-velocity diagram for dispersion. Picking the points to be entered into the dispersion curve is done manually along the low velocity envelope appearing in the p-f image.

Terrestrial measurements were completed using 8 Hz. vertical receivers (geophones) using the same arrays configured for SR. Receiver overlap of 12 channels were used to provide continuous records through the long arrays of Lines A and B.

Data were recorded using a pair of networked DAQ III seismographs manufactured by Seismic Source in Ponca City, Oklahoma, USA, connected to an HP laptop computer.

4.2. Horizontal and Vertical Control

The horizontal and vertical locations were recorded by JTA as the geophysical operations were in progress. JTA worked alongside the geophysical crew each day of operations and provided staking to locate the lines in accordance with data illustrating the anticipated orientation of the HDD corridor. The North American Vertical Datum of 1988 is the basis for the elevations presented by the geophysical tomograms and details regarding the onsite survey including tabulations of the measured coordinates and a scaled site plan are presented in Section 8 of this report. Coordinates have also been uploaded to ArcGIS, a GIS database for future reference. Details regarding the GIS database and upload data formats are described in Section 9 of this report. Figure 100 (Geophysical Exploration Plan) is a rough, visual illustration of the line locations and not intended to reflect the accuracy of the JTA survey.

4.3. Ancillary Operations

4.3.1. Traffic Control

At the start of each workday, SA established a safe corridor to maintain public awareness. When operations moved to the parking lot, the west end of the lot was closed to traffic. The plan consisted of signage and cones and a few cars that where within the closed area were allowed to exit across the survey cables that were protected by a rubber road mat that allowed traffic to travel directly over the survey cables as operations were underway.

4.4. Summary of Challenges

4.4.1. Operations

Several difficulties were experienced with the most severe related to the rapid flood tide experienced on the first day of operations and associated strong wave breaks that displaced the initial setting of the ER cable along Line A. The crew needed to adjust operations including changing the planned sequence for the SR survey on Line B and re-doing the ER on Line A at a later time. Also, at the higher elevations of the parking lot, the sand was quite resistive and significant difficulty was experienced in achieving proper contact resistance at the electrode pins. The pins were watered with a saline solution and driven deep to mitigate this condition. Along Line D, both Dipole-Dipole and Wenner electrode configurations were used and the Wenner data proved to be more robust due to a stronger signal and was used in the final data processing.

4.4.2. Data Quality and Interpretation Challenges

In general, the recorded data are judged to be of moderate to high quality. The lines were laid out to optimize definition of the subsurface throughout the upper 100 feet, roughly twice the anticipated depth of the HDDs through this zone. The results provide an outstanding first look at subsurface conditions including a solid understanding of the relative strength, character and position of the various layers encountered. A summary of the engineer's judgment regarding quality and confidence in the results presented by each geophysical line is as follows:

ER-1, ER-2, SR-5, SR-6 and RM-1 through RM-4: High quality/confidence

SR-4: Good quality, challenged by some velocity reversal, not severe

ER-3, ER-4, SR-1 and SR-2, SR-3: Moderate quality, challenged by high contact resistance at the electrode pins (ER) and velocity reversal (SR)

5. Processing

5.1. General

During the data gather, partial interpretation was completed in the field for quality control purposes and to assist in setting and confirming proper data acquisition parameters.

The interpretation for each line is presented as appendix to this report with the general locations shown graphically on Figure 100 (Geophysical Exploration Plan).

It is worthy to emphasize that the geophysical results are presented in 2D yet the data collection is influenced by a 3D environment. Unless the geology is simple, like a flat stack of pancakes, the various geophysical methods cannot be expected to match perfectly. In addition, geophysical interpretations are often compared to direct observation of conditions discovered in geotechnical drill holes. Note that the drill hole is a 1D representation of the subsurface and represents a very small sampling, unlike the geophysical approach. Correlation and conflict are expected and both must be considered in context with the complication of the subsurface and the various factors influencing the measurements.

A description of the data processing, interpretation methods and results are presented as follows:

5.2. Electrical Resistivity (ER)

Important factors which affect the resistivity of different geological material are:

- Porosity
- Moisture content
- Dissolved electrolytes
- Temperature (resistivity decreases with increasing temperature)

- Water conductivity (in marine environments)

5.2.1. Processing

The AGI, R-8 SuperSting stores field measurements to proprietary data files with a .stg extension. Each dataset was filtered to remove spikes and noisy data through a systematic progression to produce inversion models with acceptable RMS error data fit without excessive iteration, which tends to produce artificial anomaly. Geometry (elevation data) was included in the processing. The data sets from overlapping measurements were combined for processing using AGI Earth Imager and Res2DINV by Geotomo Software. In the end, SA selected the inversion produced by Earth Imager; however, the two software packages produced similar findings.

5.2.2. Presentation and Interpretation

At this site, electrical contrast ranges from less than 10 Ohm meters near the ocean and is roughly 4 orders of magnitude near the parking lot. This presents a challenge in presenting the results since using a common resistivity scale for each of the tomograms effectively masks important characteristics. The difficulty was resolved by changing the resistivity presentation scale to match the range illustrated by the data measured along each line.

Since different resistivity scales are used, it is difficult to correlate similarities from line to line. Nevertheless, the ER results tend to illustrate stratification boundaries that generally are supported by the results of the other geophysical methods.

A common horizontal and vertical scale of 1 inch = 50 feet was selected for presentation of each line and the long lines A and B are presented with a horizontal scale of 1 inch = 100 feet while the shorter lines C and D offer a horizontal scale of 1 inch = 50 feet to better illustrate the findings.

5.2.3. Seismic Refraction (SR)

Refraction data were recorded along each line and the data were excellent. Lines A, B and C were challenged by several factors. First, the soils were either saturated from the surface or the water table was very shallow. This promotes P-wave velocity related to the saturated condition (essentially the speed of a compression wave traveling through water) and can be many times faster than the velocity of the same wave through the same soil if it were not saturated. Hence, the P-wave is a poor measure of soil strength when saturated. Second, the sediments appear to be layered such that stronger, faster layers are bedded at depths above weaker, slower layers. This causes problems with the refraction method since the fastest raypaths return to the receivers from shallow depth and deep geology is not sampled as thoroughly.

5.2.4. Processing

SA processed the refraction data using software known as SeisOpt@2D, version 6.0, developed by Optim. The process uses a forward modeling and nonlinear optimization procedure capable of resolving features to about one-half of the receiver spacing generating results using only geometry, source and receiver locations, and first arrival times. Many models were generated for each line to determine the best fit for various possibilities of raypaths refracting to each receiver from each shot. The primary variable (and unknown) is the depth to the refractor and in this is case, SA judges that the refractors are a complicated system of layers offering velocity reversals challenging the normal precision of the refraction method. This is particularly true for Lines A, B and C, and less of an issue with the remaining lines that are at higher elevations.

The raypath hitplots are presented to illustrate the path of the refracting waves for the models that were selected. These plots clearly show that the P-wave velocity through the interior regions of Lines A, B and C is not well constrained. This is a classic example of when the refraction seismic method is not the most effective geophysical technique for the given geology.

5.2.5. Presentation and Interpretation

The geology described by the 2D refraction surveys defines a strong layer with an elevation that ranges as deep as about -80 feet to as shallow as about -20 feet. This interpretation is judged to be suspect due to the velocity reversal “blind zone” as discussed. In the opinion of SA, the 2D ReMi interpretations are probably a better estimate for depth to hard, strong layers and a much better description of the strength of the shallow, saturated soils and the lateral variability.

A common vertical scale of 1 inch = 50 feet was selected for presentation of the Lines A, B, C and D, and a horizontal scale of 1 inch = 30 feet was used for the short lines E and F to better illustrate the findings. A common velocity range was used for each velocity tomogram.

5.3. Refraction Micro-tremor (ReMi)

A two-dimensional shear-wave model was produced along each of the geophysical traverses for Lines A through D. The models are of particular value as the shear wave velocity is directly related to the strength of a geologic material and is not influenced by saturation since water has no shear strength. The models were produced by Dr. Satish Pullammanappallil, Ph.D. of Optim, Reno, Nevada, USA using SeisOpt ReMi software. The 2D models illustrate the trend in the subsurface in terms of shear-wave velocity that correspond closely with trends in the ER and, in some cases, SR adding confidence in the interpretation.

Shear-wave velocity, V_s is used to determine the shear modulus, G, of soil or rock:

$G = \rho (V_s^2)$: a valuable measure of soil stiffness and rock strength.

Where ρ = mass density (i.e. total unit weight / gravitational acceleration constant, 32.2 ft/s^2).

The ReMi derived V_s from small strain measurements produced by non-destructive surface waves (Rayleigh waves) with strain on the order of 10^{-4} %. Shear modulus (G) derived from shear-wave velocity measured insitu using surface wave methods is commonly referred to as the small-strain shear modulus G_{max}.

The shear-wave velocities observed in the 2D ReMi profile illustrates numerous velocity reversals in the shallow layers and a clear, typically abrupt transition to hard, strong material at elevations ranging from about -100 feet to as shallow as -20 feet or so. The data for ReMi analysis are robust and SA judges the 2D ReMi profile to be a valid estimate of the prevailing geology. Overall, the ReMi appears to define complicated, disconnected layers of variable strength underlain by competent, hard strata.

5.3.1. Processing

Dr. Pullammanappallil, Ph.D. took the lead on processing the ReMi datasets. He created a series of 1D shear-wave depth profiles along each line using 12 to 24 channels per analysis progressing through the data one channel at a time (channels 1 to 12, 2 to 13, 3 to 14 and so on). As many as 24 channels were used to constrain the deepest parts of the models; however, even the 12 channel analysis offered data constraining depth of exploration approaching 70 feet.

5.3.2. Presentation and Interpretation

The 2D ReMi data is presented using a template similar to the ER and SR with common horizontal and vertical scales.

5.3.3. Seismic Site Classification (ASCE 7)

Seismic Site Classification in accordance with ASCE 7 was also calculated from data along each of the 2D ReMi lines. Site Class C dominates with the average V100 well above 1200 f/s.

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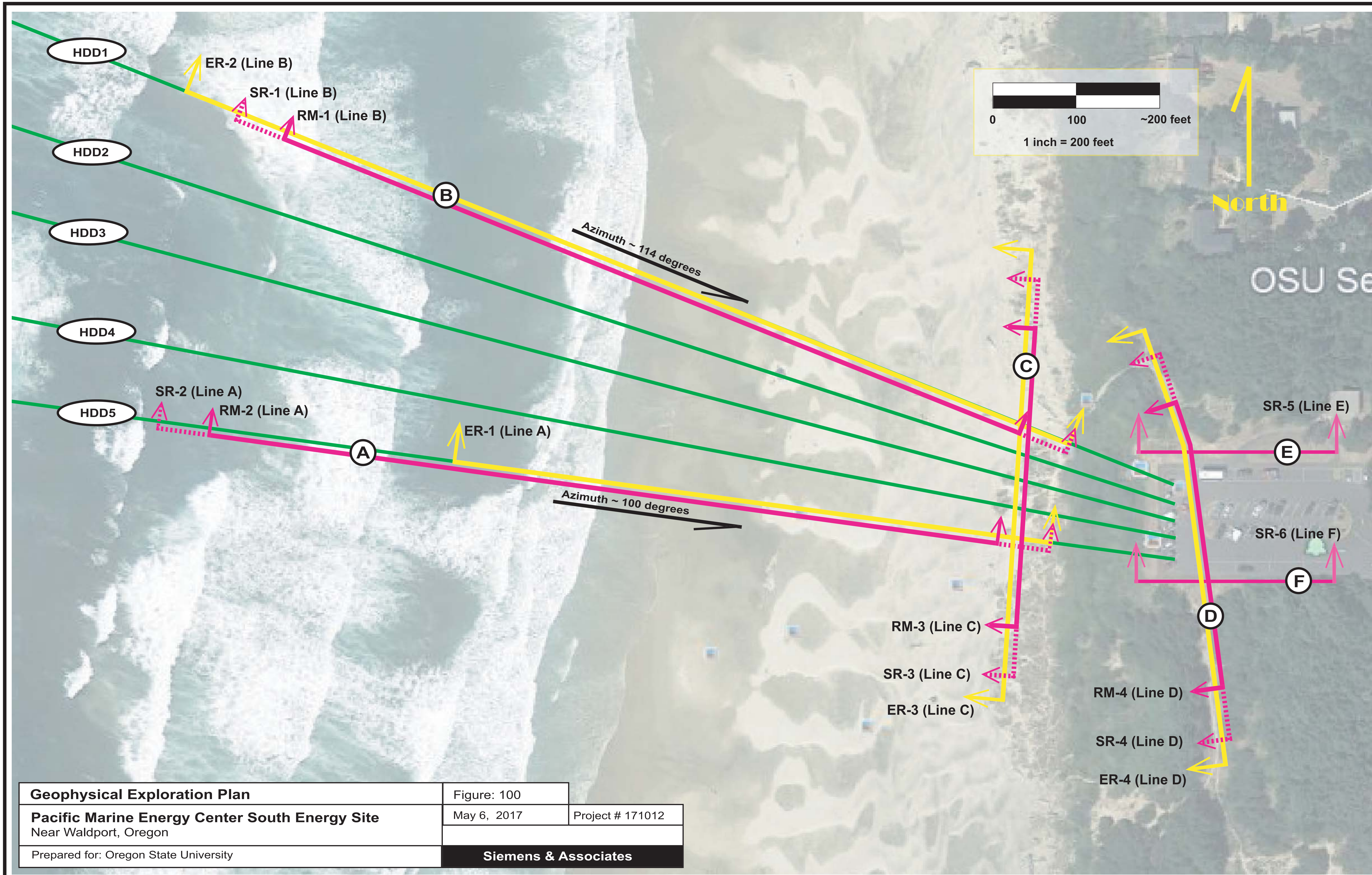
7. Graphical Presentation of Results

The interpretations are presented in 2D with the location of each line illustrated on Figure 100 (Geophysical Exploration Plan).

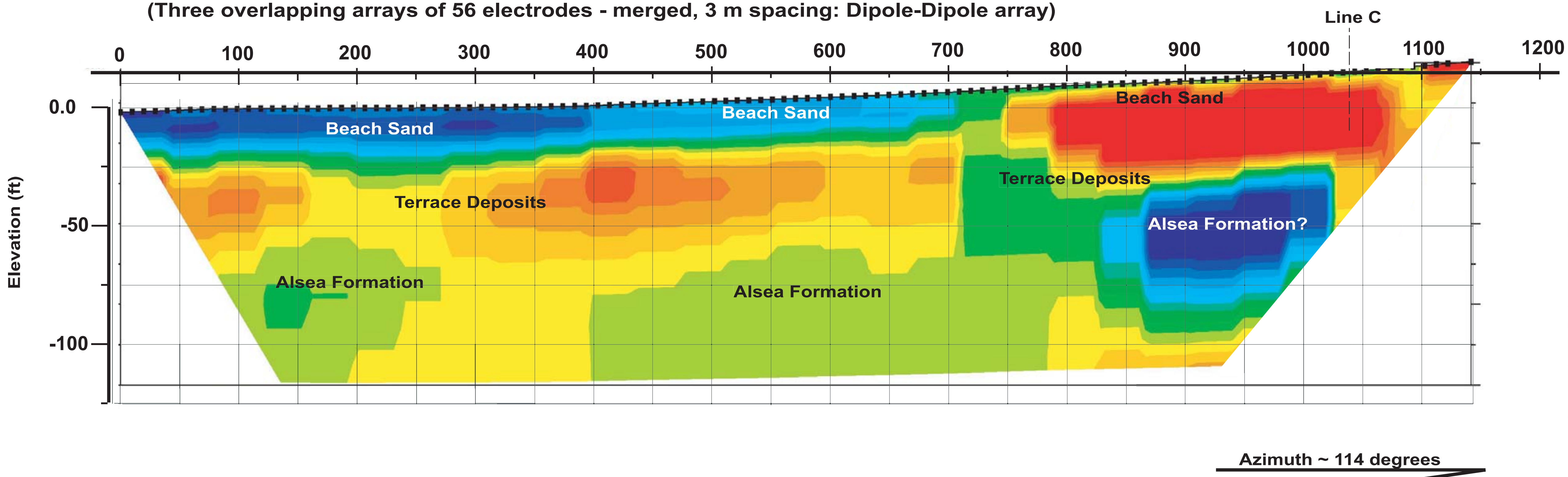
7.1. Figure 100: Geophysical Exploration Plan

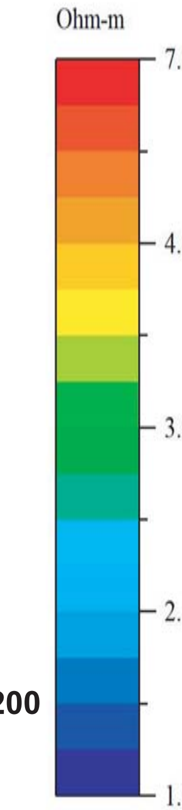

HDD1
HDD2
HDD3
HDD4
HDD5
ER-2 (Line B)
SR-1 (Line B)
RM-1 (Line B)
B
Azimuth ~ 114 degrees
0
100
~200 feet
1 inch = 200 feet
North
OSU Se
C
SR-2 (Line A)
RM-2 (Line A)
ER-1 (Line A)
A
Azimuth ~ 100 degrees
SR-5 (Line E)
E
SR-6 (Line F)
F
D
RM-3 (Line C)
SR-3 (Line C)
ER-3 (Line C)
RM-4 (Line D)
SR-4 (Line D)
ER-4 (Line D)
Geophysical Exploration Plan
Figure: 100
Pacific Marine Energy Center South Energy Site
Near Waldport, Oregon
May 6, 2017
Project # 171012
Prepared for: Oregon State University
Siemens & Associates

7.2. Results on Line A: ER, SR and ReMi

Line B: Electrical Resistivity Tomography: ER-2

(Three overlapping arrays of 56 electrodes - merged, 3 m spacing: Dipole-Dipole array)

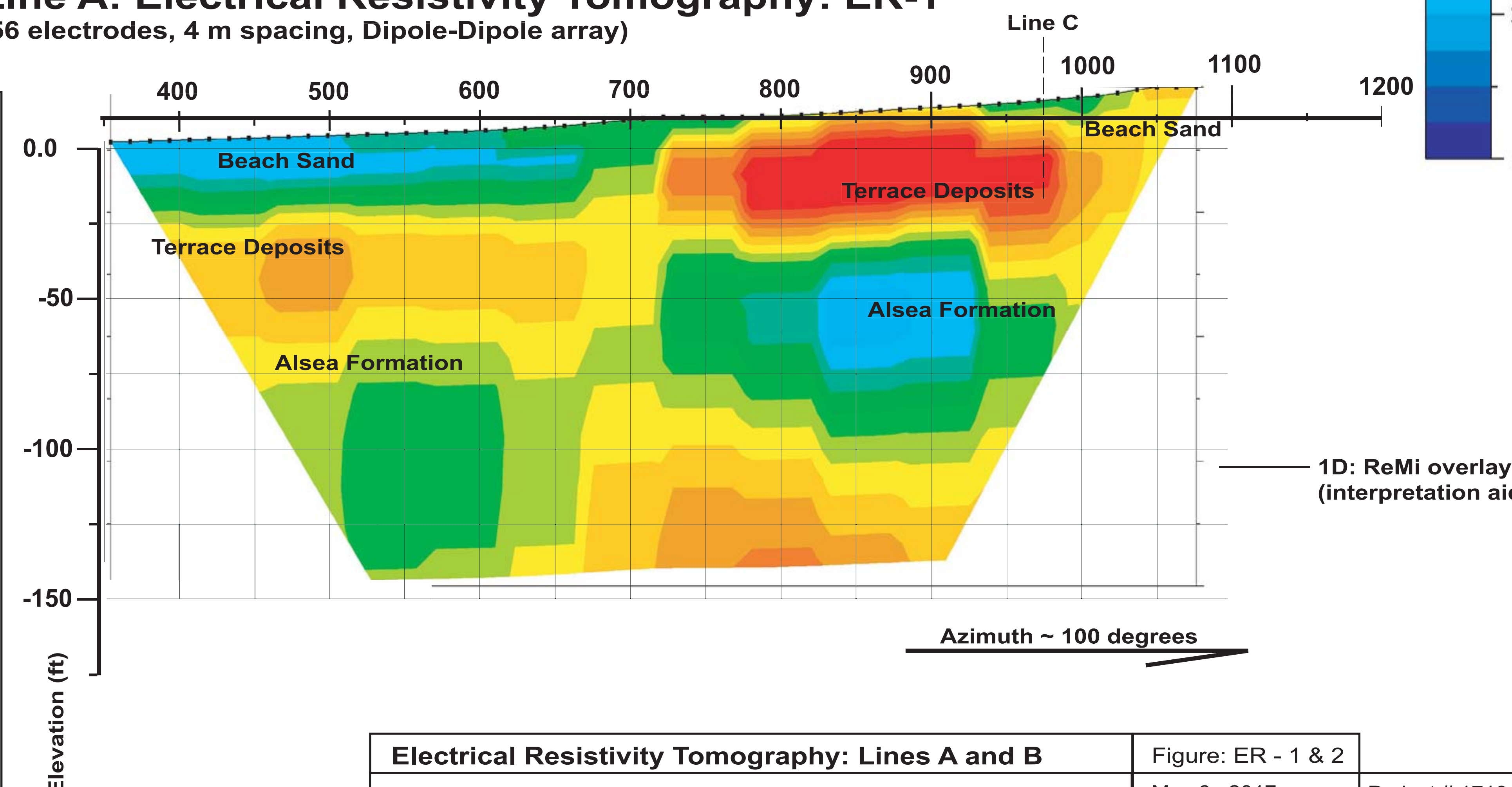




Line A: Electrical Resistivity Tomography: ER-1

(56 electrodes, 4 m spacing, Dipole-Dipole array)

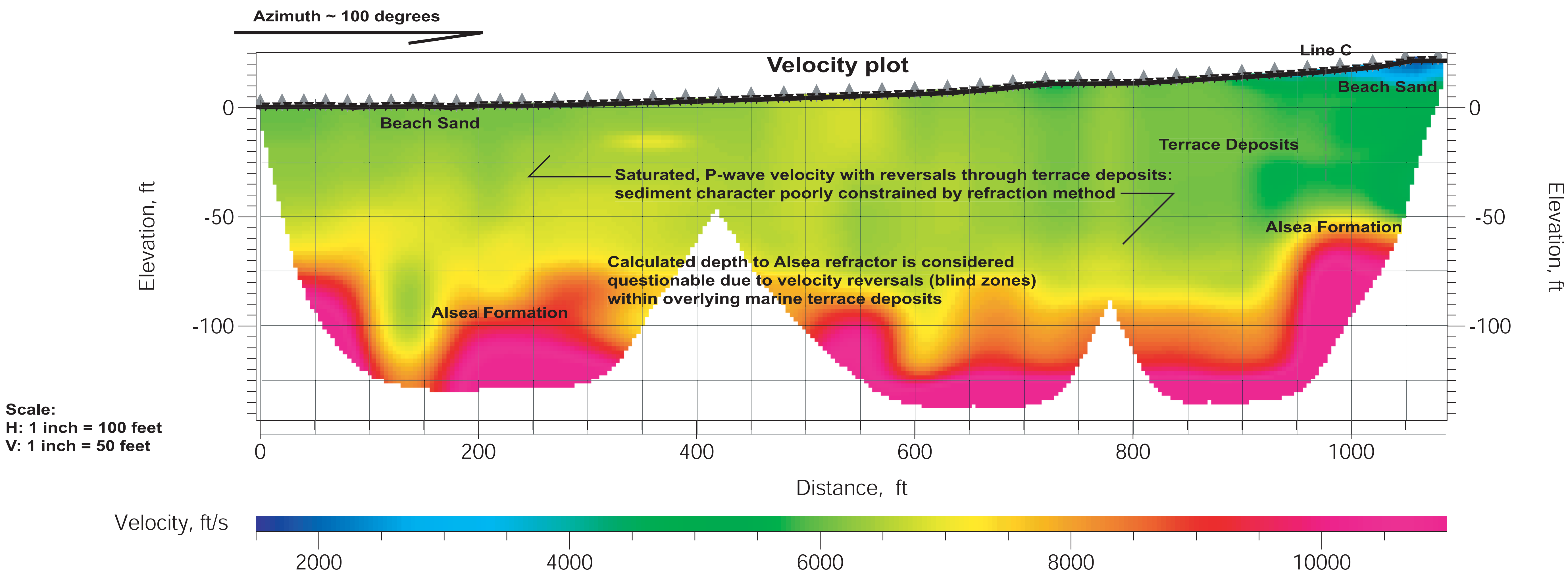
Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

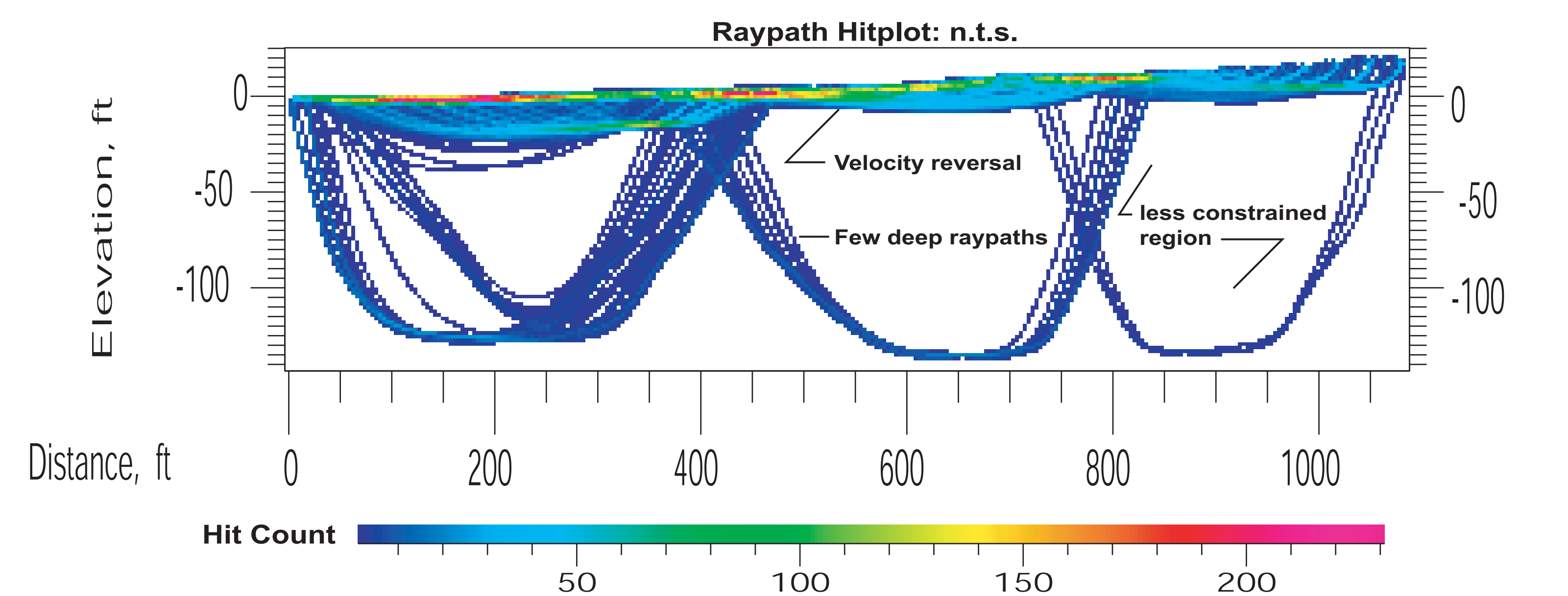


Electrical Resistivity Tomography: Lines A and B	Figure: ER - 1 & 2	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

Line A: P-wave Seismic Refraction Tomography: SR-2

(two 48 receiver spreads and one 36 receiver spread on 10 foot spacing, 12 receiver overlap, 8 Hz. receivers: shots on 20 to 30 foot spacing)



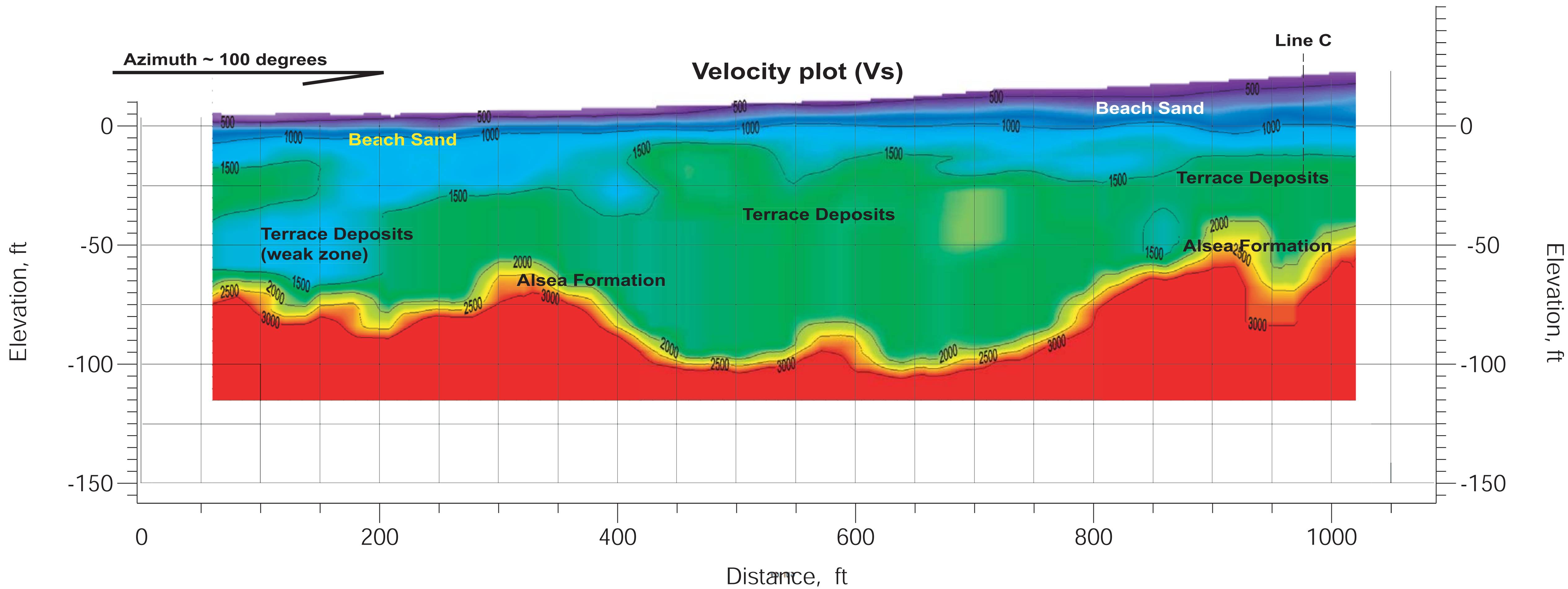


P-wave Seismic Refraction Tomography: SR-2	Figure: SR-2	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 29, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

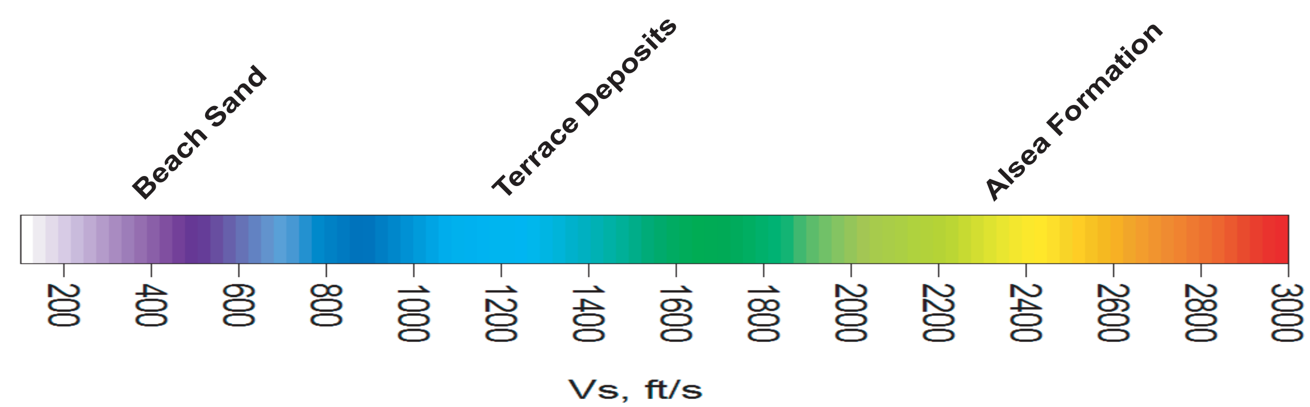
Line A: S-wave Seismic Refraction Microtremor (ReMi): RM-2

(two 48 receiver spreads and one 36 receiver spread on 10 foot spacing, 12 receiver overlap, 8 Hz. receivers)

SeisOpt ®ReMi ™



Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

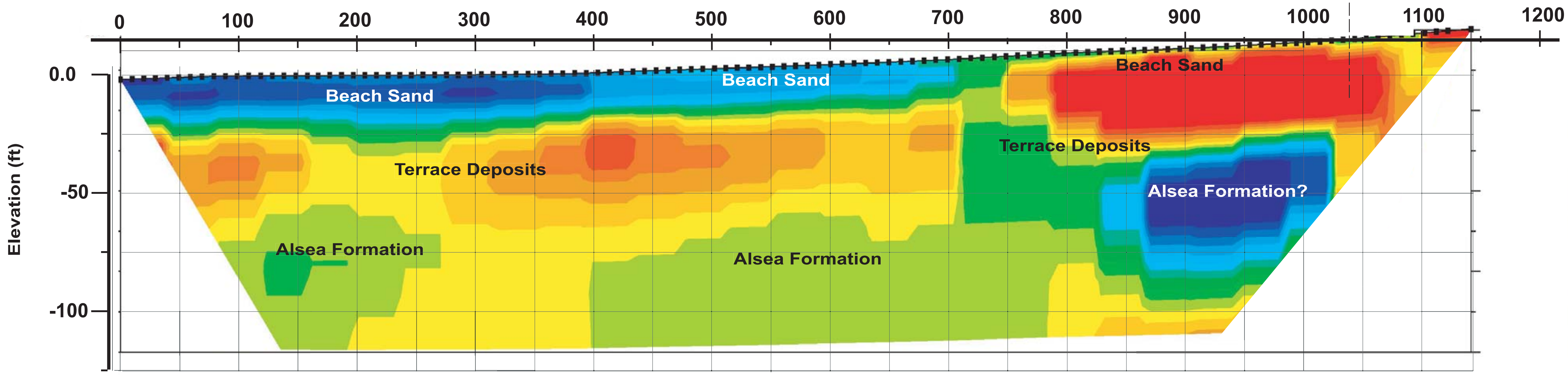


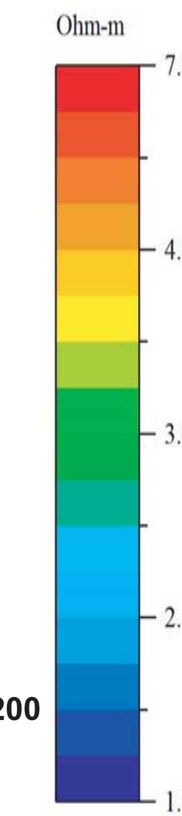
Seismic Refraction Microtremor (ReMi): RM-2	Figure: RM-2	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 29, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.3. Results on Line B: ER, SR and ReMi

Line B: Electrical Resistivity Tomography: ER-2

(Three overlapping arrays of 56 electrodes - merged, 3 m spacing: Dipole-Dipole array)

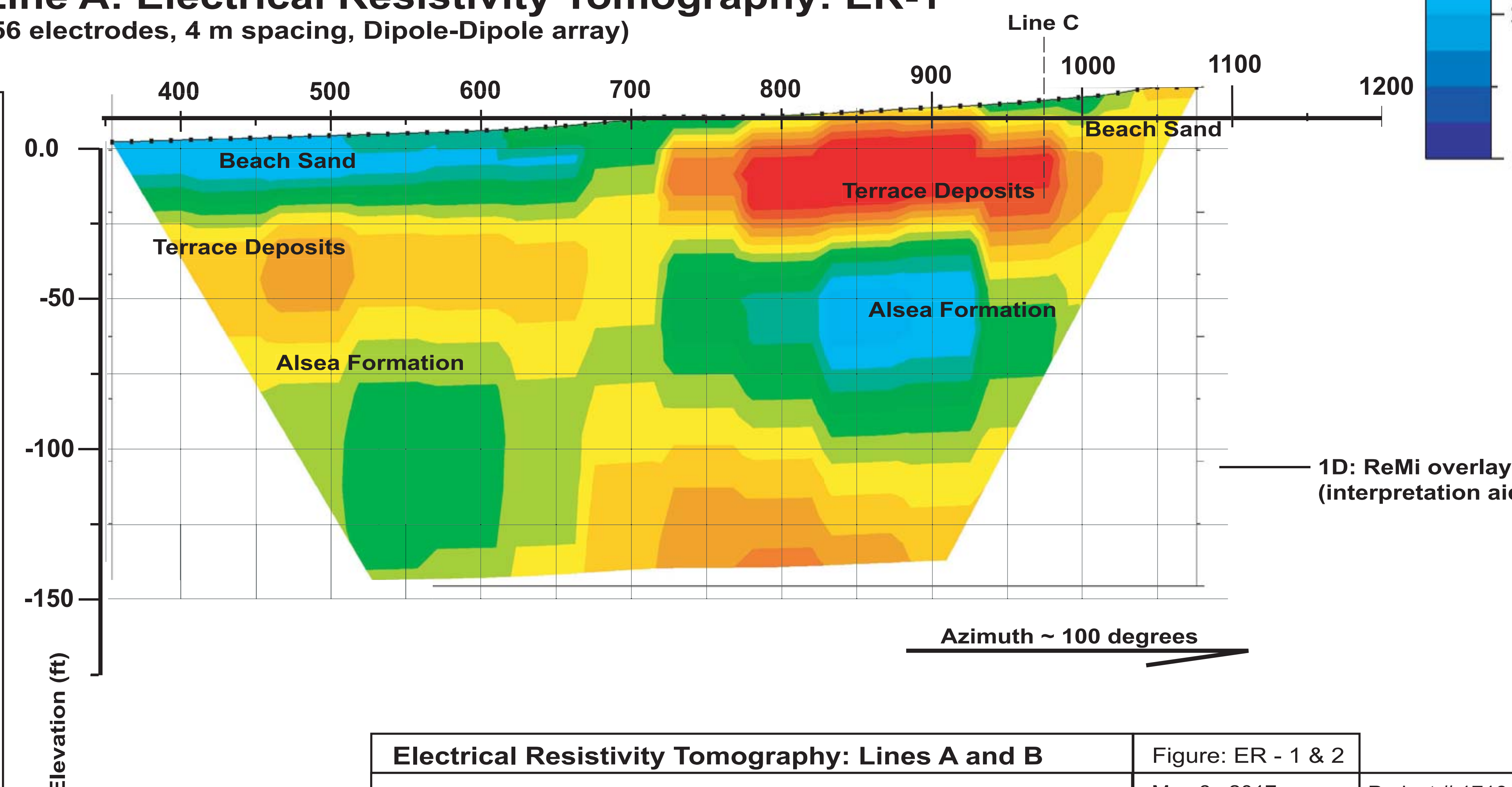




Line A: Electrical Resistivity Tomography: ER-1

(56 electrodes, 4 m spacing, Dipole-Dipole array)

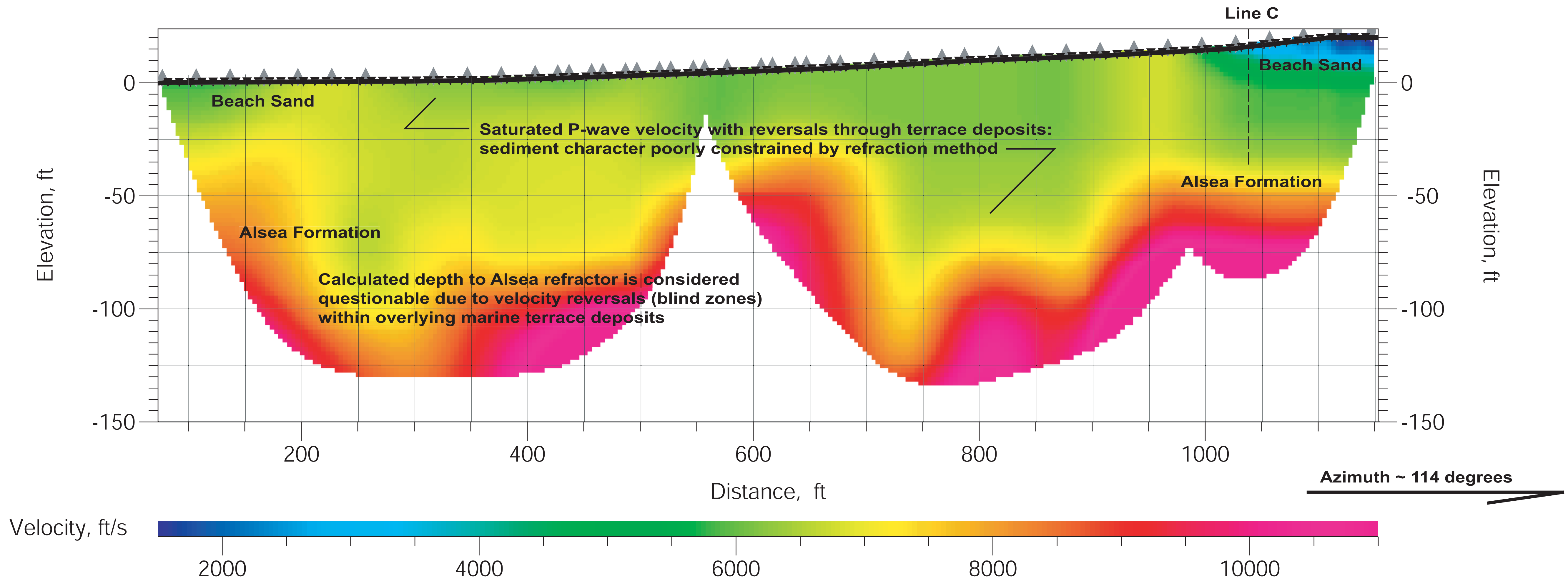
Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

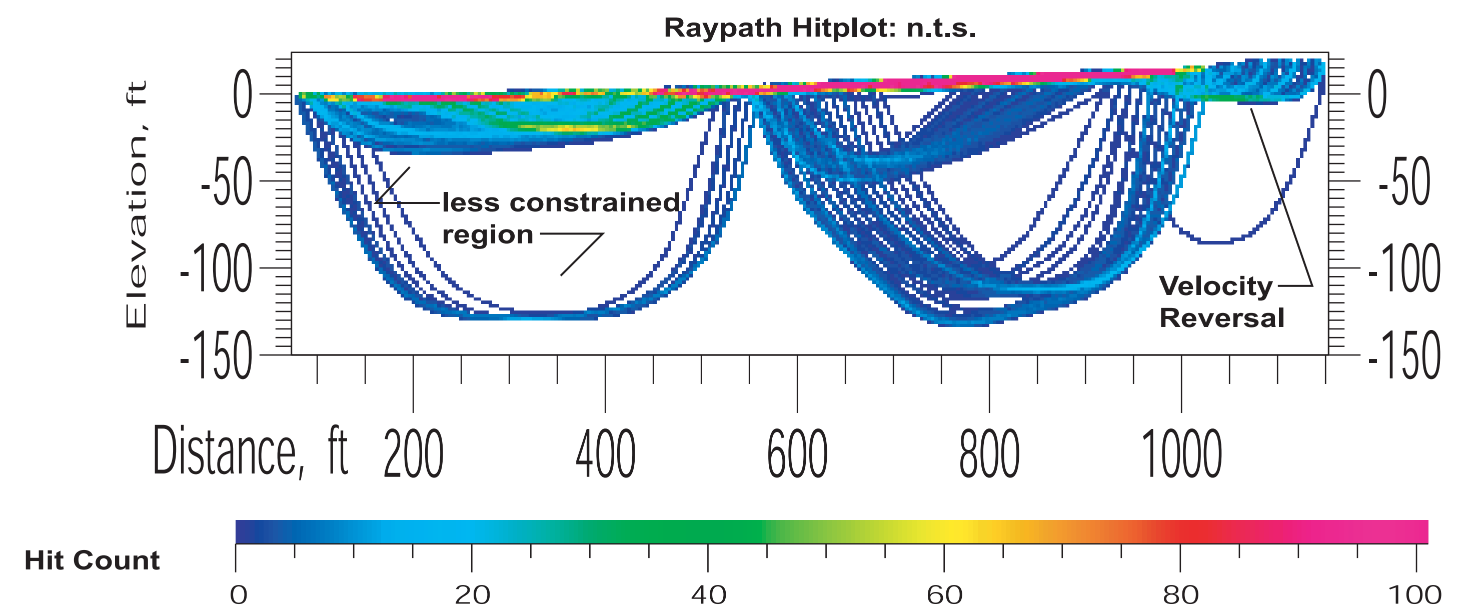


Electrical Resistivity Tomography: Lines A and B	Figure: ER - 1 & 2	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	Siemens & Associates	

Line B: P-wave Seismic Refraction Tomography: SR-1

(two 48 receiver spreads and two 24 receiver spreads on 10 foot spacing, 12 receiver overlap, 8 Hz. receivers: shots on 30 foot spacing)





Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

P-wave Seismic Refraction Tomography: SR-1 on Line B	Figure: SR-1	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 27, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

Line B: S-wave Seismic Refraction Microtremor (ReMi): RM-1

(two 48 receiver spreads and two 24 receiver spreads on 10 foot spacing, 12 receiver overlap)

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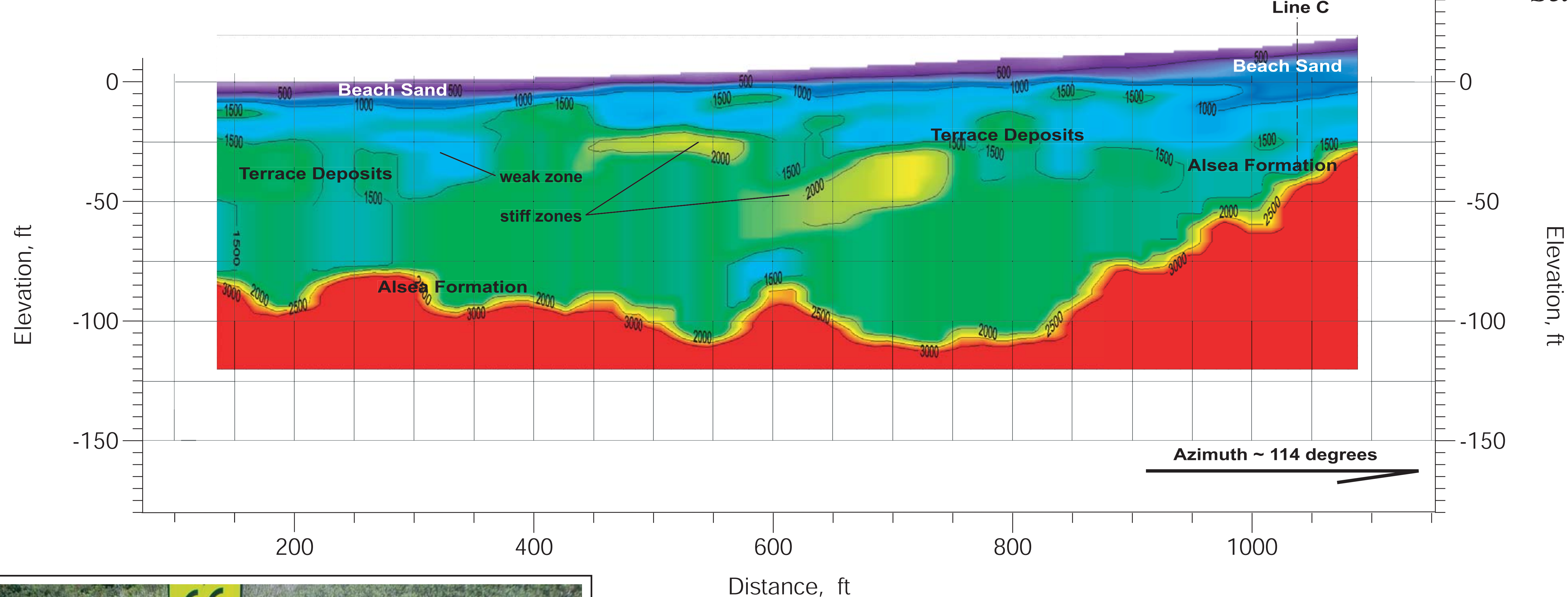
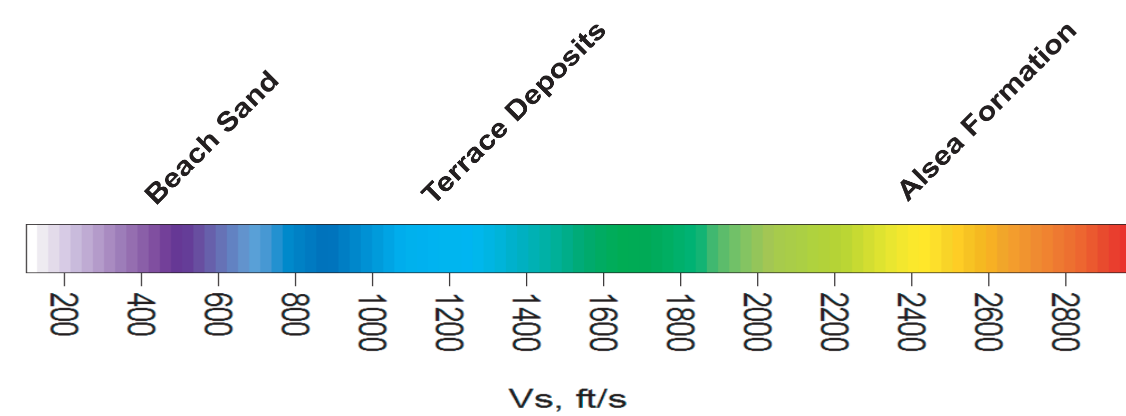




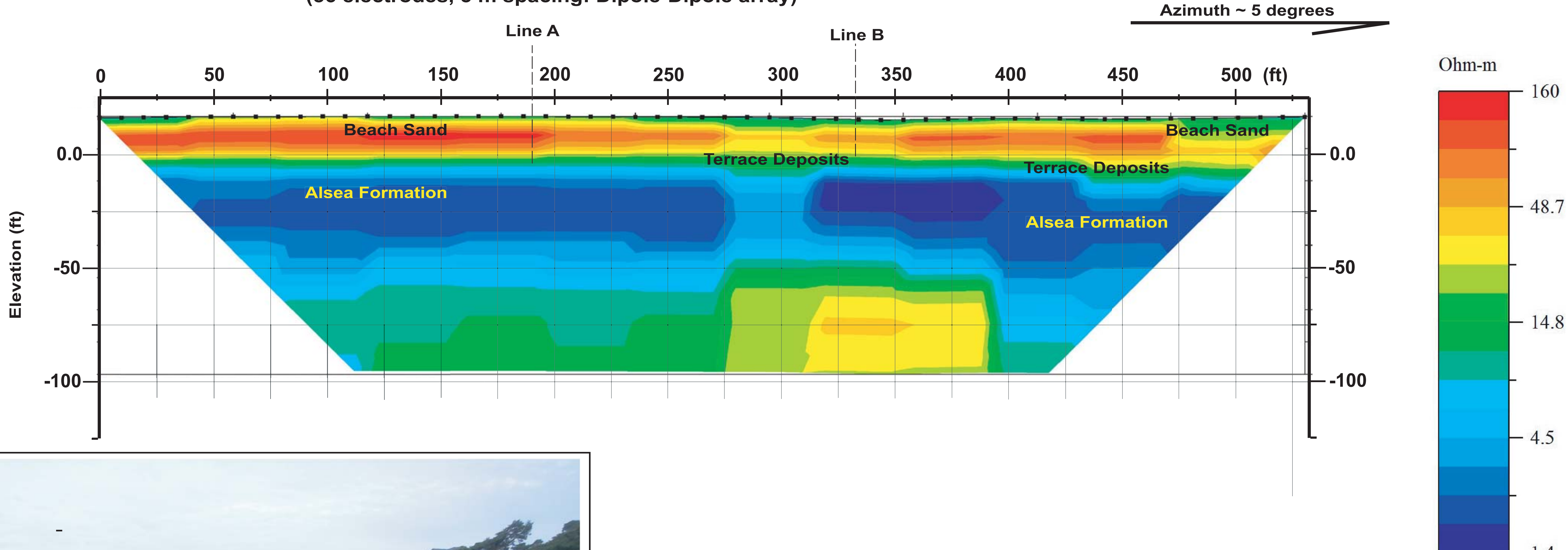
Scale:
H: 1 inch = 100 feet
V: 1 inch = 50 feet

Seismic Refraction Micrtotremor (ReMi): RM-1	Figure: RM-1	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 27, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.4. Results on Line C: ER, SR and ReMi

Line C: Electrical Resistivity Tomography: ER-3

(56 electrodes, 3 m spacing: Dipole-Dipole array)

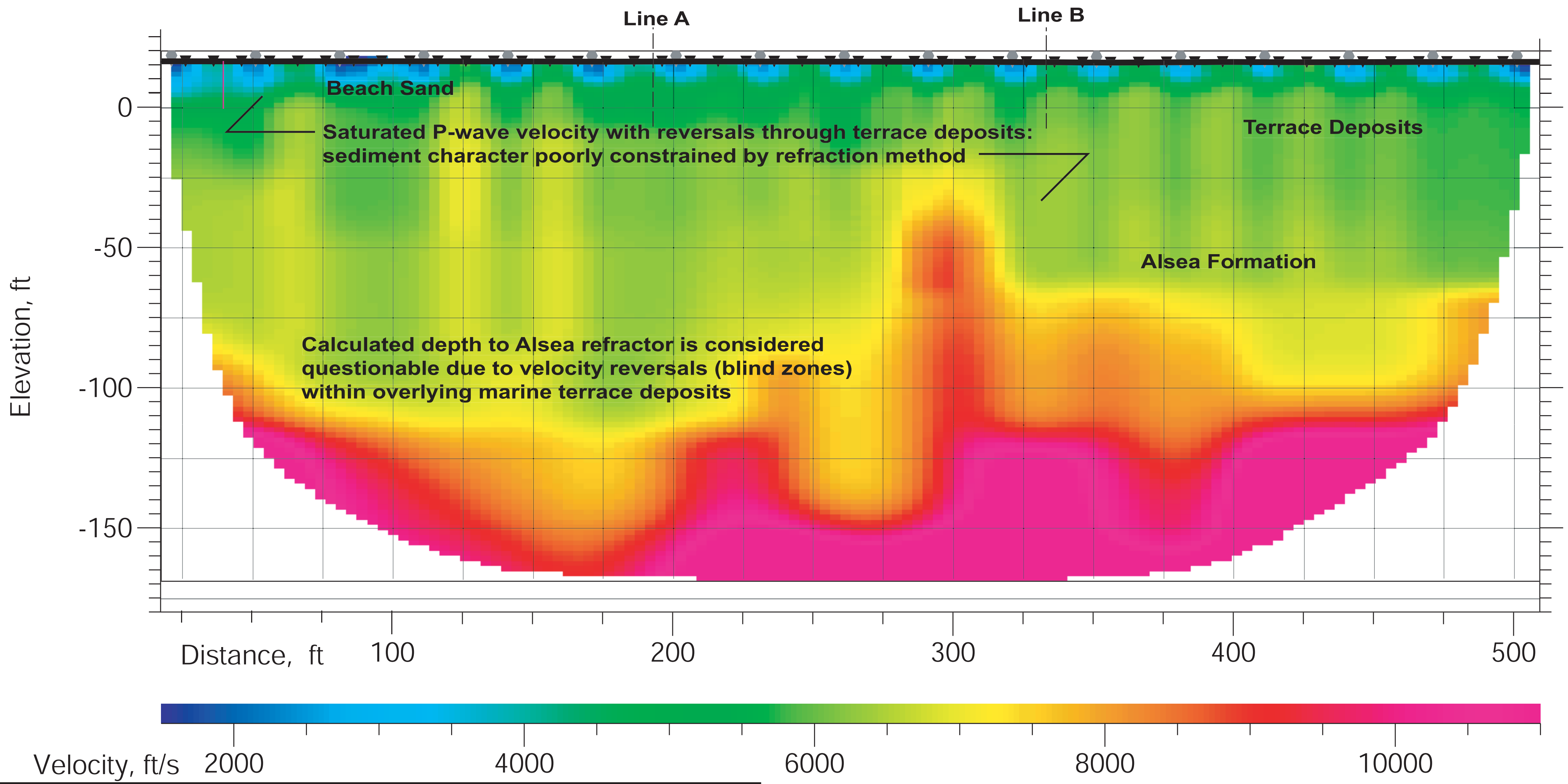


Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

Electrical Resistivity Tomography: Line C	Figure: ER-3	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 29, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

Line C: P-wave Seismic Refraction Tomography: SR-3

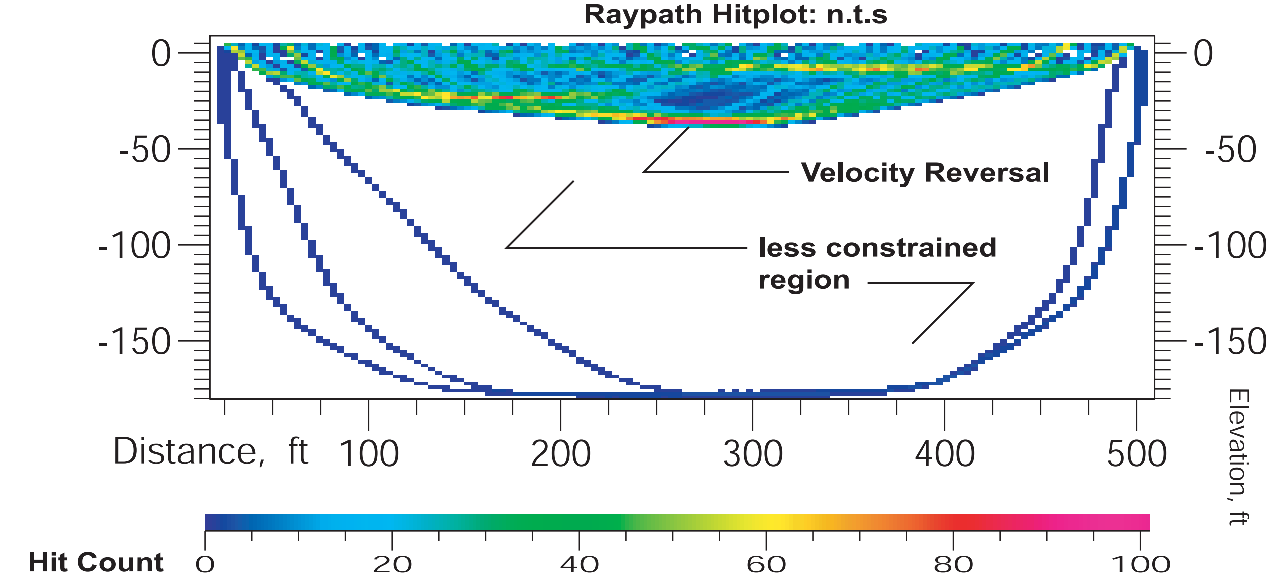
(48, 8 Hz. receivers on 10 foot spacing, shots on 30 foot spacing)



Azimuth ~ 5 degrees

Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

Raypath Hitplot: n.t.s



P-wave Seismic Refraction Tomography: SR-3 on Line C	Figure: SR-3	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 28, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

Line C: S-wave Seismic Refraction Microtremor (ReMi): RM-3

(48, 8 Hz. receivers on 10 foot spacing)

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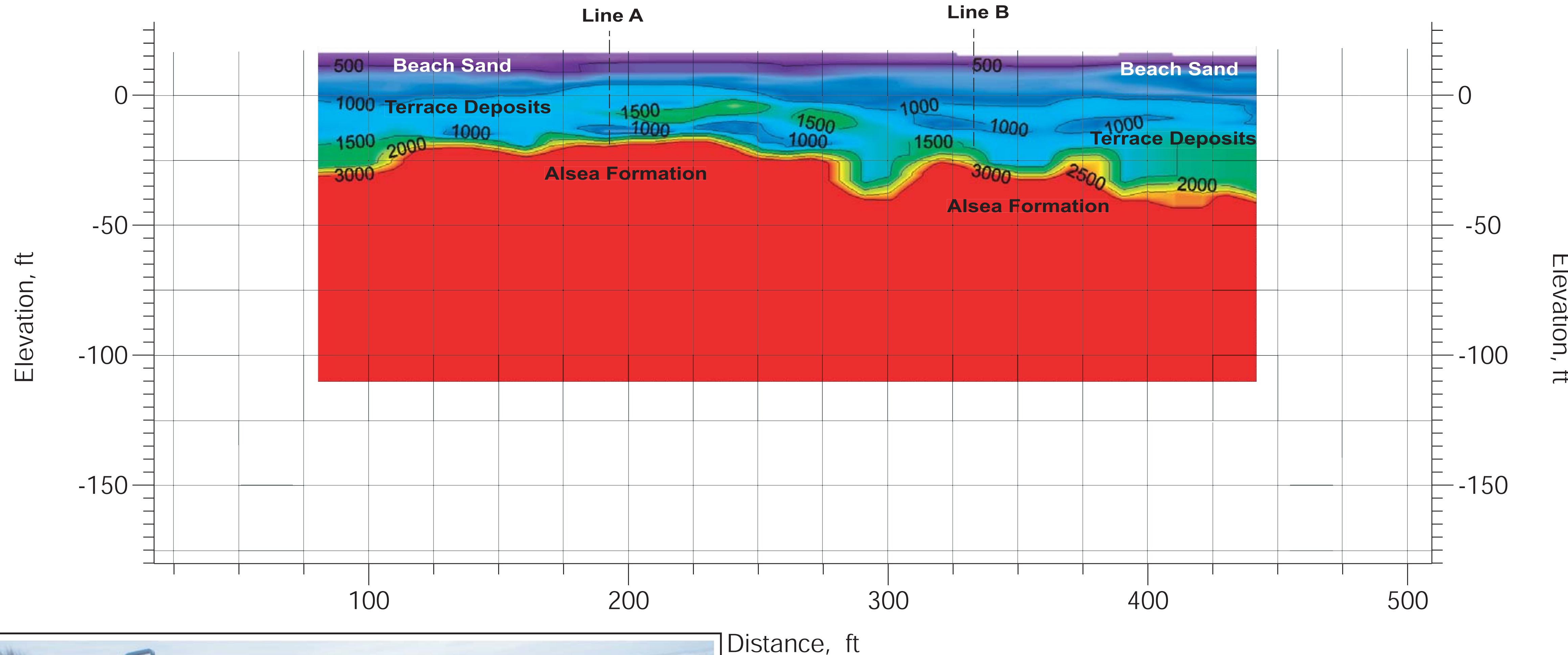
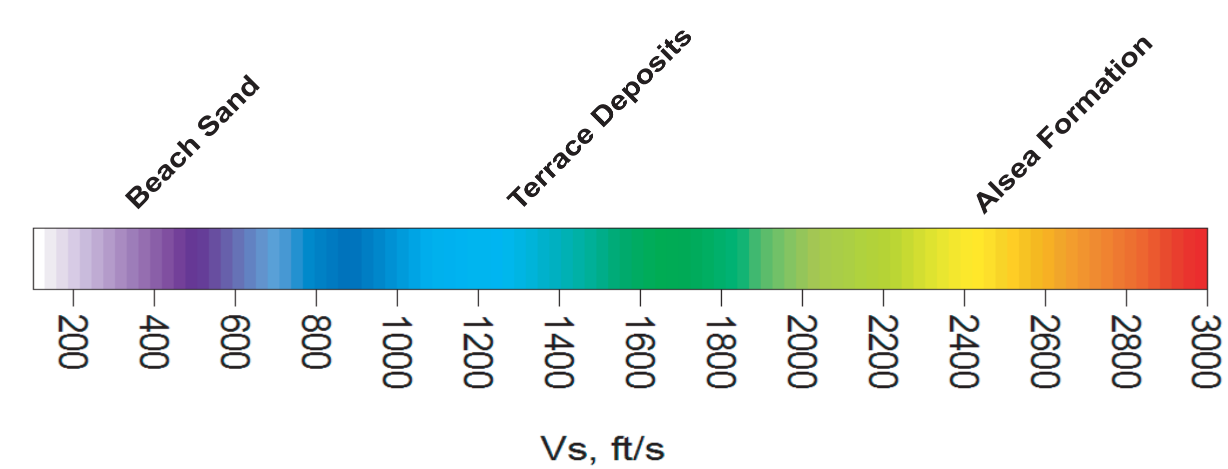


Azimuth ~ 5 degrees

Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

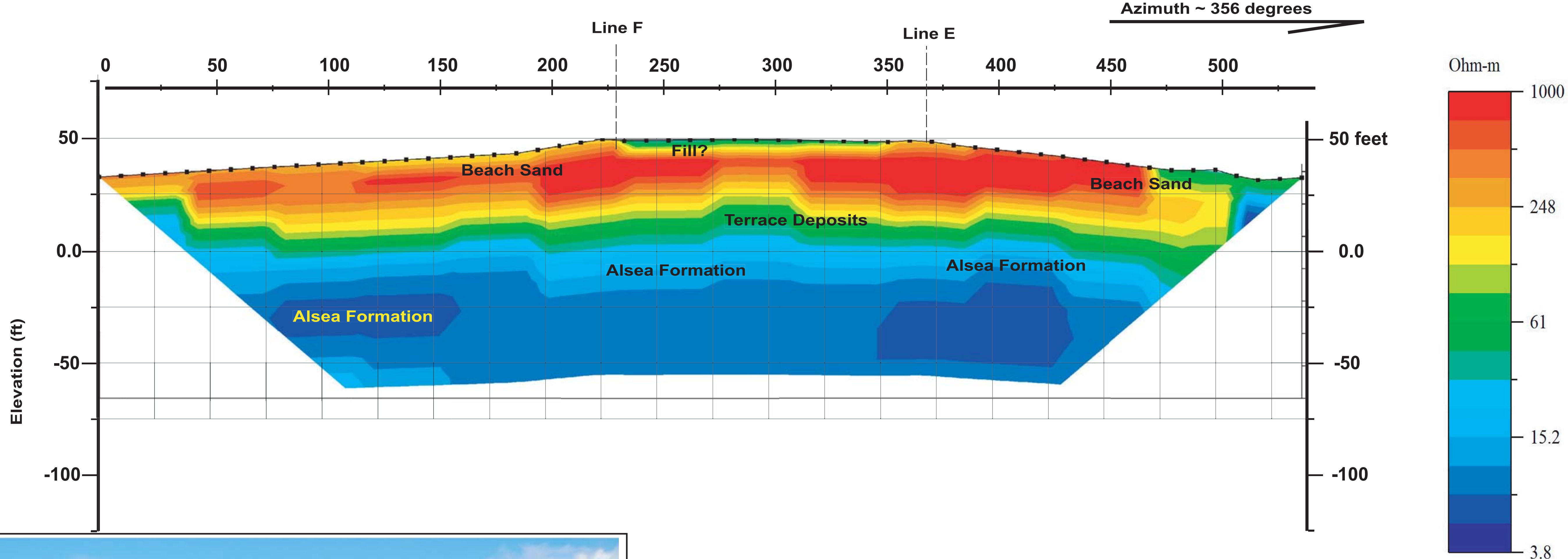


S-wave Seismic Refraction Microtremor (ReMi): RM-3	Figure: RM-3	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	April 29, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.5. Results on Line D: ER, SR and ReMi

Line D: Electrical Resistivity Tomography: ER-4

(56 electrodes, 3 m spacing: Wenner array)

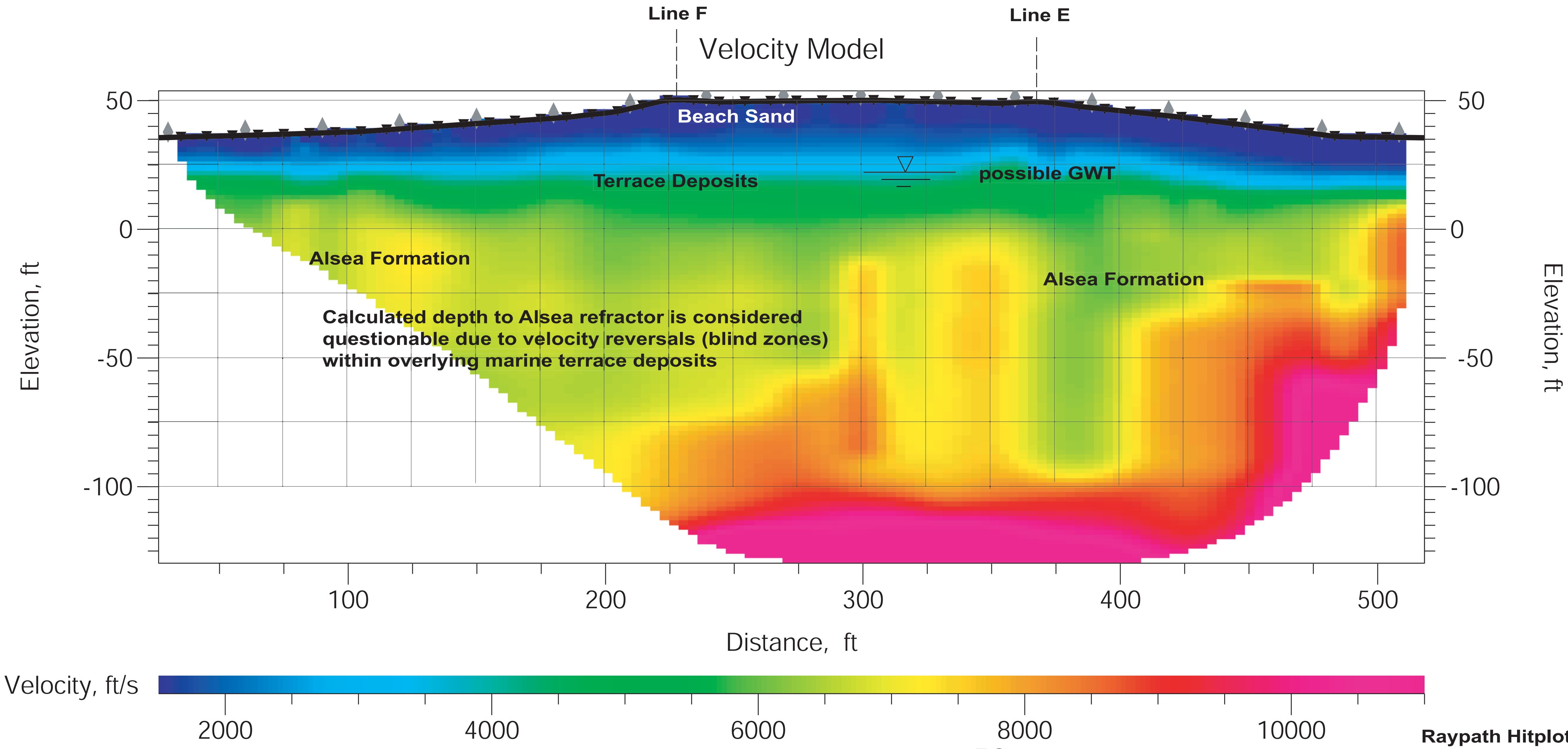


Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

Electrical Resistivity Tomography: Line D	Figure: ER-4	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

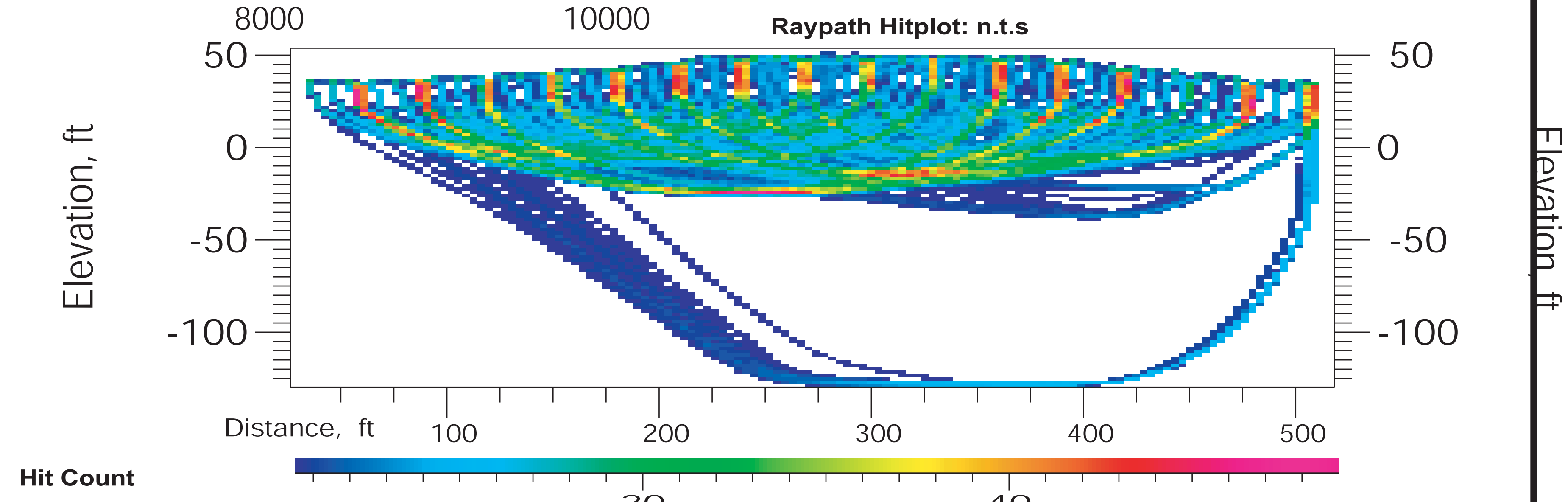
Line D: P-wave Seismic Refraction Tomography: SR-4

(48, 8 Hz. receivers on 10 foot spacing, shots on 30 foot spacing)



Azimuth ~ 356 degrees

Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet



P-wave Seismic Refraction Tomography: SR-4 on Line D	Figure: SR-4	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

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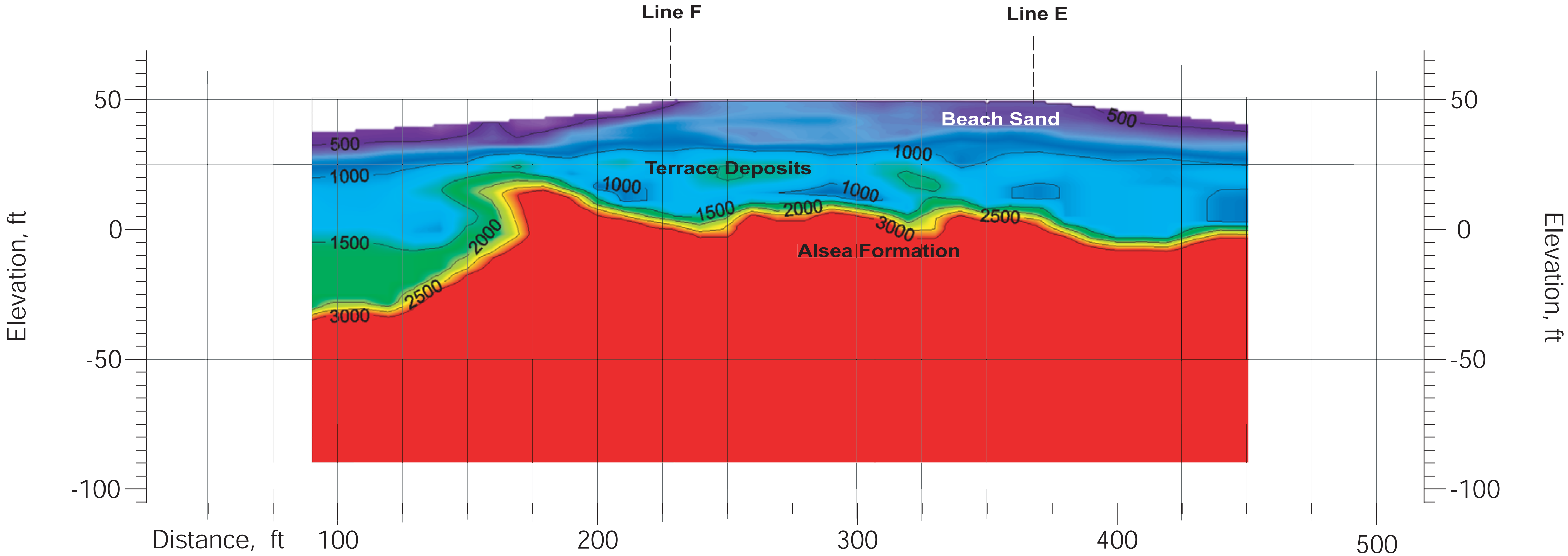
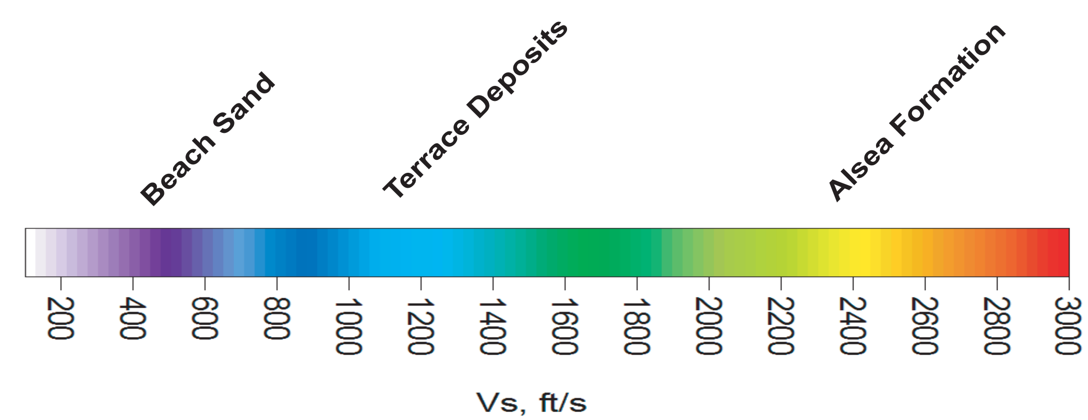
Line D: S-wave Seismic Refraction Microtremor: RM-4

(48, 8 Hz. receivers on 10 foot spacing)



Azimuth ~ 356 degrees

Scale:
H: 1 inch = 50 feet
V: 1 inch = 50 feet

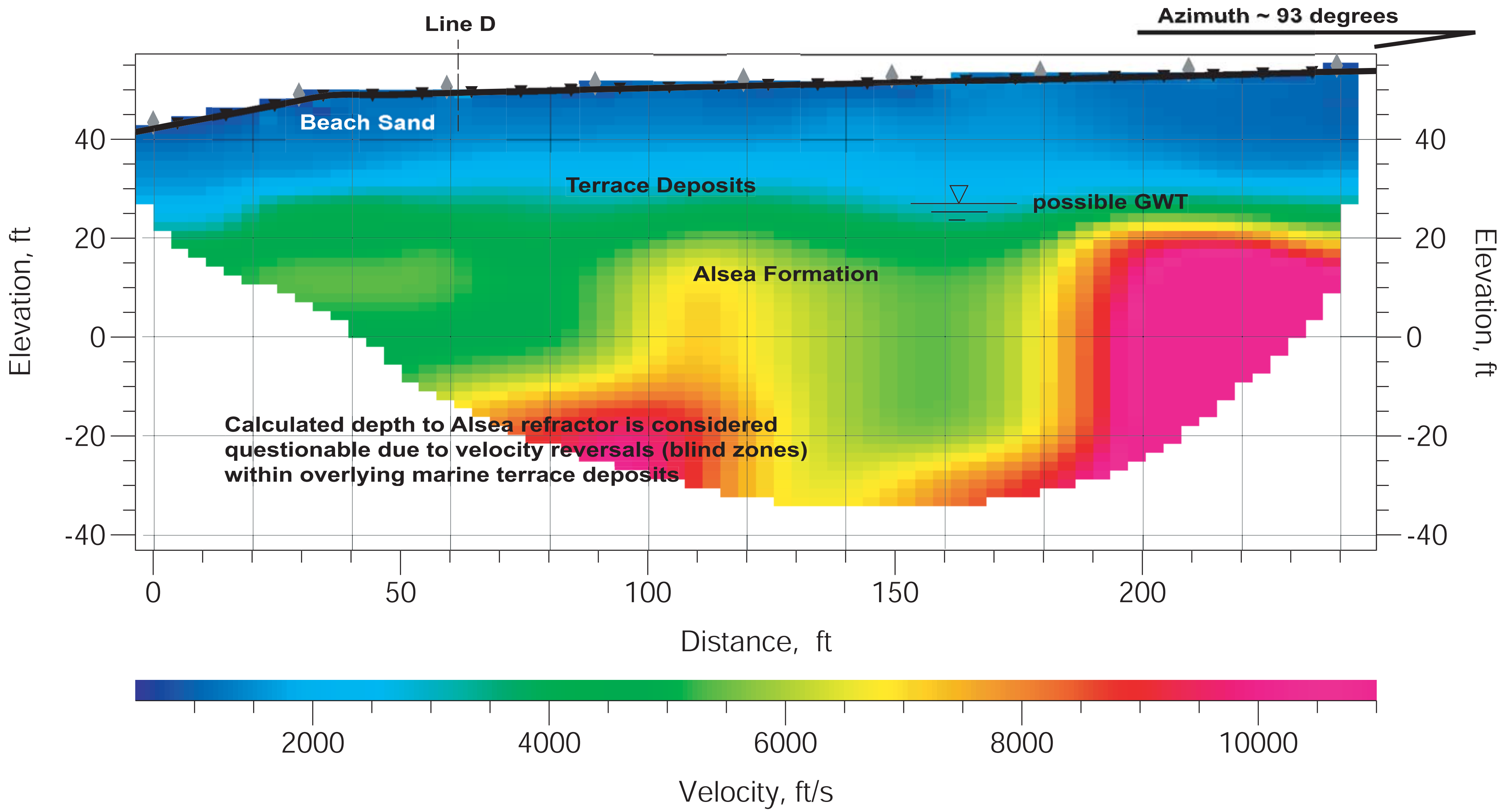


S-wave Seismic Refraction Microtremor (ReMi): RM-4	Figure: RM-4	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.6. Results on Line E: SR only

Line E: P-wave Seismic Refraction Tomography: SR-5

(24, 8 Hz. receivers on 10 foot spacing, shots on 30 foot spacing)



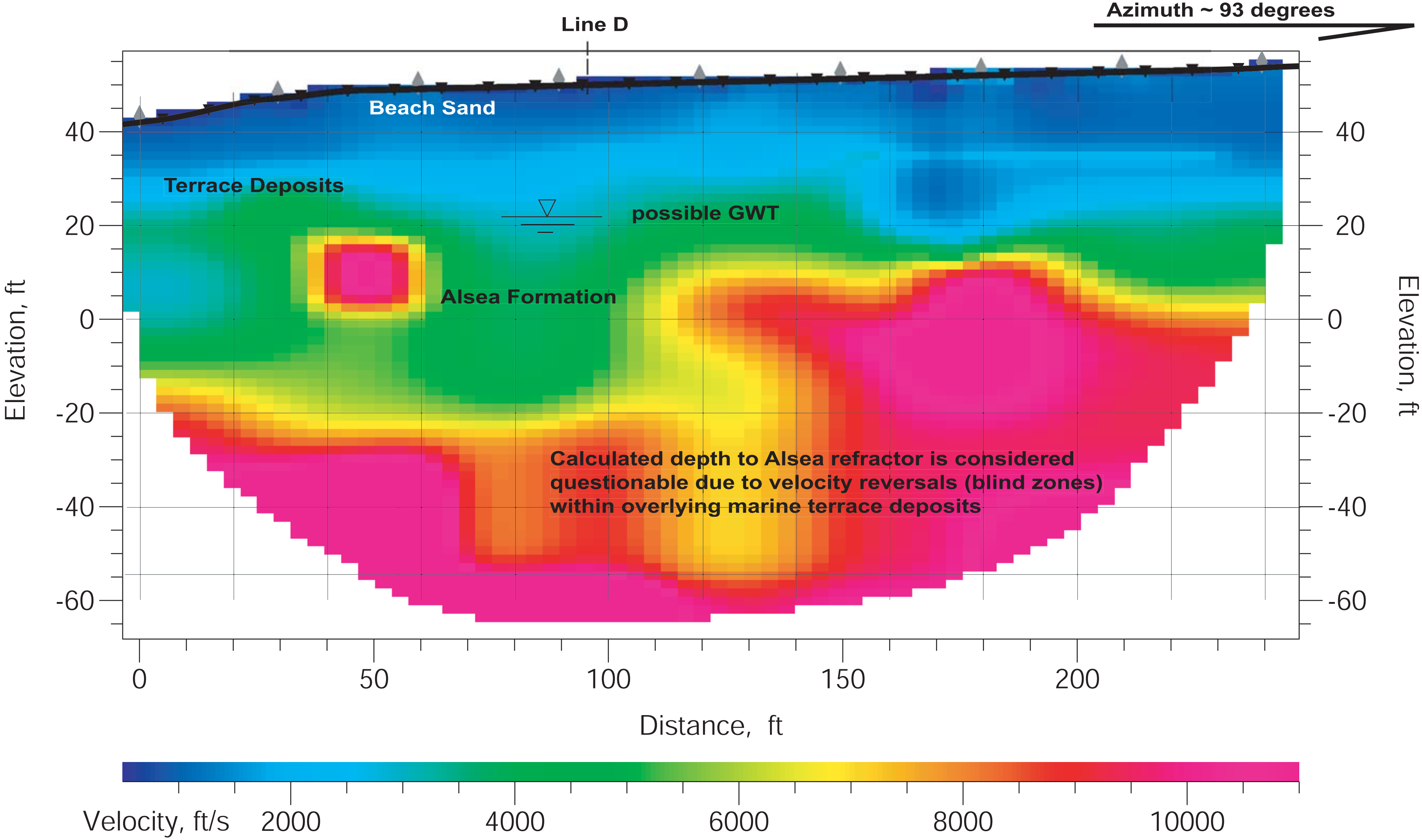
Scale:
H: 1 inch = 30 feet
V: 1 inch = 30 feet

P-wave Seismic Refraction Tomography: SR-5 on Line E	Figure: SR-5	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

7.7. Results on Line F: SR only

Line F: P-wave Seismic Refraction Tomography: SR-6

(24, 8 Hz. receivers on 10 foot spacing, shots on 30 foot spacing)



Scale:
H: 1 inch = 30 feet
V: 1 inch = 30 feet

P-wave Seismic Refraction Tomography: SR-6 on Line F	Figure: SR-6	
Pacific Marine Energy Center South Energy Site Near Waldport, Oregon	May 6, 2017	Project # 171012
Prepared for: Oregon State University	**Siemens & Associates**	

8. Land Survey Records: John Thompson and Associates, Inc. (JTA)

8.1. Control

Three survey control points were set in the Driftwood Beach State Recreation Site parking area. JTA selected 5/8 inch iron rods and 1-1/2 inch aluminum caps for monument construction because of their durability. These control points can be used throughout the lifecycle of the project.

8.2. Reference

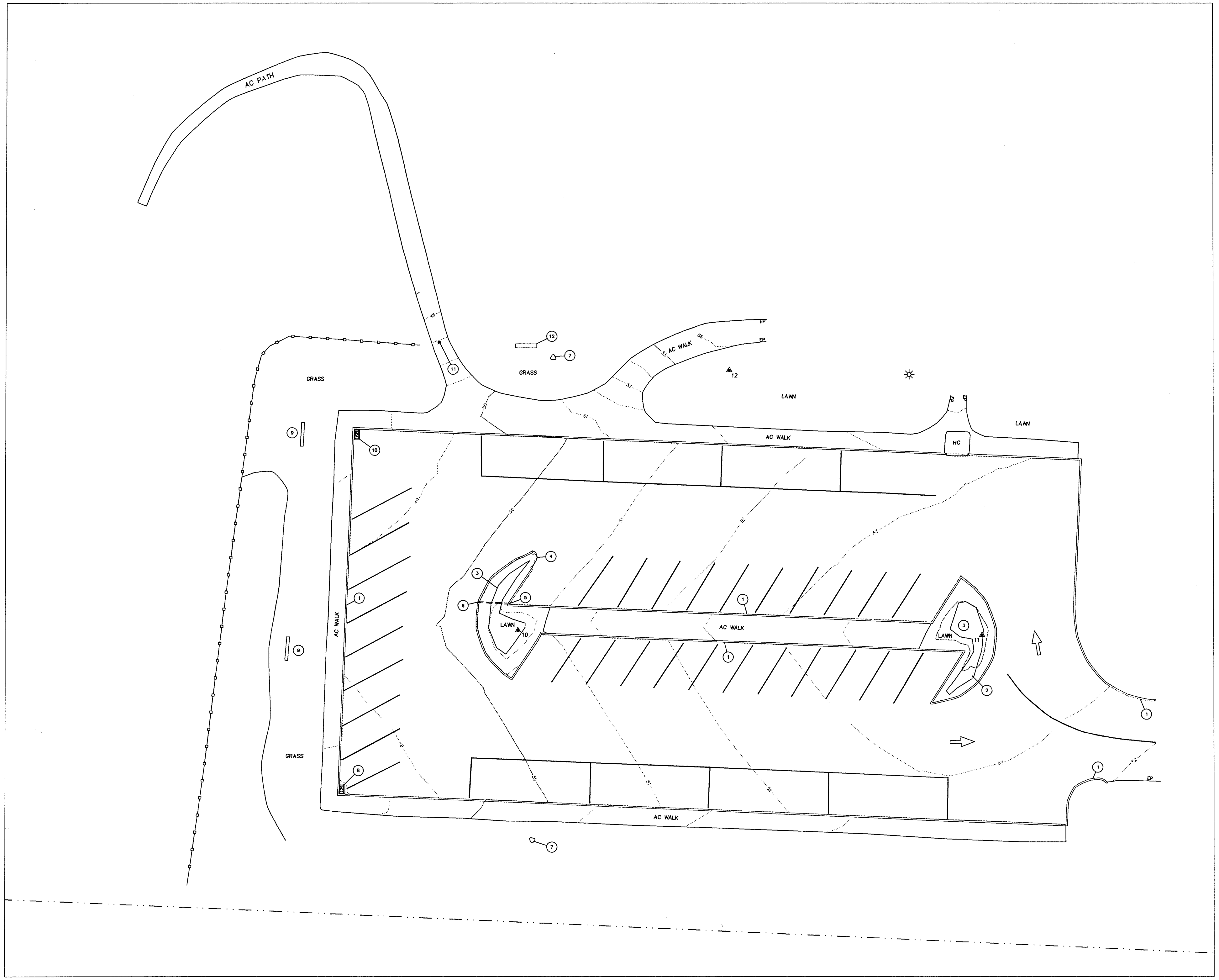
This project is referenced to NAD 83(2011) Epoch 2010.00 and NAVD 88. This is the current reference frame supported by the National Geodetic Survey (NGS). Using the current NGS datum simplifies the establishment of on-site survey control. NGS also computes Oregon State Plane North Zone (3601) coordinates on their Data Sheets. The CAD deliverables use this reference frame and the project units are international feet.

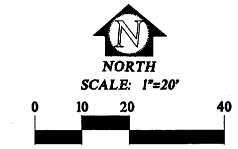
8.3. Mapping Products

JTA created two mapping products for this project. The first is the topographic map of the parking area of Driftwood Beach State Recreation Site. This map and digital terrain model will aid the design engineers in the development of the boring equipment staging plan and can be used to document the existing condition of the parking area which will be useful if repairs to the parking area are needed after construction. The second mapping product illustrates the geophysical survey line geometry in plan dimension. This map is used for both for the on-shore and off-shore phases of this site exploration. The line geometry is the basis of sampling for the on-shore study. The survey coordinates along Lines A and Line B are useful to integrate similar explorations and associated overlap when similar data are gathered during the marine survey of the HDD route.

The mapping products are delivered in several formats. The CAD drawings were created using Autodesk Civil 3D. The drawing files will include the survey point data, 3D breakline data and a digital terrain model (DTM) of the existing ground surface conditions. JTA compiled an ASCII file of the survey data points and LandXML files for the survey point data and the existing ground DTM. These files can be imported into various engineering or GIS programs used by project stakeholders. Also provided were PDF files generated from the CAD drawing files.

T.13S. R.12W. W.M.
SEC. 01





LEGEND

- BOLLARD
- LIGHT POLE (TAPER METAL BASE.)
- SIGN AS NOTED
- CB STORM CATCH BASIN
- SURVEY BENCH MARK / CONTROL POINT

LEGEND

- EP EDGE OF PAVEMENT
- HC HANDICAP RAMP AC SURFACE POOR CONDITION

LEGEND

- FENCE WOOD HT=3.0 FT. (TYP.) CONDITION VARIES
- PARCEL BOUNDARY LINES APPROXIMATE, SEE NOTE 3

NOTES

1. THE COORDINATES SHOWN ARE BASED ON THE OREGON STATE PLANE NORTH ZONE (3601). THE PROJECT IS REFERENCED VERTICALLY TO NATIONAL GEODETIC SURVEY MARK V 79 (PID QE1300) BY STATIC GPS OBSERVATIONS.

   LINEAR UNITS: INTERNATIONAL FEET
   HORIZONTAL DATUM: NAD 83(2011)(EPOCH: 2010.0000)
   PROJECT COMBINED FACTOR (GROUND TO GRID): 0.99997084

   VERTICAL DATUM: NAVD88 (GEOID 12B)

2. CONTOUR INTERVAL IS 1 FOOT.

3. THE PROPERTY LINES SHOWN ARE BASED ON DATA PROVIDED BY CLIENT AND ARE APPROXIMATE ONLY. BOUNDARY DETERMINATION AND RESOLUTION ARE OUTSIDE THE SCOPE OF THIS PROJECT.

UTILITY STATEMENT

THE UNDERGROUND UTILITIES SHOWN ARE BASED ON SURVEYED UTILITY LOCATE MARKINGS AND EXISTING DRAWINGS. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE SURVEYOR FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED ALTHOUGH HE DOES CERTIFY THAT THEY ARE LOCATED AS ACCURATELY AS POSSIBLE FROM INFORMATION AVAILABLE. THE SURVEYOR HAS NOT PHYSICALLY LOCATED THE UNDERGROUND UTILITIES.

EXISTING FEATURES

(1) CURB (TYP.)
(2) LANDSCAPE FEATURE, DRIFTWOOD WITH SIGN "ONE WAY"
(3) LANDSCAPE FEATURE, DRIFTWOOD
(4) DAMAGED CURBING
(5) STORM DRAINAGE PIPE STEEL, 4-IN. DIA. I.E.=50.59' (IN)
(6) STORM DRAINAGE PIPE STEEL, 4-IN. DIA. I.E.=50.32' (OUT)
(7) POSSIBLE LIGHT POLE BASE, NO POLE BASE, PLATED, NOT IN USE
(8) STORM CATCHBASIN, WATER FILLED NO INVERTS VISIBLE, GRATE EL.=47.96'
(9) BENCH WOOD
(10) STORM CATCHBASIN, WATER FILLED NO INVERTS VISIBLE, GRATE EL.=48.03'
(11) BOLLARD, CONCRETE DIA.=8-IN. HT.=3.4 FT. W/SIGN: "MOTOR VEHICLES PROHIBITED"
(12) SIGN 6"x6" WOOD POST W/SIGNS "DRIFTWOOD" & MULTIPLE PLACARDS

SURVEY CONTROL DATA TABLE

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
10	311507.8949	7267656.6567	52.87	5/8" IRON ROD W/2-1/2" ALUM. CAP MARKED "JTA INC. CONTROL POINT 10 2017"
11	311506.3886	7267812.3870	55.41	5/8" IRON ROD W/2-1/2" ALUM. CAP MARKED "JTA INC. CONTROL POINT 11 2017"
12	311595.0785	7267727.6627	57.34	5/8" IRON ROD W/2-1/2" ALUM. CAP MARKED "JTA INC. CONTROL POINT 12 2017"

UNITS: INTERNATIONAL FEET

JOHN THOMPSON & ASSOCIATES, INC.
P.O. BOX 683 BEND, OREGON 97709
PHONE: (541)312-9421
JPT@JTASURVEY.COM

07-22-2017
REGISTERED PROFESSIONAL LAND SURVEYOR
OREGON
JANUARY 12, 1999
JOHN P. THOMPSON
49220
RENEWS 06-30-2018

REVISIONS

NO.	BY	DATE	REMARKS

SHEET INFO

DRAWN	JPT
CHECKED	JPT
APPROVED	JAS
LAST EDIT	06/26/2017
PLOT DATE	07/22/2017
SUBMITTAL	

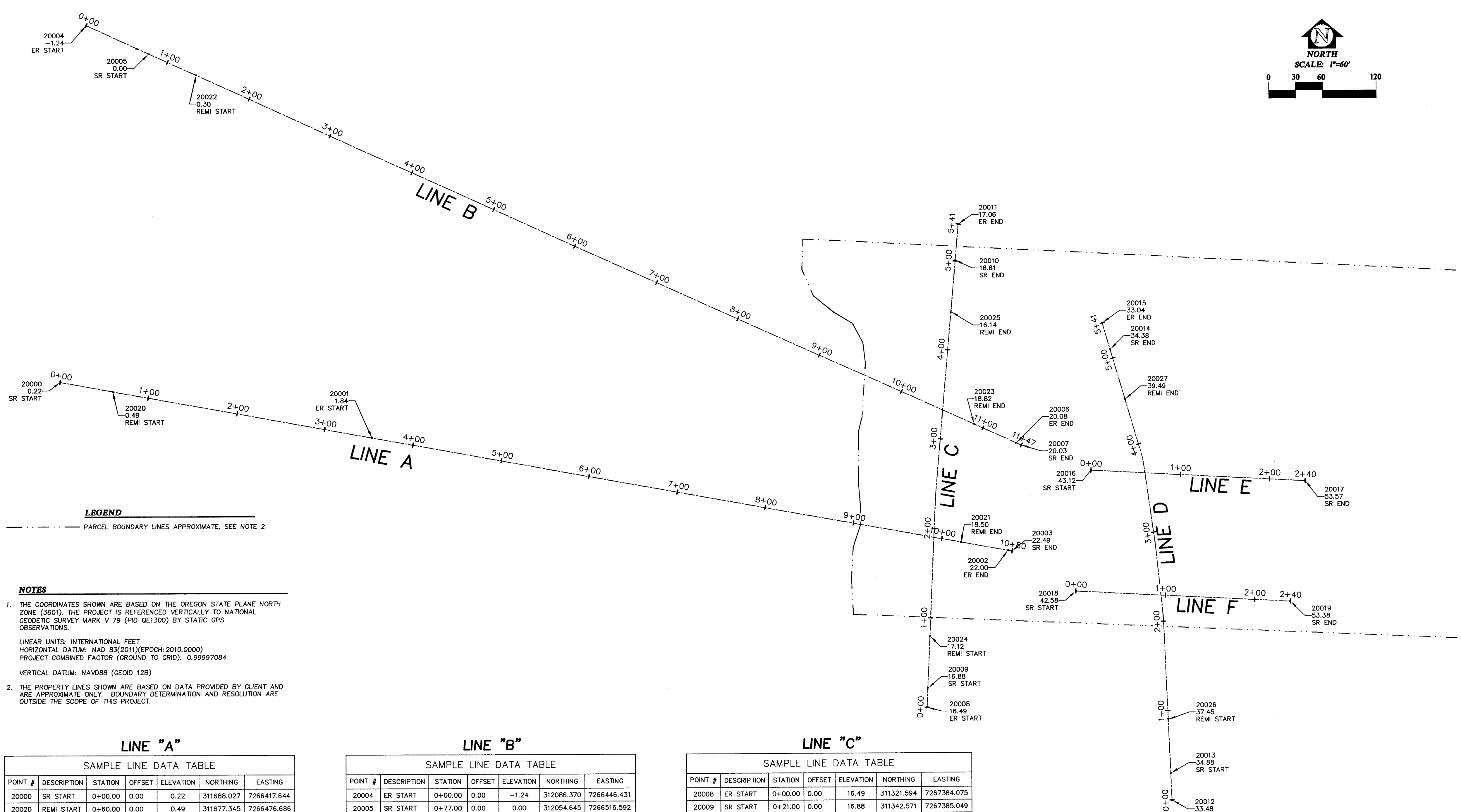
PACIFIC MARINE ENERGY CENTER SOUTH ENERGY TEST SITE:
GEOPHYSICAL EXPLORATION
DRIFTWOOD BEACH STATE RECREATION SITE

PROJECT NUMBER: SIEM0001
DRAWING FILE NAME: SIEM1DWPARKING
SCALE: 1"=20'

SHEET NUMBER
1
OF 2 SHEETS

XREF INDEX:

T.13S. R.12W. W.M.
SEC. 01



LEGEND

— · — · — PARCEL BOUNDARY LINES APPROXIMATE, SEE NOTE 2

NOTES

1. THE COORDINATES SHOWN ARE BASED ON THE OREGON STATE PLANE NORTH ZONE (3601). THE PROJECT IS REFERENCED VERTICALLY TO NATIONAL GEODETIC SURVEY MARK V 79 (PID QE1300) BY STATIC GPS OBSERVATIONS.

   LINEAR UNITS: INTERNATIONAL FEET
   HORIZONTAL DATUM: NAD 83(2011)(EPOCH: 2010.0000)
   PROJECT COMBINED FACTOR (GROUND TO GRID): 0.99997084

   VERTICAL DATUM: NAVD88 (GEOID 12B)

2. THE PROPERTY LINES SHOWN ARE BASED ON DATA PROVIDED BY CLIENT AND ARE APPROXIMATE ONLY. BOUNDARY DETERMINATION AND RESOLUTION ARE OUTSIDE THE SCOPE OF THIS PROJECT.

LINE "A"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20000	SR START	0+00.00	0.00	0.22	311688.027	7266417.644
20020	REMI START	0+60.00	0.00	0.49	311677.345	7266476.686
20001	ER START	3+54.00	0.00	1.84	311625.004	7266765.989
20021	REMI END	10+22.00	0.00	18.50	311506.080	7267423.318
20002	ER END	10+75.00	0.00	22.00	311496.644	7267475.471
20003	SR END	10+80.00	0.00	22.49	311495.754	7267480.391

LINE "B"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20004	ER START	0+00.00	0.00	−1.24	312086.370	7266446.431
20005	SR START	0+77.00	0.00	0.00	312054.645	7266516.592
20022	REMI START	1+35.00	0.00	0.30	312030.749	7266569.440
20023	REMI END	10+89.00	0.00	18.82	311637.691	7267438.705
20006	ER END	11+41.00	0.00	20.08	311616.266	7267486.086
20007	SR END	11+47.00	0.00	20.03	311613.794	7267491.553

LINE "C"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20008	ER START	0+00.00	0.00	16.49	311321.594	7267384.075
20009	SR START	0+21.00	0.00	16.88	311342.571	7267385.049
20024	REMI START	0+80.00	0.00	17.12	311401.508	7267387.787
20025	REMI END	4+43.00	0.00	16.14	311763.508	7267413.566
20010	SR END	5+01.12	0.00	16.61	311821.391	7267418.773
20011	ER END	5+41.47	0.00	17.06	311861.579	7267422.389

LINE "D"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20012	ER START	0+00.00	0.00	33.48	311216.431	7267656.667
20013	SR START	0+30.00	0.00	34.88	311246.407	7267655.467
20026	REMI START	0+90.00	0.00	37.45	311306.359	7267653.068
20027	REMI END	4+52.00	0.00	39.49	311664.180	7267607.614
20014	SR END	5+10.19	0.00	34.38	311720.063	7267591.376
20015	ER END	5+41.19	0.00	33.04	311749.832	7267582.726

LINE "E"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20016	SR START	0+00.00	0.00	43.12	311585.277	7267568.981
20017	SR END	2+40.00	0.00	53.57	311572.158	7267808.622

LINE "F"

SAMPLE LINE DATA TABLE

POINT #	DESCRIPTION	STATION	OFFSET	ELEVATION	NORTHING	EASTING
20018	SR START	0+00.00	0.00	42.58	311450.548	7267551.208
20019	SR END	2+40.00	0.00	53.38	311437.988	7267790.879

[DATE: 7/22/2017 8:05 PM] [AUTHOR: admin] [PLOTTER: HP LJ 5000DN Universal Printing PCL 6.pc3] [STYLE: DEA-STD-STB.stb]
[PATH: L:\PDrive_Recover\Projects\SIEM0001-Waldport\Dwg_Deliverables\SIEM1GEOLAYOUT3.dwg] [LAYOUT: SHEET2]

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REVISIONS			
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LAST EDIT	06/26/2017
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SUBMITTAL	

PACIFIC MARINE ENERGY CENTER SOUTH ENERGY SITE:
GEOPHYSICAL EXPLORATION
GEOPHYSICAL SAMPLE LINE GEOMETRY

SCALE: 1"=60'

PROJECT NUMBER: SIEM0001

DRAWING FILE NAME: SIEM1GEOLAYOUT3

SHEET NUMBER
2
OF 2 SHEETS

9. GIS Database Records: Rhine-Cross Group

9.1. Summary

The mapping and geophysical sample line geometry represented in the Autodesk Civil 3D drawings was converted to .dxf files that can be accessed by non-CAD users utilizing the Global Mapper Software. The data can aid stakeholders in the future planning and decision making process.

In addition, the processes results used for the generation of the geophysical tomograms were provided to the client in text delimited format. The deliverable included georeferenced beginning and endpoints for each line and tabulated points describing the x-distance and elevation along the traverse associated with a value relative to the physical property measured, including, P-wave velocity (f/s), S-wave velocity (f/s) and apparent electrical resistivity (Ohm-m).