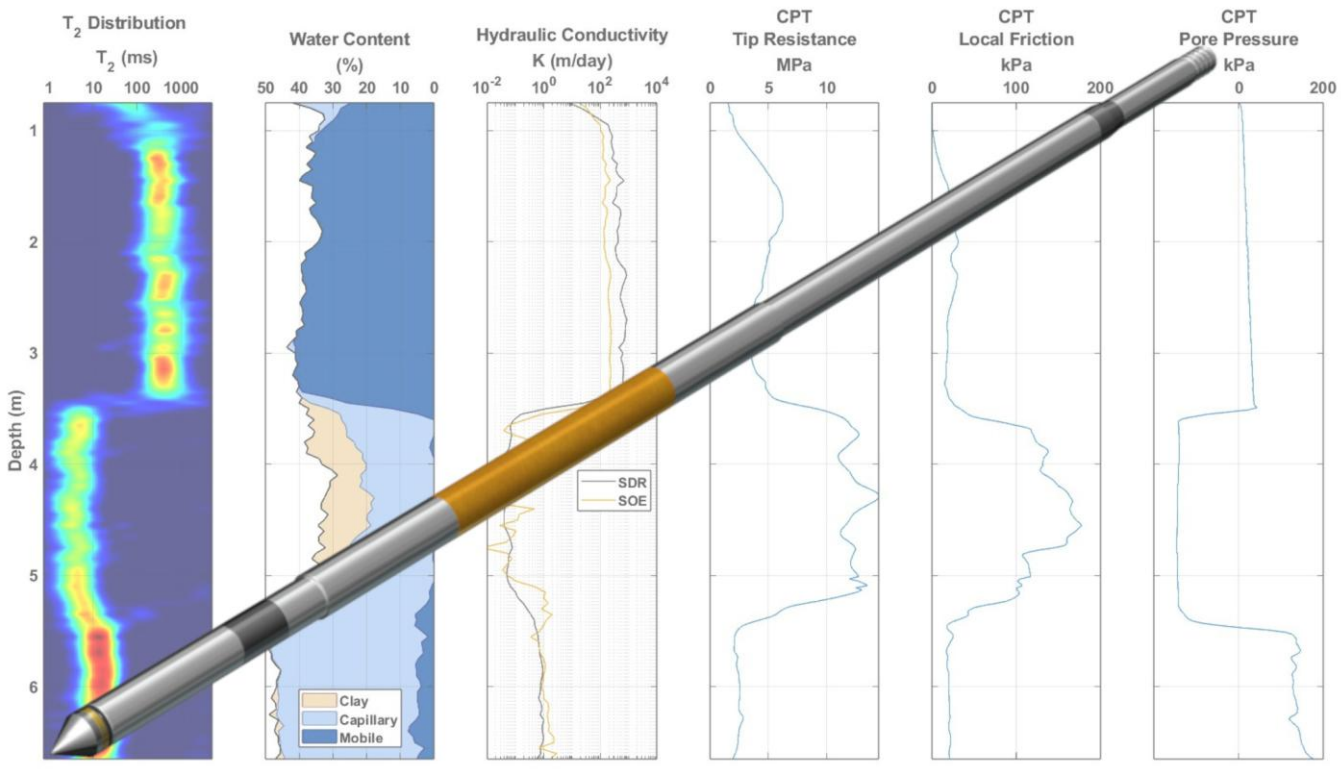
Harpoon®

CPT-deployable tool that provides both CPT and Magnetic Resonance measurements in a single push.



HIGH-RESOLUTION IN-SITU MEASUREMENTS OF SOIL MECHANICAL AND HYDROGEOLOGIC PROPERTIES

LOWER COST AND HIGHER CONFIDENCE COMPARED TO SOIL SAMPLING AND LABORATORY ANALYSIS

PERFECTLY CORRELATED MAGNETIC RESONANCE AND CPT DATA

DATA ARE AVAILABLE IMMEDIATELY FOR ENGINEERING ANALYSIS

COMBINED NMR AND CPT DATA ADDS CONFIDENCE, REDUCE PROJECT RISKS

FOR USE ON LAND OR ON THE SEAFLOOR

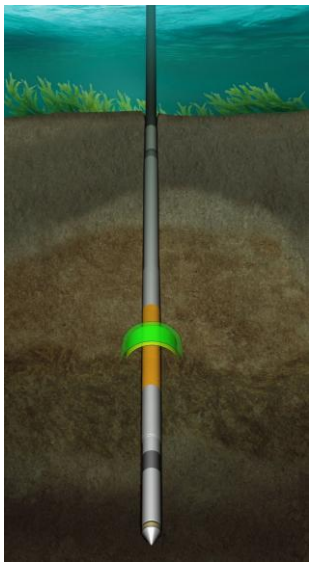
VISTACLARA INC.
NMR GEOPHYSICS

- Marine engineering
- Offshore cable routes exploration
- Seafloor characterization
- Geotechnical applications

Harpoon®: A Breakthrough Technology for Geotechnical Investigations

Harpoon® technology combines CPT and in-situ nuclear magnetic resonance (NMR) measurements in a single CPT-deployed tool

Direct Measurement of Hydrogeologic Properties



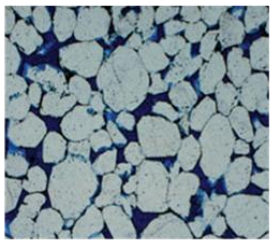
Harpoon® provides high-resolution (5cm) measurement of volumetric water content and porosity in the native formation via stepped or continuous modes. Harpoon® NMR measurements are directly sensitive to the pore size distribution, which provides a new and enhanced mode for sediment classification. Harpoon® NMR measurements can differentially estimate the bound and mobile water content, and provide quantitative estimates of hydraulic conductivity up to 3000 m/day (10000 ft/day) . Harpoon® technology provides more reliable estimation of bulk density as compared to conventional lab tests, especially for sands where sampling methods tend to create large disturbance to the samples.

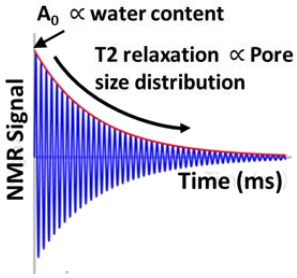
Soil Mechanical Properties

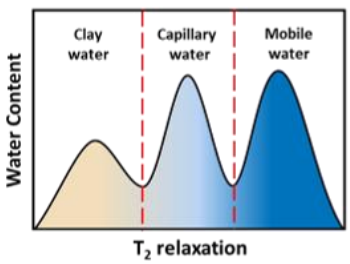
Harpoon® utilizes detachable Cone Penetrometer Test (CPT) cones that are commonly used in land and seafloor geotechnical investigations including investigations for development of offshore wind turbine foundations and cable routes. CPT measurements are used to determine the geo-mechanical engineering properties of soils and delineate soil stratigraphy.

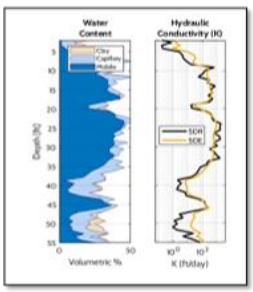
The Magnetic Resonance Advantage

Harpoon® incorporates NMR-based technology that uses the same physics as medical MRI. This technology provides inherently non-invasive detection of water in sediments, using static and alternating magnetic fields to polarize and excite hydrogen in the native formation fluids outside the zone of disturbance from drilling. The initial amplitude of the NMR signal observed after this perturbation is linearly proportional to the volumetric fluid content, or the total porosity if the formation is saturated. NMR relaxation times are strongly correlated with the size of the pore space and are used to distinguish between water bound in small pores from more mobile water in large pores and fractures.









Harpoon® Technical Specifications and Features

Harpoon® conducts CPT measurements while pushing down and NMR measurements while retracting upwards.

Physical Specifications

- Sensor Length = 1.65 m
- Sensor Max Diameter = 48 mm
- Push rod type: 36 mm OD or 45 mm OD
- Marine logging cable with 8 conductors
- Max push force = 100 kN
- Cone: 15 cm^2 cone (multiple vendors supported)
  - Tip resistance
  - Pore pressure
  - Sleeve friction
  - Tilt angle

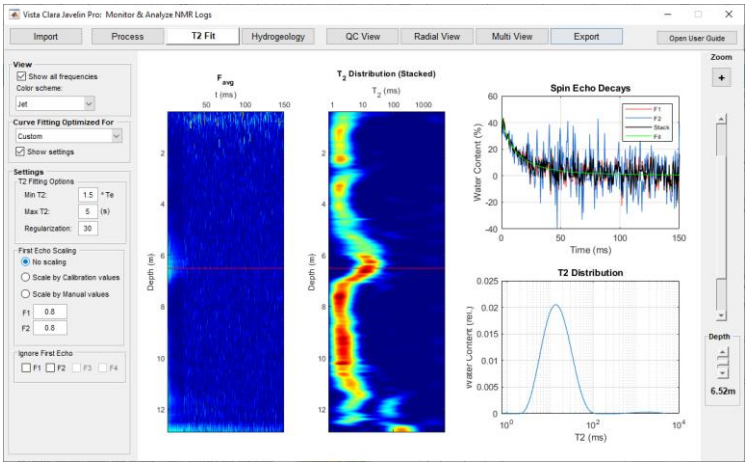
NMR Sensor Specifications

- Dual Frequency with NMR sensitive zone diameters of 12.5 cm and 15 cm
- Echo Spacing = 0.5 ms
- Vertical Resolution = 5 cm
- Data outputs:
  - Volumetric water content (total porosity)
  - Bound/mobile water fractions
  - Relative pore size distribution (sediment classification)
  - Estimated hydraulic conductivity

Data Processing and Interpretation

Vista Clara's full-featured data processing and analysis software allow users to see the NMR logging results in real time while logging. Users can perform real-time data processing, quality control, and interpretation of hydrogeological and CPT measurements.

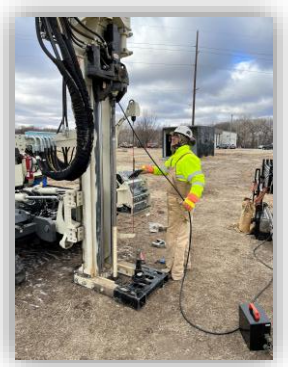
The software allows users to control all aspects of data analysis from acquisition to visualization, to final reporting. The data processing software automatically imports corresponding CPT data for joint analysis with NMR results.



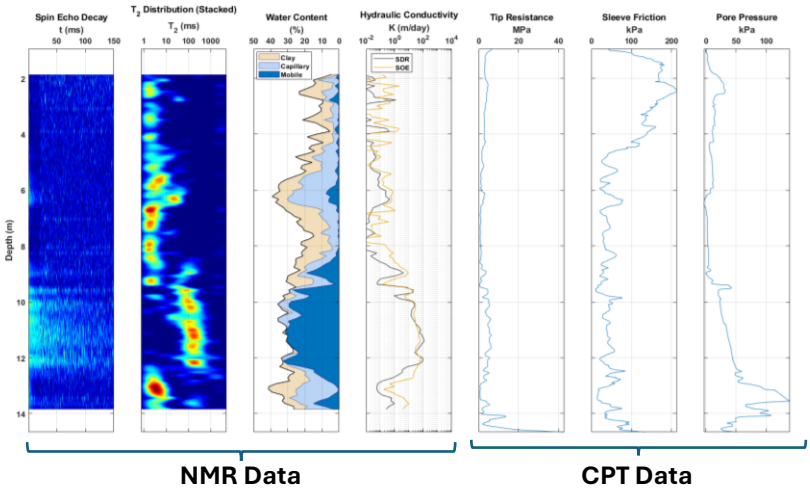
Harpoon® Applications

Harpoon® enables high-resolution, continuous measurement of soil mechanical and hydrologic properties in single push.

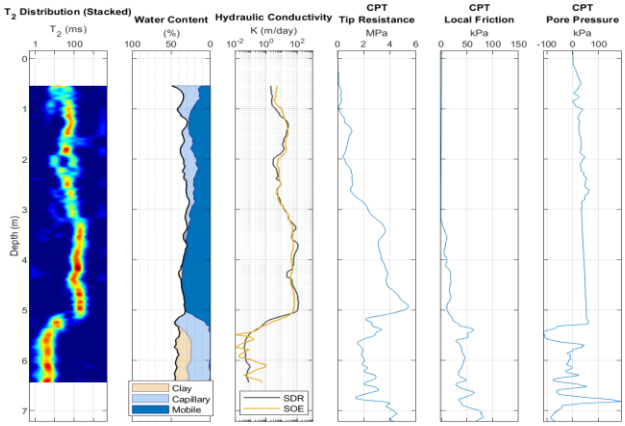
Land-Based CPT+NMR



Land CPT+NMR measurement, Salina Kansas, USA



Nearshore/Offshore CPT+NMR



Seabed CPT+NMR cable route survey, East Coast USA

Turnkey Service Offerings

- On site engineering for integrating Harpoon® technology with vendor-specific CPT drill rigs and equipment.
- State of the art Harpoon® equipment provided at day use rates and standby rates.
- USGC STCW- and BOSIET-qualified expert NMR field operators to collect and QC/QA CPT+NMR data in the field and offshore.
- Expert training of customer CPT operators in the field and offshore.
- Real-time remote engineering and data analysis to support 24-hour operations offshore.

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