Multi-Sensor Track and spectrophotometer analysis

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INTRODUCTION

The Geotek Multi-Sensor-Core-Logger installed on board the Marion Dufresne in the « MST » container is dedicated to the first measurements of physical properties of sediment cores. Measured properties are: low field magnetic susceptibility, Gamma ray attenuation, P-Wave travel time, digital camera, spectrophotometer and temperature.

Magnetic susceptibility point sensor

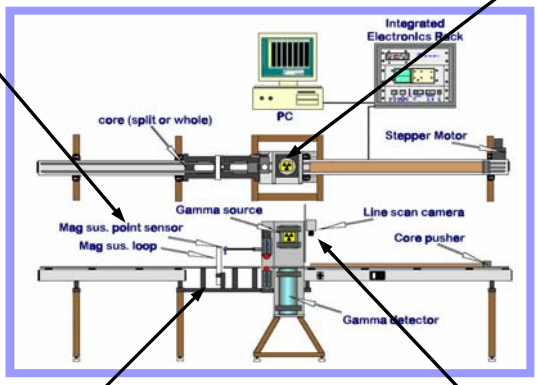
Each substance has magnetic susceptibility, which depends of its constituent materials. Some particles have a low magnetic susceptibility, like micas, feldspaths, and some others have high magnetic susceptibility like magnetite or iron oxydes.

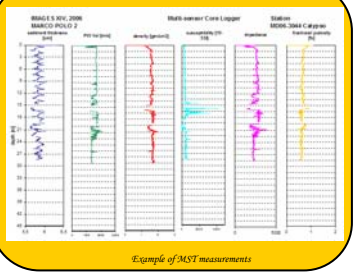
The point sensor is mounted on a moving arm which allows contact with the sediment. A magnetic field is created. The presence of magnetic material near the sensor changes the magnetic field. This variation gives information about the properties of particles which compose the sediment. Magnetic susceptibility can be useful in determining volcanic ash layers and change in the mineralogical composition.

The Gamma Ray

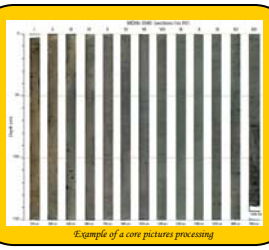
The gamma ray source and detector

The MST uses gamma ray attenuation to derive sediment bulk densities. The gamma ray source is located in a lead container above the core, with the detector directly underneath. Caesium-137 acts as a source of gamma rays in a beam of either 2 or 5 mm diameter with energies principally at 0.662 MeV. Gamma rays are attenuated when they hit the atoms of the sediment, a process known as Compton scattering.
The attenuation, therefore, is directly related to the number of electrons in the gamma ray beam, core thickness and electron density. We assumes that all grains are of equal density and that attenuation in air is negligible, also the Compton mass attenuation coefficient varies with the density of material (which is mainly controlled by the water content). By measuring the number of unscatter gamma photons that pass through the core, the density of the core material can be determined. Pulses from the detector unit are sent continuously to a counter board where the count rate and count period are calculated.

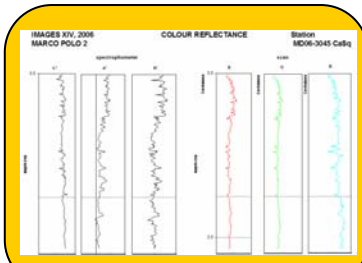




Example of MST measurements



Example of a core pictures processing



Example of RGB analysis results

P- wave velocity

A transducer generates ultrasonic compressional waves (P) and sends them across the sediment. Another transducer receives the P-waves, which propagate across the sediment. The MST computer measures the travel time, which is influenced by the temperature of the core.
The P-wave transducer allows to estimate the core thickness : it is the deviation from a known distance between the active faces of the P-wave transducer. The value of this thickness is used to correct the density measured by the Gamma Ray.
The P-wave velocity is the ratio between the sediment thickness and the pulse travel time in the sediment.
It gives a comparison with the density of the sediment found thanks gamma ray.

Digital Camera and spectrophotometer

Digital camera

Spectrophotometer

The digital camera produces a digital image of the core sections. Thanks to detectors, this camera measures the reflectance of the red, green and blue lights, called RGB.
This type of camera can generate high resolution images. After, images are modified in order to obtain better contrast and colours. Finally, all the sections of a core are put together and RGB measurements are processed with Excell.
To complete the study of the sediment reflectance, a spectrophotometer analysis is made.

The spectrophotometer used on board the N/V Marion Dufresne measures the reflectance of the sediment every five centimeters. Those measurements give information about the composition of the sediment: light sediments involve the presence of carbonates whereas dark sediments indicate the presence of organic mater.

References : GEOTECK MSCL Manual

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