Homogeneous and heterogeneous sediment experiments using fiber optic sensing technology for detecting gas hydrate formation

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The 72 liter Seafloor Processing Simulator (SPS) was developed as a mesoscale apparatus to bridge laboratory scale characterization of gas hydrates and seafloor conditions. Originally during an experiment the overall pressure and temperature of the SPS were monitored with traditional thermocouples and 1-2 pressure transducers and hydrate formation/dissociation was viewed visually using multiple ports with sapphire windows. Recently we have added a fiber-optics temperature/strain sensing system to observe temperature changes that correspond to gas hydrate formation (exothermic) or dissociation (endothermic) throughout the system. The optical fibers have Bragg gratings every 1 cm so that each fiber has around 150 – 200 gratings matching the spatial scale of natural hydrates occurrences in nature. In addition to adding spatial resolution data can be collected at specified time intervals resulting in time-resolved 3-D temperature monitoring. Experiments have been conducted where the optical fibers were buried at various levels above and below a gas diffuser outlet and used to observe methane hydrate formation. During one experiment the fibers were buried in a homogeneous sediment column (Ottawa sand only) and during a second experiment the fibers were buried in a heterogeneous sediment column split vertically with one side being Ottawa sand and the other side being slit. The results of these experiments indicate the the fiber optic sensors are a viable technology for sensing hydrate formation and that hydrate formation takes place preferentially in the the more porous sediment.

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Multi-element laser mapping of geological materials: Improving data collection, image production and analysis using time series and innovative inference techniques

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Laser ablation ICP-MS imaging 'laser mapping' is a flexible technique which has been applied to find the spatial distribution of a wide range of elements in medical, zoological, archaelogical and geological samples. Geological applications include the mapping of element concentrations and isotopic ratios in zoned minerals [1, 2, 3], which are often characterised by element concentration variations over orders of magnitude on small spatial scales. They also present a combination of sharp changes and gradational zones in element abundance. We present the results of investigative work which aims to improve three distinct parts of the laser mapping process: 1) Data collection, 2) Image production and 3) Image analysis.

Our investigations concerning data collection, the first of these stages, are in the form of an adaptive process whereby the laser operation and scanning procedures are optimised for the following image production stage. In the second stage, strategies from geophysical time-series analysis are used to minimise the influence of data collection procedures. The interaction between extreme count regions and mass spectrometer response is responsible for unwanted artifacts in laser mapping images and these are again minimised using geophysical time-series strategies. At the end of stage two, the aim is to produce an image in which the laser scanning history is substantially removed.

In the third and final part of the process, we investigate the application to geological samples of some of the innovative spatial data inference techniques which have emerged from the digital imaging revolution. In particular, we show techniques which make use of correlations between the related images produced by multi-spectral techniques.

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