Geotek Gas Hydrate Quantification

Assessing gas hydrate concentration and distribution

Multiple lines of evidence

The best assessment of gas hydrate concentration and distribution takes place when multiple lines of evidence converge. Along with downhole measurements and thermal infrared core scans, direct measurements on samples of gas, liquid, and sediment from cores are pieces of evidence that can be assembled to solve the gas hydrate puzzle.

The 'gold standard'–methane mass balance from pressure cores

Pressure cores capture and seal a volume of sediment with all its constituent parts, including any gas hydrate. The absolute quantity of natural gas within the core, whether dissolved in pore fluid, frozen in hydrate, or even present as free gas, can be measured in the laboratory through controlled depressurisation experiments.

The total amount of methane or other natural gases, once measured, can be calculated and partitioned into dissolved, hydrate, and free gas phases with knowledge of the in situ conditions and thermodynamics of the system. This mass balance method is the best calculation of in situ gas hydrate concentration and is the only method that can positively confirm the absence of hydrate in a sample.

Intensive porewater sampling for detailed hydrate distribution

Gas hydrate quantification from porewater freshening analysis is a simple idea: as gas hydrate melts, it leaves behind fresh water. If this amount of fresh water can be measured, the gas hydrate that created it can be estimated.

Geotek uses intensive porewater sampling guided by core infrared imaging to fully characterise the gas hydrate concentration and distribution in each core. Small-volume sediment plug samples and small porewater squeezer cells allow rapid sampling and processing while minimising the removal of precious core material.

Freshening is measured by the dilution of the conservative ion chloride, and sulphate measurement provides assurance of the quality of the fluid sample. Baseline chlorinities, from which freshening excursions are calculated, are provided by pressure core mass balance measurements.

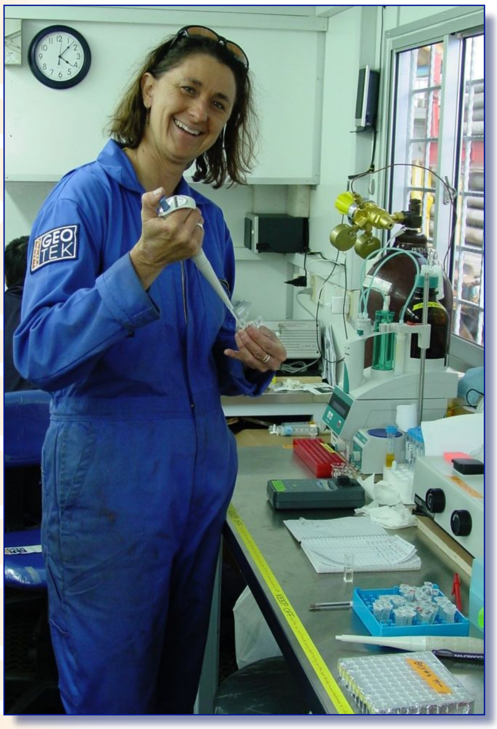
Gas analysis for hydrate composition

While most natural gas hydrate studied has been almost pure methane hydrate, there are locations where gas hydrate can be composed of other hydrocarbons. These alternate compositions affect the thermodynamic stability and the predictions for where gas hydrate will exist in the sediment column.

Gas samples are taken from core voids, sediment, or hydrate pieces, as well as pressure core depressurisation experiments, and analysed by gas chromatography to estimate gas hydrate composition and thus hydrate stability.

Grain size analysis to determine controls on hydrate distribution

Gas hydrate is often concentrated in coarse-grained sediment layers, if such layers are present. It is often advantageous to make this observation in real time, so that the extent of this correlation can be quantified throughout the section. Small samples for grain size analysis via rapid laser diffraction techniques are removed from sediment plugs for porewater analysis to allow correlations of hydrate concentration with grain size.



Integration with other data sets

Downhole log data sets and core infrared measurements also provide information on the concentration and distribution of gas hydrate. While these data sets cannot provide quantitative hydrate concentrations on their own, they have the advantage of being more continuous than the accurate measures of hydrate concentration calculated from methane mass balance and porewater freshening.

Correlation of these calculated hydrate values to the continuous downhole log data (electrical resistivity and sonic logs) or the semi-continuous core infrared measurements allows extrapolation of accurate hydrate measurements to the entire borehole.

Self-contained laboratory container

All the geochemical equipment and analyses, with the exception of the depressurisation experiments themselves, take place in a self-contained, transportable 20-foot laboratory container. This laboratory is fully fitted with lights, air conditioning, sink, uninterruptible power supplies, ethernet network, and file server.

Quantitative hydrate geochemistry van specifications

- **Porewater squeezing:** Two Carver hydraulic presses; each can accept four Geotek mini squeeze cells or one maxi squeeze cell at once. Eighteen mini squeeze cells (nine titanium, nine aluminium bronze) and six maxi squeeze cells (three titanium, three aluminium bronze)
- **Chlorinity analysis:** Silver nitrate titration with chromate indicator
- **Sulfate analysis:** Barium sulfate nephelometry
- **Gas analysis:** Oxygen, nitrogen, methane, ethane, propane, butane, isobutane, and carbon dioxide analysis using an Agilent MicroGC 3000 with molecular sieve and PLOT U columns and thermal conductivity detectors
- **Grain size analysis:** Laser diffraction particle size analysis using a Malvern Mastersizer 2000 with a HydroMU dispersion unit (can be supplied in geochemistry or sedimentology laboratory depending on requirements)

Sample processing speed

An average sample set for one core (eight porewater samples, eight grain size samples, and four gas samples) can be analyzed in 2.5 hours by two scientists/technicians.

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