Fluid History—Gas detection and fluid evolution in gas-rich geological systems

CSIRO develops and applies innovative techniques to investigate the movement of hydrocarbons in petroleum reservoirs and sedimentary basins at geological time scales, by analysing rocks and associated fluids at the micro-scale

Expertise

Micro-thermometry, Raman spectroscopy and thermodynamic modeling are combined to investigate fluid inclusions trapped in minerals to:

- detect hydrocarbons,
- provide temperature and pressure data,
- derive composition (CH_4, CO_2, water salinity).

The results aim to be integrated to understand gas charge, fluid evolution, and thermal history of basins.

Raman spectroscopy

Raman spectroscopy is a laboratory technique that offers a new method to directly detect dissolved gas and measure the salinity of palaeo-formation water trapped in mineral micro-defects known as fluid inclusions.

From core to microscope, fluid inclusions trap palaeo-fluids (gas, water, oil)

Raman microscope

Applications to gas and formation water

These methods have direct application to the petroleum industry in the fields of:

- palaeo-water salinity evolution.
- irreducible water salinity in gas zone.
- fluid modelling (PVTx).

The Raman-based method for calculating salinity overcomes the limitations of metastability frequently associated with conventional micro-thermometric techniques.

Combining the ability to quantify methane with homogenisation temperature (Th) and salinity, fluid modelling in the CH_4-H_2O-NaCl system can constrain the

pressure and temperature conditions of fluid entrapment and provide insights on gas charge history.

Raman spectroscopy can also detect:

- hydrocarbon gasses such as: CH_4, C_2H_6, C_3H_8.
- non-hydrocarbon gasses: CO_2, H_2S, N_2, H_2.
- organic acids, polyatomic species (CO_3^{2-}, HS^-, SO_4^{2-}…).

Case Study—Browse Basin

Palaeo-temperature, salinity and gas content of water inclusions from rock samples in the aquifer below large gas accumulations in the Browse Basin (Plover Formation and Brewster Member) were investigated. The fluid inclusion data show that the salinity of palaeo-formation waters decreases with increasing methane content, and that those salinities associated with water having reached methane saturation (i.e. contemporaneous with free-gas) are between 11,000 to 24,000 ppm (1.1 to 2.4 wt%). Detection of CO_2, however shows that water inclusions with dissolved CO_2, often in association with CH_4, do not follow the same trend with salinity, and in some cases show an opposite trend (Extract from Bourdet and Kempton 2015, AAPG ICE Abstract).

Other type of applications include:

- Mineralogy characterisation.
- Petrographic mapping.
- Carbon signature.

Facilities

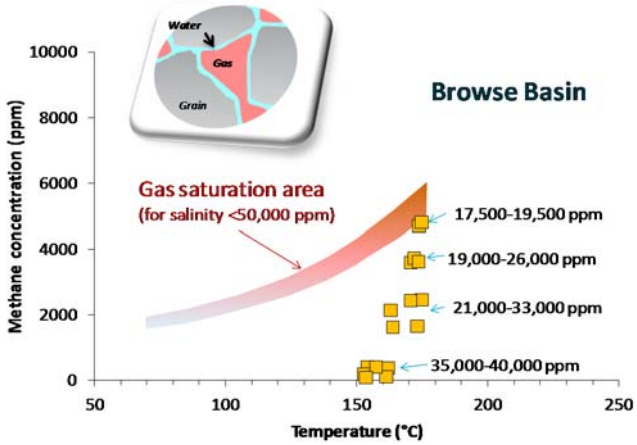
We have access to unique facilities to conduct research and provide analytical services. CSIRO owns and operates a fully equipped fluid inclusion laboratory with:

- Sample preparation capability.
- Horiba LabRam HR Evolution Raman spectrometer.
- Linkam Scientific micro-thermometric heating/freezing stage.
- CSIRO GOI™ microscopy work stations.

Getting involved

The expertise and technologies of the Geofluids team can be accessed through:

- routine commercial consulting services.
- collaborative research.



Example of fluid evolution in the Browse Basin—Plover aquifer

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