

New Multi-Client Study: Call for Interest

The Geology of Fractured Basement Reservoirs Executive Summary of Proposal

This proposed multi-client study will build on significant recent developments in our understanding of fractured basements to provide a basis to better constrain your reservoir properties.

Permeability in fractured basement reservoirs can be located in filled and open fractures, filled fissures and within weathered basement rock itself. Understanding this permeability, its development and link with tectonics is critical to predict reservoir quality. Using both analogue outcrop and subsurface data from historical and recent rifted basement margins, this study will bring improved understanding of reservoir quality in fractured basement.

Summary of Suggested Project Scope

A. Characterisation of Reservoir Properties

- Integrated poroperm and attribute study of fractures (including fissures) and their fills from pore to outcrop to field scale using outcrop and core analogue studies, set within the tectonic context. This will deliver both a conceptual model of reservoir properties and quantitative ranges of geometric properties in fractures and fissures.

B. Play Characterisation

- Synthesis of the current understanding of the play, including an evaluation of the global significance of fissure-fill.
- Collation of an atlas of fractured basement reservoir analogues.

C. Regional Studies

- Creation of a play map of NW Europe or parts thereof.
- Regional mapping of basement structures across multiple licences.
- Regional fracture geochronology and fluid inclusion study.

Further details of possible workscope on following page



Dates:

- | | |
|---|----------------------|
| • Expressions of interest | Autumn 2019 |
| • Project definition | Autumn - Winter 2019 |
| • Contracts signed | Winter 2019 |
| • Project Kick-off | Early 2020 |
| • Project delivery with field workshop (schedule dependent on final workscope, possible delivery spring 2021) | |

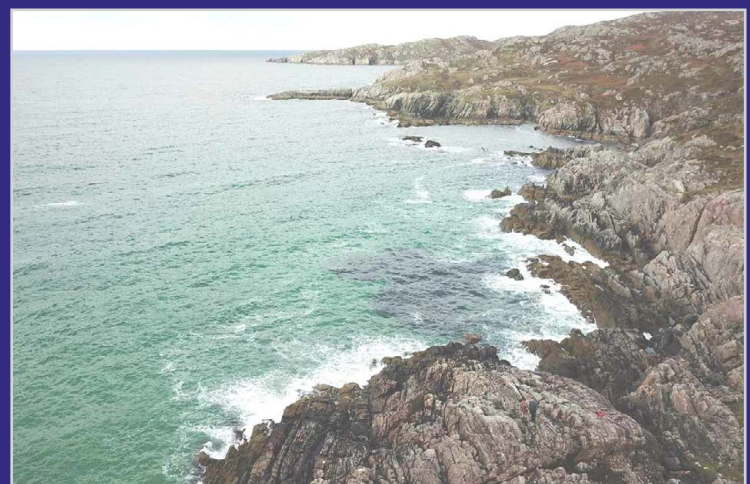
Principle Investigators

Professors Bob Holdsworth & Ken McCaffrey (expertise researching basement-hosted fractured reservoirs in Northern Europe).

GRL (expertise delivering integrated multi-client studies within fractured reservoirs).

Dr Rich Walker (expertise in mechanics of fracture formation in crystalline rocks, with experimental rock deformation and fluid flow).

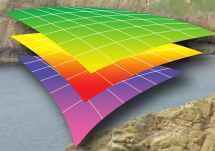
Collectively we have worked with major players in fractured basement reservoirs including Hurricane and the Clair JV.



Next step: Express Interest !

✉ susie@geospatial-research.com

☎ +44 191 384 1759



Further details of proposal

Possible Details of Workscope

A. Characterisation of Reservoir Properties

1. A full-field-scale to modelling-cube-scale to pore-scale fracture attribute study using outcrops and core data to derive both conceptual and quantitative fracture models.

- Acquisition of new data from analogues could incorporate:
 - Fracture sizes from seismic scale down to hand specimen scale.
 - Properties of different types of fractures: cemented tensional and shear fractures, sediment-filled fissures, including the relationship between fractures and faults and fissures.
 - Profile across present-day basement fissures.
 - Evaluation of the significance of faults, length of exposure, weathering, host rock geology and lithological contacts on fracture properties and fills.
 - Acquisition of shallow subsurface core across a fissure, fault damage zone and wall rock.
 - Application of onshore geophysics to further constrain fissure extent (e.g. GPR, VSP).

2. Poroperm study of fracture fills: resources, flow rates and recovery factors are all strongly influenced by the poroperm properties of the fracture fill.

- Investigating the link to age, host mineralogy and conditions of activity. Utilising both onshore and offshore (core) samples.
- Link to other fracture properties onshore, sampled within fracture attribute study.
- Including a fault seal analysis on faults cutting basement (using outcrop and core).

3. Flow modelling of derived fracture, fault & fissure properties.



B. Play Characterisation

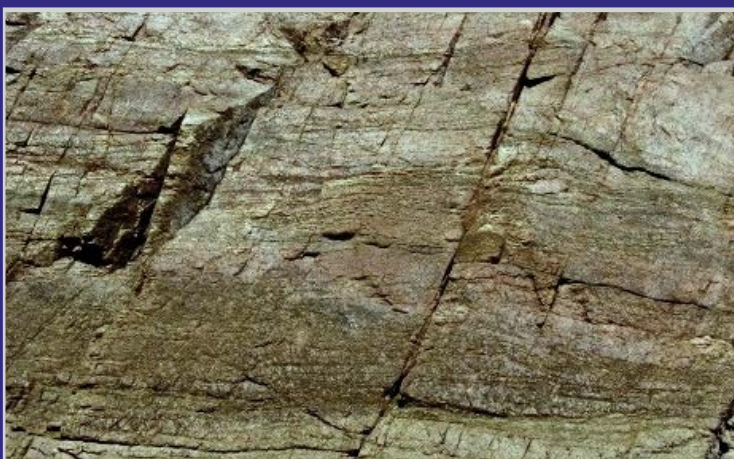
- Literature review summarising global fractured basement discoveries and fields (organised thematically and geographically).
- Collation of an atlas of surface and sub-surface analogues with various known parameters (including poroperm data).
- The fractured basement play and exploration indicators:
 - Derivation of fractured basement play criteria.
 - Evidence for low salinity Fm. waters in cover as an indicator of oil-filled basement reservoir.

C. Regional Studies

- Regional fracture geochronology and fluid inclusion study.
- Regional seismic mapping and structural interpretation of specific locations e.g. Rona Ridge, Utsira High, etc, possibly using regional gravity data to identify significant basement features.

Analogue Outcrop Locations

Outer Hebrides (Lewis and Harris), Iceland, Southern Italy, Torbay, UK, Lofoten Basement, Oslo Graben, Oman, East, South & West Greenland



Next step: Express Interest !

✉ susie@geospatial-research.com

☎ +44 191 384 1759