Department of Employment, Economic Development and Innovation
Geological Survey of Queensland

Comparative mineralogical study

X-ray diffraction *vs* optical microscopy, Moolayember Formation, Springsure Shelf, Galilee Basin

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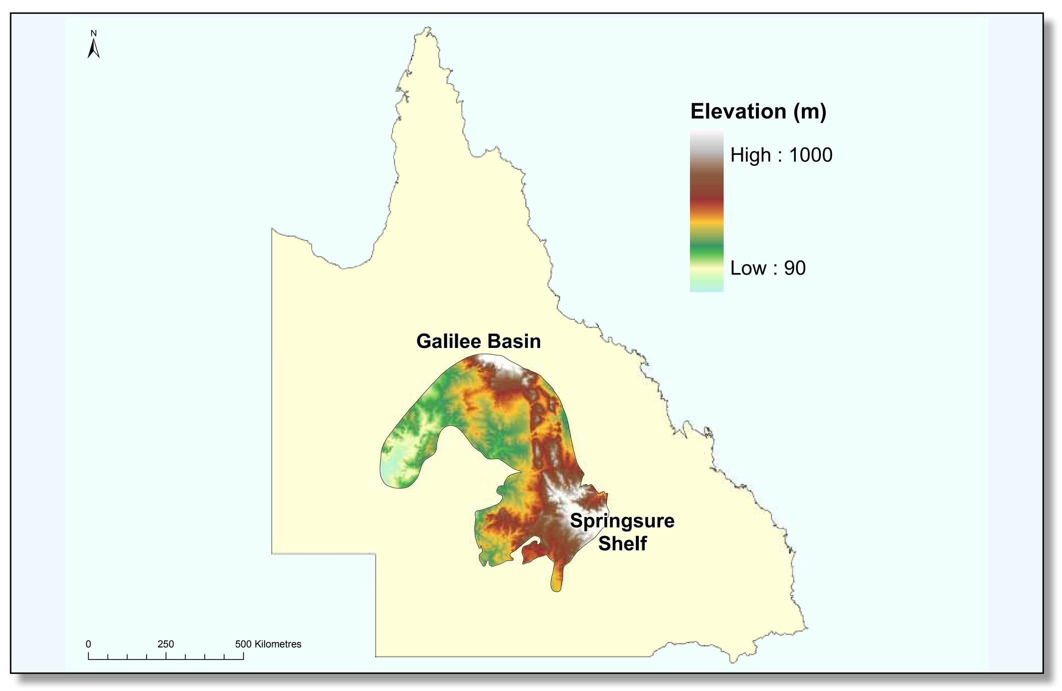
Introduction and study rationale

A recent data gap analysis undertaken by the Carbon Geostorage Initiative group (QCGI 2009) proposed the Galilee Basin as a region suitable for detailed investigation, with respect to carbon dioxide geostorage.

The main target is the southern section of the basin, the Springsure Shelf, and the reservoir-seal pair comprising the Clematis Sandstone and the Moolayember Formation. One aspect of interest is the mineralogy of the sedimentary sequence at selected sites, proximal to an area that will soon be tested for geostorage suitability. Subsequently, this type of work will assist the geochemical modelling of carbon geostorage impacts on the local mineral framework and groundwater chemistry.

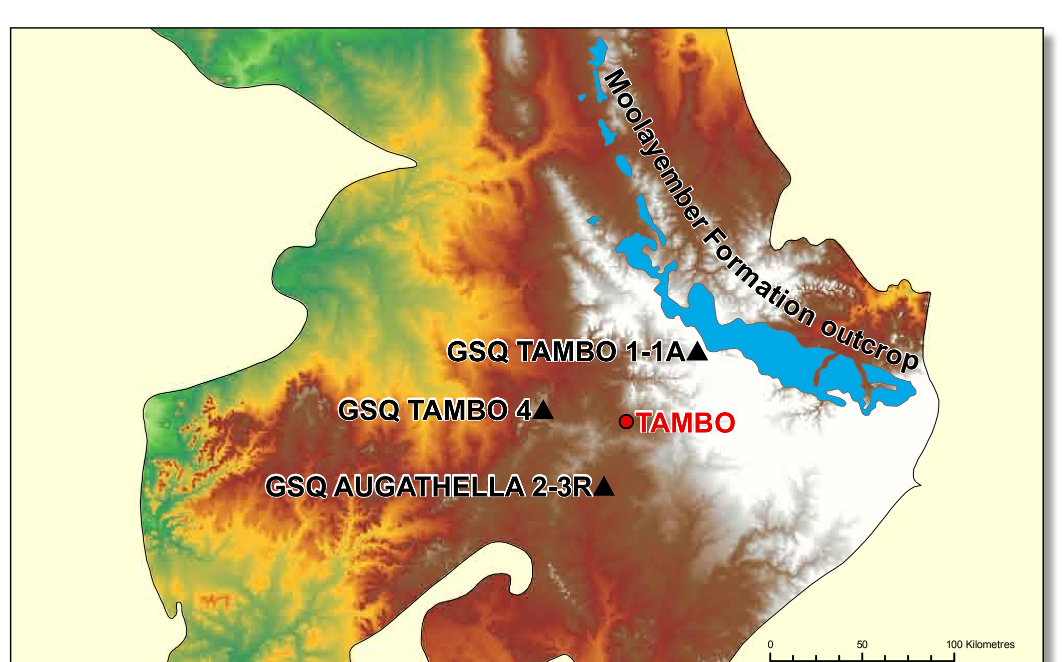
Reference
QCGI 2009. Potential for carbon geostorage in the Taroom Trough, Roma Shelf and the Surat, Eromanga and Galilee Basins – Preliminary Report. *Geological Survey of Queensland, Carbon Geostorage Initiative.*



Sampling and analytical methods

Preliminary work was undertaken on the Moolayember Formation to establish its seal characteristics. Sixty five core samples were collected from three stratigraphic wells drilled on the Springsure Shelf: GSQ Tambo 1-1A (10 samples, 109-169 m depth), GSQ Tambo 4 (16 samples, 946-1026 m depth) and GSQ Augathella 2-3R (39 samples, 1023-1099 m). The core samples from the GSQ core library were described, photographed, and analysed using X-ray diffraction (XRD) and optical microscopy.

The XRD relies on the unique crystallographic structure of minerals for their identification and is the best method to detect clay minerals and carbonates. However, the method does not allow for the unequivocal identification of series compositions (e.g. feldspars). To overcome such limitations, optical microscopy was employed to both validate the XRD results and assist in the determination of textural attributes.

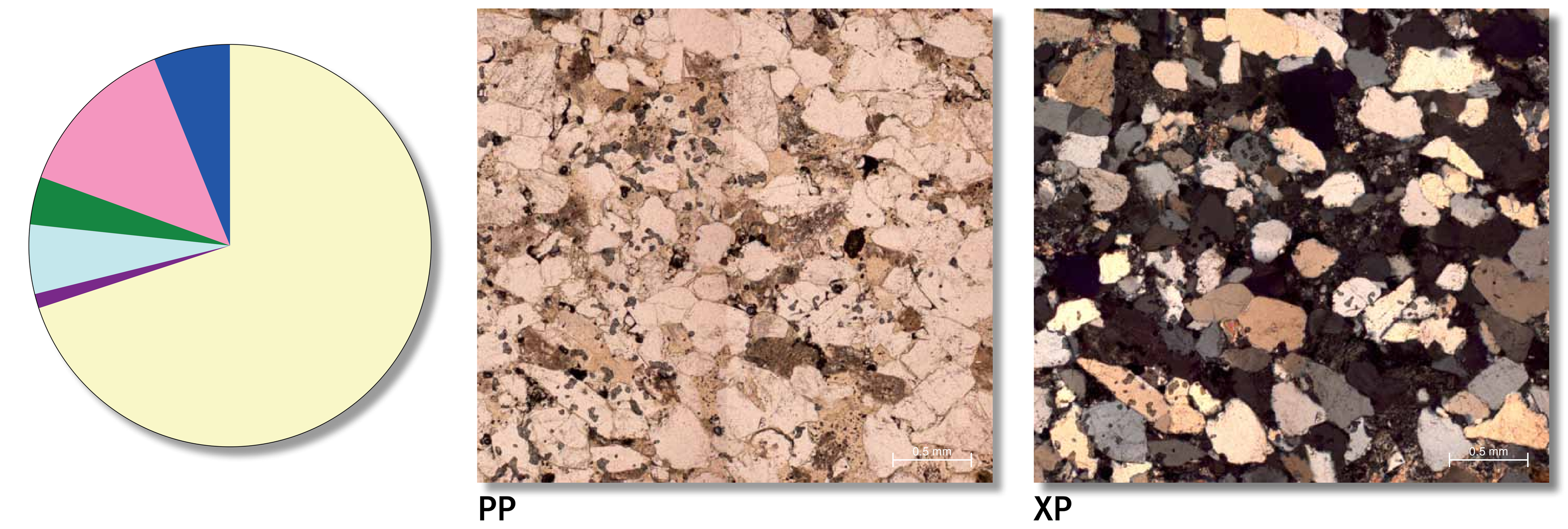


Prepared by Spatial Graphic Services, Geological Survey of Queensland Dec. 2011

Results

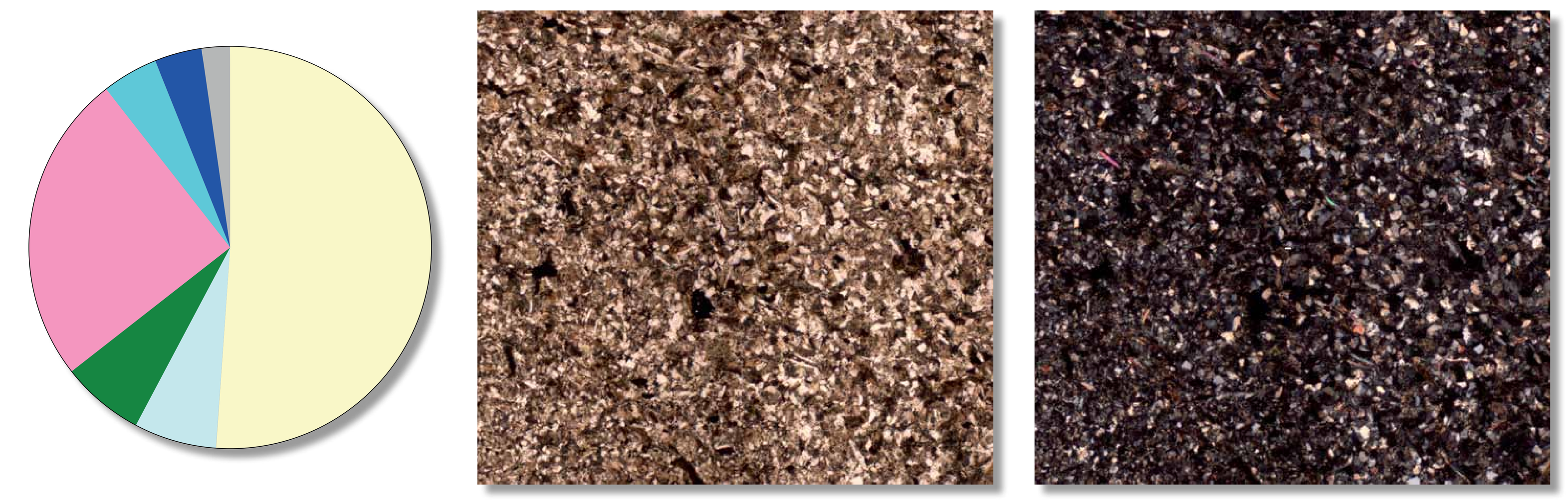
Moolayember Formation consists predominantly of finely interbedded grey to tan siltstones, deposited in a fluvial environment. Composition is predominantly litho-feldspathic, occasionally quartzose, with an argillaceous cement. Other features include: convolute laminae, rip-up clasts, micaceous matrix and sideritic veins.

1. Quartz (65-88%) – Kaolinite (3-13%) – K-feldspar (<8%) – Mica (<10%)



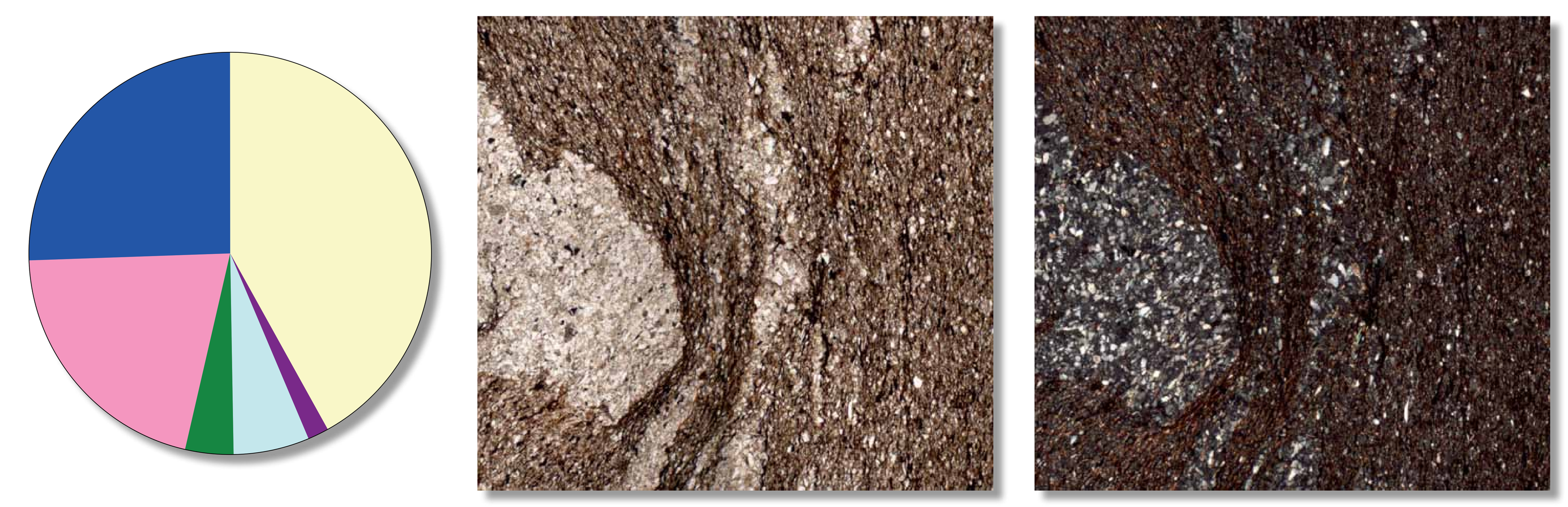
GSQ Augathella 2-3R

2. Quartz (45-61%) – Kaolinite (10-30%) – K-feldspar (3-13%) – Mica (3-13%)



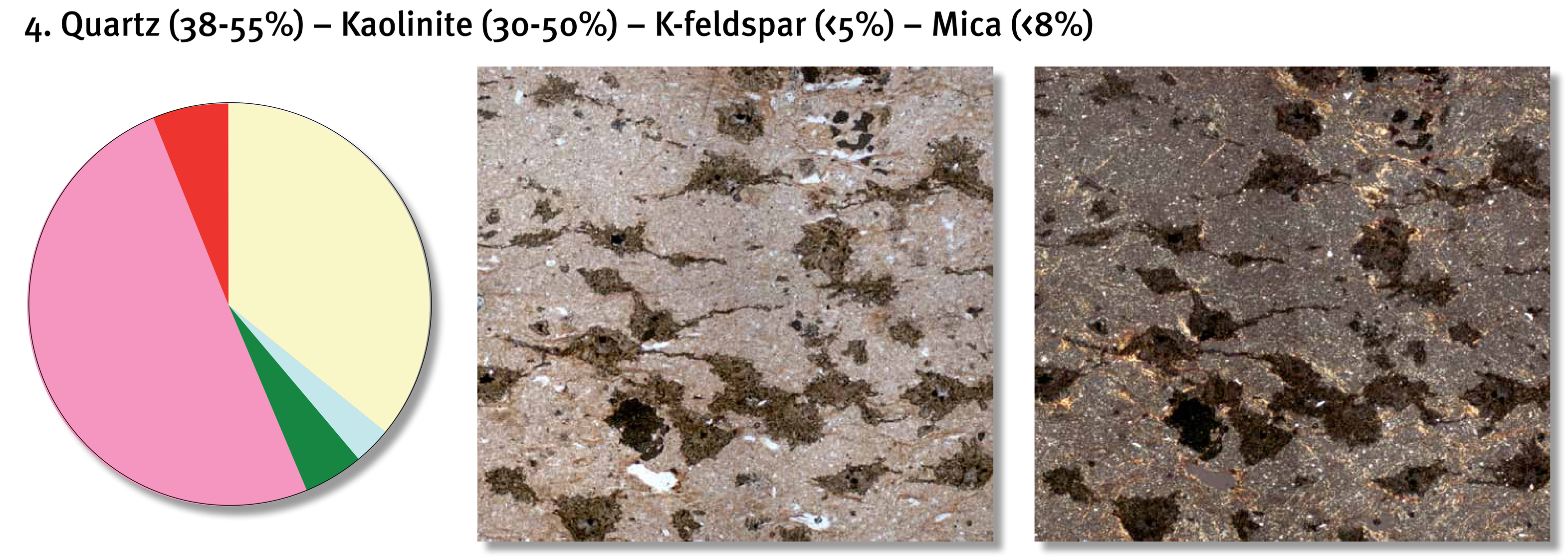
GSQ Tambo 1-1A

3. Quartz (35-55%) – Kaolinite (13-30%) – K-feldspar (<10%) – Mica (15-28%)

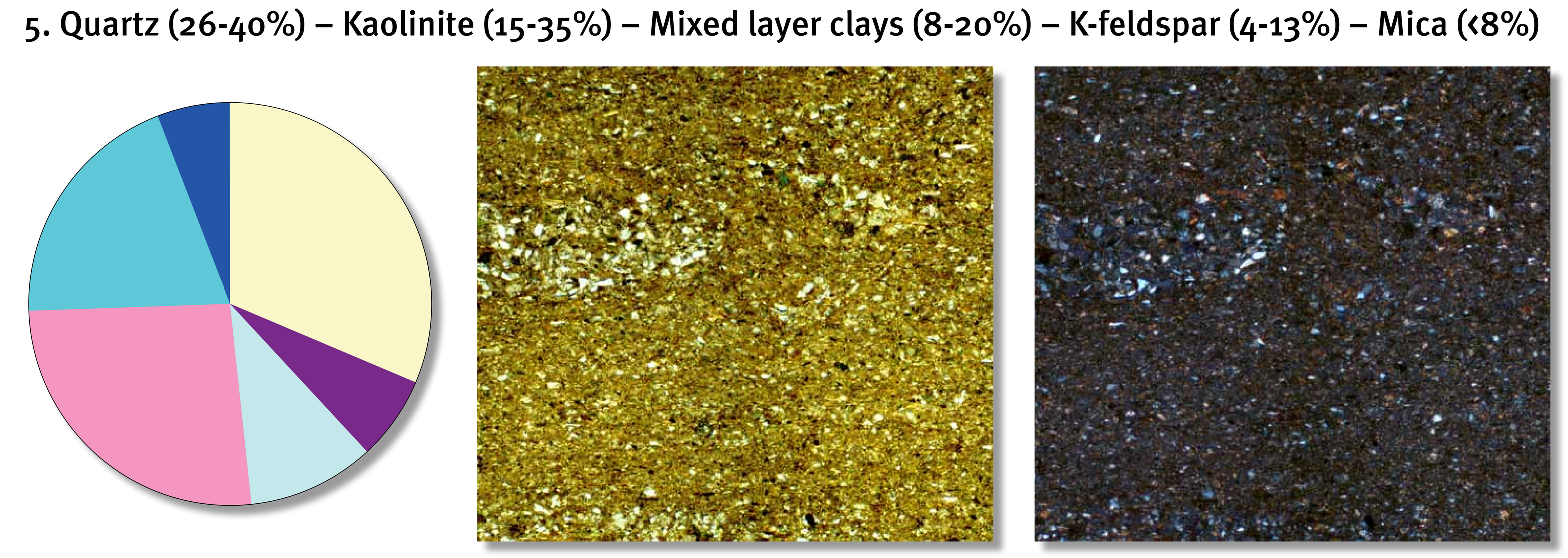


GSQ Tambo 4

4. Quartz (38-55%) – Kaolinite (30-50%) – K-feldspar (<5%) – Mica (<8%)



5. Quartz (26-40%) – Kaolinite (15-35%) – Mixed layer clays (8-20%) – K-feldspar (4-13%) – Mica (<8%)



XRD analyses (pie charts show mineral composition in %) complemented by optical microscopy (magnification 5x, PP – plain polarisation, XP cross polarisation) showed that the mineral character of the Moolayember Formation can be divided into 5 major types:

- Quartz
- Plagioclase
- K-feldspar
- Chlorite
- Kaolinite
- Mixed layer
- Mica
- Siderite
- Hematite

Conclusions

The silty sandstones (Folk classification) of the Moolayember Formation are predominantly quartz-rich and fine-grained (~100 µm); there are also units with abundant coarse (<600 µm) lithic fragments (mica shist, quartzite, volcanic rocks). Although some samples have significant concentrations of feldspars, they could not be accurately identified in thin section, due to their weathered and pitted surfaces. Regardless of their composition, grains are angular and the material is moderately sorted.

The clayey and sandy siltstones are more complex. The quartz and feldspar grains are very fine, while the clay minerals and mica (in the form of sericite) form a heterogeneous fine matrix. Lamination or lack of structure due to bioturbation, mica- or quartz-rich lenses and stylolite seams are often visible. Rare flakes of muscovite, biotite and chlorite have been observed, as well as fine grains of zircon.

The XRD method enabled the identification of feldspars and clay minerals, while the optical microscopy allowed the determination of grain size, sorting, lithic fragment composition, microscopic structures and the relationship between grains and the matrix. Of particular note is the abundance of lithic fragments in some sandstones, and the sericite-rich matrix of some clayey siltstones. These features are observed in all wells, regardless of depth.

The combined use of XRD and optical microscopy proved to be a good approach in describing the depositional complexity of the Moolayember Formation. This preliminary study suggests that the fine grained clay-rich material of this formation could potentially provide sealing capacity for the underlying reservoirs.