Queensland University of Technology
BRISBANE AUSTRALIA

Sedimentary systems research to inform responses to resource development and earth-systems events

Research by QUT focuses on developing and applying science, technology, engineering and mathematics to major contemporary and ongoing global issues.

The main focus of QUT geosciences research is on sedimentary systems. Sedimentary rocks host much of Australia's energy and mineral resources including the vast coal, oil and gas accumulations of Queensland. Sedimentary systems studies are also critical for understanding the environment and effects of natural hazards, including cyclones, and the effects of climate change impacts, especially on fragile ecosystems such as the Great Barrier Reef.

QUT sedimentary systems research builds on existing expertise in 'soft rock' geosciences with significant new investment in staff and infrastructure. This expertise is enhanced by strong links to a wide range of other QUT disciplines such as mathematical modelling, chemistry and ecology. The university has an outstanding track record of graduate employment, and long-established links with government and energy resources sectors in delivering education and research products.

There are three major areas of societal interest where QUT's sedimentary system research is applied: unconventional energy resources, groundwater resources, and natural hazards and earth-system responses to climate change.

Unconventional resources

Unconventional resources are already an important part of the energy mix in North America providing 50 per cent of oil production in Canada and over 60 per cent of natural gas production in the United States. The potential for unconventional resources is being realised elsewhere in the world but nowhere more than in Queensland, Australia, where the rapidly developing coal seam gas (CSG) industry aims to become a major supplier of liquid natural gas (LNG) to East Asian markets.

Substantial amounts of shale gas, shale oil and tight gas are likely in Australia and other parts of the Asia-Pacific region, though the true potential remains to be ascertained. While unconventional resources offer the promise of meeting increased demand for oil and gas, they must be developed in an environmentally responsible and socially acceptable manner.

At QUT, unconventional resources research and education aims to provide science and engineering outcomes for the environmentally sound and economically viable development of natural gas and oil, through a holistic approach to exploration and development.

Research areas

Shale gas and shale oil

- Shale reservoir characterisation
- Sequence stratigraphy of fine-grained strata
- Identifying and quantifying shale gas resources
- Environmental aspects of shale gas/oil exploration and development

Coal seam gas

- Depositional environments of coal and coal-bearing strata
- Identification of sweet spots
- Reservoir characterisation
- In-field and regional stress models
- Groundwater aspects of CSG development

Tight gas

- Understanding tight gas reservoirs
- Regional basin studies
- Reducing exploration risk

Other unconventional resources

- Oil shales
- Oil sands
- Geothermal resources
- Hydrates

Production of unconventional resources

- Geomechanical models for drilling and completion
- Water management
- Aquifer interactions

Carbon storage

- Basin studies for injection sites
- Reservoir and seal properties

Global oil and gas resources

- World distribution of known oil and gas resources
- Global potential for unconventional resource development
- Petroleum systems

Groundwater resources

Safe and reliable groundwater resources are critical to meet and sustainably manage increasing demand by cities, agriculture and industry. Sound scientific information is required for environmentally acceptable water disposal and reuse by the industrial sector. This is especially true with the extensive coal and coal seam gas industries of Queensland where it is important to understand their effect on regional groundwater levels, particularly in the Great Artesian Basin: the largest and deepest artesian basin in the world and an important source of fresh water throughout much of inland Australia. The major thrust of QUT's research on groundwater is the development of geologically and hydrogeologically sound conceptual models of a range of groundwater systems and flow within them. These models use state-of-the-art 3D visualisation and time series animations, support numerical simulations, and integrate hydrochemistry and isotope hydrology.

Research areas

Conceptual hydrogeological models

- Regional geologic studies integrating a wide range of surface and subsurface data

- Various settings including catchments, basins, coastal zones and sand islands

Hydrochemical and isotope studies

- Hydrological processes
- Recharge, mixing and dating of waters
- Evolution of groundwaters and aquifer interaction

Coastal zone and sand island groundwater systems

- Tidal influence
- Saltwater intrusion
- Management
- Environmental factors and chemistry

Environmental aspects of groundwater use

- Unconventional resources
- Management and monitoring
- Climatic response
- Links between groundwater and surface waters
- Terrestrial and marine ecosystems

Natural hazards and earth-system responses to climate change

There is a growing national and international concern about the human and economic costs of natural disasters and the effects of climate change on the land and oceans. This is particularly true in Queensland with its expanding population and resource industries, and its fragile environments, including the Great Barrier Reef.

Understanding the processes, magnitude, frequency and impacts of natural hazards such as volcanic eruptions, earthquakes, flooding, tsunamis, coastal erosion and landslides is critical to improving humanitarian and economic preparedness and resilience. Recent events, such as the earthquakes and tsunamis in the Indian Ocean (2004) and Japan (2011), the Brisbane floods (2011), and volcanic eruptions with associated ash clouds have increased awareness of the impact of natural hazards on the global community. As the global population continues to increase and urban environments expand, so will impacts from natural hazards. Greater understanding, prediction, mitigation and recovery from such events will be needed.

Global climate change can increase the frequency and magnitude of large-scale, weather-related hazards such as tropical cyclones, flooding and drought, which impact societal decisions on issues ranging from insurance and building infrastructure to food supplies. Sedimentary systems provide valuable information about the frequency and severity of climatic events at time scales relevant to society. QUT's research aims to understand environmental and earth-system responses to climate change through examination of the geologic record. Of particular interest are the effects of sea-level change on the sedimentation and erosion patterns on coastlines and the evolution of carbonate reefs with climate change. Methods include field and laboratory analysis and use of geophysical technologies for remote observation, sampling, and assessment.

Research areas

Earth-system response to climate change

- Sea-level change and coastlines of South-East Queensland
- Effects of climate variability on coral reefs
- Coastal to deep marine sedimentary processes

Natural hazards

- Volcanic eruption processes and dynamics
- Timescales of volcanic eruptions
- Sedimentary system responses to volcanism
- Earthquakes and faulting
- Biotic recovery from volcanic eruptions
- Coastal processes

Proven research performance and expertise

- Clastic and carbonate sedimentology
- Sequence stratigraphy
- Petroleum geology
- Basin analysis
- Hydrogeology
- Coastal sedimentology
- Quaternary geology
- Geochemistry
- Resource assessment

Key researchers

Search for QUT experts online by keyword of name at: **http://staff.qut.edu.au**

- **Professor David Gust** – volcanic stratigraphy, geochemistry, geological mapping
- **Professor Peter J. McCabe** – sequence stratigraphy, basin analysis, sedimentology, petroleum geology
- **Professor Malcolm Cox** – hydrogeology, groundwater resources, subsurface models and visualisation, chemical and isotope hydrology
- **Dr Craig Sloss** – clastic sedimentology, coastal geomorphology, sea level change
- **Dr Luke D. Nothdurft** – carbonate sedimentology, coral reef geology, climate change
- **Dr Mauricio Taulis** – hydrogeology, modelling, environmental engineering
- **Dr Christoph Schrank** – structural geology, shear zones, computational mechanics, digital rock physics
- **Dr David Murphy** – isotope geochemistry, petrology
- **Dr Scott Bryan** – volcanology, stratigraphy and physical sedimentology, tectonics, provenance analysis, geochemistry
- **Dr Jessica Trofimovs** – marine bioclastic and volcaniclastic sequences, sedimentary provenance
- **Dr Maree Corkeron** – sedimentology, stratigraphy, medical geology
- **Dr Matthias Raiber** – hydrogeology, 3D visualisation, hydrochemistry, isotopes, groundwater dating
- **Dr Lynda Petherick** – clastic sedimentology, coastal geomorphology, sea level change

QUT is ranked among the highest performing Australian institutions for research in the energy-related fields of physical sciences, chemical sciences, applied mathematics, information systems, and environmental engineering.

QUT is proud of its long-term research relationships that add real value to industry and the community through services including contract research, consultancy, expert witness, research collaboration and commercialisation.

Confidential commissioned research is delivered on time and within budget by research teams who understand industry needs, have local knowledge and are also internationally renowned for leadership in their respective fields.

QUT can arrange professional and pragmatic business arrangements for industry projects, and provide opportunities for leveraging research funding through Australian Research Council programs.

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