South Australian Geothermal Research Centre

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The emergence of the Australian Geothermal Sector has focussed attention on the potential of the Australia's non volcanic thermal systems to provide both direct and indirect energy. However the challenges are significant, and require a coordinated effort between the private, government and R&D sectors to focus expertise and bring projects to demonstration. The Development Framework and Technology Roadmap (DRET, 2008) outlines a clear plan for project development. A key aspect of this roadmap is consultation between the private sector and research organisations that prioritises research gaols that directly aid the sector. In this context there are now a number of research centres within Australia that are seeking to form a cohesive national R&D effort to assist the sector. This paper provides an overview of the South Australian Geothermal Research Centre (SACGER), which is hosted at the University of Adelaide, and provides a compliment to the national overview presented by Long et al (this volume).

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South Australian Centre for Geothermal Energy Research - SACGER

The South Australian Centre for Geothermal Energy Research is based at the University of Adelaide within the Institute for Minerals and Energy Resources (IMER), www.adelaide.edu.au/imer. The centre is funded from the South Australian Renewable Energy Fund, established with a grant of AU$1.6M over two years from 1 July 2009. However initiation of expenditure was delayed until July 2010. The University of Adelaide is providing AU$400,000 over the same period. Within IMER the South Australian Centre for Geothermal Energy Research forms part of a broader R&D portfolio on energy that includes the Centre for Energy Technologies which has a focus that includes the energy conversion and hybrid technologies whose aim is to optimise the geothermal energy delivered to the surface.

The SACGER research program has three principal foci which compliment the research programs of other centres around the country and build on strengths in subsurface modelling and characterisation to foster reliable estimates and efficient development of geothermal resources.

Program 1: Development of Electromagnetic tools to monitor and assess geothermal reservoir behaviour

This program is designed to the development of technologies and methods to make surface-based magnetotelluric (MT) surveys useful in (1) predicting the presence of fractured reservoirs ahead of the drill bit and (2) monitoring fluid flows in Engineered Geothermal Systems.

Under certain conditions, MT surveys can indicate the presence of naturally occurring hot fractured rock targets that are susceptible to reservoir enhancement with fracture stimulation to create Engineered Geothermal Systems. MT surveys can provide measurements that indicate the nature of changed fracture networks and post reservoir enhancement with hydraulic fracture stimulation. The development of MT technologies and MT interpretation methods is identified as a priority for research in the Australian Government's Geothermal Industry Development Framework and its associated Geothermal Technology Roadmap as requiring immediate attention. The University of Adelaide is internationally recognised for its expertise in the use and development of MT techniques, and is well positioned to become an international leader in the development of electromagnetically based tools for the geothermal industry.

The initiation and propagation of the underground fluid-reservoir is dependent on several parameters, including the stress regime, geometry of pre-existing faults, and reservoir lithologies. Currently, measurements of shear-wave splitting (SWS) is deployed to define EGS stress regimes, while refined measurement of seismicity (natural and induced during EGS field operations) is a standard approach to determine the location of the enhanced extent in the subsurface of EGS reservoirs (by locating seismic events associated with the creation of fractures during EGS operations). Because MT surveys can, under certain conditions, detect fluid flow patterns, advances in MT technologies and interpretation methods hold promise to foster more accurate delineation of EGS reservoirs, and models of fluid flows in EGS reservoirs. Locating MT measurement stations alongside micro-seismic detectors is a way to better understand the relationship between the two datasets and delineate the location of fracture zones in EGS fields.

The proposed research leverages on knowledge obtained from a pilot project concluded by the University of Adelaide with Petratherm Ltd. Initial studies and field surveys indicate close site spacing of the MT sites and high data quality are crucial for successfully monitoring the reservoir development.

The technologies and approaches developed will be readily transferable to other potential EGS sites in South Australia and more globally.

Program 2: Fluid-rock interactions in geothermal reservoirs

Fracture and flow

Australia's three flagship geothermal projects are all located in South Australia (Geodynamics' Cooper Basin project; Petratherm's Paralana project; and Panax's Salamander (Penola) project. The Geodynamics and Petratherm projects represent two of the world's most significant Engineered Geothermal Systems (EGS) projects. Both projects entail the enhancement of naturally fractured rocks with hydraulic fracture stimulation. Additionally dependent on the reservoir nature, Hot Sedimentary Aquifer systems such as those targeted in Panax's Salamander project may also require stimulation.

Reliably predictive flow modelling of EGS reservoirs is a recognised critical research challenge that is driving a peak international consortia (the International Partnership for Geothermal Technologies; the IPGT) to focus on improving 3-D modelling of reservoir performance through the life of a geothermal field life e.g. models that couple heat exchange, pressure, rock-fluid interaction, fluid flow dynamics, geomechanical properties and other geothermal reservoir and geothermal well parameters over life-cycle production history. The aim of research in SACGER will be to:

(1) Improve 3D models with new information from the EGS projects, and work in collaboration with the R&D expertise in Australia and internationally. This work will have implications for the risk management of induced seismicity by characterising the geometry of naturally existing fracture patterns, and improving knowledge of the in-situ stresses and potential overpressure regimes.

(2) Develop laboratory procedures using core flooding under stress aimed at predicting formation damage in production/injection wells and removal of well damage.

Program 3: Chemical reactivity in geothermal systems

Area-specific research to mitigate fouling and geothermal reservoir (pore and fracture) blocking is essential for efficient geothermal energy development projects. This research will build on pilot studies using a hydrothermal cell at representative reservoir temperatures (100-250^{o}C) to study fluid-rock interactions in geothermal reservoirs. However, the pilot study cell operated at pressures (roughly 50 bar, the saturation pressure of fluid) well below pressures (~ 300 bar) typical of EGS reservoirs in South Australia. More realistic reservoir conditions will be simulated by the creation of a high temperature, high pressure flow through cell to experimentally explore the risks of fouling and reservoir blockage at conditions that mimics conditions in the South Australian EGS projects.

The research will also allow the chemical processes in HSA systems to be examined. This will allow prediction of permeability for down-dip (thermally viable) targets HSA targets as well as scaling and fouling.

Development and application of tracers and smart particles to track fluid flow within reservoirs

Tracer technologies are a critical factor in calibrating reservoir performance models in all geothermal projects and can be used to determine the reactive

Conservative tracers for characterizing inter-well reservoir flow processes are:

- Thermally stable to 350^{o}C
- Detectible to low parts per trillion
- Environmentally friendly and non-toxic

Reactive tracers for characterizing fracture surface areas in injection/backflow tests are:

- Thermally decomposing
- Reversibly sorbing
- Possessing contrasting diffusivities

In addition to these research programs is work currently underway within the within the Centre for Energy Technologies that is experimenting verification of underground cooling for efficient thermal cycles and examination of low temperature thermal processing using geothermal energy aimed at optimising geothermal energy investments.

For more information see www.adelaide.edu.au/geothermal/
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