# The next Australian EGS Reservoir – Jolokia 1 stimulation

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Abstract

Geodynamics drilled the Jolokia 1 well in 2008 to a depth of 4,911m in the Innamincka granite at a location 9.5km west of the Habanero EGS field in north eastern South Australia. The reservoir stimulation program was delayed until 2010. Initially the delay was related to the need to undertake further evaluation of the well and implementation of a technical solution to allow multi-fracture stimulation. The stimulation was further delayed when the casing in Habanero 3 well failed in April 2009.

The aims of the stimulation are to:

(i) Confirm the capacity to create heat exchange reservoirs at locations spread across the Innamincka granite resource.
(ii) Develop two separate reservoirs in the one well, both deeper and hotter than the reservoir operated at the Habanero field
(iii) Demonstrate injectivity increases compared to the Habanero field.

Prior to the stimulation the well is to be logged with a high temperature imaging tool and completed with a liner, tubing and packer. The stimulation consists of injecting more than 20,000 cubic metres of clean water into the well at pressures up to 69MPa. A conservative benign chemical tracer is included in the injected water. It is expected that a single reservoir will be created at a depth below the liner set to 4,350m. The reservoir development is monitored by a microseismic network of seven triaxial geophone stations up to 5 km from the well and 100 to 200m deep. The stimulation will be carried out over a period of 10 days. A pumping regime has been determined based on (i) the understanding that has come from the stimulations of the Habanero field, and (ii) the best information from international experts who have carried out such operations in other projects. Currently the operation is due to take place in August 2010. A comprehensive site-specific microseismic risk analysis was needed before the South Australian regulators could give approval to proceed.

Existing understanding of the stimulation process indicates that once a fracture zone begins to stimulate its transmissibility increases by orders of magnitude so that that zone dominates the continuance of reservoir growth with time. At the Habanero field the reservoir grew outwards at a relatively constant rate of 1 $km^2$ for every 12,000 $m^3$ of water pumped after an initially more rapid growth within 200m radius of the wellbore. Based on transient well-test analyses the transmissibility of the Habanero reservoir increased from a pre-stimulated 50 milliDarcy metres to a post stimulation 2000 milliDarcy metres. This increase is less than has been observed in the lower stress conditions of other projects. The increase is considered permanent because the roughness of the fracture surface gives rise to self-propping of the fracture once it has slipped by an amount in the order of the dimensions of the grain size of the rock. This permanency was vindicated at Habanero since stimulation in 2005 proceeded aerially beyond what had been achieved by the first stimulation in 2003, with virtually no overlap in development within 1 km of the injection well.

Only one reservoir can be developed at a time. Given the stress conditions of the Innamincka granite determined at the Habanero field there is ample potential for the stacking of multiple reservoirs in a vertical interval of well-bore provided these can be grown separately. The Jolokia reservoir program envisages one reservoir built from Jolokia 1 and a second built from a later well Jolokia 2 at a different depth interval. Future use of open hole high temperature packers should allow for such multiple reservoir development to be achieved in a single well.

The Jolokia 1 stimulation is to be carried out in August 2010 and measurement of injectivity and mapping of reservoir growth based on microseismic returns will allow comparisons with the Habanero reservoir. The stimulation program includes pressure transient fall-off analysis using down-hole gauges and pressure-temperature-spinner logs to evaluate the distribution of permeable fractures.

This paper reports on the results of the Jolokia 1 stimulation and the implications for further development of the vast Innamincka granite geothermal resource. The Jolokia stimulation is the key to proving that EGS development can be effected at virtually any location in granite bodies. The prize of large scale economic production of zero-emission EGS electricity will then depend on achieving increased heat extraction rates and reduced development costs.

Keywords:

Stimulation, EGS, microseismic monitoring, multi-fracture reservoir