

Unconventional gas mining risk to deep aquifers Cadda Terrace

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Abstract

This report provides a screening level of risk assessment to determine whether deep aquifers are likely to be compromised as a result of shale gas mining on the Cadda Terrace. Locations from south to north included Drover well, Woodada gasfield and Arrowsmith 2. The methodology included analysis of downhole geophysical logs to determine salinity in the Lesueur Aquifer which is the most proximal aquifer to the fracture target. Fracture stability assessment was conducted for the Kockatea Shale which is both a source rock and seal. Fault slip can be associated with hydrocarbon leakage into overlying formations.

The stress state is strike slip/normal at Woodada and close to failure. Uncemented phyllosilicate faults oriented west to north-west are critically stressed pre-development using a threshold of 10MPa increase in pressure. Significant volumes of gas are leaking pre-development into most aquifers at Woodada. It is assumed that this leakage is via critically stressed faults in the Kockatea Shale. At hydraulic fracture stimulation pressure the proportion of critically stressed faults increases. The worst case scenario is for uncemented faults at the lower limit of normal stress. In this case, faults at all orientations and most dips are at risk of slipping. The stress state is strike slip at Arrowsmith 2. Virtually no faults are critically stressed pre-development. Thermogenic gas is contained in the Lesueur Aquifer with only trace amounts of methane leaking to surface. At hydraulic fracture stimulation pressure, the worst case scenario is for the lower limit of strike slip regardless of cementation with 100% of faults at risk of slipping. Gas leakage pre-development at Woodada suggests that gas levels in shallow aquifers may increase post hydraulic fracture stimulation at Arrowsmith 2. At Gairdener well, (immediately adjacent to Drover) small volumes of gas are contained in the Woodada Formation immediately above the shale gas target. The north-west faults at this location may not be critically stressed, however, breakout data is required to accurately resolve the stress state. The absence of gas in the overlying Lesueur Aquifer pre-development may also be linked to the biodegradation of gas in an aerobic environment. The confining influence of the Cattamarra Coal Measures is absent at Drover well.

Based on leak off test data, there is no stress barrier between the Kockatea Shale and the Lesueur Aquifer on the Cadda Terrace. In a strike slip/normal environment, newly created fractures can potentially penetrate the deep aquifers. Geophysical log interpretation of salinity validated with water samples indicates the Lesueur Aquifer is fresh to marginal between Drover

and Woodada 3. North of Woodada 3, the aquifer is saline and is disconnected from the regional flow system due to faulting.

A screening level of assessment is presented for regulators to consider. The first component involves review of gas levels logged during drilling exploratory wells. The existence of thermogenic gas in shallow aquifers should alert regulators to the possibility that the crust is already close to failure. The second component emphasises the importance of assessing baseline salinity in deep aquifers. If salinity is less than 5000 ppm NaCl equivalent in deep aquifers then it is suggested that hydraulic fracture stimulation be prohibited in such areas. It is recommended that regulators also investigate slow aseismic slip as a leakage mechanism during hydraulic fracture stimulation.
