

Timing of Illite Authigenesis within a Tight Gas Reservoir, Onshore Taranaki Basin, New Zealand

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The onshore Taranaki Cardiff Field is a large four-way dip anticlinal structure with an original estimated volume of gas-in-place for the main reservoir (K3E) between 200 BCF and 1 TCF. The discovery well (Cardiff-1) was plugged and abandoned after failing to produce commercial quantities of hydrocarbons due to low sandstone permeability. Recent drilling of the K3E reservoir in a second well (Cardiff-2/2A) by operator Austral Pacific has to date not resulted in the original predicted flow rates.

Petrographic studies of conventional cores through the sandstone reservoir at Cardiff-1 suggest that low permeabilities are largely the result of common, widespread authigenic illite. The timing of illitisation has been constrained by K-Ar dating of the <2 micron illite fraction and suggests precipitation in the Early Pliocene (c. 4.5Ma).

The timing of illite authigenesis is consistent with a rapid burial event where temperatures in the reservoir reached c. 130°C due primarily to burial depths approaching 5 km. This event postdates the onset of quartz cementation (as suggested by fluid inclusion analyses) and modelled oil migration from underlying Cretaceous coaly source rocks.

It is suggested that most of the authigenic illite formed by illitisation of earlier formed authigenic kaolinite with potassium sourced by K-feldspar dissolution. The acidity to drive these reactions could have been derived from CO₂ in aqueous solution, with CO₂ expelled from intraformational coaly source rocks. An Early Pliocene illite age is roughly coincident with the modelled very early thermogenic maturation of intraformational late Eocene coals and supports this interpretation.