

## **The Early Silurian Qusaiba Member as an Unconventional Gas Play in Northern Saudi Arabia: Evidence for Hydrothermal Alteration**

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### **ABSTRACT**

The lower Silurian Qusaiba hot shales are proven source rocks within Paleozoic-age reservoirs in Saudi Arabian basins. A burial based maturation model with a consistent basal heat flux was originally considered for assessing thermal maturity, yet high variability in these data was observed across various analytical methods including geochemical, optical and isotopic analyses. Detailed investigation of maturity trends across the hot shales suggests a complex and variable maturation history in the Northern part of the Nafud Basin. We propose that the maturation history of the lower Qusaiba Member in Northern Saudi Arabia has been variably affected — minor to complete over-print — by heating associated with deep-seated batholith driven hydrothermal systems (subsurface, hot, mineralized aqueous solutions). The implication of this is that the maturation history, and aerial variation, of the lower Qusaiba Member in parts of Northern Saudi Arabia is entirely different to what would be predicted using the traditional burial and uplift scenarios, both at individual locations and aerially. There exists a diverse range of evidence for the existence of hydrothermal systems that variably affected the organic maturity of the lower Qusaiba in Northern Saudi Arabia. This evidence includes the presence of indirect indicators such as carbon isotopes, organic matter alteration and gravity/magnetic anomalies S