

## **A Very Unconventional Hydrocarbon Play: The Mesoproterozoic Velkerri Formation of Northern Australia**

**Alan S. Collins<sup>1</sup>, Morgan L. Blades<sup>1</sup>, Darwinaji Subarkah<sup>1</sup>, Yaser Noorian<sup>1</sup>, Johann Soares<sup>1</sup>, Ananyaa Deepak<sup>1</sup>, Dana Imbrogno<sup>1</sup>, Lesley Edwards<sup>1</sup>, Ruoheng Li<sup>1</sup>, Juraj Farkas<sup>1</sup>, Andrew Wilson<sup>2</sup>, Carl Spandler<sup>1</sup>, Rosalind King<sup>1</sup>, Simon Holford<sup>1</sup>, Sarah Gilbert<sup>3</sup>, Tony Hall<sup>1</sup>**

<sup>1</sup>The University of Adelaide

<sup>2</sup>ImageStrat Pty Ltd

<sup>3</sup>The University of Adelaide

### **Abstract**

The ca. 1.5–1.3 Ga upper Roper Group of the greater McArthur Basin is a component of one of the most extensive Precambrian hydrocarbon-bearing basins preserved in the geological record, recently assessed as containing upwards of 500 trillion cubic feet of gas (P50) in place. It was deposited in an intra-cratonic sea, referred to here as the McArthur-Yanliao Gulf.

The Velkerri Formation forms the major deep-water facies of the Roper Group. Trace metal redox proxies from this formation indicate that it was deposited in stratified waters, in which a shallow oxic layer overlay suboxic to anoxic waters. These deep waters became euxinic during periods of high organic carbon export. The Amungee Member of the Velkerri Formation contains up to three high organic carbon shales with total organic carbon values up to 10 wt%. Organic carbon isotopes are consistent with carbon enrichment being associated with a broad increase in primary productivity and export, rather than sea-level fluctuations or variations in mineralogy. We link this to an increase in nutrient supply due to tectonic uplift of the southern margin of the North Australian Craton as the West Australian Craton amalgamated with Nuna at ca. 1.4 Ga. The variations in the different high-carbon shales (number of shales and gaps between them) are largely due to the location within the basin and detrital smothering caused by northward progradation of a delta-toe that makes up the sediments of the overlying Wyworrie Member.

Although deposition of the Velkerri Formation in an intracontinental setting has been well established, recent global reconstructions show a broader mid to low latitude gulf, with deposition of the Velkerri Formation being coeval with the widespread deposition of organic-rich rocks across northern Australia and North China, and even extending to the Belt Basin of Laurentia. The deposition of these organic-rich rocks may have been accompanied by significant oxygenation associated with such widespread organic carbon burial during the Mesoproterozoic.