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Geologic H_2 from overmature organic sources: Numerical modelling application in the Cooper Basin, Australia

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Molecular hydrogen from geological sources (geologic H_2) is receiving increasing interest as a potential resource to help reduce carbon emissions. However, geologic H_2 from inorganic sources has been a focus in the recent literature where those sources from the radiolysis of water and the oxidation of ferrous iron are most amenable to modelling H_2 generation rates, hence derived overall H_2 volumetrics at the local to global scales. Based on studies of overmature shales in China (Horsfield et al., accepted) and coals in Australia, we here present considerations with respect to the kinetics of H_2 generation from organic matter where the maximum rate of organic H_2 generation (20 mg H_2/g TOC) is lower than that for late methane generation (50 mg methane/g TOC). Petroleum system modelling in the Permo-Triassic Cooper Basin, Australia indicates free organic H_2 is generated between a calculated vitrinite reflectance of 3.0% (onset at TR = 0.1) and 5.0% (TR = 0.5) at the maximum burial temperature in the Burley 2 well; at which time/temperature the late methane generation is exhausted (TR = 0.95) (Figure 1). It is estimated that large volumes of free organic H_2 generation are focussed deep within the Nappamerri Trough were this level of overmaturity is encountered. The fate of the free organic H_2 is uncertain but its relatively low reactivity with overmature Type III organic matter suggests that preservation of free organic H_2 is more likely than if generated at lower maturity levels. However, the disconnect between the locality of the 'sweet spot' of organic H_2 generation and Cooper Basin natural gases with [H_2] from 0.1 to 4.6 mol% suggests H_2 sources additional to organic H_2 are in play. Nevertheless, exploration drilling within the Cooper Basin's depocentre is sparse so a deep H_2 system remains largely untested.

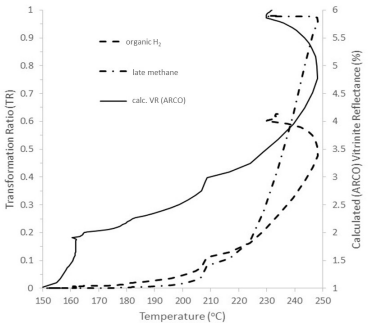

Figure 1. Petroleum system modelling output for mid-Patchawarra Formation coal from Burley 2 well (https://doi.org/10.1306/05111817249) using Zetaware software (https://www.zetaware.com/).

Horsfield, B., Mahlstedt, N., Weniger, P., Misch, D., Vranjes-Wessely, S., Han, S., Wang, C. (accepted). Molecular hydrogen from organic sources in the deep Songliao Basin, P.R. China. International Journal of Hydrogen Energy.