ORIGIN AND USE OF HELIUM IN AUSTRALIAN NATURAL GASES

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Over 800 natural gases representative of Australia's hydrocarbon-producing sedimentary basins have been analyzed for their helium (He) content and around 150 gases for their helium isotopic composition, supplemented by isotopic compositions of the higher noble gases. Australian natural gases have helium abundances to over 10%, with the highest values in the Amadeus Basin, in central Australia, while $^3He/^4He$ ratios range from around 0.01 to 4.2 Ra (Figure 1). The onshore Gunnedah Basin of southeastern Australia and the offshore Bass and onshore/offshore Otway basins in southern Australia show the highest $^3He/^4He$ ratios, indicating a significant mantle contribution. Interestingly, the offshore Gippsland Basin, adjacent to the Bass Basin, has slightly lower $^3He/^4He$ ratios. In the Gunnedah Basin, the associated CO_2 has a relatively low abundance compared to extreme concentrations of CO_2 in some Otway Basin wells, which are associated with recent volcanism. The onshore Bowen and Cooper basins of eastern Australia, where natural gases are predominately sourced from Permian coals, show intermediate $^3He/^4He$ ratios with the former having a higher mantle contribution. At the other end of the spectrum, low $^3He/^4He$ ratios characterize natural gases of the offshore North West Shelf (Bonaparte, Browse, Carnarvon) and onshore/offshore Perth basins in northwestern and southwestern Australia, respectively, and radiogenic helium predominates. Hence the sometimes extensive volcanic activity and igneous intrusions in these western basins are not expressed in the helium isotopes. The accompanying high CO_2 contents (up to 44%) of some of these North West Shelf gases, together with the carbon isotopic composition of CO_2, infer an inorganic source most likely from the thermal decomposition of carbonates.

The geochemical data suggest that the origin of helium in Australian natural gas accumulations is region specific and complex with the component gases originating from multiple sources. The relative low $CO_2/^3He$ ratio ($< 1x10^9$) for many natural gases indicates a systematic loss of CO_2 from most basins. The process by which CO_2 has been lost from the system is most likely associated with precipitation of carbonates (Prinzhofer, 2013). The age of the source (and/or reservoir) rock has a primary control on the helium content with radiogenic ^4He input increasing with residence time (Figure 1).

With the increasing exploitation of Australia's enormous reserves of natural gas, the many LNG processing plants across Australia present the opportunity to commercialize helium from the N_2-enriched reject gas. Such has already occurred for the Bayu-Undan field

(Bonaparte Basin) with the gas field having only 0.1% He and N_2/He around 30. A key factor to the gases monetary value is the conservation of an inherited low N_2/He. Hence the planned LNG production from the Ichthys field in the adjacent Browse Basin, although having a lower av. He of 0.065% is considered even more prospective for helium due to it very low N_2/He (av. 9). From the $^{15}N/^{14}N$ ratios (-7.3‰ to +1.2‰), N_2 generated from organic matter (N_2 < 5% and depleted in ^{15}N) and abiogenic sources (N_2 > 5% and enriched in ^{15}N) critically impact the economics of helium extraction.

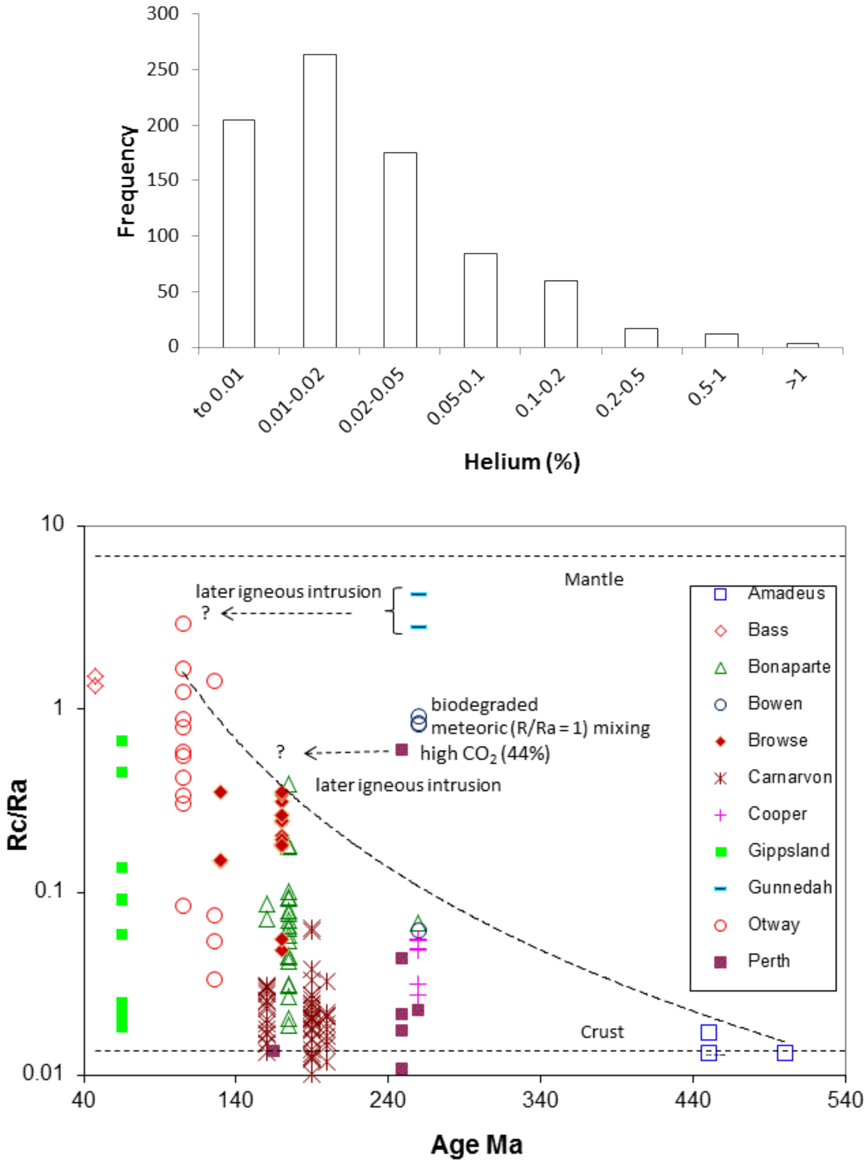

Figure 1. *Frequency plot of helium concentration (top) and the helium isotopic composition (R = $^3He/^4He$ ratio of the natural gas and Ra = $^3He/^4He$ ratio of air) verses source rock age of co-existing hydrocarbon gases (bottom).*

References:

Prinzhofer, A., 2013. Noble gases in oil and gas accumulations. *The Noble Gases as Geochemical Tracers*. Springer. 225-245.