Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.7891

Formation of primary N_2-He gas reservoirs in sedimentary basins

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Helium is an important and, on a human timescale, non-renewable element that faces a supply crisis. Helium-rich natural gas formation mechanisms focus on helium dissolved in sedimentary fluids. To date, the processes identified to generate a helium-rich gas phase, essential for commercial viability, involve a separate CH_4 or CO_2 phase either directly 'stripping' dissolved helium from the water phase or causing the solubility limit to be exceeded during uplift-related depressurisation [1,2,3], with resulting dilution of the available helium.

Another form of helium-rich gas field formation is viable in ancient intracratonic basins. We have developed a one-dimensional diffusion-and-exsolution model which simulates the N_2 (always associated with helium) and ^{4}He basement flux, comparable to that observed in sedimentary basins [1,3,4], into the base of an evolving basin system. Dependant on basin architecture and age, the model predicts formation of a nitrogen-helium rich gas phase in some sedimentary lithologies overlying the crystalline basement. This is caused when the He-associated N_2 concentration exceeds its local solubility limit in the water phase, and the conditions required for this event can be explored within the model. Independent model outputs demonstrate a good match with N_2-^{4}He rich gases observed in the Williston Basin, North America. This new model provides a mechanism for primary ^{4}He-N_2 gas reservoir formation, without CH_4 or CO_2 involvement.

[1] Ballentine and Sherwood Lollar (2002) Geochim. Cosmochim. Acta. 66, 2483-2497

[2] Sorenson (2005) AAPG Bulleting 89, 921-938

[3] Danabalan (2017) Unpublished PhD thesis, University of Durham

[4] Torgersen (2010) https://doi.org/10.1029/2009GC002930