La Barge, Wyoming: A non-magmatic carbon dioxide and helium accumulation

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Noble gas isotopic data from the La Barge field, Wyoming indicates a crustal origin in contrast to the magmatic origin of other carbon dioxide (CO_2) fields in the Rocky Mountains [1]. La Barge has $CO_2/^3He$ ratios of approximately $1x10^9$, which are considered the edge of mantle based gases. However, six noble gas samples from wells in the reservoir show helium isotopic compositions of 0.069-0.085 R/R_A, a near crustal production endmember composition. Neon and argon isotopes suggest crustal-air mixing with $^{20}Ne/^{22}Ne$ values below 9 and average $^{40}Ar/^{36}Ar$ values of 16,000. Therefore, the accumulation does not fit into a magmatic gas source model.

Crustal sourced helium has been attributed to high heat flow, which can release helium produced in the crust [2]; however there is no evidence of a nearby thermal anomaly. In-situ radiogenic helium production would require billions of years and cannot account for the concentrations found in the reservoir. Additionally, the basal helium flux rate from continental crust would take longer to charge the reservoir than the age of the trap. In light of no evidence to support other known helium accumulation models, the helium may be supplied from migrating fluids, possibly associated with hydrocarbon charge. This could explain the helium accumulation at La Barge as well as other relatively high helium and hydrocarbon bearing accumulations north and south of the field.

[1] Gilfillan et al. (2008) *GCA* **72**, 1174-1198. [2] Lowenstern et al. (2014) *Nature* **506**, 355-358.