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Noble gas characteristics of produced gases from the Lost Hills and Fruitvale oil fields, USA

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Noble gases are effective tracers for assessing the effects of oil and gas production activities on groundwater systems. Non-radiogenic noble gases are introduced into undisturbed oil and natural gas systems through exchange with formation waters [1]. Systems with extensive hydraulic fracturing and/or injection for enhanced recovery or waste disposal introduce an additional isotopically distinct signal. Isotopic characteristics and relative elemental abundance ratios of noble gases can be used to 1) assess the migration history of the injected and formation fluids, and 2) determine the extent of exchange between multiphase crustal regimes.

We present noble gas isotope and abundance data from casing, separator and injectate gases of the Lost Hills and Fruitvale oil fields located on the west and east sides, respectively, of the San Joaquin basin, California. Samples were collected as part of the California State Water Resource Control Board's Oil and Gas Regional Groundwater Monitoring Program. Lost Hills gases are dominantly thermogenic, whereas Fruitvale samples are a mix of thermogenic and biogenic methane. All gases are strongly radiogenic with respect to helium isotopes ($^{3}He/^{4}He$), however Fruitvale samples are more air-like, with higher air-derived noble gas concentrations and heavy noble gas elemental ratios (i.e., $^{84}Kr/^{36}Ar$; $^{132}Xe/^{36}Ar$), whereas Lost Hills gases preserve more pristine crustal values.

Lost Hills and Fruitvale gases are isotopically distinct in their noble gas compositions, which is supported by ancillary findings in produced waters and overlying groundwaters [2] and likely reflects substantial differences in hydrogeologic depositional settings [3]. In addition, these signals may suggest that fluids in these two fields have subsequently experienced different production and enhanced recovery histories. Further studies will provide a more thorough characterization of the chemical and isotopic compositions of produced waters in and between oil fields, which will further constrain fluid exchanges between aquifers and oil fields.

[1] Barry et al., (2016) *GCA*, 194, 291-309. [2] McMahon et al., (2016) *USGS Open-File Report* 2016-1100. [3] Wilson et al., 1999, *GSA Bulletin*, 111, 432–449.