Noble gas characterisation of produced waters from the Fruitvale and Lost Hills Oil Fields, CA, USA.

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To identify the source and mechanisms controlling the occurrence of oil-field fluids in adjacent protected groundwater, the potential source fluids, including zones where enhanced oil recovery projects increase fluid circulation, must be characterised. Both the extant reservoir composition, and the geochemical evolution during production need to be constrained. Air-derived noble gases (^{20}Ne, ^{36}Ar, ^{84}Kr, ^{132}Xe), which are introduced into oil and gas formations by equilibration with formation waters [1] and injection for enhanced oil recovery, are powerful tools for characterising oil-field fluid compositions. Produced waters are the residual mixture of water, oil and gas, once casing gases have been removed. In addition to the insight gained from the casing gases, noble gases in these produced waters will also allow for the characterisation of this component of the hydrocarbon reservoir.

We present noble gas data from produced water and injectate water samples from the Fruitvale (n=6) and Lost Hills (n=5) Oil Fields in the San Joaquin Basin, CA. These samples were collected as part of the California State Water Resources Control Board's Oil and Gas Regional Groundwater Monitoring Program. Samples had variable phase compositions. Total noble gas concentrations dissolved in produced water samples are depleted relative to air-saturated water (ASW), suggesting significant loss has occurred since hydrocarbon formation. Concentrations of each of the air-derived noble gases vary by four orders of magnitude, with considerable overlap between the Fruitvale and Lost Hills Oil Fields. Seven ^{20}Ne/^{36}Ar values plot within the solubility range of ASW and oil, whereas the remaining four fall above this range, which is likely due to excess-air injection during enhanced oil recovery [2]. We are investigating both open and closed system models to account for gas lost during casing gas removal to identify the in-place and evolved reservoir noble gas signature.

[1] Barry et al., (2016) *GCA*, 194, 291-309. [2] Barry et al., (2017) *AGU abstracts 2017*.