Noble gas characteristics of Jurassic sourced oils and gases of the Gulf of Mexico, USA

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Non-radiogenic noble gases are mainly introduced into oil and natural gas through exchange with formation waters. Isotopic characteristics and relative elemental abundance ratios can be used to differentiate between gas and oil contact and quantify the extent of interaction (e.g., Barry *et al*., 2016). This is because partitioning between each distinct hydrocarbon phase and water will result in a diagnostic noble gas signature in the hydrocarbon phase. Using this approach we can 1) estimate relative volumes of gas, oil and water, 2) assess the migration and accumulation history of the hydrocarbon phase, and 3) determine the extent of geologic compartmentalization within a given hydrocarbon field.

We present noble gas isotope and abundance data from three adjacent oil and gas fields in the Diana-Hoover mini-basin located in the western Gulf of Mexico: Hoover, Madison and South Diana. Hydrocarbons are sourced from Jurassic marine shales and charged Tertiary reservoirs in the Pliocene (5-1 Ma). Hoover and Madison produce from oil reservoirs with a small gas cap. In contrast, South Diana produces mixed thermogenic-biogenic gases. The migration pathway from the source rock to the producing reservoirs in this mini-basin is complex and has resulted in separation of the dominantly oil reservoirs in the east and gas reservoirs in the west.

We observe overlapping noble gas concentrations in two Hoover samples and one Madison sample. This result strongly suggests that Hoover-Madison oils share a common origin, and must be well-mixed prior to any compartmentalization. In contrast, a third sample in the Hoover field has approximately twice the concentration. The role of hydrocarbon production has been ruled out as a control on noble gas content. Instead we suggest that the higher concentrations of noble gases are the result of a smaller gas cap in an isolated compartment. The South Diana sample is relatively gas poor due to dominantly gas-water partitioning and differences in the migration pathway in the west of the mini basin. We discuss a new Ar-Kr-Xe equilibrium model and quantify the extent of gas-oil-water interaction of reservoired hydrocarbons in this system.

[1] Barry *et al*., (2016) *Geoch. Cosmochim. Acta*, submitted.