Integrating noble gas and compound-specific stable isotopes to characterize the generation and migration of oil-associated gases and H_2S in the Eagle Ford shale of Texas, USA

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The production of unconventional shale gas and oil continue to increase in the US and abroad. The Eagle Ford Shale has been an example of an economic success story with combined production of oil, condensates, and wet gas. Despite these successes, production has been spatially variable and hampered by high H_2S contamination. Nonetheless, to date there has been a dearth of published reports on gas chemistry including compound-specific stable isotopes, noble gases, or H_2S concentrations. Here we combine compound-specific stable isotopes (C_1-C_5), the full suite of noble gas isotopes (He-Xe), and general gas compositional analyses (including H_2S) with site-specific seismic data. Our preliminary results indicate the presence of mantle-derived noble gases and carbon dioxide in producing oil and gas wells. Interestingly, with increasing mantle contributions, we identify distinctly higher maturity hydrocarbons and elevated levels of H_2S associated with local faults. Most of the Eagle Ford samples fit the Natural Gas plot ($\delta^{13}C$ vs. 1/n) with r^2 values better than 0.980, while those that do not, also show anomalies in their noble gases and other gases indicative of low initial fluids-in-place. The slopes of individual samples on the $\delta^{13}C$ vs. 1/n plots vary with inferred maturity and apparent mantle contributions. One prospective implication is that a single thermal pulse, the intensity of which varied regionally, generated the regulated the thermal maturity of Eagle Ford gases and the formation of H_2S via thermal sulfate reduction.