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Three-dimensional methane fingerprinting using simultaneous measurements of ethane and deuterium and ^{13}C isotopologues of methane

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Methane is a growing source of energy in the world that is the source of heat for billions of people which offers efficient burning and is sufficiently cleaner than coal. With an increase in global demand and a move toward methane sequestration, methods for monitoring and distinguishing origins of gas are essential. Methane identification is not only necessary for source discrimination, but also aids in gas and oil exploration by mapping reservoir types and distinguish between gas well, oil wells, or dry wells. Presence of ethane, longer hydrocarbons and measurements of δ^{13}C in CH_4 can distinguish the stage the gas was produced, while deuterium in CH_4, δ^D, can further classify natural gas reservoir types. This study describes an analyzer used for measuring methane sources and mapping them to determine sources and processes these gasses originate from. This has been done by developing cavity ring-down analyzer that measures both δ^{13}C and δ^D in CH_4, as well as the ethane to methane ratio (C_2:C_1). For a continuous flow sample at 10,000ppm CH_4, δ^{13}C and δ^D can be measured to $<$0.06‰ in 5 minutes, while C_2:C_1 ratio is measured to $<$0.05% in 5 minutes. Using these measurements has allowed for discrimination of biogenic and thermogenic samples, as well as processes such as shallow gas migration in which thermogenic gas is stripped of hydrocarbons.