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Distinction of Bacterial and Thermogenic Gas Using Radiogenic Isotopes of The Noble Gas Family

The importance of methanogenesis in natural gas reserves is still subject to discussion. Bacterial contamination is also an important issue when characterizing the gas origins and migration when using stable isotopes, as the correct interpretation of the data may be difficult to interpret. In the last decades, it seemed easy to distinguish gas generated by thermal cracking from methanogenesis using the carbon and hydrogen isotopes. Recent studies have shown that bacterial oxidation of bacterial gas may give a residual gas showing a thermogenic signature, whereas diffusive processes during migration may give a bacterial signature to a thermogenic gas. We present a totally independent way of distinguishing these two origins, where gas ratios of two radiogenic noble gases 4He and 40Ar are determined, as they are not much affected by secondary processes. As these molecules are generated from the mineral network, their ratio in a gas phase depends on the production ratio in the rock and the fractionation during their transfer from the solid to the gas phase. As Helium diffuses more easily than Argon, the ratio 4He/40Ar is higher in bacterial gas, as the generation temperature is low enough to forbid the major part of Argon to leave the solid. On the contrary, the higher generation temperatures of thermogenic gas promote a quasi neutral transfer of these two molecules, and the 4He/40Ar ratio measured in these gases is always close to the average crustal production ratio. Several well documented natural examples validate this new way of characterizing gas generation.