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Natural hydrogen occurrence in Bougou-1 well (Mali): geological accumulation or ongoing generation, insights from stable isotopes and noble gas tracing

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BOUGOU-1 well in Mali, exploited by Petroma, is the first well in the world producing almost pure natural hydrogen. This well, 112m depth, initially drilled in 1987 for water production, was then used for hydrogen production in 2011. An intense drilling campaign surrounding BOUGOU-1 well occurred in 2018. This study reports the gas signature before any drilling activity could have altered the fluid system.

Analyses of production gas aim to better characterize H_2 system in terms of generation, transport, and potential accumulation.

To do so, a production gas sampling campaign of BOUGOU-1 well occurred on the 25th and 26th of October 2017. Main phase composition and stable isotopes of carbon and hydrogen on H_2, CH_4, C_2H_6 and C_3H_8 were measured in CSTJF facilities (Pau, France). Noble gas ($^{3\text{-}4}$He, $^{20\text{-}21\text{-}22}$Ne, ^{36,38,40}Ar, ^{84}Kr and ^{132}Xe) were analyzed in SUERC (Glasgow). Gas compositions and isotopic signatures were compared to measurements previously done by [1] in 2015.

Results show a comparable composition with 97mol% of H_2, 1.7mol% of N_2 and 1.3mol% of light hydrocarbons. From an isotopic point of view, $dD(H_2)$ is extremely light and a cross calibration with other stable isotopes laboratories was done to confirm the value accuracy. Isotopic signature of light hydrocarbons obtained by [1] sampled in 2015 is intermediate between the mature thermogenic fluid from Taoudenni basin and results from this study. Noble gas pattern shows diffusive process with a significant enrichment of the light elements and more intense compared to previous results. $N_2/^{36}$Ar is fully compatible with ASW signature [2].

As main conclusions, this study suggests H_2 generation is ongoing (whatever the mechanism implied) and is followed by a rapid bubble percolation through a meteoric-sourced water column at shallow depth. Hydrocarbons were initially thermogenic and then progressively diluted in H_2 with a small fraction abiotic methane [3]. Occurrence of abiotic methane is potentially linked to a chemical reaction between H_2 and CO_2.

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