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Abiotic gas occurrences in the Rio das Velhas Greenstone Belt, SE Brazil

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Ongoing studies have demonstrated the importance of the Precambrian crust as potentially isolated reservoirs of fluids over geological time, which are associated with abiotic production of methane and hydrogen gas via water-rock reactions. Here we present the first data obtained for water and gas sampled from two underground mines, Cuiabá and Córrego do Sítio (CdS), located in the Quadrilátero Ferrífero region, Minas Gerais, Brazil. The rocks are part of the Nova Lima Group of the Rio das Velhas Greenstone Belt (RVGB; age ~2.8 Ga). The Cuiabá mine lies in a metavolcanosedimentary sequence at the base of the RVGB, the Córrego do Sítio mine is hosted in an overlying metaturbiditic sequence.

We observed the presence, in both locations, of gas phases rich in methane and higher hydrocarbons, He, and N_2. While the composition of the gas at CdS is homogeneous, sampling in Cuiabá showed variable composition. The signatures are consistent with an abiotic origin, with evidence for a contribution from a biotic component. Unlike fracture fluids studied at other Precambrian Shield sites[1,2,3,4], the waters are not highly saline in either mine, and likely represent fracture fluids impacted by either the local aquifer and/or by percolation of mine service waters.

Noble gases in the gas samples are highly radiogenic. $^{3}He/^{4}He$ values of <0.01 R_A rule out the presence of a mantle component. Radiogenic isotope (^{4}He, $^{21}Ne^{*}$, and $^{40}Ar^{*}$) ratios can be compared to the theoretical crustal production values. Neon isotopes indicate the presence of an elevated $^{21}Ne/^{22}Ne$ component that has been associated with Precambrian Cratonic gases from deep mines in Canada and South Africa[3,4].

These rocks differ from previously studied Precambrian Shield environments because they have been substantially affected by several deformational events, providing the opportunity for understanding how tectonic deformation may impact fluid production, evolution, and storage in the crust.

References: [1]Sherwood Lollar et al. (2021) GCA 294:295-314. [2]Warr et al. (2021) GCA 294:315-334. [3]Lippmann-Pipke et al. (2011) Chem Geo 283:287-296. [4]Holland et al. (2013) Nature 497:357-360.