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Noble gas concentrations in a Brazilian semiarid aquifer: new data

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Hydrogeochemical multi-tracer analysis of groundwater has contributed significantly to understanding past hydroclimatic conditions in semiarid regions, thereby providing insights into future trends in groundwater availability.

Dissolved noble gas concentrations in groundwater are well-established paleoclimate proxies.

A previous study in Piauí Province, northern Brazil [1], initially estimated a 5 °C temperature difference between the Holocene and the Last Glacial Maximum (LGM); this estimate was later updated to 7 °C in a recent reanalysis [2]. During this period, the prevailing hypothesis suggests a wetter climate and the presence of a moisture corridor extending from the Amazon Basin toward northeastern Brazil, as recorded in isotopic signatures [3][4].

Here, we present new data from the porous Açu Aquifer in the Potiguar Sedimentary Basin, located in a semiarid climate along the equatorial margin of South America. Long groundwater flow paths, controlled by the geological and structural framework of the basin, were preferentially identified along a SW–NE direction. Radiocarbon (^{14}C) was used as a qualitative age tracer, and the results showed consistency with this flow configuration, with more enriched pMC values observed in recharge areas. Elevated $^{3}He/^{4}He$ ratios indicate mantle contributions in the deep and confined portions of the aquifer.

Updated noble gas concentrations revealed the presence of two distinct groups: the first characterized by high excess air and low noble gas temperatures, and the second by low excess air and high noble gas temperatures. This pattern is consistent with groundwater systems in semiarid regions.

Furthermore, noble gas temperatures suggest paleotemperatures up to 9°C lower than the modern mean annual temperature. High excess air values in older, deeper groundwater indicate greater water table fluctuations under wetter climatic conditions.

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