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A new ^{14}C groundwater dating approach, applied to an aquifer in North-West India

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^{14}C is the only dating tracer to estimate groundwater ages ranging from several hundred years up to 40 ka. However, radiocarbon dating of dissolved inorganic carbon in groundwater implies some major complications due to open or closed system equilibration with soil CO_2 and related isotope fractionation, as well as calcite dissolution during infiltration or later. Numerous models exist to estimate the resulting so-called hardwater effect using different physical perspectives. Some models constrain open or closed system situations, while others neglect crucial effects such as carbonate exchange with the aquifer matrix. These influences, when considered incorrectly, may lead to misinterpretation of older radiocarbon ages by several thousand years.
Here we introduce a new correction approach for the hardwater effect in groundwater, by transferring a model that has been developed for the study of cave dripwater [1]. It is applied along with several established models to account for the hardwater effect to a multitracer palaeoclimate study of a groundwater aquifer in North-West India. The new model simulates a mixed open and closed system equilibration based on hydrogeochemical correlations. Advantages and shortcomings of the used models are compared and discussed. Furthermore, a quantitative method to consider matrix exchange for the new as well as for traditional models is applied. Finally, the resulting ^{14}C ages are calibrated with the IntCal09 database to obtain calibrated ages also for the groundwater archive. Thus, the variable input curve of ^{14}C in the atmosphere is considered, which is not the case in most hydrologic age records, misinterpreting old radiocarbon ages by up to 3000 years.
Applying this approach to the example from India, a groundwater age scale is established. Its age reaches from recent to late Pleistocene times, enabling palaeoclimatic reconstruction of the information contained in the archive.

[1] Fohlmeister, J., et al. (2011), Modelling Carbon Isotopes of Carbonates in Cave Drip Water, *Geochimica et Cosmochimica Acta, 75(18)*, 5219 – 5228, doi:10.1016/j.gca.2011.06.023.