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Inter-comparison exercises on dissolved gases for groundwater dating (GDAT 2012) : analytical uncertainties, apparent ages and other derived parameters.

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An inter-laboratory comparison exercise dedicated to environmental tracers used for groundwater dating was organized in 2012 in France. The goal was to compare sampling and analytical protocols through results obtained by the community of groundwater dating laboratories. Sampling and analytical protocols were compared through three different exercises on various supports : (1) on groundwater from a homogeneous aquifer, (2) on groundwater from a fractured heterogeneous aquifer and (3) on an air standard. The two tests allowed 31 Laboratories from 14 countries to compare their protocols for both sampling and analyses. It allows discussing the uncertainties related to sampling protocols issuing from each laboratory methods.

The results show a good agreement between laboratories on the aquifers and the air standard. The dispersion of SF6 results in air standard is low (rsd 2%) compared to CFCs (rsd 3 to 7%), even if its concentration is two orders of magnitude lower. Results obtained in recent groundwater (recharge after 1980) show that the uncertainty on groundwater dating with SF6 is between 3 and 4 years. This large uncertainty is mainly due to sampling and/or analytical problems. For CFCs, uncertainties obtained over all the laboratories are less than 2 years for groundwater with recharge between 1965 and 1996.

The goal of the inter-laboratory comparison exercise was also to quantify the analytical uncertainty of the 3H and noble gas measurements and to assess whether they meet the requirements for 3H/3He dating and noble gas paleotemperature reconstruction. The reproducibility of the tritium measurements was 13.5%. The reproducibility of the 3He/4He ratio and 4He, Ne, Ar, Kr and Xe concentrations was 1.4%, 1.8%, 1.5%, 2.2%, 2.9%, and 2.4%.

The propagated uncertainty of the tritium and noble gas measurements meets the desired precision for typical 3H/3He dating applications. However, the measurement uncertainties for the noble gas concentrations are insufficient to distinguish the appropriate excess air model if the measured helium concentration is not included. While the analytical uncertainty introduces an unavoidable source of uncertainty in the 3H/3He apparent age estimate, other sources of uncertainty are often much greater and less well defined than the analytical uncertainty.