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Reliability of current CFC data for age dating of water

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Age dating of water based on dissolved CFCs and Krypton-85 has been applied extensively for many years. CFCs were adopted as an approach for water dating due to the availability of global input functions and because of a straightforward methodology. In the last decade, due to international treaties, CFCs production and atmospheric concentrations of some trace gases (e.g. Krypton-85) are decreasing. The impact of reduced atmospheric trace gas concentrations on precision and uncertainty of age dating are investigated. Methods for the quantification of uncertainties and approaches for data analysis are presented. The uncertainty analysis is based on the application of different residence time distributions (piston-flow, exponential, advection-dispersion models and combined thereof) for trace gas concentrations and trace gas ratios. Different ways forward are presented to solve the problem of age ambiguity and increased uncertainty: the use of trace gas ratios is demonstrated and their potential of separating pre- and post-peak samples; the combined use of CFCs with additional tracers such as SF6 and 3H are discussed. While both SF6 and tritium have technical limitations themselves, such as multi-finality and observed deviations from the input function, benefit can be gained by combining them with other tracers or combined data analysis approaches. The quantification of uncertainties and of the adaptation of stringent data analysis provides a basis for the use and critical evaluation of CFCs as water age dating methods in the future.