



## **Hydrochemical Impacts of Past Glacial Cycles**

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It is well established that groundwaters contain hydrochemical 'signatures' of the hydrological conditions at the time of recharge. The stable isotopic composition of water and the concentrations of dissolved atmospheric gases both reflect the temperature of the recharge environment. Combined with isotopic residence times, e.g. from carbon-14, studies have focused on the correlation of these climate signals with independent palaeoclimate evidence. A further interpretative step is involved in attempting to deduce how the groundwater system might have responded to changing climate, specifically to glaciation. This involves testing hydrogeological models by simulation of hydrochemical conditions, e.g. salinity or stable isotopic distribution, and comparison with observed data.

This paper will summarise the background to these hydrochemical measurements and their interpretation. Uncertainties arise from alternative interpretations of variability and also from the small number of calibration in natural systems. Hydrochemical signatures corresponding to cold climate are usually attributed to late Pleistocene climate deterioration at the last glaciation. However the groundwater 'legacy' of earlier glacial cycles is unclear.

The Pleistocene history of recharge to English groundwater systems has been influenced by cycles of glacial, periglacial, boreal and temperate conditions (Nirex, 1995). Periglacial and boreal conditions probably dominated over time, and are therefore expected to have been the dominant recharge environment. Stable isotopic and dissolved gas compositions of groundwater in a sandstone aquifer have been attributed to climate changes associated with the late Pleistocene glaciation (Bath et al., 1979). A more speculative additional interpretation has related chloride and chlorine-36 isotope variations to changes in hydrometeorological conditions (Andrews et al, 1994). Glacial climate signals appear to varying extents in other English aquifers.

Site characterisation investigations at Sellafield, in northern England, have included hydrochemical measurements. These are making an important contribution to establishing a conceptual model for the groundwater system, and to understanding how the system has been influenced by glacial processes. Deeper groundwaters in the potential repository zone show palaeoclimate signals in stable isotope and dissolved gas compositions with respect to those in shallow groundwaters (Bath et al, 1995). Broadly, this reflects contrasting transmissivities and expected differences in gross residence times. Other hydrochemical data are evidence of mixing between groundwater masses from different sources which may extend back beyond the last glacial cycle. Mixing effects have to be considered in comparing data with the palaeoclimate record and with data from aquifers. Uncertainties in the recharge response to climate and in the response of the pre-existing groundwater system to glacial cycles are tackled by integrating a wide range of hydrochemical and modelling methods.

## References

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