Excess air formation below spreading ponds

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Managed aquifer recharge (MAR) is a strategy aimed at augmenting water supplies. This practice consists of recharging imported, surplus or storm runoff, and reclaimed (recycled) wastewater into aquifers for storage and later extraction. It can take place at both injection wells (i.e., ASR) and spreading ponds (engineered basins). Generally, the recharge charge water is of lower quality than the native groundwater and therefore it is important to be able to trace its movement through the subsurface. This is needed to establish hydraulic connections and travel times in order to document biogeochemical reactions, which general improve the water quality. Measurements of dissolved noble gases have shown that excess air is typically significantly higher in recharge water than in the local groundwater. As part of a deliberate gas tracer experiment, noble gas concentrations were examined at an artificial recharge site in Ventura County, CA. Surface water samples collected within a spreading basin were in equilibrium with the atmosphere ad show little excess air. Noble gases were supersaturated in groundwater samples collected directly below the spreading pond due to the dissolution of air trapped below a rising water table. The amount of excess air ranged between 9 and 17 cm^3/L and averaged 13.7 cm^3/L more than twice the typical value in groundwater away from MAR operations. The enrichment in noble gas concentrations indicates that excess air is a valuable tracer of surface water artificially recharged water from spreading ponds. Furthermore, excess air formation should aid in the recharge processes by removing bubbles from the aquifer and thus raising its hydraulic conductivity. This could lead to near saturated conditions below ponds that are used continuously for long periods of time.

An isotopically distinct hydrogen reservoir in the South Pacific mantle

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The upper mantle (DMM) is classically assumed to be homogeneous in terms of water characteristics, with $\delta D=-80\pm10‰$ and $H_2O/Ce=175\pm25$. Yet most data originate from the northern Atlantic and Pacific basins, leaving the possibility that several distinct mantle domains may exist. In this respect, the Pacific Atlantic ridge (PAR) is a key area to better address the isotopic composition of hydrogen in the mantle and, as a moderately fast ridge, to shed light on the global water cycle. Moreover, the South Pacific mantle has been shown to be slightly different from the North Pacific mantle for Sr, Nd and Pb isotopic compositions [1]. 40 N-MORB (La/Sm_N from 0.44 to 0.94, average 0.67) from the PAR were analysed in this study. Water concentrations, obtained by manometry, range from 840 to 7800ppm (average 2850ppm for the northern area, 2400ppm for the southern area, and H_2O/Ce ratios range from 113 to 255, with an average of 180±25 in both areas. δD, measured by spectrometry, range from -76.6 to -48.9‰ (with averages of -58.3 and -63.3‰). While H_2O concentration and abundance relative to Ce are normal (typical values for N-MORB are 3000±2000 and 200±50 respectively), δD values are enriched compared to typical values, which range from -90 to -65‰. For all of our samples, degassing has been negligible and partial melting does not influence δD or H_2O/Ce. Part of the variability can be explained by contamination by hydrothermal fluids, especially for the samples having undergone more crystal fractionation (shown by low MgO contents). However the dataset is not compatible with a mixing model between a depleted mantle end-member with $\delta D\approx-80‰$ and hydrothermal fluids. The values measured are mainly inherited from the local upper mantle, which is enriched in deuterium ($\delta D\approx60‰$) as compared to other basins. This study shows the existence of distinct mantelic domains for H isotopes, but with concentrations similar to those seen along other ridges. In terms of chemical geodynamics, it raises questions on the isotopic budget of subducted water and about the convection cells under the Pacific Ocean.

[1] Vlastélic *et al.* (1999) *Nature* **399**, 345–350.