Young apparent ages (<1000 years) of hyperalkaline groundwater in the peridotite section of the Samail Ophiolite, Oman

AMELIA N PAUKERT VANKEUREN1, MARTIN STUTE2, JUERG MATTER3, FLORIAN MEIENBURG4, WERNER AESCHBACH4, MARKUS OBERTHALER4 AND GRACE BROWN5

1California State University, Sacramento
2Lamont-Doherty Earth Observatory
3University of Southampton
4Heidelberg University
5Barnard College - Columbia University

Presenting Author: vankeuren@csus.edu

The rate of peridotite (mantle rock) alteration (serpentinization, oxidation, and carbonation) by meteoric water in a continental environment remains unknown. Lab experiments suggest low-temperature alteration should be minimal, but field evidence in the form of hyperalkaline (pH >11) water with H2 gas in ophiolites around the world suggests it may occur at a significant rate. Groundwater ages in peridotite provide a possible constraint on alteration rates by serving as a maximum timeframe for this water-rock interaction.

Groundwater in the mantle section of the Samail Ophiolite, Oman has been evaluated using multiple age tracers: 3H, 39Ar, and 14C. Type I shallow Mg-HCO3 groundwater samples have 39Ar apparent ages ranging from modern to 210 years, while uncorrected 14C ages range from 240 to 14,000 years. d13C in these samples is -15 to -9 ‰ and 3H is 1 to 2 TU, though one sample has 0.4 TU. This water may be considered the starting point for continued alteration in a system closed off from the atmosphere. The resulting Type II hyperalkaline (pH >10) Ca-OH waters have 39Ar apparent ages ranging from 90 to 720 years and uncorrected 14C ages from 820 to 12,000 years. These samples are depleted in d13C with values of -22 to -17 ‰. 3H is less than 0.7 TU. Tracer distributions suggest that two or more component mixing is likely an important process in this fracture flow dominated system.

The apparent disparity between 39Ar and uncorrected 14C ages may be attributed to changes in 14C along the groundwater flow path. NETPATH simulations demonstrate that precipitation of carbonate minerals and associated fractionation can account for the removal of dissolved carbon and depletion of d13C along the path from Type I to Type II groundwater, but that exchange with old carbonate veins within the ophiolite is necessary to attain 14C ages so much older than the 39Ar ages.

The relatively young (<1000 years) 39Ar ages of Type II groundwater samples suggest that the geochemical processes responsible for producing hyperalkaline Ca-OH water are either faster than previously thought, or mixing and/or other chemical reactions are at play.