Carbon sources and signals through time in an alpine groundwater basin, Sagehen California

J. F. CLARK[1] AND E. D. BLUMHAGEN[1]

[1] Dept. of Earth Science, Univeristy of California, Santa Barbara, CA 93106 USA ; jfclark@geog.ucsb.edu

Springs are natural windows into groundwater systems, which can be a good archive of signals inherited from soil processes and chemical weathering [1,2]. In many catchments, springs provide the only means to sample groundwater. Nine springs in Sagehen Basin were sampled to examine the chemical weathering and soil contribution of dissolved inorganic carbon (DIC) to the shallow groundwater.

Geochemical ages of spring waters were determined using chlorofluorocarbons (CFCs) and $T/^3He$ and were between 0 and 45 yrs. While the apparent ages correlate, the $T/^3He$ ages are systematically younger than the CFC ages. The differences between the tracer ages are caused most likely by gas loss near the springs. Rademacher et al. [2] demonstrated that excellent agreement exists between the apparent ages and the spring chemistry. Springs with similar apparent ages had very similar chemistry despite the fact that they could be found in different areas of the watershed. With increasing apparent age concentrations of rock-derived cations (Ca^{2+}, Na^+ and Mg^{2+}), conductivity, temperature, and pH increase, documenting the chemical evolution of this groundwater system.

In contrast with these evolving chemical parameters, $\delta^{13}C$ and DIC show no clear correlation with apparent age. However, $\delta^{13}C$ displays a strong linear relationship with 1/DIC (R^2 = 0.89), so that decreasing 1/DIC values (increasing DIC) correspond with lighter $\delta^{13}C$ values. This is consistent with results from a soil CO_2 production/diffusion model developed by Cerling et al. [3], which predicts a strong dependence of the isotopic composition of soil CO_2 on soil respiration rates. Spring radiocarbon content ranges between 85 and 110 pmc and correlates very well with age, whereby the youngest groundwater has the highest radiocarbon values. Model results indicate that the spring radiocarbon trend can be best described with solely a soil organic source composed of 75% fast- (15 years) and 25% slow- (4000 years), cycling components. These results are consistent with previous soil carbon models.

References

[1] Garrels, R.M. and Mackenzie F.T. (1967) In Gould, R.F., ed., *Equilibrium Concepts in Natural Water Systems*, American Chemical Society Publication, 222-242.

[2] Rademacher, L.K., Clark, J.F. Hudson, G.B. Erman, D.C. and Erman N.A. (2001) *Chem. Geol.* **179**, 37-51.

[3] Cerling T.E., Solomon D.K., Quade J. and Bowman J.R., (1991) *GCA* **55**, 3403-3405.