Using isotopes and other chemical indicators to track the impacts on groundwater quality from the land application of treated municipal wastewater in a mantled karst aquifer

B.G. KATZ[1]*, J.H. DAVIS[2] AND J. SHAKAR[3]

[1]U.S. Geological Survey, 2639 North Monroe St., Suite A200, Tallahassee, FL 32303, USA (*correspondence: bkatz@usgs.gov)
[2]U.S. Geological Survey, 2639 North Monroe St., Suite A200, Tallahassee, FL 32303, USA (hdavis@usgs.gov)
[3]City of Tallahassee Undergound Utility, Tallahassee, FL 32301, USA (jamie.shakar@talgov.com)

Isotopic and other chemical indicators were used to assess groundwater-quality impacts from the land application of treated municipal wastewater in the karstic Wakulla Springs basin in northern Florida. Nitrate-N concentrations have increased during the past 30 years from about 0.2 to 1.1 mg/L in Wakulla Springs, a regional discharge point for groundwater [mean flow about 11.3 m^3/s from the Upper Floridan aquifer (UFA). One source of nitrate to the UFA is the approximately 64 million liters per day of treated municipal wastewater applied at a 774-ha sprayfield farming operation. Chemical indicators were analyzed in water samples from the sprayfield effluent reservoir, from two wells upgradient from the sprayfield, and from 21 downgradient wells and springs. Concentrations of nitrate-N, boron, chloride, and stable isotopic signatures ($\delta^{18}O$ and $\delta\ ^{2}H$) were elevated in water samples from the sprayfield effluent reservoir and in downgradient monitoring wells near the sprayfield boundary. Mixing of sprayfield effluent water with native groundwater was indicated by a systematic decrease in concentrations of these constituents with distance downgradient from the sprayfield, and by a nearly 10-fold dilution at Wakulla Springs, about 15 km downgradient from the sprayfield. Groundwater with elevated chloride and boron concentrations in wells downgradient from the sprayfield and in Wakulla Springs had similar nitrate isotopic signatures ($\delta\ ^{15}N$ and $\delta^{18}O$ of nitrate), whereas the nitrate isotopic composition of water from other sites was consistent with denitrification or nitrate from inorganic fertilizers. In response to these findings and other studies, the City of Tallahassee is currently planning to upgrade its wastewater treatment plants to reduce nitrogen levels by 75%.

A fossil oceanic core complex in the Troodos ophiolite, Cyprus: Field and isotope evidence

Y. KATZIR[1]*, P. NURIEL[1], M. ABELSON[2], J.W. VALLEY[3], A. MATTHEWS[4], M.J. SPICUZZA[3] AND A. AYALON[2]

[1]Dept. Geological and Environmental Sciences, Ben Gurion University of the Negev, Be'er Sheva 84105, Israel (* correspondence: ykatzir@bgu.ac.il)
[2]Geological Survey of Israel, 30 Malkhe Israel St., Jerusalem 95501, Israel
[3]Dept. Geology and Geophysics, University of Wisconsin, 1215 W. Dayton St. Madison WI 53706, U.S.A
[4]Institute of Earth Sciences, Hebrew University of Jerusalem, Jerusalem 91904, Israel

Heavily serpentinized ultramafic rocks occur adjacent to a major axis-parallel fault, the Amiandos Fault (AF), at a fossil ridge-transform intersection (RTI) in the Troodos ophiolite. So far, serpentinization and faulting were not considered to be related to the Cretaceous ocean spreading history of the Troodos ophiolite, but instead were interpreted as associated with late, emplacement-related tectonics and diapirism. Here, petrographic and stable isotope tracers (δD, $\delta^{18}O$) of water-rock interaction are examined in three profiles across the AF to determine the spatial distribution, temperature, and the type of water involved in serpentinization in the Troodos RTI. Two distinct serpentinization events were identified: 1) Low-$\delta^{18}O$ serpentine (4.6 to 6.6‰) that occurs close to the AF probably formed by fault-localized hydrothermal (100-200°C) alteration initiated by deep infiltration of seawater during seafloor spreading. 2) This was overprinted by pervasive high-$\delta^{18}O$ (10.6-12.6‰), low-δD (–70 to –86‰) low-temperature hydration and chrysotile veining that may have occurred during ophiolite emplacement. Post-magmatic decrease of $\delta^{18}O$(plagioclase) in non-amphibolitized gabbros in the footwall of the AF suggests high-temperature, off-axis gabbro-water interaction and focused fluid flow extending to the lower crust through the AF zone. The Amiandos Fault was thus active during seafloor spreading; operating as a detachment fault in a core complex structure, progressively exhuming deeper levels of the oceanic lithosphere. This scenario is supported by additional observations such as proximity to RTI and spatial association with highly-rotated blocks in the sheeted dikes.