Helium Isotope Variations along Southern California Fault Zones

J. LUPTON[1*], M. LILLEY[2], J. BOLES[3] AND L. EVANS[1]

[1]NOAA/PMEL, Newport, OR, USA 97365 (*john.e.lupton@noaa.gov)
[2]Univ. Washington, Seattle, WA, USA 98195
[3]Univ. Califronia, Santa Barbara, CA, USA, 93106

Samples from hot springs, water wells, and petroleum wells along southern California fault zones show a large variation in helium isotope ratios, presumably due to the interplay of mantle and crustal components. With a few exceptions, samples from wells along the San Jacinto, Elsinore, and San Andreas Faults have crustal $^3He/^4He$ ratios in the range of 0.1 – 1.0 Ra. One of the exceptions is the southern end of the San Andreas Fault, where some of the thermal wells in the Salton Tough have $^3He/^4He$ up to 6.5 Ra, including the Cerro Prieto geothermal field in Mexico with 6.3 Ra helium. Recently we measured ^3He, ^4He, and Ne in 18 samples from producing oil wells in the Los Angeles Basin [1]. Wells on the periphery of the basin and on the Whittier Fault had crustal ratios of 0.1 – 0.7 Ra. However, the wells along the Newport-Inglewood Fault Zone (NIFZ) had much higher values ranging from 1.1 up to 5.3 Ra, clearly indicating the presence of mantle helium. $CO_2/^3He$ and $\delta^{13}C$ of the CO_2 in the NIFZ wells are inversely correlated with the helium isotope ratio, indicating an isotopically light CO_2 fraction of mantle origin. The presence of mantle helium and an associated mantle CO_2 component along the NIFZ suggests that the fault represents a major conduit to the lower crust and upper mantle. This is surprising, since the NIFZ lacks significant geothermal gradients, is not extensional in nature, and was thought to be truncated by a major decollement beneath the basin.

[1] Boles et al. (2015) *G-cubed*, doi:10.1002/2015GC005951.