Helium and carbon characteristics in forearc fluids of Central America

*Peter H Barry[1], J. M. de Moor[2], M. Nakagawa[3], D. Giovannelli[4], M. Schrenk[5], A. M. Selzer[1], K. G. Lloyd[6]

1. Woods Hole Oceanographic Institution, 2. Observatorio Volcanológico y Sismológico de Costa Rica (OVSICORI), Universidad Nacional, Costa Rica, 3. Earth-Life Science Institute, Tokyo Institute for Technology, Tokyo, Japan, 4. Department of Biology, University of Naples “Federico II”, Naples, Italy, 5. Department of Earth and Environmental Sciences, Michigan State University, MI, USA, 6. Department of Microbiology, University of Tennessee, TN, USA

Volatile movement between Earth’s surface reservoirs (crust, sediments, atmosphere and oceans) and the deep mantle occurs at subduction zones. Typically, outputs are characterized as emissions from volcanic centers, however more recently it has become apparent that potentially significant outputs may be occurring in the forearc and backarc regions. Carbon fluxes associated with arc and backarc localities are relatively well-constrained for the Central America Volcanic Arc (CAVA)[1,2,3], however, until recently[4], the forearc flux via cold seeps, hot springs and groundwaters were poorly constrained.

The border between Costa Rica and Panama represents the transition between the orthogonal subduction of the Cocos Plate and the oblique subduction of the Nazca Plate relative to the Caribbean Plate. We present unpublished He and CO_2 isotope and relative abundance data for the from forearc fluids of southern Costa Rica and western Panama in (n=43) water and (n=22) gas samples. These data allow us to determine the extent of tectonic, chemical and biological controls on forearc carbon outgassing. Helium isotope ($^3He/^4He$) values range from 0.3 to 8.8 R_A (where air = $1R_A$). The upper range of He isotope values measured is consistent with to - slightly above - published He isotope results for CAVA volcanoes. In Panama, helium isotope values are remarkably high (approaching plume-like values), in fluids from non-active volcanic areas, suggesting that subduction of the Galapagos hotspot track may be influencing geochemical signatures in modern fluids. Carbon isotopes of CO_2 ($\delta^{13}C$) vary from −29.7‰ to +6.7‰ vs. PDVB, suggesting a variety of fractionation processes are at work in this complex region. These data are modelled to show that CO_2 loss due to calcite precipitation may be an important process, similarly to what was recently shown in Costa Rica’s Nicoya Peninsula[4]. $CO_2/^3He$ values of the seeps are also variable and fall between 10^3 and 10^{12}, with the low values being consistent with a significant sink due to calcite precipitation. In summary, we show that 1) there is a pervasive (deep) mantle component in all forearc samples, and 2) extensive CO_2 fractionation is occurring in the low temperature forearc region across southern Costa Rica and Panama.

[1] Shaw et al., 2003.

[2] De Leeuw et al., 2007.

[3] de Moor et al., 2017.

[4] Barry et al., 2019.

[5] Sano and Marty, 1995.

Keywords: Carbon, Helium, Central America

