Development of a Field-Portable Helium Isotope Detector for Survey and Long-term Monitoring

GARY M. MCMURTRY[1], DAVID R. HILTON[2], AND JAMES E. BLESSING[3]

[1]SOEST, University of Hawaii, Honolulu, Hawaii 96822 USA, mcmurtry@hawaii.edu

[2]Scripps Institution of Oceanography, Univ. of California, San Diego, California 92037 USA, drhilton@ucsd.edu

[3]MKS Instruments, Inc., San Jose, California 95134 USA, James_Blessing@mksinst.com

The $^{3}He/^{4}He$ ratio in volcanic emissions and groundwaters is often co-seismic with, and sometimes precursory to, volcanic unrest and earthquake activity [1]. Because of the extremely low abundance of primordial ^{3}He to radiogenic ^{4}He, and difficulties in resolving ^{3}He in the presence of hydrogen isobars such as HD, the measurement of this ratio has so far been confined to the laboratory. A field-portable He isotope instrument to monitor critical locations must overcome these analytical hurtles and be small, compact, lightweight and low in power consumption.

We describe a new instrument consisting of two compact mass spectrometers, an MKS ion trap and a frequency-modified quadrupole mass spectrometer (MS), pumped using NEG, noble diode ion and turbo-rough pumping. Helium separation and inlet into the vacuum system is via high-purity quartz glass heated under high vacuum. The ion trap monitors vacuum quality and the quadrupole MS determines hydrogen and helium isotopes. Two methods of isobaric separation are utilized: a statistical mass-2 vs. mass-3 regression intercept, and an adjusted (threshold) ionization mass spectrometry (AIMS) technique. Comparison of these two independent methods for 44 data pairs yields a significant correlation (r = 0.89). Results on laboratory air are within a factor of 2 of the R_a ratio of 1.40×10^{-6}.

[1] Sano et al. (2015) *Scientific Reports*, **5**, doi:10.1038/srep13069.