A NEW SYRINGE PUMP APPARATUS FOR THE RETRIEVAL AND TEMPORAL ANALYSIS OF HELIUM (SPARTAH) IN GROUNDWATERS AND GEOTHERMAL FLUIDS.  P. H. Barry¹, D. R. Hilton¹, K. M. Brown¹, M. D. Tryon¹ and J. T. Kulongoski², ¹Geosciences Research Division, Scripps Institution of Oceanography, UCSD, La Jolla, California 92093-0244, USA. ²U.S. Geological Survey, California Water Science Center, 4165 Spruance Road, Suite 200, San Diego, CA 92101, USA. E-mail addresses: pbarry@ucsd.edu (P. H. Barry), drhilton@ucsd.edu (D. R. Hilton), kmbrown@ucsd.edu (K. M. Brown), mtryon@ucsd.edu (M. D. Tryon), kulongos@usgs.gov (J. T. Kulongoski).

Numerous studies of the helium [He] characteristics of crustal fluids (groundwaters and geothermal fluids) have focused on seismically active regions. As He is chemically inert, variations in its concentration or isotopic composition can be related to physical changes or perturbations occurring within the crust. Studies at Kobe, Japan [1], the Italian Apennines [2], and the western Eger rift, Bohemia [3] are all examples where monitoring of helium isotope (³He/⁴He) trends in groundwaters and/or geothermal fluids has identified changes in fluid provenance, mixing and/or flow histories related to specific seismic events. In these studies, the general aim of the monitoring program (i.e., repeated sampling at a given location over an extended period of time) is to reveal changes in a geochemical parameter, such as He, which can either forewarn the impending occurrence of a seismic event or result from, and hence provide information and insight on, a past event.

The relationship between a transient event, such as an earthquake, and a time-monitored geochemical parameter, such as He isotopes or concentration, is undoubtedly complex and likely site-specific. It should be no surprise, therefore, that monitoring programs in some seismically-active areas (e.g., Long Valley Caldera; [4]; the North Anatolian Fault, Turkey, [5]) showed little or no changes in ³He/⁴He values (R), even over extended periods. Clearly, the magnitude of particular events and proximity to monitoring sites are key factors in generating geochemical responses: however, the frequency of monitoring used to produce a time-series is just as critical. Indeed, in the above-cited Apennines case, the duration of the seismically-induced ³He/⁴He anomaly lasted ~3 months – an anomaly thus identified only because of the weekly sampling regimen. At Long Valley and in Turkey, sampling frequency was every 3-4 months, so an anomaly of the duration seen in the Apennines would have been caught only fortuitously.

Here we present a new sampling device – SPARTAH (Syringe Pump Apparatus for the Retrieval and Temporal Analysis of Helium) - which can produce a quasi-continuous record in groundwaters and geothermal fluids. SPARTAH (Fig. 1) is comprised of a commercially available syringe pump connected to coils of Cu-tubing, which interfaces the syringe and the groundwater or geothermal well-head. In a single deployment, samples are captured and stored in Cu-tubing - for periods of 6 months or more. Thus, all geochemical anomalies - irrespective of duration - can be captured, and later matched against external transients.

Figure 1. Upper: The Syringe Pump apparatus with stainless steel syringe along with sectioned Cu-tubing of 5-inches length. Note: sectioned Cu-coil with 2 refrigeration clamps and ultra-torr fitting attached to one end. Lower: Deployment of SPARTAH at the California geothermal well-head. The Pelican case houses the syringe pump apparatus and a single Cu-coil. One end of the coil is attached to the syringe, the other leads through a hole in the case to the well-head.

Through test deployments at geothermal wells in Iceland and California, we show that well fluids are
drawn smoothly, accurately and continuously into the Cu-tubing. Sampling frequency is determined in the laboratory, following instrument retrieval and prior to analysis. The tubing is sectioned to reveal fluid helium characteristics at times and for durations of interest (Fig. 2). This is a key advantage in that it promotes efficient targeting of specific sections of the time-series. SPARTAH has application in monitoring projects assessing the relationship between external transient events (e.g. earthquakes) and geochemical signals in aqueous fluids. We argue that SPARTAH has the potential to revolutionize the approach to time-series geochemical monitoring.

Figure 2. Helium isotope variations captured in the Cu-coils at Selfoss, Iceland (1-week deployment) and San Bernardino, California (1-month deployment). Note: helium is mainly mantle-derived in Selfoss but is predominantly crustal in origin at San Bernardino. Individual error bars are given at the 2σ level. The mean ³He/⁴He values for Selfoss (black) and San Bernardino (red) are illustrated by dashed lines. The standard deviation on the mean values is also at the 2σ level.

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