

Use of U and Th Decay-Series Disequilibrium to Characterize Geothermal Systems: An Example from the Coso Geothermal System

Bret W. Leslie, U.S. Nuclear Regulatory Commission and Douglas Hammond, University of Southern California

Uranium and thorium decay series isotopes were measured in fluids and solids in the Coso geothermal system to assess the utility and constrain the limitations of the radioisotopic approach to the investigation of rock-water interaction. Fluid radioisotope measurements indicate substantial kilometer-scale variability in chemistry. Between 1988 and 1990, radium isotope activity ratios indicate temporal variability, which is exhibited by apparent mixing relationships observed as a function of time for single wells. Activity ratios of Ra-224/Ra-226 and Ra-228/Ra-226, and the processes that contribute and remove these radionuclide to and from the fluids, constrain residence times of fluids and may help constrain fluid velocities in the geothermal system. Activity ratios of Ra-224/Ra-226 > ten were measured. In groundwater and geothermal systems ratios of Ra-224/Ra-226 > ten are limited to zones of thermal upwelling or very young (days to weeks) waters in mountainous areas. Rn-222 results indicate that radon is also an effective tracer for steam velocities within the geothermal system. Analysis of carbon dioxide and Rn-222 data indicates that the residence time of steam (time since separation from the liquid) is short (probably less than four days). Estimates of fluid velocities derived from Rn-222 and radium isotopic measurements are within an order of magnitude of velocities derived from a fluorescein tracer test. Both Rn-222 and Ra-224 activities are higher in single-phase fluids in the northwest as compared to the southeast, indicating a higher rock-surface-area/water-volume ratio in the northwest. Thus, measurements of short-lived radioisotopes and gaseous phase constituents can constrain processes and characteristics of geothermal systems that are usually difficult to constrain (e.g., surface area/volume, residence times).

The NRC staff views expressed herein are preliminary and do not constitute a final judgment or determination of the matters addressed or of the acceptability of a license application for a geologic repository at Yucca Mountain.