

Trace Element Profiles of Geothermal Field Matrices Associated with a High Background Radiation Area (HBRA) Analyzed Using Chemo metrics-Assisted XRF Spectroscopy

Abstract:

Trace elements have been widely used to study geothermal systems around the world, for the purpose of resource exploration and exploitation. Each geothermal system exhibits a unique elemental composition and thus also unique characterizing model. Kerio Valley in the mid Rift System of Kenya is a geothermal field that is associated with elevated background radiation from naturally occurring radioactive materials (NORM). Certain areas in the region have been characterized as high background radiation areas (HBRA). Such a setting provides a unique setting to understand the relations between geothermal characterizing trace elements and NORM signatures. The goal of this study was to determine as well as characterize the trace element patterns unique to the geothermal field, in Kerio Valley field matrices (rocks, soil, plants, and water) using chemo metrics-assisted Cd-109 radioisotope-excited X-Ray Fluorescence (XRF) spectroscopy, realized via analysis of the spectral results by selected multivariate chemo metric tools via Principal Components Analysis (PCA) and Partial Least Squares (PLS) using Unscramble Camo version 9.8 software. Twelve sites were sampled. Rocks served as control matrix in evaluation of thermal fluid interaction with soil at the emergence surface, while plants were used to evaluate the intake of toxic elements associated with the geothermal field. Sixteen trace elements were resolved both in rock and soil, while in water only ten could be resolved. The number of detected trace elements in plants varied from eleven to thirteen due to variation in the accumulation capacity of trace elements in different plant species. PCA results from soil and water trace elements from the Kureswa hot springs revealed unique patterns which can be regarded as a characteristic geothermal signature. From the PLS results it can be concluded that the Kerio Valley geothermal field is composed of acid-sulfate aquifers which, by inference, have elevated temperatures. Unlike pH and ambient absorbed dose rate, measured water temperature correlates strongly positively with Sr, K, Rb, Br, Ca and Cr. The highest determined concentration of toxic elements (As, Cu, Pb) in the plants was low (As: 7 ppm, Cu: 28.6 ppm, Pb:9.7 ppm). No Hg, usually associated with U-238, was detected. Background radiation in the sampled area was however low (dose rate average 0.2 μ Sv/h) showing that the sampled area is not a HBRA and earlier published radiation levels are not probably due to geothermal activity.