Delineation of groundwater zones using weighted overlay analysis of hydrochemical and multiple isotopic data, Ulaanbaatar, Mongoila

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The water demand in Ulaanbaatar (UB), the capital of Mongolia, is quickly increasing due to significant population growth. Municipal water supply in UB depends solely on groundwater withdrawn from alluvial aquifer that is developed along and near the Tuul River. To overall understand the status of groundwater in UB, we performed a hydrochemical and environmental isotopic survey. Concentrations of cations and anions, $\delta^{13}C$ of dissolved inorganic carbon, $\delta^{15}N$ and $\delta^{18}O$ of nitrate, and $\delta^{34}S$ and $\delta^{18}O$ of sulphate were analysed. Three major hydrochemical types of groundwater occur in UB: 1) Ca-HCO_3 type, 2) Ca(-Mg)-HCO_3 type, and 3) Ca(-Na)-Cl(-NO_3) type. Types 1 and 2 mainly occur in forest and grassland areas at outskirts of UB and represent the natural water chemistry without anthropogenic contamination. Type 3 occurs predominantly in urbanized areas and is characterized by increased concentrations of TDS, Cl+NO_3 (and NO_2)+SO_4 due to significant contamination. The $\delta^{15}N$ and $\delta^{18}O$ values of nitrate in type 3 groundwater indicate the main source of contamination from latrines (manure) and sewage. To delineate several groundwater zones under contamination risks, we conducted digital image processing techniques of remote sensing and GIS. Then, multi thematic maps on lithology, slope, land-use, lineament, drainage, soil and rainfall were integrated in a raster based GIS (i.e., weighted overlay analysis) to identify the weighted factors of groundwater contamination and to classify and map the groundwater zones as very poor, poor, good, and very good in relation to contamination susceptibility. The results of this study will be helpful for planning schemes for sustainable groundwater management in UB.

Raman spectroscopy and powder diffraction study of synthetic Coffinite ($USiO_4$) at high pressures

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Coffinite, $USiO_4$, can form under reducing conditions from UO_2 in contact with silica-rich waters (Langmuir's criterion) [1]. Spent nuclear fuel (SNF) consists to > 90% of UO_2, therefore the safety assessment for a final repository in deep geological formation will benefit greatly if coffinite is taken into account as a potential secondary phase. While high pressures are not of specific relevance for a final repository for SNF, its structural behaviour at high pressures is of general interest to understand the phase stabilities and to benchmark model calculations. The high pressure behaviour of coffinite has been studied before on natural and synthetic samples [2,3]. A pressure-induced irreversible phase transformation from the zircon- to the scheelite-type structure was found at about 15 GPa using an alcohol-water mixture as a pressure medium [3].

Here, synthetic coffinite was studied under high pressure conditions in the diamond anvil cell with neon as quasi-hydrostatic pressure medium up to pressures of 35 GPa. The samples are free of impurities of UO_2, as characterized by XRD and HRTEM. Powder diffraction experiments with synchrotron radiation indicate a pressure-induced phase transformation at 18-20 GPa. In contrast to the earlier high pressure study [3], this transformation is reversible on pressure release and no UO_2 is formed during the process. A detailed data analysis is currently in progress.

Raman spectra were obtained up to a pressure of 18 GPa. Further measurements at higher pressures are on-going.

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