4.62.P13

The behaviour of nickel in fractured chalk: Data from lab, field and large, undisturbed columns

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The chalk underlying much of Denmark contains pyrite with nickel in solid-solution. When the pyrite oxidises, such as when the water-table fluctuates as a result of pumping for municipal supply wells, Ni is released. Nickel in drinking water or vegetables grown on contaminated soil causes skin irritation for people who are allergic, thus forcing closure of many water supply wells. Although groundwater is aerated and sand-filtered before distribution to consumers, Denmark still has the general policy of no treatment for drinking water supply. Therefore, better information about the natural retardation capacity of aquifers is vital for water resource forecasting and predictive modelling of water quality.

One pervasive handicap in contaminant transport modelling is scaling laboratory data to field conditions. Investigations with column experiments help, but even at best, traditional columns are a disturbed representation of natural materials. Sediment may not settle as it was in nature and cohesive material with fractures, such as chalk or till, cannot be studied. However, results from experiments in large, undisturbed columns, help fill the gap between lab and field. Columns 50 cm across and 50 cm long are drilled from cohesive, undisturbed porous media and packed within a cylinder fitted to prevent channelling on edges and maintain temperature and pressure consistent with natural conditions. A conservative tracer, in our case, bromide, provides control on water flow in fractures and matrix, while Ni uptake and release are monitored under various flow conditions.

Results from field, large column and batch experimments show Ni uptake by the chalk. In lab experiments, Ni removed from solution is not all released again under desorption conditions. Uptake extent depends on flow rate and solution composition, but release is controlled by the composition of the solid. Experiments in progress at the batch and nanometer scale are investigating the minerals responsible for retention. Aside from calcite, the minerals present within the chalk, and particularly on the large and abundant fractures, are mostly clay, Fe- and Mn-oxides and hydroxides. Our specific goals are to derive retardation factors to describe nickel behaviour at field scale and define the mechanisms controlling uptake and immobilisation at the molecular level.

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Contamination and water/rock interactions in the groundwater system of Guiyang, SW China

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Residence time of groundwater is generally short in aquifers and exchange between surface and ground waters is strong in karst region, and therefore, the groundwater system, once contaminated by human activities, is difficult to recover. In order to understand water/rock interactions and contamination of groundwater system in karst environment, chemical and Sr isotopic compositions of the surface and ground waters collected in winter and summer seasons from Guiyang, the capital city of Guizhou Province, have been analyzed. The variation in water chemistry of the water samples shows a wide range. Calcium, Mg^{2+}, SO_4^{2-}, and HCO_3^- are the ions, respectively accounting for more than 80% of total cations and anions. Two chemical types of the water samples are recognized: Ca-Mg-HCO_3 and Ca-HCO_3-SO_4. Two water samples from an aquifer enriched in sulfate evaporates is characterized by Ca-SO_4 composition. Nitrate ion, a clearly anthropogenic input, can be identified to different extents in most of the groundwater. As compared with the surface water, the groundwater samples have greatly changeable Sr concentrations and isotopic compositions, and show lower Sr concentration and higher $^{87}Sr/^{86}Sr$ ratios.

In general, the ground waters from the carbonate aquifers are mainly Ca-Mg-HCO_3 type, with high Sr concentration and low Sr isotopic ratios. In contrast, the ground waters from the aquifers of clastic rocks show more Na and K, and lower Sr concentrations and high Sr isotopic ratios. The anthropogenic inputs include Cl^-, NO_3^-, SO_4^{2-}, Na^+, and K^+, as judged from the relationships between different elemental ratios and direct analyses of the chemical compositions of the sewage samples. The waters especially of summer season are of high contents of those anthropogenic inputs. The difference in chemical compositions between the surface and ground water samples is larger as compared with the waters in summer seasons, which indicates a quick exchange of surface and ground water in karstic region. Companied studies on the C, N, S, and B isotopic compositions of the surface and ground waters are under way, and will significantly contribute general discussions on geochemical cycling of natural solutes and contaminants in the ground water system.

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