longitudinal sideline chains. Due to its sorptive and rheological properties, palygorskite is widely used in different industrial fields. In particular, palygorskite clays depict a high susceptibility to ion exchange, large special surface area, considerable porosity and thermal stability. The structural formula of the iron-rich palygorskite is established as: $(\text{Si } 7.66 \text{ Al } 0.34) (\text{Al } 1.08 \text{ Fe } 0.81 \text{ Mg } 1.99 \text{ Ti } 0.05\text{--}1.07) \text{O}_2 0(\text{OH})_2(\text{OH}_2)_4$. The SEM images (Figure 1) reveal the fibers of high-iron palygorskite have the short-stick shape and the fibers can occur as the bundles of agglomerate needle-like structures. The interspaces of the structures increase the special surface area evidently. Compared to the iron-rich sample, the low-iron palygorskite fibers present as the compact stack without many interspaces and some fibers are flexural in shape. Tunnel-like rectangular microspores with the channels approximately 3.7–6.4 Å in the crystal structure should also be considered. The iron-rich palygorskite has a normally higher special surface area (180–200 m²/g) than other palygorskites (110–130 m²/g) and the pore size is distributed from micropore (<2 nm) to macropore (>100 nm), which could extend the range of the adsorbate size. After acid leaching, the special surface area will increase up to 250–300 m²/g. Previous studies proposed maximum sorption values of 37.2 mg/g for lead, 17.4 mg/g for copper, 7.11 mg/g for zinc and 5.83 mg/g for cadmium at pH 5–6. For excellent adsorption capacity of organic molecules, the clay has been applied in treatment of dye wastewater, decoloring edible oils and absorption of odorant molecules recently. The original palygorskite clays contain palygorskite associated with quartz, smectite and lesser opal, influence on the sorptive capability cannot be neglected. For example, the expansibility of the interlayer in the smectite often reinforces the sorptive capability of the clays, especially for positive ions or large molecules. The iron-rich palygorskites, which can avoid the secondary pollution, can be extensively used as support for catalyzer, support for some metals or oxide phases and selective adsorbents for heavy metal ions or organic contamination.

Key words palygorskite; pore; sorptive property

Effect of Zob-Ahan effluent water on ground water quality

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Even though, application of industrial effluent water may alleviate the irrigation water shortage in dry regions such as Iran, but uncontrolled discharge into environment and agricultural land may cause unirreversible harmful damage to environments. Therefore, application of industrial effluent water should consider the environmental consequences such as soil, ground water and food contamination. In this study the effect application of Zob-Ahan effluent water for irrigation water and seepage from evaporation ponds on the chemical composition of surrounding well-water were seasonally investigated from April to March in 2003. The water from the selected well was sampled and analyzed for pH, EC, nitrate, hardness, TSS, TDS, and cations including Na⁺, Ca²⁺, Mg²⁺, anions including SO₄²⁻, CO₃²⁻, HCO₃⁻, Cl⁻, and heavy metals including Pb, Cd, Cu, Fe, Cr, Mn, Co, and Zn. The results were compared with standard levels for ground water resources, irrigation water, and direct human consumption. The result shows that the ground water in the vicinity of effluent water application fields and evaporation ponds is contaminated and the concentrations of NO₃⁻, Cl⁻ and Fe are higher than standard permissible levels for ground water resources. For irrigation or discharge into absorption well the heavy metal concentrations of Cu, Cr, Co, and Fe are limiting. For irrigation using sprinkler irrigation system or gravity surface irrigation the Cl⁻ concentration is the limiting factor even for the most Cl⁻ tolerance plants. Due to utilization of well water for land irrigation, direct and indirect human consumption and, washing and sanitary application should be controlled and used cautiously. As for well water, principal limitations for land irrigation are TDS, EC, SO₄²⁻, Cl⁻, SAR, HCO₃ and NO₃⁻ and, heavy metal concentrations of Cr, Fe, Co, and Cu.

Key words pollution; waste water; permit limit; effluent water; ground water

Geomicrobiological *in-situ* containment of uranium in subsurface and its long-term stability

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Uranium is a redox-sensitive element. While U (VI), the oxidized form of uranium, is soluble and thus mobile in groundwater, U (IV) readily forms UO₂(s) and is precipitated. Recent geomicrobiological researches demonstrated that dissimilatory metal reducing bacteria can effectively remove uranium from contaminated groundwater by reducing soluble U (VI) to relatively insoluble U (IV). This novel form of microbial reduction of U (VI) is reported to be much faster than abiological reduction. The objective of this work

was to investigate U (VI) reduction by indigenous bacteria in uranium-bearing black shale sediment and to determine whether microbially-precipitated uranium has long-term stability in subsurface. Through this study, fundamental information on the effects of microorganisms on the fate of redox-sensitive elements in natural settings will be provided. Soil and sediment samples were collected from uranium-bearing black shale in the Dukpyung area in Korea. Microbial inoculum was prepared from soil and sediment slurry supernatant. The reactors were purged with $N_2 : CO_2$ gas (80 : 20) to maintain anaerobic condition. Glucose, acetate or lactate was added as an electron donor at a final concentration of 5 mM. The reactors were incubated for 40 days at 30°C and concentrations of U, Fe and anions were monitored at set time interval. Uranium was removed from microbial solutions faster than controls. Since dissolved form of U is considered to be U (VI), the result indicated that indigenous bacteria initiated the reduction of U (VI) through either biological or chemical reaction and thus precipitation of uraninite. The observed decrease in dissolved U implied that microbial *in-situ* stabilization of uranium in deep subsurface can be expected. The activity of indigenous bacteria also led to the formation of black precipitates, which were proved to be mackinawite (FeS 0.9) after XRD and SEM-EDS analyses. It seemed that indigenous bacteria reduced Fe^{3+} and SO_4^{2-} into Fe^{2+} and HS^- , respectively, and these two combined to form mackinawite. It is important to consider the risk of uraninite reoxidation after *in-situ* reduction and precipitation in aquifer. However, the biogenic mineral mackinawite may prevent uranium from being re-oxidized even though unexpected change in subsurface environment happens. Indigenous bacteria were observed to be capable of immobilizing uranium in anaerobic sediment with various organic materials supplied. The indigenous bacteria reduced Fe^{3+} and SO_4^{2-} , leading to the formation of mackinawite which can enhance the stability of precipitated uranium. The present results suggest that *in-situ* stabilization of uranium is possible and it may be effectively used in remediation of uranium in contaminated subsurface.

Key words uranium; indigenous bacteria; reduction; black shale; *in-situ* stabilization

The simulation of airborne disease virus transmission in group buildings

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With the densification of population and the deterioration of urban ecological cycle, the airborne disease virus is becoming a new crisis for human. It is well known that airborne disease virus such as smallpox, hives, mumps and SARS can cause respiratory disease by the aerosol of sneezes or cough of infected person. The pathogens release virus aerosol to the environment. If the virus can live some time in the air, it can go with air flowing far away. The aim of the present research is to simulate the transportation of airborne disease virus in a group of buildings by taking into account the time-dependent virus aerosol source. A commonly used virus-host dynamical model is introduced to simulate the time-dependent development of virus aerosol releasing process. The wind velocity field is described by the continuity equation, momentum equation and turbulence model to enclose the Reynolds stress in the momentum equation. The RNG model is used in all simulations. The aerosol of microbial pollutant is assumed flowing at the same velocity as the air. The computation time is one life cycle of virus T. We assume that the pathogens release virus aerosol at the upper wall of building A. The conclusions are: (1) The microbial pollutant begins to be discharged after its delitescence $1/12 T$. As the virus goes into logarithmic growth period, the concentration of virus and the pathogenic area increase very fast. After entering the virus decay period ($1/3 T$), the pathogenic area decreases. It should be noticed that no secondary infection is considered in present simulation. Generally, as the virus concentration is above the pathogenic concentration, new pathogens will be infected and release virus aerosol to the environment. With the increase of new pathogens, the pathogenic area would increase very fast and finally result in the outbreak of infection. The coming paper will consider the secondary infection case. (2) For the above arrangement of buildings and the pathogens releasing virus from the upper wall of building A, the virus can threaten two sides of building A and building B and one side of building C. The other two buildings suffer few effects. Numerical results show that the effects of virus are possible to be reduced by proper arranging the position of buildings according to the wind speed and direction.

Key words numerical simulation; airborne disease virus; virus transmission; group building

Chemical reduction of nitrate by nanoscale Fe/Ni bimetallic particles