Geochemical equilibria and kinetics of the formation of iron precipitates in groundwaters : preliminary results and comments on water treatment

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Formation of brown precipitates during and/or after the pumping of bedrock groundwaters is often observed. This would result in serious problems in water supply, such as the encrustation and lowered efficiency of pumping wells and the trouble of an underwater pump as well as the unfitness to the drinking water standards. Abunbant brown precipitates are typically formed in a few hours after the pumping-out of bedrock groundwaters in the Pajoo area. The groundwaters vary significantly in water qualty with time (storage time after pumping), space (well location) and pumping technique (steady or intermittent pumping), and do not fit with the Korean drinking water standards in terms of color, turbidity and dissolved Fe. Thermodynamic and kinetic considerations of the formation of brown precipitates are undertaken in this study, in order to help to design an efficient water treatment process.

The precipitates resulting in temporal increase of turbidity of water are identified as amorphous iron oxides by SEM-EDS and XRD analyses. The Fe-rich nature of deep groundwaters is probably due to the dissolution of Fe chlorites in the local cataclasite acting as a passway of water circulation. Datailed examination of the relationships among in-situ measured Eh values (-9.2~39.7 mV with respect to Ag/AgCl electrode), calculated Eh values with respect to O2/H2O redox couple (791.2~857.3 mV) and measured dissolved oxygen contents (1.3~9.2 ppm) indicates that the groundwaters are in disequilibrium in redox state during the pumping but change toward the equilibrium with the supply of oxygen after pumping-out. The calculation of the saturation indices using PHREEQC as well as the thermodynamic consideration

of the Eh-pH stability predicts that the precipitates are finally transformed to Fe oxides. The temporal decrease of dissolved Fe with gradual precipitation of precipitates can be expressed as a regression equation: Fe = 23.53exp(-0.0002t), r2 = 0.9046. The size distribution of precipitates was determined by multi-step filtration, and shows that most particles fall in the size from 1 to 0.45 μm. Based on the results, the most efficient water treatment process is proposed.