Energy Landscapes, Oxidation State Control, and Nanophase Stability in the Critical Zone

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Iron, manganese, and uranium are elements of variable oxidation state in low-temperature aqueous environments. Particle size and interaction with H_2O, CO_2, and other cations all affect crystal structure, phase stability, oxidation state, and solubility. Distinguishing the kinetic and thermodynamic factors in competition among different phases remains a major challenge. Recent progress in understanding nanoparticle stability will be illustrated by examples taken from the Mn_2O_3-MnO_2-H_20, UO_2-UO_3-SiO_2-H_2O, and Fe_2O_3-Fe_3O_4-H_2O systems, utilizing new calorimetric data on surface energies and formation enthalpies of competing phases.