Genesis and mineralogical characteristics of hematite in loess-paleosol sequences of China

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Hematite is an important iron oxide mineral in loess-paleosol sequences of China, and it is benefit reconstruction of paleoclimate of Chinese inner terrene investigation and understanding mineral characteristics, forming process of hematite as well as relationship with other iron oxides and containing iron minerals. For example if we know on grain size distribution, exactly quantitative testing of hematite will be obtain by diffuse reflectance spectroscopy. Employed optic microscopy, X ray diffraction, scanning electron microscopy, high resolution transmission microscopy for original samples and magnetic extracted samples, obtaining results as follows:

There are four kinds of mechanisms for hematite occurring in loess-paleosol sequences of China during pedogenic. (1) Weathering from containing iron silicate, example for chlorite, etc, which released free iron ion, hydrolyzed, and dehydration; (2) Oxidation from magnetite which is micrometers and wind dust origin; (3)Phase transformation from wind dust goethite to hematite by topomorphology; (4) Hematite forming on the edge of maghemite. The hematite forming from the first mechanism is the best important occurrence and size from several to tens nanometers, irregular morphology, low crystallinity, as well as characteristic mesoporous because of dehydration from iron hydroxide (example for ferrihydrite), which results in redness in paleosol.

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Mechanical, chemical, magnetic, transport, and electronic properties changes at the nanometer scale

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Systems (such as materials, minerals, and fluids) at nanometer scale behave differently from their bulk systems. Nanoscience and nanotechnology are making big progress now because it is possible to purposefully manipulate materials and theoretically simulate / compute the properties of small systems at nano-scale. Deformation mechanisms for nanocrystalline metals will be dominated by twinning, grain boundary sliding, wide stacking faults, and partial dislocation emission from grain boundaries. Brittle oxide minerals will behave like elastic when their sizes reach the nanometer scale. Reactivity and stability of nanocrystals needs to be modified according to their crystal sizes, shapes, and textures. Geochemical reactions in nanopores and nanotube environments will be greatly different from those in bulk solution systems because of electric double layer overlap and water property changes (such as activity and dielectric constant). Especially the change in dielectric constant of water will modify Born solvation energies of ions, which will affect many aspects of geochemical processes, such as chemical weathering, ore deposit formation, replacement reactions, and fate of toxic metals in ground water aquifer. Nanocrystalline and nano-structured magnetite and maghemite that are superparamagnetic will enhance magnetic susceptibility of rocks and sediments dramatically. Darcy’s law for the transport behaviour of water in nanoporous media will deviate. The band gap between valence band and conduction band of nano-crystalline semiconductor minerals (such as CdS, and CdSe) and materials will be a function of their crystal dimensions. The electron densities of states of nanocrystalline semiconductors will be greatly different from their bulk system. This property has been used in many opto-electronic materials and devices.

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