Mineral Nanoparticles, Nanominerals and Natural Nanoporous Oxide Materials

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Abstract:
Of particular interest in Nanogeoscience is the study of nanometer-sized crystalline minerals or even poorly-, non-crystalline minerals, such as mineral nanoparticles, and nanominerals. Mineral nanoparticles are the nanoscale-versions of ordinary minerals (exhibiting different physicochemical properties compared to the micro- and macro-scale analogues), whereas nanominerals are distinctive phases ocurring only in nanoscale without equivalents at larger scales. Besides, nanominerals are classified as naturally occurring crystalline substances (with a highly ordered, repeating atomic arrangement), having a specific chemical formula and exhibiting crystal dimensions -nanocrystals- that fall between 100 nm and 1 nm. Subsequently, it has been proposed that the classic definition of the term “mineral” has to be re-defined, down to the deep knowledge of atomic structure and arrangement. Moreover, naturally occurring nanoclusters, polyphasic nanominerals, nanoporous phases, amorphous nanomaterials, amorphous-nanocrystalline transitional phases, surface-disordered nanoparticles, and mesocrystals, all related to the natural progressive transition between amorphous and crystalline materials, have to be considered. The environmental importance of mineral nanoparticles and nanominerals, either crystalline or amorphous, is attributed to their vital role to mobility and (bio)geochemical cycles of hazardous elements and compounds in nature. Additionally, nanominerals and mineral nanoparticles are crucial in the study of raw materials & mineral resources, inasmuch they frequently occur in basic and noble metal deposits, as well as into related metallurgical products and wastes. On the other hand, natural nanoporous mineral oxides are important materials when studying the Earth and developing environmental technology and industrial applications. Tunnel-structured hydrated Mn-oxides with a 3×3 array of edge-shared MnO_6 octahedra, known as todorokites, exhibits a stable nanoporous molecular sieve structure similar to that of zeolite and have been proved to exhibit remarkable ion-exchange and catalytic properties. Finally, it has recently been revealed that common natural Fe-oxide minerals, such as hematite, may form nanocystals containing a network of distinct nanopores.