Nanoparticles and bioavailability of minerals and metals

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Gold and uranium ores are quite widespread in Romania and their mining has produced considerable amounts of waste dumps, still containing non-recoverable metals. Two areas were selected for a deeper investigation with a view to envisage the form of metals within the waste dump materials as a basis for both recovery (Au) and stabilization (U).

Some shear zone related gold ores in the metamorphics of the South Carpathians have shown to bear also gold nanoparticles several nanometers in size, forming isolated spheres and/or coral like aggregates consisting of spheres of the same size [3]. Such features of gold morphology have been considered appropriate to give supplementary supports for gold uptake by plants as postulated by Anderson at al (1999) [1]. Nanoparticles exhibit considerable deviation from the standard properties at different size scales [4], including their reactivity. Common plants growing in Romania such as *Zea mays* and *Trifolium sp.* were thus selected for these investigations. Both natural soils formed on gold-bearing waste dumps as well as neutral soils artificially enriched by gold containing solutions were used to prove the gold uptake by such plants. Deviations for standard anatomy, especially of *Zea mays* suggest that the approach is sustainable. Investigations by SEM/TEM are now in progress.

Uranium ores in the Crucea-Botusana area in the East Carpathians have been thoroughly investigated as concerns their bearing on the U discharge produced by waste dumps [2]. Waste dumps related soils contain between 0.2-8.6 ppm U, whereas some plants naturally growing on such soils contain much higher U contents, i.e. *Picea excelsa* (roots) up to 311 ppm U, *Abies alba* (roots) 235 ppm U, *Rubus idaeus* (stems) 187 ppm U, *Fragaria vesca* (roots) 125 ppm U. Most likely the uptake of U by such plants relies on fixation of U- and/or UO_2-phosphates at the level of plant cells. Further investigations are in progress.

[1] Anderson *et al.* (1999) *Gold Bulletin* **32**(2), 48-51. [2] Petrescu (2007) Uranium waste dumps in the Bistrita Mts. (in Romanian). *Univ. of Bucharest Publ. House*, 283 p. [3] Udubasa *et al*. (2006) *An. Inst. Geol. Rom.* **74**, Spec. Issue, 247-250. [4] Waychunas & Zhang (2008) *Elements* **4**, 381-387.

Phase decomposition in a ternary system with different component diffusivities

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The decomposition model of Cahn and Hilliard deals with interdiffusion of two components by direct exchange of atoms. In particular, the diffusion coefficients of the exchanging atoms have to be identical. This model is ideally suited for, e.g., the description of binary alloys.

In solids both self-diffusion and interdiffusion occur by the vacancy mechanism. Therefore application of the classical Cahn-Hilliard equation to phase decomposition in solids implies the additional assumption that the vacancies have a uniform spatial distribution and ordinary interdiffusion occurs. However, the exchange of components with vacancies can take place at different rates. This is why a direct application of the classical Cahn-Hilliard theory to solids bears limitations.

To overcome this difficulty we introduce a generalization of the Cahn-Hilliard approach for a multicomponent system such that the diffusivities of the individual components can differ. The governing equations for the ternary system are first systematically derived using Onsager's principle and then solved numerically with the finite elements method.