



Geochemistry of phosphogypsum from Turnu Magurele, Romania

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The aim of this paper is the mineralogical and geochemical description of phosphogypsum from a Romanian location for an accurate assessment of its environmental impact. The investigated samples were taken off from the deposits at Turnu Magurele. The samples were analyzed by X-ray powder diffraction, scanning electron microscopy, X-ray fluorescence, Fourier-transform infrared absorption spectrometry and inductively-coupled plasma atomic emission spectrometry.

Phosphogypsum is a technogenic product remaining after the extraction of phosphoric acid from raw phosphate, mainly apatite [ideally $\text{Ca}_5(\text{PO}_4)_3(\text{F},\text{OH},\text{Cl})$]. The technology of extraction consists normally in sulfuric leaching of apatite, which is the case in all the Romanian deposits. Huge quantities of phosphate rock, of both sedimentary and magmatic origin, were imported by Romania from Morocco, Jordany, Tunisia, Syria, and Russia, respectively. Their processing at Turnu Magurele gave an important phosphogypsum deposit (64 ha of stacks).

XRD analyses of phosphogypsum taken off from this location, corroborated with Fourier-transform infrared absorption spectra, showed that the main crystallized phases in this kind of material are gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), and bassanite ($\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O}$), reaching up to 90 percent and 5 percent from the mass, respectively. A phosphate-bearing phase identified as ardealite or brushite is common. Impurities consist of quartz, calcite (probably resulted from the treatment of the plants with CaO, in order to reduce their acidity) and minor clay minerals.

The chemical analyses of selected samples from Turnu Magurele, performed by XRF and ICP-AES, showed that the chemistry of different samples is quite similar: the chemical differences between samples from different deposits are minor, and all the analyzed samples have chemical composition indicative for a production by the hemi-dihydrate (HDH) or dihydrate (DH) procedure (relatively low contents of CaO as compared with the phosphogypsum obtained by the hemihydrate procedure).

The SEM study shows that the masses macroscopically perceived as powder crusts are composed of randomly oriented or compact radiating aggregates of platy crystals. Two kinds of aggregates were identified: (1) aggregates of randomly oriented interlocking or subparallel platy crystals, having locally rosette-like nuclei and (2) rosette-like aggregates of spherical shape, resembling to the gypsum "sand roses". These aggregates are sometimes composed by fully idiomorphic crystals issued by recent precipitation from acidic solutions, but normally they are composed by "broken" aggregates of parallel grown crystals, sometimes reduced to cauliflower-like concretions.

The infrared absorption spectra of representative phosphogypsum samples from Turnu Magurele show vibrations that could be assumed to gypsum or bassanite, quartz, and rarely calcite. The bands assumable to molecular water are particularly well developed, suggesting a high level of hydration of the samples.