

Occurrence of (Na,K)₂Zn₃[Fe(CN)₆]₂·nH₂O in Gold heap leach mine waste

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Cyanide is used extensively for the extraction of gold, and mine waste may contain significant quantities of aqueous cyanide complexes and solid phases. The geochemistry of dissolved cyanide has been well studied [1] but solid phases have rarely been identified from mine waste. The objective of this study was to characterize a solid cyanide phase from a spent gold heap leach pad

Blue pseudo-cubic crystals, 2-25µm, were found with mica and pyrite in a sample from Leach Pad 91, Landusky Gold Mine, Montana [2]. Single crystal XRD indicates a rhombohedral unit cell [*a* = 12.4980(15), *c* = 32.2618(41)] with space group R-3c and that the solid belongs to a group of zeolitic cyanide phases with a framework of [(ZnN₄)₃(FeC₆)₂]²⁻ and cavities occupied by two alkali cations (K⁺, Na⁺ or Cs⁺) and H₂O [3, 4, 5].

Electron microprobe analysis gave average values (wt.%) of 1.0 Na, 1.6 K, 25.8 Zn, 14.3 Fe, 0.8 Cu, 22.3 C, 26.1 N and 8.1 H₂O (calculated as the difference from 100%). Values for the light elements (H, N, C, O, Na, and K) have large errors. Nevertheless, the atomic ratio of 1:1 for Na:K, and 3:2 for Zn:(Fe²⁺+Cu²⁺) fits the zeolitic cyanide group with the formula calculated from EMPA and structure refinement to be NaKZn₃(Fe_{1.9}Cu_{0.1})₂(CN)₁₂·3.7H₂O.

This solid phase was formed by Zn²⁺, CN⁻ and Na⁺ in the processing solution reacting with Fe²⁺ and Cu²⁺ from the oxidation of pyrite and chalcopyrite. Hexacyanoferrate salts are more soluble at alkaline than neutral pH. The production of acid by pyrite oxidation neutralizes the initial alkaline solution promoting the precipitation of solid cyanide phases. These form a sink for cyanide and metals during mining operation but can later release them to the environment.

[1] Smith and Mudder (1998) *Rev. Econ. Geol.* **6A**, 229-248.

[2] Sidenko *et al.* (2005) *Can. Mineral.* **43**, 1157-1170.

[3] Gravereau *et al.* (1979) *Acta Cryst.* **B35**, 2843-2848.

[4] Garnier *et al.* (1982) *Acta Cryst.* **B38**, 1401-1405.

[5] Gravereau *et al.* (1983): *Rev. Chim. Miner.* **20**, 68-77.

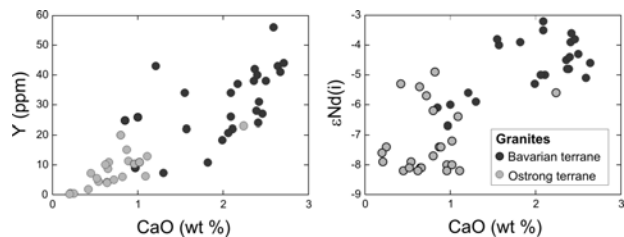
Element and isotope compositions of Variscan S-type granites reflect different basement domains

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We have studied the compositional and isotopic (Nd, Sr) features of a large (representative) number of post-deformational late-Variscan S-type granites from the western Moldanubian sector, Bohemian Massif. The granites can be regarded as a more or less coherent group derived from predominantly crustal sources. We will present evidence from zircon dating that the granites were formed during the same magmatic episode within a few million years (328-321 Ma). When the geochemical and isotopic data of the granites are examined, it appears that granites northeast and southwest of the Bavarian Pfahl shear zone have conspicuously different compositional features. Plutons located southwest of the shear zone (Bavarian terrane [1]) define a high Ca-Sr-Y suite, whereas plutons northeast of this zone (Ostrong terrane [1]) constitute a low Ca-Sr-Y suite. The high Ca-Sr-Y granites have significantly more radiogenic initial Nd and less radiogenic initial Sr isotope ratios than the low Ca-Sr-Y granites. The geochemical features can be explained by the partition of different source materials rather than locally distinct fractionation processes. These results emphasize the role of the Bavarian Pfahl shear zone as a terrane boundary and lead to the idea that the difference in magma composition is linked to the nature of the underlying basements. Finally, data from these basement units and their compositional features in comparison with those of the granites will be explored.



[1] Fiala, J. *et al.* (1995) in Dallmeyer, R.D. *et al.* (eds) *Pre-Permian geology of central & eastern Europe*. Berlin, Springer, pp. 417-428.