'X-Phase' Ca_2UO_5•2-3H_2O: long-term behaviour in natural cement-like rocks

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The analogue of 'X-phase' (Ca_2UO_5•1.3-1.7H_2O) of Atkins *et al.* [1] has been found as the main secondary phase in the Late Cenozoic marbles with cement-like mineralogy (Tulul Al Hammam natural analogue site, Jordan). The rocks were exposed to supergene alteration during 100 ka that led to the total hydration of primary high-temperature (T=800-850ºC) Ca-U(VI) oxides ($CaUO_4$, Ca_2UO_5, Ca_3UO_6, Ca_4UO_7, Ca_5UO_8, $Ca_3U_2O_9$ and Ca_6UO_9) [2]. Natural hydrated Ca-U compound is non-crystalline, more hydrous than 'X-phase' and close to Ca_2UO_5•2-3H_2O (CaO – 21-26; UO_3 – 61-70). Unlike to synthetic 'X-phase' the natural compounds are impured by (in wt%): SiO_2 (0.3-6), F (0.4-4), Al_2O_3 (0.2-1.8), Fe_2O_3 (up to 1) and Cl (up to 1.3). It occurs as heterogeneous pseudomorphs after primary Ca-U(VI) oxides and shows specific lamellae-like ('finger') microtexture, typical of synthetic analogue [1]. In some grains naturally-etched tracks of α-particles are visible. Other secondary U-bearing phases are gel-like Ca silicate hydrates (e.g. $(CaO)_3(UO_3)_2(SiO_2)_{2.5}\cdot 6H_2O$), while uranophane is very rare.

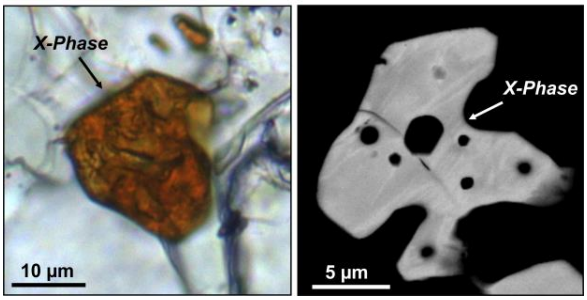

Figure 1: Appearence of natural 'X-phase'.

Thus in natural Ca-rich and high pH environment the U^{6+} long-term behaviour is solubility controlled by the formation of hydrous Ca uranates after primary Ca-U(VI) oxides. *Study was supported by RFBR grant 15-05-00760.*

[1] Atkins et al. (1988) *Radiochim. Acta* **44/45**, 255-261.
[2] Khoury et al. (2015) *Can. Min.* **53**, 61-82.