Characteristics and Crystal chemistry of U-V bearing minerals in abandoned mine wastes

We used spectroscopy, electron microscopy and diffraction techniques to determine the characteristic and crystal chemistry of a U-V bearing minerals occurring at an abandoned mine waste site in Northeastern, AZ. The diffraction lines in the X-ray diffractogram of these U-V bearing minerals showed up to 80% agreement with that of the synthetic carnotite from literature. The carbon (C) in the U-V bearing mineral phase was found to co-occur as an organic carbon inclusion based on results from the bright field transmission electron microscopy (BFTEM) imaging; energy filter transmission electron microscopy (EFTEM); and electron energy loss spectroscopy (EELS). Therefore, after excluding C from the quantitative electron microprobe analysis the elemental composition of U-V bearing minerals was 4.45% K_2O, 0.53% CaO, 62.72% UO_2, 0.04% Na_2O, 20.65% V_2O_5, 0.56 Fe_2O_3, 0.09% TiO_2 and 1.70 H_2O at a K:U:V ratio of 1:2:2.1 with an empirical formula of $(K_{0.87}, Na_{0.012}, Ca_{0.088})((Ti_{0.005}, U_{0.99})O_2)_2((Fe_{0.033}, V_{1.05})O_4)_2 \cdot 2H_2O$. Although the simplified empirical formula $(K(UO_2)_2(VO_4)_2 \cdot 2H_2O)$ of U-V bearing minerals shows reduced potassium concentrations, its d-spacing is similar to that of anhydrous carnotite reported in literature with minor discrepancies due to degree of hydration. Furthermore, this hydrated carnotite (U-V bearing mineral) rapidly amorphized on short term exposure to the electron beam (<60s). Results from this investigation provide an improved understanding on the characteristics and crystal chemistry of naturally occurring U-V bearing minerals in abandoned mine wastes. Identification of these uranyl vanadates can be crucial to better understand and predict the long term transport of U in abandoned mine waste sites.