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E-mail Delivery

Mr. Patrick Siglin
Western Uranium Corporation
31127 Highway 90 Road
Nucla, CO 81424

Subject: Mineralogical Characterization of Two Uranium-Bearing Samples
Hazen Project 12258

Dear Mr. Siglin:

Two uranium-bearing samples were analyzed at Hazen Research, Inc. on the QEMSCAN[1] system to characterize the uranium mineralogy. This report summarizes the results of this work.

SAMPLE CHARACTERISTICS AND PREPARATION

The samples were received on May 16, 2016, and were labeled Pre-AMT[2] ROM and Post-AMT Ore. Hazen assigned internal reference numbers 54560-1 and 54560-2 to the samples. Sample 54560-2 reportedly represents the minus 325 mesh size fraction of the post-impact slurry stream.

The Pre-AMT ROM sample reportedly contains 0.135% U and 0.252% V, and the minus 325 mesh Post-AMT sample reportedly contains 0.459% U and 1.06% V.

A split of both samples was mounted as a polished section, i.e., the sample powder was mixed with epoxy and polished to a high surface finish when the epoxy set. The section was carbon coated and then analyzed and imaged using scanning electron microscopy.

[1]QEMSCAN (Quantitative Evaluation of Minerals by Scanning Electron Microscopy) uses advanced electron beam technology and combines this with high-resolution imaging and energy-dispersive spectrometry (EDS). The components are integrated to provide a comprehensive tool capable of identifying most ore- and rock-forming minerals as well as man-made phases on a micro-scale in just milliseconds.

[2]Ablation Mining Technology

RESULTS

Automated energy-dispersive x-ray spectrometry was used to quantify the minerals present. The analysis point spacing was 2.4 µm. Table 1 shows the semiquantitative[3] mineral abundance results. Identified silicates were quartz, feldspar (predominantly K-feldspar), mica (muscovite and biotite), and clays (kaolinite and a magnesium–iron–aluminum silicate). Also present are carbonates (predominantly calcite) and titanium oxide. Other minerals observed are zircon, apatite, barite, iron oxide, iron sulfide, clinochlore, lead selenide (probably clausthalite), and arsenic-bearing phases. The concentrations of these minerals are grouped as "Miscellaneous" in the table. Figure 1 shows the abundance mineral data graphically.

Table 1. Semiquantitative Mineralogy

Sample	Pre-AMT ROM	Post-AMT Ore Minus 325 Mesh
Mineral	**Analysis, mass%**	
K–U–V oxide (carnotite)	0.09	0.15
K–U–Si–O (boltwoodite)	0.01	0.01
U mineral	0.5	1.7
Quartz	76.6	14.8
Feldspar	9.7	35.0
Muscovite	0.3	1.4
Biotite	2.2	11.8
Mg–Al–Fe silicate (clay)	4.5	20.9
Kaolinite	1.0	3.9
Carbonate	1.7	2.6
Ti oxide	0.4	1.0
V-bearing clay	1.4	1.9
V-bearing clay-(U)	0.1	0.2
Miscellaneous	0.6	2.1
Unidentified	0.9	2.6
Total	**100**	**100**

Although the uranium minerals occasionally form larger clusters (up to 75 µm; measured at the longest axis), the individual uranium-bearing grains are very fine-grained (less than 2 µm) and occur intimately associated with silicate gangue. Potassium–uranium-vanadium oxide (probably carnotite with the general formula $K_2(UO_2)_2V_2O_3{\cdot}3(H_2O)$) and potassium–uranium–silicate (possibly boltwoodite with the general formula $HK(UO_2)(SiO_4){\cdot}1.5(H_2O)$) are the predominant uranium phases. Carnotite concentration is

[3]Data are considered semiquantitative with respect to the uranium mineralogy because the particles, except quartz, are predominantly smaller than the excitation volume (interaction volume of the electron beam in which x-rays are generated).For very fine-grained material, the analysis stepping interval of 2.4 µm is bigger than the grain sizes, resulting in a high percentage of mixed phase EDS spectra.

higher than that of boltwoodite. Both minerals occur as globular aggregates of prismatic and needle-like crystals. Figure 2 shows a backscattered electron image of carnotite intergrown with clay.

Uranium-bearing grains are also observed as very small inclusions in a vanadium-bearing clay mineral, as very small inclusions in quartz, and in aluminum silicate (kaolinite).

Frequently, the uranium-bearing grains are too small for an exact identification as either carnotite or boltwoodite during the automated data acquisition. In these cases, the analysis data pixels are identified as uranium mineral, referred to as "U mineral" in the table. Most of the data points that fall into the uranium mineral category are believed to represent carnotite and boltwoodite, but other uranium-bearing minerals may or may not be present. Because of the very fine-grained nature of the Post-AMT sample, the determination of the exact nature of the uranium mineralogy is more difficult, and a higher percentage of the total uranium-bearing minerals falls into the uranium mineral category. It is expected that these data points also represent the main uranium minerals carnotite and boltwoodite.

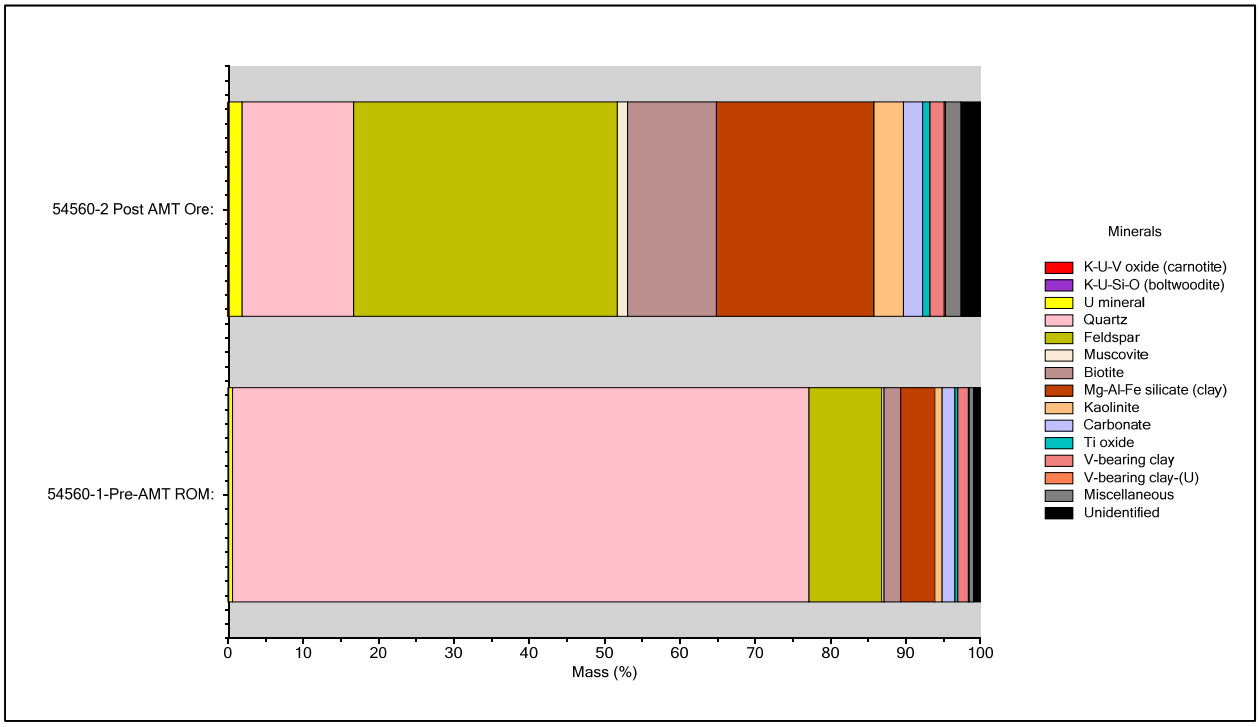

Figure 1. Mineral Abundance Analysis

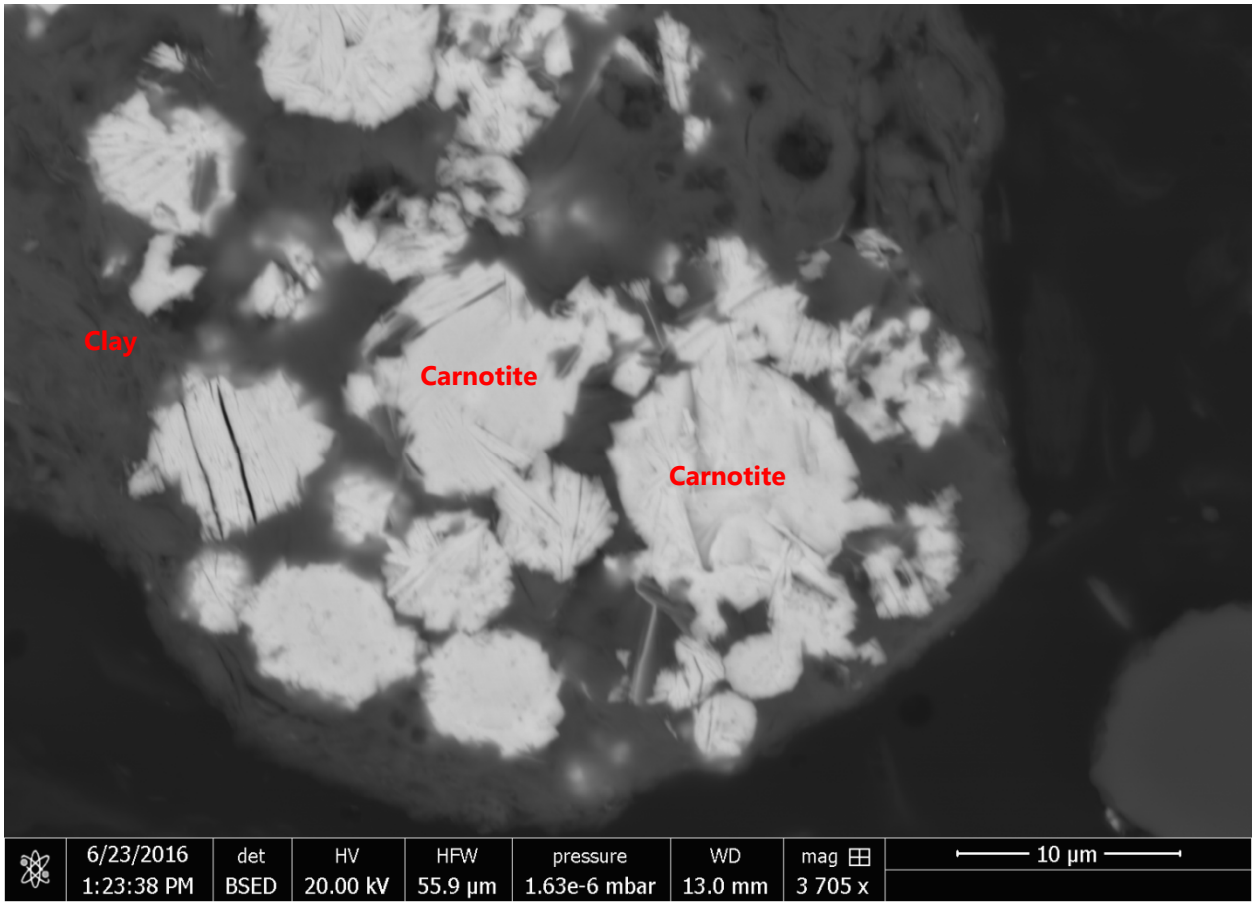

Figure 2. Carnotite Aggregates in Clay

Figures 3 and 4 show the QEMSCAN color-enhanced particle map of the analyzed area on the polished sections. Each color represents a chemically distinct phase. Apparent, larger particles in the Post-AMT sample are agglomerates of fine-grained material. These agglomerates most probably formed during the drying process after wet screening. Before mounting the sample material in epoxy, the agglomerates were broken up as much as possible without introducing additional breakage of particles.

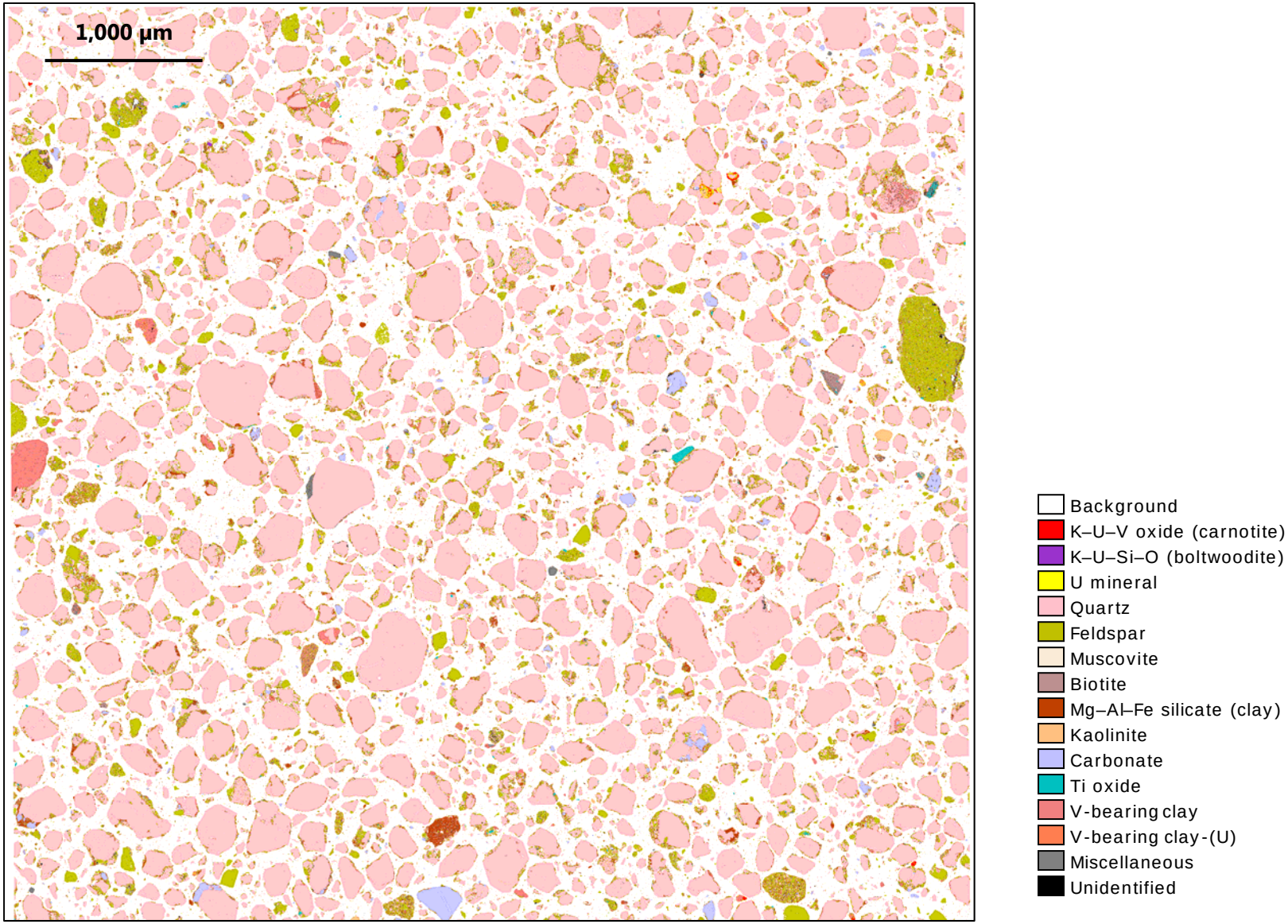

Figure 3. QEMSCAN Color-Enhanced Particle Map of Area Analyzed on Polished Section of Pre-AMT ROM Sample

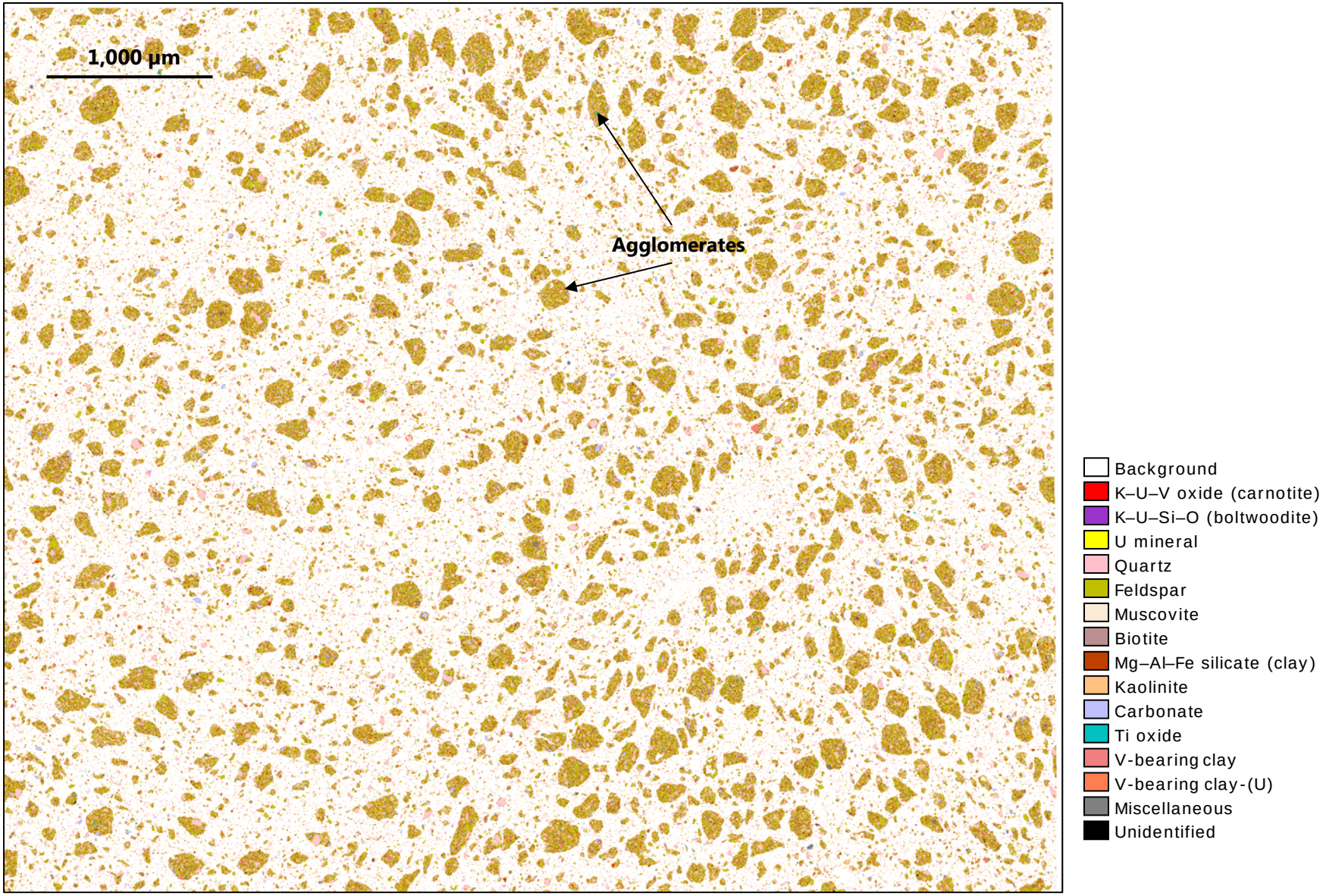

Figure 4. QEMSCAN Particle Map of Area Analyzed on Polished Section of Post-AMT (Minus 325Mesh) Sample

SUMMARY AND RECOMMENDATION

Automated QEMSCAN mineral abundance analyses indicate that a potassium–uranium-vanadium oxide (probably carnotite with the general formula of $K_2(UO_2)_2V_2O_3 \cdot 3(H_2O)$) and a potassium–uranium–silicate (possibly boltwoodite with the general formula of $HK(UO_2)(SiO_4) \cdot 1.5(H_2O)$) are the main uranium phases in both samples. Frequently, the uranium-bearing grains are too small for an exact identification as either carnotite or boltwoodite during the automated data acquisition. The total concentration of uranium-bearing minerals is higher in the Post-AMT sample.

To validate the nature of the uranium mineralogy and to confirm that both samples contain the same uranium minerals, x-ray diffraction (XRD) analysis could be performed. In general, the detection limit of XRD is 2–5 vol% of a mineral. Because the uranium minerals occur at a lower concentration than the XRD detection limit, the uranium minerals must be preconcentrate, possibly using a centrifuge-assisted heavy liquid separation process. The other possibility that could be evaluated as a means of preconcentrating the uranium minerals is to deslime the samples and analyze the minus 10 µm fraction (about 1,200 US mesh) by XRD.

Hazen hopes these results are beneficial to you. If you have any questions, please contact me at your convenience.

Regards,

Hanna E. Horsch
Manager, Quantitative Mineralogy

HEH/gr

xc: Tom Bujnowski, Hazen Research, Inc.
Roland Schmidt, Hazen Research, Inc.