10 July 2017

Ms. Keirsten Medvedich
Gaiam, Inc.
833 S. Boulder Rd.
Louisville, CO 80027

RE: MT17-0182 (2) – Supplemental analysis of unknown powder from mummified remains

Dear Ms. Medvedich,

We have completed additional analysis of the off-white powder recovered from mummified remains, which we recently identified as diatomaceous earth (see report MT17-0182, dated 06 July 2017). As requested, the follow-on analysis was completed on an UltraRUSH basis, and, as such preliminary results were discussed with you on Friday, 07 July 2017. This report describes our analytical methods, documents our results, and discusses the conclusions we have drawn from them.

Sample

The following sample was received at our laboratory on 05 July 2017:

- Unknown white powder recovered from the skin of mummified remains

Task

- Screen the sample for modern/anachronistic materials in attempt to constrain the age of the material.

Analytical Approach

The unknown, off-white powder submitted to our laboratory has been identified as a mixture composed predominately fragments of diatom frustules and mineral grains. This combination of ingredients indicates that the powder is a sample of diatomaceous earth. The microscopic pores make it a natural absorbent, and its corresponding large surface area makes this material an excellent adsorbent. Based on these facts, we proposed to screen the powder sample for the presence of adsorbed chemicals and attempt to identify them, if detected.

Small samples of the off-white powder were placed into micro test tubes and extracted with solvents of increasingly polarity: hexanes, chloroform, acetone, and water. This range of solvent characteristics allows chemicals with a wide range of solubility to be selectively dissolved from the diatoms. The solvent droplets were deposited onto microscope slides, which were examined for the presence of residues after the solvents evaporated.

A yellowish, liquid residue was recovered from the hexanes and acetone extracts. Chemical analysis of the liquid by means of Fourier transform infrared microspectroscopy characterizes the material as a hydrocarbon based oil (Figure 1). The spectrum obtained is not that of a simple, straight-chain, aliphatic oil (*e.g.*, mineral oil) and is more complex than common vegetable oils (*i.e.*, triglycerides of varying chain lengths). It exhibits similarities to reference spectra of long-chain aliphatic esters (*e.g.*, lanolin-type oil/grease). It is possible that a more detailed analysis of the residue (which shows characteristics of being a complex chemical mixture)[1] by means of gas chromatography-mass spectrometry, could provide a more specific identification of this substance.

No appreciable residue was obtained from the chloroform extract. The water extract yielded several types of crystalline material, the majority of which is sodium chloride, NaCl (*i.e.*, common salt), which has been confirmed through elemental analysis of the recovered crystals (Figure 2). This data also reveals low levels of calcium (Ca) and sulfur (S), which suggest the presence of calcium sulfate (*e.g.*, gypsum), a naturally occurring mineral and desiccant. Carbonate is also present in the residue from the water extract.

Summary and Conclusions

The diatomaceous earth powder from mummified remains was extracted with various solvents in search of any chemicals which may be adsorbed on or absorbed into it. The extracts yielded a complex oil as well as common salt, a carbonate mineral, and possible traces of gypsum. The compounds recovered from the sample provide no evidence to indicate that the sample is of modern origin; however, it is important to state that this result does not entirely eliminate that possibility.

If you have any questions concerning this report, or if we may be of further assistance, please do not hesitate to contact either of us directly. Thank you for consulting Microtrace.

Sincerely,

Ethan Groves
Research Microscopist

Skip Palenik
Senior Research Microscopist

[1] Infrared spectroscopy is a very good method for identifying pure organic compounds but not for mixtures or compounds that differ primarily in chain length.

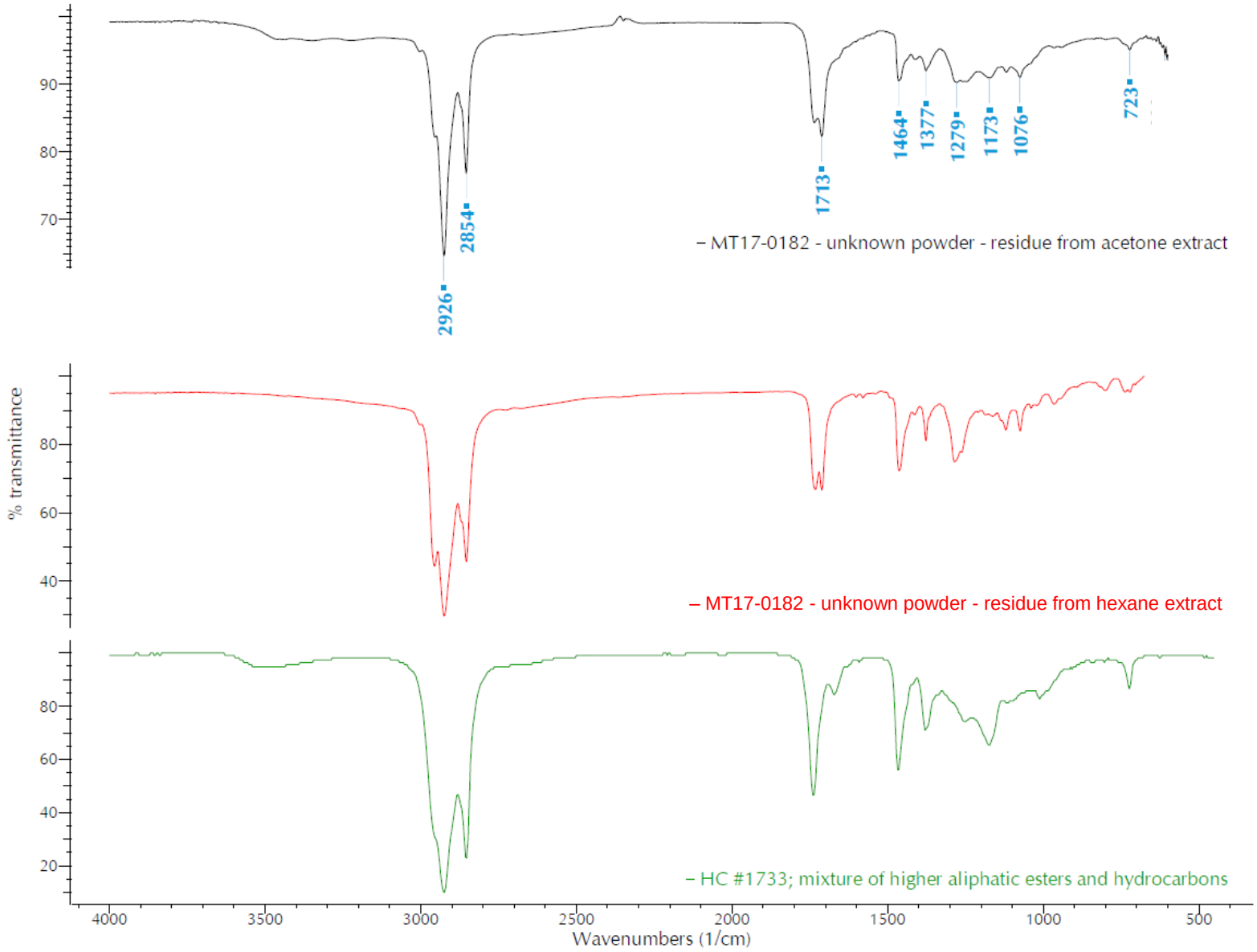

Figure 1. Liquid residues from extracts of the white powder sample (black and red), shown compared to a reference spectrum of a mixed hydrocarbon oil (green).

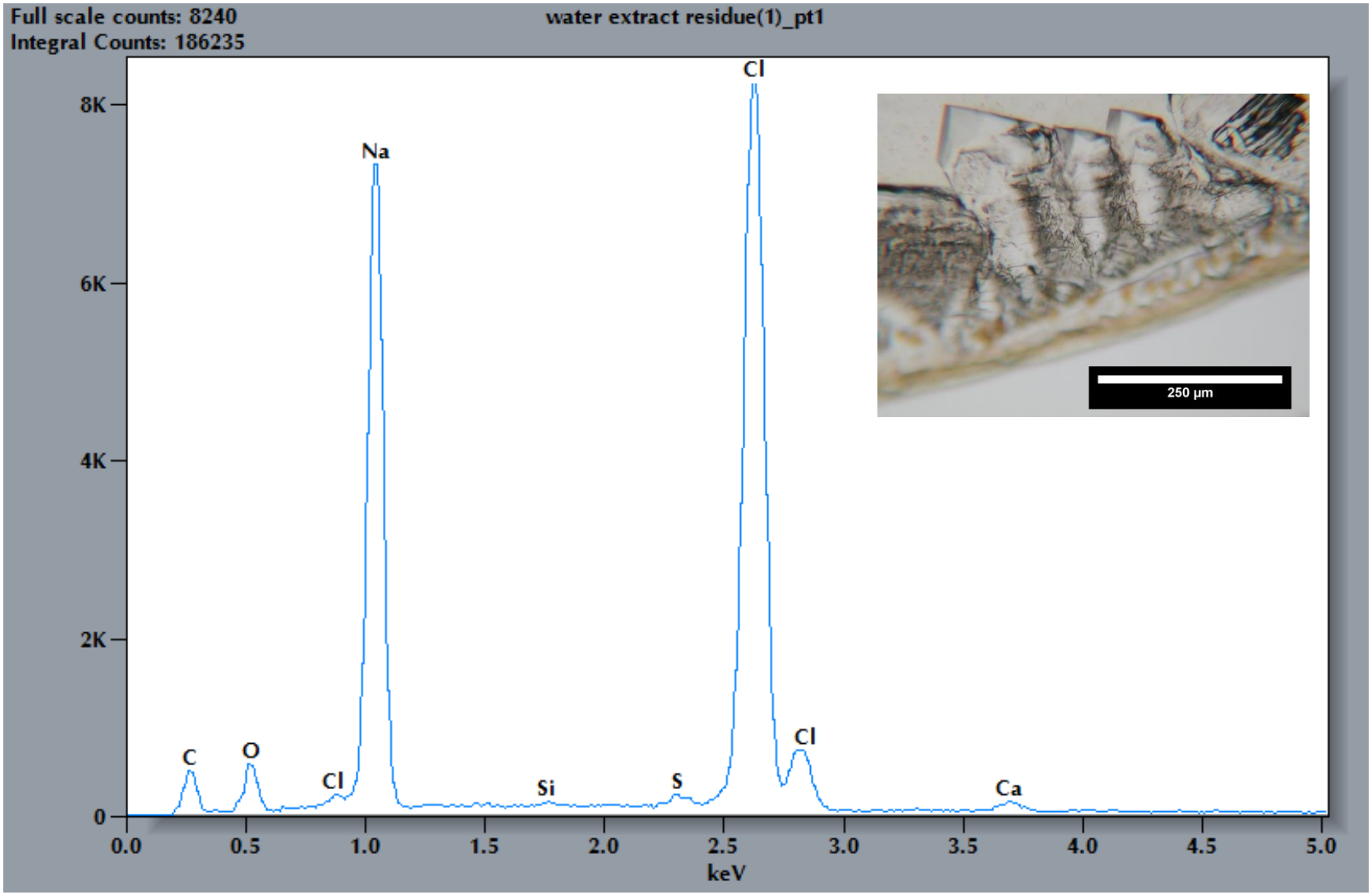

Figure 2. Energy dispersive x-ray spectrum of the colorless crystalline residue from the water extract of the diatomaceous earth. Inset shows a light micrograph of the crystals from the edge of the test drop that were analyzed.