High-tech X-Ray Spots Unusual Element in Ancient Manuscript

Thu, 07/20/2017 - 8:13am 1 Comment
by **Michelle Taylor - Editor-in-Chief - @LabEquipment**

A portable-point X-ray flourescence (p-XRF) scanner is used on an illuminated manuscript fragment. Credit: Cornell University Library

Using extremely high-tech X-ray fluorescence, researchers at Cornell University have detected an unexpected trace element in manuscript pages (or fragments) dating back to the 13th to 16th centuries.

Louisa Smieska and Ruth Mullet were surprised to find barium in the azurite blues of medieval illuminated manuscript pages. Azurite, a soft, deep blue copper mineral produced by weathering of copper ore deposits, has been recognized since ancient time. However, the trace element barium is more often associated with modern paints, and, according to the researchers, has never been reported in illuminated manuscripts before.

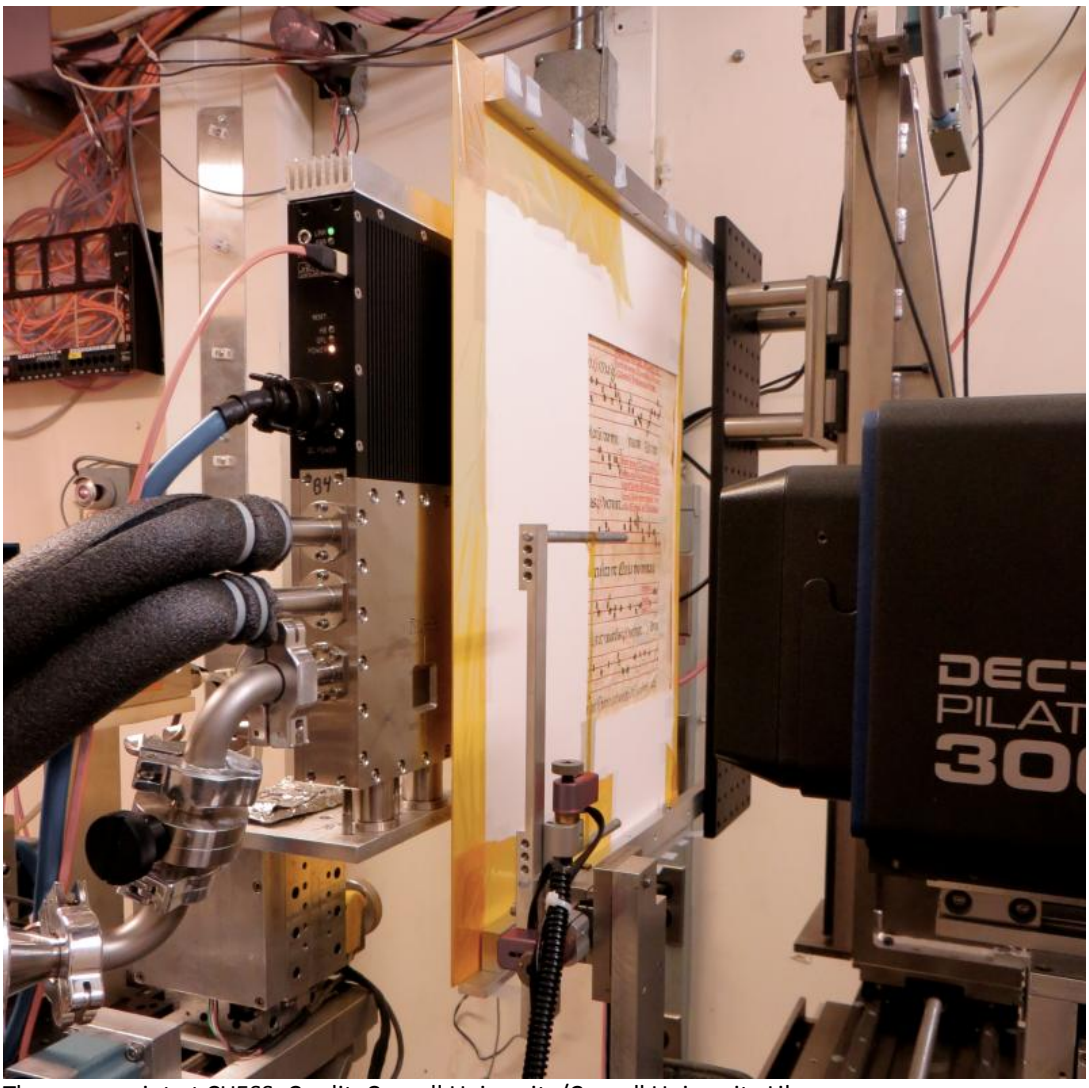
“We found that many azurite blues contain small amounts of the mineral barite, or barium sulfate,” Smieska explained to *Laboratory Equipment.* “Barite is a fairly common mineral, and its presence is likely related to how the azurite mineral deposits formed. We are excited because the relative amount of barium in each azurite blue is not the same, and combining this information with the amounts of other trace elements such as iron, zinc, and antimony might help with efforts to learn whether different fragments were originally related to one another.”

Research into ancient manuscripts using scientific tools and techniques is part of a larger trend toward "bridging" the arts and sciences.

"There is a strong technical value in bridging the arts and sciences," Smieska said. "Art objects present numerous challenges for analysis—they are extremely complicated and messy systems, and analysis is frequently limited to noninvasive techniques. Trying to answer complex questions in cultural heritage pushes science to develop new tools and techniques."

For this research, which was recently published in *Applied Physics A,* Smieska and Mullet used X-ray fluorescence (XRF) due to its ability to detect a wide range of inorganic elements—a useful capability when working with manuscripts. It is sensitive to low concentrations of material, so it's a good choice for noninvasive testing. Mullet said they also relied on X-ray diffraction (XRD) to study smaller areas of the manuscript and confirm the presence of specific compounds.

But, the researchers wanted an even closer look at some of the more interesting fragments, so they turned to CHESS—the Cornell High Energy Synchrotron Source. CHESS is a high-intensity X-ray source, supported by the National Science Foundation, that provides over 1,000 scientists annually with state-of-the-art synchrotron radiation facilities.



The manuscript at CHESS. Credit: Cornell University/Cornell University Library

“The facilities at CHESS provided several advantages over the laboratory-based point XRF survey we began with,” Smieska explained. “We were able to use a Maia XRF detector at CHESS, which allowed us to move from point XRF measurements to fast-scanning XRF experiments of square centimeter areas. There are only a few Maia detectors in use around the world. Using the Maia detector meant that we could quickly scan large areas and discover spatial trends in the elemental maps, such as confirming that barium can be associated with azurite.”

CHESS’ high-energy X-rays also provided greater XRF sensitivity to heavier elements, including barium, than its traditional lab-based counterpart could.

Identifying which trace elements are present and in what amounts can give a unique fingerprint to a pigment, which could help link scattered pages in different collections, and even provide information on historic trade routes, mining sites, geology, and other historical and scientific inquiries.

Until very recently, fragments received very little scholarly attention, often being bucked in favor of complete manuscripts or even half-full manuscripts. However, Muller told *Laboratory Equipment* their recent research is just one example of how fragments have the potential to offer real contributions in manuscript studies.

“They present significant practical advantages for technical study: they are easier to mount and study in small spaces like a synchrotron; there is little or no conservation effort required for their examination; and they can be more readily transported to external facilities. While the wider contexts of these fragments is frequently lost, the application of technical analysis can allow some contextual lacunae to be filled,” Muller said.

Thus far, the researchers have only examined six fragments containing azurite pigments at CHESS, but Smieska would like to expand the study, noting it would be “extremely valuable for uncovering broader trends in azurite trace mineral compositions.”