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From the standpoint of analytical chemistry, these two 5¢ 1847 stamps are identical—but not many collectors would treat them as duplicates. Gordon Eubanks' analysis of the ink used to create these stamps (page 337), shows that chromium was not part of their make-up.

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PIGMENT COMPOSITION OF 5¢ 1847 STAMPS: NO CHROMIUM

GORDON EUBANKS

For decades collectors and researchers have worked to explain the large variation in color found in the 5¢ 1847 stamps. The two stamps in Figure 1 show how dramatic the color differences can be. The stamp on the right is a red orange, almost orange in color. The stamp on the left is a dark black brown. Clearly these stamps appear to be very different colors, which could indicate that their inks were different. These two images were previously shown in the *Chronicle* in 2013, in an article by Wade Saadi, "Putting the Ink to the Paper."[1]

Color vision is the ability of an organism (or machine) to distinguish objects based on the wavelengths of light reflected by the object. Individual perception of color is a subjective process. As a result, different people see the same object differently.

For the 5¢ 1847 stamp, there are dozens of recorded shades. Saadi listed 27 major shade varieties and almost 100 additional minor varieties. An important and often unstated caveat is that these are the shades we see today. They do not necessarily reflect the colors that were present when when the stamp sheets came off the press and were hung up to dry.

Variations in color during printing should be expected. Inconsistent mixing of ink, or inaccurate measurement or purity of its components, could lead to color variation. Ink is a mixture, not a chemical compound. Variation is to be expected.

Noted philatelists have studied the questions of why the colors of the 5¢ 1847 stamp vary so much and what are the ink components that contribute to the perceived color differences. Carol Chase believed that the ink was composed of compounds of iron. Roy White

Figure 1. Contrasting colors on 5¢ 1847 stamps. The stamp on the left is categorized as dark black brown. The stamp on the right is red-orange.

used spectrographic analysis to determine that the 5¢ 1847 ink was actually lead-based. He was the first to publish scientific evidence that the ink was based on compounds of lead, rather than iron.[2] White also believed that the orange shades contained lead chromium compounds. Calvet M. Hahn wrote that the ink formulation of the 5¢ 1847 stamps changed in 1850 to include chrome orange, a basic lead chromate introduced as a pigment in the first decade of the 19th century.[3]

The goal of the research presented here was to use modern analytical techniques—X-ray diffraction (XRD) and infrared absorption spectroscopy with attenuated total reflectance sampling (IR-ATR)—to resolve the question of what specific compounds made up the ink of the 5¢ 1847 stamps.

The subject stamps for this study were the same 5¢ 1847 stamps used by Saadi in his article in *Chronicle* 239. Saadi's article presented research done by Tom Lera using equipment in the analytical research laboratory at the National Postal Museum. This equipment could detect some elements that were present but could not detect specific components. Saadi's article clearly showed that lead and sulfur were present. It did not resolve the question of whether chromium was present in the ink on some stamps (as Hahn and White suggested) or what specific compounds of lead were present.

To determine the components of the ink, the research discussed in this article used XRD and IR-ATR equipment in the laboratory of Harry Brittain. Brittain is both a philatelist and a research chemist. In two previous *Chronicle* articles, he presented extensive information about the use of this equipment in the forensic analysis of the ink and the paper used to create postage stamps.[4]

In addition to the subject stamps used in the Saadi study, on-cover 5¢ 1847 stamps were also tested, to evaluate if stamps not soaked from a cover might show a different set of components. Spectra for each stamp as well as six stamps on cover were then evaluated.

Without getting into the technical minutia, both the XRD and IR-ATR analyses showed that the spectrum details for all the subject stamps were extremely consistent. The primary components of the ink are calcium carbonate ($CaCO_3$), lead sulfide (PbS) and lead sesquioxide (Pb_3O_4), sometimes called red lead.

No chromium components of any sort were found in any of the stamps. We can conclude, with scientific certainty, that lead-based inks, and only lead-based inks, were used for all the 5¢ 1847 printings.

As for the two highly contrasting stamps shown in Figure 1 (which were stamps #1 and #14 in Saadi's original study): Both the XRD and IR-ATR spectra show a very close match. There is no evidence at all that the inks on these two stamps are based on different formulas. From the viewpoint of analytical chemistry, the two stamps are identical.

Conclusion

Eye perception of color is a poor indicator of ink compounds. But most philatelists, including this author, collect on the basis of what they see. While the two stamps in Figure 1 may be chemically identical, I would certainly not regard them as duplicates. The large variation in color found in the 5¢ 1847 stamps is not the result of different metal compounds in the ink.

Endnotes

1. Wade E. Saadi, "Putting the Ink to the Paper," *Chronicle* 239, pp. 244-250.
2. Roy White, *Color in Philately*, New York, 1979.
3. Calvet M. Hahn, "The 1847 Issue—A Brief Synopsis," *Chronicle 185,* pg. 18.
4. Harry G. Brittain, "Forensic Analysis: Composition of Ink and Paper of the 1¢ 1861 Stamp," *Chronicle* 239, pp. 264-271; "Use of Infrared Absorption Spectroscopy as an Adjunct in the Differentiation of the 1¢ Franklin Bank Note Stamps," *Chronicle* 245, pp. 74-84. ■