# A Travelogue of Rediscovery Sites

## Part 6



James L. Marshall, *Beta Eta 1971*, and Virginia R. Marshall, *Beta Eta 2003*, Department of Chemistry, University of North Texas, Denton, TX 76203-5070, *jimm@unt.edu*

*This is a continuation of a review of "Rediscovery" episodes, initiated in the Spring 2017 issue of* The HEXAGON. *This series includes the visits to mine sites taken by Jim and Jenny Marshall over the ten-year period of 1999–2008 in their successful search for the actual original source for the elements. The present issue is devoted to Eastern Europe.*

**Russia—platinum, ruthenium, chromium, and beryllium.** Russia is the largest country, stretching across eleven time zones from Belarus to the Bering Sea and covering two continents—Europe and Asia—separated by the Ural Mountains, 1300 kilometers east of Moscow. The Urals are a north-south chain of mountains created 250–300 million years ago as the supercontinent islands Siberia and Baltica collided, giving rise to geological hydrothermal processes that produced abundant treasures of precious metals and gems, as well as valuable mineralogical specimens. The region in Russia most interesting to scholars of "Rediscovery" is the Southern Ural Mountains range. One can travel by automobile from Paris, France, to this area in perhaps two days' constant driving—a distance of over 4000 kilometers, equivalent to the distance between New York City and San Francisco.

Although the Northern Ural Mountains boasts lofty peaks reminiscent of the Rocky Mountains, the Southern Ural Mountains are rolling plains, interrupted by low-lying hills (Figure 1). Several monuments have been erected along the Urals, reminiscent of the Continental Divide of the United States of northwestern New Mexico (Figure 2)—a gentle rise in elevation, without the alpine scenes further north.



*Figure 3. The Urals Mineralogical Museum in Ekaterinburg, Ul. Khokhryakova and Ul. Kujbysheva (N56° 49.59 E60° 35.76).*

The center of industrial/mining activity in this area is Ekaterinburg, which has a famous mineralogical museum with many impressive exhibits and mineral specimens from the region (Figures 3,4). (Historians will recognize



*Figure 1. The Southern Urals are generally rolling hills, punctuated by occasional low-lying mountains, reminiscent of northern New Mexico in the U.S. In this general area, 130 kilometers northwest of Ekaterinburg, near Nizhniy Tagil (30 km to the east), the first major Russian platinum discoveries were made in the early 1800s. This view is ¼ km west of the monument shown in the next figure.*




*Figure 2. All along the spine of the Urals, several monuments of variable design have been erected to commemorate passage of a traveler from Europe to Asia. Here at Pereval Bolshoy Urals ("Big Urals Pass"), the continents "Asia" (facing west) and "Europe" (the other side, facing east) are written in the Cyrillic (Russian) alphabet (location: N57° 53.71 E59° 33.83).*



*Figure 4. Dr. Jevgeni Burlikov, curator of the Urals Geological Museum, poses with this huge crystal of quartz weighing 784 kg.*



*Figure 5. Platinum can be found north of Ekaterinburg. This is an example of a platinum placer from the famous Nizhniy Tagil Massif, which is located 35 km southwest of Nizhniy Tagil, near the village of Visim. The Nizhniy Tagil Massif has produced more platinum than any other site in the world. As platinum was being produced in the Nizhniy Tagil area in the early 1800s, it was sent to the St. Petersburg mint.*

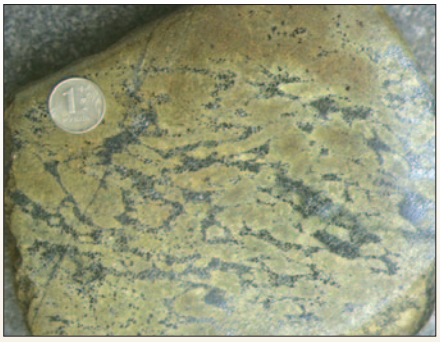


*Figure 6. This is typical platinum ore taken from the Nizhniy Tagil region—platinum-group elements are typically found as tiny inclusions in seams of the chromite (darker veins) imbedded in dunite (lighter brown matrix). For size, a 1-ruble coin is shown, about the size of a U.S. nickel.*




*Figure 7. This is the mint ("Monetniy Dvor"="Money Yard") on the Peter and Paul Fortress in St. Petersburg, Russia (N59° 57.00 E30° 18.87). This mint, founded in 1724, furnished the raw platinum ore in which Klaus discovered ruthenium at his university in Kazan, Russia.*

Ekaterinburg as the the famous city where Tsar Nicholas II and his family were assassinated in 1918).

**Platinum, ruthenium.** Although the Ekaterinburg region was commercially most important for its gold production (first discovered in 1747), also noteworthy was the discovery of platinum in 1819. Platinum was conveniently collected in placers near Nizhniy Tagil (Figure 5). Platinum can be collected in a similar manner to gold—both elements are extremely heavy (both have a specific gravity of ca. 20, almost twice that of lead), and they can be separated from silt in slush boxes or by simple panning. The source ore is composed of chromite ($FeCr_2O_4$) inclusions in igneous rocks, mainly dunite (a magnesium iron silicate) formed by the up-thrusting of deep mantle rock during the continental collision forming the Urals (Figure 6).

Platinum was actually first discovered a century earlier in South America, with the original samples brought back by Spanish explorers to Europe.[1f] In 1803, four additional elements were found in crude platinum procured from the Spanish by two British chemists: rhodium and palladium by William Hyde Wollaston (1766–1828) and osmium and iridium by Smithson Tennant (1761–1815)[1f] The remaining element of the platinum group—ruthenium—was later discovered as an impurity in Russian platinum by Karl Karlovich Klaus (1796–1864) in 1844 at the University of Kazan, 950 kilometers to the west.[1g] The rich platinum deposits in the Southern Urals in Russia served as the source of Klaus' platinum ore; the St. Petersburg mint (Figure 7) provided Klaus with the metal residues after minting quantities of platinum coins during the period 1828–1844 (Figure 8).



*Figure 8. This 3-ruble coin was minted in 1836 in St. Petersburg. It is the size of a U.S. quarter and weighs 10.2 grams.* Private collection, J. Marshall.



*Figure 9. This is a view of surface mining in the Berezovskiy region. Notice the birch trees (recognized by the white bark) surrounding the mine area—"Berezovskiy" means "Birch-ville."* Courtesy, Jevgeni Burlikov.



*Figure 10. This is the pithead and tower of the Tsvetnoi Mine. These can be seen in Figure 9, on the hill, right-hand portion of the figure (N56° 55.65 E60° 48.62).* Courtesy, Jevgeni Burlikov.

**Chromium.** This element was discovered[1d] in crocoite (lead chromate, $PbCrO_4$) found in the Tsvetnoi Mine ("Painted Mine"), a gold mine in Berezovskiy, 15 kilometers northeast of Ekaterinburg. (Figure 9). The Tsvetnoi gold mine is located on Assumption Hill (Upsenskaya Gorka) on the outskirts of Berezovskiy (Figure 10). The locality is known for its gold-bearing quartz veins, which were actively processed for two centuries.

Crocoite was known as "red lead of Siberia" (Figure 11), first described in 1753 by Mikhail Vassilevich Lomonosov (1711–1765), professor of chemistry at the University of St. Petersburg.[1e] Lomonosov was known as the "Russian Lavoisier," anticipating Lavoisier's work disproving the phlogiston theory, The Law of Conservation of Mass, critical in the research of both chemists, is sometimes informally called the "Lomonosov-Lavoisier Law."

A sample of Russian crocoite was carefully analyzed by Nicolas-Louis Vauquelin (1763–1829) in Paris in 1797 and found to have a new element named "chromium" for its highly colored compounds.[1d] He isolated not only compounds of chromium, but also the metal itself.

**Beryllium.** This element was also discovered by Vauquelin in Paris in 1798.[1d] His discovery was made by a careful analysis of beryl and emeralds, which had been suggested by his crystallography colleague René-Just Haüy (1742–1822) to be of the same composition because of their like morphology (Figure 12). Beryl and emeralds had been known for centuries; emeralds were originally discovered in Egypt, and beryl was commonly seen in granitic rocks, especially in the Urals. Vauquelin found the composition of "Siberian beryl" and the "Colombian emeralds" to be identical. Earlier investigators had characterized beryl to be "aluminum silicate," but Vauquelin was alert to recognize that some of the "aluminum" previ-



*Figure 11. Specimen of crocoite from Berezovskiy, Russia (left), collected from the Tsvetnoi Mine, typical of the original historic samples of this mineral analyzed by Vauquelin. More recent spectacular specimens have since been collected, for example from Tasmania (right).* Private collection, J. Marshall.



*Figure 12, Beryl (left) from Malesheva, 55 km northeast of Ekaterinburg; and emeralds (right) from Colombia, South America. Each has the chemical formula of $Al_2Be_3Si_6O_{18}$, with identical hexagonal prismatic crystals. The two differ only in the purity of the mineral, the purer (right) of gem quality.* Private collection, J. Marshall.






*Figure 15. "Youth park" announces the entrance to the Börzsöny Mountains Reserve, a national park (N47° 55.96 E18° 50.20).*

*LEFT: Figure 14. Mining museum in Nagybörzsöny, Hungary (N47° 56.14 E18° 49.56). Tellurium was co-discovered by Kitaibel from ore taken from this mine.*



*Figure 13. Entering Nagybörzsöny, Hungary. "Nagy" means "big," and "börzsöny" means logwood, referring to the wooded mountains to the east.*

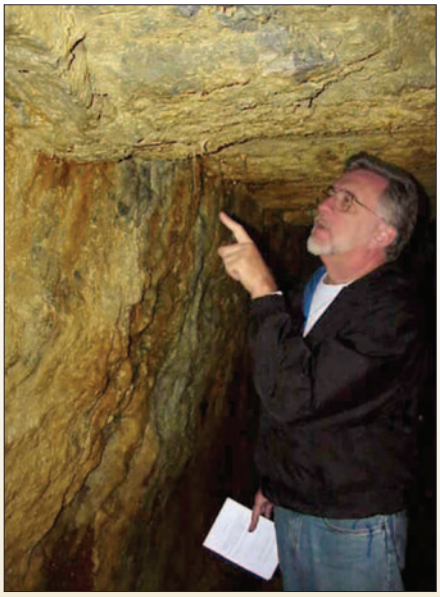


*Figure 16. The author inside one of the mines in the Börzsöny Mountains. The narrow tunnels are typical of earlier mines before blasting powder was used to widen the cavities.*

ously identified behaved differently—it would *not* dissolve in strong base. He recognized this insoluble white residue to be the hydroxide of a new element, originally named "glucina" because of its sweet taste (it is also poisonous!). It later was named "beryllium" from the common mineral. The metal itself was prepared by Friedrich Wöhler (1800–1882) in Berlin in 1828.

**Hungary–Tellurium.**[1h] This element was first discovered by Müller von Reichenstein (1740–1825) in Romania in 1782, but independent discovery was made by Pal Kitaibel (1757–1817) in Budapest, Hungary, in 1789. These two scientists were unaware of the other's work, so co-discovery may well be shared between the two scientists. Whereas Reichenstein's ore which furnished tellurium was nagyagite ($Pb_5Au(Te,Sb)_4S_8$) and sylvite ($(Ag,Au)Te_2$) from the Faţa Băii Mine in the Transylvania Mountains of Romania (Dracula country!),[1a] the ore which furnished Kitaibel's tellurium was wehrlite ($Bi_2Te_3$), from Nagybörzsöny in northwestern Hungary (Figure 13).[1h] This historic mining town was originally founded by German settlers and is also known as Deutschpilsen. Today a mining museum may be visited (Figure 14) which describes the history and displays equipment used in the former mining days. The city now boasts a youth park (Figure 15) and a tourist train can take one sightseeing up the mountain slopes. Permission can be made for access to the mines which have the typical narrow passages of the galleys of these centuries-old mines (Figure 16).

**Slovakia—origin of the "crossed hammers"—Banská Štiavnica and Kremnica.** Banská Štiavnica has been declared a UNESCO World Heritage Site because of its rich history (Figure 17 on page 42). This city was known for its silver production. More important, it boasts one of the oldest mining universities in Europe, running a close second (1770) to the TU Bergakademie Freiberg in Germany (1767).[1b] Here in this Slovakian university some of the famous chemists studied, including Müller von Reichenstein (see Hungary–Tellurium on this page) and Andrés del Río (1764–1849, the Spanish chemist who discovered vanadium in Mexico).[1c] The university is now devoted to both mining and forestry. In earlier years, the city and university were known by the German name, Schemnitz, or by the Hungarian name, Selmecbánya (at the time, Slovakia was part of the Hungarian Empire). The city sits inside a huge caldera resulting from a volcanic explo-

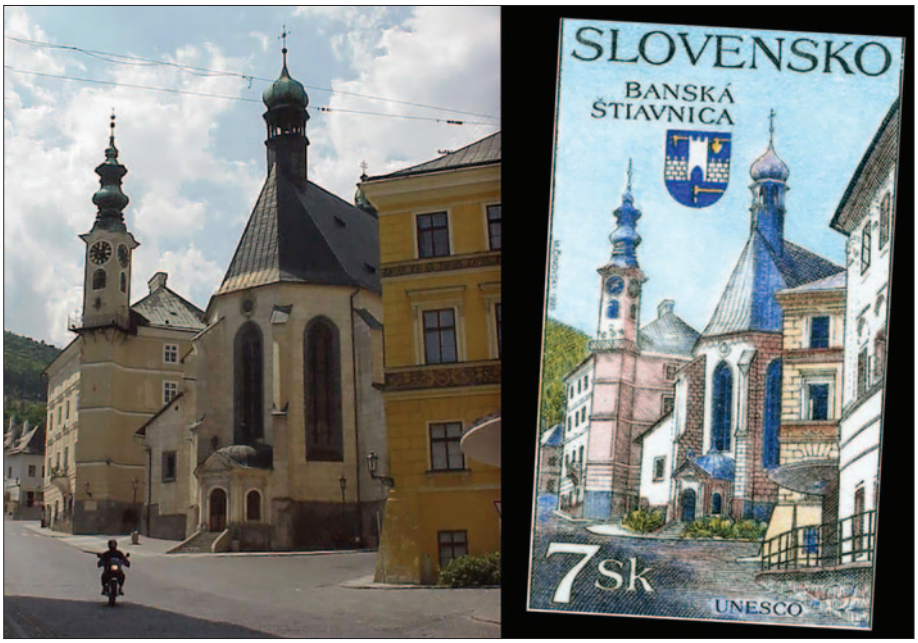



*Figure 17. View of central Banská Štiavnica, Slovakia, a UNESCO site (N48° 27.52 E18° 53.58), with the famous St. Katharine church (Kostol Sv. Kataríny), dating back to 1491 (center right, high windows and a portal with stairs). By chance, the authors took this photograph (left) of the same view later found to be on a Slovakian postage stamp (right). "Sk" means "Slovak coruna."*



*Figure 18. This is the ancient caldera (volcano crater) of Banská Štiavnica. In former times this was part of the Hungarian Empire, but had been settled extensively by Germans.*

sion perhaps 15 million years ago (a caldera is the same geologic formation as Crater Lake, Oregon). (Figure 18). On the hillside overlooking the city, an old foundry can be visited where a few tellurium coins were minted as commemorative souvenirs (Figure 19).

Kremnica is 45 kilometers north of Banská Štiavnica. This historic mining town, once the principal gold producer of Eastern Europe, is important because it is here that the iconic "crossed hammers" originated. (Figure 20) This logo has been used for centuries, spreading all the way across northern Europe through Germany to Norway, adorning buildings, badges, and mine uniforms during parades.[1b] Gold mining in Kremnica (original Hungarian name Körmöcbánya) dates back to the 12th century, and in the 14th century was granted permission to mint its own gold coins by the King of Hungary. The Kremnica mint, still active in Kremnica, is famous for having produced important gold coins—in particular, the gold ducat, a gold coin about the size of a U.S. dime (last minted in 1881). This coin was prized for its purity and was immediately recognized and accepted throughout Europe for centuries, with a reputation of arguably being the hardest currency in the continent (Figure 21).




*Figure 19. This tellurium coin was minted in Banská Štiavnica, dated 1896. The inscription reads "Selmeczbanya Magy Kir Femkoho" ("Hungarian Royal Smelter at Selmeczbanya").*



*Figure 20. Crossed hammers in Kremnica, at the site of a historic mine, 45 kilometers north of Banská Štiavnica. The crossed hammers motif, so common throughout mines of Europe, originated in Kremnica in the 13th century.*

**Mendeleev's legacy.** The original home of the family of Dimitri Ivanovich Mendeleev (1834–1907)[1e] was in Tobolsk, 500 kilometers east of Ekaterinburg. The family established a glass factory on the slopes of the Aremzyany River in the village of Verkniye Aremzyany, 20 kilometers northeast of Tobolsk. (Figure 22). It was here that Mendeleev learned the rudiments of chemistry as he learned the art of preparing different colored glass. Mendeleev's father died in 1847; soon afterward, the glass factory burned down and in 1849, Mendeleev's mother took him to St. Petersburg. Two decades later, he won fame as one of the originators of the Periodic Table.[1e]

Mendeleev last visited this village in 1899. In the local school at Verkniye Aremzyany, a special exhibit has been created to honor the legacy of Mendeleev, featuring a plaque, several posters, and numerous photographs. Examples of the glass products—glasses, bottles, and vases—and others can be viewed in the Kremlin Museum on top of a hill overlooking Tobolsk (N58° 11.95 E68° 15.12).

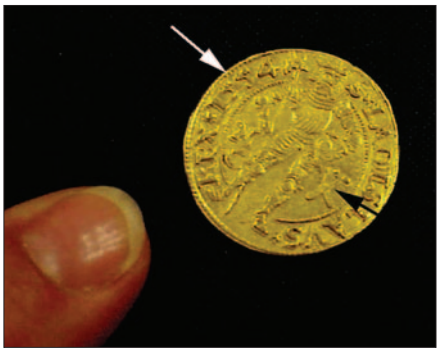


*Figure 21. Hungarian ducat, dated 1554 (white arrow) and showing the crossed hammers icon (black arrow). (The author's finger is included to show size.) This particular coin was actually minted at Nagybánya (now Baia Mare, Romania); the Kremnica ducat did not include this icon, otherwise is the same). This specimen is in the coin exhibit of TUI (Touristik Union International), Hannover, Germany.*

## References


1. J. L. Marshall and V. R. Marshall, *The Hexagon of Alpha Chi Sigma*, (a) "Tellurium," **2000**, *91(3)*, 43–45; (b) "Freiberg, Germany," **2001**, *92(2)*, 20–22; (c) "Vanadium, Mexico," **2003**, *94(4)*, 60–62, 65; (d) "Chromium, beryllium," **2004**, *95(2)*, 24–28; (e) "Mendeleev, Lomonosov," **2007**, *98(2)*, 23–29; (f) "Platinum group," **2009**, *100(1)*, 8–13; (g) "Ruthenium," **2009**, *100(2)*, 20–23, 31; (h) "Hungarian connection," **2016**, *107(2)*, 20–25.

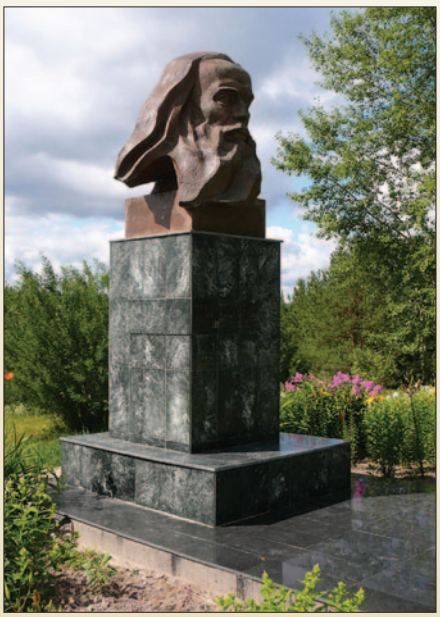



*Figure 22. This monument devoted to Dimitri Mendeleev overlooks the Aremzyany River in the village of Verkniye Aremzyany, near Tobolsk, Siberia (N58° 18.25 E68° 35.15). The glass factory of Mendeleev's family lay down the slope from this monument.*