Rediscovery of the Elements: Tellurium and Faţa Băii (Fascebanya), Romania.

James L. Marshall, *Beta Eta '71* and Virginia R. Marshall, Department of Chemistry, University of North Texas, Denton TX 76203-5070; *jimm@unt.edu*; Computer Technology, Denton ISD, Denton TX 76201

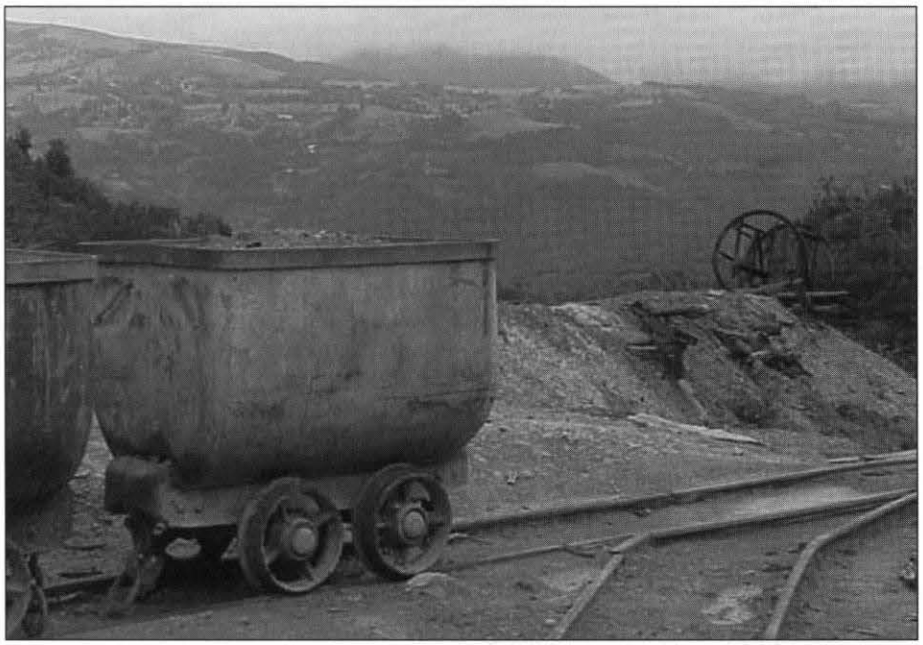

Figure 1. The Faţa Băii mine area is in the Transylvania region, a brooding environment that gave rise to the Dracula stories. Faţa Băii was known as "Fascebanya" (the Hungarian name) in the original literature two hundred years ago.

Figure 2. The tallus slopes, rich in pyrites, extend 200 meters down from the mines.

Edward Daniel Clarke (1769–1822), Professor of Mineralogy at the University of Cambridge, was an ambitious explorer visiting countries ranging from Russia to Africa to Sweden. In an 11-volume series (1), he meticulously set down his experiences as he observed chemical factories, mines, and laboratories, as well as the countryside and the culture of the peoples. One of his trips took him through Transylvania, in 1802, which was "the only country in the whole world where tellurium has yet been discovered."

As part of our "Rediscovery of the Elements" ACS Speaker Tour Project, we sought the ancient site where tellurium was discovered (2). Our guides included Clarke's description (3) and a subsequent account and commentary of Clarke's travels (4) including copies of old maps.

The original name of the mine where tellurium was discovered—Fascebanya (Hungarian)—is now called Faţa Băii (Romanian); and the city where Müller von Reichenstein performed the chemical discovery of tellurium, was then known by the German name of Hermanstadt, but is now known by the Romanian name of Sibiu[1].

Our search for the old Fascebanya Mine took us to the Babes-Bolyai University of Cluj-Napoca, an eight-hour train ride east of Budapest, Hungary. Our hosts were Dr. Dana Pop, Curator of the Mineralogical Museum, and Dr. Valer Toşa of the Institute of Isotopic and Molecular Technology of the University. Study of geological maps identified the mine area near Zlatna, which was reached by a 3-hour drive from Cluj-Napoca. From Zlatna a group of geologists guided us via an ascending muddy road to the final site in the Transylvanian forests above. This group of geologists was headed by an Australian company that was investigating the reclamation of residues accumulated over the past several hundred years in the "Golden Quadrilateral."[2] The ascending road terminated at a base camp (Figure 1), from which a 30-minute hike through the mud and woods led to the final mine site, identified by a huge tallus slope (Figure 2). At the top of the tallus

slope was an old wooden frame, rotting but still intact—the ancient Fascebanya Mine (Figure 3).

From Zlatna we drove to Sibiu (150 kilometers distance), where we visited the Muzuel de Istorie Naturala Sibiu, also known as the Brukenthal Museum, which housed pharmaceuticals, ancient pottery, minerals, and an art collection. The curator, Mr. Viorel Ciuntu, led us to the ancient Brukenthal collection, described by E. D. Clarke 200 years previously (1). This collection consisted of huge samples of gold minerals, 10–30 centimeters across, which on the Western market would fetch thousands of dollars in price. The main minerals were elemental gold, Schreib Tellur, and nagyagite. "Schreib Tellur" is German for "graphic tellurium," named so because it grew in huge splays of graphite-like rods (Figure 4). This mineral is equivalent to our "sylvanite," $AuTe_2$[3], actually named after the Transylvanians (5, 6), and was the mineral from which tellurium was originally discovered[4]. Nagyagite, $Pb_{13}Au_2Sb_3Te_6S_{16}$, was named for the ancient gold mine of Nagyag (5), still operational.

Figures 5 and 6 serve as a guide for future visitors of the Fata Baii Mine. GPS (Global Positioning System)[5] was used to prepare the detailed map of Figure 6.

Figure 3. Entrance to Fata Baii Mine, difficult to spot because of the rich woodlands and vegetation. Left to right: J. L. Marshall (author) and Virgil Berberich (leader of the transportation party).

Acknowledgments

Extreme gratitude is extended to Dr. Dana Pop, Mineralogical Museum, Babeş-Bolyai University, Cluj-Napoca, 1, Kogalniceanu St., Romania, whose gracious hospitality and planning allowed the success of this enterprise. Dr. Pop also translated the critical portions of reference 7 into English. Thanks are also given to Dr. Valer Toşa, Institute of Isotopic and Molecular Technology, P.O. Box 700, R-3400 Cluj-Napoca, Romania, who accompanied the tour and helped with English-Romanian translations. The authors are particularly indebted to Viorel Ciuntu, Muzeograf, Muzeul de Istorie Naturala Sibiu, whose cooperation and knowledge allowed us to view the ancient mineral collections and to understand the local history of the chemical investigations. Finally, the geologists—Virgil Berberich, Laurenţiu Nădăşan, Líviu Tusa, and Pascu Oaída—are warmly acknowledged for providing the transportation to the final site.

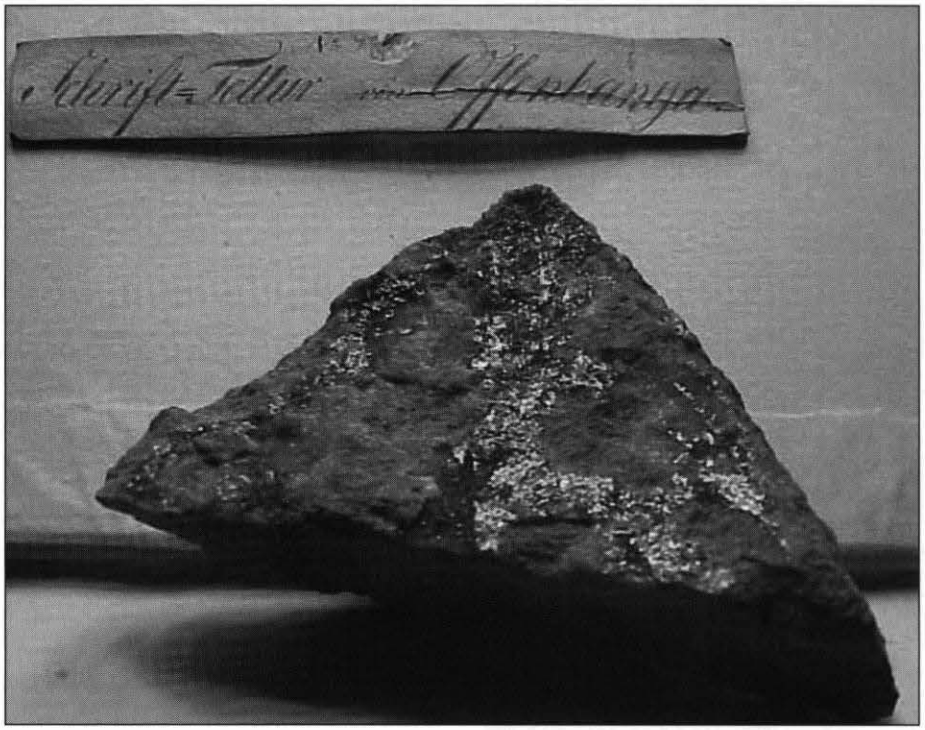

Figure 4. Sample of "Schreib Tellur" or "graphic tellurium" (sylvanite, $AuTe_2$), so named because of the long pencil-like rods. Sylvanite was almost certainly the mineral from which Müller von Reichenstein isolated tellurium. This superb 15-cm diameter sample was collected and labeled by some unknown collector as long as 200 years ago. The collection site was Offenbanya, now known as Baia de Arieş.

Notes

1. Faţa Băii is Romanian for "face of the mine;" the Hungarian "Fascebanya" is a phonetic transcription. The area is also known by its Latin "Facebai mons." The mountains of the immediate area have been described as the "Faţa Băii Mountains," "Zlatna area mountains," "Munţii Metaliferi," "Munţii Apuseni de Sud," etc. The mine that Clarke visited, the Nagyag Mine (Hungarian name), is now known as Săcărimb (Romanian), and has been known under other variants. Some samples of tellurium-bearing minerals were procured from other mines in the Fata Baii Mountains, under the names of Mariahilfe Mine, Maria Loretto Mine, etc., with exact locations unknown.

2. The "Golden Quadrilateral" is a 800-square kilometer area defined by the four cities Offenbanya (present Baia de Arieş), Brad, Nagyag (present Săcărimb), and Zalatna (present Zlatna). In Clarke's maps the area is known as "Siebenbürgen" or "Transylvania" in the country of Hungary of the Austrian Empire.

3. Sylvanite is technically known by the formula $(Au,Ag)_2Te_4$ (5), but in the gold-rich Romania area of interest the formula may be considered $AuTe_2$. Some variations of the formula of nagyagite include Bi substituting Sb (5, 6).

4. There has been some ambiguity in the exact source of the original tellurides used in Müller von Reichenstein's work (2)—Clarke himself stated that tellurium was discovered only in Offenbanya [Baia de Arieş] and Nagyag [Săcărimb] (1), but this is in error. A detailed analysis of the early history of tellurium (7) makes it clear the original site was in the Zlatna region. The first mention on the tellurium ore was 1767 by Fridvaldszky who mentioned an ore (previously unknown in Europe) from the Faţa Băii area which "when burned" formed gold dew-drops (8). A succession of investigators—Born (9), Brünnich (10), Fichtel (11), and Ruprecht (12)—continue the investigation on Faţa Băii material. Müller von Reichenstein first fully characterized the ore and concluded in 1785 that it contained a new earth (13). The title of his contribution ("Fortsezung der Versuche mit dem in der Grube Maria Hilf in dem Gebirge Facsebay bey Salathna in Siebenbürgen vorkommenden vermeinten gediegenen Spiesglaskönig") likewise makes it clear this analysis was on Faţa Băii material (13). Probably Müller von Reichenstein was analyzing mostly sylvanite ($AuTe_2$) (7), but this is not absolutely certain, because he undoubtedly dealt with various mixtures including not only tellurium minerals but also native tellurium, bismuth, antimony, and gold. Klaproth, who performed the ultimate characterization of tellurium in Berlin, named it, and gave credit to Müller von Reichenstein, also worked with Faţa Băii minerals (14). Klaproth also confirmed the discovery of Paul Kitaibel, a Hungarian chemist who independently found tellurium, subsequent to Müller von Reichenstein (2). The general problem of duplication and priority in original chemical discoveries has been discussed (15).

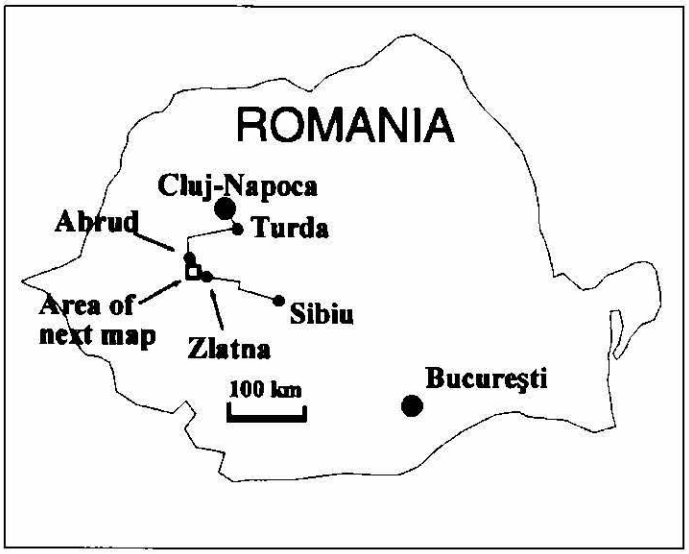

Figure 5. The tour of Cluj-Napoca to Sibiu is a 320-kilometer trip taking two days along a paved highway. The trip to the Faţa Băii starts 3.6 km north of Zlatna (see Figure 6). The ancient mine of Nagyag (not shown on this map), which E. D. Clarke visited, is now called Sacarimb and is not located on highway maps; it is about 40 kilometers south of Zlatna.

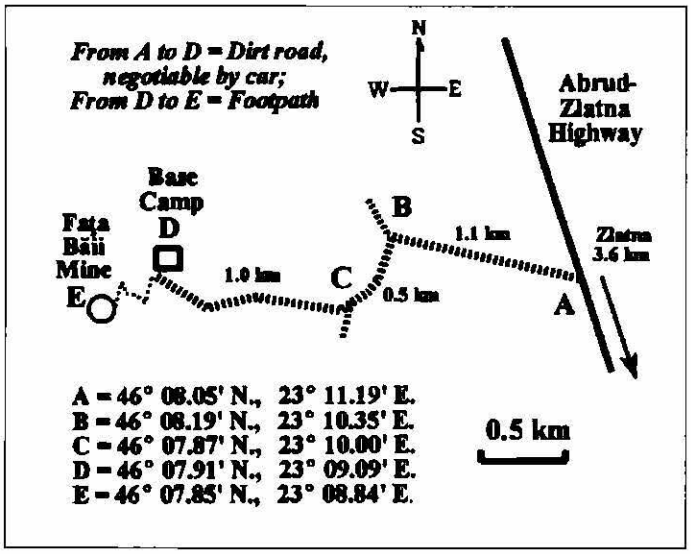

Figure 6. Route from Abrud-Zlatna highway to Fata Baii mine. Intersections A-D are identified by latitudes and longitudes, since there are no obvious or permanent landmarks. Values of lat/long values are considered to be accurate within 0.01 arc minute, which translates to 0.01 nautical mile, or <20 meters (5). From the paved Abrud-Zlatna highway, 3.6 km north of the Zlatna central section, a dirt road proceeds to the west, ending at the Base Camp at a 700 meter (2500 foot) altitude. A rough and ill-defined footpath proceeds up to the Faţa Băii Mine 60 meters (200 feet) higher. Several shafts exist for the Faţa Băii Mine, scattered about a small area.

5. Garmin model GPS 92, Olathe KS. Specifications include an accuracy of 15 meters RMS, subject to 100-meter degradation. The authors have noted an absolute maximum error of 0.04 nautical mile (~70 meters) by observation of a known site over a two-year period.

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