

Rediscovery of the Elements

Germanium: Freiberg, Germany

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Half a millennium ago, alchemy was maturing into chemistry by advancing on two fronts: medicine and mining. In medicine, Paracelsus (Phillipus Aureolus Theophrastus Bombastus von Hohenheim, 1493–1541) was promoting the use of chemical preparations and preached that a medicine possessed a quintessence that could be extracted and used to combat disease.¹ In mining, Georgius Agricola (Georg Bauer, 1494–1555) was preparing classic treatises on mining and metallurgy.² The most famous work of Agricola was *De Re Metallica*, which appeared a year

after his death.³ Agricola lived most of his life in Saxony and Bohemia; he was born in Glauchau, Saxony; worked in Sankt Joachimsthal, Bohemia; and later became Bürgermeister of Chemnitz, Saxony (Note 1). *De Re Metallica*, translated from the original Latin into English by Herbert and Lou Henry Hoover,⁴ not only contains full textual descriptions of the construction of mines and the assay and smelting of metals, but also abounds with detailed woodcut figures. Agricola was one of the first to differentiate among bismuth, antimony, tin, and lead.

The rich mining tradition of this Saxony-Bohemia region carries on to this day and centers about Freiberg, Germany (Figure 1). Annual festivals and parades are held with the miners in their uniforms with the classic crossed hammers (Figure 2). The uniforms are worn with pride, as they commemorate a centuries-old guild tradition that gifted the miners with rank and respect. The crossed hammers, known as “Eisen und Schägel” originated in the thirteenth century near Kremnica, Bohemia,⁵ and are now the universal symbol of mining throughout eastern Germany and the western Czech Republic. Not only can visitors to the region attend these festivities, but they can also roam through scores of mines which in past centuries have delivered silver, gold, nickel, tin, bismuth, tungsten, and copper, and which today are open to the public as “museums.”

One of the famous mining institutes in this region is the Technisches Institut Bergakademie (Mining Academy) in Freiberg, founded in 1765. Freiberg had become the economic and scientific center of the Saxony Erzgebirge region, where silver ore had been discovered in 1168. During the early days of the Bergakademie, chemistry and mining had not yet separated into different disciplines. The best known mineralogist of this time, Abraham G. Werner (1749–1817) of the Bergakademie, was a proponent of the Neptunian hypothesis, which held that geological structures were laid down by water deposition.⁶ Indeed, the present



Figure 1. Freiberg is the focus of mining activity in the Saxony area and boasts the major mining university in the region, the Technisches Institut Bergakademie (the technical institute and mining academy).



Figure 2. Frequent festivities are held celebrating the mining tradition. On the hat of this musician are the famous “crossed hammers” (“Eisen und Schägel”), the symbol of the miners in the Saxony and Bohemia regions. Inset: close-up of pewter chalice with “crossed hammers” and the miner’s greeting “Glück auf!”

famous Mineralogical Museum at the Bergakademie is named after him.⁷

Of the hundreds of mines about the region, one particularly rich mine named the Himmelsfürst Mine in St. Michaelis (about 15 kilometers south of Freiberg) yielded an unusu-

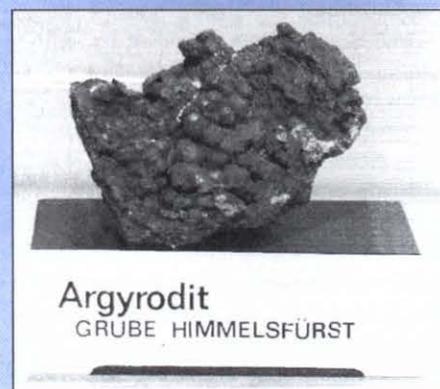


Figure 3. Argyrodite, Ag_8GeS_6 , collected from the Himmelsfürst Mine south of Freiberg, and displayed in the Werner Mineralogical Museum. Argyrodite was the source of the germanium discovered by Winkler. “Grube” translates as “mine.”

debris, and only abandoned, torn-down stone ruins may be occasionally found (Figure 9). An occasional tourist sign marks the site of a previous shaft (Figure 10).

For visitors interested in an active mine, perhaps the most interesting, and certainly the most convenient, is the Himmelfahrt Fundegrube Mine which produces silver to this day on the outskirts of the city. Other important sites which may be reached by day trips in a rented automobile include St. Joachimsthal (Jáchymov, Czech Republic), whence the Curie's radium ore originated, and Johanngeorgenstadt, the source of Klaproth's uranium ore—but descriptions of these will have to wait until a future installment of *Rediscovery of the Elements*. To the interested tourist who wishes to visit mines and mining museums, a most informative brochure has been developed by the Tourist Bureau.¹¹ Visitors to the Erzgebirge are greeted with a friendly "Glück Auf!"—the historic standard miner greeting (Note 4)—as they visit mines, museums, hotels, and restaurants in this very beautiful and scenic region of the world. ☉

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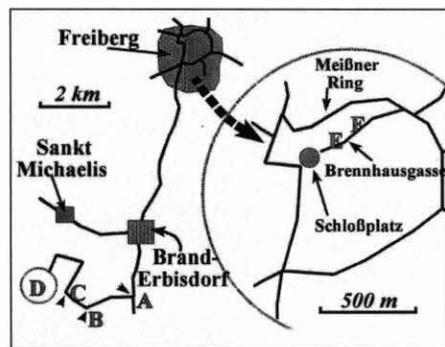


Figure 8. Maps of Freiberg and Himmelsfürst Mine. Olbernhauer Strasse from Freiberg proceeds south (Route 101) through Brand-Erbisdorf, about 5 km south. About 2 km south of Brand-Erbisdorf, a right turn (west) at "A" (N 50° 51.48', E13° 19.15') leads one into the general Himmelsfürst region south of Sankt Michaelis. "B" = N 50° 51.30', E 13° 18.37'; "C" = N 50° 51.38', E 13° 18.12'. The "D" region holds several historical markers and evidence of mines (talus, stone ruins): N 50° 51.74', E 13° 17.77'; N 50° 51.84', E13° 17.62'; N 50° 51.57', E 13° 17.40', among others. The inset of Freiberg shows the location of Winkler's laboratory at 5 Brennhausegasse ("E" = N 50° 55.21', E 13° 20.70'). About 100 meters down the street (west) is the famous Werner Mineral Museum (Mineraliensammlungen der Bergakademie).



Figure 10. Historical post identifying an old shaft. The shafts have long been filled in and little evidence remains except for a few talus piles and stone ruins.

Woman's University, Denton, TX, who helped the authors with the German translations and etymologies.

Notes

1. Saxony is present-day Eastern Germany and Bohemia is the Czech Republic. Joachimsthal is the etymological source of "thaler" and "dollar." St. Joachimsthal is now known by its Czech name "Jáchymov."

2. Blowpipe analysis originated in Sweden in the 1700's and its methods were further refined at the Bergakademie during the next century.¹² By blowing through a 20-cm curved pipe through a candle or burner, an operator could project smelting-furnace temperatures on a test sample as small as a pepper seed. By directing the stream either through the oxidizing portion or reducing portion of the flame, and by varying the types of fluxes or reagents, the analyst could gain a great deal of information about the constituents of a sample. Typical tests included: color of the oxide layer; behavior during decrepitation; physical aspects of a glass or borax bead; color of the flame itself. Blowpipe analysis was an art that demanded experience and talent, but in the right hands was capable of even quantitative analysis by measuring the amount of a chemical derivative bead.¹²

3. The Technische Universität Bergakademie Freiberg Institut für Wissenschafts—und Technikgeschichte boasts a long line of well-known faculty and students. A few are mentioned here: Carl F. C. Mohs created the Mohs hardness scale for minerals; Hiernonymus R. Reichter and Ferdinand Reich discovered indium; the famous world traveler Alexander Humboldt was a student there.

4. Historically, a typical greeting among city folk was "Glück zu [Sie]," i.e., "Luck to you." The country folk (miners) distinguished themselves with a play on words by using "auf" ("on") instead of "zu" ("off"). The expression "Glück auf" has stuck ever since, and can be found on buildings, signs and documents. The famous Werner Museum has such a greeting on its stone edifice.

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Figure 9. One of the few mine entrances remaining in the Himmelsfürst ("heavenly prince") region.