Rediscovery of the Elements

Althofen, Austria and Auer von Welsbach

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Tucked away in South Austria (Figure 1) is the relatively unknown Kärnten region (Carinthian Range of the Alps), with rolling landscape and distant white-capped mountains. Here one can find the treasure of the Welsbach Museum, a tribute to Baron Carl Auer von Welsbach (1858–1929), a fascinating and prolific chemist.

We reached this historic site after a four-hour meandering train ride from Innsbruck, disembarking at Treibach, Austria onto a desolate platform (see Figure 2). Some school children were passing by and we asked directions to the Prechtlhof Hotel, where we had reservations. "Ja, ja, folgen Sie uns" they chattered as they trotted up a hillside trail. They giggled as they glanced back at us, huffing and puffing, struggling to keep up, with our packs on our backs. After 20 minutes we arrived at the summit; they pointed at the hotel and departed. The panorama was gorgeous (Figure 3). The quiet atmosphere of the Prechtlhof was elegant and the hospitality was sumptuous.

The Welsbach Museum can be reached by a 10-minute walk from the hotel (Figure 4). The museum, open only since April, 1998, holds six large rooms devoted entirely to Auer von Welsbach, his life, and his work. The museum has displays commemorating the productive and imaginative life of Welsbach (Figure 5), including the first metallic filament incandescent lamp (note 1), the world's largest display of cigarette lighters (note 2), and the incandescent "Welsbach mantle" which is used in outdoor and camp lanterns today (note 3).

In the "Chemical Room" of the Museum are Welsbach's original samples of praseodymium and neodymium ammonium nitrate salts (a brilliant apple-green Pr and a rich magenta Nd) which he separated after 167 crystallizations from "didymium" salts in concentrated nitric acid solutions.[3] Didymium had been discovered by Carl Gustav Mosander of Stockholm in 1841, which he separated from lanthanum.[4] Welsbach not only discovered these two rare earths, but also "cassiopeium" and "aldebarium,"[5] presently known as lutetium and ytterbium (note 4).

In another room of the Museum is a complete replica of Welsbach laboratory, with the original equipment and furniture. Also stored are hundreds of bottles containing Welsbach's

Figure 1. Austria lies in the Eastern Alps region of Europe. The Kärnten (Carinthian) region of south Austria is shaded, in which the Welsbach Museum at Althofen is located. Auer von Welsbach performed his original work in Vienna, and later settled in Treibach. Other sites of interest to the traveling scientist include Salzburg, where Paracelsus lived during the latter part of his life; München with the Technisches Museum; and Bolzano with its Museo Archiological, the final resting place for Ötzi, the iceman. Innsbruck is a famed summer and winter resort.

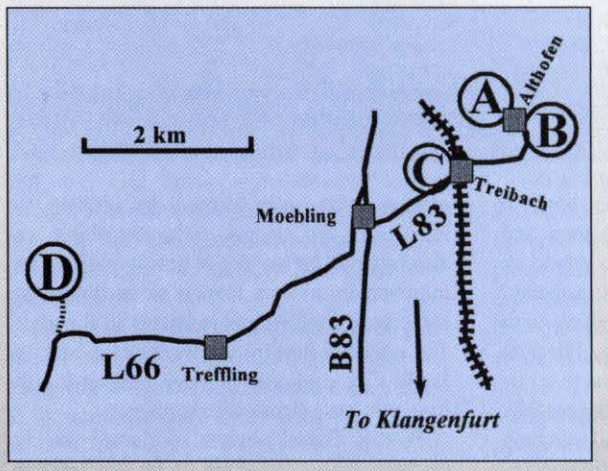

Figure 2. The Welsbach Museum (A) is situated at the highest point in Althofen at 800 meters (N 46° 52.52; E 14° 28.43). The Prechtlhof Hotel (B) is 300 meters down the road (N 46° 52.37; E 14° 28.54). Welsbach performed his later work at Treibacher Industrie (C), on Auer-von-Welsbach-straße (N 46° 52.10; E 14° 27.74). His home, Schloß Welsbach, Welsbach Castle, (D), which is not open to the public and cannot be seen from public roads, may be reached by driving 5 kilometers west (N 46° 51.32; E 14° 23.70).

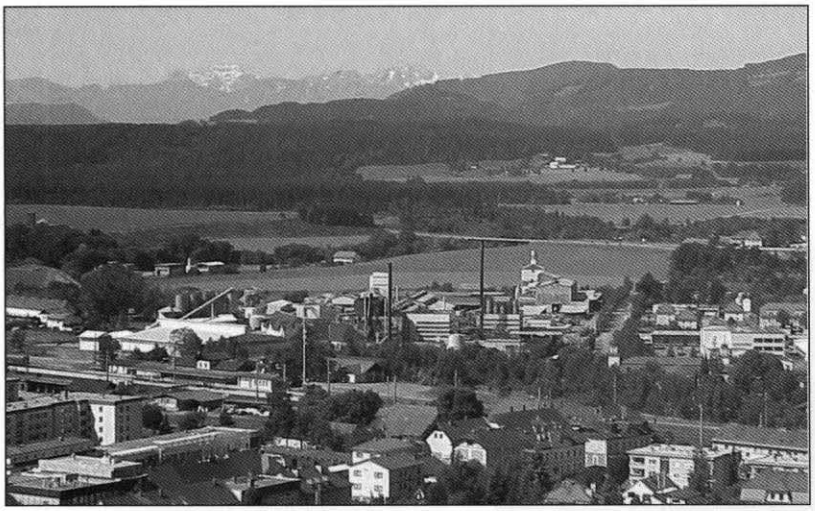

Figure 3 (LEFT). View westward from Althofen, looking towards the Welsbach Castle (which cannot be seen) and over Treibacher Industrie in the Gurk River valley. In the distance are the snow-covered Alps. Welsbach established this company in 1907 ("Treibacher Chemische Werke GesmbH") for the production of ferrocerium lighter flints under the tradename "Original Auermetall." Today the company produces various alloys and catalytic powders.

Figure 4. Auer von Welsbach-Museum at Burgstraße 8, Althofen, Austria, constructed inside a 12th century dwelling. Inside are six large rooms devoted to exhibits and memorabilia of the life of Carl Auer von Welsbach. Inset: Plaque on side of building.

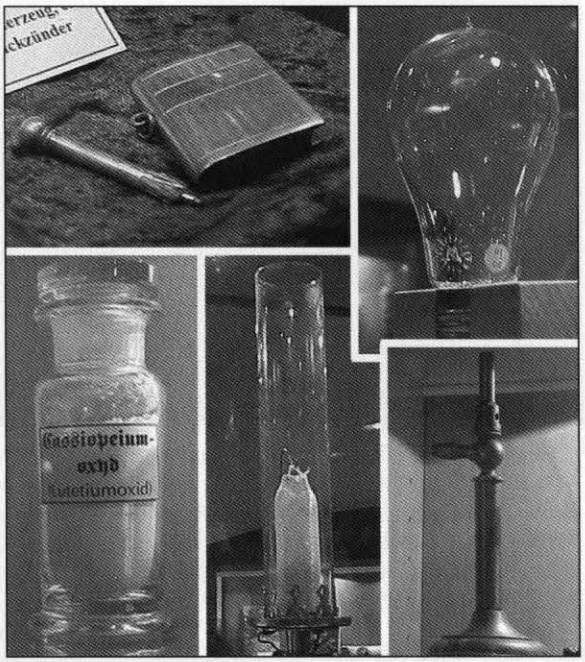

Figure 5. A montage of selected exhibits at the Welsbach Museum include (starting upper-right, clockwise): osmium filament light bulb; an original Bunsen burner from Heidelberg (where he was a student); the Welsbach mantle with its "Glühstrümpf," or "glowing stocking"; casseopeium (lutetium) oxide; and a gold "Sunday lighter" showing the detached striker. The vast collection of exhibits exemplifies the phylogeny of Welsbach's inventions by hundreds of lighters, strikers, lamps, and bulbs. Welsbach was an expert glass-blower and made the first use of borosilicate glass.

separated products of lanthanides and actinides. Welsbach had isolated measurable amounts of "ionium" (thorium-230) which were used by Ernest Rutherford in his own studies of radioactive elements. The plate camera used by Welsbach in his pioneer color photography studies is included in the collection, as is the spectroscope and spectra used in the identification of the rare earths. Welsbach learned his spectroscopic techniques while a student with Robert Wilhelm Bunsen at Heidelberg University.

The entrance room of the Museum includes photographs and other memorabilia outlining the life of Welsbach and his family, including a self portrait, in color, identifying Welsbach as the first color photographer in Austria. The volumes from the personal scientific library of both Robert Bunsen and Auer von Welsbach are on the second floor.

Figure 6. Schloß Welsbach, the home of Carl Auer von Welsbach, hidden in dense forest 5 kilometers west of Treibach.

During his later life, Welsbach lived at Schloß Welsbach (Welsbach Castle), 5 kilometers west of Treibach. Although this is not open to the public, the proprietor of Prechtlhof kindly drove us to the site, negotiating the serpentine dirt roads through the forest. The castle (Figure 6) testifies to the magnificence of Welsbach and his work, where he nurtured an exotic garden and pursued hobbies of ornithology, photography, and his beloved chemistry.[10]

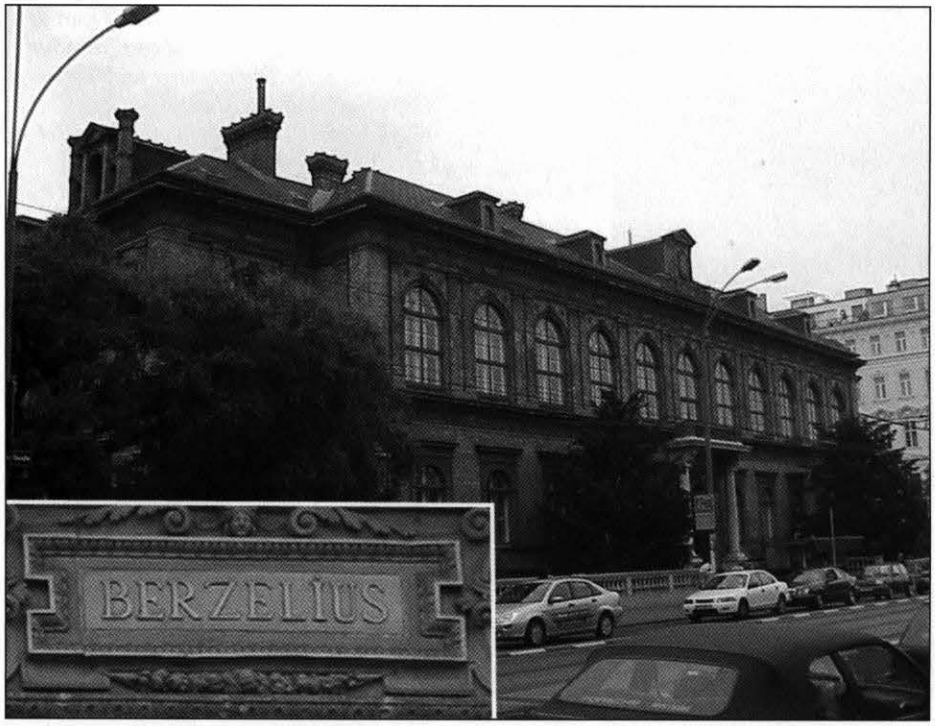

Figure 8. University of Vienna, Chemistry Building, where Welsbach discovered praseodymium and neodymium (N 48° 12.97; E 16° 21.62). The laboratory was in the basement. Now the building houses the Institut für Medizinische Chemie der Universität Wien (Medical chemistry, University of Vienna). This building is 1.0 km north-northeast from the Hofburg (the Imperial Castle of Vienna). Inset: Close-up of one of the 29 chemists' names engraved around the parapet.

His seventieth birthday was celebrated by a lavish festivity in 1928, a year before his death.[11] Now the castle is quietly maintained by his family.

In 1901 Franz Josef I, Emperor of Austria and King of Hungary, bestowed upon Welsbach the title of "Freiherr" (Baron) (Figure 7). As Franz Josef congratulated Welsbach upon the many discoveries, the ever business-minded but beneficent Welsbach responded, "Thank you, up to now over 40,000 persons have won gainful employment through my discoveries."[11]

The old chemistry building of the University of Vienna, where Welsbach performed his original work, including the separation of praseodymium and neodymium, still stands (Figure 8). Close by, a monument dedicated to his work (Figure 9) stands at the current departments of analytical and organic chemistry at the University of Vienna. Inscribed on the stone are the words "plus lucis" ("more light"), a maxim that guided him throughout his productive life.

Acknowledgments.

The authors wish to thank Mr. Roland Adunka, proprietor of the Welsbach Museum, for supplying the bulk of the information used in this report,[12] and for giving directions to Schloß Welsbach and the relevant sites in Vienna.

Notes.

1. After Thomas A. Edison's carbon prototype in 1879, Welsbach in 1898 first produced a light bulb with a metallic filament, using osmium. After a subsequent interlude of tantalum's use as a filament, the tungsten filament bulb was invented by William David Coolidge of General Electric Company in Schenectady, New York, in 1910.

2. While working with Robert Bunsen, Welsbach learned that cerium when struck would emit sparks. Welsbach utilized this idea to invent the "striker" cigarette lighter, and later the "rotary" cigarette lighter. He developed ferrocerium, which is still used as the "flint" in cigarette lighters. Selecting the most effective pyrophoric composition of 70/30 Ce/Fe, Welsbach named this substance "Auermetall." At the museum one can purchase working examples of the "striker" lighter ("Treibacher Feuerzeug," meaning "Treibach match-box") that Welsbach invented (Figure 5).

3. The original Welsbach mantle was impregnated with incandescent yttrium/lanthanum oxide; later versions used thorium oxide (99:1 thorium oxide:cerium oxide being the most effective). By the early 1930s street lighting in London was equally divided between gas (mantles) and electricity (bulbs).[1] For a review of illumination, including the competition between the incandecent mantle and the incandescent bulb, see ref 2.

4. Welsbach first reported the spectroscopic identification[6] of the two elements two years before Georges Urbain of Paris claimed the discovery.[7] Lutetium was also independently discovered by Charles James of New Hampshire, and Welsbach.[8] Welsbach worked out detailed separation techniques for the rare earths (by means of tartrates, citrates, malonates, maleates, and succinates) using chemical operations which paralleled those of Charles James. The history of the discovery of lutetium, its claims, and its counterclaims have been discussed.[9]

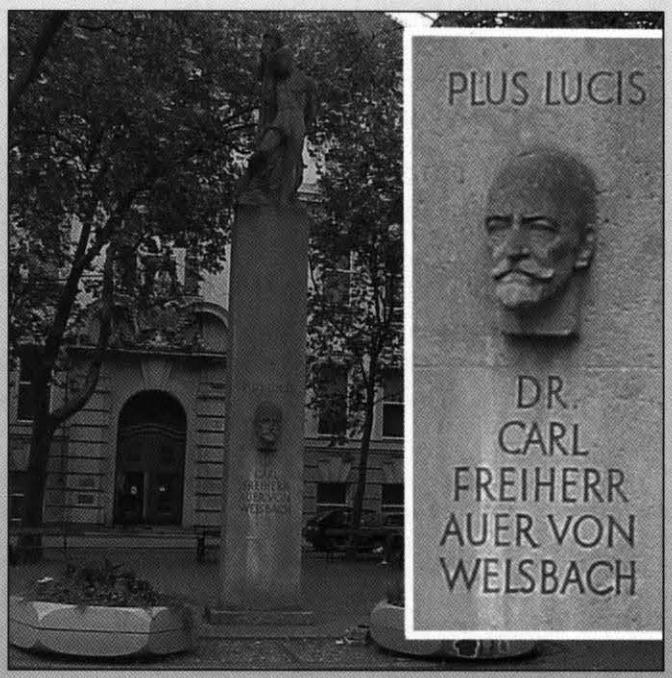

Figure 9. Denkmal (monument) of Welsbach, erected in 1935, in front of the present Institut für Analytische Chemie der Universität Wien and Institut für Organische Chemie der Universität Wien (analytical and organic chemistry, University of Vienna) (N 48° 13.21; E 16° 21.39), at the corner of Boltzmanstraße and Währingerstraße, 0.6 km north-northeast of old chemistry building. Inset: Close-up, showing the maxim that powered Welsbach's life: "plus lucis" ("more light").