Rediscovery of the Elements

Klaproth and Berlin: How Jim and Jenny tracked down the discoverer of uranium.



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Jenny and I had just visited Cornwall,[1] England, where William Gregor, "The Scientific Parson" (1761–1817), had discovered titanium in the village of Manaccan. This element was found in "black sand" in a stream washed down from the Goonhilly Hills above. This sand was unusual because it "followed the compass," i.e., was magnetic. This black sand is known today as "ilmenite" (iron titanate, $FeTiO_3$,). Jenny was surprised to learn that the new element, originally called "menachanite" by Gregor, was actually named titanium by Martin Heinrich Klaproth (1743–1827) of Berlin. We were now on a flight to Berlin to investigate this German chemist.

"Wasn't the discoverer of an element customarily given priority in the naming of a new element?" asked Jenny.

"Klaproth was recognized as perhaps the most important chemist of his time," I answered. "He was asked many times to confirm the results of others as they studied the composition of minerals. He developed gravimetric analysis and gave special attention to quantitative measurements. He refused to recognize a discrepancy in analysis as simply an error in experimental procedure, but instead he realized that these inconsistencies were indicating a more complicated formula. For example, Klaproth recognized that water of hydration was actually common in minerals; he proved that gypsum ($CaSO_4 \bullet 2H_2O$) was identical chemically to anhydrite ($CaSO_4$). The composition of Plaster of Paris, originally described in France, rapidly followed from his developed analyses to be an intermediate hemihydrate ($CaSO_4 \bullet \frac{1}{2}H_2O$). Another example of how his exacting work led to deeper understanding of mineral composition involved potassium. Potassium had been considered to be a substance existing only in the Plant Kingdom—hence, the origin of the name 'potash,' i.e., 'ashes from the pot.' In chemical analysis potassium was commonly observed but was presumed to be a remnant of reagents used in the chemical procedures (KOH, K_2CO_3, etc.). However, because of his meticulous methods, Klaproth showed that potassium was actually very common in the Mineral Kingdom, and is an abundant element in crustal silicates. Feldspars, for instance, are commonly potassium silicates. His methods were so advanced and refined, that he was called "the creator of the art of analytical chemistry."[2]

"So why isn't Klaproth recognized as the discoverer of titanium?"

"Klaproth did not offer his services for recognition, and he modestly never sought publicity. He was known to be generous and kind to all."

"Where did he perform his laboratory work?"

"In pharmacies where he worked. He began his important discoveries in Berlin as an apprentice of Valentine Rose (1736–1771), the discoverer of Rose's metal (an alloy of lead, bismuth of lead."

"Sounds like solder, which you dealt with when you worked with electronics for Motorola."



Figure 1. This painting (ca. 1800) locates the The Rose pharmacy; it is entitled "Die Rosesche Apotheke, gegen ber der Heiligen-Geist-Kirche in Berlin zu Anfang des vorigen Jahrhunderts" ("The Rose Pharmacy in Berlin at the beginning of the previous century"). The wall to the left is the church, as was established by a subsequent painting (see FIGURE 2). From Fritz Ferchl, Von Libau bis Liebig: Chemikerköpfe und –Laboratorien, *Mittenwald, 1930.* Courtesy, Kupferstichkabinett, Staatliche Museum zu Berlin. *This figure actually appears in M. E. Week's* Discovery of the Elements, *but she does not mention the church.*

"In electronics, Rose's metal is too low melting for electronic appliances, with a melting point around 95°C, even below the boiling point of water. Ordinary tin-lead solder, the most common composition in today's appliances, melts at 183°C. At Motorola we tried to discover a new composition to substitute the customary alloy of tin and lead for solder—because the rage at that time was to eliminate lead from the environment. We tried to concoct

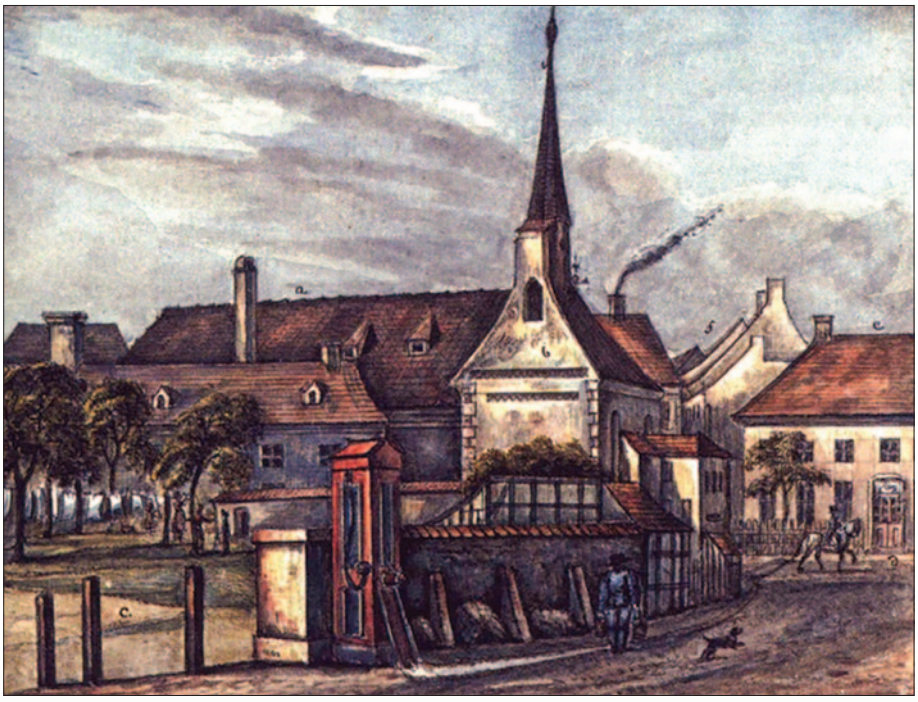


Figure 2. This water color painting by Leopold Ludwig Müller (1804) verifies the relative position of the church and the pharmacy in 1804. Courtesy, Kupferstichkabinett, Staatliche Museum zu Berlin.



Figure 3. Photograph of the Holy Ghost Church from the Catholic Archives. The pharmacy is to the right. This view is from the opposite direction from the paintings of Figures 1 and 2. The date is uncertain, but it was pre-World War II, but not before 1906, when the modern tower was built. Private communication, Fritz Schwalm, Texas Woman's University, Denton, TX.

an alloy of bismuth and tin—but never succeeded."

"So, what's the story about Klaproth and Rose?"

"Rose was owner of an apothecary in Berlin. After he died, Klaproth took over. I tried to locate this pharmacy, and came upon this old painting (FIGURE 1). We were able to obtain this from the Berlin Museum of Prints and Drawings (Kupferstichkabinett, Staatliche Museum zu Berlin). It does not show the church, but the title was given to us by the Museum: "The Rose Pharmacy directly across from the Holy Ghost Church" [translated from the German].

"But where's the church in the painting?"

"Immediately to the left, out of view. We were able to obtain a different painting from the Berlin Museum which shows both the church and the pharmacy (FIGURE 2). The name of the pharmacy was "Zum Weissen Schwan" ("The White Swan"). If you look very carefully, you can barely discern in both paintings the white swan over the door of the pharmacy."

"So that's why you said we should visit this church, hoping to find some remnants of this pharmacy."

"And we can locate the present location of the church on today's map of Berlin, here it is, on Spandauerstrasse. Moreover, we even have a photograph giving a more recent view of the pharmacy and the church, from a different perspective. Our good colleague from biology department of our sister institution in Denton furnished this; he is originally from Berlin." (FIGURE 3).

"It should be easy to find the pharmacy!"

"We can hope. I remember, when you were doing genealogy in West Texas, you have often been disappointed. A person might search for a historic ranch house, and find it to be totally gone, replaced by an apartment building or a parking lot! All we might have here in Berlin is nothing but a story—and a set of GPS coordinates!"



Figure 4. Modern view of the Holy Ghost Church, from the perspective of Figure 3.



Figure 5. The previous pharmacy is now gone, apparently destroyed during World War II, and now replaced by the city's University Bookstore.

"Back to titanium…"

"Yes, Klaproth was responsible for 'co-discovering' several elements, including titanium, tellurium, strontium, beryllium, chromium, and cerium, but in each case he relinquished credit and gave it the respective persons whose names you see in the discovery 'official' list. He shunned praise and was one of the most gentle and charitable persons that lived. When Rose died, Klaproth very kindly assumed responsibility of Rose's sons. One of them died young; the other became an expert chemist checking Klaproth's results. (Valentin Jr, 1762–1807)."

"Did Klaproth receive exclusive credit for any elements?"

"Well, yes…uranium and zirconium. We were able to contact the mineralogy expert at the Berlin Museum of Natural History (Museum für Naturkunde), Dr. Ralf-Thomas Schmitt, Institut für Mineralogie, who agreed to show us the actual specimens that Klaproth used in these discoveries."

"Well… I'm so anxious to see if there is any evidence of Zum Weissen Schwan…Then we'll go to the Naturkunde."

The search in Berlin. After checking into our hotel, we set out for the Heilige Geist Kirche (Holy Ghost Church). The city transportation, as usual for German cities, was swift and efficient—we were soon walking



Figure 6. The Klaproth showcase in the Berlin Museum für Naturkunde, displaying authentic samples of minerals he analyzed as he discovered (or codiscovered) many elements, as well as copies of his famous treatises.



Figure 7. Dr. Ralf-Thomas Schmitt, Institut für Mineralogie, Museum für Naturkunde, Berlin. Dr. Schmitt is showing the authors the original samples of torbernite ($Cu(UO_2)_2(PO_4)_2 \bullet 11H_2O$), which Klaproth carefully analyzed in his discovery of uranium. Also included were samples of the more abundant Pechuran (pitchblende), the common black ore of uranium. There were over 300 of Klaproth's samples in Dr. Schmitt's archives, most of which had original labels.

along Spandauerstrasse, and promptly came upon the church (see Figure 4).

"This is the same view as in the Catholic photograph," Jenny said.

"Yes, the view agrees perfectly." (Figures 3 and 4). "Now all we have to do is to turn around and we will see the old pharmacy site."

We turned, and saw—not a pharmacy, but a high-rise university bookstore! (FIGURE 5).

"Nothing! What a bummer!" Jenny exclaimed.

"Maybe destroyed in the war," I said.

"Let's look for any hint of the old pharmacy— plaques, anything," Jenny urged.

But a careful search inside and outside the church, and along the street beside the bookstore, revealed no information beyond the history of the church itself.

"All we can do is to record GPS data and document the location," said Jenny.

I sadly agreed. "Let's go to the Natural History Museum."

Natural History Museum. The efficient German rail took us swiftly to the Museum für Naturkunde. This museum is well known for its first specimen of Archaeopteryx (first fossil bird with obvious feathers), discovered in the Solnhofen limestone quarries in Bavaria, Germany. In the mineralogical aisles of the museum were fascinating exhibits including the original sample of vanadinite, which Alexander von Humboldt (1769–1859) took from Mexico from Andrés Manuel del Río (1764–1849); this specimen yielded erythronium (as named by del Río) but was not recognized as an element until "rediscovered" in

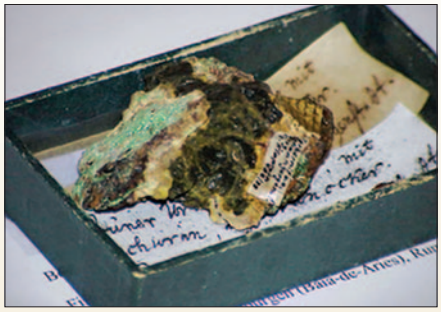


Figure 8. This is the original sample of torbernite ("Grüner Uranglimmer"="green uranium mica") analyzed by Klaproth from the mines at Johanngeorgenstadt, Germany.

Sweden by Nils Gabriel Sefström (1787–1845). But the main focus of the mineral section in the museum was the exhibit on Klaproth, with specimens of all the minerals he analyzed as well as some of his writings (FIGURE 6).

"Look, there's a book written by him as well," said Jenny.

"Yes, 'Beiträge für Chemischen Kenntniss der Mineral Körper'—'Contributions to the chemical knowledge of mineral bodies.' He wrote many articles and several books outlining his modern analytical procedures and mineral analyses."

"That was a lot of work."

"Yes, but that wasn't all. Not so well known to the chemical and mineralogical world was his philosophical contributions to chemistry itself. He carefully repeated the work of the famous French chemist Antoine Lavoisier (1743–1794), who formulated the modern concept of elements that debunked the idea of phlogiston. You have to realize that this demonstration had to be utterly convincing to Klaproth's immediate audience, since phlogiston was originally a German concept."

The museum attendant directed us to Dr. Schmitt in the archives and offices in the rear of the museum, who graciously showed us the original samples of Klaproth (FIGURE 7). Dr. Schmitt told us, "All the literature states that Klaproth discovered uranium in pitchblende (crude uranium oxide), but Klaproth actually characterized it from torbernite, a copper uranium phosphate mineral, from a mine in East Germany (Johanngeorgenstadt), which he carefully analyzed to get a true composition. Here is a sample of torbernite, labeled 'Grüner Uranglimmer' (FIGURE 8). It is fluorescent, glowing bright green in ultraviolet light. This is the original sample he analyzed."

"I understand he never isolated the metal uranium himself," I said, "only the oxide."

"Yes," said Schmitt, "Eugène Melchior Péligot (1811–1890) of France accomplished that later."

Dr. Schmitt also showed us the original zircons from Ceylon that Klaproth analyzed, and we had the privilege of holding them in our hands in a few minutes (FIGURE 9).

"Historic specimens!" Jenny said.



LEFT: Figure 9. The original zircon specimens analyzed by Klaproth, which yielded his discovery of zirconium. We were allowed to hold these historic specimens, collected and analyzed over two centuries ago.



ABOVE: Figure 11. The huge tabletop model of historic Berlin in the Märkisches Museum proved to be invaluable in locating historic landmarks in Berlin, including the apothecaries of Klaproth.



ABOVE: Figure 12. The Märkisches Museum attendant carefully identified the buildings of interest in our exploration of Klaproth's pharmacies. The prominent landmark, The Nicholas church (Nilolaikirche), proved to be quite valuable in pinpointing the Apotheke zum Bären of Klaproth.



Figure 10. This painting in the Märkisches Museum (unknown artist, ca. 1775) portrays the appearance of pharmacies during the time of Klaproth. Apothecaries would import raw opium, willow bark (the source of aspirin), oak-apples (oak galls, for ink), other herbs, barks, roots, and seeds, as well as tobacco, sugar, and brandy.

We told Dr. Schmitt how we had sought the original White Swan pharmacy of Klaproth, but it was now gone. "We understand he purchased and moved to another pharmacy further down Spandauerstrasse," I said.

"Yes, his final pharmacy was at the corner of Spandauerstrasse and Probststrasse," said Dr. Schmitt. It was called 'Apotheke zum Bären' ('Pharmacy of The Bear'). "I suggest if you want to get a good idea of the appearance of Berlin at that time, so that you can locate the location of the pharmacy, you visit the Märkisches Museum, at Am Köllnischen Park in Old Berlin. This is a museum highlighting local Berlin history. It is close to both Klaproth's 'The White Swan' and 'The Bear' pharmacies. He actually performed his most important work at 'The Bear.'"

"That's the next stop on our list!"

Märkisches Museum. This modernistic museum had an impressive collection of paintings, including descriptive renditions of the boisterous insides of old German pharmacies (FIGURE 10).

"This doesn't look like a laboratory to me!" said Jenny. "Looks like a Saturday night bar in Texas."

"Actually, they did serve spirits as well, and it was a regular meeting site for camaraderie and gossip. But the laboratory was in the back, out of sight. Klaproth did his pioneering work in his spare time, away from the crowd."

Of particular interest to us in the museum was a huge tabletop model of old Berlin (FIGURE 11). We spent a full morning studying and speaking with the museum attendant to identify the buildings of interest. She told us, "If you walk up Probststrasse, past the historic Nikolaikirche (St. Nicklaus Church), you will be at the site of your old pharmacy." (FIGURE 12). She continued, "Don't be confused by the street sign, it is 'Propststrasse,' not 'Probststrasse.' This is all part of an official change in 1996 (after the unification of German), as a consonant shift had occurred in the German language in these past many decades. You should have no problem; just find the Nikolaikirche, and follow the street up towards Spandauerstrasse."

Jenny grinned, "Thank the Lord for churches! They are sometimes the only old landmark still existing…Remember the old church in Manaccan? How it guided us to the titanium discovery site?"

The second pharmacy. Another rail ride took us to a stop close to the Nikolaikirche, a most prominent landmark in Old Berlin. And yes, up from the church was Probststrasse—



Figure 13. View northeast along Probststrasse; this street may be known by either "Probststrasse" (old) or "Propststrasse" (new). The Nikolaikirche was the key landmark which led us down the Probststrasse (straight ahead) which historically intersected with Spandauerstrasse. At the end of this view, according to the Märkisches Museum attendant, should be the location where Klaproth's Apotheke zum Bären was located. This street is rich with souvenir shops, prominently offering Berliner Bären (teddy bears). However, the end of Probststrasse was blocked off from Spandauerstrasse (the far wall at the end of the street), visible in this figure.

identified by a street sign spelled "Propstrasse." This delightful street had an abundance of souvenir shops and boutiques, including several teddy bear shops, which featured the famous Berliner Bären (Berlin bears), very popular for the German shoppers visiting from all parts of the country (FIGURE 13).

We trudged up Probststrasse and along its shops until we came to what was supposed to be the intersection of the street and Spandauerstrasse—and found it blocked off by a towering wall! There was a pedestrian passage through the wall, but there was no sign of a pharmacy—instead, just a restaurant, Zum Nussbaum ("Walnut Tree") (FIGURE 14).

"Let's get something to eat," said Jenny, "Aren't you tired?"

"Yes… Well, I guess that's that," I said.

We sat down in the outdoor section and ordered Spargelsuppe (asparagus soup), a seasonable and delectable summer offering, with Brot (bread).

"This is the most delicious soup I have ever had!" said Jenny. "In our restaurant in West



Figure 14. Zum Nussbaum ("Walnut Tree") restaurant at the end of the Probststrasse. The view is the opposite direction as in the previous figure.



ABOVE: Figure 15. Looking from the outside restaurant of Zum Nussbaum, a plaque could be seen on the wall blocking off Spandauerstrasse.

RIGHT: Figure 16. Plaque identifying the original site of the zum Bären, where Klaproth discovered uranium and zirconium. (See text on next page for translation).

Texas that Mom managed, we never served anything like this!" Finishing her lunch, her eyes roamed across the street—and suddenly lit up. "Jimmy, what's that sign on the wall… Way up high, almost hidden in the vines." (FIGURE 15).



"It's a plaque!" We both rushed out and crossed the street. And there it was: this was the site of old pharmacy (FIGURE 16).

"We're here!" exclaimed Jenny.

Indeed, we were. We had found Klaproth. We reverently read the plaque:

[translated] Berlin Memorial Plaques.
At this site, in his apothecary, 'Zum Bären,"
Martin Heinrich Klaproth
(Jan 12, 1743–Jan 1, 1817)
lived and worked from 1780 until 1800.
Member of the Academy of Sciences in Berlin
from 1788 and first Professor of Chemistry in
the Berlin University, which was
founded in 1810. In this apothecary laboratory,
he discovered many chemical elements,
among which was uranium in 1789.
In 1799, he produced the first Prussian
physician's manual.

Time to rest and celebrate! We returned to the restaurant and ordered glasses of white wine and savored the moment.

"Ordinarily I prefer just a glass of tea," said Jenny as she sipped her glass, "but this is delicious! Why don't we get German wine that tastes this exquisite in America?"

"Because the Germans are smart—they keep the best stuff for themselves!"

We sat back and relaxed under the walnut tree of the outdoor restaurant, and reflected on the history of the site. We were swept back in time—this was where the originator of the craft of analytical chemistry performed his art. We breathed in the air that we knew had passed by countless generations and scores of laboratories in Berlin… It was simply divine.

Epilogue. Years later, we were able to obtain a pre-WWII photograph of the Nikolai region (FIGURE 17). It showed the modernized pharmacy, before it was destroyed in the war. The street was not yet blocked off, and clearly showed, in the distance down Probststrasse, the Nikolaikirche.



Figure 17. This is a pre-WWII photograph of the intersection of Probststrasse and Spandauerstrasse; the view is southwest, opposite to that in Figure 13 (Nikolaikirche in the distance). At this time Simon's Apotheke existed on the site of Klaproth's pharmacy (destroyed in 1945). After the war, Probststrasse was blocked off from Spandauerstrasse, but today is accessible via a pedestrian thoroughfare. No pharmacy exists today.

Many times during our tours, Jenny and I have been asked, "Of all the locations you have visited, which is your favorite?" We answered: "There are so many to choose from! … The historic sites of Madame Curie; the old mines in Romania, the spas in Jáchymov in old Czechoslovakia; haunts of Scotland; the pharmacies of Scheele in Sweden … But we had to admit of all the sites, the one that most brings back nostalgic memories of historic chemists was the Nussbaum restaurant, where we could enjoy the German delicacies outside and could quietly view the historic scene, cloistered and uncluttered by tourists and noise … Every time we visit Berlin, we return here to relive Rediscovery."[3]

REFERENCES:

1. J. L. and V. R. Marshall, *The HEXAGON of Alpha Chi Sigma*, **2012**, 112 (3), 40–43.
2. T. Thomson, *The History of Chemistry*, **1975**, Vol II, 206 [reprint of 1830 edition, H. Colburn and R. Bentley, London].
3. More details regarding Klaproth's life are given in J. L. and V. R. Marshall, *The HEXAGON of Alpha Chi Sigma*, **2008**, 99(2), 20–25.

