Rediscovery of the Elements

Thallium, Crookes, and Lamy

With the development of spectroscopic analysis by Bunsen and Kirchhoff and their discovery of cesium and rubidium (1860-1861), the hunt was on for more element discoveries using this new tool. Almost immediately, thallium was independently discovered by William Crookes (1832–1919) and Claude-Auguste Lamy (1820–1878) (Figure 1).

At an early age Crookes developed a passion for photography, a hobby he pursued in his Brook Green home laboratory built for him by his parents in 1851 (Figure 2). Here he developed new photographic techniques which required a wide broadening of his chemical knowledge. Blending his expertise in photography and chemistry, he designed instrumentation and devised techniques in the spectroscopic examination of chemical substances. Hence, by the time Bunsen discovered cesium spectroscopically in 1860, Crookes had already launched his own search for new elements. When his old mentor Hofmann needed a spectroscope in 1861 for a demonstration lecture on Bunsen and Kirchhoff at the new South Kensington Museum, he turned to Crookes for the only high quality instrument equal to the task in the entire British Isles.

The Role of the Independent Editor.

Modern research journals, such as The Journal of the American Chemical Society, utilize a formal protocol of submission and peer review. In earlier years, however, it was common for a journal to be owned and/or managed by an independent editor free to pontificate on various matters. Often a journal would be more easily recognized by the editor’s name, e.g., “Gilbert’s Annalen” (Annalen der Physik) or “Liebig’s Annalen” (Annalen der Chemie). For example, the editor Ludwig Wilhelm Gilbert (1769–1824) would editorialize on the significance of Döbereiner’s Triads (precursor to the Periodic Table), or he would suggest alternate possible names for Stromeyer’s new element isolated from zinc—not only “Kadmium,” but also “Junonium” and “Melinium.” Berzelius in his Jahres-Bericht über die Fortschritte der Chemie und Physik was an entrepreneur and scientific journalist with research achievements in chemistry, physics, and photography. His many inventions included the Crookes tube, the radiometer, and the sphintariscope (Note 1), and he was awarded Fellowship of the Royal Society (1863), knighthood (1897), the Davy Medal (1888), and the Order of Merit (1910).

William Crookes was born to Joseph (1792–1884) and Mary né Scott (1806–1884) Crookes; Joseph was a well-to-do tailor with a home and shop on Regents Street on the west end of London with its prospering gentry (Figure 2). Soon the family would move westward with expanding London. William’s schooling was gained at the new Royal College of Chemistry (Figure 3), founded in 1845 by Prince Albert (consort of Queen Victoria) who was keen on promoting the technology base of Great Britain. Using the German model, Albert invited August Wilhelm von Hofmann (1818–1892) from the group of Justus von Liebig (University of Giessen). At the Royal College Crookes researched selenocyanides (-SeCN compounds) using material procured by Hofmann from the Harz Mountains of Germany.

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Figure 1. Claude-Auguste Lamy (left) and William Crookes (middle) are shown when thallium was discovered and characterized (early 1860s). Crookes lived well into his eighties and his elderly portraits (right) with his classic waxed mustache and goatee, at the apex of his career, are more familiar in the biographical literature. Lamy did not live so long after the thallium work, and is only known by this portrait.
Mineralogie coined the term “catalyst” for his concept of a special agent in plants, anticipating the concept of enzymes by almost half a century. The discovery of thallium,5a he cautiously precluded all other possibilities— which he named junonium, vestium, and hebeium—until more careful study showed the lines belonged to known elements.5

In Crookes’ study of thallium,5b he cautiously precluded all other possibilities— for example, John F. W. Herschel (1792–1871; son of William Herschel 1738–1822, discoverer of the planet Uranus) in his naïve exuberance originally interpreted the manifold spectral lines now appearing in modern spectroscopes as new elements—which he named junonium, vestium, neptunium, asataeum, and hebeium—until more careful study showed the lines belonged to known elements.4 In Crookes’ study of thallium,5c he cautiously precluded all other possibilities by both spectroscopic and chemical means, in all 55 other known metals and metalloids, as well as the gases and carbon.5

The Surprise at the International Exhibition of 1862. Eager to introduce his new element at the 1862 International Exhibition at Hyde Park in London, Crookes received a rude shock—another scientist, a Frenchman Claude-Auguste Lamy (1820–1878), a professor of the Université de Lille (northeast France), was brought in his own exhibit of thallium.6 He had previously corrected others who had “discovered” new elements—for example, John F. W. Herschel (1792–1871; son of William Herschel 1738–1822, discoverer of the planet Uranus) in his naïve exuberance originally interpreted the manifold spectral lines now appearing in modern spectroscopes as new elements—which he named junonium, vestium, neptunium, asataeum, and hebeium—until more careful study showed the lines belonged to known elements.4 In Crookes’ study of thallium,5c he cautiously precluded all other possibilities by both spectroscopic and chemical means, in all 55 other known metals and metalloids, as well as the gases and carbon.5

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Figure 2. Sites pertaining to William Crookes in London (asterisk denotes edifice no longer exists).

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Figure 3. The Royal College of Chemistry at 299 Oxford Street, where William Crookes was trained in chemistry and published his first paper on selenocyanides. Today this site is occupied by a men’s apparel store. By 1872 the institution had moved to New Kensington (200 meters west of the present Science Museum) and by 1907 had evolved to the modern Imperial College (N51° 29.86 W00° 10.66), where the original dedication stone laid by Prince Albert in 1846 is on display.
At the London Exhibition of 1862, Lamy inspected Crookes’ sample of the element—merely a few grains of dark powder—and proclaimed it was a sulfide derivative (immediately disputed by Crookes). Although Crookes had prepared many derivatives of thallium in a full chemical study, Lamy’s exhibit stood out because he had prepared an ingot of the metal. The Exhibition jury, headed by A. J. Balard, of bromine fame, awarded Lamy a prize for his accomplishment. Crookes protested bitterly—“What would one expect when the majority of jurors were foreigners!” The fight was on. Much rode on this priority issue—both Crookes and Lamy “had a reputation to establish.”

Crookes had the advantage of immediate control of a British journal, and his propaganda campaign, coupled with a general British zeal for priority, led to his being elected as a Fellow of the Royal Society—new credentials which gave considerable weight to the International scene. Meanwhile, the famed Jean-Baptiste André Dumas (1800–1884) came to the aid of Lamy. Dumas argued that Lamy should be credited with the discovery of the metal since Crookes had originally characterized it as a metalloid. To the credit of Crookes, he published Dumas’ (translated) article in his Chemical News.

Lamy and Dumas argued that thallium must be a member of the alkali metals: It could form oxides of the formula M₂O, and its spectrum was strong and sharp, just as those of the alkali metals (Li, Na, K, Rb, Cs) (Figure 7). However, other properties were more puzzling; Dumas dubbed it the “ornithorincus [duckbill platypus]” referring to the fact that taxidermic specimens of this Australian species were first thought to be a hoax, a composite of different animal parts stitched together. Indeed, thallium more closely resembled lead (Pb) in appearance, high density, and chemical reactivity, and was capable of multiple oxidation states (+1 and +3). Thallium’s proper categorization was clarified by the Periodic Table presented a few years later (1869) by Dimitri Mendeleev and by Lothar Meyer, both of whom placed the element in the aluminum family. Auguste Lamy studied at École Normale Supérieure, where Henri-Étienne Sainte-Claire Deville (1818–1881) made his fame with aluminum. There Lamy met fellow-student Louis Pasteur (1822–1895), also from the Jura region; the two became close friends there. After graduating in 1842 Lamy taught at Lille, then Limoges, then finished his doctorate at the University of Paris in 1851. In 1854 he joined the newly founded Université Lille Nord de France (Université de Lille) as the professor of physics (Figure 8), along with Louis Pasteur who was first dean of the University as well as professor of biology (Figures 9, 10). After achieving his reputation with thallium there, Lamy moved in 1879 to l’École Central des Arts et Manufactures in Paris (today the Musée Picasso).

In 1854 Claude-Auguste Lamy married Cécile Honorine Kuhlmann (1832–1906), daughter of the prosperous chemical industrialist Charles Frédéric Kuhlmann (1803–1881). Kuhlmann’s company had a branch in Loos (a suburb of Lille) whose sulfuric acid factory proved to be a rich source of thallium (Figure 11). Kuhlmann also lent Lamy a spectroscope with which Lamy immediately observed the strong green line in his laboratory. With such an abundant supply of this new element, Lamy was able to prepare sizable amounts of metallic thallium.

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The reason why Lamy was so successful in preparing large amounts of thallium was given by Kuhlmann himself who had developed a cleaner method of preparing sulfuric acid. He inserted an intermediate chamber between the roasting chamber (which heated pyrites to generate sulfur dioxide) and the final reaction.
chamber. This intermediate chamber was designed to separate out nonvolatile impurities (arsenic as the main culprit). When this nonvolatile deposit was taken up in aqua regia and diluted with water, copious amounts of yellow thallium sesquisulfide hexagonal crystals \(3\text{TiCl}_3\cdot\text{TiCl}_2\) could be collected. It was now clear that in previous manufactory designs, the thallium had been carried on to become a contaminant in the final sulfuric acid. Another reason for Lamy's success was that his ores taken from Theux, Belgium, were blessed with a greater concentration of thallium. Crookes finally found alternative sources for thallium, but Lamy's good fortune allowed an initial burst of research that rapidly caught up with Crookes. The bitter debate between Lamy and Crookes continued for several years, until a Swede christened the first thallium-containing mineral "crookesite." 

The Discovery of Crookesite by Nordenskiöld. Readers of The HEXAGON may recall that Berzelius discovered selenium in a sulfuric acid manufactory in Gripsholm, Sweden, in 1817. Half a decade after Crookes announced his discovery of thallium, Adolf E. Nordenskiöld (a Swedish arctic explorer and mineralogist, also a biographer of Scheele) was rummaging through old selenide minerals in the Science Museum of South Kensington, London, are many exhibits on Crookes, including (top) the laboratory notebook of William Crookes, documenting his observation of the green spectral thallium line, and (bottom) his collection of thallium compounds. (A collection of Lamy's thallium compounds resides in the bibliothèque de l'École Normale Supérieure Physique, 24, Rue Lhomond, Paris, France–N48° 50.57 E02° 20.82).
in Stockholm collections. He identified eucaitite (AgCuSe) and berzelianite (Cu₂Se) but also found other unidentified minerals containing up to 19 percent of thallium! Some of these specimens could be traced back to collections of Carl Gustaf Mosander (1797–1858), a student of Berzelius and the discoverer of the elements lanthanum, “didymium,” erbium, and terbium.¹⁰ Nordenskiöld isolated and characterized crookesite,¹⁰ describing it as (Cu₇Ag,Tl)Se₄ (now known to be Cu₇(Tl,Ag)Se₄).¹¹ In his original article¹¹ Nordenskiöld muses that the “keen-eyed and alert” Berzelius and Mosander surely observed the vivid green flame color of thallium in their blowpipe studies.¹¹ These Swedish masters, he concluded, apparently mistook the green flame of thallium for that of omnipresent copper, which can appear emerald green to azure blue.¹²

Priority of discovery of thallium. Most texts credit both Crookes and Lamy as co-discoverers of thallium. The French think they have the better case²—a—Lamy was able to produce large ingots of the new element, thus recognizing it as a metal. Lamy was also the first to appreciate the extreme toxic nature of thallium. But Crookes seized on Nordenskiöld’s new mineral named in his honor.¹³ Although in Crookes’ Chemical News the Swede explained he chose “crookesite” after the discoverer of the metal,¹³ in his original article¹³ he specifically credited Crookes and Lamy as independent discoverers, but he honored Crookes who had “observed it first.”¹³ At last, Crookes thought, this clinched it: He really was “the first Englishman since Davy to have identified a new chemical element!”¹³

A historical lesson of this “Rediscovery” episode might be: if you want to be recognized as the discoverer of an element, not only must you see it first, but you must publish it first, but most importantly — just as in the French episode with Urbain and lutetium¹³ — you must name it first. There have been some 50 different thallium minerals discovered — but none has been named “lamyite.”¹³

The legacy of Crookes and Lamy. The lengthy (11-page) obituary¹⁶ of Crookes was written by William A. Tilden (1842–1926), noted biographer and researcher in terpene chemistry, and friend of the deceased. Tilden lauds Crookes’ success story as he worked from humble beginnings to great achievements including editorship of Chemical News; many inventions and scientific discoveries, including his further spectroscopic verification of helium; even his dabblings in spiritualism where he intellectually investigated the psychical force, requiring proof while the “spiritualists” only needed faith (Crookes was president of the Society for Psychical Research); service to his community as he sought ways to solve such problems as sewerage and sanitation deficiencies, “The Wheat Problem” (nitrogen fertilizers), and the “Cattle Plague” (phenol as an antiseptic); and his many honors and awards.

Lamy’s eulogy was delivered by his mentor Louis Pasteur in Paris, archived in “four typewritten pages,”⁸ who described Lamy as a “simple man, upright, fearing God and shunning evil.” With major accomplishments in chemistry (principally thallium), Lamy was praised as a scientist of “the first order,” eventually becoming président de la Société française de chimie in 1873. Pasteur emphasized Lamy’s triple

Figure 9. This was the building where Lamy performed his thallium research. It was originally the Lycée [high school] Faidherbe, before Napoleon III founded the Université de Lille at this site in 1854. The physics department, where Lamy did his work, was on the premier étage (second floor).

Figure 10. Carnot College now occupies the original site of the Université de Lille where Lamy performed his work on thallium. The monument in the foreground is in memory of Louis Pasteur; the plaque on the disk rim reads [translated]—“Tribute to Louis Pasteur, founded here the science of microbiology. Lille 1857.” In Lille Pasteur solved the problem of ruinous lactic acid production at a sugar beet factory by postulating bacteria as the source of the problem.
sense of “honor, discipline, and duty,” carrying on the tradition of his father who was among those who “carried the flag gloriously in all the capitals in Europe during the Napoleonic campaigns.” (Note 2) 

Next episode: In the following HEXAGON, we will travel to the Harz Mountains to explore the source of Crookes’ thallium.

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Notes.

Note 1. The Crookes tube was a low-pressure discharge tube which emitted “cathode rays” (electrons). The radiometer is an evacuated bulb enclosing a spindle with vanes, blackened and silvered on opposite sides, which rotates when exposed to light; this device is common in educational institutions. The sphintarsiscpe was a device for observing individual scintillations from a radioactive alpha source (Ra or Po) on a phosphorescent zinc sulfide screen—old-timers may recall the “Atomic Bomb Ring,” which could be ordered in the late 1940s by mailing in 15¢ and the top of a KIX breakfast cereal boxtop.

Note 2. The father Désiré Lamy was wounded and captured in the Moscow campaign of 1812. After he was released he participated in the 1815 Waterloo defeat and then returned home to have five sons. The eldest son (Claude-Auguste) turned to science and the other four served in the military; one was killed in 1863 during the Maximilian Affair during the Battle of Puebla, Mexico (which is commemorated today in Mexico as “Cinco de Mayo”).

References.


