

Rediscovery of the Elements

Strontium

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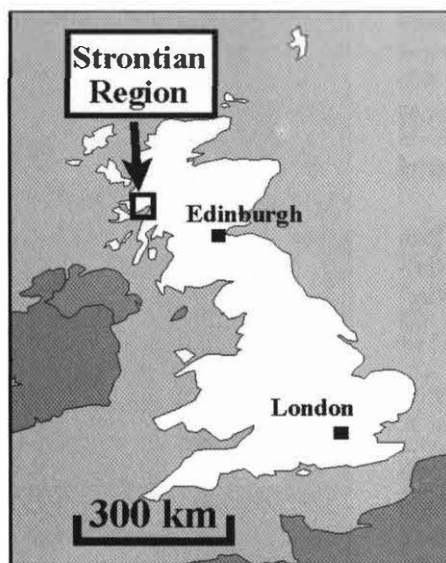


Figure 1. Key regions involved in the history of strontium are London, Edinburgh, and Strontian.

The history of strontium encompasses the length of Great Britain (Figure 1).

In the late 1700s the physician Adair Crawford (1748-1795), a physician at the charitable St. Thomas Hospital in Southwark (pronounced Suth-erk), was prescribing various salts for his patients' ailments ranging from tumors and scabs to fevers and swellings. Southwark is across the Thames River from London, in the East End of the South Bank (Figure 2), historically the home of the laboring class and a red light district. This bawdy area had been the site of Shakespeare's Globe Theatre and later would be a sorrowful source of material for Charles Dickens' tales. One of Crawford's favorite concoctions was muriated barytes (barium chloride), which he found to be a good "evacuant, deobstruent, and tonic."² Many of the patients were being treated with mercurial salts (discovered by Paracelsus some

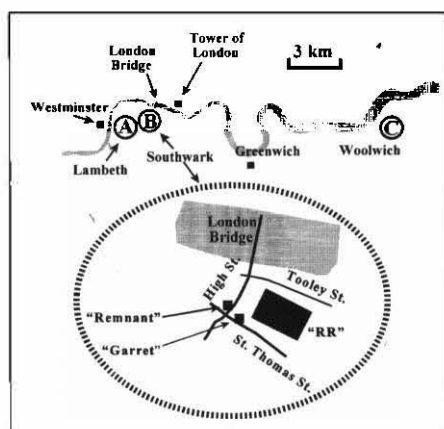


Figure 2. Lambeth (A). This is the present site of St. Thomas Hospital and holds statues of King Edward VI (outside) and of the famous "cripples" (inside), all of which were at the old site in Southwark. The entrance of the hospital is on Lambeth Palace Road ((N 51° 29.99, W 00° 07.01) and is located 400 meters southwest of Waterloo Underground Station. Also at the Lambeth site is the Florence Nightingale Museum, which holds memorabilia of the nursing profession.

Southwark (B). See inset in lower half of figure. The old St. Thomas Hospital, now demolished, lay roughly at the London Bridge Underground/Railroad Station complex. A portion of the original wall still stands (Remnant) which is now incorporated into a

post office and can be found at the corner of High St. and St. Thomas St. (N51° 30.32, W 00° 05.36). The Old Operating Theatre Museum (Garret) is located 30 meters east on St. Thomas St. (N 51° 30.30, W 00° 05.33); although not formally a part of St. Thomas Hospital, it was used for surgical operations. Guy's Hospital (not shown) is 200 meters further southeast on St. Thomas St. and should not be confused with the St. Thomas Hospital.

Woolwich (C). One reaches the sites of interest by taking a train to Woolwich Arsenal Railway Station (not Woolwich Dockyards Railway Station), walking 200 meters north on Woolwich New Road and crossing Plumstead (major road) to the entrance. The Royal Military Academy (where Crawford performed his lectures and Cruickshank did his chemical analyses on barytes (and strontium) can be found by continuing to walk 250 meters to the north (N 51° 29.64, E 00° 04.14).

two hundred years earlier to be the most effective treatment for venereal diseases³). Along with treating scrofula and tumors, Adair Crawford aspired to ameliorate the serious side effects of this heavy metal medication with his muriated barytes. Crawford was a part-time lecturer at Woolwich Arsenal, and he used the services of the "Elaboratory" Chemist, William Cruickshank, Surgeon of Artillery and to the Medical Department,⁴ who prepared the medicaments.² Cruickshank tested salts from various geographical locations, one of which was Strontean [sic], Scotland. His experiments suggested that this mineral "really possesses different properties from the terra ponderosa [barium carbonate] of Scheele and Bergman."² These different properties included a different solubility in cold water, a different amount of 'cold' arising from dissolution (i.e., different heat of solution), and a different crystalline form. Adair Crawford thus concluded that "It is probable, indeed, that the Scotch mineral is a new species of earth which has not hitherto been sufficiently examined."² In his paper Dr.



Figure 3. The famous cripples which stood outside the old St. Thomas Hospital. They now are on display inside the present St. Thomas Hospital.

Crawford cautioned that "From trials which have been made with dogs it appears that a very large dose of muriated barytes would prove fatal. I therefore think it necessary to caution those who are unskillful [sic] in medicine, not to tamper with this remedy."²

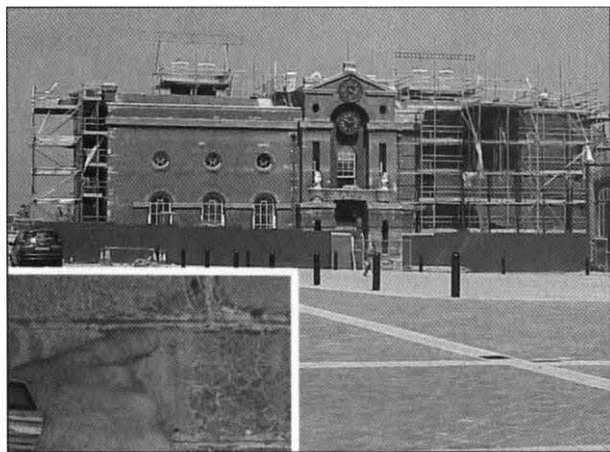


Figure 4. The Royal Military Academy Building, where the actual preparations of the barytes medication and analysis of the strontium salts were made by Cruickshank. Inset: This building can be placed during the Georgian period because of the "penny roller" style (thin recessing) of jointing between bricks.

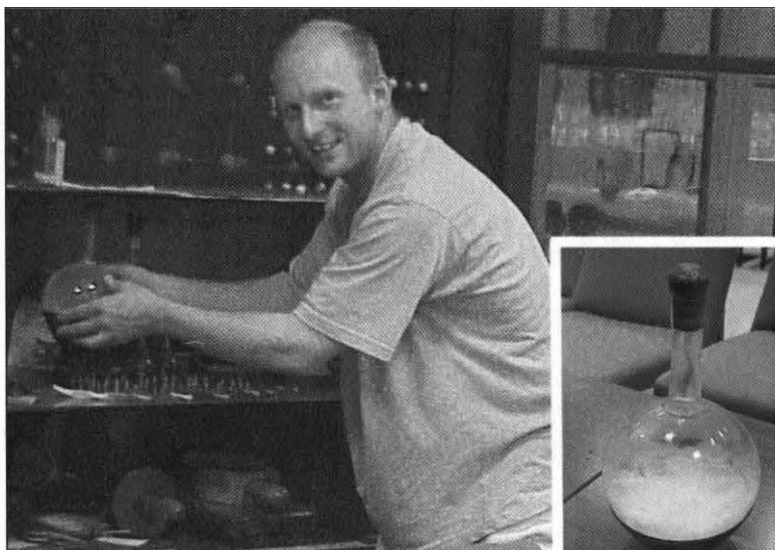
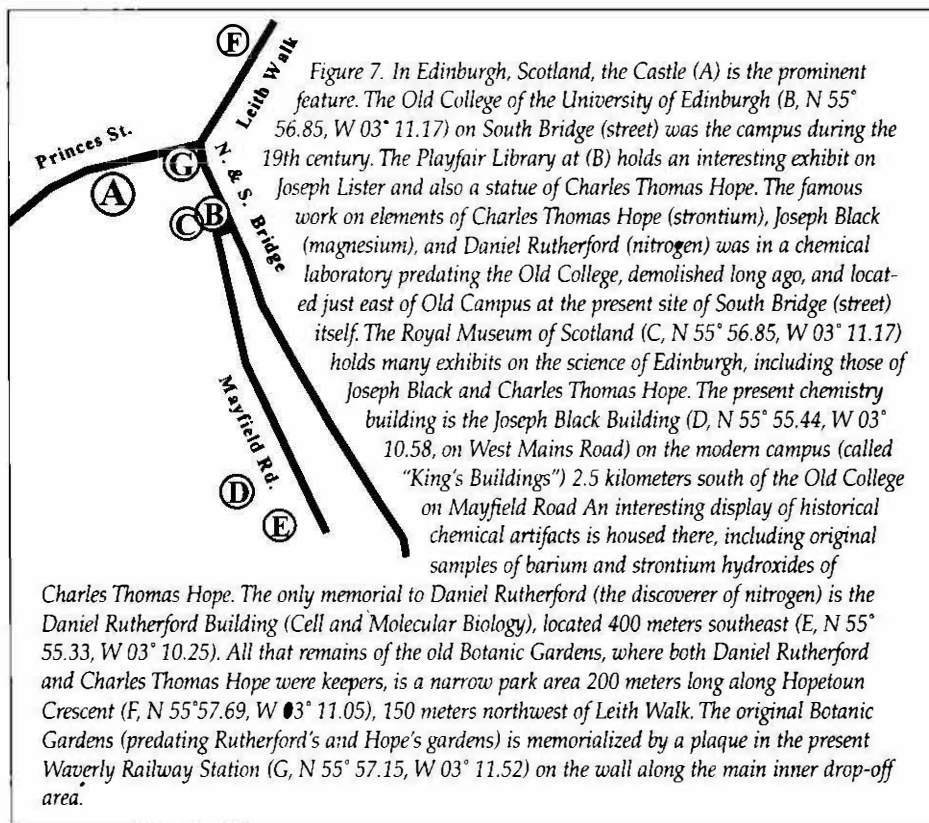


Figure 5. The original sample of strontium hydroxide of Charles Thomas Hope, over 200 years old, being carefully handled by Dr. Gavin Whittaker of the Department of Chemistry, University of Edinburgh, curator of the departmental museum.



Figure 6. Joseph Black Building, the chemistry building, of the "King's Buildings" (new campus) where Hope's samples reside.

In London the original St. Thomas Hospital no longer exists; it was a victim of the railroad age and was torn down and relocated in the mid-1800s when tracks were laid just south of the London Bridge. One can discover two remnants of St. Thomas Hospital (Figure 2): part of the original wall on High St. and the Old Operating Theatre on St. Thomas Street. This theatre is now a museum which holds collections of medical instruments and herbal medicines and exhibits of surgical practices of St. Thomas Hospital, one of the earliest sites of anaesthesia use in 1846. This museum occupies the roof garret of an 18th century church of St. Thomas. Although not formally a part of the hospital, it contained Britain's oldest operating theatre. (Note 1) In front of St. Thomas Hospital



were the famous statues of "the cripples" which reminded Londoners that the hospital's purpose was to serve not the rich but the needy. These statues were moved to the new site of the hospital in Lambeth and may be viewed there (Figure 3). (Note 2)

The actual site where the chemical preparations and analysis on muriated strontia were done still exists at the Royal Military Academy building (Figure 4) in Woolwich Arsenal (pronounced "Wool'-ich"), 13 km east of London on the Thames River (Figure 2). In this building

(Figure 4), the chemical lectures and analyses were performed on the first floor. The muriated barytes (or muriated strontia) would be prepared by simply dissolving barytes (barium carbonate) or "Strontean barytes" in hydrochloric acid and heating. References exist to both Crawford and Cruickshank in the Arsenal's records:⁵ "March 1788 Dr. Allen [sic] Crawford appointed Lecturer in chemistry and Mr. Cruickshank to be his assistant." A second and last entry states "Dr. Rolls to take over in view of Cruickshank's illness, 1803." When we visited the Royal

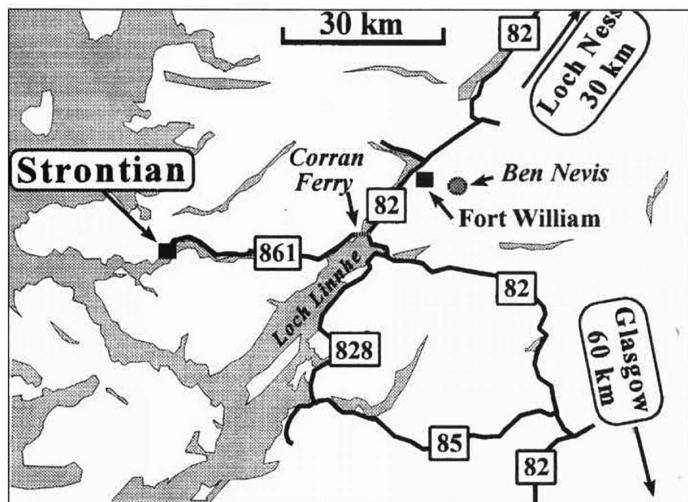


Figure 8. Strontian is in western Scotland, and can be reached by driving north from Glasgow, then crossing Loch Linnhe on the Corran Ferry (N 56° 43.30, W 05° 14.06) and proceeding westward. Loch Linnhe is well-known for the large schools of jellyfish observed during ferry rides. Interesting tourist attractions in the area include Ben Nevis, the tallest peak in Scotland (4406 feet) where snow might be seen, and Loch Ness where monsters probably will not be seen.



Figure 13. Famous Bell's Grove, where (insets) barium minerals (left) and galena (right) can be easily found.



Figure 9. Entering the Strontian area after crossing Loch Linnhe via ferry. "Strontian" itself is Gaelic for "place where barges could cross the water."



Figure 10. The original lead smelter of Strontian, now used as a post office.



Figure 12. Brooding landscape, while driving up the road to the Strontian mine.

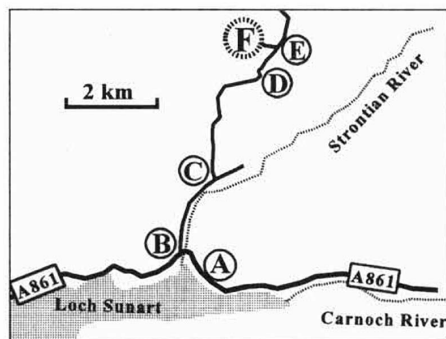


Figure 11. Strontian area. The present post office (A, N 56° 41.47, W 05° 34.09) was once the smelter for the mines. To reach the mines, drive west from A, cross the Strontian River bridge (B, N 56° 41.76, W 05° 34.37); drive north 1.6 km and take the left fork at C (N 56° 42.49, W 05° 33.76). After 3.0 km further, Bell's Grove (D, N 56° 43.72, W 05° 32.84) may be reached, which is well known to the mineralogists as a source of rich specimens. After 0.6 km further, the mine area is reached (E, N 56° 43.95, W 05° 32.47) where several shafts may be found. The largest mine area is 0.4 km west (F, N56° 44.03, W 05° 32.84). Although one can no longer enter the mines themselves, extensive excavation has exposed much, and many interesting mineral specimens may still be found.

(summer of 2001), it was closed because of major renovation, but we were able to tour the facility owing to the kind hospitality and special arrangements of the personnel (see Acknowledgments). At some future time after major development, the Arsenal will be open to the public as a historical site. (Note 3)

Although Dr. Adair Crawford was the first to recognize the new earth, the first careful work

on strontium was performed in 1798 by Thomas Charles Hope of the University of Edinburgh.⁶ He noticed that the properties of strontia compounds were intermediate "but clearly distinguishable" from those of calcium and barium. He also noted that the three elements could be distinguished by the colors of their flames "brick-red for calcium, brilliant scarlet of strontium, and green of barium."⁵ Although the laboratory where Hope performed his analyses is gone (Note 4), his original samples of strontium hydroxide "over 200 years old" still exist! (Figure 5) They are stored in the museum section of the University of Edinburgh, in the Joseph Black (Chemistry) Building (Figure 6) at King's Buildings (i.e., the new campus) in Edinburgh. (Figure 7)

The mineral itself from which strontium was procured was strontianate (SrCO_3), obtained from the lead (Pb) mines of Strontia (pronounced stron-TEE-a), Scotland. (Figure 8) We reached this site by automobile from Glasgow, Scotland. Entering "Strontia" territory (Figure 9), the road was commonly a one-lane venture; thus, we did not have to remember on which side of the road to drive. Frequently, there was a widening of the road to allow vehicles to pass one another. When two vehicles met, one vehicle would back up to the nearest aneurism and let the other pass.

Strontia is a tiny village with one hotel, which in early June had plenty of room. At the local pub, we asked about the history of the village and the mines. Everybody knew plenty. The present post office (Figure 10) used to be the smelter, the mines themselves could be easily reached by road (Figure 11), and there still remained scattered galena (PbS) which was the source of the mined lead. The patrons pointed



Figure 15. The main mine region of Strontian is huge with towering walls carved out of the hillsides.

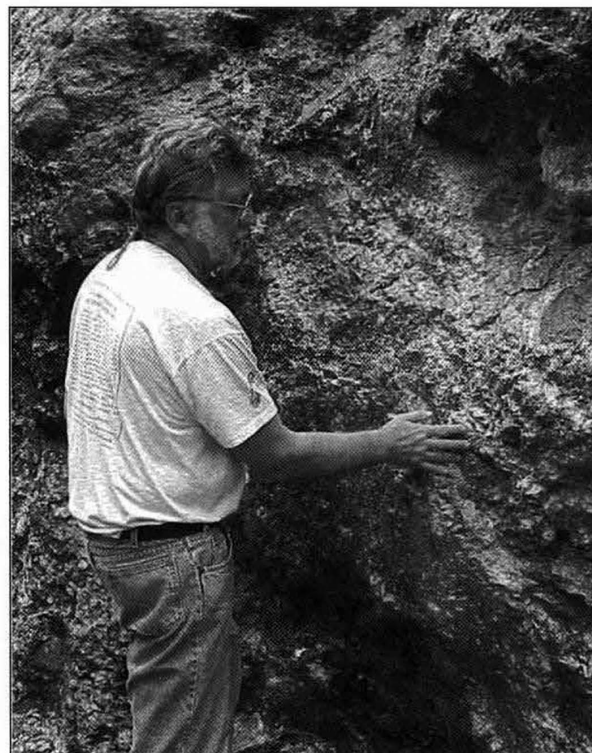


Figure 16. Rich veins of minerals are abundant in this mine area.

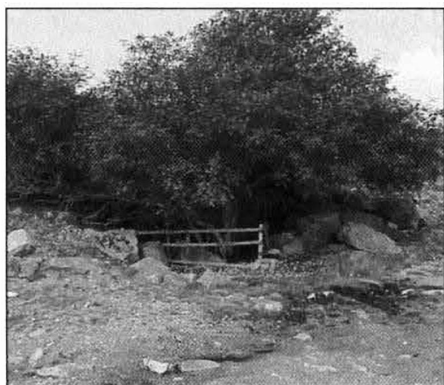


Figure 14. One of many shafts which led down to the lead mines. These shafts have not been filled in and are very dangerous to explore.

outside the window: The ore would be hauled down from the hills, smelted, and shipped out to sea via Loch Sunart (Figure 11).

As we drove up the hillside to the mines, we encountered a mystic landscape (Figure 12). On the way, we passed through Bell's Grove (Figure 13), a site famous for its barium minerals, such as harmotome (barium zeolite). Indeed, at that site we had no problem in finding "ponderous" minerals as well as galena (Figure 13, inset). Further up the hill were the mines themselves, frequent open shafts that had not been filled in (Figure 14), as was seen previously, such as the Himmelsfürst mine in Germany;⁷ instead, they were fenced off for safety. The main mine itself was huge (Figure 15), and on the walls rich veins of minerals

could be spotted, notably with the alkaline earth carbonates (Figure 16). The classic strontianite itself (Figure 17) was green and fibrous. This was one of the most interesting mine areas we had ever visited, with fascinating minerals in abundance!

A final chapter of strontium would take us to the Royal Institution in London where Sir Humphry Davy prepared it in the elemental state,⁸ but we should defer this story until we can devote more time to the activities of Davy and of the Institution.

Strontium played an important part in the development of the Periodic Table. Johann Wolfgang Döbereiner of Jena, Germany, developed the concept of the triads. While Hope had noticed that strontium was intermediate in its properties between calcium and barium, Döbereiner quantified the triad phenomenon



Figure 17. The original mineral, where it all started: this strontianite (SrCO_3) specimen from the region is green and fibrous.

with these three elements: the equivalent of strontium (42.5) was the arithmetic mean of those of calcium (20) and barium (65).⁹ Döbereiner later generalized this phenomenon with the triads Cl, Br, and I; S, Se, and Te; and P, As, and Sb.¹⁰ Such patterns suggest an underlying pattern that was finally elucidated by Meyer and Mendeleev in 1869 with their discovery of the Periodic Table.¹¹

Acknowledgments.

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Notes

Note 1. St. Thomas Hospital should not be confused with Guy's Hospital which exists today, across St. Thomas Street from the Old Operating Theatre (Figure 2). The history of St.

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Thomas Hospital dates back 1000 years to charitable monasteries in the area. The original hospital was built in the twelfth century and was named for Thomas Becket (1118–1170); the hospital was endowed by Edward VI in 1552. After the great fire of London in 1666 and subsequent fires in Southwark in the late 1600s, a new building was constructed in 1693; this was the building in which Crawford practiced. An attempt to procure more information from the St. Thomas archives, regarding Adair Crawford (including optimistically hoping for a portrait!), proved fruitless. A large volume dating from 1819,¹ describes in detail the organization and operations of the hospital.

Note 2. The hospital moved to its current site in Lambeth (Figure 2) in 1862. Florence Nightingale (1820–1910), the founder of modern nursing, set up a training school for nurses at the old site in Southwark which was transferred to the Lambeth site. A Florence

Nightingale Museum exists at Lambeth covering interesting features of her life and times.

Note 3. In the 1500s the Woolwich Dockyard was founded on the Thames River which played an important part in supporting the King's Navy. Through the following years the site developed into an Arsenal for weapons and a storehouse for gunpowder and saltpeter, and then into a munitions and guns factory in 1696. Later the Royal Regiment of Artillery was developed in the 1700s. The Royal Laboratory was built during this time and was instrumental in developing munitions and explosives from then on. In 1854 an official office of Ordnance Chemist was established and Frederick Abel (who invented cordite, a mixture of nitrocellulose, nitroglycerin, and petrolatum extruded into cords) held the first appointment. Woolwich was active and important during the Crimean War, the Boer War, and particularly World War I, when 80,000 workers were

employed. During the next World War, the threat of air attacks mandated the dispersal of the munitions and armament activities throughout the country. Woolwich is still home to the famous Arsenal Football Club.

Note 4. The "Old College," close to the center of the city (Figure 7) is over two hundred years old but is still not old enough to claim the chemistry laboratories of the Black, Rutherford, and Hope of the late 1700s. Joseph Black quantitatively differentiated between magnesium and calcium in his studies of fixed air, or carbon dioxide, and is considered by some to be the discoverer of magnesium. His student Daniel Rutherford discovered phlogisticated air, or nitrogen (he is not to be confused with Ernest Rutherford of a century later). These three scientists performed their work in chemical laboratories which the authors have located at a site just east of the present Old College and actually under present South Bridge.¹² A bust of Hope

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is displayed at the Playfair Library at the Old College. A Daniel Rutherford Building (biology) exists at the new campus (Figure 7) which houses Cell and Molecular Biology. Both Hope and Rutherford were Regius Keepers¹³ of the Royal Garden, then situated off Leith Walk, where botany lectures were given each summer. Only a tiny remnant of this garden, an unmarked wooded park, still exists (Figure 7). The Royal Museum holds important exhibits devoted to Thomas Charles Hope and Joseph Black, as well as other scientists (Figure 7).

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