

Additional Reading: William Wollaston

William Wollaston was an English chemist and natural philosopher who was born in East Dereham, Norfolk on April 6, 1766. He was educated at Charterhouse and Caius College, Cambridge. He became a fellow and started his practice of medicine in 1789 at Bury St. Edmunds. He soon moved to London but failed to obtain a vacant physicianship at St. George's hospital. He hence abandoned medicine and took to original research. He devoted much attention to the affairs of the Royal Society, of which he was elected a fellow in 1793, made secretary in 1806, and elected interim president in June 1820 on the death of Sir Joseph Banks. He lived alone, conducting his investigations in a deliberate and exhaustive manner. He worked in the most rigid seclusion, where no person was admitted to his laboratory on any pretext. He died of a brain tumor in London on December 22, 1828.

A Remarkable Career

William Hyde Wollaston discovered the elements palladium and rhodium and first reported the dark lines in the spectrum of the Sun. His consideration of geometrical arrangements of atoms led him into crystallography and the invention of the reflecting goniometer to measure angles of crystal faces. He also proved the elementary nature of niobium and titanium, developed a method of making platinum malleable, proved the identity of voltaic and frictional electricity, and invented the camera lucida to aid microscopists. The mineral wollastonite was named in his honor.

In 1802, in what was to later lead to some of the more important advances in solar physics, William Hyde Wollaston discovered that the spectrum of sunlight is crossed by a number of dark lines. This is considered to be 'A Great Moment in the History of Solar Physics' since it was the birth of Solar Spectroscopy. In 1814, Joseph Fraunhofer (Germany) rediscovered the dark lines in the solar spectrum noted by Wollaston and determined their position with improved precision.

Notably, in 1861 Robert Wilhelm Bunsen and Gustav Kirchoff performed experiments leading to the conclusion that the dark lines in the solar spectrum, observed by Wollaston and Fraunhofer, arise due to the absorption of light by gases in the solar atmosphere that are cooler than those emitting the light.

In 1804, Wollaston found palladium in platinum.

In 1806, he invented the camera lucida, a compact, portable prism-like device which supplants the camera obscura as a drawing-from-nature tool. This is an optical device that projects the virtual image of an object onto a screen. This drawing aid invented Wollaston was a product of the Romantic Movement. It superimposes by means of a prism a virtual image of any view on the plane of a drawing board so that the artist can trace it. Men of science such as Sir John Herschel were enthusiastic users, but Henry Fox Talbot was disappointed with the results and turned to photographic experiments.

In 1810, Wollaston isolated the second amino acid, cystine, from a bladderstone.

In 1828, Wollaston died of a brain tumor.

Excerpts from a Dean P. Currier Article

While Gautherot, Ritter, and Van Marum were working with the newly discovered pile of Volta in 1800, William Wollaston, also at the same time, performed experiments resulting in similar contrasts between galvanic and static electricity. He then confirmed van Marum's work by demonstrating that copper obtained from a copper sulfate solution could be deposited on the wire connected to the negative pole of an electrical machine similarly to that of the pile. He next decomposed water using the Leyden jar, and found that the difference between galvanism and the Leyden jar was that galvanism was less intense but of better current quality. Then in 1801, Wollaston complemented Ritter's work by decomposing sulfur sulfate solution when a wire was placed through each end of the vessel and into the solution while the other ends of each wire were connected to a frictional electrical machine.

Wollaston was the first scientist to outline the differences between the new galvanic current and that of the standard frictional current when he presented a paper before the Royal Society in June 1801. He showed convincingly that the pile of Volta was electrical, had less tension (later called volts), but more quantity (later called current) than that of frictional electricity. This paper also revealed that he had decomposed water using galvanic current. He believed that the decomposition of water depended on the proportioning of electrical charge to a specific quantity of water, and that the discharge of current on the surface of a substance depended on the size of its surface. He learned that a piece of silver when connected with the positive pole of a pile and put into a solution of copper would become coated with the copper. This coating was found to withstand the operation of burnishing

He was educated at Charterhouse and at Caius College, Cambridge University (1782 to 1787). He received a degree in medicine in 1793, was immediately elected as a member of the Royal Society, and then began his medical practice in Huntingdon (London) in the same year. He also established a private laboratory to conduct research at the Royal Society in 1793, and became a foreign associate of the French Academy of Sciences. Between 1793 and 1797 he published several papers in science. He became renowned in physiology. In 1797, he described the main components of urinary calculi. Then he suddenly gave up his medical practice in 1800 to devote time to pursue his dominant interest, scientific research. He became an associate of Humphry Davy at the Royal Institute. Wollaston was becoming partially blind about this time, also.

While working with Davy in 1809, he described a vibratory action of muscular activity. He identified a new type of bladder stone that he named "cystic oxide" (later called cystine) the first known amino acid in 1812, and then in 1824 he provided the best physiological description of the ear up to that time.

He was a very careful experimenter in physiology. In 1802, Wollaston determined refractive indices after which he was able to conclude that there were just four colors in the solar spectrum, and that it contained dark lines (later called Fraunhofer lines). He had verified the laws of double refraction in Iceland spar that had been studied by Huyghens, and from his work he wrote a treatise that he presented before members of the Royal Society on 24 June 1802. Then in 1803, he worked in optics and designed a dip sector (modified sexton) that was used by Ross and Perry while exploring the arctic region. He also described "periscopic spectacles," designed meniscus lenses that permitted clear vision in oblique directions, and designed his camera lucida (a quadrilateral glass prism) in 1807.

Wollaston formed an association with Smithson Tennant to conduct experiments in chemistry. Platinum had eluded the efforts of chemists to produce it. Tennant tried to produce platinum, but ended up discovering the new elements of iridium and osmium. Wollaston's effort, in turn, led him to the discovery of the new metals palladium (1803) and rhodium (1804). He then found the process to produce malleable platinum in 1805 which earned him considerable money by 1826, and which apparently compensated him more than had his medical practice. He waited until 1828 to present a paper describing the process of platinum to the Royal Society.

Wollaston became a Fellow of the Royal Society between 1797 and 1800. He established the Wollaston medal for research in mineralogy, and in 1802 received the Copley medal of the Royal Society. In 1806, Wollaston was elected Secretary of the Royal Society, and over the years contributed to all 39 "Memoirs" of the society in Philosophical Transactions. He later served as its president (1820-1828) when succeeding Banks as president of the Royal Society in 1820. Sir Joseph Banks became president of the Royal Society in 1778 and served until 1820 at which time he picked Wollaston for president rather than Michael Faraday who wanted the job.

He made improvements to the galvanic pile in 1813 or 1815. In Wollaston's battery the copper plates were doubled (a copper plate bent round into a U-shape) with a single plate of zinc placed in the center of the bent copper. The zinc plate was prevented from making contact with the copper by pieces or dowels of cork or wood. In his single cell design, the copper U-shaped plate was welded to a horizontal handle for lifting the copper and zinc plates from the activating solution when the battery was not in use. The metal plates and the solution were contained in an earthenware vessel. His design was the best battery at the time. Wollaston also put several (5 at times) separate cells in a series to form larger batteries. In these batteries the metal plates in each cell were welded to a single overhead bar (replacing the single handle arrangement) that was then mounted to two adjustable ring stand type uprights. This unit formed a trough, and was considered an elementary galvanic cell.

He experimented with element sizes until he found that one inch square was sufficient to ignite a wire of platinum one three thousandths of an inch in diameter. The solution used in the cell (s) by Wollaston was sulfate of copper ($Zn + CuSO_4 = ZnSO_4 + Cu$). This chemical reaction left a deposit of copper as a black powder (oxide of copper) on the zinc plate which then had to be constantly scraped off in order to maintain acceptable current amplitude. The deposited metallic copper on the zinc formed a clean solution also had to be constantly added. After a while the Wollaston battery was displaced by improvements of others.

By 1820, the excitement of animal electricity of 1791 (Galvani), and the electrical pile of 1800 (Volta) had subsided among the public and the general scientific community. Suddenly, the excitement for electricity resurfaced when Oersted announced his discovery that a current carrying wire could deflect a magnetic needle. Ampere claimed in his electromagnetic theory that electrodynamic molecules existed while C Becquerel of Paris and de la Rive of Geneva also used the electrodynamic model in their electrochemical research. Faraday doubted the explanations of these scientists because he did not accept ideas of ether and fluids as part of electromagnetism.

On 1 October 1820, Davy told Faraday of Oersted's discovery of the interaction of electromagnetism (6 weeks earlier Arago had reported it to the Academy of Sciences in Paris). Oersted's discovery of electromagnetism was very slow in reaching England. Davy however, when learning about Oersted's work misinterpreted it and conveyed the wrong version to Faraday. Davy thought that the wire itself became magnetic while electricity was passing through it because metal filings stuck to it as did the needle of a compass during his experiments. Faraday from the information given him by Davy thought that the forces acting on the needle were attractions and repulsions. Faraday now began serious research in electricity and at first replicated the electrical experiments of others.

Wollaston in the meantime also learned about Oersted's discovery and reasoned that Ampere's circular currents of electromagnetic action were the result of helical current revolving around its own axis when a permanent magnet was close to the wire. Wollaston conducted some experiments and then told Davy about them. Then in April 1821, he and Davy tried the experiments in the laboratory at the Royal Institution. Their experiments failed to show rotations of electromagnetic currents. Wollaston went on to show attraction and repulsion moving in opposite directions around a wire carrying current, but he never was successful in demonstrating electromagnetic rotation.

Arriving in the laboratory one day when Davy and Wollaston were supposedly discussing the experiments of Wollaston who was still working at the Royal Institution along with other scientists, Michael Faraday (Davy's assistant) apparently entered the room and went about his usual laboratory activities without communicating or remaining in the room with Davy and Wollaston. In the summer of 1821, Faraday began conducting his own experiments on magnetism, and by September had observed that a wire carrying current would rotate around a magnet when placed above the magnet. Faraday published the results of his experiments in the October 1821 issue of Quarterly Journal of Science. Rumors soon circulated that Faraday had stolen Wollaston's idea. Faraday was later accused of applying the contents of the conversation to his personal benefit in discovery of electromagnetic rotation. Being aware of the rumors and accusation, Faraday after awhile invited Wollaston to his laboratory to observe several experiments. After observing Faraday and his experiments, the rumors stopped and Wollaston was convinced that his idea had not been stolen.

Since Faraday never entered anything about electromagnetism in his diary for that day, history records him as not overhearing Davy's and Wollaston's discussion on electromagnetism. Apparently Faraday's thinking at the time was preoccupied by experiments in chemistry and the courtship of his girlfriend. History also records the story as possibly being started by Davy, since he was a very greedy and jealous individual. Davy's career was somewhat tarnished because of his confrontation with Faraday who later succeeded him at the Royal Institution, and surpassed him in scientific achievement. Later Davy tried to block Faraday's election to the Royal Society when he was still president of the Society. Faraday was elected overwhelmingly, and became a member of the Royal Society in January 1824.

Wollaston may have been the first to suggest the idea of electrical magnetic rotations (1821). In 1801, he determined the polarity of the pile. When he placed litmus in the water the positive pole of the pile turned the paper red. Acid and afterwards the negative pole turned the water blue with the litmus (alkaline) in the same area that was once red. He was able to pave the way for Dalton's atomic theory being received.

Then in 1808, he experimented on carbonates, sulfates, and oxalates to show how they conformed to the law of multiple proportions. In a paper of 1812, he mentioned that spherical particles consisting of mathematical points surrounded by forces of attraction and repulsion could explain the structure of crystals that he had been studying. Later, Faraday accepted Wollaston's explanation (theory of unextended point centers of force) rather than the theory of atoms by Dalton.

Wollaston designed a logarithmic slide rule for expressing the proportions of common chemical substances combined (standard oxygen unit of 10). The slide rule was used in chemistry for more than 20 years.

Wollaston died in London on 22 December 1828. The mineral Wollastonite was named in his honor.

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