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Movement of Scientists and the Production of Aluminum

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TECHNICAL PAPERS

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INTRODUCTION

Students seeking education and scholars seeking knowledge have been moving from one laboratory to another, from one university to another, and from one country to another since ancient times. Movement of scientists played an important role in the discovery, isolation, and industrialization of a number of metals, e.g., platinum, rare earths, tungsten, and vanadium. The isolation and industrialization of aluminum also involved movement of scientists.

Naturally occurring alum stone used by alchemists to enhance the dyeing of textile fibers, was known to yield a white "earth" when heated at high temperature. This white earth was known as alumina and was an exceptionally stable material that it was considered a chemical element like gold, copper, and tin. When Alessandro Volta in northern Italy discovered in 1800 that an electric current was generated when two metals were separated by an electrolyte, chemists in Europe immediately started to study this new phenomenon and tried to make use of it. Napoleon Bonaparte as First Consul invited Volta to Paris in 1801 to demonstrate to him at the French National Institute (the body that replaced the French Academy during the revolutionary period), the principle of his discovery. Napoleon was impressed by the demonstration. He gave Volta the Gold Medal of the Institute and ordered funds to the École Polytechnique to build a large battery for research.

The news of Volta's discovery reached England rapidly and a very large battery similar to the one constructed in Paris was built at the newly founded Royal Institution in London. Humphry Davy (1778-1829) (Figure 1) at the Royal Institution succeeded in 1807 to isolate potassium and few days later, sodium using this battery. Once these two reactive metals were available they became the focus of intensive study. Their vigorous reaction with water and their spontaneous burning in air was very impressive. In 1808, Davy announced further his belief that the plentiful compound alumina was the earth (oxide) of an undiscovered metal. Since then, scientists had been making efforts to obtain this new metal.

Figure 1 - Humphry Davy (1778-1829)

A visitor to Copenhagen

Davy never made any aluminum himself, but in the early 1820s the Danish scientist Hans Christian Oersted (1777-1851) (Figure 2) succeeded in producing a tiny sample of the metal in the laboratory by reducing the aluminum chloride with potassium amalgam. He had prepared aluminum chloride few years earlier for the first time by heating a mixture of alumina and charcoal in a stream of chlorine. Chlorine at that time was a laboratory curiosity isolated few years earlier by Carl Wilhelm Scheele. Friedrich Wöhler (1800-1882) (Figure 3) on his return trip from Stockhom after finishing his studies there with Jöns Jacob Berzelius, stopped in Copenhagen in 1824 to visit the University. He met Oersted there and learned about his experiments to isolate aluminum. Now in his laboratory in Berlin he repeated successfully Oersted's experiment in 1827. In 1836 he moved to Göttingen to accept a professorship position at the University and in 1845 succeeded in making aluminum in slightly larger amounts from which he was able to show that aluminum was a light metal. Wöhler devoted his work later to organic chemistry and became known for his synthesis of urea from ammonium cyanate, a reaction that defeated the concept of "vital force", that organic compounds could be produced only by living organism.

Figure 2 - The Danish scientist Hans Christian Oersted (1777-1851)

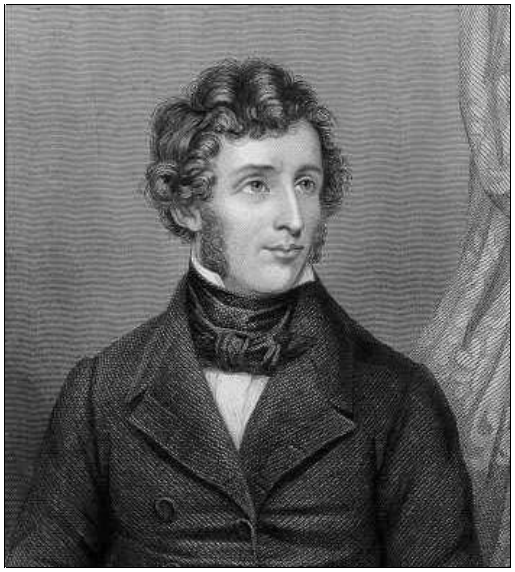

Figure 3 - Friedrich Wöhler (1800-1882), young chemistry student on his way from Stockholm to Berlin, stopped in 1844 in Copenhagen to visit Oersted

Aluminum production in France

French chemists were also active in research to produce aluminum. Henri Sainte-Claire Deville (1818-1881) (Figure 4) professor of chemistry at the École Normale in Paris already produced aluminum in 1854 by electrolyzing molten aluminum chloride-sodium chloride mixture. However, this route was abandoned because, at that time, electric current needed for electrolysis was obtained only from batteries, which were tedious to construct, to operate, and to maintain. He, therefore, considered the chemical method devised by Wöhler and developed the process on a commercial scale. In 1854, he was able to prepare a small bar of the metal to show at the meeting of the French Academy of

Sciences. His friend the great chemist Jean-Baptiste Dumas got an audience with Emperor Napoleon III (Figure 5) and convinced him to subsidize the researches on aluminum. As a result Sainte-Claire Deville was also able to expose the bar at the Paris Exposition in 1855 under the title "The Silver of Clay" which attracted a great attention. He then went ahead to commercialize the process in a small plant at the Glacière District of Paris. However, the process was expensive.

Figure 4 - Henri Sainte-Claire Deville (1818-1881)

Figure 5- Emperor Napoleon III financed the first aluminum research

A visitor from America

Frank Fanning Jewett (1844-1926) (Figure 6) who had received his undergraduate and graduate education in chemistry and mineralogy at Yale University spent two more years, 1873 to 1875, at the University of Göttingen with Wöhler. There he learned about the promise of the new metal. Jewett returned home to become an assistant at Harvard University. Soon he was nominated to teach at the Imperial University in Tokyo, Japan where from 1876 to 1880 he was one of the small groups of westerners who initiated the teaching of science at the university. In 1880, he became professor of chemistry and mineralogy at Oberlin College in Oberlin, Ohio.

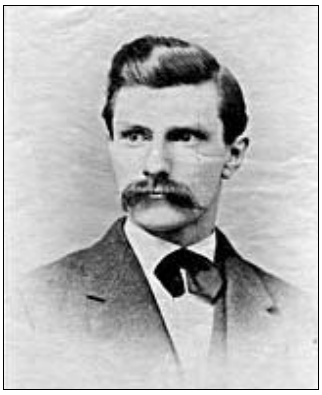

Figure 6 - Frank Fanning Jewett (1844-1926) an American chemist spent two years (1873-1875) with Wöhler in Germany and became mentor to Charles Martin Hall

Figure 7 - Charles Martin Hall (1863-1914)

When Charles Martin Hall (1863-1914) (Figure 7) took his chemistry course at Oberlin, he heard Jewett lecture on aluminum, display his sample of the metal, and predict the fortune that awaited the person who could win this metal from its ore. Under Professor Jewett's guidance and encouragement, Hall worked on aluminum chemistry in Jewett's laboratory and at home until he succeeded in 1886 in producing the first ingot of aluminum by electrolyzing alumina dissolved in molten cryolite. Figure 8 shows a potline of early Hall cells in Pittsburgh in 1890. The same process was discovered simultaneously and independently by Paul Louis Heroult (1863-1914) (Figure 9) in France and is the same process used today. Figure 10 shows Pot with six cylindrical anodes corresponding to the first type of pot installed by Héroult at the La Praz Plant in France in 1893.

Figure 8 - Potline of early Hall cells in Pittsburgh in 1890

Figure 9 - Paul Louis Heroult (1863-1914)

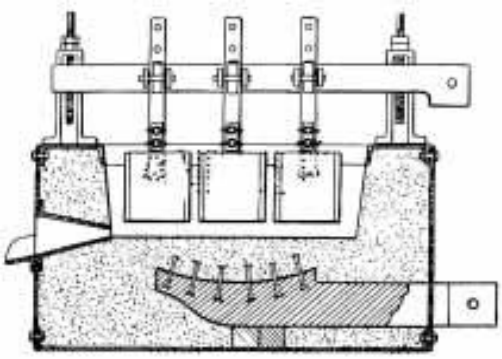

Figure 10 - Pot with six cylindrical anodes corresponding to the first type of pot installed by Héroult at the La Praz Plant in 1893

EPILOGUE

Travelling scientists certainly have contributed to advancing knowledge by communicating their observations to others. Famous professors attract students from different countries to study in their institutions and the interaction among these students is of immense importance in the diffusion of knowledge. The invention of a process for the production of aluminum is an example.

SUGGESTED READINGS

F. Habashi, *Aluminum. History & Metallurgy*, Métallurgie Extractive Québec, Québec City, Canada 2008, 160 pages. Distributed by Laval University Bookstore: **www.zone.ul.ca**