# THE WORLD'S OLDEST ALUMINIUM CASTING

**Dr DAVID A. HARRIS, CONSULTANT, ALUMINIUM ADVOCATES**

At 8% aluminium is the most common metallic element in the earth's crust, exceeded only by oxygen and silicon. Unfortunately aluminium is never found naturally in the metallic state since it readily forms very stable, complex alumino-silicates. The stability of the bond between aluminium and oxygen means that aluminium oxide cannot be reduced by carbon, at achievable temperatures, as is the case with several other metals, principally iron. The electrolytic process for the production of metallic aluminium in tonnage quantities had therefore to wait until Michael Faraday discovered the principle of electro-magnetic induction in 1831 which made possible the development of the electric motor and the dynamo. Consequently it was not until 1886 that the electrolytic production of aluminium metal was first established by two workers, Charles Martin Hall working in America and Paul Heroult working in France, Fig I and II.

By a strange coincidence Hall and Heroult had both been born in the same year, 1863 and were therefore only aged 23 when they independently and simultaneously developed the electrolytic process, for the production of aluminium metal, Hall working in the family woodshed and Heroult working in the family's leather tannery. Also by

coincidence they both died in the same year, 1914, at the relatively young age of 51. In the year 1886 Paul Heroult was the first to claim a patent for the process in France in April of that year. When Charles Hall claimed his patent in the USA in July he was dismayed to learn of the earlier claim. Remarkably however, his early experiments had been carried out in February of that year and his letters and his laboratory logbook had been verified by witnesses at that time, very astute of one so young. His patent therefore in the USA was declared valid but only after three more years had elapsed. Hall developed the commercial applications of his process in the Pittsburgh area in the company that eventually became Alcoa. Heroult developed his process in France in the company that eventually became Pechiney.

Their process briefly was an electrolytic reduction of aluminium oxide using cryolite as a flux, otherwise the temperature required to fuse aluminium oxide would have been impossibly high. A graphite cathode was used at which aluminium metal collected together with a carbon anode at which oxygen collected, from the breakdown of the Al-O bond, leading to the anode being consumed. The commercial acceptability of the process was complete when Carl Bayer, during the five years 1887 to 1892, developed the Bayer Process in which the

ore Bauxite is digested in a caustic solution to produce pure aluminium oxide.

Once these two processes, the Hall-Heroult Process and the Bayer Process, had become established then aluminium, instead of being regarded as a precious metal, became a commercial reality. The development of the world production of primary aluminium is shown in Figs III and IV. In 1885 the world production was 13 tonnes and in 1999 was 22 million tonnes. At the same time the energy efficiency of the Hall-Heroult Process improved dramatically from 45,000 Kwh/t initially down to an average of 13,000 Kwh/t at the present time. The properties of low density, high strength, good corrosion resistance, good formability and high electrical and thermal conductivity has seen aluminium alloys take a major share in many markets, particularly transport, building and packaging. The ease of recycling has made the metal readily available and helped to gain markets as aluminium castings.

The first UK primary smelter using the Hall-Heroult Process was built at Foyers on the side of Loch Ness and in 1900 this plant produced 510 tonnes of primary aluminium. Smaller amounts of aluminium had been produced in the UK prior to this plant being built and the statue

of Eros by the sculptor R.A.Gilbert was cast and erected in June 1893 using aluminium produced by the sodium process Fig V. The chemical analysis of the metal used to cast Eros varies according to the position but analysis of a sample from the head gives the results shown in Fig VI. It is sometimes thought that Eros is the oldest aluminium casting still in existence but as we shall see this is not the case.

At this point we need to summarise the path by which metallic aluminium was first discovered and then produced up to 1886. The discovery of metallic aluminium can be attributed to Humphrey Davy working in 1809, who fused together iron powder and aluminium oxide in a tiny electric arc, produced by a huge set of small batteries. He produced tiny globules of an aluminium-iron alloy. In 1827 F.Wohler produced small amounts of impure aluminium by reducing aluminium chloride with potassium. No commercial quantities were ever produced until Henri Saint-Claire Deville, shown in Fig VII, working in France in 1854 found that by using sodium metal instead of potassium he could reduce a double chloride salt of aluminium and sodium. Two of his assistants found that the introduction of cryolite greatly improved the efficiency of the sodium reduction. One of these assistants was a man by the name of Paul Morin. In 1856 Deville,

together with Paul Morin and others set up a company that became the Societe d'Aluminium, producing 50 kilograms of aluminium metal per day. In 1859 the company changed it's name to Fabrique d'Aluminium, Paul Morin & Cie, with a works near Paris, with Paul Morin as the Managing Director. It is known that this company produced many works of art, medallions, statues and jewellery in aluminium but then, from 1860 onwards, concentrated on the production of aluminium bronzes, particularly for cannons.

At this point we turn to the aluminium casting which is the subject of this paper. The casting is of a classic Greek pose of a lady, the original marble statue 2.25m high appears in the Louvre. The original piece was found in Italy, at the town of Gabies, and the original statue is known as Diane de Gabies. The aluminium casting is a one third reproduction of the original and is 90cm high and weights 7 kilograms, Fig VIII. The composition of the casting, taken at the back of the base, is given in Fig IX. The casting is hollow and is clearly an investment casting produced by building up the wax on top of a solid core. The composition gives no definitive clues to the origin of the casting except that it is a composition that would not be chosen today in order to make a very complex investment casting. Both the casting

of Diane and Eros show very high iron content, lower than expected silicon content and a significant amount of copper.

The casting came into the possession of the Aluminium Federation when the then Director of the Aluminium Development Association, Dr E.G. West purchased the casting from an antique dealer in the 1950s. The seller claimed that the casting had been exhibited at the Great Exhibition of Paris at the turn of the 19th Century.

Often with castings, particularly bronzes, the age and the manufacturer can only be estimated by examination of the quality of the piece. In the case of the aluminium casting of Diane de Gabies we are fortunate that we have at the base of the casting a small engraved signature Paul Morin et Cie. Fig X. This piece of evidence, together with the composition and the appearance of the piece leads to the conclusion that it was cast at Nanterre between 1858 and 1860 by the company operated by Paul Morin. That being so the casting pre-dates Eros by over 30 years. It must then be one of the oldest pieces of aluminium in existence and probably the oldest aluminium casting. It is therefore remarkable that such a piece, produced at the very beginning of the “Aluminium Story” should be of such breathtaking quality.