PROFESSOR ANTON RUPRECHT AND THE METALLIZATION OF EARTHS

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In the Middle Ages, mining of noble and non-ferrous metals was very significant in Upper Hungary, the present Central Slovakia. Half of the world's gold production and one third of its silver production came from this area. One of the largest mining and metallurgical works in Europe was established here in the 15th century by the Thurzó—Fugger family. This historical mining region gave birth to one of the most ancient institutions for higher education in technology: King Charles III of Hungary (as Emperor Charles VI) founded a mining engineers' school in Selmecbánya (Schemnitz in German, Banska Stiavnica in Slovakian) in 1735, and this school was raised to the rank of an academy in 1763 by his daughter Queen Maria Theresia. Simultaneously, the Department of Chemistry and Metallurgy was established, the first chemical department in Hungary. The Academy of Selmecbánya soon became famous in Europe, above all owing to its teaching of analytical chemistry, since essaying was taught here not only theoretically, but in practice, too. What appears natural to us, laboratory training of the students, stemmed from the Selmecbánya Academy, and this didactic method was adopted some decades later, in 1794, in the École des Travaux Publics, the later École Polytechnique in Paris, as evidenced by the school project laid before the Convent by Fourcroy in 1794. This speech appeared in the Moniteur, and the following citation originates from it: "La physique et la chimie n'ont été montrées qu'en théorie en France. L'école des mines de Schemnitz en Hongrie nous fournit un example frappant de l'utilité de faire exercer ou pratiquer par les élèves les opérations qui font la base de ces sciences utiles. Des laboratoires y sont ouverts et munis des ustensils et des matériaux nécessaires pour que tous les élèves y répètent les expériences et voient par leurs yeux tous les phénomènes que les corps présentent dans leur union. Le Comité du salut public a pensé qu'il fallait introduire dans l'école des travaux publics cette méthode. . ." [1, 2].

It was at the École Polytechnique that Liebig became acquainted with this didactic method and subsequently, when he was appointed professor at the Giessen University, he introduced it. From that university it then spread to all universities of the world.

From its foundation on, intense research work was being carried on at the Selmecbánya Academy. The first professor of chemistry was the Dutchman Jacquin, a medical doctor who later was appointed to the University of Vienna. He carried out the experiments confirming Black's statements in Selmecbánya. These experiments were cited and highly estimated by Lavoisier. Jacquin's successor was Scopoli, an Italian, also a medical doctor, later appointed to the University of Pavia. He was still a partisan of the phlogiston theory. The third professor, however, was no more a medical doctor, but a graduate of the Selmecbánya Academy, Anton Ruprecht. He was born in Selmecbánya or its surroundings, studied at the Academy and became assistant to Scopoli. He made a long study tour in Sweden where he worked in Torbern Bergman's laboratory in Uppsala and in Esmark's laboratory in Stockholm. He then returned to Selmecbánya and was appointed professor of chemistry and metallurgy in 1779. In 1792 he became councillor of the Mining Chamber in Vienna and the supreme chief of mining in the Austro-Hungarian monarchy. He died presumably in 1802.

Ruprecht was a born researcher and soon became known on an international level. The scientific dispute between Ruprecht and his colleague Ferenc Müller led the latter to the discovery of tellurium. Ruprecht was the host of the international scientific meeting in Selmecbánya, held in 1786 with the objective to study the pilot plant for gold production using the amalgamation method developed by Born. The participants of that meeting, among them their host Ruprecht, were the founders of the first international scientific society, the Sozietät für Bergbaukunde. He analyzed numerous ores and published the results [3].

In his lectures he equally discussed phlogistic and antiphlogistic chemistry, as demonstrated by one sentence in one of his publications: "... da ich schon in diesem Jahrgange meinen Zuhörern alle Erscheinungen nach beyden Theorien vorgetragen habe", but he was, in his conviction, a firm adherent of antiphlogistic chemistry, one of the first in the Monarchy. This is proved by his research activity that became known under the name "metallization of simple earths" at the end of the 18th century and evoked passionate scientific debates. Westrumb, a great opponent of Ruprecht's statements even went as far as to write a book against them under the title "Geschichte der neuentdeckten Metallisierung der einfachen Erden", which appeared in Hannover.

As it is known, the term earths was used for the oxides of alkali earth metals which were usually considered elemental substances. Lavoisier, too, described them as simple substances, although, at another place in his Traité, he suggested that possibly they might be compounds: "Il est à présumer que les terres cesseront bientôt d'être comptées au nombre des substances simples... Les terres. . . seraient peut-être des oxydes métalliques. . . Ce n'est, au surplus, qu'une simple conjecture que je présente ici . . . ne pas à confondre avec des vérités de fait et d'expérience. . ." [4] Presumably, at that time Ruprecht was already at work to prove that the earths contain metals. It is obvious that Lavoisier's combustion theory, the findings that numerous so-called chalks are nothing else but metal oxides, e.g. iron oxide, tin oxide etc. have led Ruprecht to this assumption. On the other hand, it is also obvious that he must have started these experiments before the appearance of Lavoisier's Traité, since that was in 1789, in Paris, while Ruprecht's paper was published in 1790, in Crells Chemische Annalen, and although the time for getting through the press was presumably shorter than it is nowadays, none the less the difference in time appears too small as compared to the geographical distance.

Ruprecht constructed an oven which allowed him to achieve very high temperatures: for the first time in science he succeeded in melting platinum meaning that the temperatures must have been as high as 1600 °C [5]. Regrettably no record was left on the construction of this oven. Westrumb, in his cited book, mentions the oven, and uses an expression "purest air". One might, therefore, consider that perhaps Ruprecht fed his oven with oxygen. It is, however, doubtful how — at the time — he could have been capable of steady oxygen production with an output satisfactory for that purpose.

The oven was used by Ruprecht for reducing various metal oxides. At the time, many new metals were discovered by reduction of the corresponding oxides. Ruprecht made a paste of the material to be tested with linseed oil and coal dust and placed it into a Hessen crucible lined with coal dust. By using this method he produced manganese from manganese dioxide and molybdenum from molybdenum oxide. These were, however, processes known at the time. He then started experimenting in a similar manner with barium, calcium and magnesium oxides [6]. His assistant in this work was Tondi, an Italian who studied in Selmecbánya with a scholarship granted by the King of Naples. Ruprecht announced that he obtained metal pellets in all cases, and accepted this as evidence that these earths are not simple substances, but metal compounds. He determined the density of the metal pellets and gave names to the metals he believed to have discovered: borbonium (after the royal family of Naples), parthenum and austrium (after Austria).

Let me interject a remark here: Austria was the unluckiest country concerning the naming of elements. In the course of history it happened three times that an element newly discovered was named after Austria, and all three times it turned out to be a mistake. It is also characteristic that none of the austriums was discovered in Austria proper, but in other parts of the Habsburg Empire. The first alleged discovery was Ruprecht's in Hungary in 1790. Another austrium was "discovered" in 1886 in Prague, that is, in Bohemia, and a third in 1899 in Chernovits (Bucovine) [7].

Ruprecht's results attracted great attention. Westrumb, a mine superintendant in Hameln repeated the experiments and was uncertain for some time, because he, too, obtained metal beads. Soon, however, he came to the conclusion that Ruprecht was mistaken: the pellets originated from contaminations in the material and from the crucible itself, and consisted mainly of iron [8]. Ruprecht's assistant Tondi repeated the experiments in Vienna, in the foundry of the artillery in the presence of Ignatius Born, and insisted on the correctness of the results obtained in Selmecbánya. Klaproth, the famous analyst of the period also became engaged in the dispute. He repeated Ruprecht's experiments in the Berlin mint, and supported Westrumb's opinion: the pellets consist mainly of iron and take their origin from contaminations in the crucible. The controversy between Born and Klaproth went on for some while. Klaproth briefly termed the whole question "Schemnitz delusion" (Schemnitzer Irrlehre). He expounded that the decomposition of earths is impossible on principle. "Von den primitiven Erden aber ist es, wenn ich etwa den Herrn von Lavoisier ausnehme, wohl noch keinem Naturforscher in den Sinn gekommen, zu vermuthen, daß sie in Metallkalken bestehen sollen. . . Des to auffallender ist es, daß die gedachten Personen in Schemnitz dieses. . . behaupten und aus ihren angestellten Reduktionsversuchen beweisen wollen." [9]

Well, in science one should be very careful in using expressions like "impossible on principle". There are numerous examples for things having been declared impossible on principle were found possible. In the case of the earths in question, this took less than twenty years: in 1808 Davy, by the electrolysis of alkali earth metal oxides in mercury, demonstrated that on principle, Ruprecht was right: these earths do contain metals. Ruprecht did not live to hear this, but Klaproth did. Anyhow, it still took a long time till he accepted Davy's finding.

In practice, though, Klaproth's opinion was correct in the dispute. It is certain that alkali earth metals cannot be obtained from their oxides by reduction with carbon. The density data measured by Ruprecht also disagree with his theory, being much higher than those of alkali earth metals, though lower than that of iron.

In the 'thirties of our century professor Proszt, the umpteenth successor of Ruprecht as head of the Department of Chemistry at the Mining Academy (which, after World War I, when Upper Hungary and in it Selmecbánya was annexed to Czechoslovakia, moved to the town Sopron) attempted to give an experimental and theoretical explanation of Ruprecht's procedure. He concluded that eventually iron beads containing small amounts of alkali earth metal carbides were formed in Ruprecht's experiments [10]. It is difficult, however, to accept such a compromise as justification.

Summary

Prof. A. Ruprecht of the Mining Academy of Selmecbánya in Hungary, one of the first adherents of Lavoisiers antiphlogistic chemistry in Middle-Europe tried in 1790 in a self-constructed high-temperature oven to reduce with coal dust the so called earths (alkali earth oxides) for proving that they contain metals. He announced that he obtained metal pellets in all cases. Westrumb and Klaproth, both repeated Ruprechts experiments and came to the conclusion that Ruprecht was mistaken, the metal pellets originated from contaminations Klaproth expounded the impossibility of a decomposition of earths. Though it is presumable that Ruprechts results were in practice really wrong, on principle he was right as Davy demonstrated in 1808 by the electrolytic decomposition of earths.

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