

ANTON LEOPOLD RUPRECHT - A CHEMIST, MINERALOGIST, METALLURGIST AND A DISTINGUISHED PERSONALITY OF THE CHEMICAL REVOLUTION IN THE 18TH CENTURY

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Introduction

Based on Empress Maria Theresa's order (of December 13, 1762) the first higher school institution specialised in technical education in Europe with the Department of Chemistry, Mineralogy and Metallurgy was founded in Schemnitz (present-day Banská Štiavnica) in 1763. The efforts to educate highly qualified technicians in mining, metallurgy and related fields in Austria-Hungary was crowned by foundation of this school, which in 1770 (after establishment of the Department of Mathematics, Mechanics and Hydraulics, and the Department of Mining Art and Mining Law) changed its name to a loud-sounding the Mining and Forestry Academy. Within a relatively short time, the school achieved a European recognition also by its research activities. Its particular importance emerged from the application of new scientific knowledge and development of progressive technological methods performed due to research outcomes. The school was characterised by adopting experimental methods based on measuring and weighing, and thus contributed significantly to revolutionary changes of scientific understanding of chemical processes, to supporting of Lavoisier's oxidation theory and to discarding of the phlogiston interpretation of combustion. In the rich history of the Mining Academy since its foundation, the top positions were held by eminent and internationally recognized authorities who provided not only theoretical and practical teaching and training, but also research activities linked to the production practice – Nikolaus Joseph von Jacquin, Giovanni Antonio Scopoli, and particularly Anton Leopold von Ruprecht [1 – 10].

Nicolaus Joseph Jacquin (1772 – 1817)

He was the first professor of chemistry and mining at the Mining Academy (**Fig. 1**)- born in a Dutch Leyden, studied medicine and natural sciences at universities in Paris and Vienna. He established at the Academy in Krecsmáry's House one of the best chemical laboratories in Europe. At the same time, he amassed a collection of local and exotic mineral samples and rocks, not only for practical training, but also for chemical research. He defined chemistry as "practical science dealing with changes of natural substances, their composition, and research

of their component parts“. He claimed: “If the theory is not connected at the same time with the experiment, it has no foundation.“ He educated several outstanding graduates from the Academy, including F. J. Müller von Reichenstein, a discoverer of tellurium. Jacquin was a member of several universities and belonged to first prominent supporters of Lavoisier’s oxidation theory of combustion, combination of substances with oxygen. After six years of his activities at the Mining Academy, he was appointed Professor of Medical Chemistry and Botany at the University of Vienna [10 – 14].

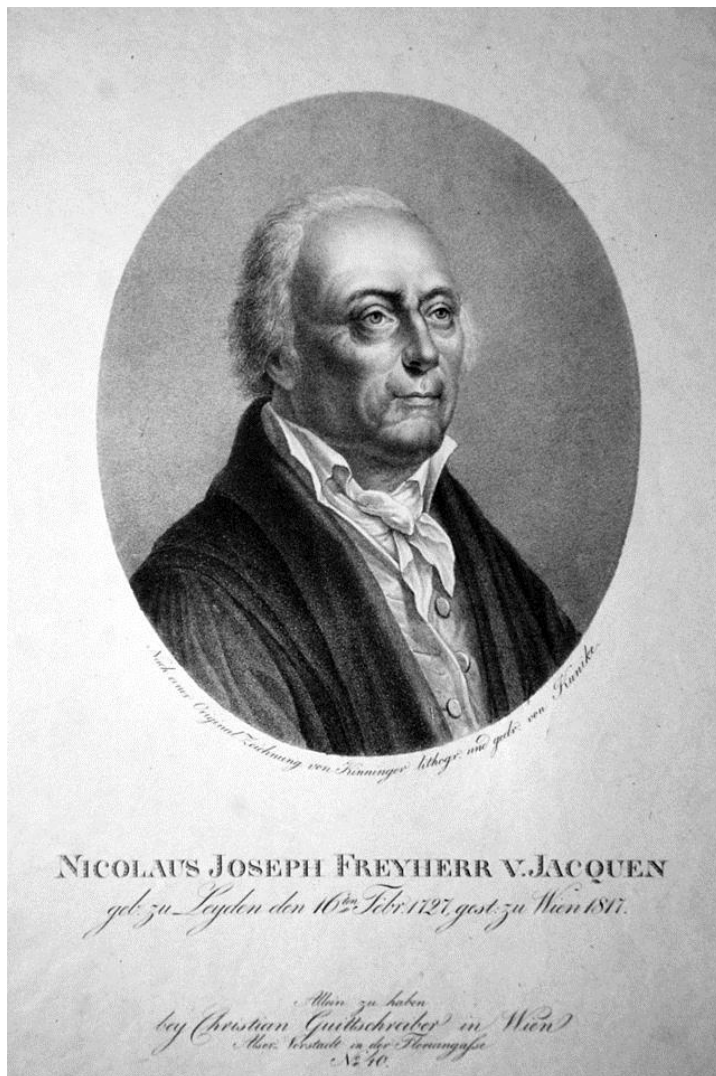


Fig. 1 Nikolaus Joseph von Jacquin (lithography by Adolf Kunike)

Giovanni Antonio Scopoli (1723–1788)

Was born at Cavalese in Italy, graduated from the Faculty of Medicine University of Innsbruck, was appointed Professor of chemistry and metallurgy at the Mining School in Idrija (Slovenia).

He followed the successful activities of his predecessor, paying special attention to the research of silver ores and minerals particularly from the region of the central Slovakia – assessing their shape, physical and chemical properties, where he admiringly depicted the beauty and diversity of crystals from Schemnitz mines. He continued in completing a mineralogical collection; in teaching activities he put the emphasis on problems of mining and metallurgic mineralogy. Scopoli's mineralogical work has the key priority in the history of mineralogy in both Slovakia and Europe. During his work at the Academy in Banská Štiavnica, he did not confine himself only to chemical-metallurgical and geological-mineralogical research. Of particular importance is also his 5-volume botanic-faunistic monograph *Anni Historico Naturales* (1769 - 1772; Leipzig), in which he provided description of plants and animals located in the area of Banská Štiavnica already according to the system of Carl Linnaeus. Some genera and subgenera are even named after Scopoli, including a known alkaloid scopolamine. In 1777 he accepted professorship of botany and chemistry at the University of Pavia, where he remained for the rest of his life [10, 15 – 18].



Fig. 2 Giovanni Antonio Scopoli (portrait on the title page of his monography “Principles of Systematic and Practical Mineralogy“

Anton Leopold Ruprecht (1748 - 1814) (Fig. 3)

A. L. Ruprecht – a native of Smolník (Smolnícka Huta) in Slovakia, already known since the 13th century with mining gold, silver, and copper ores. He completed his studies at the Mining

Academy in Schemnitz and was a student under G. A. Scopoli's supervision. Shortly after a successful completion of his studies, the Court Chamber in Vienna sent him in 1774 to a 2-year study stay in Scandinavian countries. In Sweden he worked mostly at the University of Uppsala and led by then most respected European chemist and mineralogist Torbern Olof Bergman, the father of crystallography and a mineral classification scheme based on chemical characteristics. Among his students there were outstanding chemists, discoverers of chemical elements – J. G. Gahn (manganese), C. W. Scheele (oxygen together with J. Priestley, and fluorine together with H. Moissan), P. J. Hjelm (molybdenum together with Scheele), etc. After returning from Sweden Ruprecht was named Professor of chemistry and mining at the Mining Academy and after G. A. Scopoli's leaving for the University of Pavia he was appointed Head of the Department of Chemistry, Mineralogy and Metallurgy [(10, 11, 17, 19 - 22)].



Fig. 3 Anton Leopold Ruprecht (portrait from around the year 1792). SBM in Banská Štiavnica, UH-865, photo: Ľ. Lužina

During his time at the Academy Ruprecht built a unique collection of domestic and exotic minerals, rocks, soils, and fossils. He contributed with exhibits from Schemnitz mines to scientific cabinets in Milan, Pavia and Paris [23, 24]. He was a prominent chemist – theorist and

also experimentalist, author of original experiments of thermic reduction “metallization“ of simple soils, which resulted in discovering of various chemical elements. He updated a chemical laboratory, which had been built already by Jacquin and Scopoli, and the laboratory of Bergman in Uppsala served for him as the model. He performed a number of chemical analyses of minerals, precious opals in particular (25). It is to his merit that the Academy became the centre of chemical research in Europe, where worked a number of experts – chemists, mineralogists and metallurgists from abroad [3, 18, 21, 22].

A. L. Ruprecht belonged to a progressive direction not only in research, but also in schooling. His lectures were of high professional level with presentation of original knowledge. In education, he put a great emphasis on laboratory work, thus following a tradition based by N. J. Jacquin. He was the first to introduce in classes a term “chemical process“, which he described orally instead of presenting alchemical symbols, and this allowed better understanding of chemical changes (Fig. 4). In his reactive mechanisms there started to appear already a sort of seeds of today’s chemical equations. Besides chemistry, he lectured also on testing, mineralogy and metallurgy, mining law and forestry. Part of teaching mining were also lectures on atmospheric electricity in relation to construction of lightning rods that he himself designed for church towers and building roofs, where gunpowder was stored. Vocational training at the Mining Academy became a model to follow even for such an excellent university as the school *École polytechnique* in Paris was, as evidenced by the statement of A. F. Fourcroy presented at the French National Convention of 28th September 1794: “*The Mining School in Schemnitz (Banská Štiavnica) gives a noteworthy example of usefulness of exercises and practice of students in operations being the basis for applied sciences*“ [22, 26, 27].

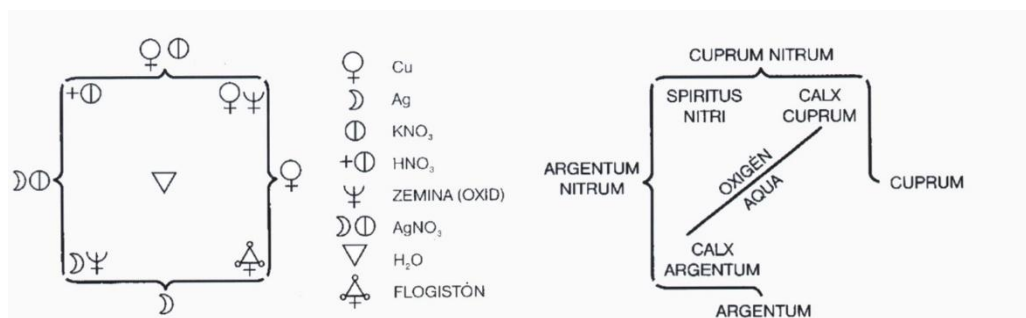


Fig. 4 Scheme of copper reaction with AgNO₃ in alchemistic expression (above) and by A. L. Ruprecht (below)

A. L. Ruprecht’s scientific interest was focused particularly on the three following areas: a) extracting gold from Transylvanian ores; b) metallization of simple soils; c) introduction of a new I. Born’s amalgamation method for the separation of silver from gangue.

The timeliness of the first research area was related to the effort to increase extraction of gold, as in metallurgic processing of Transylvanian ores there was a lower extraction of gold less than it had been expected to be based on testing procedures. Ruprecht solved this problem in parallel with F. J. Müller von Reichenstein (at that time director of mining district in Transylvania). The research resulted in discovering a new element – tellurium and the credit of the discovery was given to Müller. The new element was named after ancient Roman goddess of the earth *Tellus* and is associated with H. Klaproth, who discovered it again 16 years later. A technical problem

of lower extraction of gold from Transylvanian ores was solved not until a hundred years later by elimination of tellurium before its metallurgical processing. Schemnitz (present-day Banská Štiavnica) smelter produced tellurium in this way in the end of the 19th century in substantial quantities for scientific laboratories in order to research into its physical-chemical properties and practical use [22, 28 - 30].

Issues on metallization of simple soils Ruprecht was dealing with in the late 1780s were the focus of his scientific interest, where he relied on Lavoisier's oxidation theory. It was a bold plan because these soils were at that time considered final, indecomposable objects (an element due to Aristotle's philosophy). All previous experiments and efforts to decompose such soils failed, including experiments performed by A. L. Lavoisier himself. Ruprecht firmly believed that such soils contain less-precious metals in the form of oxides, which can be heat-metallized. Practical solution required to establish appropriate laboratory conditions – introduction of new experimental procedures and construction of a high-power smelting furnace, which was not found in any European laboratory. Ruprecht's furnace temperature reached 1,600 °C, at which destructive reduction analysis of soils occurred. However, despite great dedication and efforts Ruprecht definitely failed to prove searched scientific truth. Some of his experiments remained unfinished or unused, or failed due to emerging thermostable carbides. Nevertheless, he was very close to the discovery of new elements. Scientific papers in which he presented the results of his metallizing experiments caused great sensation and were considered of extraordinary significance. The accuracy of his thermal "reduction metallization" was verified 15 years later, when there were discovered new elements – magnesium, calcium, barium and boron by electrochemical reduction (Sir Humphry Davy in 1807 and 1808).

High international recognition that A. L. Ruprecht reached for his contribution to development of scientific chemistry of the 18th century was reflected in initiating a "**Millennium Project**" of the Federation of European Chemical Societies (FECS) – *Celebration of the 100 distinguished European Chemists from the Chemical Revolution to the 21st Century* (**Fig. 5**). The official list includes 14 chemists from the 18th century as follows: T. O. Bergman, C. L. Berthollet, J. Black, H. Cavendish, J. Gadolin, R. Kirwan, M. H. Klaproth, A. L. Lavoisier, M. V. Lomonosov, J. Priestley, J. B. Richter, **A. L. Ruprecht**, C. W. Scheele, and L. N. Vauquelin [31, 32].

Another particular merit of A. L. Ruprecht and the Mining Academy in Banská Štiavnica stemmed from his participation in improving and applying into practice a new Born's amalgamation method of extracting precious metals (gold, silver) from low-grade ores [28, 33, 34].

Ignaz Anton von Born (1742-1791) (**Fig. 6**) –came from Transylvanian Alba Julia in present-day Romania. He first studied law (did not complete the studies) at the Charles University in Prague and then he studied at the Department of Mining Sciences of the Faculty of Arts headed by Jan Tadeáš Peithner. He was one of the founders and first president of the Royal Bohemian Learned Society. In 1769, Born appeared at Schemnitz as a newly appointed mining councillor of the Great Duke Chamber Board. Even before it, he conducted an exploratory trip throughout Transylvania and neighbourhood of Banská Štiavnica, during which he was engaged in research into minerals and soils. The knowledge obtained was published in his work *Briefe über mineralogische Gegenstände*, which puts him by its importance in a position of "the father of Slovak geology". From 1776 even to his death, he worked as a custodian of the Imperial Science and Natural History Collection of minerals in Vienna. I. A. Born was engaged also in metallurgical chemistry, where he was mostly interested in amalgamation process of extracting precious metals, which was known and used in Spanish colonies in South America. He managed

to come up with a new so-called indirect process of amalgamation, which he made public (with the consent of Emperor Joseph II) in the publication *Über das Anquicken der Gold- und Silberhaltigen Erze Rohrsteine, Schwazkupfer und Hüttenspeise* (Vienna, 1786) [33 - 35].



FEDERATION OF EUROPEAN CHEMICAL SOCIETIES

Millennium Project: Celebration of 100 distinguished European Chemists from the Chemical Revolution to the 21st Century

The FECS is initiating, as a Millennium Project, the celebration of Distinguished European Chemists spanning a period of over two hundred years.

Member societies of FECS are invited to submit their nominations of distinguished European chemists from, say, the end of the 18th century until the present day. In addition to Nobel Prize winners, there will be nominations of many others from Europe who have over more than two centuries transformed the science and influenced others across the world.

It is suggested that FECS member societies may wish to arrange for their Boards to establish a working group to develop their list of nominations. Individuals will also be given the opportunity to submit nominations via the FECS web site.

The closing date for nominations is 26 February 1999.

Criteria

Nominations will be considered on the basis of the extent to which the individuals have transformed chemical sciences and influenced science, industry or society worldwide. It is expected that the final list will include a diversity of nationalities.

European Chemists can be defined as individuals who have carried out a major part of their significant work in Europe.

Please complete the attached forms and return them to Ms E K McEwan, FECS Secretariat, c/o The Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN, UK; FAX +44 171 437 8883

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AllChemE web site <http://www.chemsoc.org/gateway/AllChemE.htm>

Fig. 5 Federation of European Chemical Societies: Millennium Project “Celebration of the 100 most distinguished European chemists from the Chemical Revolution to the 21st century“.



Fig. 6 Bust of Ignaz Anton von Born in Sklené Teplice (Slovakia)

Born's method was laboratory tested and refined by A. L. Ruprecht in a new laboratory in Banská Štiavnica (in Belházy's House) (**Fig. 7**). The refinement consisted in increasing of extraction of precious metals (gold and silver), which was reached by rough crushing and fine grinding of the ore and followed by double sulphatizing roasting of the ore, where the second roasting was performed with the addition of salt. This method also contributed to the reduction of water consumption, wood burnt and to shortening of the entire process. A. Ruprecht deserved most of the credit that Born's amalgamation was successfully implemented into practice. He selected Sklené Teplice for a production facility where a suitable object of the shutdown

smelting plant was located and nearby there were also deposits of silver ore. The new method showed a great deal of interest abroad. Born invited to the public demonstration of his method the metallurgists from the whole Europe. This event impressed particularly Spaniards, as the original procedure of amalgamation was a lengthy process with large losses of mercury. This immense interest eventually resulted in the decision to organize an international gathering of experts – **Congress at Skleno** (present-day Sklené Teplice) [36].



Fig. 7 Belházy's House in Banská Štiavnica

The Congress started on 27th August 1786 with an opening speech delivered by I. Born, and there participated 27 outstanding figures and top experts in Europe for mining, metallurgy, geology, mineralogy and chemistry – J. Hawkins from England, J. Charpentier (mining councillor of Saxony and professor of the Mining Academy in Freiberg), J. J. Ferber (geologist from Prussia), M. H. Klaproth (chemist and pharmacist from Berlin), brothers Claus and Georgius Henckel from Norway, Count Castine from France, Barons F. W. H. von Trebra and von Uslar from Hannover, D. Weber from Palatinate, Count Belmonte Ventimiglia, Baron Dietrich (royal commissioner for mines in France), Faustus d'Elhuyar (chief director of Royal Spanish Tribunal for mining in Mexico) with companions, mineralogist Gordogann, Count Vrbna (court councillor in Vienna), H. Völkner from Russia and others. From domestic specialists besides I. Born and A. L. Ruprecht there was present also M. Poda, with trainees and masters [36].

Public demonstration of a new amalgamation method at the Congress was an extraordinary international event. Publishing a scientific and technical discovery, which had a huge economic and commercial importance, represented a new moment in the scientific world. Even less important novel technological procedures were then kept in secret, and thus being a brake of general progress. The experts present at the Congress in Sklené Teplice could mutually exchange their opinions and technical experience, and thus learn how it was needed to organize systematically exchange of knowledge in terms of technical and scientific progress worldwide. F. d'Elhuyar (a discoverer of tungsten in 1783) reported on information from the Congress in two comprehensive articles entitled *Theorie der Amalgamation*, where he evaluated both Born's and Ruprecht's work with gratitude and acknowledgements. Enormous achievement of the Congress was a **foundation of the first internationally organized scientific society of the world** – *Le Société de l'art de l'exploitation des mines* (Societät der Bergbaukunde). The

initiators and later principal officials were I. Born, F. W. H von Trebra, J. J. Ferber, M. Poda, A. L. Ruprecht, F. d'Elhuyar, J. F. Charpentier, J. Hawkins, and O. Henckel. The Society's activities were focused on development of mining and metallurgy through improving of mining technique and acquiring new knowledge in related disciplines (geology, mineralogy, chemistry, including history of mining). Report on foundation and articles of the Society were published in *Annales de Chemie* (1789). The Society gained its reputation also by declaring the necessity of organizing international scientific cooperation. Its articles were designed in order to converge theory with practice in mining and metallurgic industry [33, 37 - 39].

The international learned society was organized according to the countries headed by directors (in the Habsburg Empire it was I. Born). Already in the early years, it comprised 147 members from 15 countries – 75 ordinary, 55 associate and 17 honorary members. The members of the Society were such eminent European figures as A. L. Lavoisier, J. L. Proust (a discoverer of the law of constant composition), J. G. Gahn, W. H. Klaproth (a discoverer of uranium, zirconium, cerium and titanium), J. Watt (an inventor of steam engine), J. W. Goethe, L. F. Crell (a publisher

of periodicals *Chemisches Journal* and *Chemische Annalen*), S. Tennant (a discoverer of osmium), S. P. Pallas (a Russian scientist) and others. The Society issued an annual almanac called *Bergbaukunde* in order to inform its members. The first volume comprising 408 pages was issued in 1789 in Leipzig, the second one as comprehensive in the following year. Difficult and turbulent political and social events in the further period (the French Revolution, the Napoleonic Wars, the War between France and Prussia-Austria-Britain coalition), and to some extent I. Born's death resulted in break of scientific contacts and finally also in the end of the Society.

The fact that the place of foundation of the Society was the territory of Slovakia is not accidental. In the early beginning of the 18th century there took place rapid development of mining production and metallurgy, which was conditioned by technical progress. Its centre became the Mining Academy in Banská Štiavnica, whose Department of Chemistry, Mineralogy, and Metallurgy played a challenging pioneering role in science development in related disciplines in the second half of the 18th and early 19th century. Born's amalgamation process, the international gathering in Sklené Teplice and foundation of the first scientific-technical society for development of mining and metallurgy were events closely related to activities of the Academy [33, 34, 38].

A. L. Ruprecht's performance at the Mining Academy lasted until 1792, when he was appointed to hold a post of Councillor of the Hofkammer in Vienna for mining, metallurgy and minting. In this high position hold until 1802, he regulated mining and metallurgical matters of the whole Austria-Hungary (39). With his results in chemical, mineralogical, and metallurgical research, he brought fame to the Mining Academy all over the world. He was one of the most progressive and distinguished experts of his time, which was extremely rich in new discoveries. In 1808 Emperor Franz I awarded him the Royal Hungarian Order of Saint Stephen. On the day of Ruprecht's death - 6th October 1814 - the Court Chamber in Vienna ordered to display his portrait (**Fig. 3**) in the aula of the Mining Academy [22]. Nowadays this picture is located in the Kammerhof in Banská Štiavnica. Objectification of scientific activities of A. L. Ruprecht as a professor of chemistry, mineralogy, and mining at the Mining Academy and as a mining official is worked out in detail and knowledgeably in a recent publication of the author P. Konečný, expert of the State Central Mining Archives in Banská Štiavnica [39].

A dignified successor to Ruprecht at the Mining Academy was his student **Michal Ignác Patzier**, a native of Krompachy in Slovakia, an experienced mineralogist and author of 4-volume newly drawn up work *Anleitung zur metallurgischen Chemie* (Budín, 1805). In his research, he was dealing with processing of antimony ore and non-ferrous metal ores [26, 40].

Conclusion

A. L. Ruprecht belongs to the most progressive and distinguished mining and metallurgic experts of the second half of the 18th century. With the results in chemical, mineralogical, and metallurgical research, he made the Mining Academy in Banská Štiavnica famous and become a training and research centre in Europe. His name has a well-founded place in the list of the most distinguished European chemists from the Chemical Revolution to the 21st Century.

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