Miner Econ (2015) 28:131–132
DOI 10.1007/s13563-015-0071-2

BOOK REVIEW

Hjalmar Fors, The Limits of Matter—Chemistry, mining & enlightenment

The University of Chicago Press Chicago USA 2015

Magnus Ericsson[1]

Published online: 15 September 2015

Swedish chemists have discovered more elements than scientists from any other nation. Over more than 100 years, from the early 18th century to the end of the 19th century, 20 elements of which 18 metals or non-metals and 2 gases, nitrogen and chlorine were independently isolated and described. Some of these are as follows:

Element	Name	Year of discovery
Cobalt	Brandt	1735
Nickel	Cronstedt	1751
Manganese	Gahn	1774
Molybdenum	Hjelm	1781
Yttrium	Gadolin	1794
Tantalum	Ekeberg	1802
Cerium	Berzelius	1803
Selenium	Berzelius	1817
Lithium	Arfvedson	1817
Silicon	Berzelius	1828
Thorium	Berzelius	1829
Vanadium	Sefström	1830
Lanthanum	Mosander	1839
Erbium	Mosander	1843
Terbium	Mosander	1843

How was this possible? What made a small country in the periphery of Europe reach such a top position among the much larger and wealthier countries such as Germany (although at that time not united into one yet), France and England? Part of the answer is surprisingly bureaucratisation or the creation of an administrative institution called Bergskollegium in Swedish or English Bureau of Mines as *Hjalmar Fors* calls it in his new and path-breaking study *The Limits of Matter—Chemistry, mining & enlightenment.* Another part is the need of improved processes and better yields in Swedish mines, which played such a vital role in the Swedish economy during this period. The Swedish ruling groups saw these demands and founded the Bureau of Mines, which acted in several ways to solve problems, that had arisen in the mining industry. R&D in those days was highly applied but nevertheless led to important purely scientific results.

The Bureau was set up in 1634 based on a predecessor, which was started already in 1630. Already from the start, the Bureau was instructed to run a *chamber of assaying* to investigate minerals from the various mines in the Kingdom of Sweden. In the latter part of the 17th century, a fully equipped laboratory, Laboratorium Chymicum, was finally inaugurated in 1686. In addition to its work in the field of mining and minerals, the Bureau was also responsible for the manufacturing of medicines for the mines and at times also for the entire Swedish army.

Fors uses the term *chymistry* to characterise the unified pre-1720s tradition of alchemy and chemistry. In the late 17th century, the traditional goals of the alchemist to find the philosopher's stone, to learn the secret of the universal elixir to gain a prolonged life and to transmutate common metals into gold (chrysopoeia) were gradually spun off, and the chemist became a servant of the state supporting the development of industry. A chymist was a dedicated artisan, who through skilful manipulation of matter and by devoting both body and soul to the project and sometimes with the support of supernatural forces, was successful in these endeavours. A

✉ Magnus Ericsson
magnus@gladtjarnen.se

[1] Luleå University of Technology, Luleå, Sweden

chemist only accepted the existence of matter, which could be isolated and handled in the laboratory. He, it was always a man, concentrated on what could be useful economically and for the state.

During the end of the 17th century, the Bureau was instrumental in the early stages of this transformation, not only in Sweden but also in Europe, by gradually turning its attention away from transformational chymistry and focusing on what at the time was called mechanical chemistry, i.e. early-stage modern chemistry. Fors shows how the systematic and gradual building of a European network and creating of a national cadre of knowledgeable persons allowed influences to flow in *both directions* not only into Sweden but also sending ideas and experiences into central Europe. This was not a linear development, but over 100 years, and in spite of many problems of various kinds, there was progress.

The Bureau had many well-known directors and employees, such as Urban Hiärne, of international reputation and a range of early metallurgists, for example, Georg Brandt, Axel Fredrik Cronstedt, Johan Gottlieb Gahn (compare the list above) and others and not the least the later world-renowned philosopher Emanuel Swedenborg. There is no doubt that the laboratory at Bergskollegium served the mining industry in Sweden and the development of chemistry as a science in Europe very well. It is highly likely that its successes inspired the set-up of a department of chemistry at the University of Uppsala in 1750 which further supported the strength of early Swedish chemistry.

Fors sheds new light on the gradual disappearance and dismissal of gnomes, trolls, keepers of mountains and other magical and mythical creatures by learned men in the Bureau. As the subtitle of his book implies, he also discusses these changes in the context of the Enlightenment. During the first phases of the Bureau's existence, spirits and supernatural forces were still accepted and played an important role in the explanation of nature and matter. Transmutative chymistry was, however, abandoned as it was not useful in solving the problems of the mining industry. But as late as 1735, when Georg Brandt, at the time acting director of the laboratory at the Bureau of Mines, isolated an unknown element, he called it "cobalt". *Kobold* is an old German word for a type of gnome in the mountains. A gnome, which made life difficult for the miners in various ways. Ores containing cobalt could not be treated and gave no valuable products when smelted but was useless and called kobold after the gnomes, which were thought to cause the problem. Obviously, these age-old beliefs were still in Brandt's mind as late as the early part of the 18th century.

Fors moves in a fascinating way from the details of the Bureau of Mines and its developments during 100 years to the political and societal situation in Sweden in the late 17th and early 18th century to a general discussion of how the modern notion of matter emerged, and how these men made an important contribution to European views of reality and the development of the Enlightenment. The book should be of interest not only to specialists in its field but to a wider range of economists, geologists and mining engineers who want to ground their specific knowledge on a wider understanding of the present discourse among historians of science.