

## BOOK REVIEWS

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*The Limits of Matter: Chemistry, Mining, and Enlightenment*, Hjalmar Fors, University of Chicago Press, 2015, 248 pp, ISBN: 9780226194998, \$40.

Hjalmar Fors's *The Limits of Matter* is an erudite and absorbing book. Its general, ambitious aim is that of tracing and delineating a major transition in early modern European culture: the construction and establishment, in the first half of the eighteenth-century, of the "modern notion of materiality." By the term "materiality," Fors identifies a wide intellectual territory, generally comprising sets of beliefs, worldviews and theories about the nature of matter. This is of course a daunting task, which Fors wisely approaches by considering the case of Sweden, in the period between the end of the seventeenth-century and the first half of the eighteenth-century. Moreover, Fors describes this major transition focusing on a specific group: the intellectuals, natural philosophers and chemists who founded and led the Royal chemical laboratory of the Bergskollegium, or Swedish Bureau of Mines.

*The Limits of Matter* opens on the fascinating figure of Urban Hiärne, head of the chemical laboratory at the Bureau between 1683 and 1720. Hiärne occupies a central position in Fors's argument. For Fors, Hiärne represents the epitome of the curious, inquisitive late seventeenth-century virtuoso and natural philosopher. Hiärne was a complex figure, belonging contemporarily to several and different worlds. A Cartesian by formation while a student at the university of Uppsala, he turned subsequently to Paracelsian doctrines. Fors's discussion of Hiärne is intriguing, and thoroughly shows how the Paracelsian worldview well adapted to the popular beliefs on trolls and the other invisible entities populating Swedish and European mines and forests. While at the Bureau of Mines, Hiärne transformed the role of the

chemical laboratory from that of a pharmacy into the leading institution for the study of chymistry in Sweden and a "showpiece for the Swedish state" [49]. Hiärne's efforts brought to the institutionalization of chymistry in Sweden as a useful and profitable discipline. Most of all, thanks to Hiärne, the laboratory and the Bureau of Mines established themselves as a cultural "contact zone" (a notion that Fors derives from the work of historian Kapil Raj), where artisanal knowledge about matter was "transformed into the knowledge of high-status mining officials" [52].

A crucial section of the book is dedicated to the practices through which the Bureau gathered new knowledge. Again, Hiärne was instrumental in establishing many of these procedures. In particular, young officers of the Bureau were sent abroad to acquire new skills. This was the case of Hiärne's trusted disciple, Erich Odhelius. Fors reconstructs Odhelius's travels through Europe in order to learn an array of useful disciplines, including "practical and theoretical chymistry, medicine, and pharmacology, mining crafts such as smelting and assaying, as well as administrative skills" [53]. Odhelius's task was that of learning, and also passing newly acquired knowledge to his teacher. For instance, during his stays in Saxony and in Freiberg, Odhelius became conversant with assaying and mining, a familiarity Hiärne himself lacked. Most importantly, thanks to Hiärne's efforts, the Bureau of Mines institutionalized this type of training system for its young officials: if in the first half of the seventeenth-century the Bureau's officials were mainly immigrant artisans from Germany, by the end of the eighteenth-century they were fully trained directly by the Bureau, according to Hiärne's principles. Additionally, contacts abroad brought a steady flux of skilled and knowledgeable assistants, especially from the mining districts of Saxony. Fors's account does

not follow the conventional scheme of peripheries versus centers of knowledge production, and emphasizes instead the European character and the international interactions of late seventeenth- and eighteenth-century mining.

The new generation of officers at the Bureau brought a strongly different approach. Fors characterizes this moment as the passage from an age of “curiosity” to one of “ingenious knowledge.” This new, strongly utilitarian character developed in parallel with the adoption of markedly mechanistic worldviews. In this process, “mechanical project making” took the place of chymistry as the mainstream form of expertise at the Bureau. Christopher Polhammar (ennobled Polhem) was certainly the most important figure of mechanical projector at the Bureau. Of humble origins but a gifted mechanic, Pohlem had a swift and striking career there. The creation of a new *Laboratorium Mechanicum* in 1697 (at the same time a laboratory, a school and a permanent of exhibition of mining machines) fully represented this change of direction in the Bureau’s policies.

The move from the chymical to the mechanical paradigm did not regard only projects. The start of the eighteenth-century saw a concomitant move toward the “mechanization of chymistry,” according to the example of Herman Boerhaave. The passage from Paracelsian chymistry to “useful” mechanical chemistry, together with the emphasis on assaying and natural history, brought about a new mineralogical chemistry, based on the notion that metals constituted the “basic species of nature,” “building blocks from which the world of matter was composed” [100]. In fact, a central chapter of *The Limits of Matter* (“Elements of Enlightenment”) is devoted to the historical reconstruction of this research program, culminating in Axel Fredrich Cronstedt’s mineralogical classification system. Fors convincingly argues that this research was fully integrated into the industrial requirements and interests of the Swedish state. Elemental, pure metals were the sought-after commodities of the mining industry. The classification of minerals in terms of constituent metals was then not only a natural philosophical research program—but the necessary theoretical component of an “integrated system of production,” the goal of which was “to increase the revenues of the mining business” [117].

One of the major merits of *The Limits of Matter* is its eclecticism. As its author states, among other things, this is a book about “witches, trolls, angels, premoni-

tions, transmutative chymistry, mechanical philosophy, and utilitarian, patriotic science” [147]. It is certainly the account of the establishment and growth of a scientific institution. It is also a concrete case study of the obliteration of chymistry and the Enlightenment repudiation of chrysopoeia. In Fors’s book, these two narratives are intertwined: the rise of mechanical and mineralogical chemistry (a “cameral science at the service of the state” [148]) mirrors the growth of the Bureau of Mines as a center of scientific and economic power. The history of the Bergskollegium and the redefinition of the disciplinary notions of matter are a major concern of the book. Fors’s discussion is rich and nuanced, and “invites not only chemists into the debate, but also assayers, miners, mineralogists, and alchemists” [2].

However, *The Limits of Matter* is far from being just an exercise in the history of chemistry. Fors is careful not to delimit his narrative in too narrow disciplinary perspectives. Complementary to his analysis of institutions and disciplines is a very engaging discussion of folk and popular culture on issues of materiality and spirituality. Borrowing the notion of “boundary work” from sociologist of science Thomas Gieryn, Fors delineates the slow cultural and rhetorical processes through which disreputable popular beliefs on materiality became marginalized among the learned as superstitions and were replaced by acceptable and newly sanctioned views. This phenomenon regarded “a small group of well-educated men belonging to the middle and upper classes,” involved in natural philosophy, industry and manufacture [148]. By no means, Fors suggests, we should assume that these new skeptical and rationalistic approaches were diffuse and widespread in society. At the same time, the redefinition of the limits of materiality brought about by social environments like the Swedish Bureau of Mines meant a major reshaping of the intellectual landscape of the European savants. Trolls and kobolds inhabiting mines could still raise the curiosity of Paracelsian natural philosophers of the seventeenth century, but became irrelevant fantasies for the new generations of Enlightenment experts concerned with utilitarian chemistry and efficient means of industrial production. Slowly, they fell off the edge of the map.

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