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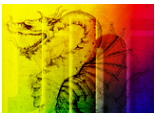

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Erasmus, Agricola and Mineralogy

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Erasmus, Agricola and Mineralogy

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This paper is a contribution to the assessment of the role and relevance of studia humanitatis *in the emergence of Renaissance mineralogy, which will further consolidate our understanding of early modern science. It focuses on the relationship between Erasmus and the German physician Georg Agricola, while highlighting the humanist background of Agricola's mineralogy. Influenced by the lessons of Erasmus, Agricola drew a humanistic programme for the study of minerals. He criticized vernacular metallurgical writings and their alchemical roots. For Agricola, the study of minerals was not independent from the resurgent ancient natural history. Following humanist topics such as the distinction between* imitatio *and* æmulatio*, and the link between* res *and* verba*, this paper reconstructs the relationship between Erasmus' Christian humanism and Agricola's humanist mineralogy.*

1. A place for mineralogy

The predominance of botany and zoology in Renaissance natural histories appeared to Ferrante Imperato as an indubitable fact. In his famous *Dell'historia naturale*, published in 1599, Imperato noted that nature is an endless subject of inquiry. In spite of our undertakings, it "remains entirely, or in greatest part unknown, and always leaves to naturalists a large field of new things". The book

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focused "more on minerals than on animals or plants, as the latter are most discussed" by early modern natural historians. According to Imperato, the study of minerals consisted in the inquiry of an almost unexplored field. Ancients "neglected or imperfectly and obscurely discussed" them. The object of mineralogy are "things which are unknown or because of the antiquity of writers or the mutation of terms"[1]. Mineralogy, therefore, consists in the reconstruction of the correct link between mineral substances and mineralogical taxonomy. This endeavour can be achieved by means of the philological study of ancient texts and the direct observation of the mineral kingdom. Philology and experimental practice are two complementary phases of this process.

Four centuries later Imperato's note is still applicable to the state of historical studies of Renaissance natural history, and to the general study of early modern science. For long time historians have closely identified the new science with the seventeenth-century physico-mathematics.

In spite of their antithetic views on the origins of modern science, the two main historiographical approaches of continuism and discontinuism shared the focus on the physical sciences, and a disparaging view of humanism. For historians like Alistair Crombie, humanism was essentially a literary and rhetorical phenomenon, which did not break the continuity between late medieval mechanics and early modern physics[2]. On the other hand, the discontinuist historian Alexandre Koyré considered Renaissance as an essentially pre-scientific age, dominated by literary humanism and magic thought. In Koyre's eyes, Renaissance lacked a "classifying theory, the possibility to classify in a reasonable way the facts gathered". This theory was offered later mostly by Galilean mechanics. Regardless of his emphasis on Archimedean roots of classical physics,

[1] Ferrante Imperato, *Dell'historia naturale* (Napoli, 1599), 1.

[2] Alistair Crombie, *Augustine to Galileo: The History of Science A.D. 400-1650* (London: Falcon Press 1952), 268-270.

Koyrè conceived humanism as resolutely opposite to early modern science. If we move from the criticism of Aristotelianism to the evolution of science, Koyrè noted, "we can undoubtedly affirm that it took place at the margins of the proper activity of Renaissance"[1]. His criticism of Renaissance corresponds with his view of modern science as something essentially theoretical[2]. Along with humanists' contributions it also excludes the works of natural historians, physicians, engineers, craftsmen and instrument makers–in short, both experimental and philological knowledge.

Focusing on these disciplines and influenced by Leonardo Olschki and Edgar Zilsel, Eugenio Garin advanced a view radically alternative to both continuist and discontinuist accounts. According to Garin, the new science originated from the convergence of the critical work of humanists and the mechanical contribution of craftsmen. In other words, it was the result of the union of philological and mechanical techniques in a new form of knowledge. Garin's thesis was based on an insightful knowledge of humanism. Linguistic in essence, humanist learning influenced the modern appropriation of ancient scientific knowledge. This influence was not limited to mathematical texts, but also concerned medicine and the vast field of natural history. To access natural science, Renaissance men did not need to abandon the *studia humanitatis*. On the contrary, they could achieve science only by means of the philological knowledge. Early modern science was also a development of humanist philology[3].

[1] Alexandre Koyré, *Études d'histoire de la pensée scientifique* (Paris: Presses Universitaire de France 1966), 38-40.

[2] Brian P. Copenhaver, "Did Science have a Renaissance?", *Isis* 83 (1992), 387-407 (quotation, p. 392); Alfred Rupert Hall, "Alexandre Koyré and the Scientific Revolution", *History and Technology* 4 (1987), 285-295 (quotation, pp. 486, 487, 492).

[3] Eugenio Garin, *L'età nuova: ricerche di storia della cultura dal XII al XVI secolo* (Napoli, Morano: 1969), 457-458; Id., *La cultura filosofica del Rinascimento italiano: studi e ricerche* (Milano: Il Saggiatore 1992), 338-339, 424.

Garin's thesis has been the source of the most important recent revisions of the traditional historiography of early modern science. Unlike other scholars, such as Paul Otto Kristeller, Garin did not propose a general and indirect influence of literary humanism on science[1]. He considered what we currently distinguish in sciences and humanities as part of the same revolutionary process which altered the course of Western knowledge. This historical unity, however, has not always been maintained by scholars inspired by Garin's seminal work. In particular, the hypothesis of a convergence between philological learning and craftsmen knowledge has not been adequately inspected[2]. Furthermore, historians interested in Renaissance science have mainly emphasized the role of ancient texts in physical sciences such as astronomy and mechanics, or in the fields of medicine and botany[3]. For these reasons, the relevance of humanism for early modern mineralogy has been largely neglected[4]. Some essays on Georg Agricola and sixteenth-century Italian mineralogy by the late Nicoletta Morello represent a significant exception to this historiographical trend[5]. Lim-

[1] Paul Otto Kristeller, "L'influsso del primo umanesimo italiano sul pensiero e sulle scienze", in Giovannangiola Tarugi (a cura di), *Il pensiero italiano del Rinascimento e il tempo nostro* (Firenze, Olsckhi: 1970), 1-21 (quotation, pp. 14, 20-21); a similar approach is also maintained by Ann Blair and Anthony Grafton, "Reassessing Humanism and Science", *Journal of the History of Ideas* 53 (1992), 535-540 (quotation, p. 538), and Anthony Grafton, *Defenders of the Text: The Tradition of Scholarship in an Age of Science, 1450-1800* (Cambridge MA: Harvard University Press, 1991), 3.

[2] A significant exception is offered by Pamela Long, "Humanism and Science", in Albert Rabil jr. (ed.), *Renaissance Humanism: Foundations, Forms and Legacy* (Philadelphia: University of Pennsylvania Press 1988), vol.3, 486-512 (quotation, pp. 492, 494).

[3] Cf. Karen Meier Reeds, "Renaissance Humanism and Botany", *Annals of Science* 33 (1976), 519-542 (quotation, pp. 522, 527); see also Grafton, "Humanism, Magic and Science", in Anthony Goodman and Angus Mackay (eds.), *The Impact of Humanism in Western Europe* (London: Longman 1990), 99-117 (quotation, 102-103).

[4] See, for instance, Laurent Pinon "Natural History", in Anthony Grafton, Glenn Most and Salvatore Settis (eds.), *The Classical Tradition* (Cambridge MA: The Belknap Press of Harvard University Press 2010), 621-627.

[5] Nicoletta Morello, "Bermannus—the Names and the Things", in Friedrich Naumann (hrsg.), *Georgius Agricola 500 Jahre* (Berlin: Birkhäuser 1994), 73-81 (quotation, pp. 74, 75, 79); Id., "Mineralogical Classification in Sixteenth-Century Italy", in Bernard Fitscher and Fergus Henderson (eds.), *Towards a History of Mineralogy, Petrology and Geochemistry* (Munich: Institut für Geschichte der Naturwissenschaften 1998), 53-64 (quotation pp. 53-54); Id. "Agricola and the Birth the Mineralogical Sciences in Italy during the Sixteenth Century", in Gian Battista Vai and Glen Caldwell (eds.), *The Origins of Geology in Italy* (Colorado: Geological Society of America 2006), 23-30.

iting herself to Agricola's humanist background, Morello did not acknowledge Renaissance mineralogy's role in upholding the interaction between humanist learning and craftsmen knowledge, which had the pioneering impact of producing an experimental approach to nature.

2. Antibarbari

Thanks to the conjunction of ancient natural history and miners' practical knowledge, Agricola's works played a decisive role in the formation of early modern mineralogy. Educated in an Erasmian cultural climate, Agricola was "first and last a humanist"[1]. After studying at the University of Leipzig, he moved to the city of Zwichau in order to teach Greek and Latin in the local gymnasium. Here in 1520 he wrote a Latin grammar. Loyal to the Catholic credo, Agricola came back to Leipzig when Lutheran ideas spread into the city of Zwichau. Once in Leipzig, he started to study medicine, and later moved to Italy. In Ferrara and Venice he completed his medical studies and took part in the Aldine edition of Galen, editing its fifth volume in 1525[2]. He spent his last days in the mineral district of Joachminsthal devoting himself to the cure of mineworkers and to the study of mineralogy, composing his entire range of works, from *Bermannus* (1530) to *De re metallica* (1556).

[1] Owen Hannaway, "Georgius Agricola as Humanist", *Journal of the History of Ideas* 53 (1992), 553-560 (quotation, p. 554).

[2] Even Erasmus was involved in the enterprise of Aldus Manutius's heirs, cf. Peter Krivatsy, "Erasmus' Medical Milieu" *Bulletin of the History of Medicine* 17 (1973), 113-154 (quotation, p. 117) ; Jean Paul Margolin, "Erasme traducteur de Galien: régime de santé, art de vivre, philosophie", in Silvia Ferretto, Pietro Gori e Massimo Rinaldi (a cura di), *Libertas philosophandi in naturalibus: libertà di ricerca e criteri di regolamentazione istituzionale tra '500 e '700* (Padova: Cluep 2011), 257-280.

As a humanist, Agricola criticized the decay of ancient learning and stressed the importance of its recovery. His humanistic programme was not limited to the theoretical knowledge as it also incorporated mechanical arts. He maintained that during the centuries which separated late antiquity from Renaissance, ancient scientific learning and mechanical practices had been neglected:

"Thinking of the objects that nature has produced or art has created, but also of their Latin and Greek names, I have realized that they have been damaged in the course of the centuries. A part of these objects lays neglected, another one is entirely ignored. Their names have been absurdly altered or replaced by certain barbarous voices"[1].

Change was manifest in forms wherein Greek and Latin names of natural species were altered, resulting in the loss of the link between knowledge and practice, despite the continuance of mining activities. Modern miners and craftsmen ignored ancient names designating objects and practices. Consequently, they "necessarily ignore[d] the greatest parts of their uses". The recovery of Greek and Latin mineralogical terminology was a philological task which extended beyond ancient texts towards the direct observation of mineral species. It also included the recovery of practical knowledge of craftsmen and miners[2].

In Italy and in other European countries the purity of Latin and Greek languages had been restored. 'Eloquence', broadly intended, had already recovered by means of philological techniques. But "a very great part of the knowledge of things, which has a very huge domain and includes all that the senses and the soul can comprehend and perceive" was still neglected[3]. Agricola's programme for recovering this vast knowledge included three sources: nature, classical writers, and the direct observation of mines' and workshops' activities[4].

Mechanical knowledge and metallurgical practices also featured in Vannoccio Biringuccio's *De la pirotechnia* (1540). Biringuccio often preferred notions derived from practical metallurgy over "speculative things"[5]. Opposing the eye

[1] Georg Agricola, *Bermannus sive de re metallica* (Basileae: 1530), 10.

[2] Anne Françoise Garçon, "Réduire la mine en science? Anatomie des *De re metallica* d'Agricola (1528-1556)", in Pascal Glatigny et Hélène Vérin (éds.), *Réduire en art. La technologie de la Renaissance aux Lumières* (Paris : Édition de la Maison des sciences de l'homme 2008), 317-36 (quotation, p. 320).

[3] Agricola, *Bermannus*, 11.

[4] Id., *De veteribus et novis metallis* (Basileae: 1546), 383-384.

[5] Vannoccio Biringuccio, *De la pirotecnia* (Venezia: 1540), 12v.

to the mouth, he affirmed that a real and accurate knowledge of metals was achievable only by means of assay[1]. In contrast to Biringuccio, Agricola conceived the study of ancient texts as complementary to direct experience and craftsmen's practices. In Agricola's humanist approach, the recovery of ancient natural history through a philological method ended in the appeal to the direct experience of mines and workshops.

A vast portion of the ancient texts discussing minerals and mines were lost. The remaining ones were mostly ignored by medieval Latin and Arab scholars. A confused knowledge replaced ancient learning. Pure Greek and Latin terms were corrupted by Arabic translations. In this passage, the "perverted and false" notions of Arabs altered ancient real and true knowledge of nature. The original link between words and things was lost. Scholars, on one hand, discussed their confused notions with no interest in minerals and mines. Craftsmen, on the other hand, transmitted their knowledge in vernacular with no reference to ancient texts. For these reasons, Agricola aimed to extend humanist philological techniques to the ancient mineralogical knowledge. The recovery of the original link between words and things passed through the correct understanding of ancient Latin and Greek sources. An uninterrupted dialogue between text and nature on one side, and text and metallurgical practices on the other side was necessary to achieve this goal.

In response to, and in arising out of his steadfast refusal of medieval barbarism, Agricola's programme seems to echo Erasmian *Antibarbarians*' manifesto. In this book published by Froben in 1520, Erasmus criticized the decadence and corruption of ancient knowledge. A "tragic and terrible deluge had shamefully overwhelmed all the literature of the ancients which used to be pure". The "rich, flourishing, joyfull fruits of the finest culture" were replaced by "a confused sort of teaching, a kind of uneducated erudition, which corrupted not only humane studies but, in distressing ways, theology itself"[2]. The barbarians' ignorance was hidden by calls to Christian religion. But ancient learning was not opposed to real religion, as ancient scholars produced knowledge which medieval Christians ignored:

[1] Ibid., 43.

[2] Erasmus, *The Antibarbarians*, in *Collected Works of Erasmus vol. 23, Literary and Educational Writings vol. 1*, edited by Craig R. Thompson (Toronto: University of Toronto Press 1978), 23-26.

"You arrogate yourself those barbarous titles and love to be called Albertist, Thomist, Scotist, Occamist, Durandist as long as you take these names from Christians. For my part, I will allow myself to be called after any pagan so long as he was deeply learned or supremely eloquent; nor shall I go back on this declaration, if only the pagan teaches me more excellent things than a Christian"[1].

This knowledge was part of the providential plan of Christian history. It was made at that time in order to be used by the future Christians[2]. It is significant in this respect that even Agricola's *antibarbarism* was linked to a humanistic approach to Christian faith. Like Erasmus he refused Luther's theological ideas and expressed scepticism towards alchemy and criticised Paracelsian medicine[3]. These similarities are reflected in the letters exchanged between them through 1531-1534. The first reference to Agricola in Erasmus' correspondence appears in a letter of Leonard Casembroot. Writing from Padua on 23 August 1525, Casembroot describes Agricola as the "young scholar who admires you" and is involved in the edition of some works of Galen in Venice. Another reference is an letter written by Peter Plateanus on 8 September 1529. After attending the Brethren of Common life in Liège, the Collegium Trilingue at Louvain, and the University of Wittenberg, Plateanus moved to Joachminsthal, where he became the rector of the town school and met Agricola. Promoting the publication of Agricola's first mineralogical work, Plateanus sent the manuscript of *Bermannus* to Freiburg first and later to Basle. It is not clear why the book was not published in Freiburg, but when Plateanus decided to send it to the publisher Hieronymus Froben in Basle, he asked for Erasmus's help.

In 1518, the Latin translation of the *New Testament* opened an impressive series of publications of Erasmian works by Froben[4]. In the same year the publisher's catalogue included 23 works written by Erasmus. The following year the number went up to twenty-six, including a catalogue of Erasmus' works published at Basle. As this evidently suggests, Erasmus played an important

[1] Ibid., 58.
[2] Ibid., 60.
[3] Marco Beretta, "Humanism and Chemistry: The Spread of Georg Agricola's Metallurgical Writings", *Nuncius* 12 (1997), 2-46 (quotation, pp. 22-23); Alan Rocke, "Agricola, Paracelsus, and Chymia", *Ambix* 32 (1985), 37-45 (quotation, pp. 39-40).
[4] Cf. Paul Botley, *Latin Translation in the Renaissance: the Theory and Practice of Leonardo Bruni, Giannozzo Manetti and Desiderius Erasmus* (Cambridge: Cambridge University Press 2004), 115-133.

role in Froben's publishing activities. His works seem to have represented a sort of editorial programme for the Basle publisher[1]. For this reason perhaps, Plateanus submitted the book to Erasmus after sending it to Froben. According to Plateanus, the book would have not been published without Erasmus's approval and support.

Introducing the *Bermannus*, Plateanus described its author as an admirer of Erasmus. "Whether for the singular love of you or for the public affection to all good and learned men, he deserves your esteem". Reminding Erasmus of Agricola's philological work in Venice, Plateanus emphasized his new commitment to mineralogy. Until then Agricola's fame was limited to his Aldine editions of Galen's texts. But a major *De re metallica* and some other minor works would follow the *Bermannus*. When these works would be published, Plateanus stated, physicians "will be much more obliged to him"[2]. Erasmus' letter to Andrew and Christopher von Könneritz on 18 February 1529 proved that Plateanus achieved his aim[3]. Writing in support of the *Bermannus*, Erasmus defined the text an example of προγυμνὰσματα, or preparatory exercises, whose "simplicity of prose reminds the attic style". The "vividness of the descriptions" caught Erasmus' attention. "It seemed to me—he wrote—not to read of but to see those valleys, hills, mines and machines"[4].

It should be noted here that in Erasmus's view style was not the only feature of clear and elegant Latin. As he observed in *De ratione studii ac legendi interpretandique auctore* (1511), language was an essential element of human knowledge. This was composed of two elements: things and words. The knowledge of words came earlier, but that of things was more important. Despite this, the latter needs the previous:

"Some, the 'uninitiated' as the saying goes, while they hurry on to learn about things, neglect a concern for language and, striving after a false economy, incur a very heavy loss. For since things are learnt only by the sounds we attach them, a person who is not

[1] This hypothesis has been advanced by Valentina Sebastiani, "Gli Antibarbari di Erasmo e il programma editoriale della stamperia Froben", *Bruniana & Campanelliana* 19 (2013), 385-395.
[2] *Opus Epistolarum Des. Erasmi Roterodami*, denuo recognitum et actum per P.S. Allen et H.M. Allen, (Oxonii: Clarendon Press 1906-1958), vol. VIII, 279.
[3] Ibid., vol. IX, 333.
[4] Agricola, *Bermannus*, 4.

skilled in the force of language is, of necessity, short-sighted, deluded, and unbalanced in his judgement of things as well. Finally you may observe that none are more given to constant quibbling over the minutiae of language than those who boast that they pass over mere words and concentrate to the matter itself".

Since nearly all natural knowledge was expressed in Greek and Latin, the recovery of a correct knowledge of things was achievable through the knowledge of words, namely the ancient Greek and Latin languages. Only after "having, developed a pure, if not ornate, skill" in these languages, naturalists can "direct the mind towards the understanding of things"[1]. Philology, therefore, was a necessary premise of a correct approach to nature.

For Erasmus Agricola's work held other merits as well. Minerals such as gold and silver, as Erasmus noted, elicit human cupidity. Along with the rest of the Earth, they have been created in order to support man's life. Metallurgy, therefore, should not be discredited. But, however fertile, mineral veins cannot make man happy. Indeed, most men regretted the desperate search for gold and silver. Only the "vein of the holy writings" can really enrich man. "Since we could not expect anything less from his genius—Erasmus notes—our Georg has widely premised it"[2].

These observations on the limits and aims of metallurgical activities echo a classical debate[3]. Agricola discussed it, particularly in a series of essays published in 1546 and in the posthumous *De re metallica*. In *De veteribus et novis metallis* the philological study of ancient sources was linked to the collecting of modern observations. The book contained descriptions of ancient and modern mines. Following classical mythology, Agricola maintained that metals were discovered during the age of heroes. But in his view, the criticism of metallurgy by ancient poets and classic historians was in reality a criticism of the avarice of some wealthy sovereigns. Poets transformed in fabulous terms their stories. The fables of Midas, Tantalus, Croesus, Geryon and others referred to historical figures whose wealth was largely based on the extraction of precious

[1] Erasmus, *On the Method of Study*, in *Collected Works of Erasmus*, vol. 24 *Literary and Educational Writings 2*, ed. by Craig Thompson (Toronto: University of Toronto Press 1978), 666, 669.
[2] *Opus Epistolarum*, VIII, 363.
[3] Cf. Robert Lenoble, *Esquisse d'une histoire de l'idée de la nature* (Paris: Albin Michel 1969), 177-182.

stones and metals. Despite they "should have been sincere narrators of deeds", ancient historians followed fables and myths[1].

For Agricola, the extraction of metals does not differ from agriculture. Like the rest of the Earth, metals have been created to support human life. Their presence into the bowels of the Earth do not warrant dissuasion from their use. Like fishes in the deep seas, metals can be accessed by men in order to sustain their lives. Despite limited to the surface of the Earth, agriculture is largely based on the extraction of metals as most of the agricultural instruments are made out of them. Without the extraction of metals and stones, civil life would not be possible:

"If there were no metals men would pass a horrible and wretched existence in the midst of wild beasts; they would return to the acorns, and fruits, and berries of the forest. They would feed upon the herbs and roots they plucked up with their nails. They would dig out caves in which to lie down at night, and by day they would rove in the woods and plains at random like beasts, and inasmuch as this condition is utterly unworthy of humanity, with its splendid and glorious natural endowment, will anyone be so foolish or obstinate as not to allow that metals are necessary for food and clothing and that they tend to preserve life?"[2].

Metals in themselves are not source of evil as is understood by some of their uses. "The products of the mines are not themselves the cause of war". Metal products are instruments. "Good men employ them for good, and to them they are useful; the wicked use them badly, and to them they are harmful". Refusing the traditional consideration of mechanical arts as servile, Agricola describes metallurgy as an activity worth for free men, namely as a liberal art. "For that art—he observes—the pursuit of which is unquestionably not impious, nor offensive, nor mean, we may esteem honourable"[3]. In Agricola's programme, mineral kingdom, a field traditionally limited to craftsmen and engineers, was opened to scholars learned in Greek and Latin.

For the reasons described above, Erasmus considered Agricola's book to be

[1] Agricola, *De veteribus*, 390-393.
[2] Id., *De re metallica*, edited by Herbert Clark Hoover and Lou Henry Hoover (New York: Dover 1950), 8-10.
[3] Ibidem., 14-20.

a potential match to Froben's interest[1]. Attesting to the fact, the *Bermannus* was published the following year, and Erasmus' letter was premised to it[2]. The relationship between Erasmus and Agricola does not represent a unique case of interaction between religious humanist thinkers and Renaissance mineralogists. A letter of Philipp Melanchton, for instance, was premised to Christopher Entzelt's *De re metallica*, published in 1551 in Frankfurt by Christopher Egenolphus. Unlike Agricola, Entzelt converted to Protestantism under the direct influence of Luther in Wittenberg. Furthermore, both Entzelt and Melanchton acknowledged the superiority of Agricola's work. According to Melanchton, Entzelt's book could not compete with the works of "the very learned and ingenious Georg Agricola"[3].

Erasmus also did his share in spreading the word about his high personal regard for Agricola's work. Writing on 29 August 1531, he expressed admiration for Agricola, defining him as a "very learned man, who, unless all mislead me, will have a leading place among the foremost men of letters". In the same letter, he acknowledged the receipt of the manuscript *de mensuris ac ponderibus* which Agricola published two years later[4]. In a letter dated 3 May 1533, Erasmus informs one of his correspondents that Agricola's "work on measure and weights in five books is already printed in Basle"[5]. Eramus' emphasis on *Libri quinque de mensuris et ponderibus* was probably due to the fact that the work well reflected Agricola's humanist programme in mineralogy. In offering a comparison of ancient and modern measuring scales, the book represents a bridge between ancient knowledge and modern craftsmen practice. An accurate correspondence between ancient and modern measures is the bridgehead for a better understanding of ancient texts and the application of their knowledge[6].

Erasmus's unwavering appreciation for Agricola's humanist programme is reflected in his last letter to Agricola. Though it does not deal with any mineralogical work, the letter confirms Erasmus's support to Agricola's publications. Writing in April 1534, Erasmus shared with the catholic Agricola his hostil-

[1] *Opus Epistolarum*, VIII, 363.
[2] Agricola, *Bermannus*, a2 r-v.
[3] Christopher Entzelt, *De re metallica* (Francofurti: 1551), α2 r-v.
[4] *Opus Epistolarum*, IX, 333.
[5] Ibid., X, 182, 214.
[6] Agricola, *Libri quinque de mensuris et ponderibus* (Parisiis: 1533), 9-11.

ity towards Luther, describing him as a man completely submitted to passions. Complaining about his age and precarious health, Erasmus concludes his letter by inviting Agricola to send the manuscripts of his works to Froben[1]. The reference to the Basle's publisher supports, perhaps, the hypothesis of the existence of a sort of Erasmian editorial programme for Froben. If this was the case, it can be safely deduced that in Erasmus' view Agricola's work was part of it.

3. Res et Verba

The first pages of the *Bermannus* contain an analysis of the state of mineralogical knowledge in the early decades of the sixteenth century. As part of ancient learning mineralogy has been neglected during the period spanning from late antiquity to early modern humanism. "Thinking of the things that nature has produced or art has created, but also of their Latin and Greek names", Agricola realized "that they have been damaged in the course of the centuries". Medieval Latin and Arab scholars' disinterest for practice produced an alteration of the original links between the words and the things. A great part of things "lays neglected, another one is completely ignored". Their Greek and Latin names "have been absurdly altered or replaced by certain barbarous voices". Unable to maintain the original link between the ancient words and things, medieval scholars introduced confused notions by means of new terms[2].

[1] *Opus Epistolarum*, X, 372-374.

[2] Agricola, *Bermannus*, 10. For this reason Peter Harrison's inclusion of medieval texts among the "heterogeneous" sources of early modern natural historians cannot be maintained here, see. Peter Harrison, "Natural History", in Peter Harrison, Ronald Numbers and Michael Shank (eds.), *Wrestling with Nature. From Omens to Science* (Chicago and London: The University of Chicago Press 2011), 117-72 (quotation, p. 120).

For Agricola, the main obstacle for a new science of minerals consisted in the separation of words and things owing to different causes—medieval *barbarism* was the primary culprit, and alchemy another. Like Erasmus, Agricola criticized the claims of alchemists. For him, the alchemists' use of furnaces and metallurgical operations, and their contiguity with the world of miners led to a diffusion of alchemical theories among metallurgists and miners. Ignorant of Latin and Greek, these groups lacked access to ancient knowledge. Alchemical ideas were often diffused in vernacular texts which these people largely consulted. Since the last decades of the fifteenth century an impressive series of such books were published. Combining alchemical theories with practical notions of metallurgy, these books flourished till the first half of the seventeenth century[1]. Several of them were often republished in the course of the sixteenth century.

The first to appear was *Bergbüchlein*, in dialogical form. The author of this little book on ores was Ulrich von Kalbe, described by Agricola as "a well-known doctor"[2]. As Daniel, one of the characters of the dialogue notes, "this little book uses simple words and unpolished phrases", but "conveys something useful". This knowledge "is based on the books of ancient philosophers and on the experience of practising miners"[3]. The reference to ancient philosophers should not mislead. Unlike Agricola, von Kalbe refers to alchemists, not to ancient naturalists.

Another widely diffused text was the work of Lazarus Ercker, initially published in 1574 under the title *Beschreibung aller fürnemisten mineralischen Ertzt*. Educated at the university of Wittenberg, Ercker in 1558 became superintendent of the mines of the Holy Roman Empire[4]. Ancient texts, according to Er-

[1] Warren Dym, "Alchemy and Mining: Metallogenesis and Prospecting in Early Mining Books", *Ambix* 55 (2008), 232-254 (quotation, pp. 235-238); Pamela Long, "The Openness of Knowledge: An Ideal and Its Context in 16th Century Writings on Mining and Metallurgy", *Technology and Culture* 32 (1991), 318-355 (quotation, p. 325); David E. Connolly, "A Research Bibliography of Early Modern German Mining and Metallurgy", in Robert Bork (ed), *De re metallica: The Uses of Metals in the Middle Ages* (Aldershot: Ashgate 2005), 387-401 (quotation, pp. 390-394).

[2] Agricola, *De re metallica*, XVI.

[3] Ulrich von Kalbe, *Bergwerk and Probierbüchlein*, edited by Annaliese Grünhalt Sisco and Cyril Stanley Smith (New York: The American Institute of Mining and Metallurgical Engineers 1949), 17-18.

[4] Dern Dibner, "Assayng Gold by Lazarus Ercker", *Technology and Culture* 6 (1965), 444-445.

cker, did not offer any adequate description of mineral extraction and transformation. The available books on minerals were limited to the classification of stones and metals. Ercker correlated this fact to the authors of the texts who "were mere theorists without any substantial knowledge about their subject from working at it themselves or practising the art or handling these things". Thus, philosophers' "thick tomes on the subject" were of no use. "Since the opinions of the philosophers and the theories of the miners do not always agree but, on the contrary, often diverge widely", a comprehensive understanding of minerals was lacking[1]. Ercker's work however did not go beyond instanced generalized statements.

Despite an emphasis on practice and direct contact with mineral practitioners, the profusion of similar metallurgical literature was criticized by Agricola. His objection was largely due to the predominance of alchemical theories in them. For Agricola, alchemy did not offer any contribution to the direct study of nature, but perpetuated the distinction between words and things and diffused a confused knowledge. Alchemists "employ an obscure language". They "use strange names, which do not properly belong to the metals". Some of them even "employ now one name now another, invented by themselves, though the thing itself changes not". All their writings aim to the transmutation of the metals in gold, towards which Agricola expressed scepticism[2]. Described as "unlearned and inept", alchemists are opposed to miners[3]. According to Agricola, only Biringuccio, "a wise man experienced in many matters", wrote a treatise based on the direct knowledge of miners' and craftsmen's work[4]. Even the Italian engineer criticized the obscure language of alchemists and opposed their works to that of miners. However, Biringuccio's attitude towards alchemy cannot be reduced to a sceptical refuse[5].

In Agricola's view, alchemy contributed to maintain the division of theory and practice, *verba et res*. Consequently, philosophers and physicians who were

[1] Lazarus Ercker, *Treatise on Ores and Assaying*, edited by Annaliese Grünhalt Sisco and Cyril Stanley Smith (Chicago: The University of Chicago Press 1951), 3, 4, 11-12.
[2] Agricola, *De re metallica*, XXVII-XXVIII.
[3] Id., *Bermannus*, 77.
[4] Id., *De re metallica*, XXVII.
[5] Biringuccio, *De la pirotechnia*, 5, 7, 123-124; cf. Alberto Tenenti, "Il contesto mentale della Pirotechnia", *Intersezioni* 20 (2000), 447-456 (quotation, pp. 453-454).

entirely devoted to the study of these abstract notions neglected the observation of nature. On the other hand, craftsmen and miners were actively engaged in the manipulation of mineral species and mechanical instruments. These two separate worlds as it would appear were indifferent to the activities of the other. Mechanics and miners, in particular, ignored the results which ancients achieved in metallurgy. Agricola also emphasised the importance of ancient knowledge for mineralogical theory, and metallurgical practice. His programme did not distinguish classification of mineral species, their extraction and refinement as detached branches of knowledge. Indeed, the previous was the basis of the latter. In the first decades of the sixteenth century however, metallurgy represented the only part of mineral knowledge entailing the direct observation of nature. Ancient texts contained both theory and practice. Thus their recovery was necessary to rejoin them in the new mineralogy. "If ancient and incorrupt names were not hidden—Agricola asks—would not we know the things they denote"?[1]

According to Agricola, ancient texts can be compared to natural objects owing their discovery and correct understanding to natural science. They contain vast knowledge which should be recovered in order to progress in the study of nature. Agricola's humanist programme, therefore, consists in the application of the philological method to ancient mineralogical texts. In order to reconstruct the varieties and characters of mineral species, naturalists compare the various versions of the same text and the various texts discussing the same species. But minerals are natural objects. This comparative practice is not then limited to texts, but includes nature itself. The final comparison is made against nature. As Nicoletta Morella observed, in this process nature becomes the "last term of the collation"[2]. The philological work extends to the direct observation and experimental research, since it also refers the practices of miners and metallurgists.

[1] Agricola, *Bermannus*, 10-12.

[2] Nicoletta Morello, "Alle radici della mineralogia sistematica: il XVI secolo", *Geologica romana* 29 (1993), 567-582 (quotation, p. 567).

4. Imitatio et æmulatio

These practices were theorized by Niccolò Leoniceno, physician and humanist in Ferrara, in *De Plinii et aliorum in medicina erroribus* (1492). Leoniceno's work explicitly connected philological method and experimental study of nature. The aim of the book consisted in seeing whether "Pliny agrees with Dioscorides, Galen, Paul and other physicians, and with the great master: experience itself"[1]. Adopting Leoniceno's method, Agricola and other Renaissance natural historians extended the list of Pliny's errors in the field of mineralogy.

The recourse to the direct observation of nature was due to various factors. Ancient texts were imperfect for a range of reasons. Despite being the main source of natural knowledge available these texts did not offer a complete description of the mineral world. Their philological recovery was not complete. Most of the works written by the ancients were lost, while others were only partially recovered and included interpolations of barbaric terms. Agricola's emphasis on the importance of ancient texts was one and the same with his awareness of the historical nature of ancient sources[2]. Both elements were taken into account in his humanist programme:

> Since I use to link together ancient and new things, others affirm that they prefer to separate the ancient ones derived from Latin and Greek writers, and do not value much new things. Having seen Aristotle, Theophrastus, Strato of Lampsacus and many other philosophers employing in these things much work and study, and Dioscorides and

[1] Niccolò Leoniceno, *De Plinii in medicina erroribus*, a cura di Loris Premuda (Roma: Il giardino di Esculapio, 1958), 153.

[2] Cf. Garin, *La cultura del Rinascimento* (Milano: Il Saggiatore 1988), 20; Grafton, *Defenders of the Text: The Tradition of Scholarship in an Age of Science 1450-1800* (Cambridge MA: Harvard University Press 1991), 30.

Galen and many other physicians diligently enquiring them, and that what was transmitted by the ancients is lost or not enough disentangled, I think that its disentanglement is worthy, and that disputing about truth is highly suitably for me and useful to the scholars of letters, and is needed for the understanding of the writers. If the ancient writers neglected new things, which ancient things would we now have?"[1].

Far from entailing a passive repetition of the ancients, the programme included a criticism of the sources. The recourse to the direct observation of nature and the practical knowledge of mechanics permitted correction and expansion of ancient learning. "Despite Greeks are expert in this kind of matters—Agricola states—no one of them explained the nature of all minerals". The only systematic discussion is contained in Pliny's *Natural History*. But the book is no more than a passive compilation of Greek and Roman sources, to which Pliny did not add new observations[2]. For this reason, Pliny made errors which were reported by Leoniceno[3].

For Agricola, craftsmen, miners, and metallurgical engineers represented a source of knowledge comparable or rather complementary to ancient texts. Though based on practice, this new source of knowledge needed a critical evaluation[4]. Thanks to German miners, new minerals, such as bismuth, antimony, zinc and cobalt were added to the seven known by ancients[5]. Ancient natural history was almost limited to the basin of the Mediterranean. The new species discovered in northern Europe were designed by vernacular names. Influenced by Erasmus' emphasis on the importance of words for the understanding of things, Agricola employed new names to define new minerals. These names were composed according to Latin and Greek natural terminology[6].

Deeply influenced by humanist ideals, Agricola maintained the primacy of

[1] Agricola, *De veteribus*, 384.

[2] Id., *De natura fossilium* (Basileae: 1546), 168-169. The term *fossilis* here designates all the bodies dug out from the underground, regardless of their organic or inorganic origin, cf. Bern Dibner, *Agricola on Metals* (Norwalk CT: Burndy Library 1958), 19; Beretta, *The Enlightenment of Matter: The Definition of Chemistry from Agricola to Lavoisier* (Canton MA: Science History Publications 1993), 80.

[3] Agricola, *Bermannus*, 85-86.

[4] Id., *De re metallica*, XXX-XXXI.

[5] Maurice Crosland, *Historical Studies in the Language of Chemistry* (New York: Dover 1978), 70-96.

[6] Agricola, *Bermannus*, 83; Id., *De natura fossilium*, 169.

Latin and Greek language[1]. Notwithstanding the limits of ancient writers, the purity of their languages remained a stable element of Agricola's humanist mineralogy.

[1] Cf. Pamela Long, "Of Mining, Smelting, and Printing: Agricola's De re metallica", *Technology and Culture* 44 (2003), 97-101 (quotation, p. 99); Isabelle Pantin, "Latin et languages vernaculaires dans la littérature scientifique europenne au début de l'epoque moderne (1550-1635)", in Roger Chartier et Pietro Corsi (éds.), *Sciences et languages en Europe* (Paris: École des hautes études en sciences sociales 1996), 43-58 (quotation, 44, 48).

Rosino, Sad Miner. Mina de São Domingos, Portugal [2011], `http://www.flickr.com/rosino/5721955014`.