

## GEORGIUS AGRICOLA (1494–1555)

By JOAN M EYLES

IF one were to ask a well-informed student of the history of science to name the three most important scientific books published in the first half of the sixteenth century, his first choice would certainly be the "De Revolutionibus Orbium Coelestium" by Copernicus, published in 1543. Next he would probably select the "De Humanis Corporibus Fabrica" by Vesalius, which also appeared in 1543. He would probably hesitate before making a third choice, and might possibly decide in favour of one of the great herbals, perhaps that of Leonard Fuchs, published in 1542. If reminded of Agricola, he might answer that this author's famous "De Re Metallica" was not published until 1556, and was, in any event, like the "Pirotechnia" of Biringuccio (1540), essentially a work on technology rather than science. It is unlikely that he would be acquainted with the contents of Agricola's earlier book, "De Ortu et Causis Subterraneorum", published in 1546, which consists of several treatises, the first of which gives the book its name. Yet it can be justly claimed that this book, which contains almost all that Agricola wrote on mineralogy and geology, laid the foundations on which these sciences were built, and entitles Agricola to be ranked equally with Copernicus and Vesalius as one of the really great sixteenth-century scientists.

In many well-known histories of science, the name of Agricola either does not appear at all, or is mentioned only in connexion with his great work on mining and metallurgy, "De Re Metallica". Wolf's "History of Science, Technology and Philosophy" is an exception, for its author does record some of the geological opinions of Agricola contained in the "De Ortu". These have been extracted from the excellent notes given by H. C. and L. H. Hoover in their well-known translation of the "De Re Metallica". However, Wolf, while realizing the importance of the views which he quotes, makes no attempt to appraise Agricola's standing among the scientists of the early sixteenth century.

Lack of appreciation of Agricola's "De Ortu" is not surprising, for in most general histories of science the evolution of geology, the one subject that forms a bridge between the biological and physico-chemical sciences, is allotted a very minor role. It must be admitted that this is largely the fault of geologists themselves, who by neglecting a rewarding field of research, have failed to arouse general interest in the subject.

The neglect of Agricola by modern geologists, particularly those of the English-speaking world (for his own countrymen have always been more appreciative of his merits), was recognized by the Hoovers when they wrote in 1912: "The wider interest of the members of the medical profession in the development of their science than that of geologists in theirs has led to the aggrandizement of Paracelsus, a contemporary of Agricola, as the first in deductive science. Yet no comparative study of the unparalleled egotistical ravings of this half-genius, half-alchemist, with the modest sober logic and real research and observation of Agricola, can leave a moment's doubt as to the incomparably greater position which should

be attributed to the latter as the pioneer in building the foundation of science by deduction from observed phenomena. Science is the base upon which is reared the civilization of to-day, and while we give daily credit to all who toil in the superstructure, let none forget those men who laid its first foundation stones. One of the greatest of these was Georgius Agricola".

Agricola's life has been related in some detail by Hofmann<sup>2</sup>, and more recently by Hartmann<sup>3</sup>. His surname was, in the vernacular, Bauer, but he had adopted the Latin version by the time his first book, a small Latin grammar, was published in 1520, and he retained this form thereafter. He was born in Glauchau, in the Saxon Erzgebirge, at a time when the leaven of the Italian Renaissance was already working in the universities of northern Germany. Therefore, when he went to the University of Leipzig in 1514, he was able to study Greek as well as Latin, first under the instruction of an Englishman, Richard Croke, who later became lecturer in Greek at Cambridge, and then under Petrus Mosellanus, father of humanism in Saxony. Agricola spent four years at Leipzig and after graduating was appointed vice-principal of the town school at Zwickau, a place of some importance near his home. The town council of Zwickau clearly appreciated the brilliance of the young teacher, for in 1519 they opened a new trilingual school, in which Greek, Latin and Hebrew were taught, with Agricola as rector. Three years later, however, he returned to Leipzig as lecturer, assisting Mosellanus; and about this time he began to interest himself in the study of medicine and philosophy. A desire to hear the most famous doctors and to read the texts of Galen in the original Greek took him next to Italy. Here he spent two years, mostly in Venice, where he was closely associated with the Aldine Press, and assisted in editing the great collected edition of Galen's works in Greek, which it issued in 1525.

On returning to Zwickau in 1526 he was, so he wrote later, burning with a desire to know more of the mines and minerals so abundant in the Erzgebirge. This region had for the previous fifty or sixty years been the scene of intense mining activity. Agricola had graduated in Italy as a doctor of medicine, and in 1527 he accepted the post of *Stadtarzt* (town physician) in Joachimsthal, a new mining town in Bohemia, on the south side of the Erzgebirge. There he was in a most favourable position for following up his new interests. The mines at Joachimsthal, at that time producing much silver, supplied, some 450 years later, the pitchblende used by the Curies in their researches on radioactivity. They were first opened up in 1516, and by the time Agricola arrived the population of the district was already some 10,000, nearly all miners and officials.

The first fruit of Agricola's interest in the mines was a small volume entitled "Bermannus sive de re metallica", published at Basle in 1530 by the Froben Press, which also published most of his later works. There is a foreword, praising the book, by the great humanist, Erasmus of Rotterdam. The text takes

the form of a conversation between three learned men, one skilled in mining matters; and it contains descriptions of many minerals and ores. Its publication added to the reputation of Agricola, already renowned as a classical scholar, and his friends eagerly awaited further works on the subject from his pen.

In 1530 he gave up his post at Joachimsthal, and a few years later returned to Saxony, settling at Chemnitz, another mining centre, where he remained until his death in 1555. He was appointed *Stadtkarzt* and in later years was several times *Bürgermeister*. Apart from a minor, though still valuable, work on weights and measures, he published nothing further until 1546, when the results of his many years of research in geology and mineralogy appeared in "De Ortu et Causis Subterraneorum".

Each treatise is preceded by a dedicatory letter to some friend or patron, and these letters often contain interesting information about Agricola himself. In one he lists the works he has yet to publish. Of these, some appeared in 1550, but the "De Re Metallica", the great work on mining and metallurgy so long awaited by his friends, was not issued until 1556, four months after his death. In the interim he had been called on to serve his patron, Duke Maurice, who became Elector of Saxony in 1547, in a diplomatic capacity. Maurice was a Protestant, and Agricola had remained a staunch Catholic during the stormy years of the Reformation.<sup>5</sup> However, his writings reveal a tolerant outlook, and no doubt his wide knowledge and experience were valuable to the Elector, who sent him on various missions to the Emperor Charles V, Ferdinand, King of Hungary, and other princes. The rich mines of Saxony and Bohemia played an important part in the economy of Europe at that time, and probably Agricola's specialized knowledge made him a valuable intermediary. The Elector died in 1553, and was succeeded by his brother Augustus, who continued the patronage Agricola had previously enjoyed from Maurice. The text of the "De Re Metallica", dedicated to Maurice and Augustus, appears to have been completed by the end of 1550, but was long delayed, probably by the preparation of the several hundred woodcuts. In 1553 the completed book was sent to the Froben Press; but it was March 1556 before it appeared in print. Meanwhile, Agricola had died on November 21, 1555, from a sudden fever that lasted only four days. His position as a Catholic *Bürgermeister* in a fiercely Protestant town must have been anomalous, yet it is sad to learn his family were not allowed to bury him in the cathedral of Chemnitz, the town in which he had been so distinguished a citizen. Four days after his death, his body was conveyed to Zeitz, some forty miles away, and interred there, in the Catholic cathedral.

New editions and translations of his books, particularly the "De Re Metallica", continued to appear at intervals in the succeeding centuries, and a reprint of the Hoover translation was issued only a few years ago. No English translation of the "De Ortu" has yet appeared. For this reason it has been eclipsed in fame by the better known and beautifully illustrated "De Re Metallica". Nevertheless, it has every right to be regarded as a major scientific classic. Agricola brought to a study of the Earth and its constituents the touchstone of his own experience, and assayed the theories of earlier authors in the crucible of his profound knowledge of their writings, often finding the 'ore' to be of poor quality.

The "De Ortu" contains four new works and a reprint of the earlier "Bermannus". Though each treatise is self-contained, and the titles may appear unrelated, yet in fact their arrangement follows a methodical plan. The first book, "De Ortu et Causis Subterraneorum", discusses the physical phenomena affecting the earth, in particular the part played by water; and Adams<sup>4</sup> comments that Agricola's description of the earlier stages of erosion might well have been written in the twentieth century. Another of the topics in this treatise is the origin of ore deposits, and here Agricola's reasoned view, that ores were deposited from solutions in channels or fissures that had originated after the containing rocks, constitutes a remarkable advance on all previous speculations. The next two treatises deal with the constituents of the Earth. The first ("De Natura eorum quae effluunt ex Terra") discusses those which are vapours or liquids, and the second ("De Natura Fossilium") discusses solid bodies, for which he uses, for the first time, the word 'fossil'. The use of this term to describe all substances dug out of the earth continued for well over two centuries, and it is only since the beginning of the nineteenth century that it has been restricted to fossil organisms. The "De Natura Fossilium" is the first attempt at a systematic mineralogy, and in it Agricola describes many minerals for the first time. His classification of these 'fossil' bodies has been described by Adams, but a fact of considerable historical importance, which does not appear to have been commented on by chemists, is his recognition of the difference between chemical compounds ('mista') and mixtures ('composita'). The former, he states, are composed of two or more simple fossil bodies, so intimately mixed that "even in the smallest part there is not wanting any substance contained in the whole", and inseparable except by fire; whereas the components of the 'composita' can be separated not only by fire but also by water and sometimes by hand ("De Natura Fossilium", 1546, p. 185). This clear statement was made more than a century before that of Boyle in the "Sceptical Chymist". Boyle, incidentally, was familiar with the works of Agricola, whom he described as "the most classick author we have about mines".

Agricola's fourth treatise, on old and new mines and minerals ("De Veteribus et Novis Metallis"), contains a wealth of information concerning the situation of mines and the metals obtained from them. It is worth mentioning here that he gives a list of places in Cornwall where tin was worked, and refers to the meeting of miners from Cornwall and Devon every seven or eight years on "Hengsten-donus mons" (Hingston Down, twelve miles north-west of Plymouth) to discuss their affairs. This is later mentioned by Camden.

The "De Ortu" was translated into Italian in 1550, and other Latin editions appeared in 1558, 1612 and 1657; but the most useful edition for the student is the German translation, with many notes, which appeared during 1806-10. Unfortunately, this is as scarce as the earlier editions. An English translation would be most valuable and attract to the book the attention it undoubtedly merits. Meantime, one can say there is no question of placing Agricola among the great—he already stands there—but, unfortunately, almost unrecognized.

<sup>1</sup> London, 1912, reprinted 1950.

<sup>2</sup> Hofmann, R., "Dr. Georg Agricola" (Gotha, 1905).

<sup>3</sup> Hartmann, H., "Georg Agricola" (Stuttgart, 1953).

<sup>4</sup> Adams, F. D., "The Birth and Development of the Geological Sciences" (Baltimore, 1938).