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Herbert Hoover and Georgius Agricola: The Distorting Mirrors of History

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In my address today I wish to take a comparative look at the lives and careers of two men who lived more than 300 years apart, but whose names have become inextricably linked in the English-speaking world of the history of science and technology. They are Herbert Hoover, mining engineer, organizer of international relief efforts during World War I and President of the United States of America; and Georgius Agricola, 16th-century humanist, physician, and author of a number of works in Latin on the phenomena to be found underneath the earth. What linked these two men was a book - one of Agricola's books, namely, his *De re metallica* of 1556 that Herbert Hoover had translated into English and published in 1912 in a sumptuous edition, which in its typeface, quality of paper and vellum binding sought to come as close as possible to the magnificent standards of the original masterpiece of Renaissance printing that was published by Froben in Basel (1). Not the least of the glories of the original, and the translation, were the hundreds of woodcuts that illustrated the book. These depicted the miners and smelters, tools and machines, techniques and processes of the mines of Saxony and Bohemia in the mid-16th century where Agricola had lived, worked and made profitable investments. By 1912, the year the translation was published, Herbert Hoover had made successful investments, too, and was, in fact, close to the apex of his career as a mining engineer and consultant who, from his base in London, had interests that literally spanned the globe from Western Australia, New Zealand, Burma, China, and Russia to North America. He was a wealthy man and had succeeded with some years to spare in his self-professed ambition of making a fortune by the age of 40 (Hoover was 38 in 1912).

An interest in mining was obviously a mutual concern of Hoover and Agricola. But why should a highly successful mining engineer of the early 20th century be concerned with a book written in the middle of the 16th century? An attempt to answer that question requires us to look at Herbert Hoover's career and its trajectory. For this I am greatly indebted to the first volume of George H. Nash's *Life of Herbert Hoover*, although I shall depart somewhat from Nash's interpretation of the significance of the Agricola translation for Hoover (2).

Orphaned in childhood, Herbert Hoover acquired from the Quaker relatives who brought him up on the frontier of Iowa and Oregon, a strong sense of duty and responsibility, as well as initiative and a well developed work ethic. The place that first gave him opportunity to exploit these attributes in the larger world was Stanford University in whose very first class Hoover enrolled in 1891. There is evidence that already when

Herbert Hoover at age 40, two years after publishing his translation of Agricola's *De re metallica*

he went to Stanford he had the intention of becoming a mining engineer, but there being no curriculum in that subject, he followed the courses for mechanical engineering in his first year. In the second year, however, there appeared on campus Stanford's new professor of geology, John C. Branner. Hoover at once found his subject and his most influential mentor. Probably the most important educational experiences for Hoover's subsequent career were the summer jobs that Branner was able to arrange for him doing field work as an assistant for the United States Geological Survey. Hoover got both course credit and pay for these expeditions on which he developed his skills at making quick but accurate assessments in the field. During term time, in addition to his studies, Hoover began to refine those managerial and executive skills for which he later became famous as treasurer of various student societies (3, 4).

In May 1895, Herbert Hoover graduated from Stanford University with an A.B. in Geology. At several social events before graduation, he was accompanied by a young woman named Lou Henry, who just that year had come to Stanford to study geology with Professor Branner. Herbert Hoover later married her and she would play an important part in the translation of Agricola (5). But these steps lay in the future: Hoover had first to set the course of his career. The summer immediately following graduation found Hoover back in the

Sierras working for the U.S. Geological Survey under the direction of Waldeman Lindgren as he had done in summers before. He found himself torn between the attractions of academic geology on the one hand, and his old ambition to be a mining engineer on the other. At one point he contemplated doing post-graduate work at either Columbia or Johns Hopkins where he hoped to make a specialty of "mining geology" (6).

At any event, when the summer season of geologizing for the U.S. Survey ended in October, Hoover took himself off to the Nevada City gold mines where for two or three months he labored as a miner both at the face and in pushing hand carts filled with ore. This was Hoover's harsh introduction to practical mining; but it was scarcely mining engineering. Hoover's dilemma was that he knew what he wanted to be, but he did not know how to get there. In the end it was a suggestion by an experienced mining engineer named George Hoffmann that directed him to Louis Janin, who was a mining consultant operating out of San Francisco. Janin was the director of one of the many consulting firms which gave managerial, technical, and financial advice and assistance to mining interests. Hoover began here on the ground level as an office boy, but his expert knowledge of the geology of some California gold mines derived from his work with Lindgren enabled him to provide his boss with some convincing testimony in a law suit involving one of his clients. In short order Janin sent Hoover off as assistant manager of a mine in New Mexico which was quickly followed by spells in Colorado, Arizona, Nevada, and Wyoming. Hoover was quickly being initiated into the profession of a mining engineer by being one (7).

This business of mining consultancy and mining engineering was an international one, as events in Hoover's career soon showed. Late in 1896 Louis Janin was approached by a representative of the London-based firm of Bewick and Moreing to recommend a mining inspector who would look out for their current and prospective interests in the gold fields of Western Australia. Janin nominated Hoover for the job in spite of his youth (Hoover was only 22 at the time). In March 1897, he set out for Australia by way of London where he was interviewed by one of the senior partners of his new firm, C. A. Moreing. Passing muster, he continued on his journey to Western Australia where he arrived in May (8). The gold fields of Western Australia were at this time undergoing a transition. An initial phase of boom and speculation that was encouraged by the presence of alluvial gold on or near the surface, was giving way to mining at depths that required more geological knowledge, more technology for draining and crushing, and, hence, more rational use of labor and capital. In these conditions, Bewick and Moreing could not have chosen a better man than Hoover to evaluate their current and prospective mine holdings. For the first several months of his stay in Australia he traversed the rugged outback evaluating mines and making recommendations to his firm. Among the properties most strongly recommended by Hoover was the mine known as

Lou Henry Hoover with her sons, Allan (left) and Herbert Jr. (right), circa 1908

"Sons of Gwalia". After lengthy inspections, Hoover felt this mine would return well on investment over a period of time if modern equipment were employed to mine and mill the low grade ore, but he was insistent that the firm must have control of the design and purchase of the equipment. Bewick and Moreing paid close attention to all of Hoover's recommendations.

They secured an option to buy from the original owners, floated stock on the London market, and when the time came to begin operations, they made Herbert Hoover the superintendent of the mine. At age 23, Hoover had the chance to put the theoretical principles that lay behind his mine evaluations into practice. The chief of those principles was that the key to long-term profitability in any mining enterprise was to keep working costs low. This in turn meant the most efficient use of machinery and labor. Hoover was able to implement his principles so successfully at "Sons of Gwalia" that he not only won the confidence of his employers, but he also established his reputation internationally as a mining engineer (9).

In the fall of 1898, the senior partner of the firm, C. A. Moreing, invited Hoover to leave Western Australia for China. Moreing had ambitious schemes afoot there, including the building of an ice-free port near the vast Kaiping coal fields and assisting the Chinese to develop their gold and other mines in the province of Chihli. Hoover was tapped to be the company's

on-site representative in both schemes. Tired by the harsh conditions of the Australian outback, Hoover quickly accepted the offer. But he insisted that he be allowed to stop over in the United States before proceeding to China. The purpose of the stop was so that he could marry Lou Henry to whom he had proposed by cable from Australia (10).

This is not the time and place to discuss in detail the tumultuous two years the Hoovers spent in China. Suffice to say they were punctuated by the Boxer Rebellion and in the course of them, Herbert Hoover was introduced to a new world of international finance and political negotiation that went far beyond his experience in Australia. Although there were no successes like the "Sons of Gwalia" mine, Hoover had obviously moved to a different level of operation with Bewick and Moreing which merited him the reward of a senior partnership in the firm (11).

With the new status came a new location - the Hoovers moved to London where they established their home between 1901 and 1914. Not that traveling ceased, for Hoover still logged thousands of miles to far-flung parts of the globe to inspect mining properties for the firm. This continued even after he parted company with Bewick and Moreing and set up on his own as a mining consultant in 1908. The Hoovers remained in London during these years principally because London was the center of the world's mining finance, and it was increasingly to this side of the business that Herbert Hoover turned his attention. But London also provided amenities not found in the Australian outback or the coal fields of Northern China. There were theaters and concerts to attend, museums to visit, and books to buy and read (12). These were new kinds of interests for Herbert Hoover and he went about them with the same methodical efficiency that he brought to everything else he did. Around 1904 he set himself an ambitious program of reading in history, government, politics and economics, perhaps already anticipating the career in public life which he hoped to undertake once he had made his fortune by age 40. Books of this sort were something new for Hoover, whose education at Stanford had focused largely on scientific and technical subjects (13). Hoover's professional success had built upon that educational base, but it had been supplemented most significantly by practical experience.

This experience is clearly manifest in a book by Hoover that appeared in 1909 titled *Principles of Mining: Value, Organization and Administration: Copper, Gold, Lead, Silver, Tin and Zinc* (14). The book derived from a set of lectures that Hoover delivered, first at Stanford and then at the Columbia School of Mines, and its theme is firmly rooted in Hoover's own career. The work is essentially about the relationship between mining and finance and in the course of it, Hoover spells out the professional responsibilities of the mining engineer. He argues that the latter is distinctive since "the most dominant characteristic of the mining engineering profession is the vast preponderance of the commercial over the technical in the daily work of the engineer" (15). It is in the domain of the commercial that the profession of mining engineering should exert its moral authority by giving informed accounts of the state and prospects of mines, thereby curbing speculation in mining shares and encouraging informed, long-term investment. Only in this way could the reputation of the industry be kept high enough to attract the capital it needed (16). To this end, a very large part of the *Principles of Mining* is devoted to the valuation of mines (which had also been a large part of Hoover's professional career). This consultative role for the mining engineer reflected, as Hoover made explicit, the new scale of capitalization in mines that saw the formation of companies floating shares on the public exchanges. Thus, the mining engineer became in Hoover's eyes the moral gatekeeper of mining shares on the stock market (17).

This is not to say he ignored the organization and administration of the mine in his book *Principles of Mining*, as both these factors were important in the valuation of mines. And here again he waxes eloquent on the moral duty of the mining engineer. The very essence of the profession is to direct men - mining engineers are officers in the great industrial army who usually serve far from civilization. In these circumstances, their duties extend beyond mine management; to them falls "the responsibility of example in fair dealing and good government in the community" (18).

What will strike the contemporary reader as odd about the contents of *Principles of Mining* is the relatively small part science and technology play in it. Technology, in fact, does not appear to be a word in Hoover's vocabulary; instead he speaks of science, and science applied to industry. "To the engineer falls the work of creating from the dry bones of scientific fact the living body of industry" (19). The principal science that the mining engineer applied to industry was geology (20).

To this period in Hoover's life belongs the translation of Agricola's *De re metallica*. Work on this translation began around 1906 and it went to press at the end of 1912; thus the *Principles of Mining* was published right in the midst of the work on Agricola. One might expect that there would be some reflection of one book in the other. George Nash, Hoover's biographer, has linked the two together by suggesting that both represent efforts to raise the professional image and status of the mining engineer (21). Clearly the Hoovers' translation of *De re metallica*, produced as it was in a handsome, vellum-bound folio, and handprinted on paper specially made in Scotland to resemble the original, was meant to impress. In fact, in every way the translation was made to resemble the masterpiece of the printer's art that Froben had produced in 1556 (22). The Hoovers' book as a physical object was a magnificent symbol of the dignity of mining. But if we penetrate to the contents of the translation itself and try to understand how these elevated the professional dignity of the mining engineer, we find some surprises.

Before discussing the text of the translation, it is important

to understand Herbert Hoover's role in the translation. The title page appears unambiguous: *Georgius Agricola De Re Metallica translated from the first Latin edition of 1556* ... by Herbert Clark Hoover and Lou Henry Hoover ... But there is a problem with this; Herbert Hoover did not know the languages to carry out that translation. (Besides the original Latin version, *De re metallica* had been translated into German and Italian, neither of which Herbert Hoover knew) (23). In fact, the initiative for doing the translation in the first place seems to have come from Lou Henry Hoover, who wrote to J. C. Branner, the Hoovers' former geology professor at Stanford, that she could not find an English version of *De re metallica* in the British Museum so she thought she would undertake a translation herself (24). The bulk of the English text that appeared may well have been by Lou Henry Hoover, although we know that from 1908 on the Hoovers hired a number of people to do translation and bibliographic work for them. As the project moved on, Herbert Hoover seems to have defined a bigger role for himself in it, and that was to provide technical commentary by way of footnotes. This may have been behind the advertisement in *The Times of London* in July, 1911 for "a Lady Secretary who can translate Latin and German with facility and has done work at the British Museum" (25). If one looks at the footnotes to the translation of *De re metallica*, one can see the necessity for that facility in languages and familiarity with a great library, because frequently incorporated within them were lengthy passages of translation either from other works by Agricola or from treatises by classical authors. Those footnotes carry a weight of scholarly authority that their alleged author did not possess. On the other hand, let us appreciate the Hoover translation for what it was - a magnificent piece of industrial scholarship in which the master engineer, Herbert Hoover, mobilized and managed a team of translators and bibliographers to produce a work of enduring scholarship in the space of only six years.

This efficiency in the production of the translation contrasts with the protracted labor of 25 years that Georgius Agricola spent on writing the original. In fact, Agricola never saw his own book published as he died in 1555, one year before it appeared. It is scarcely imaginable that Agricola would have hired translators to speed up the production of his humanist Latin. To Agricola, the language of his book was everything; to Hoover, the language of *De re metallica* was a matrix from which the meaning had to be extracted. To understand this better, we need to look at aspects of Agricola's life and career.

Georg Bauer, who would later Latinize his name as Georgius Agricola in order to underline his identification with classical antiquity, was born in Glauchau in the Duchy of Saxony in 1494 (26). He was the son of a dyer and woolen draper, which were important trades in that cloth manufacturing town. His family obviously had ambitions for him beyond the family trade, for he entered the University of Leipzig in 1514. This was an important period in that university's

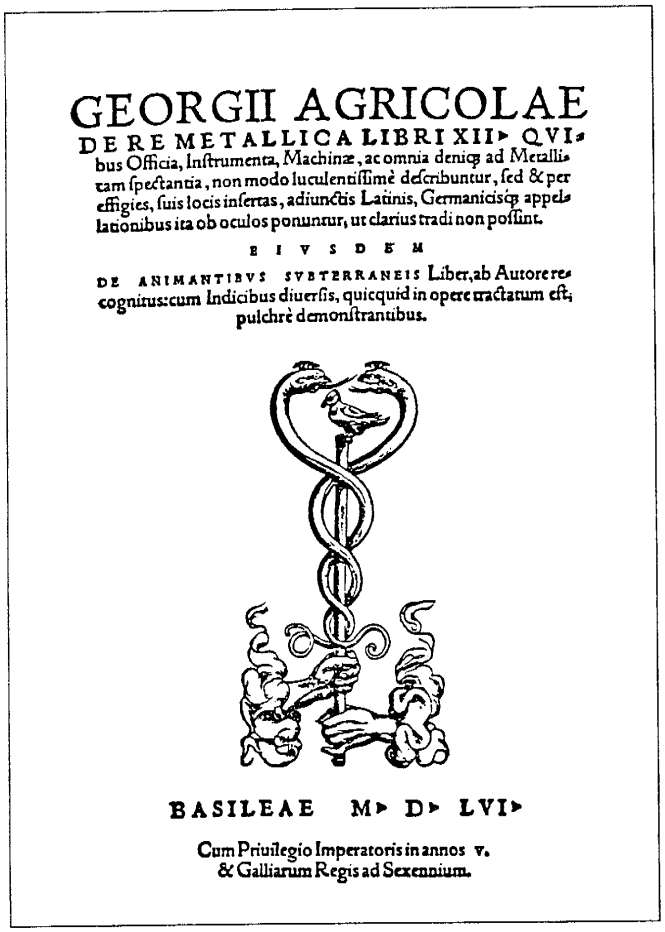
Georgius Agricola (1494-1555), born Georg Bauer

development which saw the introduction into the curriculum of the new humanism that we associate with the Renaissance, namely, the appreciation of the literature and culture of classical antiquity through a renewed study of the ancient languages of Latin and Greek. So infected was Georg Bauer by the new learning that after graduating he went to Zwickau where he introduced Latin and Greek into the municipal school. It was about this time that he adopted the name Georgius Agricola, and, indeed, he might have spent the remainder of his days in Zwickau happily teaching Latin and Greek, had not disruption caused by the preaching of some radical religious reformers undermined the peaceable conduct of the municipal school (27). Agricola decided to return to the University of Leipzig, this time to study in the higher faculty of medicine. Even here his humanist predilections showed, as he shortly set off for Italy - the home of Renaissance humanism - where, among other things, he worked in the Aldine Press as an editor of some of the Greek texts of the ancient physicians Galen and Hippocrates. Thus in his study of medicine, Agricola was also able to keep up his study of ancient languages as well.

This required much more ingenuity after Agricola returned to Germany around 1526. His first position was as town physician and apothecary to Joachimsthal, which at that time was a boom mining town on the Bohemian side of the mountain range known as the Erzgebirge (i.e., in modern Czechoslovakia). Here Agricola came into daily contact with mines and mining officials; but in such an environment, how was he to keep alive his humanist interest in ancient languages? His solution to this was a project to identify those mineral species that the ancients employed in the preparation of their medicaments. This involved the identification of the words used by the ancient authors in their texts with the substances that could be inspected first hand in the mines and workings of Joachims-

thal. It was a good example of that classic humanist enterprise of linking words to things and vice-versa. Quickly, however, this project took on broader dimensions as Agricola's interest moved beyond the names and identities of therapeutic species to embrace the whole phenomenon of mining, its products and its operations. This change in the project is clearly seen in Agricola's first publication on mining, the *Bermannus* of 1530 (28). This short work takes the form of a dialogue conducted in Latin between a mining expert and two physicians. The trio make a tour of the Joachimsthal valley in the course of which they debate not only the names and identities of minerals, but also discuss the machines and technology of mining.

The *Bermannus* is in a sense a prologue to *De re metallica* which was, in fact, the subtitle given to the dialogue. But the great work itself would be 25 more years in the making and much would happen to Agricola in that time. In the first place, he moved back to his native Saxony and the town of Chemnitz, which was still within the same silver mining region of the Erzgebirge where Joachimsthal was located. Agricola made very successful investments in the mines and with this wealth came increased responsibility in the community. He became a town councilor and was appointed Burgomeister on several occasions. He also served on legations of Duke Maurice and Albertine Duke of Saxony (29). Throughout this crowded private and public life, he continued to work on the book that would become *De re metallica*, and most astonishingly of all, he found time in between to compose five other works which dealt comprehensively with all natural phenomena occurring beneath the earth. Together they comprise a kind of natural philosophy of the underworld on the model of Aristotle: *On the Origin and Causes of Subterranean Phenomena; On the Nature of Those Things that Flow from beneath the Earth; On the Nature of Stones; On Ancient and Modern Metals* (30). In these works can be seen the full range of Agricola's humanism - it consisted of attempting to describe and understand events and phenomena with the same sensibility as that of the ancients, and that meant expressing those experiences and thoughts in the language of the ancients.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lationibus ita ob oculos ponuntur, ut clarius tradi non poſſint.
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DE ANIMANTIBVS SVBTERRANEIS Liber, ab Autore re▸
cognitus: cum Indicibus diuerſis, quicquid in opere tractatum eſt,
pulchrè demonſtrantibus.
BASILEAE M▸ D▸ LVI▸
Cum Priuilegio Imperatoris in annos v.
& Galliarum Regis ad Sexennium.

The title page of the first edition of *De re metallica*

Agricola's reaching back to the world of antiquity contrasts sharply with Herbert Hoover's projection of Agricola's writings forward into the progressive movement of science. This is most clearly seen in that section of the introduction to the Hoovers' translation entitled, "Agricola's Intellectual Attainments and Position in Science" (31). The question Herbert Hoover asks in this section is what advances did Agricola make in the sciences of geology, mineralogy and mining engineering. Hoover is not unsophisticated in the answers he gives. He is aware of the danger of reading modern concepts into Agricola's terminology; he understood that Agricola's ideas were deeply indebted to the ancients, especially the Aristotelians; and he recognized that as regards geology and mineralogy, the important texts were *On the Origins and Causes of Subterranean Things* and *On the Nature of Stones* (long translated passages of both appear in Hoover's footnotes to the translation of *De re metallica*). Hoover depicts Agricola trying to break away (not always successfully) from the confines of ancient thought whereas Agricola in fact was attempting to reestablish dialogue with the ancients. In accounting for the limited advances he made in the sciences of geology and mineralogy, Hoover says that Agricola can scarcely be blamed for not seeing forward "to the atomic theory and our vast fund of chemical knowledge" that was now available (32). In the end, Hoover makes his broadest claims for Agricola in the realm of scientific methodology and offers an interesting comparison between him and Paracelsus (33):

> 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 phenomenon.

What is interesting and surprising to note here is that the highest pedestal on which Hoover places Agricola is science (not engineering); that the sciences to which he believed Agricola made his most important contributions were geology and mineralogy, not mining engineering; and when Hoover makes his comparison of the adulation accorded Paracelsus by the medical profession with the neglect shown - not by the profession of mining engineering - but by the profession of geology. If the Hoover translation was intended to elevate the status and dignity of the profession of mining engineering, it did not do so by celebrating Agricola as a model mining engineer; rather it claimed him to be one of the founders of modern scientific method.

What is surprising in this is that Agricola has, in fact, much to say about mining and its virtues in terms that should have appealed directly to Herbert Hoover. Agricola in the first book of *De re metallica* is at pains to argue that mining is a respectable and rewarding activity. Why was this necessary? Fundamentally, it stemmed from Agricola's posture as a humanist, seeking to understand and write about his own world with the sensibilities of the ancients. To accomplish this, he had to choose, as any humanist would have done, a classical model for his book. The model Agricola adopted was the treatise on agriculture by the 1st century A.D. Roman author, Moderatus Columella, entitled *De re rustica* (34). One can see how Agricola's title echoes that of its ancient precedent. But there was a problem with this choice in that Columella (like other ancient writers) celebrated agriculture as the only honorable and virtuous way to accumulate wealth. The first book of *De re metallica* is largely devoted to overcoming this deeply held conviction of the ancients that the economic well being and political virtue of the free-born citizen was rooted in the ownership and cultivation of land. Mining, on the other hand, was an activity carried out by slaves in the ancient world. Agricola mounts many arguments against this position, but one is of particular interest in relation to Herbert Hoover.

Agriculture was virtuous and natural to the ancients because it represented a renewable and (fairly) predictable method of acquiring wealth; the growth of crops and the raising of livestock were natural processes that followed the seasons of the year; the rhythms of agriculture were in harmony with those of the cosmos. On the other hand, other forms of economic activity, such as trade and mining, were unnatural and unpredictable - or as the ancient Romans would have put it, were subject to the goddess "Fortuna". "Fortuna" was luck or chance, and while every human life and endeavor was subject to it, it had to be combated by means of virtue. The charge that mining is too much subject to "fortuna" is the one that Agricola is at most pains to refute in his first book of *De re metallica* (35). Now recall what Herbert Hoover thought was the primary role of the mining engineer: it was to solidify confidence in mining as representing a reliable return on investment. The technical expertise of the mining engineer was meant to end short-term speculation (i.e., fortuna) in mines and introduce to them long-term investment (i.e., virtue). Agricola, like Hoover, advocates technical knowledge acquired on-site as the best antidote to rash speculation in a mining enterprise; but he also recognized that investors can devise their own strategies to outwit "fortuna". We would call it diversification of one's portfolio.

Here is what Agricola has to say about it (36):

> When a man owns mines but is ignorant of the art of mining, then it is advisable that he should share in common with others the expenses, not of one only, but of several mines. When one man alone meets the expense for a long time of a whole mine, if good fortune bestows on him a vein abundant in metals, or in other products, he becomes very wealthy; if, on the contrary, the mine is poor and barren, in time he will lose everything which he has expended on it. But the man who, in common with others, has laid out his money on several mines in a region renowned for its wealth of metals, rarely spends it in vain, for fortune usually responds to his hope in part.

Thus had Herbert Hoover made his fortune. What is surprising is that Hoover, the author of *Principles of Mining*, makes no comment whatever on Agricola's lengthy defense of the virtue of mining as an economic activity and on his suggestions as to how income from investment can be stabilized.

One last aspect of Agricola's *De re metallica* is worth comment on in relation to Herbert Hoover. As I have hinted at, but not yet made explicit, mining in Agricola's day was a business of share capital; that is, there already existed by the first half of the 16th century companies of shareholders who financed and derived income from mining operations. This was how Agricola, too, had made his substantial fortune. The introduction of share capital into the finance of the silver workings of Central Europe arose in part from technological innovation; namely, the introduction of the cupellation process, whereby the silver in argentiferrous copper ores could be extracted by smelting with lead. This technique made profitable the mining of these copper ores at much greater depths than before; but this in turn meant much more capital to build the drainage and ventilation engines necessary for mining at such depths. It was this need for capital that gave rise to shareholding companies in the Central European silver mines in the 16th century (38). Not only was Agricola the beneficiary of investment in such companies, but the illustrations in *De re metallica* gave graphic testimony of the transformation in the scale and complexity of the workings that such mining brought to the regions he was familiar with. Once again this should recall Herbert Hoover in the gold fields of Western Australia, where he superintended a similar transformation in mining practice that saw the necessity of increased capitalization of

mining operations in order to make possible the profitable exploitation of low-grade ores at depth. But once again, Hoover is silent about Agricola's description and depiction of the new technology of drainage and ventilation that was at the service of a new kind of mining very close to that of Hoover's own experience (38).

Why was Hoover oblivious to those aspects of Agricola's work that most reflected Hoover's own experience and seemed to support his own version of the *Principles of Mining*? One obvious reason is that he did not know much about the conditions of mining in Agricola's time and therefore was not in a position to recognize the really novel elements and arguments in *De re metallica*. Hoover's historical footnotes to the translation are of a chronological kind, identifying who first knew of such and such a substance or process. They usually begin with a scriptural or classical source, liberally quoted, and go up to the 16th century and beyond. In fact, it is a form of history rather close to that which Agricola himself wrote in his *On Ancient and Modern Metals*, although I do not believe Hoover ever had that text translated.

And, finally, why in a work that was intended to elevate the standing of mining engineers, was Agricola not celebrated for enunciating some of the principles of mining as Hoover understood them? Why does Hoover praise Agricola primarily as a geologist and a scientist? I believe we may find the answer to that question if we see the Hoover translation less as a manifesto for engineering and more as a labor of love. The heart of this work lies at Stanford and not at varied mining fields around the globe. It was there that the young Herbert Hoover had majored in geology; it was in the halls of the geology department that he first met his wife and "fellow" translator, Lou Henry; and both were students of the professor of geology, John C. Branner. The Hoover translation of *De re metallica* is, in fact, dedicated to Branner, and in elevating Agricola's standing amongst geologists, I rather think its translators were paying a joint tribute to their old teacher. There was another sense in which the Hoover *De re metallica* led back to Stanford. The translation represented an envoi to mining engineering for Herbert Hoover. He had made his fortune and it was time in that well-planned life to move on to a career in public service. The first place he sought to exercise that role was on the Board of Trustees of Stanford University to which he was elected in the fall of 1912, just as the sheets of *De re metallica* were coming from the presses (39). There could scarcely be a more legitimating symbol for a trustee of a major university. Many could claim to be rich, but how many amongst them could also claim to have produced an enduring work of scholarship.

References and Notes

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1. The title page of the translation reads: *Georgius Agricola De Re Metallica translated from the first Latin edition of 1556 with biographical introduction, annotations and appendices upon the development of mining methods, metallurgical processes, geology, mineralogy and mining law from the earliest times to the 16th century* by Herbert Clark Hoover and Lou Henry Hoover, The Mining Magazine, London, 1912. The title page of the original reads: *Georgii Agricolae De Re Metallica Libri XII Quibus Officia, Instrumenta, Machinae, ac omnia denique ad Metalllicam spectantia, non modo luculentissimè describuntur, sed & per effigies, suis locis insertas, adjunctis Latinis, Germanicisque appelationibus ita ob oculos ponuntur, ut clarius tradi non possint. Eiusdem De Animantibus subterraneis Liber, ab Authore recognitus; cum Indicibus diversis, quicquid in opere tractatum est, pulchre demonstrantibus*, Froben, Basel, 1556.

2. G. H. Nash, *The Life of Herbert Hoover; the Engineer 1874-1914*, Norton, New York, NY, 1983. This is the first volume of a projected three-volume life of which the first two have already appeared.

3. *Ibid.*, pp. 26-41.

4. Hoover's own recollections of his Stanford years are recorded in H. C. Hoover, *The Memoirs of Herbert Hoover: Years of Adventure*, Vol. 1, Macmillan, New York, NY, 1951, pp. 16-24.

5. Reference 2, pp. 37-39; reference 4, Vol. 1, p. 23. Lou Henry, an athletic and attractive young woman, was the daughter of a Monterey banker and had trained as an elementary school teacher. She was captivated by geology after hearing an extension lecture given by Professor J. C. Branner and came to study the science with him at Stanford. There seems little doubt that her first encounters with Herbert Hoover were within the confines of the geology department at Stanford; in Professor Branner's office, in the geology laboratory and at the geology club. Geology, Professor Branner and Stanford University were amongst the oldest and strongest bonds of their union.

6. Reference 2, p. 44. This indicates a residual pull towards academic geology, perhaps born out of emulation of his teachers; but this was in conflict with his ambition to make a fortune at an early age.

7. *Ibid.*, pp. 42-50.

8. *Ibid.*, pp. 50-52. The London interview with C. A. Moreing was not without its tension. Bewick and Moreing had stipulated to Janin that they wanted someone over 35. Hoover was only 22. To disguise the discrepancy, Hoover grew a moustache and beard. There is a splendid photograph of him in London on his way to Australia, newly hirsute and sporting a top hat and morning coat that quite transformed the chubby, boyish looks of the Stanford graduate. (See *ibid.*, p. 93.)

9. *Ibid.*, pp. 52-87. For a discussion of mining in Western Australia around Hoover's time there see Geoffrey Blainey, *The Rush that Never Ended: A History of Australian Mining*, 3rd ed., University of Melbourne Press, Melbourne, 1978, pp. 161-207. Hoover is specifically mentioned on p. 202 and the illustrations between pp. 206 and 207 include a photograph of the Sons of Gwalia mine with a portrait of Hoover - still sporting a moustache - as an inset.

10. Reference 2, p. 86.

11. Nash discusses the Hoovers' activities in China and their legal fallout in great detail in *ibid.*, pp. 167-222.

12. *Ibid.*, pp. 496-502.

13. *Ibid.*, p. 292.

14. H. C. Hoover, *Principles of Mining: Value, Organization and Administration:: Copper, Gold, Lead, Silver, Tin and Zinc*, McGraw-Hill, New York, NY, 1909.

15. *Ibid.*, p. 185.

16. This is a recurrent theme in *Principles of Mining*; see, for instance, *Ibid.*, pp. 2-3, p. 52; p. 184 and p. 192.

17. *Ibid.*, p. 52.

18. *Ibid.*, pp. 192-3. The last chapter entitled "The Character, Training, and Obligation of the Mining Engineering Profession", (pp. 185-193) elaborates on this and related themes.

19. *Ibid.*, p. 193.

20. *Ibid.*, pp. 21-22 and p. 19.

21. Reference 2, pp. 475-495.

22. Reference 4, Vol. 1, pp. 118-119.

23. Hoover had no working knowledge of any language but English.

24. Reference 2, pp. 490-491.

25. Nash indicates that at times three or more hired translators may have been at work on *De re metallica* and its footnotes. *Ibid.*, pp. 491-492. Hoover in his *Memoirs* does not acknowledge the part played by these translators.

26. The standard life of Agricola is H. M. Wilsdorf, *Georg Agricola und seine Zeit*, VEB Deutscher Verlag der Wissenschaften, Berlin, 1956. See the same author's article on Agricola in C. C. Gillispie, ed., *Dictionary of Scientific Biography*, Vol. 1, Schribner's, New York, NY, pp. 77-79. In what follows, I have made extensive use of H. Prescher, *Georgius Agricola, Persönlichkeit und Wirken für den Bergbau and das Hüttenwesen des 16. Jahrhunderts* [Kommentarband zum Faksimiliedruck 'Vom Bergwerck XII B ücher Basel 1557], Acta humaniora der VCH Verlagsgesellschaft mbH, Weinheim, 1985.

27. For a good general account of the Reformation in Zwickau, see C. Karant-Nunn, *Zwickau in Transition, 1550-1574: The Reformation as an Agent of Change*, Ohio State, Columbus, OH, 1987.

28. G. Agricola, *Bermannus sive de re metallica*, Froben, Basel, 1530.

29. See Prescher, reference 26, pp. 60-76.

30. These works were published together with a second edition of the *Bermannus* as G. Agricola, *De ortu et causis subterraneorum Lib. V; De natura eorum quae effluent ex terra Lib.iiii; De natura fossilium Lib.X; De veteribus & novis metallis Lib.II; Bermannus, sive De re metallica Dialogus, Interpretatio Germanica vocum vel metallicae addito Indice foecundissimo*, Froben, Basel, 1546.

31. Reference 1, pp. xiii-xv.

32. *Ibid.*, p. xiv.

33. *Ibid.*, p. xv.

34. L. J. M. Columella, *On Agriculture*, (with a revision of the text and English translation), 3 Vols., Harvard University Press, Cambridge, MA, 1941-1955.

35. Reference 1, pp. 5-8; 12-13; 20-22; 23-24.

36. *Ibid.*, p. 27.

37. J. Nef, *The Conquest of the Material World*, World Publishing, Cleveland, OH, 1967, pp. 42-52.

38. Agricola's description of drainage and ventilation machinery is contained in Book VI of *De re metallica* to which there are very few footnotes in the Hoover translation.

39. Reference 2, p. 527.

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STEREOCHEMICAL MODELS OF BENZENE, 1869-1875

The Conflicting Views of Kekulé, Koerner, Le Bel and van't Hoff

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The stereochemical models of benzene proposed by Joseph Achille Le Bel and Jacobus Henricus van't Hoff in 1874-1875 were related to the well-known controversies on its constitution which began soon after the publication of August Kekulé's papers of 1865 and 1866. The models examined by van't Hoff in his booklet *La chimie dans l'espace* (1875) were based on a tetrahedral model for the carbon atom which Kekulé himself had described in 1867. However, the first to use Kekulé's model for a stereochemical treatment of the six-carbon benzene nucleus was Wilhelm Koerner in a paper published in 1869. The connections between these events have not received the attention they deserve.

The development of stereochemistry during its first decade was outlined by van't Hoff when he published the second edition of his booklet in 1887 (1). His historical introduction, however, was limited in scope: it reprinted both his and LeBel's 1874 papers, Johannes Wislicenus' preface to the 1877 German translation of *La chimie dans l'espace*, and the violent critique of Hermann Kolbe. After citing some more favorable notices by chemical authorities, van't Hoff concluded by quoting textbooks which presented his theory. At the end of Part IV of the work he devoted only one page of comment to aromatic compounds, opening with the statement that his theory (1):