Journal and Proceedings of the Royal Society of New South Wales, vol. 147, nos. 451 & 452, pp. 29-54.
ISSN 0035-9173/14/0100029-26

Signal to Noise Ratio in Renaissance Writing: an example concerning Georgius Agricola (1494-1555)

D.F. Branagan[1*], D.W. Emerson[2], I. Kelly[2]

[1] School of Geosciences, University of Sydney
[2] Independent Research Scholar, Sydney

* Corresponding author.
E-mail: dbranaga@mail.usyd.edu.au

Abstract

The modern term 'Signal to Noise Ratio' – a measure in science for comparing the level of a desired signal with that of its background noise – is used here with reference to the views of Adam Siber expressed in an elegy comparing the scientific and literary output of mediocre writers with that of Georgius Agricola (1494 – 1555). Written in Latin, much of Agricola's important work still remains untranslated into English, but his numerous works formed the basis of the understanding of many geological and mineralogical principles. The authors, in the process of translating one of his works – *De ortu & causis subterraneorum* – found the prefatory elegy which is also written in Latin. This paper outlines salient aspects of Agricola's life, including the social, 'scientific' and technological milieu in which he worked, and the influence on him of writers, both contemporary and ancient. This serves as background to our translation of Siber's elegy, wherein Agricola's communication skills are compared most favourably with those of lesser communicators.

Keywords: Agricola, Elegy, Siber, Hertel, Renaissance, Mining

1. Introduction

This paper has as its genesis the authors' foray into a translation of *De ortu & causis subterraneorum* (about the origin and causes of subterranean phenomena), a Latin work of Georgius Agricola (1494-1555). The volume from which we worked contains a prefatory elegy written by Adam Siber (1516 – 1584**)** and dedicated to Valentin Hertel (ca. 1500 – 1547). It, like most of Agricola's works, is written in Latin and we decided that it, too, deserves to be translated.

We chose the title – *Signal to Noise Ratio in Renaissance Writing* – because in our view this scientific phrase provides a most apt analogy for Siber's contrast between the clarity and significance of Agricola's works and the ineffectual and often pointless efforts of lesser writers. The information torrent and its often irrelevant vortexes and eddies are not modern phenomena: the itch to impress ink on papyrus, palimpsest, parchment and paper has a long history, producing results of varying quality and utility in prose, poetry, philosophy, theology, engineering and science. Over against much fruitless and unoriginal work, any work of clarity, originality and utility stands out and persists as a work of distinction. In present day terms such relative measures are taken into consideration, even if largely unconsciously, when editors and reviewers rate a paper as worth publishing. In this paper we have taken the concept back to a time when publication was largely the prerogative of the writer himself (there were few female

authors). The Latin 'Elegy' by Adam Siber introducing Agricola's *De ortu* ... deals with this problem in considerable detail and calls on writers to be self-critical, even to the extent of withholding their work if it is not of sufficient quality.

This is the burden of Siber's *Elegy* written at a time of dynamic change: the Renaissance. Immersion in the classics of ancient Greece and Rome was considered essential to the standing and influence of learned scholars and this period produced prominent writers such as Erasmus, Thomas More and Rabelais, to mention but a few. It was also a time of religious turmoil: Martin Luther's Propositions drove a wedge among the Germanic people and, elsewhere in Europe John Calvin had initiated religious reforms.

Scientific thought grappled with three competing mechanisms of the recognised universe: the ancient geocentric view of Ptolemaeus; the heliocentric one of Copernicus and Kepler, and Tycho Brahe's geo-heliocentric compromise with the sun revolving around the earth and the other planets revolving around the sun. Educated elites believed in Aristotle's four elements of fire, water, earth and air**,** and all materials were believed to be mediated compounds of these basics.

Amidst this restless, developing intellectual milieu, Georgius Agricola researched and published works that laid the foundations of modern mineralogy. Siber's *Elegy* is a fitting paean to Agricola's intellectual rigour and painstaking observations**,** as it lists many questions the answers to which had previously been based on speculation rather than exact observation. Siber's praise of Agricola's lasting contribution to the body of knowledge of minerals resounds all the clearer when balanced against his persistent condemnation of writing that is of no significant value. Indeed, Virgil's comment about Lucretius could justifiably be added to Siber's paean:

Felix qui potuit cognoscere causas.
Virgil (*Georgic*s, 2, 4900)
[Blessed the man able to know the cause of things].

A translation of the elegy has in itself very little meaning – apart from justifying the title of the paper – unless it is prefaced by a brief summary of Agricola's life and work: the embodiment of clear communication. To this end, the first part of the paper describes his background; his achievements and the significance of his writings and researches in the development of the geological sciences. The translation itself presents the links between Agricola and many ancient written sources which he consulted and commented on in his works.

2. **Agricola's Works** (major and minor)

Georg Bauer, better known as Georgius Agricola (Figure 1), was the author of the well-known *De re metallica*, published posthumously in 1556. Although important for its text, this book's reputation is perhaps due largely to the fine woodcut illustrations which adorn the book and which have been widely reproduced. These woodcuts**,** showing technical mining devices**,** were prepared at St. Joachimsthal (now Jackymov), under Agricola's supervision. Skilled artists, led by Basilius Wehfring assisted by Rudolf Manuel Deutsch and Zacharias Specklin, prepared the mirror images for printing, all re-published in the first English translation by Hoover & Hoover (1912 and reprinted 1950) (Figure

2).[3] Preparation of the illustrations delayed the original publication of *De re metallica* until shortly after Agricola's death (Lefèvre, 2010). It should be noted, however, that illustrations such as these were a common feature of the mining literature of the period (see for instance Urban (1980), Bork (2005)).

However Agricola was well respected during his lifetime for other important works on geological subjects, published much earlier, and essentially lacking diagrams, and this paper deals specifically with such a work.

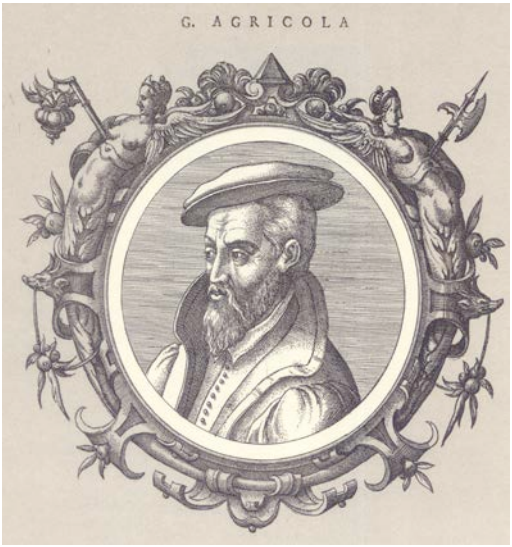


Figure 1. Agricola, reproduced from Dibner (1958; original source unknown).

As quoted by Dibner (1958) Agricola wrote "Those things which we see with our eyes and understand by means of our senses are more clearly to be demonstrated than if learned by means of reasoning".

Figure 2. This illustration from Book VIII (Hoover & Hoover, 1912, p. 330) typifies the woodcuts which made Agricola's De re metallica famous. Here Agricola points to the 'reality' of the Argonauts' search for the Golden Fleece. In the water emerging from an underground stream (lower left – letter A) carrying material from a mineralised source a fleece is being used so that it traps gold particles. As the Hoovers point out Strabo gave a similar explanation centuries before Agricola did. [4]

In 1546 Agricola put together five separate works in Latin – one of which (*Bermannus* (1530, 1541) had previously been published (Michaëlis et al, 1971) – to form an important volume which we refer to as *Opuscula* ('minor works', which they certainly are not) because this is the title on the copy which is the source of our study. However the title *Opuscula* seems to be rarely used by other scholars, who refer instead to the volume in terms of one or other of the five separate 'essays' it contains (see for instance Morello, 2006).

[3] The University of Sydney (Rare books) has an original copy

[4] Glover (2003) noted this fact about the illustration.

In total this volume consists of:

1. Introductory Elegy
2. *De ortu et causis subterraneorum* libri V, first publication 1546, Basel; (pp. 1 – 82)
3. *De natura eorum quae effluunt ex terra* libri IV, first publication 1546, Basel; (pp. 85 – 164)
4. *De natura fossilium* libri X, first publication 1546 Basel; (pp. 167 – 380)
5. *De veteribus et novis* libri II , first publication 1546, Basel (pp. 381 – 416)
6. *Bermannus, sive de re metallica Dialogus ,* first publication 1530, Basel (pp. 417 – 468)
7. Interpretatio Germanica vocum rei metallicae addito [List of Terms (pp. 469 – 487; including the names of previous writers)]
8. Indice faecundissimo [Unpaged Index 49 pages].

There were later Latin editions (essentially reprints: 1558, 1612, 1657), an Italian translation (1550), and a German translation (1806 – 1810) of *Opuscula*. There was no extended English translation of any part until 1955, when Bandy & Bandy (1955) published their translation of *De natura fossilium*, the third 'essay' in the volume.[5] There is a modern translation of *Bermannus* into French (Halleux & Yans, 1990).

Although no English translations of the other essays have appeared, some of them have clearly been read, at least in part, by various English-speaking scholars, and their importance recognised, most notably by the Canadian geologist F.D. Adams (1938), who discussed some of the volumes' main themes. Later scholars discussing the works include Eyles (1955) and Davies (1968), with fuller studies by Ellenberger (1988), Schmidt (1995a), Morello (1994, 2006) and Mottana (2006); and brief comments by Oldroyd (1996). Eyles (1955) attributed the lack of recognition of Agricola as a pioneer of geology to the general neglect of the history of geology by historians of science, although this neglect has been reduced since Eyles made the comment. Following his detailed biography in 1956, Helmut Willsdorf continued leading the way with his editing, in association with W. Quellmarz, of *Georgius Agricola – Ausgewählte Werke Erganzungsband* 1, Bergwerke und Huttenanlagen der Agricola-Zeit (Willsdorf and Quellmarz, 1971). In this work they deal specifically, inter alia, with Joachimsthal (pp. 157 and following), presenting information about the geology from recent research. Horst et al (1992) present the correspondence between Agricola and many associates, while H. Prescher (1994a, 1994b) has followed as the principal researcher on Agricola since the 1990s. The celebration at Chemnitz, in 1994, of the 500th year since Agricola's birth, saw considerable research publications on his work, and this stimulated continuing studies. See, for instance Morello (1994), Vai and Cavazza (2003), Conolly (2005) and Vai and Caldwell (2006.). Related publications includes Aldrich et al (2009). A major work is that of Neumann (1994), consisting of the papers presented at the Dresden meeting celebrating Agricola. The comprehensive list of works on Agricola, published between 1819 and 1977, prepared by Sarjeant (1980) is very useful, but is overwhelmed by the 1520 – 1963 bibliography (in German) by Michaëlis et al (1971).

[5] Bandy & Bandy (p. 82) point out Agricola's ground-breaking recognition of 'mineralizing solutions' [succus lapidescens] in the formation of mineral veins.

3. The Royal Society of New South Wales Connection

As far as we are aware the Royal Society of New South Wales holds the only book copy of this work in Australia.[6] Although its source has not yet been traced an inked note on the flyleaf indicates it had been in French-speaking hands earlier. It was obtained by the Society some time prior to 1889, and has been re-bound and boxed (Branagan, 2007). The title *Opuscula* was possibly suggested by Archibald Liversidge of the Royal Society at the time the work was acquired by the Society and rebound.

With permission from the Society's then President, John Hardie, all the pages, including blanks (536 pages, containing only several 'formal' or decorative illustrations) were photographed in natural light, late 2010 – early 2011, with the assistance of Elizabeth Ellis (formerly State Library), and the Society's then Administrative Secretary, Brittany Cooper. Two missing pages were obtained later from Dr. Angela Kiesling (Bergakademie Library, Freiberg). Three copies were printed, with the view to translate into English at least some of the previously untranslated essays [to date the emphasis has been on *De ortu & causis subterraneorum*]; to examine their significance within the history of the Earth Sciences and to make the texts more readily available to English-speaking scholars. Our intention is to complete separate papers on some of these previously untranslated individual 'essays'. Some pages were quite difficult to work from as they did not reproduce well.

[6] The University of New South Wales has a microfilm copy.

4. Available Sources concerning Agricola

Hollister-Short (2000) points out the paucity of studies by English-speaking researchers about Agricola, and comments that even much of the available work in English 'is seriously flawed', although space did not allow him to do more than point out what he regarded as incorrect in that respect. He suggested that the biography (in German) by Wilsdorf (1956) had been 'scrupulously researched'. Hollister-Short's brief review pointed to important aspects of recent research on Agricola's life, mainly in French and German. We have been able to access only a limited number of these publications to date, notably works by Wilsdorf and Quellmarz (1971), Michaëlis et al (1971), Horst et al (1992), so some minor points we make are open to revision. However some reviews in English indicate a growing interest in Agricola's works among English-speaking scholars (see, e.g. Hannaway (1992) and Beretta (1999)).

Other German language biographies of Agricola's life (notably Hofman (1905), and Hartmann (1953)) are useful, but there are only brief biographical essays in English. We have relied largely on Wilsfdorf (supplemented by Prescher) in the *Dictionary of Scientific Biography*, 1985 vol. 1, 77-79; Hannaway (1992); Prescher (1994, a & b), the summary by Killy & Vierhaus (2009), but also Hoover & Hoover (1912, 1950) for the biographical information, although other sources, notably Horst et al (1992) have been useful for certain aspects of Agricola's life.

5. Agricola's Life: Social and Religious Context and Influences

Agricola was born Georg Pawer (Bauer) on 23 March 1494, one of four sons and three daughters of textile manufacturer Grigor

Pawer (his mother's name has not been identified) at Glauchau (on the right bank of the Mulde River, 12 km (7 miles) N of Zwickau, and 26 km (17 m) W of Chemnitz) (Figure 3 and Table). Zwickau is a district where there is strong mineralisation associated with a massive occurrence of serpentinite. Callenberg, a locality in that region, has been the site of recent (1952 to 1990) extensive mining of nickel occurring in a weathered serpentinite body. The region is also known for the occurrence of fine crocoite (lead chromate) specimens, first discovered at Ekaterinberg, Russia in 1786. Dundas, Tasmania, too, is known for its famous crocoite specimens.

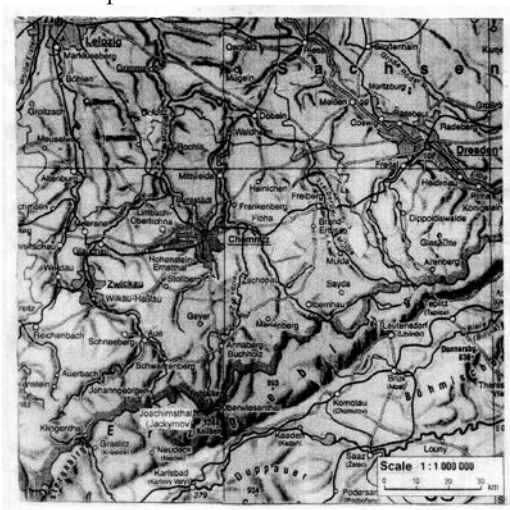


Figure 3. The Saxony region, showing localities related to Agricola's life [modified from Mitten in Sachsen pamphlet, Brand–Erbisdorf, Freiberg (n.d., ca. 1988)].

Of particular significance to Agricola's life was the turbulent religious environment in which he grew up. The long period of relative religious calm within the Holy Roman Empire was shattered by the upheaval caused by the thirty-three year old Augustinian friar and university professor, Martin Luther, when he posted his ninety-five propositions concerning the theory and practice of Indulgences on the door of the University Church, Wittenberg on All Saints' Eve (October 31, 1517), when Agricola was just twenty-three. The consequent activities of the Reformation split the Germanic region in two.

Despite growing up in what became essentially a major Lutheran stronghold, and later working at times on diplomatic missions for the Lutheran Duke Maurice**,** Elector of Saxony, whose patronage he enjoyed, Agricola clung firmly to his Catholic faith, strengthened perhaps most notably by his long-term friendship with the scholarly humanist Dutch priest, Desiderius Erasmus (1466 – 1536), whom he probably first met in Bologna. It is a tribute to the tolerance of all involved that despite his firm adherence to 'Rome', Agricola maintained the respect and long friendship of many adherents of Protestantism. However his death was purportedly brought on by apoplexy, when arguing with a Protestant divine, and his site for burial became controversial.

In the early 1520s Agricola's travels took him to Italy, where, in addition to completing his training in medicine (doctorate awarded 1523, according to Beretta, 1999), he, like so many contemporaries, became aware of the rich history and culture of classical times. He also learnt something of the art of printing in Venice, particularly through being involved there in the editing of Galen's works for publication by the Aldine Press. This work gained the praise of Erasmus, who later proofread and recommended for publication Agricola's first mining study, *Bermannus* (1530).[7]

[7] For a detailed discussion of Agricola's *Bermannus* see Morello (1994).

Table showing key events in Agricola's life

1494	Georg Pawer (Bauer), born 24 March 1494 at Glauchau
1506	Bauer family moved to Chemnitz, attended Grammar school there
1511	Bauer family moved north to Magdeburg, Agricola schooled there
1514	Bauer enrolled at Leipzig University
1518	Graduated, moved to Zwickau, teaching, studying philosophy, published Latin textbook, possibly acquired the Latin name 'Agricola' at that time
1522	Returned to Leipzig, studying medicine, physics, chemistry
1522 – 24	Travelled to Italy (mainly Bologna/Ferrara), qualified as medical doctor
1524	Moved to Venice & Padua, worked on the publication of Galen's work
1526	Returned to Zwickau
1527	Moved to Chemnitz
1527 – 1530	Moved to St. Joachimsthal (then a newly important mining centre), as medical doctor, began a detailed study (and recording) of mining
1530 – 1533	Travelled, (touring central European mining districts), but with residence at Chemnitz
1533	Returned to Chemnitz, remaining there, apart from short visits away
1546	*Opuscula* published
1555	Died 21 November, refused local burial; buried Schlosskirche, Zeitz (Halle), 45 km SW of Leipzig
1556	Agricola's last work, *De re metallica*, published posthumously

1527 was a significant year when Agricola was appointed the town physician at St. Joachimsthal[8] in Bohemia, on the south side of the Erzgebirge mountains (Figure 3). As Hannaway (1992) says, it was an unusual move for a Humanist, but it suited Agricola who was 'concerned not with eloquence or rhetoric but with the recovery of knowledge'. The presence there of the humanist schoolmaster Petrus Plateanus (1505-1551), a Brabantine, provided a supportive friendship for Agricola. It was a newly flourishing mining town, where mining on a large scale began in 1516, producing mainly silver (Urban 1980), but the miners would probably have puzzled over another 'mineral' present in the orebody. This was pitchblende, the radioactive substance which was to be the source for the important research by Pierre and Marie Curie in the 1890s (Curie et al, 1898).[9] It is highly likely that some, at least, of the miners would have been affected by radioactivity, but there is no recorded indication that Agricola had any hint of this threat to the miners' health.[10] However in the

[8] Silver from the Joachimsthal mines was the source of coinage that was named the 'thaler'. This name was taken over by Dutch banks, and from this the word 'dollar' came.

[9] Mme. P. Curie, (*Comptes rendus*, vol. 126, p. 1101) expressed gratitude to Eduard Suess, [1831 – 1914] 'Correspondent of the Institute and Professor at the University of Vienna. Thanks to his benevolent intervention, we have obtained from the Austrian government the free gift of 100 kg of a residue from the treatment of the Joachimsthal pitchblende, containing no uranium, but containing polonium and radium. This gift will greatly facilitate our researches'.

[10] For a surprisingly full detailed history of Joachimsthal mining history and the problems of radioactive minerals (including the discovery of uranium by Martin Klaproth

early pages of *De re metallica* ... while admitting that miners are sometimes killed by the 'pestilential air which they breath' or that 'their lungs rot away' Agricola gives a strong defense of the safety and value of mining.

At Joachimsthal (now Jackymov) Agricola began to take a serious interest in mining and geology during his leisure hours. He became friendly with Lorenz Wermann (ca 1490-1531/32), an earlier graduate from Leipzig, and an expert in metallurgy and mining who tutored Agricola (as probably also did Plateanus). Wermann soon appeared as the mining expert and protagonist Bermann in the Platonic-like dialogue *Bermannus sive de re metallica Dialogus [Bermannus or about matters metallic]* (1530), Agricola's first foray into publications on geology and mining, which he reissued in 1541 and in *Opuscula* five years later. Three years were apparently enough for Agricola at Joachimsthal, and he travelled extensively again, gaining experience and knowledge on mining and geological matters before settling in Chemnitz. But there are few details of these times.

Probably following on from *Bermannus,* Agricola, in 1533, announced his intention to write a larger work on metals and mining technology (essentially what finally appeared as *De re metallica*). He had apparently been thinking about such a project in 1529, and might have already begun it. However it seems to have been put aside, or only worked on slowly while other publications appeared.

Ellenberger (1988, pp. 195-196) placed Agricola's life in its regional and economic context:

> *the region of central Europe stretches from Bohemia to the Harz, embracing Saxony and Thuringia, at that time the richest in metal mines and the most advanced in mining technology. While the mineral concessions had belonged to the feudal rulers or to private capitalists, the mining communities had the use of franchises and considerable autonomy. … The Saxon (s. lat.) miner was not a convict, but a man proud of his occupation, and whose competence was recognised throughout Europe. When one speaks of mines, one speaks also of interest in the reality of the underground. Now, differing from the Greco-Roman intellectual elite, Renaissance man began to integrate the best of practical knowledge into the higher levels of knowledge. The mining knowledge of central Europe (and just a little later, of Sweden) contributed, in a decisive fashion, to the birth of modern Geology, in particular causing the theoreticians to take into consideration that the underground was a developed framework, essentially a vast underground 'architecture'* [our translation].

6. Relations with Contemporary 'Scientific' Authors

While Agricola was perhaps the best informed of the authors of the Renaissance who both studied and interpreted the works of ancient writers interested in mining and geology, he was by no means alone. However it is not appropriate in this paper to do more than touch on this subject. Suffice to mention only works such as *Pirotechnia* (1540) by Vanoccio Biringuccio (1480 – 1538?) and the later *Treatise on Ores and Assaying* (1574) by Lazarus Ercker (1528 – 1594), which deals with matters similar to those discussed by Agricola in *De re metallica*, the last-named 'justly regarded as a masterpiece of early technological writing' (Hall, 1984). Also worth mention is *The Schwazer Bergbuch*, 1556, for which see Lefèvre (2010), where the colourful illustrations bear comparison with those of Agricola's *De re metallica.* As Sprague de Camp (1963) points out, Agricola and

in 1789, its later exploitation and consequent health problems during and after WWII) see the internet site *Joachimsthal and pitchblende*, [h@g2, approved entry A1045 1099].

Biringuccio influenced each other, not an uncommon phenomenon then as now.

Dibner (1958) considered the difficulties met by Hoover & Hoover (1912, 1950), Bandy & Bandy (1955) and others in translating and understanding the many new Latin words coined by Agricola to name previously unnamed substances and mining terms**,** and to explain his ideas on numerous matters. The Hoovers had the advantage of a series of professional translators, and Herbert Hoover carried out laboratory experiments to test some of Agricola's statements (Lerud, 1995). The problems posed by Agricola's Latin were also considered in some detail by Morello (1994, p. 24). The major claim that Agricola was the first to put geology on a firm footing hinges on his abandoning speculation in favour of direct observation, as mentioned above.

7. Adam Siber and Valentin(e) Hertel, Source and Inspiration of the Elegy

The Elegy was written by Adam Siber to his friend Valentin(e) Hertel.[11] Siber (Siberius) (1516 – 1584) was born in Schönau, son of a First Reformed preacher, Stephan Siber, of that town. In 1546 Siber came from Halle to Chemnitz, and became an *Assistent* to Agricola. For a summary of Valentin(e) Hertel's life (ca 1500-1547) see Horst et al (1992). He was one of Agricola's younger friends, born at Glauchau, studying at Leipzig from 1515 and appearing as a disputant on the subject of the Triune God where he is noted as being a graduate of Leipzig**.**[12] He

Figure 4. Adam Siber. Source: Wittenberg Collection of Evangelical Preachers. No portrait of Hertel has been located.

was twice,over several periods, cantor of St Mary's Church, Zwickau, and teacher at the Latin school there. From 1539 he was Rector of the Latin School at Chemnitz where he is buried. Hoover & Hoover (1912, p. xiv) make a brief mention of letters Hertel wrote to the leading scholar Georgius Fabricius (1516 – 1571), author of the introductory 'poem' in *De re metallic*a. Following Hertel's early death Siber became Rector at Chemnitz until 1559 when he moved to Grimma, dying there on 24 September 1584. Siber was also a friend of Fabricius, and is referred to as a humanist and pedagogue. He was a teacher and minor poet whose dedication to Hertel appears not only in the prefatory section of Agricola's *De ortu et causis subterranaeorum* (1546) but also – in revised form – in his *Aeolostichon*, possibly written in 1550, and published in a collection of his works (1612). In translating the elegy we have occasionally turned to the revised edition (see Appendix) in an attempt to determine as accurately as possible the meaning of certain

[11] Hertel is not mentioned in any of the standard German biographical works such as Killy & Vierhaus *Dictionary* or Killy's *Literaturlexikon.*

[12] See the title page of *De Aere Theoremata Physica qua favente & fovente Deo Triuno*, a debate between M. Georgius Gölner and Valentino Hertelio. Published Leipzig, 1620.

fairly abstruse couplets. Siber (Siberius) (Figure 4) is much better known than Hertel.

8. Siber's Elegy and its Structure

In addressing the 'Signal to Noise Ratio' of this paper's title we now consider and translate the introductory Elegy to Agricola's *De ortu et causis subterraneorum*.

We are quite struck by the sentiments expressed by Siber, who was clearly an admirer of Agricola. Siber was apparently satisfied enough with the elegy to have it reprinted, with modifications, some years later with other of his poetical works, as mentioned above. In comparing Agricola with other writers Siber recognised the natural human desire to burst into print, but lamented the prevalence of psitticistic mediocrity in contemporary writing and rejoiced in Agricola's original work.

Many earlier writers on bookishness and scribbling have decried writing that is obsessive, vainglorious, or lacking in lucidity; writing that is a vehicle for vanity and even an impediment to the spread of knowledge, motivated purely by vanity. Several such are quoted here:

qui de contemnanda Gloria libros scribunt, nomen suum inscribum
[those writing books about the duty of despising glory, [don't forget to] inscribe their own name (on the title page)]. [Cicero (*Tusc. Disp.*, 1, 15)]

Catullus, too, criticised the 10,000 lines written by Suffenus on royal papyrus:

neque idem umquam / aeque est beatus ac poema cum scribit / tam gaudet in se tamque se ipse miratur
[he is never so happy as when writing poetry, so much does he delight in and admire himself]. [Catullus 22: 15 – 21.]

The Latin elegy is a form that imposes considerable constraints upon the poet because of its metrical requirements: that is to say, it is to comprise a series of couplets each of which has the first line in hexameter and the second line in pentameter, with each pentameter consisting of two halves of two and a half feet each (see below). These criteria proved quite challenging to Siber with the result that several couplets seem clumsily constructed and, ironically, their meaning also consequently becomes by no means crystal clear. For these reasons our translation is a free one.

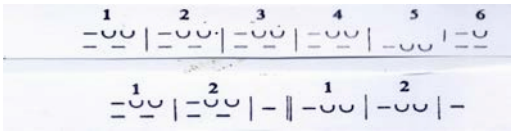


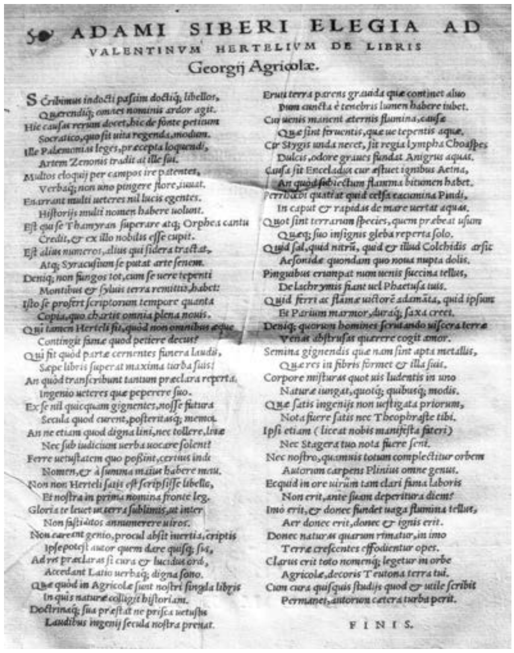
Figure 5. Latin Elegy metrical requirements

Siber's Elegy – dedicated to Hertel – consists of forty-one couplets. The first fifteen directly relate to our title, S*ignal to Noise Ratio*, in that the poet laments the proliferation of worthless works that produce nothing that has clarity and meaning. Couplets sixteen to nineteen list the requirements for good writing and express the hope that (like Agricola) Hertel will distinguish himself by producing, through diligent and painstaking effort, work that will justly earn him praise. The three following couplets offer a paean to Agricola whose work is rightly to be valued. Then couplets twenty three to thirty three introduce a list of the many contributions Agricola has made to the current body of knowledge of mineralogy. The couplets take the form of indirect questions and outline the many solutions to age-old questions that Agricola developed

through direct observation and careful recording.

Throughout this section, and indeed, through the entire elegy, Siber liberally resorts to literary allusions the better to illustrate how effectively Agricola demolishes mythical explanations for the earth's phenomena. There follow three couplets remarking on the lack of knowledge displayed by the eminent thinkers Theophrastus author of 'On Stones …', Aristotle and even Pliny the Elder (a major source for Agricola), and then four couplets (thirty seven to forty) constituting an accolade to the value and deserved permanence of Agricola's work. The final couplet validates the choice of title for our paper: so much that is worthless simply fades away, while Agricola's signal is received loud and clear.

Although such introductory poems are relatively infrequent in 'geoscience' publications, there are several such in Agricola's works, this one in *De ortu* … and that in *De re metallica.* The Hoovers (1912) dismiss Fabricius' relatively long introductory poem to *De re metallica*, written in 1551, as 'of little intrinsic value' and 'not poetry of a very high order' and they simply reproduce it in Latin. However we believe that the elegy introducing *De ortu* … is a legitimate object of study, and deserves translation and comment, being a window into the intellectual climate of the times, and showing many of the links between Agricola and his ancient sources.[13]


ADAMI SIBERI ELEGIA AD VALENTINVM HERTELIVM DE LIBRIS Georgij Agricolæ.

Scribimus indocti passim doctiq; libellos,
Quærendiq; omnes nominis ardor agit.
Hic causas rerum docet, hic de fonte petitum
Socratico, quo sit uita regenda, modum.
Ille Palemonias leges, præcepta loquendi,
Artem Zenonis tradit at ille sui.
Multos eloquij per campos ire patentes,
Verbaq; non uno pingere flore, iuuat.
Enarrant multi ueteres nil lucis egentes.
Historijs multi nomen habere uolunt.
Est qui se Thamyran superare atq; Orphea cantu
Credit, & ex illo nobilis esse cupit.
Est alius numeros, alius qui sidera tractat,
Atq; Syracusium se putat arte senem.
Deniq; non fungos tot, cum se uere tepenti
Montibus & syluis terra remittit, habet:
Illo se profert scriptorum tempore quanta
Copia, quo chartis omnia plena nouis.
Qui tamen Herteli fit, quòd non omnibus æque
Contingit famæ quod petiere decus?
Qui fit quòd partæ cernentes funera laudis,
Sæpe libris superat maxima turba suis?
An quòd transcribunt tantum præclara reperta,
Ingenio ueteres quæ peperere suo.
Ex se nil quicquam gignentes, nosse futura
Secula quod curent, posteritasq; memor.
An ne etiam quod digna lini, nec tollere, litæ
Nec sub iudicium uerba uocare solent?
Ferre uetustatem quo possint, certius inde
Nomen, & à summa maius habere manu.
Non non Herteli satis est scripsisse libello,
Et nostra in prima nomina fronte leg.
Gloria te leuet ut terra sublimis, ut inter
Non fastiditos annumerere uiros.
Non careant genio, procul absit inertia, scriptis
Ipse potest autor quem dare quisq; suis,
Ad res præclaras si cura & lucidus ord,
Accedant Latio uerbaq; digna sono.
Quæ quòd in Agricolæ sunt nostri singula libris
In quis naturæ colligit historiam.
Doctrinaq; sua præstat ne prisca uetustas
Laudibus ingenij secula nostra premat.
Eruta terra parens grauida quæ continet aluo
Diim cuncta è tenebris lumen habere iubet.
Cur uenis manent æternis flumina, causæ
Quæ sint feruentis, quæ ue tepentis aquæ,
Cur Stygis unda necet, sit regia lympha Choaspes
Dulcis, odore graues fundat Anigrus aquas.
Causa sit Enceladus cur æstuet ignibus Aetna,
An quod subiectum flamma bitumen habet.
Perpetuò quatiat quid celsa cacumina Pindi,
In caput & rapidas de mare uertat aquas.
Quot sint terrarum species, quem præbeat usum
Quæq; suo insignis gleba reperta solo.
Quid sal, quid nitrū, quid & illud Colchidis arsit
Aesonidæ quondam quo noua nupta dolis.
Pinguibus erumpat num uenis succina tellus,
De lachrymis fiant uel Phaetusa tuis.
Quid ferri ac flāmæ uictorē adamāta, quid ipsum
Et Parium marmor, duraq; saxa creet.
Deniq; quorum homines scrutando uiscera terræ
Venas abstrusas quærere cogit amor.
Semina gignendis quæ nam sint apta metallis,
Quæ res in fibris formet & illa suis.
Corpore misturas quot uis ludentis in uno
Naturæ iungat, quotq; quibusq; modis.
Quæ satis ingenijs non uestigata priorum,
Nota fuere satis nec Theophraste tibi.
Ipsi etiam (liceat nobis manifesta fateri)
Nec Stagera tuo nota fuere seni.
Nec nostro, quamuis totum complectitur orbem
Autorum carpens Plinius omne genus.
Ecquid in ore uirūm tam clari fama laboris
Non erit, ante suam deperitura diem?
Imò erit, & donec fundet uaga flumina tellus,
Aer donec erit, donec & ignis erit.
Donec naturas quarum rimatur, in imo
Terræ crescentes effodientur opes.
Clarus erit toto nomenq; legetur in orbe
Agricolæ, decoris Teutona terra tui.
Cum cura quisquis studijs quod & utile scribit
Permanet, autorum cætera turba perit.

FINIS.

Figure 6. The Latin text of the Elegy (page 2 of our copy of De ortu . . . .)

[13] Schmidt (1995a) lists some of the ancients which Agricola used. They include Aristotle, Theophrastus, Epicurus, Strabo, Seneca and Pliny the Elder; Arabic authors and mediaeval authors such as Dietmar von Mersburg, Elke von Repow and numerous contemporary writers.

9. A more legible form of the elegy

Adam Siberi elegia ad Valentinum Hertelium de libris Georgius Agricolae

1 Scribimus indocti passim doctique libellos,
Quaerendique omnes nominis ardor agit.

2 Hic causas rerum docet, hic de fonte petitum
Socratico, quo sit vita regenda, modum.

3 Ille Palaemonias leges, praecepta loquendi,
Artem Zenonis tradit at ille sui.

4 Multos eloquii per campos ire patentes,
Verbaque non uno pingere flore, iuvat.

5 Enarrant multi veteres nil lucis egentes.
Historiis multi nomen habere volunt.

6 Est qui se Thamyran superare atque; Orphea cantu
Credit, et ex illo nobilis esse cupit

7 Est alius numeros, alius qui sidera tractat,
Atque Syracusium se putat aete senem.

8 Denique non fungos tot, cum se vere tepenti
Montibus et sylvis terra remittit, habet;

9 Isto se profert scriptorum tempore quanta
Copia, quo chartis omnia plena novis.

10 Quid tamen Herteli fit, quod non omnibus aeque
Contingit famae quod petiere decus?

11 Quid sit quod partae cernentes funera laudis,
Saepe libris superat maxima turba suis?

12 An quod transcribunt tantum praeclara reperta,
Ingenio veteres quae peperere suo.

13 Ex se nil quicquam gignentes, nosse futura
Secula quod curent, posteritasque, memor.

14 An ne etiam quod digna lini, nec tollere, limae
Nec sub iudicium verba vocare solent?

15 Ferre vetustatem quo possint, certius inde
Nomen, et a summa maius habere manu.

16 Non non Herteli satis est scripsisse libellos,
Et nostra in prima nomina fronte legi.

17 Gloria te levet ut terra sublimis, ut inter
Non fastiditos annumerere viros.

18 Non careant genio, procul absit inertia scriptis
Ipse potest autor quem dare quisquam suis.

19 Ad res praeclaras si cura et lucidus ordo,
Accedant Latio verbaque; digna sono.

20 Quae quod in Agricolae sunt nostri singula libris
In quis [quibus?] naturae colligit historiam.

21 Doctrinaque sua praestat ne prisca vetustas
Laudibus ingenii secula nostra premat.

22 Eruta terra parens gravida quae continet alvo
Dum cuncta e tenebris lumen habere iubet.

23 Cur venis manent aeternis flumina, causae
Quae sint ferventis, quae ve tepentis aquae.

24 Cur Stygis unda necet, sit regia lympha Choaspes
Dulcis, odore graves fundat Anigrus aquas.

25 Causa sit Enceladus cur aestuet ignibus Aetna,
An quod subiectum flamma bitumen habet.

26 Perrhoebi quatiat quid celsa cacumina Pindi,
In caput et rapidas de mare vertat aquas.

27 Quot sint terrarum species, quem praebeat usum
Quaeque suo insignis gleba reperta solo.

28 Quid sal, quid nitrum, quid et illud Colchidis arsit
Aesonidae quondam quo nova nupta dolis.

29 Pinguibus erumpat num venis succina tellus,
De lachrymis fiant vel Phaetusa tuis.

30 Quid ferri ac flammae victorem adamanta, quid ipsum
Et Parium marmor, duraque saxa creet,

31 Denique, quorum homines scrutando viscera terrae
Venas abstrusas quaerere cogit amor.

32 Semina gignendis quae nam sint apta metallis,
Quae res in fibris formet et illa suis.

33 Corpore misturas quot vis ludentis in uno
Naturae iungat, quotque quibusque modis.

34 Quae satis ingeniis non vestigata priorum,
Nota fuere satis nec Theophraste tibi.

35 Ipsi etiam (liceat nobis manifesta fateri)
Nec Stagera tua nota fuere seni.

36 Nec nostro, quamvis totum complectitur orbem
Autorum carpens Plinius omne genus.

37 Ecquid in ore virum tam clari fama laboris
Non erit, ante suam deperitur a diem?

38 Imo erit, et donec fundet vaga flumina tellus,
Aer donec erit, donec et ignis erit.

39 Donec naturas quarum rimatur, in imo
Terrae crescentes effodientur opes.

40 Clarus erit toto nomenque legetur in orbe
Agricolae, decoris Teutona terra tui.

41 Cum cura quisquis studiis quod et utile scribit
Permanet, autorum caetera turba perit.

10. English Translation of Adam Siber's Elegy to Valentin(e) Hertel on the Works of Agricola

1) Learned or not we freely write books;[14]
The passion for celebrity drives us all.

2) One teaches the causes of things, another the Socratic[15] way:
How our life ought to be directed.

3) Another propounds Palaemon's laws,[16] the precepts of discourse;
But he passes on the arts of his mentor, Zeno. [17]

4) Many are delighted to pass through the fields of eloquence[18]
And to compose in a florid style.

5) Many, not lacking in esteem,[19] expound the ancients;
Seeking a name in history books.

6) There's the lyricist who, with his crowing, deems himself superior to Thamyris[20] and Orpheus,[21]
And craves fame on that account.

7) There is one who deals with numbers – another with stars;
One who, indeed, regards himself a veritable Archimedes.[22]

8) In point of fact one sees fewer mushrooms sprouting
In the spring-warmed earth of mountains and woods,[23]

---

[14] A direct quote from Horace, *Epistle* 2: 1, 117.
[15] Socrates (469– 399 BC) wrote nothing himself, but his ideas have come down to us – however accurately – through his interpreters, Plato (c. 427 – 347) and Xenophon (c. 430 – c. 355 BC). His concern seems to be that intellectual investigation leads to happiness; 'the unexamined life is not worth living'. For footnotes on the ancients see Harvey (1937) and Howatson (1989).
[16] Quintus Remmius Palaemon (fl. Ist century AD): grammarian and teacher at Rome under Tiberius and Caligula. An interesting account of him exists in Suetonius *De Grammaticis,23.1,45-47.*
[17] A follower of Parmenides in the Eleatic school of philosophy, Zeno pointed out the paradoxical views on space and time held by the supporters of other philosophical doctrines.
[18] The phrase '*per campos ire patentes*' occurs in Book 1, line 386 of *De Arte Poetica* (1527) by the Italian humanist and poet, Marco Vida (1485?-1566)).
[19] The phrase *nil lucis egentes* appears in Bk. 6**.** of Vida's – *Christiados libri sex* (The Christiad in Six Books); we ponder Siber's originality.
[20] A legendary poet and musician who, in a contest at Delphi, won with his hymn in honour of Apollo. According to Homer, he met the Muses at Dorion and challenged them in song. In a jealous rage, the Muses deprived him of his gifts.
[21] A legendary pre-Homeric poet whose lyre-playing held wild beasts spellbound by his music. In Hades he succeeded, by the power of his music, in having his dead wife, Eurydice, released but on the condition that he not once look back to see if his wife were following. Forgetting his promise his wife vanished forever.
[22] Referred to as the Syracusan in this elegy, Archimedes (c.287 -212BC) was one of the greatest mathematicians (an astronomer and an inventor in physics and mechanics) of antiquity.

9) So great now is the plethora of authors
That the writers' world is weighed down by new works.

10) What is the point of it all, Hertel?
Hoped-for distinction eludes most of them.

11) What do we make of them demolishing established reputations
While complete confusion often dominates their own works?

12) Or that their 'distinguished' discoveries merely copy
Those the ancients achieved by their own ability.

13) Bear in mind they themselves are producing nothing
That future ages and thoughtful posterity would care to remember.

14) Though such works deserve to be erased
The authors regularly fail to hide them or submit them to crticism.

15) The pedants display their knowledge of antiquity
The better to be named by the most exalted writers.

16) Hertel, it is not good enough to have written books
Just for our names to be visible right there on the front page.

17) May distinguished work exalt you
To be numbered among men of reputation.

18) Such men should have talent and be diligent in their writings.
Such abilities are manifest in every leading authority.

19) If painstaking and methodical and writing in elegant Latin
They are equipped to engage with noble themes.

20) The fact is, all these qualities are characteristic of Agricola's works
Where he compiles an account of Nature.[24]

21) So pre-eminent is his learning that
Sages' ancient doctrines do not eclipse current knowledge[25]

---

[23] The revised version of the elegy (1612) clarifies the meaning of this and several other difficult couplets. Perhaps consideration of Virgil's Georgics, Bk II, 218 'ex se ipsa remittit' may validate our fairly loose translation. Perhaps, too, since fungus can have the meaning of dolt, Siber is saying that there seem to be more dolts than there are mushrooms in Spring.

[24] Siber may be suggesting that there is, among so many contemporary writers, no practice of ideas being submitted to critical discussion: what today we would call peer review.

22) As he sheds light on all those mineable substances
That Mother earth holds in her laden interior:[26]

23) Why subterranean streams perpetually flow,
What the causes are of boiling or of lukewarm water

24) Why the water of the Styx[27] is deadly, the sacred Choaspes[28] sweet,
And why the Anigros[29] is malodorous;

25) Whether Enceladus[30] be the reason for Aetna's seething fire
Or whether the flame has bitumen in its thrall;

26) What shakes the high peaks of Thracian Pindus[31]
And turns rushing water from sea to river mouth;

27) How many are the kinds of earth, and what their uses,
Each sample has now its particular category;

28) What is salt, what is trona,[32]
How did Medea[33] deceitfully set Jason's new bride ablaze**,**

29) Can the earth vent forth amber from her rich veins
Or is it made, Phaetusa,[34] from your tears?

---

[25] The revised version is different: *if anyone denies that these qualities reside in Agricola's works / Would you not think him lacking in judgment?*

26 At this juncture Siber inserts in his later version a couplet not present in the text from which we are working: *And with Ciceronian phrasing he clarifies / What formerly was hidden out of sight.*

[27] In Greek mythology, the river Styx is the main river of the underworld. Here, it would seem to refer to a small river in what is now Chelmos. Men would swear oaths on its waters which were thought to have some deadly property.

[28] The Choaspes is a river remarkable for its pure water, said to be drunk by Persian kings. It is in what is now Kerrah (or Kerkhah or Kara-su).

[29] The Anigros is a river rising on Mauropotamo; its waters were muddy and unpleasant in smell.

[30] Enceladus was, in Greek mythology, one of a group of monstrous giants who attacked the gods and were defeated. As punishment, they were imprisoned in the earth. In the case of Enceladus, he was confined under Mt Etna.

[31] Pindus is a lofty mountain in Thessaly close to the reputed home of the Muses.

[32] Trona is a native hydrated double salt of sodium carbonate and sodium bicarbonate, occurring especially as an evaporite.

[33] Medea is referred to as Colchis after the province Colchis in Asia, east of the Black Sea: the setting for the story of Jason and the Golden Fleece. When Jason rejects Medea and takes another wife, Medea uses her magical skills to create a cloak which – given as a present to the new bride – bursts into flames as soon as it is placed on the wearer. In this elegy, Jason is referred to as Aesonides, a descendant of Aeson. In the legend, Medea had earlier used her magical potions to restore youthful vigour to Aeson – Jason's aging father.

[34] Phaetusa was, in Greek mythology, the daughter of Phoebus and sister of Phaeton. When Phaeton crashes to earth after losing control of his father's chariot, his body is finally found by his mother and his sisters, one of whom is Phaetusa. She and her sisters weep so profoundly over his body that, as they lie on the ground, they are transformed into trees. Their distraught mother tears at the trees in an effort to release their bodies causing drops like blood to trickle from the wounds. The bark closes over the wounds, hardening the tears into amber (Ovid, *Metamorphoses*, Bk. II, 330-366).

30 How flame and iron produce the conquering steel;
What brings about hardy rocks, especially Parian marble.[35]

31) Natural strong interest in such matters
Drives men to examine Earth's interior, seeking mineral veins:

32) What are the essentials for generating metals;
What substances form in stringers and what seeds them;

33) How many compounds does capricious Nature combine in one body
By however many and whatever possible ways;

34) These matters, not sufficiently traced by the intellects of the ancients
Were not even known adequately to you, Theophrastus.[36]

35) May we be permitted to speak the obvious?
Nor were these things known to your old Stageran[37] himself.

36) Nor, in our time were they known to Pliny[38]
Although he embraces the whole world, grazing over every type of author

37) Surely the reputation of [Agricola's] so distinguished a work
Will not perish in the sight of men before its time.

38) On the contrary, his reputation will endure
As long as the earth's rivers flow, as long as there's air and fire.

39) As long as he examines the nature of these phenomena
Increasing riches of the earth will come from deep below.

40) Famous he will be and, through the entire world,
The name of Agricola – your adornment, oh Teuton land – will be read.

41) One who cares for scholarship, writing what is useful, survives;
Mediocre scribblers sink without trace.

---

[35] Parian marble is found in Paros, one of the Cyclades, and is renowned for its beauty and fineness. Paros (now Paro) was the birthplace of the poet Archilochus.

[36] Theophrastus (c.371-c. 287 BC) was a pupil and friend of Aristotle and his successor as head of the Peripatetic school of philosophy.

[37] Here, Aristotle is referred to as Stagera, a town in Macedonia where he was born.

[38] Pliny the Elder (23 or 24 – 79 AD) was a man thirsty for knowledge. His greatest achievement is the *Naturalis Historia* in thirty seven books, dedicated to the future emperor Titus in 77. He perished in the great eruption of Vesuvius in 79. His nephew, Pliny the Younger, wrote an account of his uncle's fatal trip to investigate the smoke coming from the mountain.. See also Holland (1962). The phrase 'our times' is perhaps used by Siber to distinguish AD writers from those of the BC era.

11. Conclusions

From our own translations of both Agricola's *De ortu & causis subterraneorum* (a work in progress) and Siber's elegy, the authors have formed the strong conviction that Agricola was an outstanding applied scientist who had a coherent vision and a clear *modus operandi*. In every age there are learned people of such ability as to rise above the scribbling crowds peerlessly and effortlessly and to be justifiably esteemed. We found Siber's elegy of great interest because - like other dedicatory elegies – it reflects the thoughts and attitudes of a key part of the subject's audience: friends and supporters. Within the lines, one detects a strong exhortatory tone: Hertel should emulate Agricola's rigor and clarity if he wishes to attain lasting recognition. Of particular interest is the fact that Siber chooses to underpin his paean to Agricola and his work with a condemnation of communication characterised by anything that makes a work obfuscatory: vainglory, carelessness, or plagiarism. For this reason we consider the scientific term Signal to Noise Ratio an appropriate title for this paper: Agricola's signal is received loud and clear.

Acknowledgements

We particularly thank the two anonymous referees who pointed out the deficiencies of the original version of this paper. While we have accepted many of their positive suggestions we have retained a largely unaltered title and, through a re-arrangement of text. have focussed early on the appropriate meaning of this title.

We acknowledge the valuable help of the Royal Society of New South Wales, notably former President John Hardie, former Administrative Secretary, Brittany Cooper and present Administrative Secretary, Emma Dallas giving access to the *Opuscula* volume; The Library of the University of Sydney for organising inter-library loans from interstate and international bodies; the Universities of New South Wales and Melbourne for access to publications; discussion with Dr. David Daintree, formerly Campion College, on Latin texts; Elizabeth Ellis for knowledgeable assistance in photographing the *Opuscula* volume; Wikki Raymonde, University of Neuchatel Library Switzerland; Angela Kiesling, Bergakademie Library, Freiburg; and Julie Sweeten, State Library of New South Wales for locating published and unpublished sources.

References

Adams, F.D. 1938. *The Rise and Development of the Geological Sciences*. Dover, NewYork.

Aldrich, Michele L., Leviton, Alan E. and Sears, Lindsay, 2009. Geogius Agricola. De amantibus subterraneis, 1549 and 1556. A Translation of a Renaissance Essay in Zoology and Natural History. *Proceedings of the California Academy of Sciences*. Fourth Series **60** (9), 89 – 174. 5 figures,1 Table.

Bandy, M.C. & Bandy, Jean A., 1955. *De Natura Fossilium* (Textbook of Mineralogy). Geological Society of America Special Paper **63** (Dover Reprint, 2004).

Baumgarten-Crusius, D.C.W., 1845. *Georgii Fabricii Chemnicensis Epistolae ad W. Meurerum et alios Aegualis*. Leipzig [(p. 85, letter No. 93)].

Beretta, M.,1999. Georgius Agricola. In Grendler, Paul F. (editor-in-chief) *Encyclopedia of the Renaissance*, **1**. Charles Scribner's Sons, New York, 17-18.

Bork, R., (editor), 2005. De Re Metallica: The Uses of Metal in the Middle Ages. *AVISTA*

Studies in the History of Medieval Technology, Science and Art Vol. **4**. Ashgate, Aldershot, UK.

Branagan, D.F., 2007. The Royal Society of New South Wales: Report on the Cultural, Historical and Scientific Significance of the Society's Library and its state of preservation. *Journal and Proceedings of the Royal Society of New South Wales*, **139**, 101 – 123.

Connolly, D.E., 2005. Ulrich Rúlein von Kalbe's Bergbüchlein in the context of Sixteenth-century German Mining / Metallurgical Literature. In Bork, R., (editor), 2005. De Re Metallica: The Uses of Metal in the Middle Ages. *AVISTA Studies in the history of Medieval Technology, Science and Art* Vol. **4**. Ashgate, Aldershot, UK, 347 – 366.

Curie, P., Mme. P. Curie and G. Bémont, 1898. Sur une nouvelle substance fortement radio-active contenue dans la pechblende," *Comptes rendus de l'Académie des Sciences,* Paris, (1898, 26 Decembre), **127**, 1215-1217. [See also Translation by Alfred Romer, in A. Romer, (editor), 1970. *Radiochemistry and the Discovery of Isotopes* (Dover: New York)].

Davies, G.H., 1968. *The Earth in Decay: A History of British Geomorphology 1578 – 1878*. Macdonald Technical and Scientific, London.

Dibner, B., 1958. *Agricola on Metals*. Burndy Library, Norwalk, Connecticut.

Ellenberger, F. 1988. *Histoire de la Geologie* (vol. 1). Technique et Documentation – Lavoisier. Paris.

Eyles, Joan M., 1955. Georgius Agricola (1494 – 1555). *Nature*, **176**, 949-950, Nov. 19, 1955.

Glover, J (edited Jenny Bevan), 2003. *Geological Journeys: from Artifacts to Zircon*. Geological Society of Australia (Western Australiia Division), Perth.

Hall, A. Rupert, 1984. *The revolution in Science 1500 –1750*. Longman, London.

Halleux, R. and Yans, A. 1990. *Bermannus (le mineur): Un dialogue sur les mines*. Belle Lettres: Paris.

Hannaway, O., 1992. Georgius Agricola as Humanist. *Journal of the History of Ideas*, **53** (4, October-December), 553-560.

Hartmann, H., 1953. *Georg Agricola, 1494 – 1555: Begründer dreier Wissenschaften*. Mineralogie-Geologie-Bergbaukunde, Stuttgart.

Harvey, Sir Paul, (compiler and editor), 1937. *The Oxford Companion to Classical Literature* (First edition), Oxford University Press, Oxford.

Hofman, R., 1905. *Dr. Georg Agricola*. Perthes: Gotha.

Holland, P., (edited P. Turner), 1962. *The Natural History of c. Plinius Secundus Pliny*. McGraw Hill, New York.

Hollister-Short, Graham, 2000. Agricola, Georgius 1494-1555 German humanist and scientist. In Arne Hassenbruch (editor), *Readers Guide: The History of Science*. Fitzroy Dearborn Publications, London & Chicago, 18-20.

Hoover, Herbert, C. & Hoover, Lou H., (translaters), 1912. *Georgius Agricola: De Re Metallica*. The Mining Magazine, London, (reprinted 1950, Dover, New York).

Horst, U., Prescher, H. and Fraustadt, G. (editors), 1992. *Georgius Agricola: Briefe und Erkunden*. Georgius Agricola – Ausgewählte

Werke, **IX**. Hüthig Verlagsmeinschaft Heildelberg: Berlin.

Howatson, M. C., (editor), 1989. *The Oxford Companion to Classical Literature* (Second edition), Oxford University Press, Oxford.

Killy, W., 1988-1993. *Literaturlexikon: Autoren & Werke Deutsche Sprache*. Bertelsmann Lexikon Verlag, 15 vols.

Killy, W. & Vierhaus, R. (Editors in Chief), 2009. *Dictionary of German Biography*, vol. **1**. K.G. Saur, Munchen, 52 – 54.

Lefèvre, Wolfgang. 2010. *Preprint 407*. Annual Meeting Renaissance Society of America, Venice, April 8-11, 2010.

Lerud, J. 1995. Herbert Hoover – mining engineer, translater of *De re metallica*. **In** Schmidt, P., (editor) 1995b. *International Newsletter: The Cultural Heritage of Libraries concerned with Geosciences, Mining and Metallurgy*, Volume **1** (1994)). Freiberg (Sachsen), 40 – 42.

Michaëlis, R., Prescher, H & Horst, U., 1971. *Agricola – Bibliographie 1520 – 1963*. Ausgewählte Werke, **X**. Deutscher Verlag der Wissenschaften, Berlin.

Morello, N., 1994. Bermannus – the names and the things. In Neumann, F. (1994), *Georgius Agricola – 500 Jahre: Wissenschaftliche Konferenz vom 25-25 Marz 1994 in Chemnitz, Freistaat Sachsen*, pp. 73 – 81**.**

Morello, N., 2006. Agricola and the birth of the mineralogical sciences in Italy in the sixteenth century. In Vai, G.B. & Caldwell, W.G.E., (eds.) *The Origins of Geology in Italy*. The Geological Society of America, Special Paper **411**, 23 –30.

Mottana, A., 2006. Italian gemology during the Renaissance: A step toward modern mineralogy. In Vai, G.B. & Caldwell, W.G.E., (eds.) *The Origins of Geology in Italy*. The Geological Society of America, Special Paper **411**, 1–21.

Neumann, F. (editor), 1994. *Georgius Agricola – 500 Jahre: Wissenschaftliche Konferenz vom 25-25 Marz 1994 in Chemnitz, Freistaat Sachsen*. Birkhauser, Basel, Boston, Berlin.

Oldroyd, D., 1996. *Thinking about the Earth*. Athlone, London.

Prescher, H., 1994a. Georgius Agricola – ein sächisher Humanist und Naturforscher von Europpäischer Bedeutung. In Neumann, F. 1994). *Georgius Agricola – 500 Jahre: Wissenschaftliche Konferenz vom 25-25 Marz 1994 in Chemnitz, Freistaat Sachsen,*

Prescher, H., 1994b. Dr. Georgius Agricola 1494-1555, A European Scientist and Humanist from Saxony. *Geojournal* **32** (2), 85-89.

Sarjeant, W.A.S., 1980. Agricola, Georgius In *Geologists and the Hitory of Geology: An International Bibliography from the Origins to 1978*. vol. **2:** The Individual Geologists, A – K. Arno Press, New York 402-405.

Schmidt, P., 1995a. Georgius Agricola (1494 – 1555), books and libraries. In Schmidt, P., (editor) 1995. *International Newsletter: The Cultural Heritage of Libraries concerned with Geosciences, Mining and Metallurgy*, Volume **1** (1994)). Freiberg (Sachhsen), 38 – 40.

Schmidt, P., (editor) 1995b. *International Newsletter: The Cultural Heritage of Libraries concerned with Geosciences, Mining and Metallurgy*, Volume **1** (1994)). Freiberg (Sachsen), 84pp.

Siems, P.L., 2005. In Bork, R. (editor), De Re Metallica: The Uses of Metal in the Middle Ages, *AVISTA Studies in the history of Medieval Technology, Science and Art,* Vol. **4**. Ashgate, Aldershot, UK, pp. 367 – 385.

Sprague de Camp, L., 1963. *Ancient Engineers.* Tandem, London.

Urban, J., 1980. On the History of Geological Mapping in Czeckoslovakia. *Annals of Science* **37,** 413 – 432.

Vai, G. & Caldwell, G.E. (eds), 2006. *The origins of Geology in Italy*. Geological Society of America, Special Paper **411**, 223, pp.

Vai, G. & Cavazza, W., 2003. *Four Centuries of the word GEOLOGY: Ulisse Aldrovandi 1603 in Bologna.* Minerva Edizioni, Bologna.

Wilsdorf, H., 1956. *Georgius Agricola und seine Zeit mit einem Geleitwort von Friedrich Leutwein und einem anhang: Georgius Agricola's Werke.* Ausgewählte Werke **I**, Deutsche Verlag der Wissenschaften, Berlin.

Wilsdorf, H., 1970. Agricola, Georg. In Gillespie, C.C., Editor-in-Chief. *Dictionary of Scientific Biography*. Charles Scribner's Sons, New York, Vol **1**, 77-79.

Wilsdorf, H. and Quellmarz, W., 1971. Bergwerke und Hüttenanlagen der Agricola Zeit. Ergänzungsband **1**. Deutsche Verlag der Wissenschaften, Berlin.

Appendix: Siber's Revised Version of the Elegy (c. 1550)

Scribimus indoctri passim doctique libellos,
Quaerendique omnes nominis ardor agit.

Explicat hic rerum caussas: hic fonte petitum
Socratico, quo fit vita regenda, modum:

Ille Palaemonias leges: praecepta diferti
Zenonis pressa monstrat at ille manu:

Eloquii multos per campos ire patenteis,
Verbaque non uno pingere flore iuvat:

Enarrant multi veteres, nil lucis egentes:
Historiis multi nomen habere volunt:

Est qui se Thamyran superare, atque Orphea cantu
Credit et ex illo nobilis esse cupit:

Est alius numeros, alius qui sidera tractat,
Atque Syracusium se putat arte senem.

Denique non fungos tot, cum se vere tepenti
Montibus et sylvis terra remittit, habet:

Se profert isto scriptorum tempore quanta
Copia, quo libris omnia plena novis.

Quid tamen Herteli, quid fit, non omnibus aeque
Ut veniat famae, quod petiere, decus?

Non raro partae cernentes funera laudis,
Et superet libris maxima turba suis?

An quod transcribunt tantum praeclara reperta,
Ingenio veteres quae peperere suo?

Nil ex se quidquam gignentes, nosse futura
Secula quod curent, posteritasque memor.

An ne etiam, quod digna lini nec tollere, limae
Nec sub iudicium verba vocare solent?

Ferre vetustatem quo possint, certius inde
Nomen, et a summa maius habere manu.

Non satis, Herteli, non est scripsisse libellos,
Indicet ut titulum pagina prima tuum:

Gloria te levet ut terra sublimis, et inter
Non fastiditos ut numerere viros:

Non careant genio: procul absit inertia scriptis
Ipse potest autor quem dare quisque suis;

Ad res praeclaras, si curo et lucidus ordo,
Accedant Latio verbaque digna sono.

Quae neget Agricolae monumentis si quis inesse,
An non iudicio iure carere putes?

Agricolae, qui nunc praestans ne docta vetustas
Laudibus ingenii secula nostra premat:

Ingressus terrae latebras, Plutonia regna,
Audax, naturae perficit historiam.

Et Ciceroneo sermonis lumine, clara,
Occultata prius quae latuere, facit.

Aeternis manent cur venis flumina, caussae
Quae sint ferventis, quaeve tepentis aquae.

Cur Stygis unda necet, sit regia lympha Choaspes,
Dulcis odore graveis fundant Anigrus aquas.

Caussa sit Enceladus cur aestuet ignibus Aetna:
An quod subiectum flamma bitumen habet.

Perrhoebi quatiat quid celsa cacumina Pindi,
In caput et rapidas de mare vertat aquas.

Quot sint terrarium species, quem praebeat usum
Quaeque suo insignis gleba reperta solo.

Quid sal, quid nitrum: quid et illud, Colchidos arsit
Aesonidae quondam quo nova nupta dolis.

Pinguibus erumpat num venis succina tellus,

Illa fluant lachrumis an Phaetusa tuis.

Quid ferri ac flammae victorem adamanta, quid ipsum
Et Parium marmor, duraque saxa creet.

Denique quorum hominess scrutando viscera terrae,
Venas abstrusas quaerere cogit amor:

Semina gignendis quaenam sint apta metallis,
Quae res in fibris formet et illa sui

Corpore misturas quot vis ludentis in uno
Naturae iungat, quotque quibusque modis.

Quae satis ingeniis non vestigata priorem
Nota fuere satis nec Theophraste tibi.

Ipsi etiam (liceat nobis manifesta fateri)
Nec Stagera tuo nota fuere Sopho.

Nec nostro, quamvis totum complectitur orbem,
Autorum carpens Plinius omne genus.

Et fore quis putet, ut tam pulchri fama laboris
Obscura ante suum fit peritura diem?

Non ita: sed donec fundet vaga flumina tellus,
Aer donec erit, donec et ignis erit:

Donec naturas quarum rimatur et ortus,
Quas gignit tellus effodientur opes:

Clarus erit, toto nomenque legetur in orbe
Agricolae, decoris Theutona terra tui.

Cum cura, studiis quicunque quod utile, scribit,
Permanet: autorum caetera turba perit.

D.F. Branagan is an Honorary Associate, School of Geosciences, University of Sydney, where he was formerly Associate Professor. His main field of research is presently in the History of Geology.

D.W. Emerson, Geophysicist, an Independent Research Scholar, student of Latin and Greek, was formerly Head of the then Department of Geology and Geophysics (now subsumed in the School of Geosciences) at the University of Sydney.

I.Kelly, PhD (University of Sydney) is an Independent Research Scholar.