Chapter 6

Set in Stone: Medicine and the Vocabulary of the Earth in Eighteenth-Century Scotland

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Introduction

Throughout his career, Linnaeus continually paid tribute to the importance of nomenclatural names and descriptions. This is why he included a glossary of terms in almost every edition of his *Systema Naturæ* from 1735 onwards.[2] A large percentage of the systematically minded natural history arrangements during the Enlightenment followed the same practice. The reason so much attention was paid to this subject was because most naturalists knew that the very definitions of a natural object's characters inherently determined how it would be classified. Even though Enlightenment natural philosophers consciously set themselves the task of re-evaluating natural knowledge via the production of dictionaries and encyclopaedias, surprisingly little work has been done to contextualise the actual language they used to describe the terraqueous globe. Even more so than the animal and vegetable kingdoms, eighteenth-century mineralogical vocabulary in the Anglophone world, save for work of the *Oxford English Dictionary*, is a relatively uncharted field of study. Despite the plethora of mineralogical classification systems that existed in 'chymical' writings, lapidaries, herbals,

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[1] Various parts of this chapter were presented at the History of Science 2002 Annual Meeting in Milwaukee, WI, the 2002 'Science and Beliefs' conference at the University of Durham and the History and Philosophy of Science spring 2003 seminar series at the University of Leeds. Further research on this topic was conducted while I was a postdoctoral fellow at the Max Planck Institute for the History of Science (Berlin). In addition to the helpful comments that I received at the above meetings, I would like to thank the following people who gave me helpful advice along the way: David M. Knight, Ursula Klein, Andreas-Holger Maehle, Geoffrey Cantor, Robert Fox, Dane Daniel, John Dettloff, Susan McMahon and Ernst Hamm.

[2] He also included such lists in *Fundamenta Botanica* (1736) and in its later manifestation *Philosophia Botanica* (1751).

library catalogues and pharmacopoeias, most work on the nascent earth sciences tends to address 'stones' in relation to issues that proved to be of importance to nineteenth-century chemistry and geology. Such a historiographical disposition is useful for those interested in exploring the foundations of crystallography and historical time, but it offers little for scholars interested how mineralogy was understood by its eighteenth-century practitioners.

When one begins to delve into the variegated world of early modern mineralogical vocabulary, it becomes quite clear that the transmutation of stone taxonomy into the discipline of nineteenth-century geology was guided by a vocabulary moulded by a background of beliefs which were closely connected to medical perceptions of the human body and theological convictions about matter's relationship with a divine creator. When this vocabulary is explored in closer detail, topics previously considered anomalous to 'scientific' conceptions of the earth, chemico-theology and seminal principles for example, start to become more relevant. When these ideas are placed in conversation with recent work done on Enlightenment views of probability,[3] chemical epistemology[4] and medical language,[5] the beliefs that shaped the vocabulary of a topic like mineralogy, and hence related topics like chemistry, pharmacology and even cosmology, start to re-emerge as significant epistemological factors for a world where, as Hamm has stated, 'Studies of the Earth's crust were largely empirical and not especially well suited to a model of geometrically demonstratible truth.'[6]

In the past few decades, Laudan, Oldroyd, Rappaport and Emerton have treated several philosophical and experimental issues which are of direct relevance to the vocabulary of mineralogy in the early modern period.[7] These studies suggest that medicine played a central role in the language used to classify minerals. To

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[3] For a re-evaluation of Enlightenment probability in relation to 'geology', see R. Rappaport, *When Geologists were Historians, 1665-1750*, London, 1997. For mathematical probability, see L. Daston, 'The Doctrine of chances without chance: determinism, mathematical probability and quantification in the seventeenth century', in *The Invention of Physical Science* (ed. M. J. Nye, J. L. Richards and R. H. Stuewar), London, 1992, 27-50.

[4] W. R. Newman and Lawrence M. Principe, *Alchemy Tried in the Fire: Starkey, Boyle and the Fate of Helmontian Chemistry*, London, 2002.

[5] Through close study of words in relation to 'rules and norms' consistent with the 'cognitive style' of the eighteenth century, Duden demonstrated that 'keywords like heart, womb or blood connote a dynamic, direct perception'; that is, words considered to be metaphorical by modern scholars were often taken literally in the eighteenth century. See B. Duden, 'Medicine and the History of the Body', *The Social Construction of Illness* (ed. J. Lachmund and G. Stollberg), (tr. J. Mason), Stuttgart, 1992, 39-51, quotations taken from pages 39 and 40.

[6] E. P. Hamm, 'Of "histories" by the hand of nature itself', *Annals of Science* (2001), **58**, 311-317.

[7] R. Laudan, *From Mineralogy to Geology: The Foundations of a Science, 1650-1830*, London, 1987; D. R. Oldroyd, *Sciences of the Earth: Studies in the History of Mineralogy and Geology*, Aldershot, 1998; Rappaport (1997); and N. E. Emerton, *The Scientific Interpretation of Form*, London, 1984.

lay a firmer foundation for future studies on the background 'beliefs' which shaped Enlightenment conceptions of the earth's form and structure, this essay investigates how medicine shaped eighteenth-century mineralogical vocabulary in Scotland. To begin, I will identify three key areas which helped supply the linguistic framework by which the characters and qualities of stones were discussed by physicians in the University of Edinburgh's Medical School: medical Latin, botany and chemistry. Since the conception of a 'stone' was dominated by chemistry, the second section shows how the Medical School's vocabulary (especially that of experimental pharmacology) was applicable to both the human body and mineral composition. Though there are many examples of this linguistic overlap, I focus on how the chemical language of bladder stone composition was transferred into geology via mineralogy. Although there were many Scottish mineralogists during the mid and late eighteenth century, I concentrate on William Cullen (professor of chemistry and *materia medica*, 1756-1766) and two of his students: Joseph Black (professor of chemistry, 1766-1799) and John Walker (professor of natural history, 1779-1803). I chose these three professors because they dedicated a notable amount of their lectures to stones and/or mineralogically related topics.

Linguistic Framework

Medical Latin

Almost all of the students who matriculated at the University of Edinburgh's Medical School during the Enlightenment could read Latin. Since lectures were given in Latin until the mid part of the century, the scientific names assigned by classical authors were quite authoritative. For those interested in mineralogy, the Latin names of stones and minerals could be learned in several courses, but were specifically taught in the mid eighteenth-century *materia medica* and chemistry lectures, especially those of Charles Alston and William Cullen. Thus, the mineralogical terminology of Theophrastus, Hippocrates and Pliny were commonly known.[8] These names were re-iterated by most in the Medical School's faculty, including professors Black and Walker, up until the last decades of the century. Even though his mineralogy lectures mentioned Theophrastus' *De lapidibus*,[9] Walker was fonder of citing Pliny's *historia naturalis*. (This was also

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[8] For the importance of Pliny's *Historia Naturalis* in history, see E. W. Gudger, 'Pliny's Historia naturalis. The most popular natural history ever published', *Isis* (1924.), **6**, 269-281. The influence of medical Latin in England and in continental Europe is addressed in *Medical Latin from the Late Middle Ages to the Eighteenth Century* (ed. W. Bracke and H. Deumen), Brussels, 2000.

[9] For more on how Theophrastus' work fared through the Middle Ages and early modernity, see S. A. Walton, 'Theophrastus on *Lyngurium*: medieval and early modern lore from the

the case in his early notebooks).[10] Pliny discusses minerals in books XXXIII (Metals), XXXIV (Ores), XXXVI (Stones), XXXVII (Precious Stones) and Walker used many of these names for the genera in his own mineralogical system: 'The number of Genera is exceedingly extensive and it is proper that each should have a name, for this purpose many of the Classical names of Pliny are adopted.'[11] This situation was quite common and Theophrastian and Plinian mineralogical terms were used in most medical communities in Europe. Their continued usage provided a common reference point for an international community of natural philosophers who could read and write Latin.[12] However, since early modern mineralogists had difficulty in identifying the actual composition of Pliny's minerals (as is the case even today), the same Latin names were sometimes applied to completely different stones.[13] Additionally, there was disagreement over how Pliny's terms should be translated into the vernacular. Such hermeneutic issues ensured that local contexts, both intellectual and natural, played a notable role in mineralogical vocabulary.

Despite these translation problems, Latin terms were recycled over and over again in early modern mineralogical works. This was especially true for plinian characters that addressed colour, texture and shape. Walker even cites a few of these terms. For instance, he uses the adjective '*cæcum*' because it was 'a Term used by Pliny, and which, indeed, is very useful in Mineralogy, to denote the

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classical lapidary tradition', *Annals of Science* (2001), **58**, 357-379. See also A. Mottana, 'Il libro Sulle pietre di Teofrasto: prima traduzione italiana con un vocabolario di termini mineralogici', *Atti della Accademia Nazionale dei Lincei* (1997), **8**, 151-234.

[10] Walker cites Pliny's comments on porphyry in the report (*Kings* MS) that he wrote on the Hebrides for George III. See John Walker, *The Rev. Dr. John Walker's Report on the Hebrides of 1764 and 1771* (ed. M. M. McKay), Edinburgh, 1980, 190.

[11] John Walker *Lectures on Geology: Including Hydrology, Mineralogy, and Meteorology with an Introduction to Biology by John Walker* (ed. H. W. Scott), London, 1966, 'Mineralogy Lecture', 229. For more on Pliny's mineralogical names, see J. F. Healy, *Pliny the Elder on Science and Technology*, Oxford, 1999, 115-141; 173-346. See also the 'Index of Minerals' in H. Rackham's introduction to Pliny the Elder, *Historia Naturalis*, (ed. and tr. A. H. Rackham), (London: 1912), 419-421.

[12] At the University of Edinburgh, students were required to write their medical dissertations in Latin to the end of the eighteenth century. This context is treated in L. Rosner, *Medical Education in the Age of Improvement Edinburgh: Students and Apprentices 1760-1826*, Edinburgh, 1991.

[13] D. E. Eichholz briefly treats this problem in the introduction to the Loeb edition of Pliny's *Naturalis Historia*: *Pliny Natural History with an English Translation in Ten Volumes, Volume X, Libri XXXVI-XXXVII*, Cambridge, Mass., 1962, ix-xv. A good example of this is Agricola's use of *stannum* in *De Re Metallica* (1556). In this work, he interpreted Pliny's *stannum* to be the correct term for lead-silver alloys. This definitional difference caused problems for the next two centuries because *stannum* was generally associated with tin, not lead. See G. Agricola, *De Re Metallica: Translated from the First Latin Edition of 1556* (tr. H. C. Hoover and L H. Hoover), New York, 1950, 473 and ff. 33.

lowest degree of transparency.'[14] Not only did Pliny's vocabulary serve as a guide for descriptive Latin adjectives, it also standardised the names given to fossils that were anthropomorphic, zoomorphic or astralmorphic. For example, Walker skipped over the medieval tradition and used Plinian terms to name stones that resembled tongues (*glossopetra*) and stars (*asteria*).[15] Pliny also addressed what Walker and his medical contemporaries saw as chemical characters. The Roman use of heat in metallurgy and saline mixtures in the cleaning and assaying of gems was quite a complex business that resonated with the Medical School's interest in five-principle chemistry.[16] In addition to displaying the typical eighteenth-century anecdotal interest Pliny's pharmaceutical formulas,[17] Edinburgh's chemical community used his physical and chemical vocabulary to name mineralogical simples and compounds, and to create taxonomical terms. It is for this reason that many of the names that they gave to species, genera, orders and classes had corollaries in Pliny's work.[18]

Botany

A second medical source for mineralogical vocabulary in Edinburgh's Medical School was botany, particularly Linnaeus' *Systema naturae* and *Philosophia botanica*. Even though Linnaeus' botanical system was initially opposed by several members of the medical faculty, particularly Charles Alston, its utility had become accepted by the mid 1760s. By the 1770s, many of the professors, especially Cullen,[19] recognised the pedagogical advantages of applying Linnaean nomenclature to medical taxonomy. However, the Scots had no problem with accepting Linnaeus' definition and division methodology on the one hand while rejecting several of his classification characters on the other. This meant that there

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[14] David Pollock (transcriber), *An Epitome of Natural History Vol. IV* (1797), University of Edinburgh Special Collections Library (hereafter EUL), Gen. 706D, f. 26.
[15] For *glossopetra* see *Naturalis Historia* (37.164) and for asteria see (37.131).
[16] On the interaction of mineralogy and chemistry in classical times, see K. C. Bailey (trans.), *The Elder Pliny's Chapters on Chemical Subjects*, London, 1932; F. Greenaway, 'Chemical Tests in Pliny', in *Science in the Early Roman Empire: Pliny the Elder, His Sources and Influence* (ed. R. French and F. Greenaway), London, 1986, 147-161.
[17] Even though Pliny gives numerous pharmacological recipes, he is critical about the state of pharmacology in Rome. See § 34.108.
[18] Pliny's mineralogy is also briefly discussed in R. French, *Ancient Natural History*, London, 1994, 233-240.
[19] As is plainly evinced in the title Cullen's *Nosology, or, A Systematic Arrangement of Diseases: by Classes, Orders, Genera, and Species... and Outlines of the Systems of Sauvages, Linnaeus, Vogel, Sagar, and Macbride, Translated from the Latin of William Cullen*, Edinburgh, 1800. M. Barfoot treats the interaction of pedagogy and method in 'Philosophy and method in Cullen's medical teaching', in *William Cullen and the Eighteenth Century Medical World* (ed. A. Doig, J. P. S. Ferguson, I. A. Milne and R. Passmore), Edinburgh, 1993.

was no one uniform implementation of the Linnaean nomenclature. This had repercussions when Linnaeus' system (which was originally developed for botany) was applied to mineralogy. Throughout Europe, the simplicity of his binomial nomenclature led many naturalists to use his system to classify minerals. A leader in this movement was Linnaeus himself. For terminological simplicity, he had turned to the scientific Latin that he had already developed for botany.[20]

Many of Linnaeus' words were descriptive adjectives that addressed a plant's morphology and/or colour; others addressed essential characters, which, for him, were the parts associated with reproduction. When he began to classify minerals, he decided that the characters by which stones should be classified were, once again, externally observable morphological parts. Thus, the term *rhombus* could not only be applied to the shape of a leaf, but also to the crystalline appearance of a mineral; or, the term *albus* (white) could be used to describe a flower or a type of marble.[21] The dual use of such words was not unique to Linnaeus, but his system had a particularly important impact on botanical and mineralogical vocabulary because it had become a common reference work for naturalists by the late eighteenth century—even for those who disagreed with it. Likewise, most physicians and naturalists in Edinburgh's Medical School had no problem with 'transplanting' botanical terms into mineralogy and numerous examples of this dual terminological usage could be cited. For example, in his early lectures on mineralogical topics, William Cullen used botanical words like foliaceous and fibrous to describe a species of gypsum.[22] Indeed, Walker followed the same practice.[23]

Botanical vocabulary was convenient for those who thought that minerals should be arranged by their externally observable characters; and the wide circulation of Linnaeus' works in Britain and Europe later in the century ensured that these mineralogists were at least using the same words to describe similar stones. Yet Linnaeus' naturally based, but externally focused, vocabulary presented a few problems for Edinburgh's chemically trained physicians and naturalists, most of whom where heirs to the Becher-Stahl School of chemistry

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[20] The classic source (in English) for Linnaeus' botanical Latin is W. T. Stearn's *Botanical Latin: History, Grammar, Syntax, Terminology and Vocabulary*, Newton Abbot, 1973.

[21] *Ibid.*, 311-357.

[22] Cullen used the words foliaceous and fibrous to describe different types of Gypseous Earth. University of Glasgow Special Collections Library (hereafter GUL) Cullen MS 264. He also applied it muscles during the 1760s: William Cullen, *Lectures on the Materia Medica…*, London, 1773, 14-15. See the *OED* for further eighteenth century mineralogical uses. Additionally, the word *stamen* (filament, thread) was used by Marcello Malpighi in 1672 and it was subsequently taken up by embryological studies throughout the Enlightenment. H. B. Adelmann, *Marcello Malpighi and the Evolution of Embryology, Vol. I*, Ithaca, 1966.

[23] While travelling in the Hebrides during 1764, Walker noted the similarity between amiantus and petrified wood fibres. Walker (1980), 219. Also see the vocabulary terms in Pollock (1797) EUL 706D, ff. 6-32; 36-40.

and/or the teachings of Herman Boerhaave.[24] Even though they accepted Linnaeus' definition and division methodology, they based their mineralogical systems on chemical characters. Furthermore, although Linnaeus' basic chemical vocabulary was firmly grounded on the five-principle chemistry that was used in the Medical School (especially in pharmacology),[25] he had only used chemical characters as a last resort.[26] This meant that his system did not provide a vocabulary robust enough to create names for a mineralogical system based primarily on chemical characters. Another standard source was needed to provide names for the chemical characters which could be used to classify minerals. This source ended up coming from the thriving chemistry community in the Medical School.

Chemistry

As Crosland and others have shown, the vocabulary of eighteenth-century chemistry was a complicated affair.[27] Despite this confusion, Edinburgh's professors were united in their belief that there were five basic chemical 'principles': Water, Earths, Salts, Inflammables and Metals.[28] This sort of chemistry was promoted in almost every chemically related course taught in the Medical School: *materia medica*, medical theory, physiology, chemistry, botany and natural history. From the 1750s to the 1790s, the different definitions associated with the key terms of these five principles led to several different types of mineralogical systems in Edinburgh alone (for instance, Charles Alston offered several alternate classifications for minerals in his *materia medica* lectures).[29]

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[24] Many of Edinburgh's mid eighteenth-century professors had been trained by Boerhaave in Leiden. See E. A. Underwood, *Boerhaave's Men at Leyden and After*, Edinburgh, 1977.

[25] Stearn addresses these chemical terms on pages 358-363. For the meaning and historical background of pharmaceutical terms, see W. E. Flood, *The Origins of Chemical Names*, London, 1963; J. W. Cooper and A. C. McLaren, *Latin for Pharmaceutical Students*, London, 1950.

[26] He believed this because he held that chemical analysis destroyed a mineral's essential composition. See C. Linné, *A General System of Nature, Through the Three Grand Kingdoms of Animals, Vegetables, and Minerals…* (tr. W. Turton), London, 1804, 9.

[27] M. P. Crosland, *Historical Studies in the Language of Chemistry*, London, 1962. M. Beretta, *The Enlightenment of Matter: The Definition of Chemistry from Agricola to Lavoisier*, Canton, 1993.

[28] To avoid confusion, the names of these chemical principles will remain in upper-case form for the duration of this essay. The methodological and epistemological assumptions that guided these principles in Edinburgh is treated in M. D. Eddy, 'The doctrine of salts and Rev John Walker's analysis of a Scottish spa, 1749-1761', *Ambix*, (2001a), **48**, 137-160 and in A. L. Donovan, *Philosophical Chemistry in the Scottish Enlightenment: The Doctrines and Discoveries of William Cullen and Joseph Black*, Edinburgh, 1975.

[29] This was often influenced by how the mineralogical simple was being use in a pharmacological compound. For more on Alston's views on mineralogical simples, see his *Index medicamentorum simplicium triplex*, Edinburgi, 1752, 69-70.

Likewise, outside Edinburgh, there were a wide variety of mineralogical systems based on chemistry. These arrangements have been overlooked by historians because they occurred in such diverse sources as museum catalogues, indices in chemistry texts and lists given in *materia medica* lectures.[30] When one looks at the wide variety of these and other chemical mineralogies available to naturalists in Edinburgh, it becomes very clear that there were almost too many sources.

By the mid part of the century, the chemically orientated Latin works that emerged as the standard points of comparison for mineralogical characters and vocabulary came from Sweden. After an initial interest in Johann Pott's experiments on Primary Earths,[31] Cullen's work during the 1750s shows that he came to accept the chemically based mineralogical classification of Johan Gottschalk Wallerius, the eminent professor of chemistry at the University of Uppsala.[32] By the 1760s, he was also entertaining a similar system offered by another Swede, Axel Fredrik Cronstedt. In fact, Walker's personal notes state that it was Cullen who gave him a copy of Cronstedt's *Versuch einer neuen Mineralogie* in 1764.[33] This being the case, from the 1760s onward, Cullen, Black and Walker favourably mention the chemical mineralogy of Wallerius and Cronstedt. The Swedish influence upon Scottish chemical vocabulary was further canonised after the second edition of Torbern Bergman's *Sciagraphia regni mineralis* was made available to the Edinburgh community in 1783.[34] Although Wallerius, Cronstedt and Bergman disagreed on several points, their basic vocabulary and systems of arrangement were similar and this allowed their works to become the main source of mineralogical vocabulary in the Medical School.

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[30] See the wide variety of chemical mineralogy sources contained in Walker's library catalogue: Cornelius Elliot, *A Catalogue of the Books in Natural History with a Few Others, which Belonged to the Late Rev. Dr. Walker, Professor of Natural History in the University of Edinburgh*, Edinburgh: C. Stewart, 1804. For a set of unpublished lectures that influenced Scottish chemistry, see Charles Alston, *Introduction to Materia Medica* (1736), EUL Dc.8.12.

[31] Black also recognised the value of Pott's work in his early lectures: Thomas Cochrane (transcriber), *Notes from Doctor Black's Lectures on Chemistry 1767/8* (ed. Douglas McKie), Wilmslow, 1966, 82.

[32] William Cullen, GUL Cullen MS 264. Wallerius' system is explained in Johan Gottschalk Wallerius, *Mineralogié, ou Description Générale des Substances du Regne Mineral. Par Jean Gotschalk Wallerius, Professeur Royal de Chymie, de Métallurgie & Pharmacie dan l'Université d'Upsal, de l'Académie Impériale de Curieux de la Nature*, Paris, 1753.

[33] See Axel Fredrik Cronstedt, *Versuch einer Neuen Mineralogie aus dem Schwedischen Übersetzt*, (tr. G. Wiedeman), Kopenhagen, 1760. Whether or not this is the copy used by Cullen is unknown.

[34] Torbern Bergman, *Sciagraphia regni mineralis secundum principia proxima digesti*, Londini, 1783. It was also translated during the same year: *Outlines of Mineralogy,* (tr. William Withering), Birmingham, 1783.

Chemical Composition

Chemistry and the Earth

So far I have demonstrated that mineralogical vocabulary in Enlightenment Edinburgh came from three areas that were primarily the domain Edinburgh's Medical School: medical Latin, botany and chemistry. Indeed, because of its importance to so many medical subjects (especially chemistry and pharmacology), mineralogy, in some form or another, had been part of the medical curriculum since the school had been founded.[35] In addition, almost every mineralogical classification system developed in Scotland during the eighteenth century was offered by a naturalist who at some point had received a medical education and a good working knowledge of chemistry. This category of mineralogical systematisers included not only Black, Walker, Cullen and their patron Lord Bute,[36] but also those often grouped under the historiographical rubric of geology, especially Robert Jameson,[37] James Hutton[38] and James Hall.[39] Since the vocabulary of mineralogy was so influenced by medicine, this means that these men employed the same words and terms as the physicians who were performing experiments upon stomach acids and who were developing new pharmacological cures. This created a linguistic context in which the vocabulary used to describe minerals and the human body were the same.

This overlap becomes quite significant when one considers that eighteenth century medical language was often not as metaphorical as modern scholars have

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[35] R. G. W. Anderson, 'Chymie to Chemistry at Edinburgh', *Royal Society of Chemistry Historical Group Occasional Papers* (2000), **2**, 1-28.

[36] Bute's scientific background and interests are discussed in D. P. Miller, ''My Favourite Studdys': Lord Bute as Naturalist', in *Lord Bute: Essays in Re-interpretation*, (ed. Karl W. Schweizer), Leicester, 1988, 213-239.

[37] Aside from studying with Walker and Werner, Jameson held a medical doctorate from Edinburgh. He published many mineralogically related works during the nineteenth century, two of his more well-known being: *System of Mineralogy…*, Edinburgh, 1804-1808, and *Manual of Mineralogy…*, Edinburgh, 1821.

[38] Hutton studied medicine for three years in Edinburgh and then went to Holland where he took his medical doctorate in Leiden in 1749. Unsurprisingly, he maintained his own mineralogical collection: Jean Jones, 'The geological collection of James Hutton', *Annals of Science* (1984), **41**, 223-244; and he based his conception of mineral formation on chemistry: P. A. Gerstner, 'The reaction to James Hutton's use of heat as a geological agent', *Isis* (1971), **62**, 353-362. Even on the last day of his life, he occupied himself by writing down remarks on a 'new mineralogical nomenclature'. J. Playfair, 'Biographical account of the late Dr. James Hutton, F. R. S. Edin.', *Transactions of the Royal Society of Edinburgh* (1805), **5**, 39-99; 88.

[39] Sir James Hall (as well as John Playfair) had studied under Walker in 1782. See M. D. Eddy, 'The University of Edinburgh natural history class lists, 1782-1800', *Archives of Natural History* (2003), **30**, 97-117.

assumed.[40] This is a particularly important point because it was the Medical School's chemical mineralogy which laid the conceptual foundation for geology in Edinburgh. This is clearly evinced in John Walker's geology lectures.[41] Indeed, Joseph Black lectured on the chemical aspects of geology throughout his entire career.[42] Such a situation means that it was quite easy for Edinburgh's naturalists to draw analogies between minerals harvested from the Highlands and the chemical experiments being conducted in the Medical School. Traditionally, historians who have looked at chemistry's impact upon eighteenth-century Scottish geology have trained their gaze towards experiments that involved high levels of heat. The obvious reason for this being the later success of Playfair's edition of Hutton's *Theory of the Earth*. Yet, a quick browse through the lecture notes taken at the feet of Edinburgh's medical professors demonstrates that the prominent form of analysis was humid, that is, it utilised Salts (acids and alkalis). This was because late Enlightenment medical theory was based upon a form of neo-humouralism which maintained that the fluids of the body needed to be properly balanced.[43] This being the case, Edinburgh's medically focused forms of saline analysis had a direct impact upon mineralogical vocabulary that would become of foundational importance to geology. There are many examples that could be used to illustrate this claim, but in what remains of this essay I will present a case study of bladder stones which shows why the geology of Edinburgh's naturalists should be seen through the lens of the chemistry practised by its medical community.

Experimentation and Fieldwork

Bladder stones masqueraded under a variety of names during the Early Modern period. The most common appellations were *calculi* and the 'Stone'; but they were

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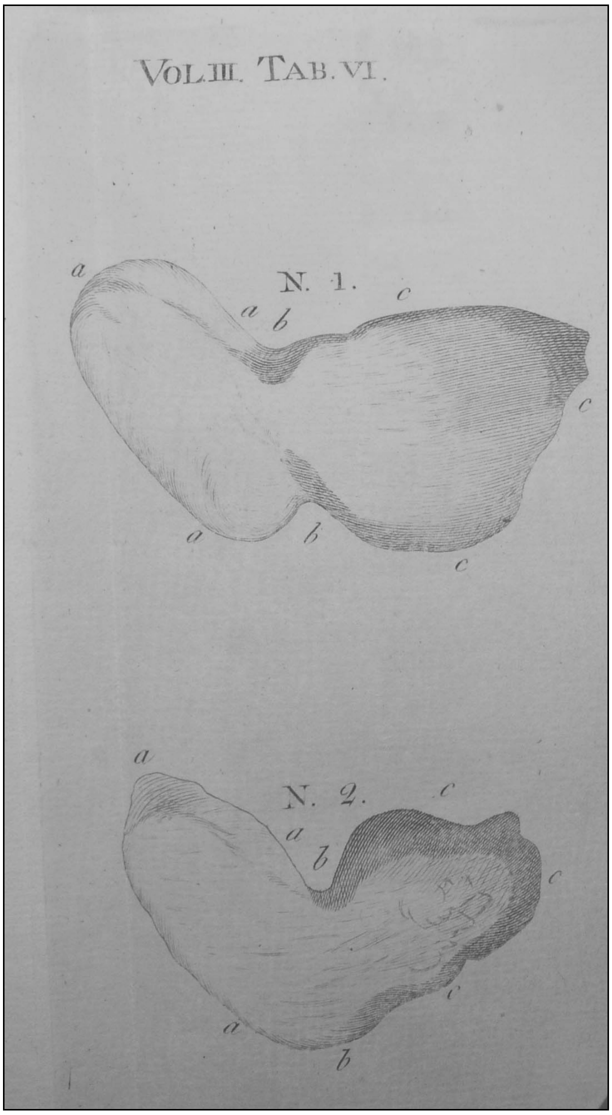
[40] See Duden (1992).
[41] Walker (1966). The chemical background of these lectures is treated in M. D. Eddy, 'Geology, mineralogy and time in John Walker's University of Edinburgh natural history lectures', *History of Science* (2001b), **39**, 95-119.
[42] His lectures during the 1760s referenced many different types of geological formations, and even went so far as to define strata at the beginning of the section on Primary Earths, see especially his comments on earthquakes and the deluge: Cochran (1966), 55, 144, 165-168. See also his comments about the stratigraphical occurrence of Gypseous Earths, Calcareous Earths and clay on pages 77-78. Likewise, his *Elements* (1803) is interspersed with many comments on geology. As John Dettloff has pointed out to me, geology and mines were also discussed in French chemistry lectures, particularly those of Macquer and Roulle.
[43] Cullen valued the fluids of the body because he felt that they influenced the 'laxity' or 'rigidity' of the 'solid' parts of the human body. This meant that he believed them to be of central importance to pathology. Cullen (1773), 7-9.



A bladder stone as pictured in the 1771 edition of Edinburgh's *Essays and Observations Physical and Literary*, the city's premier scientific journal. It was included to illustrate an article entitled 'The history of two cases of stones lodged partly in the bladder, and partly in the urethra' written by 'Dr Livingston', a physician in Aberdeen.

also called 'Earth of Animals', 'Animal Substances' and 'Animal *calculi*'.[44] As Maehle has shown, and as is so clearly evinced in Edinburgh's *Essays and Medical Observations*,[45] bladder stones received a great deal of attention in the Medical School during the entire eighteenth century.[46] Likewise, many of the most prolific chemists in Enlightenment Europe had published at least one tract, essay or letter on the subject. Some, like Wallerius, even included *calculi* in their mineralogical systems.[47] Even though these stones could be surgically removed via a lithotomy, the safer option was to dissolve them via chemical means. This could be done two ways. The first used a syringe to inject a solution up through the urethra and into the bladder. The second utilised oral remedies, either in the form of dietary regulations or via medicines (called lithontriptics) that dissolved and/or dislodged the stones. In order to know which Salts or Earths were most likely to work for any of these remedies, the Medical School performed a barrage of tests *in vitro*. These experiments considered *calculi* to be composed in the same manner and by the same matter as stones found in nature. By employing the same acids and alkalis on mineralogical specimens that they used to test *calculi* (especially Metals and Earths), the vocabulary of medical chemistry was implicitly transferred into mineralogy. The compositional verisimilitude between bladder and mineralogical 'stones' is well evinced by fact that physicians, Cullen's student William Hunter for instance, included *calculi* in their natural history collections.[48] Moreover, the surgeons of Edinburgh's Royal Infirmary also kept a 'collection of curiosities' that included animal and human concretions. Like *calculi*, these were subjected to chemical experiments and were described with the same vocabulary used for minerals: '[T]here is a ball taken out of the stomach of a horse, which is nearly spherical, and nineteen inches in circumference. Its surface… being composed of a

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[44] 'Earth of Animals', see fold out chart in the 'Chemistry' entry in *Encyclopædia Britannica; or Dictionary of the Arts and Sciences, Vol. II*, (ed. William Smellie), Edinburgh, 1771; 'Animal Substances', which Joseph Black seldom got around to discussing completely in his early lectures, Cochrane (1966), 190; 'Animal *calculi'*, Stephen Hales. *Statical Essays: Containing Hæmastaticks…Also an Account of Some Experiments on Stones in the Kidneys of the Bladder; with an Enquiry into the Nature of those Anomalous Concretions*, London, 1732, 190. Additionally, Cullen sometimes discussed bladder stones under the disease category 'nephritics' and treatments involving 'diuretics'. See related entries in the index of *The Works of William Cullen, vols. I and II*, Edinburgh, 1827.

[45] This was the main publication of Edinburgh's Philosophical Society and the Medical School. See *Essays and Medical Observations, 5th Edition*, Edinburgh, 1771.

[46] A. H. Maehle, *Drugs on Trial: Experimental Pharmacology and Therapeutic Innovation in the Eighteenth Century*, Amsterdam, 1999.

[47] The best overview of their placement in his mineralogical classification can be seen in the introductory tables: Wallerius (1753), xxiii, xxxiii-xxxiv.

[48] Hunter's *calculi* collection is briefly treated in W. D. I. Rolfe, 'William and John Hunter: breaking the great chain of being', in *William Hunter and the Eighteenth-Century Medical World*, (ed. W.F. Bynum and Roy Porter), Cambridge, 1985.

number of hemispherical knobs… [and] their outward shell looks like a thin crust of sandy clay.'[49]

To merely dissolve *calculi* and other biological concretions *in vitro* was only the first step. The second objective, in the words of Stephen Hales, was to find 'Menstruums powerful enough to dissolve Metals and Stones, yet so mild as not to hurt, or offend, the tenderest part of the Body.'[50] For the Scots, this came in the form of lime water, an alkaline solution made out of Calcareous Earth.[51] The most common source for this type of Earth was limestone. This created a situation during the last half of the century where many students who had been trained in the Medical School were interested in locating minerals for pharmacological reasons. Cullen led the way with his forays into nature, but he would be followed by Walker, Black, James Henderson and a variety of others. Because of limewater's use in *calculi* experiments, medically trained naturalists were quite keen to identify limestone deposits or mineral wells that contained varying levels of Calcareous Earth.[52] This can be seen in the Highland and Hebrides travel notes taken by Walker and Henderson.[53] (Additionally, Black frequently discussed how to locate minerals in strata in his 1760s lectures). This fostered a context in which observations of Scotland's geological terrain were being made in relation to minerals that were required to prepare saline and terrene solutions which were being used for *calculi* research.[54] As a result, the experiments carried out on the various types of calcareous minerals collected in the field would go on to influence how the Scots viewed the chemical composition of geological formations. A good example of this knowledge transfer is evinced in Black's chemistry lectures where he uses the results from *calculi* experimentation to explain the composition of limestone strata.[55]

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[49] A. Monro, 'Histories of tophaceous concretions in the alimentary canal', *Essays Physical and Literary*, (1756), **2**, 351.

[50] Hales (1732), 190. In addition to being recommended by Black in his lectures, this was a commonly cited source in eighteenth-century Edinburgh.

[51] The production of limewater engendered a heated debate between Charles Alston and Whytt and they both published vociferously on the topic during the 1750s and 1760s. This spurred related essays by other authors in the *Medical Essays and Reviews.* Black mentioned the 'The disputes that arrose bewixt D^{r} Whytt & Alston' on several occasions in his 1760s lectures. Cochran (1966), 65.

[52] See Black's 1760s comments on mineral water, Cochran (1966), 165-170. Using mineral water to dissolve bladder stones went back to ancient times, but began to receive concerted 'chemical' attention at the end of the Middle Ages. See L. Daston and K. Park, *Wonders and the Orders of Nature 1150-1750*, New York, 1998, 135-159. For the early modern period see *The Medical History of Waters and Spas* (ed. Roy Porter), London, 1990.

[53] Walker (1980). James Robertson, *A Naturalist in the Highlands*: *James Robertson, His Life and Travels in Scotland 1767-1771*, (ed. D. M. Henderson), Edinburgh, 1994.

[54] Since I am concentrating on *calculi*, I will refrain from commenting on the chemical efficacy of pharmacological observations made on mineral wells (Salts) and mines (Metals).

[55] Black specifically states that his original experiments 'into nature of *magnesia*' were conducted because he wanted to find 'a new sort of Lime-water, which might possibly be a

Stone Formation

The medically engendered conceptions of mineral composition discussed above also led to background beliefs about stone formation, particularly in relation to 'gluten', 'incrustations' and 'concretions'. One of the best examples of where the chemical vocabulary associated with *calculi* experimentation had a direct impact upon Scottish conceptions of geological composition occurs in Black's 1767 chemistry lectures on absorbent Earths. When discussing the composition of limestone, he states: 'The Calcareous Earth is most generally the Matter whereby bodies[,] Vegetable or Animal Substances[,] that have been exposed to water become Stones. w^c shows that it can be keep't in water of a Solid or fluid form & it's by this the diff^t. waters petrify bodies.'[56] He then states that the substance which concretes these stones together is 'animal Glutinous Matter'. Here the word 'Glutinous' is of particular note. It came from the Latin term *gluten* (the French form being *glutineux*)[57] and was commonly used in medical circles to describe the sticky material that was often produced by putrefaction experiments conducted on both animal and plant remains.[58] That Black transferred it to limestone is not surprising, since he clearly indicates that he believed Calcareous Earth came from compressed shells. What is notable is that, two decades later, Walker used the terms 'gluten' and 'congluten' to describe the cemented matter that held together the rocks which were found in *primary* strata (e.g. the oldest rocks of the earth). These rocks contained no biologically engendered glutinous material because they were devoid of extraneous fossil remains.[59] This means that he had transferred a chemical term from its usage in Edinburgh's medical world to the newly emerging field of geology. This is a particularly significant point because Walker was the first professor in the Medical School to designate 'geology' to be a separate topic within his syllabus.

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more powerful solvent of the stone than commonly used'. Joseph Black, *Experiments upon Magnesia Alba, Quick-lime, and other Alcaline Substances…*, Edinburgh, 1777, 6-7. Limewater's connection to *calculi* is not as clearly stated in his *Lectures on the Elements of Chemistry* (Edinburgh: 1803) (which might be a result of editorial omission). In the sections on this subject, however, Black clearly addresses 'calcareous earth in its natural state' (e.g. limestone) and refers the reader to sections of the *Edinburgh Pharmacopoeia* which address the preparation of limewater for the treatment of *calculi*. Black (1803), 36-38.

[56] Cochrane (1966), 57. Johnson's *Dictionary* states: 'Stones are bodies insipid, hard, not ductile or malleable, nor soluble in water.' *A Dictionary of the English Language: First and Fourth Editions* (ed. A. McDermott), Cambridge, 1996.

[57] The first and fourth editions of Johnson's *Dictionary* state: 'GLUTINOUS. *adj*. [*glutinex*, French, from *gluten*, Latin.] Gluey; viscous; tenacious.'

[58] Hence, 'glue', which served as a cognate of 'glutinous' in the Early Modern period. Cullen also used the terms 'gummy' and 'resinous'. Cullen (1773), 2.

[59] This belief about primary strata was generally held by the chemists in the Medical School. For Black see (1803), 167; Walker (1966), 175.

The fact that Edinburgh's chemists thought *calculi* and several different types of minerals were made out of the same kinds of concreted matter was not unique; in reality, this had been the case in Britain since at least the end of the seventeenth century.[60] It was generally believed that Salts (both from mineral wells and ocean water)[61] and even corals[62] could produce indurated stones that were just as chemically and mechanically resilient as rocks dug out of the earth or compounds synthetically produced by heat analysis. Moreover, the formation and composition of *calculi* and indurated stones took place over a relatively short period of time. Such sentiments about formation of stony substances might appear of limited significance to the nascent earth sciences until one considers that the professors of the Medical School were transferring chemical language into geology via mineralogy. Walker's use of gluten is the best example, but other words like 'concretions', 'petrefactions', 'congellations' and 'incrustations' were also imported into various lectures that both he and Black gave on the chemical composition of strata.[63] Thus, the vocabulary and associated concepts of chemistry implicitly effected the Medical School's perception of geology and suggested that a great many of the Earth's minerals could be formed within the terrestrial time spans suggested by the Bible and other classical texts[64]—and in this sense, scientific experimentation and theological beliefs could exist side by side within the same epistemological framework.[65] Such a context also explains the rocky reception to Hutton's 'Theory of the Earth' paper when it was read before the Royal Society of Edinburgh in 1785. Even though it was based on chemical

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[60] For instance, Hales drew no distinction between 'tartarine' incrustations formed in the human body and in mineral wells. Hales (1732), 236.

[61] This point is well illustrated in a letter written from Edward King to Sir John Pringle (a Scott commonly cited in the lectures of both Cullen and Walker) in the 1779 edition of the *Philosophical Transactions*. This *communiqué* addressed the 'petrefactions' and 'incrustations' that had formed around the rope of a ship that had been wrecked off the cost of Scotland in 1745. King asserted: 'The substance of the rope is very little altered; but the sand is so concreted round it, as to be hard as a bit of rock…just in the same manner as impressions of extraneous fossil bodies are often found in various kinds of strata.' Edward King, 'Account of a petrefaction found on the coast of East Lothian', *Philosophical Transactions of the Royal Society* (1779), **69**, 36.

[62] In reference to corals found on a shipwreck described by Sir Hans Sloan, Black stated: 'these Shelly Concretious matters float in great quality in the Sea.' Cochrane (1966), 58. Interestingly, based on both artificial and natural criteria, corals were classified as stones in seventeenth century pharmacological systems and lapidaries. See Robert Lovell, *ΠΑΝΖΩΟΡΥΤΟΛΟΓΙΑ. Sive Panzoologicomineralogia. Or a Compleat History of Animals and Minerals…Vol. I*, Oxford, 1661, 71; Thomas Nicols, *A Lapidary or History of Precious Stones…*, Cambridge, 1652, 160-165.

[63] Especially the concept of 'concretion'. Pollock (transcriber), *An Epitome of Natural History Vol. VI* (1797), Gen 708D, ff. 59-63. Additionally, Black described Jasper as a 'concretion' during the 1760s. Cochran (1966), 80.

[64] The authoritative role played by classical texts (a category that she takes to include the Bible) in the nascent earth sciences is treated in Rappaport (1997).

[65] For more on Walker's conception of the earth's age, see Eddy (2001b).

concepts, it simply did not fit within the experimental culture's perception of the earth's composition (or heat for that matter).[66] It therefore is not co-incidental that his ideas became more probable in the early nineteenth century, a time when the Medical School's influence over the language of mineralogy and geology was becoming weaker.

Conclusion

This essay has addressed the medical vocabulary of mineralogy in Enlightenment Edinburgh. The first half concentrated on three larger linguistic considerations, medical Latin, botany and chemistry, while the latter part used bladder stone research to show how the vocabulary of chemistry was transferred from medicine to geology via mineralogy. As I have indicated in several of the footnotes along the way, this essay only treats a fraction of the eighteenth-century mineralogical vocabulary that was affected by a medically orientated epistemology. For instance, for bladder stones alone, several other topics could have been pursued—especially how cross sectional representations of their contents closely resemble early stratigraphical drawings, both of boulder stones and mountains. Furthermore, *calculi* were sometimes called petrefactions, a term also used to identify extraneous fossils. Aside from bladder stones, the vocabulary of botanical characters was also employed by the Scots to delineate the external features of stones and this allowed words (and their associated definitions) from anatomy and physiology to be used to describe the physical structure of geological formations and phenomena (especially volcanoes and earthquakes). Furthermore, medical vocabulary not only interacted with the observations by physicians who toured the countryside, it also was tested against what was being dug out of the many mines found throughout Scotland. The latter point is particularly important because Scotland did not have any mining academies and this meant that the Medical School's professors played an important role in assaying ores.

In the 1966 forward to his first book, David M. Knight wrote: 'If we are to assess scientists of the past, we must judge their views…by their consistency and their power to explain the phenomena then known and felt to be puzzling.'[67] In many ways, my comments about the medical vocabulary of mineralogy in this essay have addressed the 'consistency' of language in a historical context where words migrated between studies which treated both human and earthy bodies. This has allowed me to show that the mineralogically-minded Scots addressed in this study were very interested in the form and the structure of the earth, but not in the

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[66] P. A. Gerstner, 'James Hutton's theory of the earth and his theory of matter', *Isis* (1968), **59**, 26-31.

[67] D. M. Knight, *Atoms and Elements: A Study of Theories of Matter in England in the Nineteenth Century*, London, 1967, 1.

way which has been portrayed by most histories of the earth sciences. When these men pondered the terraqueous globe, they were puzzled, in an experimental sense at least, by questions of systematisation and medical utility—and this no doubt explains why the bulk of laboratory work in late eighteenth-century Edinburgh revolved around issues that were relevant to experimental pharmacology. As several other essays in this collection also mention, asking questions about intellectual milieus in such a manner brings important, and often intangible, intentions to the foreground and takes us one step closer to understanding the beliefs that motivated early modern natural philosophers to be so inquisitive about the natural world.