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The forgotten uses of selenite.

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WE are apt to regard selenite or transparent gypsum as a useless mineral, apart from the very small quantity used in plates for microscope work. It is the object of this paper to show that from the first, to at any rate the seventeenth century in Europe and to the first half of the nineteenth in South America, considerable use was made of it. For the classical period the argument is based upon the identification of *lapis specularis* as mainly, if not entirely, selenite. Most translators render the name as talc or mica, the first word probably a vulgar error for the second, while some admit gypsum to have been included; Bailey in his notes on Pliny considers that two passages suggest gypsum but gives the preference to mica, while Zeitler claims nearly all the passages referred to below for this mineral. Pliny is, of course, our chief authority: I give the relevant passages in Philemon Holland's translation as more in keeping with the greater part of this paper, adding notes and the original Latin where necessary. Book XXXVI, Chapter 22, reads:

'As touching Talc [*specularis*] (which also goeth in the name of a stone) it is by nature much more easie to be clouen into as thin plates as a man will. This kind of glasse stone, the hither part of Spaine only in old time did affoord vs, & the same not all throughout, but within the compasse of a 100 miles, namely about the city Segrobrica: but in these daies we haue it from Cypros, Cappadocia, and Sicilie, and of late also it hath been found in Barbary [Africa: i.e. the province of that name, now Tunis and Tripolitania]: howbeit the best glasse stone comes from Spaine and Cappadocia, for it is the tenderest and carrieth largest pannels, although they be not altogether the clearest, but somewhat duskish. There be also of them in Italy about Bononia [Bologna], but the same be short and small, full of spots also and joined to pieces of flint [*complexu silicis alligatae*]; and yet it seemeth that in nature they be much like to those that in Spaine bee digged out of pits which they sinke to a great depth. Moreover, there is found of this Talc betweene other stones inclosed in a rocke and lying vnder the ground, which must be hewed out if a man would haue them. But for the most part, this Talc lieth in manner of a vein in the mine by it selfe, as if it were perfectly cut already by nature; and yet was there neuer a piece knowne to be aboue fvee foot long. Some are of opinion, that it is a liquid humour of the earth congealed to an yce after the manner of Crystall. Certes, that it groweth hard into the nature of a stone, may appeare evidently by this, That when any wild beasts are chanced to fall into such pits where this glasse stone is gotten, the very marow of their bones (after one winter) wil be conuerted and turned into a stony substance like to the Talc it selfe.'

He goes on to say that it is 'tender and brittle' [*mollis*], that it will withstand the sun and the cold, does not age unless injured, and that Juba tells us that there is a similar stone found in Arabia, clear as glass and used for windows. The only other relevant passage, apart from the uses given below, is IX, 35, where he says that the pearls from India resemble scales of *lapis specularis*. This again suggests some form of gypsum rather than mica, especially as beads of satin-spar are known to have been in use as cheap jewellery in Rome in the early Empire.

Taking the localities in the order of mention, Segobriga is now Priego in Spain; the Tertiary formation here is full of gypsum, and selenite may also occur in the neighbouring Lias: the same Oligo-Miocene Beds include the Cardona locality quoted below from Ray's travels.

The gypsum of Cyprus has always been famous: Theophrastus says it is the best ('*Ἡ δὲ γύψος γίνεται πλείστη μὲν ἐν Κύπρῳ*, Cap. LXIV). Pliny also mentions it (XXXVI, 182); he always uses the word gypsum for plaster of Paris—'it is obtained by roasting stone (*e lapide coquitur*); the stone cooked must be a kind of alabaster (*lapis non dissimilis alabastritae*); it is recognized that the best is made from *lapis specularis*'. Here we have proof that the *lapis specularis*, at any rate of Cyprus, was a form of calcium sulphate; also that mineralogists are justified in confining 'alabaster' to that compound. The word refers primarily to the handleless vases often made of it: the many similar vases of Egypt are correctly called *alabastra*, but are made of the carbonate and are therefore not alabaster. The best description of the Cyprus gypsum I have found is given by Gaudry; he says:

'The gypsum of Cyprus is of many varieties. The most abundant is that which is grained. Some is also found crystallized in lance-heads exactly like that of Montmartre, near Paris; this is reserved for fine mouldings. These lance-headed crystals were called by the ancients, specular stone. . . . The island also contains gypsum which is nearly compact and tabular; it can be taken up in large plates. This gypsum is excellent material for the interior flooring of rooms. It wears out much less than might be expected from its softness. It is true that the eastern nations either walk barefoot, or with very light papouches, and that mats abound even in the houses of the poor. The flags of Cyprus are very extensively exported. I have seen them carried as far as the centre of Mount Libanus.'¹

Gaudry deals at some length with the minerals of Cyprus and a translation of his work was issued as a government publication in 1878; he makes no allusion to mica. He is keenly interested in the classical authors, Theophrastus, Dioscorides, and Pliny, and amongst other identifications is the original and well-supported suggestion that the adamas (diamond) was analcime. Cyprus 'diamonds' were carefully distinguished from rock-crystal by several authors whom he quotes from the sixteenth and seventeenth centuries, but were confused by Pococke in the eighteenth.

Cappadocia is a large province in Asia Minor occupied mainly by gypsiferous Tertiary marls, but including some granitic rocks; these no doubt contain mica, but I have not found any reference to comparatively large crystals. Pliny further tells us (XXXVI, 46) that Cappadocia produced a stone with the durability (*duritia*) of marble, white and translucent even when veined with yellow,

¹ Gypsum (from Cyprus?) was used in the palace of Knossos in Crete, 'nearly all the pavements being of that material' (Antiq. Journ., 1927, vol. 7, p. 267). The palace was finally destroyed about 1400 B.C.

from which character it is called *phengites*. It is not improbable that this also is a form of gypsum. He says that Nero used it in the construction of the temple of Fortune and that it admitted light. Bailey objects that gypsum is very soft and unsuitable for building; but it was used for over a thousand years in Cyprus and its durability, which I prefer as a rendering of *duritia*, would call for comment. Doubtless it is the same stone that Strabo mentions (XII, 2), without name—'another place in Cappadocia produced large masses of transparent stone for windows, which was exported'. His Geography antedates Pliny's Natural History by about sixty years and Nero's building by about forty-five. According to Suetonius, Domitian, who died in A.D. 96, had in his palace a portico, where he was accustomed to walk up and down; he decorated the walls with *lapis phengites*, from the lustre of which he was able to see a reflection of anything behind his back, in his case a most desirable precaution. Whatever *phengites* was, it was not phengite.

Both in Sicily and in Africa, which means of course the Roman province, now Tunis and Tripolitania, between Mauretania on the west and Cyrenaica on the east, gypsum in various forms is abundant. In Sicily the best-known locality for good crystals is Girgenti; in North Africa, Sandford mentions the gypsum in the Upper Cretaceous and Tertiary rocks as ubiquitous and assures me (personal letter) that there is no mica.

The Bologna district is formed mainly of Miocene beds with gypsum and is the source of the selenite used in the fifteenth and sixteenth centuries. Pliny's small flakes firmly embedded in silex may possibly have been mica in boulders of schist in the recent gravels, but Bristow states that the Miocene gypsum is accompanied by flints and other minerals.

Arabia probably means Arabia Petraea, i.e. Sinai, of which King Juba I wrote a history. I have not verified Pliny's reference in the existing fragments of Juba's words. Gypsum is abundant in various forms, sometimes highly translucent; apart from such prosaic works of reference as Geological Survey Memoirs, Dr. Thomas Shaw in the first half of the eighteenth century says, 'amongst the fossils the Selenites is observed to shoot itself sometimes for 30 or 40 yards together in a great variety of shapes and colours'.

Thus we have seen that of seven localities mentioned by Pliny for *lapis specularis* all can produce gypsum or selenite; two or three might produce mica, but there is no evidence that any produce crystals of that mineral of a size possible for the chief use mentioned below; the properties mostly suit both minerals, but some *lapis specularis* is burnt to produce plaster of Paris, as has been done with the gypsum of Cyprus from the fourth century B.C. to the present day. It seems certain that there can be no great inaccuracy in assuming that the term means translucent gypsum or selenite, with the proviso that mica may have occasionally been mistaken for that substance. The view is supported by Isidorus, who wrote early in the seventh century; he is the first commentator on Pliny and was specially interested in the meaning of words; he says that there are many kinds of gypsum, the mineral not plaster, of which *lapis specularis* is the best.

It should perhaps be mentioned that both the words *mica* and *selenites* are used by Pliny. The former means a grain or crumb and is applied to rock-salt, marble, &c., not to any specific mineral. The latter, adopted from the Greek of Dioscorides, occurs only once, in the catalogue of gemstones which concludes his

book (XXXVII, 10): it is white, transparent, with a lustre like honey and holds an image of the moon. It is supposed to originate (*nasci putatur*) in Arabia. This last phrase is a cautious emendation of Dioscorides, who simply says it comes from Arabia. It seems certain that we should translate, not transliterate, the word as moonstone in the sense of adularia; it probably came with other gems from Ceylon (Taprobane). The trade in these gems through the Red Sea ports (see the 'Periplus of the Erythrean Sea') was beginning to be understood by the Romans in Pliny's time. Many fantastic legends of the connexion between *selenites* and the moon (Greek, *σελήνη*) grew up later; a full history is given by Adams in his chapter on 'Quaint stories and beliefs' with the appropriate subtitle 'mineral moonshine'. That the medieval confusion makes any scientific identification of the mineral hopeless is indicated by the opening words of Marbodius's account: 'Nor must we pass the Selenites by, Whose hues with grass or verdant jasper vie.'

For the classical use of the material, the most important passage, since it gives a date, is Seneca, Epistle XC: 'We know that certain devices have come to light only within our own memory, such as the use of window-panes [*specularia* as opposed to *fenestra*, which is the opening in the wall] which admit the clear light through a translucent slab (*per lucente testa*).' Seneca died in A.D. 65. In his better-known letter about Scipio's villa (Ep. LXXXVI) he commends the simplicity of his bath-house with mere chinks for ventilation as opposed to the modern luxury of glazed windows, behind which one could sun-bathe and acquire tan as well as wash! There are several allusions to such panes, though some leave it vague whether stone or glass was used. Juvenal (IV, 20) has an amusing passage about a gourmand who gave a huge price for a mullet and ate it himself; it would have been better if it had been a present for a courtesan, carried about the streets in a sedan chair with wide *specularia*. Pliny, the Younger, nephew of the naturalist, described his country house; it had a little hall with glazed windows, as had also the summer-house or gazebo in the garden. Some interesting passages are quoted by Nixon, but I have not been able to verify the first by reference to the original texts. Philo Judaeus in his account of his embassy to the Emperor Caligula says that the Emperor broke off the discussion and hurried away into a spacious hall where he ordered the windows to be shut on every side; these were constructed with plates of *lapis specularis* almost as transparent as glass, which admitted the light but excluded the wind and the heat of the sun. The embassy was in A.D. 40. Again, he quotes Lactantius, who died in 325, to the effect that light is admitted through the eye as though through windows of clear glass or *lapis specularis* (De Opifice Dei, VIII).

From the younger Pliny's gazebo it is an easy step to greenhouses. Martial (VIII, 14) speaks of fruit trees protected by *specularia*, to admit the sun and keep out the cold winds and also (VIII, 68) of grapes similarly protected by transparent stone (*perspicua gemma*), covered but not concealed, like the charms of a lady in a silk dress. Cucumbers should be grown in wheeled frames so that they can be moved into the sunniest spots; even so they must be protected by *specularia*. In this way the Emperor Tiberius was enabled to have cucumbers all the year round (Columella XI, 398, and Pliny XIX, 64). Beehives were often made with windows of *lapis specularis* so that the bees could be watched at work within. As Pliny (XXI, 20) uses the word *lapis* here, it seems probable that the

cucumber frames also were of this material rather than glass. He also mentions the use of the stone in small fragments to sprinkle on the arena and produce a glitter (XXXVI, 22), while Petronius says that the floor of Trimalchio's dining-room was spread with a mixture of sawdust dyed with saffron and cinnabar, and of ground-up *lapis specularis*. Here again the mineral cannot be mica, which can only be ground in a ball-mill, since it lubricates the surfaces of millstones and would not be separated from the quartz of powdered mica-schist for such a purpose. Isidorus refers to the earlier uses and says that *lapis specularis* is a most delightful addition to a head-dress (*corona*); this probably implies glittering particles and may be compared to the powdered head-dresses and wigs of a much later period.

Some of the uses mentioned above seem to have died out in the Dark Ages. The *Geoponica*, composed originally by Cassianus Bassus about A.D. 600 but revised and published for the Emperor Constantine Porphyrogenitus about A.D. 950, gives very full details for growing cucumbers, including methods of getting early fruit, but makes no mention of frames with either glass or *lapis* panes. But in Renaissance times the use of selenite for window-panes was widespread.

The premier author is, of course, Georg Bauer, better known by his Latin name Agricola, who has been called the father of mineralogy. His 'Bermannus,' a dialogue on minerals, is dated 1529. He says that *lapis specularis* is now called Mary's Glass and then quotes Pliny's account, incidentally mentioning 'Aphrica' [i.e. Africa]: 'on account of the properties described it is used in windows no otherwise than glass, as in the old Church of Marsiburg (Thuringia). It is found in Germany so plentifully that they get it in cart-loads, and also in Gaul.' There follows an account of its use in medicine, chiefly for stopping bleeding, external or internal as in dysentery; this is mainly taken from Dioscorides and Galen. His later 'De natura fossilium' (1546) adds very little except, what might have been guessed from the medicinal use, '*lapides quaedam obturant viscera, ut gypsum, ut lapis specularis*'. He is responsible for the statement, universally adopted, though as quoted above probably wrong originally, that selenites is gypsum.

The '*Musaeum metallicum* of Aldrovandus' was published by his pupil Bartholomaeus Ambrosinus in 1648. It is impossible to say how much is the original material and how much is editorial comment: in translating the following extracts I have had the assistance of Dr. Eichholz of Bristol University.

'Since *Lapis specularis* is easily split into thin plates, it fulfilled in antiquity the function of glass as a means of filling in windows in buildings, just as it does even to-day in districts where it is found most commonly. Consequently "*speculare*" and "*specularium*" are terms applied to a kind of window so designed as to admit light into a building and at the same time exclude damaging rain and wind. Windows of this kind used to be made in winter and removed in the summer. As a matter of fact in Italy and particularly at Bologna, the home of Aldrovandus, where it is quarried in great quantities, this stone is used even now during the winter in show rooms. The merchants fashion casements of parchment and insert in them strips of selenite. In this way they protect themselves from the inconveniences of the cold weather and also watch the public as it passes by.'

We must remember that window-glass was then a rare and costly luxury. Thirty years later Edward Brown refers to Bohemian glass, saying that in Prague 'the windows of palaces and fair houses are of glass and look not so tatteredly as the paper windows of Florence'. Ambrosinus then quotes Martial, Juvenal, and

Agricola, adding a church at Korswyk in Saxony as having, on the last's authority, windows of *lapis specularis*. Though I have not noted any other German localities, the general use of the terms Marienglas or Our Lady's glass seems to imply familiarity with the material; Rudler mentions that in the Permian rocks close to Reinhardsbrunn there is a grotto called the Marienglashöhle. The term is comparable with the constantly used 'Muscovy glass' for our muscovite mica. After giving the passages I have already used from Pliny and Columella, the account in Aldrovandus continues 'nor should we draw a veil of silence over the statement which Andreas Bacchus has entrusted to his memoirs regarding the employment of the specular stone in public baths. A transparent slab (*testa*, cf. Seneca above) of the stone would be placed in front of the baths and, reflected in its pellucid depths, the naked persons of the bathers within would appear larger than life and almost like giants'. The quotation is presumably from Andrea Baccio or Baccius, whose 'De gemmis et lapidibus' was published in 1603, but, according to Adams, in Italian at an earlier date. I have not been able to see this book and check the reference; the picture given presents certain obscurities, but perhaps that is as well! Referring to Pliny's beehives he says that 'even in our time some people have constructed hives with this material, in which one can see to advantage how much the bees have produced on any one day'. The remainder of the passage refers to magical properties and ends with the bold statement 'this I consider to be nonsense'. We are also indebted to Aldrovandus for the illustration mentioned below.

For Cyprus, Richard Pococke included a chapter on Natural History, published in 1745: 'The soil of Cyprus is for the most part rocky; there are in it many entire hills of talc or gypse, some running in plates and another sort in shoots, like crystal; the latter is used in many parts especially at Larnica as stone for building.' Jeffrey, in his recent archaeological report, says that the church of St. Catherine at Nicosia has windows 'filled in with the curious perforated gypsum slabs in place of glass', as has also the cathedral of Famagusta and a medieval monastery. The date when these slabs were inserted is unknown.

In 1664 Francis Willughby was travelling in Spain; his account is preserved with John Ray's Travels. On September 1 he records 'near *C. de Creux* upon the mountains they find a kind of *Selenitis* which may be cut or slit into very thin plates like the common *Muscovy glass*' [mica]; and later 'we came to *Cardona* . . . we viewed the mountain of salt . . . not far from this there is another mountain of salt where the salt sticks to the rocks, and is most of it tinctur'd with red . . . amongst this red salt there is a kind of *Selenitis* (which some call ising-glass and the *Italians Gesso* from the *Latin* word *Gypsum* signifying Chalk, because when burnt it is turned into a white *calx*) which naturally roches into parallepipediums of the figure of a lozenge'. Though it is not definitely stated, the passage strongly suggests that the mineral was used.

No doubt the increase of glass manufacture soon ousted the use of selenite for windows in the old world, except Cyprus. In parts of South America it continued. Speaking of the Permo-Trias of Bolivia, David Forbes in 1861 wrote: 'The gypsum beds are frequently of great thickness and extent . . . and produce abundance of fine alabaster extensively used for the purposes of architecture (for example, the fountain in the Alameda of La Paz, &c.): some of the slabs of this material are so transparent that tablets of it, until very lately, have been in

general use in this part of Bolivia as a substitute for window-glass: I noticed that the windows of the church at Pisacoma were formed of this material in slabs of about two inches thick.' Clear gypsum invariably accompanies the copper ores, as does some of the Cyprus material.

One point arising out of the above deserves discussion. It has been suggested by John Woodward that in the use of selenite lies the reason for the use of diamond-shaped or diamond-wise placed panes of glass in windows. Some explanation of this ancient custom is necessary, since it involves the needless trouble of a border of half-panes in order to fill a rectangular space. Similar labour-wasting habits can frequently be traced back to a former use of a material that necessitated them. Innate conservatism causes a lag in adaptation to the new conditions. Now a diamond shape, or to use Willughby's word a parallelepipedum or lozenge, is almost inevitable when a cleavage plate of selenite is used. That it actually was so is shown by a specimen of such a pane of Roman imperial date dug up in the Campagna and figured in Aldrovandus; this is a lozenge with diagonals $6\frac{1}{2}$ by 3 inches, assuming that the figure is natural scale. His figures of fossils (in the modern sense) show that this was his custom. In the first century selenite and glass panes were introduced almost simultaneously, but the former did not control the shape of the latter. Mr. J. Allen of the British Museum tells me that in the tepidarium of the villa of Diomedes at Pompeii four panes of glass were found still in a wooden frame; they were squares of about $10\frac{1}{2}$ inches. All the available evidence points to rectangular glass panes and even in this country May has described what is almost certainly a stone mould for making window-panes at the Roman glass works of Wilderspool near Warrington; the panes were rectangular, 12 by 8 inches.

On the other hand, when window glass began to be common in the fifteenth and sixteenth centuries, selenite panes were in considerable use in the very countries, Germany and northern Italy, where glass making began to flourish. The only other attempt to explain diamond-shaped panes that I have come across is in Brigg's 'History of building crafts'. 'The background (of coloured windows) was divided into diamond-shaped quarries, this form probably having been suggested by the light "lattices" of inter-lacing twigs that preceded glazing in the windows of earlier cottages.' But this does not explain why the lattice of twigs should be diagonal instead of parallel to the sides of the frames. The connexion with selenite must at present, and may always, remain a plausible but unproven suggestion.

To what extent gypsum or selenite panes still exist I do not know. It is a point which few authors, whether antiquaries or geologists, are likely to mention, and the time is not favourable for research or inquiry in either Germany or Italy; there is reason to believe that some survive in the latter. King, in his 'Natural history of gems' published in 1867 says (footnote *s.v.* Alabastrites) that 'in certain very ancient Italian churches (as San Miniato) the windows are filled in with single slabs of a translucent stone which is not Talc, and thus, probably, preserve an example of this Phengites'. Maurice Hewlett describes the church of San Miniato near Florence: 'then there is the upper Choir which contains the Tribune . . . its windows are of sliced onyx'. The word onyx, when not referring to a siliceous mineral, normally means stalagmite or travertine, but it seems more probable that the material in San Miniato is the gypsum of Volterra, 30 miles

distánt. In any case the panes are clearly mineral, not glass. A visitor as recently as 1938 has told me that she noticed the delightfully soft effect of the light.

Since this paper was read, Dr. R. W. Pocock (of the Geological Survey, a descendant of Dr. Richard Pococke quoted above) tells me that he saw window panes of fine alabaster in one of the ancient churches of Rome.

Also I am indebted to Mr. R. C. Spiller for the information that the mineral collection in the museum at Oxford contains a plate of selenite labelled 'Cyprus'; it is a rhomb with sides 10 and $5\frac{1}{2}$ inches, the obtuse angle between them about 115° . It is $1\frac{1}{4}$ inches thick; it is colourless and transparent, with slight yellow zoning near the edges. Obviously such material would be quite suitable for use in windows.

References.

- For classical authors the text and/or translation given is that which has been consulted. Roman numerals before B.C. or A.D. give the century during which the author wrote.
- ADAMS (F. D.). The birth and development of the geological sciences. London, 1938.
- AGRICOLA (G.). De ortu et causis subterraneorum, De natura fossilium, Bermannus sive de re metallica dialogus, &c. Basle, 1546.
- ALDROVANDUS (U.). See Ambrosinus.
- AMBROSINUS (Bartholomaeus). U. Aldrovandi . . . Musaeum metallicum. Bologna, 1648.
- ANSTED (D. T.). In search of minerals. London (S.P.C.K.), 1880. Includes many extracts from a verse translation of Marbodius by Rev. J. King.
- BAILEY (K. C.). The Elder Pliny's chapters on chemical subjects. Text, translation, and notes, parts I and II. London, 1929 and 1932.
- BASSUS (Cassianus). Geoponica. c. 600 A.D. Edited for and attributed to Constantine Porphyrogenitus, c. 950 A.D. Text and Latin version by P. Needham. Cambridge, 1904. French translation, Lypn, 1550.
- BAUER (Georg). See Agricola.
- BRIGGS (M. S.). Short history of the building crafts. Oxford, 1925.
- BRISTOW (H. W.). Glossary of mineralogy. London, 1861.
- BROWN (E.). Travels through Germany. London, 1667.
- COLUMELLA (L. Jul. Moderatus). ob. 42 A.D. De re rustica. Text in Libri de re rustica. Paris, 1543.
- CONSTANTINUS (Porphyrogenitus). See Bassus.
- DIOSCORIDES (Pedacius). I A.D. Opera omnia. Hanover, 1598.
- FORBES (D.). On the geology of Bolivia and southern Peru. Quart. Journ. Geol. Soc. London, 1861, vol. 17, p. 38.
- GAUDRY (A.). Geology of the island of Cyprus. English translation from French. London (H.M.S.O.), 1878.
- HEWLETT (M.). The road in Tuscany. London, 1906.
- ISIDORUS (Bishop of Seville). ob. 636 A.D. Originum, sive etymologiarum Libri XX (Lib. XVI de metallis). In Auctores Latinae linguae. St. Ger vase, 1602.
- JEFFERY (G.). Historic monuments of Cyprus. Cyprus Government, 1918.
- JUVENALIS (D. Junius). fl. 82 A.D. Text with notes by Prateus. London, 1699.
- KING (C. W.). Natural history of gems and ornamental stones. London, 1867.
- LACTANTIUS FIRMIANUS (L. Coelius). ob. c. 340 A.D. Opera omnia. Cambridge, 1685.
- MARBODUS. XI A.D. See Ansted.
- MARTIALIS (M. Valerius). ob. 103 A.D. Text with notes by Farnabius. Leyden, 1661. Translation, Bohn's Library, London, 1909.
- MAY (T.). Warrington's Roman remains. Warrington, 1904.
- NIXON (J.). Antiquity of glass in windows. Two letters in Phil. Trans. Roy. Soc. London, 1759, vol. 50, pt. 2; 1761, vol. 52, pt. 2.
- 'Periplus of the Erythraean Sea.' I A.D. Author unknown. Text, wrongly attributed to Arrian, in Dodwell's Geographicae Scriptores Graeci Minores, vol. 1, Oxford, 1698. Translation with notes by W. H. Schoff, New York and London, 1912.

- PETRONIUS (T. Petronius Arbiter). *ob.* 67 A.D. Text and translation by W. H. D. Rouse, Loeb Classical Library, London, 1913.
- PLINY, THE ELDER (C. Plinius Secundus). *ob.* 79 A.D. *Historia mundi [or] naturalis*. Text Elzevir. Leyden, 1635. Translation by Philemon Holland, 2 vols. London, 1634 and 1635. *See also* Bailey.
- PLINY, THE YOUNGER (C. Plinius Caecilius Secundus). *fl.* 109 A.D. *Epistolae*. Text Elzevir. Amsterdam, 1659. Translation by J. D. Lewis. London, 1879.
- POCOCKE (R.). *Description of the East, &c.* vol. 2, pt. 1. London, 1745.
- RAY (J.). *Travels in the Low Countries . . . to which is added the travels of Francis Willughby*. London, 1738.
- RÜDLER (F. W.). Gypsum. *Encycl. Brit.* 11th ed., 1910, vol. 12.
- SANDFORD (K. S.). *Geology of Italian North Africa*. *Quart. Journ. Geol. Soc. London*, 1842, vol. 98, p. xv.
- SENECA (L. Annaeus). *ob.* 65 A.D. *Epistolae*. Text with notes by Lipsius. Antwerp, 1652. Text and translation, Loeb Classical Library, London, 1930.
- STENO (Nicolaus). *The prodromus of . . .* 1669. Translated by J. G. Winter, Univ. Michigan Studies, vol. 11, New York and London, 1916.
- STRABO. I B.C.-I A.D. *Geography*. Translation by Hamilton and Falconer, Bohn's Library, London, 1912.
- SUETONIUS (C. Suetonius Tranquillus). *fl.* 116 A.D. Text with notes by S. Pitiscus. Leuwarden, 1714.
- THEOPHRASTUS. IV-III B.C. Text and Latin Version, F. Wimmer, Paris, 1931. Text and translation with notes, Sir J. Hill, 2nd ed. London, 1774.
- WILLUGHBY (F.). *See* Ray.
- WOODWARD (J.). *Natural history of the fossils of England*. vol. 1. London, 1729.
- ZETTLER (H.). *Mica; its history, production and utilisation*. London, 1913.
-