Ships' loadstones.

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FROM the beginning of classical times it was well known that the mineral conveniently called loadstone, whether magnetite in the strict sense or some other compound, attracted or, better, adhered to iron; also that this property was imparted to a piece of iron in contact with a loadstone, so that a chain of disconnected iron rings could be suspended from it. This action aroused such wonder that many superstitions gathered round the stone which was reckoned throughout the Middle Ages as a gem. A genuine economic value was given to loadstone when the further discovery was made that a suitably shaped piece of the stone, or of iron touched with it, if free to move, would always aline itself approximately north and south. When, where, and by whom this property was discovered and turned to practical use as a direction-indicator, in short the origin of the magnetic compass, has long been a subject of controversy. The evidence cannot here be considered, but it is certain that a primitive compass was familiar in various parts of Europe by A.D. 1200. Informed opinion tends to the conclusion that this knowledge was derived neither from the Chinese nor from the Arabs, but was original to the west. H. Winter (1937) has recently argued, against the claims put forward for Italy and the Mediterranean or for northern France, in favour of a Viking origin. Without further research the only definite evidence is assigned to about the year 1225, somewhat later than the references in the works of Alexander Neckham, the Englishman who was for some time in Paris, and Guyot de Provins; this is a gloss on a passage in the Saga of Floki, the discoverer of Iceland in A.D. 874, as follows: 'in northern lands those who sailed the sea had not then the loadstone.' On the other hand, a northerner who was for many years a superintendent of mines, Emanuel Swedenborg, discusses the question at length (Principia, Cap. XI, Experiment LXXXI) and says that 'the use of the compass at sea seems to have been first known to those inhabitants of Gaul who occupied the shores of the Mediterranean'.

It is possible that in the earliest times the loadstone itself was fixed in a wooden case which would float on water; this method is mentioned

by Petrus Peregrinus, and is reflected in the Italian word for a compass, *bussola*. That there were two poles in a natural magnet had been known since classical times. More often a conveniently shaped piece of iron was touched on the stone to magnetize it and this was floated.[1] Such objects were always to hand on board ship—the needles used for repairing sails; hence the pointer of a compass, though soon made specially and adorned with a fleur-de-lis at the point and made to balance on a pivot, became known generally as a needle. An actual needle magnetically suspended from a loadstone is figured by Gesner (1565). The needle was floated on water either on a straw or stick, the 'festu' of Guyot de Provins (1206), or, according to another poet of about the same date, passed through a cork. Neckham, in the 'De utensilibus' (? 1200) seems to indicate a pivot. A needle attached to a compass-card is regarded as a novelty by Camillus Leonardus in 1502. About the same time Leonardo da Vinci, in an allegorical drawing, shows a wolf steering a boat by means of a compass with a card: by this means deviation from true north, well known by the end of the fifteenth century, could be allowed for.

In earlier times it was generally supposed that the pole of the magnet was influenced by and directed to the north star. This is stated (about 1218) by de Vitry (Hist. of Jerusalem, Cap. LXXXIX), but Roger Bacon (about 1260) doubted it; he demonstrated the property of the 'ugly black stone' to Brunetto Latini (about 1294), whose pupil Dante states that 'the Star the needle's course incites' (Paradiso, XII, 28–31). Another popular theory was that the needle pointed to the original source of the loadstone with which it was touched; North Sea mariners —Norwegians, Danes, French, and English—might for a while have found this idea plausible, as their loadstones mostly came from the extreme north of Europe. Gilbert's book on the magnet, describing his many experiments, appeared in the year 1600. Not everyone accepted his famous conclusion that the earth is itself a magnet: Kircher in 1643 denies it, as does Martin Lister (1698), who not unjustifiably maintains that it is premature to formulate any theory until more is known about the 'effluvia' which pass between the poles of a magnet and the iron, as also that the earth does not as far as is known consist of iron. Gilbert's method of increasing, or concentrating, the power of a loadstone was, however, immediately adopted everywhere. Iron caps or plates were

[1] Michael Scot, probably not later than 1216, says that those who sail the high seas make use of the magnet and iron (L. Thorndike, History of magic and experimental science. New York, 1923, vol. 2, p. 324).

attached at the poles, and a loadstone thus treated was said to be 'armoured' or 'shod'. Kircher figures one corresponding exactly with those now exhibited; Lister mentions one that he was shown in Paris; it 'weighed not above a Drachm and would naked take up a Drachm and a half; but shod it would take up 144 Drachms of Iron'. He adds a caution—'N.B. A strong Loadstone ought to have large Irons, and a weak one but thin Irons; so that a Stone may be over-shod.'

Such mounted loadstones, with the two iron pole-pieces projecting above the body to facilitate application to a needle, were in common use by the middle of the seventeenth century. Webster's 'Metallographia' (1671) says 'like this description are the fragments that we buy at the shops as also that which we have capped with Steel, and bound with Brass or Silver'. Artificial magnets, an easy method of making which was described by John Canton in a paper read in 1750, had probably ousted loadstones by about the end of that century.

Thus for a full 600 years loadstone was an economically important mineral. Pre-eminence over gemstones was claimed for it: Robert Norman, in 'The newe attractive' (1581), described a dispute among precious stones:

> Magnes, the Loadstone I your painted sheaths defie,
> Without my helpe, in Indian Seas the best of you might lye,
> I guide the Pilot's course, his helping hand I am,
> The Mariner delights in me, so doth the Marchant man.
> My vertue lies unknowne, my secrets hidden are,
> By me the Court and Common-weale are pleasured very faire.
> No ship could sayle on seas her course to run aright,
> Nor Compasse shew the ready way, were Magnes not of might.

or Nathaniel Baxter's 'Sir Philip Sydney's Ourania' (1606):

> All mariners of force must be dismayed
> If they should want the Load-stone's blessed ayde;
> By this they saile, else knowe not where they were,
> Such sov'reigntie in Ship doth Magnes beare.

After its supercession for practical use by artificial magnets loadstone degenerated into a mere ore of iron or a scientific curiosity. As late, however, as 1819 Sir Richard Colt-Hoare writes that in Elba at Punta della Calamita, the headland so called from the loadstone rocks there, 'large veins of this substance are intermixed with iron ore'; so some trade may have survived.

The mounted specimens are commonly called 'ships' loadstones' and were sometimes at any rate carried on board ship. Captain Thomas James made a voyage to discover the north-west passage in the years

1631–32; the inventory of the instruments taken includes, besides dozens of 'meridian compasses' and needles, 'four special needles . . . of six Inches Diameter and toucht curiously with the best Load-Stone in England' and 'a Load-Stone to refresh any of these, if occasion were; whose Poles were marked for fear of mistaking'. Again, on a voyage of de Castro in the east in 1538–39 'the stone now used by the pilot to remagnetise the needle was from the coast of India'.

Such loadstones would be used by all compass-makers and by some land-surveyors and travellers, as well as by sea-captains: Pero Tafur in 1439 says, of the Egyptian desert, 'they navigate here with the compass as at sea'. Mine-surveyors seem to have made comparatively little use of loadstones: Agricola (1556) in Book III of the 'De re metallica' gives an elaborate description, with a figure, of compass-cards—'within the innermost circle it is hollowed out to contain a magnetic needle'. The notes and appendix in the Hoover translation mention an earlier work, the 'Nützlich Bergbüchlin' of Calbus (von Kalbe), a mine-surveyor and burgomaster of Freiberg, who died in 1523; this describes and figures a miner's compass, but 'there is not the slightest reference to its use for anything but surface direction of veins'. Porta (1558), who devotes the whole of Book VII of his 'Magia naturalis' to the magnet, also mentions the use for this purpose and 'especially in making tunnels for aqueducts' (Cap. xxvii).

The method of touching the iron with the stone is described in full by Martin Cortes in 1551 and by William Barlowe in 'The navigator's supply' (1597). By this time the single needle had been replaced by two wires, their ends soldered together and their middle parts attached to and separated by the 'fly' or socket-piece to be placed on a pivot. (The Oxford Dictionary gives the word fly as 'a compass card', with the date 1571 for its earliest use.) Barlowe writes:

'As for the touching of the wyars of the Flie with the Load-stone, I would wish it to be performed after this sort. First of all, have a great care of the goodnesse, the quantitie and the forme of the Stone; for if he be never so good, and very small therewith, he can give but small force unto the Compass: and againe, though he be never so great, yet if he be of base qualitie, his touche can be but faint. An ovalle forme, or somewhat longer, retaining a like proportion from the middle to each end, is very good. Alwayes provided that the length of the stone lie according to his owne line of North and South: for a stone of this forme giveth foorth his vertue in the touche a great deale more forcibly then it can, if by reason of the evil shape thereof, his force in himselfe be confusedly dispersed, and not joyntly directed to his due points. The wyers before they bee touched, ought to be polished and made very cleane, and fitted unto the Flie, and then touched after this manner. With the North end of the Stone, presse each wyer, beginning at the middle, and so along unto the ende, that you would have turne Southerly: and with the South end of the

Stone doe the like from the middle of eache wyer, unto the end that you would have turne Northerly. Then glewe them in such sort, that the Flie may stand equally upon his pinne, having both the North and South endes of the wyers uncovered, that their Touche may be refreshed, as occasion shall require.'

Loadstone is said by Pliny to have been found first on Mt. Ida; also at two of the ancient places called Magnesia (in Macedonia and Asia Minor respectively), Cantabria in Spain, Boeotia, the Troad, and Aethiopia (XXXIV, 42 and XXXVI, 25). Isidorus (early seventh century) practically quotes Pliny, but substitutes India for Ida (XVI, iv, 1). India became the best-known locality; it is given by Marbodus (*c.* 1080) and all his imitators, and by de Vitry (Hist. of Jerusalem, LXXXIX) about 1218. Marbodus also mentions the country of the Troglodites, probably equivalent to Pliny's Aethiopia. Albertus Magnus, writing about 1250, adds the interesting fact that he himself saw it mined in Germany (De Min., Lib. II, Tract II, Cap. 11). He does not mention the directive property, but in 1269 Petrus Peregrinus wrote the first treatise specifically on the loadstone. He describes clearly a method of finding the poles and says that the stone is found in northern regions and is brought by sailors to the ports of Normandy, Picardy, and Flanders. Only his epistle on the magnet appears to have survived, but Roger Bacon (Op. Tert., Cap. XIII) declares that he 'knows by experiment all natural history, and physic, and alchemy, and all things in the heavens and beneath them. . . . Wherefore he has inquired into all the operations of metal-founding, and the working of gold and silver and other metals, and of all minerals' (trans. S. P. Thompson). Though I have not found a definite statement earlier than Porta (VII, Cap. vii) in 1558, it seems likely that the loadstone of Elba was known by this time; the exact locality, Cape Calamita, is named from it. The name *calamita* for loadstone, current all round the Mediterranean, is, according to C. H. Haskins, used by Michael Scot about 1217; it is almost certainly derived from Arabic and has been attributed to Rhazes (first half tenth century); Scot, at the court of Frederick II, Stupor Mundi, in Sicily, was one of the earliest scientists to introduce oriental learning to the west. Popular attempts to derive the word *calamita* from Latin or Greek result in nonsense.

The first independent and reliable list of localities for loadstone is given by Agricola in 1546 (De Nat. Foss., V): the Cantabrian province of Spain; an island in the north off the coast of Lapland, which takes its name from Magnes; in Germany he gives, obviously from personal observation, the Harz Forest, Swarzburg, Joachimsthal, Franconia, and Bohemia; for several of these his localities are precise; for example, the

first is a single shaft beyond Harzburg by the seventh (mile)-stone from Goslar, and for others a particular mine is named. He then gives a version of Pliny's list with additional comments—India, near the river Indus and in certain coastal rocks. Agricola evidently was as careful with his references as with his observations, for he points out that Pliny follows, as he himself mentions, an otherwise unknown author, Sotacus. Throughout the seventeenth century others quoted or misquoted, with or without acknowledgement, from Agricola; one Italian writer (Moscado) omits several words and, more disastrously, a semicolon, with the misleading result that he implies an island called Calamita off the Cantabrian coast of Spain.

There is no need to mention here the gradual accumulation of known localities for loadstone, but those in Britain may be of interest; apparently only those in Devon were actually utilized. Unfortunately the earliest records are open to question: Gilbert (Book I, Cap. 2) says 'In England quite lately a huge power of it was discovered in a mine belonging to Adrian Gilbert, gentleman; also in Devonshire and the Forest of Dean' (translation, p. 11). Silvanus Thompson has a note that 'Adrian Gylbert of Sandridge in the Countie of Devon, gentleman, received from Queen Elizabeth a patent for the discovery of a North West passage to China'. He would therefore be interested in loadstones; but Sandridge Park is about four miles west of Brixham. Both that district and the Forest of Dean are well known for deposits of haematite, but not of magnetite. We can only speculate on the explanation; neither locality is mentioned again. Camden in 1607 mentions 'Dertmore where loadstones have lately been found' (Gibson's translation). Childrey's 'Britannia Baconica' (1661) adds that they are 'of good value and vertue'; in the same year Webster (Metallographia, p. 350) says 'I have had it from some Gentlemen of very great worth that lately there is found good store of it in the aforesaid county of very excellent force and vertue'; but Christopher Merrett (Pinax, 1667), after commending the Dartmoor loadstone, adds 'et alibi viliores'. The Philosophical Transactions for 1666 (no. 23) record that a loadstone from Devon weighing 60 lb. was exhibited to the Royal Society; it was not very strong in lift, but moved a needle at a distance of nine feet. Polwhele's 'History of Devonshire' (1797, vol. 1), quoting various topographical writers, mentions the following Devon localities: Sotwardstone, South Brent, North Molton, Ashburton, and Hennock, but adds significantly that the stones from the Persian Gulf are better. John Woodward's collection included two specimens of loadstone from Devon. The only other

mention of British loadstone that I have noticed is Sibbald's remark (1684, Lib. IV, Cap. v) that it is said to occur (not necessarily worked) 'in Rupe Arcis Britannodunensis', i.e. in the Castle Rock of Dumbarton.

Besides the two mounted loadstones exhibited, that in brass belonging to, that in silver on loan to, the Geological Survey Museum, Commander A. M. Hughes, R.N., kindly supplied me with a list of nine in the National Maritime Museum, Greenwich; the earliest, in brass with poles marked N. and S., is attributed to the second half of the sixteenth century; five, in brass, bronze, or silver, to the seventeenth; and three to the eighteenth. In the Museum of the History of Science at Oxford some half-dozen examples include a very small one in gold and one in silver closely resembling that lent to the Geological Survey Museum; this bears an inscription in Russian and the date 1741.

One of the many superstitions regarding the loadstone may be mentioned as it is relevant to the use for compasses. It was held for many centuries that garlick or onion nullified the power of a magnet. I can offer no suggestion as to the origin of this idea. It was refuted by Porta (Magia naturalis, VII, Cap. xlviii) about 1530; confirmed by Van Helmont in 1621; again refuted by Sir Thomas Browne with many experiments. Several other writers have pronounced against it, but such well-established traditions die hard. In the sixteenth and seventeenth centuries there was current definite rule that ships' captains must not eat garlic at sea, lest their breath subsequently cause the compass to deviate and so lead to the loss of their vessels. Perhaps Mediterranean captains carried mounted loadstones to revive the needle if or when they yielded to temptation. The passage in Porta is worth quoting. I have not seen the English translation of 1658, but copy it from Silvanus Thompson's notes:

'It is a common Opinion amongst Sea-men, That Onions and Garlick are at odds with the Loadstone: and Steers-men, and such as tend the Mariners Card are forbid to eat Onions or Garlick, lest they make the Index of the Poles drunk. But when I tried all these things, I found them to be false: for not only breathing and belching upon the Loadstone after eating of Garlick did not stop its vertues: but, when it was all anoynted over with the juice of Garlick it did perform its office as well as if it had never been touched with it. . . . And again when I enquired of Marines, whether it were so, that they were forbid to eat Onions and Garlick for that reason, they said They were old Wives fables, and things ridiculous; and that Sea-men would sooner lose their lives then abstain from eating Onyons and Garlick.'

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(Includes text of Neckham's De utensilibus and of Guyot de Provins's poem La Bible, with notes.)

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