II. "On the Magnetism of Iron Ships, and its accordance with Theory, as determined externally, in recent Experiments." By the Rev. W. Scoresby, D.D., F.R.S., Corr. Memb. Inst. France, &c. Received June 21, 1855.

The magnetic condition of iron ships is a subject of so much importance, practically and scientifically, that I have been induced to submit to the Society a few characteristic facts (hastily indeed brought together) derived from recent experiments.

In a work in the Society's library, entitled 'Magnetical Investigations,' it was shown, by deductions from an elaborate series of experiments on plates and bars of malleable iron, that the magnetic condition of iron ships should, theoretically, be conformable to the direction of terrestrial induction whilst on the stocks; and the *retentive* quality, which is so highly developed by virtue of the hammering and other mechanical action during the building, should be so far fixed in the same direction, as to remain after the ships might be launched, until disturbed by fresh mechanical action in new positions of their head or keel. In this view, taking, for instance, the condition of the middle, or the main breadth section of a ship on the stocks, the magnetic polar axis should assume the direction of the dipping-needle (with an equatorial plane, or plane of no-attraction at right angles to it), passing through or proximate to the centre of gravity of the iron material in such section. Thus every ship should have a characteristic magnetic distribution, primarily, dependent on her position whilst on the stocks; so that, being built with the head north or south, the *equatorial plane* should appear externally on the same horizontal level, the *polar axis* only being inclined from the vertical, in correspondence with the direction of the axis of terrestrial magnetism (Magnetical Investigations, vol. ii. pp. 331, 332).

It was also inferred, that whilst such individuality of the magnetic distribution would be rendered *retentive* on the same principles as this quality of magnetism is developed in bars or plates of iron by mechanical action, so the axial direction of the ship's magnetism would be *liable to change*, under mechanical action, in new positions of the ship's head, or under new relations of terrestrial magnetism,

just as the retentive magnetism is liable to change in bars or plates of iron if hammered, vibrated, or bent whilst held in new positions.

And it was further inferred, that the analogy with plates and bars might be expected to hold, notwithstanding the numerous pieces of which the ship's hull might be composed, because, in experiments on combining short magnets into long series, or submitting piles of short bars of iron to terrestrial induction, it was found that no material difference in the effects occurred betwixt a *single* steel magnet of a given length, or a *single* bar of iron, and the same substance and dimensions combined in short or small pieces in contact. Hence it was considered that an iron ship should exhibit in its general fabric the characteristic phenomena of one undivided mass, or a unity as a magnetic body.

These anticipations, it will be seen (published betwixt three and four years ago), have, so far as we have now time to elucidate them, had verifications, in actual experiments on iron ships, as beautiful as they are conclusive.

In the case of the 'Elba,' an iron ship of 200 feet in length, built recently on the Tyne, the magnetic condition before launching, which I was invited to investigate by Mr. Robert Newall, the owner, was found satisfactorily accordant with theory. Her head pointed south a few degrees westerly, and her lines of no-deviation (indicative of the position of the magnetic equatorial plane) were at a small distance in elevation different on the two sides, that of the starboard side being the highest. Proceeding in a direction at right angles to the dip, and passing through, or near to, the ship's general centre of gravity, the lines of no-attraction (descending forward) came out near the junction of the stem with the keel. And *there*, it was remarkable, as I had suggested as probable to Mr. James Napier of Glasgow, before making any experiment, there was found a departure from the ordinary regularity of the lines of no-attraction in a considerable downward bend.

Towards the stern, the equatorial lines rose out of and came above the iron plating of the *top-sides*, about 40 feet from the tafrail; thus giving to the *after-part* of the ship a uniform northern polarity. The ship, consequently, had become a huge simple magnet—the north pole at the stern and the south at the head. The attractive

power, as was expected, was highly energetic. At the distance of 50 feet, a compass on the level of the keel, at right angles to it abreast of the stern, was deviated to an extent of above 10°; at 100 feet distance the ship's magnetism caused a deflection of about half a point; and at 150 and even 200 feet there was a very sensible disturbance!

In the case of the 'Fiery Cross,' built at Glasgow and launched in January last (a case which I have elsewhere referred to), the lines of no-deviation, as taken for me by Mr. James Napier, were still more rigidly in accordance with theory,—the difference of elevation of the observed lines of no-deviation at the main-breadth section agreeing with calculation, theoretically, to within an inch or two. In the other case, that of the 'Elba,' a slight discrepancy as to the comparative level of the lines of no-attraction on the two sides, might, perhaps, be satisfactorily explained by the proximity and somewhat disturbing influence of another iron ship (advanced only to the frames or angle irons) on the port side of her.

In the case of the 'Elizabeth Harrison,' a large iron ship built at Liverpool, the first I had carefully examined, the correspondence of the magnetic polar axis and equatorial plane with those of terrestrial action was equally characteristic and conclusive.

Hence we may perceive a sufficient reason for some of the peculiar phenomena in iron ships of the compass disturbances and their changes. We may see why a ship built with her head easterly or westerly, and having the polar axis inclined over 18° or 20° to the starboard or port side, should be *particularly liable to compass changes*, if severely strained or struck by the sea with her head in an opposite direction. We see why the compasses of the 'Tayleur' should have been exposed to such a change as appears to have taken place in her lamentable case. We see in the case of the 'Ottawa*' (one I have elsewhere referred to), why a heavy blow of the sea, with the ship heeling and her head pointing eastward, would be likely to produce a change in her magnetism, when her previous magnetic distribution was solicited by terrestrial action in an angle of 30° or 40° of difference. And we see why the *deviations* of the compass in iron ships should, differently from those of wooden ships, be sometimes *westerly* and sometimes *easterly* in ships built and trading in home

* Where the compass suddenly changed two points.

latitudes; for here, whilst in wooden ships, where the iron work is in detached masses, the ship can have but little, externally, of the character of a true magnet, and can possess but small comparative differences from the position of her head whilst building; in iron ships, on the converse, where the ship is rendered by percussive action a powerful and, *retentively*, true magnet, her deviating action must be expected to be different, as the polarity of the head or stern may differ in denomination, or as the ship's magnetic polar axis may happen to lie over to starboard or port.

As an objection might be made to deductions from experiments on simple individual bars or plates of iron being applied to the case of iron ships built up of thousands of pieces, I have repeated the experiments, substituting for an entire plate or bar of iron a plate about 18 inches long and 3 broad, made up of numerous separate plates, and combined in the manner of the plating of iron ships. The compound or combined plate of some eighteen or twenty pieces yielded, under percussion, vibration or bending, results precisely similar to those obtained by the use of single plates or bars.

III. Extract of a Letter from Professor Langberg of Christiania to Colonel Sabine, dated June 10th, 1855. Communicated by Colonel Sabine, V.P. and Treas. R.S.

"Of all the important results from the discussions of the British Colonial Observatory, the discovery of the *direct* action of the sun on the magnetism of the earth is certainly a fact of the highest interest, in opening quite a new field for investigation; and few modern discoveries in this branch of science have interested me more than yours of the annual variation of the diurnal variation of declination. It seems that M. Secchi of Rome has nearly touched at the same discovery, and I am indeed glad that the enormous quantity of calculations, which you are superintending, did not prevent you from publishing your results before the ripening fruit was plucked by another. The first beautiful result of this annual variation is the explanation of the fact, which you have deduced from the observations at St. Helena and the Cape of Good Hope, that the horary variation