

The position of the rock is in latitude $14^{\circ} 22' 8''$ S., longitude $42^{\circ} 41' 32''$ E., 18 miles from the island of Jebel Zukur, and the same from the eastern shore of the sea, and out of sight of land except in clear weather, when Jebel Zukur is visible. The dangerous portion of the rock is only about 40 yards in diameter, but the soundings round for about 100 yards give indications of its presence.

Its slope is not so very steep as in some other instances of coral banks in this sea. Assuming that coral after it attains within a certain distance of the surface grows mainly outwards, and that the almost perpendicular sides of some of the Red Sea reefs are mainly the result of such outward growth, the comparatively gentle slope of the *Avocet* rock may be taken to show that it is in an early stage of its development; a view which its small size also supports.

The rock lies on the bank of soundings on the eastern side of the deep-water gully up the centre of the Red Sea, near its edge, and close to the point where it comes to an end. It has frequently been noticed that coral patches most readily form on the edges of such steep submarine slopes—witness other parts of the Red Sea itself—but they generally take the form of a scattered line along such an edge, and it is not usual for one small and isolated patch to alone make its appearance.

This rock is nearly midway between the *St. Oswald's* position for the *Avocet* and the telegraphed position of the *Teddington*, and is about 350 yards from where the *Sylvia* was at one time anchored. It lies about $5\frac{1}{2}$ miles off the direct line between the Abu Ail channel and a point 3 miles west of the Zebayir Islands—the course generally taken by ships.

Seeing that transverse currents are by no means rare in the Red Sea, and also that many vessels—especially when bound north at night—habitually pass outside Abu Ail, it is a cause for marvel that no ship has ever struck this small danger before. One of the telegraph cables passes close to it—so close that it is doubtful on which side it lies, and the ship laying it may therefore be considered to have had a narrow escape. On the very morning of the *Avocet's* loss, a large troopship passed east of that vessel an hour before she struck. Evidence is already forthcoming of many ships having been swept to the eastward at different times, so that they must have passed very close to the *Avocet* rock.

The absence of a marked break on the rock is another somewhat curious fact, and shows how a short heavy sea without the accompaniment of an ocean swell can pass over as little water as 15 feet without showing more than the white horses which crown every wave when the wind is strong.

MAGNETIC STRAINS.

IT has long been known that when an iron rod is magnetized its length is in general slightly increased. This phenomenon was first studied by Joule about the year 1847, and most of his experimental results have been confirmed by other physicists, among whom may be mentioned the names of Tyndall, Mayer, and Barrett.

Joule enunciated the law that the elongation of a magnetized rod is proportional to the square of its magnetization, a law which seems to have been pretty clearly supported by his experiments so far as they went. Now, when iron is subjected to the action of continually increasing magnetizing force, a point is at length reached when further increase of the force produces comparatively little effect upon the magnetization. The iron is then, in popular language, said to be "saturated," and is (or until lately was) commonly supposed to have attained a condition of magnetic constancy, so that none of the properties of the metal connected in any way with

its magnetism would be materially affected by any increase of magnetizing force, however great, beyond what was necessary to produce saturation.

Joule carried many of his observations up to the so-called "saturation point," and then, perhaps naturally, seems to have assumed that nothing would be gained by going any further, and accordingly discontinued his experiments. It is, however, a somewhat remarkable fact that although his interesting discovery was soon widely known, an account of it appearing in almost every text-book dealing with electricity, while an exhibition of the phenomenon in question became a familiar lecture illustration, yet for the thirty-seven years following the publication of Joule's paper it seems never to have occurred to any experimenter to try what would be the effect of subjecting an iron rod to stronger magnetizing forces than those applied by Joule himself. Perhaps I may be pardoned if I refer to the accidental circumstance which led me to do so.

In 1884, a reprint of Joule's scientific papers was issued by the Physical Society, and I then read, for the first time, his original memoir on the effects of magnetism upon the dimensions of iron and steel bars. I had recently been engaged in an investigation of the heat-expansion of sulphur, changes in the length of rods of that substance being indicated by their action upon a small movable mirror which reflected the focussed image of a wire upon a distant scale; and it struck me that a similar method would be well adapted for the exhibition of magnetic expansions. Wishing to have the satisfaction of witnessing some of these effects, I put together a rough apparatus, in which the mirror principle was applied. The battery employed consisted of five large bichromate cells, the zinc plates of which were immersed in the solution by the action of a treadle, and withdrawn by an opposing spring when the pressure on the treadle was removed. The circuit included the magnetizing coil, a galvanometer, and a contact-key.

The first results of experiments made with this apparatus were disappointing. Everything appeared to be quite right: the mirror worked perfectly, as was shown by its deflection when the temperature of the iron rod was slightly varied; the iron was well annealed, and there could be no doubt that the magnetizing force used was more than sufficient to "saturate" it (in the popular sense). Yet the elongation indicated when the circuit was closed was only a small fraction of what had been expected, the movement of the focussed index upon the scale being, indeed, scarcely perceptible.

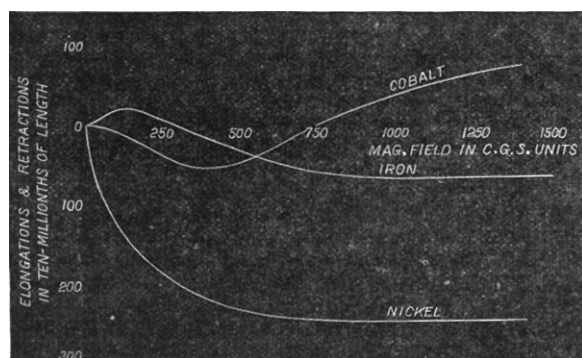
The arrangement was varied in several details, and further attempts were made, but without any better success. In these perplexing circumstances I happened to remove my foot from the battery treadle while the contact key was still depressed, and at the moment of doing so I noticed a curious "waggle" of the focussed image. A movement of the same kind was found upon trial to occur if the zincs were lowered into the liquid while the key was down. The operation was then performed very slowly, and the exact nature of the waggle became clearly revealed. As soon as the zinc plates touched the surface of the liquid the index immediately jumped into a position indicating a certain small elongation of the magnetized rod. As the zincs went in deeper, this elongation at first steadily increased, but only up to a certain point, after which it was *diminished*; and when they were completely immersed in the liquid, the focussed index had returned nearly to the zero position, showing that the elongation had almost entirely disappeared. When the zincs were again slowly raised, the same cycle of changes occurred in inverse order.

The conclusion obviously suggested by these observations was one that could not be readily accepted. It appeared as if the magnetizing force which had been used in the first instance was *too great* to produce Joule's

effect, and that it was only when the current was diminished by increasing the resistance of the battery that the elongation of the iron became well developed. This view clearly involved the assumption that the common notions as to magnetic saturation must be at least in part erroneous, and I therefore endeavoured to find some other explanation of the apparent anomaly. In particular, I suspected that it might be due to electro-magnetic action of the kind known as "solenoidal suction" between the iron rod and the coil; but a few careful experiments convinced me that, although this might well have been the case, yet in fact it was not so. Nor did any other hypothesis present itself which would bear examination, and I accordingly fell back upon the first and natural interpretation of the facts, which implies that magnetizing force may exert an important molecular influence upon iron even when its magnetism is saturated.

A fuller investigation of the phenomenon was then made with very delicate apparatus and greater battery power, and the results were communicated during the next year to the Royal Society, the principal conclusion arrived at, so far as regards iron, being the following: When an iron rod is subjected to a continually increasing magnetizing force, its length at first increases to a maximum and then diminishes, ultimately becoming actually *less* than when the rod is unmagnetized.

I have since published accounts of further experiments, and amongst others of a series in which iron rings



surrounded by magnetizing coils were used instead of straight rods. The changes produced by magnetization in the diameter of the rings were of exactly the same nature, showing conclusively that the effects before observed could not have been due to any unexplained action of the ends of the rods.

By the kindness of Mr. W. H. Preece, F.R.S., who placed at my disposal the large secondary battery used in lighting his house at Wimbledon, I have recently been able to repeat some of my experiments with magnetic fields of exceedingly high intensity. Rods of iron, nickel, and cobalt were thus tested, and the results are clearly shown in the accompanying curves, where the abscissæ represent the magnetic fields due to the coil in C.G.S. units, and the ordinates the elongations and retractions of the rods in ten-millionths of their lengths.

The retraction of iron, it will be seen, becomes ultimately greater in amount than its maximum elongation, and reaches a limit in a field of 1000 or 1100 units, after which its curve becomes sensibly parallel to the horizontal axis. Nickel, unlike iron, retracts¹ from the very commencement, rapidly at first and afterwards more slowly, until in fields of 800 units and upwards its length becomes apparently constant. Cobalt behaves in a very remarkable manner. While the field is comparatively weak, no sensible change in either direction can be detected. After

about 50 units of magnetizing force, the rod begins to contract, attaining its minimum length with 300 or 400 units. But instead of remaining unchanged in fields stronger than this, it again becomes longer. At 750 it regains its original length, and thence up to 1400, the highest field reached in the experiment, it continues to elongate steadily.

It should be understood that so far as mere details are concerned the curves in the diagram relate only to particular specimens of the metals in question. With different rods there will be certain small variations, dependent upon the purity of the metals and their physical condition. But I have always found that under increasing magnetizing force iron is at first extended and then contracted, nickel is contracted from the beginning, while cobalt is first contracted and afterwards extended.

My best thanks are due to Mr. Preece, not only for having given me the opportunity of carrying out the experiments described above, but also for the exceedingly kind and cordial manner in which he did so.

SHELFORD BIDWELL.

A METEOROLOGIST AT THE ROYAL ACADEMY.

ARTISTS and poets are supposed to draw their inspirations from communing with Nature; but it is well known that painters in oil are rarely successful with the cloud portion of their pictures.

For some reason or other, skies and clouds are always far more satisfactory in the water-colour exhibitions than in galleries devoted to oils. The transparency of the former medium enables a painter to put an amount of detail into his clouds which would make the sky far too heavy if attempted in oil; so there is no doubt that oil as a medium is peculiarly unsuitable for the reproduction of cloud-forms, and that the utmost skill is required to give even passable results.

Painters generally do pretty well when they only try to represent shading of the sky, or what Mr. Lockyer has called the zoning of colour in the heavens. They can paint the blue sky overhead gradually getting whiter and grayer as you approach the horizon, or the red round the horizon at sunset surmounted by a zone of orange shading through green into the blue above, as only shade and colour have to be rendered. But when artists try to delineate the form, and, still more, the texture, of clouds, the difficulties are so great that few painters attain excellence in this branch of their work.

Few have yet learnt that, putting the difficulties of the medium aside, the structure of a cloud has an anatomy as definite as that of a man; and that the perspective of cloud-forms obeys the same laws as that of bodies on the earth's surface. Everybody paints ordinary objects so as to show a characteristic texture or structure: the silk dress, the woollen carpet, the wooden floor, are all carefully distinguished; but how many realize the essentially different structure of cloud-forms—the hairy cirrus, the lovely fleecy sky, or the rocky masses of cumulus? Nobody would dare to draw a building, a road, or a tree out of its due perspective; but many seem to think that the forms and distances of the sky can be rendered by daubing white and blue and gray promiscuously over the canvas.

The chapters on clouds in Mr. Ruskin's "Modern Painters" sin against every canon of literature. They are disjointed, discursive, irrelevant, and wander into many by-paths; for one note brings in the causes of the failure of the Reformation in Germany, and the whole ends with a commentary on the nineteenth Psalm. But, in spite of all this, they preach in brilliant and poetic language the two great truths that clouds have distinctive characteristic structures, and that their perspective must be as carefully drawn as that of a building. In one of the

¹ The retraction of nickel under magnetization was first observed by Prof. Barrett (NATURE, xxvi. 585).