have done much to supply what has all along been a fundamental defect in the conditions for the discussion of the problem—the want of detailed and carefully observed facts. But geologists will never be able satisfactorily to work out the problem until they construct large detailed sections on a true scale, vertical and horizontal, and insert upon them the thicknesses and angles of inclination of the rocks in their exact relations. It would be a task well worthy of the time and energy which any enthusiastic student of the science could bestow to run such a section across the Alps, or at least across some typical portion of the chain. The true outlines and related structure as thus determined, would make most of the existing diagrams of alpine structure appear as ludicrous exaggerations.

Among those who have essayed to follow in the wake of Sir James Hall, the founder of experimental geology, and to seek a solution of some of the problems of mountain building by well-devised experiments, Daubrée and Favre have in recent years been specially successful. Another experimenter has just appeared in the person of the accomplished Dr. Pfaff, of Erlangen. His previous works have shown him to possess no ordinary powers of scientific exposition, and in particular his "Allgemeine Geologie als exacte Wissenschaft" deserves the attention of geologists as a remarkably incisive criticism of their science in its present aspects. He is essentially an experimenter, who would reduce every geological problem if possible to the test of actual measurement and experiment. Some of his own practical work in this department is full of ingenuity and suggestiveness. He has now come forward as a disputant in the vexed question of the formation of mountains. His critical faculty, however, here shows itself rather destructive than constructive. He institutes numerous experiments to prove the inadequacy of previous theories, but he leaves us with very little that is satisfactory to put in their place.

As we read Dr. Pfaff's essay and note how he gravely argues as to the capabilities of rocks under pressure and the processes of mountain building, from what he has been able to do with a few square inches of limestone, a steel punch, and other appliances, we are reminded of the censure pronounced by Hutton on the temerity of those who "judge of the great operations of the mineral kingdom from having kindled a fire and looked into the bottom of a little crucible." He forgets that while much may be learnt from experiment, it must always be first of all determined how far the conditions of experiment resemble those of nature. Thus he takes a solid cylinder of Solenhofen limestone 4 mm. in diameter, tightly fitting into a hollow steel cylinder with a small aperture on one side, and subjects it to a pressure of 9,970 atmospheres for seven weeks. He then finds that the stone has not in the least degree been forced into the empty aperture prepared for it, and that its microscopic structure shows no sign of internal alteration or rearrangement. Accordingly he concludes that even with so high a pressure rock acquires no plasticity. With this conclusion no fault can be found until it is applied to the solution of problems in mountain structure. Surely Dr. Pfaff does not mean to affirm that there is any analogy between his solid cone of homogeneous limestone tightly fitting into a steel cylinder and the alternations of various sediments differing so much in texture, structure, density, and inclosed water which constitute most of the visible part of the earth's crust. He does not seem to be aware of the fact that rocks have been experimentally proved to be plastic under much less pressure than he applied. We would recommend him to read the classical memoir of Sir James Hall and the researches of Daubrée and Tresca on the flow of solids. He will find also some convincing proofs in Mr. Miall's paper on the contortion of rocks, that even on the surface, under every-day conditions, not inconsiderable curvatures of solid stone take place merely through gravitation. If he will visit this country we shall be happy to conduct him to some graveyards where the centres of vertically-placed slabs of Italian marble have, under the influence of weathering, been started out from their backing, so that they "belly" out like partially-filled sails.

Dr. Pfaff does not, of course, deny that rocks have been violently compressed and contorted, and he is no doubt well aware that their inclosed fossils have often undergone extraordinary deformation. He contends, however, that these are mere superficial phenomena, and endeavours to support and explain his contention by sections of the earth's crust, about which we venture to predict that Prof. Heim and his Swiss colleagues will have something to say before long. Dr. Pfaff has a theory of his own to explain curvature and deformation. He regards these as the results of the co-operation of water with gravity! Though hitherto no Neptunist, he now distinctly avows himself as a believer in the paramount power of water in the elevation of mountains. It is a pity that after more than a hundred pages devoted to the demolition of all our views as to the effects of terrestrial contraction due to secular cooling, he should tantalise us with a mere brief statement of his own theory. Perhaps it seems so self-evident to himself, that it needs no elaborate experiments to prove its truth, and no expanded statement to insure its acceptance. That a man at this time of day can honestly persuade himself that the upheaval of mountains, the plication, inversion, and deformation of rocks can be accounted for merely by the effects of subsidence due to the abstraction of materials from below by percolating water seems incredible. But that such a creed should be professed by one who has shown himself so good an observer and so acute a reasoner, is still more astonishing. When, after perusing the greater part of his book, and noting argument after argument, and experiment after experiment brought forward to upset all accepted theories on the subject, one comes suddenly and without warning upon his own theory, it is as if some rogue had incontinently put the lamp out. One does not know what to make of the situation. There is something too ludicrous about it. Serious argument is no longer possible. Dr. Pfaff must be bantered out of his hydropathic geology. His abilities are too great to be lost in a monomania of this kind. We would recommend for his speedy restoration to geological sanity a trip into Switzerland, under the care of Drs. Baltzer and Heim. This treatment, if taken in time, will, no doubt, restore him at least to such measure of health as can be enjoyed by a man who works out his geology in his study and laboratory rather than in the field.

A. G.

THE SWEDISH NORTH-EAST PASSAGE EXPEDITION

THE following notes are taken from a letter from Prof. Nordenskjold to Mr. Oscar Dickson, dated Ceylon, December 16, 1879, printed in the *Göteborgs Handels Tidning*:—

Dredging was carried on at a number of places on the coast of Japan, but with scanty results, in consequence of the poverty of the sea-bottom in animal life. The same was the case with the dredgings which were carried on between Hongkong, Labuan, and Singapore, and in the Strait of Malacca, although the bottom consisted in some places of clay, in others of sand, coral-sand, or rock, and thus ought, at least at some of the places, to be favourable to the development of a rich animal life. While the trawl-net in the Polar Sea almost always brought up several hundred animals, the zoologist in these southern seas obtained seldom more than one or two at each draw, and frequently not one. By far the most abundant animal life has been found during the Swedish Arctic expeditions, at favourable places in the

bottom of the Polar Sea; for example, at a depth of between 20 and 100 fathoms in the middle of Hinloopen Strait in Spitzbergen, on the east coast of Novaya Zemlya, in the sea east of Cape Chelyuskin, and south of Behring's Straits. At these places the temperature of the sea all the year round is between 0° and – 2°·7 C. A temperature at or under the freezing point appears thus to be much more favourable for the development of an abundant animal life at the sea-bottom than one of 15° to 25° C., a very remarkable circumstance, which, as far as Nordenskjöld knows, has not received the attention which it deserves. It is to be remarked, however, that the invertebrate animals in the south are larger and finer than in the north, and that the shore fauna, which is entirely absent in the sea of the high north on account of the destructive action of the drift-ice, is here richly developed.

Japan is so poor in land- and fresh-water crustacea, that one often searches for hours in the most favourably situated places without finding a single specimen. Even in the most northerly part of Scandinavia more land crustacea may in many places be collected in a few hours than in Japan in as many days. Lieut. Nordquist, however, has made a fine collection, which is expected to yield many interesting new contributions to the fauna of Japan.

In the numerous dredgings carried on during the voyage from Japan to Ceylon at depths in which algæ are met with in abundance on the coasts of Scandinavia, *not a single alga was brought up by the dredging apparatus*. Even in the shore belt marine plants are in many places almost wholly wanting. Some places were found, however, more fortunately situated. The observations made here and the information obtained by an examination of the collections in the museums of Tokio have enabled Dr. Kjellman to obtain a general view of the occurrence of algæ on the east coast of Japan of special interest in many respects in connection with researches carried on by him during the preceding part of the voyage, for example, with respect to the boundaries of the areas occupied by different algæ, with respect to the mutual relation between the abundance of individuals and species at different places, and with respect to the types which are to be considered distinctive of the different areas.

The lichen flora of Japan was examined by Dr. Almquist. In the more elevated regions, as on the sides of the mountain Fusijama, 13,000 feet high below the snow limit, at a height of 6,000 to 8,000 feet above the sea, it has a certain resemblance to that of Scandinavia, but in the low country it is limited to a very few localities. In the purely tropical countries, for instance at Labuan and Singapore, the lichens appear to be confined almost exclusively to the bark of trees, and the whole of this division of the vegetable kingdom here consists mainly of a single group, *Sclerolichenes*, which occur in abundance and in very varying types.

Prof. Nordenskjöld and Lieut. Hovgaard ascended the mountain Asamajama, a still active volcano, 8,200 feet high, on October 4.

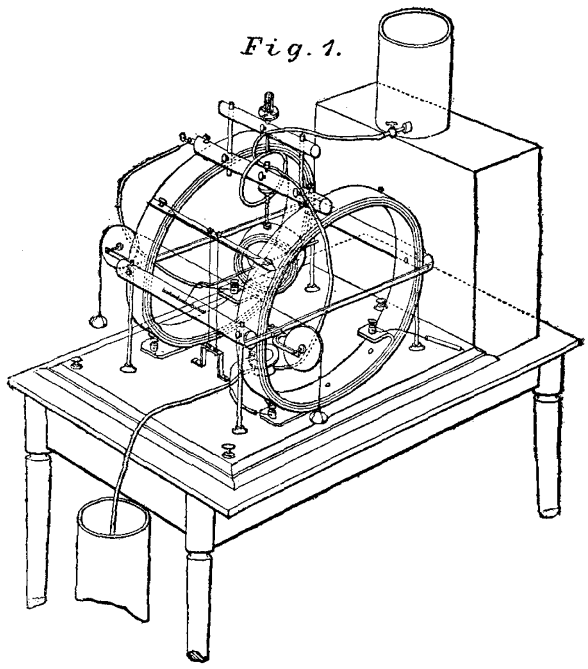
Prof. Nordenskjöld has made extensive collections of fossil plants from fossiliferous strata at Mogi, a fishing village on the coast of Japan, and from the coal-mine Takasima, both in the neighbourhood of Nagasaki, and from the coal-seams at Labuan. The fossils from Mogi lie in a fine white clay slate, and consist almost exclusively of beautiful leaf impressions. At Takasima the fossils consist principally of water plants imbedded in the brownish-black shale which accompanies the coal. At Labuan the fossils lie imbedded in balls of clay-ironstone found in the sandy beds between the coal-seams. They consist of ferns, *Cycadeæ*, and large-bladed leaf-trees, which appear to have a tropic stamp, while the Mogi fossils, on the other hand, indicate a moderately warm climate.

AN ELECTRO-DYNAMOMETER FOR MEASURING LARGE CURRENTS[1]

THE use of electric machines of large size for the generation of currents of great strength has become extensive, and promises to increase materially. In connection with this, the best mode of measuring the currents obtained is a matter of much importance as well as one of some difficulty.

Of the possible methods the galvanometric is probably the most used, but it is objectionable as shunts of low resistance must be employed. In general, a method depending upon the estimation of a *very small proportional part* of the magnitude to be measured is objectionable, since extreme accuracy is necessary and errors of observation are magnified. The mode of measurement by the electro-dynamometer is to be preferred for many reasons, and it has also the advantage of being applicable to to-and-fro currents, as well as to those in one direction. Weber's electrodynamometer is only suitable for measuring very small currents unless shunts are used. Trowbridge has designed an electro-dynamometer through which large currents may be transmitted and directly measured (*Proc.* Am. Acad. Arts and Sci., October 9, 1878). This instrument works well and gives good results.

Fig. 1.



During the past year the writer has been experimenting at the U.S. Torpedo Station with an electro-dynamometer differing from Trowbridge's in the manner of determining the deflective power of the current, and which seems to present some advantages in simplicity and readiness of working, while especially suitable for technical use. In its general plan, particularly in the arrangement by which the entire current may be passed through the instrument, it follows Trowbridge's form.

Fig. 1 is a general view of the instrument. Figs. 2 and 3 show the details of the suspended coil. The large, fixed coils are made of thick copper ribbon. The turns are insulated from each other, and the metal framework is insulated from the coils. The suspension arrangement

[1] By Walter N. Hill, Chemist to the U.S. Torpedo Station, Newport R.I., U.S.A.