RECENT EXPERIMENTS ON THE FLOW OF ROCKS CARRIED OUT AT McGILL UNIVERSITY.

Some very interesting experiments on the flow of rocks are now being carried out by Prof. Adams and Prof. Nicolson, of McGill University, Montreal, and in a paper read before the Geological Society of America, at its Montreal meeting, last December, a brief account of the methods which are being employed and the results so far obtained was presented.

The authors point out that the fact that rocks, under the conditions to which they are subjected in many parts of the earth's crust, become bent and twisted in the most complicated manner, as recognized by the earliest geologists, and we have only to look at the detailed sections of Heim, Baltzer and others to convince ourselves that in many cases even the hardest rocks have moved like so much dough, and that in many cases there has been a marked transfer or "flow" of material from one point to another.

The exact manner in which this contortion with concomitant flowing has taken place is, however, a matter concerning which there has been much discussion and a wide divergence of opinion. Heim, however, in his great work on the mechanism of mountain making, published some twenty years since, enlarges upon the very valuable results which might be obtained in elucidation of these questions from a carefully conducted series of experiments upon the deformation of rocks under conditions as nearly as possible approximating those which obtain in the deeper parts of our earth's crust. From the results obtained under known conditions he believed that we might learn much concerning the conditions under which known results were produced.

Three chief factors, it is pointed out, contribute toward bringing about the conditions to which rocks are subjected in the deeper parts of the earth's crust.

1. Great pressure from every direction. 2. High temperature. 3. The action of percolating waters.

In the present experiments the attempt has been made to reproduce only the first of these conditions in the case of a single rock; in subsequent experiments the endeavor will be made to reproduce all three of them, making use of several different rocks.

Pure Carrara marble has been employed, and this has been slowly deformed under great pressure while completely inclosed in a material having a much higher elastic limit than the marble and possessing at the same time a very considerable ductility. Under such conditions the marble cannot break, even when submitted to a pressure far above that which under ordinary conditions would be required to crush it; for it is inclosed on all sides by a stronger substance, and, the pressure being increased, it will remain intact until the elastic limit of the inclosing material has been passed, when it will commence to move, acting in this way as water or any other inclosed fluid might.

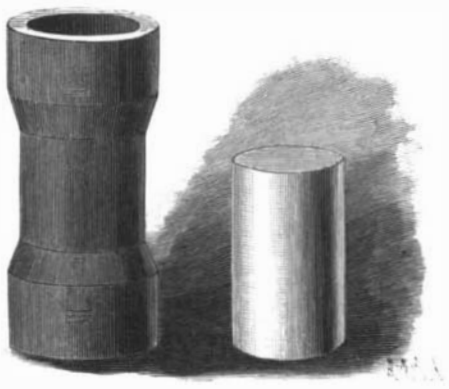
After a long series of experiments on various alloys, it was found that none possessed a sufficiently high elastic limit combined with the required ductility except certain aluminum bronzes, which, however, it was difficult to obtain with constant composition and properties. Wrought iron tubing of a peculiar construction was then experimented upon and found to fulfill the required conditions.

Another series of experiments was then made in order to ascertain the best method of inclosing the rock in the metal so as to secure a perfect contact of the two at all points, and thus prevent the breaking of the rock at some point where it lacked support. As a result of these experiments, the following procedure was adopted:

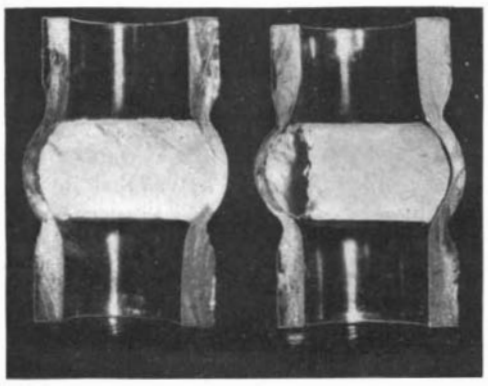
Columns of the marble, 1 cm., 2 cm. or 2·5 cm. in diameter and 4 cm. in length, were very accurately turned and polished. Heavy wrought iron tubes were then made, imitating the plan adopted in the construction of ordnance, by rolling long strips of Swedish iron around a bar of soft iron and welding the strips to the bar as they were rolled around it. The core of soft iron composing the bar was then bored out, leaving a tube of welded Swedish iron, 6 mm. thick, so constructed that the fibers of the iron run around the tube instead of being parallel to its length.

The tube was then very accurately fitted around the marble. This was accomplished by giving a very slight taper to both the column and the interior of the tube, and so arranging it that the marble would only pass about half way into the tube, when cold. The tube was then expanded by heating, so as to allow the marble to pass completely into it and leave about 3 centimeters of the tube free at either end. On allowing the tube to cool, a perfect contact between the iron and marble was obtained and it was no longer possible to withdraw the latter. The middle portion of the tube was then turned down so as to make the walls here somewhat thinner and thus localize the position of the flow. Any very slight failure to fit, if such failure existed in any case, was rendered harmless by the fact that, under a comparatively low pressure, the limestone is found to be sufficiently elastic not only to fill up any such minute space, but even to stretch the tube, and on relief of the pressure to contract again to its original volume, so that it would drop out of the tube which had been thus enlarged.

Into either end of the tube containing the small column an accurately fitting steel plug was inserted, and by means of these the marble was submitted to a pressure far above that which would be sufficient to crush it if not so inclosed. The machine employed to give the pressure was so arranged that the pressure might be maintained for weeks or even months if necessary. Under these circumstances the conditions of pressure to which the marble is subjected are those in the "zone of flow" in our earth's crust, those namely of being submitted to a pressure above that of its elastic limit, yet being unable to break in the ordinary manner, owing to the tube having a still higher elastic limit. Under the pressure, which was applied gradually and in some cases continued for several weeks, the tube was found to slowly bulge until a well marked enlargement of that portion of it surrounding the marble had taken place.



IRON TUBE AND MARBLE COLUMN.

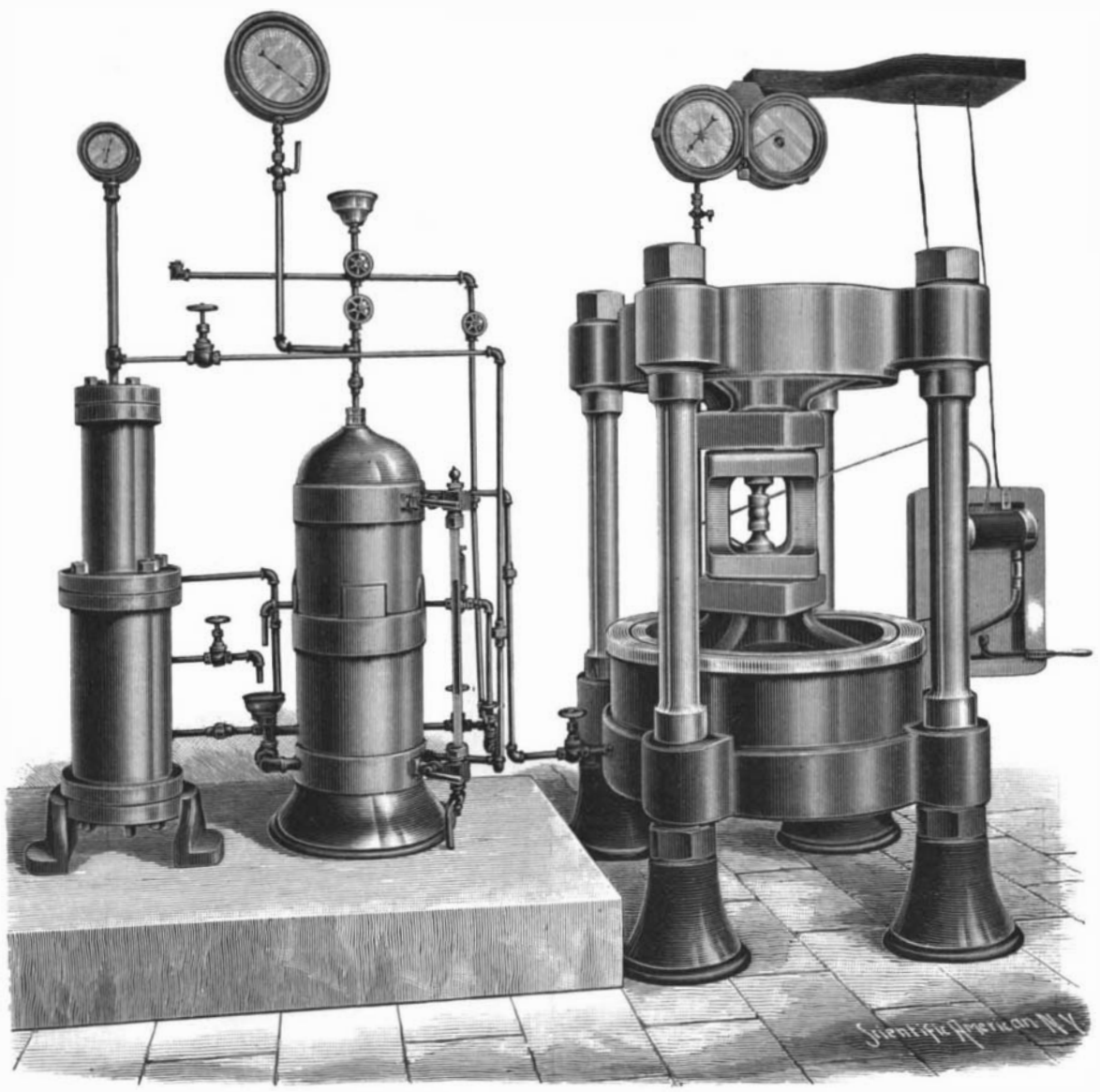


SECTION OF IRON TUBE AND MARBLE AFTER PRESSURE.

The machine used in these experiments is shown in the accompanying photograph. It was designed by Prof. Nicolson, and built for the most part in the machine shops of McGill University. It is a hydraulic accumulator which, starting with the ordinary pressure of the water mains, namely, 130 pounds to the square inch, can be made to increase this until small columns of the strongest steel may be crushed, and, as has been mentioned, a constant pressure may be maintained and recorded for months if necessary. The photograph shows the arrangement of the tube and plugs, and a distinct bulging of the former, the pressure in this case having been continuously applied for ten days previous to the taking of the photograph, the marble within the tube at the time the photograph was taken being under a pressure of about 80,000 pounds to the square inch. The small boiler on the left is not attached to the machine, but is intended for some future experiments in which the deformation will be carried out under a high steam pressure.

After the completion of the experiment the tube was cut through longitudinally by means of a milling machine, along two lines opposite one another. The marble within was still firm, and held the respective sides of the tube, now completely separated, so firmly together that it was impossible, without mechanical aids, to tear them apart. By means of a wedge, however, they could be separated, splitting the marble through longitudinally. The marble column, in one experiment, was reduced to one-half its original height. When the tube with the inclosed marble is thus cut in two, the marble may often be detached without breaking it further by a smart blow of a hammer on the back of the tube—in other cases it adheres more firmly. The exterior, where it was in contact with the tube, is smooth, and conforms to the curve of the bulging iron, its surface reproducing perfectly all the fine tool marks on the iron.

It differs somewhat in appearance from the original rock in possessing a dead white color, somewhat like chalk, the glistening cleavage surfaces of the calcite being no longer visible, and the difference being well brought out in certain cases, owing to the fact that a certain portion of the original marble often remains unaltered and unaffected by the pressure. This, when present, has the form of two blunt cones whose bases are the original ends of the columns resting against the ends of the steel plugs, while the apices extend into the mass of the deformed marble and point toward one another. These cones, as is well known, are developed in all cases where cubes of rock are crushed in the testing machine in the ordinary manner. They never constitute any large proportion of the whole mass, and in some cases are absent or but faintly indicated, but there is always in immediate contact with the ends of the steel plugs a thin cake at least of marble possessing the characters of the original rock. The deformed marble is uniform and



APPARATUS FOR EXPERIMENTING ON THE FLOW OF ROCKS UNDER PRESSURE.

compact, and seems to break with equal ease in all directions, and although not so hard as the original rock, is still firm, and especially so when the deformation has been carried out very slowly.

No accurate measurements of its strength have yet been made, but it will withstand a sharp blow, and a fragment of it weighing ten grammes has been allowed to fall through a height of eight feet on to a wooden platform, from which it rebounded without breaking.

When thin sections of the deformed marble are examined under the microscope, the nature of the movement which has taken place is clearly shown. If the deformation has been rapid, that is to say, if a column 40 mm. in length has been reduced to two-thirds of its length in five or six hours, a distinct cataclastic structure can be seen along certain lines of motion, though this is often on so minute a scale that a high power is necessary to make it clearly visible. This cataclastic structure is precisely like that seen in the rocks of many highly contorted districts.

When, however, the deformation is carried out very slowly, as, for instance, in one experiment where the column was reduced from 40 mm. to 35 mm. in height, the movement being very gradual and extending over thirteen days, the cataclastic structure is absent. In these cases the grains still fit closely together and are of substantially the same size as in the uncrushed marble. Well marked strain shadows, indicating a twisting of the grains, are common, with, in some places, an elongation of certain of the grains in one plane. The dull, chalky color of the deformed rock in those cases is chiefly due to a fibrous structure which developed in the calcite and which, in most cases, when magnified, is seen to be due to a very fine polysynthetic twinning, which is often so exceedingly fine that it can be recognized as such only by the use of very high powers. Each individual of calcite, in fact, has changed its shape and relative position, either by twisting or by slowly moving along its gliding planes, the chalky aspect of the granulated rock being apparently chiefly due to this repeated twinning destroying the continuity of the cleavage surfaces of the calcite, thus making the reflecting surfaces much smaller.

The experiments, therefore, show that marble, even when dry and at ordinary temperatures, does under great pressure develop a certain degree of plasticity and can be made to flow, and that this movement consists chiefly in a bending of the constituent calcite individuals or a shearing along their gliding planes. All the microscopic structures present in the rock are found in the highly contorted limestones of many mountain regions; although many of these present, in addition, certain other structures which indicate that the conditions under which the movements in their case took place were not exactly those of the experiment, but that moisture and possibly heat played a part as well.

The experiments are now being continued, a modification of the machine having been arranged whereby the pressure may be applied while the rock is maintained at a temperature of from 100° C. to 250° C. When these are completed, it is intended to try the effect of compression in the presence of steam at a high temperature, and results of great interest to the physicist and geologist may be expected.

LAOTIAN TATTOOING.

Our thanks are due to Prof. Frank T. Adams, who has kindly sent us photographs of the apparatus used in the experiments, and who has furnished us with the above particulars.

TROY, with the ruins Schliemann explored, has been presented to the imperial Osmanic museum of antiquities at Constantinople by the owner of Hissarlik, the Englishman, Frank Calverley.

THE ART OF TATTOOING.

Tattooing has been studied from many points of view. It is very widely practiced, and has various origins. It is due to religious ideas, forms distinctive signs among tribes, is offered as a recompense to the valiant, or, finally, is a true initiation marking the passage from childhood to the adult age.

JAPANESE TATTOOING UPON THE BODY OF A WEALTHY AMERICAN.

It is practiced in different ways: by burns which form scars (as among the Australians); by wide incisions (as among the Africans); or, finally, by fine punctures, and in this case becomes an art. It is from the latter viewpoint that we desire to examine it.

The greater the perfection to which a race has brought its art, the handsomer will be its tattooing. The Australians are acquainted with very primitive drawing only. They trace straight parallel lines or angles upon their arms and their few utensils. They have not reached the conception of the polygon, curve or spiral. They are ignorant of symmetry, alternation, and the various principles that preside over the grouping of ornamental designs. So their tattooing is rude, and composed simply of a few parallel or intersecting lines or of dotted ones. The African worshipers of fetiches, whose art is very crude, trace lines and angles, which the repeat in series; but make very little use of curves.

NEW ZEALAND TATTOOING UPON A FUNERAL STATUE.

Opposed to these are the Polynesians, whose ornamental art is considerably developed. They know how to draw curves and spirals; and they combine geometrical lines in such a way as to obtain harmonious results. So they tattoo very complicated and very beautiful designs. In New Zealand the figures are supercharged with close and parallel curves, which surround the mouth, nose and eyes. In the Marquesas Islands travelers have admired the perfection and fineness of the lines of tattooing practiced there, and in which figures of animals are harmoniously mixed with geometrical designs, upon the human body as well as upon sculptured objects. These tattooing designs, like the ornamental art of the natives, have, according to the testimony of travelers, varied since the discovery of these islands.

The ornamental art of New Guinea is highly developed, but tattooing is not much practiced. However, the women of the Motu tribe tattoo themselves, and do it with a perfection that cedes in nothing to the art as practiced by the Polynesians.

The Americans have taught us to admire the very original art of the Haidah, a people of Colombia, who represent man and the animals according to regular curves that give them the appearance of geometrical designs. Their tattooing is in every respect like the designs which they sculpture upon wood, and it suffices to see a specimen of it in order to recognize it among a thousand others.

Tattooing therefore constitutes an artistic manifestation, and not one of the least, of primitive races. It even happens that, as regards the Guanches of the Canary Islands, it is the principal art of this race that remains to us. These people did not tattoo themselves in the proper sense of the word (which signifies a puncture of the skin into which a coloring substance is introduced), but printed designs upon the body by means of matrices or "pintaderos." The Museum of Las Palmas (Canary Islands) possesses a fine collection of these matrices in which we can see what was the ornamental art of this race, which has now disappeared. The Guanches were acquainted with polygonal figures, drew the rose ornament, and inscribed figures one within another—the circle in a square, the rose ornament in a circle, etc. They opposed and alternated designs and even knew how to arrange figures according to a double plan of symmetry; but they were ignorant of those complicated figures of which Greek art later on made so excellent use.

In the extreme East, on the contrary, tattooing is not composed of geometrical designs. Sino-Japanese art has abandoned them in our day, although it formerly employed them, as may be seen from some ritualistic vases that have been preserved. The artist now applies himself to a faithful reproduction of animals and of plants, or else conceives fantastic monsters. So the tattooing is purely figurative. Those so handsomely draped women that are found upon the Japanese Kakemonos are observed again in a no less pleasing form in the tattooings. Men, monsters and flowers form the decorative motive.

So, too, the Laotians delineate upon the skin those monsters and fantastic figures that are so dear to the Chinese imagination. Linear tattooing is not practiced.

In Burma, the Hindoo style prevails. The tattooing figures are those of men, trees and scenes from life.

Among us, the art of tattooing is left to the lower class; so it is a degraded art. The representations are coarse, and, as a general thing, poorly executed. Sometimes the artist is capable of drawing very fine artistic figures that are the admiration of physicians who have an opportunity of seeing them. But such cases are becoming rarer and rarer, and tattooing has become gross and vile, like every despised art.

We are indebted to the Revue Larousse for the above particulars.

Improved Practice in Surgery.

A report by M. Reclus, in one of the French journals, of several cases of severe injuries of limbs, treated successfully by a novel conservative method, has attracted much attention. Instead of removing a crushed limb, M. Reclus would embalm the injured structures in antiseptic applications and wait for a natural separation of the dead from the living parts, not interfering except to saw through bone, and after careful disinfection of the skin and removal of detached fragments of bone and of loose tendons and torn muscle, the whole wound is forcibly injected with water heated to 140 degrees Fahrenheit. Hot water actsas an antiseptic and increases the activity of other antiseptic agents, and, moreover, when injected into a large and deep wound, it arrests hemorrhage and warms the chilled and collapsed patient. The interior of the wound is next thoroughly disinfected by a solution of permanganate of potash applied on pieces of wool, and finally embalmed by what is called a polyantiseptic pomade, containing a very large proportion of active agents, some of which, being absorbable, such as corrosive sublimate, carbolic acid and iodoform, are in small quantities, while others, which are not so absorbable, as boric acid, salol and antipyrin, are distributed more abundantly. This pomade is spread quickly on bands of tarlatan, which are thrust into all the crevices of the wound. The injured part is covered with a layer of cotton wool, which is firmly bound down to the surface of the limb by bandages. By the end of the third week, it is stated, the dead have become detached from the living structures and the sloughs are quite loose.

NEW GUINEA TATTOOING. HAIDAH TATTOOING. HAIDAH TATTOOING.