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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

TECHNICAL HEADS FOR TECHNICAL CITY DEPARTMENTS.

The costly blunder which has recently been discovered in the design of the Blackwell's Island Bridge, raises the question of the desirability, we had almost said the imperative necessity, of having technically qualified men at the head of such highly technical departments as that of bridges. We say this without the least intention to disparage the present Commissioner of Bridges, or any of the gentlemen who have preceded him that did not happen to possess the training of a civil engineer. With one exception, the present and former Mayors of this city have not considered it necessary that the Commissioner of the Department of Bridges should be a bridge engineer. It has been the custom for the newly-appointed Commissioner to select a chief engineer, and hold him responsible for all the strictly technical matters pertaining to the work of the Department.

But would it not be much more satisfactory if, in the future, the Mayors of this city, in looking for a Commissioner, selected from among the many eminent and fully qualified bridge engineers of the country a man who combined in himself the professional knowledge and administrative ability required for this enormously responsible position? If, during the past decade, in which three of our most important bridges have been constructed or commenced, the Bridge Commissioner had been a qualified engineer, we are satisfied that mistakes would have been avoided, many economies achieved, and above all the colossal blunder of the Blackwell's Island Bridge would never have occurred.

By way of throwing further light upon this matter of the Blackwell's Island Bridge, it should be explained that, in the bridge as originally designed, the congested live load was very much less than that which was subsequently adopted. The contract drawings were made for a bridge with six tracks (two elevated and four trolley), a roadway for vehicles, and two sidewalks; the maximum loading being set down at 12,600 pounds per lineal foot of the bridge. After the contract was made there came a change of administration and engineers, and under the new *régime* it was decided to increase the number of elevated tracks from two to four by adding two tracks to those already provided for on the upper deck of the bridge. This change involved an increase, first in the live load, which was raised from 12,600 pounds to 16,000 pounds per lineal foot for congested loading; and, secondly, in the dead weight of the bridge itself, due to the enlargement of the sections of the bridge to meet the heavier live loads thus imposed.

Now we believe it is a fact that when this most important revision of the plans occurred, the present Commissioner had not been appointed to office, and the responsibility for the mistakes which followed cannot therefore lie upon his shoulders. His predecessor also was not an engineer, for had he been, he would have made it his first duty to see that the bridge was entirely redesigned, and an entirely new strain sheet drawn up. Whether this was done has not yet been disclosed to the public; but it cannot be denied that the extraordinary conditions revealed by the investigations of Prof. Burr and Messrs. Boller & Hodge would seem to suggest that the increase in the strength of the bridge was made by some rough-and-ready method of percentages.

The conditions revealed by these reports are so disconcerting, so strongly suggestive of gross incapacity somewhere in the Department, that we think the matter should be made the subject of a searching investigation, similar to that which followed the fall of the Quebec Bridge. It is only by getting at the real facts of the case, and disclosing to public view the history of the design and construction of this bridge, that the city can be placed in a position intelligently to make such reforms in the Bridge Department as are necessary.

MAKING ROCKS AND MINERALS ARTIFICIALLY.

The completion of the Geophysical Laboratory of the Carnegie Institution of Washington puts at the disposal of investigators attacking the many problems connected with the physics of the earth unique facilities in the way of organization and equipment. The new laboratory was erected especially for this purpose at a cost of $100,000. A staff of expert and special investigators under the general direction of Dr. Arthur L. Day is engaged on researches of considerable importance, as they are designed to supply information in fields where present scientific knowledge is all too scanty.

The science of geophysics is typical of a modern tendency to unite in a single field certain elements of two or more of the older sciences. In geophysics there is an application of pure physics and pure chemistry to the data supplied by the geologist and mineralogist, or in other words a blending of physical or exact science, so far as the study of the earth is concerned, with natural and descriptive science. The phenomena presented by the earth to-day are due to the action of chemial and physical forces, and these phenomena range all the way from the most minute crystal to the earth itself in its relation to other celestial bodies. Now in the geophysical laboratory these phenomena are studied quantitatively by experimental methods.

One of the first tasks of the geophysicist is to study from surface conditions the nature of the interior of the earth and investigate the distribution of different materials and more especially the conditions under which they exist, such as temperature, pressure, density, and other characteristics. Accordingly if the nature of the interior materials of the earth and the temperature conditions are known it is possible to reach definite conclusions as to the nature of the formative processes, while if the distribution of pressure is studied it is possible to gain a more adequate idea of earthquakes and their transmission.

At the Carnegie Institution Laboratory the chief work at present is a study of rocks and their formation. Now the ordinary geologist studies the outside appearance of rocks and minerals at the surface of the earth, but the rocks and minerals so found are by no means pure, because so many kinds of action have been at work at different times that the ultimate result is different from that occasioned by the combination of simple substances under elemental conditions. So at great pains and trouble, after a mineral has been analyzed, the experimenter, using perfectly pure substances, combines them to form a chemically pure mineral. The chemical and physical properties of the artificial mineral are studied in comparison with its natural prototype, and knowing with accuracy not only its constituents, but the processes by which it was formed, it is possible to determine the nature and extent of the processes of nature. Thus a new and real science of mineralogy is being built up by the geophysicists, a science which shows quantitatively the combining conditions of rocks. Incidentally such studies often lead to matters of great economic and practical importance. For example, in the study of calcium oxide and silica, two constituents most frequently found in rock and also essential materials of Portland cement, it was demonstrated that they could combine only in certain ways and in certain proportions and not in the way that had been assumed by cement manufacturers. Now the basis of combination of these two oxides being understood, it will of course provide the cement maker with a scientific basis on which to prepare his product, replacing arbitrary and rule-of-thumb methods. Then again the question of adding alumina to a mineral combination is under consideration, as that substance also figures in many important minerals, as well as being essential to cement, and the results of the investigation may have an important bearing on that industry.

Another practical field in which these investigations of mineral formation seem destined to play an important part is in the study of ore deposits. If the fundamental conditions under which ores are formed are thoroughly understood, then the range of practical geology is widely extended and the amount of ore bodies available for economic exploitation can be materially increased.

In reproducing the original constructive processes of mineral formation in the experimental laboratory, the first requirement is the application of intense heat whose degree and quantity can be measured with accuracy. This of course is a difficult undertaking, but with exact thermometric measurements to establish the points at which various minerals act on one another to form certain combinations careful laboratory work can be carried on along definite and determined lines. With the apparatus of the Geophysical Laboratory high temperature measurements can be made up to 1,500 deg. C. with an accuracy of one degree, and between that point and 1,600 deg. C. with an accuracy of two degrees, so that it is possible to realize almost the precision of ordinary mercurial thermometry. This is important, as most minerals are formed below 1,600 deg. C., but above this temperature measurements can be made by optical methods of pyrometry even to the temperature of the sun with the error diminishing rapidly as better apparatus is invented. The mixtures of minerals to be subjected to the action of heat are inclosed in strong steel bombs and then placed in electric furnaces where any desired degree of heat can be maintained constant for several weeks or months as desired, generators, transformers, and storage batteries supplying adequate current. Using the Nernst arc and iridium crucible furnace a temperature as high as 1,800 deg. C. can be obtained, and this to-day represents practically the maximum temperature available for exact experimental investigations on minerals. The investigator concerned with studying various rock formations subjects the minerals to the action of intense heat, noting the temperature at which they react or the point on the selected scale of temperature at which melting or fusing occurs. For every such phenomenon or chemical reaction there is either a gain or loss of heat, and this can be measured by calorimetric processes which have been developed to a high degree of accuracy at the Geophysical Laboratory.

The product of combination of two or more minerals is then studied, and what is more, the artificial is compared with the natural mineral, chemist, physicist, and mineralogist uniting in the examination and employing the microscope and polariscope among other methods and making a record of the mineral by photomicrography, for which the laboratory contains a special equipment. Should any striking differences be found the reasons for these must be investigated, and especially the presence of impurities, which often occur naturally in a mineral that in the laboratory may be made from chemically pure components without any disturbing influences. By the introduction of a third substance the problem becomes slightly more complicated and the range of the investigation extended, but the results are no less sure and interesting.

After high temperature work the effects of intense pressures must be considered, and the Geophysical Laboratory has on its staff one of the most expert men in the world for high-pressure research. He was the first to make liquid carbon and came to the laboratory from Europe especially to advance this side of its work. Thus it is known that to produce diamonds and other precious stones artificially, extremes of pressure, to imitate the forces of nature, are demanded. Accordingly such pressures are applied to the reactions taking place in the electric furnace, and while the production of gems artificially is no more an object of study than the formation of any other minerals the study is interesting as showing where such investigations may lead.

In addition to temperature and pressure must be considered the effect of carbon dioxide and water vapor in their solvent action on the earth in forming minerals. The relation of water to the combining conditions of minerals is most important, and the universal presence of water and carbon dioxide in all natural rocks forces the belief that it is an important if not a controlling factor. To investigate this, steel bombs of great strength are filled with the minerals. Water vapor or carbon dioxide at pressure is introduced, and the rock is reproduced by imitating original conditions. On account of the great pressures the action goes on faster and at lower temperatures than in nature, and as the effect of the carbon dioxide is entirely unknown the outcome of this investigation is being looked forward to with great interest.

The conductivity of rocks for heat is another property that must be studied in order to understand volcanoes and their phenomena, and especially to determine the effects of the intrusion of lava or other liquid rock into the cracks of the solid rock. The thermal properties of the earth-forming materials afford a most promising field for investigation and here the scientific staff of the laboratory is at present concentrating its attention. In addition there are many other properties as worthy of attention. A study of the elastic properties of matter as involved in the materials of the crust of the earth is now being undertaken at the laboratory by Dr. George F. Becker of the U. S. Geological Survey. This investigation deals with the relation between the force exerted on rocks and their displacement with the idea of determining quantitatively how and what forces have been at work to bring about the various displacements and changes noted by geologists.