THE INTERIOR OF THE EARTH.

To the Editor of Science: Professor Thomson's recent article on the cause for volcanic action, which begins with a reference to the theory of a liquid interior of the earth as exploded, taken in connection with a recent paper by my friend, Dr. Daly, has set me thinking as to what we mean by speaking of the interior of the earth as either solid or fluid. That if fluid it is in general highly viscous is certain; that if solid it is also often subject to stresses above its crushing strength, under which it flows like punched steel, all will agree. But are we clear as to where we are to draw the line between viscous fluid and solid? We have, on the one hand, substances, which, like the splinters of albite described by Day, are so viscous as to retain their form even when heated so that they have lost their crystalline structure and then become optically homogeneous, and we have, on the other hand, experiments like those of Adams on the flow of rock solids. I do not think we can come to any clear idea or definition without emphasizing the relation of time. Molasses candy and tar appear ordinarily as solids and crack and break as such, yet given time enough they flow, and are properly classed as viscous fluids. In geologic problems we have large quantities and long times at disposal. The argument for the solidity of the earth from its resistance to the pull of the sun and moon proves that it is highly rigid, but not at all that it may not be a viscous fluid, because the time in which the stresses are applied is relatively brief.

The scientific distinction between solid and fluid may be derived from the common idea of a solid as that which has a form of its own, while the fluid takes the form of the containing vessel, bounded by a level surface on top. It is obvious that we must give it time to take the form in question. A very viscous fluid may take a very great time, yet it will ultimately assume the same form as the other fluid. Whence we may base an ideal definition and say that anything to be classed as fluid will, in sufficient time, come to the same state of equilibrium as water, *and is not able to rest in a state of strain, but yields to a stress however small or slowly applied.* Whereas a solid, such as a crystal of quartz, might be under a light stress producing a slight strain for infinite time without any tendency to permanent distortion.

For geological purposes we do not need to deal with quite infinite time. While stresses such as those of the tides and volcanic earthquake shocks are far too quickly applied to discriminate between viscous fluids and solids, the slow erosion of a continent by the fraction of a thousandth of a foot a year, the slow attendant deposition of sediment on the ocean floor and the slow escape of energy from the interior of the earth are examples of forces so slowly applied that if there is any degree of real fluidity worth mentioning in any layer of the earth, there could be no accumulation of such stresses in it, but they would be yielded to as fast as formed.

According to a geological theory known as that of isostasy, there is something like this continuous yielding in the case of erosion and deposition, the continents being uplifted as they are eroded, while the ocean shores are depressed, so that continents float above the general earth level because they are lighter, like icebergs in water, and not because they are supported by stresses in the earth beneath. In the same way the earth is supposed to have been depressed beneath the icecap and to have risen again, tilting the shore lines of the Great Lakes, when the ice melted away. If this theory is strictly true it would seem to me that we must assume a viscous fluid substratum. But is this process absolutely continuous, or only 'steady by jerks,' the yielding occurring only after a certain degree of strain is accumulated? Upon the possibility of accumulation to some extent of very slow strain should depend the answer as to whether there is a viscous fluid or plastic solid substratum of the earth. As President McNair has suggested to me, there is an experiment now being unwillingly tried on a gigantic scale which might throw light on this. The Colorado River is about to cover some 2,000 square miles in the next 30 or 40 years with water over 200 feet deep. Will this gradually applied extra load produce a gradual depression? This might almost seem a crucial test, and it would seem as though a few well-placed and well-determined bench marks on projecting hills, or possibly triangulation tripods, in the area to be submerged would answer the question. And it is the hope of arousing interest and causing the necessary measurements to be made that has spurred me to write this note.

ALFRED C. LANE.

THE GEOGRAPHICAL DISTRIBUTION OF STUDENTS.

IN the article on 'The Geographical Distribution of the Student Body at a number of Eastern and Western Universities and Eastern Colleges,' which appeared in the issue of SCIENCE for August 10, 1906, I neglected to call attention to the fact that the showing of a number of the state universities is somewhat misleading, for the reason that many students from outside the state in which the university is located endeavor to establish a state residence, in order to escape the tuition charged to outsiders. This is true particularly with reference to the University of California, on account of the isolation and the large size of the state. Families of students from outside often establish a temporary residence in Berkeley, and a similar state of affairs no doubt exists with reference to the University of Michigan and other state universities. At California not over one quarter of the students coming to the university from outside the state and from foreign countries are so registered.

RUDOLF TOMBO, JR.
Registrar.

SPECIAL ARTICLES.

THE PRESERVATION OF SURFACE CONDENSER TUBES IN PLANTS USING SALT OR CONTAMINATED WATER CIRCULATION.[1]

THE prevention of electrolytic corrosion of condenser parts where they are subject to contact with condensing water that contains electrolytic properties has been a serious problem with condenser engineers at sea as well as on land, where the condensing water contains salts in solution. This action is especially destructive where the cooling water is contaminated further with chemicals or with sewage.

In the great steam plants of New York city where the water bills extend into thousands of dollars per annum, in fact, are approximately one tenth of the fuel bills, this is an important condition bearing upon the cost of the hourly power unit, but the attempt to use surface condensers in the past for the purpose of saving this waste has not been accompanied with any degree of success. The highest economy demands such precautions as shall leave the hot-well water coming from the condensers in a proper condition for feeding the boilers.

The waste incident to the inability to save this water in stationary generating plants has caused the construction of surface condensing apparatus at such plants as that of the Brooklyn Edison Company at Bayridge, and of the Metropolitan Street Railway Company at 96th Street, New York City.

At the time the design of the Long Island City Power House of the Pennsylvania Railroad was undertaken, it became evident that true economy in the operation of a plant which would have under ordinary circumstances an annual water bill of about $100,000, when the plant has been fully put into service, justified an attempt to save the water from the hot well for replenishing the boilers. This seemed to demand a thorough investigation of the matter of condenser protection where the circulation cooling water was an electrolyte as it was in this case.

The site where this plant was to be constructed was at Long Island City near the harbor front, and the plant was designed to contain, when fully constructed, fourteen 5,500 K.W. generating units. With such an equipment and with an ordinary loading, the amount of boiler feed water required per annum would cost in the neighborhood of $100,000.

In the investigation of possible methods for

[1] Read at the Ithaca meeting of the American Association for the Advancement of Science, June 29, 1906, before Section D—Mechanical Science Engineering.