servant. Can the Nathan Smiths and Benjamin Sillimans of our present-day faculties make any better produce of the raw material in their hands?

So while we rejoice that the Yale Medical School through the erection of this new Sterling Hall is at last provided with laboratories admirably equipped not only for research but also for the instruction of students in the methods of science, let us hope that from the outset these preclinical subjects will so far as possible be presented in terms of the ill or maimed patient across the way. There far more than here, where normal structure and function is largely dealt with, is experience found fallacious and judgment difficult.

HARVEY CUSHING

HARVARD UNIVERSITY

THE CAUSES AND PREDICTION OF EARTHQUAKES

EARTHQUAKES can be predicted as to time and place but the strength of the quake is uncertain, the element of time is long and the place is large. We may say with some certainty that there will be an earthquake in California during the next week and it is practically certain that it will occur. This statement is based on the fact that there has been, each week during past years, a recorded earthquake shock, or at least one would have been recorded had there been a sufficient number of recording stations in the state of California. These earthquakes vary greatly in intensity. In 1906 an earthquake occurred near San Francisco causing great destruction of property. Within the last two years an earthquake occurred in southern California which caused some damage. Many earthquakes have occurred which were felt by man but which caused no material damage. However, by far the greater number of earthquakes have not been felt by human beings but have been recorded on the very delicate instrument called the seismograph.

We may predict that, within the next century, a heavy destructive earthquake is likely to occur along the Atlantic coast. This is a logical deduction from the fact that, in the early part of the last century, there was a destructive earthquake in New England, and in 1886 there was a destructive earthquake in Charleston, South Carolina. We may predict, however, with reasonable certainty of fulfillment that there will be an earthquake on the Atlantic coast within the next year or within the next five years; this is based on the evidence that many earthquakes have occurred along the Atlantic coast during recent decades, some of which have been felt but most have only been discovered by the seismograph records.

It also seems to be reasonably certain that we shall have a heavy earthquake during the coming century in the Mississippi valley, for, in 1811, there was a very destructive earthquake in the vicinity of New Madrid, Mo.

Scarcely a day passes without there having been recorded on a seismograph, located at one of the many stations of the world, an earthquake with some degree of severity. The newspapers are giving attention to this subject as is indicated by their frequent notices of earthquakes.

A few such notices are:

December 1, 1923, dispatch from London. A severe earthquake shock was felt in the Ceprano district, Rome Province, during the night.

December 3, 1923, dispatch from Tokyo, Japan. A sudden and severe earthquake which lasted 40 seconds was felt at Nagoya, 171 miles southwest of Tokyo, on the island of Bondo at 10:18 o'clock last night according to advices received here. Residents of the city were badly frightened but no damage was done.

December 15, 1923, dispatch from Bogota, Colombia. Many persons have been killed and many injured by an earthquake which to-day destroyed two small towns in the region of Ipiales, near the Colombia-Ecuadorian frontier. The report has it that 85 dead have been recovered from the ruins of Cumball which with the town of Chile suffered most severely from the effects of the shocks, according to report received.

December 20, 1923, report from Douglas, Arizona. According to a report received by the president of Agua Prieta the Mexican towns of Granados, Huasabas and Oporto were razed by an earthquake about nine o'clock last night. Many were killed and injured according to the reports.

December 22, 1923, Guayaquil, Ecuador. Three new earthquake shocks have been felt in Tulcan.

The short space of time during which the above mentioned earthquakes took place gives some indication of the great number of rather severe earthquakes which occur over the earth's surface during the course of a year. Many severe earthquakes occur in regions where there are few or no inhabitants and again in other places where communication is so difficult that reports are not received concerning them.

While we may predict an earthquake for a certain general region, it is a very much more difficult matter to make a prediction for a small area such as that covered by a city or even a county. In fact, one would be rather bold who would say that any one city in the United States is likely to have an earthquake of a destructive nature within any given period of years no matter how great.

The earth's surface has changed its elevation greatly in various places during geological time. It has been

stated by an eminent geologist that about 1,500,000,000 years have elapsed since the earliest existing sedimentary rocks were formed. During this period mountains have come and gone, and, in fact, some areas have been mountains and again covered by the oceans several times. The Himalayan mountains now have a maximum elevation of about 28,000 feet, more than 5¼ miles. Tremendous forces have been in operation to cause such great changes in the elevation of the earth's surface and with the changing there has been fracturing, crushing, folding and overturning of the sedimentary rocks, resulting in sudden movements. With these movements have occurred the tremors called earthquakes. If the rock has been very strong the stresses have accumulated to great proportions until the forces have overcome the resistance. The giving way shatters the rocks of the crust and produces a destructive earthquake. Of course, this term destructive must be associated with man and structures made by him. An earthquake could not be called destructive, no matter how intense, if there were no artificial structures within the zone of effective action.

Many of the earthquakes occur at sea, under the bottom of the oceans; these make their occurrence felt by the seismograph records and the great tidal waves which, sweeping across the ocean, rush inland destroying the works of man and human life. At times these tidal waves have torn ships from their moorings and carried them inland, leaving them high and dry when the waters receded.

The great source of energy which changes the elevation of the surface of the earth is gravitation. This force, acting on the water which falls to the ground as rain, sweeps vast quantities of eroded material from the uplands and deposits them along the margins of the continents. The equilibrium of the earth's crust, approximately 60 miles in thickness, is disturbed by this process. The magmatic or subcrustal material is pushed away from the region on which sediments are deposited and is forced by gravitation back towards the region from which the eroded material came. In one case, a portion of the earth's crust is pushed down into regions that are hotter, while in the other case the portions of the crust under areas of erosion are lifted higher to colder regions. In the first case, the material of the crust will be subjected to greater heat and in the second the material will lose heat. In consequence of this, chemical or physical changes will occur which cause an expansion or shrinking of the crustal material. It is these changes which are most effective in the upbuilding of a mountain mass or the sinking of a coast.

While change in density of the earth's material is taking place there will be much yielding of the earth's crust without fracture. But some of the yielding will be sudden, and then there will be an earthquake. Earthquakes are also caused by the sinking of the crust under the overload of sediments. This undoubtedly was the cause of the destructive earthquakes at Charleston, S. C., and New Madrid, Mo. There will be fracture of the earth's material, causing earthquake shocks in regions of erosion, for as the surface material is worn away and the region becomes lighter than normal, the subcrustal material will force up the crust, breaking and crushing strata.

The earthquake is merely a symptom of something more fundamental taking place in the earth's crust. The earthquake is the effect rather than the cause, just as we may say that for a human being the chill is a symptom of malaria rather than the disease itself.

WILLIAM BOWIE
U. S. COAST AND GEODETIC SURVEY

FIRST AWARD OF THE PENROSE MEDAL[1]

BY invitation from the council of the Geological Society of America, the first award of the Penrose Medal by the Society of Economic Geologists was made a special feature of the Geological Society's annual banquet, which was held in Prudence Risley Hall, Cornell University, Ithaca, N. Y., on the evening of December 30, 1924. After the dinner had been served, President Lindgren, of the Geological Society of America, called the diners to order and introduced President Kemp, of the Society of Economic Geologists, who spoke as follows:

A year and a half ago, under the presidency of Mr. J. E. Spurr, the Council of the Society of Economic Geologists passed a resolution to establish a gold medal, to be awarded by the society. A committee was appointed to carry the resolution into effect. On canvassing the situation, the committee learned that Dr. R. A. F. Penrose, Jr., the first president of the society, was ready to supply the die and to establish an endowment with whose income the council might award the medal once in three years. In conference with the committee, it was decided that the award should be made for "exceptionally original work in the earth sciences." In accepting the foundation, the council voted that the name of the "Penrose Medal" should be attached to the award. This year it has become possible to present the Penrose Medal for the first time, and after discussion among those members of the council who could meet together, and after correspondence with members at a distance, the council awarded the medal to Professor Thomas

[1] Presentation address at the first award of the Penrose Medal of the Society of Economic Geologists to Professor Thomas Chrowder Chamberlin.