Etna Predicted.

The Dawn of Earthquake Science.

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When the man of science is asked "What caused the earthquake," he must confess to ignorance. It was either subterranean steam, or unequal yielding to internal contraction of immense blocks of the earth's crust, or deep-seated movements of lavas slowly rising under Etna. Or, what is still more likely, it was all three of these in mutual dependence. If we maintained earth observatories as we do astronomical ones, we might know, and we might perhaps have predicted and forewarned.

This new catastrophe is the thirteenth of the century, and brings the death-list to about 300,000, or 100 persons a day since January 1, 1901. An eruption of Etna is also beginning and may still further swell the fatal roll. The record includes Guatemala, Martinique, St. Vincent, Mobile, Galveston, San Francisco, Valparaiso, Jamaica, Kartaghan, India, Calabria, Vesuvius, and Messina. The property lost is countless millions. Eight of these places are American. At all of them the destruction has been wrought by natural agencies. In the cases of Mobile and Galveston there was definite prediction by the Weather Bureau. This office, which systematically records the movements of the atmosphere at widely distributed stations, is now recognized as one of the most efficient, valuable, and humane scientific organizations in the world. Similar meteorological establishments are maintained by all civilized nations. The other disasters were occasioned by volcanoes or earthquakes. With these facts before us, it would seem justifiable to call science to account for its attitude with regard to the lithosphere (or rock-crust) as contrasted with its point of view concerning the atmosphere. Sometimes a great affliction, like this which has stunned and mutilated Italy, may work beneficiently by stimulating men to a new vision of their usefulness.

If a Martian astronomer were to appear suddenly among men, after returning from a visit to the Lowell observatory at Flagstaff, where his own existence had been so wonderfully interpreted, the following dialogue might be expected:

"Where you know the heavens so well, of course your own earth is to you as an open book?"

"Yes," reluctantly.

"You have observatories for the recording of all earth phenonema?"

"No."

"What! Did you not learn anything about local terrestrial motions before you studied the stars?"

"No, we do not know anything about terrestrial movements."

"Do you mean to tell me that you have not many instruments for observing them?"

"We have the seismograph, but none of us understands it, and as for other earth motions, all we know we have learned from the physicist and the astronomer."

"But you live on the earth, and have to meet every crisis as it arises; can you foretell nothing?"

"Well, you see, we don't think of it that way. We treat it historically, and make notes, and use a hammer and a compass, and are very much interested in the bones of Jurassic reptiles and in making maps of the rocks, and in finding out all about iron and coal. But we have no such precise knowledge as the astronomer."

"But surely, in teaching your young men in the universities, you begin by precise instrumental study of the present earth and its processes, and have a vast accumulation of experience concerning these processes, in the form of tables, measurements, formulae, curves, diagrams, and computations?"

"No, almost nothing has been done in accumulating experience or empirical data, *except by the Japanese.* When a volcanic eruption or an earthquake occurs we send a geologist to study the results, and he writes a thick and learned report. We do not know anything about what the conditions were during the months before the disaster. We teach our young geologists first a litle physics and chemistry, and a few generalities about earth process, and then set them to work mapping ancient rocks. The highest development of geology is the unravelling of the history of the past. We havn't time to go into prediction and humanistic geology."

The above is not exaggerated. The blame does not rest with the geologist, it rests rather with the hap-hazard growth of the science. The very proximity of the earth has made terrestrial observation and measurement difficult, in view of the littleness of man. This plea, however, can no longer be urged in extenuation of the study of earth process. We have a considerable knowledge of physical science, and there are many instruments applicable to the earth. There is a very precise science known as geodesy, which has for its object the determination of the figure of the earth. There is geology, which aims to decipher earth history. Between these two there is needed a new science, many phases of which are now being studied, and this might well be named geonomy, the science of the laws which govern the earth.

There is one grave difficulty in the way of rapid development of this science, and that is expense. It is a science that calls for the establishment of observatories in many lands. These observatories will have for their objects the study of changes which are going on in the crust of the earth under them and the relations of those changes to astronomical and meteorological changes. The new science. like astronomy and the study of the atmosphere, deals with moving things and so requires continuous local records, through weeks and months and years. Seismographs, microphones, magnetographs, gravity, pendulums, pyrometers, tromometers, gas-collecting apparatus, and many special instruments are needed.

The Japanese have taken the lead, and their island empire is girdled with observatories. The writer has before him a pamphlet, in English, printed in Tokio in October, 1908, containing eleven contributions to practical seismology by a Japanese investigator, F. Omori, the first of which bears the significant title "On the Fore-Shocks of Earthquakes." Dr. Omori declares, "My belief is that a large destructive earthquake will be foretold in its epicentral region by some fore-shocks," and this belief he substantiates by exact instrumental proofs.

With reference to Sicily, it is well to make note of the fact that an American volcanologist, Frank Alvord Perret, has predicted disaster on Mount Etna for two years past. Mr. Perret, who was decorated by the Crown of Italy for his splendid service to science and to humanity on Vesuvius in 1906, wrote in the World's Work of November, 1907:

"By the rational methods of scientific research, we know that a great eruption of Mount Etna is impending, the only uncertainty at present being which side of the mountain will break open."

Great volcanic eruptions are preceded by great earthquakes, and the Messina disaster of December 28 comes on an earthquake date ("terrestrial maximum of gravitational stress") actually plotted in advance by Mr. Perret on his diagrams for 1908. Like Dr. Omori, he is a man whose whole time is unselfishly devoted to these studies, but he has no observatory and no adequate means of support. A few business men in Springfield, Mass., last year came valiantly to his aid, and now their foresight is worthy of all honour. When young men think of making science their life-work, it would be well to remember Pasteur, and to consider carefully whether the highest development of the investigative faculties may not concern itself with humane rather than with historical motives. To those who will give time and money to the establishment of earth observatories, there will come by way of reward some of the most astonishing discoveries of the twentieth century.

Plans have been prepared in Boston for an earthquake proof observatory and museum, built on Japanese lines, to be equipped with instruments for measuring earth tremor, earth waves, earth sounds, earth tilt, earth gravity, and earth magnetism.

It is proposed to secure an endowment which will provide for expeditions as the most important work of the observatory, whereby trained men will be sent to volcanic lands to carry on research which may not be done at home. The Geological Society of America has passed urgent resolutions strongly recommending "to governments and to private enterprise the establishment of volcano and earthquake observatories." What should be done in New York? It may be well to state briefly the vision of what *could* be done to set an example to the world: Provide £840,000. Erect ten small observatories costing £4000 each, in New York, Porto Rico, Canal Zone, San Francisco, Alaska, Aleutian Islands, Phillipines, Hawaii, Scotland, and Sicily. With £40,000 per annum, the income of £840,000, supply each observatory with £2,000 per annum to maintain its director, assistant, and expenses, and reserve £20,000 for the central office for administration. exploration, and publication. Define the objects of the work to be direct measurement and record of earth process with a view to the benefit of humanity. Define three immediate goals for the investigators: (1) Prediction of earthquakes; (2) prediction of volcanic eruptions; (3) engineering and construction in volcanic and seismic lands. The objects of the two European stations are to cover the important volcanic fields of Iceland, the east Atlantic, and southern Italy, and to keep in touch with the advance of European science. The work would be strictly American, and if it were carried out, it would be epoch-making in the history of science.