It can hardly be less than an educational and scientific duty for us to see to it that the young people who are graduated from our modern colleges shall have at least a realizing sense of this new scientific development, all of which has grown up within the last forty years.

The Charleston (Mo.) Earthquake. By A. H. Purdue.

The earthquake of October 31, 1895, is the greatest seismic disturbance that has occurred in the Mississippi Valley since the noted earthquake of 1811. Though nowhere intense enough to do great injury to buildings, it was perceptible over an area of more than 400,000 square miles.

A short time after the occurrence of the earthquake the writer communicated blanks to the teachers of science in seventy-five cities and towns in the States of Indiana, Illinois, Missouri, Arkansas, Alabama, Mississippi, Georgia, Kentucky and Tennessee, requesting information concerning the time, duration and intensity of the shock, together with the apparent course of wave movement, and subsequent phenomena. The major part of these blanks was sent to science teachers of Indiana with a view to determining, if possible, whether the great volume of gas removed in recent years has had any effect on the stability of the crust within the gas region. It seemed not unreasonable to suppose that the relief of pressure within the rocks from which gas has been removed has left them in a strain, in which case the earthquake waves might produce a collapse which would be indicated by their reinforced intensity.

Of the seventy-five blanks sent out, only thirty-nine were returned, consequently my information is not so complete as I had hoped to secure. Of the thirty-nine received, however, twenty-seven are from Indiana, so that the facts concerning that field are tolerably complete.

The reports sent in substantiate what the newspapers had already indicated, viz., that the epicentrum was in the vicinity of Charleston, Missouri. The person* reporting from that place says that the force was "sufficient to break several plate-glass windows, crack brick walls, and throw down brick chimneys." He also reports: "About four miles southwest of this place the ground was cracked open in several places, and sand and water were forced from the fissures, causing what are commonly known in this section as sandblows. For a few minutes afterward water spurted from several pumps." There were at least two

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* A. R. Boon.

slight shocks immediately following the severe one, at intervals of ten or fifteen minutes. Subsequently earthquakes occurred on November 1 at 8:15 P. M.; November 2 at 9:50 A. M., and November 17 at 9:20 P. M.

A good deal of injury to buildings is reported from Cairo, Illinois. At that place there is reported to have been at least one shock each day during the first five days of November. During one day there were three shocks.

At Columbus, Kentucky, the shock was sufficient to crack brick walls and throw off plaster. As at Charleston the first shock was immediately followed by two others of less intensity. One subsequent earthquake is reported for November 1 at 8:00 P. M.

From nowhere else do the reports indicate such intense movement as at these three places, and from no other place is there an earthquake reported subsequent to the one of October 31st. As the three places are within a radius of twenty-five miles, the epicentrum can be considered fairly well located.

Reports from the Indiana gas field and vicinity indicate a movement slightly more intense than those from other parts of the State, but the increased force was not sufficient to justify the conclusion that it was due to the removal of gas. Three shocks in rapid succession are reported from Portland and Marion; two from Decatur, Goshen, Lafayette and Frankfort. From other places only one is mentioned. The average duration of the shock in six towns and cities within the gas region was 44.1 seconds. The average duration of the shock in sixteen towns and cities outside of the gas field was 43.2 seconds. That the apparent increase of intensity within the gas region and vicinity is not necessarily due to the removal of gas is shown in the reports from Bowling Green and Frankfort, Kentucky, each of which announces three shocks. Frankfort and Indianapolis are about an equal distance from the centre of disturbance. At Batesville, Arkansas; West Plains, Missouri, and Nashville, Tennessee, the shock is reported intense. At Wichita, Kansas, it was scarcely felt. At Atlanta, Georgia, it was slight.

Following the earthquake were increased flows of gas at Portland, Marion, and Bluffton. There were increased flows of water at Columbus, Shelbyville, Albion and Wabash. The water in Blue River rose several inches at Columbia City. The water in Pigeon Creek, Warrick County, rose one and a half feet the day following the earthquake, but soon subsided. Phenomena of this kind are a common result of earthquakes.

The average time of the shock as reported from Indiana was 5 o'clock, 10 minutes, and 30 seconds, A. M. There was no preceptible difference between the time the wave was felt in the southern part and in the northern part of the State.

This indicates either an extreme velocity of movement or great depth of disturbance, probably both. The large area affected and the comparative mildness of the shock at the epicentrum indicate that the disturbance was deep. A disturbance at a small depth might be felt over a large area, but if so, the force at the epicentrum would be great. According to the conclusions of Capt. Dutton from his studies of the Charleston (S. C.) earthquake,* the wave movement at that time had a velocity of about three miles per second. At this rate, it would require 1.38 minutes for a wave to travel from Charleston, Missouri, to Indianapolis. It will be seen that it would have required close observation to determine the difference in time at which the wave was felt at Evansville and at Indianapolis. The average time of the shock as reported from Charleston, Cairo, and Columbus was 5 o'clock 8 minutes and 20 seconds, or 2 minutes and 10 seconds earlier than the average time reported from Indiana.

An interesting feature of this earthquake is the fact that its epicentrum has approximately the same position as that of the earthquake of 1811 which resulted in the sinking of large areas about the mouth of the Ohio River for a distance of several feet.

There are newspaper reports of an earthquake at Cotapaxi, Colorado, November 18 at 4:10 P.M.; one at Greeley, Colorado, November 24th at 5 A. M.; and one at Clayton, Delaware, November 20, at 3 A. M. There was an earthquake of some severity reported from Rome and Naples, Italy, November 1. When we consider the great frequency of earthquakes in volcanic regions and in regions where there is great crustal disturbance, these closely simultaneous earthquakes in distant parts appear as probable coincidences hardly worthy of remark. It is reported† that in Japan there is an average of at least one earthquake a day. According to the records kept at Lick Observatory‡ there was an average of one earthquake for every 11.4 days in the State of California for the years 1890 and 1891.

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* Ninth An. Rep. U. S. Geolog. Survey.

† Rep. Brit. Association, 1884, p. 242.

‡ Bull. U. S. Geolog. Survey, No. 79.