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THIRD SERIES

VOL. XXV.—[WHOLE NUMBER

Nos. 145—150.

JANUARY TO JUNE, 1883.

WITH FIVE PLATES.

4809

NEW HAVEN, CONN.: J. D. & E. S. DANA.
1883.

Rocks of the Park; by WILLIAM BEAM.

3. *Rock from Yellowstone Cañon near Falls.*—Consists of white, opaque fragments, rough to the touch. Fracture conchoidal, texture porous. Hardness, 3.5; sp. gr., 2.36; fusibility, 5.5. Gives a colorless bead with microcosmic salt and borax; moistened with cobalt nitrate and heated, it turns bright blue. Hydrochloric acid dissolves 14.6 per cent of the powdered mineral. Analyses gave:

SiO ₂	64.60
Al ₂ O ₃ and Fe ₂ O ₃	25.65
MgO }	traces
CaO }	
K ₂ O76
Na ₂ O43
H ₂ O	8.70
	100.14

The rock has the appearance and qualities of a very compact or baked clay; it adheres strongly to the tongue; when breathed upon has a distinct pipe-clay odor, and the powder becomes plastic with water. Not being familiar with this region, I am unable to give a full explanation of the character of this rock; but I incline to the view that it is a clay metamorphosed by proximity to a dyke or lava stream. The specimens examined may have been taken at some distance from the source of heat, as it seems difficult to suppose that a clay would retain its plasticity after having been heated to the degree which immediate contact with the melted rock would cause.

4. *Trachyte from Junction Valley.*—The pieces were greenish-blue, interspersed with white and dark spots and small particles of free silica. Fracture uneven. Hardness, 4.5; sp. gr., 2.84; fusibility, 5.5. Gives reaction with borax for iron. Heated with cobalt nitrate, the whole parts become blue and the rest brown. Composition:

SiO ₂	69.90
Al ₂ O ₃	17.58
Fe ₂ O ₃	2.41
CaO }	traces
MgO }	
K ₂ O	4.16
Na ₂ O	2.41
H ₂ O by ign.	3.65
	100.11

ART. XXXVI.—*Notes on American Earthquakes*: No. 12. By Professor C. G. ROCKWOOD, Jr., Ph.D., Princeton, N. J.

THIS article embodies such information as the author has obtained in regard to the earthquakes which occurred on the American continent and adjacent islands during the year 1882, with notice of some earlier ones not before reported here.

Items which depend on single sources of information usually have their source indicated; and if regarded as doubtful, are printed in smaller type.

For assistance in collecting information the author is again indebted to J. M. Batchelder, Esq., of Boston; to Professor F. E. Nipher, of the Missouri Weather Service; to Dr. J. W. Dawson, of Montreal; to Charles Carpmael, of the Meteorological Service of Toronto; and especially to Mr. Edwin Rockstroh, of the Ynstituto Nacional, at Guatemala, to whose kindness are due the unusually full reports from that region.

The Monthly Weather Review of the U. S. Signal Service has also furnished much valuable information.

1879.

- June 8.—10.51 A. M. An earthquake occurred at San José de Costa Rica.
- June 19.—3.00 A. M. A slight shock at Guatemala.
- Sept. 21.—11.13 A. M. A weak shock at San José de Costa Rica.
- Oct. 11.—12.45 A. M. A slight shock at Guatemala.
- Nov. 18.—10.40 A. M. A weak shock at San José de Costa Rica.
- Dec. 29.—7.43 P. M. A somewhat strong earthquake at San José de Costa Rica.

1880.

- Jan. 11.—8.42 P. M. A slight shock at Guatemala.
- The following were all at San José de Costa Rica.
- Jan. 7 and 26. Weak shocks.
- Mar. 3.—9.50 A. M. A weak shock.
- Mar. 17.—10.32 A. M. A strong shock.
- May 15.—8.31 P. M. A light shock.
- May 22.—6.17 P. M. A light shock.
- May 25.—2.58 A. M. A strong shock of seven or eight seconds' duration.
- July 13.—7.30 P. M. A weak shock.
- Dec. 30.—10.04 P. M. An earthquake of three seconds' duration.

1881.

- Jan. 23.—5.30 A. M. A moderate shock at Guatemala; reported also (5.55 A. M.) at San José de Costa Rica.
- Mar. 3. During the night of the 2d and 3d several slight shocks were felt at San Marcos, a town northwest from Guatemala.
- Mar. 7.—7.52 A. M. A slight shock, lasting three seconds, reported from Dos Caminos, Mexico.
- Mar. 15.—1.50 P. M. A moderate shock lasting four seconds at the same place.
- Mar. 29. A moderate shock (N. to S.), reported from Oaxaca (12.50 P. M.), and Tlacolula (12.55 P. M.).
- Mar. 30. Slight shocks reported at Villa Juarez Ixtlan (12.55 A. M., N. to S., 5 sec.), and at San Carlos Yautepec (1.30 P. M., E. to W., 4 to 6 seconds).
- The last four items are by E. R., from a Mexican paper.
- April 6. A heavy shock reported from San Salvador, Central America.
- April 16 to 22. More than fifteen moderate shocks, all vertical, reported from San Salvador during these six days.
- April 27.—10.20 A. M. and 11.30 A. M., moderate shocks at Guatemala.
- April 28. At 9 P. M. a violent shock with vertical movement, lasting more than fifty seconds, did some damage at Managua, in western Nicaragua, and was followed by other shocks at 10.00, 11.00 and 11.30 P. M. The first shock was also reported as very heavy at San Juan del Sur and Chinandega, and was felt at various points between these places.
- May 13.—5.30 P. M. A slight shock, S. to N., duration three seconds, at San Carlos Yautepec, Mexico.
- May 27.—12.15 P. M. A slight shock, duration three seconds, at Oaxaca, Villa Juarez Ixtlan, and San Carlos Yautepec (S. to N.), Mexico, and also at San Cristobal las Casas (1 P. M., E. to W.).
- May 29.—1.40 P. M. A slight shock at Guatemala.
- Aug. 13.—12.30 P. M. A strong earthquake at San Marcos, Guatemala; felt also slightly at the capital city.
- Sept. 25.—4.20 P. M. An earthquake of about two seconds' duration at San Cristobal las Casas, (Chiapas) Mexico.
- Oct. 3.—9.30 P. M. A slight shock at Acaponeta, Mexico.
- Oct. 17. At 12.50 A. M. a shock of two seconds' duration at Dos Caminos, Mexico. At 1.55 P. M. a strong shock, duration three seconds, at Chilpancingo.
- Also at Mexcala, hour not given, a strong shock of two seconds' duration, probably coincident with that last mentioned.

- Oct. 19.—4.20 P. M. A strong shock at Tehuantepec, Mexico, duration six seconds.
- Oct. 20.—2.58 P. M. Another shock at same place, duration four seconds; reported also at Juchitan, with direction E. to W.
- Oct. 21.—At 8.05 P. M. a shock, E. to W., duration three seconds at Tlacolula, Mexico.
- At 9.22 P. M. and 11.30 P. M. shocks of six and two seconds, at Tehuantepec, with subterranean rumbling.
- A shock was reported the same day from Oaxaca, hour not stated, direction E. to W., duration six seconds; very likely coincident with one of those mentioned above.
- Oct. 22 to 27. Shocks were noted at Tehuantepec as follows: 22d, 4.10 A. M. (6 seconds); 8.15 P. M. (3 seconds); 9.20 P. M. (3 seconds); 11.30 P. M. (4 seconds). 23d, 1.00 A. M. (11 seconds and rumbling); 8.53 A. M. (rumbling); 9.30 A. M., 10.00 A. M., 11.38 A. M., 3.37 P. M., 7.05 P. M., 8.43 P. M., 10.00 P. M. (all 3 or 4 seconds). 27th, 10.03 A. M. (N. to S., 3 seconds).
- All the above items, in 1879-81, are from Mr. E. Rockstroh, of Guatemala.

1882.

- Jan. 8.—5.10 P. M. A shock of ten seconds' duration at Cape Lookout, N. C. *U. S. Weath. Rev.*
- Jan. 20.—10.02 P. M. A slight shock at Guatemala. E. R.
- Jan. 26. Two severe shocks in the evening at Centreville, Cal.
- Feb. 3.—2.40 A. M. A sharp shock, direction apparently S. to N., at San Geronio, California. *U. S. Weath. Rev.*
- Feb. 12.—1.30 A. M. A shock at Pagosa Springs, Lake City, and Capitol City in southwestern Colorado.
- Feb. 26.—6.25 P. M. A shock, lasting three or four seconds, at Murray Bay, Quebec.
- Mar. 2. At 2.48 A. M. a strong shock, lasting twenty-four seconds, was felt at Guatemala, and the neighboring places, doing some damage in Antigua. At 5.58 A. M. a less heavy shock followed, lasting seventeen seconds. The direction of these two shocks at Guatemala was S.W. to N.E. The same night five moderate shocks were reported from Salamá, a town sixty miles north from Guatemala. E. R.
- Mar. 3.—7.48 A. M. A strong earthquake, from N.E. to S.W., in San José de Costa Rica; duration, forty-seven seconds. It was felt also in Puntarenas, Alajuela, Heredia and Cartago, and generally from the dividing ridge between the oceans to the Pacific coast. Light shocks followed in Puntarenas, at 11.30 P. M. of 3d and 4.30 A. M. of 4th.
- The first accounts of this earthquake were greatly exaggerated, reporting a loss of several thousand lives. The real damage appears to have been very slight.

- Mar. 11.—4 P. M. A slight shock, N. to S., at San Diego, California; reported also from Poway, California, at 3.30 P. M.
- Mar. 16.—1.15 A. M. A strong shock at San José de Costa Rica; duration, two seconds. E. R.
- Mar. 16. A shock in the morning in the City of Mexico. *N. Y. Times.*
- Mar. 16.—1.46 P. M. A light shock in San Francisco, California. *U. S. Weath. Rev.*
- Mar. 21.—1.30 A. M. A weak, and at 2.42 A. M. a strong, shock at San José de Costa Rica. E. R.
- March. At Salinas City, California, light shocks twice during the month. *U. S. Weath. Rev.*
- April 2. At Newmarket, Va., several shocks reported in the evening.
- April 2. Two shocks in the morning at Amsterdam, N. Y. J. M. B.
- April 11.—11 P. M. A slight shock in New Orleans, La. *N. Y. Times.*
- April 13.—6.30 A. M. A sharp shock, N. to S., lasting about four seconds, in San Francisco, Cal. *U. S. Weath. Rev.*
- April 17. "A few minutes past two o'clock" a sharp shock at Hopkinton, N. H. J. M. B.
- April 30. At 10.48 P. M. the vicinity of Portland, Oregon, was shaken by two earthquake shocks, a few seconds apart, the first light, the second more severe, with a low rumbling; vibration in a general west-east direction. Another light shock followed at 12.25 A. M. of May 1. The heavier shock was reported as far north as Olympia, W. T., and Victoria, B. A.
- May 1. An earthquake at East Greenwich, R. I. J. M. B.
- May 8. About 4 A. M. a slight shock at Concord, N. H. *Concord Monitor.*
- May 11.—8 P. M. A slight shock at Pagosa Springs, Col. *U. S. Weath. Rev.*
- May 21.—9.37 P. M. A moderate earthquake in Guatemala. E. R.
- June 8 to 10. At 11.52 P. M. of 8th, at 9.20 P. M. and 9.28 P. M. of 9th, and at 10.37 P. M. of 10th, moderate earthquakes in Guatemala. E. R.
- June 27.—5.22 A. M. Two severe shocks at San Francisco and vicinity, each about ten seconds' duration, with four seconds between. They were felt along the coast from Petaluma to Hollister, and as far inland as Stockton.
- July 15.—7.45 P. M. A sharp shock at San Francisco, Cal., felt slightly at Point San José.
- July 19.—2.35 P. M. A very severe shock in the City of Mexico, lasting two and a half minutes. It was said to be the most severe since 1864.
- July 20.—4 A. M. A shock, duration fifteen seconds, at Cairo, Ill.
- July 22.—11.08 A. M. A very light shock at San Francisco, Cal. *U. S. Weath. Rev.*

- July 28. A single shock, hour not stated, at Ironton, Mo.
- July 31. About noon a light shock at Cape Mendocino, Cal. *U. S. Weath. Rev.*
- Aug. 1.—6 P. M. A light earthquake at Point des Monts, at the mouth of the St. Lawrence River. *Canadian Meteorol. Serv.*
- Aug. 8. Light shocks, S.E. to N.W., at Oakland, Cal. *U. S. Weath. Rev.*
- Aug. 9.—8.45 P. M. A light shock at San Francisco, Cal. *U. S. Weath. Rev.*
- Aug. 15.—10.30 A. M. A strong earthquake at Point des Monts, Quebec. *Canadian Meteorol. Serv.*
- Aug. 24.—3.56 P. M. A moderate earthquake in Tecpan, Patzizia and Quezaltenango, Guatemala. E. R.
- Aug. During the month two severe earthquakes and several minor shocks occurred in Caracas, Venezuela. *H. D. Warner, in Atlantic Monthly.*
- Aug. At Salinas, Cal., shocks were felt twice during the month. *U. S. Weath. Rev.*
- Sept. 6. An earthquake in Aux Cayes, Hayti. *Troy (N. Y.), Daily Times.*
- Sept. 7. About 3.20 A. M. (variously given from 3.15 to 3.24), the isthmus of Panama was shaken by a very severe earthquake lasting about sixty seconds. This violent shock had been preceded by rumblings, and was followed by another shock after half an hour, and by other lighter shocks during that and the succeeding days, especially at 1 P. M. and 11.30 P. M. of 7th, and about 5 A. M. of the 9th. The violent shock affected a very wide extent of country. It was felt at Panama, Aspinwall and generally throughout the isthmus and adjacent islands; at Rivas and Greytown in Nicaragua; at Guayaquil, in Ecuador; at Buenaventura and Cartagina, in Colombia; at Maracaibo and Caracas in Venezuela; that is, along the whole northwestern coast of South America. At Panama the Cathedral and other public buildings were partly overthrown and fifty or sixty houses were injured. The damage was estimated at \$250,000. Two lives were lost by falling walls. The railroad between Aspinwall and Panama was injured in many places by the sinking of the road-bed and the breaking of culverts, and the telegraph cable from Aspinwall to Jamaica was broken by the shocks about fifty miles from the isthmus. At Caracas, where the most violent shock occurred at 2.20 A. M., the loss amounted to eight persons killed, twenty-six wounded, sixty-two buildings totally destroyed and sixty-seven others badly cracked.
- Sept. 13. In the evening a slight shock reported in Caledonia, Livingston County, N. Y.
- Sept. 19.—4.17 P. M. A moderate earthquake in Guatemala. E. R.
- Sept. 20. At noon a light earthquake at Point des Monts, Quebec. *Canadian Meteorol. Serv.*

Sept. 27. At 4.20 A. M. (St. Louis, Mo., time), a somewhat severe earthquake was felt throughout southern Illinois. Its influence extended west and east, from Mexico, Mo., to Washington, Ind., and Henderson, Ky.; and north and south from Springfield, Ill., to Pinckneyville, Ill., being reported from numerous places within these limits. The area affected would therefore be an ellipse, measuring 250 miles east and west by 160 miles north and south. From many places round about this area and in its borders came the report that *no* shock was felt, so that its boundary is pretty well defined. The time stated above is based upon several closely accordant and trustworthy observations in and near St. Louis. The reports from other persons varied all the way from 2.15 A. M. to 5.05 A. M. The reports of direction were equally various, but on the whole point to a general east-west motion which is also indicated by the form of the district affected. In very many places more than one shock was reported, the number being variously given from two to twelve. In almost all places subterranean rumbling was heard, but a few places, as Whitehall, Ill., and Louisiana, Mo., distinctly reported that *no* sound was heard. The motion was sufficient to crack chimneys, overthrow small objects, as toilet bottles, and set pictures vibrating. This summary is based on reports from over fifty different places, for many of which I am especially indebted to Professor F. E. Nipher.

Sept. 30.—10.57 A. M. A sharp shock at Campo, Cal., lasting two seconds; direction S.E. to N.W. *U. S. Weath. Rev.*

Oct. 8. At 2.00 A. M. a heavy shock, lasting several seconds, at San Diego, Cal.; felt generally in the surrounding country.

Oct. 8.—5.00 A. M. A sharp shock at Antigua, W. I. *N. Y. Times.*

Oct. 9. News of this date from Cape Haytien, W. I., says: "Three slight shocks of earthquake were felt here during the past week."

Oct. 10.—4.15 A. M. A slight shock at Montreal; felt also at Lachine, St. Hiliare, Huntingdon and other points near.

Oct. 11.—11.15 P. M. A slight shock at Panama.

Oct. 12. "An earthquake shock is reported to have been felt in the southern part of Humboldt Co., Nev." *U. S. Weath. Rev.*

Oct. 13.—4 P. M. Two sharp shocks at St. Thomas, W. I.

Oct. 14-15. About midnight southern Illinois again felt several shocks of earthquake similar to that of Sept. 27th but feebler. The district affected was from St. Louis and St. Charles, Mo., east and northeast to Springfield and Decatur, Ill. It was also reported at Indianapolis, Ind. There appear to have been at least three distinct shocks, the first at 11.49 P. M., St. Louis time (reported at Collinsville, 11.50½ P. M.); another between 12 and 1 A. M., and a third between

4 and 5 A. M. At Manchester, Scott Co., Ill., the times were given as 12.33 A. M. and 4.35 A. M. Most observers reported only two of the three shocks, some the first two and others the last two. Centralia, Ill., was the only place where all three were reported.

Oct. 15. At 12.30 P. M. a slight shock reported at Murphy, N. C.

U. S. Weath. Rev.

(Should *p. m.* be *a. m.*, and this be a part of the earthquake in Illinois already noted?)

Oct. 20.—1.40 A. M. A slight shock at Lima, Peru. *N. Y. Times.*

Oct. 20.—2.15 A. M. A severe shock at San Francisco, Cal., felt lightly at Point San José.

Oct. 20. At 7.30 (A. M. ?), a slight shock at San Salvador, Cent. Amer. *N. Y. Times.*

Oct. 22.—At 12.10 A. M., Indianapolis time, a slight shock at Greenville, Bond Co., Ill.

Oct. 22. About 4.15 P. M. an earthquake was felt in northern Texas, western Arkansas and eastern Kansas, and presumably in the intervening portions of the Indian Territory. The region affected extended from Greenville and Paris, Tex., and Little Rock, Ark., northwesterly to Wichita and Leavenworth, Kan., a distance of some 300 miles. The shock was reported from numerous places within these boundaries, and also, as a light shock, from Warrenton, Mo., which is farther eastward. The most definite report of time was from Wichita, Kan., which gave 4.19 P. M., Jefferson City, Mo., time. In many places two or three pulsations were noticed, having a duration of about thirty seconds in all. Reports of direction are too various to be classified. No damage was done other than overturning movable articles and knocking bricks from chimney-tops.

Oct. 23. About 7 P. M. a slight shock reported at Newberne, N. C.

U. S. Weath. Rev.

Oct. 31.—6.45 P. M. A sharp shock at San Francisco, Cal., felt also at Sonoma, Napa, Petaluma and San Rafael; vibration east and west.

Nov. 7. About 6.30 P. M. an extensive earthquake was felt in Colorado, Wyoming and Utah. It was reported from Salt Lake City and all along the Union Pacific R. R. eastward to Laramie City and Cheyenne, Wyoming Ter.; from Georgetown and Louisville, Col.; from Denver, where the clocks were stopped at 6.25 P. M., and from Salina, Kansas. At some places three shocks were noticed. The direction was generally east and west, and the intensity sufficient to set chandeliers vibrating.

Nov. 14. In the morning an earthquake at Panama, felt on both sides of the isthmus.

Nov. 14. A light shock felt at St. Louis, Mo., 9.14 P. M. (9.16½ P. M., by B. D. Kribben); at St. Charles, 9.21 P. M., and at Collinsville, Ill., 9.17½ P. M.

Nov. 27.—6.30 p. m. A severe shock occurred at Welland, Allandburg, Port Colborne and other places along the Welland Canal between Lake Erie and Lake Ontario.

Nov. 28.—5.15 p. m. A sharp shock at San Salvador, Cent. Amer.

Nov. 30. A second lighter shock at daylight at the same place.

N. Y. Tribune.

Dec. 11. Two slight shocks at Santiago de Cuba followed by a more severe one on the morning of the 12th. *N. Y. Times.*

Dec. 19. About 5.20 p. m. a shock occurred in the southeastern part of New Hampshire. It was felt at Dover (5.15 p. m.), Contoocook (5.20 p. m.), Concord (5.24 p. m.), New Market (5.25 p. m.), and other neighboring places. It lasted several seconds and was accompanied by a rumbling noise.

Dec. 19. Two slight shocks at Panama.

Dec. 19.—11.45 p. m. Two light shocks, east to west, at Visalia, Cal. *U. S. Weath. Rev.*

Dec. 31. About 10.05 p. m. a decided shock with rumbling noise was felt in Halifax, N. S. and other places along the railroad to Truro. It was also reported from Eastport (9.55 p. m.), Rockland (10.00 p. m.) and Bangor (9.30 p. m.), in Maine.

The above record for 1882 includes seventy-two items, of which thirteen are in small type. They may be classified geographically as follows:

Canada,	6	
New England,	5,	3 doubtful.
Atlantic States,	6,	4 "
Mississippi Valley,	11,	2 "
Pacific Coast,	19,	3 "
Mexico and Central America, ..	18	
Venezuela,	1	
West Indies,	5,	1 "
Peru,	1	
	72	13

The following may be selected as the more important of the earthquakes noticed above:

March 2, Guatemala; March 3, Costa Rica; April 30, Oregon; June 27, California; Sept. 7, Central America; Sept. 27, Illinois; Oct. 14, Illinois; Oct. 22, Arkansas, Kansas, etc.; Nov. 7, Colorado and Wyoming.

Thirty-six items are added to the record of previous years. They all refer to the Central American region, and are distributed as follows: 1879, six; 1880, nine; 1881, twenty-one.

Princeton, N. J., March 12, 1883.

ART. XXXVII.—*A Four Years' Record of Earthquakes in Japan, studied in their Relation to the Weather and Seasons*; by THOS. H. STREETS, M.D., U. S. Navy.

"FROM time immemorial it has been asserted by the natives of the countries which are most frequently ravaged by earthquakes, that these commotions bear some intimate relation to the movements of the atmosphere, and very generally coincide with certain meteorological conditions, such as rainy seasons, numerous storms, warm and damp winds."—(Reclus, Earth.) Humboldt, likewise, seemed to have been impressed with the importance of this relation. He says, "but if no meteorological phenomena indicate the coming earthquake, either on the morning of the shock or a few days previously, the influence of certain periods of the year (the vernal and autumnal equinoxes), the commencement of the rainy season in the tropics, after long drought, cannot be overlooked even though the genetic connection of meteorological processes, with those going on in the interior of our globe, is still enveloped in obscurity."—(Cosmos.)

Japan is preëminently a country of earthquakes, as the list given abundantly testifies. It was compiled from the weather statistics kept at the United States Naval Hospital at Yokohama, Japan, which is a station for taking international meteorological observations. The list includes every shock, that could be appreciated without the aid of a seismometer, that occurred in a period of four years, beginning with 1878; and, counting only those that were separated by a lapse of several hours; there were in this period 124 distinct shocks. There is no questioning the accuracy of the accompanying observations, which were carefully recorded every three hours. The height of the barometer above the sea-level is 115 feet.

In the first place I think we may conclude that the barometer gives no indication of the approach of an earthquake; but the charts would indicate that they are associated with a comparatively high state of atmospheric pressure. Between the highest and lowest barometer with which they were accompanied, there is a variation of little more than one inch, from 30.44 to 29.33; and within these limits we have them occurring under the most variable conditions of the barometer, when it was rising and when it was falling, as well as when it was steady.

At first sight it would appear as if the shocks were associated with atmospheric commotions. About 75 per cent of them preceded, or accompanied, rainy or threatening weather, or heralded clearing weather. To one unacquainted with the