Seismological Investigations.—Tenth Report of the Committee, consisting of Professor J. W. JUDD (*Chairman*), Mr. J. MILNE (*Secretary*), Lord KELVIN, Professor T. G. BONNEY, Mr. C. V. BOYS, Professor G. H. DARWIN, Mr. HORACE DARWIN, Major L. DARWIN, Professor J. A. EWING, Dr. R. T. GLAZEBROOK, Mr. M. H. GRAY, Professor C. G. KNOTT, Professor R. MELDOLA, Mr. R. D. OLDHAM, Professor J. PERRY, Mr. W. E. PLUMMER, Professor J. H. POYNTING, Mr. CLEMENT REID, Mr. NELSON RICHARDSON, *and* Professor H. H. TURNER. (*Drawn up by the Secretary.*)

[PLATE I.]

CONTENTS.

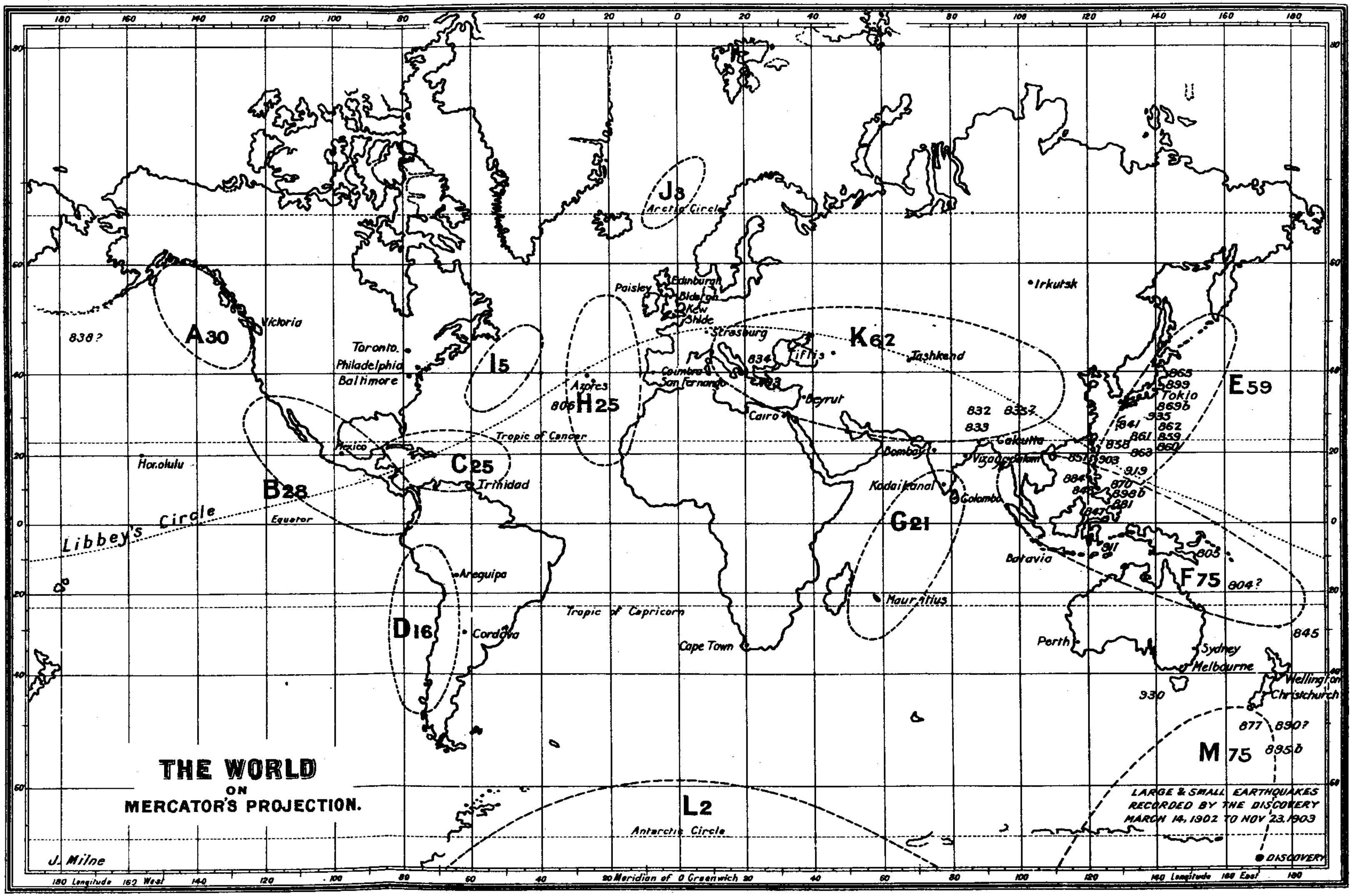
I. *General Notes on Stations and Registers.*

THE registers issued during the past year are Circulars Nos. 10 and 11. They refer to Shide, Kew, Bidston, Edinburgh, Paisley, Toronto, Victoria (B.C.), San Fernando (Spain), Ponta Delgada (Azores), Cape of Good Hope, Alipore, Bombay, Kodaikânal, Batavia, Perth, Trinidad, Christchurch, Cairo, Cordova (Argentina), Irkutsk, Baltimore and Beirût.

Records obtained by means of horizontal pendulums (Milne type) at Irkutsk, Tiflis and Tashkent are published in the 'Bulletin de la Commission Centrale Sismique Permanente' of St. Petersburg, whilst references to similar records made in Strassburg are to be found in the 'Monatsbericht der Kaiserlichen Haupstation für Erdbebenforschung

British Association, 75th Report, South Africa, 1905. *The Large Earthquakes of* 1904. [Plate I.

Origins for 1904 are indicated by their B.A. Shide Register number. Earthquake districts are indicated A, B, C, &c., and the number of earthquakes which since 1899 have originated from these is expressed in large numerals. Observing stations are named.



Illustrating the Report on Seismological Investigation.

zu Strassburg, i/E.' These latter records only indicate whether the instrument had responded to certain disturbances, and do not furnish information as to times and amplitudes.

It is anticipated that continuations of registers from Mauritius, Tokyo, and Wellington will shortly be received.

From the United States Coast and Geodetic Survey your Secretary learns that copies of registers are to be forwarded from Honolulu, while Professor H. F. Reid writes to the effect that Professor S. J. Cunningham will recommence observations at Strathmore College, Philadelphia.

Four other observatories, the records from which would be of great value, particularly as an assistance in localising seismic foci, are Mexico, Arequipa, Melbourne, and Sydney. The registers from the latter two, taken in conjunction with those from New Zealand and those obtained by the 'Discovery,' the examination of which has been entrusted to your Secretary, will undoubtedly throw light upon suboceanic changes now in progress in the Antarctic regions.

II. *The Situation of Stations.*

As it is recognised that the character of a seismogram is to a greater or less extent dependent upon the topographical and geological situation of the observatory at which it was obtained, a letter was sent to each of the stations at which horizontal Milne pendulums have been established, asking for information relating to their installations. The replies which have been received run as follows :—

Abbasia. Cairo, Egypt. (See also Helwan.)

Lat., 30° 04′ 36″ N.; long., 31° 17′ 13·5″ E.; alt., 33 metres.

Foundation is on sandy loam.

Topographical Situation.—On the border between desert and cultivated delta; 5 kilometres from the Nile.

Geological Structure.—The neighbouring desert to the east is mainly horizontally bedded limestone. The actual surroundings are Nile valley deposits.

The station is at an astronomical observatory.

B. H. WADE, Superintendent.

Azores. Ponta Delgada, S. Miguel, Azores (Meteorological Observatory).

Lat., 37° 44′ 18·3″; long., W.G. 25° 41′ 15″ (1h. 42m. 45s.); alt., 16 metres.

Foundation is on a layer of basaltic rock.

Topographical Situation.—On low ground with an extent of nearly 2 kilometres. To the south (nearly 120 metres) is the sea. The hills (small or great craters) near the town have a mean altitude of 180 metres. The nearest is situated at a distance of 2 kilometres. The great mountains lie to the N.E. and E. Their height is 900 metres, and they are 9 and 12 kilometres from the town.

Geological Structure.—A very thin soil of volcanic cinders, covering a layer, very thick (unknown thickness), of basaltic rock. The layer was produced by the descent to the sea of a lava stream poured from a crater situated at the north of the town of Ponta Delgada.

Time-keeping.—The hour of the watch is every day compared with the regulator established in the Observatory.

FRANCISO A. CHAVES,
Director of the Meteorological Service of the Azores.

Baltimore, Md., U.S.A.

Lat., 39° 17′ 8″ N.; long., 76° 37′ 25″ W.; alt., 100 feet.

Foundation is on brick pier, built nearly thirty years ago, on sands and clays.

Topographical Situation.—On a hilly plateau.

Geological Structure.—Sands and clays, about 60 feet thick at this point, rest on an irregular surface of crystalline rock dipping toward the south-east. The water-level is about 50 feet from the surface.

Time-keeping.—My clock is checked weekly by means of a sidereal clock. My clock does not keep very good time.

HARRY FIELDING REID.

Batavia. Royal Magnetical and Meteorological Observatory.

Lat., 6° 11′ 0″ S.; long., 7h. 7m. 19s. E.; alt., 8 M.

Foundation is on brick pillar.

Topographical Situation.—Flat country.

Geological Structure.—Alluvium.[1]

Time-keeping.—An electrical signal is given hourly by an observer from the astronomical clock, controlled monthly by observation of the sun.

Dr. S. FIGEE, Director.

Beirût Protestant College, Syria.

Lat., 33° 54′ 20″ N.; long., 35° 28′ 10″ E.; alt., 105 feet.

Foundation is on solid rock.

Topographical Situation.—The general trend of the coast ridge, which has an altitude of 2,000 feet, is N.N.E.–S.S.W. At Beirût a limestone spur juts out about five miles due west. It was, doubtless, once an island. It is now joined with the mainland by a narrow alluvial plain, and the space to the south is filled in by a late formation derived from shifting sand. Along the northern face of this spur there is a ledge, averaging 100 yards wide, about 10 feet above sea-level; then a sudden rise to a terrace 100–140 feet above sea, with a further rise to the highest part of the ridge, 500 yards back, the height of which is 225–300 feet. The Observatory is at the very edge of the middle plateau, about 400 yards from its western extremity, and is about 100 yards south of the seashore, which is rocky. Six miles to the east the first ridges of Lebanon rise to an altitude of 2,500 feet, with the main ridge, 15–20 miles further, rising to 5,000–8,700 feet.

Geological Structure.—Stratified limestone (tertiary), of unknown thickness, but probably not less than 500 feet, and probably with underlying sandstone 100–400 feet thick, under which is limestone. Water-bearing strata at sea-level. Dip of strata, 5° N.–S.

The station is at an astronomical observatory.

ROBERT H. WEST.

Bidston (Liverpool Observatory), England.

Lat., 53° 24′ 5″ N.; long., 3° 4′ 20″ W.; alt., 202 feet (barometer cistern). The foundation of seismometer is at an altitude of 178 feet.

Foundation is on sandstone.

Topographical Situation.—On the top of a small eminence, from which the ground slopes away rapidly in every direction but the south. It is the highest ground in the immediate neighbourhood.

Geological Structure.—The rocks at Bidston are strongly current bedded, hence dips are not very reliable. The general dip is to the east, about 5°. Under the Observatory there are 25 feet of Keuper basement beds, then a thin band of marl less than a foot in thickness, followed by Upper and Lower Bunter. In a boring near Bidston station the Bunter has been proved to be 2,850 feet below surface. This may include some Permian. The line of water saturation varies, as it is affected by pumping. It is probably at a depth of 200 feet.

The station is an astronomical observatory.

WILLIAM E. PLUMMER.

[1] Also see *Brit. Assoc. Rep.*, 1899, p. 178.

Colaba, Bombay.[1]

Lat., 18° 53′ 45″ N.; long., 72° 48′ 56″ E.; alt., about 35 feet above sea-level.

Foundation is on rock—a large boulder.

Topographical Situation.—The Observatory is located at almost the extremity of a narrow and somewhat rising strip of land called Colaba, about two and a half miles in length, running into the sea almost S.S.W. from the island of Bombay. The breadth of the strip where the Observatory is situated is about 500 yards, about 200 yards of which, near the eastern side, being occupied by the Observatory compound. The main Observatory buildings are located on the top of a small mound, sloping somewhat more abruptly on the east than on the west. The mean level of the ground on which all observation buildings are located is about 32 feet above mean sea-level.

Geological Features.—The rocks generally in the vicinity and of the neighbouring hills, such as the Malabar and Cumballa Hills, are basaltic traps and are highly magnetic. The probable dip of the trap is about 5° to the westward. Excavations show here and there large boulders of basalts lying in thick and hard beds of red and somewhat sandy soil. At several places where the rock crops out through the soil the depth of basalts appears to be very great, continuous rock being met to a considerable depth, as shown by the sides of an existing deep well in the compound. Water is always available at a depth of about 30 feet below ground. The nearest hill is Malabar Hill, about four miles north, across the Back Bay, while the highest hill, the Karauja Hill, about eight miles across the harbour towards E.S.E., subtends an angle of about 1° as seen from the Observatory.

This is an astronomical observatory.

N. A. F. MOOS, Director.

Calcutta (Alipore Observatory), India.[2]

Cape of Good Hope, Royal Observatory.

Lat., 33° 56′ 3″·6; long., 1h. 13m. 54.76s. E.; alt., 33 feet.

Foundation is on the partly weathered rock of the Malmesbury beds—a quartzose slate—with good unweathered rock at from 16 to 30 feet below.

Topographical Situation.—In a cellar of the main Observatory building, which is situated on a rising ground on the comparatively level country between Table Bay and False Bay.

Geological Structure.—'The site is underlain by the oldest rocks of this part of South Africa, the slates and quartzites known as the Malmesbury beds. These rocks form the whole S.W. corner of the Cape Colony, and extend over many hundred square miles of country. No fossils have been discovered in any of the outcrops, but there is no doubt that the old slates and quartzites were deposited at some period long anterior to the Devonian rocks of Europe. The Bokkevelt beds of Cape Colony contain Devonian fossils. Between these beds and the tilted Malmesbury slates there are 4,000 to 5,000 feet of Table Mountain sandstone, which is itself separated by a very marked unconformity from the old slate series. The Malmesbury beds in petrological character resemble some of the Silurian slates and grits of the southern uplands of Scotland. "Cleaved quartzite" is the most accurate description.'—*Dr. Corstorphine's Report.*

DAVID GILL, H.M. Astronomer.

Carisbrooke (Newport, Isle of Wight), England.

Observations at this station have been discontinued. Its situation is described in the 'British Association Reports' for 1896, p. 185.

[1] See *Brit. Assoc. Rep.*, 1899, p. 176. [2] *Ibid.*, 1899, p. 177.

Coimbra (Observatorio Magnetico-Meteorologico), Portugal.

Lat., 40° 12′ N.; long., 8° 25′ W., Green.; alt., 141 metres.

Foundation is on rock. The pier is a cut limestone, erected on a base of masonry, which rests on a 25 cm. layer of concrete, spread on the rock.

Topographical Situation—On a hill-top. The height above the surrounding country is about 100 metres from the south side and 15 metres from the north. The slopes are gentle from all sides.

Geological Structure.—The nature of the rock is generally Old Red Sandstone. Depth of water-bearing strata undetermined.

Time-keeping.—The time-keeping is secured by transits of stars, frequently observed in the adjoining Observatory. The watch of the seismograph is compared every day with a mean-time chronometer, whose corrections are carefully determined.

DR. A. S. VIÉGAS, Director.

Edinburgh Royal Observatory, Edinburgh, Scotland.

Lat., 55° 55′·5 N.; long., 3° 11′ 3″ W.; alt., 441 feet.

Foundation is on granite pier, 3 feet high and 18 inches square, built on the surface of the rock, 431 feet above sea-level. A brass plate is placed under each of the levelling screws.

Topographical Situation.—The Observatory, in the basement of which the instrument is placed, is situated on the ridge of the Blackford Hill, sloping upwards to the west, 1 in 10, to a height of about 520 feet above sea-level, and downwards towards the east, about 1 in 12, to the 300 feet contour line. Towards the north the hill slopes downwards, at first 1 in 7, afterwards less steeply, to about the 200 feet contour line, where it reaches the general level of the neighbourhood. Towards the south the decline is less rapid, being practically level for some 300 yards, after which it slopes to the top of a cliff, about 80 to 100 feet high, overhanging the Braid Burn.

Geological Structure.—'Blackford Hill is practically one great mass of andesite lava (of Devonian age). There is a very thin band of tuff, which is a few hundred feet below the surface of the rock upon which the Observatory stands, but it is only 2 feet in thickness, and it is almost as compact as the lava above it and below. The chief disturbing factor, so far as the andesite lava is concerned, is the shattered condition of the rock, arising from the joints and divisional planes which traverse it in many directions. But deep within the hill I think that these are almost negligible.'

THOMAS HEATH.

Helwan Observatory, Cairo, Egypt. (*See also Abbasia.*)

Lat., 29° 51′ 34″ N.; long., 31° 20′ 30″ E.; alt., 115 metres above sea.

Foundation is on Eocene limestone rock.

Topographical Situation.—The Observatory is situated on a spur of the eastern desert plateau, which is cut up by numerous 'wadies,' or dry valleys. The spur, which rises some 55 metres above the level of Helwan town, is about 80 metres in width, with a flat top and a valley on either side.

Geological Structure.—Horizontally bedded Eocene limestone, mostly of a rather chalky nature, in thick beds, with occasional siliceous and marly bands. Comparatively little vertical jointing is seen in the rock, but the horizontal bedding-planes are well marked. Water-bearing beds do not occur higher than 60 metres below the site.

The station is an astronomical observatory.

B. H. WADE, Superintendent.

Honolulu Magnetic Observatory (U.S. C. and G. Survey).

Lat., 21° 19′·2 N.; long., 158° 03′·8 W.; alt., 45 feet.

Foundation is on a concrete pier on solid coral limestone.

Topographical Situation.—The Observatory is located on the large, level coral plain which forms the south-western part of Oahu Island, west of Pearl Harbour. This plain is about nine miles in length, and of an average width of about two and a half miles, and is practically level. The Waianæ mountains rise to the west of north, the first high summit being 5½ miles distant N., 30° W., 2,450 feet; the second, 6½ miles N., 22° W., 2,740 feet; the third, 7¼ miles, N. 20° W., 3,110 feet. The Observatory is about one mile from the seashore.

Geological Structure.—The coral plain is a raised barrier reef of great depth, estimated at 2,500 feet at the seashore. On the basis of this estimate the depth at the Observatory would be about 1,800 feet. The surface is covered with loose coral stones of all sizes, with very little soil, and there are frequent large, irregular holes, 10 or 15 feet deep (some reaching a depth of even 30 feet or more). Water is found at a depth of about 45 feet, or about sea-level.[1]

Time-keeping.—Star observations with theodolite.

S. A. DEEL, Magnetic Observer U.S. C. and G. S.

Kodaikánal Observatory, Madras, India.

Lat., 10° 13′ 50″; long., 5h. 09m. 52s. E.; alt., 7,688 feet.

Foundation is on rock.

Topographical Situation.—On the top of a hill. At a distance of about two miles on the east and south sides the hills slope very steeply down to a height of 800 to 900 feet above sea-level. Towards the west and north the plateau is much more extensive. The highest point lies to the W.S.W., is four miles distant, and the top is 8,200 feet. The Palani Hills, on which Kodaikánal stands, form a mass fifty-four miles long from east to west and fifteen miles broad. The plateau is at an average elevation of 7,300 feet above sea-level.

Geological Structure.—'Charnockite,' 'a group of hypersthene-bearing rocks, which form the largest single section of the Archæan gneisses in peninsular India.'[2] The rocks have been but little disturbed, and there are well-marked lines of false bedding running N.E. and S.W. The chief precipices face either nearly south or nearly east, so the chief lines of jointing may be considered parallel to these directions.

It is an astronomical observatory, but it also receives a direct signal from the Madras Observatory clock at 4 P.M. daily.[3]

C. MICHIE SMITH, Director Kodaikánal and Madras Observatories.

Royal Alfred Observatory, Mauritius.

Lat., 20° 5′ 39″ S.; long., 3h. 50m. 12·6s. E. of Greenwich; alt., 178 feet.

Foundation is on alluvium.

Topographical Situation.—On a plain three miles from the west coast. From N. through E. to S.E. the ground generally rises to Mount Pitou, the summit of which bears about E.S.E., and is 917 feet above mean sea-level. Between S.E. and S.W. there is a chain of mountains, the highest peak of which, the Pieterboth, bears nearly six miles due south and has an altitude of 2,874 feet.

Geological Structure.—The island is of volcanic origin. It has been supposed that the alluvium has a depth of from 2 to 14 feet, below which is solid basalt; but I have recently dug 23 feet, to obtain a solid rock foundation for the seismograph, and instead of rock I came to water, which has risen 9 feet in the hole. This will account for the large changes of level produced by heavy rains. I have also recently discovered that a lamp at night (to check tremors) introduces a change of level, the boom tilting away from the lamp. It seems as if the tremors were caused by radiation of heat from the pier, and I thought our magnetic basement (whose floor is 13 feet below the surface of the ground, and in which the diurnal range of temperature is usually less than 0·3° F.) would be an ideal place for the seismograph. There is only one spot where there is sufficient room for the instrument, and in that spot, as I have said, we came to water at 10½ feet, *i.e.*, 23½ feet below the surface.

[1] See *Brit. Assoc. Rep.*, 1903, p. 78.

[2] Holland, *Memoirs of the Geological Survey of India*, vol. xxviii.

[3] Also see *Brit. Assoc. Rep.*, 1899, p. 175.

I hope to be able to try another spot shortly, below the floor of the main building.

Time-keeping.—By the usual methods at an astronomical observatory.[1]

T. F. CLAXTON, Director.

Paisley (The Coats Observatory), Scotland.

Lat., 55° 50′ 44″ N.; long., 0h. 17m. 43·3s. W.; alt., 100 feet above sea-level.

Foundation is on boulder clay.

Topographical Situation.—Instrument is placed near the top (but on the south side) of Oakshaw Hill, the most northerly of a series of ridges which run east and west between the Gleniffer Braes (800 feet high and three miles to the south) and the Clyde, a tidal river, three miles to the north.

Geological Structure.—Alluvium, *i.e.*, boulder clay, which may be 30 feet thick, resting probably on limestone or sandstone. The district is, geologically, a very troubled one; *e.g.*, the surface of Paisley town—say, a mile square—showing moss, running sand, shell clay, boulder clay, limestone, sandstone, coal, dolerite, &c.

The station is an astronomical observatory.

DAVID CRILLEY, Superintendent.

Kew Observatory (National Physical Laboratory), England.

Lat., 51° 28′ N.; long., 0° 19′ W.; alt. of seismograph, 20 feet above M.S.L.

The instrument's foundation is on pipes filled with cement, resting on a thick bed of cement. The ground immediately below, consisting of earth and brick rubbish, was rammed hard before the cement was laid. The supports are isolated from the paving-stone of which the flooring is composed.

Topographical Situation.—The Observatory stands on a low mound, presumably artificial. It has a deep basement, in which the seismograph is situated, the whole surrounded by unused subterranean cellars. The surrounding ground is nearly level and covered with grass, except a small garden. The Old Deer Park, in which the Observatory stands, is bounded on its west and north by the Thames, whose nearest approach to the building is some 300 yards. In exceptional floods and high tides water sometimes spreads to within fifty or sixty yards of the Observatory, and has once or twice reached the basement. The nearest ground showing any considerable slope is Richmond Hill. The upward slope of the hill commences about 1,500 yards away in a south-eastern direction. Its altitude is only some 200 feet, the highest point being some two miles distant.

Geological Structure.—We have no special knowledge. No deep boring has been made nearer than that of the Richmond Water Company. The soil of the immediately adjacent park is alluvium (there are patches of sand and gravel not very far off). This we suppose to rest on the London Clay at no great depth.

Time-keeping.—A daily Greenwich time-signal is received, and there are good clocks.

CHARLES CHREE, Superintendent.

Perth Observatory, Western Australia.

Lat., 31° 57′ 07″·4 S.; long., 7h. 43m. 21·74s. E.; alt., 200 feet.

Foundation is on sand.

Topographical Situation.—Hilltop. Level for half a mile south, then drops suddenly to sea-level. Gradual slope downwards in other directions, though steep to east.

Geological Structure.—Considerable depth of sand (may be 100 feet or more) on top of limestone.

W. ERNEST COOKE, Government Astronomer.

San Fernando (Observatorio de Marina), Cadiz, Spain.

Lat., 36° 27′ 42″; long., 0h. 24m. 49·34s. W.G.; alt., 28·5 metres.

Foundation is on rock.

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[1] See *Brit. Assoc. Rep.*, 1899, p. 179.

Topographical Situation.—The Observatory is situated on a hilltop, whose height above the environs is 10 metres. The dip (mean) is 7°.

Geological Structure.—The instrument is mounted on a pillar built on the same rock, which is a calcareous one, whose thickness is very variable.[1]

The station is an astronomical observatory.

CAPITAN DE FRAGATA TOMAS DE AZCARATE, Director.

Shide, Newport, Isle of Wight, England.

Lat., 50° 41′ 18″ N.; long., 1° 17′ 10″ W.; alt., about 50 feet.

Foundation is on a brick column, 18 inches square and 6 feet in height, founded upon disintegrated chalk, beneath which there is solid chalk.

Topographical Situation.—On the eastern side of a valley running north and south. The station is 40 feet above a small stream in the bottom of the valley and 200 feet below the crest of a ridge which runs E.S.E. to W.N.W., across which the valley is cut. In the bottom of the valley, which is about half a mile in breadth, there is alluvium and grass land. Its eastern side is steep (about 25°) and covered with grass and gorse.

Geological Structure.—The station is on the chalk ridge which forms the backbone of the island. The dip is steep, approaching the vertical, and towards the north. The strike is as given above.[2]

Time-keeping.—Time is obtained from the post-office at Newport, which receives a daily signal from Greenwich. It can also be obtained by noting the time when the sun is due south. For this purpose, in the south wall of the Observatory there is a vertical slit made of two sheets of iron. The image of this is thrown by the sun on to a north wall 16 feet distant. When this image reaches a line on the wall the sun is due south. Accuracy ± 1 sec.

JOHN MILNE

Strassburg, Elsass, Germany.

Lat., 48° 35′ N.; long., 7° 46′ 10″ E.; alt., 135 metres.

Foundation is on compact pure gravel, alluvium.

Topographical Situation.—The instrument is on an isolated pier in water-bearing strata, on the Rhine plain, in the University Garden, 60 metres from Goethestrasse and 65 metres from the Universitätsstrasse, along which heavy traffic is not permitted. The Vosges Mountains are about 20 kilometres distant and the Schwarz Wald about 15 kilometres.

Geological Structure.—On the compact gravel of unknown depth which fills the valley between the above-mentioned ranges. Water-bearing strata are found at a depth of 1·50 metre.

Time-keeping.—Time is kept by means of a Strasser and Rohdesche 'Normal Uhr' (chronometer), in telegraphic connection with the Astronomical Observatory. Weekly, or more frequently, if required, this is compared.

PROFESSOR DR. BR. WEIGAND.

Sydney, N.S. Wales.

Lat., 33° 51′ 41″; long., 10h. 4m. 50·81s. E.; alt., 142 feet.

Foundation is on clay and ironstone shale on sandstone. The seismograph is placed on a glazed brick pedestal about 3 feet from floor, as per instructions sent with the instrument.

Topographical Situation.—On top of a hill 142 feet above sea-level. Gradual slope south and east side, precipitous on north and west side.

The station is an astronomical observatory.

H. R. LENEHAN, Acting Govt. Astronomer.

Toronto, Canada.[3]

[1] See *Brit. Assoc. Rep.*, 1899.

[2] *Ibid.*, 1896, p. 184, and 1902, p. 60.

[3] *Ibid.*, 1899, p. 170.

Trinidad, West Indies.

Lat., 10° 40′ N.; long., 61° 30′ W.; alt., 66·71 feet above mean sea-level.

Foundation is on hard pan—sand and clay—on a base of concrete 6 feet deep.

Topographical Situation.—On fairly level ground at the foot of a ridge distant about 500 feet and 500 feet in height. In the opposite direction, at a distance of about two miles, is the sea.

Geological Structure.—Yellowish sandy, slaty shale with quartz contortions.

Time-keeping.—Daily astronomical observations are taken by Survey officer.

J. H. HART, Director.

Victoria, British Columbia, Canada.

Lat., 48° 23′ N.; long., 123° 19′ W.; alt., 12 feet.

Foundation.—The instrument is placed upon a concrete pillar (about 18 inches square at top), which goes down 9 feet 6 inches to a bed of hard pan which overlies the native rock of the island.

Topographical Situation.—The station is in the basement of a large three-storey brick building, formerly used as a Custom House. The ground floor of this building is on the water-front street, from which there is a gradual slope down to a wharf; the basement is about 10 feet below the level of this street, and from the street the city gradually rises up a further incline of about 150 feet.

The nearest hill is Mount Douglas, 696 feet altitude, distant between four and five miles to the north-eastward.

To the westward, about 12 to 14 miles away across the water (sea) known as Royal Roads (the entrance to Esquimalt Harbour), lies the range of mountains the Sooke Hills, running north-west and south-east, and reaching about 1,000 feet altitude. These hills are outlying parts of the great mountain ranges which form the backbone of Vancouver Island, with peaks reaching an altitude of 6,000 feet.

Twenty miles to the southward, across the Straits of Juan de Fuca, is the northern coast of the State of Washington, and from the water's edge rise in successive tiers, running east and west, the splendid chain of mountains known as the Olympian Range, whose summits attain 8,000 feet of altitude. These summits are distant from Victoria from 60 to 75 miles.[1]

Geological Structure.—Dr. G. M. Dawson, the late Director of Geological Survey of Canada, says on page 88 of his Report, 1876–77:—

'Volcanic action has played a large part in the building up of these rocks of Vancouver Island, and near Victoria probably nine-tenths of their entire thickness is made up of ashbeds, interleaved with lavas and other igneous rocks. These, from their composition, have yielded readily to metamorphism, and now lithologically resemble, as you have pointed out, the rocks of the Huronian and altered Quebec groups of Eastern Canada. This likeness, with the fact that the rocks still preserve not alone the chemical, but also in some places the mechanical, characteristics of volcanic rocks,' &c.

Mr. W. L. Sutton, a well-known resident geological expert, says that the Victoria rock is dense, igneous, and quite massive, with comparatively little jointage, and closely allied to diabase in general character.

Time.—This is not an astronomical observatory, but our chronometer is rated at least once a week by comparison with the time which is given over the Canadian Pacific Railway telegraph, from the Montreal Astronomical Observatory; our office telegraph being switched on to the local C.P.R. telegraph office and communication received direct from Montreal.

E. BAYNES REID, Superintendent.

III. *The Origins of Large Earthquakes in* 1904.

The number of earthquakes recorded at Shide in 1904 was eighty-three. The localities from which twenty-eight of them originated are

[1] See *Brit. Assoc. Rep.*, 1899, p. 172.

indicated by their Shide register number on the accompanying map. They are distributed as follows :—

District E (Japan—Formosa)	12
District F (Java to Fiji)	9
District F (Himalayan Line)	4
District M (New Zealand Fold)	3

Large earthquakes do not appear to have been noted in any other districts. From 1899 to 1902 there was marked activity in the Alaskan, Cordillerean and Antillean regions. This has gradually waned, whilst activity on the opposite side of the Pacific has not undergone any marked change. M is a district brought into notice by records brought home by the 'Discovery.' These show that to the south-west of New Zealand there is a region where geotectonic changes are much more marked than has hitherto been supposed.

IV. *On International Co-operation for Seismological Work.*

In the British Association Report for 1904, p. 45, a short statement is given of efforts which have been made to establish international inquiry about earthquakes. Amongst other matters, reference is made to a Committee appointed by the International Association of Academies. This Committee recommends that the Associated Academies should take action with their respective Governments in favour of joining the Seismic Association founded in Strassburg, but proposes changes in the terms of the Convention. One change is to the effect that a State may join the Association either through its Government, or through one of its scientific bodies. Another relates to the choice of a central station, which is left to the General Assembly. At present this is at Strassburg, but the Committee did not consider it was necessary that the locality should be named in the Convention. Other proposed changes were of a minor character.

These resolutions have been considered by the Seismic Committee of the Royal Society, and His Majesty's Government will be advised to join the German Convention under certain conditions. Three of these are as follows :—That the suggested changes be adopted ; that the United States of America and France are willing to co-operate ; and that seismology receives State aid in Britain.

V. *Tabulation of the Records obtained in Tokyo of the Gray-Milne Seismograph for the Years* 1886–1901. *By* R. D. OLDHAM.

The discussion of the records of the Gray-Milne seismograph was undertaken primarily with the view of detecting any possible effect of the variation in tidal stresses on the frequency of earthquakes, and though the result has been inconclusive, the figures may be useful in some other connection.

The cost of the calculation was defrayed by a grant from the Research Fund administered by the Royal Society ; the work was conducted by Babu Phanindra Lal Ganguli, Research Scholar of the Calcutta University, and consisted in calculating for each shock (1) the exact local time of occurrence ; (2) the lunar time, taking the interval between two successive, similar, meridian passages of the moon as representing twenty-

Tokyo.—Gray-Milne Seismograph, 1886–1901.—*Shocks with Measurable Amplitude.*

I. *Solar Day and Time.*

Hour . .	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Declination:																									
> 11° N. .	5	9	1	3	6	5	4	9	10	4	6	7	10	5	12	4	6	4	5	3	8	7	9	5	147
< 11°. .	4	3	2	9	4	7	7	7	1	4	3	4	5	5	4	8	4	4	4	6	6	6	7	4	118
> 11° S. .	8	8	9	7	1	3	7	4	9	5	9	8	5	5	6	3	7	6	6	9	4	10	7	9	155
Sum . .	17	20	12	19	11	15	18	20	20	13	18	19	20	15	22	15	17	14	15	18	18	23	23	18	420

II. *Lunar Day and Time.*

Hour . .	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Declination:																									
> 11° N. .	7	2	8	6	4	0	2	5	10	8	4	6	9	2	4	8	5	4	5	9	5	4	8	6	131
< 11°. .	5	2	3	5	9	7	11	1	5	5	6	6	11	7	8	8	4	6	4	8	8	4	2	3	138
> 11° S. .	8	7	6	3	6	5	4	10	7	6	2	1	7	12	3	4	6	3	10	9	11	7	8	6	151
Sum . .	20	11	17	14	19	12	17	16	22	19	12	13	27	21	15	20	15	13	19	26	24	15	18	15	420

four lunar hours ; and (3) the declination of the sun and the moon at the time of the shock.

The results are tabulated according to the declination and time, the classification being such that each group of shocks represents a period during which the distribution of the tidal stresses was practically uniform. The grouping adopted has also the advantage that, by taking 11° as a limit, and dividing the year into three portions, according as the declination of the sun is greater or less than that limit, we get three almost equal periods, corresponding closely to the four winter months, November, December, January, and February ; the four summer months, May, June, July, and August ; and the spring and autumn months, March, April, September, October respectively.

The discussion of the record as a whole gave no indication of tidal periodicity, differing in this respect from that of the seismograph at Shillong, but this may well be due to the difference in the character of the record. At Shillong only true tectonic earthquakes of a degree of violence corresponding to at least III of the Rossi-Forel scale were registered ; at Tokyo, on the other hand, the greater part of the record is composed of shocks which could not be felt, which were so feeble that, even instrumentally, they could only be detected, not measured, and which are very probably of quite a different nature to the tectonic earthquakes, in which alone the effect of tidal stresses is to be looked for.

If only those shocks which had a measurable amplitude are considered, the distribution is as represented in the second set of tables. The total number of shocks is too small for detailed discussion, but a comparison of the ratio of shocks occurring between the hours of 18 and 6 on the one hand and between 6 and 18 on the other, when the declination is more than 11° north or south, and for the whole record, gives the following result :—

—		Declination >11° N.		Declination >11° S.		All Shocks	
		6 h. to 18 h.	18 h. to 6 h.	6 h. to 18 h.	18 h. to 6 h.	6 h. to 18 h.	18 h. to 6 h.
Solar	No. of shocks	81	66	74	81	211	209
	Ratio to mean	1·10	·90	·95	1·05	1·01	1·99
Lunar	No. of shocks	67	64	65	86	210	210
	Ratio to mean	1·02	·98	·86	1·14	1·00	1·00

From this it will be seen that in the case of both sun and moon the ratio of shocks occurring in the half-day containing the upper culmination to those occurring in the half-day containing the lower culmination is above the average ratio when the declination is north, and below it when the declination is south. As the rate and range of variation of tidal stresses in Japan is greater in the half-day containing the upper culmination when the declination is northerly, while the reverse is the case when the declination is southerly, this result falls in with the supposition that tidal stresses have some effect, and tend to increase the frequency of earthquakes at the time when they have the greatest range and rate of variation. As regards the effect of the attraction of the sun, this principle may be more briefly expressed : that the ratio of day to night shocks is higher in summer than in winter.

Tokyo.—Gray-Milne Seismograph, 1886–1901.

I. *Solar Day and Time.*

Hour	0		1		2		3		4		5		6		7	
Declination:																
> 19° N.	4	8	10	8	5	7	7	5	7	4	8	6	8	7	10	13
14° 40′ to 19° N.	1	2	2	2	5	2	4	2	5	5	7	2	6	4	8	6
11° „ 14° 40′ N.	2	6	3	6	1	2	0	6	3	1	0	2	0	2	3	2
9° „ 11° N.	0	1	2	0	3	1	0	1	1	2	2	3	0	1	2	0
6° „ 9° N.	1	3	0	1	0	0	3	2	2	2	2	2	3	3	0	2
0° „ 6° N.	1	3	1	5	4	2	3	7	2	0	5	2	3	3	3	2
0° „ 6° S.	2	1	3	1	5	3	2	4	1	4	3	3	4	4	4	3
6° „ 9° S.	0	0	1	1	0	1	0	2	0	2	1	0	1	2	3	3
9° „ 11° S.	0	1	2	2	1	2	0	1	2	0	0	1	0	2	2	1
11° „ 14° 40′ S.	1	4	1	2	3	4	2	0	0	0	1	3	2	6	5	8
14° 40′ „ 19° S.	2	3	3	1	2	3	2	4	3	1	1	1	2	6	4	2
> 19° S.	5	10	7	8	7	6	10	11	6	6	2	8	6	6	6	5
Sum	19	42	35	37	36	33	33	45	32	27	32	33	35	46	50	47
Sum by hours	61		72		69		78		59		65		81		97	

Hour	8		9		10		11		12		13		14		15	
Declination:																
> 19° N.	10	10	7	11	11	10	5	6	11	8	4	10	13	9	8	8
14° 40′ to 19° N.	3	7	6	7	3	7	4	4	7	3	2	5	0	8	3	3
11° „ 14° 40′ N.	1	3	3	3	3	0	3	1	7	6	3	1	0	0	1	1
9° „ 11° N.	2	0	1	0	0	1	0	2	1	0	0	0	2	1	4	4
6° „ 9° N.	1	4	0	0	4	1	1	1	2	2	4	1	0	4	3	2
0° „ 6° N.	3	3	7	4	4	3	1	5	5	2	4	1	4	4	6	4
0° „ 6° S.	1	2	5	5	5	3	4	2	2	2	4	4	4	2	3	1
6° „ 9° S.	3	1	2	1	2	1	1	1	1	1	3	0	3	2	1	3
9° „ 11° S.	3	0	0	0	0	1	3	0	1	0	1	0	1	0	1	4
11° „ 14° 40′ S.	4	4	1	3	3	1	2	3	5	3	2	3	2	0	2	6
14° 40′ „ 19° S.	3	7	0	3	9	3	3	0	2	1	4	4	7	4	4	5
> 19° S.	8	5	9	8	5	6	7	11	3	6	5	5	7	6	2	7
Sum	42	46	41	45	49	37	34	37	47	34	36	34	43	40	38	48
Sum by hours	88		86		86		71		81		70		83		86	

Hour	16		17		18		19		20		21		22		23		Total
Declination:																	
> 19° N.	7	11	9	7	7	12	12	12	7	8	11	9	13	10	9	7	409
14° 40′ to 19° N.	3	6	0	2	3	5	4	3	4	1	4	1	4	3	3	4	185
11° „ 14° 40′ N.	1	2	2	4	4	0	2	1	2	1	1	2	4	2	0	5	108
9° „ 11° N.	3	2	0	1	1	0	2	3	1	2	1	1	2	3	2	3	64
6° „ 9° N.	2	1	4	1	4	0	1	0	1	2	0	2	1	2	2	0	79
0° „ 6° N.	2	3	1	2	3	4	2	3	5	6	7	4	3	5	3	5	164
0° „ 6° S.	1	2	1	2	3	5	1	5	7	2	9	0	0	1	1	3	139
6° „ 9° S.	2	6	1	4	1	1	2	1	1	1	0	0	4	1	3	3	74
9° „ 11° S.	0	0	0	0	1	0	0	1	2	0	4	4	1	1	1	2	49
11° „ 14° 40′ S.	3	2	5	0	4	2	1	5	4	3	2	4	2	3	2	1	129
14° 40′ „ 19° S.	3	2	6	7	3	3	1	3	3	0	4	2	3	4	5	2	150
> 19° S.	5	9	4	9	8	6	8	5	5	3	7	5	6	8	14	9	320
Sum	32	46	33	39	42	38	36	42	42	29	50	34	43	43	45	46	1,872
Sum by hours	78		72		80		78		71		84		86		90		1,872

NOTE.—Two shocks occurring at declination 0° are included in the totals.

II. *Lunar Day and Time.*

Hour	0		1		2		3		4		5		6		7	
Declination:																
> 19° N.	12	8	9	5	3	8	10	3	15	6	4	12	13	12	13	11
14° 40′ to 19° N.	3	6	10	2	2	5	3	3	1	5	1	2	3	7	2	4
11° „ 14° 40′ N.	1	2	2	2	1	2	3	0	2	3	1	4	3	0	1	3
9° „ 11° N.	2	2	0	1	0	1	1	0	1	1	1	3	1	2	1	1
6° „ 9° N.	3	0	2	2	2	1	5	5	3	2	1	3	1	0	1	1
0° „ 6° N.	2	2	2	4	2	4	4	7	1	1	4	2	3	2	6	2
0° „ 6° S.	6	1	4	3	7	5	1	2	2	6	8	5	3	1	6	2
6° „ 9° S.	2	5	3	2	2	1	2	2	2	1	3	1	0	1	4	2
9° „ 11° S.	0	0	2	0	1	2	2	3	0	1	0	1	0	1	1	0
11° „ 14° 40′ S.	1	2	2	5	4	2	0	1	2	3	4	0	1	1	2	3
14° 40′ „ 19° S.	4	3	3	4	4	3	8	1	3	5	4	2	4	4	5	5
> 19° S.	11	8	7	4	11	8	6	8	8	6	10	6	11	10	7	6
Sum	47	39	46	34	39	42	45	35	40	40	41	41	43	41	49	40
Sum by hours	86		80		81		80		80		82		84		89	

Hour	8		9		10		11		12		13		14		15	
Declination:																
> 19° N.	6	8	7	8	5	6	8	7	7	13	7	6	7	11	7	4
14° 40′ to 19° N.	5	0	3	6	2	4	2	3	4	3	2	2	4	4	2	6
11° „ 14° 40′ N.	4	4	2	4	3	4	7	3	2	5	1	3	5	4	2	2
9° „ 11° N.	2	0	1	1	0	0	1	1	0	2	0	3	2	0	2	2
6° „ 9° N.	1	1	1	2	2	3	3	0	5	3	3	1	3	0	0	1
0° „ 6° N.	1	4	1	5	2	7	1	1	5	4	3	3	0	3	2	1
0° „ 6° S.	6	1	5	2	3	1	3	1	4	5	4	3	7	2	7	4
6° „ 9° S.	0	6	1	0	1	0	0	2	0	2	0	1	2	0	3	1
9° „ 11° S.	3	0	4	2	2	0	2	1	1	0	0	0	1	0	1	1
11° „ 14° 40′ S.	2	2	2	5	0	4	0	2	1	1	2	1	1	0	3	1
14° 40′ „ 19° S.	8	4	5	6	7	1	5	1	6	8	7	2	2	3	2	2
> 19° S.	7	9	8	3	10	8	7	8	7	7	5	12	10	6	6	7
Sum	45	39	40	44	37	38	39	30	42	53	34	37	44	33	37	32
Sum by hours	84		84		75		69		95		71		77		69	

Hour	16		17		18		19		20		21		22		23		Total
Declination:																	
> 19° N.	7	10	6	7	4	5	9	9	6	7	9	10	4	11	10	7	382
14° 40′ to 19° N.	4	0	5	3	4	5	3	0	6	4	3	4	5	3	4	3	167
11° „ 14° 40′ N.	0	3	1	5	0	1	1	3	1	1	2	4	0	0	4	0	111
9° „ 11° N.	2	1	0	3	1	4	2	0	2	2	1	2	1	5	1	3	65
6° „ 9° N.	2	2	0	1	4	3	1	1	0	1	4	2	3	4	0	4	93
0° „ 6° N.	3	4	3	1	2	4	3	3	6	1	2	2	3	3	3	5	139
0° „ 6° S.	3	1	4	3	5	2	2	3	3	4	1	4	2	5	3	0	165
6° „ 9° S.	2	2	1	0	4	4	1	0	0	2	2	2	1	1	4	1	79
9° „ 11° S.	1	1	1	1	0	0	0	0	1	3	1	2	0	0	2	1	46
11° „ 14° 40′ S.	1	1	1	0	2	2	2	5	3	1	1	1	2	3	2	1	88
14° 40′ „ 19° S.	4	5	3	4	6	4	3	6	1	3	6	3	2	2	2	1	186
> 19° S.	9	3	3	4	5	4	14	9	14	3	8	6	7	5	5	5	351
Sum	38	33	28	32	37	38	41	39	43	32	40	42	30	42	40	31	1,872
Sum by hours	71		60		75		80		75		82		72		71		1,872

Figures in italic indicate the half-hour in which the vertical tide-producing force reached its maximum.
Figures in black indicate the half-hour in which the horizontal tide-producing force reached its maximum; except in the case of declinations 14° 40′ to 19°, when they indicate the passage of the circle of maximum horizontal tide-producing force during one of three successive half-hours on either side of a meridian passage.