is the large excess in the upper lake region, New England, and the upper Mississippi valley; and the large deficiency in the southern states, which materially affected the crops in that section. The following table contains the rainfall record: —

Average precipitation for July, 1883.

Districts.	Average for July. Signal-service observations.		Comparison of July, 1883, with the average for several years.
	For several years.	For 1883.	
	Inches.	Inches.	Inches.
New England	3.92	5.76	1.84 excess.
Middle Atlantic states	4.04	3.28	0.76 deficiency.
South Atlantic states	5.65	4.92	0.73 deficiency.
Florida peninsula	5.77	4.49	1.28 deficiency.
East gulf	5.04	2.50	2.54 deficiency.
West gulf	4.16	2.44	1.72 deficiency.
Tennessee	4.06	3.07	0.99 deficiency.
Ohio valley	4.55	5.35	0.80 excess.
Lower lakes	3.84	4.51	0.67 excess.
Upper lakes	3.36	5.42	2.06 excess.
Extreme north-west	2.83	2.44	0.39 deficiency.
Upper Mississippi valley	4.02	5.58	1.56 excess.
Missouri valley	4.44	3 37	1.07 deficiency.
Northern slope	1.94	0.82	1.12 deficiency.
Middle slope	2.77	2.57	0.20 deficiency.
Southern slope	2.50	3.19	0.69 excess.
Northern plateau	1.01	0.00	1.01 deficiency.
Southern plateau	2.35	2.50	0.15 excess.
North Pacific coast	0.58	0.00	0.58 deficiency.
Middle Pacific coast	0.01	0.00	0.01 deficiency.
South Pacific coast	0.08	0.15	0.07 excess.

In some portions of the southern states, the deficiencies were even greater than those recorded in the above table: at New Orleans the rainfall was 5 inches less, and at Vicksburg 6.82 inches less, than in July, 1882. Eastport, Me., reports a fall of 5.24 inches in 10 hours, on the 14th inst.

The local storms reported are very numerous, and much damage resulted from rain, lightning, and hail. The greatest damage from rain was at London, Ont., on the 10th, due to the overflowing of the river Thames. Much damage to crops, especially in the west, was caused by hail. A vessel in lake Michigan reports a hail-stone weighing two pounds. The rivers were not high, except at the very beginning of the month; and navigation was suspended in the Savannah and Cumberland rivers on account of low water.

Among miscellaneous phenomena may be noted the brilliant aurora on the nights of the 29th and 30th, which was observed from Dakota eastward to New England, and southward to southern Virginia. Slight earthquake shocks were experienced in Nevada, Illinois, California, and Kentucky; though insignificant in comparison with that on the island of Ischia, of which a condensed account is given. Sun-spots were numerous; and an instance is noted in Oregon, of their observation with the naked eye, taking advantage of the smoky state of the atmosphere caused by forest-fires.

The accompanying chart represents the distribution of the mean pressure, temperature, and wind direction for the month.

THE EARTHQUAKE OF JULY 28, 1883, IN THE ISLAND OF ISCHIA.[1]

HAVING visited the island of Ischia by order of the inspector-in-chief of the Royal corps of mining engineers, a few days after the earthquake of the 28th July, I present some observations made during my short tour; and begin with a brief account of the topographical and geological conditions of the island, which last are, without doubt, the chief cause of the terrible disaster.

The formation of the island of Ischia is wholly volcanic, with the exception here and there of some argillaceous elevations, of marine formation, but derived from the disintegration of pre-existing volcanic matter. In connection with the islands of Vivara and Procida, it belongs to the volcanic group of the Campi Flegrei, and forms its western limit.

The aspect of the island as seen from the north is pleasant and delightful, although with deep hollows crowned by the towering and indented crest of Epomeo, rising to an elevation of 792 metres.

The town of Casamicciola, now destroyed by the terrible scourge, was built on the side of Epomeo sloping towards the north, upon two small hills, beside which flow two of the principal streams of the island, one near the mountain, fed chiefly by the waters of thermal springs, the other emptying into the sea near Lacco Ameno, a little farther to the west; these run from south to north; and another more important stream, called the Scarrupato, runs from north to south, flowing through a deep and precipitous valley on the southern slope of the island, having on its banks the villages of Fontana, Serrara, Moropane, and Barano. These last two streams are, in my opinion, very important; being, as we shall see, situated directly in one of the principal gorges of the island.

Forio is on the west coast, upon a plain gently rising towards Epomeo, bordered upon the north by Mount Zale. Eastward of Casamicciola are seen the volcanoes of Monte Rotaro and Montagnone (respectively 215 and 236 metres in height.)

According to Fuchs, the most ancient terrane of the island is composed of the tufa of Epomeo, of a clear green color, containing numerous sanidin, and sometimes pumice and lapilli. On this rest, here and there, strata of pumice and trachytic tufa, and depositions of trachytic lava, with beautiful sanidin from the mountains Rotaro, Montagnone, Tabor, Garofali, etc., which may also be seen on the road from Lacco Ameno to Forio, forming the promontory of Zale.

On the tufa of Epomeo rests a great extension of

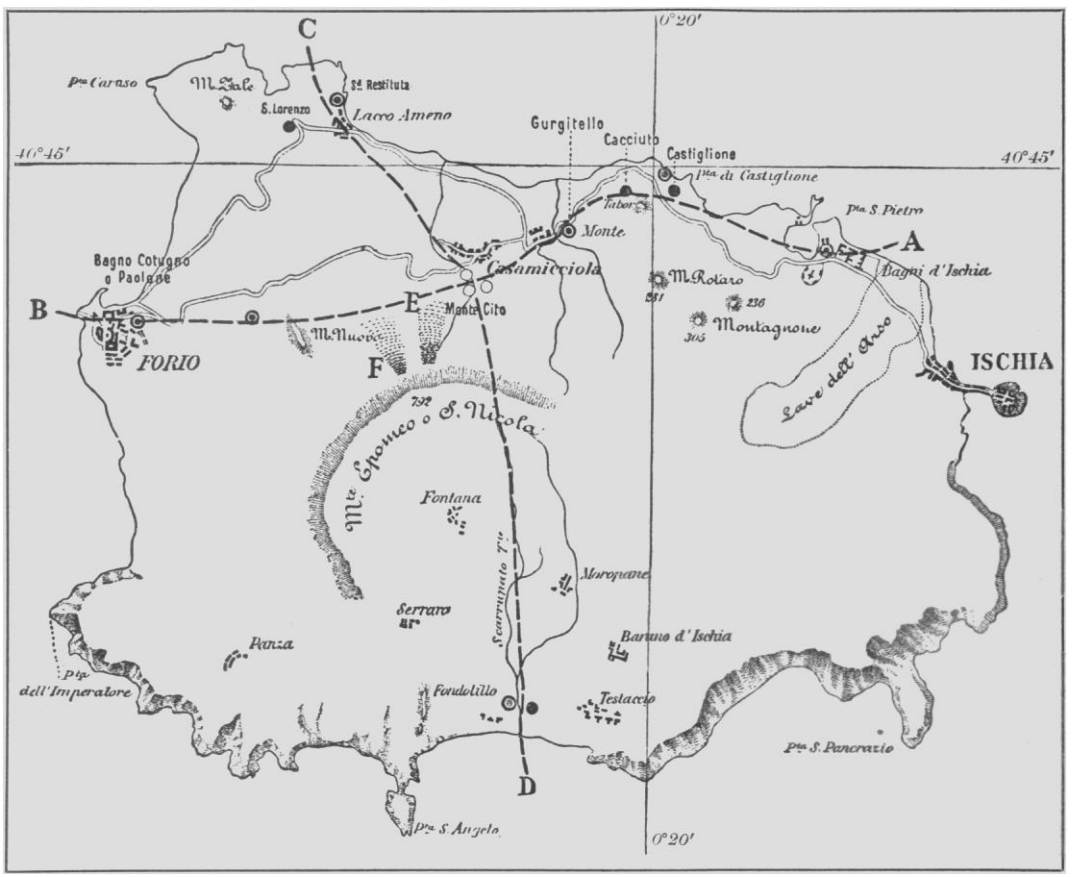
[1] Translated from the Italian of L. Baldacci of the Royal corps of mining engineers (*Boll. R. com. geol.* 1883, nos. 7, 8).

a product of decomposition of this tufa, of submarine origin, which passes occasionally into a plastic argillite well suited for the making of brick. Casamicciola was built upon this disintegrated clayey soil; while Lacco is partly upon trachyte, and partly upon the tufa of Epomeo; and Forio, as also Fontana, Serrara, etc., are built exclusively upon the above-mentioned tufa.

To these formations constituting the island must be added the trachytic lava and scoriae of Arso, the last eruption of which occurred in the year 1301; and, finally, the gravelly or clayey deposits, containing numerous marine fossils of species now living, indicating, that, in an epoch not very remote, a great part of the island was submerged.

For the description and analyses of the rocks forming the soil of Ischia, we must refer to the very important monograph of Fuchs previously cited: what chiefly interests us now is to observe how they are connected with the manifestations of innate activity which are developed in the island. These are of three classes, — hot mineral springs, stufas or jets of aqueous vapor, and fumaroles. These will be easily seen on the accompanying chart. They could not all be given with so small a scale, but I was obliged to limit myself to the most important.

The northern coast contains the chief evidences of volcanic activity. Thus, traversing the coast from east to west, we find the thermal springs of Pontano, Fornello, and Fontana, near Ischia; the stufas and thermal springs of Castiglione, near the point of that name; the stufas of Cacciuto, on the trachytic lava of Tabor; the rich and abundant thermal springs of Gurgitello, near the mountain (il Monte) at Casamicciola, besides others, less important, in that neighborhood; the fumaroles of Monte Cito, to the west of Casamicciola, which on the day of my visit was actively emitting steam and sulphuric acid from different crevices in the tufa of Epomeo; and, finally, trending slightly to the south-west, the thermal springs which are so valuable at the Bagno Cotugno or Paolone of Forio, and which flow from the side of Monte Nuovo



ISLAND OF ISCHIA, EARTHQUAKE OF JULY 28, 1883.

⊙ Hot mineral springs. ● Stufas and jets of steam. ○ Fumaroles. AB, CD, supposed fissures. E, F, Land-slides, happened since July 28.

at the east of that town. In these jets of water, steam, and gas, the temperature always ranges from 40° to 100° C.

From these elements, it appears to me, we may reasonably conclude that there exists a large curving line of cleavage from which arise such manifestations, turning its convexity chiefly to the north, running between the baths of Ischia and Forio, and passing exactly through Casamicciola (A B on the chart).

Examining now the other principal manifestations from north to south, we find in Monte Zale and Marecocco, near Lacco Ameno, the thermal springs of Santa Restituta and the stufas of San Lorenzo, the fumaroles of Monte Cito, already mentioned, in the stream which flows into the sea near Lacco; and in the same direction, on the other slope of Epomeo, we have the valley of the Scarrupato, at the southern end of which we find the hot springs of Fondolillo and the stufas of Testaccio. I am assured that on this line will be found other similar but much less important fumaroles, also on the heights of Monte Epomeo; but for want of a guide or exact indications, I cannot verify the assertion. Therefore, also, there is evident to me the existence of another fracture running from north-north-west to south-south-east, which crosses the first exactly at Monte Cito, almost under the town of Casamicciola (C D). These two grand lines of fracture are designated by broken lines drawn upon the annexed chart.

The reason which inclines me to believe that there are two principal fractures, and not an intersection of the fracture C D with the line of superposition of one crater (that of Epomeo) upon another, submarine and more ancient, according to the opinion of the celebrated Prof. de Rossi, is the identity of the manifestations along the two lines, A B and C D; the thermal springs, the stupas, and the fumaroles being identical in the two cases, I believe that they may be more simply attributed to an identical cause, without having recourse to hypotheses hitherto not entirely demonstrable by facts.

As to the phenomena which heralded the terrible disaster, the information collected on the spot is somewhat contradictory. It is certain only, that, for some days previous, slight shocks were felt with faint rumblings; that the springs of Gurgitello, etc., had shown irregularities of quantity and temperature; and that the fumaroles of Monte Cito, hitherto almost inactive, had evinced symptoms of excitement, emitting a peculiar hissing and quick jets of steam and sulphurous acid. It is said that the wells of Casamicciola and Forio were almost dried up, but that assertion does not agree with the facts. There are no spring wells in Casamiccola and Forio, only cisterns; and a scarcity of water observed in some, not all, of these, might perhaps be attributed rather to the drought prevailing for some time in Ischia, than to cracks in the walls of the cisterns. At Forio, I learned from trustworthy persons, that, in the cisterns between San Pietro and the upper part of the town, a remarkable increase of temperature was observed in the water. That seems highly probable, such cisterns being exactly in the direction and neighborhood of the great fracture above described.

The shock which brought desolation upon these lovely regions occurred on the evening of 28th July, at 9.25 P.M. I need not dilate upon its deadly effects, which are already too familiar from numerous accounts. The shock was accompanied by a horrible bellowing, and lasted, apparently, twenty seconds. Casamicciola, Lacco Ameno, and Forio were almost levelled to the ground, with a frightful sacrifice of life; Serrara, Fontana, and other lesser villages suffered terrible injury. The seismic disturbance was felt at Ischia, — where, however, it did but little damage, — and extended to great distances, having been indicated by the seismographs at the geodynamic observatory of Rome.

At Casamicciola and Lacco Ameno, the shock was vertical at first, and then undulatory. Information obtained at the place, and the few observations which I was able to make, indicate that the direction of the wave at Casamicciola was from west to east, then from north to south; at Lacco Ameno, from south-east to north-west; at Forio, the shock was first vertical, then undulatory, and the direction from north-east to south-west. In examining the localities destroyed, I could observe but little in respect to the greater or less resistance offered to the shock by buildings according to their orientation: this idea was advanced by Prof. de Rossi in his account of the earthquake at Casamicciola, in March, 1881, and is certainly based on sound reasoning and also on proved facts. But, in the first place, this shock was so violent and complete that but few walls had been left standing; and secondly, at the time of my visit to Casamicciola, eight days after the catastrophe, the state of the ruins was no longer such as was caused by the earthquake alone: many walls had been torn or thrown down, in order to render less difficult and dangerous the work of rescuing the living, exhuming the dead bodies, and searching among the ruins.

Among other things, I could perceive that some of the walls still standing presented crevices at an angle inclined 30° or 40° from the vertical, with the apex upward, indicating a prevailing upward and downward movement.

On the upper portion of the front wall of the church of the Anime del Purgatorio, in Forio, I observed a clean horizontal crack, showing here, also, the decidedly vertical character of the shock. This character seems confirmed by the condition of a large gate at a short distance to the east of Forio: only the two blocks of stone forming the lower part of the jambs remain in place; the two blocks upon them are thrown towards each other, projecting about six centimetres from those beneath, while the upper parts and the arch have fallen down.

Between Forio and Casamicciola, it seems as if the greatest seismic activity had been manifested along the road joining the two towns, passing by S. M. delle Grazie, and under Fango. The road is, in fact, completely destroyed, and the little cottages that bordered it are ruined. Besides this, the shock has produced two great land-slides, which, descending

from the precipitous flanks of Epomeo, have covered a wide extent of chestnut-groves and vineyards; and on the southern slope are great fissures in the earth.

In summing up my observations of all the localities most devastated by the calamity, I am convinced that the buildings standing upon the trachyte at Lacco Ameno and Monte Zale suffered incalculably less than those built upon the tufa of Epomeo and the argillite resulting from its disintegration. Casamicciola was almost entirely built upon this argillite; and it can be said without exaggeration, that not one stone rests upon another. Forio was built upon tufa; and of this town, also, very little remains standing. At Lacco, the houses and walls erected on the trachyte offered, as was stated above, great resistance to the shock, while those built upon the tufa were destroyed.

This agrees completely with the theory of Mallet. Mallet says, that when a seismic or a terrestrial wave passes rapidly from a soil possessing limited elasticity, — as would be the case with our tufas and clays, — to another soil of great elasticity, like the trachytic lavas, it changes not only its velocity, but in some degree also its direction; one part being reflected, the other refracted. The seismic wave, being thus checked, produces a shock in the opposite direction, causing great injury to buildings by the recoil. At the same time the shocks are diminished in force when they reach the more elastic soil, such as granite or trachyte.

This would explain very satisfactorily why Ischia, separated from the cleft AB by the great masses of trachytic lava of Rotaro, Montagnone, and Arso, which would absorb much of the energy of the seismic wave, felt it in so slight a degree.

With respect to the causes of these seismic disturbances, which still continued after the great earthquake of the 28th July, other shocks, accompanied by subterranean rumbling, being felt even when I was on the island and afterwards, it seems to me that they must be attributed to an awakening of the residual volcanic activity of Epomeo. The opinion has been advanced by the illustrious Professor Palmieri, that the violence of the shocks might be especially attributed to the fact of the existence of great subterranean caverns directly beneath Casamicciola, and to the giving-way of the supports which upheld these vaults, caused by seismic action, and facilitated by the weakening of these supports by the underground flow of thermal waters. This opinion does not appear to me to be fully demonstrable. There exist, it is true, in the neighborhood of Casamicciola, caverns of plastic argillite, formed by the lapse of ages; but certainly it is not of these that the illustrious professor of Naples intends to speak: the cause would assuredly be insufficient to produce effects so imposing, and such far-reaching seismic disturbances. I could not enter these caves, for want of persons disposed to serve as guides at such a time; but it is certain that they could be only more or less tortuous galleries of small diameter and but a few metres in height, as is generally the case in such formations. I have been assured also, by persons worthy of trust, and experienced in these caverns, that this is the case. Besides, neither at Casamicciola nor in the vicinity could I see any lowering whatever of the level of the soil: the roads which lead from Guardiola or the shore to Casamicciola, from Casamicciola to Lacco, from Lacco to Forio, have preserved their level perfectly, and show only the longitudinal or transverse fissures inevitable after such a telluric commotion. The only road completely destroyed (but not depressed) is that which leads from Forio to Casamicciola, along the side of Monte Epomeo, which, as we have seen, is directly along the cleft A B.

In any event, when this period of desolation and ruin has passed, when perhaps the time shall have come to decide upon the fittest place to rebuild the shattered dwellings, it would be useful to make a most accurate inspection of all the ancient and modern caverns of the island, and to determine what influence they may have upon the stability of the soil and the superincumbent buildings.

In conclusion, then, it appears to me, 1°. that no other cause need be sought for the shocks which have desolated the island than the volcanic activity which still remains, and awakes at intervals; 2°. that the residual volcanic activity of the island is manifested along two principal fissures, one, A B, a curve with its convexity to the north, from the baths of Ischia to Forio, the other, C D, directed approximately north-north-west and south-south-east, between Lacco Ameno and the stufas of Testaccio; 3°. that the place where Casamicciola stood is upon the intersection of these two lines, and, therefore, at the very focus of seismic activity, and that it has been, and always will be, the locality most liable to be devastated by earthquakes; 4°, finally, that buildings erected upon trachytic lava offer a resistance to the shocks, far superior to that of buildings erected upon tufa or clay, and that this circumstance should be borne in mind when it is proposed to restore the ruined villages.

Rome, Aug. 9, 1883.

JULY REPORTS OF STATE WEATHER SERVICES.

A NUMBER of states have organized weather services which are of material benefit to the people. A brief summary of the July reports that have been received is here given.

Georgia. — The July crop report contains meteorological data from fifteen stations. The special feature is the drought, of which it is said, "In northern and middle Georgia, the drought has been almost continuous since April 23, — the date of the last general rain in the state, — broken only by light and ineffective showers at considerable intervals. A few points reported sufficient rain, but the northern half of the state, with these exceptions, has suffered a most prolonged drought, which is yet unrelieved."

Illinois. — Minimum temperatures of 47° were reported, and maximum of 99°. The prevailing wind