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WEEKLY EVENING MEETING,

Friday, March 7, 1856.

Sir B. C. Brodie, Bart. D.C.L. F.R.S. Vice-President, in the Chair.

Sir Charles Lyell, F.R.S.

On the successive Changes of the Temple of Serapis.

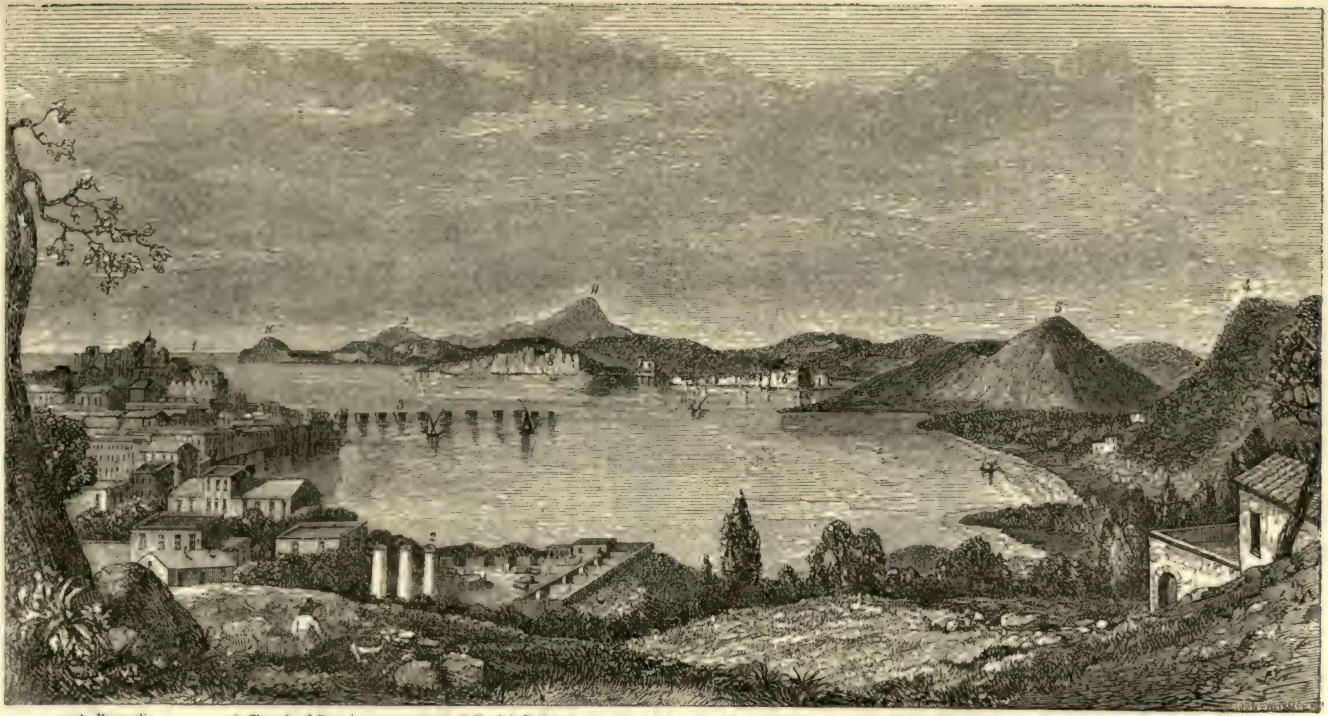
The Temple of Serapis, near Naples, is, perhaps, of all the structures raised by the hands of man, the one which affords most instruction to a geologist. It has not only undergone a wonderful succession of changes in past time, but is still undergoing changes of condition, so that it is ever a matter of fresh interest to learn what may be the present state of the temple, and to speculate on what next may happen to it. This edifice was exhumed in 1750, from a mixed deposit, extending for miles along the eastern shores of the Bay of Baiæ, and consisting partly of strata containing marine shells, with fragments of bricks, pottery, and sculpture, and partly of volcanic matter of subaerial origin. Various theories were proposed in the last century to explain the lithodomous perforations, and attached serpulæ, observed on the middle zone of the three erect marble columns now standing; some writers, and the celebrated Goethe among the rest, suggesting that a lagoon had once existed in the atrium, filled, during a temporary incursion of the sea, with salt water, and that marine mollusca and annelids flourished for years in this lagoon, at a height of 12 feet or more above the sea level. This hypothesis was advanced at a time when almost any amount of fluctuation in the level of the sea was thought more probable than the slightest alteration in the level of the solid land. In 1807, the architect Niccolini observed that the pavement of the temple was dry, except when a violent south wind was blowing; whereas, on revisiting the temple 15 years later, he found the pavement covered by salt water twice every day at high tide. This induced him to make a series of measurements from year to year,

first from 1822 to 1838, and afterwards from 1838 to 1845; from which he inferred that the sea was gaining annually upon the floor of the temple, at the rate of about one-third of an inch during the first period, and about three-fourths of an inch during the second. Mr. Smith, of Jordan-hill, when he visited the temple in 1819, had remarked that the pavement was then dry, but that certain channels cut in it for draining off the waters of a hot spring, were filled with sea water. On his return, in 1845, he found the high-water mark to be 28 inches above the pavement, which, allowing a slight deduction on account of the tide, exhibited an average rise of about an inch annually. As these measurements are in accordance with others, made by Mr. Babbage in 1828, and by Professor James Forbes, in 1826 and 1843, Mr. Smith believes his own conclusion to be nearest the truth, and attributes the difference between his average and that obtained by Niccolini (especially in the first set of measurements by the latter observer), to the rejection by the Italian architect, of all the highest water-marks of each year, causing his mean to be below the true mean level of the sea. In 1852, Signor Arcangelo Scacchi, at the request of Sir Charles Lyell, visited the temple, and compared the depth of water on the pavement with its level as previously ascertained by himself in 1839, and found, after making allowance for the tide at the two periods, that the water had gained only 4½ inches in thirteen years, and was not so deep as when measured by M.M. Niccolini and Smith, in 1845; from which he inferred, that after 1845, the downward movement of the land had ceased, and before 1852, had been converted into an upward movement. Since that period, no exact account of the level of the water seems to have been taken, or at least none which has been published.

Sir Charles Lyell then called attention to the head of a statue, lent to him for exhibition by Mr. W. R. Hamilton, and which Mr. H. had purchased from a peasant at Puzzuoli, in the neighbourhood of the temple. This head bears all the distinctive marks of the Jupiter Serapis of the Vatican; and, among others, a flat space is seen on the crown, doubtless intended to receive the ornament, called the modius, or bushel, an emblem of fertility, which adorns the ancient representations of this deity. One side of the head is uninjured, as if it had lain in mud or sand, while the other has "suffered a sea change," having been drilled by small annelids, and covered with adhering serpulæ, as if submerged for years in salt water, like the three marble columns before mentioned.

The speaker then alluded to an ancient mosaic pavement, found at the time of his examination of the temple, in 1828, five feet below the present floor, implying the existence of an older building before the second temple was erected. The latter is ascertained by inscriptions, found in the interior, to have been built at the close of the second and beginning of the third centuries of the Christian era.

A brief chronological sketch was then given of the series of

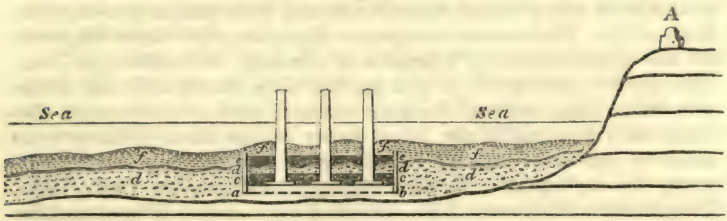


1. Puzzuoli. 2. Temple of Serapis. 3. Caligula's Bridge. 4. Monte Barbaro. 5. Monte Nuovo. 6. Baths of Nero. 7. Baiæ.
8. Castle of Baiæ. 9. Bauli. 10. Cape Misenum. 11. Mount Epomeo in Ischia. 12. South part of Ischia.

TEMPLE OF SERAPIS—BAY OF BAIÆ.

natural and historical events connected with the temple and the surrounding region; comprising the volcanic eruptions of Ischia, Monte Nuovo, and Vesuvius; the date of the first and second temples, and their original height above the sea; the periods of the submergence and emergence of the second temple; the nature of the submarine and supramarine formations, in which it was found buried in 1750; and, lastly, allusion was made to a bird's-eye view of this region, published at Rome in 1652, and cited by Mr. Smith, in which the three columns are represented as standing in a garden, at a considerable distance from the sea, and between them and the sea two churches, occupying ground which has since disappeared. The history of the sinking and burying of the temple in the dark ages, respecting which no human records are extant, has been deduced from minute investigations made by Mr. Babbage and Sir Edmund Head, in 1828, respecting the nature and contents of certain deposits formed round the columns, below the zone of lithodomous perforations.

Fig 1.

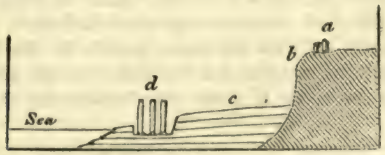


Temple of Serapis at its period of greatest depression, between A.D. 1000 and A.D. 1500.*

a, b, Ancient mosaic movement. *c c*, Dark marine incrustation. *d d*, First filling up, shower of ashes. *e e*, Fresh water calcareous deposit. *f f*, Second filling up. A, Stadium.

The unequal amount of movement in the land and bed of the sea, and its different directions in adjoining areas in and around the Bay of Baiæ, were then pointed out; and the fact that the Temples of Neptune and the Nymphs are now under water, as well as some

Fig. 2.



a, Remains of Cicero's villa, N. side of Puzzuoli. *b*, Ancient cliff, now inland. *c*, Terrace (called La Starza) composed of recent submarine deposits. *d*, Temple of Serapis in 1845, 2 ft. 4 in. below sea-level.

* A detailed account of the several up-fillings of the Temple represented in this cut will be found in the 9th Edition of *The Principles of Geology* (1853), p. 514.

Roman roads, while no evidence of any corresponding subsidence or oscillations of level are discoverable on the site of the city of Naples, which is only four miles distant in a straight line. Analogous examples of upward and downward movements in other parts of the Mediterranean were cited, such as the sarcophagus of Telmessus in Lycia, described by Sir Charles Fellows; and the changes in Candia, recently established by Captain Spratt, R.N., who has ascertained that the western end of that island has been uplifted 17 feet above its ancient level, while another part of the southern coast has risen more than 27 feet, so that the docks of ancient Grecian ports are upraised, as well as limestone rocks drilled by lithodomi. At the same time the eastern portion of Candia (an island about 200 miles long,) has sunk many feet, causing the ruins of several Greek towns to be visible under water. Looking beyond the limits of the Mediterranean, the buried Hindoo temple of Avantipura in Cashmere, with its 74 pillars, described by Dr. Thomson and Major Cunningham, were mentioned, and how their envelopment in lacustrine silt, at some period after the year 850 of our era, had caused them and their statues to escape the fury of the Mahometan conqueror Sicander, who bore the nam- of the idol-breaker. (*Principles of Geology, 9th edition*, p. 762.) The gradual subsidence of the coast of Greenland, and the elevation of a large part of Sweden, century after century, were also instanced; and lastly, the latest event of the kind, yielding to no other in the magnitude of its geological and geographical importance, the earthquake of New Zealand, of January 23rd, 1855. The shocks of this convulsion extended over an area of land and sea three times as large as the British Isles; after it had ceased, it was found that a tract of land, in the immediate vicinity of Wellington, comprising 4600 square miles, or nearly equal to Yorkshire in dimensions, had been upraised from one to nine feet, and a range of hills, consisting of older rocks, uplifted vertically, while the tertiary plains to the east of it remained unmoved; so that a precipice, nine feet in perpendicular height was produced, and is even said to be traceable for 90 miles inland, from north to south bordering the plain of the Wairarapa. In consequence of a rise of five feet of the land on the north side of Cook's Strait, near Wellington and Port Nicholson, the tide had been almost excluded from the river Hutt, while on the south side of the same straits in the Middle Island, where the ground has sunk about five feet, the tide now flows several miles further up the river Wairau than before the earthquake.*

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* Some memoranda respecting the changes in physical geography, effected during the earthquake of January 23rd, 1855, will be found in the Appendix of a new work by the Rev. Richard Taylor, entitled "New Zealand and its Inhabitants," London, 1855. These

Sir Charles then alluded to his discovery, in 1828, of marine shells in volcanic tuff, at the height of nearly 2000 feet, in the island

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were furnished by Mr. Edward Roberts, of the Royal Engineer Department, who has since (March 1856), on his return to London, communicated other particulars to Sir C. Lyell. Mr. Walter Mantell, also now in London, and who was in Wellington (New Zealand) during the shocks of last year, besides confirming the statements of Mr. Roberts, has supplied valuable information respecting the geological structure of the country upraised or depressed during the catastrophe. The upheaval around Wellington was only from one and a half to four feet, but went on increasing gradually to Muka Muka Point, 12 miles distant, in a direct line to the south-east, where it reached its maximum, amounting to nine feet, and beyond, or eastward of which, there was no movement. Mr. Roberts was enabled to make these measurements with accuracy, as a white zone of rock, covered with nullipores just below the level of low tide, was upraised.

The perpendicular cliff, at the point above mentioned, formed part of the seaward termination of the Rimutaka chain of hills, which consist of argillite (not slaty), of ancient geological date. Their eastern escarpment faces a low country, consisting of very modern tertiary strata, which also terminate when they reach the sea in a cliff, 80 feet high, and considerably lower than that formed by the older rocks. This tertiary cliff remained absolutely unmoved, the junction of the older and newer rocks constituting a line of fault, running north and south, for a great distance (according to a resident, 90 miles,) inland along the base of the hills, where rising abruptly they bound the low tertiary plains. A fissure open in part of its course, and in which some cattle were engulphed in 1855, marks the line of fault in many places.

Among other proofs of subsidence experienced on the opposite side of Cook's Straits, or in the northern part of the Middle Island, contemporaneously with the upheaval above mentioned, Mr. Roberts states, that settlers have now to go three miles further up the river Wairau to obtain supplies of fresh water, than they did before the earthquake of January 1855. There was no volcanic eruption in the northern island at the time of these events; but the natives allege that the temperature of the Taupo hot-springs was sensibly elevated just before the catastrophe.

During a previous earthquake in 1832, other alterations in the relative level of land and sea occurred; and many of the colonists fear a repetition of such movements every seven years, for in 1841 and in 1848 there were violent convulsions. The larger part, however, of New Zealand has not suffered any injury during the same period from earthquakes.

of Ischia; and to the exact agreement of these, as well as other fossil shells, since collected by M. Philippi, with species now inhabiting the Mediterranean. If the antiquity of such elevated deposits, when contrasted with those found during the last 2000 years in the neighbourhood of the Temple of Serapis, be as great as the relative amount of movement in the two cases, or as 2000 is to 30 feet, it would show how slowly the testaceous fauna of the Mediterranean undergoes alteration: and therefore that naturalists ought not to expect to detect any sensible variation in the marine fauna in the course of a few centuries, or even several thousand years.

In conclusion: the probable causes of the permanent upheaval and subsidence of land were considered—the expansion of solid rocks by heat, and their contraction when the temperature is lowered, the shrinkage of clay when baked, the excess in the volume of melted stone over the same materials when crystallized, or in a state of consolidation; and, lastly, the subterraneous intrusion of horizontal dikes of lava, such as may have been injected beneath the surface, when melted matter rose to the crater of Monte Nuovo, in 1538. A large coloured section of a cliff, 1000 feet high, at Cape Giram, in Madeira, was referred to as illustrating the intrusion both of oblique and horizontal dikes, between layers of volcanic materials previously accumulated above the level of the sea, and after Madeira had been already clothed with a vegetation very similar to that with which it is now covered. The intercalation of such horizontal sheets of lava between alternating beds of older lava and tuff would uplift the incumbent rocks, and form a permanent support to them; but when the fused mass cools and consolidates, a partial failure of support and subsidence would ensue.

[C. L.]