NOTES ON A TRIP TO THE LIPARI ISLANDS IN 1889.

(With Plate I.)

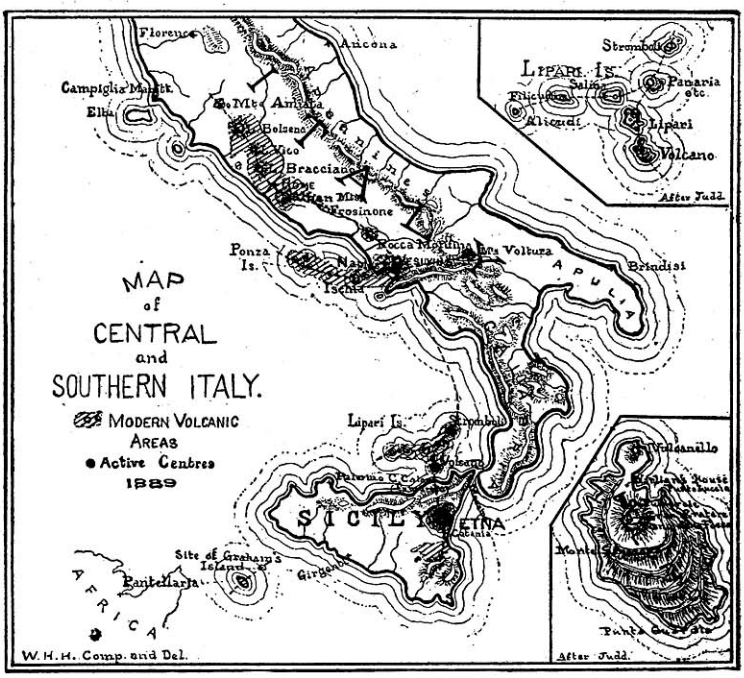
By WM. H. HOBBS.

The Lipari or Æolian group of islands are all of volcanic origin and lie in the Mediterranean Sea between thirty and forty miles northwest of the Straits of Messina. There are seven large islands and ten islets, all of which received various names by the ancients. The Greeks made them the abode of Æolus, the god of the winds, and Volcano or Vulcano, one of the two active volcanic vents, was supposed to be the forge of Vulcan.

Lipari, near the center of the group, has figured prominently in history. Plundered by the Athenians and later by the Carthaginians, it was the scene in B. C. 260 of the capture of the Roman general, Cnæus Cornelius Scipio, by the Carthaginians. Eruptions of Volcano must have taken place in B. C. 204 and 126. In the middle ages and later the government changed hands frequently.

With the exception of Lipari and Salina near the center of the group, the islands are at present but little inhabited. Volcano, the southernmost, which till recently contained vineyards and important chemical industries depending on the emanations of the torpid volcano, has been entirely deserted since the outbreak of 1888 and 1889. Yet amid all this desolation is to be found some of the most romantic scenery in Italy. Lipari, the largest and most productive of the islands, has an area of ten to eleven square miles. On the east side of the island in a natural amphitheatre is the town of the same name, the walls of the amphitheatre being formed by the now extinct volcanoes; Monte Rosa, Monte Sant' Angelo and Monte della Guardia. Monte Sant' Angelo, the highest point (1952 feet), rises in the center of the island on the west of the town. Monte Rosa extends into the sea as a rocky promontory inclosing the harbor of Lipari on the north, while Monte Guardia serves a similar purpose on the south. In the middle of the crescent-shaped amphitheatre is an isolated rock projecting above the waters of the bay and joined to the mainland by a narrow neck. This rock is crowned by the sombre walls and towers of the Fort or "Castello," and is the site of the ancient town.

The modern town is erected around the fort and contains warehouses, where are stored for shipment the products of the island—the finest pumice stone, sulphur, currants, figs, Malmsey wine, etc. The vegetation is semi-tropical. Outside of the town the *opuntia* or prickly pear is abundant. Figs, agaves and grapes thrive. The great difficulty the inhabitants have to meet is the scarcity of water, which they collect for domestic purposes on their peculiar flat-roofed houses. For this reason oranges and lemons, so abundant in neighboring Sicily, are not cultivated here. The population was formerly much larger than at present, many of the natives having emigrated to America. As a consequence the price of a day's labor, which I was informed was a few years since about a lire (20 cents), has risen to about twice that sum. The Lipari islands lie somewhat off the line of tourist travel. Except by naturalists who are interested in their volcanic features, the islands are rarely visited, both because of the difficulty in reaching them and because of the primitive character of the accommodations.

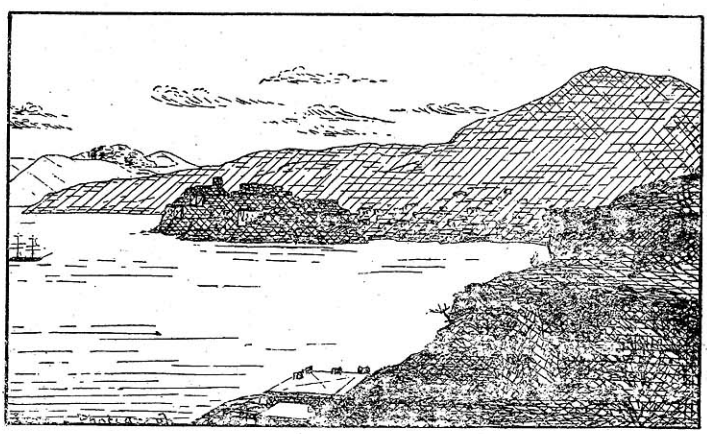


The chief interest then of the traveler in these Islands lies in the volcanoes, and particularly the active vents, Stromboli and Volcano. The map has been prepared to show the relation of these vents to one another and to the other volcanoes of Italy. First of all it will be seen from the map how the vents are arranged linearly. It will next

be noticed that the main fissure there indicated runs parallel to the backbone of the Italian Peninsula, which finds its extension in the mountain range skirting the north coast of Sicily. This principal line of vents begins with the extinct Mte. Amiata on the north, is extended in the crater lakes of the Roman Campagna — Lago di Bolsena, Lago di Vico, and Lago di Bracciano — in the Alban Hills to the south of Rome, Frosinone, the Rocca Monfina, and Vesuvius. Here the fissure line to continue its course parallel to the peninsular backbone would enter the sea. Following its approximate course we see that the Lipari islands form a continuation of it. The enlarged view giving the arrangement of individual vents on the islands indicates that this fissure forks in the island of Panaria, one branch passing westward through the extinct craters of Salina, Filicudi and Alicudi and probably continued in the shoal of Graham's Island and in Pantellaria. The other branch passes southward through Mti. Campo Bianco, Sant' Angelo and Guardia in Lipari, the vents of Vulcanello and Vulcano, and a submarine fumarole off Cape Calava on the north shore of Sicily, to Etna. Crossing the main fissure near Naples is a shorter one passing roughly east and west through the Ponza Islands, Ischia, Procida, the *Campi Phlegraeii* or Burning Fields near Naples, Vesuvius and Mte. Vultura on the eastern slope of the Apennines. This secondary fissure runs parallel to an outlying arm of the Apennines indicated in the Sorrento Peninsula and Capri. Vesuvius, the present focus of volcanic activity on the Italian Peninsula, is situated at the intersection of these two fissure-lines. Observations in other regions have shown that the largest cones have generally been built up where the fissure is widened from this or some other cause. In the Lipari islands, strangely enough it would seem, the active foci are not on Panaria where the fissure forks but on Stromboli and Volcano some distances to the northward and southward. It has been argued that Panaria was once the seat of an outburst so violent as to destroy itself, the remnants of a great crater being made out in the islets of the vicinity. To recapitulate, the positions of the Italian volcanoes illustrate well two almost universal features of volcanic regions; first, a linear arrangement of the vents, indicating that they are formed on fissures in the crust of the earth, and second a substantial agreement between the direction of this fissure and the trend of important folds in the strata (as shown in the prominent mountain ranges) which are structurally directions of weakness.

In the spring of 1889 I visited Italy in company with an English friend, Mr. Bernard Hobson, now lecturer in geology in the Victoria University, Manchester. It was our intention to observe as much as possible of the volcanic areas, especially Vesuvius and Vulcano, both of which were then active. In Naples we were privileged to meet Dr. H. J. Johnston-Lavis, the energetic and careful student of volcanic phenomena, the authority on Vesuvius as well as the best authority on

the Italian volcanoes in general. Dr. Johnston-Lavis kindly furnished us with a letter of introduction to Mr. A. E. Narlian of Lipari, and supplied us with much valuable information concerning the islands. We had in our outfit a small camera belonging to my friend, to whom I am indebted for the photographs from which the figures in this paper were prepared. We were also fortunate to fall in at Naples with Dr. Brauns of Marburg, with whom I had made geological tramps in Saxony. He was accompanied by his brother and bound for the Lipari islands, so that we joined our forces, making a party of four. I have thought that it might be well to put on record some of our observations and at the same time collect the main facts in the history of Volcano.



The town of Lipari, as seen from Mte Rosa. Mte Guardia on the right. On the left, in the distance, is Volcano, with eruption beginning.

The trip to Messina was made without notable incident, unless it be the difficulty we had in getting aboard our vessel on the evening of our departure from Naples. The vessel does not come to the wharf, but is moored out some distance in the bay so that passengers must secure boatmen with yawls to go aboard. We selected what were apparently the least villainous of the Neapolitan boatmen lounging about the landing and bargained with them to take us aboard our vessel. Just as the landing stairs of the vessel were reached a demand was made for double the tariff. I being nearest the landing stairs jumped out, throwing the boatmen the rate agreed upon. Before the others could do so the boat was pushed away from the vessel. Mounted to the deck, I saw and heard a lively discussion between my friends and the boatmen, carried on in bad Italian with occasional German and English interjections on the one hand and very voluble Italian on the other. The boat drifted

farther away, and in the dusk I could make out that the matter was apparently settled by the Italians sturdily rowing the boat toward the shore. Before they had reached it a warning whistle sounded from the vessel; again commotion in the boat and soon a change in its direction. This time my friends reached the vessel, but only by submitting to the extortion. We must have passed near Stromboli in the night, but we were too tired from our tramps around Vesuvius to watch for the "Lighthouse of the Mediterranean." After various contacts — more or less agreeable — with the Sicilians, and after watching them prepare macaroni or load oranges on British vessels bound for America, we embarked on the little steamer which leaves Messina semi-weekly for Lipari, and at midnight passed between Scylla and Charybdis.

At six o'clock the next morning, the 7th of April, we cast anchor in the harbor of Lipari. Hurrying to the deck, I saw a picture I shall long remember. Before me were the quaint town, the fertile slopes about it and the sombre but picturesque *Castello*, the whole hemmed in by frowning crater walls. A few miles south rose the wide-mouthed cinder-cone of Volcano, the most beautiful and symmetrical of all cinder-cones. Around our small steamer were numerous yawls manned by natives, who were quarreling for position at the landing stairs and vociferating in a manner only possible to Italians. We submitted to be taken ashore by them, and found them far less disagreeable than we were led to expect from acquaintance with their Neapolitan brothers. An experience of two months in Italy, spent as much in the country off the lines of tourist travel as in the cities, taught us that the most troublesome Italians are in the cities, but especially in Naples. One needs to stop in Naples to understand how Mark Twain could spend two weeks "studying human villainy." Before I had reached the shore I had seen three grand explosions of Volcano accompanied by a loud rumbling and the sending up of a great cloud of dust and ash, and followed by the rattling of the projectiles as they fell back in the crater or rolled down the outer slope into the sea. After a moment the outburst would be over, and the only visible remnant would be a dense black cloud floating away under the light breeze to the eastward. At greater distances in the same direction could be seen similar clouds due to earlier explosions. Between explosions a large fumarole sent out a volume of white vapour resembling the '*scape* of a locomotive. We were soon housed at the one rather primitive *Locanda* or hotel that the town supported, and hastened to make the acquaintance of our guide, Bartolomeo Nicotera, who was to serve us in our trip to Volcano. That day and the one following were spent on Lipari in examination of the old craters and acid lava streams, and collecting from the obsidian, pumice and liparite so abundant in the vicinity. But Volcano was an attraction that outweighed others in our minds, and to it I shall direct attention. I shall therefore interrupt my narrative to give something of its history.

The island on which the volcano is located, which bears the same name — Volcano or Vulcano, has an area of about eight and one-half square miles. The crater, the "*Gran Cratere*" of the natives, is situated a little to the northward of the center of the island. On a peninsula at the north end of the island is Vulcanello, a small triple-cratered hill joined to the mass of the island by a low and narrow neck of land. This forms two bays, of which the one on the east side is called the *Porto di Levante*, and is the landing place for boats. The present mountain is a cinder-cone *par excellence*, and rises a few hundred yards south of the landing. The crater had a diameter according to Johnston-Lavis (in September, 1889) of about 250 metres and a depth of 30–40 meters below the lowest lip. (Scottish Geographical Magazine, VI., p. 147.) These values are much lower than those of Baltzer taken in 1873, who gives the diameter of the crater as 900 metres. The depth of the crater he measured and found to be 86 metres (Zeitsch. d. d. geol. Gesellschaft, 1875, p. 9). The height of the lip of the crater (the *Piano della Fossa*) is about 700 feet above the sea. With the exception of a moderate-sized obsidian stream on the northwest flank, the material of the cone seems to be entirely fragmentary. Baltzer, in 1873, sketched beds showing the dip of the material within the lip of the crater to be toward the center. Near the obsidian stream, just outside the crater rim on the north side, is a secondary crater about 200 feet in diameter which has long been an active fumarole. Encircling the present crater at a distance of one-half to three-quarters of a mile is an older explosive crater, the highest point of which is Mte. Saraceno to the south. To the south of this Judd has described three still older craters, the centers of which lie in the medial line of the island. All these older craters including that of Monte Saraceno, unlike the present active one, are essentially composite in character being made up of lavas with ash, lapilli, etc. The lavas near the south of the island are doleritic in character, rich in olivine, while to the north they are composed of trachytic rock. The beds are traversed by radial dikes showing the former existence of parasitic cones. Some of these dikes belong to the curiously hollow type recently described by Johnston-Lavis from Vesuvius, Stromboli and this locality. ("L'Eruzione del Vesuvio nel 2 Maggio, 1885," Ann. d. Accad. O. Costa d'Asp. Naturalisti, Era 3, Vol. 1. Nature xxxviii, 13.) These are due to the draining out of the lava below after it has been injected into the fissure and a portion has consolidated on the walls.

The structure of the island shows clearly that the early eruptions which built it up were largely of basic lava, that the active vent was migratory northward along the medial line of the present island, each successive eruption blowing out the north wall of the crater formed by the preceding eruption and affording more and more acid material. According to Scrope the present form of the volcano is largely due to the

eruption of 1786. After this eruption the mountain passed into the solfatara condition, or condition of moderate fumarole activity. The gases — boric acid, sulphur, sal ammoniac, etc. — were collected by the Italian firm of Nunziate and later by the English firm of Stevenson. The method of collecting was to pile cinder over the fumaroles so that the materials would sublime, then remove to the manufactories for further concentration. One of the manufactories was within the crater and the other on the shore of the *Porto di Levante*. The competition from Asia Minor and California resulted in the neglecting of the boric acid industry, but it was proposed to build large leaden chambers over the fumaroles for the better condensation of the sulphur gases, when the increasing activity of the fumaroles interrupted the work. The light eruption which began in August, 1873, and ended in December, 1874, has been described by Baltzer and presents many interesting features. Flames, once thought so common but now known to be extremely rare at volcanic eruptions, were observed in this instance. They showed a tinge of green, doubtless to be ascribed to boric acid. The most interesting feature, however, was the fall during the early stage of the eruption of a fine snow-white powder, which covered the island to a depth in some places of three to four centimetres. This was followed by a gray ash of the ordinary type, nothing more nor less than finely divided liparite lava. The snow-white ash, however, was 94 per cent. silica, and was shown to be tridymite by its low specific gravity, its solubility in alkalies and its optical behavior. Baltzer has offered the plausible explanation that this material is formed during the long period of quiescence, by the action of the acid gases of the fumaroles on the plug and walls of the chimney under the high pressure and temperature which must attain there. This explanation accounts for the absence of the snow-white ash from the later phases of the eruption. (See Baltzer, Zeitsch. d. d. geol. Gesellschaft, 1875, pp. 3-29.)

After this very light eruption, which was not violent enough to expel the workmen from the crater, the old conditions of fumarole activity were resumed. In 1886 there came a slight eruption which cleared out the bottom of the crater, since which time it has never entered into its former quiescent condition. Before 1888 the English firm owning the sulphur industry had set out large vineyards and fig orchards at the north end of the island. Mr. A. E. Narlian, who was in charge of these, had his villa a few hundred yards north of the cinder cone of Volcano. In August, 1888, occurred an outbreak which, though not to be ranked with eruptions of the first order of intensity, caused much damage. The main facts connected with this eruption were reported to us by Mr. Narlian at his home in Lipari. They were contained in a letter to Prof. Johnston-Lavis, and were published in the London *Times* and in the Report of the British Association for the Advancement of Science for 1888 (p. 664).

On the 3rd of August an outburst took place in the crater, of sufficient force to throw projectiles out to the sides, whence they rolled down the slope. This lasted ten to fifteen minutes and was repeated at intervals of twenty or thirty minutes. With the throwing out of the projectiles there would be a great rush of thick smoke (mainly steam and dust) Such eruptions had been observed several times before within the thirteen years Mr. Narlian had been on the island, and he was led to hope that these would end like former eruptions. Toward evening the leading fumarole (the secondary crater on the north lip of the main crater), which had given off offensive gases for some months, showed a clear, high flame tinged with green or blue. Mr. Narlian was so alarmed that he did not undress for the night. Towards morning he fell asleep, but was soon awakened by a tremendous din caused by the fall of projectiles on the roof of his villa. Securing his children, he ran to the drawing room, but as the door was opened a red-hot mass of pumice, two feet in diameter fell through the roof, ceiling and floor, smashing and setting fire to everything. Turning back, they reached the verandah by another passage, when a second red-hot block, similar to the first, fell at their feet, was smashed to fragments and burned the feet and legs of the two boys. Mr. Narlian, helping his children as best he could, ran away from the thundering mountain toward Vulcanello. The men, in their despair had carried off the two available boats, leaving him without any means of escape. He was obliged to remain on Vulcanello, almost within reach of the falling blocks, until taken off about noon by boats from Lipari.

The violence of the eruption diminished somewhat in intensity, but to the end of the month the noise continued to be heard in Lipari (at a distance of six miles) as a prolonged thunder. Almost the same condition of affairs continued through the year, the quantity of projectiles diminishing somewhat and being replaced by fine ash, which mounted as a black cloud to a height of three miles or more before floating off.

When I visited the volcano on April 9th of the year following, this was the condition of affairs, with the intensity of the outbursts somewhat further diminished. We engaged four swarthy boatmen and their boat for the entire day for twelve lires ($2.40). These men, who rowed standing, were dressed in bright colored shirts and trousers rolled nearly to their hips. Their sandals they carried in their pockets while in the boat. Enormous brass rings were stuck in their ears. We carried provisions and wine, as nothing to eat or drink could be obtained on the island. The morning was clear but the sea was quite choppy. I had never seen water of such a beautiful tint. The oars as they dipped in the water showed a beautiful turquois blue. We landed at the *Porto di Levante*, the boatmen carrying us through the surf on their shoulders. We visited Vulcanello and photographed the explosions from that point. One of these photographs has been engraved, and

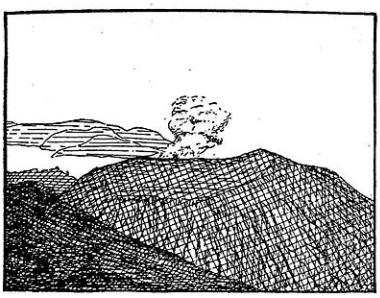
shows the great dust-cloud ascending and curiously branching as it attains a height above the crater about equal to the height of the mountain. (See Plate I., Fig. 1.) The interval between eruptions varied from three to four minutes to a half hour.

From Vulcanello we visited Mr. Narlian's ruined villa (about three-fourths mile from the crater), which presented a most desolate appearance with its smashed and charred roof and walls half buried in ashes, lapilli and bombs. The vine and fig plantation was almost completely buried in cinder and entirely ruined, occasioning a loss of about £40,000 sterling. The entire plain (Atrio) between the mountain and the encircling ring of Monte Saraceno and Monte Luccia, is covered with lapilli to a depth of several feet, and this is strewn with projectiles (the so-called "bombs") of all sizes from such as are smaller than one's fist to those several feet or even yards in diameter. The larger ones have dug themselves great pits in the loose lapilli so that they are nearly or quite buried, the lapilli being thrown out to a considerable distance. Whenever the mass was more than a foot in diameter it was sure to be cracked or broken from the force of its fall, being composed of a coarse acid pumice. Their porous character explains how they could attain to such extraordinary dimensions. We saw numerous specimens that had clearly been over four feet in diameter and at distances of one-half to three-quarters of a mile or more from the crater. Mr. Narlian mentioned one near the well of his house that he thinks was ten yards in diameter. This I did not see. A projectile at least three feet in diameter we found well up on the slope of Monte Saraceno in the encircling "Somma." The structure of these projectiles is very interesting. Their shape approaches roughly to an ellipsoid and generally one of rotation, though they are really polyhedral with peculiar warped plane surfaces. Pear-like shapes are not found and their presence would hardly be expected when the material is so porous. They have an outer glassy skin, about a half-inch thick, with fine scattered vesicles. This has a gray surface color like pumice, with cracks opened in and between the warped bounding surfaces. Dr. Johnston-Lavis has aptly termed this unique structure the "bread-crust structure," since it closely resembles both in appearance and in probable manner of formation, that of a baked bread crust, in which cracks have formed from the expansion of the gas in the dough after the surface has hardened. The larger cracks show upturned edges and reveal at the bottom of the crack a fine-grained spongy pumice. Everyone will recollect analogies to this in bread. The interior of the "bomb" is pumice with in general an increase in the size of the vesicles toward the center. (See Plate I, Figure 2.) These vesicles are usually elongated in the direction of the radi-vectori of the bomb. This is doubtless to be ascribed to the centrifugal force developed by the rotation of the mass in the air. The petrograph-

ical and chemical relations of these projectiles will be treated in another paper.

The explanation of Dr. Johnston-Lavis for the formation of the projectiles is so satisfactory that I quote from him:

Their structure is "due to the obsidian reaching that intermediate stage between a liquid and a solid or in other words a state of intense viscosity, like slightly warmed sealing wax or hardened Canada balsam, which break when exposed to strong and violent mechanical stress but bend under a slight and gradually applied one. The magma in the upper part of this volcanic chimney seems to be in this critical state, and, as the vapor collects and escapes from the more heated and fluid portion beneath the upper part, is broken in fragments and ejected, when it is relieved from the surrounding pressure and allowed to expand. The crust has cooled along the cracks before this, and continues to do so, as it is whirled through the air, and after its fall, whilst the interior expands at the same time, innumerable vesicles being formed from the water dissolved in the magma separating as steam. This expansion causes the cracking of the hardened crust and in some cases protrusion through the crust." (Proc. Geol. Assoc. London, XI, p. 390, August, 1890.)



View of Volcano from Mte Saraceno, showing the "Barrancos" and the beginning of an eruption. The island in the distance is Lipari.

We climbed Monte Saraceno and Mr. Hobson again photographed Volcano during the explosion. From this point the cone shows well the gullies (Barrancos) which in other regions figured so prominently in the "elevation crater theory." From this point we could see that the wind, which was fresh from the west, carried the projectiles of the eruptions to the east of the crater. Owing to this favorable circumstance we hoped to be able to safely ascend to the crater from the west side. Mr. Hobson and myself therefore attempted the ascent and had toiled half way to the summit through lapillo and ash lying at the angle of repose, when a severe squall that had been threatening for some time, broke upon us. The sea about the island was lashed into foam. The strong wind picked up the

loose ash and lapilli and drove it against us with such force that we were compelled to cover our heads with our coats to protect our faces. We gave up the ascent to the crater and made the descent, which was as easy as the ascent was difficult. Reaching the *Porto di Levante* we sheltered ourselves as best we could from the wind and rain till toward evening, when the violence of the storm abated and we made our way to Lipari by dint of hard rowing in a heavy sea.

On the following day with our faces still toward Volcano we took our departure from Lipari on the little mail steamer from Messina, which had again cast anchor in the harbor. After the volcano had almost vanished from sight, we stretched ourselves on the deck under the bright sun. Rising some moments after I noticed that my clothes were being covered by the fine liparite ash of the mountain which was borne to us by the wind. Spreading a paper on the deck we were able to collect a considerable quantity of the material. Thus we bid our adieu to Volcano.

Some five months later a party from the Geologists' Association of London visited the island under the guidance of Dr. Johnston-Lavis. They succeeded in reaching the crater's edge. They saw the inner sloping walls of the crater to be made up of ash with scattered "bread-crust" bombs of all sizes. In the bottom were conical depressions which emitted no steam between eruptions. Explosions at intervals of five minutes to half an hour would raise the whole or part of the bottom in a vast cloud, such as we had observed, estimated to attain to a height of 8,000 feet. (Proc. Geologists' Association XI, p. 389.)

It is interesting in this connection to recount certain accidents which have happened to the telegraph cable between Lipari and Capo Melazzo in Sicily. This cable passes quite near Volcano. On the 21st and 22nd of November, 1888, a rupture occurred near Volcano and the cable was buried. Again on March 30th, 1889, a less serious break, and again on September 11, 1889, a more serious one occurred. These facts point to the formation of a submarine vent quite near Vulcano.

University of Wisconsin, June 2, 1892.

EXPLANATION OF PLATE I.

FIGURE 1.

View of Volcano looking south from Volcanello, engraved from a photograph by Bernard Hobson, B. Sc., taken April 9th, 1889. The dust cloud mounting from the crater, which in its initial stages showed but a single important lobe, has just sent off lateral lobes the distribution of which is very symmetrical to the central lobe. The active fumerole on the north lip of the crator (in shadow) gives a smaller volume of steam than in the interval between explosions.

FIGURE 2.

"Bread-crust" projectiles from the Atrio to the west of the Cinder-Cone of Volcano. At the left of the figure is a bomb about the size of a turkey's egg, which shows the polyhedal shape, the hard, smooth surface, and the peculiar cracking. On the right is a fragment from a bomb which was about the size of a man's head. The piece is three and one-half inches high. The upper is the original outer surface and shows a vesicular obsidian extending to a depth of about one-half an inch. The rest of the material is pumice, the vesicles of which are ellipsoidal with their longest axes roughly perpendicular to the original obsidian surface. The size of the vesicles increases toward the center of the bomb.

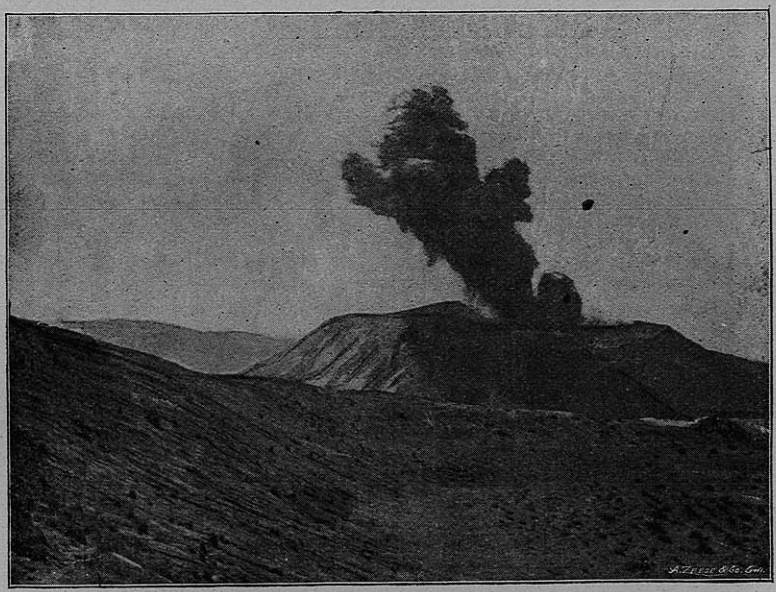


FIG. 1.

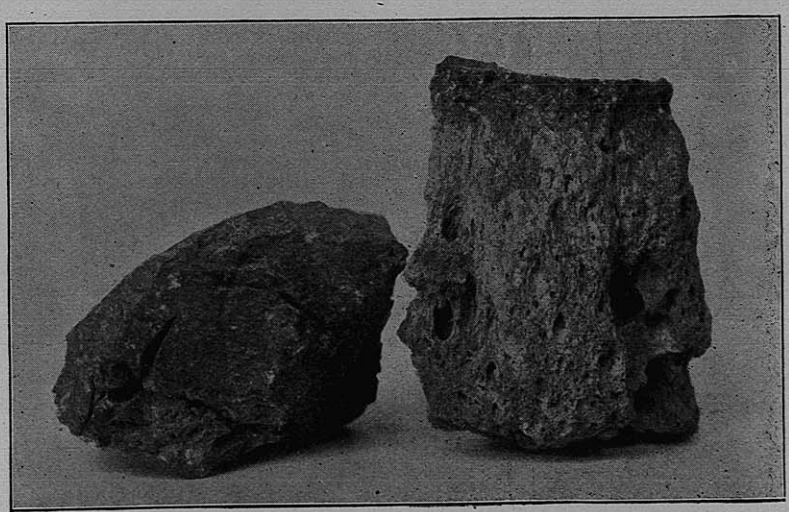


FIG. 2.