ART. XLII.—*Note on some Volcanic Rocks from Gough's Island, South Atlantic*; by L. V. PIRSSON.

THE rocks which are the subject of this note were gathered as beach pebbles from the shore of Gough's Island, South Atlantic Ocean, lat. $40^{\circ} 20' S.$, lon. $9^{\circ} 44' W.$, by the captain of a whaling vessel from New London, Conn., and they came into possession of the writer through the kindness of Prof. C. E. Beecher of the Peabody Museum in New Haven.

While in general the mere petrographical description of rocks disconnected from their geological occurrence and relationships has little value or interest, the fact that nothing so far as the writer can learn has ever been published on this remote locality, and also that the material developed several points of interest are the reasons for the publication of this note.

Gough's Island was discovered in the sixteenth century by Gonçalo Alvarez, and later by Gough, an English navigator, after whom it is generally called. The island seems to be little known and a search through the literature has given only the information that it is a craggy mass rising to a height of 4350 feet and about eighteen miles around, of a generally agreeable climate, with streams which present several fine cascades and several valleys green with turf and bushes.* Tristram da Cunha, the group of islands lying 240 miles N.W., are of volcanic origin, as others of the detached oceanic islands of the South Atlantic, and from what has been given and the evidence afforded by the present investigation it is probable that the island represents a volcanic cone.

The material consisted of a small number of rounded pebbles, all of which represent very fresh volcanic rocks or tuffs which may be referred either to trachytes or basalts.

Basalt.

This is represented by two varieties, one of which is a rock of a dark gray color thickly dotted with black phenocrysts of augite, yellow olivines and white feldspars of the microtine habit. The groundmass is dense and cannot be resolved by the eye alone. The augites are the largest phenocrysts, attaining at times a length of 5^{mm} ; the feldspars and olivines are much smaller. In thin section under the microscope the rock is seen to be beautifully fresh and unaltered and the usual minerals to be present, viz: iron ore, apatite, olivine, augite and plagi-

* Cf. *Earth and its Inhabitants*; Africa, vol. iii, pp. 97. New York, 1888. Appleton & Co.

clase, the last two in two generations. The *augite* is of a pale brownish color, non-pleochroic and shows a marked dispersion of the optic axes emerging from extinction, on one side bluish, on the other yellowish in color. In the second generation it is similar and scattered through the feldspar staves in rounded, irregular granules and often attached to iron-ore grains. The *feldspar* phenocrysts are tabular on $i\bar{z}$ (010), and from their high extinction angles in the zone $100 \wedge 001$ and on the clinopinacoid (010) it is seen that they are to be referred to labradorite. On the other hand the lath-like feldspars of the groundmass are to be referred to andesite. The usual laws of twinning abound. The other minerals present nothing worthy of mention. In structure the rock is an interwoven mesh of feldspar laths in which the other minerals lie imbedded. It is rather of an andesitic habit owing to the prevalence of the feldspar but from the abundance of olivine and the basicity of the rock, a determination of silica having given 48.61 per cent, it should undoubtedly be referred to basalt. Its specific gravity is 2.890.

The second type of this rock is macroscopically of a dark grayish brown color, weathering to a brown, porous in texture and thickly dotted with white broad lath-like phenocrysts of feldspar which frequently attain a length of from 5–6^{mm} and often group themselves into radial starlike clusters. In thin section iron ores, apatite, olivine, augite and feldspars are disclosed. The *olivine* exists in two forms, in large irregular phenocrysts attaining 1^{mm} in diameter and in small crystals averaging about .05^{mm}. The larger phenocrysts are undergoing a process of alteration into an orange-red colored mineral. This proceeds inwardly along the edges and cracks and seems to be in two stages which are best observed under crossed nicols. The first stage seems fibrous and gives a rolling extinction, until the second stage is reached where the mineral again becomes apparently homogeneous and extinguishes as such. In this product the orientation of the axes of elasticity are different from the original. In the smaller olivines mentioned the process has been entirely completed and they all appear of this orange-red color but appear otherwise homogeneous and extinguish parallel. A somewhat similar case is mentioned by Michel Lévy* as occurring in the basalts of Mont Dore. It is probably conditioned by a change of ferrous to ferric oxide and is somewhat like the coloration in the olivines in the limburgite of Sasbach.†

* La Chaîne des Puys et le Mont Dore, Bull. Geolog. Soc. France, 3d serie, xviii, 1890.

† Rosenbusch, N. J., 1872, pp. 59; also Physiog. d. Min., 1892, pp. 472.

The *augite* as a phenocryst is rare but presents nothing remarkable. The *feldspar* phenocrysts are of labradorite as indicated by their optical properties and by their sp. g. 2.708 taken with a heavy solution and Westphal balance. There is the usual albite and pericline twinning. The *groundmass* consists of fine feldspar laths in character near andesite, the small olivines referred to and between these globulitic material, augite microlites, iron ore, glass, etc. This interstitial material is of a dark grayish brown color in which the colorless feldspar laths lie, looking like slits in the section.

A determination of silica in this rock gave 49.55 per cent and its sp. gr. is 2.643, the lowness of which is no doubt due to the glass of the groundmass. From these and the mineral composition it is evidently to be referred to basalt.

Trachyte.

This is represented by trachytic tuffs and obsidian. The latter is macroscopically, a black, pitchy looking glass filled with pores which by their extension in one direction indicate flow movements in the viscous fluid. Rarely small feldspar phenocrysts are to be seen. Before the blowpipe this glass melts readily, puffing up into a grayish pumice which then melts to glass with the utmost difficulty, a small amount of water present increasing the mobility and lowering the melting point as noted previously by other observers on acid glasses. The chemical analysis of this glass gave the following composition:

Sp. gr. = 2.210	SiO ₂	61.22
	TiO ₂	.42
	Al ₂ O ₃	18.01
	Fe ₂ O ₃	1.32
	FeO	4.51
	MnO	tr.
	MgO	.44
	CaO	1.88
	Na ₂ O	6.49
	K ₂ O	5.93
	H ₂ O	.46
	Total	100.68

From the moderate amount of silica, low lime and magnesia and high alkalis, it is evident that this glass is to be referred to trachyte, perhaps of the phonolithoid type.

In thin section it appears as a fresh unaltered glass of a deep brown color scattered through which are a few grains of iron ore, apatite crystals, an occasional sanidine or olivine pheno-

cryst, and as the final products just before consolidation globulites and small sanidine microlites.

The *olivine* occurs very rarely indeed. It is fresh and of a pale yellow color and shows magnetic resorption. That it is indeed olivine is shown by its optical behavior, its high double and single refraction, its extinction parallel to two cleavages at about right angles, one of which is more pronounced than the other, and its general outline and habit.

This was confirmed by treatment of the powdered rock by hydrofluoric acid according to Fouqué's method of isolation and in the residue the lens disclosed a number of the olivines which were carefully picked out and subjected to qualitative analysis. This proved the mineral to be a silicate soluble in hydrochloric acid and in the solution were only iron and magnesia, lime not being present. The mineral is therefore undoubtedly an olivine and one rich in iron. The method of isolation also showed that it was very scarce in the rock. The crystals attain a size of .5 to 1^{mm}.

The presence of olivine in trachytic rocks is not unknown. It is mentioned by Mügge* as occurring in the trachytic lavas of the Azores, by Michel Lévy† in augite trachyte of Monte Dore which is however of an andesitic type, and by Fuchs‡ as an accessory component of the trachyte of the Arso stream on the island of Ischia. Its occurrence in the present case in a magma containing less than .5 per cent of magnesia is, however, remarkable and to be paralleled with its presence in the rhyolite of Iceland as shown by Bäckström,§ and that of fayalite in the rhyolitic obsidian of the Yellowstone Park,|| and of the Lipari Islands¶ as shown by Iddings. The latter author parallels such occurrences with that of sporadic quartz grains in basalt** and refers their origin to the mineralizing tendency of included water vapor in highly heated magmas under conditions of great pressure. In the present case the corroded state of the olivines evinces that in the later chemical and physical conditions under which the magma consolidated, the compound as a chemical one was incapable of existing and that it was therefore formed under different ones. The fact that the magma chilled as a glass proves that it was ejected and cooled with comparative rapidity, and it is reasonable to infer that such ejection through comparatively long and narrow conduits must be accompanied by varying degrees of pressure and with

* N. J., 1883, ii, pp. 217.

† Bull. Geol. Soc. France, 3d series, xviii, pp. 812.

‡ Tschermak Mitth., 1872, pp. 224.

§ Geol. Fören. Förhandl., xiii, No. 7, pp. 644.

|| This Journal, vol. xxx, p. 58, 1885; cf. also 7th Ann. Rep. U. S. G. Surv., pp. 270, 1888.

¶ This Journal, vol. xl, p. 75, 1890.

** This Journal, vol. xxxvi, p. 208, 1888.

comparatively slight variations of temperature. Such increase of pressure may be sufficient to condition the crystallization of compounds which later under lower pressures would be incapable of existing, the mobility of the magma being increased by the presence of water vapors as shown by the author cited and thereby conditions more favorable for the production of the compound.

Feldspar is scattered freely through the glass in small micro-lites of sanidine in flat tables of excessive thinness and twinned according to the Carlsbad law. They are outlined by the base

(001), clinopinacoid (010) and positive hemidome ($\bar{2}01$) and appear as in the annexed figure. They are sometimes solitary and sometimes grouped into somewhat spherical aggregates and thus exhibit the only tendency toward spherulitic structure observed in the rock.

Globulites are present composed largely of minute specks of iron ore as is shown by the colorless zones surrounding them, from which they have extracted the ferruginous coloring matter of the glass.

Tuffs are represented by several specimens. They are soft, light brown in color and enclose fragments of volcanic rock. In thin section they are seen to be composed of fragments of glass which are generally very fresh, mingled with broken crystals of sanidine and augite.

In conclusion it is of interest to note that in thus establishing, as is evinced by the material investigated, the recent volcanic nature of this solitary island, there is one more added to that line of mid-Atlantic volcanoes, which sweeping southward through the Azores, Cape Verde Islands, Ascension, St. Helena, Tristam da Cunha, and Gough's Island, terminates its volcanic fires on Bouvet Island on the confines of the Antarctic Ocean.

Laboratory of Mineralogy and Petrography,
Sheffield Scientific School, New Haven, Jan., 1893.

ART. XLIII.—*On a Champlain (?) deposit of Diatomaceæ belonging to the Littoral Plain*; by ARTHUR M. EDWARDS, M.D.

ON the 30th of March, 1859, F. C. S. Roper read a paper by me before the meeting of the Microscopical Society of London, and which was published in volume vii of the Transactions, "On Diatomaceæ collected in the United States." In it there is spoken of a gathering made at Hoboken, N. J., in which eighty-six species of Diatomaceæ, from fresh, brackish and salt water are mentioned as coming from that locality. This gathering, or rather these gatherings, for there were more than one hundred made at that time, were mostly from a large brook, the mud of which yielded the shells of the dead Diatomaceæ. At that time I did not try to work out the geology of the deposit, only pointing out that the mixture of marine, brackish and fresh water forms in the deposit was curious. Since that time I have kept the matter in view and am now prepared to assert what I believe to be the geology of the deposit. I shall show that the Diatomaceæ in it, and by which its geology is determined, are widely spread.

It is the first time that Diatomaceæ are found at all in the geological scale and referred to the brackish, although they are indicated by Ehrenberg in the *Mikrogeologie*, 1854, as coming from Norwich, Conn. This I will show is the same as those.

They are known to be marine and are referred to the Eocene, Oligocene or Miocene Tertiary. These are from Paita, Peru; San Pedro (or farther south in Southern California) to Sub Little Mines, Del Norte Co., in California; Petersburg, Virginia, to Atlantic City, New Jersey; Oran, in Africa; Mors, in Denmark; Simbirsk, in Russia; Sentz Peter, in Hungary; Moron, in Spain; Nicobar Island, in the Bay of Bengal; Cuba, Trinidad and Barbadoes, in the West India Islands; Sandai, Kobe and Netanai, in Japan; the Island of Sicily and Omaru, in New Zealand.

On the 18th of December, 1871, I read a paper before the Lyceum of Natural History, New York, "On a deposit of marsh-mud upheaval by superincumbent pressure and containing the remains of shells of Mollusca and microscopic organisms," which was not then published, but is now for the first time in the microscopic notes for January 1, 1893. As this records the instance of the shells of marine and brackish Diatomaceæ in this deposit also, it now sees the light. The third instance of marine, brackish and fresh-water Diatomaceæ mixed I have now to publish. This deposit I have studied for over three years past. Besides the many spots on the