[Proc Roy. Soc. Victoria, 21 (N.S). Pt. II., 1908].

Art. XIX.—*Obsidianites—Their Origin from a Physical Standpoint.*

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[Read 8th October, 1908].

The objects known as "Obsidianites" are apparently peculiar to the Australian continent; but are allied to the "Moldavites" of Bohemia and the "Billitonites" of Malay Archipelago. All three forms are sharply distinguished from other natural mineral forms by their physical and chemical character, and mode of occurrence.

"Obsidianites" have been well described and discussed by R. H. Walcott,[1] and all three forms very completely by Franz Suess in an exhaustive Monograph on "Moldavites and Allied Glasses."[2] Both papers give Bibliographies of the extensive literature on the subject.

The theories which have been advanced to account for the occurrence of these objects may be divided into three groups:—

(1) Those which assign to them an artificial origin.

(2) Those which regard them as natural and terrestrial in origin.

(3) Those which regard them as natural and extra-terrestrial.

The first theory has, in the case of Obsidianites, nothing to support it, and very obvious and powerful arguments to oppose it. A theory of natural origin has to explain, in the first place, the physical and chemical characters, and in the second the mode of distribution of the Obsidianites. On both these grounds there are great difficulties in the way of accepting a terrestrial origin. In particular the occurrence of these objects hundreds of miles from any region of volcanic activity has been regarded

1 Proc. Roy. Soc. Victoria, n.s., II., 1898, p. 23.

2 Jahrbuch der k.k. geol., Reichsanstalt, 1900.

as fatal to an explanation of their production by volcanic agency. This has occasioned Mr. E. J. Dunn to put forward an hypothesis as to their mode of distribution from volcanoes.[1] Mr. Dunn suggests that the Obsidianites are the "blebs of obsidian bubbles."

Apart from the general arguments against a terrestrial origin which have been put by Walcott, Suess, and other writers, there are certain others special to Mr. Dunn's hypothesis which appear to me to render it quite untenable.

(1) The forms of the obsidian buttons are not, with a few possible exceptions, those which a liquid drop assumes when hanging from a bubble. The formation of the frequently occurring "dumb-bell" type by the union of two separate bubbles is quite inadmissible. If the bubbles, and a fortiori the blebs, were perfectly liquid, the two latter would certainly coalesce to a drop of circular horizontal section; if they were not perfectly liquid we should expect signs of discontinuity at the junction: such do not occur. Mr. Dunn considers that the form figured by him in Fig. 45 of his paper was attached to the original supporting bubble around the projecting rim. There are, however, no signs of fracture around the rim such as we would expect had the obsidianite broken away from the parent bubble, nor have I been able to find such signs in any one of the numerous other specimens with rims which I have carefully examined. The specimen figured by Mr. Dunn is one of very unusual type, and the commoner forms will not afford even its frail support to his ingenious hypothesis. For instance, in Professor Spencer's Central Australian collection are many specimens without the bubble-suggesting rim at all.

(2) A more conclusive objection is the following:—

The pressure within a liquid bubble is determined by the total curvature of its inner surface (and, of course, the surface-tension of the liquid). It is evident, without exact investigation, that one part of the interior cannot be convex while another is concave. But as both upper and lower surfaces of the obsidianites are invariably convex, it is obvious that the attachment of the "bleb" to the bubble in the way imagined by Mr. Dunn is a physical impossibility.

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1 Rec. Geol. Survey of Victoria, vol. ii., pt. IV.

(3) In order that a spherical bubble of glass, vacuous, let us suppose, within, should float in air, its thickness must not be more than a certain fraction, approximately .00017, of its radius. In order that it should not collapse under the air-pressure its thickness, on the other hand, must be not less than another definite fraction, approximately .00024, of its radius. It is impossible, therefore, for a glass-bubble, vacuous within and strong enough to withstand air-pressure, to float in air. This conclusion I have been able to verify experimentally.

The case is obviously worse for the obsidian bubbles with their heavy blebs attached, of Mr. Dunn's hypothesis; unless, indeed, Mr. Dunn imagines them to have been blown with hydrogen or helium!

Although other objections may be brought against the "Bubble-theory" of the origin of obsidianites, the above are, I think, sufficient to show its extreme improbability; and since no other plausible explanation of their mode of distribution has yet been advanced by the advocates of the terrestrial theory, we are driven to explain their occurrence by means of a meteoritic hypothesis.

It has been objected that on this hypothesis such objects would be found scattered over the whole land-surface of the earth, and not confined to three comparatively small areas. This objection would be at least equally valid against any volcanic theory of origin, unless it could be established that the volcanoes of those parts of the world where obsidianites occur bear a character distinct from those of the remainder. I am not aware that anyone has attempted to show this.

Nor is the objection at all dangerous to the meteoritic theory. The virtual identity of chemical and physical properties in all obsidianites, as also in the Moldavites and Billitonites, strongly suggests, not merely a similar, but the same parentage; production, in fact, not by a long-continued succession of meteoric falls, but in a single meteor shower. This hypothesis would well account for the confinement of each species to a relatively small and well-defined area on the earth's surface; and to push it a step further it may be suggested as a possibility that the three swarms above-named have been produced in successive returns of the same meteor-shower.

The physical characteristics of Obsidianites accord well with the hypothesis of their meteoric production.

The average velocity of meteors which enter the atmosphere may be taken as about 40 miles per second. If only one per cent. of the energy which such meteors possess were, under the influence of air-friction, converted into heat and retained by the body, it would probably be sufficient to raise the substance of an obsidianite to the melting point and render it completely liquid. The melting-point of the material and its specific heat have been determined in the Physical Laboratory, Melbourne University, as 1324 deg. C. and .21 respectively. The remarkably homogeneous quality of the glass of which obsidianites are composed renders it certain that they have, prior to assuming their present form, been fused throughout.

The forms which a mass of liquid motion is capable of assuming have been the subject of discussion by many eminent mathematicians from the time of Newton to the present day. Neglecting the effect of air-resistance on the surface it has been shown that the following forms are possible:—

(1) The sphere—possible only when there is no rotation.
(2) The oblate spheroid—stable at low speeds of rotation.
(3) The prolate spheroid—stable, if at all, only at high speeds of rotation.
(4) The apioid, or pear-shaped figure of revolution.
(5) The dumb-bell or hour-glass figure of revolution.

It is remarkable that all these forms, if we ignore secondary features, are comprised among those assumed by Obsidianites. The occurrence of cigar-shaped and dumb-bell shaped figures is of particular interest since the stability of these types is still a matter of dispute among mathematicians.

The secondary features of form alluded to consist of the well-known rim, the ripples concentric with it on one face and the smaller pittings and furrowings of the surface. These features have been satisfactorily explained as due to the action of the air on the moving liquid, and Suess has succeeded in obtaining artificial pittings, etc., by the action of jets of steam on rotating lumps of resin.

I have also observed on two specimens markings which have strongly the appearance of having been produced by the impact of the glass, while still plastic, on some hard object.

Both primary and secondary features of form, therefore, while they do not negative a terrestrial origin, accord at least equally well with an extra-terrestrial.

It is much to be regretted that the few hollow specimens of Obsidianites which have been found have been cut open without the collection of the contained gas, an analysis of which would probably throw light on the true nature of the objects. The author would be much indebted to any person possessing an obsidianite of specific gravity lower than 2.38, which would probably indicate cavities inside, who would communicate with him.