ed, and in the table the figures in the top line are for the north and south polar zones.

Those adjoining each are given next, so that the lower line contains the zones immediately north and south of the equator. Zones on the same line are at the same distance from the north and south poles respectively.

The columns give the number of comets whose points of apparent origin fall in each zone, and the mean of the perihelion distances of the group.

| North. | | South. | |
|---|---|---|---|
| No. | Mean perihelion distance. | No. | Mean perihelion distance. |
| 9 | 0.730 | 16 | 0.599 |
| 8 | 1.022 | 13 | 0.713 |
| 13 | 0.745 | 14 | 0.715 |
| 12 | 0.700 | 13 | 0.526 |
| 15 | 0.838 | 28 | 0.795 |
| 14 | 1.010 | 11 | 1.008 |
| 20 | 0.821 | 17 | 0.813 |
| 11 | 0.903 | 10 | 1.091 |
| 19 | 0.767 | 12 | 0.789 |
| 15 | 0.762 | 15 | 0.912 |

So many conditions that will readily occur to any one come in to affect the number of comets discovered, and, to a certain extent, the discovery of those coming from any particular quarter, that the collection of so small a proportion cannot give much satisfaction. It will be noticed that the zones farthest south have a larger number than the corresponding zones north, while near the equator this difference is reversed.

The mean perihelion distances, taking the columns separately, vary in such a way that there is little encouragement for discussion as a whole.

But taking the corresponding zones in the two hemispheres, the comparison is interesting, if not instructive. The first seven from the north pole, or direction of solar motion, downward, have greater mean perihelion distances than those in the southern hemisphere similarly situated. The equatorial zones, where the distinction would not be so great, have an opposite difference.

With the same data combined in other proportions, the differences will be found to confirm the tendency shown by this division. Thus doubling the area of the zones, making five northern and five southern, the excess of mean perihelion distances of the north over the south exists in the three polar sets. Comparisons can also be made by fours and fives, and also by combining the two adjacent to the polar zones, the three next following these, and finally the four next north and south of the equator. Any one can make these comparisons with small uncertainty, from the table.

The most satisfactory confirmation of the tendencies here indicated is found in the discussion of the comets of the last hundred years only. These have been well observed in general, and the number does not contain so large a proportion of anomalous orbits. The table above includes all, probably, that have been computed; but, in summing up, notice was taken of the effect of the unusual cases, like the large perihelion distance of the 1729 comet, and the combination of several very small distances in one zone; and in no case would the sign of the compared difference have been changed by the omission of any extraordinary comets.

For the one hundred years the numbers in the zones are more uniform, with a similar tendency to that above.

In the comparison of perihelion distances by zones, seven of the northern exceed the corresponding southern.

The general results may be summed up in a few lines. There is an indication that more comets come in from the hemisphere from which the sun is moving.

The zones in the hemisphere towards which the sun is moving, and which has for its pole the direction of solar motion, have in general greater perihelion distances than the corresponding zones in the other hemisphere; the tendency being best exhibited as we go from the equator of the system.

As the sun moves on, the comets at great distances would come into the system, eventually, behind the quarter in which they first yielded to the attraction. Under the same general conditions, those which have come from behind the sun, and have been, as it were, dragged in its train, would pass nearest to the point of attraction when overtaking it.

These are the suggestions which most naturally occur. A complete discussion of the effect of the solar motion upon the distribution of comet-origins can hardly receive any decided confirmation with the amount of material that is likely to be available for generations to come.

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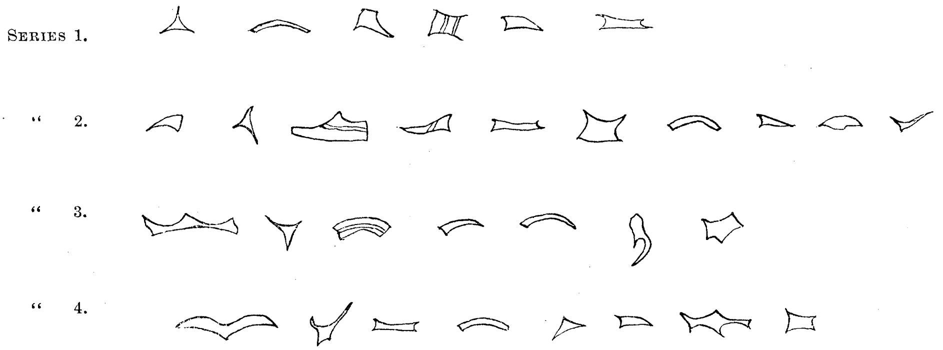
## *VOLCANIC SAND WHICH FELL AT UNALASHKA, ALASKA, OCT. 20, 1883, AND SOME CONSIDERATIONS CONCERNING ITS COMPOSITION.*

Mr. Applegate, the signal-service observer at Unalashka, reports that on the 20th of

October, 1883, about 2.30 P.M., the air became suddenly darkened, like night; and soon after, a shower of mixed sand and water fell for about ten minutes, covering the ground with a thin layer. The windows were so coated that it was impossible to see through them. A small portion of the sand was referred to me for microscopical examination; and, at this time of general concern in atmospheric dusts, it may be well to note the products of one of the Alaskan craters, which for some time has been in a state of more or less vigorous activity.

The sand is composed chiefly of crystalline fragments, of which felspar is the most abundant. It generally occurs in irregular, angular splinters, but not infrequently in well-preserved crystals with large inclusions and a distinct zonal structure. These crystals are slightly tabular, parallel to the clinopinacoid, and, lying on that plane, they present an approximately hexagonal outline, about 0.15 of a millimetre in diameter. Lath-shaped felspars, so abundant in basalts, were not observed. A few thin cleavage lamellae, with parallel extinction, showed no banding due to polysynthetic twinning; but by far the greater portion of the fragments, in polarized light, were distinctly striated. The pale green augite appears usually in the form of broken prisms; and the deep brown, strongly pleochroitic hornblende, which is less abundant than either the augite or felspar, occurs for the most part in cleavage plates. Irregular grains and crystals of magnetite complete the list of minerals which form an essential part of the sand. Crystal fragments of the minerals already mentioned constitute the largest portion of the sand; but, besides these simple grains, there are others complex in their nature. They correspond to the groundmass of a porphyritic rock, and are composed of an amorphous base, containing a multitude of microlites. Very rarely particles of clear volcanic glass may be found, and they are generally freighted with grains of magnetite. The grains of sand are fresh, and it is undoubtedly of recent volcanic origin. Its mineralogical composition is that of a hornblende andesite. Mr. Chatard of the U. S. geological survey, who made a partial analysis of the sand, found 52.48 % of silica, — an amount which is certainly much below the average for hornblende andesite. This paucity in silica, as well as in glassy particles, may be readily comprehended by considering the origin, composition, and distribution of volcanic sand and dust.



Among the various sands and dusts examined and compared for the purpose of seeking an explanation for the poverty of silica in the sand from Unalashka, is one collected about a dozen miles north-east of Mount Shasta, in northern California. This sand is considerably coarser than that from Unalashka, and is composed chiefly of crystal fragments of felspar, augite, hypersthene, hornblende, and magnetite, with particles of microlitic groundmass, and considerable pumiceous glass. The mineralogical composition of the sand is the same as that of the hornblende andesite which issued from the prominent and well-preserved crater named, by Capt. Dutton, Shastina, upon the north-western flank of Mount Shasta. There can be no doubt that the sand was ejected from Shastina, for all the other craters of that region have erupted different material. Mount Shasta itself has effused hypersthene andesite, and the smaller craters to the eastward have furnished basalt. According to Mr. Chatard's analyses, the sand contains 60.92 % of silica, while the Shastina lava, to which it belongs, contains 64.10 % of silica.

As far as definite observations upon this subject have been made, it appears to be true, in general, that volcanic *sand* is composed chiefly of crystalline fragments, and contains a lower percentage of silica than the lava to which it belongs. With volcanic *dust*, however, the case is very different. That which fell in Scandinavia, March 29 and 30, 1875, after having been carried by the wind from the great eruption in Iceland a distance of at least seven hundred and fifty miles, was composed almost exclusively of irregular, angular particles of volcanic glass. Through the kindness of Professor Rosenbusch, in Heidelberg, I have obtained various samples of volcanic dusts for comparison. In the accompanying figures, series 1 represents the acute, angular, curved-sided fragments which are common in the Norwegian dust. In an excellent article by Murray and Renard, which appeared in *Nature*, April 17, 1884, p. 585, the forms of vitreous particles of Krakatoa dust are represented. It is undoubtedly true that the shapes represented are those which prevail in volcanic dust, but they appear to be less characteristic than the curious outlines of fragments from the same dust given in series 2. In the succeeding series (3) are outlined the less common fragments in rhyolitic dust, collected by Mr. I. C. Russell along the Truckee River, in western Nevada. That these acute, angular, curved-sided forms are the most characteristic ones of volcanic glass particles, is impressed by a study of old tufas, in which the glass, originally mixed with other clastic material, is completely replaced by quartz. An interesting tufa of this kind occurs at Breakheart Hill, Saugus, north of Boston. Where vitreous fragments of the most common shapes are replaced by another material, the pseudomorph does not always suggest the original constituent; but when we find such forms as are represented in series 4, from the Breakheart-Hill tufa, there can be but little question as to the original presence of volcanic glass.

Krakatoa dust which fell at Batavia has been analyzed by Mr. Renard, and found to contain 65.04 % of silica, while the pumiceous form of the same lava, according to Mr. Iddings, contains only 62 % of silica. It is well known that volcanic dust is composed chiefly and essentially of minute particles of natural glass; and, so far as definite observations have been made, they warrant the general assertion, that with occasional exceptions, which can be readily explained, volcanic dust contains a higher percentage of silica than the lava to which it belongs.

Volcanic sand and dust must be regarded as differing, not merely in the size of their particles, but also in their physical and chemical constitution; sand being composed, in the main, of crystalline fragments, and containing less silica than its corresponding lava, while volcanic dust is made up chiefly of glassy particles, which have a higher percentage of silica than the magma from which they were derived. Between these two extremes there are, of course, all possible intermediate terms; but, nevertheless, it is evident, that, as a result of the operation of natural causes, there is a decided tendency, in connection with violent eruptions, to separate the magma into a basic and an acidic portion. The degree of separation ultimately attained depends upon the final influence of the atmosphere upon their distribution. Under favorable conditions, the dust may be spread many hundreds of miles from its source, while the sand is scattered within a comparatively small radius; but, under less violent and favorable conditions, both may be precipitated near the crater from which they issued.

The inception of this divisional process is to be found in the condition of the magma before its eruption. It is well known that crystals are frequently, and sometimes abundantly, developed in a magma; so that, before its extrusion, the magma may be regarded as made up of a crystalline, solid portion, and an amorphous, more or less fluent portion. These are generally thoroughly intermingled, but occasionally they are arranged, as in obsidians, in alternating bands; and they differ from each other in several important particulars, besides those already mentioned. The earliest products of crystallization are basic minerals, such as the ores of iron, hornblende, and mica; and, as the process continues, the amorphous portion of the magma becomes more and more siliceous. On this account, the crystalline portion of the magma does not contain as high a percentage of silica as that which is amorphous. Capt. Dutton, in his researches upon the volcanoes of the Hawaiian Islands, made the interesting observation, that, at the moment a magma solidifies, a large quantity of vapor of water is given off. In the process of crystallization, the gases absorbed in the magma are rejected from the crystallizing substances, and accumulate, under enormous tension, in that portion which is amorphous. In this manner, the non-crystalline portion of the magma becomes stored with explosive compounds, under such stress, that, when the pressure is relieved, they may blow it to fine siliceous glass-dust; while the crystalline, solid, basic portion of the magma, pulverized rather by external than internal forces, is reduced to sand.

It is doubtless true that a part of the volcanic sand and dust results from the trituration of solid material in the process of violent eruption; but, at the same time, it is generally believed that by far the largest portion of the latter is produced directly by the distention and explosion of multitudinous vesicles in the amorphous, viscous portion of the magma, and is the extreme product of the same operation which produces pumice. Mr. I. C. Russell has recently described some interesting volcanic dust from the Great Basin of Nevada. It has been traced two hundred miles from its source, the Mono craters, and has about the same chemical composition as the glassy lava of that place. This can be readily understood when we consider, that, at the time of its eruption, the magma contained few, if any, well-developed crystals. The difference in chemical composition between volcanic sand or dust, and the lava to which it belongs, appears to be directly proportional to the amount of crystallization which has taken place in the magma before its effusion. The composition of the Unalashka sand is such as to indicate that before its eruption there were many crystals secreted in the magma, so that there would be a proportionally small amount of siliceous dust produced. While it is evident that the constitution of volcanic sand is very variable from place to place, yet it is such in this case as to clearly indicate that it came from a crater erupting hornblende andesite, and that its basic character may be explained by supposing that the siliceous portion of the magma was carried away in the form of dust. The unaltered condition of the minerals and groundmass indicates that the sand has not been exposed to atmospheric influences for any considerable length of time, and favors the opinion of Mr. Applegate, that the sand came from the new crater, near the Island of Bogosloff, about sixty miles to the westward.

The precipitation of volcanic dust has been reported from several places in the United States, but it is all of very questionable determination. Mr. G. P. Merrill, of the U.S. national museum, has recently investigated that which fell at Rome, N.Y., and proved it to be an ordinary dust, composed chiefly of minute fragments of quartz and iron-stained products of decomposition. All of the reported dusts, of which I have been able to obtain samples, have been found to be like that which is most common about dusty cities and plains. A little experience will readily enable one to distinguish the Pélé's-hair and glass globules, in the dust of blast-furnaces and other iron-works, from the glass particles in volcanic dust.

The origin and distribution of the uncommon forms of dust are beginning to receive the attention they deserve; and it is a matter of gratulation, that the signal-service of this country has already taken steps towards systematic observations upon this subject at several elevated stations, such as Mount Washington and Pike's Peak, as well as in Alaska.

U. S. geological survey. J. S. DILLER.

## METEOROLOGICAL CHARTS OF THE NORTH ATLANTIC.

ONE cannot fail, in studying the progress of maritime meteorology, to be impressed with the value placed on the Maury charts, as evinced by the frequency with which they have been copied, or have served as the basis for more extended work in foreign countries. But it is also to be noticed, that in recent years the tendency has been towards more originality and independence in the work of the several nations that take part in this branch of physical investigation; and, further, that while Maury's principle of exhibiting as far as possible the separate observations on which averages are based is retained, his plan of dividing charts according to topics has been replaced by the much more practical division according to time. The master of a vessel, beginning a voyage in May, does not care to find on his chart information about the winds of all the year, but prefers information of all kinds about May, and especially about the winds, calms, gales, squalls, and fogs of that month.

Having considered, in a previous article, the development of maritime meteorology as shown in the wind-charts of the North Atlantic, published by various foreign governments since Maury's time, it is with satisfaction that we can now turn to a work on the Atlantic, executed in our own country, in which the advance from the earlier styles of charting is as well marked as in any of the examples given above.

On the charts whose title is given in the note,[1] we find the atmospheric conditions over a large area shown with greater detail, and based on a larger series of observations, than in any other charts yet published. The number of observations is extraordinary. The chart for March alone has wind-observations for 211,057 hours. That part of the chart which corresponds to the six of Toynbee's ten-degree squares north of the equator has 63,846 hours: the

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[1] Meteorological charts of the North Atlantic Ocean for the months of March, April, and May. Published June, 1883, at the hydrographic office, Washington, D. C. J. C. P. Dekraft, commodore, U.S.N., hydrographer to the bureau of navigation. Prepared under the supervision of Lieut. JOHN H. MOORE, U.S.N. Charts for June and July were published in March and April, 1884. T. R. Bartlett, commander, U.S.N., hydrographer.