bearing localities in Japan no developments of note were reported.

OCEANIA

In Borneo, Sumatra and Java no notable additions to productive area were made. In the northeastern portion of New Guinea (Papua) petroleum deposits were reported near Eitape, and in the southeastern portion of the island oil indications of great promise were found by Australian geologists on the western flank of the Albert Mountains, between the River Purari on the north and Yule Island on the south.

New Zealand.—Interest was centered in the Taranaki district, New Plymouth, North Island, where late in the year four wells producing oil simultaneously were believed to indicate the presence of a considerable quantity of oil in the locality. On South Island the Shell interests abandoned a test well at 900 feet on account of the presence of metamorphic slate.

AFRICA

Algeria.—Work on the test well of the Algerian oil fields at Abd-er-Rahim was suspended in April, 1914, at a reported depth of 902 meters, on account of parted casing. A second test started in March was located at Messila.

Egypt.—The activity of the Anglo-Egyptian Oilfields, Ltd., resulted in the completion of a number of creditable wells during the year in the Gemsah and Hurgada fields.

Somaliland.—Promising oil indications were found in British Somaliland on the south side of the Gulf of Aden.

A STUDY OF THE INFLUENCE OF VOLCANIC DUST VEILS ON CLIMATIC VARIATIONS

The series of overlapping yearly means of temperature, expressed graphically, show most characteristic crests and depressions. In the case of tropical stations, in particular, the crests of the curves are very regular and recur at intervals of two to three years, practically at the same time all around the world.

As a general result of a detailed study of the temperature data of the years 1900–1909, for Europe, Greenland and North America, I have found some striking correlations between these equatorial variations and the more complicated variations of temperate and arctic regions. This research has been published recently in the *Annals of the New York Academy.*

In another study of all available temperature data of the years 1891–1900, published some years ago, I have shown that terrestrial atmosphere, at the earth's surface, has been warmer in 1900 than in 1893 by at least 0.5° C. On the maps representing the geographical distribution of the departures of annual means from the quasi-normal values of ten-yearly means, the areas of positive departures have been called thermopleions and the areas covered by negative departures antipleions. On the curves of overlapping means the crests correspond to pleions and the depressions correspond to antipleions. I have presumed that the excess of pleions over antipleions, corresponding to pleionian crests of equatorial stations, may be due to an increase of the solar constant.

Recently, many papers have been published about the influence of volcanic dust on meteorological phenomena, on atmospheric temperature in particular, and it has been admitted by different authors that volcanic dust must have been a factor in the production of past climatic changes.

The hypothesis ascribing the origin of climatic variations to the presence of volcanic dust veils in the higher atmospheric layers, is a very plausible argument against my supposition that the changes in terrestrial temperature are due to cosmical causes. Before going any further in my researches on the mode of formation and the dynamics of pleionian variations, it was therefore necessary to find out to what extent one may be justified to suppose that the antipleionian depressions of temperature are simply caused by the presence of volcanic dust veils.

In a paper read before the New York Academy of Sciences on December 7, I have studied more in detail the effect of the eruptions of 1883, 1902 and 1912 on atmospheric temperature. Only volcanic eruptions of an explosive character had to be taken into special consideration, because it is only when volcanic dust has been projected in great quantity above the ordinary elevation of the cirrus clouds, that this dust could remain in suspension long enough to be spread out all around the globe by the winds of the stratosphere.

In the case of the famous Krakatoa eruption in 1883, the optical phenomena produced by the volcanic dust veil have been observed practically all over the world. The explosion occurred on August 27, 1883. The main sky phenomenon, produced by the dust, went around the world in fifteen days from E. to W. along the equator, spread out N. and S., was observed in the Gulf of Mexico by the end of September and all over the United States in November. Curiously enough, the effect of the Krakatoa dust veil on atmospheric temperature seems to have attracted no special attention.

Besides the Krakatoa, other volcanoes have been very active during the year 1883. St. Augustin and Bogoslof of the Aleutian chain of islands, as well as the Ometepe, may be cited.

The study of the temperature data of the year 1902 is also of special interest, not only because during that year the world's volcanic activity was greatly intensified, but also because some of the explosive eruptions which occurred undoubtedly produced a dust veil in the higher layers of the atmosphere.

Already in 1901 the outbursts of Mt. Colima, Mexico, were more frequent and more intense than during the preceding years. The same in 1902 and even more so in 1903.

On May 7, 1902, La Soufrière, St. Vincent, was in violent eruption. The particular feature of this eruption was the enormous amount of dust which was thrown into the air and distributed over a vast, somewhat elliptical area.

On May 8, 1902, a sea of fire destroyed St. Pierre, Martinique. The following violent eruptions of Mt. Pelée occurred on May 20 and 26, June 6, July 9 and August 30.

The influence these eruptions may have had on the thermal transparency of the higher atmospheric layers is questionable. The excellent photographs taken by Lacroix show, indeed, that the occasional blasts of incandescent gases and ashes did not exceed an altitude of 4,000 m. Only an extremely small proportion of the projected pulverized ashes could have reached the average altitude of the cirrus clouds or even the stratosphere. This may not have been the case in the violent eruptions of the Santa Maria volcano, in Guatemala. The eruptions began on October 24, 1902.

The eruption of the Mua, on Sawaii of the Samoa Islands, which occurred October 30, 1902, was not violent enough to be taken into consideration. The same may be said about the Isalco eruption in Salvador. On the contrary, the Tori-shima eruption of August 7 and 9, 1902, seems to have been very violent.

There can be no doubt that during the year 1902 a considerable quantity of pulverized lava must have been projected into the higher layers of the atmosphere, above the clouds. Bishop's ring was observed anew, as well as extraordinary twilight phenomena, but a comparison is hardly possible with those which were due to the Krakatoa eruption. One single volcanic explosion, if sufficiently violent, may therefore obscure the stratosphere very much more than a score of violent eruptions of a less explosive character.

This seems to have been the case of the Katmai eruption. Katmai volcano is in the Aleutian range, Alaska, latitude 58° N., longitude 155° W., approximately. On the afternoon of June 6, 1912, it suddenly became explosively eruptive, continued in a state of great activity for about three days, and was reported to be still somewhat active at the end of October, 1912.

The fact that the Katmai eruption occurred in a far northern latitude, and has not been followed by similar volcanic outbreaks in other parts of the world, is a most valuable fact. Because, since the general atmospheric circulation of the southern hemisphere is independent of that of the northern hemisphere, it is difficult to imagine how the haze produced by the Katmai eruption could have been carried south of the equator.

The meteorological observations made on the summit of Pikes Peak extend from 1874 to 1887. It seemed to me that the records of this station—situated near the center of the North American continent, on an altitude of 14,111 feet—may be considered most reliable material for the study of the influence of the dust veil of the years 1883 and 1884 upon temperature conditions in the United States.

In this abstract it is impossible to enter into the details of the discussion. I will therefore simply mention the fact that the curve of the overlapping annual means observed on Pikes Peak compared with other curves, and the Port Darwin curve in particular, forces us to admit that the formation of a pleion in the states has been completely counteracted by the influence of the dust veil. The mean of September, 1883, to August, 1884, must have been affected the most, and this maximum effect of the dust veil must have produced a lowering of the annual mean temperature of about 3.4° F.

The curve of the consecutive means of the temperatures observed at the Batavia Observatory confirms this result, and so do the curves of Singapore, Port Blair, Colombo, Bombay and Aden.

The curves of Bombay and Port Blair, as well as the Port Darwin curve, show distinctly the antipleionian depressions preceding and following the abraded pleionian crest.

During the terrific eruptions of Mt. Pelée, on May 8 and 20, 1902, the usual meteorological observations have been made at Fort-de-France. The mean temperatures were affected but very slightly. The pleionian crest of 1902–03 as indicated on the curve of consecutive means, has been depressed a little, but certainly not more than 0.15° C. or 0.2° F. It is difficult to judge how much the mean temperatures of the individual months have been affected.

The departures of the months of May, 1902, to the end of 1903 are all above the average and if the slight deflections observed during the period of great volcanic eruptions must really be attributed to dust veils, it may be presumed that the means of some months have been affected more than those of other months, but none sufficiently to mask the pleionian character of the departures. Moreover, the effect of the dust veil ceased long before the complete development of the antipleionian depression of 1904–05. This antipleion can, therefore, not be considered as a consequence of the formation of the volcanic dust veil.

The curves of the consecutive means of temperature for Pará, Cayenne and the West Indian stations Port-au-Prince, Sct. Croix Christianssted, St. Lucia and Barbados confirm this result.

A very accentuated depression between 1903 and 1904 is also characteristic for Arequipa and Mauritius, as well as St. Helena. The temperature curve of Apia, Samoa Island, displays the same very pronounced antipleionian depression, completely independent of the formation of the volcanic dust veil of 1902.

Assuming that the volcanic haze produced by the Katmai eruption of June 6, 1912, must have had the greatest effect on the temperatures recorded in Alaska and in Canada, I compared the curves of seven stations in Alaska with the curves of Victoria and Edmonton, Mauritius and Arequipa.

Since Mt. Katmai could not have affected the temperature conditions of Arequipa and Mauritius, it is safe to take the curves of these stations as a standard. Moreover, in my previous publications I have shown that the consecutive means observed at Arequipa express very well the normal pleionian variation and may serve as a standard in all cases of comparison.

The occurrence of the eruption coincided with the pleionian crest of Arequipa. For Arequipa the consecutive mean of July, 1911, to June, 1912, is the highest. From then on the temperature is decreasing till the consecutive mean of October, 1912, to September, 1913. The same at Mauritius.

The curves of the Alaskan stations, the Fort Liscum curve in particular, display practically the same variation as that observed at Arequipa.

The more important conclusions of my research are:

The dust veil produced by the Krakatoa eruption affected atmospheric temperature very greatly. The violent volcanic eruptions of 1902 as well as the Katmai eruption of 1912 influenced the yearly mean temperatures but very slightly or not at all.

The pleionian variations of temperature have nothing in common with the presence or absence of volcanic dust veils.

HENRYK ARCTOWSKI

HASTINGS-ON-HUDSON, N. Y.,
December 8, 1914

SPECIAL ARTICLES

ON THE NATURE OF ANTAGONISM

EXPLANATIONS have been suggested by Loeb and others to account for the antagonistic action of various substances on living protoplasm, but none of them go far enough to enable us to predict what substances (including both electrolytes and non-electrolytes) will antagonize each other and what degree of antagonism will exist between any two substances.

This kind of prediction is apparently made possible by a hypothesis formulated by the writer, as the result of his investigations on the permeability of protoplasm. The testing of this hypothesis has now proceeded far enough to warrant a preliminary statement of its main features.

Substances which alter the permeability of protoplasm may be divided into (1) those which cause an increase, but not a decrease, of permeability and (2) those which can produce a decrease of permeability.[1]

The hypothesis states that substances belonging to the first class will antagonize those belonging to the second, and vice versa. In order to predict which substances will antagonize each other it is only necessary to determine to which of these classes the substances belong. The amount of antagonism may also be predicted, at least to a considerable extent, since the greater effect of the substances on permeability, the greater will be their antagonistic action. This relation may be obscured by secondary causes, so that the predictions which it allows will not be of equal value in all cases.

To illustrate these relations we may take a series of experiments on *Laminaria saccharina* in which the effects of salts on permeability were determined by electrical measurements.[2] In these experiments it was found that NaCl belongs to the first class, being able to increase permeability but not to decrease it, while $CaCl_2$ belongs to the second class, as it is able to decrease permeability.[3] It was found that the antagonism between NaCl and $CaCl_2$ in the case of *Laminaria* is well marked.[4] These facts led the writer to formulate the hypothesis stated above. The next step was to test the hypotheses by the investigation of other salts. Magnesium seemed of special interest for this purpose, as in most of the writer's previous experiments (on other plants) it had shown no antagonism to sodium, though it might be expected on chemical grounds that magnesium and calcium would behave alike. To the surprise of the writer it turned out that magnesium was able to decrease permeability, though its effect was much inferior to that of calcium. The antagonistic relations for *Laminaria* were then investigated, and it was found that $MgCl_2$ was able to antagonize NaCl, though its antagonistic action was much less than that of $CaCl_2$.[5]

This striking and unexpected result strength-

[1] Substances which cause a decrease of permeability may, if the exposure be sufficiently prolonged, cause an increase.

[2] The method is described in SCIENCE, N. S., 35, 112, 1912.

[3] The decrease is followed by an increase if the exposure be sufficiently prolonged.

[4] Pringsheim's *Jahrb. f. wiss. Bot.*, 54, 645, 1914.

[5] The means by which the degree of antagonistic action are measured can not be discussed here. One method has been described in the *Botanical Gazette*, 58, 178 and 122, 1914.