

material, making *discrete*=discontinuous stony material, or the material of the regolith.

Portions of the material of the regolith are already well named. Part of it is sedentary, the remainder transported. The sedentary portion has been called *geest* (Le Duc, McGee) and *saprolite* (Becker). The transported portion is sometimes broadly included under the term *drift*, but it is more commonly classified by genesis as *alluvium*, *glacial drift*, etc. *Discrete* is proposed to include all these.

It is proper to add that for many years I have personally felt the need of a succinct term for this idea, and that I have already made experimental use of the word *discrete* in two courses of lectures on physiography as well as in unpublished manuscript. Despite Dr. Branner's deprecation,* I cannot avoid the feeling that such tests, when critically applied, are of practical value, and I therefore venture to hope that the new word will be found useful by some of my colleagues in physiographic study.

After the writing of the preceding paragraphs my attention was directed to the fact that the noun *discrete* is already in print. It is used in the sense here proposed, but without definition, in a Johns Hopkins thesis by my friend Dr. A. C. Spencer.† G. K. GILBERT.

WASHINGTON, D. C.

HARVARD'S METEOROLOGICAL WORK ON THE WEST COAST OF SOUTH AMERICA.

TO THE EDITOR OF SCIENCE: In a previous communication on 'Meteorology in South America,' published in SCIENCE, October 1, 1897, pp. 523-525, the writer gave some facts as to the meteorological work now being done in Brazil and in the Argentine Republic. It would seem well to supplement the information given in that letter with some notes on what has been and is being done in Peruvian meteorology.

With the exception of the observations made at the 'Unanne' observatory in Lima, all the meteorological work now being done in Peru is being carried on by the Astronomical Observa-

*SCIENCE, N. S., Vol. VI., 1897, p. 134.

†The Geology of Massanutten Mountain in Virginia. Published by the author. Washington, 1897. See p. 33.

tory of Harvard College. Harvard's astronomical and meteorological work in Peru is the result of a bequest left to the Harvard College Observatory by the will of Mr. Uriah A. Boyden, in 1887. By the terms of the will this money was to aid in the establishment of an observatory "at such an elevation as to be free, so far as practicable, from the impediments to accurate observation which occur in the observatories now existing, owing to atmospheric influences." In order to determine the best site for the new observatory, it was necessary to make a more or less careful study of the meteorological conditions, especially as affecting the visual conditions, at various places which seemed to promise well. Accordingly preliminary stations at which astronomical and meteorological work was temporarily carried on were established in 1888 and 1889 in Colorado and in California. It was, however, thought advisable, for various reasons, to place the new observatory within the tropics, and accordingly an expedition was sent out in 1889 to make a study of the meteorological conditions, and of the availability for astronomical work, of various places along the west coast of South America. There is, as is well known, along this coast a narrow strip of desert, which extends roughly from latitude 4° to 30° S., over the greater part of which rain seldom or never falls. This desert strip, about 1,800 miles in length from north to south, is probably best known to scientific men, and to the world at large, as containing the rich nitrate fields of northern Chili, which were seized by the Chilians in the late war with Peru. These nitrate deposits which have, since the war, furnished the greater part of the revenues of Chili, are essentially a product of the dry climate of this interesting region.

The expedition above referred to was in charge of Professor Solon I. Bailey, of the Harvard College Observatory, and reached Lima on March 6, 1889. After a survey of the surrounding country it was finally decided to place a temporary station on a summit about 20 miles northeast of Lima, at an altitude of 6,600 feet above sea-level. This summit, which had previously been unnamed, was called Mt. Harvard. Meteorological observations on Mt.

Harvard were made from May, 1889, to September, 1890, inclusive, and embraced those made with standard, maximum and minimum thermometers, rain-gauge, barograph and thermograph, sunshine and pole-star records.

Owing to the approach of the cloudy season and to the consequent difficulty of carrying on work with the meridian photometer, Professor Bailey and his party left Mt. Harvard in November, 1889, in order to spend the succeeding cloudy months in a study of the meteorological conditions of other parts of the coast farther south, with a view to selecting the most favorable site possible for the location of the permanent observatory. On this trip Arequipa was visited and a study made of its availability as a site for the observatory. Farther south, Pampa Central, in the desert of Atacama, was visited and a system of observations of cloudiness started, which were continued (thrice daily) from December 14, 1889, to August 23, 1890. In this region there is absolutely no vegetation, not even the cactus growing there. Pampa Central is in a rich nitrate field, and is distant from the Pacific Ocean about 80 miles, its altitude being 4,530 feet above sea-level.

In October, 1890, Arequipa having then been chosen as the permanent site for the observatory, the Mt. Harvard station was given up. The exact site of the observatory was chosen by, and the buildings erected under the supervision of Professor Wm. H. Pickering, who came to Arequipa in January, 1891, and remained in charge of the station for two years. Since that time Professor Bailey has been in charge.

The meteorological observations above referred to, made at Mt. Harvard and at Pampa Central, were not the first made in Peru under the auspices of the Harvard College Observatory. By means of correspondence carried on in 1887 and 1888 Professor E. C. Pickering had already been able to establish four meteorological stations, at which observations were begun in November, 1888, viz.: Mollendo, Arequipa-Vincocaya and Puno. At Arequipa observations have been continued from that date down to the present time, and at Mollendo they were continued until 1896, when the station was removed to Mejia, a neighboring town, close to

sea-level on the Pacific Ocean. At Puno the observations were discontinued in March, 1889, and at Vincocaya in November, 1890. All these places are on the line of railway running from Mollendo, on the Pacific, to Puno, on Lake Titicaca, at an altitude of 12,540 feet. The whole length of the line is 325 miles. Vincocaya, at an altitude of 14,360 feet, was, at the time when observations were there made, the highest meteorological station in the world. It is situated on an extensive level plateau, barren except for some sparse desert vegetation, and is very near the crest of the western range of the Cordillera, the highest point on the line of the railway being at Crucero Alto, 14,666 feet, a short distance east of Vincocaya. The instruments used at Vincocaya were maximum and minimum and dry-bulb thermometers, rain-gauge, wind-vane and thermograph, and observations were also made of cloudiness. At Puno, situated towards the western end of Lake Titicaca, no thermograph was in operation.

The meteorological stations at present at work under the auspices of the Harvard College Observatory in Peru are the following: Mejia, La Joya, Arequipa, Pampa de los Huesos, Mont Blanc, Misti Summit, Cuzco and Echarati. These stations are roughly in a S.-N. line, and extend from the seacoast across both ranges of the Cordillera and down to 3,300 feet, in a valley at the head of the Amazon river system. A brief description of these stations, and of the instruments in operation at each one, may be of interest. The station at Mejia has, since January, 1896, replaced that which had existed at Mollendo from 1888 through 1895, and as the two places are near together, and have similar topographic surroundings, the continuity of the records has not been seriously interfered with. Mejia is situated on the Pacific, 9½ miles from Mollendo, the port of Arequipa and the terminus of the railroad. The instruments are 55 feet above sea-level and 420 feet from the sea. The surrounding country is extremely desolate, there being only the most scanty vegetation, except where irrigation is possible. Behind Mejia there is a range of hills, barren and unattractive, and all around it there is an abundance of

drifting white sand, which gives the whole region a most inhospitable appearance. The instruments at Mejia are the dry- and wet-bulb and maximum and minimum thermometers, rain-gauge, wind-vane, Pickering sunshine-recorder, barograph, thermograph and hygrograph. Observations are made thrice daily, at 8 a. m., 2 and 8 p. m., and include, besides the records of the instrumental reading, observations of clouds (kind, position, amount) and of wind velocity (estimated). This seacoast station is especially valuable as giving data concerning the climatic conditions of the desert belt, where its climate is modified by the proximity of the ocean.

The next station inland from Mejia is at La Joya, a railroad station distant from the ocean about 40 miles, and situated in the center of the elevated pampa of Islay, at an altitude of 4,141 feet above sea-level. This pampa lies east of the coast range of mountains, and is almost completely devoid of vegetation. It is surrounded by hills, and is very largely covered, towards its eastern margin, with the curious traveling sand crescents known as *medanos*, which move across the desert from south to north, in the direction of the prevailing day wind. These *medanos* are composed of white sand, apparently quite different from that which makes up the rest of the desert surface, and they are a very striking feature of the landscape. The meteorological conditions at La Joya are very interesting, and the records will furnish abundant data for the study of what we may call *desert meteorology*, which would include such characteristically desert phenomena as mirages and dust whirls. The instruments at La Joya are similar to those at Mejia.

The central station is at the Observatory, in Arequipa. Arequipa is situated at a distance of about 80 miles, in a direct line from the Pacific Ocean, and lies on both sides of the river Chile, the water from which is extensively used in irrigating the neighboring fields. Although the surrounding pampas can support only scant vegetation, the city itself lies in the midst of green fields of wheat, barley, Indian corn and *alfalfa*. The Observatory is built on high land overlooking the city, and stands at an elevation of 8,050 feet above sea-level, being

about 500 feet above the city. Its exact location is lat. $16^{\circ} 22' 28''$ S.; long. 4 h., 46 m., 12 sec. To the north, about 12 miles distant, rises Charachani, 20,000 feet high; to the northeast, 10 miles away, is the Misti, 19,200 feet; and to the east comes the serrated ridge of Pichu-Pichu, an extinct volcano, 18,600 feet high. Arequipa, at a considerable distance from the ocean, and in close proximity to several high mountains, presents meteorological conditions, a study of which is peculiarly interesting. Observations are made at 8 a. m., 2 and 8 p. m. daily. The instruments in use are the following: Wet- and dry-bulb, maximum and minimum, solar- and terrestrial-radiation thermometers; mercurial barometers, rain-gauge, anemometer and anemoscope, Pickering sunshine recorder, barograph, thermograph and hygrograph. The observations include, in addition to readings of the instruments, tri-daily records of clouds (kind, position and amount), and of the visibility of the three neighboring mountains. Earthquake records include two observations daily of the seismograph and seismoscope, and two daily records are also made of changes in the level of the ground.

The fourth station, still farther inland, is on the so-called Pampa de los Huesos, about 30 miles northeast of Arequipa, at an elevation of 13,400 feet above sea-level. This pampa is composed of volcanic sand and ashes, and is almost completely barren. There being no possibility of securing an observer in this desolate region, readings of the wet- and dry-bulb thermometers are made whenever a visit to the shelter is possible, at which times, also, the sheets of the barograph and thermograph are changed.

On the flank of the Misti above the Pampa de los Huesos, at a height of 15,700 feet, is the fifth station, known as 'Mont Blanc,' because the altitudes of this station and of that on the summit of Mont Blanc are almost exactly the same. The 'M. B.' shelter, as it is called for brevity, is at a distance of about 300 feet from the hut where observers from Arequipa, on their way to visit the meteorological station on the summit of the Misti, spend one night. The instruments are wet- and dry-bulb and maximum and minimum thermometers, thermograph and barograph; and this station is visited, as is that

on the Pampa de los Huesos, when an expedition is made to the summit.

The most interesting of all the meteorological stations in Peru—indeed, the most interesting meteorological station in the world, because it is the *highest in the world*—is that on the summit of the Misti, at an altitude of 19,200 feet above the level of the sea. This was established by Professor S. I. Bailey in October, 1893. The shape of the Misti is that of an almost perfect, although more or less truncated cone, and the conditions of exposure of the instruments are as nearly perfect as it is possible to obtain on a mountain. The instruments now in use on the summit are dry- and wet-bulb and maximum and minimum thermometers, rain-gauge, barograph, thermograph and hygrograph. There is also a meteorograph, constructed by Fergusson, of Blue Hill Observatory, especially for this station, and designed to record temperature, pressure, humidity, and wind direction and velocity, and to run three months without re-winding. This meteorograph has not yet given as complete records as it was originally hoped would be obtained from it. For some months after its establishment the Misti station, together with the Huesos and Mont Blanc stations, was visited by one of the assistants in the Observatory once in ten days, but lately not more than one visit a month has been possible. The trip is by no means an easy one, and the altitude of the Misti is so great that almost every one going there suffers from *soroche*, or mountain sickness. The writer has twice visited the 'highest meteorological station in the world' during his present stay in Peru, and both times had some experience in the unpleasant symptoms of *soroche*. Although it has thus far been impossible, in view of the great altitude and the distance of the station, to secure complete and continuous records from it, still the broken records which have been obtained are so interesting that this, to a considerable extent, makes up for their fragmental character.

The seventh station is at some distance farther north, at Cuzco (lat. $13^{\circ} 30' 55''$ S.; long. $74^{\circ} 24' 30''$ W., approximately), lying in a valley between the eastern and western ranges of the Cordillera, at an elevation of

11,378 feet above sea-level. It is rather an interesting fact that here, in the ancient capital of the Incas, a North American university should be maintaining a meteorological station. Cuzco is at present distant from Arequipa five days' journey; two days being spent in the train, one in a vehicle and two on horseback. The instruments are wet- and dry-bulb and maximum and minimum thermometers, rain-gauge, wind-vane, Pickering sunshine recorder, barograph and thermograph.

The last station, the farthest from Mejia, is Echarati, on the eastern slopes of the eastern ranges of the Cordillera, and in the fertile valley of the Urubamba, about 130 miles north of Cuzco. Echarati is at present just at the outer limits of what may be called civilized Peru, for a short distance beyond it comes a wild territory, inhabited altogether by Indians, through which white men seldom pass. When first established, in 1894, the shelter was at Santa Ana, about 30 miles nearer Cuzco, but last year the instruments were removed farther north, to their present location. The equipment is the same as at Cuzco. The altitude is 3,300 feet.

A glance at a good map of Peru will show at once what a magnificent series of stations Harvard has thus established in this hitherto meteorologically unknown country. Reaching from sea-level across the desert pampa of Islay to Arequipa, they continue on up past 13,400 and 15,700 to 19,200 feet, and then down, towards the north, to 11,378 feet and finally to 3,300 feet. The line of stations thus cuts diagonally across the desert belt of Peru and extends through a region of increasing rainfall down to the well-watered valley of Urubamba, which belongs to the Amazon water-shed. That the large number of observations already collected in Peru, and now being tabulated for publication, will furnish data of the greatest interest and value is a foregone conclusion.

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HARVARD COLLEGE OBSERVATORY,
AREQUIPA, PERU, December 1, 1897.

THE CRUSTACEAN GENUS SCYLLARIDES.

WHILE looking into the anatomy and nomenclature of the Astacoidean crustaceans, I in-