cent of copper. The deposits of lead so far discovered are few, but its presence has been determined in Rio Grande do Sul, Sao Paulo, and Minas Geraes, generally in connection with silver — argentiferous galena — and sometimes with gold. Bismuth and antimony are found in combination with ores of other metals, but not as yet in considerable quantities.

Up to the present, the deposits of coal discovered are not, relatively, so extensive as those of iron, but its presence has been determined in Sao Paulo where the borings indicated its existence in quantities and situations that render probable a profitable extraction. In Santa Caterina, in the valley of the Tubarao, bituminous coal exists, and a concession has been granted by the Government for working the beds. The State of Rio Grande do Sul appears to be the most favored in respect to coal deposits. In the Candiota basin, veins of coal crop out, of a thickness varying from four to six feet, but the only mines worked up to the present are those of Arrois dos Ratos, which supply coal to the steamers that ply on the river and to the Government railway.

Marbles are abundant and widely distributed; they are of various colors, and resist the disintegrating influences of the climate, under conditions destructive of the marble imported from Europe. In Rio Grande do Sul and Sao Paulo are various manufactures of works of marble. Important deposits of loadstone are found in Minas Geraes. In the State of Goyaz, in the Sierra dos Cristaes (Crystal Range) are found in abundance the well-known "Brazilian pebbles," whose pure quartz is employed in the manufacture of lenses and spectacles. They are found near the surface, usually covered with a coating of iron oxide. In the calcareous caverns of the San Francisco plateau and of the river Velhas, in Minas Geraes, saltpetre has for a long time been collected. One of these grottoes, near Diamantina, furnished within a few days after its discovery forty tons of the pure crystals. Graphite is also found in considerable quantities in Minas Geraes, one of the deposits yielding 83 per cent of carbon suitable for pencils.

THE CLIMATOLOGY OF BRAZIL.

A PAMPHLET by Sr. H. Morize, entitled "Esboço de uma Climatologia do Brazil," has been issued from the Observatory of Rio Janeiro. The author divides the country into three great zones — tropical, subtropical, and temperate. The first, in which the mean temperature exceeds 77° F., embraces the northern part of Brazil, and is bounded to the south by a line running along the south side of the State of Pernambuco, across Goyaz, and somewhat to the south of Cuyabá. The second lies between the isothermals of 77° and 68°, and extends into S. Paulo and Paraná, leaving a portion of these provinces, with Sta. Catharina and Rio Grande do Sul, to form the third zone, in which the mean temperature oscillates between 68° and 59°.

The tropical zone may be again divided into three regions, the Upper Amazons, Matto Grosso and the interior of the states on the Atlantic border, and the Littoral. On the Upper Amazons there are two rainy seasons, the principal one lasting from the end of February to June, and the other from the middle of October to the beginning of January. During the intervening dry season the rivers fall sometimes as much as 46 feet. Sr. J. Pinkas found that the mean temperature was 79°, but the maximum was 103°, which is comparatively low. The heat, however, was very oppressive, owing to the excessive moisture in the air. The prevailing wind blows from the south-west, and is frequently interrupted by calms. Towards the end of the great rains the phenomenon known as *friagem* occurs, which is a sudden fall of temperature produced by an influx of cold air from the Andes. It can only take place on a calm day, and is preceded by a high temperature, an almost complete saturation of the air, and a barometric fall of about .2 inches.

In the second subdivision heavy rains occur in spring and summer, and the thermometer often rises as much as 35° in a few hours. These sudden changes are produced by the rapid alternations of north-west and south-east winds, the former warm and moist, the latter always very cold. Dr. Morsback gives the mean temperature as 79.25° F. The average rain-fall is 45.9 inches, and the number of raining days 85. In this region also there is a period of *friagem*.

The third subdivision is characterized by rains in summer and autumn, and particularly during the month of April. The differences of temperature are much less than in the other subdivisions, 84° F. having been recorded at Vizeu in Pará during December, the warmest month, and 80° F. at the same hour, 9 A.M., during July, the coolest month. The mean rain-fall is about 58 inches. In the dry season the prairies are withered and scorched by the heat, and the cattle that feed on them suffer terribly. Occasionally the rains do not make their appearance at all, and then famine spreads throughout the country. This calamity has occurred six times already during the present century.

The subtropical zone closely resembles the warm regions of the south of Europe. Both the temperature and the rain-fall vary considerably according to the situation. The climate of the third zone is one of the finest in the world, and therefore the States comprised in it have been almost exclusively chosen by European immigrants. The rainy season does not occur in the same months as in the other regions: rain falls chiefly in the winter and autumn. As the distance from the equator increases, the transition between the wet and dry seasons becomes less distinct. The meteorology of Sao Paulo and Rio Grande do Sul has already been noticed in the *Scottish Meteorological Journal* (vol vi., p. 332, and vol. vii., 556). Sr. Morize's paper is very useful for those who wish to study the subject minutely, for he has collected numerous records of observations from all parts of the country.

YEZO.

THE island of Yezo, or Hokkaido, has an area of about 30,500 square miles. Its population, said to have been 27,000 in 1869, was, in 1889, 254,805 (including the Kurile Islands), according to the Japanese census reports. The Government, according to the *Scottish Geographical Magazine*, is actively developing the country. It is constructing a net-work of roads by convict labor, and intends to form a new capital near the source of the river Ishikari. The plan provides for 17,472 colonists, besides 1,920 houses for Tonden-he. These latter are military colonists, each of whom receives a grant of about 8 acres of land and a house, on condition of serving in war up to the age of 40. Another town is to be founded on the Sarachi A railway from Sapporo to Mororan has been proposed, the harbor at this place being more convenient than that of Orunai, where the coal of Yezo is now shipped. The dwellings of the inhabitants are by no means adapted to the rigor of the climate: those of the military colonists are slightly superior, and consist of two apartments. Cultivation and fishing are the chief occupations. Vegetables, millet, potatoes, wheat, barley, rice, and beet-root are cultivated — the last for the making of sugar. Cattle, pigs, and other domestic animals are kept in small numbers, but little attention is bestowed upon them. The Government has set up mills and sugar and hemp factories. At present they have not been remarkably active, owing either to the deficiency of raw material, or to the absence of a demand for the finished article. Fishing is a far more important industry. The annual value of the products of the sea is about £833,000, and it is on them exclusively that the taxes are levied. Herrings, salmon, and trout are extraordinarily plentiful on the northern and western coasts of the island, and cod is caught in the deep water. The native fishermen number about 60,000, and in the season these are reinforced by hired men from the island of Nipon. There are in the whole island about 17,000 Ainos, but their number is decreasing owing to the effects of disease and, more than all, intermarriage with the Japanese. In the north-east they are still in a state of degradation, but along the shores of Volcano Bay they are beginning to occupy themselves in agriculture. They are well treated by the Government, and enjoy the same rights as Japanese. Where it is possible, their children attend the Japanese schools.

PROFESSOR PICTET'S LABORATORY AT BERLIN.[1]

It has often been remarked that purely scientific research frequently bears fruit of practical value. A fresh illustration of this fact is afforded by the work of Professor Pictet, the eminent man of science of Geneva, who is turning to practical account the apparatus by which, in 1877, he first reduced hydrogen and oxygen to the liquid state. At Berlin, where he now resides, he has established, on the scale of a small factory, what he terms a "laboratoire à basses températures." The following account of the work carried on and the results obtained is taken from papers read by the professor before different scientific societies of Berlin.

The refrigerating machinery, driven by several powerful steam-engines, is intended to withdraw heat from the objects under observation, and to keep them at any temperature between —20° and —200° C. as long as may be required. Professor Pictet's experience has led him to the conclusion that among the refrigerating agents known, such as rarefaction of gases, dissolution of salts, evaporation of liquids, the latter is to be preferred. A long course of research has further enabled him to choose the most convenient from amongst the great number of suitable liquids. In order to avoid the great pressure required in handling the highly evaporative substances of lowest boiling-point which serve to produce extreme cold, it is necessary to divide the difference of temperature into several stages. Each stage is fitted with especial apparatus consisting of an air-pump worked by steam, which drains off the vapors of the liquid from the refrigerator, and forces them into a condenser, whence, reduced to the liquid state, they are again offered for evaporation in the refrigerator. Thus the liquid, without any loss beyond leakage, passes through a continuous circuit, and the operations can be carried on for any length of time. The liquid made use of for the first stage is the mixture of sulphurous acid and a small percentage of carbonic acid called "liquide Pictet." It is condensed at a pressure of about two atmospheres in a spiral tube merely cooled by running water. Oxide of nitrogen (laughing gas) is the liquid chosen for the second stage. Its vapors are condensed in the same way at a pressure about five or six times as great in a tube maintained at about —80° by the action of the first circuit. As medium for a third stage, in which, however, continuous circulation has not yet been attempted, atmospheric air is employed, which passes into the liquid state at a pressure of no more than about 75 atmospheres, provided the condenser is kept at —135° by the first two circuits. The evaporation of the liquefied air causes the thermometer to fall below —200°.

By this combination quite new conditions for investigating the properties of matter are realized. In various branches of science new and surprising facts have already been brought to light. Many laws and observations will have to be re-examined and altered with regard to changes at an extremely low temperature.

For instance, a remarkable difference was noted in the radiation of heat. Material considered a non-conductor of heat does not appear to affect much the passage of heat into a body cooled down to below —100°. Or, to state the fact according to Professor Pictet's view: "The slow oscillations of matter, which constitute the lowest degrees of heat, pass more readily through the obstruction of a so-called non-conductor than those corresponding to a higher temperature, just as the less intense undulations of the red light are better able to penetrate clouds of dust or vapor than those of the blue." If the natural rise of temperature in the refrigerator, starting from —135°, is noted in a tracing, and afterwards the same refrigerator carefully packed in a covering of cotton-wool of more than half a yard in thickness, and cooled down afresh, and the rise of temperature again marked, on comparing the tracings hardly any difference will be found in the two curves up to —100°, and only a very slight deviation even up to —50°. On this ground it is clear that the utmost limit of cold that can possibly be attained is not much lower than that reached in the famous experiment of liquefaction of hydrogen. The quantity of warmth which hourly floods a cylinder 1,250 millimetres high by 210 millimetres wide (the size of the refrigerator) at —80°, is no less than 600 calories, and no packing will keep it out. At a lower temperature, the radiation being even greater, the power of the machinery intended to draw off still more heat would have to be enormous. And as —273° is absolute zero, the utmost Professor Pictet judges to be attainable is about —255°.

As an example of the surprising methods which the refrigerating machine permits the investigator to employ, it may be mentioned that, in order to measure the elasticity of mercury, Professor Paalzow had the metal cast into the shape of a tuning-fork, and frozen hard enough for the purpose in view. On this occasion it appeared that quicksilver can be shown in a crystallized state, the crystals being of a beautiful fern-like appearance.

Glycerine was likewise made to crystallize; and cognac, after having been frozen, was found to possess that peculiar mellowness commonly only attained by long keeping.

But the most important application of the refrigerating machinery has been the purification of chloroform, undertaken by Professor Pictet, at the instance of Professor Liebreich of the Pharmacological Institute, Berlin. Chloroform has hitherto been considered a most unstable and easily defiled substance. The action of sunlight, the slight impurities retained from the different processes of manufacture, perhaps the mere settling down during protracted storage, have invariably resulted in a more or less marked decomposition. By the simple process of crystallization this unstableness is got rid of, and a practically unchangeable liquid is produced. The crystals begin to form at —68°, first covering the bottom of the vessel, and gradually filling it up to

[1] From Nature.