safe to assume that not only water-vapour, but oxygen also, exists in the Martian atmosphere.

Thus we arrive at the present opposition with the knowledge that a familiar compound, capable of forming snowcaps, of filling canals, and of being pumped in order to irrigate the pastures of a thirsty landscape, exists on Mars, and is accompanied by that element which we terrestrians look upon as another essential for the existence of animal life; and crucial difficulties in the "habitability" theory have been removed. Close, persistent, and world-wide scrutiny, at this favourable epoch, should lead to further elucidation of the enigma, and enable us to "reconstruct" a being and a vegetation capable of existing there.

An idea which has caught the popular fancy is that of signalling to Mars, but as the earth, from the planet, would be in the glare of the sun and would subtend, even at the impossible moment of opposition, an angle of less than 50″—of the same order as the apparent diameter of Jupiter at his recent opposition—to say nothing of the questionable transparency of our thicker atmosphere, this problem has not yet entered the province of practical astronomy.

WILLIAM E. ROLSTON.

POLAR EXPEDITIONS AND OBSERVATIONS.

THE position and prospects of polar exploration have been given great attention in the daily Press during the last few days. No precise information as to Dr. Cook's journey to the North Pole has yet been published, but the general narrative of Commander Peary's expedition leaves little room for doubt that Commander Peary reached the neighbourhood of the pole, and probably the pole itself, though an element of uncertainty must exist until his observations for latitude are examined critically. The Berlin correspondent of the *Times* reports that an executive committee for a Zeppelin polar expedition has been formed, the object of the expedition being defined as "the scientific investigation by means of the dirigible airship of the unknown Polar Arctic Sea and the development of the dirigible airship for the carrying out of scientific labours." Announcement has also just been made that a British Antarctic expedition will start next August under Captain R. F. Scott, who commanded the National Antarctic Expedition of 1900–4, with the object of reaching the South Pole.

As all the world knows, Mr. Shackleton's record of this year has given Great Britain the premier position in Antarctic exploration, and an earnest desire is felt by British explorers to place to the credit of this country the feat of first reaching the South Pole. McMurdo Sound has in the past been used as the base for British South Polar expeditions, but it is proposed on the next journey to establish a second base in King Edward VII. Land, 400 miles to the east of McMurdo Sound. The track to the pole from the new base may be expected to include phases similar to those met with in travelling from McMurdo Sound, but it is anticipated it will continue longer on the sea-level, meet the mountains nearer the pole, and consequently leave a shorter journey on the high inland plateau. The distance to be covered is in all some 1500 miles, for which 150 days are available. The plan for the journey to the pole from King Edward VII. Land includes the use of three means of sledge traction: ponies, a dog team with a relay of men, and motor sledges.

The scientific objects of Captain Scott's expedition are stated to be as follows:—(1) Geographical.—To explore King Edward VII. Land, to throw further light on the nature and extent of the great Barrier ice formation, and to continue the survey of the high mountainous region of Victoria Land. (2) Geological.—To examine the entirely unknown region of King Edward VII. Land and continue the survey of the rocks of Victoria Land. (3) Meteorological.—To obtain synchronous observations at two fixed stations, as well as the weather records of sledge journeys. (4) Magnetic.—To duplicate the records of the elements made by the *Discovery* expedition with magnetographs. The comparison should throw most important light on secular changes. (5) Miscellaneous.—In addition, attention will be paid to the study of marine biology at both stations and in the ship, and the examination of physical phenomena will be continued.

It is estimated that an expedition of the kind projected will cost at least 40,000*l.*, and towards this sum considerable amounts have been given already. An appeal has been made to the public, and it is hoped that no difficulty will be experienced in raising the necessary money for the accomplishment of what will in any case include valuable scientific work.

The full narrative of Commander Peary's expedition to the North Pole appeared in the *Times* of September 11 and 13, and occupied six columns. By permission of the editor we are able to give a summary of this account of the journey and the observations made. The expedition left Etah, Greenland, on August 18, 1908, in the *Roosevelt,* having on board 22 Eskimo men, 17 women, 236 dogs, and about 40 walrus. Cape Sheridan was reached on September 5 and winter quarters were established there. Sledge loads of supplies were then taken to Cape Belknap, Porter Bay and other stages up to Cape Columbia, where Prof. McMillan obtained a month of tidal observations during November and December. Tidal and meteorological observations were also made at Cape Bryant, and explorations were carried on.

The expedition started for the north from Cape Columbia in several divisions at the end of February of this year. Latitude 83° 20′ was passed on March 2, and on March 5 "the sun, red and shaped like a football by refraction, just raised itself above the horizon for a few minutes and then disappeared again." The lead, or creek of open water, which was then reached, prevented further movement until March 11, when it was frozen and a start became practicable. The depth of the lead was determined by soundings to be 110 fathoms. On March 14 the lead had been passed, and the temperature was −58° (?) F. Two days later Prof. McMillan had to be sent back to Cape Columbia at once on account of frostbite. "Sounding gave a depth of 825 fathoms. We were over the Continental Shelf, and as I had surmised, the successive leads crossed in the fifth and sixth marches composed the big lead and marked the Continental Shelf."

By an admirable system of advance, main and supporting parties, the expedition moved rapidly north, covering no fewer than fifty minutes of latitude (about 57 miles) in three marches. The fourth supporting party started on the back trail from about latitude 88°, and on April 2 Commander Peary, with his party of Eskimos, moved towards the pole.

In a march of about ten hours the party travelled twenty-five miles and was well beyond the 88th parallel, "with the sun now practically horizontal." Several long marches were accomplished, and one of forty miles in twelve hours. In four days, two degrees of latitude were covered, that is, a distance of about 138 miles. On the last stage of the journey Commander Peary's only companion was an Eskimo. An observation made on April 6 showed that the latitude was 89° 57′, so that the pole had been practically reached. Thirty hours were spent in making observations there and ten miles beyond the camp, and in taking photographs. No land could be seen. The minimum temperature recorded during the thirty hours was -33° and the maximum -12° (?) F. A sounding was made five miles from the camp, but bottom was not touched at 1500 fathoms. The party returned to Cape Columbia on April 23, and to the *Roosevelt* four days later. On July 18 the ship left Cape Sheridan and arrived in Indian Harbour on September 6.

The record of the expedition is a triumph for good organisation and persistent endeavour, and though details of the scientific observations are not yet available, the narrative gives good reason for believing that, so far as the time permitted, some valuable work was accomplished. Commander Peary states that Prof. Marvin and Prof. McMillan both secured numerous observations of tidal and meteorological conditions, as well as other data of scientific interest, while Dr. Goodsell gave special attention to microscopic work.

Commander Peary's achievement has rendered unnecessary any further expedition to reach the North Pole, so that attention may now be concentrated upon systematic scientific work in the region of which a preliminary view has just been taken. Whatever may be the ultimate decision as to relative claims to have been the first to reach the pole, there can be no doubt that the work carried on by the members of Commander Peary's expedition will be of greater value to science than mere observations of latitude taken during a "dash" to the pole. The success of the expedition is associated, however, with a fatal mishap to one of the scientific members. Prof. R. G. Marvin, of Cornell University, was drowned on April 10, forty-five miles north of Cape Columbia, while returning from latitude 86° N. in command of a supporting party. Prof. Marvin was only thirty years of age, and his death has caused great regret.

Though Commander Peary refers in his narrative to observations for latitude made at various points, no particulars are given, but that may be because the narrative was written for the general public. The explorer has had a unique experience in Arctic regions, and when his observations are published they will, it is hoped, show that the instruments used and corrections applied enabled him to determine position with reasonable accuracy. The determination of latitude by observations of the sun is, however, very difficult in latitudes near the poles. Without suggesting that Commander Peary's results may be found to require correction, it is of interest to indicate the conditions of observation in polar regions and the instruments used by some explorers.

LATITUDE OBSERVATIONS IN POLAR REGIONS.

To an explorer situated at one of the poles of the earth, the stars and all other heavenly bodies appear to pass round him in circles parallel to the horizon once in twenty-four hours, and the altitude of any one star is the same at whatever time it might be taken, provided the atmospheric conditions remain unchanged. If an explorer could be at either pole during the winter months, the best proof he could have that he had really reached 90° latitude would be by observations of stars. Should he be able to measure the altitude of a star with a theodolite or sextant and artificial horizon, at not less than 35° above the horizon, and repeat his measurement at regular intervals, say, of three hours, during one complete rotation of the earth, and find the altitude to be the same at every observation, he would certainly be at an extremity of the earth's axis. Should time be pressing, instead of this somewhat lengthy operation he could take observations of different stars one after the other around the horizon, and then if, after applying corrections for refraction and instrumental errors, he found in each case the altitude to be the same as the declination of the star given in the Nautical Almanac or similar publication, he could conclude that he was exactly on a pole of the earth. The former of these two would be the more satisfactory method, because effects of refraction, which is very uncertain in high latitudes, would be eliminated.

But it is usually daylight when the explorer reaches his highest latitude, and the stars are not visible, so here is a practical difficulty in the way of either of these methods. Still, much the same plan could be followed with the sun. If an explorer is exactly at the pole the sun will pass round him in a circle in twenty-four hours, and the only change in its altitude will be due to the change in declination, which is given in the Nautical Almanac for every hour. Should it be found, then, during a series of observations of the sun extending throughout twenty-four hours, or over a number of hours, that the observations changed just the amount of the sun's change in declination for every hour, the only place where the observer could be would be at the pole.

If, instead of the altitude remaining the same, it should, during one rotation of the earth, be found to decrease for twelve hours and then increase for the other twelve, or *vice versa*, it is clear that the latitude would not be 90°, but its value could easily be computed from the observations.

As regards observations for time taken at or near the poles, the ordinary method of taking sets of altitude of east and west stars fails altogether, for the simple reason that the altitude remains practically the same at all times, and it is impossible to state the *exact* instant of time corresponding to a certain altitude. The only satisfactory method of rating a chronometer would be by taking transits of the sun or stars by a theodolite firmly fixed and left in position on a stand. Since all the meridians converge at the poles, there can be no difference of longitude, and another remarkable fact would be that an observer exactly over the North Pole would be facing south whichever way he turned, and this would interfere with his ordinary idea of bearings considerably.

There can be no doubt that the best instrument to take for accurate observations at or near a pole is a good transit theodolite, and altitudes below 30° or so should, if possible, be avoided. With a sextant and artificial horizon, a low altitude, such as 10° or 11° or below, is very satisfactory. In the first place, it is extremely difficult to make a contact at all, and then the image in the artificial horizon is usually greatly distorted, specially when a glass plate artificial horizon is used, silvered only on the back. But whether the observations are taken with a theodolite or sextant and artificial horizon, it is naturally impossible to expect any result that can be depended on unless a solid foundation exists upon which to level up the theodolite or place the artificial horizon.

To take advantage of the best conditions of the ice and ensure a safe return, a polar explorer endeavours to reach his highest latitude at an early date when the sun's declination is only a few degrees. Thus it was April 7, 1895, when Dr. Nansen arrived at 86° 12·3′ N., and April 25, 1900, when Captain Cagni, of the Duke of the Abruzzi's expedition, reached latitude 86° 34′ N., his farthest north; whilst the two explorers whose names are just now so prominent both announce that they discovered the North Pole in this month.

Although doubtless unavoidable for the reasons stated, these comparatively early dates of reaching high latitudes have great disadvantages so far as observations are concerned. The stars have disappeared, to be seen no more for five or six months, and the sun is so near the horizon, owing to its low declination, that the meridian altitude, upon the measurement of which the latitude usually depends, is not high enough to give a satisfactory result, owing to the uncertainties of the refraction correction, and, if a sextant and artificial horizon are used, to the great difficulty in making the observation at such a low altitude, and unavoidable distortion of the sun's image. For good results it is a maxim with geographical surveyors that no altitude should be taken that is less than 25° or 30°.

A meridian altitude of the sun only a little above 6°, which is what would be observed at the poles on April 6, or between 11° and 12°, which would be the amount for April 21, would not be likely to furnish a very exact latitude, even if taken with a first-rate instrument under favourable climatic conditions, much less so when these are not favourable and when the observations are made with the small portable instruments which alone can be carried by the explorer on a rapid dash to the pole, when every ounce of weight is a serious consideration.

Dr. Nansen, after leaving the *Fram*, took with him on his famous sledge journey a small altazimuth, with 4-inch circles, and a pocket sextant with an arc of 1¾ inches radius, both of which, by means of verniers, read to single minutes. It was with the pocket sextant, however, that his farthest north latitude observation was made, using the natural horizon, and he admits that the result cannot be depended upon to a minute or two.

Captain Cagni observed with a sextant, and in referring to his farthest north latitude, which depended upon an altitude of about 12°, states that he used both the artificial horizon and the natural horizon, which latter was very distinct.

Coming now to the Antarctic regions, Captain Scott's expedition was well provided with instruments, but his highest latitudes on the southern journey were taken with a small theodolite. In the case of this expedition, the dates when the high latitudes were reached were later on in the summer, so that the sun's southern declination, and consequently its meridian altitude, was higher.

This same remark also applies to Mr. Shackleton's recent expedition, for on January 3, when the last observation on his long journey to the south was made, the sun's meridian altitude was about 25° 33′, which resulted in a latitude of 87° 22′, the further distance travelled south of this depending for its measurement chiefly on the sledgeometer, which throughout the journey had been found to agree well with the latitudes observed. On his journey Mr. Shackleton used a 3-inch transit theodolite, reading to single minutes, and the adjustment of which had been thoroughly tested. He also had the advantage of observing on *terra firma* instead of moving ice, so altogether his resulting latitudes doubtless compare very favourably, as regards accuracy, with those of other polar explorers.

As regards the effect of extreme cold on the refraction correction of the altitude, it may be interesting to note that, for an altitude of 11°, there is a difference of just above 1′ for a change of temperature from +50° to −60° F.

Sextant observations taken with a glass plate artificial on moving ice would be most untrustworthy, for, in addition to the probable sources of error already referred to, there may be slow oscillations of the water, tidal or other, that may affect the level of the reflecting surface considerably.

CHEMISTRY IN THE SERVICE OF THE STATE.

It is generally known in chemical circles that Sir Edward Thorpe is relinquishing the post of principal chemist at the Government laboratory, which he has so ably held for the last fifteen years. In the closing paragraphs of the present report[1] he notes that it is the last document of the kind he will have the honour of submitting to the Treasury, and takes the opportunity of directing attention to the great increase which has occurred in the work of the laboratory during the period in question. It appears that the number of samples examined yearly is now more than double what it was fifteen years ago, the actual figures being 76,513 in the year 1894, and 176,935 in 1908–9.

Naturally there is not much of strictly scientific importance to be found in the record of an establishment devoted to "the daily round, the common task" of acting as chemical Abigail to all and sundry Government offices. Yet in its applications of chemical science to civic requirements Sir Edward's department touches the public welfare at many points; and in illustration of this some gleanings from the pages before us are not without interest. For statistics, in which the report abounds, the reader may be referred to the publication itself.

The business of the laboratory is subdivided into three main classes. Articles examined for the two great revenue departments, Customs and Excise, form by far the largest number of samples. A considerable amount of work, however, is submitted by other branches of the executive, especially the Board of Agriculture, the India Office, the Admiralty, the Board of Trade, and the Office of Works. Finally, samples, relatively few in number, but important as being objects of dispute in legal proceedings, are referred to the laboratory for examination under the provisions of the Sale of Food and Drugs Act and the Fertilisers and Feeding Stuffs Act.

In its *rôle* of revenue chemist, the laboratory is required to hold the balance fairly between the Exchequer on the one hand and the maker or importer of taxable commodities on the other. Alcoholic liquors, sugar, tobacco, tea, coffee, and chicory naturally furnish the greater number of samples for analysis, since they are the chief dutiable articles in this country. But in safeguarding the revenue derived from these products it is also necessary to analyse numerous other articles; thus the principal chemist remarks that "the duty on chicory involves the examination of many substances botanically allied to it, such as dandelion and burdock roots." Genuine cider, again, is not liable to import duty, but samples are analysed nevertheless; for "if evidence is found that spirit has been added," the cider comes under the tariff as a preparation containing spirit, and is taxed accordingly. It is noted that a large proportion —more than 13 per cent.—of certain beverages sold as temperance drinks contained an excess of alcohol, the quantity ranging from 3 to 11 per cent. of proof spirit.

Among other miscellaneous matters, an investigation into the character of the spirits usually sold to the labouring populace was undertaken. Such phrases as "adulterated, maddening liquor" are common in the mouth of the well-meaning but uninformed temperance enthusiast. The results of an impartial inquiry, however, lend no support to the charge of adulteration. Samples of whiskey, gin, rum, and brandy were purchased in the ordinary way

[1] Report of the Principal Chemist upon the work of the Government Laboratory for the Year ended March 31, 1909. Cd. 4771. Price 3*d*.