land situations. As on similar occasions, the influence of the sea in arresting the fall of temperature was strikingly seen. Thus the minimum temperatures on the 21st were 31°·7 at Portpatrick, 8°·3 at Drumlanrig Castle on the Nith, 1°·0 at Stobo Castle and Thirlestane Castle, 11°·7 at Milne Graden near Coldstream, and 17°·7 at Eyemouth on the East Coast. At Douglas Castle and Thirlestane Castle the unprotected thermometer fell to −6°·0.

MR. H. S. EATON has rendered a great service to meteorology by a paper on the average height of the barometer in London, which has just appeared in the *Journal* of the Meteorological Society for October. The great value of the paper consists not so much in the long period of 100 years for which the monthly averages of each year are given, as in this, combined with a careful and laborious elimination of instrumental errors and errors arising from breaks of one or more days in the observations of the months. The series is sufficiently extended as to entitle it to be considered one of the most valuable we possess in dealing with questions of secular meteorological variations. The mean atmospheric pressure at 32° and sea-level for London is 29·952 inches, the mean monthly maximum 29·996 inches occurring in June, and the minimum 29·900 inches in November, the mean for October being nearly as low, viz., 29·909 inches. In a discussion which followed the reading of the paper Mr. Strachan remarked that even another 100 years' observations would not alter the positions of these points of the London curve—a remark no doubt quite true for London. On advancing however to the south-west the means for June and July approach towards equality, and ultimately the July mean becomes the larger as we advance into the region of high pressure which occupies the Atlantic to the south-west during this month. On the other hand, as we proceed northward, the means for May and June approach towards equality till about the south of Scotland the mean for May becomes the maximum for the year, and the further north the more decidedly is May the maximum, till in Iceland it exceeds the mean of any other month by the tenth of an inch. Attention was drawn to the dips in the curve of pressure for April and July. These in all probability are permanent features in the London curve of pressure for March-April and July when drawn from a long average, since the former is connected with the east winds of spring and the latter with the great summer barometric depression which falls to the lowest point in July in the interior of the Europeo-Asiatic continent.

IN the same number Mr. Marriott gives a brief *résumé* of three years' observations made by Mr. F. E. Cobb at Stanley, in the Falkland Islands, which, from the geographical position of the place, possess some interest. The results show a mean annual pressure of 29·604 inches, the maximum occurring in winter, and the minimum in summer. A singular feature of the monthly means is their comparative steadiness from year to year, the highest being 29·819 inches for August 1876, and the lowest 29·342 inches for February of the same year. The difference of these two extremes is only 0·477 inch. It would be difficult to select from Mr. Eaton's 100 years mean pressures for London any consecutive three years which would show so small a variation between their two extreme monthly means as do these Falkland Islands' observations. The prominent features of pressure in those islands would appear to be its variability, the constant recurrence of rapid changes, and the comparative absence of protracted periods of very low, but especially very high pressures—occasioned in all likelihood by there being no great mass of land in that quarter of the globe. A like equableness from year to year characterises the temperature and rainfall of the climate. The rainfall is surprisingly small, amounting only to twenty inches in the year; but the falls, though not heavy, are frequent, there being 236 rainy days in the year. The lowest mean temperature of any of the thirty-six months was 35°·4, and the highest 52°·6. The climate is eminently a dripping one, and when the range of its temperature is taken into consideration, and its high winds, it is one of the most disagreeable climates of the globe.

GEOLOGICAL NOTES

NAINI TAL LANDSLIP.—In NATURE, vol. xxii. p. 505, attention was directed to landslips in connection with the catastrophe at Naini Tal on September 18. We have just received part 4 of vol. xiii. of the *Records* of the Geological Survey of India, containing a paper by Mr. R. D. Oldham, of the staff of that Survey, who was deputed to examine and report on the landslip to the Director. From this paper and a note appended to it by Mr. Medlicott, it appears that we were in error in supposing Naini Tal to stand upon Tertiary rocks. It lies just to the north of the younger formations, and is situated upon "more or less imperfectly-cleaved clay slates." These rocks are subject to a decomposition which penetrates deep into their mass, and it would seem to have been the cover of loose, decomposed detritus which, thoroughly saturated with water from the heavy rains, slid down the hill, and gave rise to the catastrophe.

THE "CHALLENGER" WORK.—Steady progress is being made in the investigation of the deep-sea deposits dredged up by the *Challenger* Expedition. M. Renard has established himself at Edinburgh, where, in concert with Mr. J. Murray, he is busily engaged in subjecting the various dredgings to chemical and microscopic analysis. In the first volume, devoted to an account of the bottom of the ocean, will be gathered together the facts amassed during this laborious study. It will avoid all speculation, but will contain such a body of data for the explication of the sedimentation and chemistry of the ocean abysses as has never before been available. In a subsequent volume the authors will develop the views to which their prolonged and minute investigations have led them. No part of the work of the *Challenger* promises to possess a profounder interest in geology.

GEOLOGICAL SURVEY OF BELGIUM.—The dual organisation for the Geological Map of Belgium is likely to lead to some curious reduplications and complications. Besides the staff under the direction of M. Dupont, there are other geologists independently at work under the Ministry of the Interior who are determined to lose no time in bringing out sheet after sheet of the geological map as surveyed by them. In particular the Baron O. Van Ertborn and M. Paul Cogels have been eminently energetic. The Baron made a convention with the Ministry towards the end of last year to complete six sheets with their explanatory texts before June 1 of the present year. He has been able to keep his engagement except as regards the Lubbeek sheet, for which he obtained a delay until the close of this year. We have just received the Boisschot and d'Aerschot sheets. Meanwhile M. Dupont makes no sign. Specimens of his map were seen at the Paris Exhibition in 1878, and also at the Dublin meeting of the British Association last year. But so far as we are aware, nothing has yet been issued. The Director is understood to be resolved to make his map the most perfect geological map that has ever been published. It is being chromolithographed at Leipzig. Considerable interest is naturally felt among geologists to see the first completed specimens of this long-expected work. We are curious also to know what will happen when the Official Survey and the free-lances meet on the same ground. Will the Government publish two different geological maps? The position reminds us of that which roused the activity of the Congress of the United States a few years ago, when it was discovered that the same Territory in the far West was sometimes independently surveyed by two or three different organisations, all paid out of the public purse. Only in Belgium things are worse, for the country is small, and the certainty of reduplication must have been foreseen from the beginning.

GEOGRAPHICAL NOTES

AT the meeting of the French Geographical Society on November 19, M. Henri Duveyrier read an important memorandum which he had drawn up on the subject of the sources of the Niger. After going carefully into the question of Major Laing's prior discovery and various matters relating to the hydrographic system of the Niger basin, he thinks it very doubtful if any other stream will ever be discovered having a right to be deemed the chief source of the river, than the Tembi-Kundu visited by MM. Zweifel and Moustier. M. Duveyrier's remarks will no doubt be published in an early number of the French Geographical Society's *Bulletin*, and it may be hoped that it will be illustrated by a large scale map. At the annual meeting of the Society last Friday, M. Maunoir read his usual report on the work of the Society and the progress of geographical knowledge. It was announced that the Society had now about 2100 members, being an increase of about 100 in the year.

HEFT 3 of vol. ii. of the *Mittheilungen* of the German African Society contains a brief report of the work of the year. The

most striking feature of the work is the successful journey of Dr. Lenz from Morocco to Timbuctoo and thence to St. Louis in Senegal. In the region to the south of the Congo some good work has been done. Dr. Buchner has probably got beyond the district known as the kingdom of Muata Yanvo, while Major von Mechow has reached the Coango from Malange by following down the valley of the Cambo, a tributary of that river. The navigation above the junction is obstructed by cataracts, but Major von Mechow did not expect to meet with any difficulty in sailing down the Coango to its mouth in the Congo. Dr. Pogge is on his way out to Portuguese West Africa to proceed to the interior to found a station at Mussumba, the chief town in Muata Yanvo's kingdom. Herr Flegel has been exploring the Niger in the *Henry Venn*, and expects shortly to reach Sokoto. Dr. J. Hann has a paper in this number on the meteorological and hypsometrical results of Rholfs' expedition to the Kufra Oasis. The Society have received instructions from the Imperial Government regarding the manner in which the 3750*l.* granted by the Reichstag is to be divided. Dr. Gerhard Rohlfs' expedition to Abyssinia will receive 1600*l.*, and 150*l.* is to form a reserve fund for this same undertaking. The expedition now being organised at Zanzibar under the leadership of Herr von Schöler will receive 800*l.*, and the remaining 1200*l.* are for Dr. Pogge, who is attempting to reach the capital of Muata Yanoo, in Central Africa, in order to found a station there. The Society has also granted 250*l.* to Herr R. E. Flegel, who ascended the Binuë River this year.

THE new number (No. 9 of vol. vii.) of the *Verhandlungen* of the Berlin Geographical Society contains papers by Herr Gustav Niederlein on some of the scientific results of an Argentine expedition to the Rio Negro in Patagonia, and by Dr. Nachtigal on the ethnological place of the Tubu and Kanuri.

THE December number of *Petermann's Mittheilungen* contains an interesting paper by Dr. Rholfs on the Libyan Desert, in which he shows that it is the eastern part of the Sahara, and not the western, that is the real desert, broken only here and there by oases. Indeed the extreme west of the Sahara, for a distance of from 400 to 500 kilometres from the coast, does not strictly belong to the desert at all; and even the eastern half, the more we know of it, the more numerous are its oases found to be. There is an eclectic article on the Liu-Kiu Islands, by Dr. v. Klöden; a paper on the New Volcano on Lake Ilopango; and a map of the South Coast of Franz Josef Land, based on Mr. Leigh Smith's recent discoveries. In the *Monatsbericht* some interesting details are given of Dr. Junker's journey to and his sojourn in the Niam-Niam country. A letter from Dr. Emin Bey, the Governor of the Egyptian Equatorial Province, informs us that Mtesa, King of Uganda, whom Mr. Stanley so whitewashed, is as tyrannical and bloodthirsty as ever, and does not intend to be either Christianised or Mohammedanised, but to adhere to the ways of his forefathers. Dr. Emin is anxious that explorers should turn their attention to the Equatorial Province, which forms a splendid field for botanists, zoologists, and other specialists.

NOTWITHSTANDING the belief in some quarters that the American Arctic steamer *Jeannette* has been lost with all hands, it is thought in San Francisco that Capt. De Long and his staff and crew may have only abandoned her, and be waiting succour at some point. An attempt is therefore being made to get a small schooner sent out next spring to search Wrangell Land.

EARLY in the present year Mr. W. H. Cornish, of the Surveyor-General's Department at Adelaide, was engaged for some two months in examining the country in the far interior for the extension of the trigonometrical survey and traverse of the Herbert River. In about lat. 30° 59′ near that river he crossed a piece of country which by his account almost baffles description; it was flood country of the Herbert, and was completely rotten. "Cracked ground," he reports, as a term is scarcely applicable, for there were yawning chasms from four to five feet deep, and even deeper, and eight to twelve inches wide at every few feet. The country indeed was so bad that it took the camels six hours to travel seven miles, and Mr. Cornish's difficulties were increased by the unusually intense heat of the weather. Mr. Cornish believes that before long the cattle-trade from the part of Queensland which he visited will go southwards to Australia as soon as the settlers who are beginning to open up the country on the Herbert, Diamantina, and Mulligan become sufficiently acquainted with the means of communication. During his journey Mr. Cornish did not see more than 300 natives, who were all friendly, but he believes there are large numbers in the region he travelled through, and that it would not be prudent to trust them.

DR. LAWS, the head of the Livingstonia station on Lake Nyassa, is actively engaged on linguistic work. He has translated various portions of the New Testament into Chinyanja, and the Laing trustees have agreed to publish his translation of St. Mark's Gospel. Dr. Laws has also begun the Yahitonga language spoken at Bandawi, and he has collected a short vocabulary of the Chungu dialect at the north end of the lake. The Livingstonia and Foreign Missions Committee of the Free Church of Scotland have recently agreed that, on the assurance that there will be no difficulty there as to civil government, owing to the presence of powerful chiefs, Bandawi shall be made the principal port of the mission on Lake Nyassa, while sanitary out-stations are to be sought on the neighbouring hills among the Angoni. As soon as possible however the east side of the lake is to be explored, in the hope of finding a better sanitarium on the so-called Livingstone Mountains.

MESSRS. GRIFFITH AND HUTLEY, who lately established the first mission station on the west side of Lake Tanganyika at Mtowa, near the mouth of the Lukuga Creek, have sent home to the London Missionary Society some information respecting the religious notions of the Waguha. There appears to be a marked difference on this point between the tribes on the opposite shores of the lake. Those on the east side have no images or idols, but on the west shore they have them in great numbers, and have certain beliefs connected with them. Mr. Griffith observes that the first thing which strikes the African traveller on entering the western half of the continent is an image at the entrance of every village, besides many others inside it. The image is in imitation of the human figure, and is called *Mkissi*, which is the same as the Mzimu of the Swahili, and means spirit.

THE new *Bulletin* of the Belgian Geographical Society contains reports relating to the International African Association's expeditions in East Africa, including tables of meteorological observations taken by M. Popelin. There is also a report on the "Conférence Géodésique Internationale de Munich," and an essay by Col. Verstraete on biological geography.

THE *Bulletin* of the Norman Geographical Society contains a paper by M. G. Gravier on M. Paul Soleillet's journey to Adrar between December, 1879, and May, 1880, as well as the continuation of M. Ch. Benner's journey from M'ruli to the capital of Unyoro.

THE Italian Expedition to the Antarctic Regions will not set out till 1882, but Lieut. Bove will shortly set out on board a whaling vessel to make a voyage of reconnaissance.

TWO Englishmen, with sixteen men belonging to an Indian convoy, are reported to have arrived at Yarkand from the direction of Tibet, whither they returned after visiting Kashgar.

M. RABOURDIN, who accompanied Col. Flatters on his survey for the proposed Trans Saharan Railway, reports that he discovered numerous remains of cut flints, not less than eighteen manufactories being found in a length of 800 kilometres from Wargla. He also found remains of the great horned oxen which, according to Herodotus, were found in the country of the Garamantes.

DR. NACHTIGAL has furnished the *Tour du Monde* with a *résumé* of the concluding portion of the forthcoming volume of his "Reise in Afrika" in advance of publication, and it now appears in that periodical under the title of "Voyage du Bornou au Baguirmi," accompanied by a sketch-map and some very interesting illustrations.

WE hear that the Geographical Society of Marseilles have awarded their gold medal to Major Serpa Pinto for his journey across Africa.

ACCORDING to the *Echo du Japon* the King of Corea has been induced to make an offer of entering into treaties with foreign powers, through his fear of his kingdom being annexed by Russia, and he has despatched two envoys to open negotiations. Though the opening of Corea will hardly be of any great commercial importance, it will pave the way for interesting geographical researches in a country which is almost unknown, except from the imperfect accounts of Roman Catholic missionaries.

THE first volume of Löwenberg's "Geschichte der geographischen Entdeckungs- und Forschungsreisen," which treats

of voyages of discovery made during antiquity and the middle ages, as far as Magellan's first voyage round the globe, will be shortly published by Herr Spamer of Leipzig. It will contain some 100 illustrations, besides maps, charts, &c.

CRITICAL TEMPERATURE OF ETHYLENE

M. AMAGAT (*Compt. rend.*[1] [1879], lxxxix. p. 437, corrected *Beiblätter* [1880], iv. p. 19) has submitted hydrogen, oxygen, nitrogen, air, carbon monoxide, methane, and ethylene at temperatures from 18° to 22° to pressures ranging between 28 and 431 atmospheres, and finds that, except for hydrogen, the product pv first diminishes and then increases as p increases, the most marked case being that of ethylene, for which the values of pv at 31·58, 84·16, 398·71 atmospheres are proportional to 2·29, 1, 3·13 respectively. Dr. van der Waals deduced this general peculiarity theoretically in 1873, and showed that its markedness is the greater, the less the temperature of compression exceeds the critical temperature: concluding, therefore, that for ethylene the critical temperature is not far below 18°, as M. Amagat has also surmised, he has recently (*Meded. der k. Akad. van Wetenschappen in Amsterdam*, Mei 1880)[2] determined it directly by a Cailletet compression-apparatus, finding it to be 9°·2, and the critical pressure 58 atmospheres.

On p. 55 of his dissertation "Over de Continuiteit van den Gas- en Vloeistoftoestand" (Leiden, 1873), van der Waals finds the characteristic equation of a gas in the form—

$$\left(p + \frac{a}{v^2}\right)(v - b) = R(1 + \alpha t),$$

where a, b, R are constants and α the coefficient of expansion, and on p. 79 *et seq.* it is shown that at the critical temperature all three values of v given by this equation, which may be written

$$v^3 - \left\{ b + \frac{R(1 + \alpha t)}{p} \right\} v^2 + \frac{a}{p} v - \frac{ab}{p} = 0,$$

are equal: hence, if V is put for this common value of v, and T, P for the corresponding values of t, p, *i.e.* for the critical temperature and pressure, the theory of equations gives

$$3V = b + \frac{R(1 + \alpha T)}{P}, \quad 3V^2 = \frac{a}{P}, \quad V^3 = \frac{ab}{P},$$

whence

$$P = \frac{a}{27b^2}, \quad V = 3b, \quad PV = \frac{a}{9b}, \quad 1 + \alpha T = \frac{8a}{27bR},$$

and also

$$a = 3PV^2, \quad b = \tfrac{1}{3}V, \quad R = \tfrac{8}{3}\frac{PV}{1 + \alpha T}.$$

The minimum value of pv at any temperature t may be determined in the usual way by $\frac{d.pv}{dv}$ being equated to zero, and, if p', v' are written for the corresponding values of p, v, there result

$$v' = \frac{V}{3(1 - \tau)}, \quad p' = 27(1 - \tau)(2\tau - 1)P, \quad p'v' = 2(2\tau - 1)PV,$$

where

$$\tau^2 = \frac{bR(1 + \alpha t)}{a} = \tfrac{8}{27}\frac{1 + \alpha t}{1 + \alpha T}.$$

Thus a minimum value of pv exists only when

$$1 > \tau > \tfrac{1}{2},$$

i.e. only at temperatures that lie between

$$\frac{a}{bR\alpha} - \frac{1}{\alpha} \text{ and } \frac{a}{4bR\alpha} - \frac{1}{\alpha}.$$

If p_1 represents the pressure of the gas when occupying unit volume at t, then

$$(p_1 + a)(1 - b) = R(1 + \alpha t),$$

and, p_1 being the value of pv in this initial state, the markedness of the minimum value of pv is greater the less

$$\frac{p'v'}{p_1} \text{ or its equivalent } \frac{(1 - b)(2\tau - 1)}{\tau^2 - b(1 - b)},$$

that is, since the sign of the t-differential coefficient of this expression is the same as that of $(\tau - b)(1 - b - \tau)$, the less t, provided that

$$1 - b > \tau > b,$$

or that the temperatures lie between

$$\frac{\alpha(1 - b)^2}{bR\alpha} - \frac{1}{\alpha} \text{ and } \frac{ab}{R\alpha} - \frac{1}{\alpha}.$$

If v represents the volume of the mass of gas which occupies unit volume at 0° under unit pressure, then

$$R = (1 + a)(1 - b),$$

as is taken in the following calculations.

In the case of ethylene van der Waals' experiments give $T = 9·2$ and $P = 58$: hence, by the above relations with $\alpha = 0·00367$,

$$\frac{a}{b(1 + a)(1 - b)} = 3·489, \quad \frac{a}{b^2} = 1566,$$

which lead to a cubic equation that gives

$$a = 0·00786, \quad b = 0·00224, \quad R = 1·0056,$$

so that the characteristic equation is

$$p = \frac{0·0037(272·5 + t)}{v - 0·00224} - \frac{0·00786}{v^2},$$

the pressure being reckoned in atmospheres; hence too $V = 0·0067$ and $PV = 0·39$. Further, when $t = 20$, the mean temperature in Amagat's experiments, $\tau = 0·5547$, and thus by calculation $p' = 76·25$, while Amagat's direct observations give $p' = 84$ approximately, so far justifying the the theory. The temperatures for which pv has a minimum value range from 678° to −35°.

The intimate agreement between Amagat's experiments and van der Waals' formula (which is entirely independent of them) is shown by the following table, wherein the first column contains the pressures (expressed in atmospheres) employed by Amagat, the second his experimental values of pv divided by 23500, and the third the values of pv calculated for $t = 20$ from the formula:—

p	pv observed.	pv calculated.
31·58	0·914	0·895
45·80	0·781	0·782
59·38	0·522*	0·624
72·86	0·416	0·387
84·16	0·399	0·392
94·53	0·413	0·414
110·47	0·454	0·456
133·26	0·520	0·520
176·01	0·643	0·642
233·58	0·807	0·805
282·21	0·941	0·940
329·14	1·067	1·067
398·71	1·248	1·254

The only serious discrepancy occurs for $p = 59·38$, and van der Waals accounts for this by supposing that in Amagat's table 12263 is misprinted for 15263, so that the asterisked number should be 0·650; for by experiment he finds that the ratio of the values of pv for $p = 45·80$ and $p = 59·38$ is 1·26 (the calculated ratio being 1·25), while Amagat's actual numbers give 1·50, but, when corrected, 1·20.

For methane the equation of van der Waals' form that best satisfies Amagat's experimental values has for constants $a = 10^6 \times 2·9$, $b = 53$, $R = 25525$, if $t = 20$, $\alpha = 0·00367$, pressures being measured in metres of mercury, and this gives −99½° for the critical temperature and 50⅓ atmospheres for the critical pressure. The constants have large values here, for, as calculation shows, the mass of the gas considered is about 24⅓ grams, which would occupy, at 0° under one atmosphere, about 33518 c.c.

This discussion—with the numbers recalculated—by Dr. van der Waals of M. Amagat's experiments in connection with the critical temperature is here reproduced, together with the brief *résumé* of his theory (which has not hitherto appeared in an English dress), for ready application in other cases.

September 17 ROBERT E. BAYNES

[1] Since the following was written, M. Amagat has published further results, which do not however affect its main point.

[2] Mr. Dickson seems to have independently discovered (*Phil. Mag.* for July, 1880) the principles laid down by Dr. van der Waals in his above mentioned dissertation, pp. 79-93, which is not sufficiently known in England

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Natural Science Tripos Class List has just been issued. There are eight names in the first class, eight in the second, and fifteen in the third. Of those in the first class three attain their first class for Physics and Chemistry, viz.: Fleming, St. John's (distinguished in Physics); S. L. Hart, St. John's, and Heycock, King's. Two attain their first class for