mous a rainfall out of the monsoon current of July, and scarcely any out of the indefinite sea-winds of May, is shown by Dr. Simpson to be twofold—the July winds are both markedly stronger and damper. At Bombay, for example, the mean wind velocity is 7.4 miles per hour in May and 14.2 in July, and the relative humidity 74 and 86 per cent. respectively. Consequently, when a wind from the Arabian Sea mounts the Western Ghats, condensation will for two reasons proceed more actively in July than in May. Referring to Figs. 1 and 2, it will be seen that the pressure-gradient over India is steeper in July than in May, which means stronger winds, and that the powerful monsoon current of the former month is supplied from the south-east trade wind, with the result that the air which reaches India, after traversing some 2000 miles of sea, is necessarily very humid. In May, on the contrary, the light winds on the west coast blow somewhat north of west and conflict with the south-east trade wind over the equatorial part of the Indian Ocean, where rain falls instead of in India.

Realising how illusory charts of mean monthly meteorological conditions may be as representing actual conditions on any particular day, Dr. Simpson is able to show that the circulation in the Indian area rarely differs essentially from the mean, and that breaks in the monsoon are associated with temporary reversions to the conditions typical of May, when clear skies and fierce sunshine are broken only by violent local thunderstorms.

One cannot but support his conclusion that without the mountains the general rainfall of India would be lighter, if more evenly distributed. Those who argue that in any case the southern portion of the peninsula, below about 18° N., would experience the full effect of the annual northward swing of the equatorial rain-belt forget that the steady equatorial rains depend upon the convergence of air-streams from the northern and southern trade systems, and that where, as on the Benadir coast (Italian Somaliland), such a convergence is prevented by the monsoon regimen itself, there is found the anomaly of a nearly rainless strip of coast within 10° N. of the equator. A problem which should engage attention as facilities for travel and research in this part of the world increase is the precise effect of the Himalayas and the high plateau of Tibet upon the strength of the south-west monsoon. The effect of a broad, cold tableland 10,000 ft. high is more likely to be negative than positive—that is, to weaken rather than to strengthen the monsoon. The late Prof. Herbertson, whose insight into climatological questions was not perhaps ade-

quately appreciated by meteorologists, used repeatedly to discountenance exaggerated notions concerning the “flue-like” action of Central Asia often entertained by those who rely too much on isothermal maps reduced to sea-level. In any case, there would be a general inflow of air towards Asia in summer, as is so well exemplified in China; but the real controlling centre of the powerful south-west monsoon of India is situated near the mouth of the Persian Gulf, and it is this “cyclonic” centre which guides the air-currents across India to the base of the Himalayas, which they must perforce mount, and thence on to the highlands of Tibet.

To summarise, the primary condition of the south-west monsoon is a centre of low barometric pressure situated to the north-west of India, due to the heated state of this region in summer, and to a certain extent of the Asiatic land-mass as a whole. The special local effect of India itself is quite subsidiary, merely serving to give the isobars and air-currents across the peninsula their final trend. In May the local heating of India, then at its maximum, does not suffice to bring about monsoonal conditions, but the general Asiatic heating in July does, for reasons discussed. A heavy rainfall accompanies the monsoon because it is both a humid and a powerful current, and is met more or less at right angles by various high mountain ranges.

Finally, it is advisable to refer to certain general principles in connection with the theory of the monsoonal circulation, the importance of which is duly emphasised by Dr. Simpson. Whilst it is a conspicuous fact that, broadly speaking, the continents command high pressure in winter and low in summer, and the oceans *vice versa*, the more detailed relationship between pressure and temperature is exceedingly complex, and the precise location of a centre of high or low pressure depends upon many other factors, such as the rotation of the earth and the configuration of the land. In other words, the atmosphere being a unity of interdependent parts, it is largely a matter of compromise, as between region and region, what type of circulation shall prevail here and what there. To take but an instance. Nothing is more perplexing than the drought-producing wind and pressure regimen of the Mediterranean basin in summer with intense insolation and active evaporation to a meteorologist who conceives of this region as isolated from other regions, and forgets that the Mediterranean circulation has to adapt itself to the great monsoon system of Asia, as well as to the conditions in other parts of the world.

Helium in Natural Gas.

By H. B. MILNER.

THE researches of H. P. Cady and D. F. McFarland in 1905 on some natural gas from Kansas led to the interesting discovery of the presence of helium in that gas, a fact of which

advantage was taken afterwards by the United States military authorities during the later stages of the war. In 1915 the natural gas resources of this country were investigated for a similar purpose

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under the direction of the late Sir William Ramsay, and those of Canada were also examined, but in both cases the efforts were unsuccessful. The dangers attending hydrogen-filled aircraft were obvious from the fate of many of the German Zeppelins, so that the possibility of extracting sufficient quantities of an incombustible gas such as helium (admirably suited in every way to the peculiar requirements of lighter-than-air machines) was too important to be ignored.

In the United States the help of certain commercial firms, employing the Linde and Claude processes of gas liquefaction for the treatment of air, was solicited, and in 1918 two plants were in operation at Fort Worth, Texas, ultimately giving an average production of 5000 cb. ft. of gas per day, yielding on purification up to 93 per cent. of helium. Although the effect of the armistice was to check military requirements, the development of commercial aviation keeps this use of helium very much in the foreground, and in view of this and also of the far-reaching scientific problems involved the United States Geological Survey has just published, from the pen of G. Sherburne Rogers, a most valuable monograph on "Helium-bearing Natural Gas" (Professional Paper 121, 1921).

The chief region from which commercial supplies of helium are obtained is that of the Mid-Continent oilfields, more especially from two areas, one in North Texas and the other in North Oklahoma and South Kansas; gas in both these areas yielded up to 0.5 per cent. of helium, in some cases the amount being as much as 2 per cent. One would naturally expect helium-rich gas to show a high nitrogen content with consequent low calorific value; generally speaking this is found to be so, though in one instance a gas with 14 per cent. of nitrogen yielded 0.35 per cent. of helium. On the other hand, a high nitrogen content is not necessarily a criterion of a high helium yield, and Rogers cites several examples of this. The nitrogen-helium ratio in natural gas in thirteen samples quoted ranges from 11.4 to 20; the conclusion to be drawn from this, and also from a careful study of several other available analyses, is that a low (N_2/He) ratio implies a low helium content.

The richest helium-bearing gas in America is obtained from comparatively shallow depths in the Pennsylvanian beds, and it is interesting to note that gas emanating from younger beds, such as the

Cretaceous or Tertiary of Texas and Louisiana, is low in helium content. Bearing in mind Czako's contention that the radio-activity of a gas is an index of its helium content, and also Holmes's work on radio-activity as a measurement of geological time, it is thus not difficult to appreciate the reason of the low helium content of European natural gas, derived for the most part from Tertiary strata. Evidence is not forthcoming as to the radio-activity of the gas from the Pennsylvanian beds, but McLennan's researches in Ontario (*NATURE*, vol. 70, p. 151, 1904) demonstrated the tendency of decreased radio-activity with increased depth, and this may reasonably be correlated with the marked decrease in helium yield with increase in depth from which the gas is obtained in the present case.

The origin of the helium in the gas affords a wide ground for speculation, though in the present state of our knowledge it would be very unsafe to dogmatise. Rogers discusses this at some length, but of the several possible theories he favours two, more particularly the first—that the helium is generated from uranium or thorium deposits disseminated through the beds proximate to the natural gas horizons, or that it is primordial and comes from abyssal sources. His arguments in favour of the former theory are very sound, though, as he admits, it assumes the occurrence of radio-active deposits of which we have no knowledge, more particularly in the upper palæozoic rocks of the Mid-Continent region, or in some of the buried igneous masses occurring as subterranean uplifts.

It is interesting to note that in the case of the three principal occurrences of natural gas in this country, at Calvert, Buckinghamshire, at Middlesbrough, Durham, and at Heathfield, Sussex, the nitrogen contents were 19.5 per cent., 16.8 per cent., and 0.9 per cent. respectively; in the first case the source of the gas is doubtful, but it is presumably from pre-Liassic beds; in the second case it is obtained from the Magnesian Limestone, and at Heathfield it is unquestionably derived from the Kimmeridge Clay. If the nitrogen evaluation is any indication of helium-bearing gas, as it would seem to be in the United States, it is extremely unlikely that helium occurs in those gases in amount greater than 0.5 per cent. (if as much as that) at Calvert and Middlesbrough, while at Heathfield it is probably absent altogether.

Obituary.

LORD BRYCE, O.M., F.R.S.

IT can be but seldom, when a man's life has been prolonged to well over eighty years, that his death is generally felt as a serious public loss. Lord Bryce's sudden, if happy, death on January 22, in his eighty-fourth year, is a shock which will be felt equally here and in the United States, where only last summer he had been engaged both by lecturing and in social intercourse in spreading a better understanding of the problems of Great Britain and

Europe. Years ago, by his great work on "The American Commonwealth," and at a later date by his tact and manifold activities while our Ambassador at Washington (he was reputed to have visited every State in the Union), Lord Bryce had made himself a living link between the two peoples. In the United States he was not only trusted by statesmen and appreciated by the leading men in thought and literature, but he was also an idol of the crowd. When he came into a popular assembly the proceed-