possible that, whilst one of the components obtained is due to oxidised beryllium, the other is due to the pure metal. This possibility is now being investigated.

Two other points of interest are observable in the spectrogram. First, a faint absorption line appears at the short-wave edge of beryllium $K\alpha$. This absorption sets in at about 111·1 A. Secondly, there is quite a strong satellite observable on the long-wave side of O $K\alpha$ at about 24·6 A. More precise determinations of these wave-lengths will be published later.

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[1] *Phil. Mag.*, **10**, 600; 1930. See also: Faust, *Phys. Rev.*, **36**, 161; 1930. Prins, *Z. Phys.*, **69**, 618; 1931. O'Bryan and Skinner, *Phys. Rev.*, **44**, 602; 1933.
[2] See Morand and Hautot, *Comptes Rendus*, **195**, 1070; 1932; **197**, 521; 1933. Prins, *Z. Phys.*, **81**, 507; 1933. F. C. and L. P. Chalklin, *Phil. Mag.* (in the press).

Dynamics and Mechanism of Aliphatic Substitution

SLATOR[1] observed that alkyl halides and symmetrical ethylene di-halides react bimolecularly with sodium thiosulphate in water, but that the velocity of reaction with iodochlorethane and bromochlorethane was independent of the concentration of thiosulphate. The phenomenon under discussion is the transition in kinetic order of a reaction due to a very slight modification in the structure of one of the reactants. The problem has been discussed by E. D. Hughes and Ingold[2], who reveal varied and more reliable instances of the same phenomenon. For example, β-phenylethyltrimethylammonium hydroxide decomposes bimolecularly, whereas halides of the corresponding *p*-nitro derivative decompose unimolecularly.

The velocity of hydrolysis of both ethyl chloride and tertiary butyl chloride depends on their concentration, but only in the former case is it influenced by the concentration of alkali. The elimination of methyl alcohol and tertiary butyl alcohol from substituted sulphonium hydroxides are processes of the second and first order respectively (E. D. Hughes and Ingold[3]). According to the theory of Ingold, relating to reactions of type *B*, high cationic stability of the rejectable group and low nucleophilic activity of the reagent-anion tend to favour a unimolecular mechanism, which in turn admittedly implies a relatively long life to the activated organic ion.

The question may now be raised whether the kinetic distinction observed between two similar but specific chemical reactions under ordinary conditions would persist at totally different concentrations. In principle it is possible for the order of reactions of B_1 and B_2 respectively to become reversed below and above a critical concentration (c) of the reagent anion; c (in gram-molecules per litre) would be related to the *average* life-time (t) of the activated organic reactant (in seconds) by the equation

$$c = \frac{A}{t}\sqrt{\frac{\mu}{T}}$$

μ is the reduced mass of the molecules concerned; and A, which is a function of the molecular diameters, is approximately 11. From Slator's data, t for iodochlorethane becomes about 5×10^{-10} second. The Lindemann mechanism thus leads to plausible results when applied to reactions in solution; but it is noteworthy that change in kinetic order due to variations in the concentration, although sought[4], has not yet been found. This fact, and the demarcation between mechanisms B_1 and B_2 may have a common origin in the limited range of dilution conventionally employed.

There is no incompatibility between the two hypotheses. On the other hand, Lindemann's theory, accepted as the explanation of a well-known effect discovered by Hinshelwood in gaseous reactions, is in a sense complementary to Ingold's theory, which derives its support from the successful prediction of the course of organic elimination reactions.

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Jan. 6.

[1] *Trans. Chem. Soc.*, **85**, 1286; 1904.
[2] NATURE, **132**, 933, Dec. 16, 1933.
[3] *Trans. Chem. Soc.*, 1571; 1933.
[4] Stewart and Bradley, *J. Amer. Chem. Soc.*, **54**, 4183; 1932.

Atmospheric Pressure and the Ionisation of the Kennelly-Heaviside Layer

EVIDENCE of a connexion between meteorological conditions in the troposphere, and the behaviour of radio waves reflected from the Kennelly-Heaviside layer has been noted by Colwell[1] in America and by Ranzi[2] in Italy. Again, Stagg[3] has discovered a relation between the diurnal variation of barometric pressure at Aberdeen and the general state of magnetic conditions over the earth. There appears little doubt that some relation exists between conditions in the troposphere and the ionosphere.

Evidence which appears to bear on the fundamental nature of the relationship has been obtained as a result of two series of experiments carried out in Melbourne and Sydney during 1931 and 1932.

In the first series, carried out at the University of Melbourne with the collaboration of Mr. R. O. Cherry, during November–December 1931, and March–April 1932, the average night intensity of the sky wave from the transmitter 3 AR (610 kc./sec.) was measured at a distance of 90 km. From the second series, carried out between Melbourne and Sydney on a frequency of 1415 kc./sec. during October 1932, it was possible to find directly the maximum ionisation density in the *E* layer from observations of the rays of known angle which penetrated that layer.

From both series a very close direct correlation is evident between the average night-time ionisation density in the *E* layer and the barometric pressure at ground-level measured at a time ranging from 12 to 36 hours after the ionisation observation. For example, if on any night the average ionisation density is greater than that on the preceding night, then the barometer invariably rises within the time interval mentioned. In most cases the time lag is near to twelve hours, the greater lag being associated with slower moving disturbances.

The results obtained in the first series of experiments are in complete accord with those of Colwell, though the explanation offered differs considerably from his. Thus, Colwell considers that the "E layer is concentrated in the regions of low pressure"[4], resulting in a stronger post-sunset signal. On general theoretical grounds it is much more probable that a stronger night signal on the frequency of KDKA (980 kc./sec.), upon which station Colwell's measurements were made, would result from a *decreased* intensity of ionisation in the absorbing portion of the

E layer. Such a deduction is even more probable for the frequency at which the first series of measurements described above was made, there being small possibility of electron limitation being operative so early in the night.

That this view is substantially correct appears to be shown by the remarkably close correlation found in the second series of experiments, which gave the ionisation density directly.

The relation of the results described above to those of Ranzi, which are principally concerned with the occurrence of abnormal night time increases in ionisation, is not so obvious. It seems clear, however, that in seeking an explanation of abnormal night ionisation, the possibility of horizontal movements of the ionosphere must not be overlooked. The phenomena described above strongly suggest the presence of winds at these high levels of the stratosphere.

This work is being carried out under the auspices of the Australian Radio Research Board, to which I am indebted for permission to publish this advance report.

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Dec. 20.

[1] NATURE, **130**, 627, Oct. 22, 1932.
[2] NATURE, **130**, 368, Sept. 3, 1932.
[3] NATURE, **127**, 402, March 14, 1931.
[4] *Phys. Rev.*, **43**, 774; 1933.

Small Sand Craters of Seismic Origin

THE small sand craters of seismic origin, described by Dr. Sheppard in NATURE of December 30 (p. 1006), as examples of unusual structures, are common results of severe earthquakes in alluvial regions. The formation of such vents and their related fissures was first explained by R. Mallet and T. Oldham in the case of the Cachar earthquake of January 10, 1869[1], and their theory was adopted later by R. D. Oldham in his description of the numerous and widely spread occurrences caused by the Great Indian earthquake of June 12, 1897[2]. Briefly, this theory postulates a certain amount of vertical movement from below, resulting in the transmission of the wave motion through layers of loose, oozy sand into the overlying, impervious and harder layers of the surface alluvium. The inertia of the latter is believed to cause a compression of the watery sub-stratum and the expulsion of part of its contents through simultaneously formed cracks above, usually as a geyser-like flow. The spurting which reliable eye-witnesses state takes place on these occasions, the return of the water when quiescence is attained and the formation of the craters with their scored sides, are all accounted for satisfactorily by this theory.

The epicentral tract beneath which the Pegu earthquake of May 5, 1930, originated, happened to form part of a vast alluvial plain in Lower Burma, and sand vents, craters and sloughs were produced over wide expanses of country as a result[3]. Similarly, after the Pyu earthquakes of December 3 and 4, 1930, in Upper Burma, many examples were noted in suitable places, for their formation demands a bed of watery sand, overlain by a thick deposit of clay[4]. In no case, so far as they were examined either by my colleagues or myself, was any evidence found to lead to a modification of the older theory, still less to adopt the belief that they originated in a subsidence of the land, followed by a restoration to its original level, as stated by Sheppard. Insufficient attention has been paid in the past to the action of gas which may be so liberated from water-bearing strata charged with decomposing organic matter in such situations, but this would in any case only intensify the known, mechanical, surface effects of the disturbances.

The suggestion that the sandstone dykes of the Tertiary formations of south-western Ecuador may have been injected during earthquakes, recalls Kendall's identical explanation of the sandstone dykes and "fossil sand blows" of various parts of the British Coal Measures[5].

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[1] R. Mallet and T. Oldham, *Quar. J. Geol. Soc.*, **28**, 255–270; 1872. T. Oldham, *Mem. Geol. Surv. Ind.*, **19**, 46–60; 1882.
[2] R. D. Oldham, *ibid.*, **29**, 85–111; 1899.
[3] J. Coggin Brown, P. Leicester and H. L. Chhibber, *Rec. Geol. Surv. Ind.*, **65**, 253–255; 1931.
[4] J. Coggin Brown and P. Leicester, *Mem. Geol. Surv. Ind.*, **62**; 1933.
[5] P. F. Kendal, *Proc. Geol. Soc.*, Jan. 17, 1919.

The Infinite and Eternal Energy

I SHALL be obliged if any reader of NATURE can give me the reference for Herbert Spencer's statement that:

"Amid the mysteries that become more mysterious the more we examine them, we find the one certainty that we are in the presence of an infinite and eternal energy from which all things proceed."

I quote from memory of reading this statement some forty years ago. I think it was in the form of a letter on the completion of the "Synthetic Philosophy". I have failed to trace it at the British Museum or in Herbert Spencer's works, and the Herbert Spencer Trustees have been unable to find the reference for me. Prof. Wilhelm Ostwald had not heard of it, and he asked me for the reference; but I was unable to give it to him.

It was widely quoted and commented upon in the Press at the time it was published. Consequently, it is strange that there should be any difficulty in finding the reference.

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Tidal Bores

IN NATURE of February 3, p. 180, reference is made to a suggestion by Dr. Vaughan Cornish that a co-operative study of the Trent Bore should be undertaken by a group of students, equipped with tide-gauges, etc.

The late Mr. Champion devoted much time to observations in the Trent, using a special tide-gauge, at a large number of places. At his death we undertook to examine and collate all his material, which was presented to us by his sister. This work is nearly completed, and the results will shortly be published. The characteristic shape of the bore in detail, size, rates of travel, etc., have been deduced for a number of stations.

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