practically identical in shape, while in the polar view the optical section through the curved tip is also very similar. It will be noted that these grains are quite distinct from the pollen of *Sequoia sempervirens* and *Sequoia wellingtonia*, which are shown for comparison (*E*, *F*).

Despite a prolonged search in the Mull coal, I have not seen pollen resembling that of the living species of *Sequoia*. It would, indeed, be interesting if other lines of palæobotanical research on *Sequoia*-like material of British origin, for example, examination of leaf cuticle, seed and wood anatomy, also suggest relationship to *Metasequoia*.

JOHN B. SIMPSON

Geological Survey Office,
19 Grange Terrace,
Edinburgh.
Jan. 8.

Brillouin Zone Effects in Aluminium Alloys

IN experiments on the solid solutions of zinc in aluminium, it has been found that there are marked deviations from Vegard's law in alloys containing less than 25 atomic per cent zinc. The deviations of the lattice spacing/composition curve from a straight line are a maximum at 16·5 atomic per cent zinc, coincident with the formation of the α'-phase at 275° C. Further, when the α'-phase is formed, the lattice spacing of the α-phase remains constant over the composition range 16·5–25 atomic per cent zinc and the corresponding temperature change from 275° to 315° C.

These results have led to a more detailed examination of the solid solutions of zinc in aluminium, and it has been found by density measurements at 283° and 318° C. that a defect lattice of the type reported by Bradley and Taylor[1] is formed, there being 5·6 per cent vacant lattice sites at 16·5 atomic per cent zinc (assuming that the pure aluminium which was used as a standard in the density measurements contained no vacant lattice sites) and less than 0·5 per cent vacant sites at 25 atomic per cent zinc. It would appear that the slope of the lattice spacing/composition curve can be correlated with the formation of vacant lattice sites in the solid solution, and that in the composition range 16·5–25 atomic per cent zinc, where the α'-phase is in equilibrium with the α-phase, the lattice spacing remains constant while the vacant sites fill up.

By the formation of vacant lattice sites the electron concentration per unit cell is reduced, and it would appear probable that the electron concentration at the point where the number of vacant lattice sites is a maximum corresponds with the filling of a Brillouin zone. In this case it is of the order of 2·68 electrons per atom, taking into account the effect of the vacant lattice sites.

It has been pointed out by Fink and Freche[2] that the plot of log S against $1/T$ gives a straight line for a number of aluminium-rich solid solutions, where S is the atomic percentage of the solute in solution at the limit of the solid solution at $T°$ Abs. It is found that the solution of zinc in aluminium does not obey this law, and this is further evidence that this solid solution is abnormal.

The aluminium–magnesium and aluminium–silver systems also have fairly wide aluminium-rich solid solutions. Neither solution obeys the law of Fink and Freche, and by analogy with the aluminium–zinc system, this may also be due to the formation of vacant sites.

It is suggested that an electron atom ratio of about 2·68 corresponds with the filling of a zone in these alloys. Such a suggestion, however, is not in accord with the $N(E)$ curve for aluminium recently calculated by Matyas[3].

E. C. ELLWOOD

King's College,
Newcastle-upon-Tyne 1.
Nov. 10.

[1] Bradley, A. J., and Taylor, A., *Proc. Roy. Soc.*, **159**, 56 (1937).
[2] Fink, W., and Freche, H. R., *Trans. Amer. Inst. Min. Met., Eng.*, **111**, 304 (1934).
[3] Matyas, Z., *Phil. Mag.*, **39**, 413 (1948).

Application of Similarity to Anelasticity

KE[1] has shown that, when the internal friction and relaxation of rigidity for very pure aluminium are measured as functions of grain size (D), temperature (T) and frequency of vibration (ω), the effects of these three variables can be stated in terms of a single parameter :

$$D.\omega.\exp H/RT, \qquad (1)$$

where H is an activation energy of 32,000 cal./mol. The exponential term represents[2] the temperature variation of the coefficient of intergranular viscosity. This parameter has the disadvantage that it is not dimensionless, so that it is not possible to transfer the results of Ke's experiments to other metals. It is therefore of interest to apply dimensional analysis to this system in the attempt to derive a dimensionless criterion for the ratio of the relaxation time $\bar{\tau}$ to the vibration time $1/\omega$. Lord Rayleigh[3] has pointed out that fundamental laws can frequently be derived by such dimensional analysis.

One way of doing this is to start from the fundamental equation for a standard linear solid given by Zener[4] in the form

$$\tau + t_\gamma\dot{\tau} = G_R(\gamma + t_\tau\dot{\gamma}), \qquad (2)$$

where τ is the shear stress, γ is the strain, G_R is the relaxed rigidity modulus, t_γ, t_τ are the relaxation times for stress and strain respectively under constant strain and stress. The geometric mean relaxation time $\bar{t} = \sqrt{t_\gamma t_\tau}$ represents the measure of the time-scale of the system governed by equation (2). To apply similarity theory it is, however, necessary to introduce a viscosity[5]

$$n = \bar{t} \,.\, \bar{G} = t_\gamma \,.\, G_u = t_\tau \,.\, G_R, \qquad (3)$$

where $\bar{G}$ is the geometric mean of the relaxed (G_R) and unrelaxed (G_u) rigidity moduli. Equation (2) then takes the form

$$\tau + (\eta/G_u)\dot{\tau} = G_R\gamma + \eta\dot{\gamma}, \qquad (4)$$

and the dimensionless parameter for the transition from the relaxed (ω small) to the unrelaxed (ω large) states is

$$N_1 = \omega\bar{t} = \omega\eta/G. \qquad (5)$$

This introduces the exponential term, since the viscosity can be expected to vary with temperature as exp H/RT; and it is now in dimensionless form, so that it might reasonably be expected to enable results to be transferred from one metal to another by ascertaining suitable values of η and $\bar{G}$. The