Dynamic and Static Elasticities of Solids

Measurement of the velocity of sound forms a convenient way of measuring elasticities. In a thin rod the longitudinal velocity is governed by Young's modulus E and the torsional velocity by the rigidity modulus n. For solids the difference between dynamic and static values arises mainly from the specific heats. Thus the ratio of the values of E will be equal to the ratio of the specific heats, γ. For torsional strains there is no change in volume, and it is assumed that there will be no difference in the values of n. On the basis of these two assumptions, the expression relating Poisson's ratio σ to the velocity measurements will be $\frac{\gamma E}{n} = \left(\frac{v_L}{v_T}\right)^2 = 2\gamma(1 + \sigma)$. The values of E, n and σ should approximate closely to static values, although deviations arising from frequency-sensitive elastic effects are to be expected.

The pulse method of measuring the longitudinal velocity described earlier[1] has been extended to torsional measurements. It enables both velocities to be measured for the same specimen under precisely the same conditions. A check of the expression given above can therefore be carried out.

The pulses are launched and received by coils on a magnetostrictive tube. For longitudinal pulses the tube is polarized longitudinally, for torsional pulses it is polarized circumferentially. A matching unit passes the pulse to a rod of the material to be measured. Two echoes are received back from the specimen, one from the end and the other from a machined shoulder of a suitable shape to give reasonably sized echoes for both types of pulse. The time interval between the two echoes gives the velocity.

In testing the method it was found that a graph of time interval against shoulder to end distance, obtained by cutting pieces off the specimen, gave a straight line which did not quite go through the origin. The error, of the order of one quarter of the pulse length, was eliminated by taking the velocity from the slope of the line.

The results on specimens chosen for a wide range in values of σ and γ are shown in Table 1. The good agreement between the observed and textbook values of σ shows the value and accuracy of the expression for the analysis of dynamic measurements.

Table 1

Solid	σ*	γ*	v_L (m./s.)	v_T (m./s.)	σ
Aluminium	0·337	1·049	5,164	3,081	0·339
Copper	0·334	1·028	3,723	2,234	0·350
Lead	0·446	1·072	1,422	803·4	0·461
Fused quartz	(0·17)	(1·001)	5,762	3,780	0·160

* Values from ref. 2

Measurements so far carried out do not show any great variation of σ with temperature or physical condition of the specimens.

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[1] Bell, J. F. W., *Phil. Mag.*, **2**, 1113 (1957).
[2] Lumsden, J., "The Thermodynamics of Alloys" (The Institute of Metals, 1952).

Age of a Pilansberg Dyke of Palæomagnetic Significance

The palæomagnetism of the dyke system radiating outward in a south-easterly direction from the large Pilansberg eruptive centre has been studied by Gough[1]. The basic parts of the dykes show a high magnetic consistency and, on the assumption of a geocentric dipole field, place the north magnetic pole in latitude 7½° N., longitude 47½° E. at the time of cooling. This time has always been inferred from surrounding systems, themselves not dated by radioactive methods.

The dykes are mainly of very fine-grained basic rock and as such are unsatisfactory for age-determination, but in the Robinson Dyke (Gough's Dyke *C*) a centre felspathic zone with development of biotite occurs. This dyke was sampled at levels No. 61 and 62 in the Robinson Deep Mine. These levels are at a depth of approximately 8,000 ft., and 160 ft. apart vertically. The palæomagnetic measurements at level 61 show a centre zone of low-intensity, unstable, felspathic material and the sample used was taken from this zone. At level 62, although the felspathic zone is developed, the magnetic measurements show stability through the full width of the dyke. The sample chosen was from the centre felspathic zone. The felspars at both levels were cloudy and altered but at level 62 the biotite, itself a late magmatic alteration product from hornblende, showed comparatively little hydrothermal alteration to chlorite. At level 61 most of the biotite had been altered to chlorite. It was not possible to separate pure samples of biotite/chlorite from either level, but, after magnetic and vibrating-table separations, samples enriched from the initial concentration of ½–1 per cent biotite/chlorite were obtained. These were used for the age determinations reported in Table 1.

Table 1

Sample	Percentage biotite/chlorite	Strontium-87	Age $\times 10^{-6}$ yr. ($T_{1/2} = 5{\cdot}0 \times 10^{10}$ yr.)
P.61	30–35	0·0796	1,340 ± 290
P.62a	20–25	0·0790	1,230 ± 240
P.62b	55–60	0·1390	1,290 ± 140

The sample numbers refer to levels 61 and 62, and *a* and *b* distinguish between two different separations from the same hand sample. The errors quoted are 99 per cent confidence limits and the most probable age is 1,290 ± 180 million years. The material is essentially poor for age determination in that the rock shows alteration and, even in the biotite-enriched separations made, the abundance of the radiogenic isotope, strontium-87, was not high. This limits the accuracy with which the age can be determined. The abundance of this isotope at the time of crystallization was found to be 0·0703 from measurements on the total rock, which has a very high ratio of strontium to rubidium.

The magnetic instability of the felspathic centre zone of level 61 and the alterations observed in the minerals of the rock weaken the argument that the ages determined are the true ages of intrusion. These ages will only be meaningful if the alteration took place within a time small compared with age after the rock had crystallized. Two arguments may be advanced to show that this was the case. First, the concordant ages measured on samples from level