…oes is less prone to errors arising from change of …se-echo shape with pressure than is that using gear …ich displays the rectified pulse-echoes. A typical …ta plot is given in Fig. 1 showing the difference be…een time of arrival of one of the maxima of echo No. 7 … the C_{44} wave in a 1.9-cm long copper crystal and a …d time-marker, as a function of pressure gauge coil …istance. The pressure range indicated is about 9800 …rs. Data points were taken about 5 min after each …essure change in order that the system be near …ermal equilibrium. Absence of hysteresis justifies the …e interval chosen. Strictly speaking one is interested …ly in the initial slopes of these curves, but experi…entally all the plots are linear over the pressure range …ed. The slope of this line can be determined by a …ast squares method and this slope, together with the …easured zero pressure transit time, enables one to …mpute the quantity $(nT_0)^{-1}dT_n/dR_g$, where T_0 is the …ro pressure transit time, n is the number of the echo …der observation, T_n is the observed time of arrival … the nth echo and R_g is the pressure gauge coil re…tance. Since one can express the pressure gauge coil …libration as $dP=KdR_g$, and $T_n(P)=nT(P)$, the …antity $k^{-1}(nT_0)^{-1}dT_n/dR_g$ represents the fractional …ange of transit time with pressure, $(T_0)^{-1}dT/dP$.

A sequence of observations made with increasing …essure or with decreasing pressure will be called a run. …ts of runs made with a given transducer cemented in …ace will be called an experiment. Each value of $(T_0)^{-1}dT/dP$ which has been used is the result of at …st two experiments each of which consisted of at …st two runs. In the case of copper this procedure was …lowed for each of three crystals.

For crystals of nearly [110] orientation the equations …ating transit times to elastic constants are given by

$$\begin{aligned} Y_2&=B_s+4(\tfrac{1}{3}-\Gamma)C'+4\Gamma C,\\ Y_4&=C+2a_1(C'-C),\\ Y_5&=C+2a_2(C'-C), \end{aligned}\tag{1}$$

…here

$$Y_2=\rho V_2^2=4\rho L^2/T_2^2,\quad Y_4=\rho V_4^2=4\rho L^2/T_4^2,\quad Y_5=\rho V_5^2=4\rho L^2/T_5^2,\tag{2}$$

T_2 is the transit time for the longitudinal wave, and T_4 …d T_5 refer to the slow and fast shear wave transit …mes, respectively. L is the length of the specimen …etween acoustic faces and ρ is the density of the …aterial under study. The notation, $C=C_{44}$, $C'=(C_{11}-C_{12})/2$ and $B_s=(C_{11}+2C_{12})/3$, has been used. B_s denotes the adiabatic bulk modulus. The quantities …, a_1 and a_2 are orientation functions[14] which are …dependent of pressure for cubic materials. For ori…ntations near [110], a_1 is about 0.5 and a_2 is nearly …ro. For exactly [110] orientation one could write: $Y_4=C'$, $Y_5=C$. That is, C' is determined by Y_4 only, …d C is found from Y_5 only. Taking the derivative …th respect to pressure, of each equation relating the Y's and the elastic constants, one obtains

$$\begin{aligned} \frac{dY_2}{dP}&=\frac{dB_s}{dP}+4(\tfrac{1}{3}-\Gamma)\frac{dC'}{dP}+4\Gamma\frac{dC}{dP},\\ \frac{dY_4}{dP}&=\frac{dC}{dP}+2a_1\left(\frac{dC'}{dP}-\frac{dC}{dP}\right),\\ \frac{dY_5}{dP}&=\frac{dC}{dP}+2a_2\left(\frac{dC'}{dP}-\frac{dC}{dP}\right). \end{aligned}\tag{3}$$

Taking the pressure derivative of the logarithm of any one of the equations relating the Y's to the transit times, one obtains the relation

$$\frac{1}{Y}\frac{dY}{dP}=\frac{1}{\rho}\frac{d\rho}{dP}+\frac{2}{L}\frac{dL}{dP}-\frac{2}{T}\frac{dT}{dP}.\tag{4}$$

The first two terms on the right-hand side of the equation sum to $(3B_T)^{-1}$, where B_T is the isothermal bulk modulus, and the third term is the result of the measurements on changes of transit time with pressure, that is,

$$\frac{1}{Y}\frac{dY}{dP}=\frac{1}{3B_T}-\frac{2}{T}\frac{dT}{dP},\tag{5}$$

with all quantities to be evaluated at zero pressure. Given the zero pressure values of all the Y's and data on pressure variation of the transit times of the three waves, one can use the Eqs. (3) to compute the pressure derivatives of C, C', and B_s at zero pressure. These equations determine the pressure derivatives of C and C' quite directly in the case of a [110] orientation, but the pressure derivative of B_s is derived from a combination of all three measurements.

The acoustic surface of each crystal was etched and a back reflection Laue x-ray taken after all acoustic measurements had been made. Ten spots were indexed and a least squares determination of the orientation was made.

The entire procedure outlined above was carried out for one crystal of each of silver and gold, and for two copper crystals of different lengths but similar orientation. Two copper crystals were used in order to form an estimate of the importance of any end effects such as nonhydrostatic stresses on the end of the specimen caused by differential compressibility of the quartz transducer and the metal, and possible change with pressure of acoustic end effects. The end effects proved to be less than the random experimental variations for copper, so that we felt reasonably safe in making measurements on one crystal only of each of silver and gold. These crystals just referred to were all within 2° of the [110] orientation. In addition, measurements were made on the pressure variation of the longitudinal wave transit time using a third copper crystal, near the [100] orientation.