yield approximately, and to within an additive factor of 2π,

$$\phi_t = 2\pi \frac{Z_t}{Z_s} \left(\frac{f}{f_r} - \frac{f}{f_{ro}}\right) \tag{10}$$

where f_{ro} is the value of f_r at zero pressure. Differentiating (10), and evaluating the result at zero pressure gives

$$\frac{\partial\phi_t}{\partial P} = -2\pi \frac{Z_t}{Z_s} \frac{f}{f_{ro}} \frac{\partial \ln f_r}{\partial P} \tag{11}$$

(Although Z_t and Z_s vary with pressure, they produce only a second-order effect.) A convenient expression can be derived for the corresponding correction to the derivative of the appropriate combination of elastic moduli, $M = \rho v^2$. The desired phase derivative is

$$\frac{\partial\phi_s}{\partial P} = \frac{\partial\phi_m}{\partial P} - \frac{\partial\phi_t}{\partial P} \tag{12}$$

where ϕ_m is the measured phase. The sample phase is $\phi_s = 4\pi fL/v$, so that

$$\frac{1}{\phi_s} \frac{\partial\phi_s}{\partial P} = -\frac{1}{2K} \left[\frac{K}{M} \frac{\partial M}{\partial P} - (1 - 2K\beta)\right] \tag{13}$$

where $\beta = -\partial \ln L/\partial P$ is the linear compressibility of the sample. The correction is, using (12),

$$\left[\frac{\partial M}{\partial P}\right]_{\text{corr.}} = -\frac{M_v}{2\pi fL} \left(\frac{\partial\phi_t}{\partial P}\right). \tag{14}$$

Now combining (14) with (11)

$$\left[\frac{\partial M}{\partial P}\right]_{\text{corr.}} = \frac{v^2}{L} \left(\frac{Z_t}{f_r} \frac{\partial \ln f_r}{\partial P}\right). \tag{15}$$

Thus, apart from the transducer properties, the correction to $\partial M/\partial P$ depends only on the sample velocity and length. Some representative values are given in Table 4, for quartz transducers on MgF_2 and spinel. The corrections to the pressure derivatives of the moduli are of the order of 0.1 for compressional waves and -0.05 for shear waves.

TABLE 4. Representative Corrections to Pressure Derivatives of Elastic Moduli Due to Transducer Phase Shifts

Mode	v,km/s	L,mm	f_r, Mhz	$(\frac{\partial M}{\partial P})_{corr.}$	$\frac{\partial M}{\partial P}$
MgF_2[a]					
[001]P	8.01	10.80	20	.069	5.66
[110]P	8.15	10.80	10	.141	8.43
[001]S	4.22	9.64	20	-.035	0.79
[110]S[c]	2.82	10.80	20	-.014	-0.68
$MgAl_2O_4$[b]					
[001]P	8.88	10[d]	20	.091	5.15
[110]P	10.22	10	20	.120	5.85
[001]S	6.57	10	20	-.082	0.89
[110]S[c]	4.23	10	20	-.034	0.19

a. *Davies* [in preparation].

b. *Chang and Barsch* [1973].

c. Polarization [1$\bar{1}$0].

d. Assume lengths for spinel.

Note that this difference in sign (arising from the opposite signs of the derivatives of the relevant quartz transducer frequencies [Table 3]). causes the corrections for some derived moduli to be compounded. This is most easily seen for an isometric material. If C_s denotes the modulus for a shear wave in the [110] direction, polarized in the [1$\bar{1}$0] direction, then the bulk modulus is $K = C_{11} - 4C_s/3$, and $C_{12} = C_{11} - 2C_s$. The effect is illustrated in Table 5 for spinel (isometric) and MgF_2 (tetragonal).