ary. In general, there was some hysteresis between points determined with increasing and decreasing load (Figure 5*b*), but the point of maximum compliance was not affected by rate of increase of stress within the range used (0.004 to 0.020 kb/sec). Table 1 shows how the magnitude of the observed compliance varied through the transition for different orientations of specimen.

The transition point given by the compliance maximum is essentially the same as that revealed by a differential temperature peak determined analogously to the usual DTA method. This was shown in a few runs with hollow samples (595, 596, and 601, Table 2), in which the difference in emf of a pair of 0.05-cm thermocouples—one 0.5 cm inside the sample and the other 1 cm above in the piston—was monitored. In 49 out of 54 times that the phase boundary was crossed, a peak of 0.5° to 1.5°C occurred at or just after the maximum in compliance, and the sign of the anomalous temperature difference was in every case consistent with the direction of crossing. (The sample cooled with respect to its immediate surroundings when going from α to β and heated when going from β to α.) The position of the peak was influenced by the rate of increase of stress: at the slowest rates it coincided with the compliance maximum, whereas at the fastest rate it lagged slightly behind.

The experimental difficulties were mainly associated with temperature variations in the specimen. If the temperature gradient along the specimen exceeded 1°C/cm, the transition became too smeared out to be reliably detected. The gradient was controlled by proportioning the current in the furnace between an upper and a lower winding, more current being required in the lower one in order to counteract the effects of intense vertical convection in the compressed argon along the furnace axis. In hollow samples the temperature gradient was observed directly, whereas in solid samples it was controlled by appropriately adjusting the gradient in the hollow piston immediately above. The temperature changed with time, sometimes erratically, but as long as the drift was less than 1°C/min the gradients in the sample remained negligible, the transition was sharp, and useful measurements could be made.

The transition did not appear to be significantly smeared by nonuniformities of stress in the specimen. This will be discussed more fully later.

Experimental Results

When the temperatures of transition at several values of uniaxial stress σ and constant hydrostatic pressure P are plotted versus stress for a given sample, the points fall remarkably close to a straight line. Figure 6 shows two such straight lines obtained in two runs on samples of different orientations at 3-kb confining pressure. Several interesting features are well illustrated: (1) the slope of the transition is quite different for the two orientations; (2) there is no identifiable curvature (less than 0.05°C/kb^2 for $0 < \sigma < 10$ kb) in either line; (3)

TABLE 1. Experimental Estimates of the Compliance of Quartz for Pressures between 1 kb and 5 kb

	Compliance, units $(10^6 \times \text{bars})^{-1}$		
Orientation	α Field	β Field	Transition Point
$\perp C$ (along x_2)	1.7±0.2	0.8±0.2	7.5±3.0
$\parallel C$ (along x_3)	1.2±0.2	1.0±0.2	3.0±1.0
o (45° to x_3)	1.2±0.2	0.7±0.1	3.3±0.5
r' (43° to x_3)	1.8±0.1	1.0±0.1	4.0±1.0

Notes.

Uncertainties listed are standard deviations, assuming the value used for apparatus distortion is correct, and thus represent the precision of the measurements. An additional uncertainty of $\pm 0.25 \times 10^{-6}$ bars^{-1} arises from uncertainty of apparatus distortion.

α and β field compliances are averages for the region outside the obvious transition (0.5 − 1.0 kb uniaxial stress away from the point of maximum compliance) region.

The transition point compliance is the 'average maximum' compliance measured in the transition region and must be regarded as intermediate between isothermal and adiabatic.

Compliances for orientations $\perp C$, $\parallel C$, and o are for both solid and hollow specimens; r' for solid only.

Data are roughly in accord with dynamically measured compliances at atmospheric pressure. Greatest inconsistency is that all values calculated for o and r' orientations are considerably greater than those in Table 1. Also the values for o and r' (and all other orientations ~45° to x_3) should be equal in the β field because of the hexagonal symmetry [*Nye*, 1957] but are obviously not in Table 1.

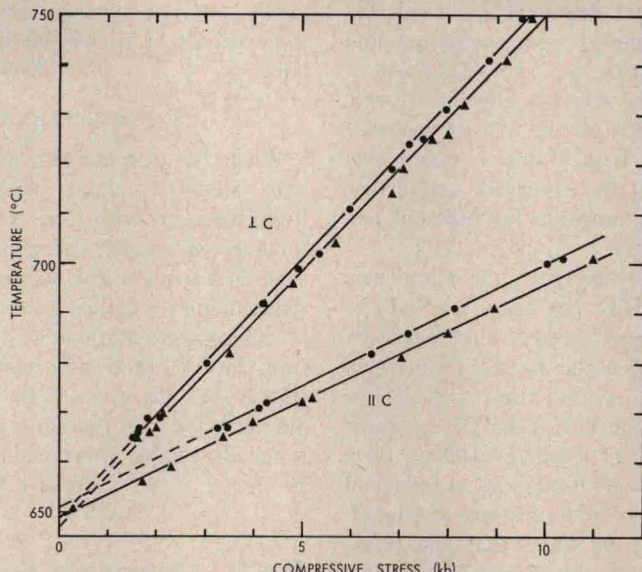

Fig. 6. Temperature of the α-β transition at a constant confining pressure of 3 kb as a function of compressive stress $\perp C$ (run 602) and $||C$ (run 603). The transition $\beta \rightarrow \alpha$ (increasing stress) is denoted by triangles, whereas $\alpha \rightarrow \beta$ (decreasing stress) is denoted by circles. See Table 2 for least-squares values of slope and intercept for these runs.

extrapolation of the lines to zero compressive stress yields essentially the same temperature intercept; (4) there is hysteresis in the transition even at zero compressive stress; and (5) the slope of the line determined from transitions from the β to the α phase, $(\partial T/\partial\sigma)_{\beta\rightarrow\alpha}$, is slightly less than $(\partial T/\partial\sigma)_{\alpha\rightarrow\beta}$.

All the pertinent experimental data are collected in Table 2, including those graphically presented in Figure 6. The slopes, intercepts, and the standard deviations of both are those for the best-fitting straight line according to the method of least squares. (These single-regression standard deviations are not statistically rigorous because errors may occur in both $T_{\alpha\text{-}\beta}$ and $\sigma_{\alpha\text{-}\beta}$, but they are useful indicators of relative scatter.)

Several points of interest in interpreting the results emerge from Table 2:

1. Solid and hollow samples behave the same under comparable conditions, as shown by runs 602 and 601, 607 and 606, and 603 and 595–596. There may be a slightly greater slope of the α-β boundary for hollow samples, but the scatter makes the reality of this distinction questionable.

2. A slight dependence of $\partial T_{\alpha\text{-}\beta}/\partial\sigma$ on pressure is observed for the $\perp C$ orientation—about +0.2°C/kb per kilobar of hydrostatic pressure in the range 1 to 5 kb. There are not enough data to be sure if this is a real variation, and the case for other orientations is even more doubtful.

3. From an analysis of the standard deviations there is a suggestion that $(\partial T/\partial\sigma)_{\alpha\rightarrow\beta}$ is slightly greater than $(\partial T/\partial\sigma)_{\beta\rightarrow\alpha}$ in the same experimental run by 0.25 ± 0.25°C/kb. A regular dependence of this difference on pressure or specimen orientation is not evident. (Therefore, in calculating the mean slope in Table 2 for those few runs in which only $(\partial T/\partial\sigma)_{\beta\rightarrow\alpha}$ was determined, 0.12 ± 0.25°C/kb was added to this measured value.) It is also observed that the standard deviation of the mean slope of a line is generally significantly less than the scatter of slopes among different experimental runs under ostensibly the same conditions. Both these details of the results may be caused by additional variable components of stress, which could arise either from the difference in lateral changes of dimension between the quartz and the adjacent carbide endpieces or even possibly from differences in the development of Dau-