action between the second and third factors since the shearing forces at the wall will perturb the stress distribution from what was considered under (b). Also, some relaxation of the stresses can be expected over long periods. Nevertheless, the results probably have some value in suggesting the relative importance of the above factors, that is, roughly equal contribution from stress gradients in the medium and from shearing at the wall, neither being strongly sensitive to pressure, while the piston friction is probably more nearly proportional to pressure and only predominant if the pressure media are much weaker than talc.

So far, we have only considered the case where the piston is advancing. If the final pressure is approached from above, it appears to be more difficult to relate the nominal pressure to the pressure at the specimen. The stress distribution in the medium can no longer be calculated from the theory of plasticity since the final approach to the working conditions will largely involve elastic changes and so the stress distribution will be sensitive to the elastic properties of the various materials in the pressure cell as well as of the cylinder. The situation will certainly not be the reverse of that of approach from below and so in neither case can the correction be obtained as half the difference in nominal pressures for a given transition determined by approach from either direction. The same remarks apply to a large extent to the effect of shearing at the wall. Even the piston friction probably cannot be obtained by reversal because our experience with fluid medium apparatus indicates that a considerable amount of movement, perhaps several tenths of a millimeter and in excess of the elastic range of the solid pressure medium, is needed before the friction settles down to its normal value.

3. Non-Hydrostatic Conditions

The presence of shear stresses in the medium implies a non-hydrostatic state of stress in the sample. This has been investigated experimentally by Lees and McCartney (1968) in a tetrahedral anvil type of apparatus. The magnitude of shear stress in the sample will be limited by its strength or by the strength of the immediately surrounding medium, whichever is the weaker, and when the temperature is high and duration of experiment long it will often be small compared with the hydrostatic component of the stress. On the other hand, it may sometimes be important to bear in mind that the specimen will have undergone some deformation in the course of reaching the operating conditions.

4. Effects in Stress-Strain Apparatus

Griggs (1967) has introduced the use of solid pressure media in apparatus for rock deformation. The confining pressure is generated in the same way as above and the differential load for the deformation of the specimen is produced by introducing an additional small piston concentrically with the confining pressure piston. To allow for friction the force needed to advance the differential load piston prior to contact with the specimen is recorded and increase in force beyond this is taken to be differential load applied to the specimen. However, during axial shortening of the specimen, pressure medium must be displaced radially. To achieve this, the radial component of stress in the medium immediately surrounding the specimen must be augmented to such an extent as to reverse the stress gradients initially set up in the pressure medium during advance of the confining pressure piston; that is, during the deformation the confining pressure effective at the specimen will rise above the indicated confining pressure and the differential stress effective at the specimen will be less than that indicated above by an amount of the order of $4\sigma_0$ (instead of the confining pressure being about $2\sigma_0$ below the nominal confining pressure due to the combination of factors discussed above (2.), it will have risen to $2\sigma_0$ above). In the case of a talc medium at moderate temperatures and at pressures of the order of 20 kb, this therefore suggests an additional correction to the differential stress which will rise to a value of the order of 4 kb in the course of straining the specimen.

This estimate of the additional correction to the differential load for stress gradients in the medium and shearing at the wall is clearly a very rough one. Apart from the approximations involved in the plastic model, the assumed geometry and the extrapolated material properties, it will also be sensitive to experimental procedure. If the confining pressure is raised in such a way that the final increment is achieved by heating rather than by advance of the confining pressure piston, or if the nominal confining pressure is approached from above, the reversal of stress gradients considered above may already have occurred, at least to some extent, and so this correction will have been eliminated or reduced in amount. The influence of whether or not the graphite supports similar shear stresses as the talc and of the relative diameters of specimen region and cylinder bore should be determined by the geometrical factors discussed above under 2.

Carter, Christie and Griggs (1964) have noted extension fractures in quartz specimens after deformation in a solid medium apparatus which they attribute to stresses from expansion of the graphite furnace during pressure release. This explanation is supported by the present observation of unusually large strain recovery in graphite during pressure release.

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Appendix: Approximate Calculation of Nominal Pressure Correction in Piston-Cylinder Apparatus due to Stress Gradients in the Medium

We consider the simple model shown in Fig. 11 in which all correction factors other than the strength of the pressure medium are neglected and the pressure medium itself is assumed to fill uniformly all space outside the sample region and to have the properties of a homogeneous perfectly plastic material. In particular, we consider the part AB which is, in effect, a hollow cylinder that we assume to be undergoing uniform shortening axially, that is, to be undergoing generalized plane strain. Thus the boundary conditions are uniform relative displacement of the ends A and B, zero radial displacement at the outside diameter (pressure vessel assumed rigid), and radial stress component equal to pressure p at the inside diameter (note that we are not considering any effect from wall friction at the outside diameter in this calculation; see above).

A substantial amount of strain is supposed to have occurred throughout the medium while raising pressure because of the elimination of misfits and porosity