stress–strain curves. The unusual order of the compression stress–strain curves at low strains and the cross-over with increasing strain has been observed previously in this rock, as has also the relatively high level of the extension curve at low strains [11]; these effects will be discussed later in relation to the volume changes. The extension tests were terminated at about 13 per cent strain because of the onset of necking.

The most notable aspect of the volume change results in compression [Fig. 3(c)] is the change from dilatational behaviour at low pressures to compaction during straining at high pressures, similar to that observed by SCHOLZ [3] in marble up to about 2 per cent strain. The initial stage of slight volume decrease in compression at low pressures and the corresponding increase in extension is presumably largely an elastic effect. The dotted curve in Fig. 3(c) represents, as a typical case, the calculated elastic volume change during the straining at 2 kb confining pressure (the choice of elastic parameter is dealt with in the discussion). It is seen that in general the observed volume changes are large compared with elastic volume changes and must be attributed mainly to changes in porosity. Interpolation suggests that, in compression, deformation at approximately constant volume should take place at about 2·5 kb confining pressure and this has been verified experimentally. It was also noticed that barrelling was pronounced in specimens deformed below 2·5 kb whereas at higher pressures the specimens remained nearly cylindrical during deformation except in the immediate vicinity of the ends.

The complete histories of the volume changes are represented in Fig. 3(d), including those occurring during the application and removal of the confining pressures (see comment above on accuracy); the slightly separated vertical lines represent the changes occurring during the stress–strain test at constant confining pressure [Fig. 3(c)]. For comparison, the calculated elastic changes for pore-free polycrystalline calcite (based on the compressibility of single crystals) are indicated by the dotted line. It is seen that:

1. Even at 8 kb, much of the initial porosity remains after application of the confining pressure. Straining while under the higher pressures was much more effective in eliminating porosity. However, only at 8 kb was the initial porosity almost completely eliminated by the 20 per cent straining in compression.
2. Relatively large increases in volume occurred during pressure release. The rate of increase of volume increased markedly at the lower pressures and the total amount was greater the higher the pressure at which the deformation was done. In all cases, the final volume and porosity was greater than for the virgin material, the difference being more marked when the pressure applied was lower.
3. The volume changes during pressure release after the extension tests at 6·5 kb confining pressure were notably less than those observed after compression tests.

Carrara marble

The stress–strain and volume change–strain curves are given in Figs 4(a) and 4(c) and the volume change–confining pressure curves for the whole experimental sequence are given in Fig. 4(d). While the behaviour is in many respects similar to that of the lithographic limestone, the following differences are to be noted:

1. The brittle–ductile transition pressure is lower, between 0·5 and 1 kb.
2. The stress–strain curves are generally lower, with no crossing over, and the effect of pressure between 6 and 8 kb is less.
3. The tendency for volume to increase during straining persists to higher pressures, presumably because of the lesser role played by elimination of the much smaller

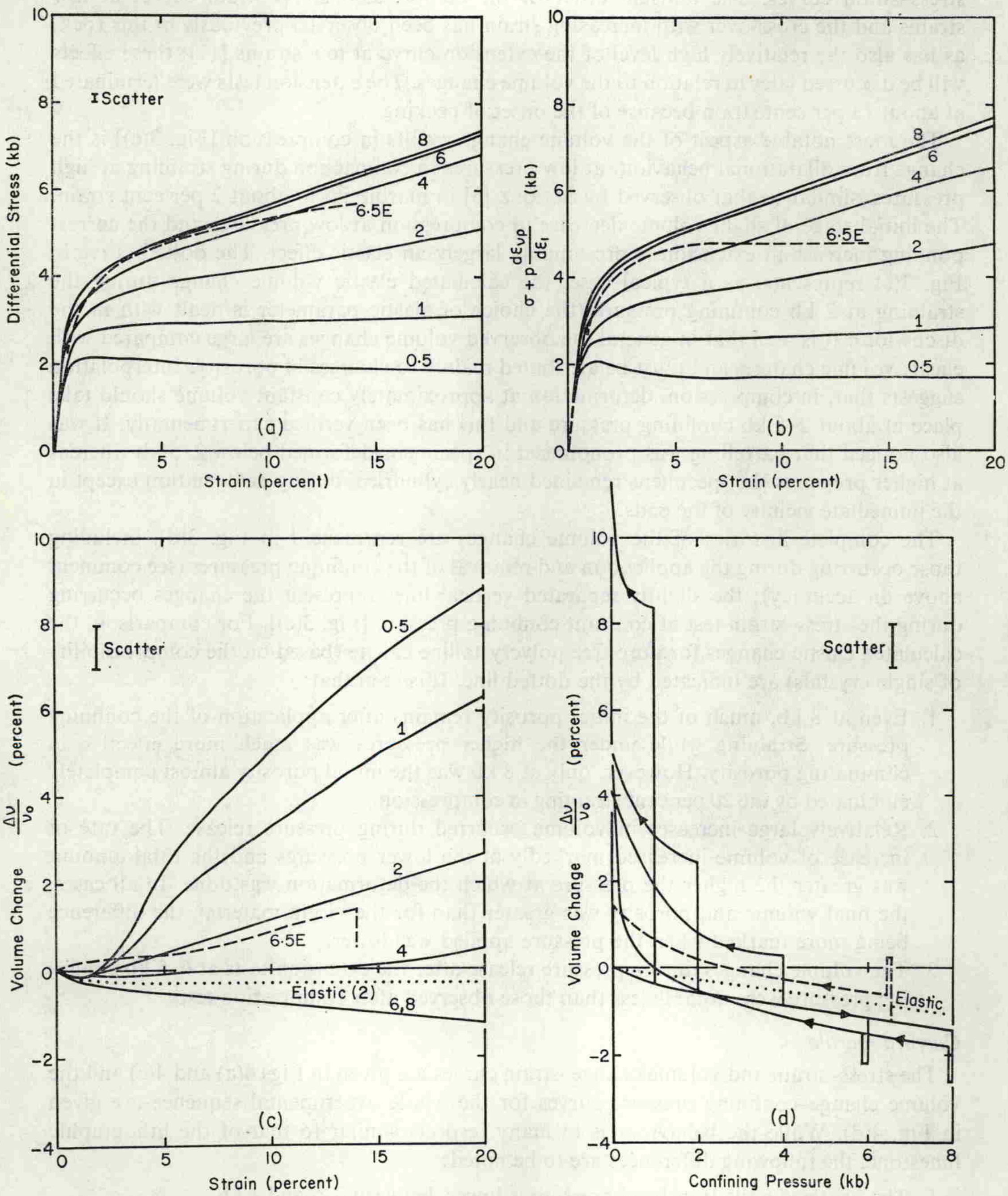

FIG. 4. Results for Carrara marble (cf. caption to Fig. 3).