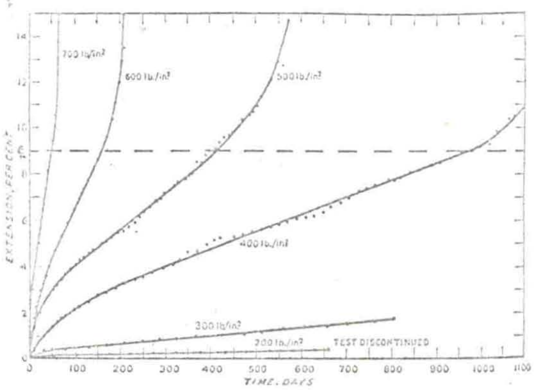

FIG. 4. Tensile creep tests on coarse-grained lead rods at room temperature. By suitable changes in coordinates this diagram can be made to express, to a fair approximation, the compressive creep tests of alabaster in water.

about the same longitudinal contraction ϵ_m provided none of the material has precipitated elsewhere. At this point the specimen has stabilized itself and from this point on should therefore behave more or less as a unit, i.e., approximate to the condition for a single crystal. Solution (or migration) then begins to work along crystallographic surfaces and will be most effective on surfaces across which the cohesive bonds are smallest, i.e., have the largest ζ, in the general 45° trend to the stress axis. If the load is large enough the specimen will then deform by a gliding action along 45° planes and the creep rate, measured by the rate of contraction, will appear to accelerate until the specimen "fails." This is graphically illustrated in Fig. 4.[15]

Plastic flow may also occur in single crystals but the effect in general is a gliding along cleavage, twinning, or parting planes from combined "melting" and snapping of bonds. Localized high stress regions may be set up in crystals, as was mentioned earlier, and thus an initially single crystal may, under a compressive load, finally become a mosaic of reoriented crystalline grains.

The energy at the external crystal faces cannot be denoted by the energy of the interior because of loss of symmetry at these external faces; the difference is known as surface tension. For ionic crystals this difference will be greatest along edges and at corners and least at the centers of faces; this is the reason for the initial skeleton growth of such crystals. With a high symmetry type of structure this difference might become greatest at re-entrants. For our system solution or melting will be most rapid at the stressed surfaces of highest ζ and growth by crystallization most rapid on the free faces of lowest ζ. These directions are, in general, indicated by the crystalline form and cleavage. For example, mica and related minerals will tend to grow with two crystal axes (cleavage planes) perpendicular to the axis of compressive load, asbestos and related minerals to elongate (one crystal axis) in the plane perpendicular to the stress. The best examples we have are the metamorphic rocks which have recrystallized according to this mechanism under high confining pressure (see below).

[15] Data taken from J. McKeown, J. Inst. Metals 60, 207 (1937).

ELASTIC AFTERWORKING

There is a type of deformation which on loading is a contraction and on unloading a recovery by extension, according to the expression

$$\dot{\epsilon} = \epsilon_1 B/(t+\tau),$$

where $\dot{\epsilon}$ denotes the strain rate, ϵ_1 the purely elastic portion of the strain, B a constant, t the time and τ a time constant. This type of recovery, after unloading, is called "elastic afterworking" and has been observed in glass fibers, in steels, and in rocks.

This is the kind of deformation to be expected from materials which are relatively strong elastically. For these materials the strain is mainly an elastic one but, for a long continued application of a moderate load, a small amount of migration of lattice points will take place if the load is left on long enough. On release of load the material tends to recover elastically, i.e., instantaneously, but it cannot recover completely because under load lattice elements have migrated and then solidified in conformity with the equilibrium conditions existing while under load. These therefore formed bonds tying in this equilibrium state so that when load is released an opposing stress distribution is consequently initiated and the initial equilibrium conditions are attained only by a backward migration of these same elements in retracing their paths.