$$M(\alpha)L^{-m} = M(L, \alpha) \quad (43)$$

Substituting equation 43 in equation 39 gave equation 44,

$$de/dt_f = [2/(n - 2)E]L_0^{(n-2m)/2}M(\alpha)v \quad (44)$$

Since $L_0 = (t_f/E)^{-[2/(n-2)]}$ from equation 35, equation 44 can be written

$$de/dt_f = [2/(n - 2)] \cdot E^{-2(m-1)/(n-2)} t^{-(n-2m)/(n-2)} \cdot M(\alpha)v \quad (45)$$

$$de/dt_f = \{[B \exp(-A/KT)]^{(2m-2)} \cdot [2/(n - 2)t]^{n-2m} L_{cr}^{-n(m-1)}\}^{1/(n-2)} M(\alpha)v \quad (46)$$

From equation 32,

$$S_{cr} = S_y \cdot 2(L_{cr}/r)^{1/2}(\sin^2 \alpha - \sin \alpha) \quad (47)$$

using Charles's terminology for cracks inclined at y to the principal compressive-stress S_y. Substituting equation 47 into equation 46 gives equation 48

$$de/dt_f = \{[B \exp(-A/KT)]^{(2m-2)}[2/(n - 2)t]^{n-2m} \cdot [S_y(\sin^2 \alpha - \sin \alpha)/S_{cr} \cdot r^{1/2}]^{2n(m-1)}\}^{1/(n-2)} M(y)v \quad (48)$$

temperature are analyzed by the structural theory.

Equation 48 can be written

$$de/dt = KS_y^{2n(m-1)/(n-2)} t^{-(n-2m)/(n-2)}$$

where K is a constant, or as

$$de/dt = b_1 t^{b_2} \quad (49)$$

where $b_1 = KS_y^{2n(m-1)/(n-2)}$, $b_2 = -(n - 2m)/(n - 2)$. Then b_1 is the strain rate at unit time, and b_2 is a strain-hardening parameter measuring the rate of decrease of the strain rate with time.

Notice that in the trivial case where m is exactly one, b_2 is minus one; this leads to a logarithmic creep law [*Scholz*, 1968]. Another consequence is that the creep rate is independent of the stress. Equation 48 also shows that, when m is close to minus one, small changes in m will cause large changes in the stress dependence of the creep rate; the time dependence is, however, much less sensitive. This emphasizes the special nature of the logarithmic creep law, $(de/dt) = b_1 t^{-1}$, which is transitional between creep laws of the form

$$e_t - e_0 = [b_1/(b_2 + 1)]t^{b_2+1} \qquad b_2 > -1$$

where there is no limit to the amount of transient creep with time, and the form

$$e_t - e_1 = [-b_1/(b_2 + 1)](1 - t^{b_2+1}) \qquad b_2 < -1$$

where creep tends to a finite limit with time. e_0, e_1 are the creep strains at zero and one time unit.

Changes in the value of m with stress are not implausible in the structural theory, but they lead to complications. As two experiments at different stresses are required to calculate a value of m, and at least three are required to test the power-law dependence of strain rate on stress, n and m cannot be determined if m changes rapidly with stress.

If the strain-hardening parameter b_2 is constant over a range of stresses, n and m can be

The creep rate of the whole specimen is the sum of the values of equation 48 over all the appropriate values of α. Equations 32 and 47 are inaccurate when α is near zero or ninety degrees. Cracks at very high or very low angles to the compressive stress will make only a small contribution to the total strain since the tensile stresses at their tips are comparatively small. There is, then, probably no serious error in evaluating the sum only between the limits of, say, eighty-five and five degrees and equation 48 is exact when all the cracks lie within one plane.

It is not possible to predict the value of the creep rate from equation 48 because there are considerable uncertainties in the values of A, B, v, and $M(\alpha)$. However, as equation 48 predicts the time, temperature, and stress dependence of transient-creep rate in the specimen, the theory can still be tested.

The Analysis of Some New Creep Experiments

In what follows, some new creep experiments on rock under uniaxial compression at room