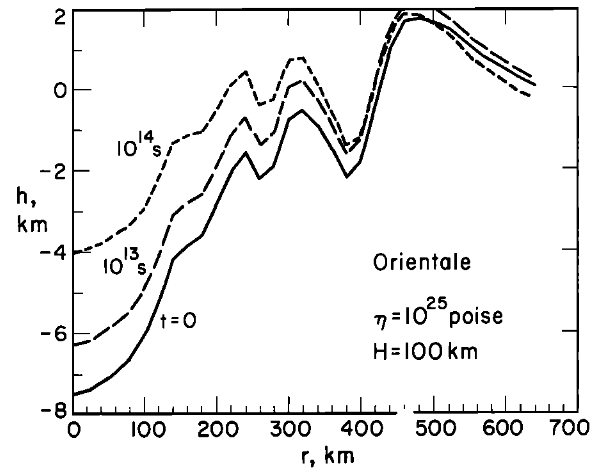

Fig. 6. Viscous relaxation of Orientale basin topography for a 100-km-thick layer of viscosity $\eta = 10^{25}$ P over an inviscid half space. Profile times and their scaling with η are as in Figure 5.

1974; *Koyama and Nakamura,* 1979]. The time constant τ_2 behaves similarly to the time constant (equation (6)) for the case of the viscous layer overlying an inviscid half space of the same density: $\tau_2 \sim k^4$ for small k and is equal to the time constant $\tau_0 \sim k$ for the half-space case at large k. The time constant τ_1, however, is considerably larger than τ_0 at all wave numbers, particularly at small k. As $k \to 0$, τ_1 approaches a constant (equation (A33)), a function of ρ, $\Delta\rho$ and H but not of k. At large k, τ_1 is proportional to k and exceeds the half-space time constant by the factor $\rho/\Delta\rho$.

Thus partial to complete isostatic compensation of initial basin topography results in a considerable deceleration of viscous relaxation of relief, compared to models without isostatic effects, for a fraction of the initial relief that depends on the degree of compensation. As shown in equation (A35), the fraction F_1 of F that decays with the time constant τ_1 approaches unity in the long-wavelength limit for complete initial compensation ($c = 1$). Further, for any value of c, the topographic relief decaying with time constant τ_1 is always completely compensated for small k; i.e., the long-wavelength basin topography is isostatic for $t \gg \tau_2$ no matter what the initial degree of compensation.

These conclusions are illustrated in Figures 8 and 9. The case with complete initial compensation ($c = 1$) is shown in Figure 8. Relaxation of relief is much slower than in Figures 2, 5, or 6, with substantial long-wavelength relief (4 km) remaining after 3 b.y. (10^{17} s) for a layer viscosity of 10^{25} P. Note that in comparison to Figures 2 or 5, the topography in the relaxed profiles is 'smoother.' This is because of the comparatively weak dependence of τ_1 on k (see Figure 7) over the wave numbers of interest; i.e., the rate of relaxation at long wavelengths is greater, compared to the short wavelengths, than for the simple half-space model or for the model with no density contrast at the base of the viscous layer.

The case with initial topography only half compensated by Airy isostasy ($c = 0.5$) is shown in Figure 9. There is a rapid partial relaxation of initial relief (governed by time constant τ_2), followed by a much slower relaxation of the remainder. The total relief at 3 b.y. (for $\eta = 10^{25}$ P) is about 2 km, or half that in Figure 8 at the same time. The case with initially uncompensated topography, but with a density contrast at the base of the layer, behaves similarly to that in Figure 5 except for a small fraction ($\Delta\rho/\rho_m$) of the long-wavelength topographic relief that relaxes at the longer time constant τ_1.

The assumptions necessary to derive (8) and (9) and the models shown in Figures 8 and 9 include, from equations (A15) and (A22) and by analogy to relations (7),

$$k|F| \ll 1$$
$$k|G| \ll 1 \qquad (10)$$
$$\left| kF + \frac{\Delta\rho}{\rho} kG \right| \ll (kH)^3/3$$

where $G(k)$ is the Hankel transform of the profile of topographic relief at the base of the layer (see the appendix). Strictly, F and G are the coefficients of $J_0(kr)$ in the summation representation of (8) and in the analogous expression for relief at the bottom of the viscous layer. The first two inequalities hold for the Orientale profile for all k and all t. The third inequality in (10) holds for a greater range of cases than does the analogous inequality in (7) because G

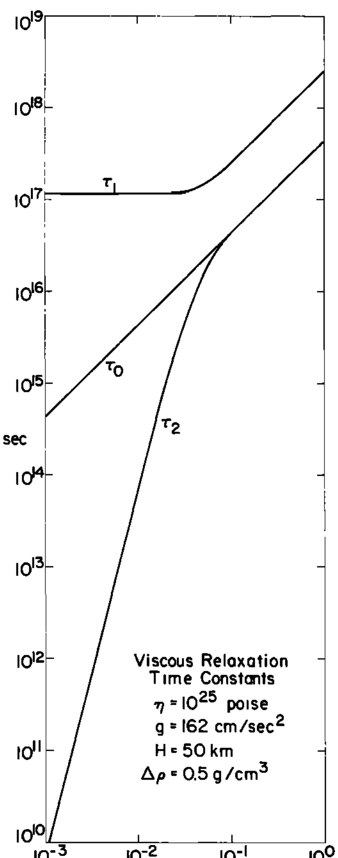

Fig. 7. Time constants τ_1 and τ_2 versus horizontal wave number k for the problem of relaxation of topography on a viscous layer overlying an inviscid half space of greater density, both in a uniform gravitational field. The layer has viscosity $\eta = 10^{25}$ P, density $\rho = 2.9$ g/cm^3, and thickness $H = 50$ km; the half space has density $\rho + \Delta\rho = 3.4$ g/cm^3; the gravitational acceleration is 162 cm/s^2. Also shown is the time constant $\tau_0(k)$ for the case of a half space of uniform viscosity η and density ρ. All time constants are proportional to η and inversely proportional to g; the long-wavelength limit of τ_1 is inversely proportional to H.