**ABSTRACT.**—It is seen that the maximum shear stress generated by the short wavelengths of the topographic load is relevant only in the uppermost part of the crust and that a feature with wavelength $w < 10$ km and load $r_w$ causes a maximum shear stress with upper limit $r_w/2$ at a depth smaller than $w$. It is also seen that in the Apennines the amplitude of the Fourier components of the topographic features of wavelength $w$ is proportional to $w^{3.5}$. Assuming for the mantle and the crust rheological properties similar to those found in the laboratory for many glassy materials and represented by stress strain relations containing derivatives of fractional order, it is seen that the creep and relaxation in a sphere are wavenumber dependent. At the same time after the formation of a mountain range a feature identified with a long wave has creep more than one identified with a short wave, in contrast with the finding that at present the topographic features with shorter wavelength have smaller Fourier amplitude than those with large wavelength. Therefore we see that the topographic load causes in the mantle a stress mostly due to the long waves while in the crust it is due to all the wavelengths; the stress due to the long waves and transmitted to the mantle is governed by its rheology and, because of the faster creep, is isostatically supported, that due to the short waves is supported elastically and governed by the rheology of the crust. 2 Myr after the formation, a topographic feature with a base of few kilometers is reduced to 82% and causes a creep of the upper crust of $3.7 \times 10^{-3}$ cm/yr, in the mantle the same feature would cause a creep rate of 0.21 cm/yr and reduce its height to 20% in only $7 \times 10^4$ yr. It is also seen that the time to reduce to one half the creep of a glacial period is approximately equal to twice the duration of the glaciation.

**INTRODUCTION**

The information presently available on the rheology of the Earth’s interior is very scarce and unreliable according to the discussion made by Köning and Müller (1989) who

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suggest that a probable model for the rheology of the mantle is that represented by stress strain relations containing derivatives of fractional order.

Laboratory data on the rheological properties of materials have been recently analyzed by Bagley and Torvik (1983a, b, 1986) who showed that many materials which have similarity with rocks have rheological properties described by the stress-strain relations of the type

\[
\tau + b \frac{\partial^{\gamma} \tau}{\partial t^{\gamma}} = E_0 + E_1 \frac{\partial^{\gamma} \varepsilon}{\partial t^{\gamma}}, \quad \frac{\partial^{\alpha} \varepsilon}{\partial t^{\alpha}} = \frac{1}{\Gamma(1-\alpha)} \int_0^t \frac{f'(\xi)}{(t-\xi)^\alpha} d\xi
\]

where \(\tau\) is the stress, \(\varepsilon\) is the strain and \(b = [s^{\gamma-1}], E_0 = [N/m^2], E_1 = [Ns^{\gamma-1}/m^2]\). \(z\) and \(z_1\) are real numbers in the range 0,1.

In fig. 1 we see one of the 143 cases discussed by Bagley and Torvik (1983a, b, 1986) and Bagley (1989, personal communication). In many cases as in that of fig. 1 it was found that \(z_1 = z\).

In this Note we shall study some effects which the new rheological models resulting from the laboratory would have when applied to the Earth studying its stress field and creep under the load of actual topographic features.

We shall use a spherical Earth model instead of a half space in order to establish constraints for the wavenumber, the radius of the Earth, the depth, the creep and the relaxation functions and to use the appropriate approximation at a given depth.

**The equations governing the creep and relaxation in 3D**

To this purpose we must extend to 3D the equation (1) assuming \(z_1 = z\). A general form of the stress strain relations with derivatives of fractional order may be