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Letters

Comments on Paper by R. F. Favreau, 'Generation of Strain Waves in Rock by an Explosion in a Spherical Cavity'

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Although *Favreau's* [1969] attempt to define more explicitly the phenomena of explosively generated elastic strain waves in rock utilizes equations and boundary conditions to define the behavior of a high-pressure gaseous-rock system, it has two primary faults that obviate the usefulness of calculated values for behavioral parameters in actual wave propagation. First, Favreau's model prescribes that the forcing function at the rock-explosive interface be applied to the surface of a cavity in an elastic material that must remain elastic and unfractured for all magnitudes of pressure applied. That is, neither the elastic limit of the material nor its strength may be exceeded if the elastic wave equation is to be applicable. Second, the residual strains obtained by Favreau are due to a continuous pressure in the cavity, whereas the residual strains obtained by *Atchison and Tournay* [1957] and others in field experiments were often caused by permanent deformation of the rock after explosive gases had escaped from the cavity.

Before considering the details of the above, it might be noted that the use of displacement potential simplifies the solution of the differential equations involved, particularly if transform calculus is employed. Expressions for displacement, stress, strain, etc. can be easily derived from the displacement potential. The mathematics of the model proposed by Favreau is more easily handled by transform calculus if a forcing function is chosen as

$$p(t) = P_0[1(t) - (3\gamma/a)u]$$

where a is the radius of cavity, γ is the heat capacity ratio, u is the displacement, $1(t)$ is a unit step function, and appropriate boundary conditions are defined.

Favreau's method requires a knowledge of the solution of the wave equation. Methods of transform calculus do not require a foreknowledge of the solution, and they constitute an elementary problem in evaluating a transform function by use of poles in the complex plane.

Experience has shown that in Favreau's model neither the forcing function nor the boundary conditions represent the conditions that exist when a confined explosive is detonated in rock in field experiments. Both model conditions assume that the rock immediately around the explosive behaves elastically. Favreau's assumed 80,000-μ strain in tension and 150,000-μ strain in compression sustained by the rock are at least two orders of magnitude greater than the elastic range to which the wave equation can be applied for most rocks. Hence, the elastic wave equation cannot be applied to the material (which does not behave in an elastic manner) immediately around the cavity. It was this fact that lead *Sharpe* [1942] to define a 'radius of equivalent cavity' at some distance into the rock away from the explosive, at which elastic behavior might be assumed. This distance, which would vary for each rock-explosive combination, has not been measured or approximated.

In the field experiments of *Atchison and Tournay* [1959] the detonation gases escaped from the cavity a very short time after the explosion took place. In Favreau's model they remain completely confined; this would cause a 'permanent' strain that would be released only if the gas pressure were to go to zero.