Bulletin of the Seismological Society of America, Vol. 93, No. 2, pp. 960–961, April 2003

Comments and Replies

Comment on "Analytical Model for Gravity and Rayleigh Wave Investigation in the Layered Ocean–Earth Structure," by T. Novikova, K.-L. Wen, and B.-S. Huang

by Tatiana B. Yanovskaya, Giuliano F. Panza, and Fabio Romanelli

In a recent article, Novikova *et al.* (2002) presented an analytical approach to tsunami and Rayleigh waves in a flat-layered laterally homogeneous model of the Earth. The same approach was already developed by Panza *et al.* (2000), who extended the procedure to laterally heterogeneous oceanic models and who corrected a mistake that was present in the paper by Yakson (now Novikova) and Yanovskaya (1996). This mistake was still present in the formulation of Novikova *et al.* (2002), who expressed the boundary condition at the liquid–solid boundary interface by the matrix relation (their equation 14c)

$$\mathbf{M}\mathbf{E}_0\begin{pmatrix} A_0 \\ B_0 \end{pmatrix} = \mathbf{V}\begin{pmatrix} C_1 \\ D_1 \\ E_1 \\ F_1 \end{pmatrix}, \tag{1}$$

which results from the continuity of the vertical component of the displacement and of the stress at the liquid–solid interface (their expression 14a):

$$\begin{pmatrix} kW \\ p_{zz} \end{pmatrix} = \mathbf{M}\mathbf{E}_0\begin{pmatrix} A_0 \\ B_0 \end{pmatrix}, \tag{2}$$

where

$$\mathbf{M} = \begin{pmatrix} \dfrac{c_\mathrm{f}\eta_{01}}{\omega} & -\dfrac{c_\mathrm{f}\eta_{02}}{\omega} \\ \rho_\mathrm{f}(-c_\mathrm{f}^2 - \psi_1) & -\rho_\mathrm{f}(c_\mathrm{f}^2 + \psi_2) \end{pmatrix}, \tag{3}$$

$$\mathbf{E}_0 = \begin{pmatrix} \exp\left(-\dfrac{\eta_{02}H_0}{c_\mathrm{f}}\right) & 0 \\ 0 & \exp\left(-\dfrac{\eta_{01}H_0}{c_\mathrm{f}}\right) \end{pmatrix}, \tag{4}$$

and

$$\eta_{01} = -\omega\sqrt{\frac{c_\mathrm{f}^2}{c^2} - 1 + \frac{g^2}{4c_\mathrm{f}^2\omega^2}} - \frac{g}{2c_\mathrm{f}} \qquad \psi_1 = \frac{gc_\mathrm{f}\eta_{01}}{\omega^2} \tag{5}$$

$$\eta_{02} = \omega\sqrt{\frac{c_\mathrm{f}^2}{c^2} - 1 + \frac{g^2}{4c_\mathrm{f}^2\omega^2}} - \frac{g}{2c_\mathrm{f}}, \qquad \psi_2 = \frac{gc_\mathrm{f}\eta_{02}}{\omega^2}$$

and at the solid–liquid interface by (their expression 14b)

$$\begin{pmatrix} kW \\ \sigma_{zz} \end{pmatrix} = \mathbf{V}\begin{pmatrix} C_1 \\ D_1 \\ E_1 \\ F_1 \end{pmatrix}, \tag{6}$$

where

$$\mathbf{V} = \begin{pmatrix} \dfrac{a_1\alpha_1}{c} & -\dfrac{a_1\alpha_1}{c} & -\dfrac{b_1^2}{c^2} & \dfrac{b_1^2}{c^2} \\ \rho_1 a_1^2\left(1 - \dfrac{2b_1^2}{c^2}\right) & \rho_1 a_1^2\left(1 - \dfrac{2b_1^2}{c^2}\right) & \dfrac{2\mu_1\beta_1 b_1}{c} & \dfrac{2\mu_1\beta_1 b_1}{c} \end{pmatrix}. \tag{7}$$

The definition of the remaining quantities can be found in Novikova *et al.* (2002).

The terms $-\rho_\mathrm{f}\psi_1$ and $-\rho_\mathrm{f}\psi_2$ in the matrix $\mathbf{M}$ are responsible for the hydrostatic pressure, which is the same in the liquid and in the solid layer. However, analogous terms in the expression for the vertical component of the stress in the solid (matrix $\mathbf{V}$) are lacking. Thus the formulation of the boundary conditions at the liquid–solid boundary (their equations 14a–c) is incorrect. In the correct formulation the terms corresponding the hydrostatic pressure should be neglected both in the liquid and in the solid because they are equal (Panza *et al.,* 2000). In fact, keeping the hydrostatic terms in the liquid, as in the first formulation made by Panza *et al.* (2000), later corrected thanks to Ward (personal comm., 1998), leads to vanishing both eigenfuctions in the solid, and consequently the excitation function, at a certain frequency, which is approximately equal to $g\sqrt{2/c_f}$ (Yakson and Yanovskaya, 1996). If one uses $c_f = 1.45$ km/sec (see the parameters given in table 1 in Novikova *et al.,* 2002), the period at which the eigenfunctions vanish is about 657 sec. Therefore, around this period the spectra in figures 3–5 of Novikova *et al.* (2002) should have a hole, as in Yakson and Yanovskaya (1996) and Novikova *et al.* (2000), a feature that is curiously absent.

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Manuscript received 9 October 2002.