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Seismic activity waves in the Earth's lithosphere

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The plot of temporal variation in the seismic activity level of the 40°–80°N segment of the Mid-Atlantic Ridge over the period from 1917 through 1987 is rather similar in shape with an analogous plot for Fennoscandia (Skordas et al., 1991) and, as is shown in the present work, for the eastern part of the North American platform (NAP). However, the characteristic features of the Mid-Atlantic Ridge plot are repeated with an ∼3-yr delay in Fennoscandia and with a 4–8-yr delay in the NAP. This positive phase shift is consistent with the hypothesis on significant dynamic control of a mid-ocean ridge (MOR) over seismic activity in adjacent platforms. This control is realized via the MOR push force. Variations in this force induced by the nonstationary process of dike intrusion in the axial zone of the ridge bring about migration of perturbations in the stationary stress–strain state of the lithosphere away from the MOR and induce seismic activity variations in platform regions adjacent to the MOR. The positive time shift in plots of platform seismic activity relative to the corresponding MOR plot is explained in terms of the delay in the arrival of the stress wave at the platform; due to energy dissipation in the asthenosphere, the amplitude of the wave significantly attenuates during its propagation from the MOR. Using the Elsasser model and the observed time shift, an estimate of $\eta = 10^{17}$ Pa s accurate to within $\pm 30\%$ is obtained for the asthenosphere viscosity in the case under consideration. Such values of the viscosity are sufficient to bring about the triggering effect of stress–strain state perturbations on platform seismicity. An increase in the obtained value of η by a few times would lead to overly large travel times of the stress wave, so that seismic activity would remain unaffected by such a wave at distances of the order of 2000 km. The examined numerical model is indirectly supported by the variation amplitude of seismic activity: as compared with Fennoscandia, this amplitude is lower in the central and eastern NAP, located farther from the Mid-Atlantic Ridge. On the other hand, the stationary seismicity level on the NAP is higher than in Fennoscandia, which can explain the difference between stationary values of shear stress intensities τ in the regions considered. The smaller stationary values of τ in Fennoscandia are due to the higher curvature of the Mid-Atlantic Ridge encompassing this region. The results of this work not only confirm the idea previously proposed by the authors according to which the MOR push force affects the stationary level of seismic activity in adjacent platform regions but also provide new insights into the mechanism of this effect in a nonstationary state.