

INVESTIGATION OF TECTONIC MOVEMENTS BENEATH THE OCEAN–CONTINENT TRANSITIONAL ZONE

V.V. Pak

The scope of the article encompasses the evolution of a two-dimensional Stokes flow of a system of thin layers floating on a relatively thick viscous layer. The flow is caused by the initial relief of the surface and layer boundaries. It is supposed that the density of the layers does not decrease with depth. We use simplified Reynolds equations to describe flow in a bunch of thin layers and Stokes equations for the thick layer. Based on the asymptotical study of stratified flow evolution, the ordinary differential equation with respect to layer boundary displacements and velocities at the interface between the thin and thick layers at long times is derived. Model calculations of the flow in the computational domain consisting of a thin two-layer with variable layer thicknesses floating on a thick viscous layer are obtained. The calculated results show that at the initial stage, the flow covers almost the whole computational domain. Nevertheless, it is almost entirely localized in the area of maximal variations of the surface topography and layer thicknesses at long times. The velocity and maximal tangential stress fields for ocean margins in the transitional zones between the oceans and continents were calculated for geophysical applications. The presented model allows calculating velocity and stress fields beneath the ocean caused by ocean floor features measured by bathymetry.

Keywords: multi-layer creeping flow, small parameter method, ocean-continent transitional zone.

References

1. Craster R.V., Matar O.K. Dynamics and stability of thin liquid films, *Rev. of Modern Phys.*, 2009, vol. 81, no. 3. P. 1131–1198. DOI: 10.1103/RevModPhys.81.1131.
2. Karakin A. V. Modeli tonkikh sloev kory i litosfery [Thin layer models of the crust and lithosphere]. *Matem. modelirovanie*, 1998, vol. 10, no. 10. P. 30–50.
3. Tan E., Choi E., Thoutireddy P., Gurnis M., Aivazis M. GeoFramework: Coupling multiple models of mantle convection within a computational framework, *Geochem. Geophys. Geosyst.*, 2006, vol. 7, no. 6, Q06001. DOI:10.1029/2005GC001155.
4. Merkt D., Pototsky A., Bestehorn M. Long-wave theory of bounded two-layer films with a free liquid–liquid interface: Short- and long-time evolution, *Phys. Fluids*, 2005, vol. 17, 064104. DOI: 10.1063/1.1935487.
5. Pak V.V. Modelirovanie polya skorostei dvukhsloynogo techeniya vyazkoj zhidkosti i nekotorye geofizicheskie prilozheniya [Modeling the velocity field of two-layered creeping flow and some geophysical applications], *Vestn. Udmurt. Univ. Mat. Mekh. Komp'yut. Nauki -The Bulletin of Udmurt University. Mathematics. Mechanics. Computer Science*. 2014, no. 1. P. 66–75 (Russian). DOI: 10.20537/vm140106.
6. Pak V.V. Chislennoe issledovanie évolýucii medlennogo techeniya neodnorodnoy zhidkosti na bol'shikh vremenakh [Numerical study of the long-time evolution for inhomogeneous creeping flow]. *Výcisl. meh. splos. sred– Computational Continuum Mechanics*. 2016, vol. 9, no. 2. P. 207–217 (Russian). DOI: 10.7242/1999-6691/2016.9.2.18.
7. Nayfeh A.H. *Metody vozmushchenii* [Perturbation methods], Moscow: Mir, 1976. 456 p.
8. Temam R. *Uravneniya Nav'e-Stoksa. Teoriya i chislennyi analiz* [Navier-Stokes equations. Theory and numerical analysis]. Moscow: Mir, 1981. 408 p.
9. Karakin A. V., Myasnikov V. P., Fadeev V. E. The hydrodynamic model of evolution of the lithosphere with variable thickness. *Docl. AN SSSR*, 1985, vol. 282, no. 1. P. 37–41.
10. Turcotte D.L., Schubert, G. *Geodinamika. Geologicheskoe prilozhenie fiziki splosnykh sred. Tom 2* (Geodynamics. Applications of Continuum Physics to Geological Problems. Vol. 2), Moscow: Mir, 1985, 360 p.
11. Bezverkhny V.L., Pak V.V. *Flyuidodinamika i tektogenez Zapadno-Tikhookeanskoi zony perekhoda* [Fluidodynamics and tectogenesis of the West Pacific transition zones]. *Vest. DVO RAN*, 2003, no. 4. P. 132–140. (Russian).
12. Fedotov S.A., Gusev A.A., Chernysheva G.V., Shumilina L.S. Seismofokal'naya zona Kamchatki: geometriya, razmeshchenie ochagov, svyaz' s vulkanizmom [Seismic focal zone of Kamchatka: geometry, the location of earthquake focuses, the relationship with the volcanism]. *Vulkanologiya i seismologiya*. 1985, no. 4. P. 91–107.
13. Huerta A.D., Harry D.L. The transition from diffuse to focused extension: Modeled evolution of the West Antarctic Rift system, *Earth and Planet. Sci. Lett.*, 2007, vol. 255. P. 133–147. DOI: 10.1016/j.epsl.2006.12.011.

About the authors

Pak Vladimir Vasilievich, Candidate of Physical and Mathematical Sciences, Leading Researcher

V.I. Il'ichev Pacific Oceanological Institute of the Far Eastern Branch of the Russian Academy of Sciences

Address: 43, Baltiyskaya Street, Vladivostok, 690041, Russia

Research interests: mathematical modeling in geophysics

E-mail: pakvv@poi.dvo.ru

ORCID ID: 0000-0002-8510-8760

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