To substantiate the high velocities of P– and S–waves in the upper mantle of Transbaikalia

© 2020 V.M. Solovyev[1], V.S. Seleznev[2], V.V. Chechelnitsky[3], A.S. Salnikov[4], N.A. Galyova[1]

[1]*ASB GS RAS*, *Novosibirsk*, *Russia*; [2]*SEB GS RAS*, *Novosibirsk*, *Russia*; [3]*BB GS RAS*, *Irkutsk*, *Russia*; [4]*JSC "SNIIGGIMS"*, *Novosibirsk*, *Russia*

Abstract The results of the analysis of geological, geophysical and geodynamic studies in the South-East of Transbaikalia are presented in order to substantiate the high speeds of P- and S-waves along the Mohorovichich boundary established here by profile seismic and area seismological studies. The issues of possible anisotropy of the upper mantle were discussed, and the experimental values of P-and S-wave velocities (according to the data of the GSS and seismology) were compared with the calculations of elastic parameters values based on the approximate mineral composition of probable upper mantle rocks (peridotites, lercolites, pyroxenites and eclogites) and experimental values of P- and S-wave velocities for these rocks obtained at pressures in the upper mantle (up to 10 kbar). By results of discussion of possible causes of increased speeds made the conclusion on the validity of assumptions about the nature of the high-speed block in the mantle of Transbaikalia as the plates eclogites (or eclogitic rocks) in the area of Mongol-Okhotsk orogenic belt.

Keywords Transbaikalia, Mohorovichich boundary, seismological data, boundary velocities of P- and S-waves, Poisson's ratio, Mongolo-Okhotsk belt, eclogites.

For citation Solovyev, V.M., Seleznev, V.S., Chechelnitsky, V.V., Salnikov, A.S. & Galyova, N.A. (2020). [To substantiate the high velocities of P- and S-waves in the upper mantle of Transbaikalia]. *Rossiiskii seismologicheskii zhurnal* [Russian Journal of Seismology], *2*(3), 22-33. (In Russ.). DOI: https://doi.org/10.35540/2686-7907.2020.3.02

References

Bamford, D., Jentsch, M., & Prodehl, C. (1979). Pn anisotropy studies in Northern Britain, and in the Eastern and Western United States. *Geophysical Journal of the Royal Astronomical Society*, *57*, 397-429.

Bayuk, E.I., Volarovich, M.P., & Levitova, F.M. (1982). *Uprugaja anizotropija gornyh porod pri vysokih davlenijah* [Elastic anisotropy of rocks at high pressures]. Moscow, Russia: Nauka Publ., 170 p. (In Russ.).

Belikov, B.P., Alexandrov, K.S., & Ryzhova, T.V. (1970). *Uprugie svojstva porodoobrazujushhih mineralov i gornyh porod* [Elastic properties of rock-forming minerals and rocks]. Moscow, Russia: Nauka Publ., 276 p. (In Russ.).

Belousov, V.V. (ed.). (1991). *Glubinnoe stroenie territorii SSSR* [Deep structure of the territory of the USSR]. Moscow, Russia: Nauka Publ., 224 p. (In Russ.).

Birch, F. (1960). The velocity of compressional waves in rocks to 10 kilobars. Pt.1. *Journal of Geophysical Research*, *65*(4), 1083-1102.

Chesnokov, E.M. (1977). *Sejsmicheskaja anizotropija verhnej mantii Zemli* [Seismic anisotropy of the Earth's upper mantle]. Moscow, Russia: Nauka Publ., 144 p. (In Russ.).

Crampin, S. (1982). Comments on "Possible forms of seismic anisotropy of the uppermost mantle under oceans" by George E. Backus. *Journal of Geophysical Research*, *87*, 4634-4640.

Didenko, A.N., Efimov, A.S., Nelyubov, P.A., Salnikov, A.S., Staroseltsev, V.S., Shevchenko, B.F., Goroshko, M.V., Guryanov, V.A., & Zamozhnyaya, N.G. (2013). Structure and evolution of the Earth's crust in the region of junction of the Central Asian fold belt and the Siberian Platform: Skovorodino-Tommot profile. *Russian Geology and Geophysics*, *54*(10), 1236-1249.

Dobretsov, N.L. (1980). *Vvedenie v global'nuju petrologiju* [Introduction to global petrology]. Novosibirsk, Russia: Nauka Publ., 200 p. (In Russ.).

Dobretsov, N.L., Sobolev, N.V., Shatsky, B.C., et al. (1989). *Jeklogity i glaukofanovye slancy v skladchatyh oblastjah* [Eclogites and glaucophane shales in folded areas]. Novosibirsk, Russia: Nauka Publ., 236 p. (In Russ.).

Dortman, N.B. (ed.). (1976). *Fizicheskie svojstva gornyh porod i poleznyh iskopaemyh (petrofizika). Spravochnik geofizika* [Physical properties of rocks and minerals (petrophysics): Handbook of Geophysics]. Moscow, Russia: Nedra Publ., 527 p. (In Russ.).

Egorkin, A.V., Zyuganov, S.K., & Chernyshev, N.M. (1984). [Verhnyaya mantiya Sibiri]. In 27 *Mezhdunarodnyj geologicheskij kongress, sekcija C08. Doklady. T. 8* [27 International Geological Congress, Geophysics, section C08, reports, V. 8] (pp. 27-42). Moscow, Russia: Nauka Publ. (In Russ.).

Fuchs, K. (1984). [Seismic anisotropy and composition of the continental subcortical lithosphere]. In *27 Mezhdunarodnyj geologicheskij kongress, sekcija C08. Doklady. T. 8* [27 International Geological Congress, Geophysics, section C08, reports, V. 8] (pp. 43-52). Moscow, Russia: Nauka Publ. (In Russ.).

Goshko, E.Y., Zhabin, V.V., & Salnikov, A.S. (2018). [Crustal structure at the junction of the Aldano-Stanovoy shield and the Sayan-Baikal folded region along a control profile 1-SB]. In *Geologija i mineral'no-syr'evye resursy Severo-Vostoka Rossii: materialy VIII Vserossijskoj nauchno-prakticheskoj konferencii, 18-20 aprelja 2018 g.: v 2 t. T. 2* [Geology and mineral resources of the North-East of Russia: materials of the VIII all-Russian scientific-practical conference, April 18-20, 2018, in 2 v. V. 2] (pp. 52-55). Yakutsk, Russia: NEFU Publ. House. (In Russ.).

Hess, H. (1964). Seismic anisotropy of the uppermost mantle under oceans. *Nature*, *2*, 629-631.

Kashubin, S.N. (2001). *Sejsmicheskaja anizotropija i eksperimenty po ejo izucheniju na Urale i Vostochno-Evropejskoj platforme* [Seismic anisotropy and experiments on its study in the Urals and the East European platform]. Yekaterinburg, Russia: UB RAS Publ., 182 p. (In Russ.).

Kharkiv, A.D. (1976). [Mineralogo-geochemical features of mantle rock inclusions in Yakutia kimberlites and their relation to diamond content]. *Geohimija* [Geochemistry], *7*, 983-996. (In Russ.).

Krasnova, M.A., & Chesnokov, E.M. (1986). *Jeksperimental'noe issledovanie sejsmicheskoj anizotropii litosfery Zemli v SSSR i za rubezhom* [Experimental study of seismic anisotropy of the Earth's lithosphere in the USSR and abroad]. Moscow, Russia: VIMS Publ., 36 p. (In Russ.).

Krylov, S.V., Mandelbaum, M.M., Seleznev, V.S., Soloviev, V.M., & Elinov, V.D. (1990). [Detailed deep seismic studies in the upper Angara region of the Baikal rift zone]. *Geologija i geofizik*a [Geology and Geophysics], *31*(7), 17-27. (In Russ.).

Krylov, S.V., Mishenkin, B.P., Mishenkina, Z.R., Petrik, G.V., Sergeev, V.N., Sheludko, I.F., Ten, E.N., Kulchinsky Yu. V., Mandelbaum, M.M., Seleznev, V.S., Soloviev, V.M., & Suvorov, V.D. (1993). *Detal'nye sejsmicheskie issledovanija litosfery na R- i S-volnah* [Detailed deep seismic studies in the upper Angara region of the Baikal rift zone]. Novosibirsk, Russia: Nauka Publ., 199 p. (In Russ.).

Parfenov, L.M., Berzin, N.A., Khanchuk, A.I., Badarch, G., Belichenko, V.G., Bulgatov, A.N., Dril, S.I., Kirillova, G.L., Kuzmin, M.I., Nokleberg, U., Prokopev, A.V., Timofeev, V.F., Tomurtogoo, O., & Yan, H. (2003). [Model of formation of orogenic belts of Central and North-East Asia]. *Tihookeanskaja geologija* [Pacific Geology], *22*(6), 1-41. (In Russ.).

Ringwood, A.E. (1981). *Sostav i petrologija mantii Zemli* [Composition and petrology of the Earth's mantle]. – Moscow, Russia: Nedra Publ., 584 p. (In Russ.).

Seleznev, V.S., Solovyov, V.M., Suvorov, V.D., et al. (1987). [The use of transverse waves in deep seismic sounding in Western Yakutia]. *Geologija i geofizika* [Geology and Geophysics], *1*, 109-117. (In Russ.).

Shearer, P.M., & Orcutt, J.A. (1986). Compressional and shear wave anisotropy in the oceanic lithosphere - the Ngendei seismic refraction experiment. *Geophysical Journal of the Royal Astronomical Society*, *87*, 967-1003.

Shevchenko, B.F., Goroshko, M.V., Didenko, A.N., Guryanov, V.A., Staroseltsev, V.S., & Salnikov, A.S. (2011). The junction of the Eastern Central Asian fold belt and the Siberian platform: deep structure and Mesozoic tectonics and geodynamics. *Russian Geology and Geophysics*, *52*(12), 1672-1679.

Sobolev, N.V. (1974). *Glubinnye vkljuchenija v kimberlitah i problema sostava verhnej mantii* [Deep inclusions in kimberlites and the problem of upper mantle composition]. Novosibirsk, Russia: Nauka Publ., 264 p. (In Russ.).

Solonenko, V.P. (1968). [Seismotectonics and modern structural development of the Baikal rift zone]. In *Bajkal'skij rift* [Baikal rift] (pp. 57-71). Moscow, Russia: Nauka Publ. (In Russ.).

Soloviev, V.M. (1988). *Ispol'zovanie poperechnyh voln pri glubinnom sejsmicheskom zondirovanii v Zapadnoj Jakutii: avtoref. diss. kand. geol.-min. nauk* [The use of transverse waves in deep seismic sounding in Western Yakutia. Cand. geol. and min. sci. diss.]. Novosibirsk, Russia, 16 p. (In Russ.).

Soloviev, V.M., Chechelnitsky, V.V., Salnikov, A.S., Seleznev, V.S., Liseikin, A.V., & Galyova, N.A. (2017). [Specific velocity structure of the upper mantle in the Transbaikalia segment of the Mongolia-Okhotsk orogenic belt]. *Geodinamika i tektonofizika* [Geodynamics & Tectonophysics], *8*(4), 1065-1082. (In Russ.). doi: 10.5800/GT-2017-8-4-0333

Solovyev, V.M., Galyova, N.A., Salnikov, A.S., Seleznev, V.S., Liseikin, A.V., Kashubina, T.V., & Vyatkina, D.V. (2019). [Peculiarities of the Transbaikal seismic structure at the site of the base line 1-SB "Vostochny" on data of differently polarized P- and

S-waves]. *Geologija i mineral'no-syr'evye resursy Sibiri* [Geology and mineral resources of Siberia], *3*, 57-71. (In Russ.).

Solovyev, V.M., Seleznev, V.S., Chechelnitsky, V.V., & Galyova, N.A. (2020). Upper mantle of Baikal and Transbaikalia according to the area data of seismological research. *Rossiiskii seismologicheskii zhurnal* [Russian Journal of Seismology], *2*(1), 7-17. (In Russ.).

Solovyev, V.M., Seleznev, V.S., Salnikov, A.S., Liseikin, A.V., Romanenko, I.E., Elagin, S.A., Schoenmaier, A.E., & Serezhnikov, N.A. (2017). [Deep structure of the Zabaikalsky portion of the Central-Asian folded belt from deep seismic sounding (1-SB survey base line)]. *Geologija i mineral'no-syr'evye resursy Sibiri* [Geology and mineral resources of Siberia], *4*, 91-103. (In Russ.).

Suvorov, V.D., Kreinin, A.B., Podmarkova, I.V., et al. (1985). [Areal deep seismic studies in the Malo-Botuobinsky district of Yakutia]. *Geologija i geofizika* [Geology and Geophysics], *1*, 82-90. (In Russ.).

Suvorov, V.D., Kreinin, A.B., Uarov, V.F., et al. (1988). [Deep seismic studies in the Central part of Western Yakutia]. *Geologija i geofizika* [Geology and Geophysics], *2*, 91-95. (In Russ.).

Volarovich, M.P. (ed.). (1978). *Spravochnik po fizicheskim svojstvam gornyh porod i mineralov pri vysokih termodinamicheskih parametrah* [Handbook of physical properties of rocks and minerals at high thermodynamic parameters]. Moscow, Russia: Nedra Publ., 236 p. (In Russ.).

Volarovich, M.P., Bayuk, E.I., & Efimova, G.A. (1975). *Uprugie svojstva mineralov pri vysokih davlenijah* [Elastic properties of minerals at high pressures]. Moscow, Russia: Nauka Publ., 132 p. (In Russ.).

Zverev, *S.M. (1999). Deep seismic sounding in oceans over 30 years of expeditions: methods and wave fields. Izvestiya*. *Physics of the Solid Earth*, *35*(7-8), 657-677.

Information about authors

Solovyev Victor Mikhaylovich, PhD, Deputy Director of the Altai-Sayan Branch of the Geophysical Survey of the Russian Academy of Sciences (ASB GS RAS), Novosibirsk, Russia. E-mail: solov@gs.nsc.ru

Seleznev Viktor Sergeyevich, Dr., Director of the Seismological Branch of the Geophysical Survey of the Russian Academy of Sciences (SEB GS RAS), Novosibirsk, Russia. E-mail: svs0428@mail.ru

Chechelnitsky Vladimir Vasil'yevich, PhD, Deputy Director of the Baikal Branch of the Geophysical Survey of the Russian Academy of Sciences (BB GS RAS), Irkutsk, Russia. E-mail: chechel@crust.irk.ru

Salnikov Alexander Sergeyevich, Dr., Head of Department of the Joint Stock Company "Siberian Research Institute of Geology, Geophysics and Mineral Resources" (JSC "SRIGG&MR"), Novosibirsk, Russia. E-mail: assalnikov@mail.ru

Galyova Natalya Aleksandrovna, Junior Researcher of the ASB GS RAS, Novosibirsk, Russia. E-mail: tatapelya@gmail.com