IJG> Vol.2 No.1, February 2011

OPEN ACCESS

Up-To-Date Geodynamics and Seismicity of Central Asia

PDF (Size:3319KB) PP. 1-12 DOI: 10.4236/ijg.2011.21001

Author(s)

Yury Gatinsky, Dmitry Rundquist, Galina Vladova, Tatiana Prokhorova

ABSTRACT

The analysis of the seismicity in central Asia shows its distribution within a "triangle" of maximal inner-continental seismic activity, which is situated between south edge of the Lake Baikal and the Himalayas. The "triangle" coincides with the central Asian transit zone which divides the north Eurasian and Indian lithosphere plates and provides transfer and relaxation of tectonic stresses that arise between them. The central Asian transit zone consists of numerous crust blocks of different sizes. Blocks' boundaries are often represented by not only single faults but relatively wide interblock zones characterized by intensive shattering of rocks and releasing a significant quantity of the seismic energy. The most active interblock zones limited the Pamirs, Tien Shan, Shan, and Bayanhar blocks as well as north boundaries of the Indian Plate. The quantity of the seismic energy releasing along each of them reaches ⩾ 5?1015 J, while along other boundaries it doesn't exceed 3?1012-2?1015 J. The majority of the most intensive seismic events took place just in these interblock zones. The total quantity of seismic energy is generally diminished away from the boundary of the Indian Plate, but sometimes the maximal quantity releases in inner parts of the transit zone at the distance 500-1500 km from the plate boundary. The most active interblock zones of central Asia differ from subduction and collision zones by depth of their penetration in lithosphere and at the same time are rather near to them by the volume of energy realizing. The examination of interblock zones shows that the majority of intensives earthquakes occur within them in regions with sharp changes of geodynamic conditions. On the whole the most part of central Asia is situated under the influence of the Indian indenter, which causes the prevailing of transpression tectonics. An abnormal high seismic energy releasing depends of deep continuation of the plate slab in collision zones (Pamirs, Himalayas), intensive displacements along strike-slips and thrusts due to collision processes and deep lithosphere unhomogeneity (Tien Shan, Bayanhar), as well as of sharp changes of geodynamic conditions because of influence of plate movement and supposed mantle plumes (north Mongolia, the Baikal region).

KEYWORDS

Lithosphere Plates, Seismicity, Active Faults, Transit Zone, Interblock Zones, Seismic Energy

Cite this paper

Y. Gatinsky, D. Rundquist, G. Vladova and T. Prokhorova, "Up-To-Date Geodynamics and Seismicity of Central Asia," *International Journal of Geosciences*, Vol. 2 No. 1, 2011, pp. 1-12. doi: 10.4236/ijg.2011.21001.

References

[1] P. N. Kropotkin, "Eurasia as a Composite Continent," Tectonophysics, Vol. 12, No. 12, 1971, pp. 261-266. doi:10.1016/0040-1951(71)90007-2

[2] A. L. Yanshin, V. E. Khain and Yu. G. Gatinsky, "The Principal Problems of Tectonocs of Asia," Proceedings 27th IGC, Vol. 5 "Tectonics of Asia", Nauka, Moscow, August 1984, pp. 3-12.

[3] W. J. Morgan, "Rises, Trenches, Great Faults and Crustal Blocks", Journal Geophysics Researches, Vol. 73, No. 6, June 1968, pp. 1959-1982. doi:10.1029/JB073i006p01959

[4] P. Molnar and P. Tapponier, "Cenozoic Tectonics of Asia," Science, Vol. 189, No. 4201, 1975, pp. 419-426. doi:10.1126/science.189.4201.419

[5] L. P. Zonenshain and L. A. Savostin, "Geodynamics of the Baikal Rift Zone and Plate Tectonics of Asia," Tectonophysics, Vol. 76, No. 1-2, 1981, pp. 1-45. doi:10.1016/0040-1951(81)90251-1

• Open Special Issues
• Published Special Issues
• Special Issues Guideline

IJG Subscription

Most popular papers in IJG

About IJG News

Frequently Asked Questions

Recommend to Peers

Recommend to Library

Contact Us

[6] Yu.G. Gatinsky, "Geodynamics of SE Asia in Relation to the Evolution of Ocean Basins," Palaeogeography, Palaeoclimatology, Palaeoecology, Vol. 55, No. 2-4, July 1986, pp.127-144. doi:10.1016/0031-0182(86)90148-3

[7] K. Fujita, F. M. Cambrey and M. A. Velbel, "Tectonics of the Laptev Sea and Moma Rift Systems, Northeastern USSR," Marine Geology, Vol. 93, 1990, pp. 127- 144. doi:10.1016/0025-3227(90) 90079-Y

[8] Yu. G. Gatinsky and D.V. Rundquist, "Geodynamics of Eurasia – Plate Tectonics and Block Tectonics," Geotectonics, Vol. 38, No. 1, 2004, pp. 1-16.

[9] D. V. Rundkvist, Yu. G. Gatinsky, W. A. Bush and V. G. Kossobokov, "The area of Russia in the Present-Day Structure of Eurasia: Geodynamics and Seismicity," In: D. K. Chowdhury, Ed., Computational Seismology and Geodynamics, Vol. 7, American Geophysics Union, Washington, D. C., 2005, pp. 224-233.

[10] Yu. G. Gatinsky, D. V. Rundquist and Yu. S. Tyupkin, "Block Structure and Kinematics of Eastern and Central Asia from GPS Data," Geotectonics, Vol. 39, No. 5, 2005, pp. 333-348.

[11] D. A. Wiens, C. DeMets, R. G. Gordon et al., "A diffuse Plate Boundary Model for Indian Ocean Tectonics," Geophysics Research Letters, Vol. 12, No. 7, 1985, pp. 429-432. doi:10.1029/GL012i007p00429

[12] R. G. Gordon and S. Stein, "Global Tectonics and Space Geodesy," Science, Vol. 256, No. 5055, 1992, pp. 333- 342. doi:10.1126/science.256.5055.333

[13] R.G.Gordon, "The Plate Tectonic Approximation: Plate Nonrigidity, Diffuse Plate Boundaries, and Global Plate Motions," Annual Review of Earth and Planetary Sciences, Vol. 26, No. 1, 1998, pp. 615-642. doi:10.1146/annurev.earth.26.1.615

[14] A. B. Watts, "Isostasy and Flexure of the Lithosphere," Cambridge University Press, Cambridge, 2001.

[15] P. Bird, "An Updated Digital Model of Plate Boundaries," Geochemistry, Geophysics, Geosystems, No. 4, Vol. 3, 2003, doi:10.1029/2001GC000252

[16] V. G. Trifonov, O. V. Soboleva, R. V. Trifonov, G. A. Vostrikov, "Recent Geodynamics of the Alpine-Himalayan Collision Belt," Transactions of the Geological Institute RAS, Vol. 541, Moscow, GEOS, 2002 (In Russian).

[17] X. Xu and Q. Deng, "Nonlinear Characteristics of Paleoseismicity in China," Journal Geophysical Research, Vol. 101, No. B3, 1996, pp. 6209-6231. doi:10.1029/95JB01238

[18] S. D. Willett and C. Beaumont, "Subduction of Asian Lithospheric Mantle Beneath Tibet inferred from Models of Continental Collision," Nature, Vol. 369, No. 6482, 1994, pp. 642-645. doi:10.1038/369642a0

[19] H. Kao, G. Rui, R.-J. Rau et al., " Seismic Image of The Tarim Basin and Its Collision with Tibet," Geology, Vol. 29, No. 7, 2001, pp. 575-578. doi:10.1130/0091-7613(2001) 029<0575:SIOTTB>2.0.CO;2

[20] S. -L. Chung, M. -F. Chu, Y. Zhang et al., "Tibetian Tectonic Evolution Inffered from Spatial and Temporal Variations in Post-Collisional Magmatism," Earth Scientific Review, Vol. 68, No. 3-4, 2005, pp. 173-196. doi:10.1016/j.earscirev.2004.05.001

[21] World stress map, "a Project of the Heidelberg Academy of Sciences and Humanities," In: O. Heidbach, M. Tingay, A. Barth et al., Eds., Commission for the Geological Map of the World, WSM Release 2008. Internet Available: http://www.world-stress-map.org

[22] Z. Shen, C. Zhao, A. Yin et al., "Contemporary Crustal Deformation in East Asia Constrained by Global Positioning System Measurements," Journal Geophysical Research, Vol. 105, No. B3, 2000, pp. 5721-5734. doi:10.1029/1999JB900391

[23] L. Xiao, C. Wang and F. Pirajno, "Is the Underthrust Indian Lithosphere Split Beneath the Tibetan Plateau?" International Geology Review, Vol. 49, No. 1, 2007, pp. 90-98. doi:10.2747/0020-6814.49.1.90

[24] D. V. Rundquist, Yu. G. Gatinsky and S. V. Cherkasov, "The Natural Trans-Eurasian Divider: Structural and Metallogenic Evidences," Abstracts 32-IGC, part 2, Florence, Aug. 2004, p. 620.

[25] V. A. Sankov, A. I. Lukhnev, V. I. Melnikova et al., "Present-day Tectonic Deformations of the Southern Mounting Frame of the Siberian Platform from GPS Geodesy Data," Proceedings International Seminar On the use of space techniques for Asia-Pacific regional crustal movements studies, Irkutsk, Aug. 2002, Moscow, GEOS, 2003, pp. 118-126.

[26] Yu. G. Gatinsky, T. V. Prokhorova, D. V. Rundquist and G.L.Vladova, "Zones of Catastrophic Earthquakes of Central Asia: Geodynamics and Seismic Energy," 2009. Internet Available: http://dx.doi.org/10.2205/2009ES000326

[27] A. Copley, "Kinematics and Dynamics of the Southeastern Margin of the Tibetan Plateau," Geophysical Journal International, Vol. 174, No. 3, 008, pp. 1081- 1100.

[28] S. I. Sherman, K. Zh. Semiyskiy and A. V. Cheremnykh, "Destruktive Zones and Fault-Produced Block Structures of Central Asia," Geology of Pacific Ocean, Vol. 16, No. 2, 2000, pp. 231-252.

[29] K. Zh. Seminskii, "Hierarchy in the Zone Block Lithospheric Structure of Central and Eastern Asia," Russian Geology and Geophysics, Vol. 49, No. 10, October 2008, pp. 771-779. doi:10.1016/j.rgg.2007.11.017

[30] A. M. Negredo, A. Replumaz, A. Villase?or and S. Guillot, "Modeling the Evolution of Continental Subduction Processes in the Pamir–Hindu Kush region," Earth and Planetary Science Letters, Vol. 259, No. 1-2, 2007, pp. 212-225. doi:10.1016/j.epsl.2007.04.043

[31] S. Li, M. J. Unsworth, J. R. Booker et al., "Partial Melt Or Aqueous Fluid in the Mid-Crust of Southern Tibet? Constraints from INDEPTH magnetotelluric data," Geophysical Journal International, Vol. 153, No. 2, 2003, pp. 289-304. doi:10.1046/j.1365-246X.2003.01850.x

[32] K. D. Solon, A. G. Jones, K. D. Nelson et al., "Structure of the Crust in the Vicinity of the Banggong-Nujiang Suture in Central Tibet from INDEPTH magnetotelluric data," Journal Geophysical Research, Vol. 110, No. B10102, 2005; doi:10.1029/2003JB002405

[33] Yu. G. Gatinsky and G. L. Vladova, "Subduction Zones of SE Asia: Main Types, Seismicity and Mineralization," Proceedings VAG International Symposium, Hanoi, November 2008, pp. 9-16.

[34] J. Liu-Zeng, Z. Zhang, L. Wen et al., "Co-Seismic Ruptures of the 12 May 2008, Ms 8.0 Wenchuan Earthquake, Sichuan: East–West Crustal Shortening on Oblique, Parallel Thrusts Along the Eastern Edge of Tibet," Earth and Planetary Science Letters, Vol. 286, No. 3-4, 2009, pp. 355-370. doi:10.1016/j.epsl.2009.07.017

[35] Yu.G. Gatinsky, D.V. Rundquist, G.L. Vladova and T.V. Prokhorova, "Geodynamics of the Sichuan Earthquake Region in May 12, 2008," Doklady Earth Sciences, Vol. 423A, No. 9, 2008, pp.1507-1509. doi:10.1134/S1028334X08090419

[36] X. Yuan, A.S. Egorov, GEMOC, "A Short Introduction to Global Geoscience Transect 21: Arctic Ocean–Eurasia– Pacific Ocean," Science Press, 2000.

[37] Chen Ji, "Finite Fault Models for M7.9 Earthquake", 2008. Internet Available: http://earthquake.usgs.gov/eqcenter/page

[38] A. I. Miroshnichenko, V. A. Sankov, A. V. Parfeevets and A. V. Lukhnev, "State of Stress and Strain of the Earth Crust of the Basins of North Mongolia from the Model Results," Proceedings Conference commemorating the 50th anniversary of the 1957 Gobi-Altay earthquake, Ulaanbaatar–Irkutsk, Aug. 2007, pp. 138-143.

[39] A. F. Grachev, "Modern Volcanism, Mantle Plumes, and Their Connection with the Stress Intensity in the Lithosphere", In: A. F. Grachev, Ed., Neotectonics, Geody- namics and Seismicity of Northern Eurasia, Probel, Moscow, 2000, pp. 245-266 (In Russian).

[40] H. Kanamori and D. L. Anderson, "Theoretical Basis of Some Empirical Relations in Seismology," Bulletin of the Seismological Society of America, Vol. 65, No. 5, October 1975, pp. 1073-109.

[41] P. N. Kropotkin, "Eurasia as a Composite Continent," Tectonophysics, Vol. 12, No. 12, 1971, pp. 261-266. doi:10.1016/0040-1951(71)90007-2

[42] A. L. Yanshin, V. E. Khain and Yu. G. Gatinsky, "The Principal Problems of Tectonocs of Asia," Proceedings 27th IGC, Vol. 5 "Tectonics of Asia", Nauka, Moscow, August 1984, pp. 3-12.

[43] W. J. Morgan, "Rises, Trenches, Great Faults and Crustal Blocks", Journal Geophysics Researches, Vol. 73, No. 6, June 1968, pp. 1959-1982. doi:10.1029/JB073i006p01959

[44] P. Molnar and P. Tapponier, "Cenozoic Tectonics of Asia," Science, Vol. 189, No. 4201, 1975, pp. 419-426. doi:10.1126/science.189.4201.419

[45] L. P. Zonenshain and L. A. Savostin, "Geodynamics of the Baikal Rift Zone and Plate Tectonics of Asia," Tectonophysics, Vol. 76, No. 1-2, 1981, pp. 1-45. doi:10.1016/0040-1951(81)90251-1

[46] Yu.G. Gatinsky, "Geodynamics of SE Asia in Relation to the Evolution of Ocean Basins," Palaeogeography, Palaeoclimatology, Palaeoecology, Vol. 55, No. 2-4, July 1986, pp.127-144. doi:10.1016/0031-0182(86)90148-3

[47] K. Fujita, F. M. Cambrey and M. A. Velbel, "Tectonics of the Laptev Sea and Moma Rift Systems, Northeastern USSR," Marine Geology, Vol. 93, 1990, pp. 127- 144. doi:10.1016/0025-3227(90) 90079-Y

[48] Yu. G. Gatinsky and D.V. Rundquist, "Geodynamics of Eurasia – Plate Tectonics and Block Tectonics," Geotectonics, Vol. 38, No. 1, 2004, pp. 1-16.

[49] D. V. Rundkvist, Yu. G. Gatinsky, W. A. Bush and V. G. Kossobokov, "The area of Russia in the Present-Day Structure of Eurasia: Geodynamics and Seismicity," In: D. K. Chowdhury, Ed., Computational Seismology and Geodynamics, Vol. 7, American Geophysics Union, Washington, D. C., 2005, pp. 224-233.

[50] Yu. G. Gatinsky, D. V. Rundquist and Yu. S. Tyupkin, "Block Structure and Kinematics of Eastern and Central Asia from GPS Data," Geotectonics, Vol. 39, No. 5, 2005, pp. 333-348.

[51] D. A. Wiens, C. DeMets, R. G. Gordon et al., "A diffuse Plate Boundary Model for Indian Ocean Tectonics," Geophysics Research Letters, Vol. 12, No. 7, 1985, pp. 429-432. doi:10.1029/GL012i007p00429

[52] R. G. Gordon and S. Stein, "Global Tectonics and Space Geodesy," Science, Vol. 256, No. 5055, 1992, pp. 333- 342. doi:10.1126/science.256.5055.333

[53] R.G.Gordon, "The Plate Tectonic Approximation: Plate Nonrigidity, Diffuse Plate Boundaries, and Global Plate Motions," Annual Review of Earth and Planetary Sciences, Vol. 26, No. 1, 1998, pp. 615-642. doi:10.1146/annurev.earth.26.1.615

[54] A. B. Watts, "Isostasy and Flexure of the Lithosphere," Cambridge University Press, Cambridge, 2001.

[55] P. Bird, "An Updated Digital Model of Plate Boundaries," Geochemistry, Geophysics, Geosystems, No. 4, Vol. 3, 2003. doi:10.1029/2001GC000252

[56] V. G. Trifonov, O. V. Soboleva, R. V. Trifonov, G. A. Vostrikov, "Recent Geodynamics of the Alpine-Himalayan Collision Belt," Transactions of the Geological Institute RAS, Vol. 541, Moscow, GEOS, 2002 (In Russian).

[57] X. Xu and Q. Deng, "Nonlinear Characteristics of Paleoseismicity in China," Journal Geophysical Research, Vol. 101, No. B3, 1996, pp. 6209-6231. doi:10.1029/95JB01238

[58] S. D. Willett and C. Beaumont, "Subduction of Asian Lithospheric Mantle Beneath Tibet inferred from Models of Continental Collision," Nature, Vol. 369, No. 6482, 1994, pp. 642-645. doi:10.1038/369642a0

[59] H. Kao, G. Rui, R.-J. Rau et al., " Seismic Image of the Tarim Basin and Its Collision with Tibet," Geology, Vol. 29, No. 7, 2001, pp. 575-578. doi:10.1130/0091-7613(2001) 029<0575:SIOTTB>2.0.CO;2

[60] S.-L. Chung, M.-F. Chu, Y. Zhang et al., "Tibetian Tectonic Evolution Inffered from Spatial and Temporal Variations in Post-Collisional Magmatism," Earth Scientific Review, Vol. 68, No. 3-4, 2005, pp. 173-196. doi:10.1016/j.earscirev.2004.05.001

[61] World stress map, "a Project of the Heidelberg Academy of Sciences and Humanities," In: O. Heidbach, M. Tingay, A. Barth et al., Eds., Commission for the Geological Map of the World, WSM Release 2008. http://www.world-stress-map.org

[62] Z. Shen, C. Zhao, A. Yin et al., "Contemporary Crustal Deformation in East Asia Constrained by Global Positioning System Measurements," Journal Geophysical Research, Vol. 105, No. B3, 2000, pp. 5721-5734. doi:10.1029/1999JB900391

[63] L. Xiao, C. Wang and F. Pirajno, "Is the Underthrust Indian Lithosphere Split Beneath the Tibetan

Plateau?" International Geology Review, Vol. 49, No. 1, 2007, pp. 90-98. doi:10.2747/0020-6814.49.1.90

[64] D. V. Rundquist, Yu. G. Gatinsky and S. V. Cherkasov, "The Natural Trans-Eurasian Divider: Structural and Metallogenic Evidences," Abstracts 32-IGC, part 2, Florence, Aug. 2004, p. 620.

[65] V. A. Sankov, A. I. Lukhnev, V. I. Melnikova et al., "Present-day Tectonic Deformations of the Southern Mounting Frame of the Siberian Platform from GPS Geodesy Data," Proceedings International Seminar On the use of space techniques for Asia-Pacific regional crustal movements studies, Irkutsk, August 2002, Moscow, GEOS, 2003, pp. 118-126.

[66] Yu. G. Gatinsky, T. V. Prokhorova, D. V. Rundquist and G.L.Vladova, "Zones of Catastrophic Earthquakes of Central Asia: Geodynamics and Seismic Energy," 2009. http://dx.doi.org/10.2205/2009ES000326

[67] A. Copley, "Kinematics and Dynamics of the Southeastern Margin of the Tibetan Plateau," Geophysical Journal International, Vol. 174, No. 3, 008, pp. 1081- 1100.

[68] S. I. Sherman, K. Zh. Semiyskiy and A. V. Cheremnykh, "Destruktive Zones and Fault-Produced Block Structures of Central Asia," Geology of Pacific Ocean, Vol. 16, No. 2, 2000, pp. 231-252.

[69] K. Zh. Seminskii, "Hierarchy in the Zone Block Lithospheric Structure of Central and Eastern Asia," Russian Geology and Geophysics, Vol. 49, No. 10, October 2008, pp. 771-779. doi:10.1016/j.rgg.2007.11.017

[70] A. M. Negredo, A. Replumaz, A. Villase?or and S. Guillot, "Modeling the Evolution of Continental Subduction Processes in the Pamir–Hindu Kush region," Earth and Planetary Science Letters, Vol. 259, No. 1-2, 2007, pp. 212-225. doi:10.1016/j.epsl.2007.04.043

[71] S. Li, M. J. Unsworth, J. R. Booker et al., "Partial Melt Or Aqueous Fluid in the Mid-Crust of Southern Tibet? Constraints from INDEPTH magnetotelluric data," Geophysical Journal International, Vol. 153, No. 2, 2003, pp. 289-304. doi:10.1046/j.1365-246X.2003.01850.x

[72] K. D. Solon, A. G. Jones, K. D. Nelson et al., "Structure of the Crust in the Vicinity of the Banggong-Nujiang Suture in Central Tibet from INDEPTH Magnetotelluric Data," Journal Geophysical Research, Vol. 110, No. B10102, 2005; doi:10.1029/2003JB002405

[73] Yu. G. Gatinsky and G. L. Vladova, "Subduction Zones of SE Asia: Main Types, Seismicity and Mineralization," Proceedings VAG International Symposium, Hanoi, November 2008, pp. 9-16.

[74] J. Liu-Zeng, Z. Zhang, L. Wen et al., "Co-Seismic Ruptures of the 12 May 2008, Ms 8.0 Wenchuan Earthquake, Sichuan: East–West Crustal Shortening on Oblique, Parallel Thrusts Along the Eastern Edge of Tibet," Earth and Planetary Science Letters, Vol. 286, No. 3-4, 2009, pp. 355-370. doi:10.1016/j.epsl.2009.07.017

[75] Yu. G. Gatinsky, D. V. Rundquist, G. L. Vladova and T.V. Prokhorova, "Geodynamics of the Sichuan Earthquake Region in May 12, 2008," Doklady Earth Sciences, Vol. 423A, No. 9, 2008, pp.1507-1509. doi:10.1134/S1028334X08090419

[76] X. Yuan, A.S. Egorov, GEMOC, "A Short Introduction to Global Geoscience Transect 21: Arctic Ocean–Eurasia– Pacific Ocean," Science Press, 2000.

[77] Chen Ji, "Finite Fault Models for M7.9 Earthquake," 2008. http://earthquake.usgs.gov/eqcenter/page

[78] A. I. Miroshnichenko, V. A. Sankov, A. V. Parfeevets and A. V. Lukhnev, "State of Stress and Strain of the Earth Crust of the Basins of North Mongolia from the Model Results," Proceedings Conference commemorating the 50th anniversary of the 1957 Gobi-Altay earthquake, Ulaanbaatar–Irkutsk, August. 2007, pp. 138-143.

[79] A. F. Grachev, "Modern Volcanism, Mantle Plumes, and Their Connection with the Stress Intensity in the Lithosphere", In: A. F. Grachev, Ed., Neotectonics, Geody- namics and Seismicity of Northern Eurasia, Probel, Moscow, 2000, pp. 245-266 (In Russian).

[80] H. Kanamori and D. L. Anderson, "Theoretical Basis of Some Empirical Relations in Seismology," Bulletin of the Seismological Society of America, Vol. 65, No. 5, October 1975, pp. 1073-109.