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Zones of catastrophic earthquakes of Central Asia: Geodynamics and seismic energy

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Central parts of the Asian continent are characterized by abnormally high seismic activity, which spreads not only along collision and subduction zones but also at withdrawal from them in inner continental regions. The majority of earthquakes' epicenters are situated along active faults, indicating boundaries of blocks in transit zones, which divide the main lithosphere plates and provide transfer and relaxation of tectonic stresses that arise between them. Such zones partly coincide to well known "diffuse plate boundaries". In central and east Asia there are the Central Asian, East Asian, and some smaller transit zones, which consist of numerous crust or crust-mantle blocks. Block boundaries are represented in the zones by not only single faults, but often by relatively wide interblock zones. Just in these zones movements of blocks and plates are realized as accumulation of the tension, which relaxes in the future as earthquakes, including the majority of catastrophic events. One can see in such zones a certain analog of transit zones between main plates that reflects a fractal structure of the continental lithosphere. Maximal volumes of the seismic energy release within interblock zones limiting such blocks as Pamir, Tien Shan, Bayanhar and the north boundary of the Indian Plate in the Central Asian Transit Zone, as well as within boundaries of the Japanese-Korean Block and partly the NW boundary of the Amurian Block in the East Asian Zone. Interblock zones in our interpretation are partly similar to "destructive zones of lithosphere" and "mobile zones", which also divide blocks of different sizes according to other scientists. Our investigation is devoted to the detaile examination of the most active interblock zones, distinguishing levels of the maximal seismic energy releasing in them and regularities of its dissipation. The examination of the zones is closely connected with the prediction of catastrophic earthquakes' possibility in some regions of central Asia that can be demonstrated at the example of the Wenchuan earthquake in south China in May 2008. *KEYWORDS:* Central Asia, earthquakes, geodynamics, seismic energy, catastrophic event, transit zones, interblock zones of lithosphere.

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Introduction

Lithosphere plates were regarded in first publications on the plate tectonics as single and indivisible. At the same time, the well-known inhomogeneous tectonic structure of continents allows to suppose the inhomogeneous geodynamic structure of main continental lithosphere plates. Later some microplates were established by seismic data first of all within the Eurasian Plate: Amurian, Indochina's, Okhotsk and others. According to GPS data different parts of main plates displace in diverse directions. Moreover, the high seismicity characterizes not only plate boundaries, but often is distributed at considerable distance from them in inner parts of plates. Central Asia is one of the most characteristic examples of such distribution (Figure 1). D. Rundquist established so-called triangle of the maximal inner continen-

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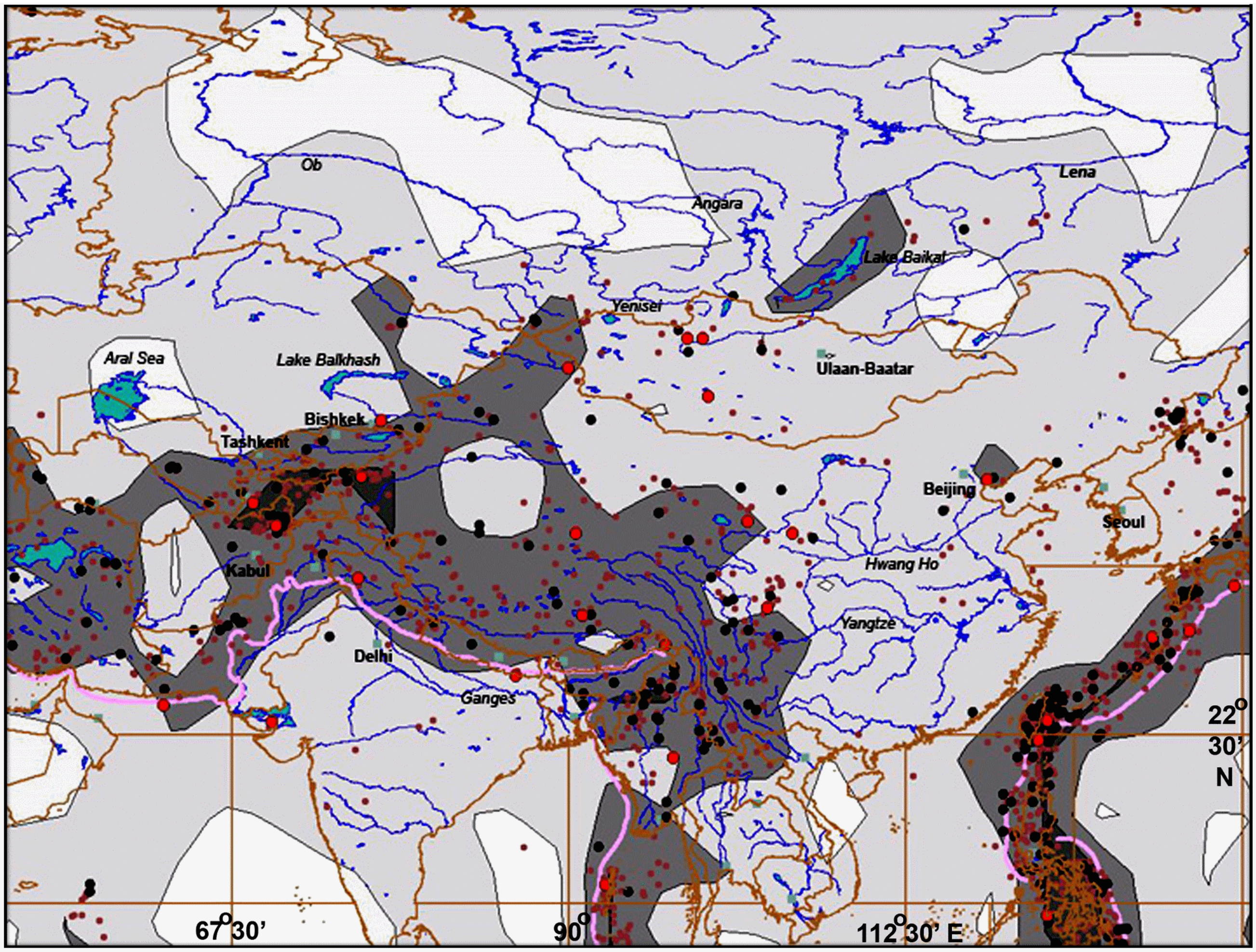

Figure 1. Density of earthquake's epicenters in central and east Asia: white fields – < 1 in 20 years, light-gray – ≥ 1 in 20 years, gray – ≤ 1 in 5 years, and dark-gray - > 1 in 5 years. Epicenters are shown by dotes (NEIC): brown (M=6–6.9), black (7–7.9), and red (≥ 8). Pink line – plate boundaries.

tal seismicity there with the vertex near the Lake Baikal and the base along the Himalayas [*Rundquist and Gatinsky,* 2003]. By the way, the bisectrix of the vertex coincides with the GPS vector of the Indian Plate (Figure 2). Some years ago it was shown on the basis of seismicity, active faults and GPS data that only the northern part of the Eurasian Plate should be regarded as an independent and relatively indivisible lithosphere unit, which was named the North Eurasian Plate [*Gatinsky and Rundquist,* 2004; *Rundquist et al.,* 2005]. The smaller blocks limited by active faults were established south and east of this plate. They reveal local divergences in vector azimuths and velocities as in the ITRF system as in respect to stable Eurasia.

Some scientists noted illegibility, "washing away" and high penetrating of boundaries between main plates and named them "diffuse boundaries" [*Wiens et al.,* 1985]. Primarily such boundaries were established for the Indian Plate, later there was shown their abundance. This aspect was based on space geodetic data [*Gordon and Stein,* 1992], plate non-rigidity [*Gordon,* 1998], isostasy data [*Watts,* 2001], digital modeling [*Bird,* 2003]. Yu. Gatinsky together with coauthors proposed to name territories with block mosaic development as "transit zones" [*Gatinsky et al.,* 2004, 2005, 2008a], because they divide large lithosphere plates and provide transfer and/or relaxation of tectonic stresses that arise between those plates. A preliminary investigation has established transit zones dividing main lithosphere plates of central Asia. The Central Asian Zone is situated between the North Eurasian and Indian plates; the East Asian Zone divides the North Eurasian Plate and some plates of the Pacific Region. Each of zones consists of numerous blocks, the independent existence of which is proved by the widespread development of active faults ascertaining geodynamic heterogeneity of central Asia (Figure 3). In our paper we'll try to establish the connection of catastrophic earthquakes with the block structure and geokinematics.

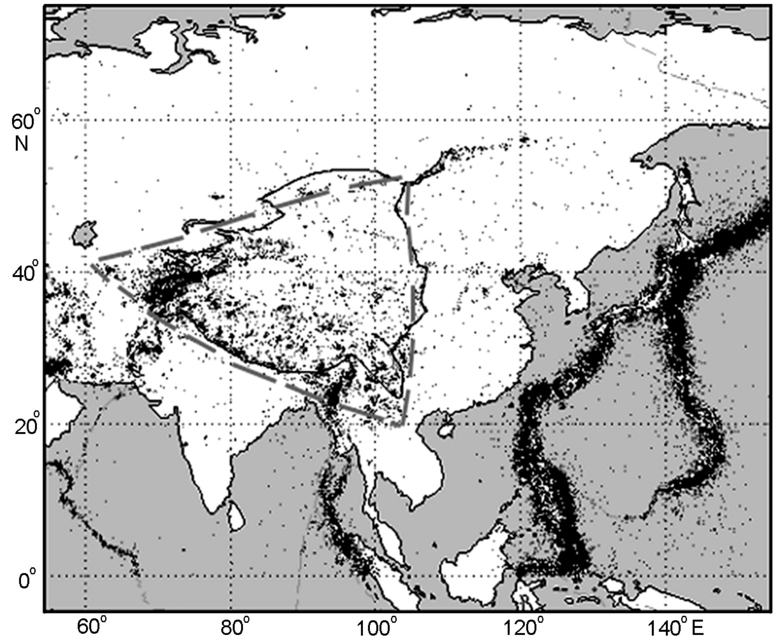

Figure 2. "Triangle" of maximal intra-continental seismic activity of central Asia. Points – epicenters of earthquakes with $M \geq 4$. Thin black line – boundaries of the central Asian transit zone.

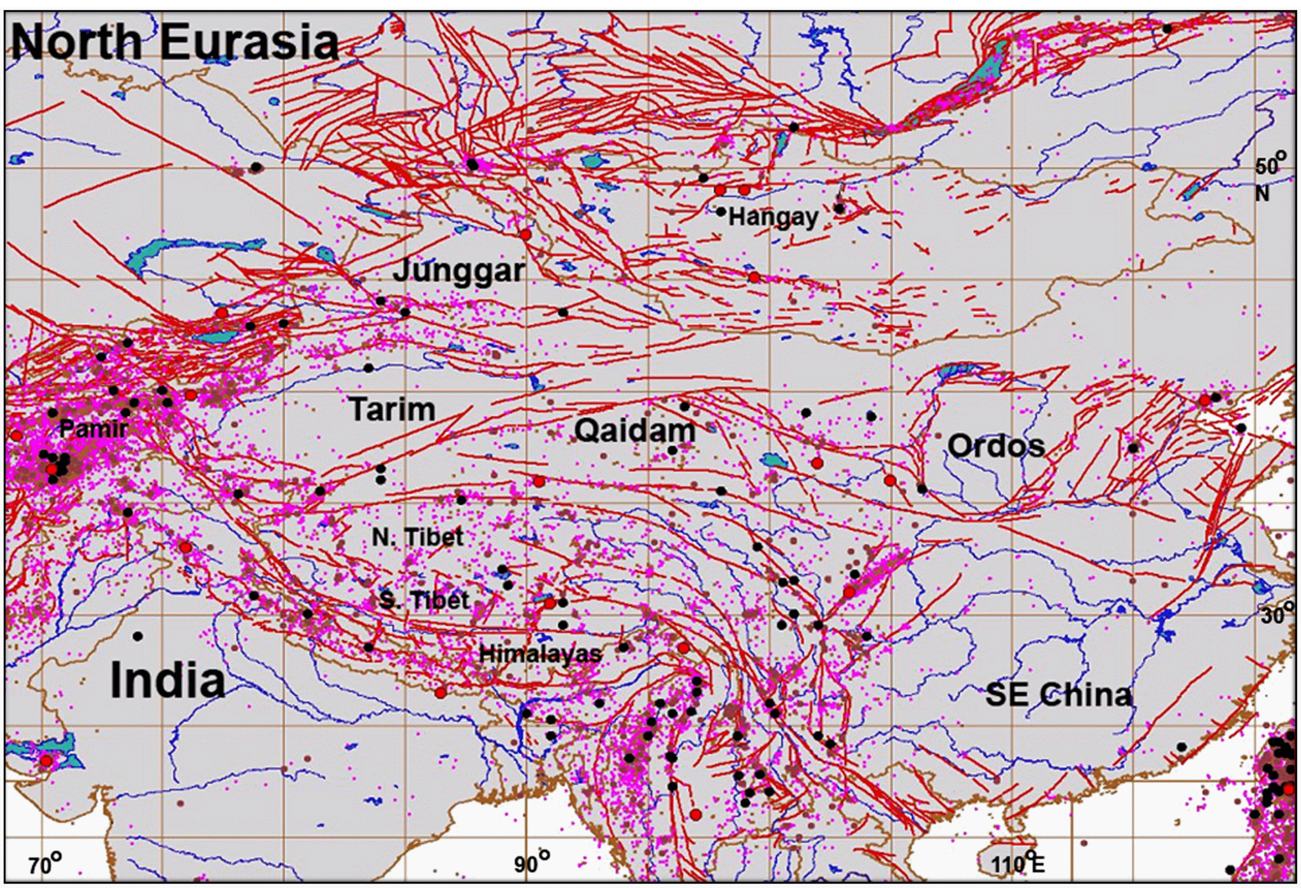

Figure 3. Active faults of central Asia after [*Xu and Deng,* 1996; *Trifonov et al.,* 2002]. Earthquake epicenters after NEIC Catalog are shown. Note, main blocks of the region are clearly visible because of their limiting by these faults.

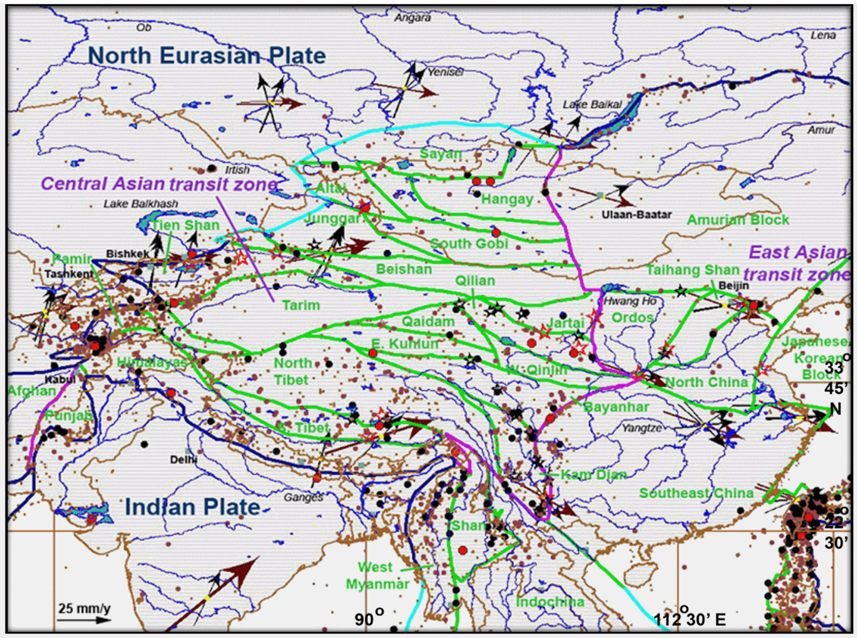

Figure 4. Up-to-date geodynamics of central Asia. Epicenters with M: red > 7.9, black 7.0–7.9, brown 6.0–6.9 (larger) and 5.0–5.9 (smaller). Asterisks – historical epicenters after [*Xu and Deng,* 1996]. Brown arrows – GPS2005 vectors (ITRF). Black arrows – model vectors with respect to stable Eurasia. Boundaries: blue – plate, violet – transit zone, green – block, light blue – supposed boundaries.

Modern geodynamics of central Asia

The most part of the Central Asian Zone undergoes the compression under the influence of the gigantic Hindustan Block with development of the transpressive tension. A predominance of strike-slip faults and thrusts from Tibet to Tien Shan and Altai confirms these tectonic conditions together with submeridional and NNE model vectors of horizontal displacement (Figure 4). Velocities of model displacements with respect to stable Eurasia decrease from 30–35 mm/yr near the collision zone up to 4–10 mm/yr north in the Sayan Block. Experimental vectors in the ITRF system are directed mainly northeast with velocities from 48 mm/yr in the south of Tibet up to 23–25 mm/yr withdrawn from the collision zone. After calculations of Yu. Tyupkin [*Gatinsky et al.,* 2005] a module of deviation of experimental vectors from model ones diminishes linearly at a distance from the Indian Plate boundary. The module diminishing in the first approximation is correlated with the decrease in intensity of seismic-energy release within the zone. But sometimes the maximal quantity of the energy releases in inner parts of the transit zone at the distance 500–1500 km from the plate boundary.

At the same time model vectors form a characteristic divergence with a west deflection (10°NE – 350°NW) near the west syntax of the Himalayas in NW Tibet and Tien Shan and east deflection up to 50–70°NE and more near the east syntax in SE Tibet, Qaidam and Sichuan. Such divergence confirms Tibet "crawling off" with rifting its central parts connected perhaps with moving aside of the crust material in front of the Indian indenter [*Shen et al.,* 2000], including a possible influence of stress from the relatively rigid Tarim Block. Some geologists explain the vectors divergence by a slab tear model, in which the Indian lithosphere has split into two slabs: a northward-moving slab subducting steeply beneath the western sector of the Tibet Plateau, and a northeastward-moving slab subducting at a low angle beneath the eastern sector of the Plateau and the Three Rivers Region [*Xiao et al.,* 2007].

Space-geodetic data on the East Asian Transit Zone differ noticeably from above-mentioned results (see Figure 4). Experimental ITRF vectors are directed mainly 106–121°SE with velocities 26–35 mm/yr east of the 102–103°E lineament, which was established in the work [*Rundquist et al.,* 2004]. A transtension tectonic regime predominates here with development of numerous rifts in the Baikal System, around the Ordos Block, inside the Japanese-Korean and SE China blocks. Such sharp change of vectors direction has different explanations: squeezing out some blocks including Amurian one to the east under influence of the collision process [*San'kov et al.,* 2005], rising of mantle plumes underneath North Mongolia and the Lake Baikal [*Grachev,* 2000], a gravitational rolling down of crust layers from the highly emerged Tibet Plateau [*Copley,* 2008].

Interblock zones and their seismicity

Block boundaries as a rule are characterized by intensive seismicity, which takes place along relatively narrow interblock zones with predominant width of fifty – one hundred kilometers (Figure 5). They are characterized by an

Figure 5. Catastrophic earthquakes in central Asia. Thin yellow lines are approximate boundaries of interblock zones. Catastrophic events of 2007–2008 are enlarged. For epicenters see Figure 4.

intensive shattering of rocks together with releasing a significant quantity of seismic energy and so can be regarded as seismically dangerous. The depth of hypocenters within interblock zones is mainly 20–40 km that proves non-dip penetration of these zones in the lithosphere. Much rarely it can reach 80–240 km (Pamir). Interblock zones in our interpretation are closely similar to "destructive zones of lithosphere" [*Sherman et al.,* 2000] and "mobile zones" [*Seminsky,* 2008], which also divide blocks of different sizes. Just these interblock zones include epicenters of the majority of the most intensive earthquakes according to instrumental and historical data. Among them such catastrophic events of 2008 year can be mentioned as in west Tibet in March (M=7.3), in the Sichuan Province in May (M=7.9), in the south of the Lake Baikal in August (M=6.3) and some others. We calculated the volume of seismic energy releasing in the majority of interblock zones of central Asia. The most active zones limit such blocks as Pamir, Tien Shan, the Himalayas, north

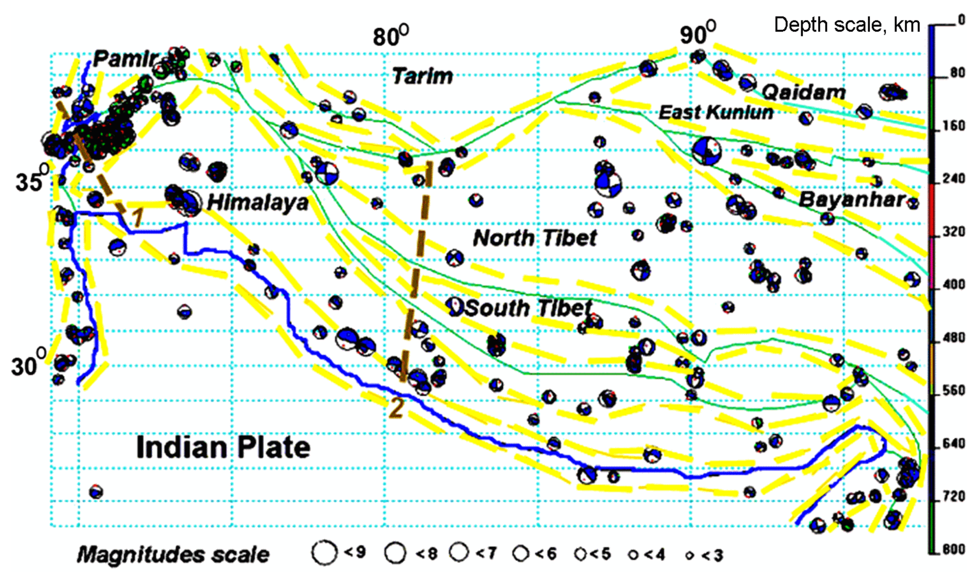

Figure 6. Seismicity of Pamir, the Himalayas, and Tibet. Boundaries: thick blue – plate, light blue – block, yellow dotted – interblock zones. Some transects are shown across interblock zones.

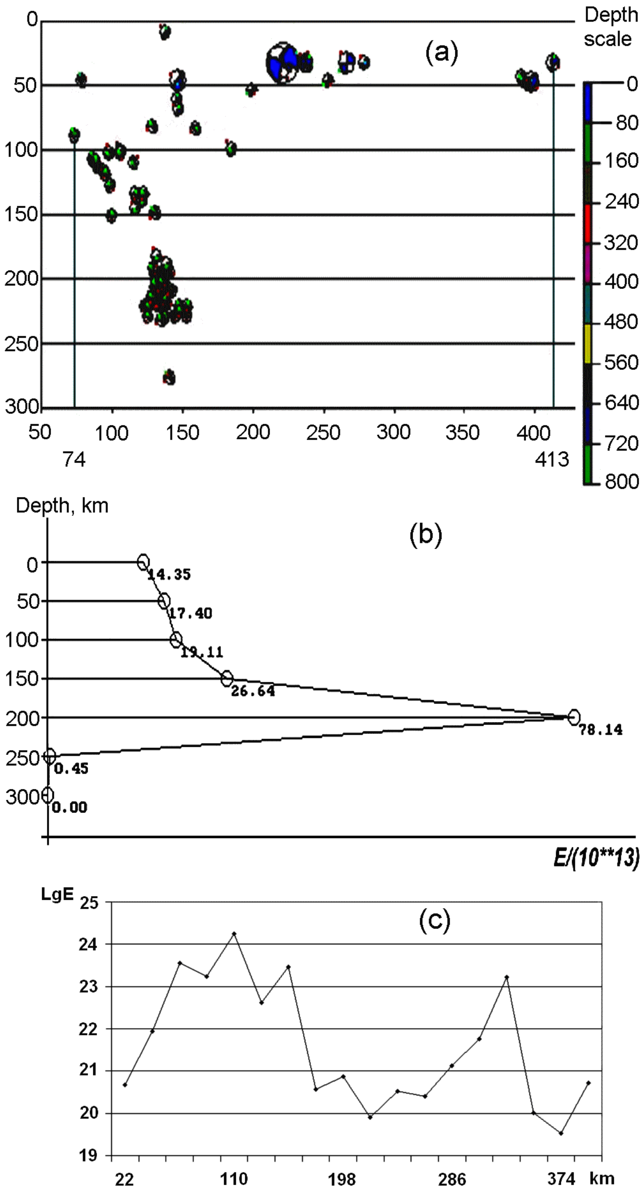

Figure 7. Depth (km) of hypocenters (a), changing of the seismic energy volume (J) with the depth (b) and graph of seismic energy dissipation (c) along transect 1 through west Pamir. Note the maximal energy releasing in the south, where the deepest earthquakes are situated. The north here and in the next figures is on the right.

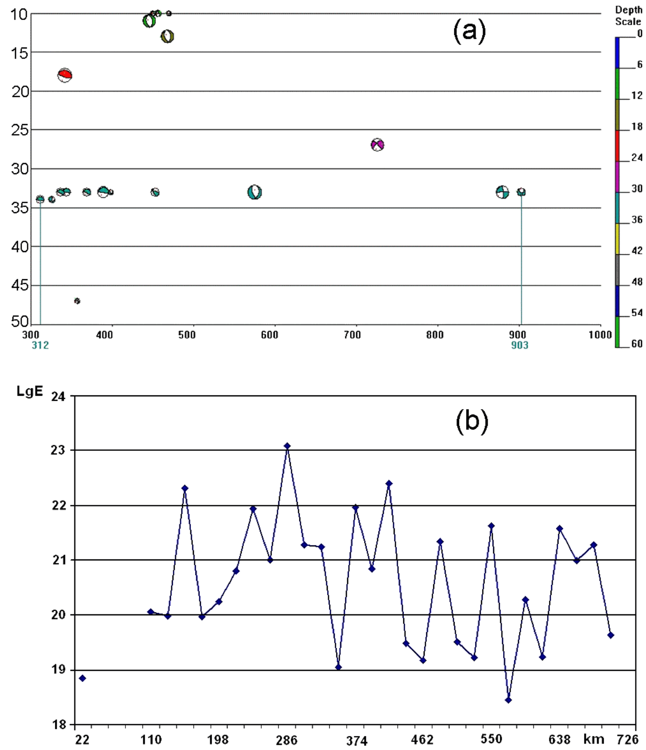

Figure 8. Depth (km) of hypocenters (a) and graph of seismic energy dissipation (b) along transect 2 through the central Himalayas. The volume of releasing energy decreases gradually at withdrawal from the collision zone.

Tibet, and Bayanhar. A volume of the seismic energy releasing along each of them reaches $\geq 5 \times 10^{15}$ J (Table 1), while along other boundaries it doesn't exceed $3 \times 10^{12} - 2 \times 10^{15}$ J. Making this calculation we took 50-km bands on both sides of boundaries. The same interblock zones are characterized by a maximal specific energy par 1 km of their length ($> 4.5 \times 10^{12}$ J) and by a maximal deviation of GPS vectors from average vector values of main plates. Some transects were constructed across mentioned interblock zones for examination of them in detail (Figure 6).

Two focal plane can be seen in the first transect through west Pamir. The south plane dips steeply north with maximal energy releasing at two hundreds kilometers depth. Hypocenters along this plane have the maximal depth in central Asia (160–240 km). Some catastrophic earthquakes took place at different time just along the south transit zone of the Pamir Block: one with magnitude more than 8 and several with magnitude more than 7. Focal mechanisms show the predominance of the compression together with local left-lateral strike-slips (Figure 7). The hypocenters are shallower (up to 40–80 km) in the north boundary of Pamir with the North Eurasian Plate, where also the compression predominates over the south-dipping Benioff Zone. The analysis of seismic tomography data together with rheology modeling [*Negredo et al.,* 2007] shows a rapider and steeper dipping subduction of the Indian slab in the south and slower and slightly sloping of the Eurasian one in the north. A graph of energy dissipation proofs the most activity of the south zone, which corresponds to the deeply situated slab of the Indian Plate.

Another picture can be seen in the second transect through the west part of the central Himalayas and Tibet (see Figure 6). The majority of hypocenters lie there at the depth not deeper than thirty-five kilometers corresponding to rather shallow seismofocal plane. It dips north from 18 to 33 km at the angle not more than 2–3°(Figure 8). Incidentally almost all-seismic energy (83.3×10^{13} out of 87×10^{13} J) releases

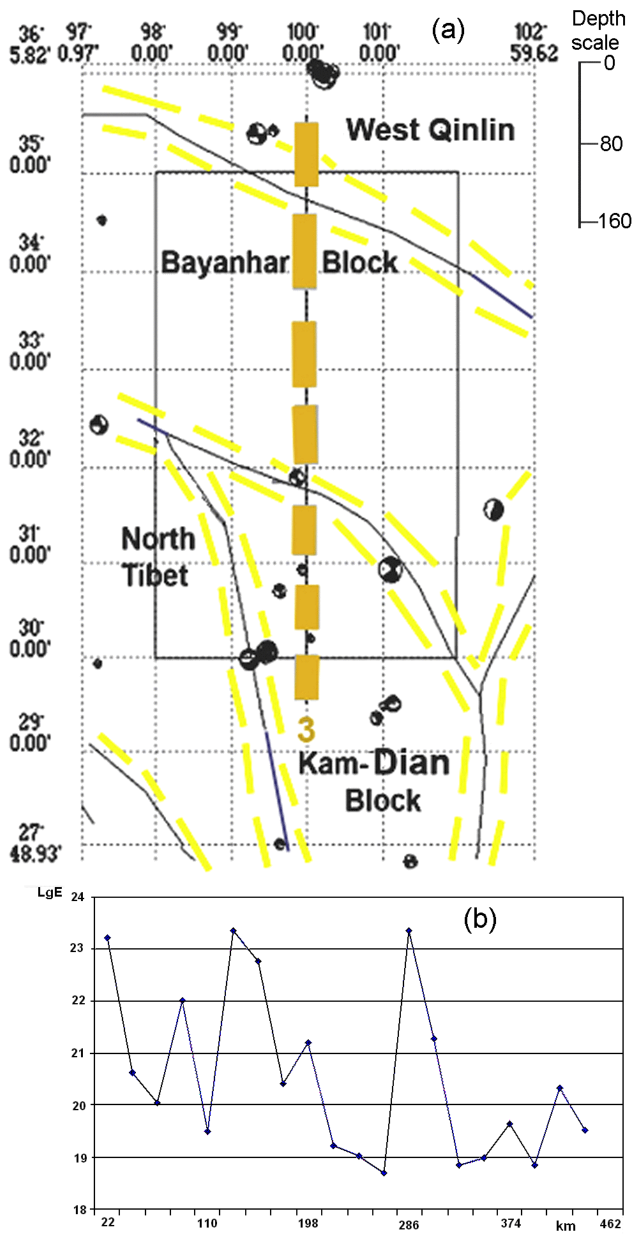

Figure 9. Transect 3 through Kam-Dian, Bayanhar, and the south part of west Qinlin blocks (a) and the graph of seismic energy dissipation along the transect (b). The energy releasing increases in interblock zones (yellow boundaries).

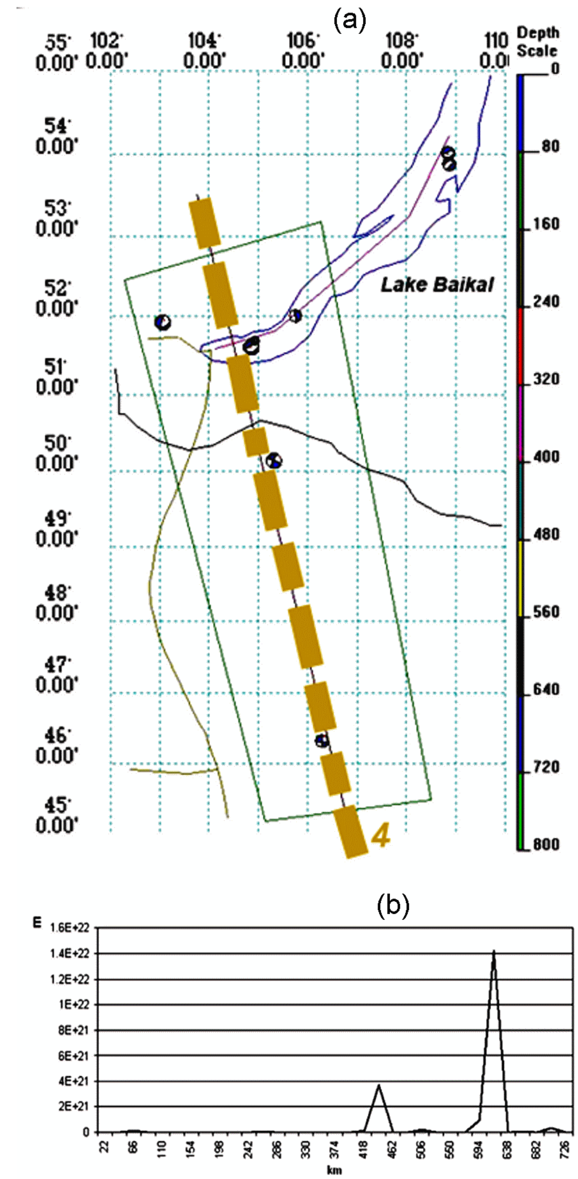

Figure 10. Transect 4 through the boundary of the North Eurasian Plate and Amurian Block (a) and the graph of seismic energy dissipation along the transect (b). Note increasing energy release in the north at boundary faults of the Baikal Rift System. In this figure the graph of energy dissipation is prepared not in $\log E$, as in previous figures, but in absolute values of the energy.

in the most surface levels. It is connected with the slopping dip of the Indian slab under Eurasia in the collision zone. Note that visibly consistent seismic level on 32–34 km corresponds in reality to hypocenters, which precise depths are not established for. They automatically get to this level in processing an electronic graph construction. The calculation of the seismic energy dissipation shows approximately uniform its distribution along the transect two. Only rather small decreasing can be seen in the north direction with fluctuation of log E values between 23.0–18.05.

The extension can be seen in the central part of the transect 2 by mechanism' solution on near surface level within north Tibet (see Figure 8a). It is connected with up-to-date rifting processes mentioned in the previous chapter. According to NEIC data the shallow-focus seismicity characterizes interblock zones of the central Himalayas and the both Tibet blocks nearly along the whole their length. It is in conformity with the shallow sloping dip of the Indian slab and existence of partial melting zones in the upper crust as it follows out of INDEPTH data [Li et al., 2003; Solon et al.,

Table 1. Interblock zones of Central and East Asia with releasing specific seismic energy more than 5×10^{12} J per 1 km

Boundaries of blocks	Total energy, J	Boundaries length, km	Specific energy, J
Punjab – Indian Plate	6.99689×10^{15}	1305	5.361×10^{12}
Himalayas – Indian Plate	2.94412×10^{16}	3094	9.515×10^{12}
Pamir – Himalayas	5.43111×10^{15}	532	1.021×10^{13}
Pamir – North Eurasian Plate	7.26692×10^{15}	504	1.443×10^{13}
Tien Shan – North Eurasian Plate	5.63879×10^{16}	1421	3.968×10^{13}
Tien Shan – Tarim	4.84380×10^{16}	1683	2.877×10^{13}
Bayanhar – East Kunlun and West Qinlin	6.37592×10^{16}	1599	3.987×10^{13}
Bayanhar – North Tibet	6.35765×10^{16}	957	6.642×10^{13}
Bayanhar – Kam-Dian	9.24193×10^{15}	540	1.711×10^{13}
Amurian – Japanese-Korean	6.63646×10^{16}	3205	2.070×10^{13}
Andaman's-West Myanmar – Indian Plate	2.44456×10^{16}	2639	9.262×10^{12}
Shan – Indochina-Sunda	8.54442×10^{15}	1443	5.923×10^{12}
North Japan – Japanese-Korean	4.17527×10^{16}	804	5.193×10^{13}
Ryukyu-Central Honshu – Japanese-Korean	1.97364×10^{16}	2774	7.114×10^{12}

2005]. Numerous catastrophic events took place within interblock zones dividing Himalayas, South and North Tibet blocks: Bihar (M=8.1) in 1934, Zhamo (M=8.6) in 1950, Lunggar (M=6.8) in August 2008, series of strong earthquakes in west and central Tibet during May 2007 – March 2008 with magnitudes 6.1–7.3 (see Figure 5).

Picks of the energy volume along the third transect through the Bayanhar Block coincide with boundary faults in SW and NE interblock zones, which characterized by contrast increasing of $\log E$ values up to 23.5–24.0 (Figure 9). The total quantity of the energy ($6.358 - 6.376 \times 10^{16}$ J) releasing along each of these zones, dividing the block from east Kunlun, west Qinlin, north Tibet, and Kam-Dian or Kam-Yunnan, is only in 2.5 lesser than energy of one of the most active north Japan subduction zone (15.332×10^{16} J) and a little more than total energy along all north boundary of the Indian Plate ($\geq 6.096 \times 10^{16}$ J). At the same time it is by order greater than the energy of relatively weakly active subduction zones, for example, south Ryukyu (7.913×10^{15} J).

Therefore, the most active interblock zones of central Asia differ from subduction and collision zones mainly by the depth of their penetration in the lithosphere and underlying upper mantle and are rather near to them by the volume of releasing seismic energy. Some intensive earthquakes

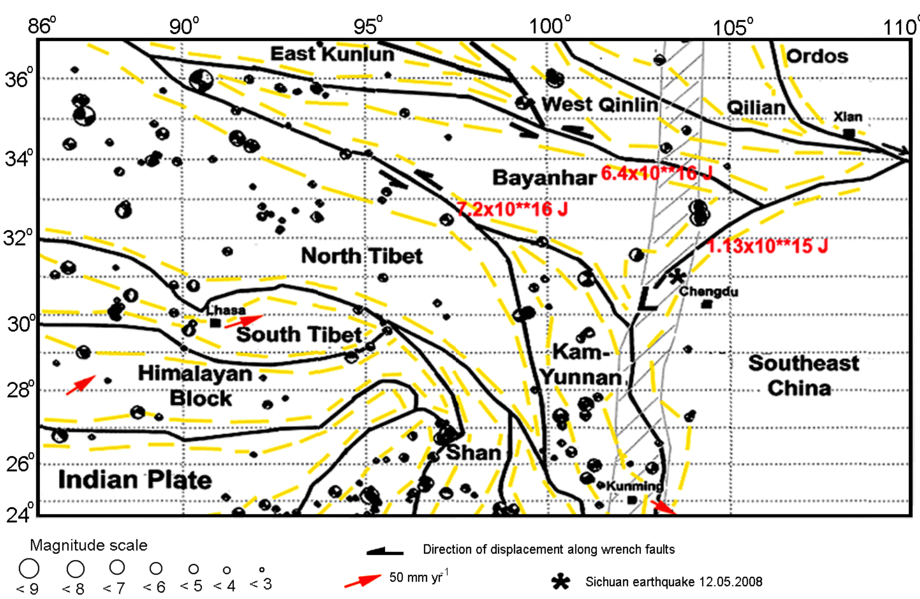

Figure 11. Geodynamics of the Bayanhar Block and adjacent areas. Red arrows – GPS vectors in ITRF system. Yellow dotted lines – boundaries of interblock zones. L – Longmen Shan Fault. The hatched stripe corresponds to the lineament of 102–103°E. Values of the seismic energy are shown for interblock zones of the Bayanhar Block.

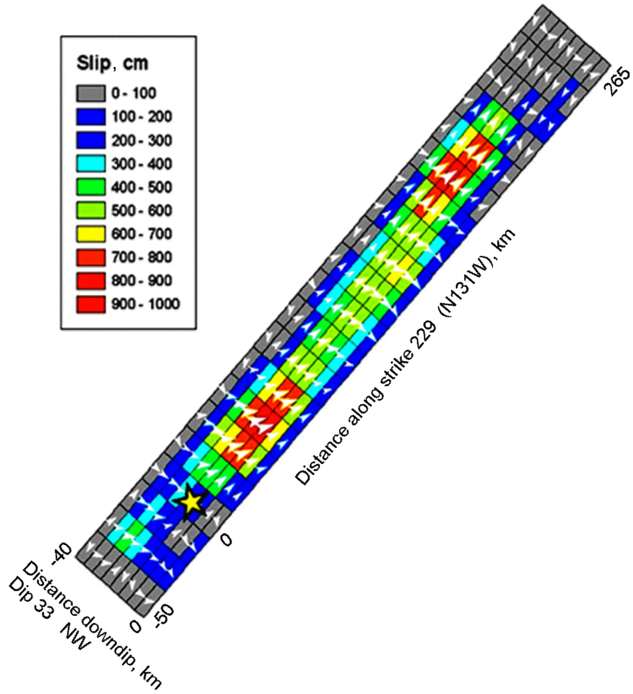

Figure 12. The finite fault model [*Chen Ji,* 2008] of the Wenchuan earthquake confirms clock-wise rotation of the Bayanhar Block along the Longmen Shan Fault. The yellow asterisk – epicenter of the earthquake.

with $M > 7$ took place along southwest and northeast interblock zones according to historical and instrumental data, but the most catastrophic Wenchuan event occurred in May 2008 within the less active southeast interblock zone of the Bayanhar Block. It will be considered in the next special chapter of the paper.

Besides above-mentioned high-energy interblock zones it necessary to name some others, a specific energy of which comes after our calculation to $1.0-4.5\times10^{12}$ J. They stretch along boundaries of Sayan, south Tibet, NW side of the Amurian Block and also can be regarded as potentially dangerous (see Figure 5). The latter boundary coincides with the Baikal Rift System. The tectonic tension changes along it from predominating left-lateral strike-slips in the east near Olekma River to strike-slips with extension west in Baikal and neighboring depressions [*San'kov et al.,* 2005; *Parfeevez and San'kov,* 2006]. Further west strike-slips with compression and thrusting predominate. So a change of the transtension regime by transpression one takes place along the sys-

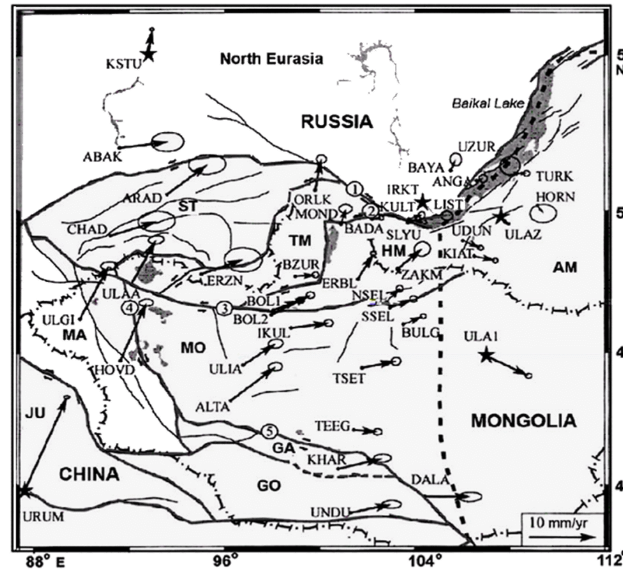

Figure 14. Experimental vector velocities field (GPS) after measurements in the Baikal, Mongolian and Tuva polygons (1994–2002) after the work [*San'kov et al.,* 2005]. Vectors of displacement relatively IRKT point are given with 95% confidence ellipses. Asterisks mark points of the global IGS network. Clock-wise vectors' rotation is clearly shown.

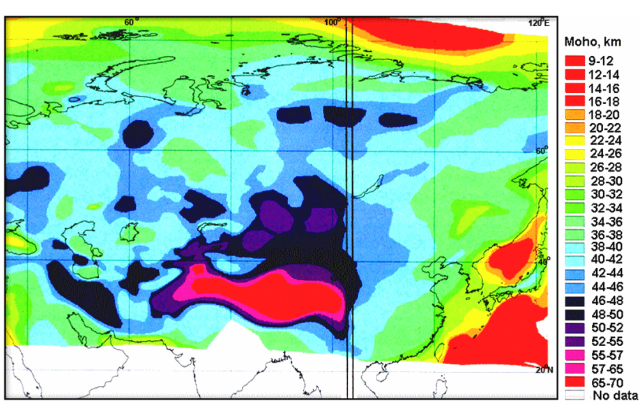

Figure 13. Crust thickness in central and east Eurasia. Note the existence of sharp step between Tibet and SE China, which the 102–103°lineament coincides with (a double black line).

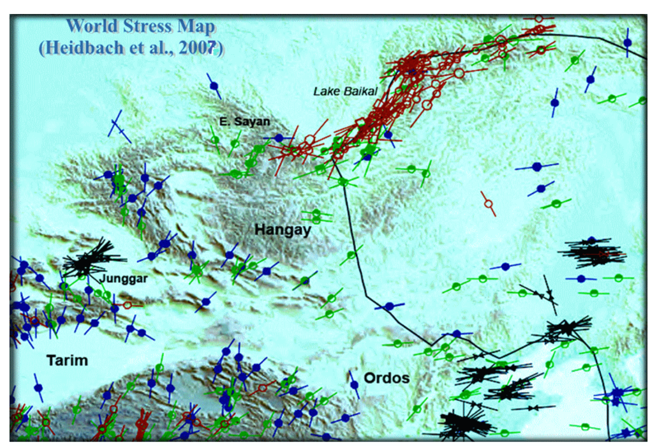

Figure 15. Fragment of the World Stress Map [*Heidbach et al.,* 2007] for the Baikal rift zone and adjacent territories. Axes of stress direction correspond to: red – normal faults, green – strike-slips, and blue – thrusts.

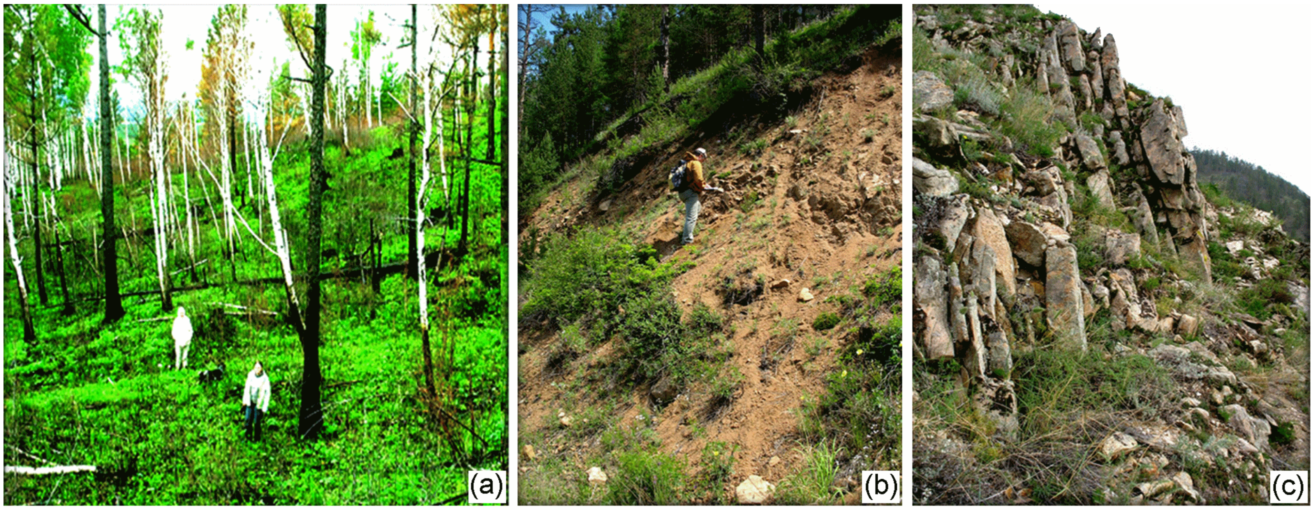

Figure 16. Holocene seismic dislocation in the north side of the Tunka Trough (a).A displacement of a streamlet thalweg along a left-lateral strike-slip can be seen. Amplitude of displacement reaches about 10 m (between girls). Normal faults replace strike slips near the Lake Kolok at the east side of the Baikal Rift (b) and at the west side of the Barguzin Trough (c), where they disturb the Paleozoic granite.

tem. A contraction of crust reaches 2–4 mm/yr at boundaries of the Sayan Block [*San'kov et al.,* 2003]. After our calculations a maximal increasing of the seismic energy volume (up to 1.4×10^{15} J) takes place near SW end of the Lake Baikal under normal faults limiting the rift depression, where the extension predominates and the depth of hypocenters reaches 10–34 km. The Kultuk earthquake with magnitude 6.3 took place there in August 2008. Peaks of the seismic energy can be seen in the graph of dissipation within fault zones limited the Baikal rift (Figure 10).

Catastrophic earthquakes and blocks' kinematics

Sharp increasing of the seismic energy quantity is closely connected in interblock zones with mobility of blocks and anomalies of the lithosphere structure. Let's examine it on examples of two regions of catastrophic events – SE part of the Bayanhar Block and NW side of the Amurian Block. Mechanism solutions show the left-lateral strike-slip displacement in the NE and SW interblock zones of the Bayanhar Block (Figure 11]. This allows supposing its clock-wise rotation. As a result the compression arises in the southeast boundary of the block, where the disastrous Wenchuan earthquake (M=7.9) took place in May 2008. This boundary stretches along the large Longmen Shan Fault. Thrusting to the SE China Block occurs there according to geological data [*Xu and Deng,* 1996]. Field investigations immediately after the earthquake showed a strong horizontal shortening along the NW-dipping rupture with thrusting to south-east together with small dextral slipping [*Liu-Zeng et al.,* 2009].

A volume of the total seismic energy releasing in the east boundary of the Bayanhar Block comes only to 1.131×10^{15} J beginning from 1976 (without the latest events in 2008). Apparently a period of the relative "seismic gap" takes place there since the last strong earthquake (M=7.4) occurred in 1973. The slow accumulation of the seismic energy during that period was relaxed by the catastrophic Wenchuan earthquake in May 2008. Experimental GPS vectors confirm the clock-wise rotation of the Bayanhar Block (see Figure 11). It is likely also that only upper part of the crust participates in such rotation, because low velocity layers are established by seismic tomography data in the east half of the Bayanhar Block at the depth 20–30 km [*Yuan et al.,* 2000].

A clock-wise rotation of this part of central Asia is proved also by the finite fault model, fulfilled by Chen Ji for the Wenchuan earthquake (Figure 12). Some researches suppose that a change of vectors is connected with the crust layering and layers rolling down from the highly emerged Tibet Plateau [*Copley,* 2008]. Results of INDEPTH seismic and magneto-telluric soundings give indirect evidences of such process. They establish some layers of increased plasticity and partial melting of rocks in the Tibet crust at the depth twenty – thirty kilometers [*Li et al.,* 2003; *Solon et al.,* 2005]. The southeast boundary of the Bayanhar Block coincides with the sharp step in the crust (Figure 13) and in the whole lithosphere along the lineament of 102–103°E [*Rundquist et al.,* 2004] with decreasing their thickness to the east.

The above-mentioned lineament stretches north through north China, central Mongolia, and SW edge of the Lake Baikal, where the Kultuk catastrophic earthquake took place in 2008. Irkutsk scientists [*San'kov et al.,* 2005] established there the predominant clock-wise rotation by the data of a local GPS net (Figure 14). Such change of GPS vector directions is corroborated by the change of the tension regiment west and east of the south edge of the Lake Baikal (Figure 15). Some authors of this paper together with ge-

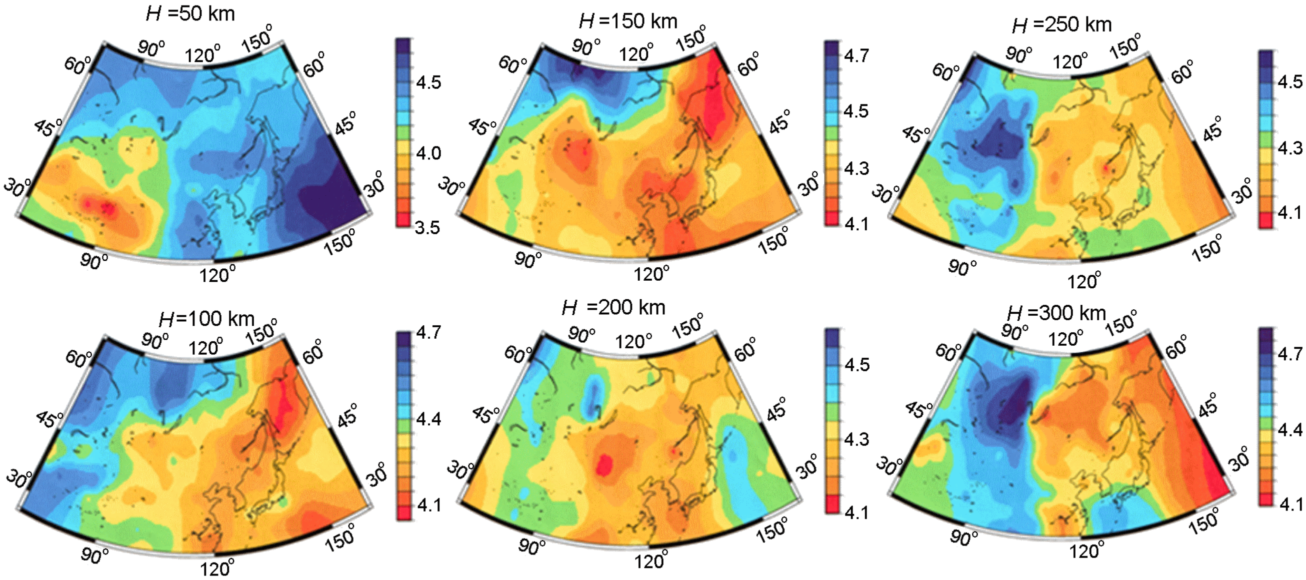

Figure 17. The distribution of S-waves velocities in the crust and upper mantle under central and east Asia after work [*Kozhevnikov and Yanovskaya,* 2005]. Their slowing-down up to 4.10–4.05 km $\sec^{-1}$ can be interpreted as a top of rising mantle plume south and SE of the Lake Baikal on the depth levels 100–200 km.

ologists of the Irkutsk Earth Crust Institute RAS fulfilled field itineraries in the summer of 2008 on the NW boundary of the Amurian Block. Transpressive tensions predominate in the west of this area in the Tunka trough, where left-lateral strike-slips are developed. More to west in the Sayan Mountains they are accompanied by thrusts to the north (see Figure 15). Strike-slips result in the Tunka trough in displacement of streamlet thalwegs (Figure 16a) and left lateral moving along the Main Sayan Fault after earthquake mechanisms. But incidentally in the east strike-slips are replaced by later normal faults in flanks of the Barguzin Depression, which is included in the Baikal Rift System east of the Lake Baikal. The earlier strike-slips give rise to some seismic dislocations displacing thalweg of right lateral tributaries of the Barguzin River. Normal faults disturbing those strike-slips go through all rocks from the Paleozoic granite to the Quaternary alluvium (Figure 16b,c).

The mantle plume formation can be one more cause of the high seismicity in the Baikal Region. It is supposed by S-waves velocities distribution (Figure 17). We tried to superpose their moderation projection with maximal heat flow anomalies and earthquake distribution. It is most probably that in this part of central Asia more intensive seismicity coincides with the asthenosphere roof rising (Figure 18).

Therefore, the significant change of horizontal displacement direction is established for blocks of the investigated part of central Asia. It most probably has direct influence in the distribution of catastrophic earthquakes arising together with anomalies of the lithosphere deep structure. Submeridional and NNE vectors predominate in the Central Asian Transit Zone, where the transpressive neotectonic regime prevails. At the same time mainly east and southeast directed vectors are distributed in the East Asian Zone in conditions of the transtensive regime. Such inference coincides with the more detail analysis of recent kinematics in the Baikal Rift System and adjacent territory. The majority of catastrophic seismic events in intra-cratonic environment of central Asia are connected with active zones, which divide crust or mantle-crust blocks. The tectonic energy relaxation due to interaction of main lithosphere plates takes place not only in their boundaries, but also in those interblock zones as a result of interaction between blocks.

Note one more peculiarity of the seismic energy distribution within the examined area. Blocks, which are bounded by high seismic interblock zones, not always have the high density of the energy inside them. The energy density for such blocks as Pamir, Tien Shan and Himalayan comes to $1.67 - 1.98 \times 10^8$ J km^{-2} yr^{-1}. At the same time for Tarim, Qaidam and Tibet it comes to $0.38 - 0.51 \times 10^8$, but for Amurian and Indochina-Sunda blocks only $0.05 - 0.15 \times 10^8$. In comparison with that the energy density reaches $3.91 - 12.1 \times 10^8$ J km^{-2} yr^{-1} for Philippine blocks over the Pacific subduction zone. Authors fulfilled all calculations of the seismic energy in the paper.

Conclusion

1. The significant change of horizontal displacement direction is established for blocks of the investigated region. Submeridional and NNE vectors predominate in the Central Asian Transit Zone, where the transpressive neotectonic regime prevails. At the same time mainly east and SE directed vectors are distributed in the East Asian Zone in conditions of the transtensive regime.

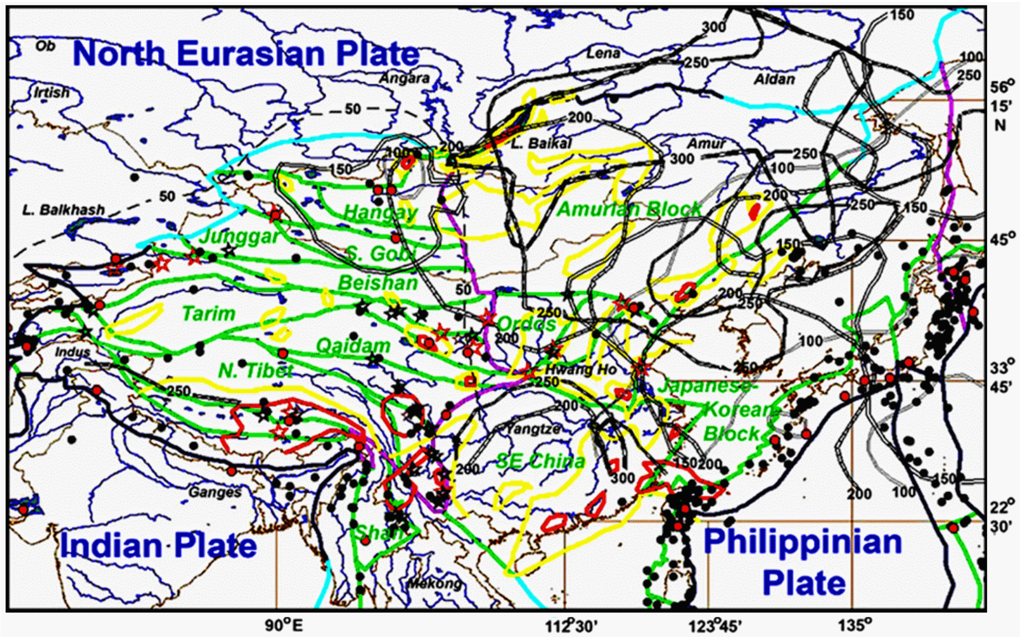

Figure 18. Deep structure of central Asia. Thin black lines of different types limit projections of S-waves' velocity slowing-down up to $\leq 4.2 - -4.25$ km sec^{-1} on 50, 100, 150, 200, 250, and 300 km depth levels [*Kozhevnikov and Yanovskaya,* 2005]. Fields of the high heat-flow are limited by yellow lines (80–99 μW m^{-2}) and red lines ($\geq$ 100 μW m^{-2}) after works [*Lysak et al.,* 2005; *Tan and Shen,* 2008]. For epicenters and boundaries see Figure 4.

2. The majority of catastrophic seismic events in intracratonic environment of central Asia are connected with active zones, which divide crust or mantle-crust blocks. The tectonic energy relaxation due to interaction of main lithosphere plates takes place not only in their boundaries, but also in those interblock zones as a result of interaction between blocks.

3. Abnormal high seismic energy releasing in interblock zones depends of a deep continuation of plate slab in collision zones (Pamir, Himalayas), intensive displacements along strike-slips and thrusts due to collision processes, blocks' interaction and deep lithosphere inhomogeneity (Tien Shan, Bayanhar), sharp changes of geodynamic conditions because of influence of plate movement and supposed mantle plumes (north Mongolia, the Baikal Region).

4. Interblock zones can be potentially dangerous in respect of intensive seismic events, if they are situated within boundaries of blocks with the rheologically layered crust and if these zones were long time in the regime of "seismic gap". During such seismic gap a tension can accumulate and further will relax as strong earthquakes.

5. It is the worth to mention that in the investigated area of central Asia the majority of interblock zones goes in Russia, Mongolia, China, Tajikistan, Myanmar and other countries through regions of dense population, widely developed infrastructure and means of communication, large mineral deposits. It emphasizes the applied significance of examination of problems connected with geodynamics of these zones that can be seen on example of the Wenchuan earthquake in May 2008 [*Gatinsky et al.,* 2008b].

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