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Velocity Structure features of Tien-Shan Crust and uppermost Mantle as Manifestation of geodynamic Processes

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Tien-Shan is known as an active seismic region of extremely complex geodynamics, but there is no unanimity about the causes of this complexity. The development of knowledge about deep structure especially with seismic tomography opens up new avenues in studies of the Tien-Shan geodynamics. Interpretation of a new 3D velocity model of Tien-Shan crust and uppermost mantle [1], computed using seismic tomography technique [2], enabled to fix following.

Tien-Shan block (kyrgyz part of Tien-Shan), being recognized in block structure of High Asia by strong earthquake (M more then 6.5) locations, contouring it, and by features of geophysical fields [3,4], is divided by Talaso-Fergana fault into two parts, having different distribution of P and S – wave velocities in crust-mantle transition zone – at depth of 50-65 km. A wide strip of low P-wave velocity (6.6-7.8 km/s) zone settles down at depth of 50-65 km eastward of Talaso-Fergana fault. The lowest P-wave velocities within strip limits are fixed in junction zone of Southern Tien-Shan and Tarim Basin. Tien-Shan block is divided by Talaso-Fergana fault into two parts, having different distribution of waveguides (velocity inversion zones) in earth crust too. Waveguides are widely developed at the depth 25-65 km to the east of fault and are practically not observed to the west, except the edges. This effect is clearly seen in crust-mantle transition zone – at depth of 50-65 km, what is evidence of ongoing deep tectonic process, responsible for observed velocity anomalies in low crust. Manifestation of those tectonic processes in crustal velocity structure of Tian-Shan may be clearly seen on meridional cross sections, passing through earth crust and uppermost mantle to the east of Talaso-Fergana fault. It follows from five velocity cross

sections, that there is the upwelling of the low velocity mantle material beneath the mountain system Kelpincheltag-Meidantag-Kokshaal, Kyrgyz Range and Moldo-Too. Mountain roots go down there to the mantle, which could be evidence of upgoing low velocity mantle material. That process (in view of published data on magma intrusions and their chemical compositions, volcanism, heat flow, hot springs, velocity anomalies in mantle, gravity field anomalies, submantle helium [5-14]) can evidently be considered as a development of mantle plume (we suppose, that Tien-Shan plume is a brunching of deep Tibetan plume [4]). In opinion of numerous authors [5,6,11], the development of Tien-Shan plume was in early Cenozoic (50-60 years ago) before orogeny, connected with the India/Eurasia collision. Most evident velocity inversion zone, outlining the whole Tien-Shan block, is at depth of 25-35 km. Block boundaries are deep faults along which mantle material probably goes up due to plume tectonic processes. Big earthquakes (M more then 6.5) tend to contour this block also [15]. Hypocenters of those big earthquakes are located in zones of high P-wave velocity gradient. Lateral velocity gradient is usually due to contact between high and low velocity zones, that at the surface corresponds to known fault, separating depression from mountain buildings. Vertical velocity gradient is related to horizontal boundaries, separating high velocity volumes in upper (5-25 km) or middle (25-35 km) crust from zones of waveguides in middle or lower (35-50 km) crust. Stress release during earthquakes may take place along above boundaries, separating volumes with different physical properties.

Conclusion.

1. Presence of local low velocity zones in crust-mantle transition zone (H=50-65 km) at the vast territory of Tien-Shan eastward of Talaso-Fergana fault, essential manifestation of waveguides zones at that territory in crust-mantle transition zone and in above lied layers of low (Í=35-50 km) and middle (Í=25-35 km) crust and reduction of waveguides manifestation in upper crust (H=5-25 km) are the evidences of developed here deep tectonic process – an intrusion and uplift of hot mantle material. Manifestation of those tectonic processes in crust and uppermost mantle velocity structure of Tien-Shan may cleary be seen on meridional cross sections through earth crust and uppermost mantle to the east of Talaso-Fergana fault.

2. Above mentioned tectonic process in view of results of other geological and geophysical studies, widely discussed in literature, may be considered as a development of mantle plume, in particular, as brunching of big Tibetan plume, controlling geodynamics of High Asia and Tien-Shan as well.

3. Geodynamics of Tien-Shan, including seismicity, is caused both by India-Eurasia

collision and plume tectonics processes.

4. The locations of big earthquakes (M more than 6.5) source zones, outlining the whole Tien-Shan block and coinciding to the known deep faults, correlate with waveguides zones, formed at depth 25-35 and 35-50 km at the periphery of Tien-Shan block.

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