THE KURAI BASIN, ALTAI MOUNTAINS (RUSSIA): FIRST EVIDENCES OF IMPACT ORIGIN.

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Introduction: The Kurai Basin (centered at 50°12' N, 87°54' E), is usually considered to be a typical example of intermontane depressions common for the Altai Region [1 and refs. therein]. However, at regional analyses of topography and Landsat data the Basin attracted attention as superimposed structure of regular crater-like shape and was selected as a possible astrobleme. The field-2006 reconnaissance resulted in first evidences of impact origin of the Basin.

General geology: Complex regional geology is represented by the compressed Salairian, Caledonian and Hercynian anticlinoria+synclinoria mainly of sub-latitudal strike; Mesozoic dislocations are also added. The tectonic cycles followed by ultrabasic, basic and granitic magmatites. After the end of Mesozoic orogeny the plane regime established in the region since K_2 to Ꝑ$_2$ times. The last orogenic cycle, caused by block tectonics and elevation, is operating since Ꝑ$_3$ up to date, to form the present Altai topography. Resurgence of old faults, and origin of new faults with their own strike, is typical for the Cenozoic orogeny. The weathering crusts formed in the region during the planation at Pre-Jurassic and K_2-Ꝑ$_2$ times. There are large anticlinoria (to N and W off the Basin) and synclinoria (to S off the Basin), separated from each other by Kurai, North-Chya and Baratal old faulting zones. New Cenozoic fracture zones (including NE faults) originated across the strike of the old geological structures. PR_3 (Aryjan series: basic volcanites, arenites, siltstones; Baratal series: carbonate rocks and silicilites), Є$_{1-3}$ (andesites, rhyolites, silt- and sandstones), D_{1-3} (rhyolites, andesites, sand- and siltstones, limestones), C_{1-3} (conglomerates, sand- and siltstones, coal shales) rocks, as well as D_2 granites+granodiorites, dominate in the bed of the Basin. The remnants of Pre-Jurassic (?) weathering crust are known on the D_{1-3} volcanites in the northern part of the Basin. Its fill is made up of loose coal-bearing Ꝑ$_3$-N_2 and Q deposits.

Morphology: The Basin is expressed in topography as a regular crater-like depression of ~21-22 km in diameter (across the contour line +2200 m), with step slopes **(Fig. 1).** It is superimposed on the bed geological structures, ignoring their NW strike. There is a fragment of central uplift (CU) in W and NW parts of the Basin, separated from Its slopes by the concentric semi-circular trough valley. The bed rocks of the CU are elevated up to 1784 m (Akturu Hill). E part of the bottom is flat; loose fill up to several hundred m in thickness, is known here, indicating the local subsidence of the Basin's bed.

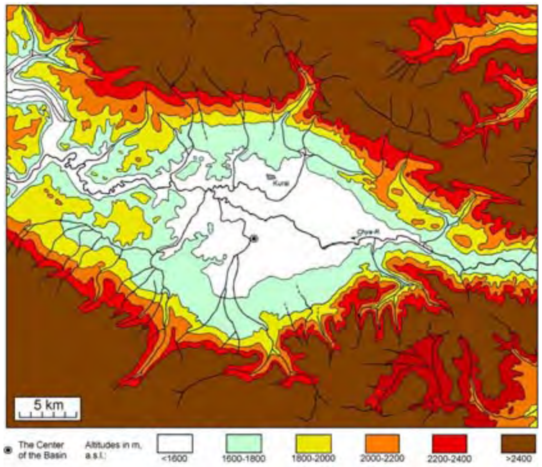

Fig. 1. General topography of the Kurai Basin

Macroscopic evidence of shock metamorphism: Shock slickensides (SSLs) are found in PR and D volcanites of the CU and similar to those known in dolerites of Loganchia [2], arenites of Shiyly [3], ignimbrites of Shunak [4] and in other impact craters. In distinction from the tectonic slickensides, the SSL planes have various orientations in the rock volume (up to 5 various directions in the hand-size sample, **Fig. 2**). Fine sculpture of striae, their smooth bending, branching and shattering are common for the SSLs **(Fig. 3)**, as if they originated by sliding in very soft and plastic matter; however, the Kurai SSLs occurred in hard and fragile rocks. Supposedly, their origin is related to rock fracturing under the plastic-elastic conditions; the fragments originated were affected to relative shift, rotation and plastic deformation. In this case the shock pressure was ~HEL for the Kurai volcanites, i.e., ~3-4 GPa (following the data by [5] for the hard rocks).

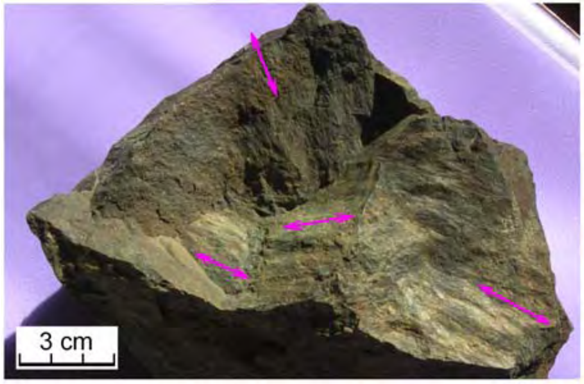

Fig. 2. Shock slickenside planes of various orientation in Kurai PR_3 diabase. Indicated in arrows, are the striae directions at each plane. Sample #K-7. Reflected light.

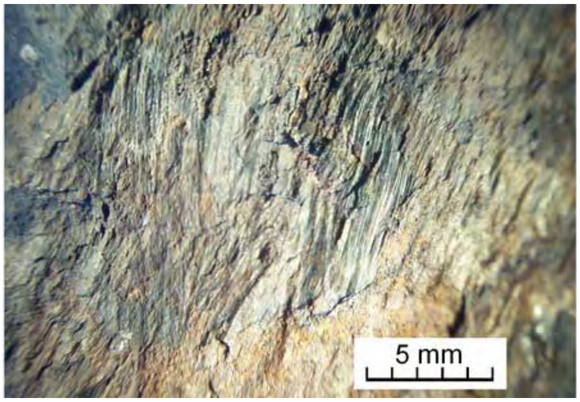

Fig. 3. Fine sculpture of striae in shock slickensides from the Kurai PR$_3$ diabase. Sample #K-18a-2. Reflected light.

Petrographic evidence of shock metamorphism: There are planar micro-deformations (PMDs) in some quartz grains from the PR volcanites of CU with SSLs. 3 types of PMDs are present, partially or completely occupying the grain of the mineral (**Fig. 4**): (1) deformation lamellae which are the systems of parallel lamina of 1 direction, each lamina is up to several μ in thickness, with 10÷30μ spaces between; their extinction is 2-3^o differ from the host grain; (2) PFs which form the systems of thin parallel cracks, with up to 10μ spaces between; (3) PDFs which form the systems of optical inhomogeneities of <1μ in thickness, with 3-5μ to 10-15μ spaces between. PFs and PDFs form 1, or sometimes 2 systems per grain; if present, the second system is subordinating. The histogram of the poles of PMDs in quartz exhibits several maxima (**Fig. 5**) along ω {10$\bar{1}$3}, π {10$\bar{1}$2}, ε {11$\bar{2}$2} and r,z {10$\bar{1}$1} orientations and clearly differs from the Böhm lamellae, typical for metamorphic quartz. So, PMDs in Kurai quartz are the petrographic evidence of the impact. The relative rarity of PMDs, together with their low density (not more than 100-300 lines per 1 mm) and a number of systems (1-2 ones per grain) show the weak shock metamorphism [7]. Minimal shock pressures to form these deformations in quartz are 5 to 8-10 GPa [8, 9].

Conclusion: The data presented indicate an impact origin of the Kurai Basin and allow consider It as a heavily-eroded astrobleme of ~20 km in diameter. The age of the Basin is estimated as Jurassic–Eocene, following to presence of Pre-Jurassic (?) weathering crust products in the target, and to ₽$_3$-N$_2$ sedimentary fill. After the start of Cenozoic orogeny in Oligocene, the astrobleme was deeply-eroded, and its filling by loose sediments begun. In spite of the Cenozoic block move-ments, the Basin has a regular crater form due to the shock fracturing zone in the target. However, the eastern part of the Basin was subsided and the present asymmetry in profile of the hard rock bed originated.

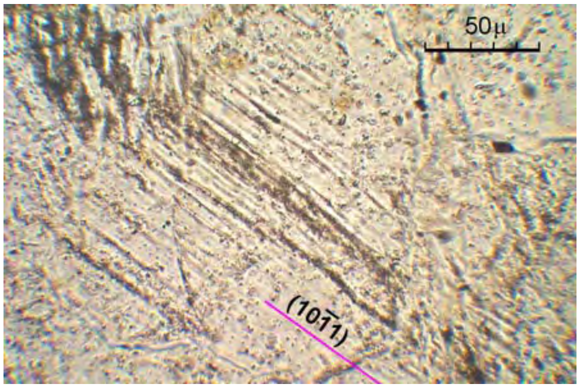

Fig. 4. One system of PDFs in shocked Kurai Quartz. Sample #K-18в. Microphoto. Plane polarized light.

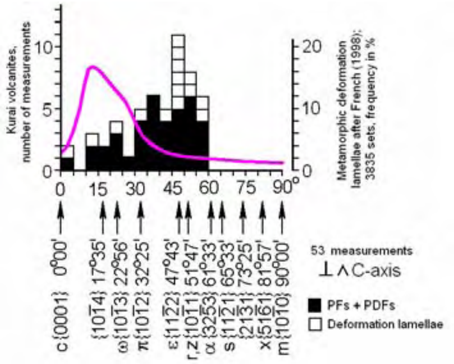

Fig. 5. Histogram of poles of planar deformation features in Quartz from the Kurai rocks. Indicated in pink-red, is the line of Böhm lamellae orientations after [6].

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Hopefully, local geologists will contribute with their geological and geophysical data in further discussions on the subject.

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