SHOCKED QUARTZ GRAINS FROM K/T BOUNDARY SEDIMENTS

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Introduction. Alvarez et al. [1] theory of Cretaceous extinction suggests that K/T boundary sediments must be contaminated by impacted ejecta material. The first search [2] of the material in the sediments was unsuccessful. However later shocked quartz grains were recognized at the K/T boundary [3] . We studied insoluble fractions (>40 μm) Mangyshlak and Turkmenia K/T sediments [2,4,5] to estimate abundance and stratigraphical distribution of the shocked quartz grains at the K/T boundary.

Results. The shocked quartz grains with planar elements (SQG) were identified by optical microscopy method in the all studied K/T sections. The planar elements in SQG are presented by both decorated and nondecorated types (Fig. 1a). Frequency of their crystallographical orientations in SQG is shown on Fig 2. Usually SQG contain one or two systems of the planar elements. In some cases SQG bear mosaicism with angle of disorientation up to 10-15° per 0,1 mm as it was established by optical observations and Debye-Scherrer patterns using method [6]. There is less then 1% of SQG with reduced refractive index. Stishovite described in K/T SQG [3] was not identified in our samples. Several shocked feldspar grains with planar elements (Fig. 1b) were found in the Turkmenia section CM-4 [4,5]. It is important that we found also in this section few intergrowths of SQG with feldspar and aggregates of SQG.

Stratigraphical distribution of SQG was studied in Sumbar section CM- 4 [4,5]. The SQG content was expressed as percent ratio of SQG number to bulk number of quartz grains in the plane of thin sections. The concentration parameter must be lower than real SQG content probably at a factor of 5-6 due 30°-40° sector visibility of planar elements in the plane of thin sections. SQG were discovered only in the brownish K/T boundary clay in the section CM-4 (Fig. 3a,b) Peak of SQG content (about 2%) is in yellowish materialat the very base of Danian. Above the K/T boundary SQG content decreases as well as Ir concentration and there is clear positive correlation between SQG and Ir contents inside the brownish layer. However no SQG were found in Upper Maastrchtian marls and greenish clay (above boundary) that are enriched in Ir relatively to background level [4,5].

Discussion. The morphology and the orientation of the planar elements in K/T quartz grains as well as the mosaicism and the reduced refractive index of this grains are very similar to shock features observed in quartz of terrestrial impactites. Comparision of the frequency of orientations of the planar elements in K/T SQG and in experimental shocked quartz [7] shows that K/T SQG were impacted at less than 15 GPa. This estimation was supported by the K/T SQG Debye-Scherrer patterns obtained by method [6] . We observed only several SQG shocked at about 20 GPa. According to experimental data [7] the SQG content in the sandstone impacted at 12 GPa is about 2%. It means that the fraction >40 μm of the yellowish boundary material in the section CM-4 must contain mostly from direct fallout. In other layers of the section the SQG content does not reach the 2% saturation and hence the shape of SQG distribution is controlled by mixing of the ejecta and local quartz during transport to place of deposition.

The SQG content as expressed relatively to bulk quartz concentration is not controlled by environment of sedimentation. Therefore the Ir-SQG correlation (Fig. 3b) demands that the K/T Ir enrichment was resulted from impact event and could not be produced by sedimentary process as it was suggested by [8] Moreover duringthe K/T brownish clay formation Ir was deposited with fallout or was redeposited without its separation from the fraction >40μm of ejecta material. Above the brownish layer Ir content must be controlled by deposition of fraction <40 μm of the fallout, and the Ir enrichment below K/T boundary [4, 5] could be resulted from diagenetical redistribution of Ir because the ejecta fraction <40 μm could not be deposited before the fraction >40 μm. Thus there were not minor K/T impact events preceding the main K/T catastrophe.

Obviously the SQG presence in K/T sediments points out continental crust as a place of the K/T event. The discovery of shocked feldspar grains and intergrowths of SQG with feldspar that can be interpreted as fragments of target rocks, are also compatible with the continental source of the ejecta. Moreover the SQG-Ir correlation shows that Ir come with continental crust material. Hence there are no any evidences for the K/T event in ocean basaltic crust.

Conclusions. (1) Our date confirm the worldwide enrichment in the K/T sediments in ejecta as well as impact modell [1] of the K/T event. (2) The K/T Ir enrichment were resulted from the impact but not from sedimentary process. (3) The K/T event took place in continental crust.

References. [1] Alwarez L.W. et al. (1980), Science 208, 1095-1108, [2] Nazarov M.A. et al. (1982), LPSC XIII, Abstr.,2, 580-581; [3] Bochor B.F. et al. (1984) Science 4651, 867-869; [4] Alekseev A.S. et al. (1986) LPSC XVII (in press); [5] Nazarov M.A. et al., Ibid; [6] Hörz F., Quaide W.L. (1973) Moon 6, 45-82; [7] Badjukov D.D. (1983) Mineralogicheskij Journal 5, 81-85 (in Russian); [8] Officer C.B., Drake C.L. (1983) Science 219, 1383-1390.

Fig. 1. Shocked grains of quartz (A) and feldspar (B) with planar elements

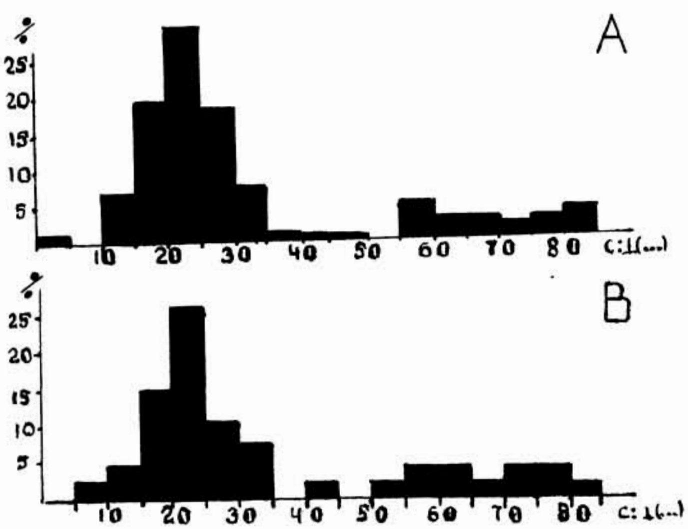
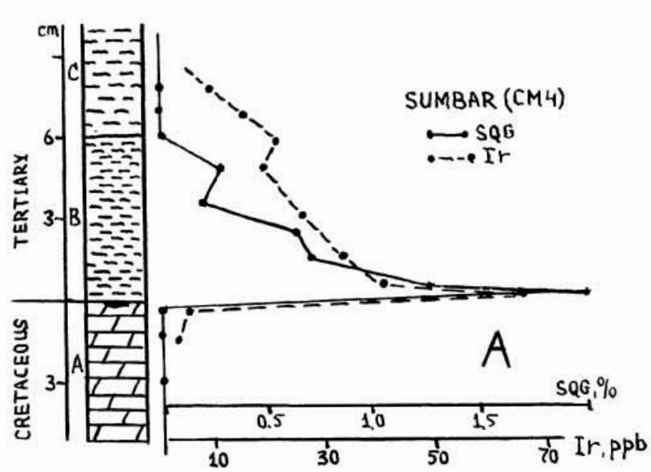


Fig.2. Frequency of orientations relative to c - axes of sets of planar elements in SQG (A - section CM-4, 108 sets, 75 grains; B - section MB-3, 32 sets, 17 grains).



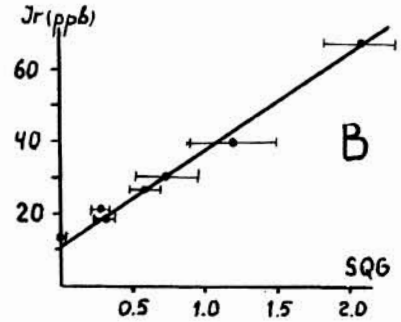


Fig.3. A - Distribution of Ir (ppb) and SQG in CM-4 section, Lithology from 4 ; B - Ir versus SQG in CM-4