EXTRATERRESTRIAL EVENT AT THE CT BOUNDARY: NEW GEOCHEMICAL AND MINERALOGICAL DATA.
M.A. Nazarov¹, L.D. Barsukova¹, G.M. Kolesov¹, D.P. Naidin² and A.S. Alekseev²; V.I. Vernadsky
Inst. of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow, USSR;² Geologi-
cal Faculty, Moscow State University, Moscow, USSR.

Introduction. High Ir contents in the Cretaceous-Tertiary boundary sediments have been interpreted as result of some extraterrestrial event, which is thought to cause Mesozoic biotic crisis [1-4]. However Ir geochemistry in sedimentary rocks is studied insufficiently and terrestrial Ir source should not be excluded also. In fact very high Ir content (40 ppb) was reported in Zechstein kupferschiefer [6] that is supported by the occurrence in these rocks of Pt-bearing minerals [7]. It suggests that terrestrial Ir can be concentrated in sulfide-rich sediments derived in environment of stagnation and H2S accumulation. The highest Ir content in Stevns Klint clays formed in similar environment [5] and common presence of pyrite at CT boundary [4] are compatible with such processes. In this work we studied Ir contents in CT sections of Denmark and USSR in combination with search of Ir anomaly in various deposits especially in deposits of heavy reduced facies. We also attempt to identify nature of Ir-bearing component by determination of Ir in various fraction of CT boundary sediments and elaborated mineralogical study.

Method. Ir was determined by RNA. Accuracy is about 10% at 50 ppb content level. We determined Ir contents in bulk samples, electromagnetic and non-magnetic-insoluble fractions of CT samples. Non-magnetic-insoluble fraction was obtained after electromagnetic separation by dissolution of non-magnetic materials in HNO3 up to the reaction stop. Our data for other elements in electromagnetic fraction are from INAA method. CaCO3 contents were obtained from CO2 determination using traditional chemical method.

Results. Ir contents in the studied CT boundary deposits are listed in Table I and shown on Fig.1. Our Ir data on the Stevns Klint fish clay show good agreement with those reported earlier [1,5,4,8,9]. Contents of Ir in YI1 and YI2 samples (Yutland) are anomalous also but less significantly than those in fish clay. In compare to data [18] our YI2 sample from the same locality has 2 times lower Ir content. In YI3 sample Ir anomaly is not observed. However this sample can not correspond to CT boundary material (see Sample list). Mangyshlak section (Fig.1) has 6.5 ppb Ir as maximum that is similar to Gubbio [1]. The highest Ir contents are at the top of clayish limestone bed, i.e. occur above the extinction level. Ir distribution in sample 1 is rather simple while it is very complicated in sample 2 by bioturbation. There is 0.5 ppb Ir at the 5m upward and 0.5 m downward this boundary. Sample CR contains only 0.7 ppb Ir that however may be considered as anomaly because of a large hiatus in this section. All other studied samples (non CT) have only <0.5 ppb Ir except of pyrite from DSDP core which contains 12 ppb Ir. Distribution of Ir among electromagnetic, non-magnetic-insoluble and soluble (calculated data) fractions of the CT boundary deposits is shown on Fig. 3. Although the magnetic fractions are obviously higher in Ir but their contents in the sediments are very low (Table 1). For this reason the major amount of Ir in the sediments is connected with the insoluble and soluble fractions in almost the same proportions. The magnetic fractions (Table 2) are very rich in siderophiles and chalcophile elements (Ni, Co, Ir, Au, As, Cd, Cu) but show significant fractionations relative to any known meteorites.

The CT boundary samples are common sedimentary rocks. Their magnetic fractions are limonite and minor amounts of pyrite, glauconite, hornblende, pyroxene, garnet, magnetite, ilmenite and rutile. The highest concentrations of limonite and pyrite are typical for Stevns Klint clay and somewhat for Mangyshlak sample. There are limonite spherules containing pyrite relics in these samples also, which are similar in composition to bulk magnetic fractions. No extraterrestrial material was identified certainly in magnetic fractions. The only strange objects found in Mangyshlak electromagnetic fraction are mellow particles (<0.5 m) composed by ZnO, Zn and smallest inclusions of Fe metal (without Ni). Coarsegrained part of the non-magnetic-insoluble fractions consists of quartz, feldspars and mica which have not any shock effects. Glassy particles and spherules were not observed. No unusual particles were detected in electron microscopy of clay fractions of the CT boundary sediments.

Discussion. Our data confirm the worldwide enhancement in Ir in the CT boundary sediments [1-4,8,9]. The absence of Ir anomaly in all other (non CT) studied samples having various age and formed in various environment, including heavy reducing conditions, means that the high Ir contents at CT boundary could not be derived from terrestrial source during sedimentation. It strongly supports extraterrestrial nature of CT Ir anomaly. Nevertheless the large difference in Ir contents at CT boundary in geographically near regions (Yutland and Stevns Klint) and Ir correlation with bulk chemistry of CT sediments (Fig.2) can not be explained by extraterrestrial reasons only, and suggest that observed Ir distribution could be connected with difference of reducing conditions during sedimentation. The high Ir contents in pyrite from DSDP core may be considered as contemporary local example of the such redistribution of extraterrestrial Ir. Our data suggest that Ir was incorporated in CT sediments in atomic-molecular form, then was fixed in sulfides or absorbed by clay minerals. It is compatible with concept of major impact with complete evaporation of projectile. However our mineralogical study and geochemical evidences [4] show absence of any ejecta material in the CT sediments. For this reason impact in ocean [20] or slowed falling of cometary material or interstellar dust [4] are plausible models of extraterrestrial event at CT boundary.
Fig. 1. Distribution of Ir contents at Mangyshlak CT boundary in sample 1 (A) and sample 2 (B). Dark is clayish limestone; light is chalk at the bottom and limestone at the top.