RADIATON AND SHOCK-THERMAL HISTORY OF THE KAIDUN CR2 CHONDRITE GLASS INCLUSIONS. Kalinina G.V., Kashkarov L.L., Ivliev A.I., Skripnik A.Ya. Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, 119991, Moscow
ugeochem@geochem.home.chg.ru

Introduction.
Inclusions of glass in the Kaidun CR2 anomalous chondrite [1,2] were studied to investigate of both: conditions of these glasses origin, and evolution history of the Kaidun meteorite as whole [3]. In this report the results of track and thermoluminescence (TL) investigation of a Kaidun glass fragments are presented. On the received data the shock-thermal history of these glasses at an early stage of a meteorite parent body formation are considered.

Kaidun glass fragments description.
The glass fragments, selected from carbonaceous Kaidun components constitute ~20 % of all ilicate fraction of a meteorite [4]. Petrology-chemical analyses of ~ 40 glass fragments of ~(100 – 300) μm size fraction indicate, that almost all the glasses have rather uniform mineral composition determined as quartz-anortite-hyperstene one. All the objects containing glass, accordingly their structural and petrology-chemical characteristics were divided into four types: (I) transparent clear glasses, (II) porphyritic glass inclusions, (III) cryptocrystalline inclusions and (IV) chondrules [4]. The presence of micro-crystals in the three last types of glass fragments indicates on no clear-melted nature of formation of these objects.

Results of track measuring.
Estimation of the contribution in measured in each of the investigated glass fragments track density (ρ) from the pre-accretion cosmic irradiation was determined with help of detailed consideration of "background" track density: $\rho_{B} = \rho_{SP} + \rho_{IND} + \rho_{GCR}$. Here ρ_{SP} and ρ_{IND} - track densities of spontaneous and induced by cosmic ray particles of ^{238}U and ^{232}Th nuclei. At the uranium concentration of C_U ~10^{-8} g/g in glasses, formed ~ $4{,}5\times10^{9}$ years ago, ρ_{SP} ~10^{4} cm^{-2}. Estimation of ρ_{IND} gives values ~(10^{3} - 10^{4}) cm^{-2}. ρ_{GCR} is due to Fe nuclei (VH-group) of the galactic cosmic ray (GCR). At the cosmogenic age of a meteorite $T_c = (0{,}5\text{-}1)\times10^{6}$ years [5], and depth of deposition of researched samples (20 ± 5) cm in a meteoroid body of radius R = (25-30) cm [6] ρ_{GCR} ~(10^{3} - 10^{4}) cm^{-2}. The rule in this search was the next: when the observed track density (ρ_{OBS}) values are essentially higher of ρ_{B}, only in this case there is a good reason to believe the presence of traces of an irradiation formed on a preaccretion stage of formation of a meteorite matter. With help of fission-track neutron-induced method [7] it was shown, that in crypto-crystalline glass inclusions (24 searched samples) C_U vary in limits of ~ $(0{,}5\text{-}7{,}5)\times10^{-7}$ g/g. In 38 of transparent glass fragments it was chosen two distinct groups with average values C_U equal to $(3{,}2 \pm 0{,}6)\times10^{-7}$ g/g and $(7{,}0 \pm 1{,}3)\times10^{-7}$ g/g accordingly. In several samples of transparent glasses the parcels of ~10 μm by size with C_U , distinguished in 2-3 time from average C_U values of a sample as a whole, were fixed. It is supposed, that the observable disorder of C_U both for separate glass samples, and for different strips in some of them, is conditioned by the strong heterogeneity and/or different melting degree of initial matter, as well as to comparatively small (~ mm^3) volume of the primary formatted glass fragments.

In ~50 investigated glass fragments approximately in 10 % of them the tracks of pre-accretion irradiation were detected. The analysis of ratio of ancient track density and C_U has shown: (а) Modal track age in ~10 % of glass samples essentially exceeds ~4.5 by, that, probably, is adjusted with considerable contribution of the tracks due to extinct ^{244}Pu fission fragments; (б) Fossil track age in ~50 % of glass fragments lies in limits of ~(4.5 - 4.0) by; (в) For the residuary glass fragments $\rho_{OBS} < \rho_{B}$, that can be caused by the partial or complete thermal annealing of the ancient tracks.

Thermoluminescence analysis.
The results of measurements of sensitivity to formation of induced by X-ray TL_{ART} for researched samples of glasses indicate a big differentiation of TL parameters in the all investigated (~40 samples) of glasses, representative various chemical groups. Note some TL-characteristics of the searched glass samples from the Kaidun meteorite. For glasses of

the I-st and II-nd of groups the formation probability of TL at T>250° C in some times below, than at lower temperatures. TL-intensity for glasses of III-rd and IV-th chemical groups is approximately identical, but that is essentially differs from TL for other glasses. The very wide temperature interval of TL-luminosity with poorly varied intensity TL in the temperature interval of (150-350)° C is characteristic for these glass groups. For colorless glasses is observed very wide and high-intensity TL at T> 250° C with a set of the several precisely expressed peaks of luminosity. At the same time at lower temperatures the TL-luminosity for these glasses practically is absent. One of distinctive features of these colorless glasses is the presence of the poorly expressed polarization indicating on their partial crystallization as a result of shock-thermal influence. Note, that data of track analysis for these glasses show, that track density in them is very low in comparison with other glasses.

The sensitiveity to TL formation for samples of crypto-crystal inclusions is characterized by essential excess of a TL-luminosity at T<250° C. TL-glow curves for two glass-pyroxene chondrules are characterized by presence of two precisely expressed peaks. The comparison of parameters of a TL-luminosity for these chondrules with TL-parameters, obtained for the pyroxene crystals from a Kaidun meteorite, indicate that the TL glow-curves for chondrules are much more compound and are determined, mainly, by chemical composition and structural features of their glass phase.

As a whole, the data of TL-research of the Kaidun glasses are resulted in the following conclusions: (a) The TL-luminosity for all investigated glass samples lies in an interval of (0.3 - 220) relative units (ru); (b) For the optically homogeneous glasses TL = (70±2) ru; (c) The glasses of crypto-crystal inclusions have TL in an interval (0.4 – 9) ru; and one sample with TL = 43.1 ru, that is, probably, connected to its secondary heating in the ablation process of a meteoric body. (d) Values of T_{PEAC} for all glass samples are in a temperature interval of (170-185)° C, that, obviously, reflects uniformity of structure of the basic TL-phosphorus, which is presented in these glasses. (e) For glasses of crypto-crystal inclusions a temperature interval of T_{PEAC} is wider: from ~170° C up to ~220° C. Obviously, the differing of their structural features in comparison with homogeneous and isotropic glasses causes it.

Conclusions:

- It is shown that some glass fragments from the Kaidun CR2 chondrite retained tracks storage in pre-accretion stage, that characterized by high values of ρ_{VH} (up to ~10^7 cm^{-2}), and the total ρ_{VH} range near of two orders of magnitude
- The predominate part of glass fragments was formed in pre-accretion stage of formation of primary bodies of the early Solar system;
- Ancient tracks in some glass fragments could be formed from the two main sources: fission ragments of extinct ^{244}Pu and VH-nuclei of the solar wind VH-nuclei ions, accelerated up to energies higher of ~100 MeV/nucleon in the proto-planet nebula environments
- The processes of complete or partial melting of initial dust matter, probably, was connected to passage of shock waves and electrical discharged accompanying the outflow of solar wind plasma from the high activity Sun at a stage of T-Tauri;
- The process of formation of glasses characterized by the large interval of a melting degree of initial matter that was caused, first of all, by the local short-thermal events of different capacity;
- Extent of the disorder of C_u values in individual fragments of a glass of meteorite, exceeding one order of value, also specifies their formation as a result of local shock-thermal events, resulting particularly, to melting of initial matte of different chemical composition;
- In the further significant share of glasses was not heated up to temperature above ~400° C within short-time interval (~1 hours), that could result in them in complete disappearance of ancient tracks.

References:

[1]. Ivanov A.V. et al. (1985) *Dokl. AN USSR. V.280. №2*. 473.
[2]. Ivanov A.V (1989) *Geokhimiya. №2.* 259.
[3]. Kashkarov L.L. et al. (1995) *Geokhimiya. №10.* 1409.
[4]. Shukolyukov Yu.A. et al. (1986). *Meteoritika. V.45*. 31.
[5]. Fleisher R.L., Price P.B., Walker R.M. (1975). *Nuclear Tracks in Solids. Berkely: Univ. alifornia Press.* 605 P.
[6]. Skripnik A.Ya. et al. (1992). *Abstr.23rd LPS Conf. Houston*. 1309.
[7].Kashkarov L.L., Koshkin V.L.(1983*). XII SSNTD Conf. Mexico*. 168.