ON THE ORIGIN OF THE KAIDUN CR2 CHONDRITE GLASSES

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Key words: *meteorite Kaidun CR2, glass inclusions, chemical composition, tracks*

Introduction

Anomalous chondrite Kaidun CR2 [1,2] contains glass inclusions, which study has essential importance at finding both conditions of their origin, and evolution history of matter of a meteorite as a whole [3]. In given work the results of structural, petrology-chemical and track researches of glass fragments of a meteorite Kaidun are presented: On the basis of the received data the possible processes of origin of these glasses at an early stage of formation of a meteorite parent body are considered.

Petrology-chemical characteristics of the glass fragments

The glass fragments in carbonaceous (C1 and CM components) matrix from Kaidun constitute ~20 % of all silicate fraction of a meteorite. Petrology-chemical analyses of ~ 40 handpicked glass fragments of ~(100 – 300) μm in size fraction has been carried out. The glass samples were preferentially out of crushed Kaidun meteorite. Some fragments under study are the individual objects in black matrix, and some of them are the components of inclusions. Electron microprobe analyses of glass fragments have been performed (see Table). Almost all the glasses have rather uniform mineral composition that was determined as quartz-anortite-hyperstene one. All the objects containing glass, accordingly their structural and petrology-chemical characteristics, were divided into four types: transparent clear glasses, porphyritic glass inclusions, crypto-crystalline inclusions and 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 investigations

The individual glass fragments were mounted in epoxy, polished, etched and examined using optical microscope under of 600-1200^x magnification. The estimation of the contribution in measured in each of the investigated fragments track density (ρ) from pre-accretion 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 density of spontaneous and induced by cosmic ray particles of ^{238}U and ^{232}Th nuclei. At the contents of uranium ~ 10^{-8} g/g in glasses formed ~ 4,5 10^9 years ago $\rho_{SP} \sim 10^4$ 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 = (0,5-1) 10^6 years [5], and depth of deposition of researched samples (20 ± 5) cm in a meteoroid body of radius R = (25-30) cm [6] $\rho_{GCR} \sim (10^3 - 10^4)$ cm^{-2}. Only when the observed track density (ρ_{OBS}) values are essentially higher of ρ_B, it is possible to count proved the presence of traces of an irradiation formed on a pre-accretion stage of formation of a meteorite matter.

Contents and micro-distribution of uranium in glasses

The definition of the contents (Cu) and micro-distribution of uranium in volume of individual glass samples was carried out with help of a fission-track induced technique that allow to measure of the lowest concentrations of uranium (up to ~10^{-9} g/g) in micro-crystals by the size up to ~100 μm [7]. It was shown, that in crypto-crystalline glass inclusions (24 samples) C_U vary in limits of ~ (0,5-7,5) 10^{-7} g/g. For 38 of transparent glass fragments two distinct groups can be chosen, by average values C_U in which are equal (3,2 ± 0,6) 10^{-7} g/g and (7,0 ± 1,3) 10^{-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 connected to strong heterogeneity and/or different melting degree of initial matter, as well as to comparatively small (~ mm^3) volume of resultant glass fragments.

Relation of ancient track density and C_U.

Among the ~50 glass investigated fragments approximately in 10 % of samples the tracks of pre-accretion irradiation are found out. 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 b.y., that, probably, is adjusted with essential contribution of the tracks formed by fission fragments of ^{244}Pu; (б) Age in ~50 % of glass fragments lays in limits ~ (4.5 - 4.0) b.y.; (в) For residuary glass fragments $\rho_{OBS} < \rho_B$, that can be caused partial or complete thermal annealing of ancient tracks.

The basic conclusions

It is shown that some glass fragments from chondrite Kaidun CR2 retained tracks storage in pre-accretion stage that characterized by a high values of ρ_{VH} (up to ~ 10^7 cm^{-2}), and the total ρ_{VH} range near of two orders of magnitude

- The prevailing part of glass fragments was formed on early pre-accretion stage of formation of primary bodies of Solar system;

. Ancient tracks in some glass fragments could be formed from the two main sources: fission fragments of extinct ^{244}Pu and VH-nuclei of solar wind VH-nuclei ions, accelerated up to energies of hundreds MeV/nucleon in the protoplanet 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 a 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 ^oC within short-time (~1 hours), that could result in them in complete disappearance of ancient tracks.

Table: Chemical composition (in weight percentages) of glass fragments in Kaidun CR2 chondrite

Component	Chemical group of glass fragments			
	I (5)*	II (9)*	III (4)*	IV (1)*
SiO_2	68.0 (66.2-9.25)[§]	62.2 (58.5-65.4) [§]	64.4 (60.9-67.6) [§]	45.70
TiO_2	0.14 (0.10-0.2)	0.14 (0.12-0.19)	0.98 (0.62-1.34)	0.88
Al_2O_3	15.9 (14.36-7.1)	14.64 (11.9-15.8)	14.3 (13.3-15.8)	14.97
Cr_2O_3	0.04 (0.00-0.09)	0.14 (0.05-0.3)	0.08 (0.04-0.14)	0.56
FeO	0.77 (0.18-1.41)	5.38 (3.82-8.48)	8.43 (7.22-9.20)	20.48
MnO	0.01 (0.00-0.04)	0.09 (0.05-0.14)	0.24 (0.17-0.34)	0.35
MgO	4.86 (4.30-5.89)	9.22 (6.07-15.25)	2.75 (1.73-4.51)	4.78
CaO	5.55 (4.96-6.00)	5.02 (4.46-5.38)	3.67 (3.07-4.73)	11.67
Na_2O	1.98 (1.14-2.48)	1.82 (0.54-2.86)	1.58 (1.15-2.16)	0.58
K_2O	0.59 (0.24-0.74)	0.38 (0.08-0.53)	0.72 (0.52-1.04)	n.d.
Sum	97.88	99.03	97.27	99.97
Fe/(Fe+Mg)[†]	0.08 (0.02÷0.14)	0.25 (0.45÷0.80)	0.64 (0.52÷0.75)	0.70
Ca/(Ca+Na+K) [†]	0.57 (0.52÷0.73)	0.62 (0.45÷0.80)	0.49 (0.45÷0.55)	0.92

[(*)]- Number of glass fragment samples under analyzing; [(§)]- total obtained intervals; [(†)] – relation of atomic percentage concentrations of elements.

References

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

Electronic Scientific Information Journal "Herald of the Department of Earth Sciences RAS" № 1(21)'2003
Informational Bulletin of the Annual Seminar of Experimental Mineralogy, Petrology and Geochemistry – 2003
URL: http://www.scgis.ru/russian/cp1251/h_dgggms/1-2003/informbul-1_2003/planet-13e.pdf
Published on July 15, 2003