THE SMERDYACHEYE LAKE: NEW EVIDENCE FOR IMPACT ORIGIN AND FORMATION AGE. L. L. Kashkarov, D. D. Badjukov, A. I. Ivliev, G. V. Kalinina, and M. A. Nazarov, Vernadsky Institute of Geochemistry and Analytical Chemistry, Kosygin St., 19, Moscow, 119991, Russia, ugeochem@geochem.home.chg.ru.

Introduction: The Smerdyacheye Lake of about 350 m in diameter is located in the Moscow district approximately 140 km east of Moscow. This lake has a circular shape and a well-developed rim. Based on the features, it has been suggested [1] that the lake is a possible meteorite crater. The suggestion was confirmed by a fragment of a possible impactite found in the rim [2]. In this paper we report on a glass bead discovered recently in the vicinity of the lake. In composition and texture the glass is similar to impactglasses and supports strongly impact origin of the lake. First data on fision track age and TL characteristics of this glass bead are reported.

Occurrence and chemistry: The glass bead was found 3 km north of the lake in a tranch made in a pinewood. The bead of a rounded shape and a dark green color is about 2.5x1.5x1.5 cm in size and covered partly with a white shell of a few mm in thick (Fig 1). The glass is totally isotropic, shows a fluidal texture and contains rare bubbles. No very significant compositional variations were found in the glass. The compositional range is (wt%):

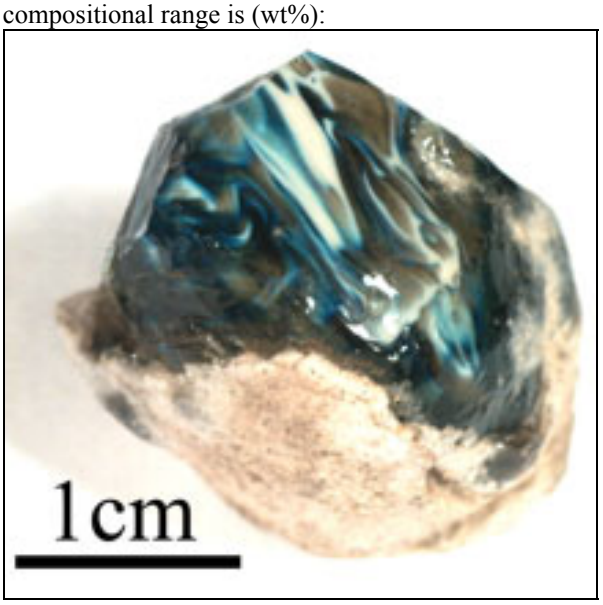

Fig. 1. The glass bead found near the Smerdyacheye Lake.

65.4-68.2 SiO_2, 0.47-0.60 TiO_2, 10.9-14.0 Al_2O_3, 1.15-2.57 FeO, 0.13-0.27 MnO, 1.08-2.07 MgO, 7.29-10.9 CaO, 0.77-1.16 Na_2O, 3.15-4.23 K_2O, 0.41-1.02 P_2O_5. In high Ca and K, and low Na the glass is completely different from any kinds of industrial glasses. The intermidiate zone (~0.2 mm) between the glass and the shell contains rare silica grains. A glass of the zone is poorer in FeO (0.2-0.8 wt%), MgO (0.3-0.8), CaO (5.3-6.5) and higher in Al_2O_3 (16.1-21.7), Na_2O (1.2-1.4), and K_2O (4.7-5.2). The shell is very porous and consists mainly of rounded silica grains (0.05-0.2 mm) set whithin a poor-crystallized melt matrix, which contains commonly thin mullite needles. Rare rounded zircon grains are present in the shell. In texture the shell material resembles a welded quartz sand. However the silica grains are almost totally isotropic and do not show any characteristic peaks in Raman spectra. No planar deformation structures were found in the grains. The melt matrix has a variable composition (wt%): 66.1-81.3 SiO_2, 0.67-1.33 TiO_2, 9.82-20.1 Al_2O_3, 0.31-1.14 FeO, <0.08 MnO, 0.23-1.44 MgO, 0.16-3.14 CaO, 0.31-1.27 Na_2O, 2.92-5.82 K_2O, 0.03-0.35 P_2O_5. As compared to the main glass the melt matrix is distinctly higher in Si, Ti, and P, and lower in Fe, Mg, Ca, and P.

Fission track dating: The main problem of fission track dating of young glasses is related with precise determination of ρ/ρ_0 and d/d_0 [3], where: ρ, ρ_0 and d, d_0 are track densities and track pit diameters of fossil and neutron-induced tracks, respectively. In the Smerdyacheye glass two fossil track groups with very different d-values were recognized. . After prolonged chemical etching in 20% HF (up to 5 min, at +20°C) d-values of the neutron induced tracks were found to be in the interval of 5 - 17 μm. Note, it is not correct to take into account the average diameter (d_{AV}) of the neutron-induced tracks because such tracks with d < 12 μm correspond to new appearing tracks during the prolonged etching.

The U concentration (C_U) was measured by (INAA and thermal neutron-induced ^{235}U fission track methods. The flux of thermal neutrons ($F_{th\ n}$)was $(1.50 \pm 0.05) \times 10^{15}$ cm^{-2}. The U contents obtained by INAA and the track method are 4.5 and 4.14 ± 0.12 ppm, respectively. The study of neutron-induced track densities demonstrates inhomogeneous U distribution in the glass. Measurements of C_U in the shell material using the autoradiographic fission track method give: (1) an average C_U value of 3.78 ± 0.11 ppm; (2) a C_U range in areas of 4×10^{-4} cm^2 from 2.0 to 6.3 ppm ; and (3) a C_U range in areas of less than 100 × 100 μm from 10 to 50 ppm. The scatter of U concentrations should be related with incomplete homogenezation of the parent melt during the short-time high-temperature

event. It is compatible with possible impact origin of the glass bead. The measured track parameters of the Smerdyacheye glass and its obtained fission track ages are presented in Table 1 and 2.

Table 1. Fission track parameters of the Smerdyacheye glass bead

* Track Group	** N_{TR}	Track pit diameters, μm***		d_{SP}/d_{IND}
		d_{AV}	d_q	
I	3	16 ± 1	-	1
II	11	6.5 ± 1.5	-	0.45 ± 0.20
III	581	11 ± 6	15 ± 2	-

I-st and II-nd groups are fossil tracks of different diameters; III-rd group is neutron-induced tracks detected on the area of 1.20×10^{-2} cm^2; ** N_{TR} – number of fossil tracks on the area of 4.27 cm^2,; *** d_{AV} is the average diameter; d_q is a quartil from the maximum of the diameter distridution of neutron-induced tracks

Table 2. Fission track ages of the Smerdyacheye glass

Track group	ρ', * cm^{-2}	ρ_{SP}, ** cm^{-2}	T , *** year
I	0.70	0.70	1,300±800
II	2.58	9.91	18,000±7,000
III	$(4.84\pm0.20)\times10^4$	-	-

ρ' is a measured track density; ** ρ_{SP} is a corrected track density; *** $T = 6\times10^{-8}\times F_{th\,n} \times (\rho_{SP} / \rho_{IND})_{GL}$.

Thermoluminescence analyses: Measurements of the natural TL_{NAT}, saved from the moment of last heatingof the glass, and TL_{REN} induced by X-ray irradiation were carried out using a high-sensitivity equipment [3]. The following parameters of TL glow-curves were measured: (1) the TL-intensity in the low-and high-temperature intervals; (2) the minimum temperature of heating of the glass, at which a very faint TL-luminosity occurs; 3) the peak position on the glow-curves, (T_{PEAK} , °C), the height of a peak (I_{TL}, rel. units) and the full width of a peak at a half of its maximum (FWHM, °C). Some of the parameters are given in Table 3 and 4.

Table 3. TL parameters of the natural TL of the Smerdyacheye glass

TL_{NAT}		
T_{PEAK}°C	I_{NAT}	FWHM,°C
190	0.003	60
320	0.01	80

Table 4. TL parameters of the X-ray-induced TL of the Smerdyacheye glass

TL_{REN}		
T_{PEAK}°C	I_{REN}	FWHM, °C
110	0.10	50
320	0.065	80

There are two poorly idendified peaks (FWHM = 60 and 80 °C) in the TL_{NAT} glow-curve of the Smerdyacheye glass (Table 3). The glow-curve of X-ray-induced TL is characterized by two well expressed peaks of different width. FWHM varies from ~ 50 °C at 110 °C up to ~ 80 °C at 320 °C (Table 4). Preliminary results of the thermoluminescence analyses give the age value of less than 10,000 years, which is compatible with the fission track age.

Conclusion: The study shows that the age of the Smerdyacheye crater should be about a few tens of Ka. The date does not conflict with the geological constrains on the crater age [3].

References: [1] Y. V. Kestlane and K. H. Melle (1987) *XX All-Union Meteoritic Conference*, Tallin, abstracts, part I, 47-48. [2] Badjukov D. D. et al. (2003) *LPSC* XXXIV, #1556. [3] D. Storzer and G.A.Wagner (1969) *EPSL*, V.5, 463-468.