TRACE ELEMENT ANALYSIS OF IMPACT GLASS SPHERULES OF THE EL'GYGYTGYN CRATER, SIBERIA.
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Introduction: The 3.58±0.04 Ma old El'gygytgyn impact crater (Central Chukotka, NE Siberia) has a diameter of ~18 km [1, 2]. El'gygytgyn is one of only two terrestrial craters with a volcanic target, therefore, analysis of it's target and impact lithologies is of basic interest for comparative planetology. The crater structure is filled with a ~12 km-large lake that has one effluent, the Enmyvaam River, in the Southwest. Because of this lake, El'gygytgyn is a very valuable climate archive in the Arctic as the structure was neither covered by glaciers [3] nor has the lake ever fallen dry. Climate and impact research were the rationale for the ICDP drilling project that finished successfully in spring 2009.

Impactites like melt rocks and breccias are rarely found in outcrops yet are present in the 80 m terrace of Lake El'gygytgyn [1]. Numerous papers on petrography, shock metamorphism, and geochemistry of impactites from El'gygytgyn are available [e.g., 4, 5]; the investigation of the material recovered in the ICDP drill program will start soon. We report new trace element data for impact glass spherules that have been collected from a terrace deposit of the Enmyvaam River at ~10 km off the crater center (see Fig. 1 in [6]).

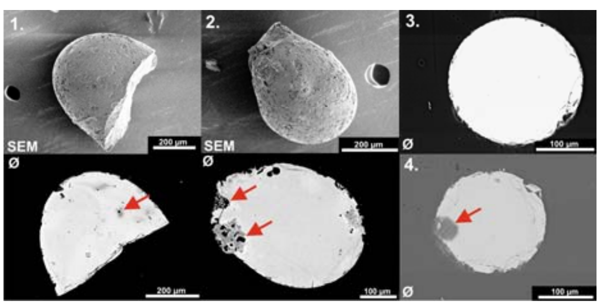

Fig. 1. Electron optical images of 4 different glass spherules, with a teardrop (1, 2) or perfect spherical shape (3, 4). (1) and (2) contain schlieren, breccias fragments, inclusions and few bubbles (red arrows in BSE images), (3) is perfectly homogeneous, and (4) has a inclusion (arrow). SEM JEOL 840, Inst. f. Planetologie, WWU, Münster.

Samples and analytical techniques: The seven glass spherules (samples E1–E4, E7–E9) have been characterized by optical, and electron optical techniques (Fig. 1), the results and major element data are given in [6]. Analysis of 31 trace elements was performed with a Finnigan Element2 LA-ICP-MS with 5 Hz, 8 to 9 J/cm² at the Institut f. Mineralogie WWU with Si as internal, and NIST 62 as external standard. 2 or 3 spots with a diameter of 60 µm were measured at each spherule.

Results: All seven samples show a very homogeneous major and trace elements distribution. Huge differences, however, exist between the samples in the SiO_2 content (53 to 68 wt.%, Table 1), in MgO (2.1 to 9.2 wt.%), in K_2O (0.6 to 3.3 wt.%), in the Ni concentrations (317 to 1096 ppm), in Co (25 to 79 ppm), Zr (100 to 169 ppm), Rb (18 to 107 ppm), and Ba (459 to 1092 ppm). The Ni/Co ratio is consistently high (11 to 14). Zr/Hf ratio of the spherules is also high, ranging from ~50 (E9) to 36 (E4), and Nb/Ta ratios vary from 17.6 (E7) to 14.9 (E8).

All glass spherules show similar REE distribution patterns (Fig. 2), yet those with low SiO_2 contents (53.1 and 58.4 wt.%) have overall lower REE concentrations except for Eu.

Discussion: Our new trace element data for impact glass lithologies from El'gygytgyn extent the range of known impactites [5] into the field of more mafic compositions. Basalts to andesites are known to occur in the El'gygytgyn area [5], and obviously were precursor lithologies for the spherules E7 and E9. In the Pearce and Cann diagram [7] of Figure 3, all samples plot in the tectonic setting for calc-alkaline rocks, as expected from the larger geological frame [8]. In agreement with this setting are the Nb/Ta and Zr/Hf values although a Zr/Hf of 50 is remarkable. Origin and importance of the exceptional Ni contents, in combination with high Ni/Co ratios are currently not understood. We exclude, however, technical reasons for these data as analyses of standard glass NIST 612 as unknown sample yield satisfactory results.

References: [1] Gurov E.P. and Gurova E.P. (1979). *Doklady Academii Nauk USSR* 249, 1197-1201. [2] Layer P. (2000). *MAPS* 35, 591-599. [3] Melles P.S. et al. (2007). *J. Paleolimnology* 37, 89-104. [4] Gurov E.P. & Gurova E.P. (1996). *MAPS* 31, A56. [5] Gurov E.P. et al. (2007). *MAPS* 42, 307-319. [6] Adolph L. & Deutsch A. (2008). *LPSC* XXXX, Abstract #1116. [7] Pearce J.A. & Cann J.R. (1973) *EPSL* 19, 290–300. [8] Chekhovich V.D. et al. (1999) *Island Arc* 8, 168-180. [9] Rudnick R.L. & Gao S. (2004) In: *Treatise on Geochemistry* (ed. H.D. Holland) Elsevier, Amsterdam, 1-56.

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Table. 1. Composition of El'gygytgyn glass spherules.

wt%	E1	E2	E3	E4	E7	E8	E9
SiO_2	62.1	65.4	64.1	66.8	58.4	67.7	53.1
TiO_2	0.88	0.76	0.88	0.73	0.88	0.67	0.94
Al_2O_3	17.8	17.7	19.4	17.1	15.6	17.1	18.0
FeO_{tot}	6.7	6.1	6.3	6.1	9.7	5.2	9.1
MnO	0.11	0.09	0.06	0.08	0.18	0.05	0.17
MgO	3.7	2.5	2.2	2.9	5.6	2.1	9.2
CaO	4.3	2.4	1.6	2.3	5.1	1.9	7.7
Na_2O	2.0	1.8	2.0	1.5	2.4	1.9	1.2
K_2O	2.5	3.0	3.3	2.5	1.8	3.5	0.6
Sc	19	18	18	15	24	17	30
Ti	5690	5770	6050	5250	6670	4990	6270
V	96	93	96	50	118	59	79
Co	29	29	25	39	79	25	66
Ni	317	318	323	459	1096	317	787
Rb	70	89	107	76	45	119	18
Sr	421	271	300	230	541	258	563
Y	21	20	21	18	21	23	19
Zr	150	153	169	146	117	203	100
Nb	7	9	10	9	6	10	5
Ba	682	843	1092	759	514	823	459
La	21	25	22	22	15	26	15
Ce	42	52	43	49	31	54	30
Pr	5	6	5	5	4	6	4
Nd	21	21	20	22	18	23	17
Sm	4.4	4.3	4.2	4.6	4.2	4.7	3.6
Eu	1.12	1.00	0.92	1.05	1.25	1.01	1.27
Gd	4.2	3.6	3.7	3.5	4.0	3.8	3.6
Tb	0.62	0.53	0.61	0.51	0.60	0.60	0.49
Dy	3.8	3.7	3.8	3.5	3.9	4.0	3.3
Ho	0.78	0.75	0.77	0.7	0.8	0.81	0.65
Er	2.33	2.33	2.27	2.15	2.24	2.43	2.17
Tm	0.34	0.34	0.35	0.34	0.34	0.36	0.29
Yb	2.36	2.51	2.46	2.47	2.23	2.46	2.03
Lu	0.33	0.35	0.39	0.32	0.33	0.38	0.32
Hf	4	4	4	4	3	5	2
Ta	0.49	0.57	0.74	0.57	0.34	0.67	0.3
W	0.14	0.48	0.5	0.1	0.07	0.22	0.08
Pb	1.3	6.6	8	0.5	0.7	1.9	0.7
Th	7	7	9	8	3	10	3
U	0.9	1.5	1.7	0.6	0.3	1.1	0.1

Average values, trace elements in ppm. Major element analysis: JEOL JXA 8600 MX Superprobe (Inst. f. Mineralogie WWU) with the following settings: 15 kV acceleration voltage, 2 nA sample current, 10 µm defoc. beam, obsidian and synthetic glass as standards, and a moldavite sample as monitor.

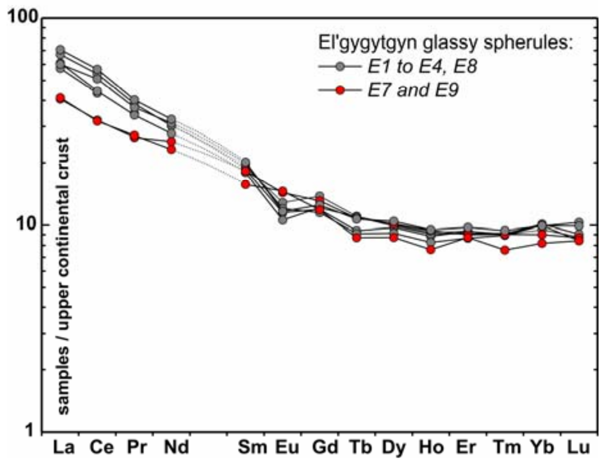

Fig. 1. REE distribution patterns for the seven glass spherules normalized to the average upper continental crust [9]. With respect to the reference material, the spherules show enrichment of the light REE, five of the spherules have a well-defined negative Eu-anomaly (•), two with low SiO_2 content (53.1 and 58. 4 wt.%) lack any Eu-anomaly (•).

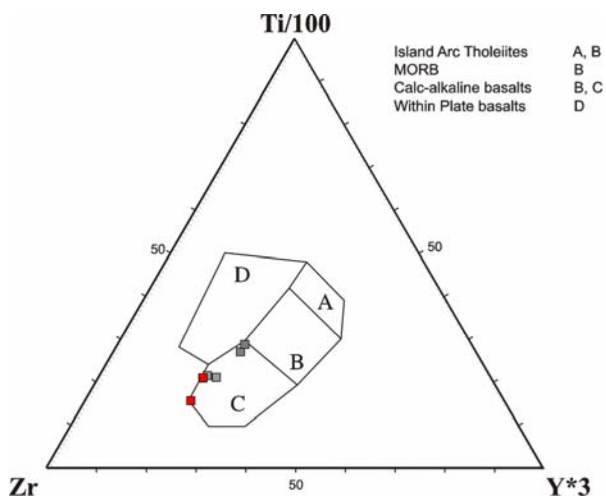

Fig. 3. Zr-Ti-Y diagram with data for the seven glass spherules. They all plot in the field of calk-alkaline basalts (C); spherules E7 and E9 (■) are those with the lowest Zr content.