GLASS SPHERULES RELATED TO THE EL'GYGYTGYN IMPACT CRATER (SIBERIA).
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Introduction: The El'gygytgyn impact crater (NE Siberia, Russia) originated 3.6 Ma ago. With a diameter of ~18 km El'gygytgyn is one of only two terrestrial craters having volcanic target lithologies (Fig. 1), hence, this structure is of fundamental importance in comparative planetology. The crater was filled in the late Pleistocene with a lake whose only effluent is the Enmyvaam River to the Southwest. The El'gygytgyn structure is target of a current ICDP project for climate and impact research [1]. Ever since its formation, the crater was free of glacial cover and the lake has never fallen dry.

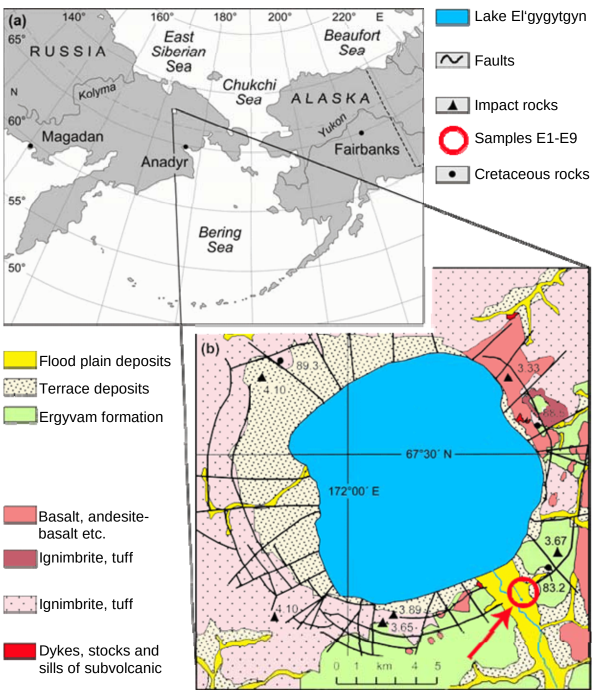

Fig. 1 Geological sketch map of the El'gygytgyn impact crater, Chukotka (modified after [2]), with sampling location (O).

The El'gygytgyn impact crater has been investigated since 1979 [3]. Due to its young age, various fresh impact rocks and glass types occur in and around the structure (e.g. [3–5]). Here we report the results of a reconnaissance study on glass spherules in an ejecta deposit outside the crater rim.

Glass spherules: The seven glass spherules (samples E1–E4, E7–E9) were collected from a terrace deposit of the Enmyvaam Rriver at ~10 km off the crater center (Fig. 1, **O**), near the flood plain deposits and the Ergyvaam formation consisting of ignimbrites and tuffs.

Analytical techniques: Shape and size of the glass spherules were documented with optical (transmitted and reflected light) and electron optical methods. The major element composition was analyzed with the 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.

Characteristics of the glass spherules: The size of the seven objects amounts from 30 to 760 µm; they display a spherical, in part slightly elongated shape. They are translucent with colors ranging from amber, dark brown to nearly black. All spherules contain a few circular bubbles, schlieren, and very rarely mineral clasts and breccia fragments (Fig. 2). Either these clasts are stuck at the surface of the spherules indicating a contact during ballistic ejection or landing before the spherules have cooled below the glass transition temperature. The cracks at the outer rim of some spherules (Fig. 2 E-G) are probably artifacts of the preparation.

Chemistry: All spherules have a very homogeneous yet quite different composition (Tab. 1): four samples (E2–E4, E8) are dacitic, two (E1, E7) andesitic, and one (E9) is basaltic-andesitic in composition (Fig. 3). The schlieren and clasts differ from the host glass in high-silica and much lower iron, aluminium and titanium contents.

Comparison with existing data: E. Gurov and co-workers [3, 4, and 6] have published an extensive data set of the chemical composition of various impact glasses lithologies from inside the El'gygytgyn crater. Most of their samples are rhyolitic, dacitic, or trachydacitic in composition, while andesitic and basaltic-andesitic compositions are lacking (Fig. 3). Basaltic-andesitic rocks, however, are known to occur in the NE sector of the El'gygytgyn crater, and similar rocks must have been the precursor lithologies for the more mafic glass spherules investigated here. We are curious if similar mafic impactites will be encountered in the ICDP drilling campaign in 2009.

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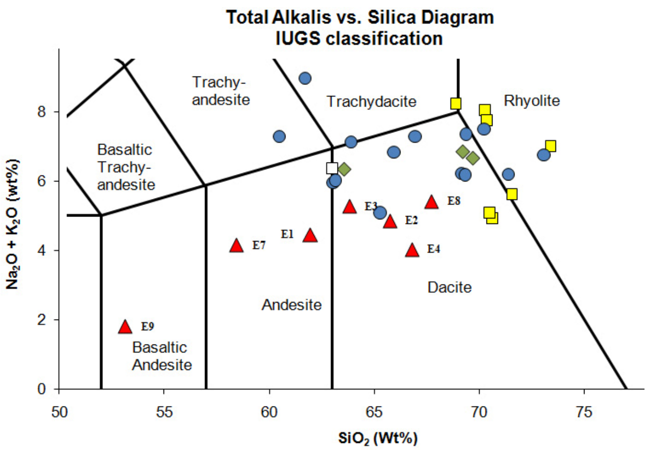

Fig. 3. TAS diagram with the data for the glass spherules from the terrace deposit of the Enmyvaam River (▲) compared to data for impact glasses collected inside the crater (dots, squares, diamonds [6]).

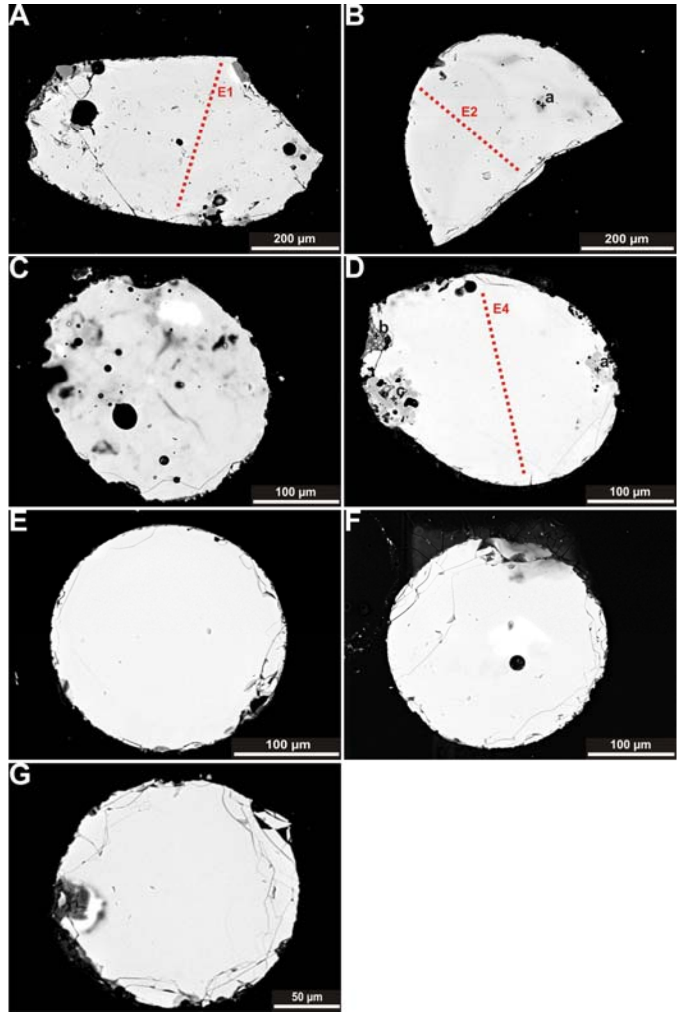

Fig. 2 (right). Micrographs of the seven glass spherules (A–D=E1–E4, E–G=E7–E9) from the terrace deposit of the Enmyvaam River. Note the clasts attached to the rim (e.g. D, a–c), the rounded to perfectly circular bubbles, inclusions, and schlieren (e.g. B, a); backscatter electron images SEM JEOL JS-840 A, operating at 20 kV acceleration voltage (ICEM WWU Münster). Dotted red lines correspond to microprobe profiles.

Tab. 1. Major element composition (mean and range) of seven glass spherules from the El'gygytgyn impact crater (Fe_2O_3 = total iron; n = number of analyses).

Sample	E1		E2		E3		E4		E7		E8		E9	
(n) *err* [wt%]	(15)	σ	(13)	σ	(11)	σ	(15)	σ	(10)	σ	(10)	σ	(7)	σ
SiO_2	62,10 ±	1,19	65,44 ±	0,91	64,11 ±	0,84	66,79 ±	0,53	58,43 ±	8,84	67,73 ±	1,48	53,14 ±	3,00
TiO_2	0,88 ±	0,20	0,76 ±	0,04	0,88 ±	0,05	0,73 ±	0,03	0,88 ±	0,14	0,67 ±	0,05	0,94 ±	0,07
Al_2O_3	17,75 ±	0,51	17,71 ±	0,44	19,43 ±	0,51	17,10 ±	0,29	15,63 ±	2,44	17,06 ±	0,34	18,05 ±	0,16
FeO	6,73 ±	0,45	6,15 ±	0,24	6,28 ±	0,23	6,06 ±	0,09	9,66 ±	1,46	5,23 ±	0,72	9,10 ±	0,82
MnO	0,11 ±	0,01	0,09 ±	0,02	0,06 ±	0,01	0,08 ±	0,02	0,18 ±	0,03	0,05 ±	0,02	0,17 ±	0,03
MgO	3,67 ±	0,19	2,53 ±	0,15	2,15 ±	0,17	2,93 ±	0,10	5,64 ±	0,80	2,06 ±	0,55	9,18 ±	1,44
CaO	4,31 ±	0,34	2,42 ±	0,26	1,58 ±	0,20	2,32 ±	0,09	5,09 ±	4,32	1,90 ±	0,46	7,67 ±	1,22
Na_2O	1,96 ±	0,10	1,84 ±	0,06	2,02 ±	0,06	1,48 ±	0,07	2,36 ±	0,32	1,88 ±	0,09	1,18 ±	0,14
K_2O	2,52 ±	0,12	2,99 ±	0,06	3,25 ±	0,09	2,54 ±	0,07	1,80 ±	0,25	3,53 ±	0,27	0,62 ±	0,56
total	100,0 ±	0,2	99,9 ±	0,2	99,8 ±	0,4	100,0 ±	0,2	99,7 ±	9,9	100,1 ±	0,3	100,0 ±	0,2
Range														
SiO_2	59,76 -	63,02	61,69 -	68,18	60,05 -	69,02	66,86 -	66,09	57,33 -	59,34	65,08 -	70,66	52,26 -	53,88
TiO_2	0,89 -	1,20	0,62 -	1,01	0,67 -	1,14	0,71 -	0,65	0,74 -	1,12	0,52 -	0,84	0,75 -	1,11
Al_2O_3	16,49 -	19,36	16,27 -	19,57	15,87 -	22,70	17,49 -	15,81	14,23 -	16,75	16,24 -	17,91	17,64 -	18,34
FeO	6,44 -	7,22	5,34 -	6,75	5,35 -	7,70	5,90 -	7,40	9,27 -	10,07	4,66 -	5,51	8,88 -	9,31
MnO	0,03 -	0,21	0,02 -	0,20	0,01 -	0,12	0,05 -	0,09	0,05 -	0,26	0,00 -	0,15	0,11 -	0,19
MgO	3,32 -	4,08	2,07 -	3,09	1,26 -	2,65	2,90 -	4,06	5,33 -	6,03	1,87 -	2,60	8,86 -	9,46
CaO	4,03 -	4,65	2,07 -	2,93	1,10 -	1,89	2,22 -	2,56	4,77 -	5,45	1,70 -	2,33	7,33 -	7,94
Na_2O	1,67 -	2,28	1,61 -	2,33	1,94 -	2,40	1,23 -	1,73	1,92 -	2,72	1,68 -	2,08	1,04 -	1,40
K_2O	2,03 -	3,16	2,54 -	3,44	2,97 -	3,69	2,56 -	2,33	1,55 -	2,07	3,26 -	3,87	0,56 -	0,70