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Chemical composition and texture of ash from the Grimsvotn 2011-eruption.

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Volcanic ash produced during the first two days of the eruption is mostly finegrained, acicular glass. Fig. 1 shows a sample (GR11-01) from Kirkjubaejarklaustur collected during the onset of fallout just after midnight May 22nd, time 0058 GMT. Fig. 2 shows a sample from Horgsland/Sida (GR11-02) collected in the morning of May 22nd, time 0845 GTM. Sample GR11-01 classifies as suspended load with grain-size diameter about or less than 10 micrometer in diameter. The grain-size of sample GR11-02 is slightly more coarse-grained and crystallites, presumeably of plagioclase, are seen embedded in the glass.

Color of the ash fallout is medium dark brownish-gray with occasional darker or black grains. In pumice fragments collected in Grimsvotn the brownish color dominates the core of the pumice, while the surface layer is black. The color difference is obviously depending on the oxidation state of iron and crystallinity.

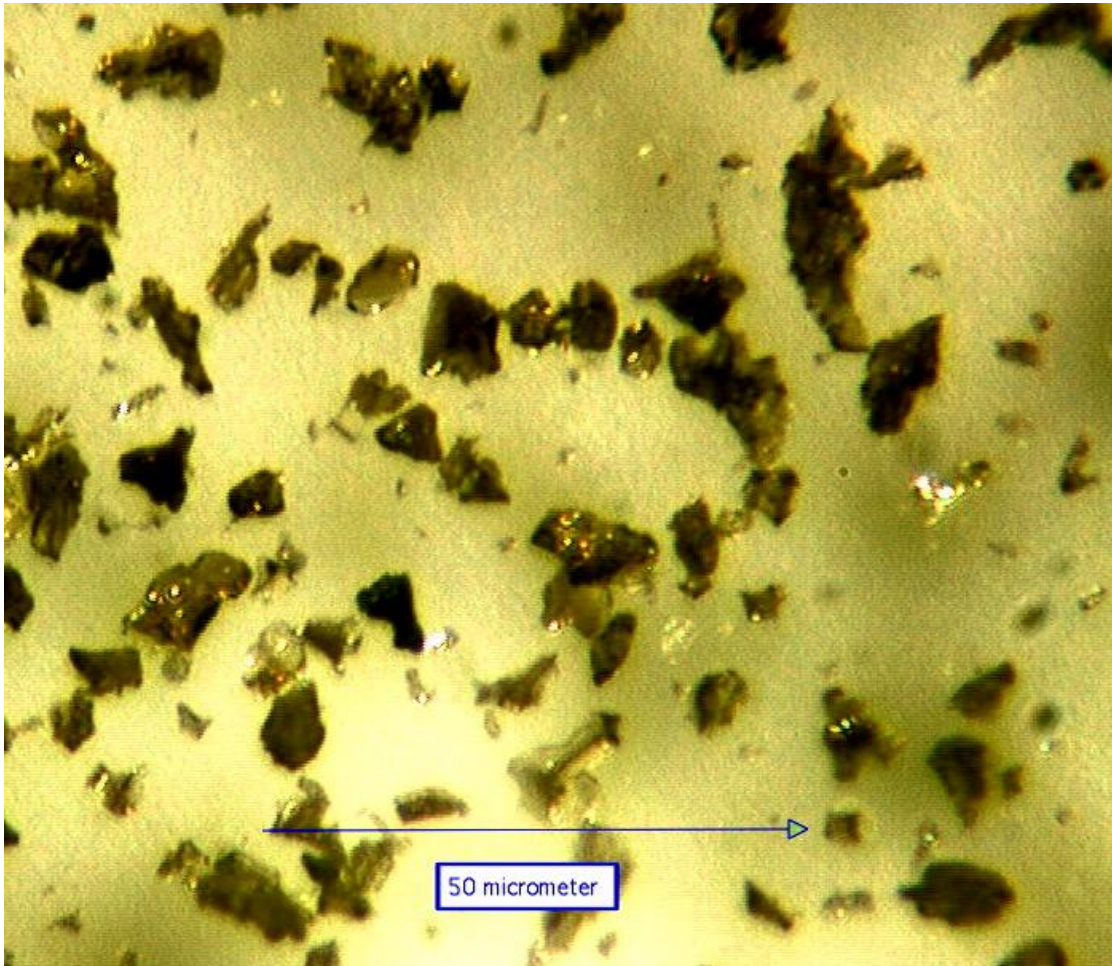


Fig.1

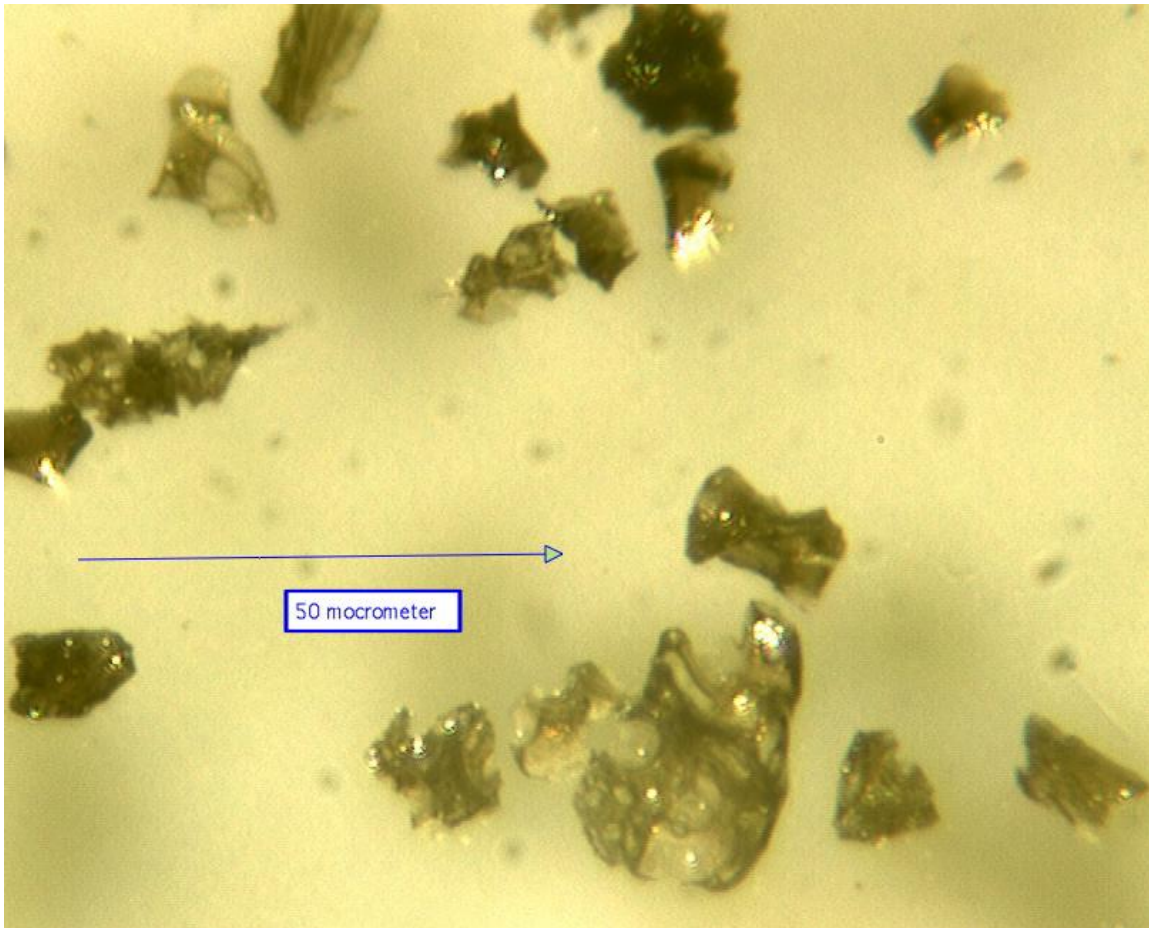


Fig.2

Based on chemical composition (Table 1), the ash classifies as tholeiite-basalt. Duplicate analysis of both samples are marked a and b. There is no significant difference between samples GR11-01 and GR11-02. Composition of the ash remained constant during the first day of the eruption. Analysis of the USGS reference material DNC-1 is shown in Table 1. Chemical composition of the ash is characteristic for the Grimsvotn rocks, almost similar to that of several recent Grimsvotn eruptions as indicated by analysis (Table 1) of rocks from the 1998 and 1934 eruptions. These eruptions showed no variation in rock composition during the most intense initial phase of production. Chemical composition of the Grimsvotn rocks is almost homogeneous. The rocks are tholeiitic basalt with MgO ranging between 5 and 6 Wt %, similar to the nearby Laki fissure and most of the youngest palagonite ridges south of the Vatnajokull glacier.

Tafla 1. Grímsvötn 2011 eruption. Chemical composition Wt%

Sample	GR11-01a	GR11-01b	GR11-02a	GR11-02b	DNC-1a	DNC-1b	DNC-1 RV
SiO2	50,54	50,89	51,01	50,98	47,91	47,31	47,61
Al2O3	13,73	13,71	13,46	13,48	18,21	18,83	18,52
FeO	13,14	13,22	13,25	13,38	9,15	8,96	9,06
MnO	0,23	0,23	0,23	0,24	0,15	0,15	0,15
MgO	5,69	5,63	5,77	5,67	10,23	10,22	10,23
CaO	10,12	9,98	9,86	9,92	11,56	11,64	11,60
Na2O	2,87	2,70	2,81	2,72	1,87	1,95	1,91
K2O	0,49	0,48	0,50	0,49	0,24	0,24	0,24
TiO2	2,73	2,70	2,67	2,69	0,48	0,49	0,48
P2O5	0,38	0,37	0,38	0,37	0,07	0,07	0,07
Ba	0,0112	0,0111	0,0111	0,0111	0,0120	0,0118	0,0119
Co	0,0070	0,0069	0,0069	0,0069	0,0058	0,0058	0,0058
Cr	0,0035	0,0032	0,0026	0,0024	0,0277	0,0268	0,0273
Cu	0,0093	0,0092	0,0077	0,0073	0,0101	0,0101	0,0101
La	0,0013	0,0012	0,0010	0,0009	0,0037	0,0036	0,0036
Ni	0,0058	0,0051	0,0044	0,0040	0,0252	0,0247	0,0249
Sc	0,0030	0,0028	0,0026	0,0024	0,0031	0,0031	0,0031
Sr	0,0098	0,0088	0,0079	0,0074	0,0146	0,0145	0,0145
V	0,0155	0,0144	0,0129	0,0119	0,0150	0,0149	0,0149
Y	0,0008	0,0007	0,0007	0,0006	0,0018	0,0018	0,0018
Zn	0,0066	0,0064	0,0060	0,0057	0,0070	0,0071	0,0071
Zr	0,0018	0,0016	0,0015	0,0014	0,0039	0,0038	0,0038

GR11-01: (Ármann Höskuldsson) Kirkjubællarklaustur, Time 22 May, 12:58 GMT.

GR11-02: Horgsland/Sidu, Time 22 May 08:45 GMT.

DNC-1: USGS reference sample, DNC-1 RV =Recommended values.

Duplicate analysis marked a and b

Method: Rock powder fluxed with lithium metaborate,

dissolved in nitric/hydrochloric/oxalic - acid mixture.

Analysis made on ICP-OES simultaneous spectrograph (Spectro CIROS)

Reference material (SRM): USGS-BHVO - USGS QLO-1.

Comparison of the eruptions 2011-1998-1934:

Sample	GR11-01a	GRIM98	SAL051(1934)
SiO2	50,54	52,00	49,34
Al2O3	13,73	12,85	14,23
FeO	13,14	12,99	13,96
MnO	0,23	0,22	0,23
MgO	5,69	5,56	4,84
CaO	10,12	9,90	9,95
Na2O	2,87	2,93	3,32
K2O	0,49	0,51	0,47
TiO2	2,73	2,57	3,10
P2O5	0,38	0,32	0,39

Leaching of soluble compounds on particle surfaces was made in order to simulate leaching of the ash upon contact with rain-water. Leaching experiment was made on 2 g ash in 10 ml of water. The sample was shaken in an ultrasonic bath for 5 min and the left in contact with the water for 10 min. Before analysis the water was filtrated through Watman 42-paper so presumably the analyzed water contained ash particles less than about 1 micrometer in diameter. Composition of the leachate (Table 2) including the smallest particles is assumed to resemble the chemical impact from the ash during contact with rain water. The most common element in the leachate is sulfur, reported as sulfate (SO₄) in Table 2. A slight sulfur smell of the fresh ash may indicate the presense of native sulfur. Measurements of pH shows neutral to weakly basic leachate that may indicate reaction with freshly broken glass surfaces of the ash.

Table 2. Concentration (mg/l) of elements leached from the ash

Sample	GR11-01	GR11-02
pH/20°C	8,6	6,9
SiO ₂	14,94	12,30
Na	47,25	45,70
Ca	32,17	36,71
Mg	11,56	8,03
K	4,70	3,15
Fe	4,32	1,37
Sr	0,10	0,09
Mn	0,52	0,37
Ti	0,59	0,18
SO ₄	223,79	216,72
Al	3,39	0,63
P	0,19	0,15
Cl	4,30	4,31
F	4,90	4,95

2 g sample leached in 10 ml water for 30 min
 Method: ICP-OES (SPECTRO CIROS)