

Report on Collection and Analysis of
Volcanic Gases from Surtsey

by

Gudmundur E. Sigvaldason and Gunnlaugur Elísson
University Research Institute, Reykjavik

The present progress report summarizes the results of gas analyses on samples from Surtsey in 1965. The lava production stopped during May 1965 and after that gas sampling has not been attempted since no vigorous fumarolic activity is found on the island.

Of several attempts which were made to collect gases during 1965 only two were successful. The collections were made using the same apparatus as described in the previous report, but the water trap was cooled in a water bath (ca. 10°C) instead of air.

The analysis are presented in table 1 and 2. The samples from Jan. 18 are heavily contaminated with air, whereas the samples from February 21 contain only 0.07% of inactive gases indicating complete absence of contamination.

On two occasions, Oct. 15 1964 and Febr. 21 1965, it has been possible to collect gases without any obvious contamination. A number of unsuccessful attempts were made and it might be worth while to compare conditions at sampling sites where good and poor samples were obtained.

The sampling sites can be divided into three groups:

1. Cracks in cooling lava, where sampling tube could be lowered into the still glowing interior of the lava stream. Temperature already below the solidus or around 800-850°C.
2. Narrow cracks in the consolidated roof of a lavatube, with large discharge of lava. The lavatube is essentially closed except for the small cracks in the roof where the gases escape under pressure.

3. Active chimneys (hornitos) on consolidated lava surface. Openings are wide with respect to the cracks mentioned under group 2 and the gases are released under atmospheric pressure.

Quality of samples from group 1 sites is poor. The only active gas found is CO_2 in small quantities (less than 1.0%) and the rest is air.

Conditions representing the group 2 sites were observed on Oct. 15 1964. This is a somewhat idealized condition, which is probably not often found under volcanic eruptions. The group 3 sites are likely to be found in most lava eruptions and special attention should be given to sites of this kind. Increasing contamination from air is found with increasing diameter of the chimney opening. Comparison of our samples from Jan. 18 and Febr. 21 1965 shows this clearly. The first samples collected from a chimney with a one meter opening are heavily contaminated, but the latter samples where the opening was ten times smaller is apparently free from any air contamination. Spattering from the chimneys may cause some difficulty by clogging the sampling tubes.

Common to sampling sites of group 2 and 3 is development of flames, and these form a positive indicator of the presence of gas discharge. Attempts to collect gases where no flames were present either failed or gave poor results.

On the basis of our field observation combined with the chemical analysis of the gases we are led to believe, that the process of degassing from a lavastream at 1400°k is essentially restricted to a relatively short time after the lava has appeared at the surface. During this short period of time the lava loses up to 80-90% of its volatile constituent (see also Björnsson, this report) in essentially the same proportions as initially present in the magma. The liberation of the 10-20% volatiles, which are

left after vigorous gas release in the fresh lava has subsided, goes very slowly and the chemistry of the gases is likely to alter because of reactions with air and the crystallizing rock.

Ellis (1959) computed a theoretical composition of magmatic gases using existing thermodynamical data. A composition with molecular ratios $H_2O : CO_2 : H_2 : S_2$, 100 : 10 : 2 : 1 was used as a basis for the calculation since this composition is similar to many geothermal and volcanic gases. In atomic ratios this composition is $H : O : C : S$, 100 : 60 : 5 : 1 and our sample from Febr. 21 1965 has the atomic ratios 100 : 60 : 4 : 2. In spite of the higher sulphur content and somewhat lower carbon in our sample, it is of interest to compare the theoretical values at $1400^{\circ}K$ with the actual composition of the Surtsey gases. The last column of table 1 gives the theoretical values from Ellis, which are strikingly similar to some of our samples. This fact gives us a certain degree of confidence to state, that the gas samples from Surtsey may be close to chemical equilibrium at PT conditions of the sampling site.

References:

Björnsson, S.: (This report)

Ellis, A.J. (1957): Chemical equilibrium in magmatic gases.
Am. J. Sci. 255, p. 416.

Sigvaldason, G.E. and G. Elísson: Preliminary report on
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Report, 1965.

TABLE I

15.10.1964			21.2.1965			theoretical composition Ellis (1959)
H ₂ O	79.20	79.20	86.16	86.16	86.13	86.0
HCl	0.80	0.80	0.40	0.40	0.43	
SO ₂	5.40	4.02	3.28	1.84	2.86	1.49
CO ₂	9.18	9.64	4.97	6.47	5.54	8.05
H ₂	4.56	4.88	4.74	4.70	4.58	3.58
CO	0.68	0.70	0.38	0.36	0.39	0.82
N ₂	0.18	0.76	0.07	0.07	0.07	
CH ₄	0.00	0.00	0.00	0.00	0.00	
T°K	1400		1400			1400

TABLE II

25.11.1964	18.1.1965		21.2.1965				
SO ₂	3.9	3.4	} 5.6	24.4	13.7	21.3	
CO ₂	4.3	3.9		37.0	48.1	41.2	
O ₂	16.0	12.1	17.3	0.0	0.0	0.0	
H ₂	0.0	0.0	0.0	35.3	35.0	34.1	34.0
CO	0.0	0.0	0.0	2.8	2.7	2.9	2.8
N ₂	} 75.8	80.6	77.1	0.5	0.5	0.5	0.75
A							0.008
T°K	1400	1400		1400			