# CHEMICAL-OCEANOGRAPHIC EFFECTS OF THE SURTSEY ERUPTION

by

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## I. Observational Data.

### 1. Oceanographic Surveys in the Surrounding Coastal Area.

During the period November 15, 1963, to November 17, 1964, a total of nine cruises were conducted to the sea area surrounding Surtsey. The number of stations worked as well as the type of data collected are listed in Table 1. During all of these cruises except one, observations were made along four sections directed east-west and north-south from Surtsey. On each section collections were made at 5 stations, located between 0.2 and 12 nautical miles off the island. On four occasions additional sections were worked farther west in the Selvogsbanki region, and on one occasion (June 1964) only 9 stations on two sections could be worked due to adverse weather conditions.

Table 1
Chemical Observations around Surtsey and in the Selvogsbanki Region.

| Cruise | Date | No. of stations | No. of observations | | | |
|---|---|---|---|---|---|---|
| | | | Sal. | Oxygen | Phosph. | Silicate Nitrate |
| Albert | 15-16/11 '63 | 20 | 87 | 61 | | 87 |
| P-63 | 1-3/12 '63 | 21 | 98 | | | 46 |
| A-64 | 21-24/1 '64 | 37 | 156 | | 73 | 88 |
| K-64 | 31/3-3/4 '64 | 43 | 198 | | 97 | 113 |
| L-64 | 10/4 '64 | 20 | 87 | | 41 | 42 |

| Cruise | Date | No. of stations | No. of observations | | | | |
|---|---|---|---|---|---|---|---|
| | | | Sal. | Oxygen | Phosph. | Silicate | Nitrate |
| P-64 | 29-30/5 '64 | 21 | 112 | | 95 | 95 | 93 |
| R-64 | 22-23/6 '64 | 9 | 48 | | 33 | 33 | |
| Q-64 | 5-7/9 '64 | 28 | 177 | | 172 | 172 | 164 |
| R2-64 | 16-17/11'64 | 21 | 83 | | 75 | 81 | 75 |
| | | 220 | 1046 | 61 | 586 | 757 | 332 |

Nutrient samples were collected in polyethylene bottles, frozen aboard the ships and analyzed sprectrophotometrically ashore. Facilities for freezing samples were poor on some of the ships and this limited the number of samples taken.

2. Collection of Water Samples from the Island.

Samples were procured by landing parties on four occasions:

a) May 31, 1964. Two samples were taken at the southwest and southeast shores of Surtsey where lava was flowing into the sea. Samples were also taken from a lagoon formed on the northern part of the island.

b) September 9, 1964. Four samples were taken on the southwest shore in a small creek formed by the lava flow.

c) October 15, 1964. A sample was collected at the south shore of the island at the edge of the lava and also from the lagoon at the north coast of the island.

d) November 25, 1964. A sample was taken at the southeast coast. At the same time an experiment was carried out extracting hot lava with sea water. The sample so obtained was partly analyzed at the oceanographical laboratory of the Icelandic Fisheries Research Institute, and the remaining part sent to the National Institute of Oceanography, England, for detailed analyses of macro- and micro-constituents.

3. Experiments on Dissolution of Nutrients from Erupting Materials.

The effect of temperature on the process of dissolving nutrients from tephra was investigated experimentally in the laboratory. Five gram portions of tephra from a sample collected from the deck of a patrol vessel sailing under the ash cloud, were added to polyethylene bottles containing 200 ml of synthetic sea water and the bottles kept at different temperatures for two hours, with occasional shaking. The samples were then filtered and the filtrates analyzed for reactive silicates, phosphates and nitrates.

## II. Results.

A paper based on the results obtained so far is in preparation and will be ready for publication within a few months. In the present report only a few of the main findings will be briefly touched upon.

1. Salinity, Dissolved Oxygen and Fluorides.

In all instances the salinity in the surrounding sea area was found to be normal for the season in question, ranging from 34.90 to 35.20 oo/oo. However, the salinity of samples taken at the shores of the island showed abnormally high values. Thus the four samples taken on September 9th in a small creek at the southwest shore ranged from 36.51 to 38.70 o/oo. These high values must be attributed to intense evaporation as the corresponding sea temperatures ranged from 26° to 38°C. But this local heating could only be traced a small distance from the shore, and the effects on the surrounding sea area must have been negligible.

Oxygen concentrations were determined at a number of stations during the first cruise. The results did not reveal abnormal concentrations for that season.

The fluoride concentration was determined on 8 samples that gave extreme values of dissolved nutrients. The fluorides ranged from 0.060 to 0.070 mg-at/litre with a mean value of 0.065 mg-at/litre. This value is practically identical with that given in the literature for sea water of the salinity in question. Thus no additional fluoride concentrations due to the eruption could be detected in the surrounding area, but considering the great dilution of sea water that comes in contact with eruption materials, this result does not exclude the possibility of fluoride enrichment.

## 2. Nutrients.

Laboratory experiments on the extraction of nutrients from tephra ejecta as well as glowing lava, revealed that significant quantities of silicates and phosphates were dissolved. At temperatures above $80^{o}$ the amounts of dissolved silicates in normal sea water increased by a factor of 4-6, the dissolved phosphates by a factor of 2-3. No significant amounts of nitrates dissolved from the eruption materials.

Horizontal distribution of reactive silicates in the study area during the first four cruises revealed a significant increase in concentrations within a small area surrounding the island. At the stations closest to the island (0.2 nautical miles or less) concentrations as high as 20 $\mu$g-at/litre were found, decreasing to 8 $\mu$g-at/litre or less 15 miles away from the eruption centre. The normal winter values in the Selvogsbanki area are about 6-7 $\mu$g-at/litre. Increased silicate concentrations were found both at the sea surface and near the bottom. It is believed that these resulted partly from sea water coming in contact with hot eruption material, and partly from dissolution of tephra fallout sinking through the sea as well as material lost from the island by marine erosion. Dissolved phosphates also increased because of the volcanic activity, but to a lesser degree than the silicates.

Results from the investigations made during the last five cruises indicate that after eruption of lava began in early April, the Surtsey eruption has had very little direct effect on the nutrient concentration in the surrounding area. An analysis of the available material suggests that although higher nutrient concentrations were found near the island than farther away during the summer; these can in most cases be attributed to reduced biological uptake associated with greater turbulence near the island.