

# Textural Analysis of Surtsey Tephra A Preliminary Report

By

MICHAEL F. SHERIDAN

Associate Professor, Department of Geology, Arizona State University, Tempe, Arizona 85281

## INTRODUCTION

Textural analysis of modern pyroclastic and hydroclastic deposits provides a means of characterizing ancient tephra units. The grain size distribution is also useful for interpretation of transportation and deposition mechanisms related to the various modes of eruption and emplacement. Iceland has several historic volcanic centers that are well suited for textural analysis of tephra. Surtsey is one of the best of these centers because of the well documented eruption, good exposures, unique environment, and wealth of interdisciplinary studies. The information herein reported is a result of the Boston College – NASA expedition to Iceland during June, 1970.

## SAMPLES

Tephra samples were collected from nine widely separated points on both Surtur I and Surtur II (Figure 1). In most cases samples were taken from a single bed (5 to 10 cm thick) with an attempt to represent a variety of stratigraphic levels and textures. The size of the tephra samples ranged from 140 g to 286 g. Because of the reconnaissance nature of the expedition and the relatively few samples, it should be assumed that some textural varieties exist that fall outside of

the range of those sampled. Two samples of beach sands (7 and 8 of Figure 1) were collected from the berm 5 m above the high tide line for comparison with the tephra.

## RESULTS

Standard mechanical analyses were made using U. S. Standard 8-inch screens with a one phi interval for the tephra and U. S. Standard 3-inch screens with a one-half phi interval for the beach sand. Because of its many advantages, the size class used in this paper is the phi unit ( $\phi$ ) proposed by Kumbein (1934). Results of the size analyses are presented in Figures 2 and 3. The data are plotted with phi vs. cumulative weight

TABLE 1  
Size Distribution Parameters of Surtsey Tephra

Sample No.	M $\phi$	Sorting	Skewness
1	1.54	2.49	0.31
2	1.01	2.99	0.37
3	1.65	2.37	0.10
4	0.24	3.05	0.44
5	1.83	3.12	0.13
6	2.19	2.76	0.21
9	1.50	3.31	0.21
10	0.79	2.56	0.27
11	-0.07	2.13	0.35
average	1.19 $\pm$ .71	2.75 $\pm$ .37	0.27 $\pm$ .11

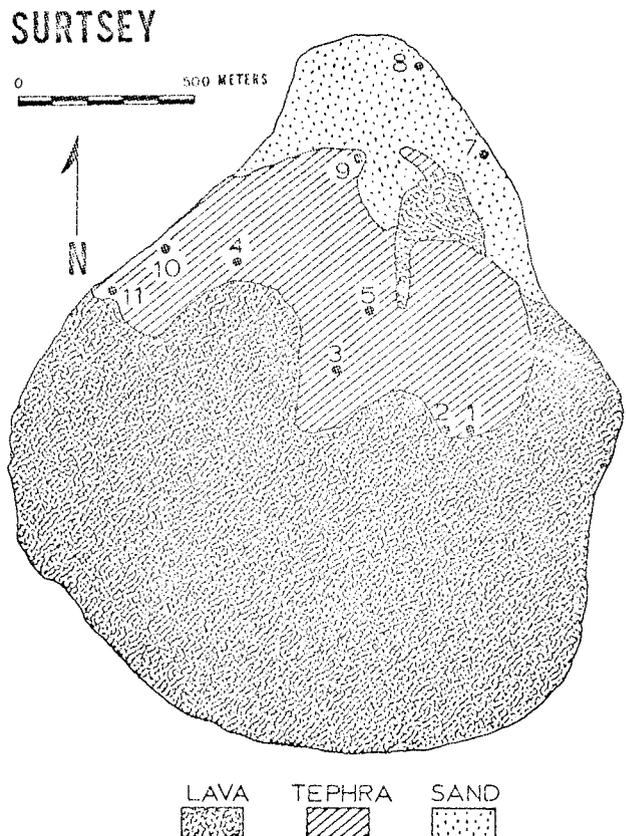


Fig. 1. Location of samples. Base from Norrman, 1970.

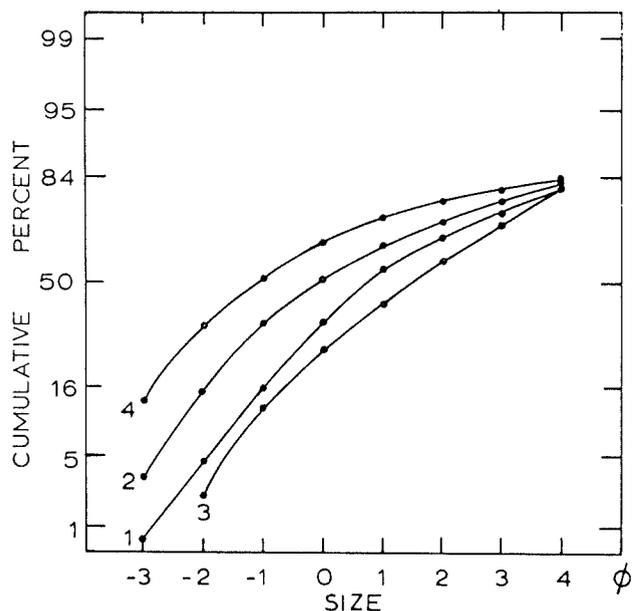


Fig. 2. Size data of tephra samples 1 through 4. Similarity of size distribution is obvious.

percent on a log-probability scale so that the statistical parameters can be readily evaluated (Krumbein, 1937, 1938). The size distribution parameters of Inman (1952) of tephra are listed in Table 1 and of beach sand in Table 2. The median size of 1.19 phi and very poor sorting of 2.75 are useful in characterizing this tephra and distinguish it from subaerial or water worked volcanic particles.

Certain characteristics of the particle size distribution are evident. The tephra curves are all of the same general form. Rather than a log-normal distribution, that would be a straight line on probability paper (Visher, 1969), the curves are convex upward representing the fine-skewed nature of the distribution. This general form is characteristic of a Rosin's law distribution (Kittleman, 1964) and suggests that the original distribution produced by mechanical crushing during eruption has not been greatly modified by secondary transportation, by dispersal in a fluid medium, by base-surge, or by water reworking.

To illustrate the unique sorting character of this tephra, two samples of beach sand were analyzed. These sands are composed of the same

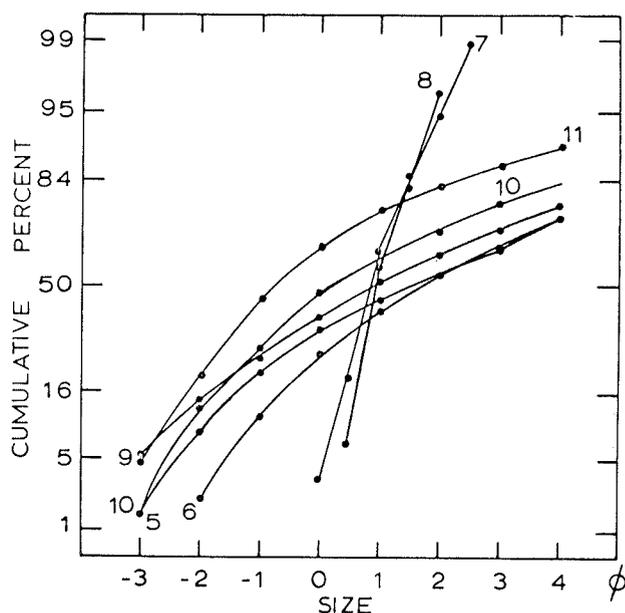


Fig. 3. Size data of tephra samples 5 and 6, and 9 through 11. Note the different plots for beach sand samples 7 and 8.

materials as the tephra, but they have been reworked and sorted by wave action. This difference is seen graphically in Figure 3 as well as by the median size of 0.02 phi and moderate sorting of 0.47.

## CONCLUSION

The Surtsey tephra represent a unique environment that can be adequately characterized by grain-size parameters. The samples are very poorly-sorted and fine-skewed. The distribution more closely approximates a Rosin's distribution than a log-normal distribution. Profitable study in the future would involve detailed sampling to test for the range in grain size and to relate changes in mean size and sorting to stratigraphic level. It would also be meaningful to compare other submarine tephra cones with Surtsey.

## References:

- Inman, D.L., 1952, Measures for describing the size distributions of sediments: *Jour. Sed. Petrology*, v. 22, p. 125-145.
- Kittleman, L. R., 1964, Application of Rosin's distribution in size frequency analysis of clastic rocks: *Jour. Sed. Petrology*, v. 34, p. 483-502.
- Krumbein, W. C., 1934, Size frequency distribution of sediments: *Jour. Sed. Petrology*, v. 4, p. 65-77.
- Krumbein, W. C., 1937, Sediments and exponential curves: *Jour. Geol.*, v. 45, p. 577-601.
- Krumbein, W. C., 1938, Size frequency distributions of the sediments and the normal phi curve: *Jour. Sed. Petrology*, v. 8, p. 84-90.
- Norrman J. O., 1970, Trends in postvolcanic development of Surtsey Island. Progress report on geomorphological activities in 1968: *Surtsey Res. Prog. Rept.*, v. 5, The Surtsey Research Society, Reykjavik, p. 95-112.
- Visher, G. S., 1969, Grain size distributions and depositional processes: *Jour. Sed. Petrology*, v. 39, p. 1074-1106.

TABLE 2  
Size Distribution Parameters of Surtsey  
Beach Sand

Sample No.	M $\phi$	Sorting	Skewness
7	-0.06	0.52	0.17
8	0.08	0.42	0.31