

Precision Levelling on Surtsey in 1968

By

EYSTEINN TRYGGVASON

University of Tulsa, Tulsa, Oklahoma

ABSTRACT

A levelling profile was established in June 1967 across the Surtsey lava. Relevelling in June 1968 showed that the lava subsided but the subsidence had slowed down since the summer of 1967.

The central part of the profile had subsided at a rate of about 1 mm per day while the benchmarks near the east coast and the west coast had been relatively stable.

INTRODUCTION

A surveying crew visited Surtsey on June 25 to 28, 1968. The profile of 1967 (Tryggvason 1968) was relevelled starting on the east side of the island at benchmark 601 and levelled towards benchmark 642 on the west side of Surtsey. The whole levelling was then repeated starting on benchmark 642 and moving towards benchmark 601.

This procedure makes it possible to estimate the rate of deformation during the four days this levelling takes.

Levelling was also made from Benchmark 601 to the research hut and the pond east of the hut and to one benchmark near the north shore of the island.

Benchmarks 603 and 604 were covered with windblown sand and were not found.

SURVEYING

The benchmarks of the Surtsey levelling profile were surveyed with triangulation to determine their relative geographic location. This surveying was only made for the purpose of making a map of the profile and therefore not precise. The geographic coordinates of benchmark 601 was found to be

63° 18' 16.1" ± 0.2" North

20° 35' 36.0" ± 1.0" West

Table I lists the position of the benchmarks on Surtsey measured towards north and east from benchmark 601.

T A B L E I

Coordinates of the benchmarks on the Surtsey levelling profile

Bench mark	North meters	East meters	Bench mark	North meters	East meters
601	0.00	0.00	622	-497.01	-648.92
602	-52.02	5.77	623	-492.79	-698.52
603*	-91.7	5.0	624	-489.90	-731.39
604*	-160.9	10.9	625	-501.96	-784.66
605	-213.55	12.86	626	-501.91	-833.78
606	-226.42	10.05	627	-525.43	-863.31
607	-268.23	16.84	628	-558.30	-911.86
608	-310.03	18.55	629	-564.02	-969.96
609	-333.39	-22.70	630	-558.01	-1008.41
610	-348.83	-63.63	631	-568.61	-1064.21
611	-359.46	-98.10	632	-521.51	-1090.82
612	-376.22	-111.09	633	-493.17	-1121.18
613	-406.01	-136.50	634	-460.44	-1152.02
614	-416.42	-169.91	635	-433.61	-1183.88
615	-438.75	-201.74	636	-403.19	-1227.62
616	-454.68	-230.11	637	-363.41	-1242.34
617	-469.48	-271.24	638	-331.35	-1277.14
618	-487.48	-319.13	639	-308.29	-1310.50
619	-514.77	-401.32	640	-260.20	-1339.81
620	-503.94	-534.82	641	-222.47	-1357.47
621	-499.34	-581.84	642	-185.85	-1410.39

* Location based on distance measurements of 1967.

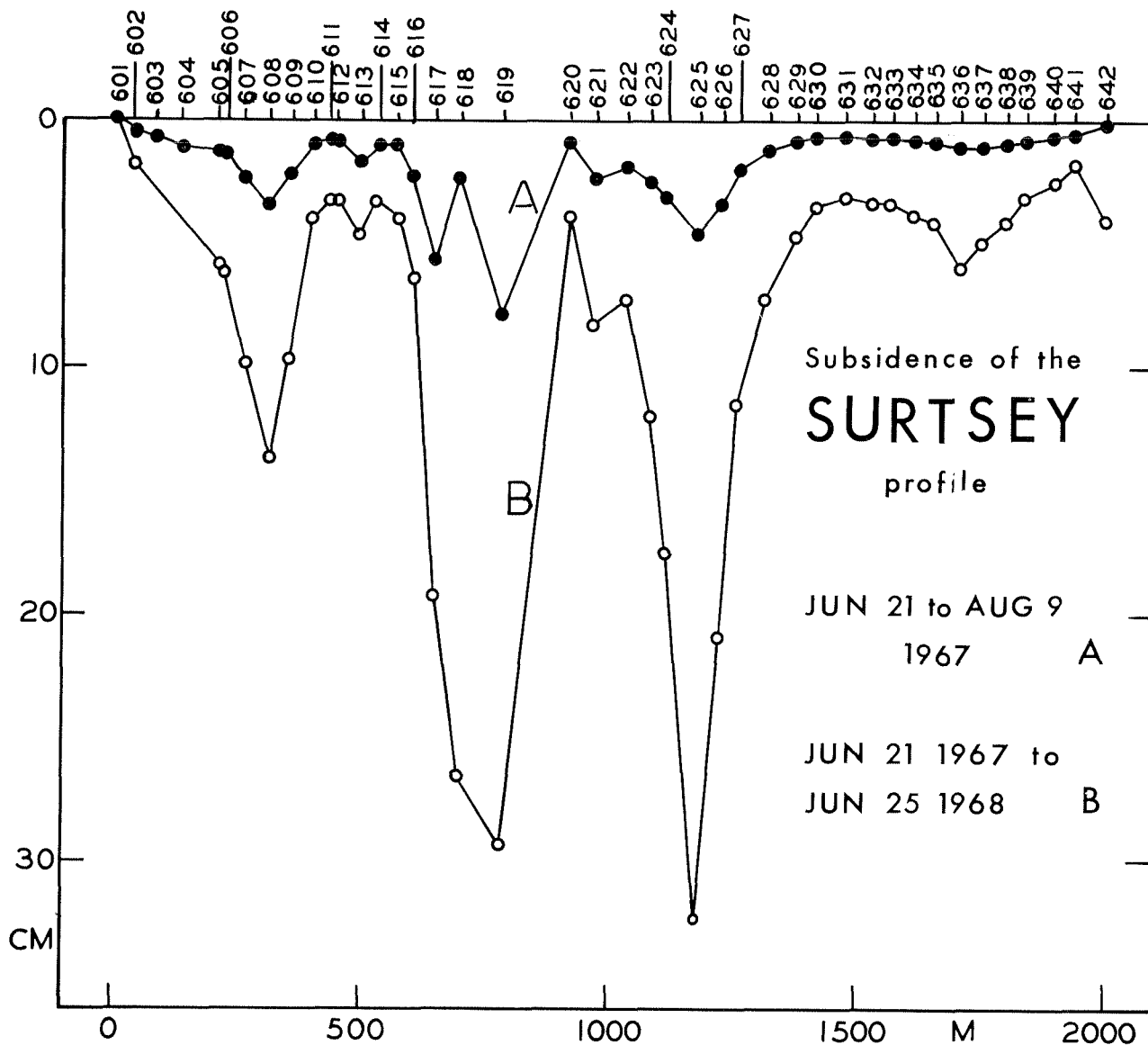


Fig. 1. Accumulated subsidence of the levelling profile across Surtsey since June 21, 1967. Distance in meters is measured along the profile from benchmark 601 on the east shore of Surtsey.

RESULT OF THE LEVELLING

The principal result of the precision levelling on Surtsey is shown on Figures 1 and 2. Figure 1 shows the accumulated vertical displacement (subsidence) relative to benchmark 601 since the first levelling of the profile in June 1967. Greatest relative subsidence was measured on benchmarks 625, 619 and 618, about 30 cm in almost exactly one year.

The absolute vertical movement (relative to the mean sea level) can be estimated from levellings on the northern part of Surtsey (Table II). A pound east of the research hut is dammed from the ocean by approximately 400 m wide sand beach. The sand is quite permeable so the water level in the pond will attain an equilibrium elevation which is close to the mean sea level. Previous estimates (Tryggvason 1968)

TABLE II

Elevation of selected points on northern Surtsey in centimeters above pond surface

	June 23, 1967	August 13, 1967	June 28, 1968
Benchmark 601	878.42	890.63	866.73
Doorstep of hut	728.42	740.32	717.75
LMI benchmark *	—	396.48	373.51
Tidal pond surface	—	-9.73	—

* Galvanized pipe north of small tuff mountain (Fjallið Eina)

placed the pond elevation approximately 10 cm above mean sea level and the pond surface behaved very similar in 1968 as 1967, with less than 1 cm change in elevation from one day to the next. This change was possibly due to change in the height of the ocean tides, and possibly

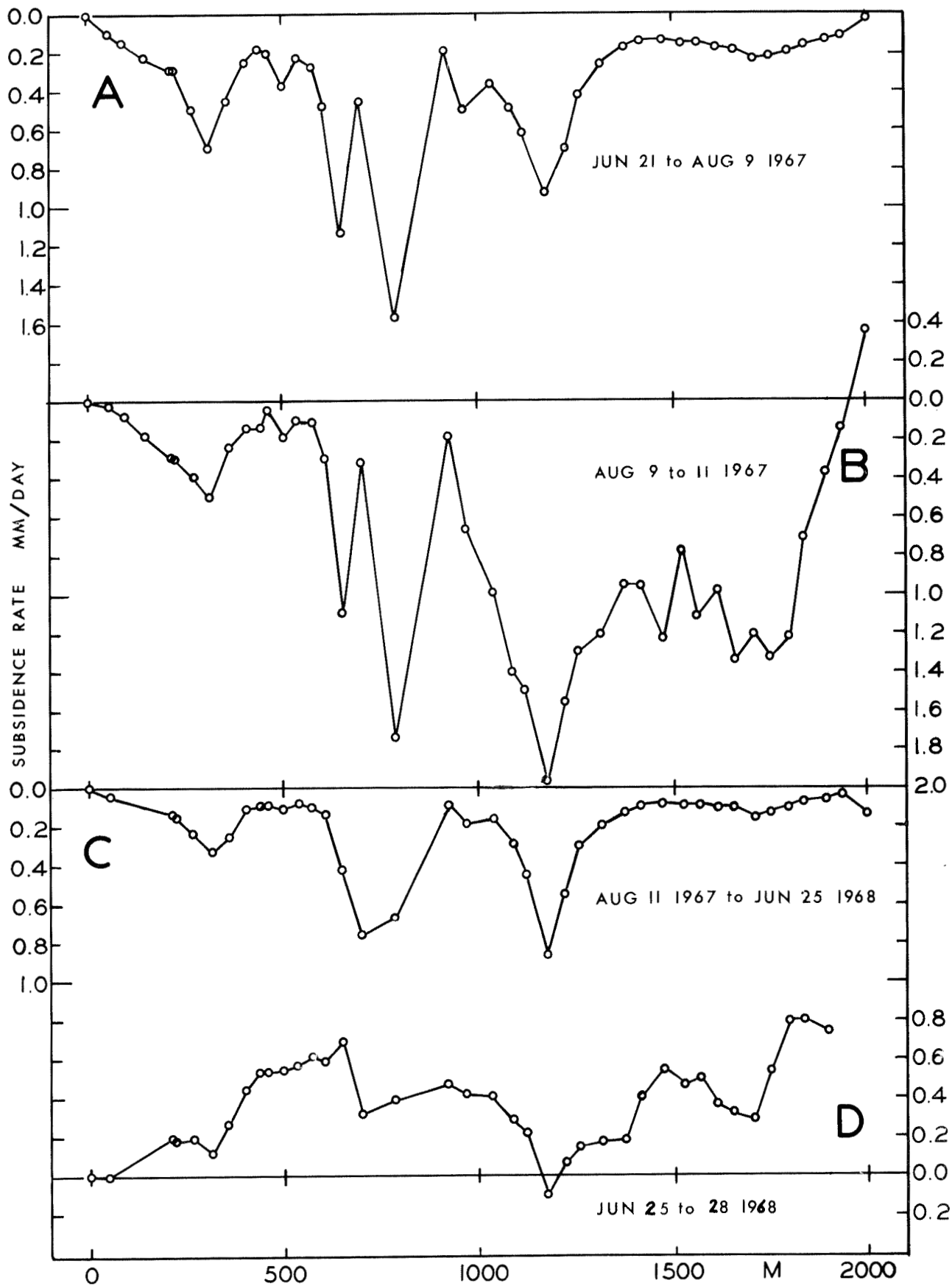


Fig. 2. Rate of subsidence of the levelling profile on Surtsey, relative to benchmark 601. Sections A and C are quite accurate while sections B and D may have an average error of 0.2 mm/day. This figure shows that the rate of subsidence is significantly slower in 1968 than in 1967.

due to changes in the atmospheric pressure. The effect of the atmospheric pressure on the pond level can be calculated if the relaxation time of the pond is known. Unfortunately this is not known, and a series of measurement of the pond level in August 1967 show no obvious relation to the change of atmospheric pressure prior to the measurements. If the pond level is entirely controlled by the sea level, then we can assume that the oscillations of the pond level are of the order of 10 cm in either direction from the average value. These oscillation will reflect oscillations in actual sea level due to tidal forces, atmospheric pressure and other phenomena.

The amplitude of the oscillation in the pond elevation is estimated from the rate of change in pond level as observed in August 9 to 12, 1967 of 4 cm in 3 days and the change of some 20 millibars which can be expected in the average atmospheric pressure over a period of several days during the summer.

The values in Table II can now be interpreted as indicating a subsidence of all the

measured points on the northern part of Surtsey. This subsidence amounts to 20 ± 10 cm during a period of one year.

CONCLUSION

The lave surface on the central part of Surtsey has been subsiding at a rate of up to 1 mm per day in 1967 to 1968. The northern part of Surtsey may be subsiding at a rate of 20 cm per year.

This subsidence indicates that the volcano Surtsey has become inactive and a new eruption is not expected.

ACKNOWLEDGEMENTS

This research was partly supported by National Science Foundation grant GA-987XI and partly by the Surtsey Research Society.

References:

Tryggvason, E. (1968), Result of Precision Levelling in Surtsey, Surtsey Research Progress Report IV, pp 149--158.