

ORKUSTOFNUN

Raforkundeild

A PRELIMINARY STUDY OF EROSIONAL
FEATURES IN VATNSFELL - DIVERSION

by

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Introduction

According to a consultation made by Virkir to Orkustofnun, (National Energy Authority, NEA), a preliminary study of certain erosional features in Vatnsfell - Diversion was made by present authors. The first part of the study was made by Kristinn Einarsson in the period 31.07.73 - 04.08.73, the later part was performed by Guttermuð Sigbjarnarson and Kristinn Einarsson in the period 10.08.73 - 12.08.73.

After a few months of operation of the Vatnsfell - Diversion it is clear that much erosion has occurred all the way within a few hundred meters from the dam site down to the Tungnaá River.

We investigated the whole diversion from both sides, with the most detailed study of that sections where the diversion cuts through volcanic rocks.

Erosional Features of the Diversion

For convenience we divided the diversion according to geological and erosional features, as shown on fig. 1. These sections are as follows

Section I: The erosion in this section has only occurred in superficial deposits, consisting of Lake Krókslón sediments, mostly diatomic clay, which is covered by eolian sand and colluvial deposits. In the beginning the erosion cut down a new channel forming a new gradient fitting to the great volume of water, but later the lateral erosion became dominating.

Section II: This section crosses subglacially formed volcanic ridge, consisting of some pillow lavas, breccia and tuffs, as shown on fig. 2. The ridge slopes are covered by tillite (often named pseudo-Môberg). In the uppermost part of the section the tillite is far thickest where the ice pressure has folded the bottom moraine together with the uppermost part of the brecciated tuff. In the middle of the section there also is some tillite. Although the tillite is jointed to some extent, it is far more resistant against the water erosion than the underlying volcanic rocks. Two types of fractures occur in these rocks. The first type is the settling one, formed during or shortly after the eruption. Usually, the fractures have been filled with fine grained material, which after consolidation is more resistant to erosion than the surrounding rocks (breccia and tuffs). The second type of fractures belongs to the regional tectonic of that area. The clearest ones are shown on fig. 2, giving all the main tectonic directions of the area as a whole. Most usually these fractures are filled with rather fine grained material, in some cases narrow fractures are still open. In one case we found a filled fracture had opened again after consolidation of the filling. In this new fracture there was some unconsolidated material, mainly in the sand-gravel fraction, consisting of palagonized and unaltered volcanic glass.

The tuffs and the breccia seem to be eroded rather easily. Fractures of the first type have very little effect on the erosion, but fractures of the second type seem to some extent trend the erosion to follow the fractured zones. The effect of the fracture zones appears also in forming narrower and deeper gulleys than elsewhere.

Section III: This section consists of a sand-filled depression. The erosion there is managed by the rock dam of Section II and the discharge of the diversion.

Section IV: The channel of this section is a gorge with some waterfalls in cube jointed basalt. The lowest part of the gorge is an older, tuffaceous formation with a tillite cover, which is more easily eroded than the upper one. The deepest part of the gorge, a plunge pool, is directed by a E-W going fracture. ^{zone} The greatest part of the gorge is cut into the cube jointed basalt formation which is the strongest and most resistant bedrock in that area. The fracture in the cube jointed basalt reaches only the lowest part of the gorge where the underlying tuff dips steeply to the North. This makes the basalt a still stronger threshold against further erosion, even though it can not be said to be very resistant.

Section V: The section consists of a sand filled depression. The erosion there behaves in similar way as in Section III and is managed by the bedrock of Section IV.

Section VI: This section is the nearest one to the end of the previously dug canal. The erosion shows that this section was a sand filled stream channel underlain by tuffaceous breccia which was near the surface at the upper end but dipping downstreams. In the beginning the erosion formed a wide channel where the sand washed away. Later on the erosion cut rather deep and narrow channels into the breccia directed by tectonic fractures. There are three main tectonic trends in that area: ENE, NE and N. At the upper end of this section these channels now reach about 10 m depth, causing great erosion in the dug canal.

Section VII: The section is the lowest part of the cut, that is where erosion already has occurred. The section is built up of breccia and pillow lava. In the lowest

part the original cut is quite eroded and transformed into a gorge following the main tectonic trends. But further up in the section there has mainly occurred bottom erosion with some slides from the walls which only in some cases can be attributed to tectonic fractures. The original slope of this section was 2 o/cc, but has increased to 12 o/cc (see Table 1).

Section VIII: The cut there is built up of pillow lava, breccia and some sandy deposits. Hardly any erosional features can be observed there but some tectonic fissures are to be seen. The cut still keeps its original 2 o/cc slope. This slope causes no apparent erosion.

The volume of the eroded material

Table I shows a very brief estimation of the volume of the eroded material in the diversion. It gives roughly erosion of 5 G1, whereof 4.7 G1 were unconsolidated sediments but 0.3 G1 erosion of the consolidated bedrock. The diversion has only been used for about 3 months with the total waterflow of about 500 G1. The average sediment load of the waterflow reaching to River Tungná has thus been about 1% or about 10000 mg/l which approaches that the total energy of the flow has been used in erosion and transportation of sediments. All these figures are only a very brief estimation and must be virtued as such.

Discussion

The results of these studies show that the erosion of Vatnsfells diversion up to day has nearly been as much as the erosive forces of the water flow in the diversion have permitted. It can be expected in the future that

it will be so until the channel will be graded corresponding to the water flow there with Tungnaá or Krókslón as erosion base. The whole diversion except in section II and section IV seems very erodible, but these two sections are more resistant and can possibly be an erosion base for the upper parts of the diversion, at least for some time, even though they are also weak. Now, a great part of the unconsolidated sediments are washed away. We can therefore expect more erosion of the bedrock because of higher velocity of the less sediment loaded water flow.

The erosion of the volcanic bedrock indicates that the regional tectonic affects the form and direction of the stream channels. There is no reason to estimate it has still caused any increase of the eroded volume nor it will do in the future, except it can speed up the breakdown of the threshold formed by section II and maybe also later on in section IV. The results shown in Table I seem to indicate the erosion is much more depending on the slope gradient of the water flow than the tectonic system.

The present paper gives only a brief idea about what is going on in the erosions matter of Vatnsfells Diversion. For further studies it would be necessary to map the present conditions there at least with 5 m contour intervals for more exact calculations and for geological mapping of the erodible material and the visual tectonic there.

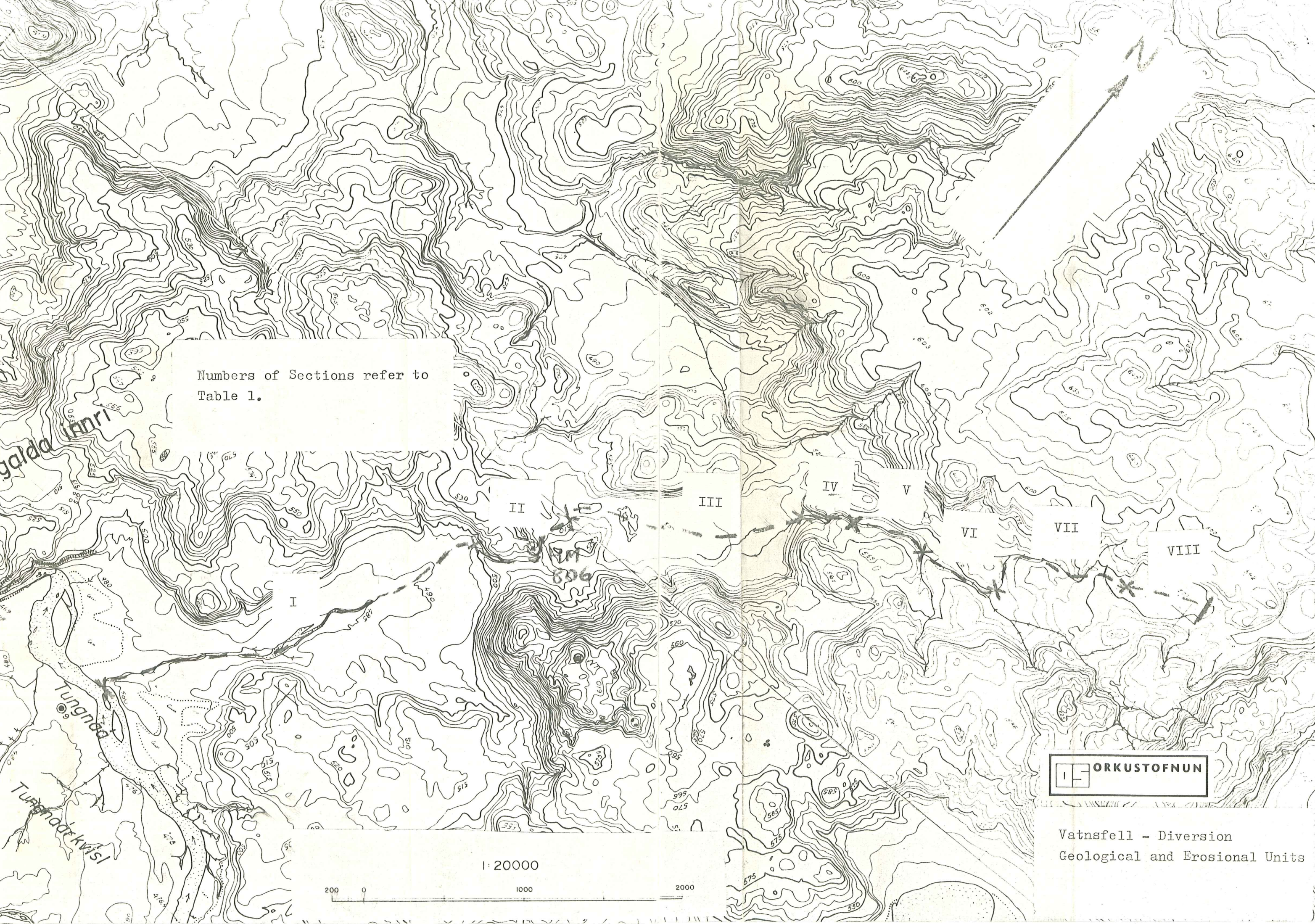
TABLE I.

Vatnsfelle Diversion

Estimate of Erosion from Tungná to the Flow Gate at Vatnsfelli.

Section	Length, m	Width, m	Depth, m	Volume, m ³	Mean gradient, %	Material eroded	Fractures
	m	appr. mean	appr. mean	m ³	%	gradient	
Section I	2000	200	8	3,170,000	6.5	185	Lake sediment, alluvial deposits
"	800	20	7.5	120,000	17.5	6.6	Breccia and tuff, some pillow lava
"	1600	300	3	1,440,000	6	150	Sand with gravel in upper half
"	350	10	10	35,000	54	1.3	More than half breccia and tuff, less than half pillow lava
"	500	50	8	20,000	12	3.3	Sand
"	500	50	5	125,000	30	9.3	Sand
"	500	10	5	25,000	30	1.6	Breccia
"	1000	25	5	125,000	12*	10.4	Breccia and pillow lava
"	1600	0	0	0	7	0	"
Total:	8950			45,000,000	11%	(mean)	

* The original slope was 2% before the beginning of the erosion.



Numbers of Sections refer to Table 1.

galdá innri

Tungnaá

Tungnaákvísl

II

III

IV

V

VI

VII

VIII

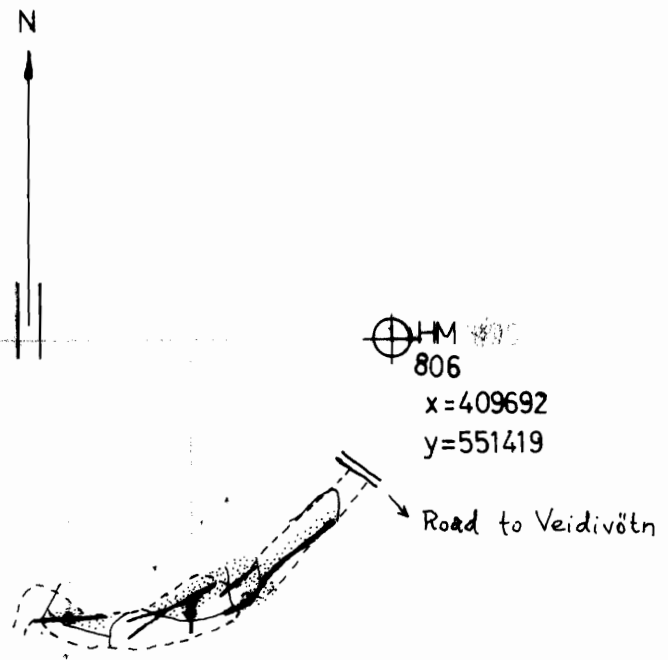
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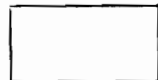






Vatnsfell - Diversion
Geological and Erosional Units

1:20000





-  Pillow lava
-  Tuffaceous breccia
-  Brecciated tuff
-  Tillite
-  Fractures
-  Zone with small fractures

