ORKUSTOFNUN
RAFORKUDEILD

SULTARTANGAVIRKJUN

JARÐSVEIFLUMÆLINGAR

JÓSEF HÓLMJÁRN
HALINA GUÐMUNDSSON
BJÖRN JÓNASSON

OS-ROD-7425

DES 1974

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C O N T E N T S

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I. PREFACE

This report is prepared on connection with damsite studies for the Sultartangi hydroelectric project.

In November 1974 about 25 seismic reflection profiles were surveyed on the area between Vaðalda and Sandafell.

The equipment used was hammer type seismohraph FS-3 produced by Huntec Ltd., Canada, with two geophones.

The aim of the geophysical survey was to determine the thickness of two basalt lavas THi, THf and also the interbeds between them as exactly as possible and correlate it with existing information of this area obtained from some drill holes.

II. THE REFLECTION METHOD

1. Description at the method

Until recently the seismic reflection method has mainly been used in oil exploration at great depths.

The problem of using reflection seismic in engineering geophysics lies in the difficulty of separating the various superimposed arrivals at short record time.

Huntec Ltd., Canada has developed the method to extract reflected arrivals from the direct and refracted ones. The fact that reflected waves at short distance between the source and geophones travel at more vertical wavepaths (smaller angle of incidence) than the direct and refracted ones is used to filter out the unwanted arrivals.

Fig. 2 explains the use of the method. Two geophones are laid out on the line (which is the seismic profile) symmetrical around the "zero" point, separated 3-10 m from each other.

The signal from the two geophones in amplified and then fed into pulseform with variable pulselength 0,5-5 ms. The pulses are then

fed to a gate which gives an output pulse to the printer, but only when both inputs are high at the same time.

Therefore only those arrivals which have less time differance between the two geophones than the selected pulsewidth (c), will be printed.

2. Limits of using this method

There are (still) some limitations to the use of this method, which make the shallow layers diffucult to survey. One is the shallowest depth which can be detected. The strong first arrivals block the geophones and amplifiers during one period of the seismic wave.

The time equal to one period of the seismic wave is about 10-30 ms at short distances and increases with the distance. Therefore reflections which arrive before T_{arr} (arrival time of the first arrival) + T_{per} (period of the first arrival) can not be detected.

Experience has shown that the positive identifiable reflections should not be expected from shallower horizons than 20-30 m.

Further resolution for discrete reflections is one wavelength even though a characteristic interference pattern made up of reflections of interfaces closer together may be identifiable on the seismic records. Such a pattern might come from a single interface, but might as well be superimposed reflections from more than one velocity contrast within a depth interval corresponding to one wavelength. In our case the wavelength may be assumed to be in the interval 20-40 m, increasing with the depth.

3. Accuracy of the method

The depths are calculated from the plotted reflection times at the zero distance and average velocity (V_{av}) of the reflected wave.

Average velocity is plotted from the travel times of each reflection on the different distances along the profile.

Where the thickness of the low velocity layer changes along the profile it is very likely that the error of the average velocity calculation (and hence the depth) will occur.

In the Sultartangi area lavas are very rough on surface and filled up with sand and volcanic ash of variable thickness.

Therefore plotted velocities are not free of errors. The differences in the average velocities from the same reflector, but taken in the different profiles, are $V_{av} < \pm 10\%$ in most cases, and therefore the error in depth calculation can be assumed too be of similar order.

III. THE SURVEY

1. Location of the profiles

Ca. 25 profiles have been surveyed between Vaðalda and Þjórsá.

Profile No 1 is at drillhole TH-3b and the other profiles approximately on the damsite line.

Some profiles were also surveyed SE of Vaðalda and two on the top of the Vaðalda hill, (see the location map).

2. Comparison between profile No 1 and borehole TH-3b

Fig 3 shows the results from profile 1 A+B, at borehole TH3b, and the borelog for comparation.

The reflections from the interface THi/interbed are not clear but readable.

The upper interface of THf gave very clear reflections at about 26 m but the reflections giving ca 35 m depth are probably multiple reflections.

3. Results of the profiles

Table 1 shows average velocity (V_{av}) and calculated depths (t) to the reflecting horizons from those profiles which give usable results.

The results are classified into three groups, good average and bad according to the quality of the records.

Column No 1 shows detected reflections from the shallowest layers. They occur in few profiles only and they are rather uncertain. Most of them can be assumed to come from the interface between THi and interbed.

In column No 2 the result is much better. Both average velocities and depths calculated from the different profiles are rather similar.

The surveyed depths near the river correspond fairly well to the thickness of lava THi in boreholes ST-4 and ST-5.

In the middle area of profile A-A the depths are likely to be the upper interface of lava THf.

The depths shown in column III should be taken with caution and scepticism because the average velocity V_{av} in this column is in most cases lower than in column II, but should increase by going through lava having higher velocities than the interbeds.

Most of the data in column III are therefore likely to orginate from multiple reflections, that is, waves which have been reflected back and forth between the interfaces before arriving to the surface.

Profiles 10-20 gave very little information and have therefore not been used to draw any geological profiles.

J A R Ð F R Æ Ð I

ALMENNT:

Í jökulrofnu lægðinni milli Sandafells og Vaðöldu er að finna tvö hraunlög (THi og THf), runnin á Nútíma (s.l. 10.000 ár), ásamt millilögum (sjá nánar Sultartangi, jarðfræðiskýrsla, Orkustofnun, 1972). Lög þessi hvíla mislægt á gömlu basalti, sem er öfugt segulmagnað Þjórsármegin (ST-5) og rétt segulmagnað Vaðöldumegin (ST-7 og 8), en kvótamunur þessara grunnbergslaga á líklega rætur að rekja til gamals misgengis, sem er a.m.k. 20 m og er sigið til austurs.

Þetta rétt segulmagnaða basalt finnst einnig í opnu vestast og neðst í Vaðöldunni skammt frá borholunum ST-7 og 8 og sunnan hennar, neðst í borholunni ST-9.

Í efsta hluta Öldunnar er öfugt segulmagnað basalt, en milli þess og rétt segulmagnaða bergsins er millilag, sem kemur fram norðvestantil í henni. Þar er móbergslegt vel samlímt völuberg (a.m.k. 6 m) með basalt- og líparítvölum. Í suðaustanverðri Öldunni er önnur opna, en þar er millilagið jökulberg (~ 5 m).

Vaðaldan er klædd mórenu, sem er sennilega til staðar í borholunni ST-8, en er um 9 m þykk í ST-9.

Eins og vestan Vaðöldu eru tvö efstu hraunin austan hennar THi og THf og í borholunni TH-2, sem er um 1.5 km suðaustan Öldunnar, eru 4 hraun með millilögum, aðallega gjósku.

JARÐFRÆÐILEG TÚLKUN SKJÁLFTAMÆLINGANNA:

Til grundvallar skjálftamælingunum voru notaðar 7 borholur (ST-4,5,7, 8,9 og TH-2, 3b) á svæðinu og af þeim eru 4 staðsettar á sjálfu sniðinu (væntanlegu stíflustæði).

MILLI ÞJÓRSÁR-VAÐÖLDU:

Bezta svörunin fékkst við mörk millilagsins og hraunsins THf, en millilagið, sem er líklega að mestu leyti gjóska, er 0.0 m næst Þjórsá (ST-5), en þykknar í áttina að Vaðöldu (max. 10 m). Í borholunum ST-7 og 8, allra næst Vaðöldunni er það 3.0 og 2.0 m, sem kemur vel heim við skjálftamælingarnar.

Aftur á móti eru skil hraunsins THf og grunnbergsins ónákvæmari. Skjálftamælingarnar sýna þar hrein mörk THf-grunnberg, en þar má búast við millilagi og/eða jökulbergi áður en grunnbergið tekur við.

VAÐALDA:

Í Vaðöldunni voru aðeins teknir 2 skjálftaprófílar, sem eru báðir óáreiðanlegir, en endurkast í punkti 20 A-B á 12-13 m dýpi á líklega við neðri mörk millilags.

HRAUNASVÆÐIÐ SUÐAUSTAN VAÐÖLDU:

Í nágrenni borholunnar ST-9 voru mældir 4 skjálftaprófílar. Þar kemur fram endurkast frá 21.2-23.4 m dýpi eða um mörk jökulbergs-grunnbergs, en í borholunni ST-9 eru þessi skil á 21.0 m dýpi.

Skjálftaprófílar teknir úti á hrauninu suðaustan Vaðöldunnar, eins og t.d. 16 og 17 A-B, gefa annars vegar neðri mörk THi eða efri mörk THf við millilagið (sbr. 7.0-12.5 m) og hins vegar neðri mörk THf eða efri mörk líklega hraunsins THe við það millilag, en niðurstöður þeirrar mælingar eru vægast sagt óáreiðanlegar.

Samanburður á kjarna úr borholunni TH-3, sem er spölkorn frá TH-3b, við endurkast, sem kemur fram um miðbik hraunsins THf (sjá fig. 3), sýnir, að þetta "falska" endurkast á ekki rætur að rekja til mismunar á gerð hraunsins, heldur orsakast af tvöföldu endurkasti (multiple reflection) í millilagi.

Í Vaðöldunni og á hrauninu sunnan og austan hennar þyrfti að taka mun fleiri skjálftaprófíla, til að skýra lagmótamyndina, en þó með þeim fyrirvara, að millilögin trufla mælingarnar, þannig að mjög erfitt verður að spá í hvort þær gefi efri eða neðri mörk millilags og hrauns nema líklega í efsta millilaginu.

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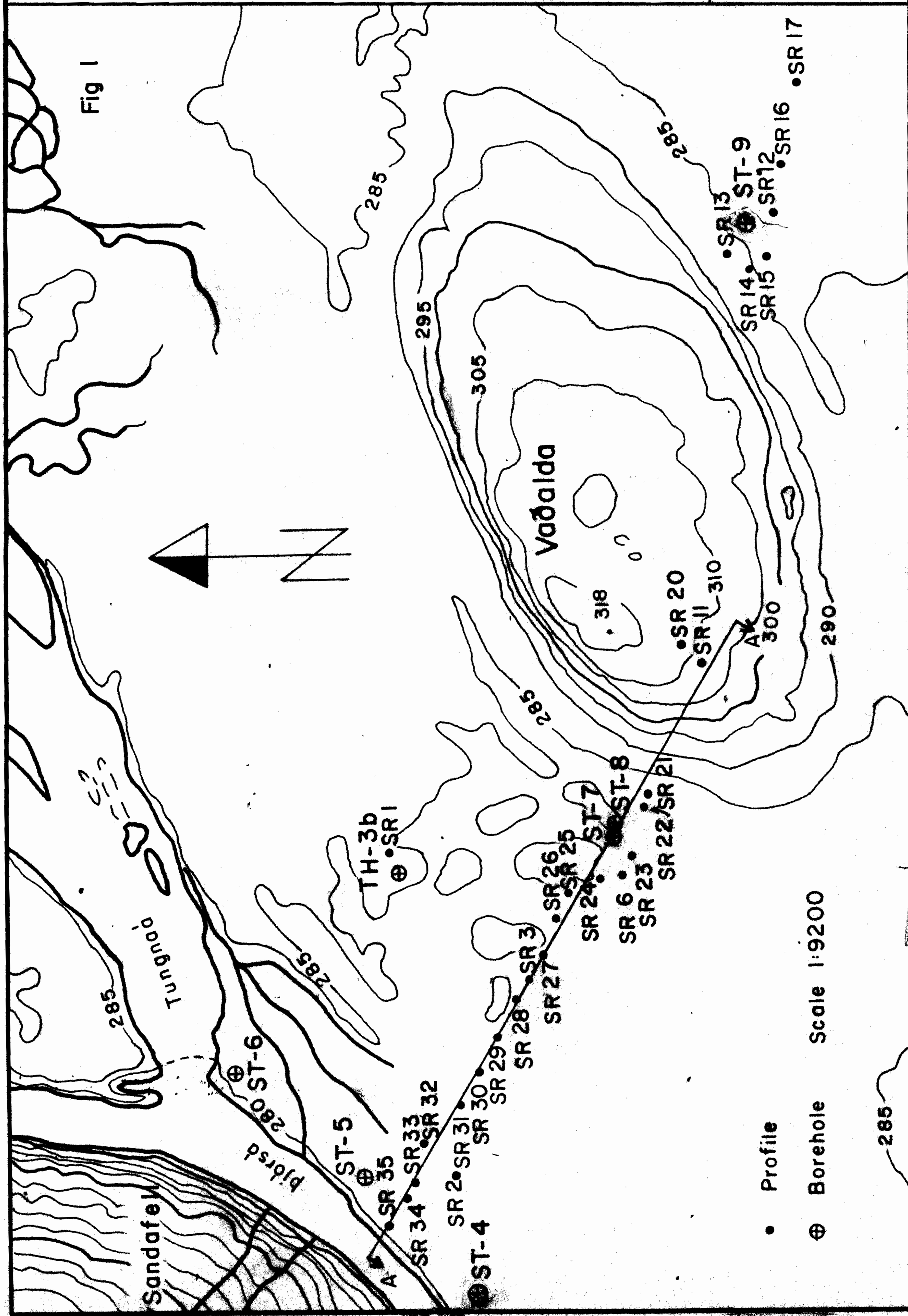
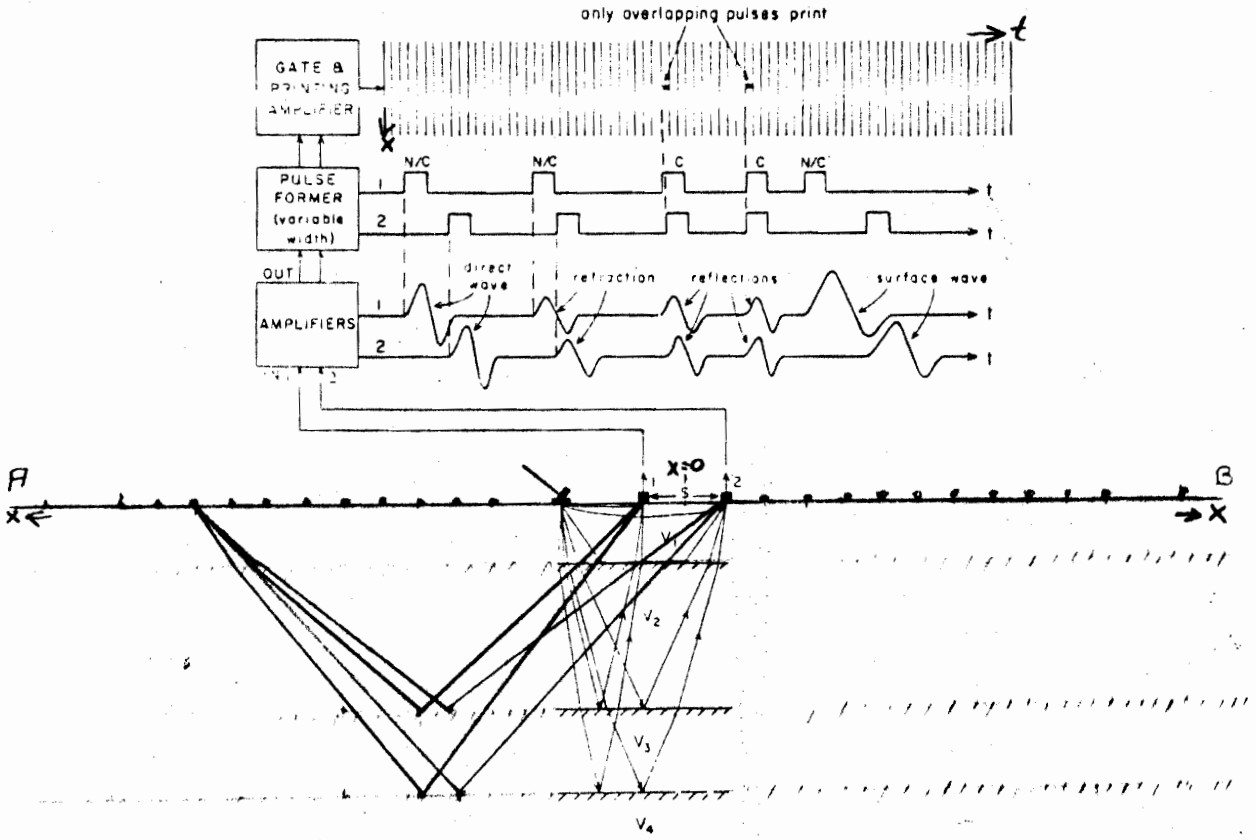
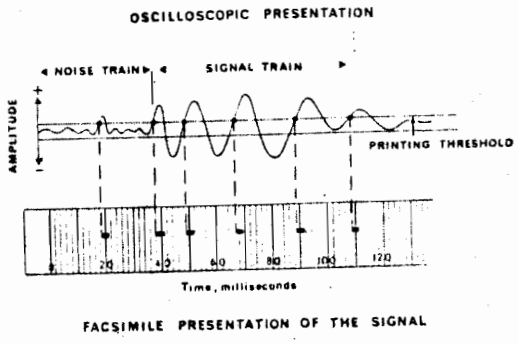
16.1.'75 JH/BJ/AVill	
Tnr 404	Tnr 131
B-332	J-Jarðsvm
Fnr 12355	

VADALDA - ÞJÓRSÁ
Location map of the seismic profiles approximately located.





Typical reversed profile and the method of filtering out unwanted arrivals. Fig 2a.



The noise filtering applied in FS-3 seismograph. Fig 2b.

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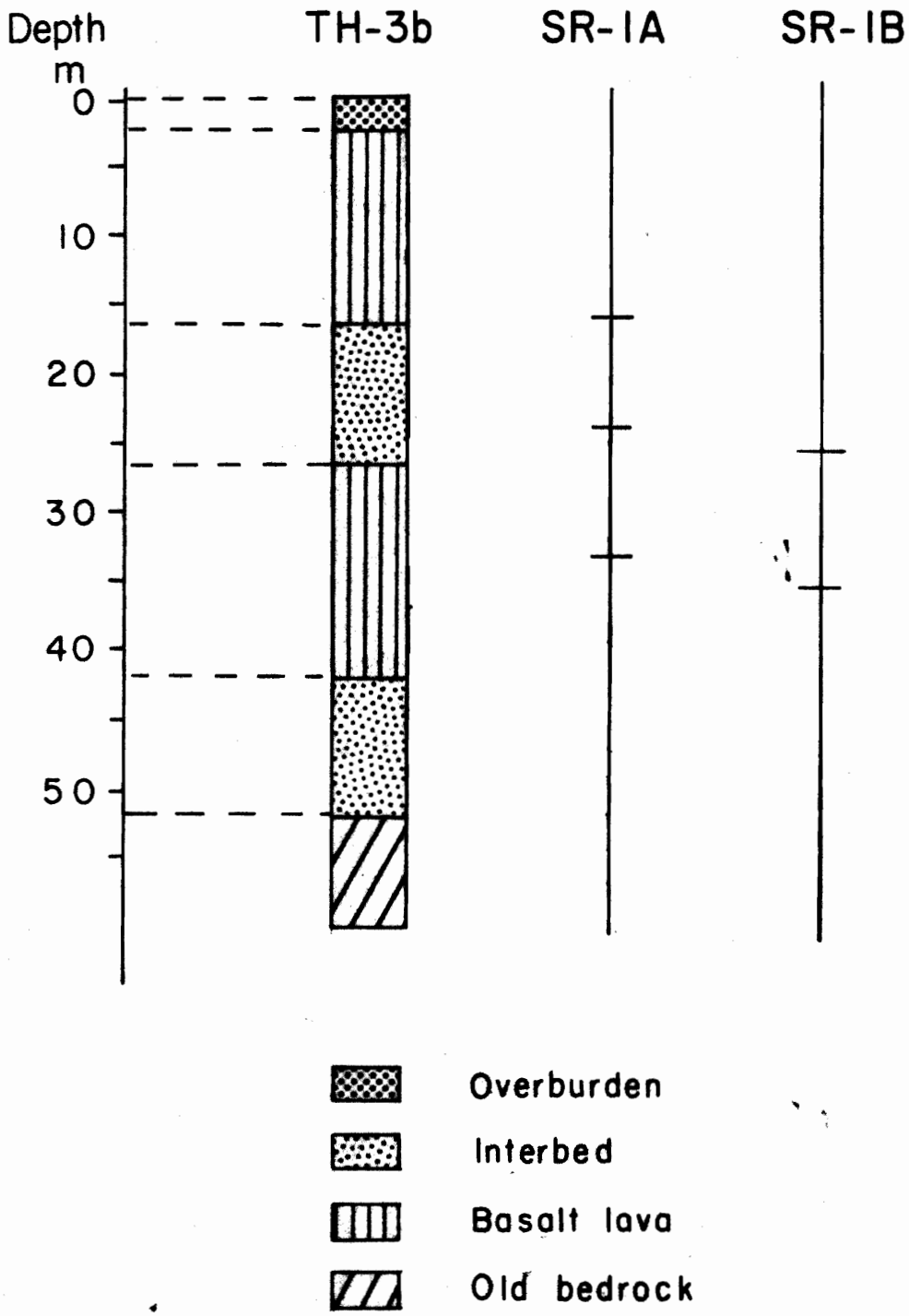
VAÐALDA - ÞJÓRSÁ

Results from the seismic profile SR 1 A+B, at borehole TH-3b, and the borelog for comparation

23.1.75 HG/JH /AVill
Tnr 405, Tnr 132
B-332 J-Jarðsv.
Fnr 12356

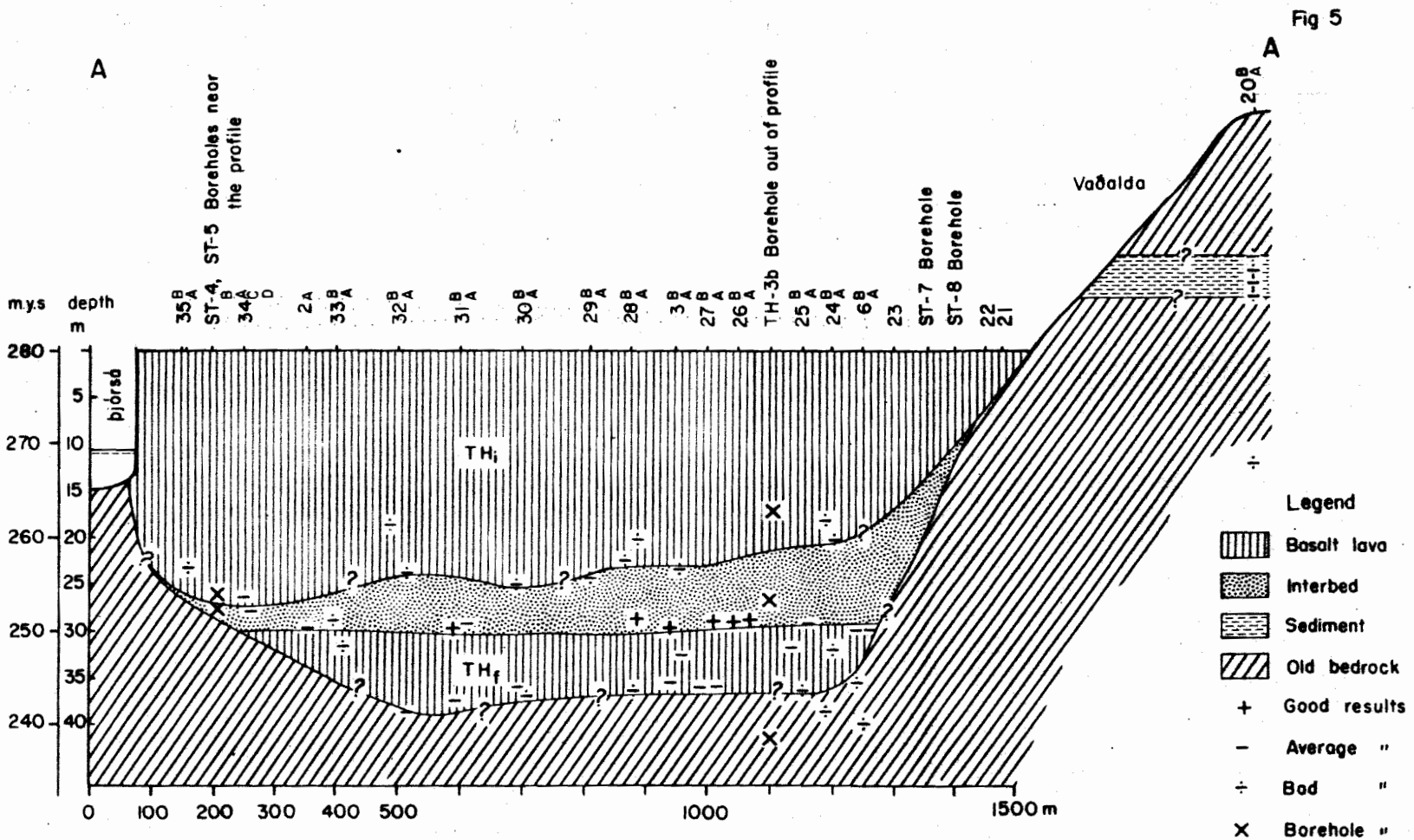
Fig 3



T A B L E 1

Profile	I		II		III	
no	V_{av} km/s	Z_0 m	V_1 km/s	Z_1 m	V_2 km/s	Z_2 m
21A					2,1	44,1
21B					1,75	42,0
22A						
22B			1,0	26,5 ?		
23A						
23B					1,4	37,8 ?
6A			1,05	29,9	0,01 ?	35,7 ?
6B			1,0	30,0	0,99	39,6 ?
24A	1,20	20,9 ?	1,20	33,0	1,10	38,5 ?
24B	1,15	18,0 ?	1,15	32,8 ?		
25A			1,15	29,3	1,10	36,8 ?
25B			1,25	32,5	1,15	42,0
26A			1,12	28,6		
26B			1,05	28,9		
27A			1,1	28,6	1,05	36,2
27B			1,1	29,7	1,0	36,0 ?
3A	1,05	23,6 ?	1,05	33,0 m		
3B						
28A	1,25	20,0 ?	1,1	28,5		
28B	1,0	15,0 ?	0.87	22,6 ?		
29A			0,9	24,3 ?		
30A					1,20	36,6 ?
30B			1,5	24,7 ?	1,15	34,5
31A			1,05	29,4	0,85	33,0 ?
31B			1,05	30,0 m	0,85	36,5
32A	1,40	23,8 ?			1,20	38,9
32B	1,30	18,2 ?	1,0	28,5 ?		
2A			1,1	29,3		
2B						
33A			0,95	31,3 ?		
33B	0,85	12,7 ?	0,9	28,8 ?		
34A			0,8	23,2 ?		
34B			1,1	30,8 ?		
34C			0,85	26,3		
34D	1,35	10,1 ?	0,85	27,2		
35A			0,83	23,2 ?		
35B						
11A						
11B	0,85	19,6 ?				
20A	1,75	13,1 ?	2,0	45 m ?		
20B	1,60	12,0 ?				
13A			1,5	26,25 ?		
13B	1,20	22,2 ?	1,00	23,0 ?		
14A	1,0	22,5 ?				
14B						
15A						
15B			0,9	26,1		
12A						
12B	0,85	21,25				
12C	0,9	23,4				
16A	1,25	12,5 ?	1,0	26,0		
16B	1,20	10,8 ??				
	1,40	7,0 ?	1,15	32,2		
17A	0,85	8,5 ?	0,9	24,7 ?		
17B			2,0	20,0 ?		

Fig 5



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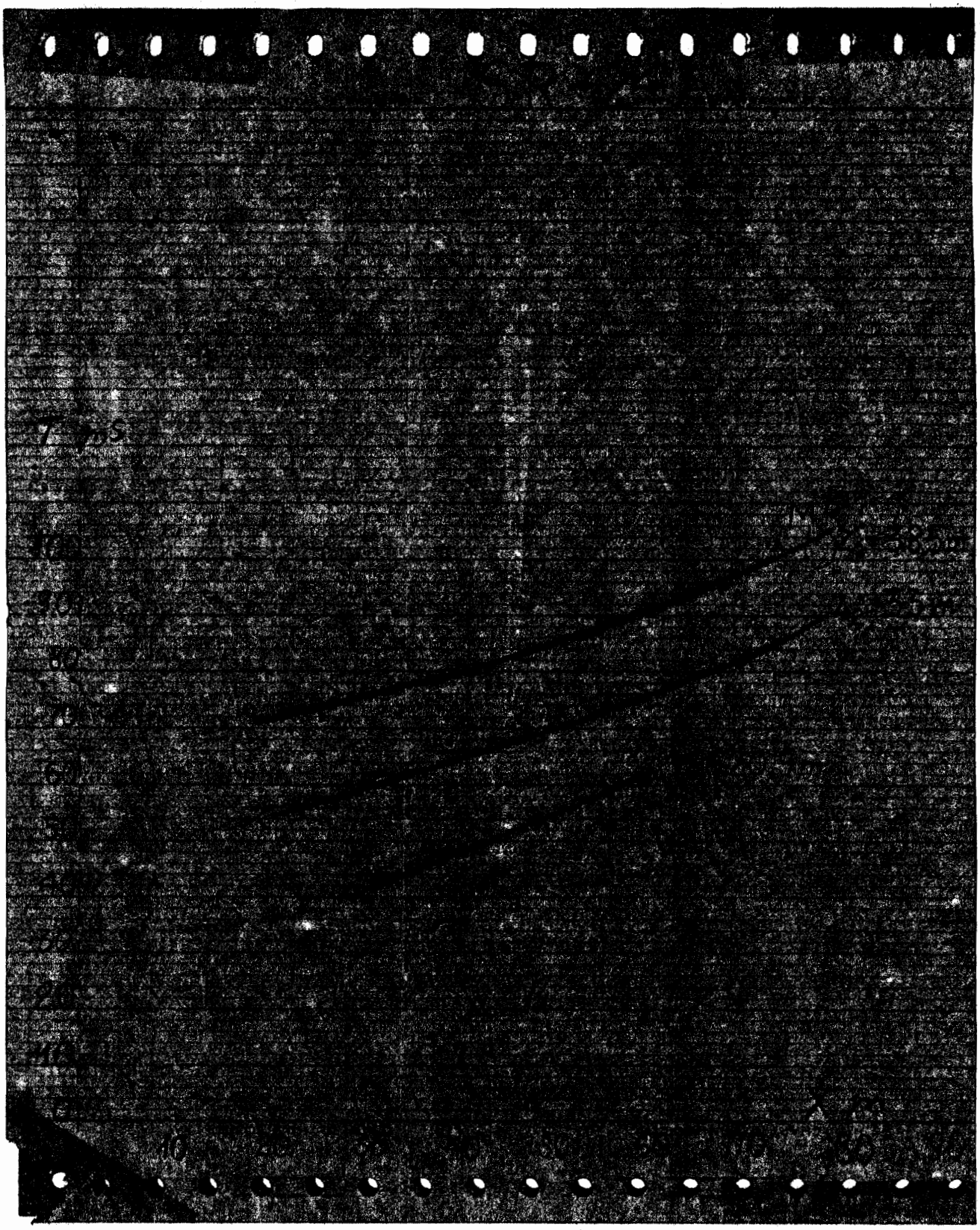
VAÐALDA-ÞJÓRSÁ Approximate locations of seismic profiles Profile A-A		
21.01.75 MS/JH/AVill	Tw 406 Tw 133 B-332, J-Jarðw	Fnr. 12357



Sample of a field record showing three reflections.

Z_1 Uncertain pattern from á few points.

Z_2 Good reflection pattern.

Z_3 Probably multiple reflections of Z_2.

Fig 6

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Hraðagreinirit

Fig. 7

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SR-24A

12.11.1974