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Regional landslide occurrences and possible post-glacial earthquake activity in northwest Western Norway:
Phase A1: Interpretation of seismic data and proposal of core-locations in fjords and along the coast.

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REPORT

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Title:
Regional landslide occurrences and possible post-glacial earthquake activity in northwest Western Norway:
Phase A1; Interpretation of seismic data and proposal of core-locations in fjords and along the coast

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Summary:

A project was begun in cooperation with NGU, Norsk Hydro, the University of Bergen and the Sogn & Fjordane College with the aim to study regional slide events and interpret triggering factors for such slides. The project involves interpretation of pre-existing and new seismic reflection profiles and multibeam-echosounder data and a large scale sampling program to analyse Quaternary fjord sediments.

The Late glacial – Holocene seismic stratigraphy of fjords along the coast from Sognefjord to Kristiansund seems to consist of a set of regional reflectors which are tentatively being interpreted to be 2,000, 7,000, 9-11,000 and 12,000 ^{14}C years old downslope events. Slides are related to these reflectors, but the slide frequency varies from north to south. The 2,000 yr event is not registered in Nordmøre and northern part of Sunnmøre, but is very strong in southern part of Sunnmøre and into Sogn og Fjordane. The 7,000 yr event is strong everywhere, but slide-frequencies are lower in Nordmøre than in Sunnmøre. Rockfall into the fjord in Syvdsfjord at the 7,000 yr event and possibly at the 2,000 yr event, indicate earthquake-triggering of the slides. Based on the proposed regional stratigraphy a coring program is proposed for the dating of regional reflectors and establishing the origin of reflector formation.

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Seismic examples - core localities

1. INTRODUCTION

On high-resolution seismic reflection profiles from fjords along the coast between Sognefjorden and Kristiansund certain seismic reflectors seem possible to be recognised from fjord to fjord. Massive sliding of fjord-side sediments and on occasions, supra-aquatic sediments or rocks are related to some of these regional reflectors. The formation of regional reflectors could either be due to climatic change, earthquakes or tsunamis.
A 8.5 m long core of fjord-sediments from Voldafjord show distinct turbidite beds in the stratigraphic record (Grøsfjeld et al 1999). The uppermost three turbidites are dated to c. 2,000, 7,000 and 9,500 radiocarbon years BP. The stratigraphy of the core is correlated to seismic records (Grøsfjeld et al 1999). On the records, two distinct reflectors end in massive debris-flows on both sides of the fjord basin and are thought to represent the events dated to 2,000 yrs and 7,000 yrs BP. In this area, a well defined tsunami related to the Storegga-slide is known to have flooded the coastline c. 7,000 ^{14}C yrs BP (Bondevik et al. 1998). Grøsfjeld et al. interpreted the 7000 BP turbidite to relate to this tsunami. If this is the case, the 2,000 yr layer may well indicate another large tsunami and possibly another offshore mega-slide.

There are strong indications that major earthquakes may have triggered slides on a regional scale at several occasions during late glacial- and post glacial time. To test this and to establish the origin of the 2,000 yr layer, NGU together with Norsk Hydro ASA, the University of Bergen and the Sogn and Fjordane College has set up a project with the following aims;

- Regional compilation of occurrences of slides, avalanches and gravitational faults that may have resulted from earthquakes in northwestern Norway
- Date single events and periods of instability in fjord- and lake sediments

Questions in focus will be:
- Can the Storegga event be recognized in fjord- and lake sediments
- If so, are there traces in the sediments of similar, younger regional events
- Are the traces seen in the sediments due to tsunamis, earthquakes or both
- Do data indicate large earthquakes to be more frequent shortly after the regional deglaciation than recently

The work will be done by identification and coring of regional seismic reflectors from fjords and near-coastal waters from Sognefjord to Kristiansund and try to date and relate sliding-events and seismic reflectors. In addition, avalanches and collaps-structures onshore will be tried fitted into the same chronologic framework. The project is done during phases A-E (Table 1).

Phase	Task
A1	Compile a regional seismo-stratigraphy based on interpretation of high-resolution seismic records collected by NGU and Norsk Hydro in near-coastal waters and fjords
A2	Collect and interpret penetration echo-sounding registrations in lakes in the actual area
B1	Sample sea-bottom sediments in near-coastal areas and fjords and collect complementary seismic registrations
B2	Core lake(A2)-sediments
C	Lab.analyses; multi-logger, XRI, sedimentology and dating
D	Compilation of data on rock-avalanches and gravitational faults onshore
E	Final reporting

Table 1

This report summarises phase A1 - the seismic reflection data interpretations - and presents a list of possible core locations for the next phase of the project.

2. DATA

The interpretation is done on high quality analogue records of high resolution seismic data. The TOPAS data used (Table below) has generally been sampled with a sweep length of 62.5 ms on an EPC 9002 thermal printer. The Pinger data and Sparker data have been sampled with sweep lengths 100 ms.

Seismic data

Data owner	Cruise	Seismic source	Area
NGU	9702	TOPAS	Førdefjord
NGU	9908	TOPAS/boomer/sleevegun	Tafjord – Storfjord, M&R
NGU	9909	TOPAS	Voldafjord
NGU	0002	TOPAS/boomer/sleevegun	Tributaries to Sognefjord
NGU	0003	TOPAS	Regional; fjords in M&R
NGU	0004	TOPAS/boomer/ sleevegun	Geirangerfjord, M&R
Norsk Hydro	Pipeline Febr.- Mar. 2001	Pinger (Fugro)	Regional; Breisundet –fjords in M&R.
Norsk Hydro	Pipeline May 2001	Sparker (GeoConsult)	Regional; fjords in M&R and S&F.

M&R – Møre og Romsdal county, S&F – Sogn og Fjordane county.

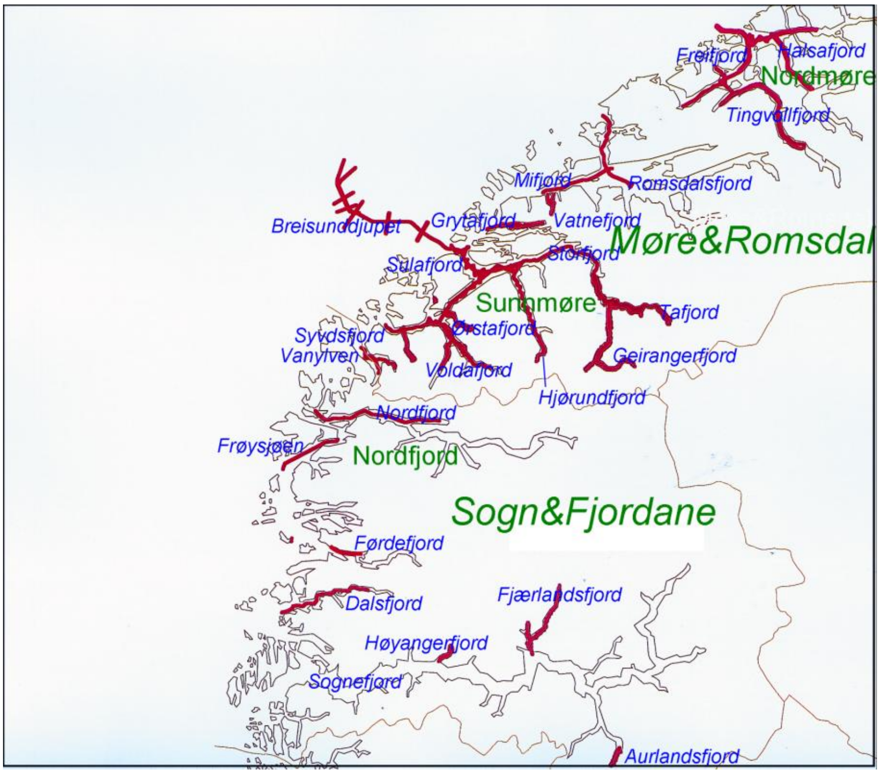


Fig. 1. Index map of investigated area. Red lines show the coverage of seismic lines.

Multibeam echosounding

Data owner	Cruise	Contractor	Echosounder	Area
NGU	May 1999	SKSK	EM 100	Tafjord - Storfjord
NGU	Mars 2000	SKSK	EM 1002	Voldafjord
NGU	Mars 2000	SKSK	EM 1002	Geirangerfjord
Norsk Hydro	Feb.-Mar. 2001	Fugro	EM 1002	Breisundet, Sulafjord, Vartdalsfjord, Ørstafjord and Voldafjord Tingvollfjord, Kværnesfjord, Freifjord, Talgsjøen, Vinjefjord, Halsafjord
Norsk Hydro	May 2001	GeoConsult	EM 1002, EM 300	Syvdefjord, Nordfjord, Frøysjøen and Dalsfjord (S&F)

Available NGU airgun and sleeve-gun data from the area has only been of limited value during interpretation.

3. SEISMIC STRATIGRAHY

3.1 Voldafjord

The fjord sediments and morphology are earlier described in detail (Grøsfjeld et al. 1999, Longva et al. 2000 and Sejrup et al. 2001). Several sets of seismic reflectors are identified and traced across the Voldafjord and tributaries – Dalsfjord (M&R) and Austefjord (Fig. 2).
A 8.5 m long core of fjord-sediments from Voldafjord (Fig. 3) shows distinct turbidite beds in the stratigraphic record. The three uppermost turbidites have been dated as c. 2,000 yr, 7,000 yr and 9,500 radiocarbon years BP. The stratigraphy of the core is correlated to seismic reflection profiles (Grøsfeld et al 1999). On the records, two distinct reflectors end in massive debris-flows on both sides of the fjord basin and are thought to represent the events dated to 2,000 and 7,000 BP. On the record of Line NGU9903 (Fig. 2) along the deepest part of the fjord, the most prominent reflectors are marked with a colour code that is used on interpreted records from other fjords (Fig. 4).

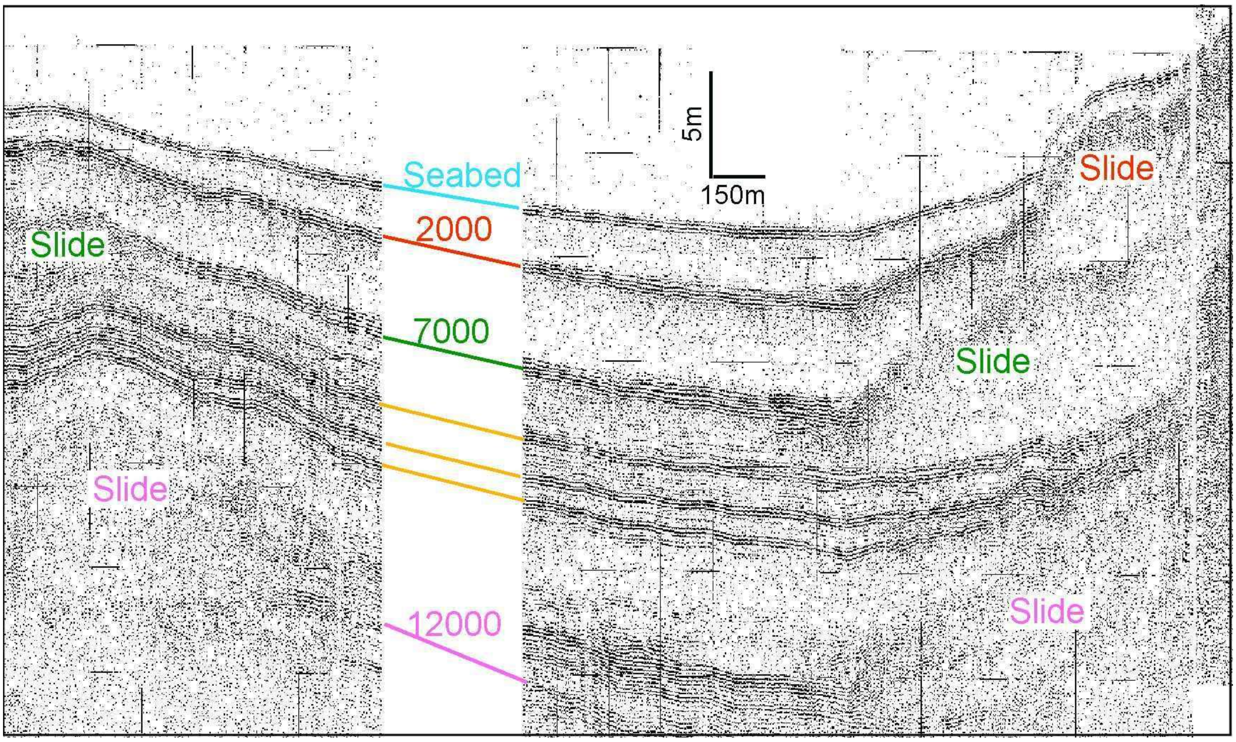


Fig. 2. Seismic profile (NGU 9909003) through the deepest part of Voldafjord. The numbers on the coloured reflectors give estimated ages -^{14}C- of individual reflectors based on the well dated core Fig. 3.

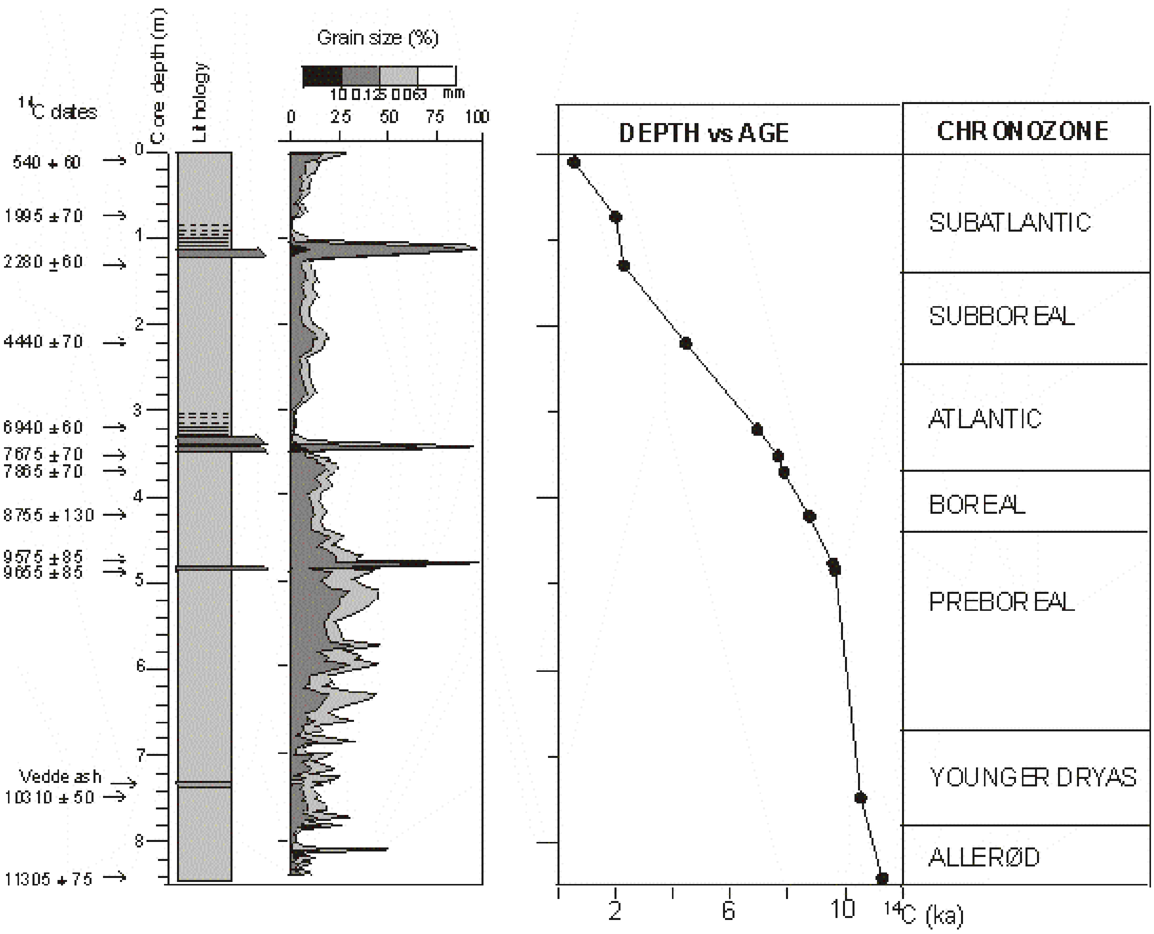


Fig. 3. The Voldafjord core, modified from Grøsfjeld et al. (1999). The distinct sand layers are 10 –15 cm thick turbidites.

3.2 Regional seismic reflectors

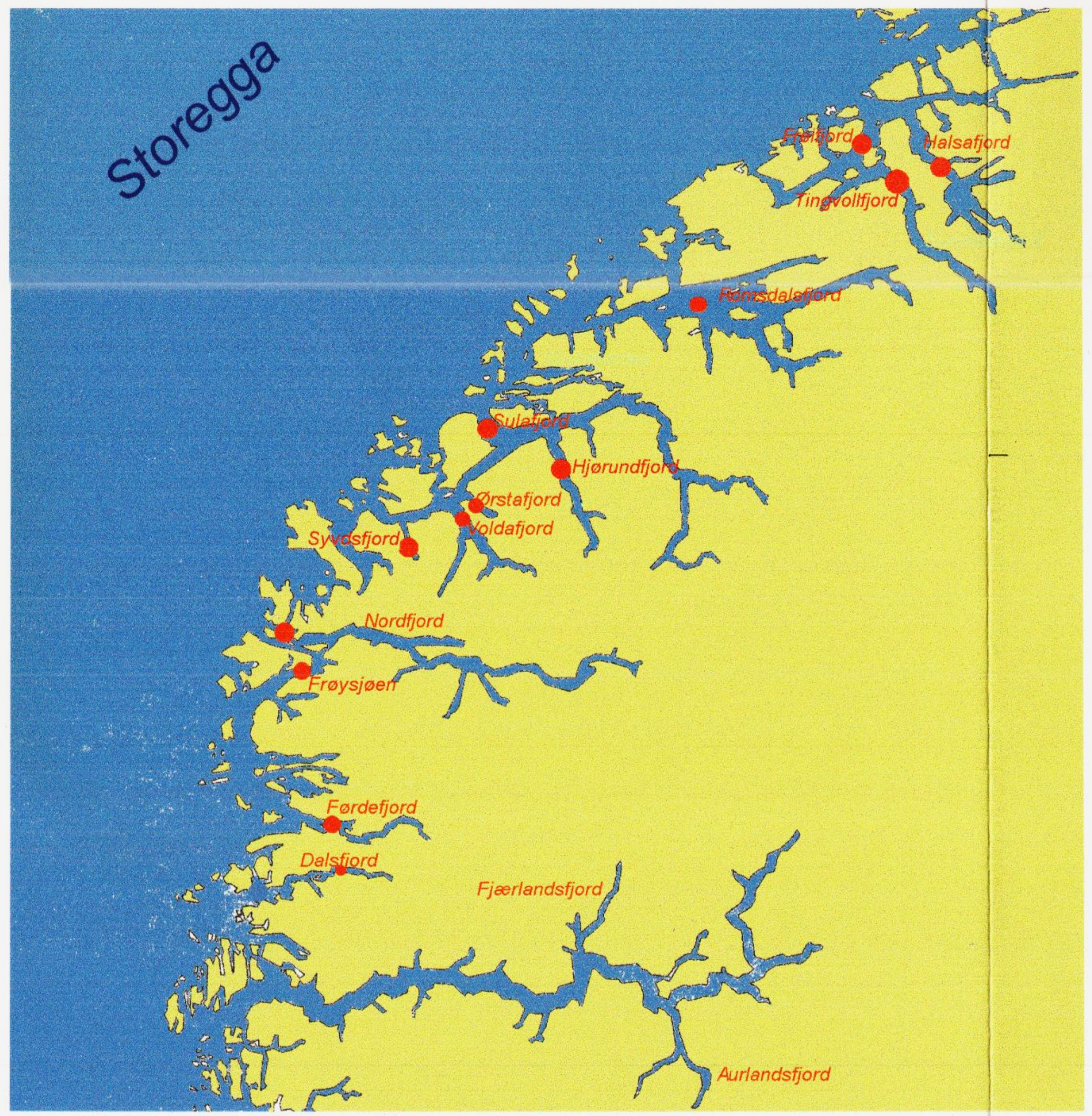
The similarity of seismic stratigraphy from fjord to fjord along the coast is striking. However, this only applies to large fjords with sediment input from rivers. Smaller fjords on the outer coast receive most of the sediments from primary production in the sea water which gives little density-contrast and accordingly low acoustic reflectivity (Fig. 5). Because of thresholds and local variations it is more difficult to follow the regional stratigraphy from the coast and into the inner parts of the fjords than it is along the coast. Therefore the first preliminary correlation is based on the colour-coded seismic stratigraphy from Voldafjord (Fig. 2) and is applied to other major fjords along the outer coast. As cores and dates are retrieved during the project this correlation will be expanded to include other fjords. Even though the stratigraphy visually can be correlated, further dating is needed to confirm and establish the chronology of the contemporaneous events from different fjords.

Below are general descriptions of the regional reflectors from Figs. 2 and 4.

Violet reflector – is often diffuse, usually on top of a 10 to 30 m thick acoustic transparent layer with chaotic seismic signature resting on planar acoustically layered glacial-marine beds. This is the main signature that has been used for the interpretation of this reflector on Fig. 4. Otherwise the acoustic picture around the reflector may vary from fjord to fjord. On a few occasions it is possible to see severe deformations of the original bedding below the

Correlation

between seismic sections from fjords along western Norway



Approximate location of seismic sections

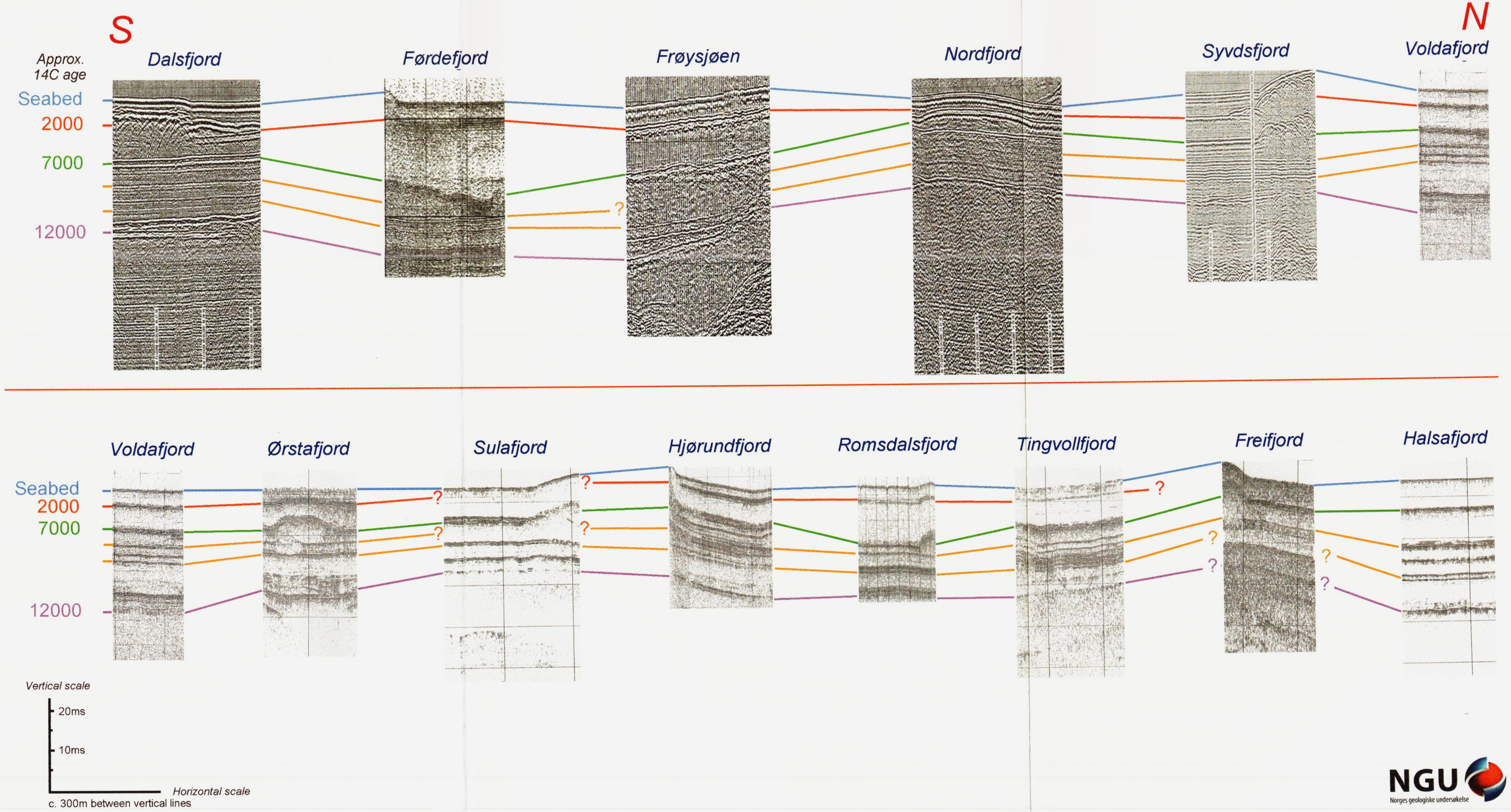


Fig. 4

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reflector that are assumed to be tectonically induced in the sediments. Several places the reflector clearly represents the top of thick debris-flows (e.g. the seismic section from Tingvollfjord in Fig. 4). The violet reflector is mainly overlain by debris flows, slides or by acoustically planar-bedded sediments. Above this follows an acoustically transparent bed usually less than c. 10 ms thick. The reflector represents a change from rapid, glacio-marine sedimentation followed by a regional event – tectonical or other - to sedimentation under ice-free conditions.
The reflector is estimated to be c. 12,000 +/-100 ^{14}C years old since the fjords were deglaciated some time before the formation.

Orange reflectors – appear as a set of three distinct acoustic beds that often occur together. The one that is seen most frequently is the lower one on top of the acoustic transparent layer described above. Occasionally there are slides related to these reflectors especially in the fjords on Nordmøre. On Fig. 2, there is not given any age for these reflectors, but based on the thickness of the stratigraphic sequence, we suggest that they were formed during the latest Younger Dryas stadial and into the Preboreal chronozones.

Green reflector – is the most prominent reflector in all fjords. There is usually an acoustically transparent bed between the upper orange reflector and the green, but locally this bed may have internal planar reflectors. In most of the investigated fjords there are large debris flows associated with this bed. Often the reflector becomes thick because the planar beds, that seem to be part of the event that formed the reflector, fill in depressions in front of slide-lobes and overlaps the lobes (e.g. in Sulafjord Fig. 7). The frequency of slides related to the reflector seems to be less in Nordmøre than further south.
Based on the dates from Voldafjord, the reflector is interpreted to have been formed at c. 7,000 ^{14}C years BP at the same time as the main construction of the Storegga-slide.

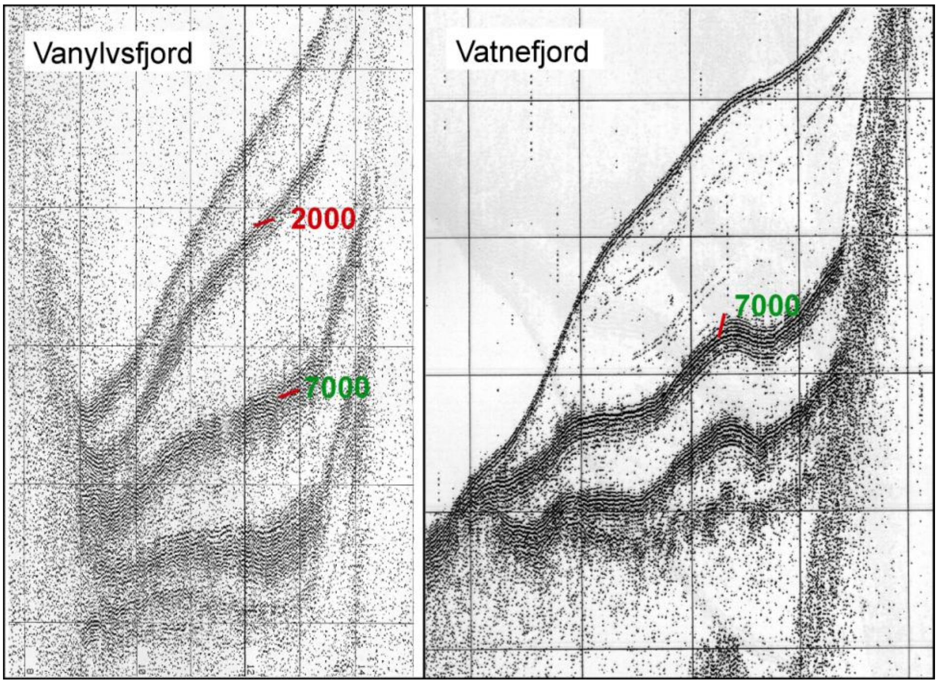

Fig. 5. Correlation between two small fjords with "marine gyttjae" on the outer coast - one south of Sulafjord the other north of. In Vanylvsfjord both the interpreted 7000 and 2000 layers are present. In Vatnefjord there is no obvious 2000 layer.

Red reflector – is very prominent and as distinct as the green reflector in southern part of Sunnmøre. The data coverage between Nordfjord and Sunnfjord is reduced, but it is assumed the reflector is present all the way between Voldafjord and Dalsfjord (Sogn & Fjordane) (Fig. 4). To the north it becomes very vague and fragmented and few, if any, slides belonging to it have been observed.
The reflector lies in acoustically transparent sediments, but the sediments above are more acoustically layered than the sediments below. The age is c. 2,000 yrs BP according to the dates from Voldafjord.

3.3 Slides

The slides observed on the interpreted seismic records are usually related to one of the reflectors described above. Most slides are found related to the violet, green reflector and red reflectors. However there are local differences.

Nordmøre

So far we have not found any slides that has been positively related to a strong reflector that may represent the 2,000 yr episode. The slides are seen as positive mounds on the bottom of the Tingvollfjord are of different ages and relates to both violet, orange and green reflectors (Fig. 7). Slide frequency of the 7,000 yr episode appears as less than further south.

Sunnmøre

In Sulafjord all the slides that can be identified on the shadow-relief image (Fig. 7) of the fjord-bottom are related to the green 7,000 yr BP reflector. There has been a number of large-scale debris flows down both fjord sides. The 2,000 yr reflector is weak and partly missing.

In Voldafjord (Fig. 2) slides are found both at violet, green and red reflectors. In the deepest part of the fjord the extent of the 7,000 yr and 2,000 yr episodes are equal, in shallower parts the 2,000 yr-event is less extensive.

In Syvdsfjord (Fig. 8) large slides have reached the fjord-bottom both at the 7,000 yr and 2,000 yr episode. Large blocks, interpreted as rock, seen on the multibeam echo-sounding images of the bottom and diffractions in the debris flows, strongly indicate that some of these slides originate from above sea-level. If this is the case, tsunamis can hardly have triggered the slides, which makes earthquake-triggering the most plausible explanation. On land in the area there are large avalanches from collapsed cliffs (Blikra et. al 1999). However the ages of these avalanches are not yet known.

Breisundet offshore Sunnmøre

Breisundet is the extension of the Storfjord-Sulafjord trough onto the shelf. The trough cuts approximately 100 m into the shelf and ends abruptly some kilometres inshore of the shelf-edge. The multi-beam bathymetry shows several debris-slides along this trench. The

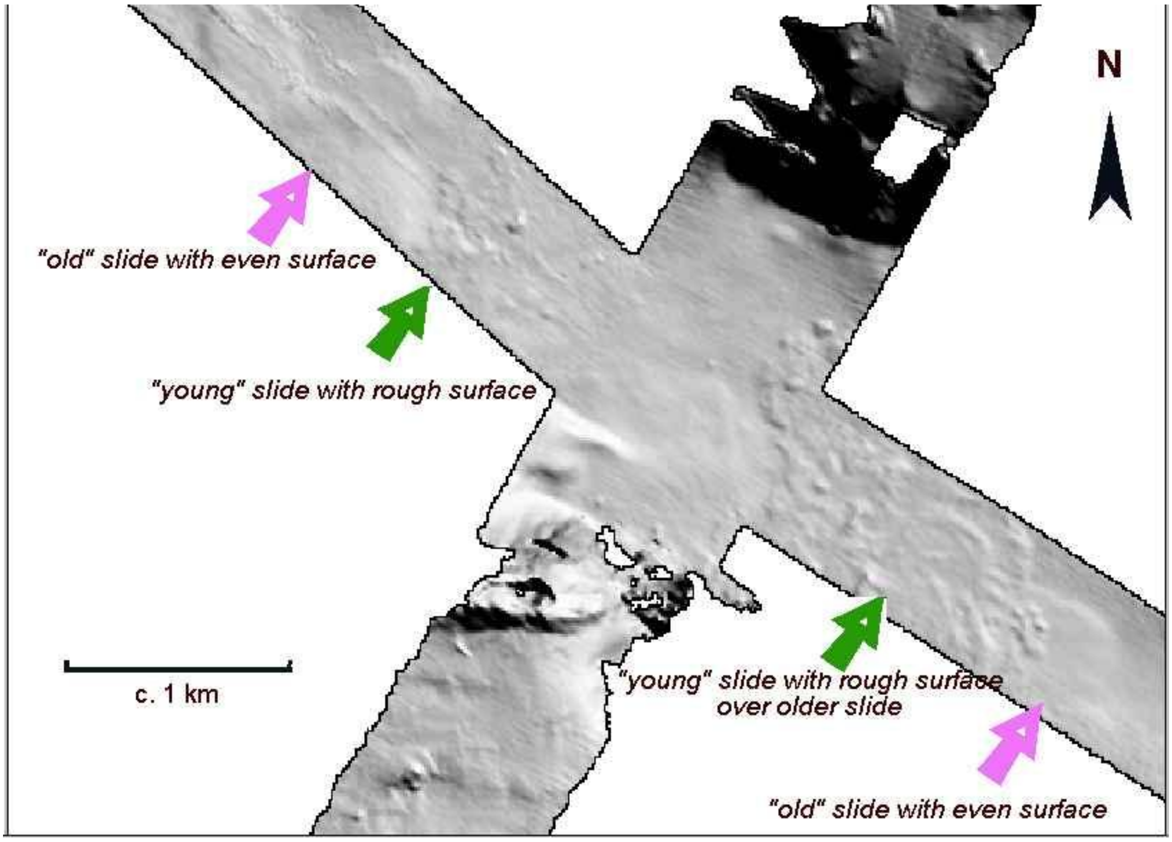

Fig. 6 Slides of different ages in Breisundet.

morphology of the sea-bottom surface indicates that they are of various ages (Fig. 6). This is also obvious from the seismic records, but without dates we have not been able to correlate the stratigraphy to the generalised stratigraphy in the fjords. The slides, if triggered by tsunamis, relate to at least two episodes of mega-slides on the shelf edge, or if released by earthquakes, two severe seismic episodes which may, or may not, have led to sliding on the shelf edge.

In the western part of the trench large areas seem to be covered by coral mounds.

Sogn og Fjordane

In Dalsfjord (Fig. 8) slides are not as visible on images of the fjord-bottom, but on the seismic record there are similar-sized slides related both to violet, green and red reflector.

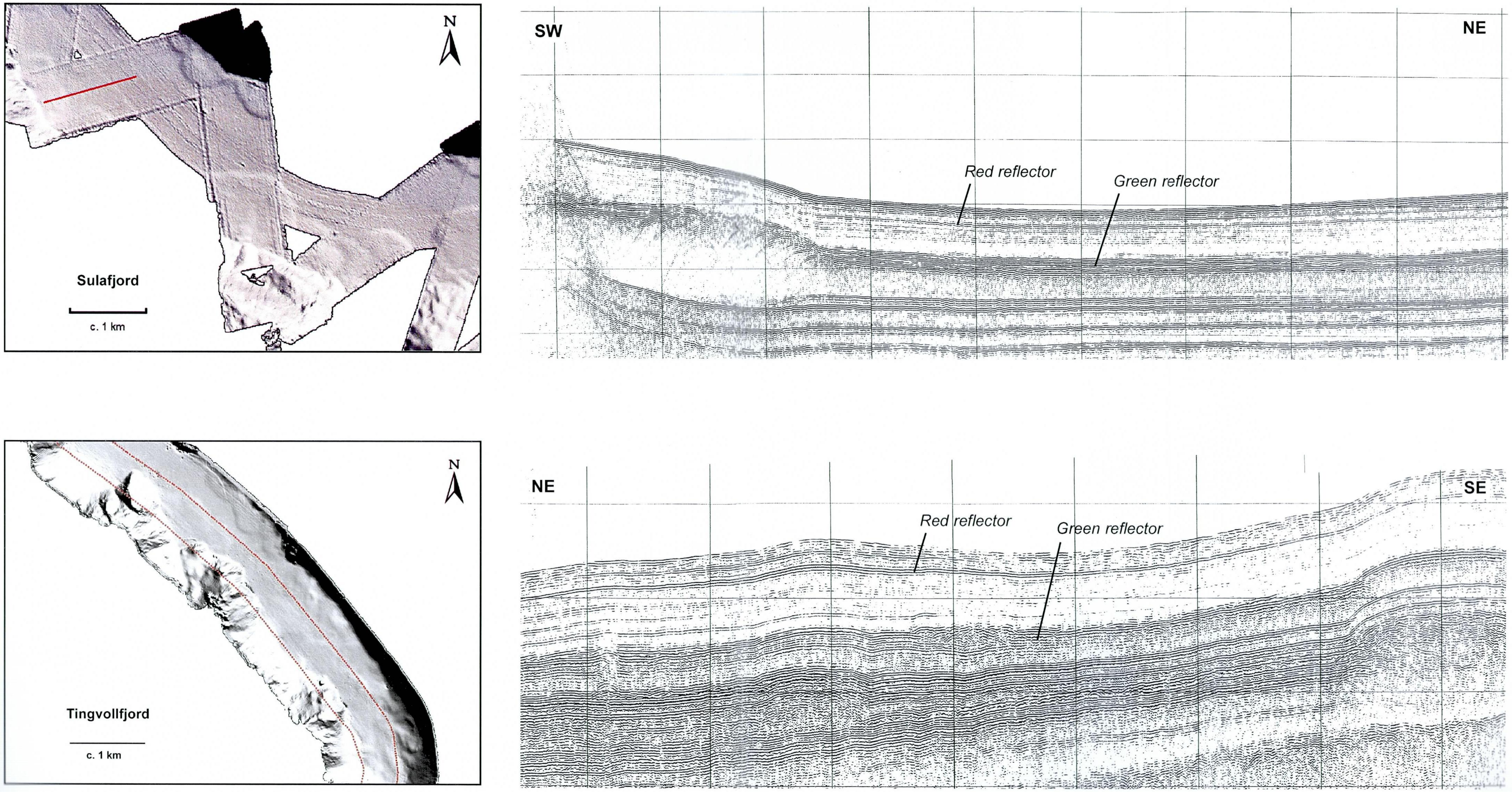

Fig. 7. Shadow-relief images of the sea-bottom and seismic sections from Sulafjord and Tingvollfjord. Note the distinct mounds on the bottom of Sulafjord reflecting slides in green reflector. In Tingvollfjord the mounds are not as distinct and represent draped slides of different ages.

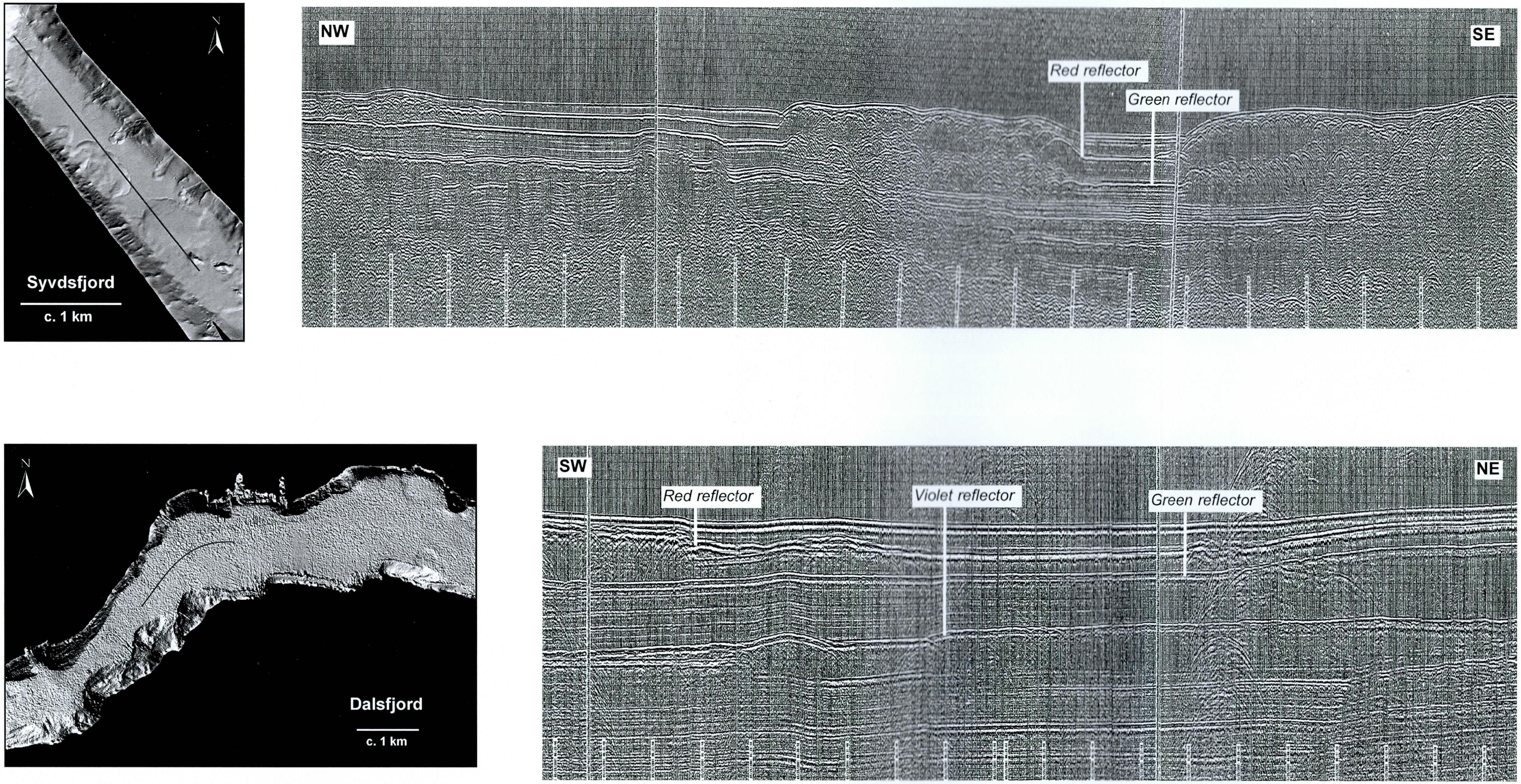

Fig. 8. Shadow-relief images of the sea-bottom and seismic sections from Syvdsfjord and Dalsfjord (S&F). Note the distinct slide scars and deposits on the fjord-bottom. On the seismic record it is visible that slides belonging to green and red reflectors sits on top of each other. The mounds on top of the SE large slide are interpreted as huge blocks of rock fallen from the mountain-side above. The blocks seem to belong to the slide in green reflector. The bathymetry of Dalsfjord is of poorer quality, but it is possible to distinguish draped slides on the image. Similar-sized slides can be seen on the seismic record related to violet, green and red reflectors.

4. SAMPLING STRATEGY

Coring of the fjord sediments covers two purposes:

- Regional correlation of seismic reflectors
- To establish the origin of the sedimentary units in order to distinguish between tsunami- and earthquake-induced events

The strategy will thus be:

- Core through regional reflectors in different fjords and date them. While strong reflectors in a seismic reflection profile may be difficult to see in a core through the sediments, slides are easily recognized in core sections. Therefore the strategy will be to core into or through debris-flows related to regional reflectors where that is possible.
  There will be a combination of many short 2-3 m long vibro-cores and some long > 5 m piston-, gravity- or Selcore-cores. The short cores will be sampled where condensed sections leads deep reflectors close to surface (e.g. as in Austefjord-Volda Fig. 9). Whenever coring with the 3 m long vibrocorer, the TOPAS seismic system will be used to optimise the core location.

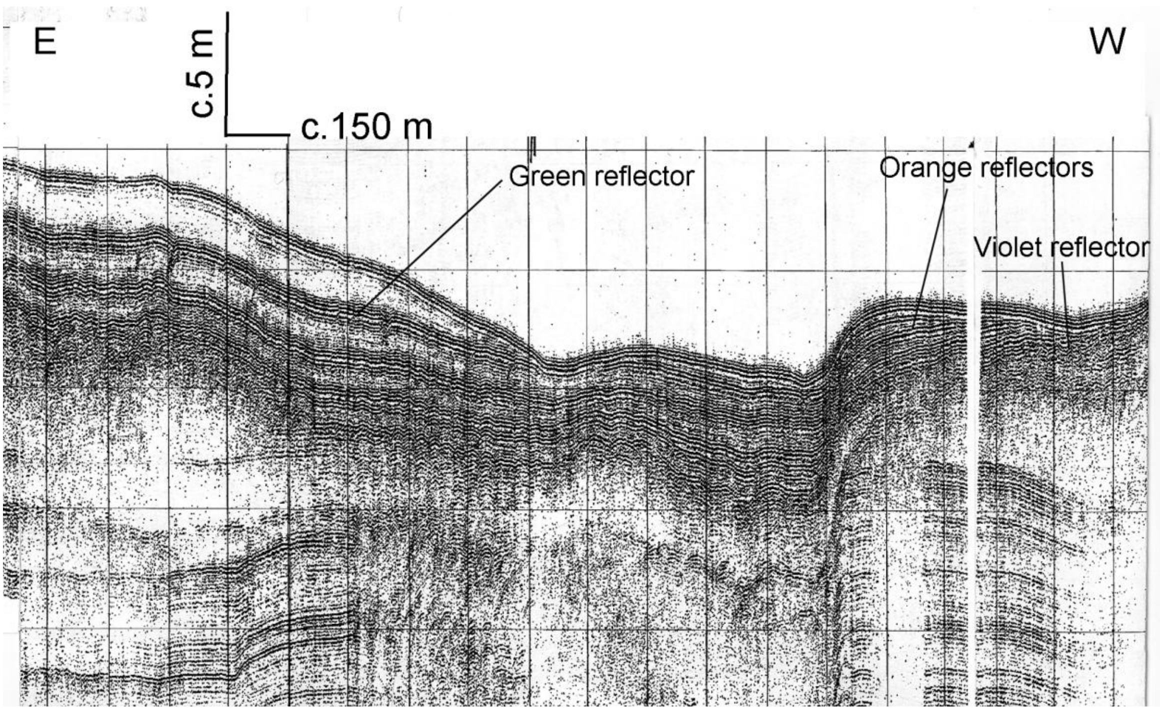

Fig. 9. Deflation due to current flow over a sill in Austefjord, the inner part of Voldafjord. The currents leads to erosion – no deposition and the result is that "old" beds can be reached by a series of short cores. Similar settings are found at the mouth of Midfjorden – the outer part of Romsdalsfjord - and in Halsafjord.

- Sampling the toes of slides and beyond for confirming if the reflectors are of turbiditic origin. If so, try to confirm whether they are generated locally from the slide-event, or onlap the slides and thus postdate them and are therefore tsunami deposits. This will be vital for the determination of triggering mechanisms for the slides and if the episodes are combined events with earthquake-released slides and resulting tsunamis – local and regional.
- Sample the sediments inshore of coral-mounds to identify and date lags of coral-gravel that may be an indicator of tsunami erosion. Such localities exist in Midfjord and offshore in Breisundet (Fig. 10).

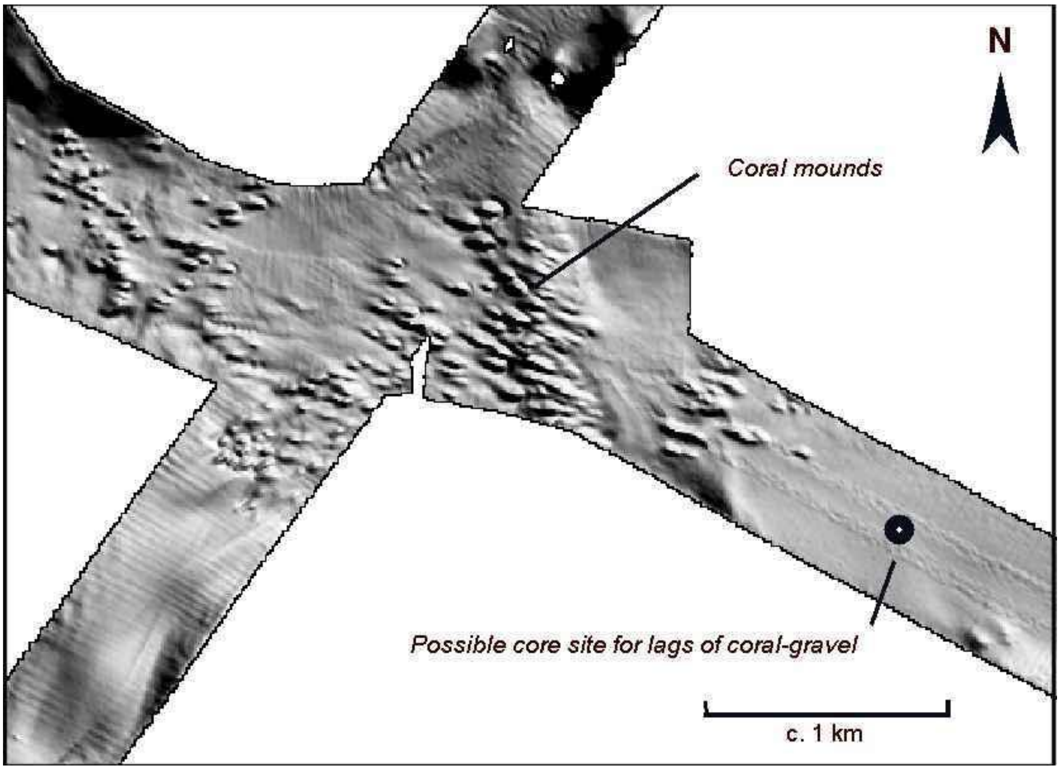

Fig. 10. Coral mounds in Breisundet

5. PRIORITY OF CORE-LOCATIONS

The table below give possible core-locations for 3 m vibro-corer (or longer barrels) and selected locations for a few long > 5 m long cores in order by priority. Priority A: High Priority, cores to be taken, B: Low to Medium priority, optional core sites.
NB Datum is WGS84 UTM zone 32.
Seismic examples of core-locations are given in Appendix 1.

Suggested core locations

Priority	Loc. No.	X (UTM32)	Y (UTM32)	Longitude	Latitude	Fjord	Object Purpose; dating or sedimentology	Depth to object
A	1	399623	6752236	7° 9.0117’	60° 3.5533’	Aurlandsfj.	Date slide	6 ms
A	2	398828	6750447	7° 8.1900’	60° 52.5783’	Aurlandsfj.	Date rock-avalanche	3 ms
A	3	398382	6750196	7° 7.7050’	60° 52.4367’	Aurlandsfj.	Date rock-avalanche	3 ms
A	4	379023	6805578	6° 44.2133’	61° 21.9200’	Fjærlandsfj.	Date rock-avalanche	3 ms
A	5	371235	6793252	6° 35.9883’	61° 15.1367’	Fjærlandsfj.	Date rock-avalanche	2.5 ms
A	6	369678	6790184	6° 34.3767’	61° 13.4533	Fjærlandsfj.	Date submarine debrisflow	2 ms
A	7	305298	6809364	5° 21.3867’	61° 22.1617’	Dalsfj. S&F	Top slide – green reflector	3 ms
B	8	308030	6810292	5° 24.3900’	61° 22.7417’	Dalsfj. S&F	Top or through red slide	1 ms
A	9	308376	6810455	5° 24.7683’	61° 22.8400’	Dalsfj. S&F	Through red reflector – same basin	3 ms
A	10	Check	In field			Førdefjord	Through red reflector	3 ms
B	11	Check	In field			Førdefjord	Through red slide	2 ms
A	12	Check	In field			Frøysjøen	Object found (Topas) in field	
A	13	307231	6868546	5° 19.8117’	61° 54.0317’	Nordfjord	Through red and green refl.	3 ms
A	14	307449	6868559	5° 20.0583’	61° 54.0450’	Nordfjord	Into green slide	3 ms
A	15	312359	6892251	5° 24.1533’	62° 6.9267’	Vanylven	Through red into green refl.	4 ms
A	16	327122	6891724	5° 41.1333’	62° 7.0683’	Syvdsfj.	Into top of red slide – terrest?	2 ms
A	17	327255	6891569	5° 41.2950’	62° 6.9883’	Syvdsfj.	Through toe of red slide	3 ms
A	18	327288	6891533	5° 41.3350’	62° 6.9700’	Syvdsfj.	Through red reflector outside toe	3 ms
B	19	327751	6890980	5° 41.8983’	62° 6.6850’	Syvdsfj.	Into red slide – terrestic?	2 ms
A	20	328370	6890255	5° 42.6517’	62° 6.3133’	Syvdsfj.	Into red slide – terrestic?	2 ms
A	21	329150	6889348	5° 43.5983’	62° 5.8467’	Syvdsfj.	Condenced section to violet reflector	4 ms
A	22	352121	6887144	6° 10.0733’	62° 5.2417’	Austefjord/ Volda	Through green reflector	3 ms
B	23	351504	6887000	6° 9.3733’	62° 5.1500’	Austefjord/ Volda	Through green and orange reflectors – tsunami erosion?	3 ms
A	24	350586	6887202	6° 8.3100’	62° 5.2367’	Austefjord/ Volda	Through green and orange reflectors – tsunami erosion?	3 ms
A	25	350446	6887276	6° 8.1450’	62° 5.2733’	Austefjord/ Volda	Through lower orange into violet reflector	3 ms
A	26	350305	6887351	6° 7.9800’	62° 5.3100’	Austefjord/ Volda	Through violet reflector	2 ms
A	27	344787	6901076	6° 0.9233’	62° 12.5583’	Ørstafjord	Through red slide	3 ms
A	28	352528	6916622	6° 9.0517’	62° 21.1083’	Vartdalsfj.	Through green slide	2 ms
A	29	352448	6916557	6° 8.9617’	62° 21.0717’	Vartdalsfj.	Through green reflector	3 ms
A	30	345749	6926168	6° 0.6950’	62° 26.0783’	Sulafjord	Into green slide	3 ms
A	31	333854	6931981	5° 46.5567’	62° 28.8967’	Breisunddj.	Into "young" slide (Fig. 6)	2 ms
A	32	334075	6931844	5° 46.8200’	62° 28.8283’	Breisunddj.	Into "old" slide (Fig. 6)	3 ms
A	33	311217	6938604	5° 19.8217’	62° 31.8067’	Breisunddj.	Coral gravel from tsunami-erosion?	3 ms
A	34	417200	6903873	7° 24.3350’	62° 15.4433’	Tafjord	Into top of slide	1.5 ms
A	35	416376	6904238	7° 23.3733’	62° 15.6283’	Taford	Into tectonized sediment	1.5 ms
B	36	334545	6947160	5° 46.4767’	62° 37.0767’	Mifjord	Through green reflector. Coral gravel?	2 ms
A	37	374839	6947337	6° 33.5400’	62° 38.1250’	Mifjord	Through green reflector. Coral gravel?	3 ms
A	38	395697	6956098	6° 57.6033’	62° 43.2300’	Romsdalsfj.	Through green and red reflectors	3 ms
B	39	395641	6956210	6° 57.5333’	62° 43.2883’	Romsdalsfj.	Through orange reflectors	3 ms
A	40	444911	6983247	7° 54.7983’	62° 58.4883’	Tingvollfj.	Into green slide	3 ms
A	41	443470	7001146	7° 52.7233’	63° 8.1117°	Talgsjøen	Through green and into orange reflectors	4 ms

Long cores, corers with barrels more than 5 m

A	1L	312772	6937752	5° 21.6883’	62° 31.3967’	Breisunddj.	Date stratigrphy – marked reflectors above slide	8 ms
A	2L	349480	6921298	6° 5.2800’	62° 23.5500’	Sulafjord	een reflector –thick with planar beds in front of slide	11 ms
A	3L	349646	6921342	6° 5.4700’	62° 23.5783’	Sulafjord	Green slide	10 ms
A	4L	459289	6988764	8° 11.7317’	63° 1.5733’	Halsafjord	Total sequence above violet reflector	16 ms

6. PRELIMINARY CONCLUSIONS

The seismic stratigraphy of fjords along the coast from Sognefjord to Kristiansund seems to consist of a set of regional reflectors which are tentatively being interpreted to be 2,000, 7,000, 9-11,000 and 12,000 ^{14}C years old downslope events. Slides are related to these reflectors, but the slide frequency varies from north to south. The 2,000 yr event is not registered in Nordmøre and northern part of Sunnmøre, but is very strong in southern part of Sunnmøre and into Sogn og Fjordane. The 7,000 yr event is strong everywhere, but slide-frequencies are lower in Nordmøre than in Sunnmøre. Rockfall into the fjord in Syvdsfjord at the 7,000 yr event and possibly at the 2,000 yr event, are strong indicators of earthquake-triggering of the slides. Based on the proposed regional stratigraphy a core-program is proposed for the dating of regional reflectors and establishing the origin of reflector formation.

7. REFERENCES

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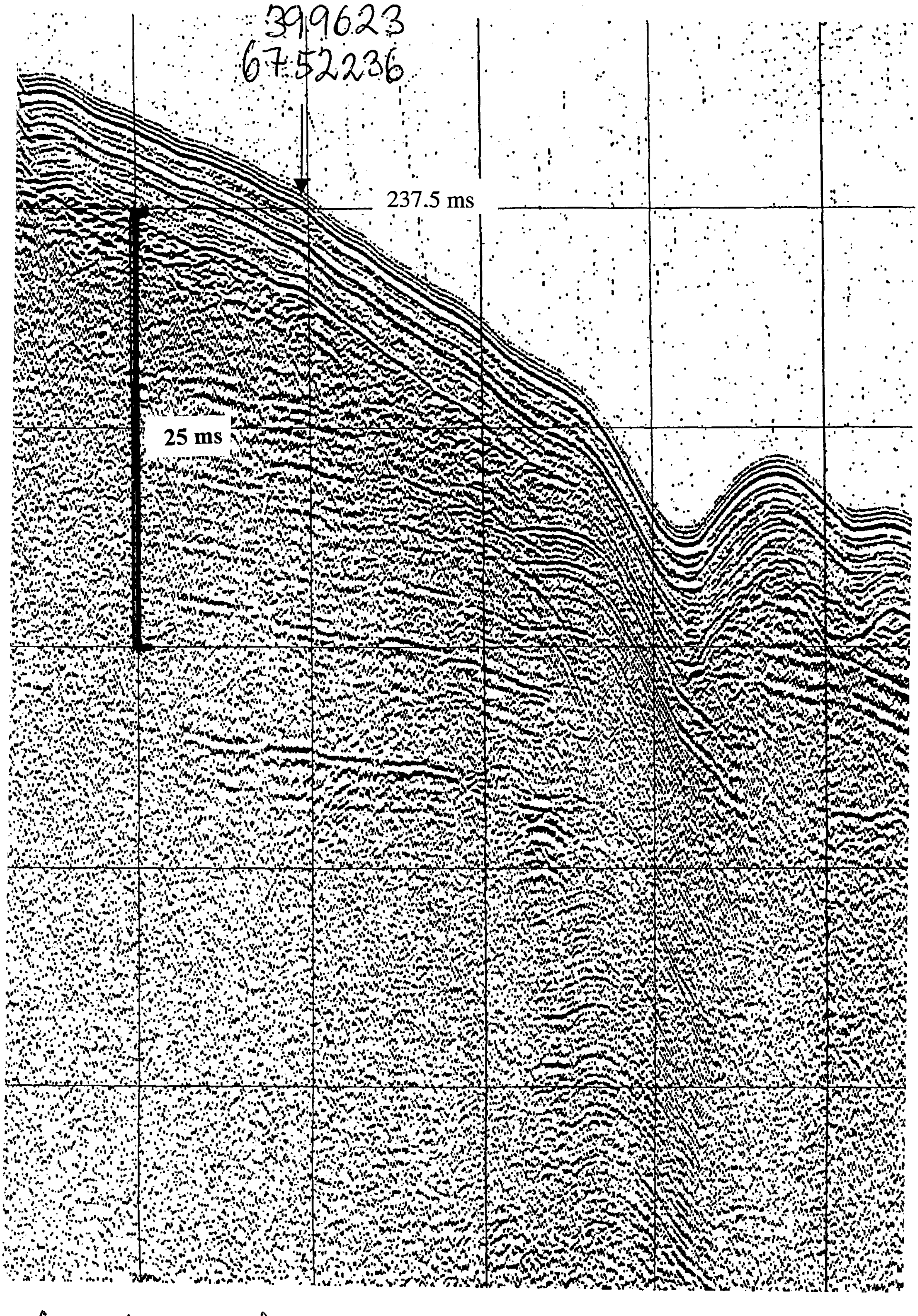
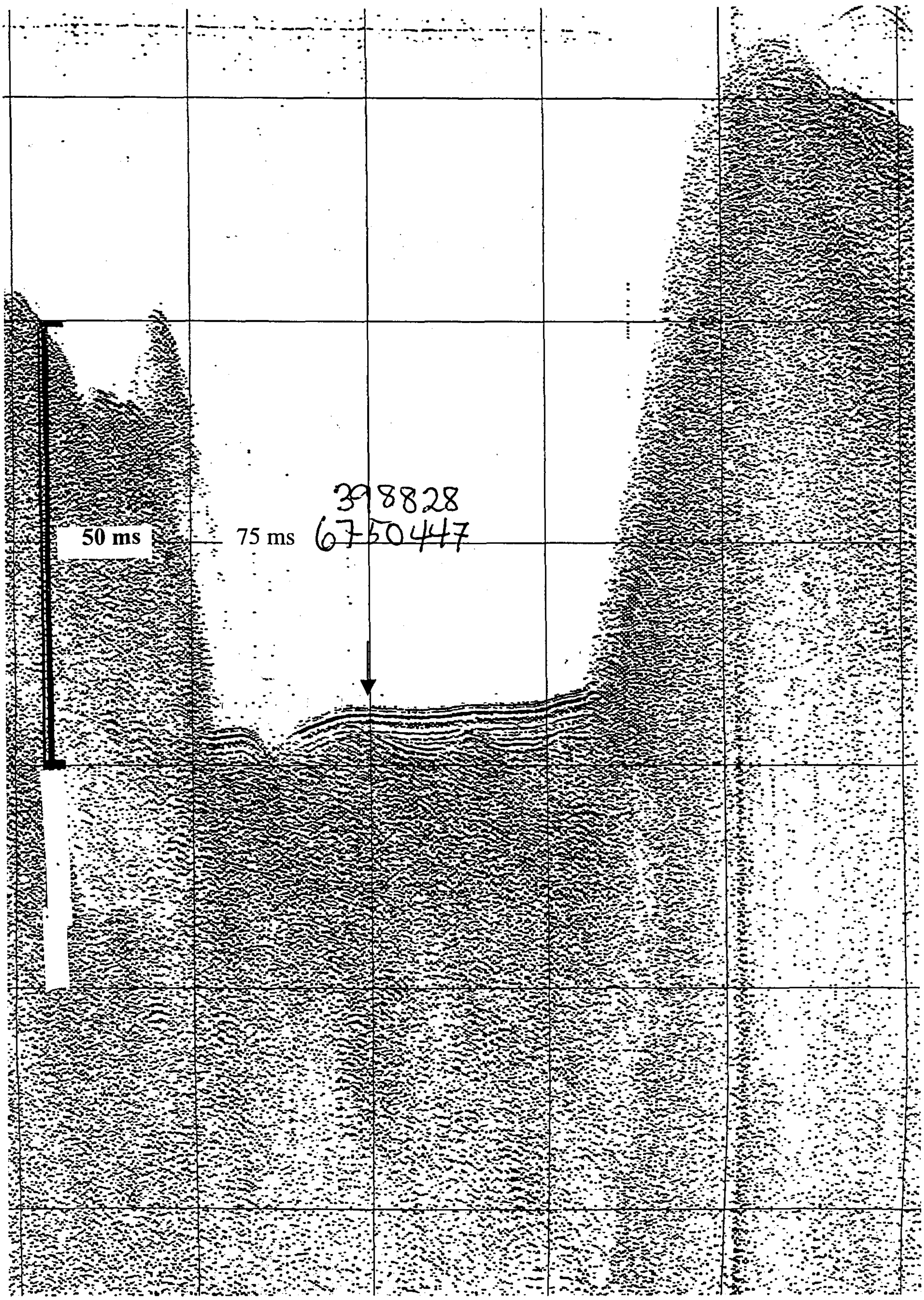
8. APPENDIX 1

Seismic examples - core localities

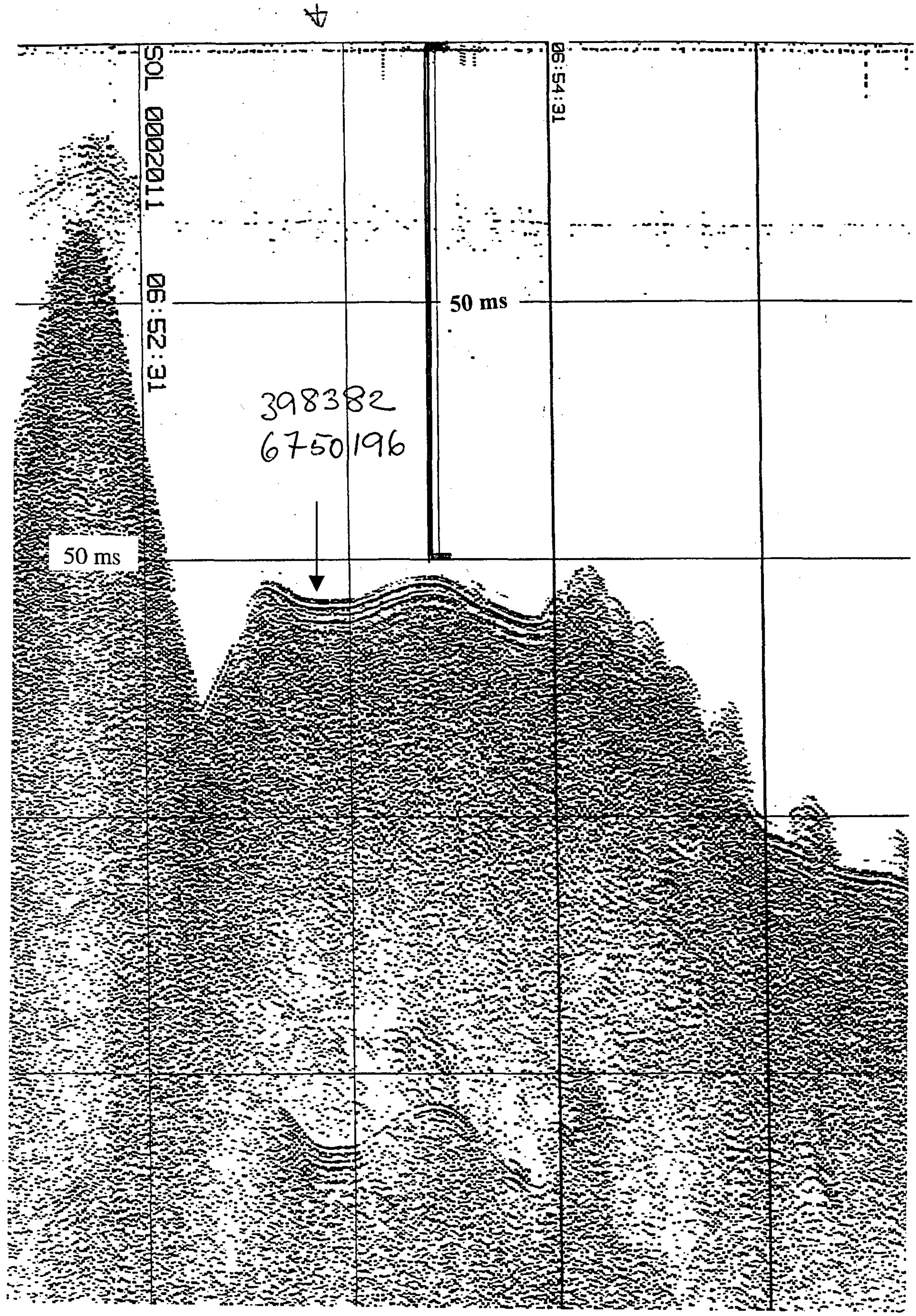


Aurlandsfjord

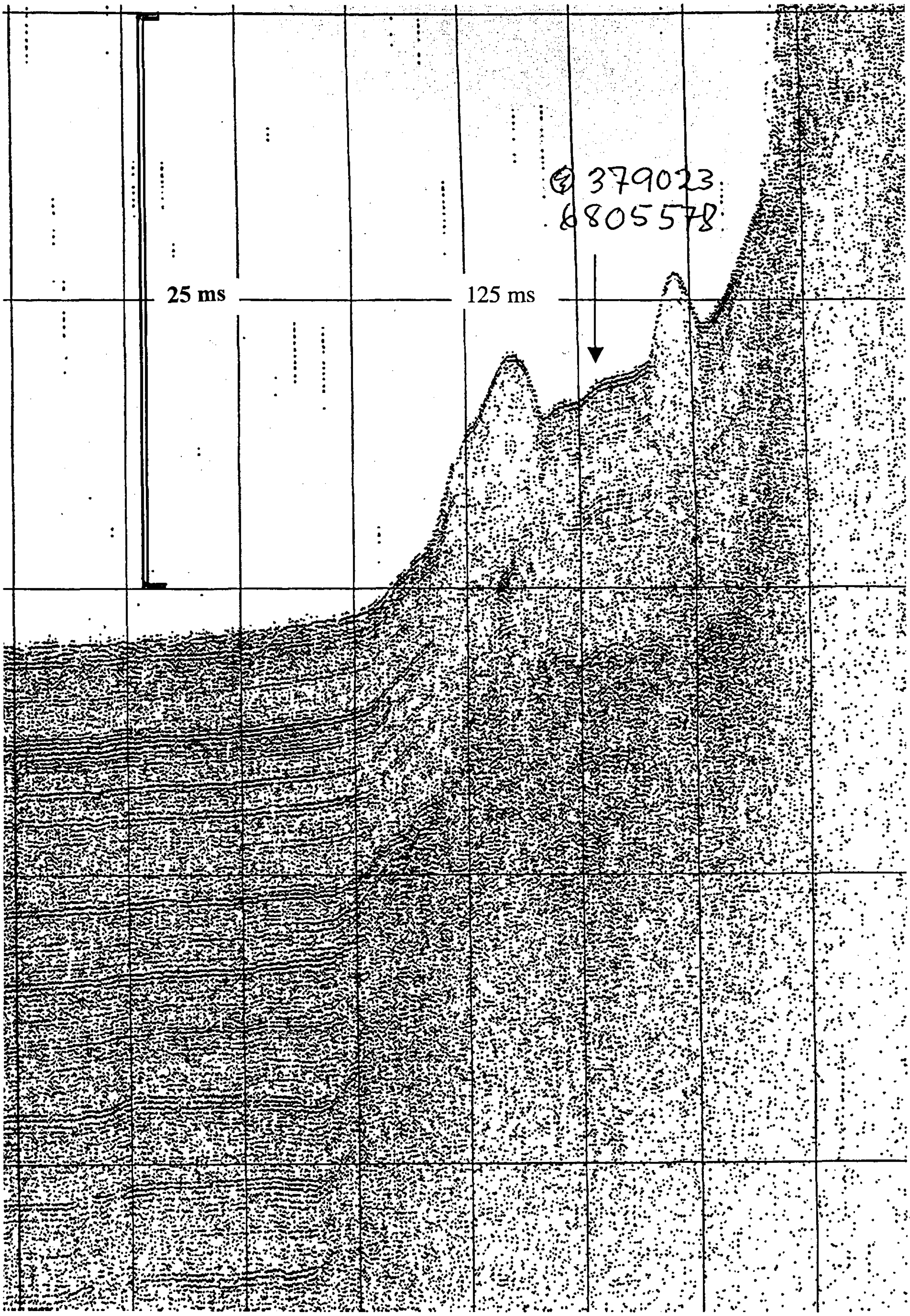
Loc. no 1



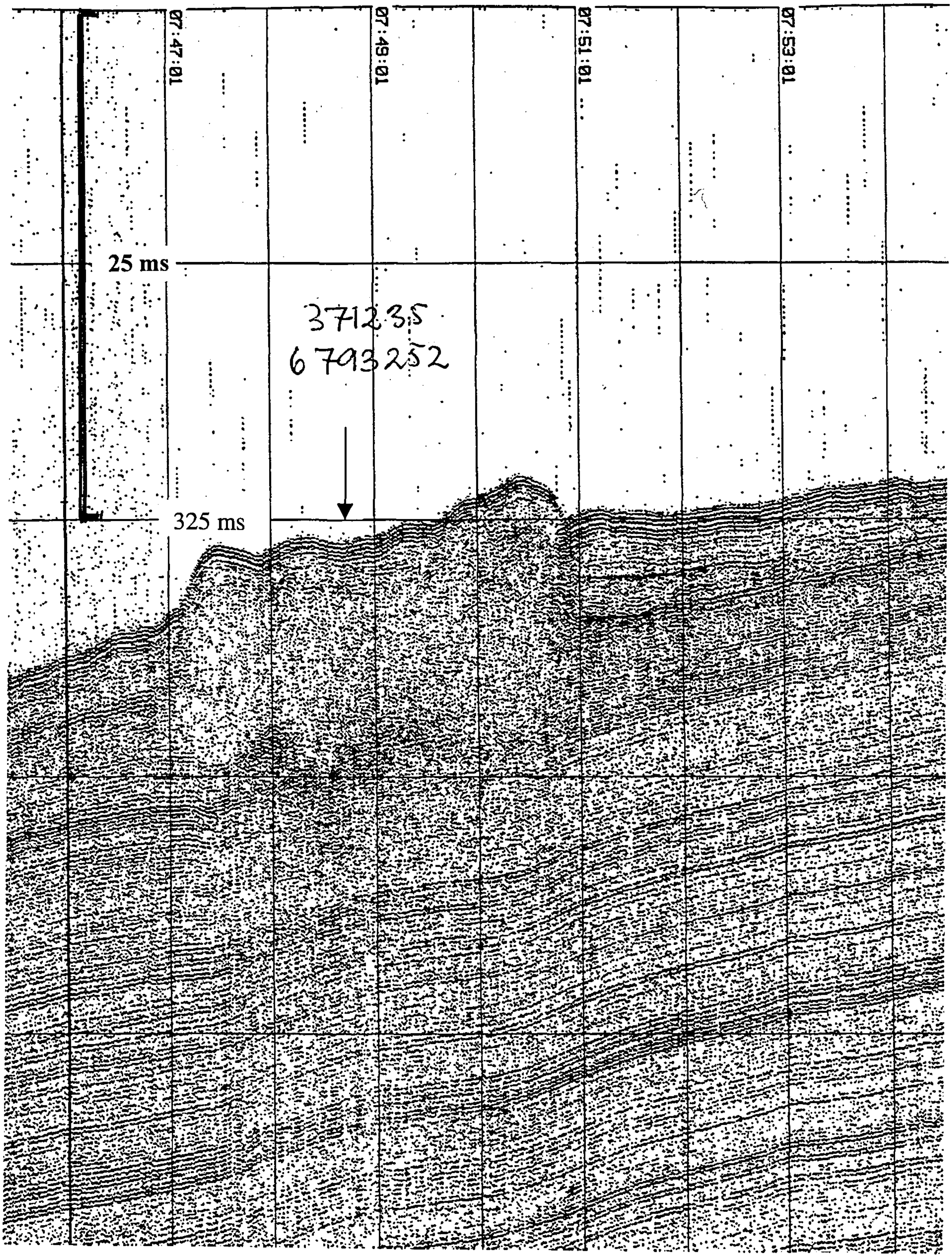
Aurlandsfjord
Loc. no 2



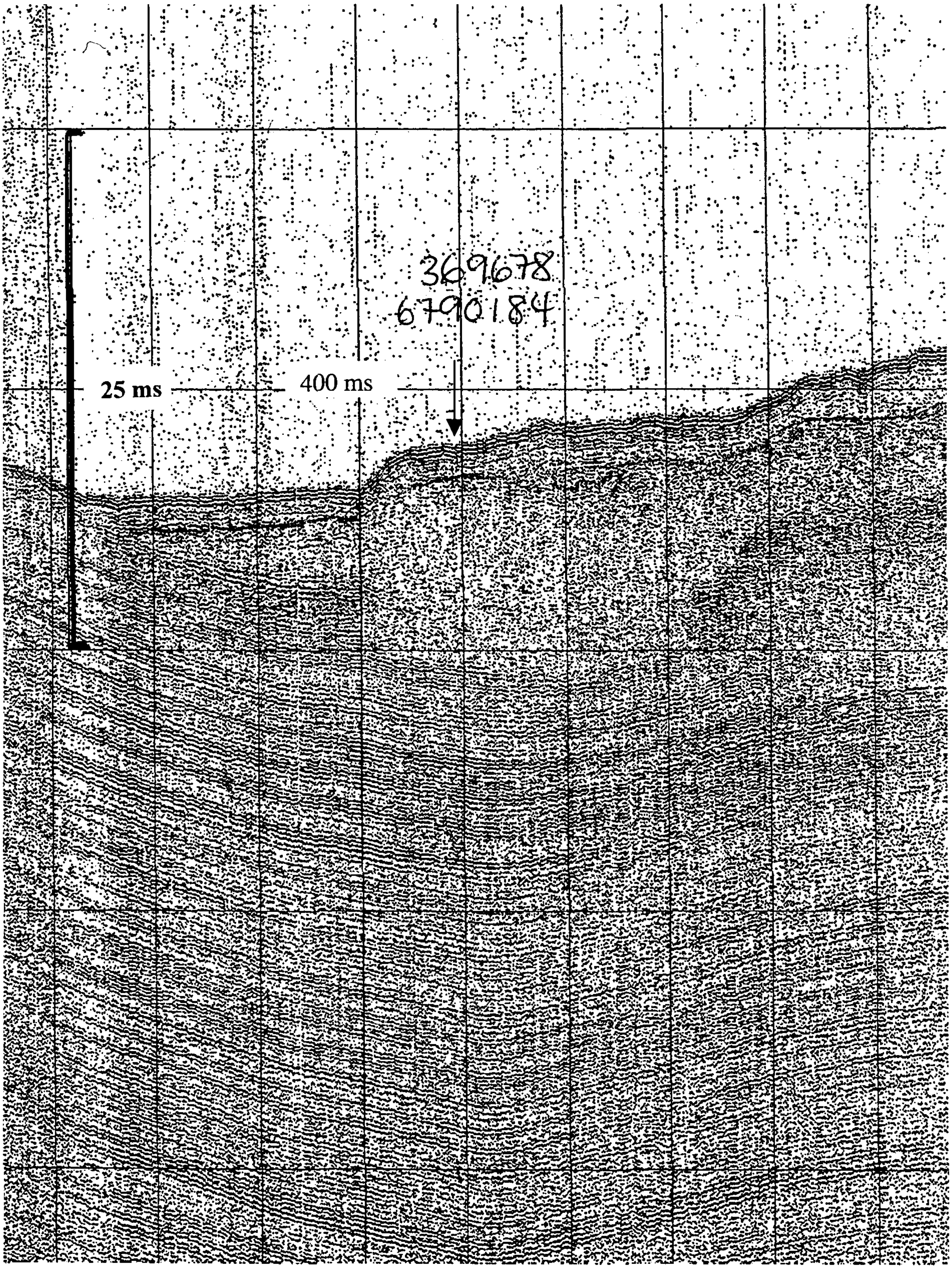
Aurlandsfjord
Loc. no 3



Fjærlandsfjord
Loc. no 4



Fjærlandsfjord - Menes
Loc. no 5



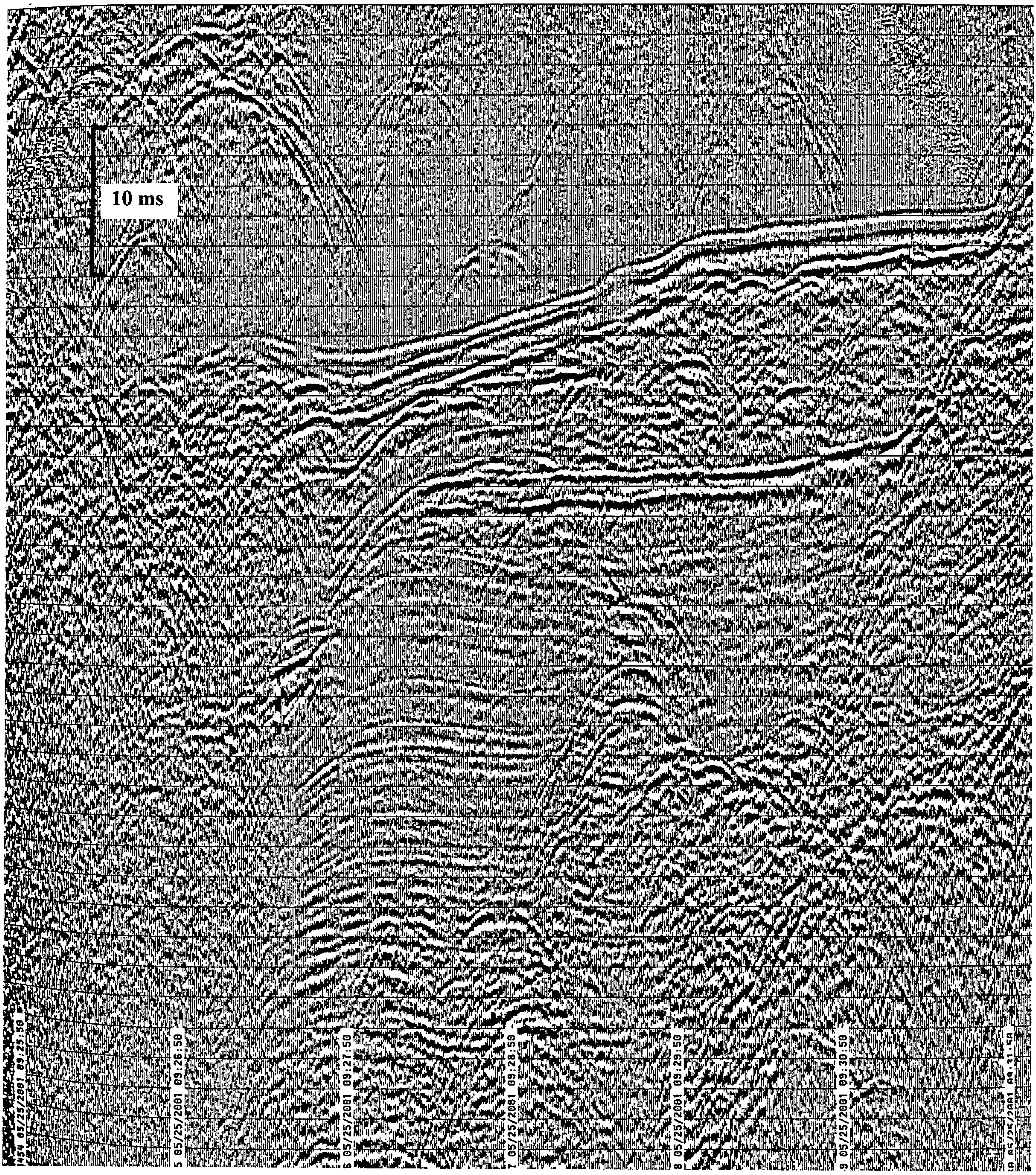
Fjærlandsfjord

Loc. no 6

Dalsfjord
Dalsøyna

Loc. no. 7

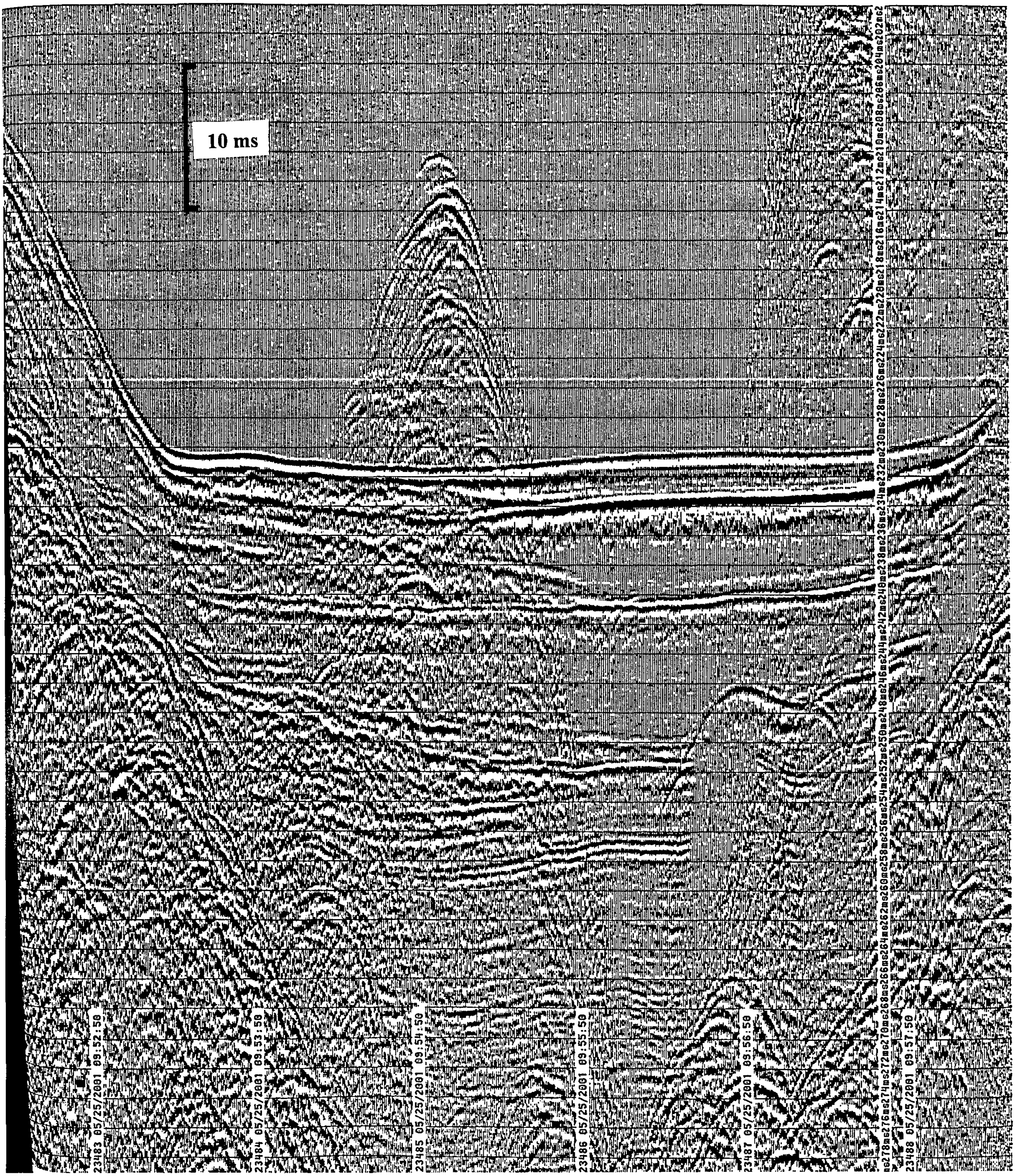
305298
6809364



Dalsfjord

Loc. no. 8 308030 6810292 ↓

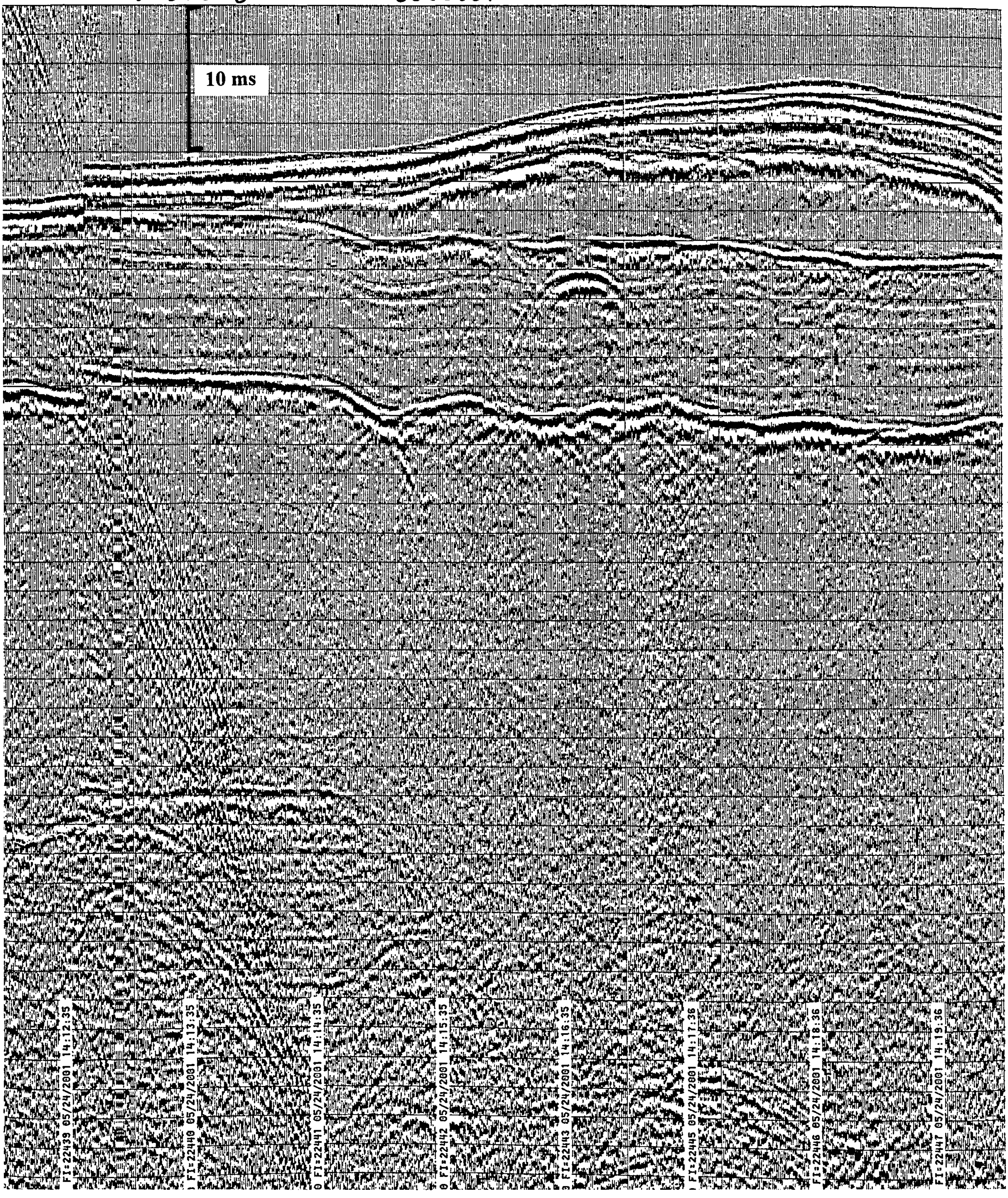
Loc. no 9 308376 6810455 ↓

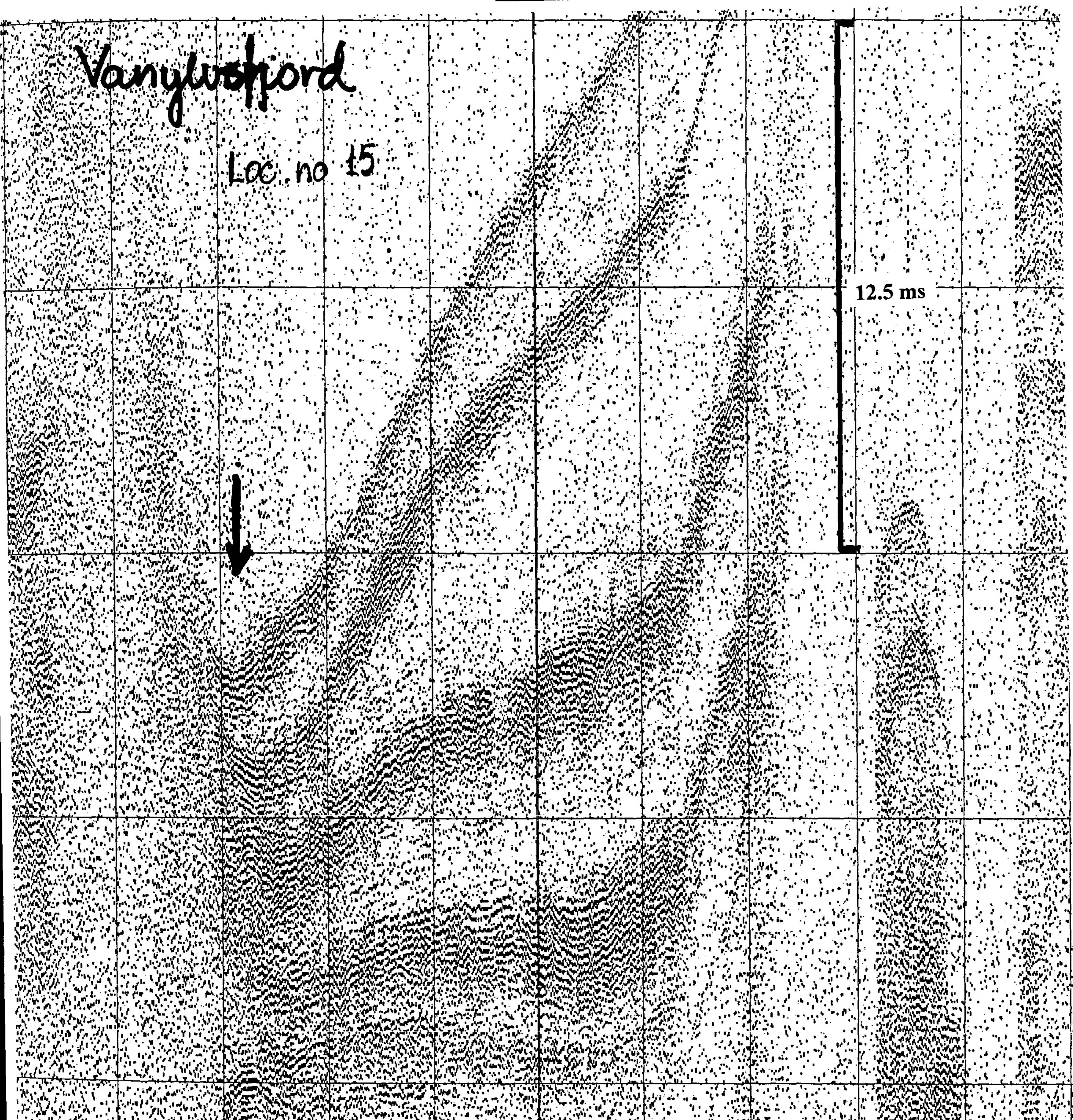


Nordfjord (Rugsund)

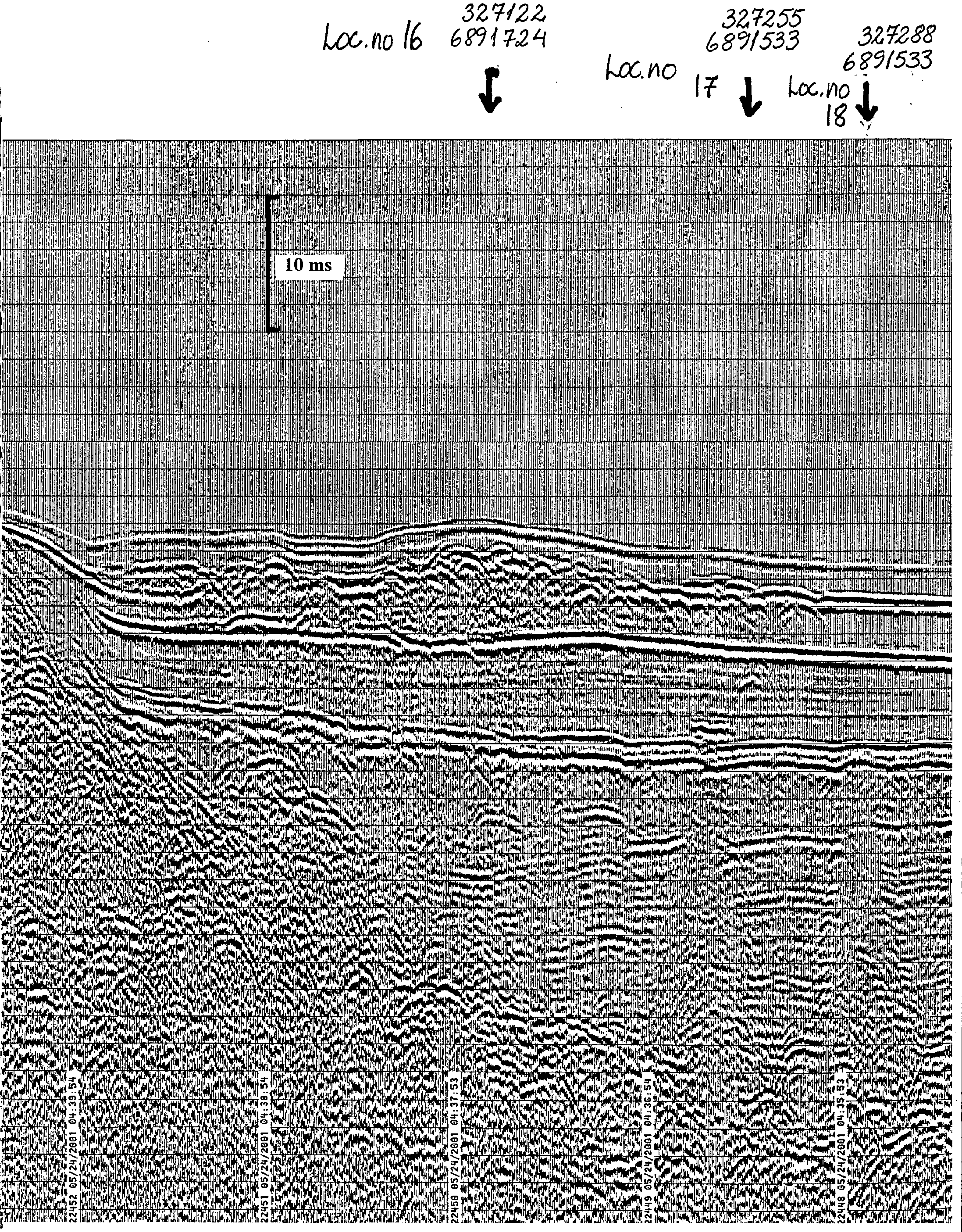
Loc. no 13
307231
6868546

Loc. no 14
307449
6868559




Vanylvsfjord
Loc. no 15
12.5 ms
8 312219 6892371
10 312461 6892161
12 312642 6891900
14 312719 6891597
16 312686 6891294

Syvdsfjord (1)

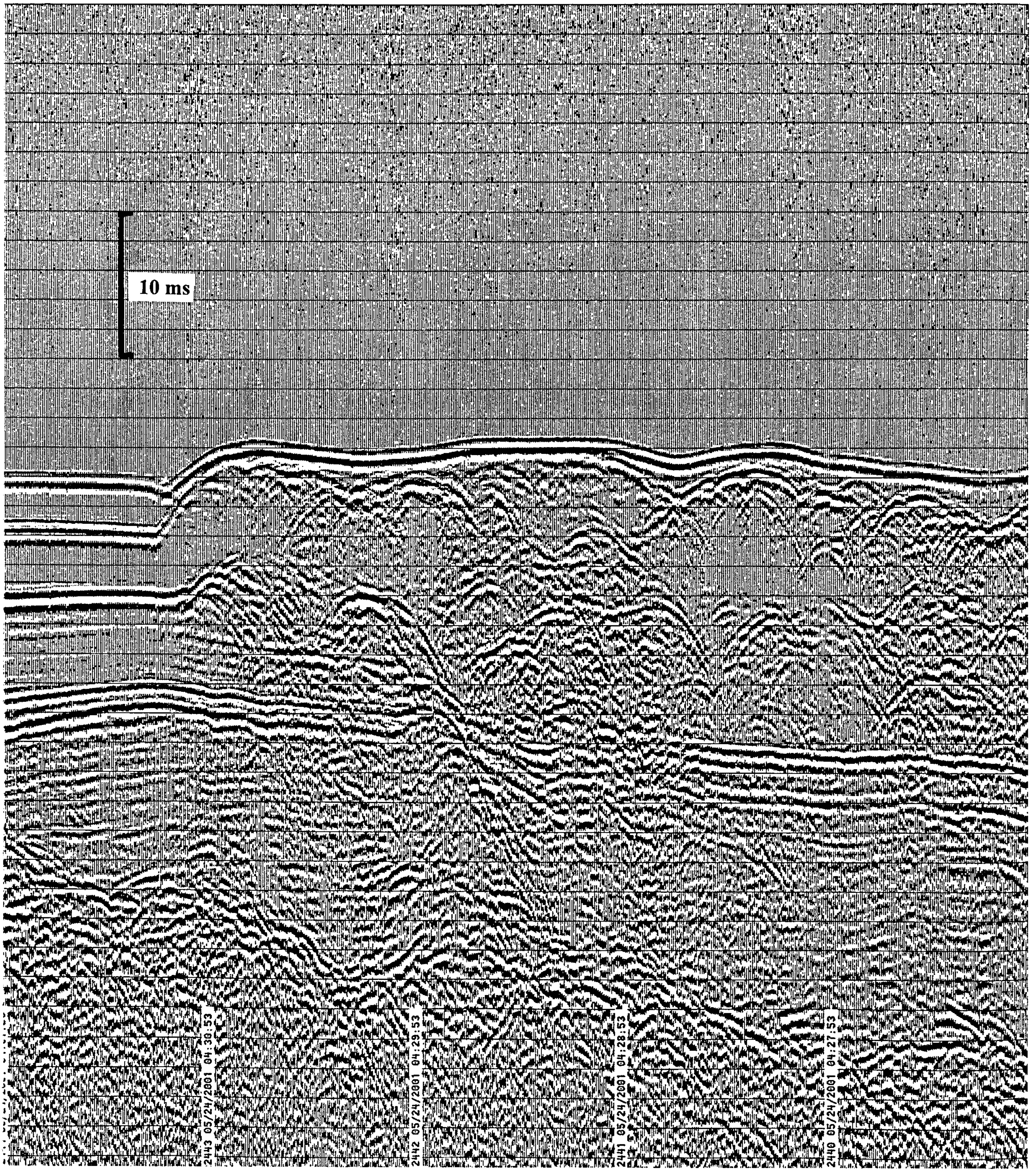


Syvdsfjord (2)

Loc.no 19

327751
6890980

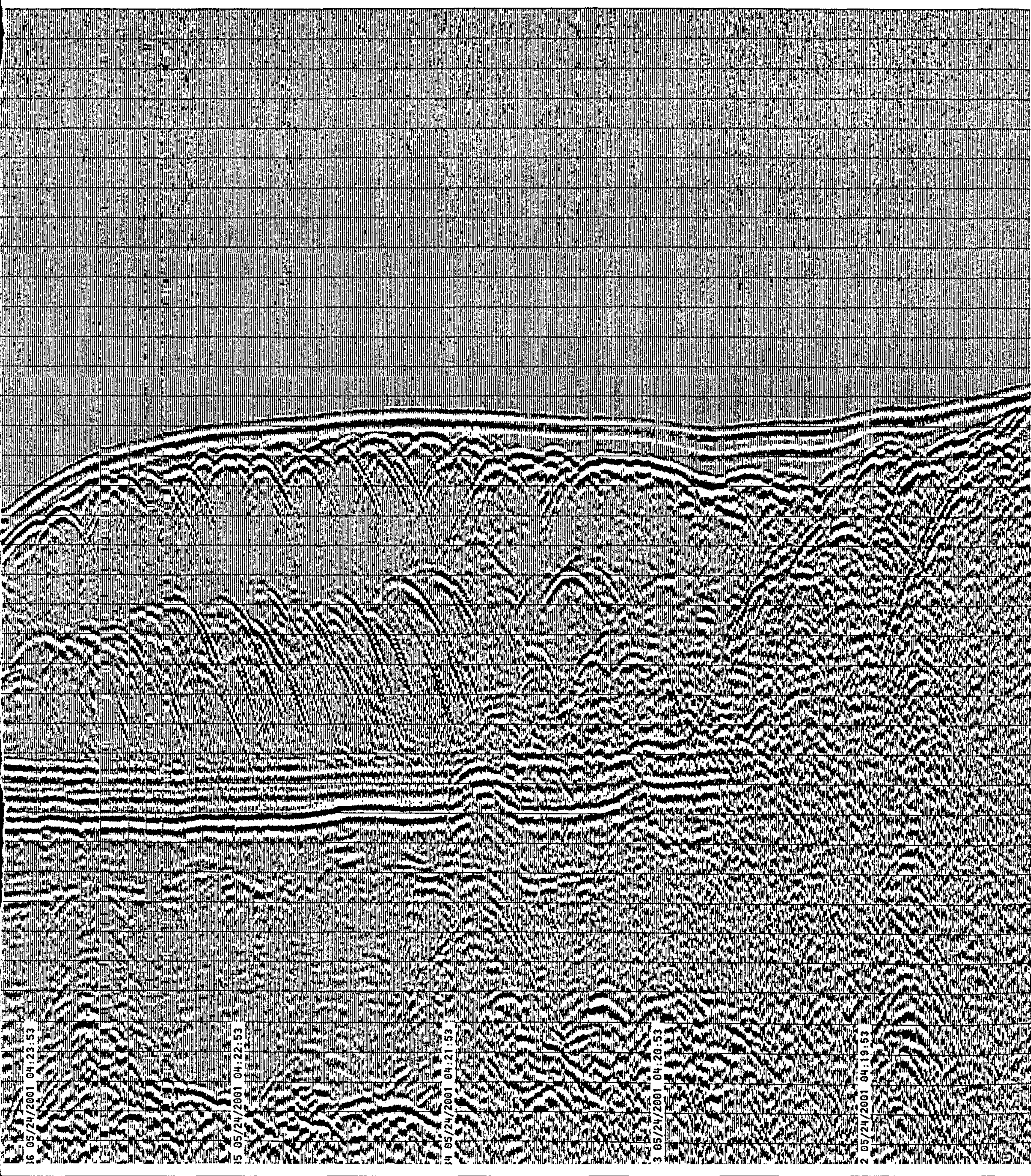
↓



sparker

Syvdsfjord (3)

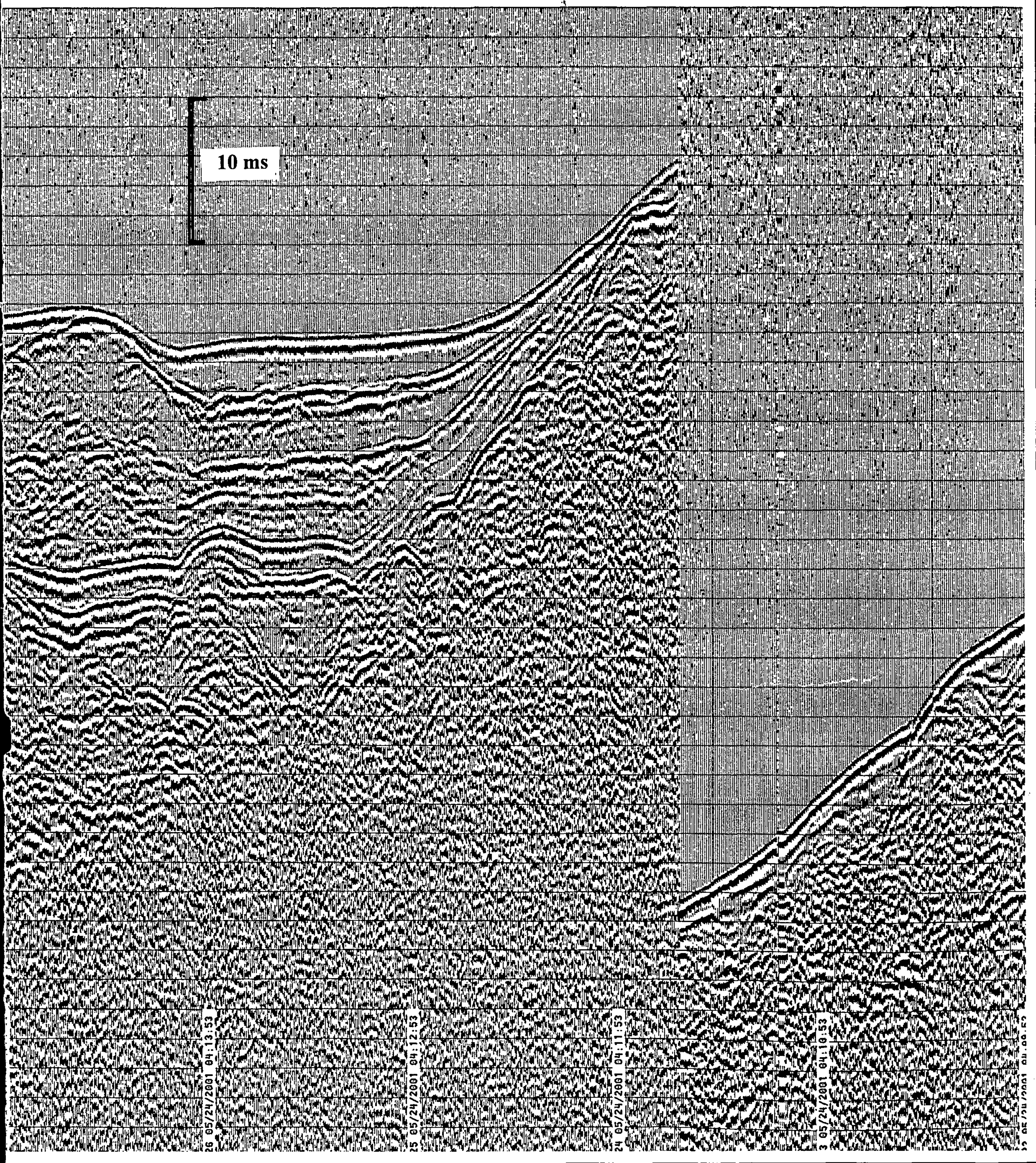
Loc. no 20
328370
6890255

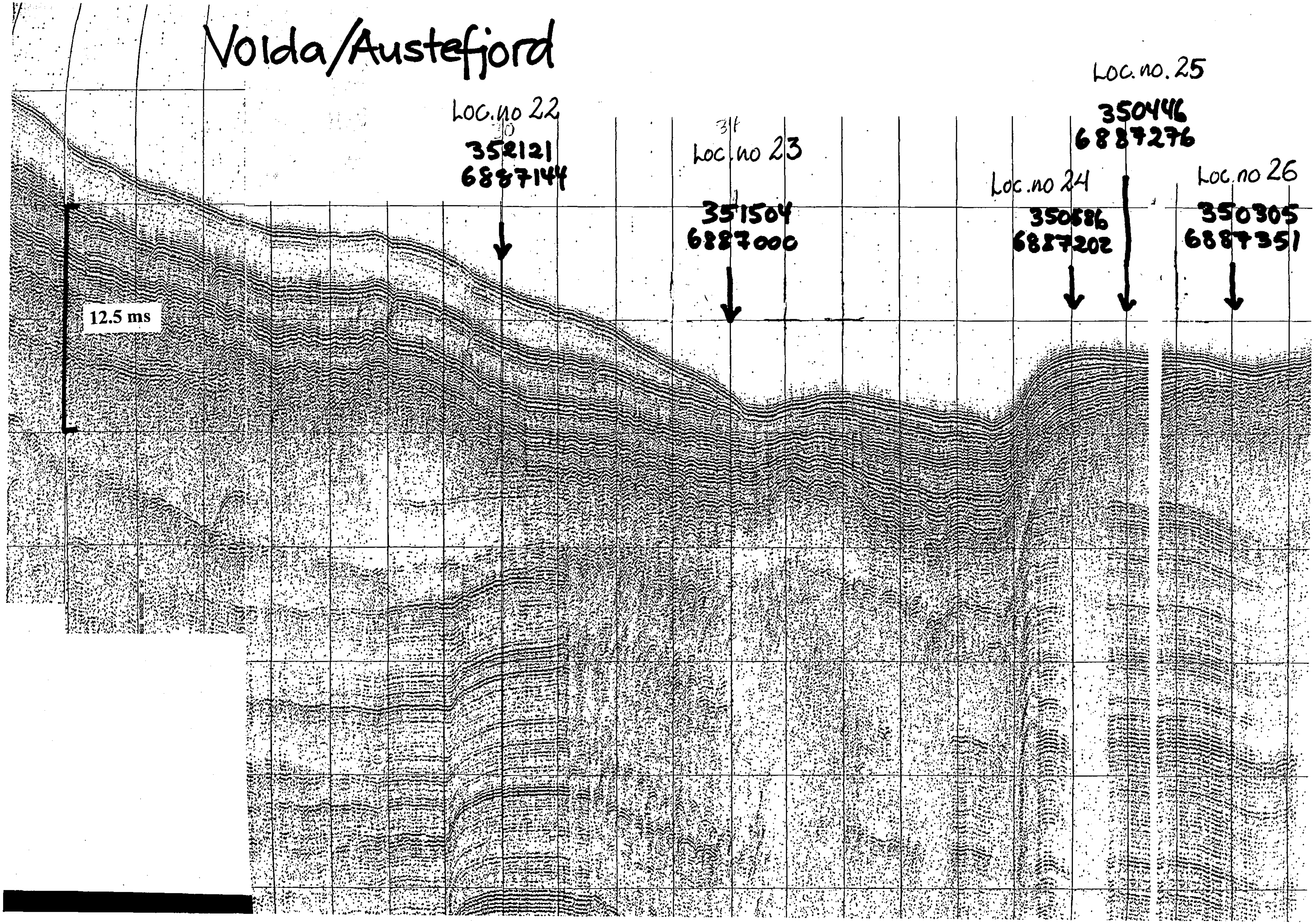


Syvdsfjord (4)

Loc.no21

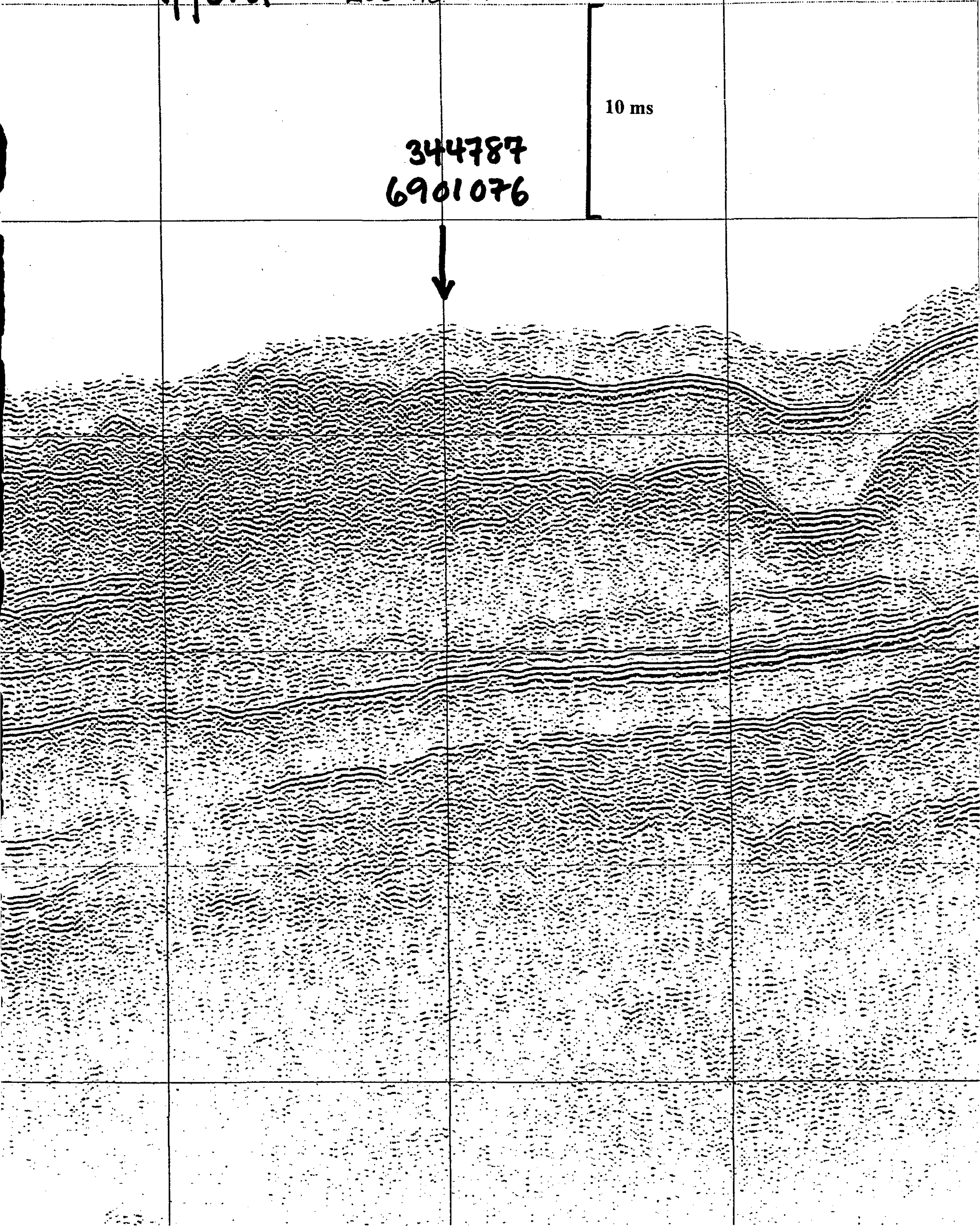
329150
6889348

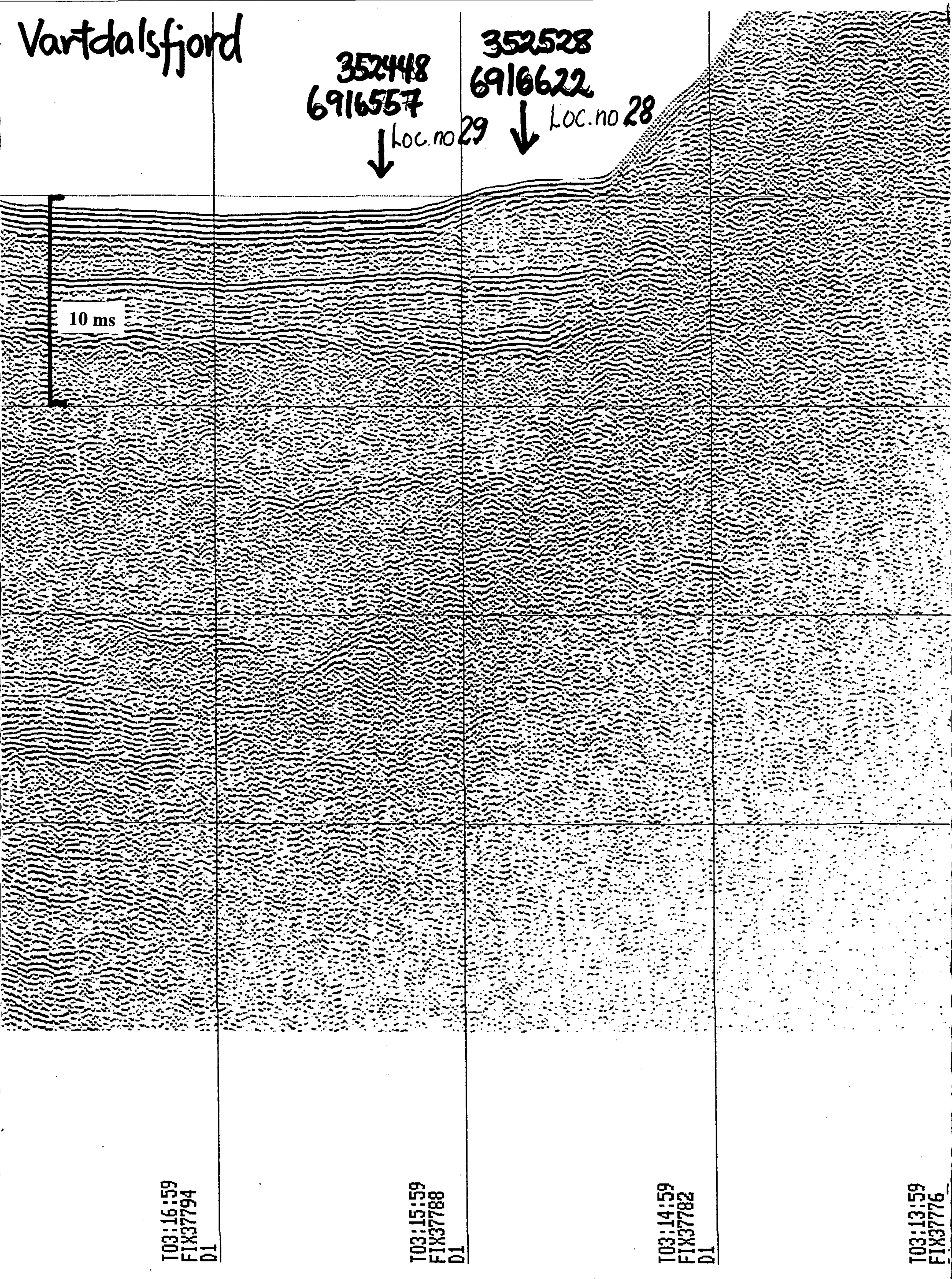


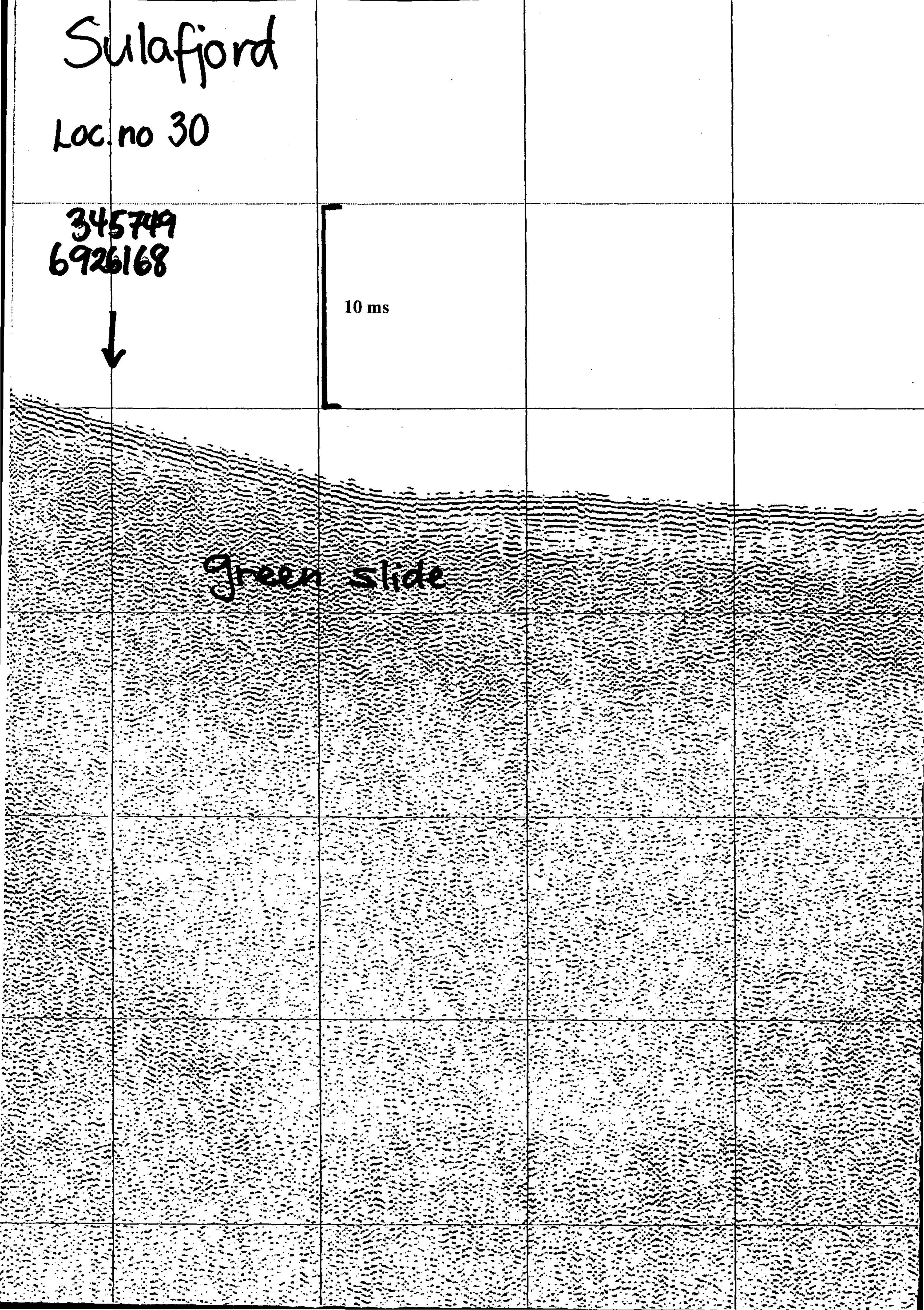

Volda/Austefjord
Loc.no 22
352121
6887144
Loc.no 23
351504
6887000
Loc.no 24
350686
6887202
Loc.no. 25
350446
6887276
Loc.no 26
350305
6887351
12.5 ms

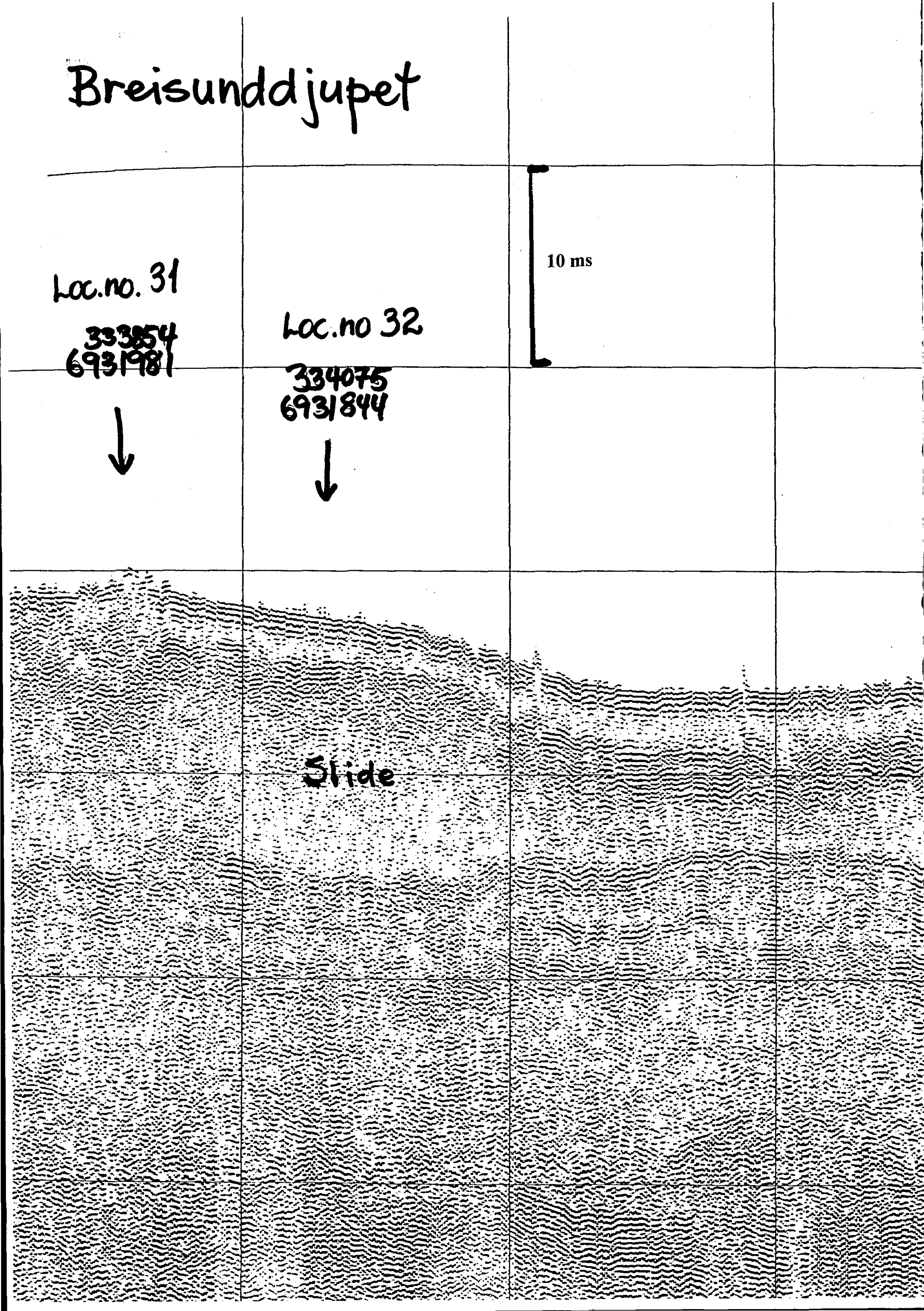
39852

Ørstafjord Loc. no 27

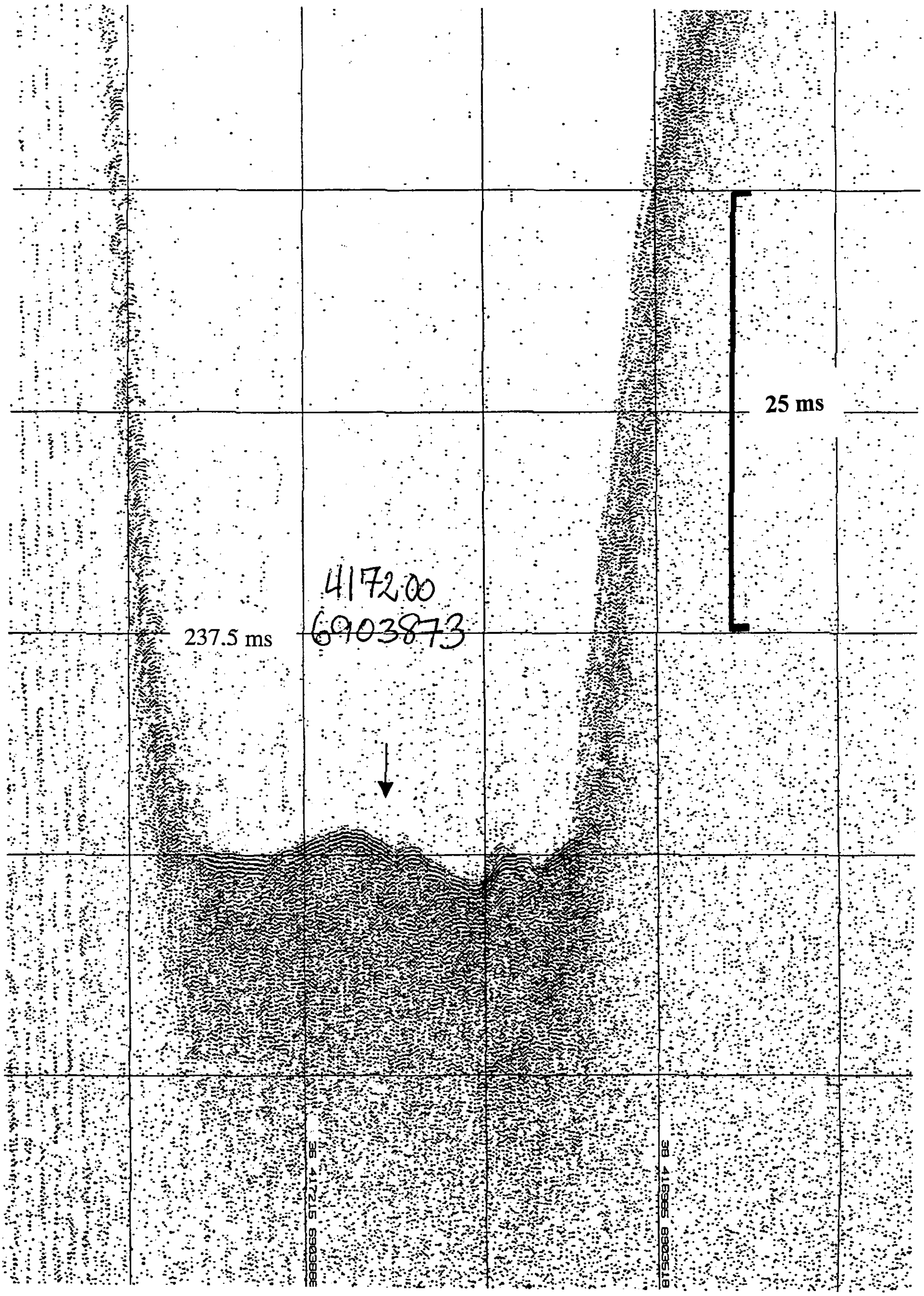



Vartdalsfjord
352448
6916557
Loc.no 29
352528
6916622
Loc.no 28
10 ms
T03:16:59
FIX37794
D1
T03:15:59
FIX37788
D1
T03:14:59
FIX37782
D1
T03:13:59
FIX37776

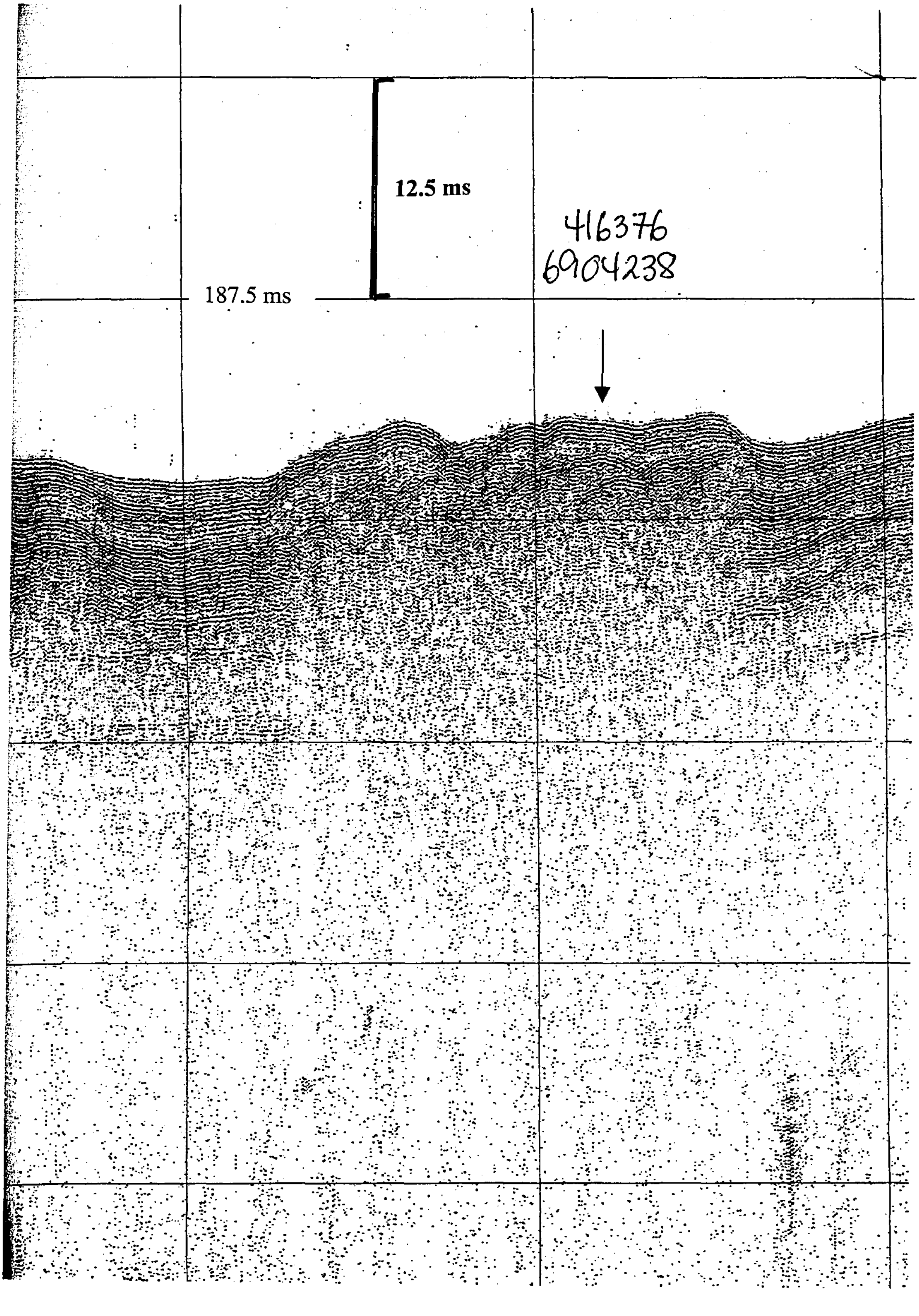

Sulafjord
Loc. no 30
345749
6926168
10 ms
green slide



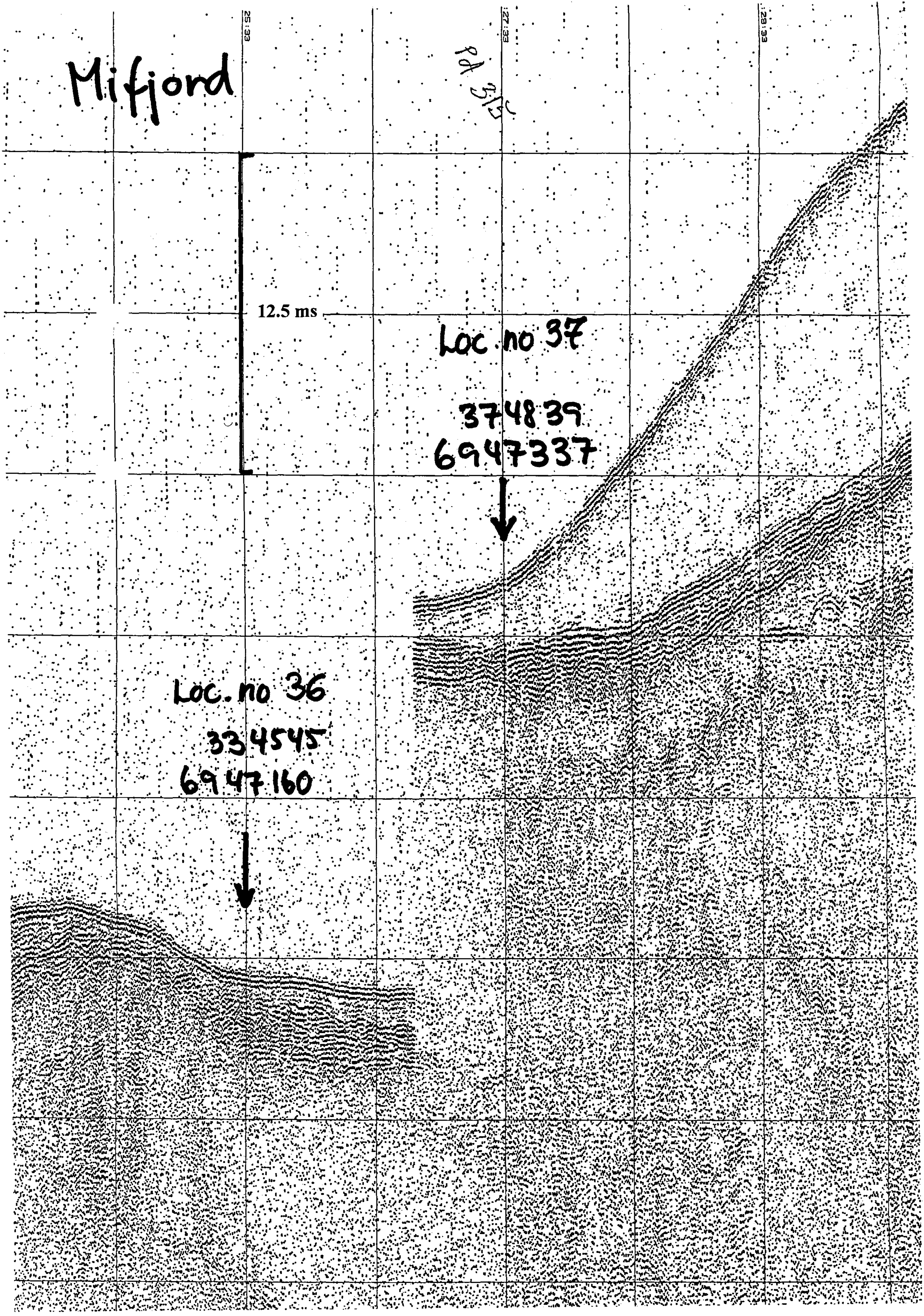
Breisunddjupet
10 ms
Loc.no. 31
333854
6931981
Loc.no 32
334075
6931844
Slide



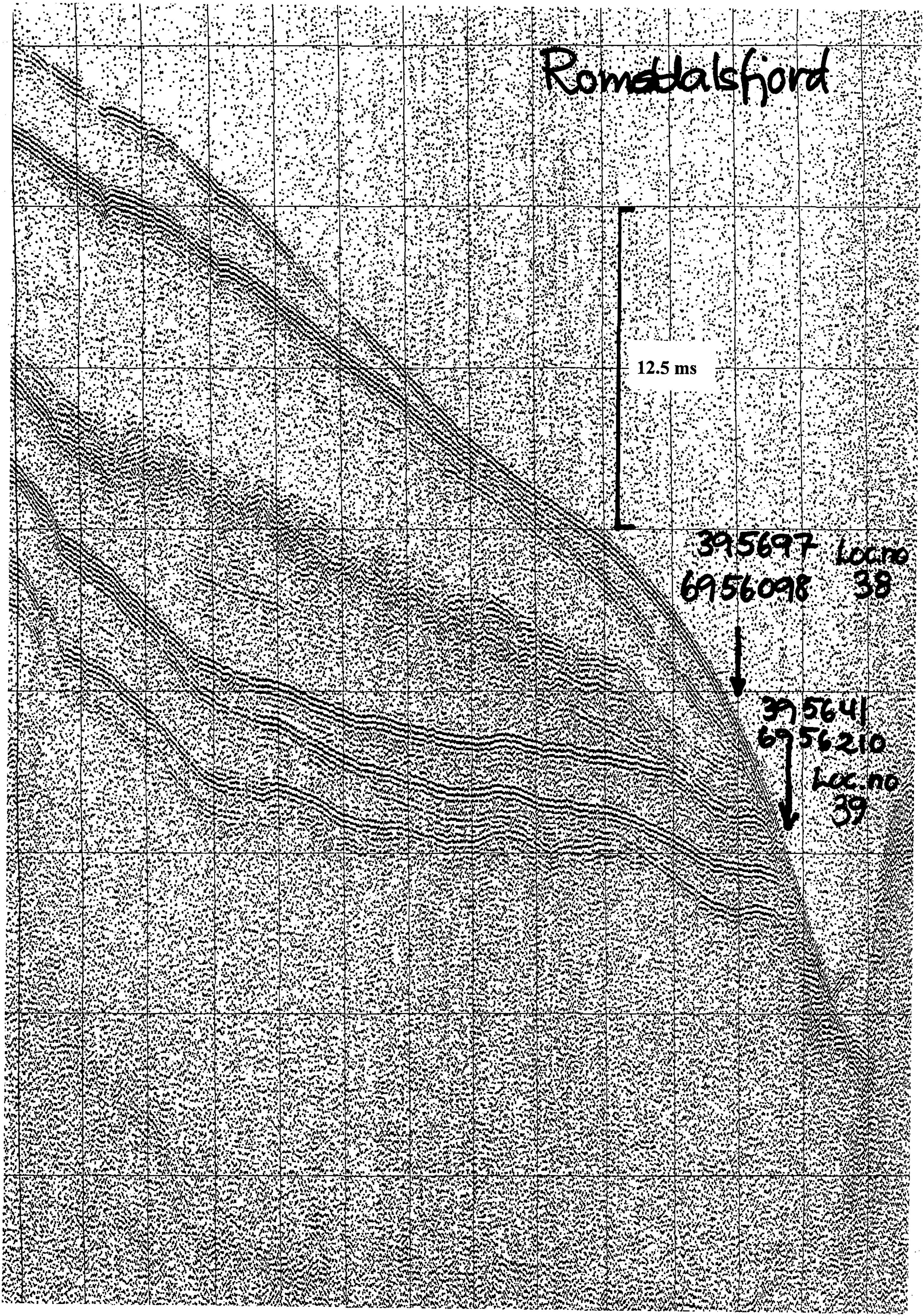
Tafjord
Loc. no 34



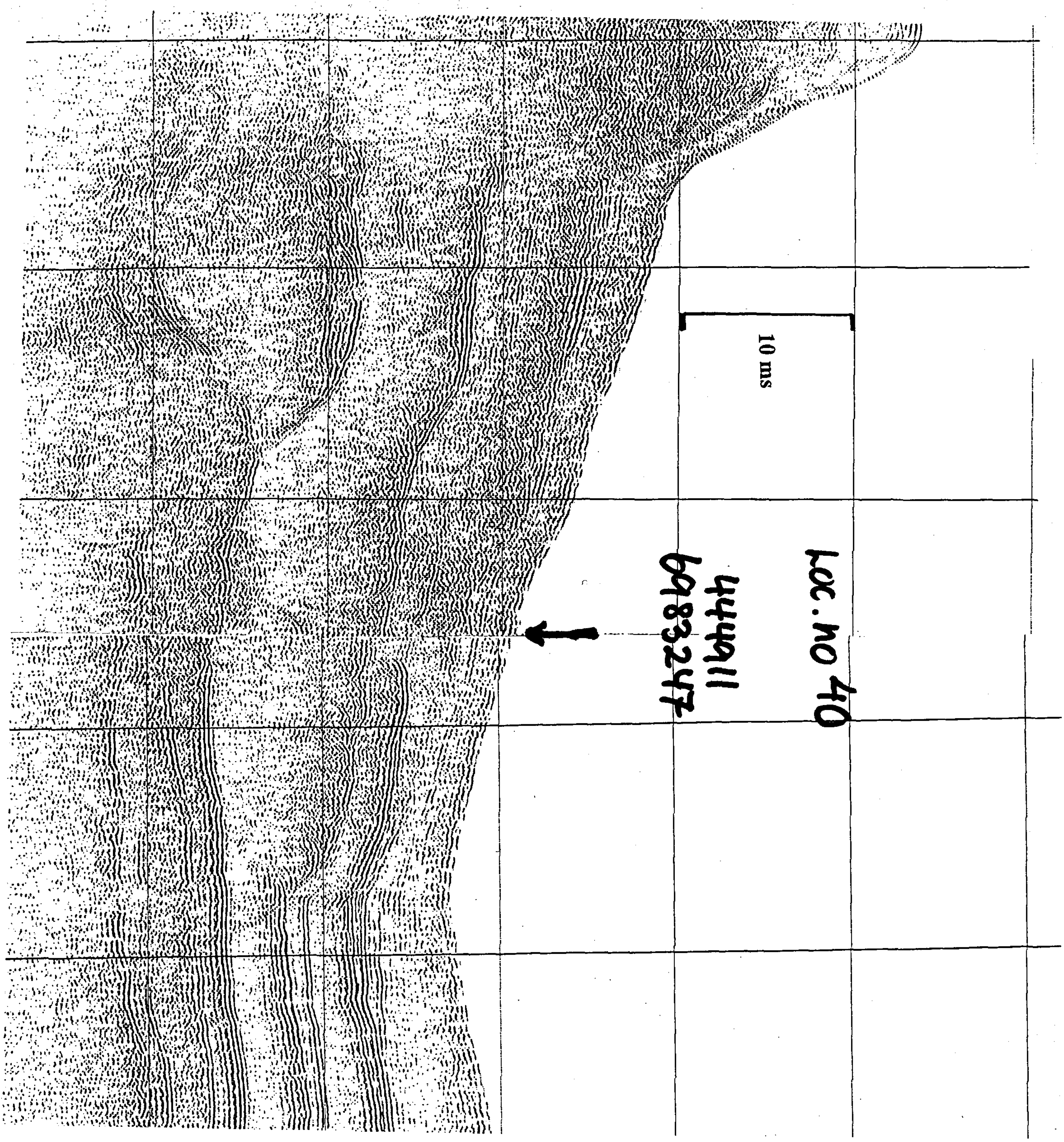
Tafjord
Loc. no 35

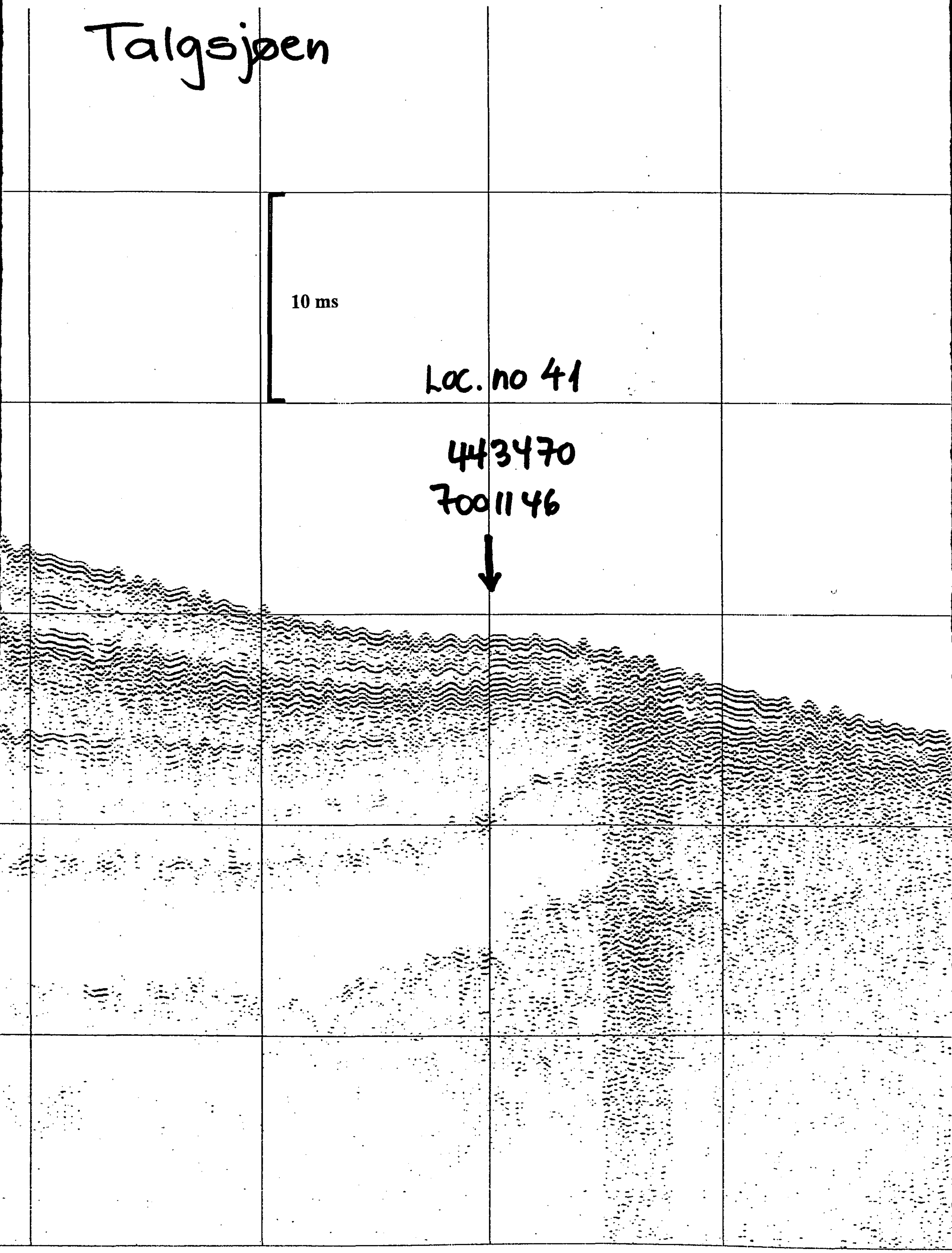


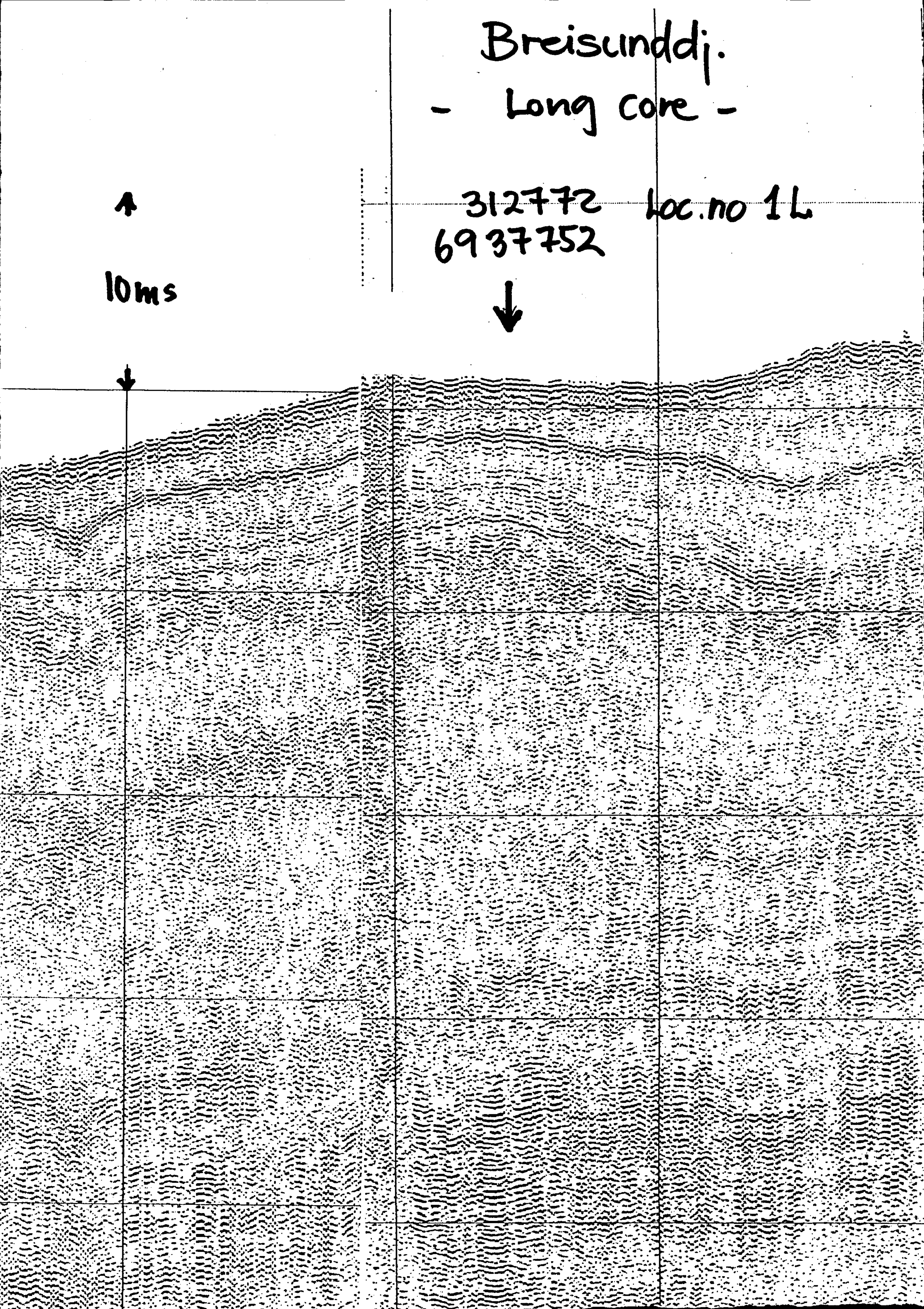
Mifjord
25:33
27:33
28:33
12.5 ms
Loc. no 37
374839
6947337
Loc. no 36
334545
6947160

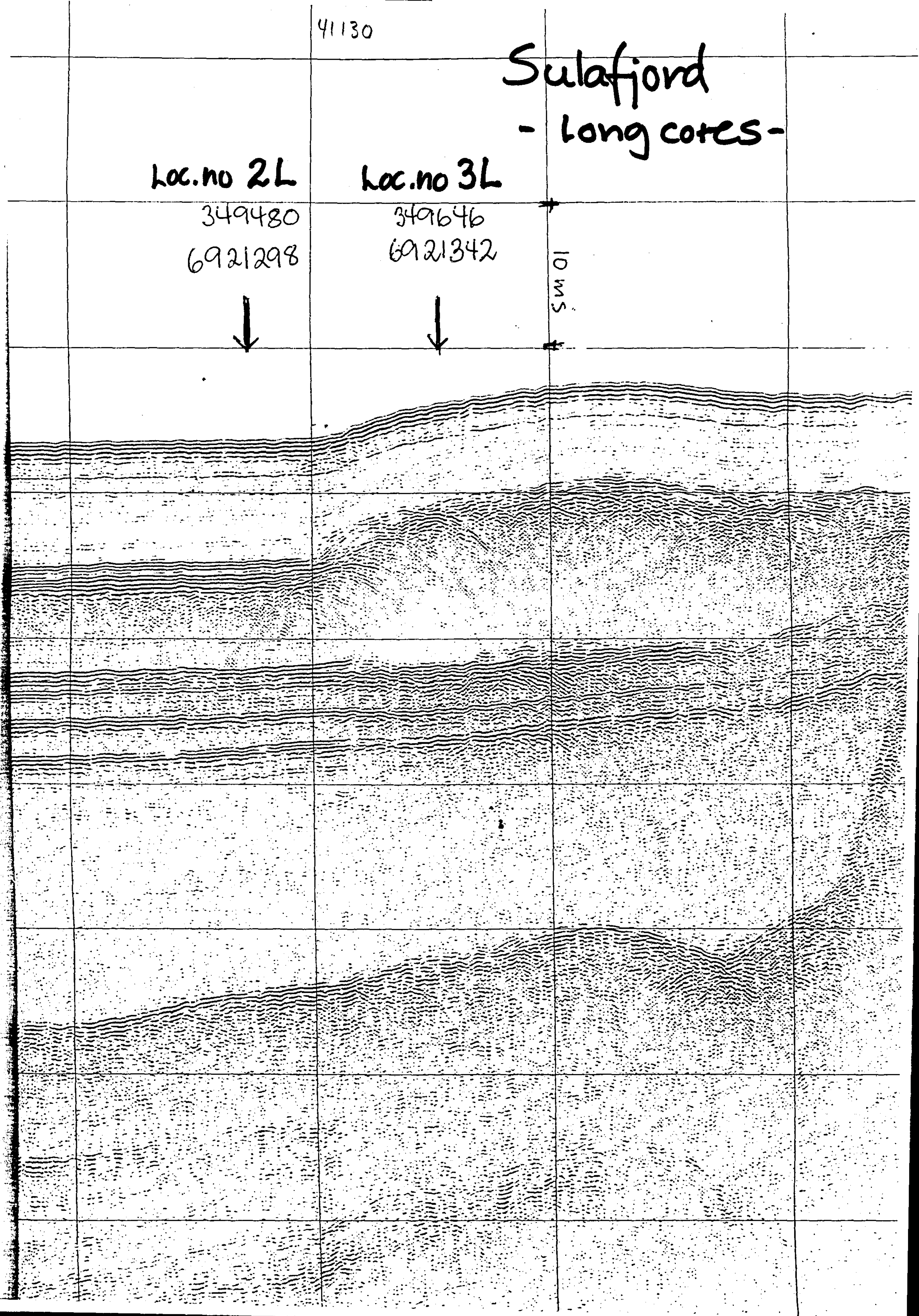

Romsdalsfjord
12.5 ms
395697
6956098
Loc.no
38
395641
6956210
Loc.no
39

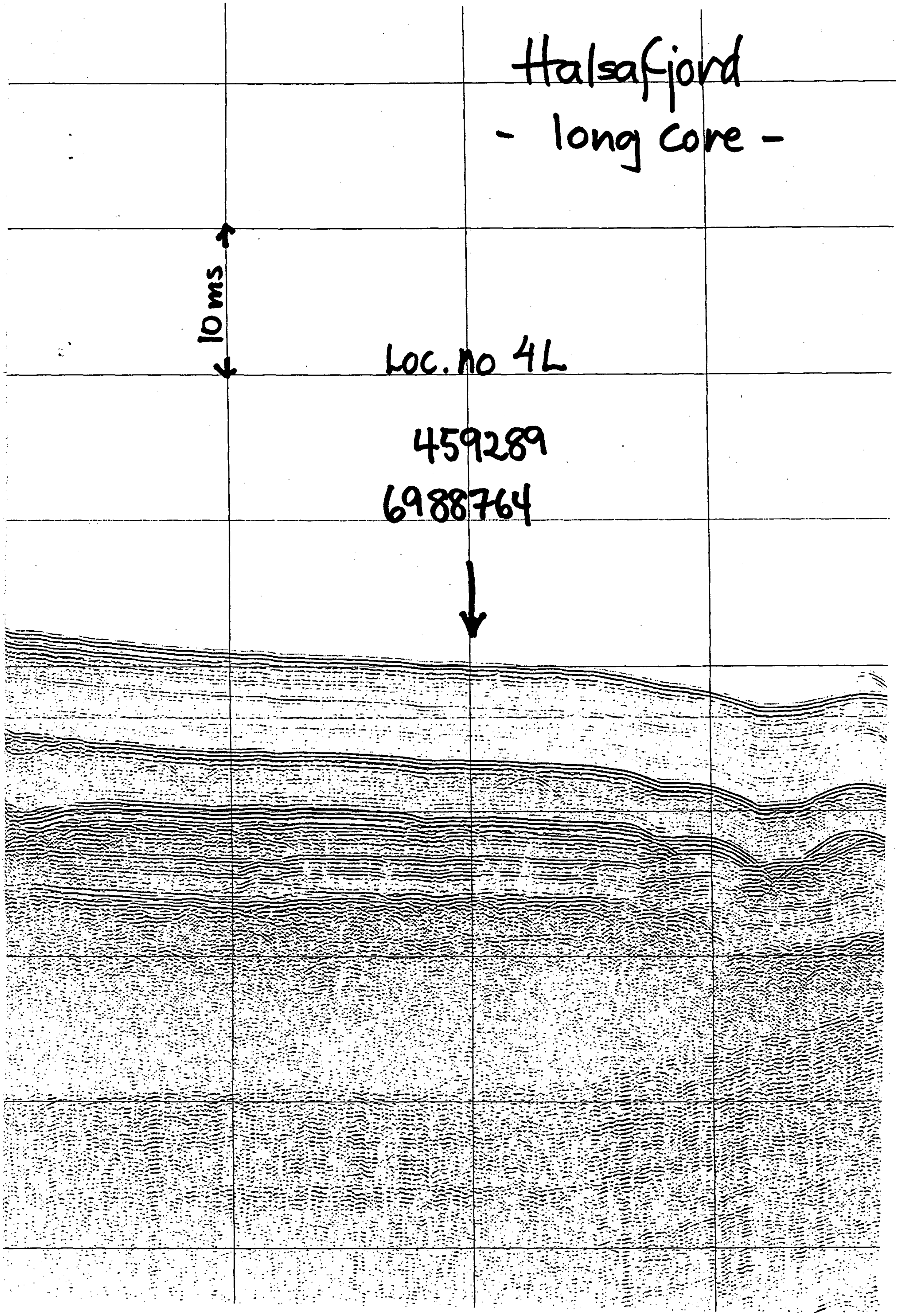
Tingvoll fjord




Talgsjøen
10 ms
Loc. no 41
443470
7001146


Breisunddj.
- Long core -
312772 Loc.no 1L
6937752
10ms


41130
Sulafjord
- Long cores -
Loc.no 2L
349480
6921298
Loc.no 3L
349646
6921342
10 ms


Halsafjord
- long core -
10 ms
Loc. no 4L
459289
6988764