Appendix A: Daily Summary Reports with seismic examples

7th June, Day 1 of cruise

R/V Arni Fridriksson departed the quay at HAFRO at 17:00 hours. David Odinsson, HAFRO technician, sailed with us to Keflavik to test the Topas and multibeam equipment and help adjust the settings. On the test cruise it turned out that the EM302 was not responding and the error source was not identified during the 2 hour test cruise between HAFRO and Keflavik.

Sailed from a position offshore Keflavik at 19:00 in direction WSW to start on the western transect as the weather condition were looking more amenable to the west of Iceland. Initially, the intention was to look for good coring positions within the level parts of the three-step topography along a WSW profile (Fig. x.3).

8th June, Day 2 of cruise

At ~00:30 we passed the flank of the glacial trough on the outer shelf (Fig. 1). The deepest part of the trough was considered a potential coring site although in the end was not prioritized. Here, the Topas recorded 3 units above a distinct unconformity displaying and even-hummocky character, presumably related to glacial erosion (Fig. A1). Topmost is a relatively transparent unit with a strong surface expression and weak internal reflections in the basal part (thickness <7 ms) that drapes over a unit with higher reflection strength and of more variable thickness due to infilling of the underlying topography. The lowermost unit displays an irregular topography and is often capped by strong reflections that are truncated by the relief. The succession is interpreted as a silty-sandy unit, possibly representing post-glacial transgression, overlying pro-glacial to sub-glacial deposits. In the deepest part of the shelf trough (>300 m) the seabed reflection was affected by noise interference that was encountered everytime the ping rate was a multiplum of water depth. This was overcome by changing the ping rate which would move the level of noise away from the sub-seabed interval (either up or down depending on the change in ping rate/water depth).

During the night we crossed the upper slope and proceeded across a gently sloping, rugged seabed relief situated between the shelf margin and a major escarpment forming part of the Reykjanes Ridge (Fig. 4 and 5). The seabed unit displays a hummocky topography with a transparent to weakly stratified acoustic facies, often eroded at seabed (Fig. A2). The base of this unit is poorly defined but occasionally an irregular surface that can be recognized within the largely transparent section. The units are interpreted as mass-transport deposits, e.g. debris flows or slides, extending from the upper slope.

In the central parts of this gently sloping section, asymmetric mounded to lenticular depositional features were encountered (Fig. A2). The mounded features are stratified with sub-units discernable by discordant reflection patterns and appear to accumulate below small escarpments, likely representing the edge of debris flow lobes. These seismic characters are indicative of contourite drifts formed locally by the interaction between bottom currents and the rugged topography generated by downslope mass-transport (Knutz et al. 2002). Contourites tend to provide good paleoceanographic records so despite the limited spatial extent of these sedimentary features it was decided to core at this location. After a detailed site survey two sites were cored within a distance of a few 100 meters (Station 1a and 1b). Both coring efforts gave limited sediment penetration (>1m) presumably related to compact sediments formed along an internal discontinuity within the top few meters.

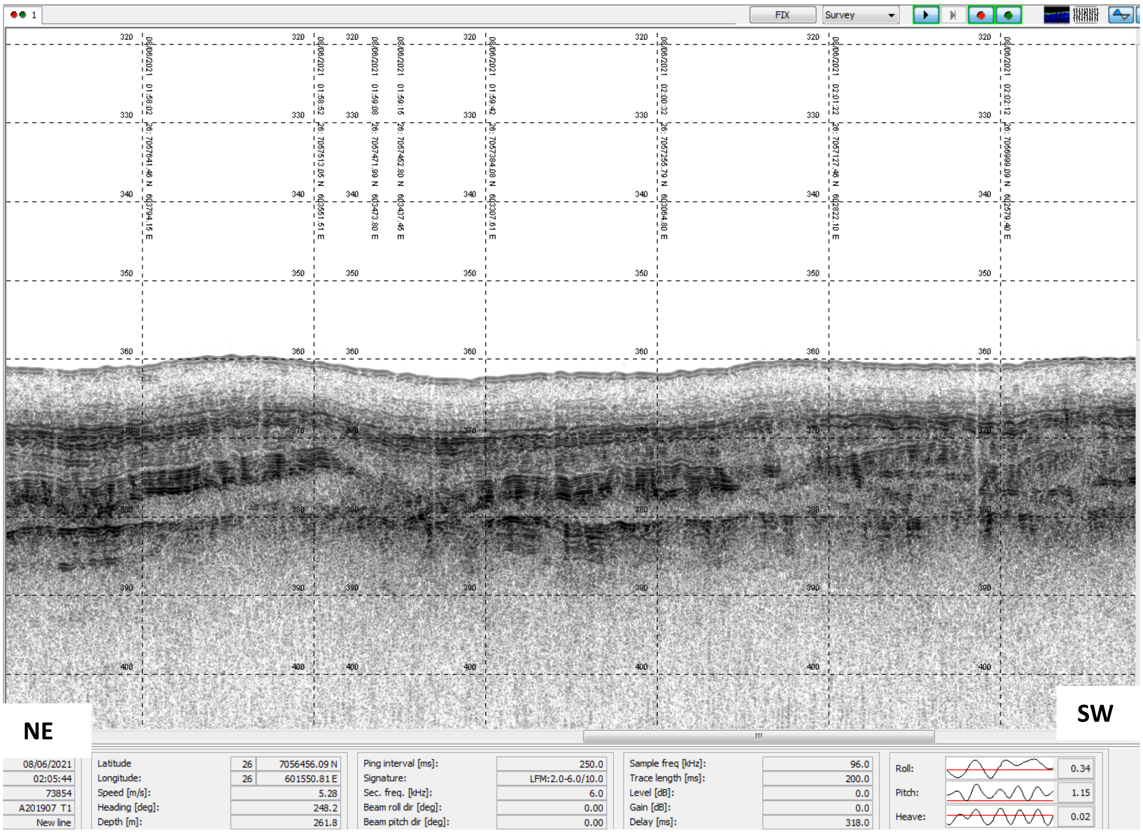

Fig. A1. Topas SBP section from the glacial trough WSW of Reykjavik (270 mbsl). Distance between horizontal grid marks is ~250 m.

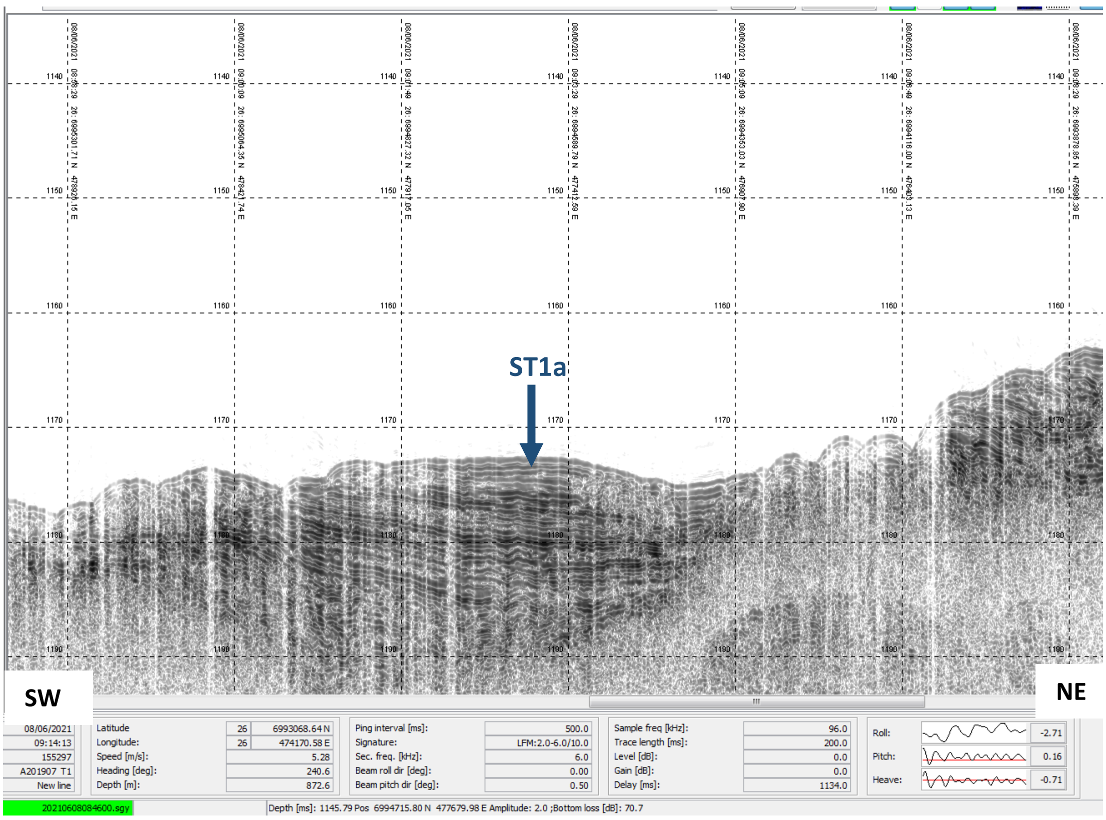

Fig. A2. Horizontal scale in ms twt. Vertical scale: The horizontal grid marks are spaced ~440 m. The lenticular sediment wedges with strong internal reflections are interpreted as contourites.

After the ST 1 coring attempts it was decided to locate a new location in deeper waters of the intra-ridge basin that could be cored in the early evening. To shorten the sail time the transect was modified to transverse the lower ridge escarpment at an angle. (Fig. 5). The modern depositional environment below the escarpment was strongly influenced by mass-transport deposits (MTD) marked by transparent to vaguely stratified sedimentary wedges (Fig. A3). Below the MTD’s a stratified sedimentary section was visible to the acoustic depth limit (45-50 ms). In western part of the intra-ridge basin, the mass-transport units thin out, leaving a well-stratified section below seabed with strong reflections in the top part (Fig. A3).

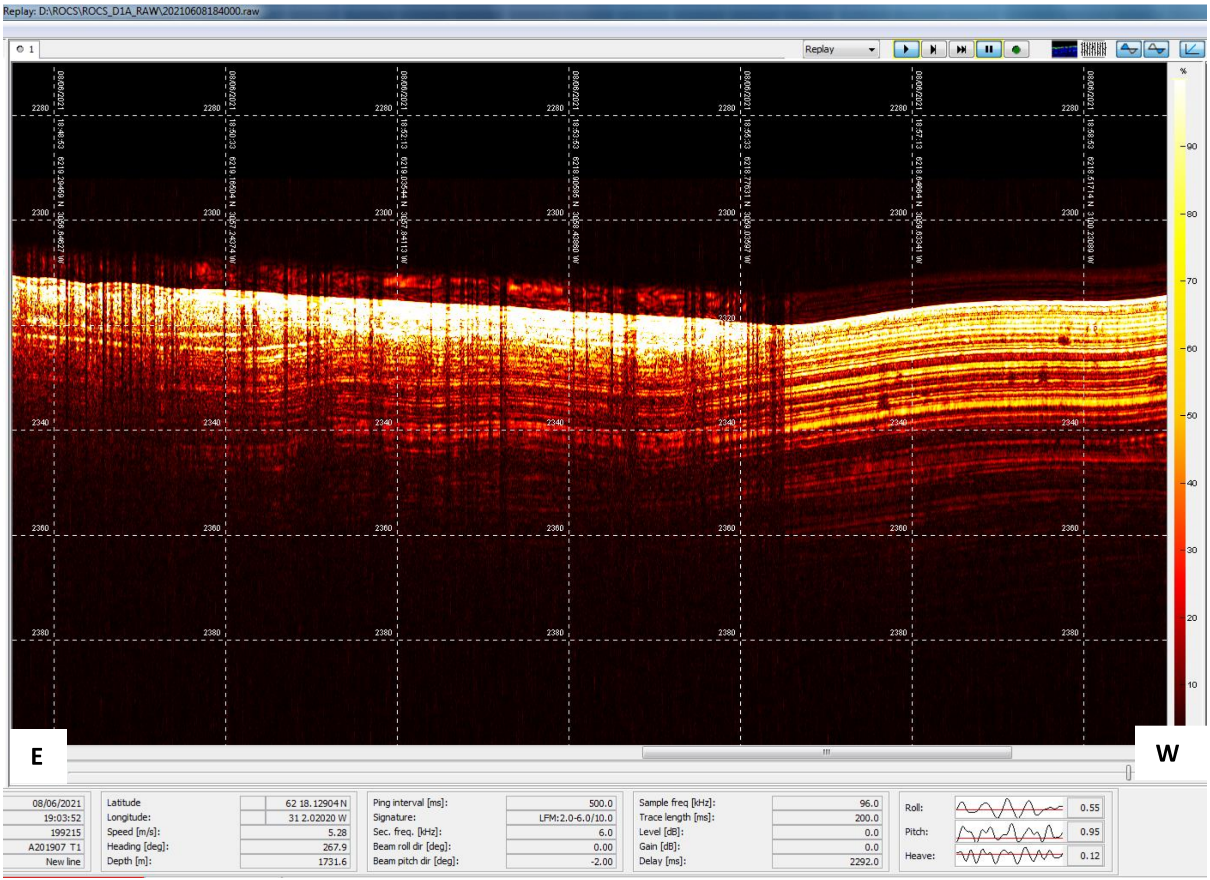

Fig. A3. Debris flow lobes thinning out over a stratified sequence within the intra-ridge basin.

Reaching the western limit of the intra-ridge basin, a sedimentary section was encountered displaying lenticular layering within a mounded geometry, typical of contourites (Fig. A4). Gravity coring was attempted but provided <1 m of sediment (ST 2). A sample taken from the core catcher showed a compact muddy character, presumably related to the high reflectivity in the top part.

After Station 2 a NW course was taken encountering stratified sediment mounds and basin infills covering the basement relief of volcanic ridges and rifts (Fig. A5).

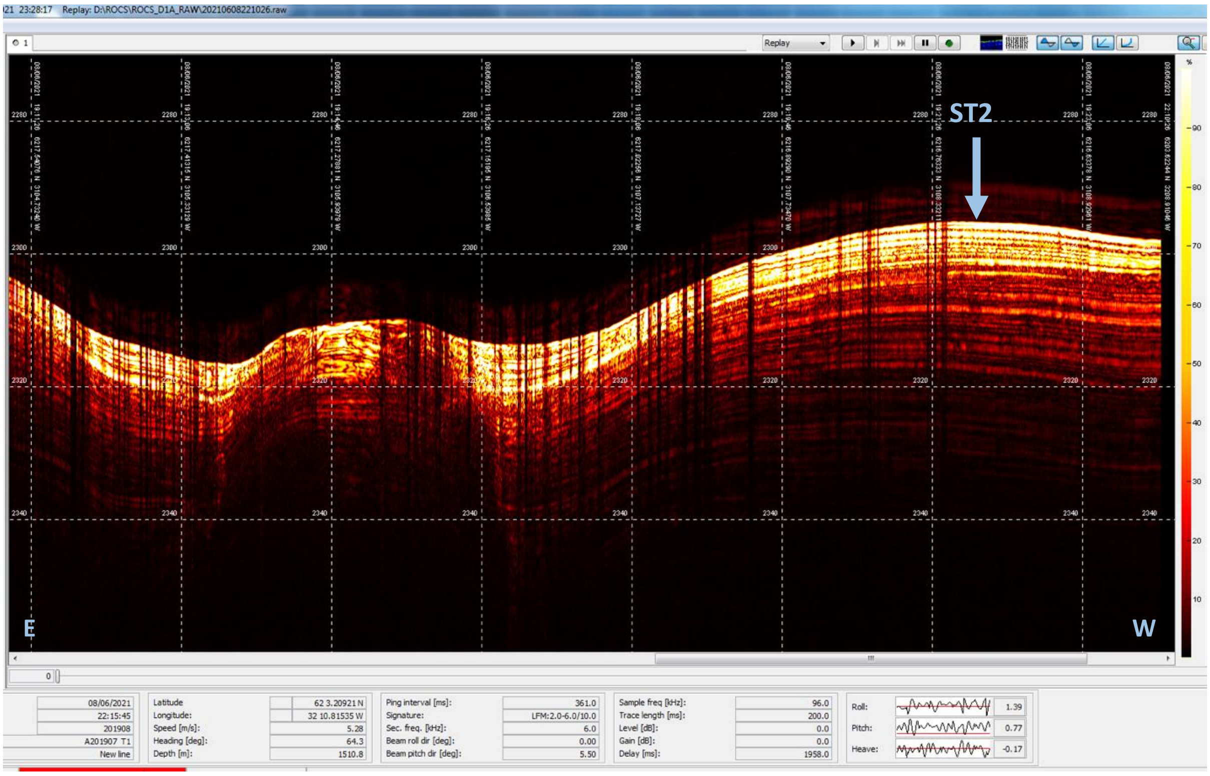

Fig. A4. Lenticular reflection patterns developed within mounded sedimentary geometries located in the western part of the intra-ridge basin (Fig. 4). Station 2 coring site is indicated. Note the bright reflections in topmost unit.

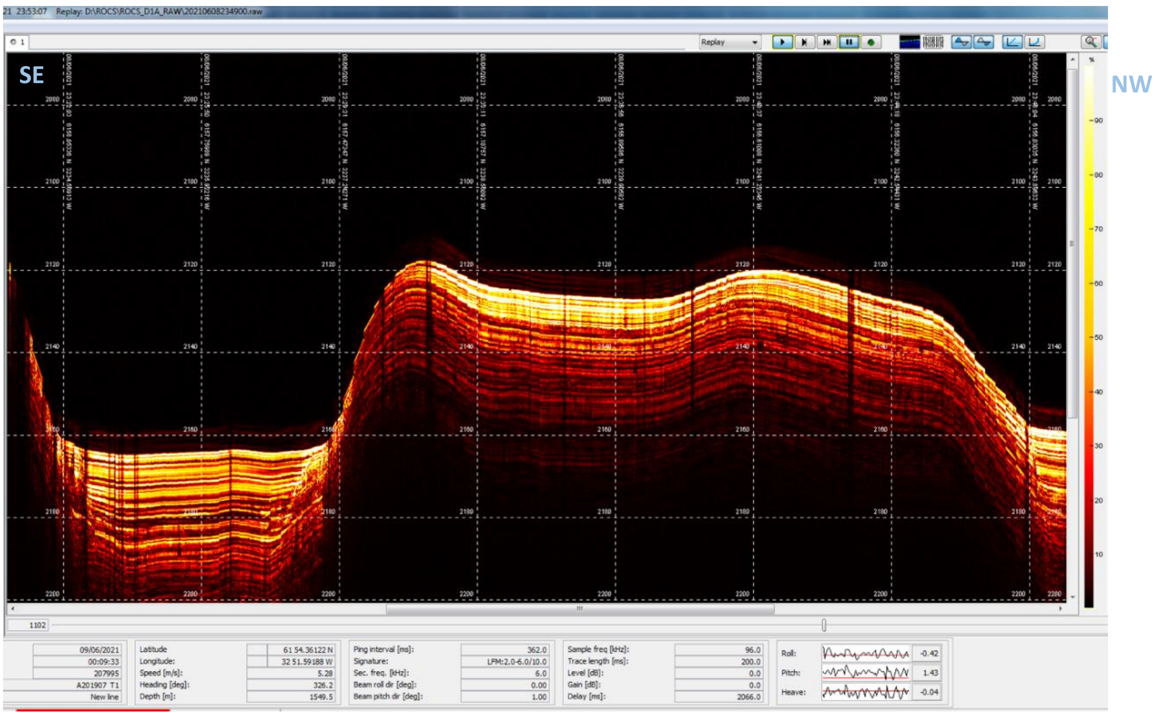

Figure A5. Thick stratified deposits covering the accentuated volcanic relief in the form of topographic highs and basins NW of ST 2.

9th June, Day 3 of cruise

Continuing along the NW transect core site SU9029 was crossed around 02:30 (Fig. A6). In the vicinity a suitable coring site (ST 3) was identified within a stratified depression. In the early hours we reached the eastern limit of Denmark Strait (south of Dorhn Bank) and proceeded in a more northerly direction toward Dohrn Bank where we crossed a small basin with stratified sediments draped along the bottom and flank. A coring locality was identified (ST8 & 10; Fig. A16) but the sea state was unsuitable for coring so instead a small site survey was carried out across the lower slope. Subsequently, it was discovered that the Topas SBP had been registering navigation incorrectly (UTM command line was missing) since we crossed the intra-ridge basin on the previous day. This was corrected and we then proceeded to sail back along the transect to reach ST 3 in the afternoon. After acquiring a Topas profile (this time with correct navigation), a full gravity core was recovered at 13:45 at a water depth of 1606 m (Fig. A6). The afternoon was spent obtaining a detailed site survey with the aim of further coring down-flank from ST 3.

To avoid a cyclone system moving into the region west of Iceland it was decided to head for the transects south of the Reykjanes Ridge, and then return to core at a later stage. We left the area in the evening and proceeded eastward along the transect in a large zig-zag pattern to cover new ground.

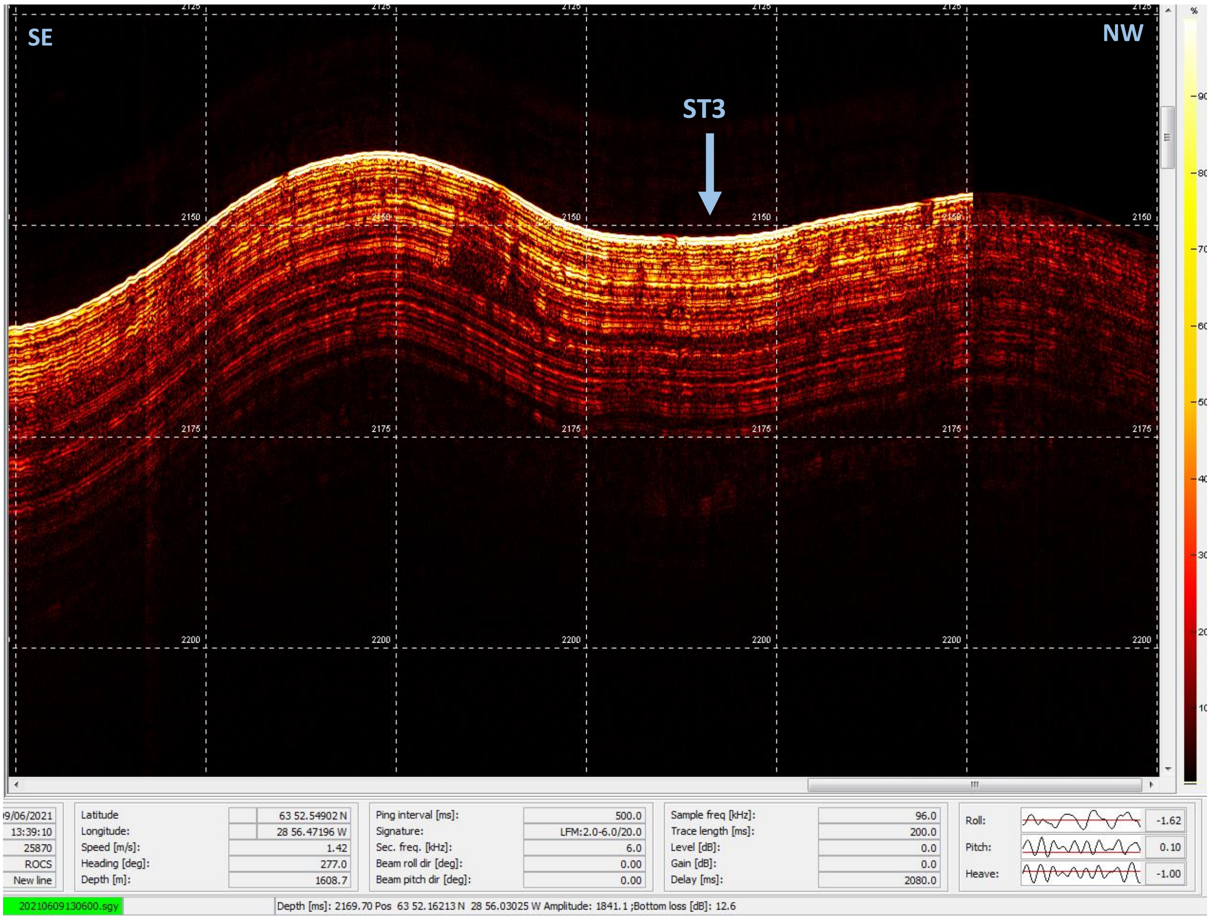

Fig. A6. Sub-bottom sedimentary sequence of continuous parallel reflections draped over a topographic high in vicinity of SU-9029. Position of ST3-GC shown.

10[th] June, Day 4 of cruise

At 03:20 we crossed Station 2 from a N-S angle gaining more sub-bottom information on the contourite drift system in the intra-ridge basin. During the afternoon we crossed the apex of the Reykjanes Ridge and for weather reasons we decided to proceed eastward along the transect south of the Iceland margin. The first of a series of deep-sea canyons and associated channel systems was crossed in the early evening (Fig. A7). Traversing across the slope into the basin we crossed more incised canyons and sections disturbed by mass-transport processes in between highs and levee banks with well-layered stratigraphy (Fig. A8).

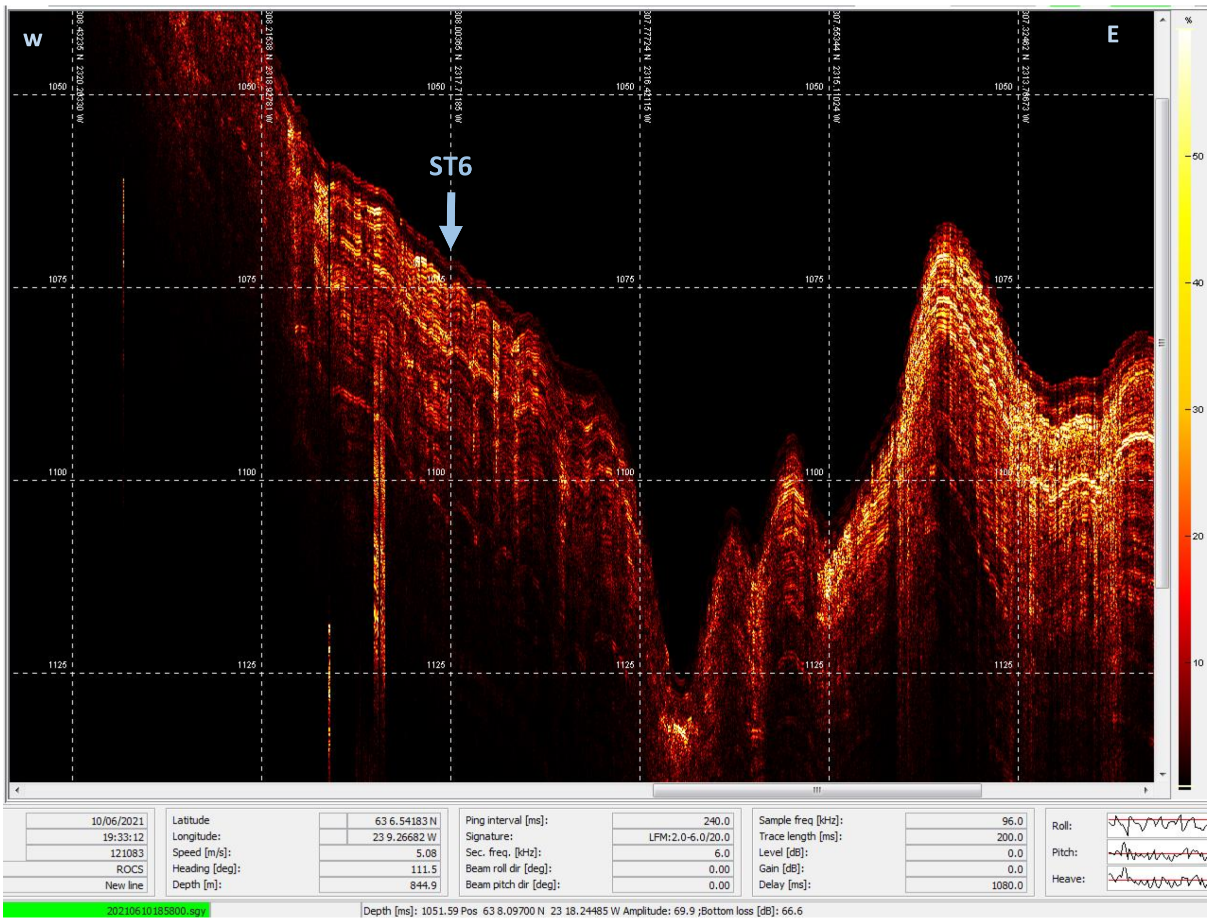

Fig. A7. A channel system on the slope south of Iceland, east of the Reykjanes Ridge. Note the contrasting appearance of the banks east and west of the channel. The sediment deposit to the left (east) displaying wavy horizons is interpreted as a levee build-up sustained by coriolis forcing of the downslope flow. Position of ST6-GC is shown.

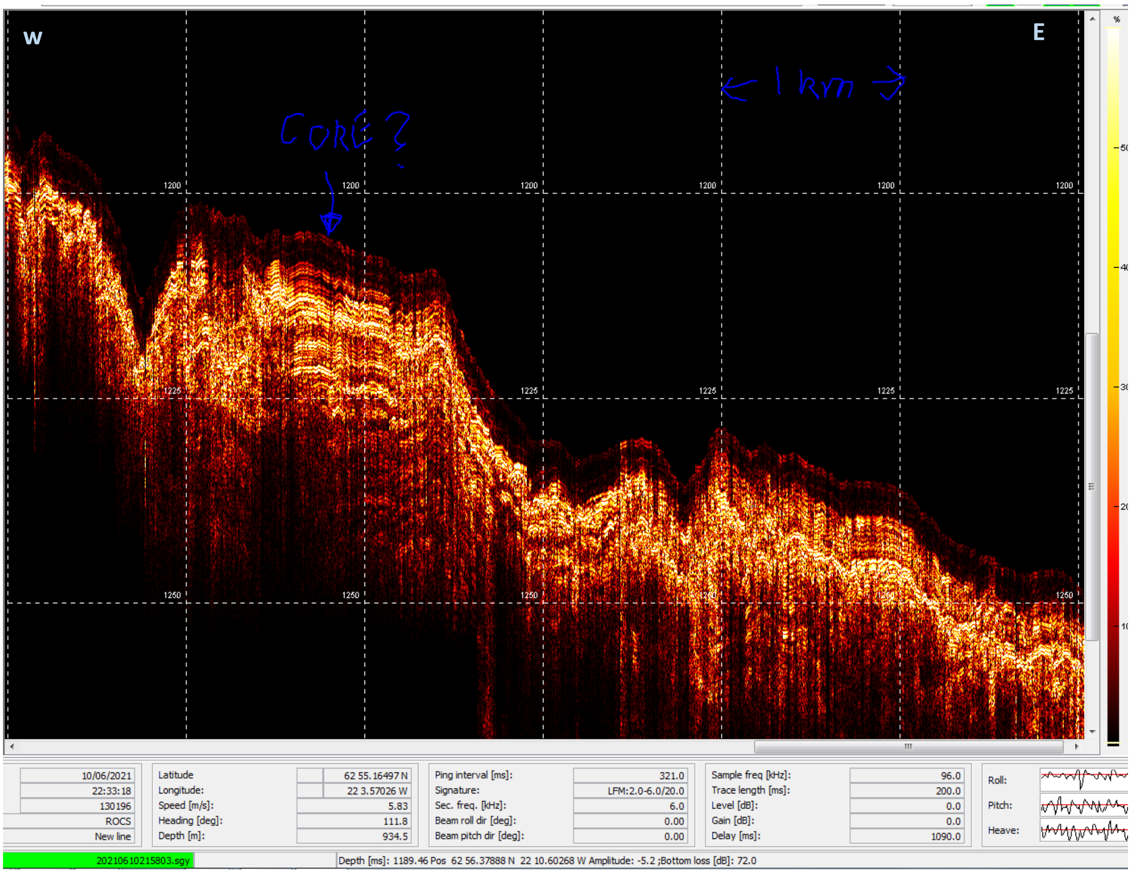

Fig. A8. Incised channels (v-shape) and levee deposits. The irregular and disrupted seismic horizons of the underlying deposits is presumably related to faulting and mass-wasting in an unstable slope regime. No core was taken.

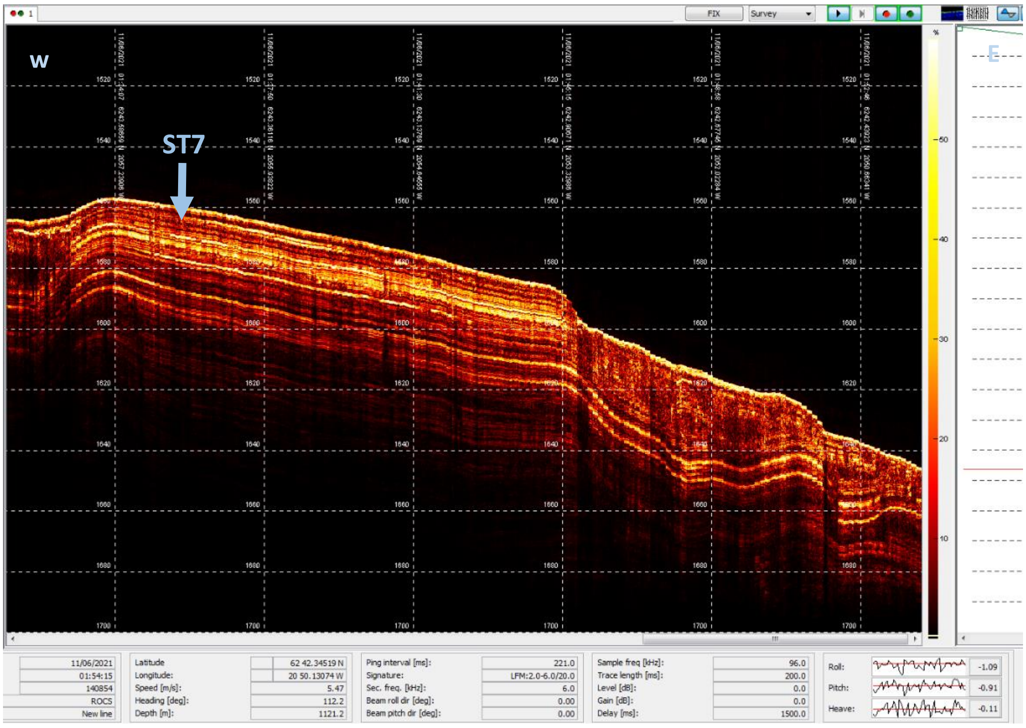

Fig. A9. A sedimentary mound with parallel reflectors and abrupt transition to disturbed deposits along its flank. This site was cored successfully on the return leg. Position of ST7-GC is shown.

11th June, Day 5 of cruise

Continuing along the eastern transect crossing the large (name) channel system. Stratified sedimentary deposits with high reflector continuity were encountered over channel flanks and intra-bank highs (Fig. A9). The channel low showed a well-layered to transparent cover suggesting a thick Holocene development with disturbed, hummocky units below (glacial?). During noon the course was changed to SW to cross the two channel/bank systems at a more distal position in deeper water masses. In the late afternoon we transected the distal part of a ridge-formed sedimentary bank separating the two main channel systems south of Iceland (Fig.4). A coring target was identified on the apex of the ridge displaying well-layered stratigraphy with “soft-looking” reflection amplitudes. At around 21:30 the site of DA-12 GC1 was crossed which according to the Topas image recovered a Holocene drape over a sedimentary wedge infilling the central channel (Fig. A10). During the evening we reverted on an eastward course to perform a coarse-grid site survey, initially recapturing the sedimentary ridge along a parallel sail line south of the ridge apex.

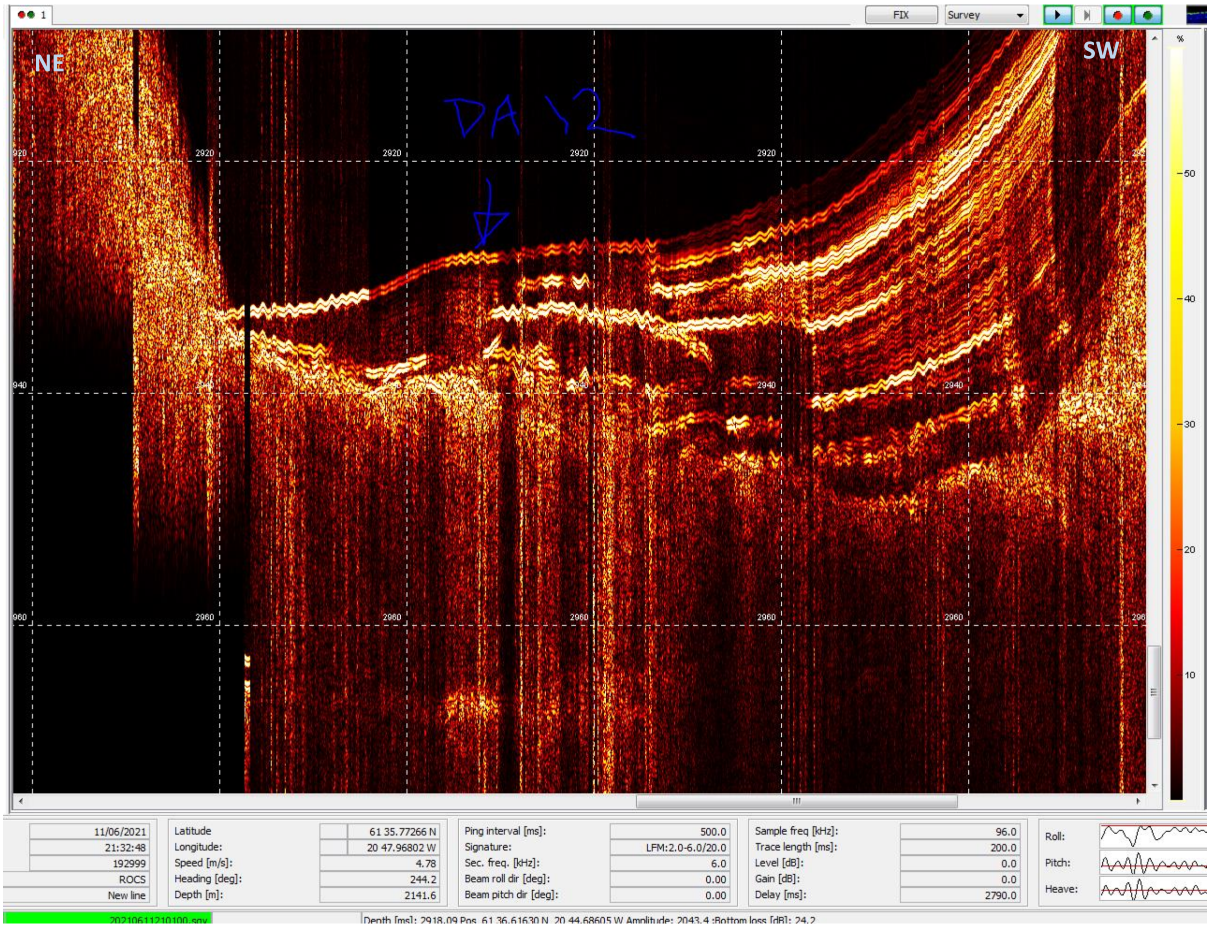

Fig. A10. Central part of the channel system showing a thick sedimentary wedge prograding into the channel from west to east. Approximate position of core DA12-01 is indicated.

12th June, Day 6 of cruise

Continuing the site survey of the ridge. A cross-section of the ridge was obtained sailing over a potential coring location identified on the 11 June (Fig. A11). From about 6:00 we proceeded on a westward course tracing the ridge flank slightly north of the transect. At ~8:00 we encountered an expanding stratified unit overlain by a mounded, relatively transparant unit of 12-13 ms thickness, suggesting a thick late glacial to Holocene development (Fig. A12). This concluded the site survey of the drift/bank-channel system; the remaining part of the day was spent gravity coring on ST 4 and ST 5 with full barrels returned at both sites (Figs. A11 and A12, Table 5). In the evening, we proceeded from ST 5 westward along the transect aiming for site SU-9032.

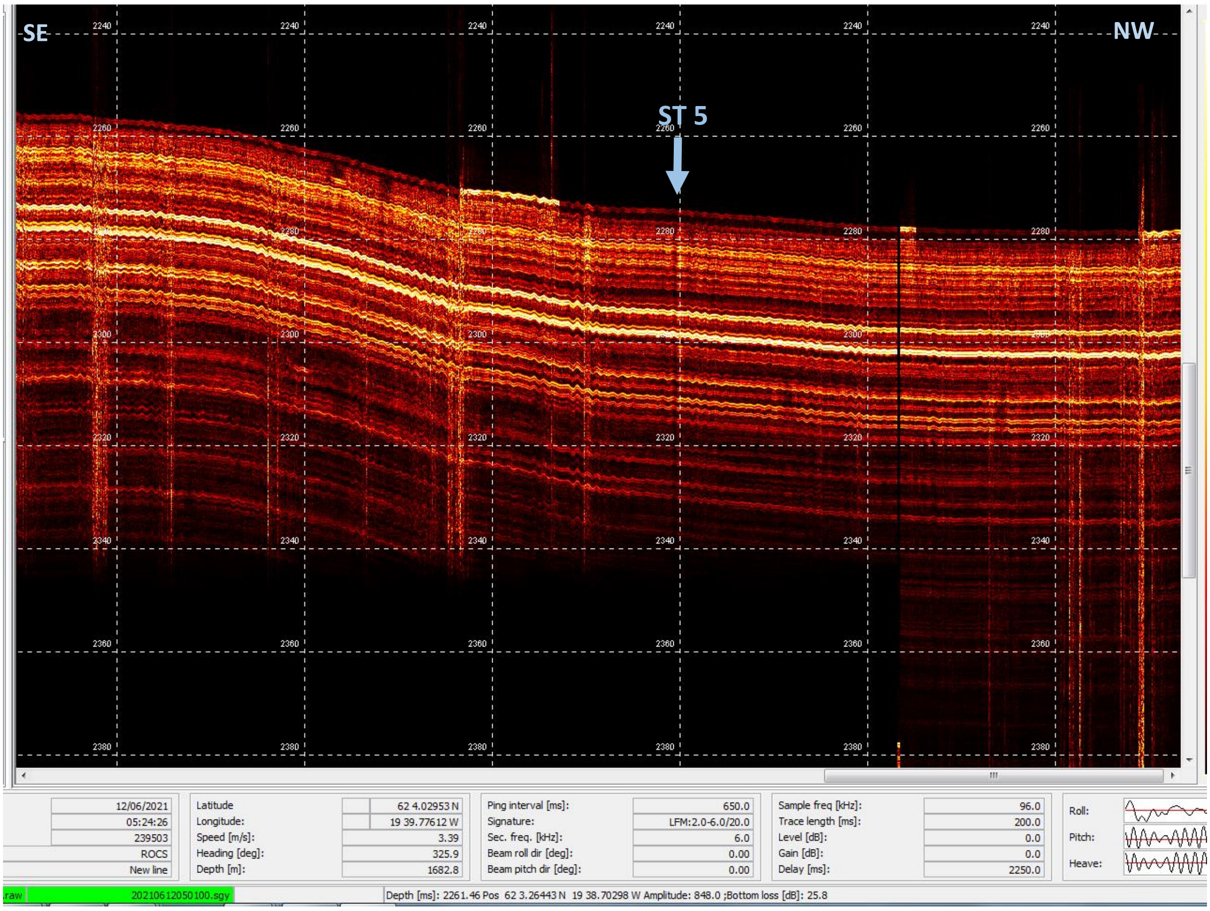

Fig. A11. Topas image displaying continuous, parallel strata of the sedimentary ridge targeted by coring at ST 5 (shown).

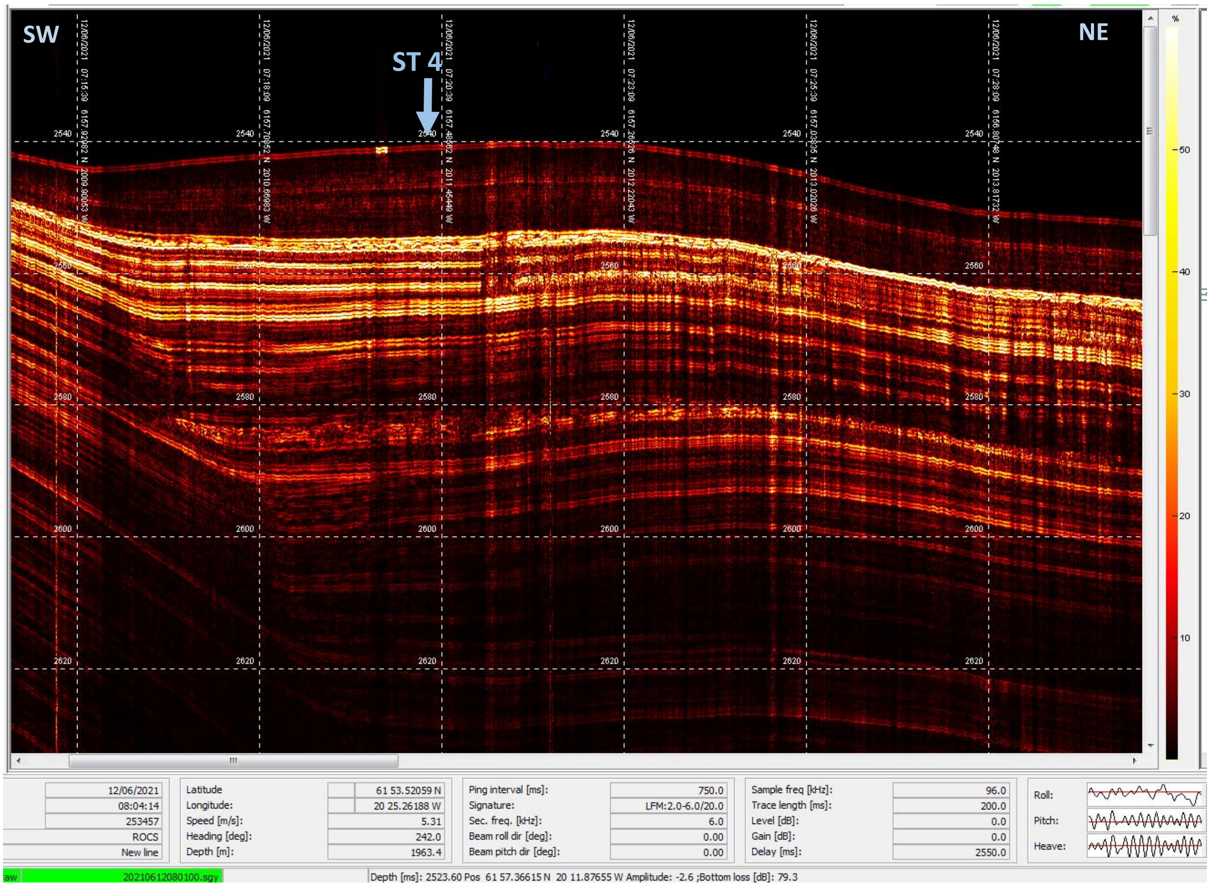

Fig. A12. Lower flank of the sedimentary ridge westward of the channel (toward right). Thick stratified-transparent upper unit with a gently mounded character may suggests a thick and soft/muddy Holocene interval. The entire sedimentary package imaged at this location is about about 100 ms deep. Position of ST4 is indicated.

<u>13th June, Day 7 of cruise</u>

After mid-night we crossed the flank of the Bjørn Drift displaying an exceptional well-imaged package with highly resolved continuous horizons (Fig. A13-A14). A bright horizon observed within a depth of 10-30 ms seem to form a regional marker, possibly related to volcanic ash deposition. A coring position was identified targeting reflections converging above the bright horizon. Hypothetically, the Eemian strata may correspond to the low-amplitude interval positioned above the bright horizon. At 00:43 we experienced a problem with the Topas that suddenly started to return a noisy signal (Fig. A15). Continuing toward core site SU-9032 the onboard technician tried to identify the problem. After ruling out software and connection issues it became apparent that the problem was related to an erratic pinger signal. At around 3:00 it was decided to sail back eastward along the transect with the aim of coring on the flank of Bjørn Drift. The sites was reached in the morning but the sea state was above the threshold for coring (waves >3 m). Hoping of calmer conditions we remained at the site until the afternoon (CTD and water sampling was carried out). Since there was no improvement and higher seas could be expected in the area it was decided to head northward to core based on the existing sub-bottom profiles with positions already identified.

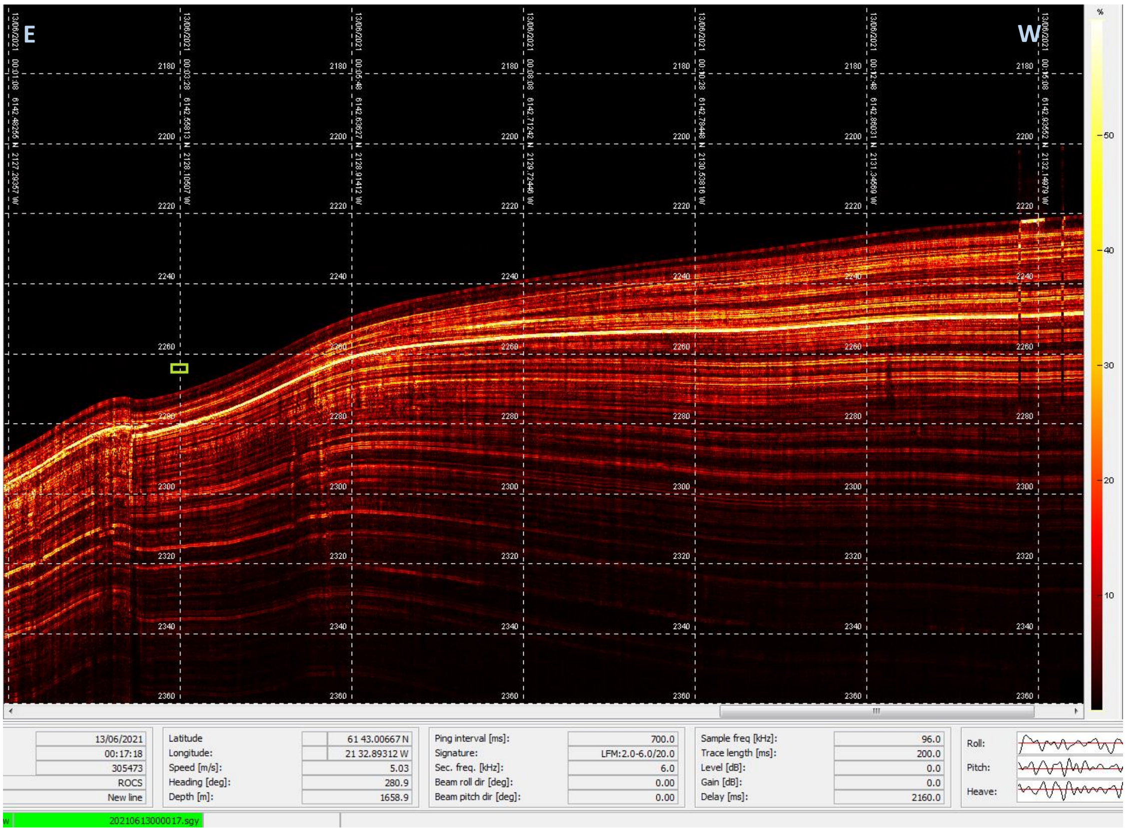

Fig. A13. Expanding sedimentary section crossing over the margin of the Bjørn Drift. Thickness of the imaged section at this location reach over 120 ms. Square marks position of potential coring site where older stratigraphy converge within 10 ms below seabed above the bright reflection. This horizon forms a regional marker that apparently can be traced between individual drift/bank system.

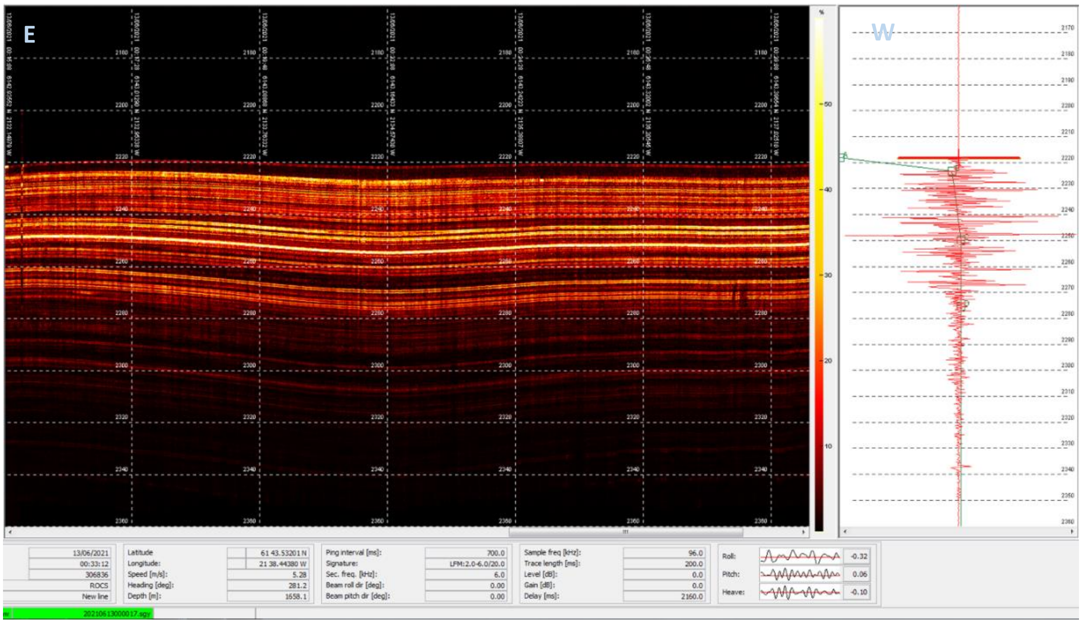

Fig. A14. Highly resolved stratigraphic section obtained over the Bjørn Drift (continuing from Fig. A13). The right-hand panel shows the signal strength.

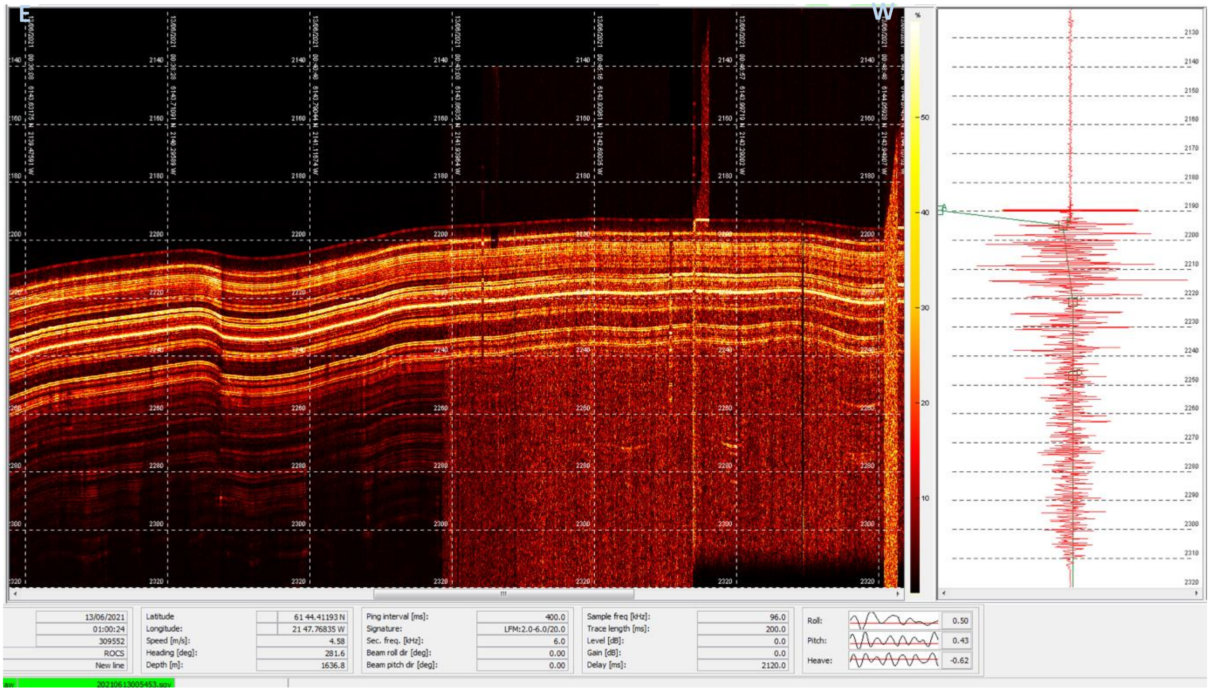

Fig. A15. Image taken during the break-down of the Topas system (noisy signal starting at 00:43).

<u>14th June, Day 8 of cruise</u>

Since the forecast looked reasonable closer to Iceland it was decided to retrace part of the eastern transect to core at two stations. In the morning coring was attempted on the channel levee south of the Reykjanes Ridge (Fig. A7) defined as ST6 (WD = 802 m). However, this site encountered compact or sandy sediments resulting in limited penetration. In the early evening coring was attempted on the evenly layered sediment mound shown in Fig. A9. Coring at ST7 (1170 m) was successful resulting in an almost full core barrel. Due to bad weather approaching from the south we decided to return to the Denmark Strait location. This would take us on the backside of the next cyclonic system where amenable weather conditions were forecasted for the next 4-5 days.

<u>15th June, Day 9 of cruise</u>

This day-night was spent in transiting westward.

<u>16th June, Day 10 of cruise</u>

In the morning we reached the margin of Denmark Strait. At 13:40 we obtained a full core on the lower slope south of Dorhn Bank (ST8; WD = 1908 m) guided by the Topas data collected during the previous week (Fig. A16). Subsequently, we headed for nearby position upslope from ST8 to core in strata that appeared more condensed on the seismic image. In the afternoon we retrieved a full core at ST9 (WD = 1835 m).

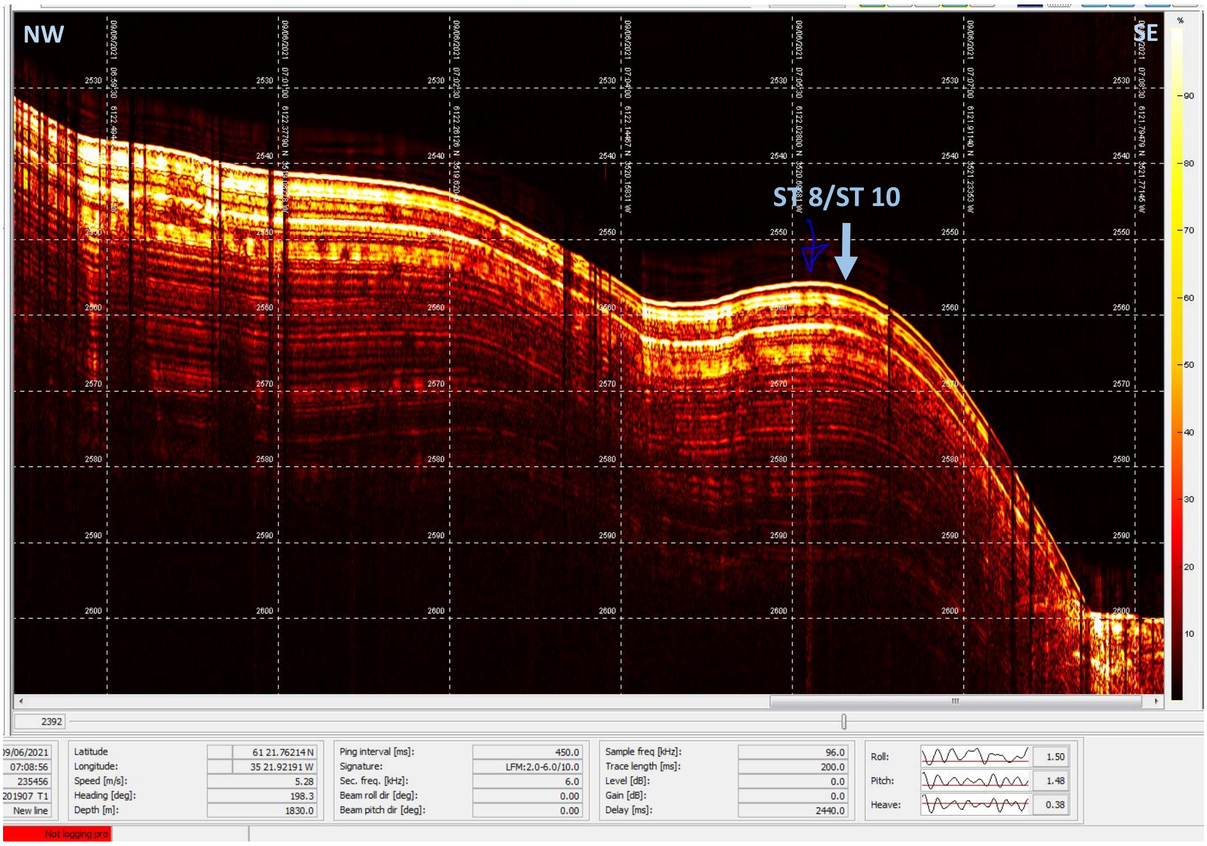

Fig. A16. Topas image from the lower slope section toward Denmark Strait with position of ST 8/ST 10 indicated. Despite a rather high reflectivity in the top section core barrels were returned containing >5 m of sediments.

17th June, Day 11 of cruise

In the morning we deployed a 9 m gravity corer on the same target as ST8. The barrel returned with nearly 7 m of sediments. Despite being on the same position as ST8 the site was labelled as ST10. In the afternoon we obtained a Rumohr-lot core on ST10. We then proceeded to transit southeast along the Topas transect. In the late afternoon coring was carried out on ST12 (WD = 1617 m); a previously identified location representing a continuous drape over a small intra-high depression. A 9 m barrel was applied but returned with <6 m of sediment. In the evening a Rumohrlot core was obtained.

18th June, Day 12 of cruise

The night was spend transiting to the site where a previous coring attempt was made at ST2. Revisiting the recorded sub-bottom data it was decided to core on the flank of a contourite mound where the highly reflective top section cored at ST2 was missing (Fig. A17). The rationale was that older strata could here be reached with the gravity corer. A nearly full 6 m core barrel was returned at ST13. We concluded the coring campaign by obtaining 2 Rumohrlot cores on ST13.

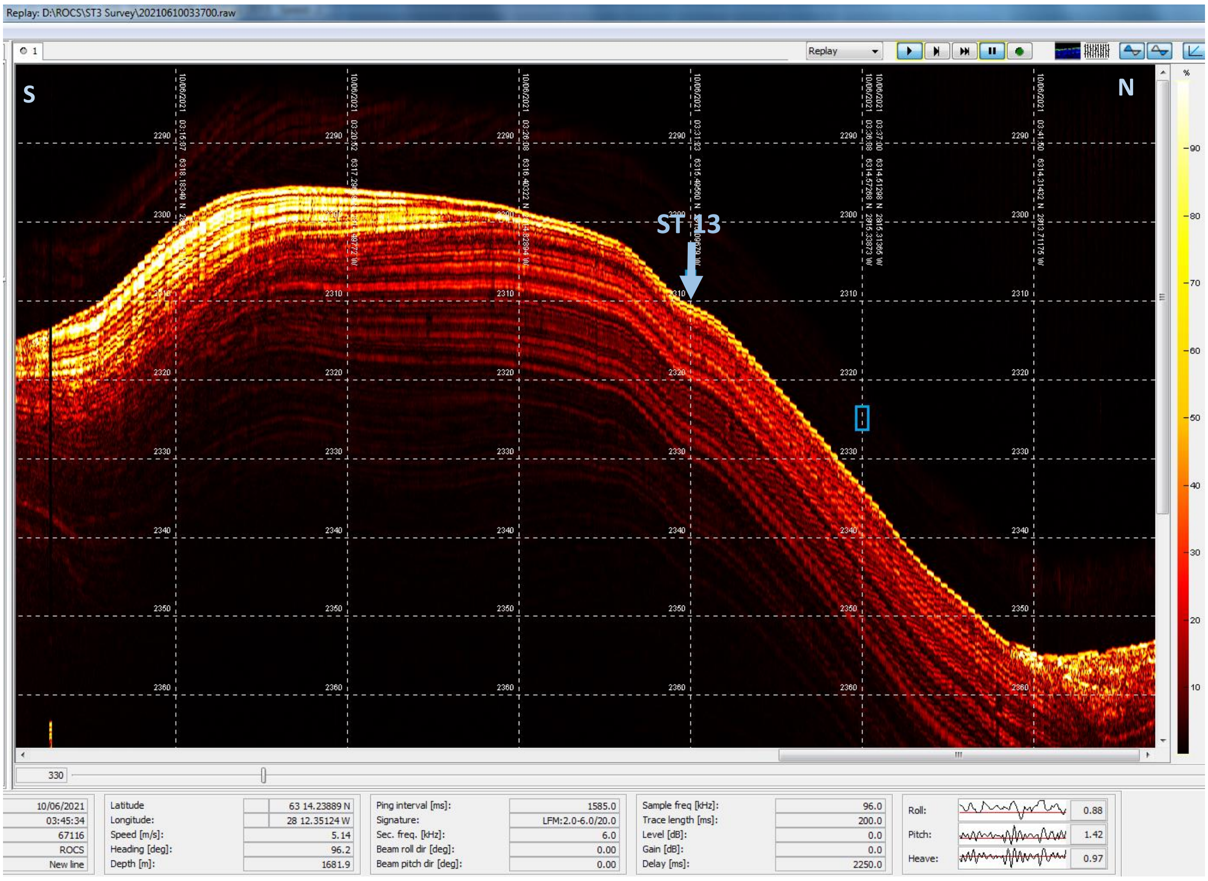

Fig. A17. Mounded depositional geometries with lenticular bedforms interpreted as contourite drifts covering the volcanic topography of the outer Reykjanes Ridge. Position of ST13, targeting a condensed section, is indicated. Blue box indicate a potential core site down flank from ST13.

<u>19th June, Day 13 of cruise</u>

CTD and water sampling

<u>20th June, Day 14 of cruise</u>

Transit back to HAFRO