DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2009/6

Rødsand-2 kabelkorridor. Geofysisk opmåling og kortlægning af mulige marinarkæologiske genstande

Kortlægning udført for Energinet.dk

Zyad Al-Hamdani & Jørgen O. Leth

DE NATIONALE GEOLOGISKE UNDERSØGELSER FOR
DANMARK OG GRØNLAND, KLIMA- OG ENERGIMINISTERIET

GEUS

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GEUS

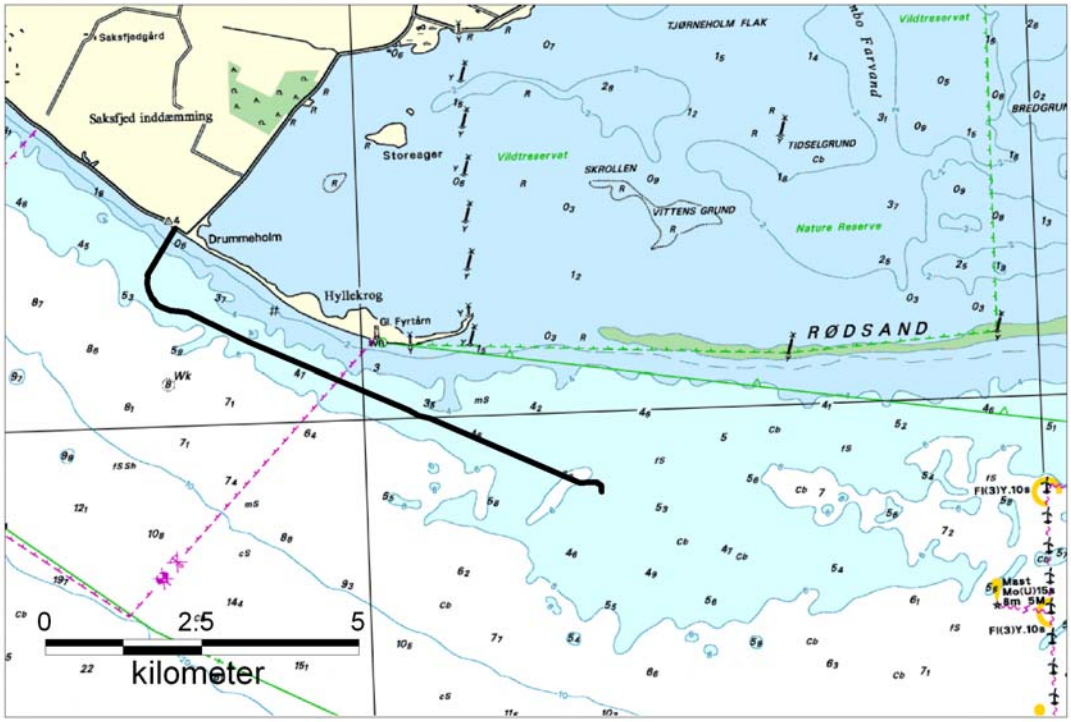
Indhold

1. Indledning

GEUS har indgået aftale med Energinet.dk om udførelsen geofysiske opmålinger med sidescan sonar og magnetometer af kabelkorridoren forløbende fra Rødsand 2 vindmølleparken til sydøst spidsen af Lolland. Resultaterne anvendes som grundlag for en marinarkæologisk konsekvens-vurdering for projektområdet, der gennemføres af Vikingeskibsmuseet og Kulturarvsstyrelsen i forbindelse med VVM-sagsbehandlingen.

Umiddelbart efter feltarbejdet foretog GEUS en gennemgang af de indsamlede data med henblik på at vurdere tilstedeværelsen af potentielle marinarkæologiske objekter. Den fremkomne liste blev sendt til Vikingeskibsmuseet som udgangspunkt for prioriteringen af en screening af hav-bunden for marinarkæologiske genstande gennemført ved dykning af Vikingeskibsmuseet.

2. Planlægning



Figur 1. Skitse over kabelkorridoren ved Rødsand.

Opmålingen blev planlagt af GEUS på grundlag af informationer om kabelkorridorens placering modtaget fra Energinet.dk (figur 1). For at kunne sikre en 100 % dækkende opmåling med passende overlap blev afstanden mellem sejllinierne fastlagt til 25m indenfor den 100m brede kabelkorridor. For at kunne dække så lave vanddybder som mulig valgte GEUS at foretage opmålingen med fartøjet "Sea Rex", der med en dybgang på 1,50m.

3. Feltarbejde og personale

Opmålingen blev gennemført den 8. december 2008. Udover skibets mandskab deltog fra GEUS seniorforsker Zyad Al-Hamdani og senior surveyor Lars Georg Rödel.

3.1 Survey skib

Opmålingsfartøjet "Sea Rex" (figur 2) blev anvendt som platform til opmålingen. Skibet ejes af rederiet Havgus i Grenå.

Figur 2. Opmålingsfartøjet "Sea Rex", der blev anvendt til opmålingen.

3.1.1 Lidt om skibets primære data:

Størrelse: 22,35m lang, 5,40m bred.
Dybgang: ca. 1,50 m
Tonnage: Brutto 64,00; Netto 23,46
Maskiner: 2 x 900hk via 2 stk. V16 Detroit Diesel maskiner. Renoveret i 2006
Gear: 2 x Servo Gear, V Gear
Propeller: 2 x 4 bladet ServoGear. VD 250 B Variable Pitch Propellers
Generator: 20 kva 380 volt.
Hastighed: 31 knob

4. Udstyr software og formater

4.1 Positionering: DGPS Sagitta

Som navigationsudstyr til korridor opmålingen benyttedes Sagitta DGPS navigation (figur 3), som gav os en navigationsnøjagtighed på omkring 1m. Beskrivelse af systemet følger (på engelsk) nedenfor.

Sagitta DGPS navigation

The DGPS system gives a navigational accuracy within 1m, and it uses 16-channel GNSS differential signal. The Sagitta™ receiver from Thales is developed for small and medium-scale marine surveys. Sagitta has real-time precision ranging from the meter to the centimetre level, depending on how it is operated (Operating modes available include: WAAS/EGNOS, DGPS, EDGPS, KART or LRK®). It is used for many types of kinematics applications such as bathymetry or coastal works, sea trials or trajectory. Sagitta has dual-frequency. Sagitta can be used as a reference station. You just need to add a U-Link station kit to deliver UHF signals over distances of 30 miles or more.

Figure 3. The Thales Sagitta DGPS system.

4.2 NaviPac

GEUS' navigationscomputer benytter navigations software NaviPac. Her indsamles antenneposi-tionen og distribuerer offset-korrigerede navigationsdata til de enkelte instrumenter.
Detaljeret beskrivelse af NaviPac følger nedenfor (på engelsk).

Navigations software - NaviPac
The NaviPac software is an integrated navigation and data acquisition software specifically suited for applications like:
- General navigation
- Hydrographic & oceanographic surveying
- Geophysical & seismic surveying

MODULARITY – NaviPac is modularity through use of multi tasking, multithreading and network-ing capabilities of the Windows NT, Windows 2000 and Windows XP operating system. The soft-ware is highly flexible and user configurable and the user interface adhere to The Microsoft Inter-face Guidelines making it very intuitive and easy to operate (figure 4).
NAVIGATION SET-UP – The NaviPac set-up module provides easy selection of geodetic pa-rameters, navigation systems, devices, offsets and port settings.
DEVICE I/O DRIVERS – A vast number of field-tested device I/O drivers are provided for most available positioning systems, GPS/DGPS receivers, gyros, motion/attitude sensors, tide-gauges, single beam echosounders, magnetometers, dynamic positioning systems, autopilots, etc. Ge-neric I/O drivers allow definition or customization of own device I/O drivers. Data is interfaced via RS232, a LAN or via a digital I/O interface
TIME SYNCHRONIZATION – Time stamping of sensor data, incoming as well as outgoing, can be done in two ways, either by the internal computer clock or by he PPS output available from most GPS receivers. Using the PPS output data are synchronized relative to the GPS/UTC time frame, resulting in an accuracy of a few milliseconds.
SURVEY PLANNING – NaviPac allows for survey planning through quickly creation of planned survey area and survey lines. A variety of methods for creation of survey lines is provided, e.g. by click-and-drag (of mouse/trackball), input of survey line coordinates, offset (parallel) survey lines, cross lines, circles, arcs etc. Survey lines can easily be adapted to fit a defined survey area. Creation of templates allows input of other data formats.

Figur 4. NaviPac skærmbilleder side scan sonar.

4.3 Side scan sonar systemet

Side scan fisken blev trukket i en fast dybde 1m under havoverfladen.
Nedenfor følger en beskrivelse af det anvendte side scan system (på engelsk).

The Benthos SIS-1600 Series Side Scan Sonar is a fully integrated system that uses both advanced Chirp and conventional continuous wave (CW) technologies—single frequency or dual frequency—and an advanced high-speed communications link to acquire high resolution side scan sonar images.

The Benthos SIS-1600 is a complete side scan sonar survey system that includes a topside acquisition system and software, a 100-meter tow cable, the CL-160 Communications Link, and one of two available tow vehicles: the TTV-196 Tow Vehicle, which acquires long range, high resolution Chirp side scan sonar images in a single frequency band; and the TTV-196D Tow Vehicle, which acquires long range, high resolution Chirp side scan sonar images in two frequency bands simultaneously (figure 5).

Figur 5. Benthos SIS-1600 Series sidescan sonar.

System Highlights

▲ CL-160 Communications Link

▲ 100 kHz, 100m range

▲ 400 kHz, 100m range

▲ Topside sonar processor

System Features

The TTV-196D Tow Vehicle includes the transceiver electronics, the processing and communications electronics, the port and starboard side scan transducer arrays, the pitch, roll and heading sensors, and the optional sensors. The optional sensors include a water temperature sensor, a pressure sensor, a magnetometer, and a responder. Hydro dynamically stable tow vehicle with operating depth up to 1,750m.

Features

■ Dynamic range - high frequency data up to 150m

■ Enhanced resolution

■ Repeatable transmitted waveforms

■ Constant temporal resolution

■ The pulse characteristics are programmable

■ Stainless steel construction

■ Seaconnet shipwreck, 400 kHz, 75m range

SYSTEM SPECIFICATIONS

Software

Application: Third party data acquisition and display (i.e.TEI “Isis Lite”, Chesapeake, “Sonar-map”)

Operating System: Microsoft® Windows® XP Professional

Hardware

Processor CPU: Intel® Pentium® 4 processor

Memory: 512 DDR SDRAM

I/O Ports: Wireless keyboard/mouse

RS-232 serial

Parallel

Ethernet 10/100 BaseT

Graphics Processor: Integrated high resolution graphics

Data Sorage: High capacity hard drive, CD/DVD-RW drive

CL-160 Communications Link

Physical Characteristics

Construction: 316 stainless steel

Dimensions: 11.4 cm (4.5 in.) outside diameter by 177.8 cm (70 in.) long

Weight in Air: 34 Kg (75 pounds)

Weight in Water: 25 Kg (55 pounds), approx.

Operating Depth: 1,750 meters

Towing Speed: 1 to 8 knots operational

Input Power: 144 VDC, 32 watts nominal

Side Scan Sonar

Acoustic Source Level: +225 dB re 1uPa @ 1m.

Range: 25 to 500m each channel

Frequency Range

Chirp Frequency Range:

(TTV-196D): Simultaneously sweeps in the 110 kHz to 130 kHz and 370 kHz to 390 kHz bands

CW Frequency

(TTV-196D): Simultaneous 123 kHz and 383 kHz

Transducer Radiation

(TTV-196D): 0.5 degrees horizontal, 55 degrees vertical (110 kHz to 130 kHz band), 0.5 degrees horizontal, 35 degrees vertical (370 kHz to 390 kHz band)

SIS-1625 Seafloor Imaging System

One Cable—CL-160 Communications Link

The comm link was designed through a program to develop a full ocean depth telemetry module for a multisensor seafloor mapping system.

- Two-way communication with tow vehicle over single coax with digital high speed multiplexor. Standard cable length—up to 10,000 meters.
- Digital multiplexor for single coaxial tow cables. Communication rates: sonar data—up to 5 megabit/sec; uplink status—9600 bits/sec; downlink command—9600 bits/sec.

SPECIFICATIONS

CL-160 Shipboard Sub-System

Chirp Processing:	Sonar/status control PC based workstation; 5-DSP based sonar matched filter processing channels.
Display:	High resolution video display.
Recording:	Large capacity hard drive, DVD writable, other..
Status Display:	Vehicle pitch, roll, heading (standard); speed, altitude, and depth (optional). Customer input ship position, vehicle position, event marks; all status data recorded.
Sonar Display:	Side scan port, starb; dual channel sub-bottom; all sonar data recorded.
Corrections:	Slant range and speed; beam angle/grazing angle.
Multiplexor:	Digital MUX for coaxial cables (ADSL).
Sonar Data:	up to 5 megabit/sec.
Uplink Status:	9600 bit/sec.
Downlink Command:	9600 bits/sec.
Power Supply:	110/220 VAC autosensing.

Side Scan

Side Scan Transducers:	Multi-element array, dual channel 100/400 kHz 0.5° horizontal beam; 60° vertical beam.
Frequency:	100/400 kHz band swept FM; 4.5 cm resolution.
Processing:	Calibrated transmit waveform stored in ROM; match filter FFT digital signal processing.
Swath Selection:	25 meters to ±500 meters.

Sub-Bottom

Transducer:	Transmit projector array; line array receiving hydrophone; 30° conical radiation pattern.
Frequency:	1 kHz to 10 kHz swept FM (4 KW output), synchronous with side scan.
Resolution:	5 cm.
Processing:	Calibrated transmit waveform stored in ROM; matched filter FFT digital signal processing.
Scale Selection:	25 meters to 500 meters full scale.

TTV-290 Tow Vehicle Sub-System

Depth rating:	2000 meters.
Vehicle Dimensions:	18 inches (45 cm) OD x 64 inches (162.6 cm) long.
Weight:	In air: 300 lbs (136 Kg); in water: 170 lbs (77 Kg).

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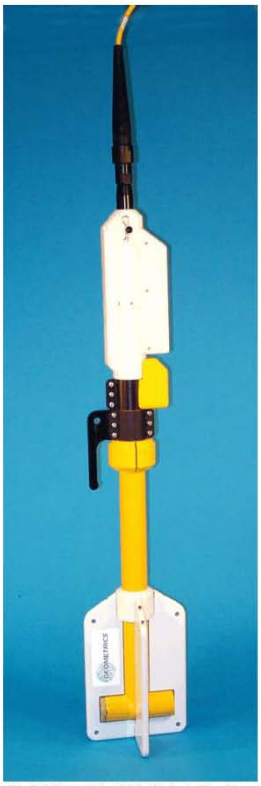
4.4 G882 marine magnetometer

Nedenfor følger beskrivelsen af det anvendte magnetometer udstyr (på engelsk).

GEOMETRICS

G-882 MARINE MAGNETOMETER

- *CESIUM VAPOR HIGH PERFORMANCE – Highest detection range and probability of detecting all sized ferrous targets*
- *NEW STREAMLINED DESIGN FOR TOW SAFETY – Low probability of fouling in lines or rocks*
- *NEW QUICK CONVERSION FROM NOSE TOW TO CG TOW – Simply remove an aluminum locking pin, move tow point and reinsert. New built in easy carry handle!*
- *NEW INTERNAL CM-221 COUNTER MODULE – Provides Flash Memory for storage of default parameters set by user*
- *NEW ECHOSOUNDER / ALTIMETER OPTION*
- *NEW DEPTH RATING – 4,000 psi !*
- *HIGHEST SENSITIVITY IN THE INDUSTRY – 0.004 nT/Hz RMS with the internal CM-221 Mini-Counter*
- *EASY PORTABILITY & HANDLING – no winch required, single man operation, only 44 lbs with 200 ft cable (without weights)*
- *COMBINE TWO SYSTEMS FOR INCREASED COVERAGE – Internal CM-221 Mini-Counter provides multi-sensor data concatenation allowing side by side coverage which maximizes detection of small targets and reduces noise*



G-882 with Weight Collar Depth Option & Altimeter

Very high resolution Cesium Vapor performance is now available in a low cost, small size system for professional surveys in shallow or deep water. High sensitivity and sample rates are maintained for all applications. The well proven Cesium sensor is combined with a unique and new CM-221 Larmor counter and ruggedly packaged for small or large boat operation. Use your computer and standard printer with our MagLogLite™ software to log, display and print GPS position and magnetic field data. The G–882 is the lowest priced high performance full range marine magnetometer system ever offered.

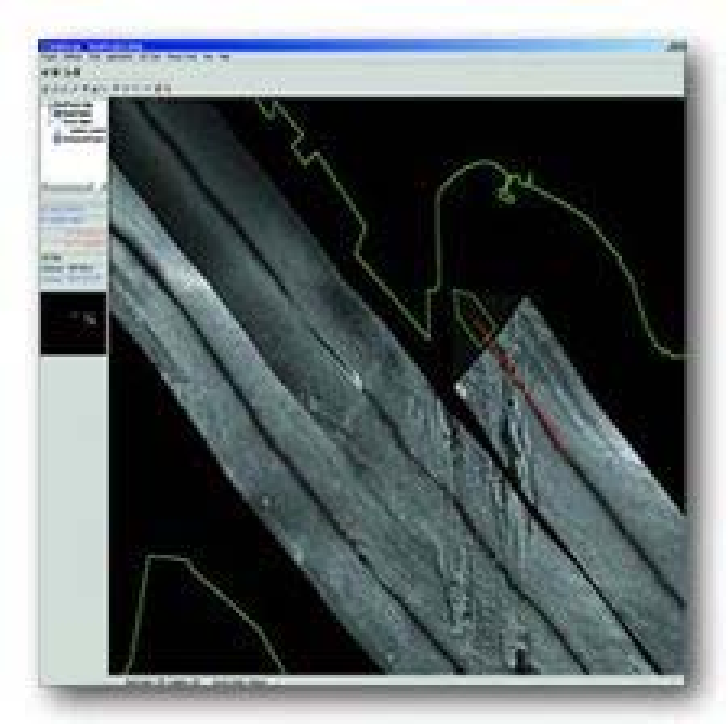
The G-882 offers flexibility for operation from small boat, shallow water surveys as well as deep tow applications (4,000 psi rating, telemetry over steel coax available to 10Km). The G-882 also directly interfaces to all major Side Scan manufacturers for tandem tow configurations. Being small and lightweight (44 lbs net, without weights) it is easily deployed and operated by one person. But add several streamlined weight collars and the system can quickly weigh more than 100 lbs. for deep tow applications. Power may be supplied from a 24 to 30 VDC battery power or the included 110/220 VAC power supply. The tow cable employs high strength Kevlar strain member with a standard length of 200 ft (61 m) and optional cable length up to 500m with no telemetry required.

A rugged fiber-wound fiberglass housing is designed for operation is all parts of the world allowing sensor rotation for work in equatorial regions. The shipboard end of the tow cable is attached to an included junction box or optional on-board cable for quick and simple hookup to power and output of data into any Windows 98, ME, NT, 2000 or XP computer equipped with RS-232 serial ports.

The G-882 Cesium magnetometer provides the same operating sensitivity and sample rates as the larger deep tow model G-880. MagLogLite™ Logging Software is offered with each magnetometer and allows recording and display of data and position with Automatic Anomaly Detection and automatic anomaly printing on Windows™ printer! Additional options include: MagMap2000 plotting and contouring software and post acquisition processing software MagPick™ (free from our website.)

4.5 Isis Sidescan Acquisition Software

Med ISIS sidescan programmellet er det muligt at optage, processere og præsentere sidescan data dels som enkelte liniedata, dels som sidescan mosaik (se appendix 2). Figur 6 viser eksempel på on-line fremstilling af en sådan mosaik.



Figur 6. ISIS on-line mosaik skærmbillede.

ISIS continues to be the most advanced sidescan sonar acquisition system available today. Isis® Sonar™ is the tool of choice for a variety of applications including: mine-hunting, hydrography, archaeology, environmental studies, oilfield engineering, civil engineering, oceanography, and law enforcement.

Real-time Sensor Quality Control
ISIS offers a wealth of display options to ensure high data quality. Typical windows for monitoring raw sensor information include a waterfall display for the sonar imagery, a signal voltage display for each incoming ping, and a parameter display for navigation, motion sensor, etc., and file storage. A real-time link with TEI TritonMap™ provides for on-line mosaic production, an invaluable tool for assessing seabed coverage and the quality of geo-referencing between adjacent lines (figure 6).

Reliable, Precise Sonar Data Acquisition
ISIS systems are active throughout the world, incorporating over 20 years of field experience in hardware and software design. Incoming sidescan sonar and ancillary sensor data are time-stamped to millisecond accuracy, thereby ensuring the final data products can be properly corrected during processing. Wide Compatibility,

Compatible with All Sidescan Sonars
ISIS interfaces with any sidescan sonar available today. Analogue or digital, regardless of the manufacturer -- we offer a custom interface that is intuitive to set up and is designed around the sonar's communication requirements. All data are stored in TEI's open XTF (eXtended Triton Format), an industry-standard, non-proprietary format.

Comprehensive Data Correction & Analysis
Numerous tools exist within ISIS for correcting and analyzing data and generating reports. Bottom-tracking, time-varying gain, slant range correction, and layback may all be applied to the imagery on-screen without affecting the raw data being logged. Events, scale lines, and notes can be associated with the imagery. A powerful ASCII report tool allows practically any information stored in the XTF file to be extracted in user-defined formats.

GIS Mosaicing
A mosaicing link exists between Isis® Sonar™ and TEI's TritonMap™ GIS product. These mosaics may be overlain on navigation charts or other background information. Contours, navigation hazards, or contacts may be overlain on the mosaics as they are being built.

4.6 Tolknings software

Tolkning af sidescan data blev foretaget ved hjælp af Isis® Sonar™. Til databearbejdning og præsentation af magnetometer data anvendtes *GeoSOFT Oasis montaj 6.0* software.

4.7 Data formater

Alle de indsamlede survey data er lagret digitalt i standardformater:

- Navigationsdata indsamledes i NaviPac og blev gemt i dette format (.npd), som let kan omformes til ASCII txt-format.

- Sidescan data indsamlet med ISIS Acquisition Software er gemt i XTF-format. Efterfølgende blev sidescan mosaik ligeledes lavet i ISIS programmet som Geo-tif, der efterfølgende er indlæst i MapInfo som geo-refereret tab-filer.

Alle originale data findes bilagt på CD-rom bagest i denne rapport.

4.7.1 GIS programmel

GEUS arbejder rutinemæssigt med MapInfo. Alle arbejdskort og tabeller, såvel som det færdige resultat præsenteres i dette format. Relevante MapInfo filer (tab-filer og workspaces) er indeholdt på CD-rom bagest i rapporten.

5. Tolkning og præsentationer

På baggrund af de indsamlede data er der lavet en række sammenstillinger og fortolkninger med henblik på at beskrive

- undersøgelsens seismiske linie tæthed/forløb som dokumentation for dækningsgraden, der danner basis for tolkningerne (sejlliniekort, figur 7)

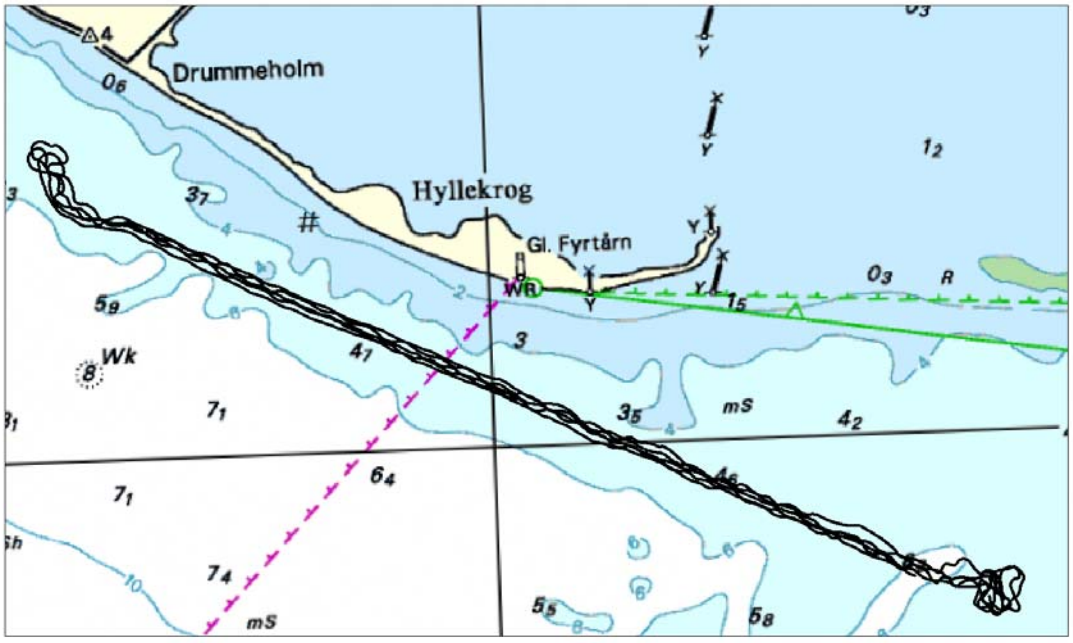
- det akustiske billede af havbundens overflade (sidescan mosaik, appendix 2), der danner baggrund for vurdering og tolkning af eventuelle arkæologiske objekter på havbunden

- de magnetiske anomalier over havbunden (magnetisk anomali kort, appendix 1), som grundlag for en vurdering af tilstedeværelsen af eventuelle magnetiske objekter.

De indsamlede data såvel som kortene i rapporten er indsamlet og præsenteret i WGS84 projektionen, UTM zone 32. Kortene og data findes også som elektroniske filer på vedlagte CD-rom.

6. Sejllinier

Undersøgelseområdet er dækket af 5 parallelle sejllinier, som sikrer en 100% dækning af sidescan sonaren. Der ses nogen afvigelse fra de planlagte parallelle linier på grund af vind- og strømforholdene på opmålingsdagen. På grund af kraftige dønninger blev opmålingen af sikkerhedsmæssige grunde stoppet omkring 3m vanddybde.



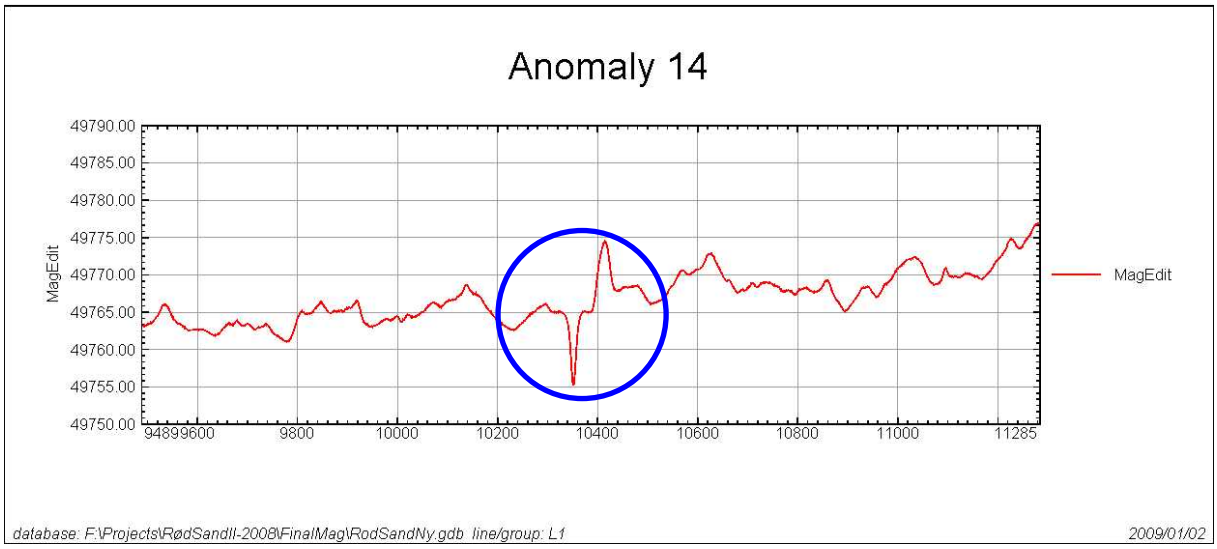
Figur 7. Sejlliniekort for de marinarkæologiske opmålinger i Rødsand-2 kabelkorridoren.

7. Resultater

7.1 Magnetometer opmåling

Der blev foretaget kontinuerte opmålinger med magnetometer med det formål at kortlægge magnetiske anomalier, der kunne relateres til marinarkæologiske objekter.

Data er renset for 'støj' ved hjælp af *GeoSoft Oasis montaj 6.0* software, hvorefter de rensede data blev importeret til Excel. De magnetiske anomalier blev linie for linie plottet i *GeoSoft,* hvorefter disse blev minutiøst gennemgået for 'spikes' (se figur 13). Alle spikes er listet med tilhørende koordinater i appendix 1. Endvidere er lokaliseringen blev plottet på MapInfo sejlliniekortet (appendix 1). Listen og plottet vil danne grundlag for Vikingeskibsmuseets prioritering af dykningskampagnen.



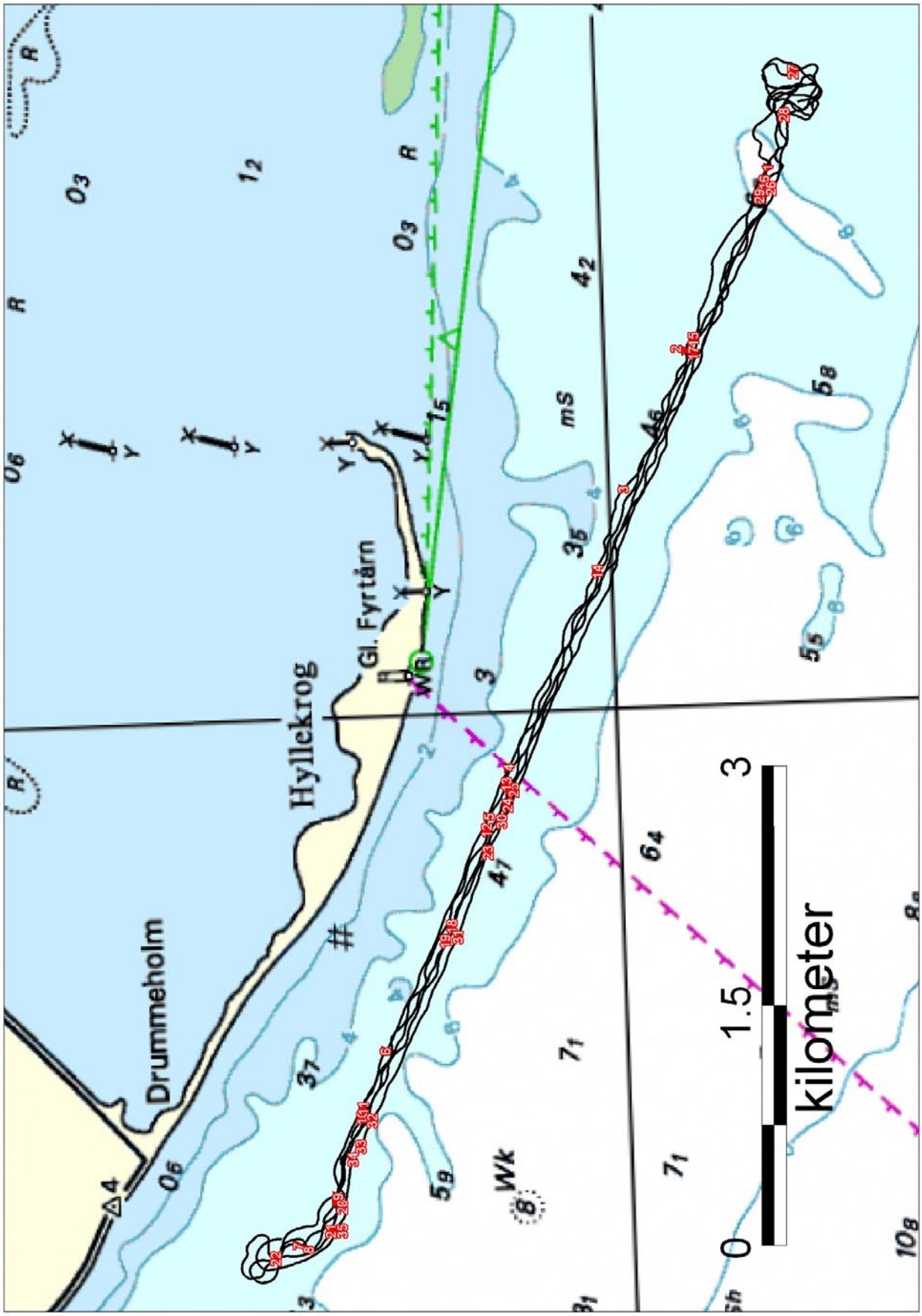
Figur 13. Eksempel på plot af den magnetiske anomali langs en sejllinie. Den blå cirkel angiver en 'spike' med en positiv og negativ fase. Vertikal skala er 5 nTesla.

7.2 Sidescan analyse for objekter

Udover sidescan data har dannet grundlag for en sidescan mosaik er disse data også blevet gennemgået for tilstedeværelsen af eventuelle objekter. Sidescan billederne i omegnen af hver magnetisk anomali er blevet affotograferet ved hjælp af tolkningsprogrammet og præsenteret i appendix 2. Flere af de magnetiske anomaliers positioner er dækket på flere sidescan linier pga. overlappet fra sidescan dækningen. I appendix 2 præsenteres kun et billede pr. position (i alt 35), men samtlige sidescan billeder kan findes på vedlagte data CD. Der er ikke konstateret objekter på sidescan billederne, hverken i omegnen af de magnetiske anomalier eller udenfor disse. Sidescan billederne fremstår til tider lettere stribede pga. bølgestøj, uden det dog har haft nogen indflydelse på resultatet.

Appendix A

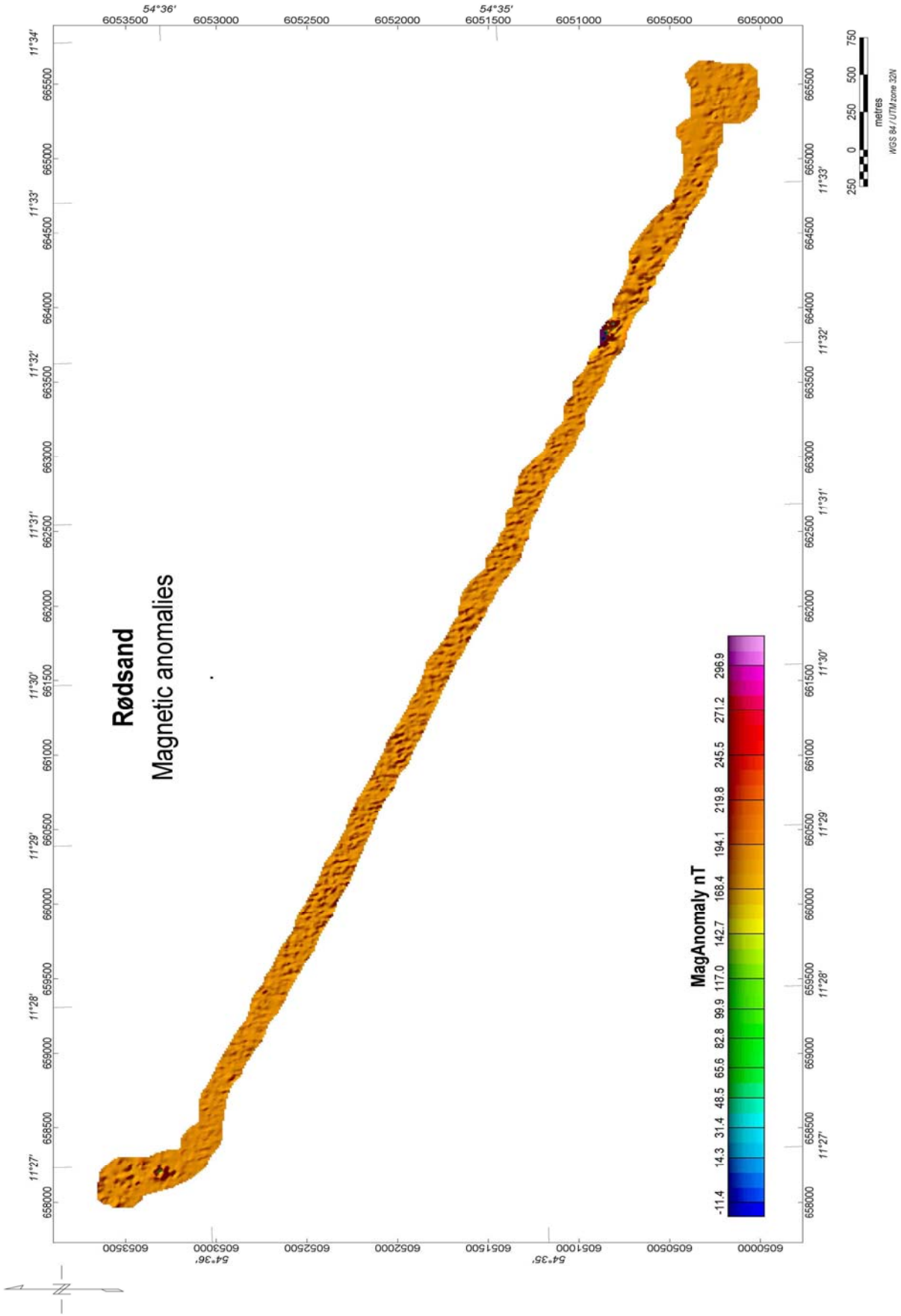
- Kort over magnetiske anomalier
- Tabel over magnetiske anomalier med koordinater
- Plot af magnetiske anomalier



Kort A1. Magnetiske anomalier med nummer, som de er fordelt på sejllinierne.

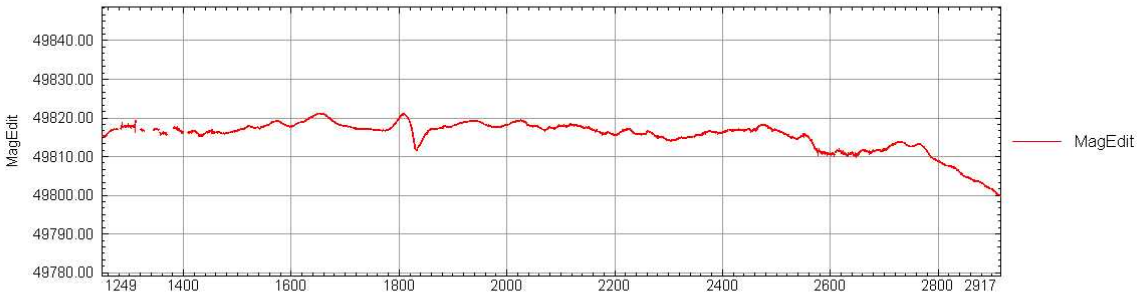
Line#	Longit_X	Latitud_Y	Mag. nT	MagAnomaly nT	Anomaly	Easting	Northing
0	11.55203	54.573711	49820.33	4.2	1	664957.9517	6050350.49
0	11.534558	54.578689	50835.56	1041	2	663808.8663	6050863.35
0	11.52139	54.582503	49786.95	7	3	662942.7726	6051256.99
0	11.494796	54.589506	49750.63	7	4	661196.8542	6051974.65
0	11.490167	54.590751	49743.81	4	5	660892.9126	6052102.53
0	11.467811	54.596985	49730.68	5	6	659424.3976	6052745.03
0	11.449366	54.602315	49707.84	5&-50(-ve Ano.)	7	658212.3887	6053296.23
0	11.448932	54.601726	49699.42	-12	8	658186.645	6053229.73
0	11.453938	54.599987	49718.6	4	9	658516.6959	6053047.57
1	11.461473	54.598485	49722.07	5	10	659009.1894	6052897.52
1	11.462421	54.598374	49722.08	5	11	659070.8499	6052887.32
1	11.488781	54.590866	49746.5	9	12	660802.9267	6052112.15
1	11.493271	54.589712	49749.5	4	13	661097.5262	6051994.07
1	11.513426	54.584156	49774.5	7	14	662421.6363	6051422.43
1	11.535617	54.578272	49827.26	29&-121(-ve Ano.)	15	663878.9689	6050819.44
1	11.550586	54.57392	49824.92	7	16	664863.7909	6050370.35
2	11.534247	54.57829	49815.67	20	17	663790.3714	6050818.24
2	11.479655	54.593024	49743.58	7	18	660204.934	6052331.35
2	11.478174	54.593411	49744.5	8	19	660107.751	6052371.03
2	11.453354	54.600059	49719.27	5	20	658478.6992	6053054.27
2	11.450664	54.600438	49718.03	6	21	658303.498	6053090.36
2	11.448163	54.603608	49718.73	8	22	658129.6859	6053437.35
2	11.486621	54.590891	49748.94	10	23	660663.297	6052109.99
2	11.491162	54.589677	49753.32	12	24	660961.4238	6051985.34
2	11.492532	54.589473	49752.04	12	25	661050.7303	6051965.79
2	11.549979	54.573617	49826.7	10	26	664825.7875	6050335.22
3	11.561218	54.572111	49824.31	4	27	665558.2027	6050194.12
3	11.556973	54.572707	49830.77	5	28	665281.4515	6050250.42
3	11.549195	54.57422	49825.57	8	29	664772.6888	6050400.46
3	11.489657	54.590007	49752.9	6	30	660862.9005	6052018.6
3	11.478672	54.592691	49746.71	5	31	660142.7445	6052292.07
3	11.461128	54.597889	49728.46	4	32	658989.2299	6052830.44
3	11.458687	54.598623	49728.68	5	33	658828.7151	6052906.57
3	11.457478	54.59905	49726.79	4	34	658748.969	6052951.34
3	11.45072	54.60015	49720.06	3	35	658308.2323	6053058.45

Tabel A1: Magnetiske anomalier (nT) angivet med anomali-nummer og geografiske/UTM positioner. MagAnomaly I kolonne 5 er den maksimale amplitude I forhold til den lokale baggrund.



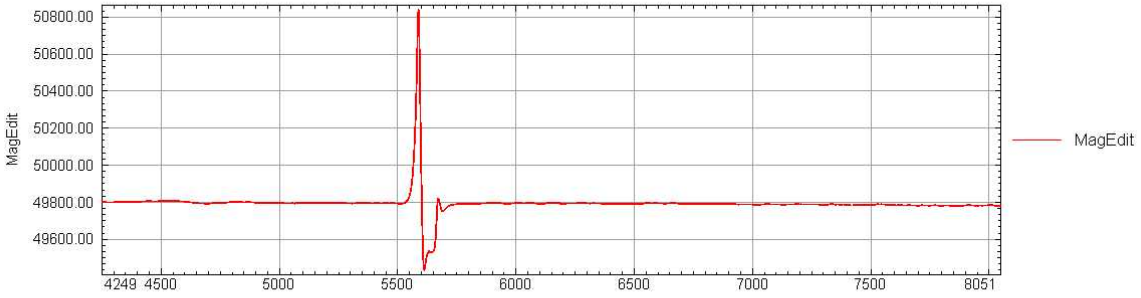
Kort A2. Plot af magnetiske anomalier.

Anomaly 1



database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L0 *2008/12/27*

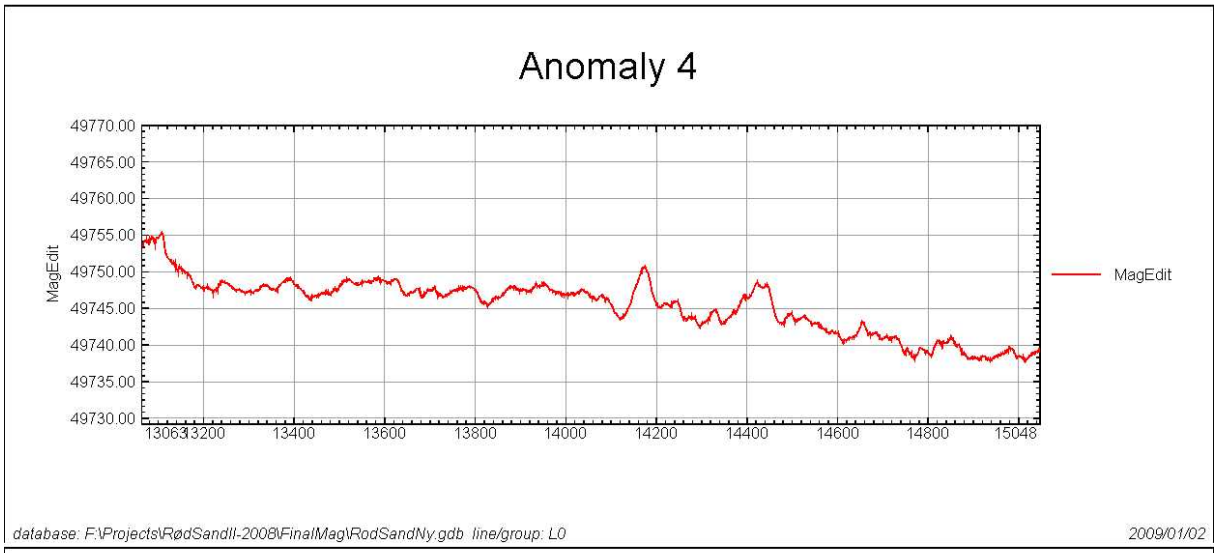
Anomaly 2

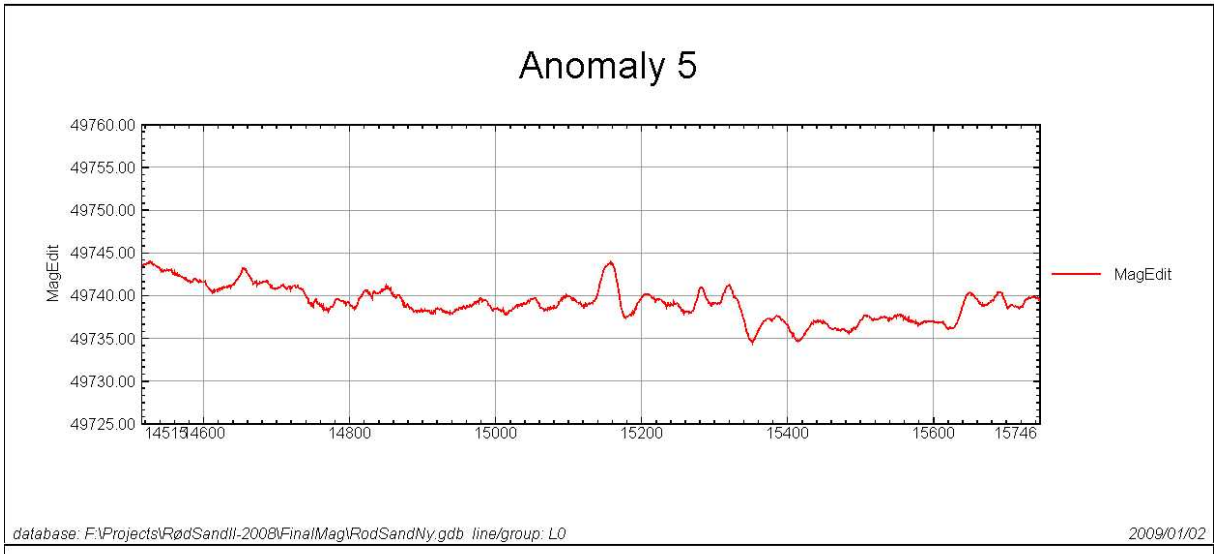


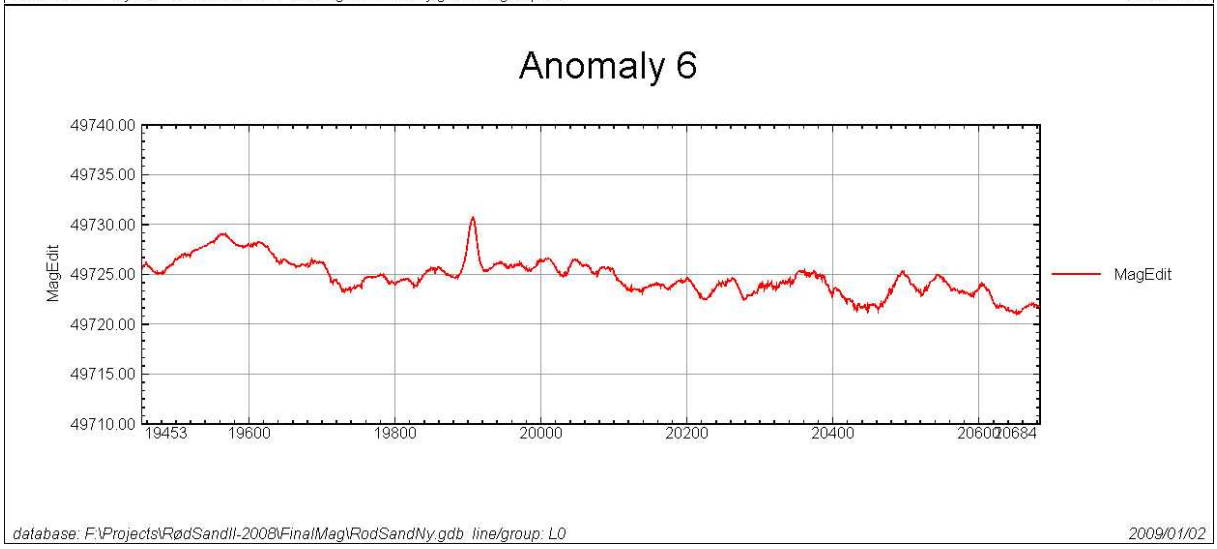
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L0 *2008/12/27*

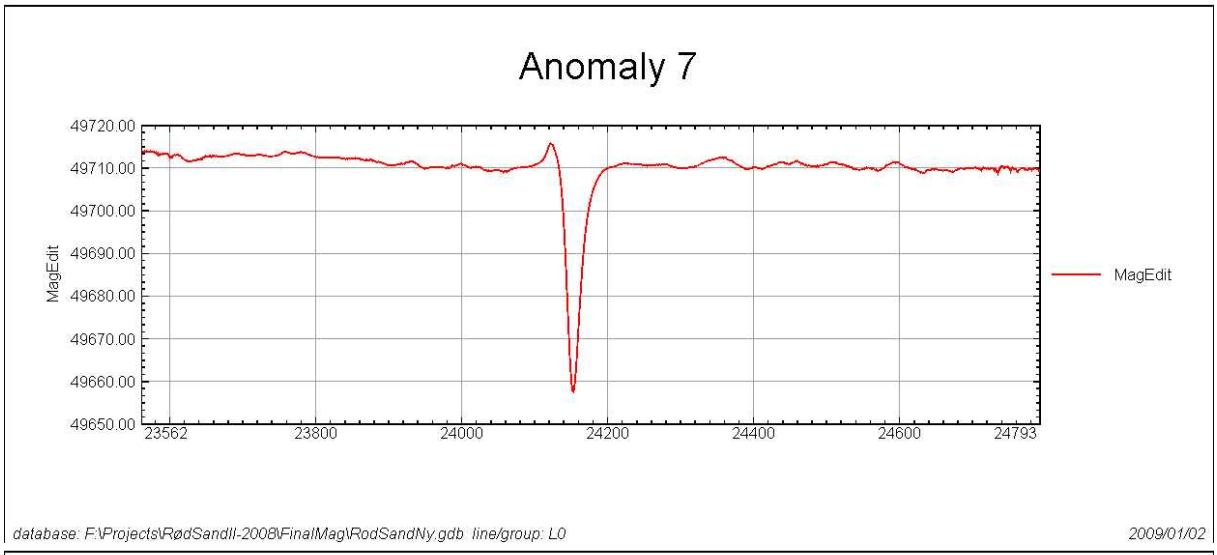
Anomaly 3

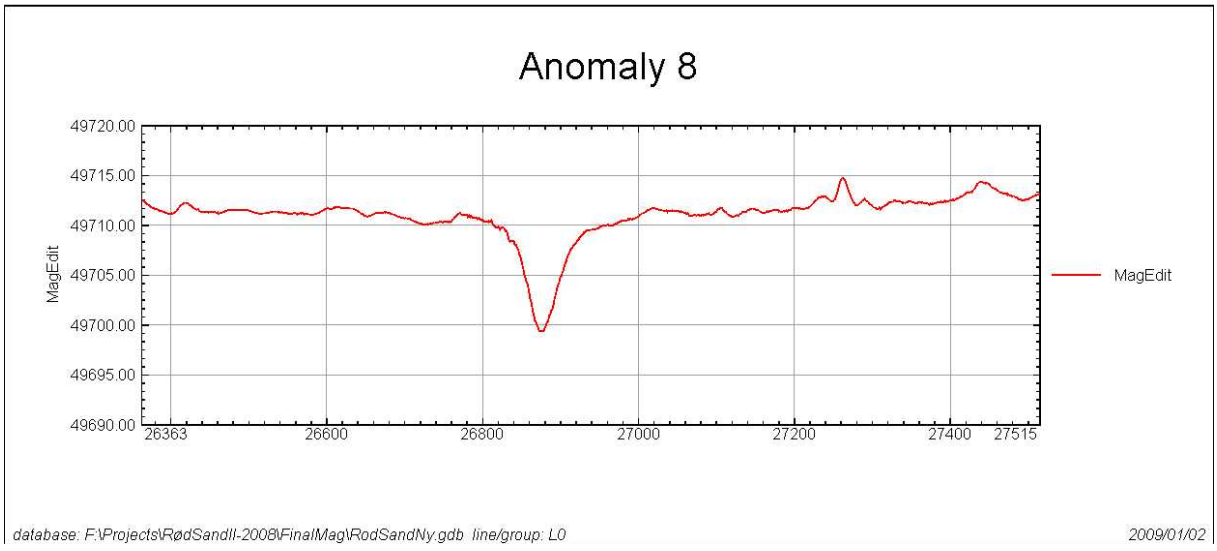
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L0 *2009/01/02*

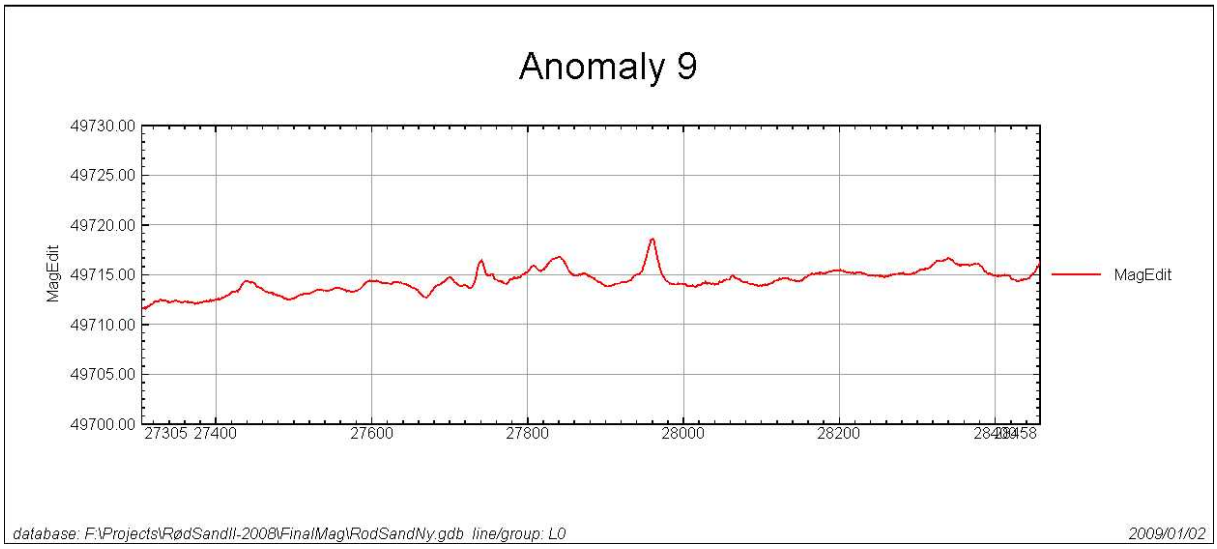

Anomaly 4
49770.00
49765.00
49760.00
49755.00
49750.00
49745.00
49740.00
49735.00
49730.00
MagEdit
13063
13200
13400
13600
13800
14000
14200
14400
14600
14800
15048
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L0
2009/01/02


Anomaly 5
49760.00
49755.00
49750.00
49745.00
49740.00
49735.00
49730.00
49725.00
MagEdit
14515
14600
14800
15000
15200
15400
15600
15746
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L0
2009/01/02


Anomaly 6
49740.00
49735.00
49730.00
49725.00
49720.00
49715.00
49710.00
MagEdit
19453
19600
19800
20000
20200
20400
20600
20684
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L0
2009/01/02


Anomaly 7
MagEdit
49720.00
49710.00
49700.00
49690.00
49680.00
49670.00
49660.00
49650.00
23562
23800
24000
24200
24400
24600
24793
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L0
2009/01/02


Anomaly 8
MagEdit
49720.00
49715.00
49710.00
49705.00
49700.00
49695.00
49690.00
26363
26600
26800
27000
27200
27400
27515
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L0
2009/01/02


Anomaly 9
MagEdit
49730.00
49725.00
49720.00
49715.00
49710.00
49705.00
49700.00
27305
27400
27600
27800
28000
28200
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L0
2009/01/02

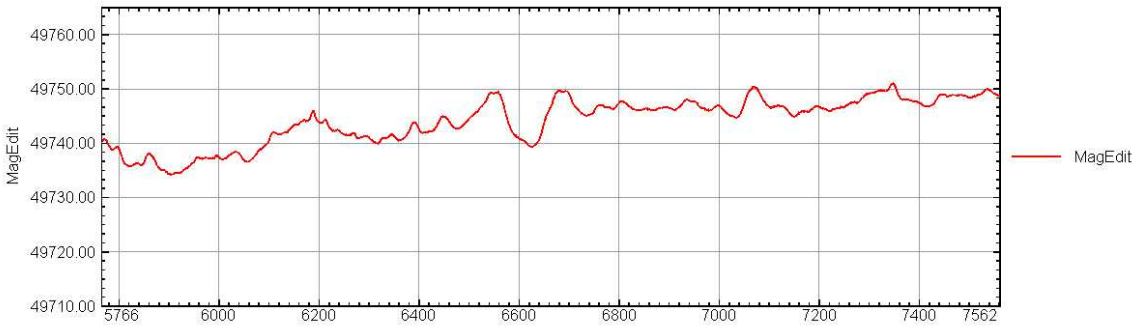
Anomaly 10,11

database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L1 *2009/01/02*

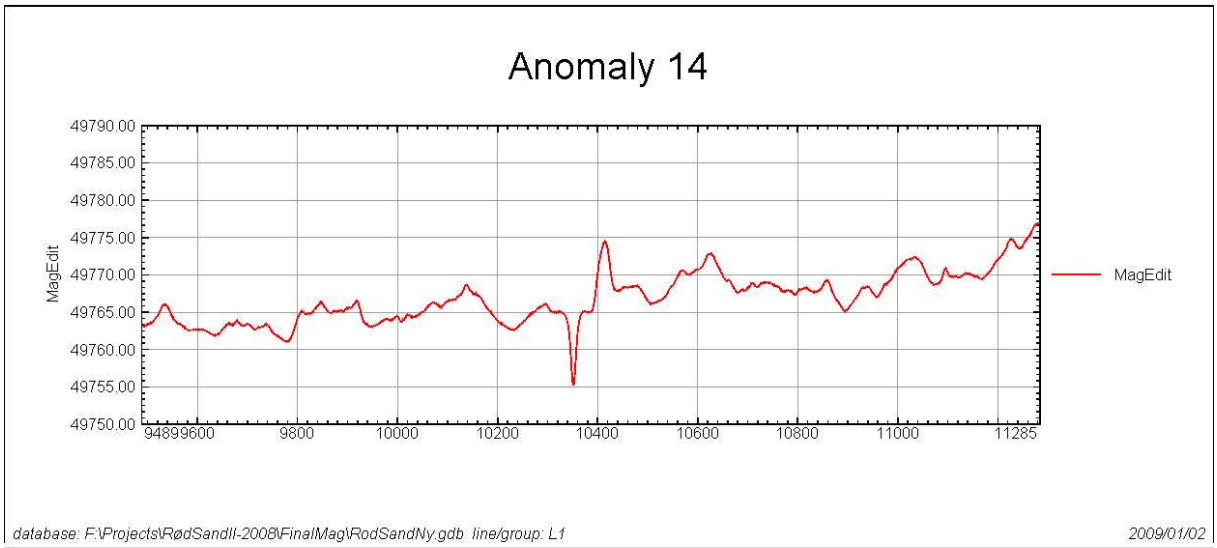
Anomaly 12

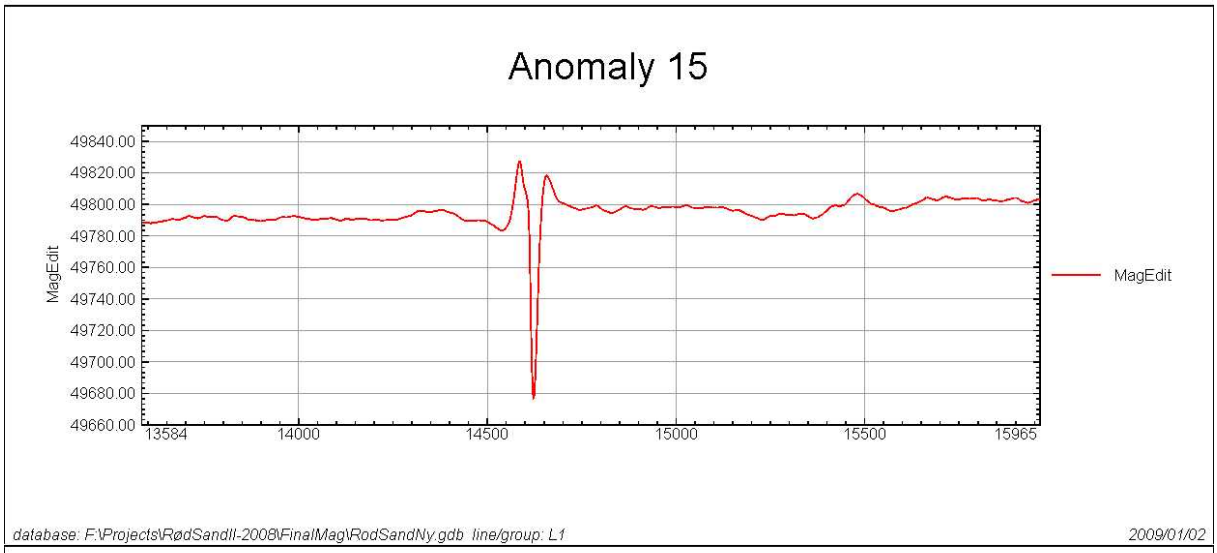
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L1 *2009/01/02*

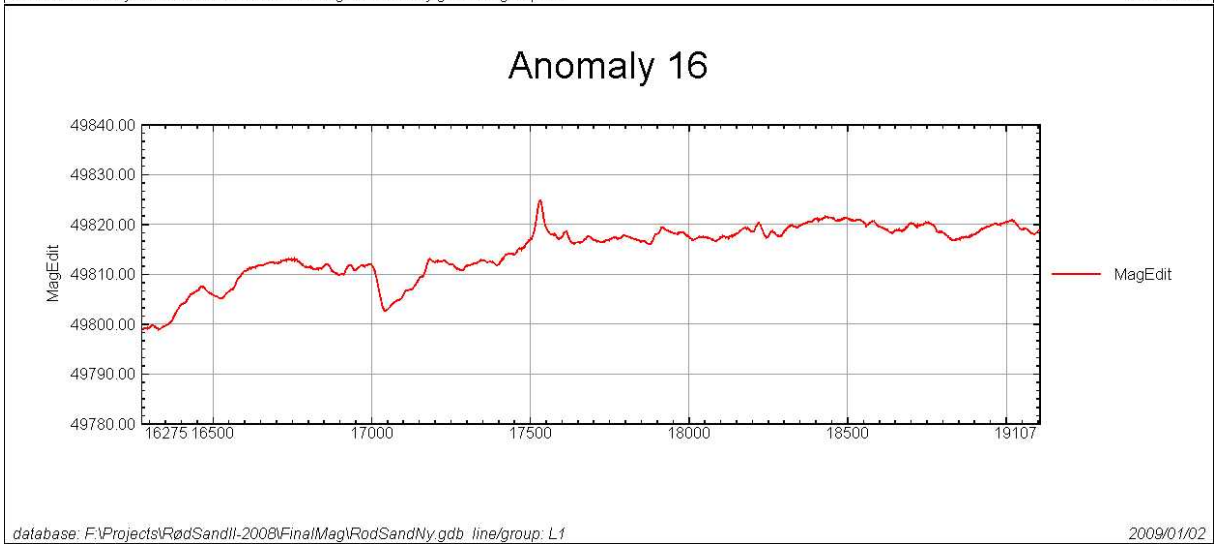
Anomaly 13

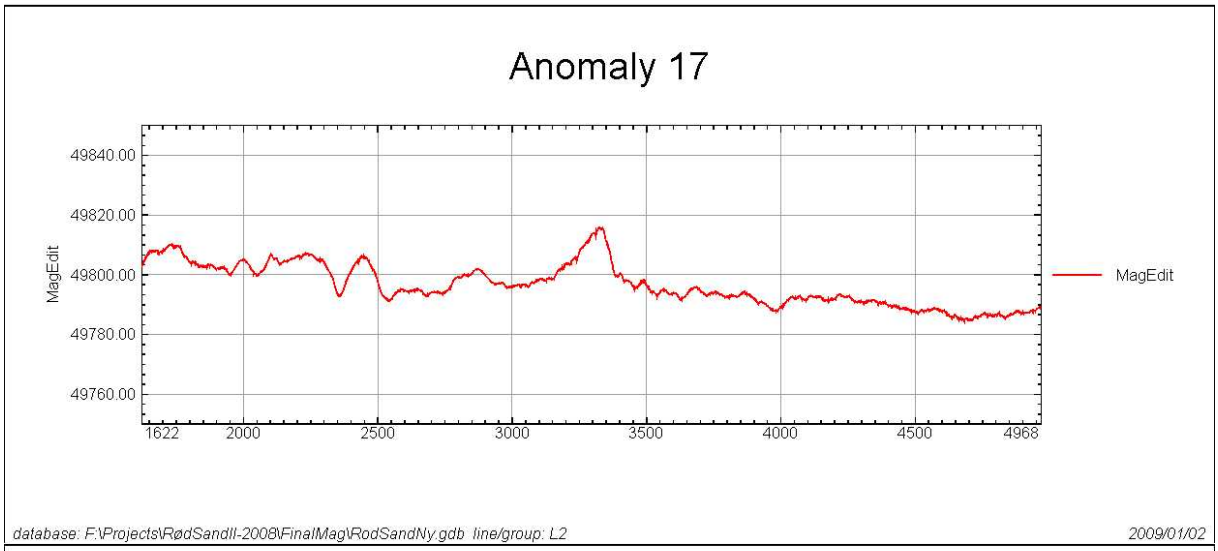


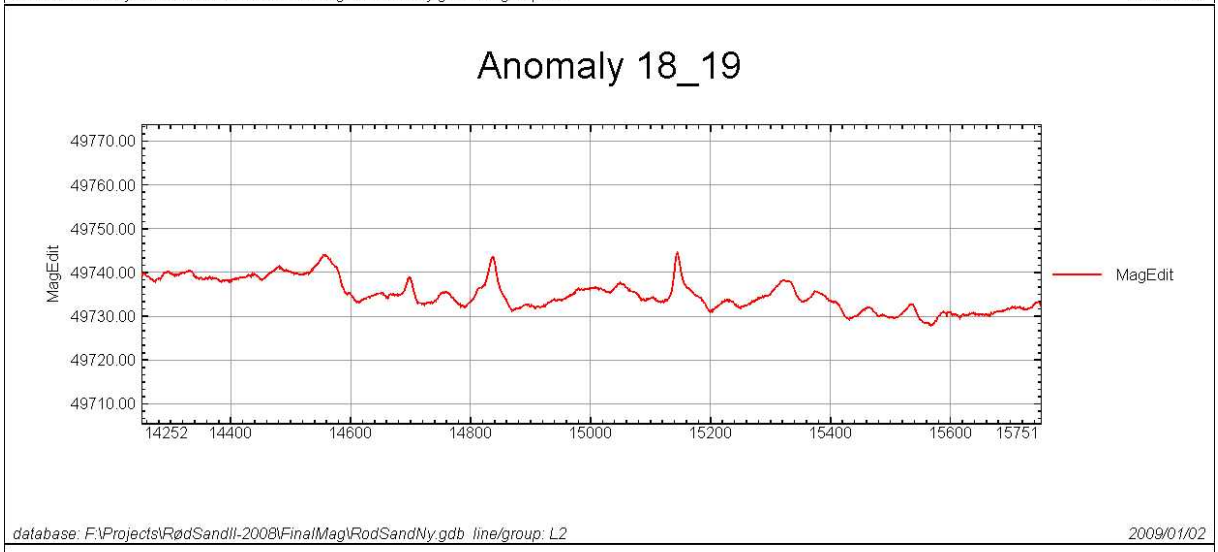
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L1 *2009/01/02*

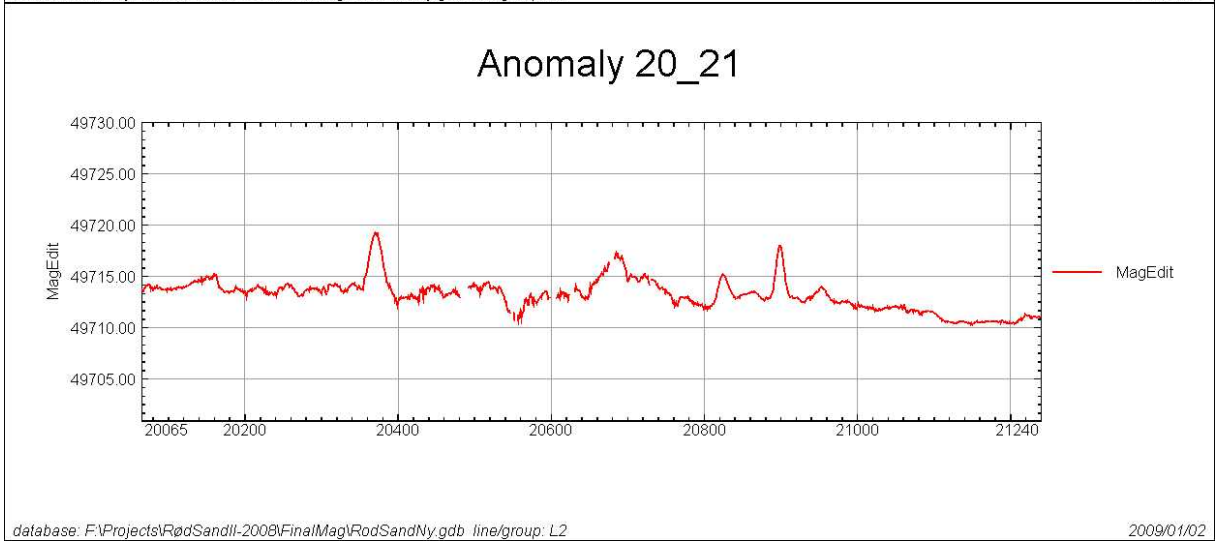

Anomaly 14
MagEdit
49790.00
49785.00
49780.00
49775.00
49770.00
49765.00
49760.00
49755.00
49750.00
94899600
9800
10000
10200
10400
10600
10800
11000
11285
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L1
2009/01/02


Anomaly 15
MagEdit
49840.00
49820.00
49800.00
49780.00
49760.00
49740.00
49720.00
49700.00
49680.00
49660.00
13584
14000
14500
15000
15500
15965
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L1
2009/01/02

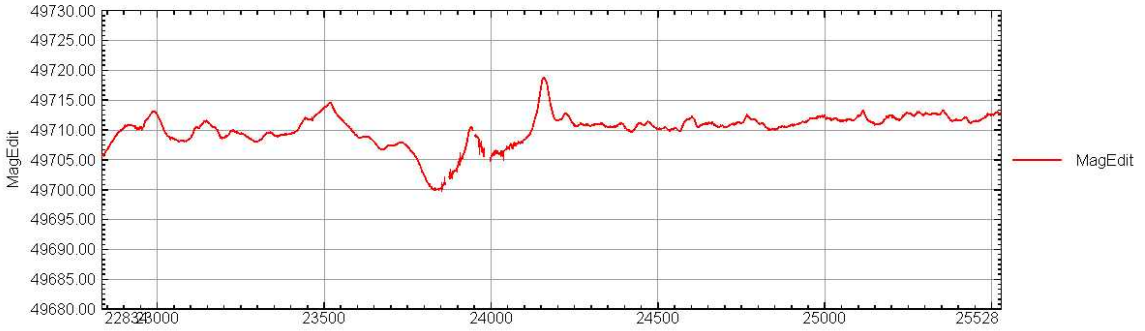

Anomaly 16
MagEdit
49840.00
49830.00
49820.00
49810.00
49800.00
49790.00
49780.00
16275 16500
17000
17500
18000
18500
19107
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L1
2009/01/02


Anomaly 17
MagEdit
49840.00
49820.00
49800.00
49780.00
49760.00
1622
2000
2500
3000
3500
4000
4500
4968
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L2
2009/01/02


Anomaly 18_19
MagEdit
49770.00
49760.00
49750.00
49740.00
49730.00
49720.00
49710.00
14252
14400
14600
14800
15000
15200
15400
15600
15751
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L2
2009/01/02

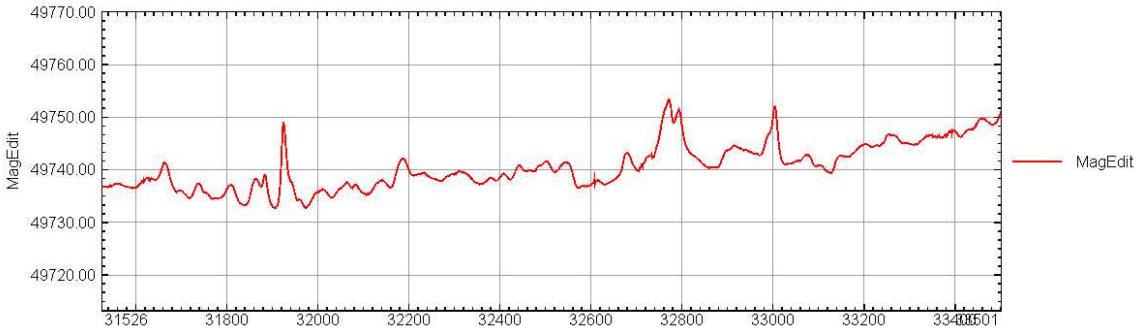

Anomaly 20_21
MagEdit
49730.00
49725.00
49720.00
49715.00
49710.00
49705.00
20065
20200
20400
20600
20800
21000
21240
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L2
2009/01/02

Anomaly 22



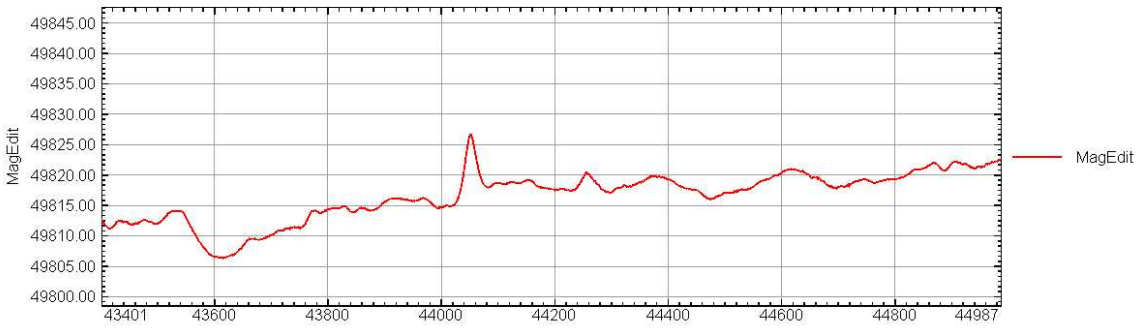
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L2 *2009/01/02*

Anomaly 23_24_25



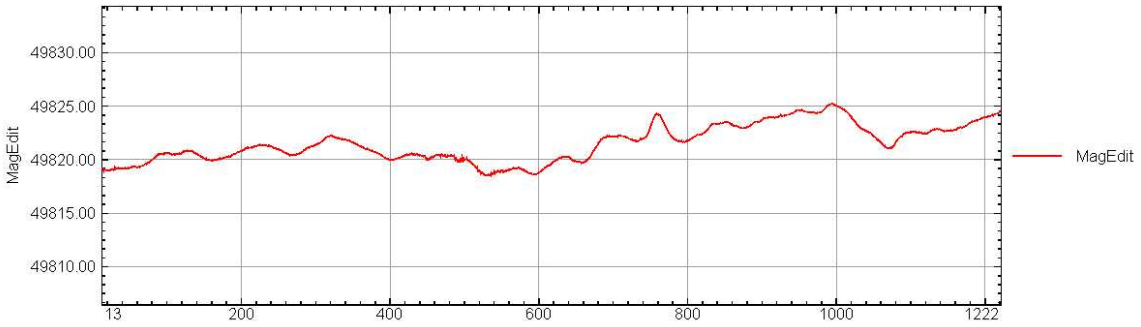
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L2 *2009/01/02*

Anomaly 26



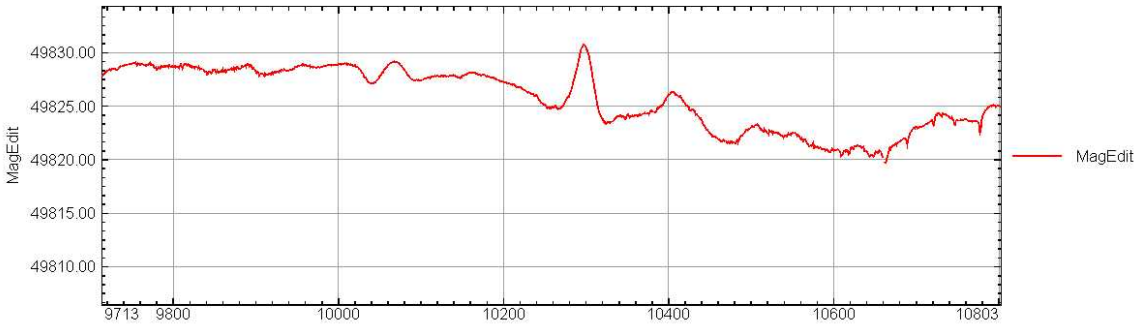
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L2 *2009/01/02*

Anomaly 27



database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L3 *2009/01/03*

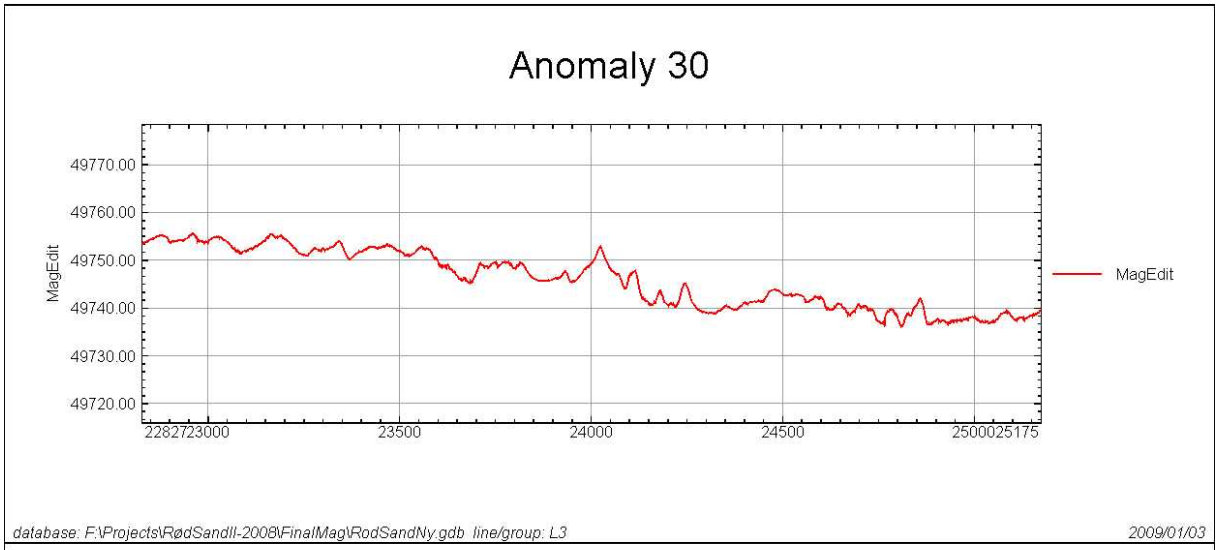
Anomaly 28

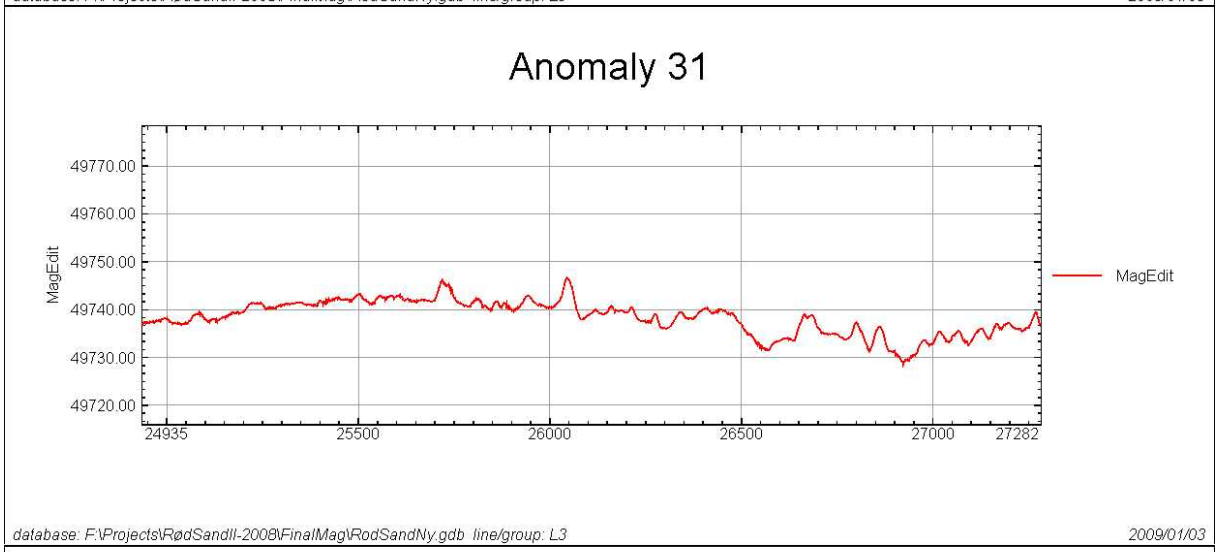


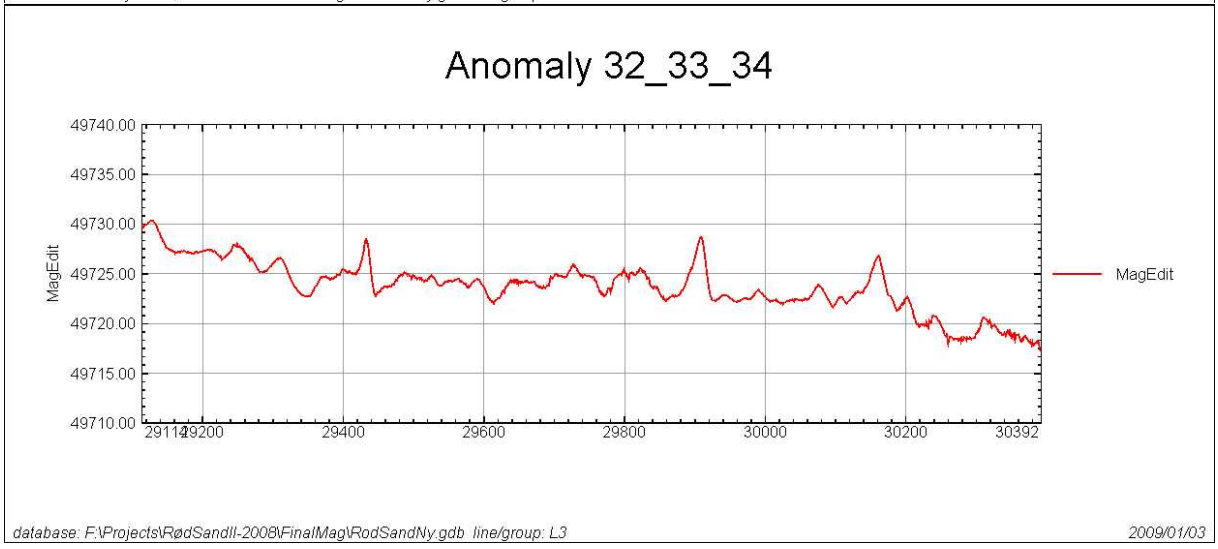
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L3 *2009/01/03*

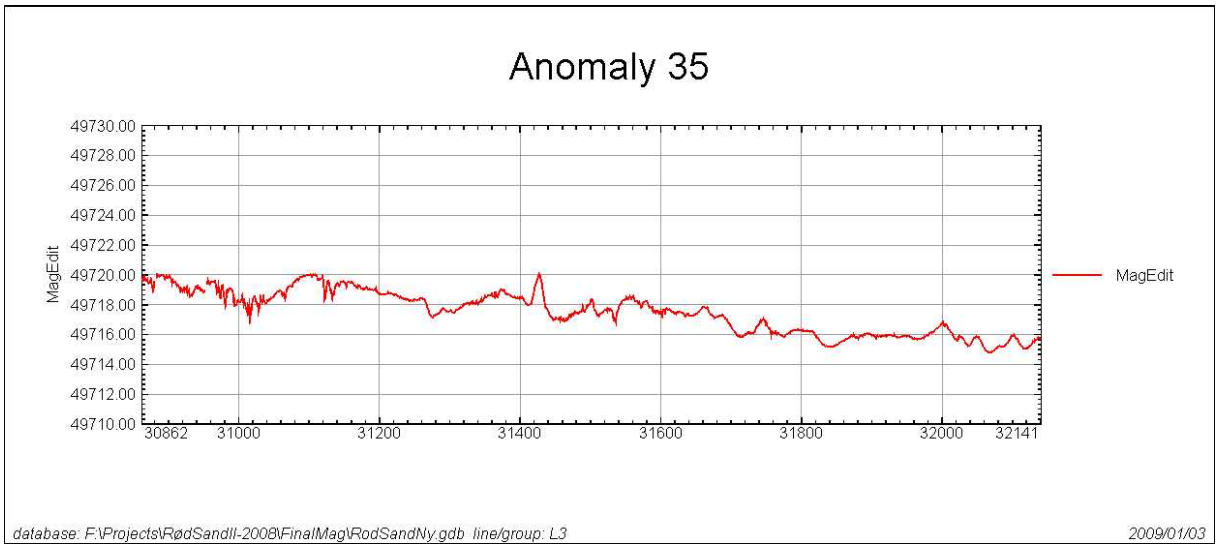
Anomaly 29

database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L3 *2009/01/03*


Anomaly 30
MagEdit
49770.00
49760.00
49750.00
49740.00
49730.00
49720.00
2282723000
23500
24000
24500
2500025175
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L3
2009/01/03


Anomaly 31
MagEdit
49770.00
49760.00
49750.00
49740.00
49730.00
49720.00
24935
25500
26000
26500
27000
27282
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L3
2009/01/03

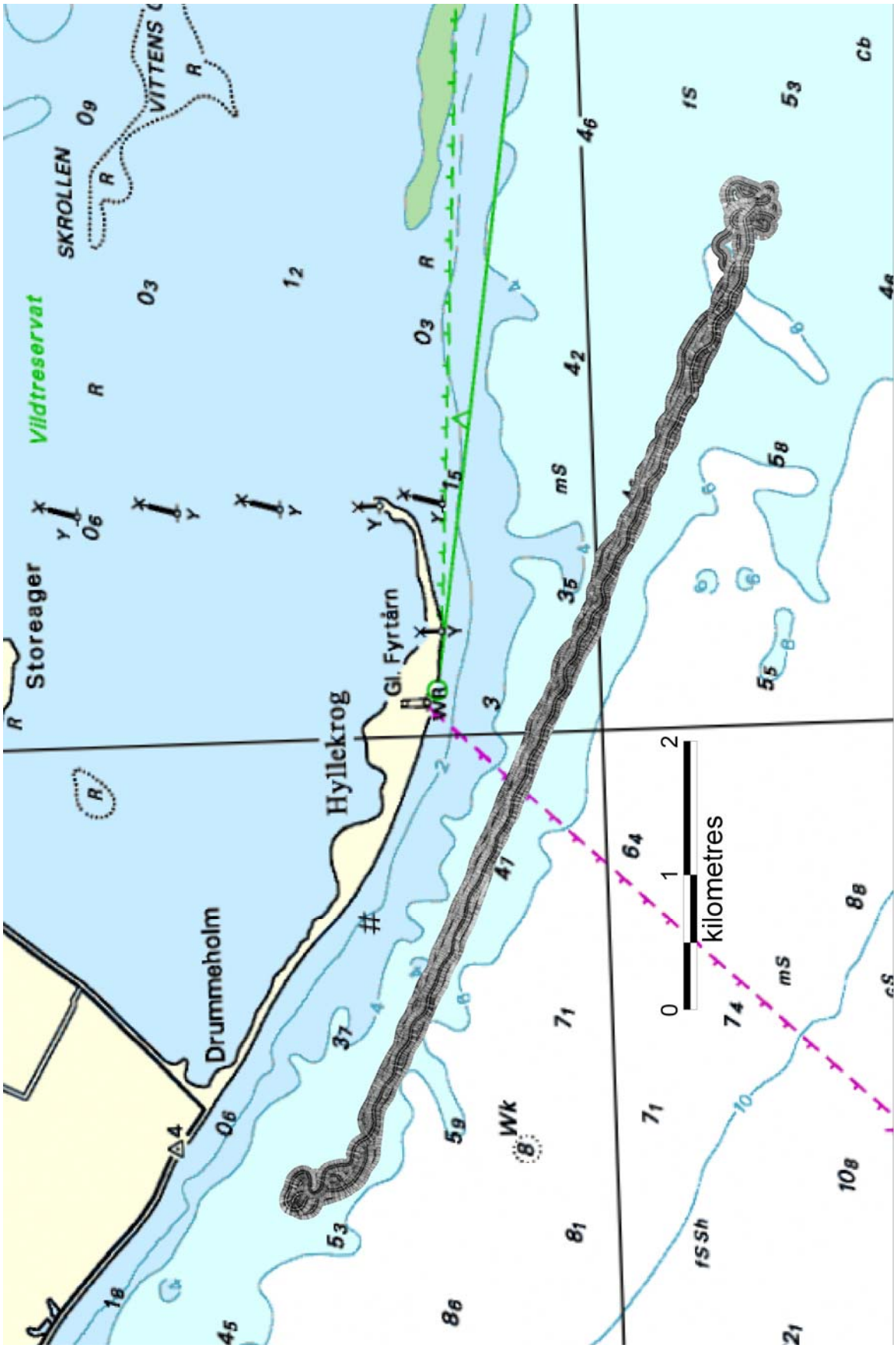

Anomaly 32_33_34
MagEdit
49740.00
49735.00
49730.00
49725.00
49720.00
49715.00
49710.00
29114
29200
29400
29600
29800
30000
30200
30392
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L3
2009/01/03


Anomaly 35
MagEdit
49730.00
49728.00
49726.00
49724.00
49722.00
49720.00
49718.00
49716.00
49714.00
49712.00
49710.00
30862
31000
31200
31400
31600
31800
32000
32141
MagEdit
database: F:\Projects\RødSandII-2008\FinalMag\RodSandNy.gdb line/group: L3
2009/01/03

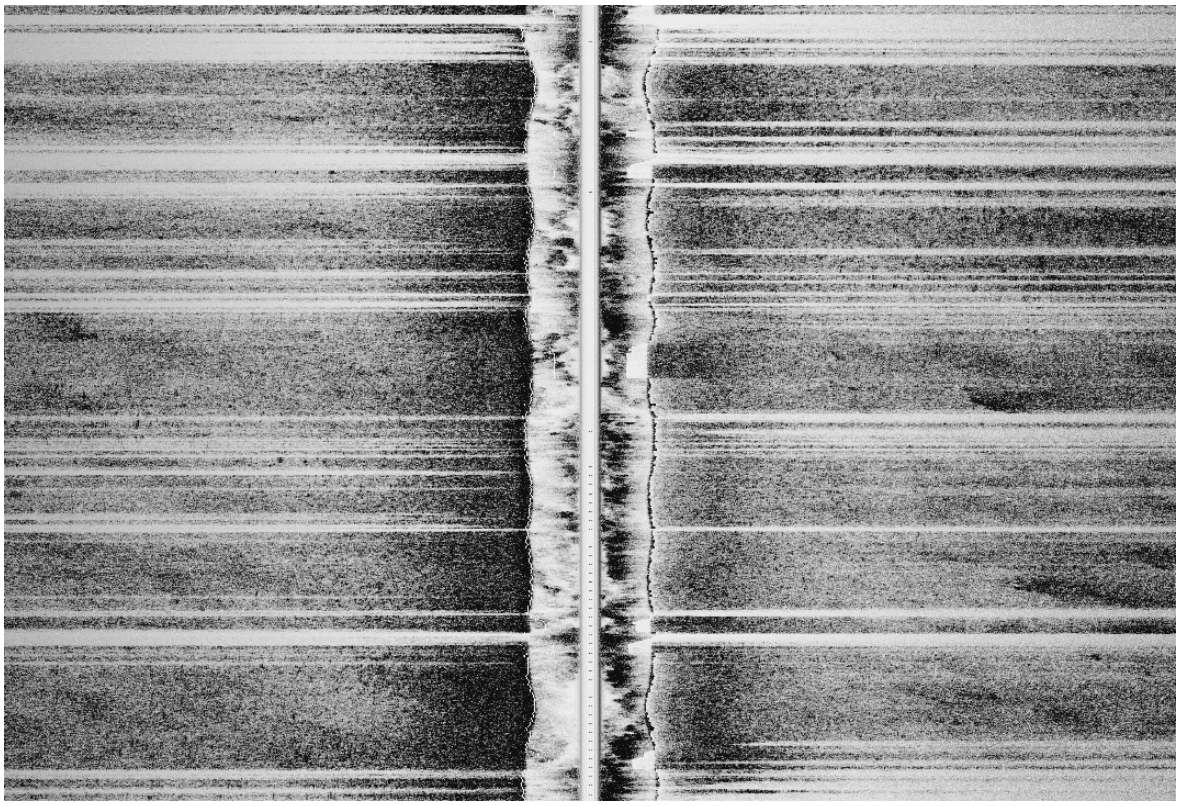
Appendix B

- Kort B1. Sidescan mosaik.

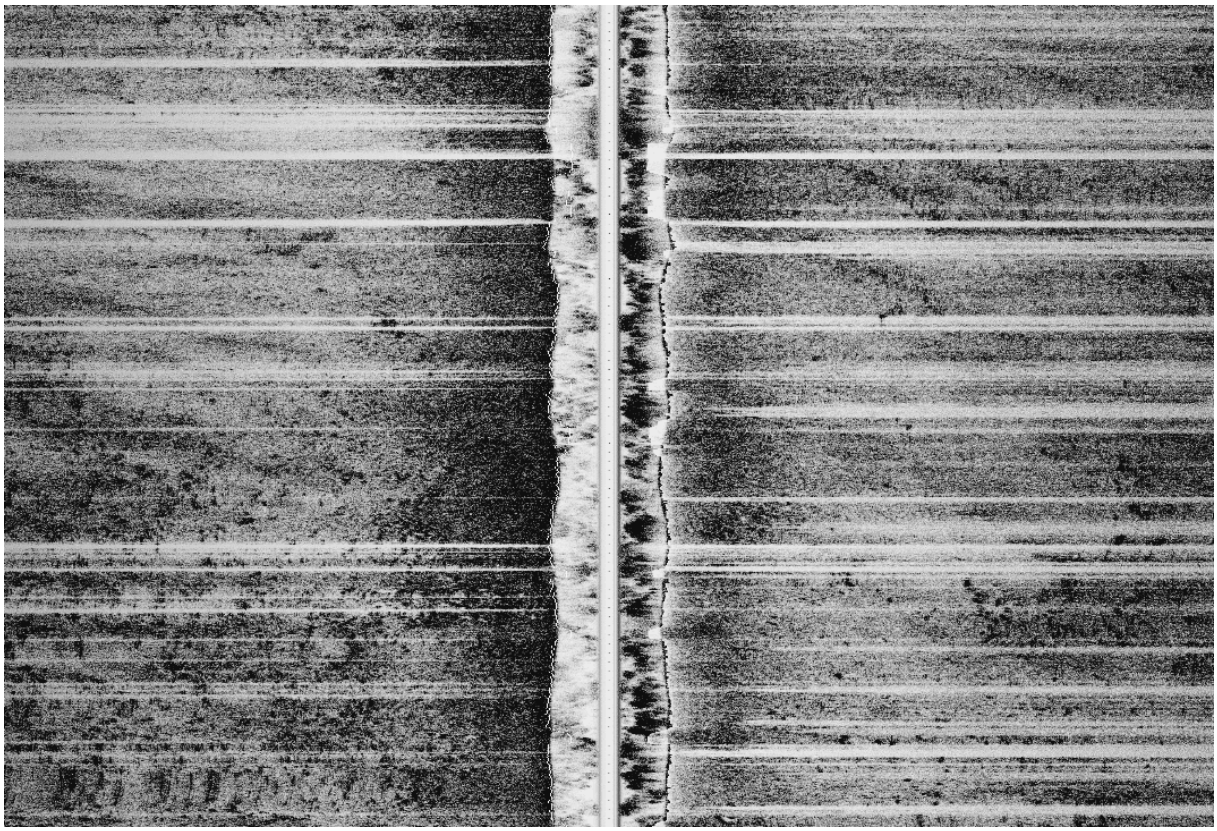
- Sidescan billeder 1 – 35 visende omegnen til hver af de magnetiske anomalier



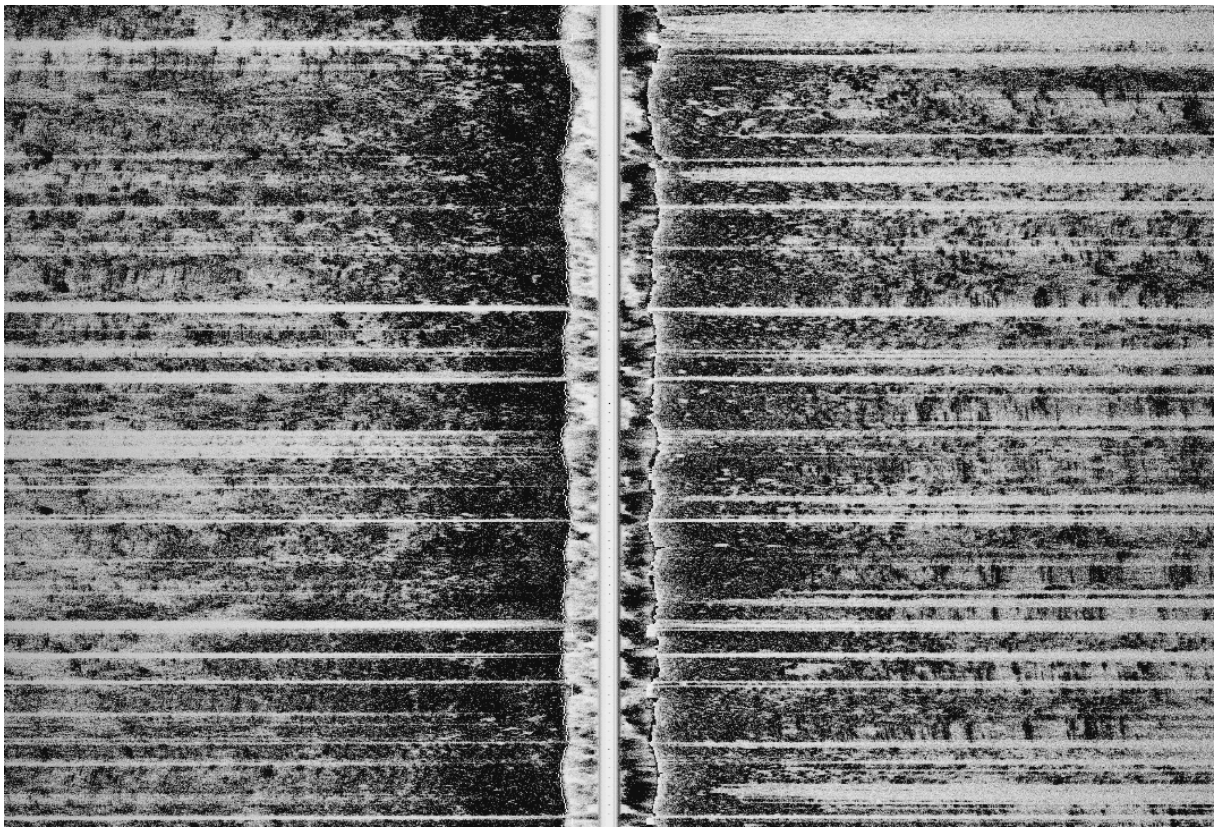
Kort B1. Sidescan mosaik.



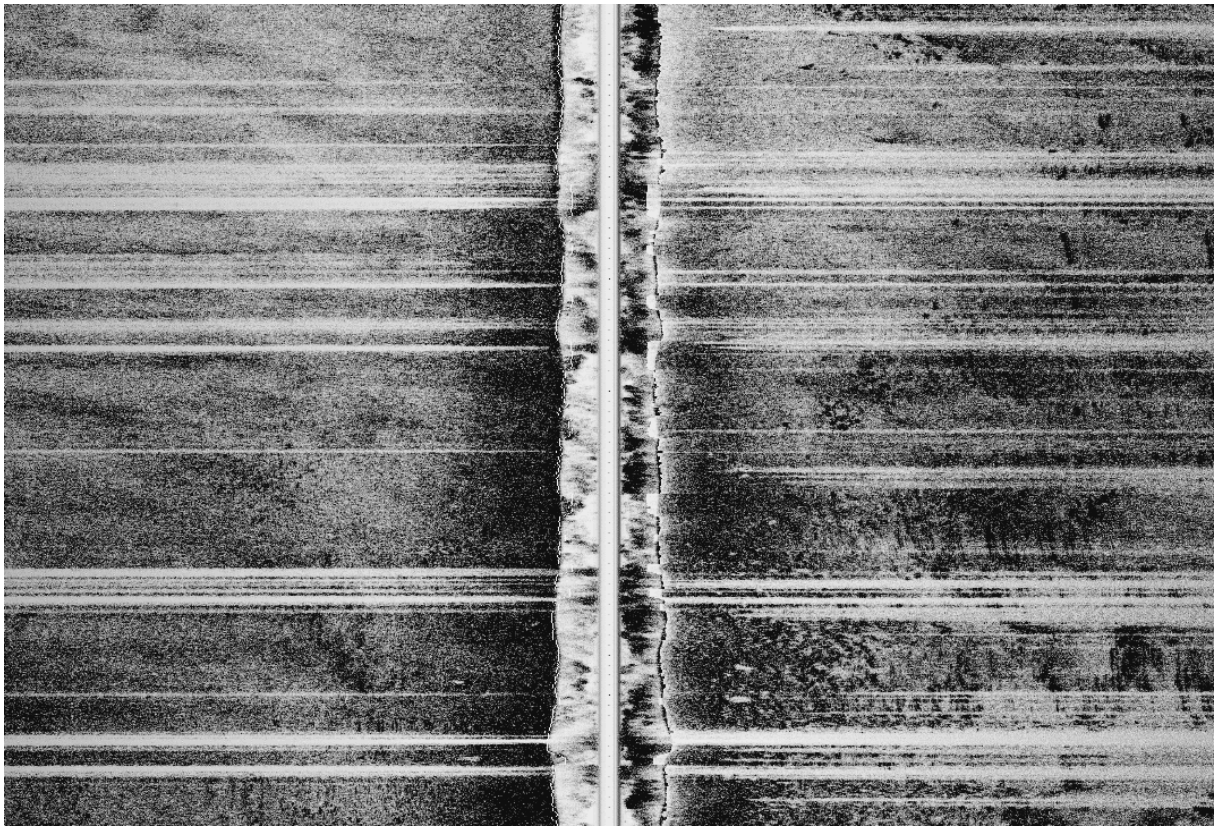
Sidescan billede af Anomali 1



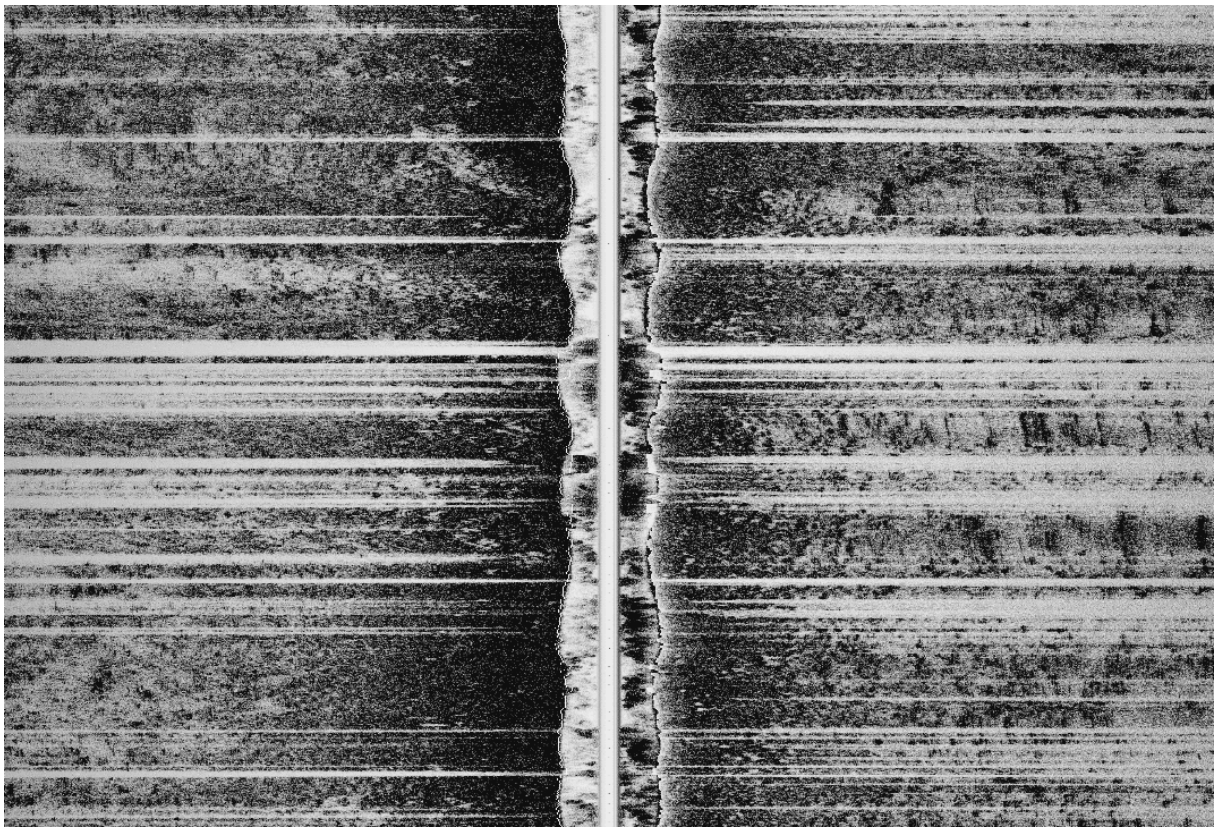
Anomali 2



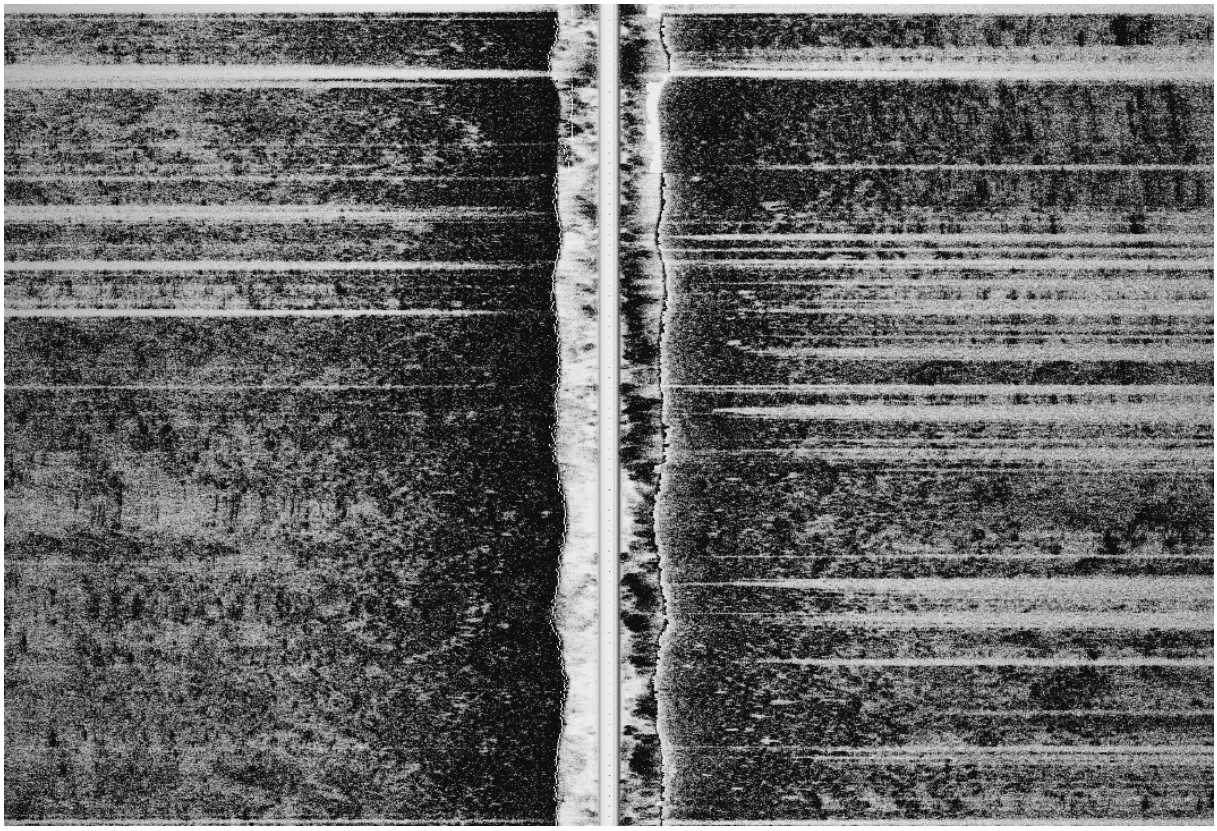
Anomali 3



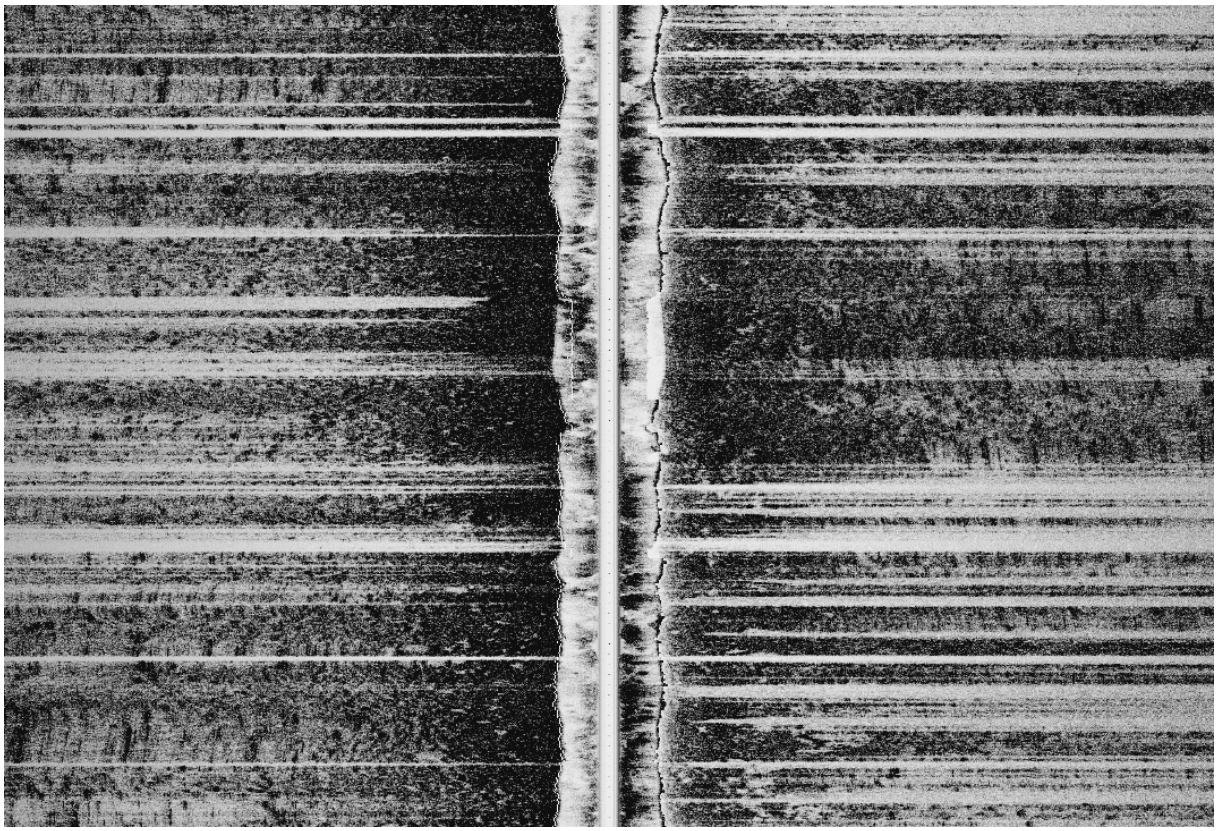
Anomali 4



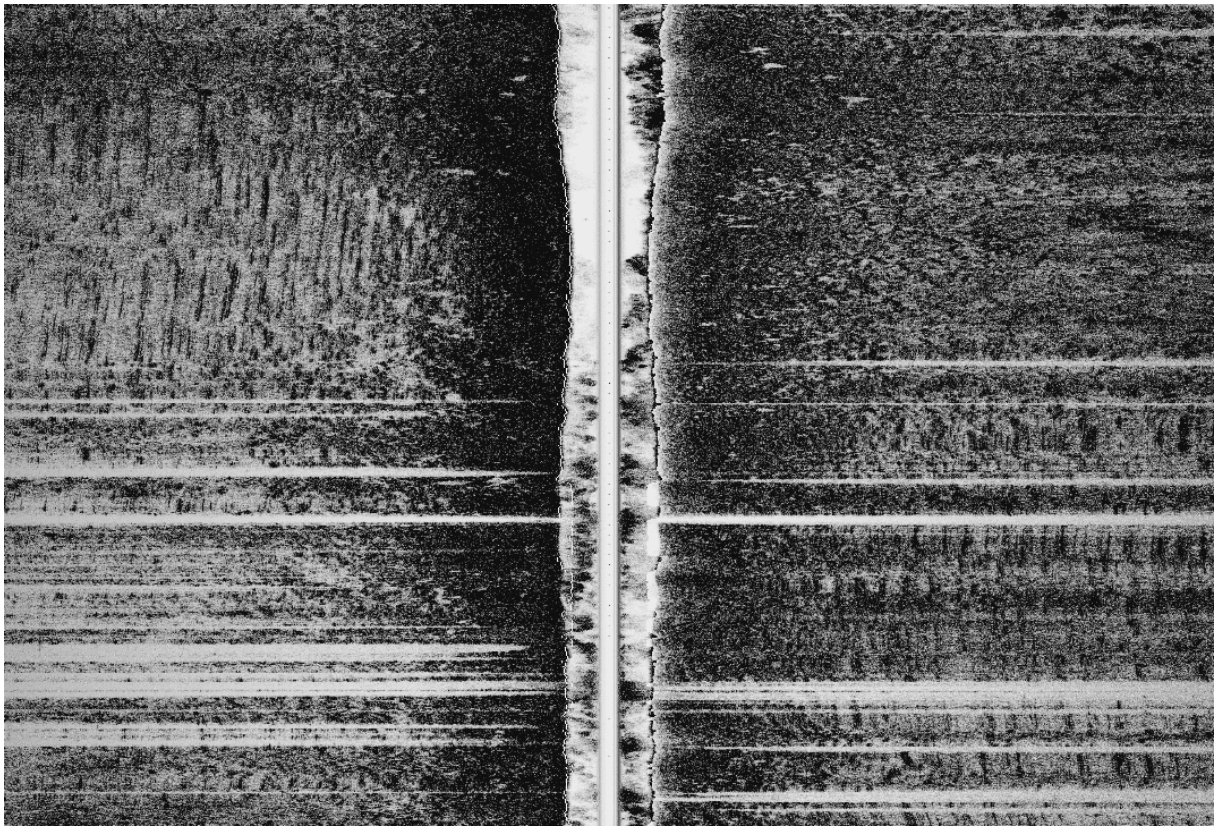
Anomali 5



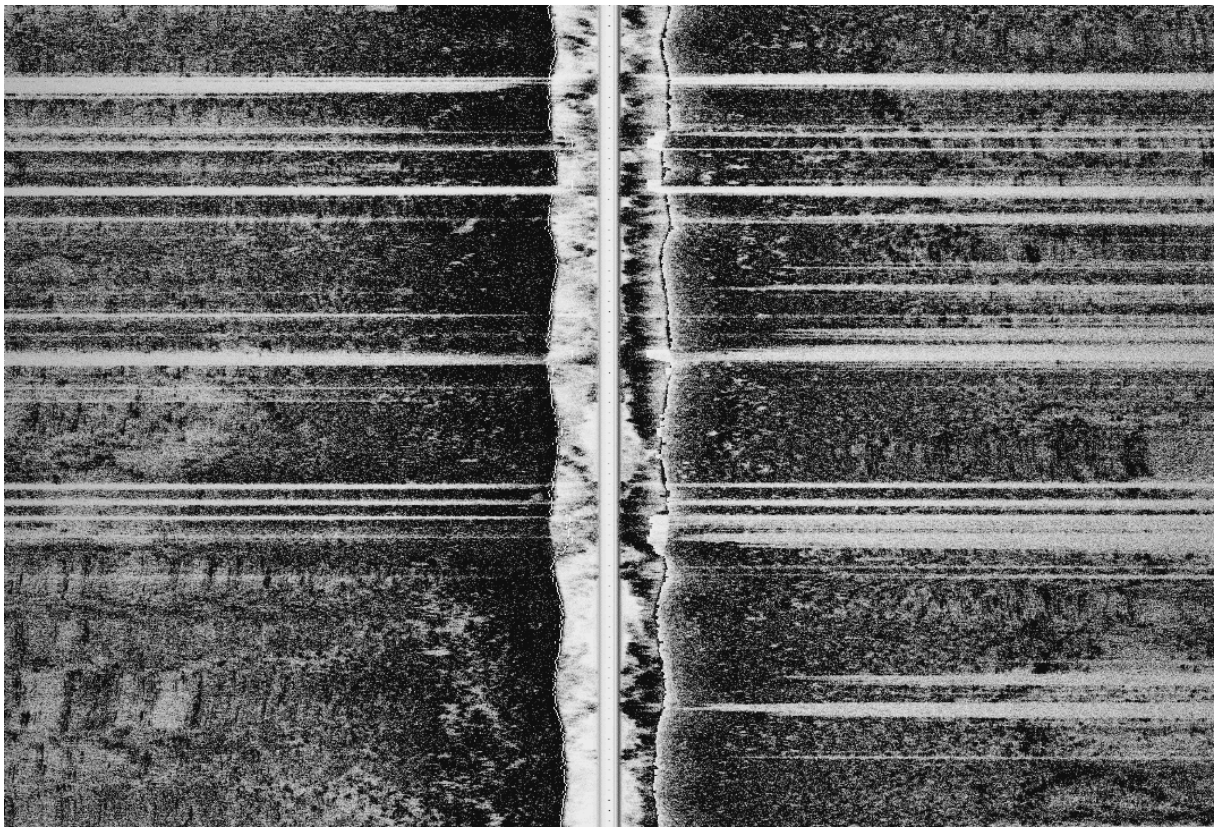
Anomali 6



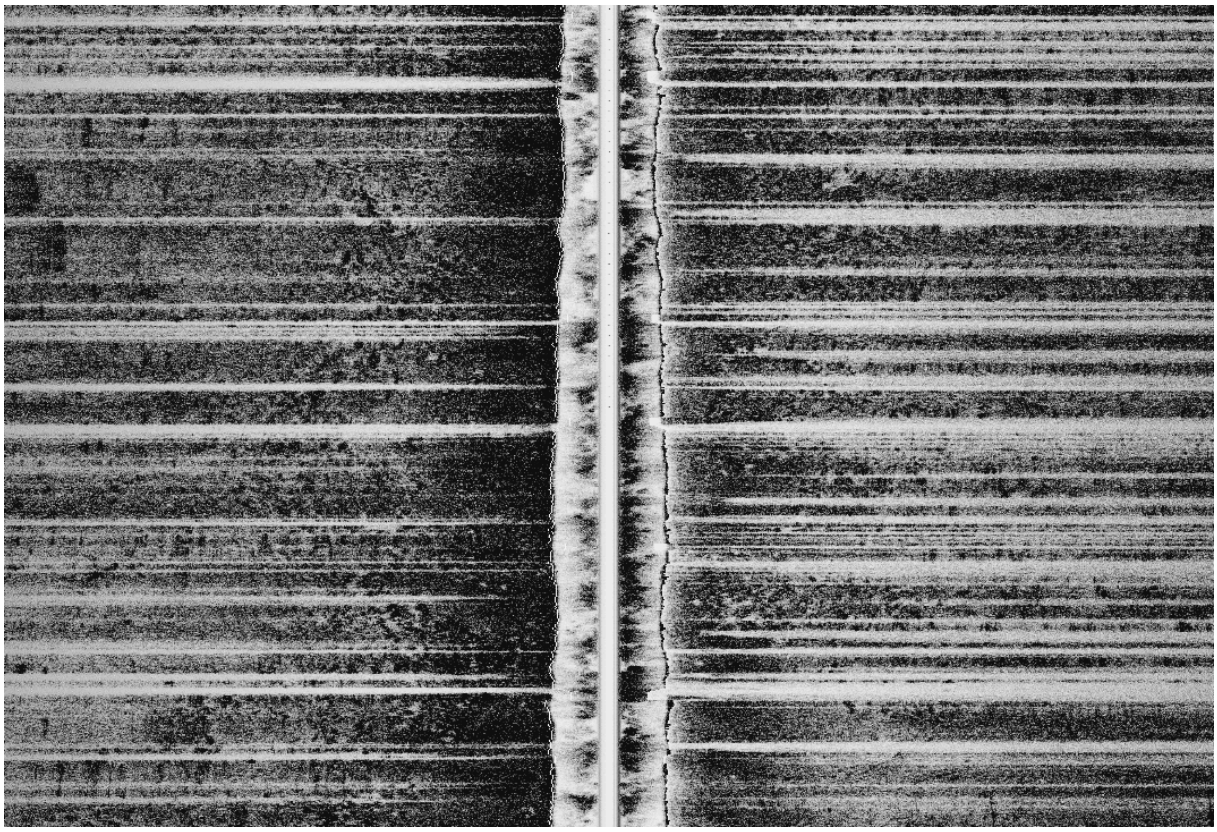
Anomali 7



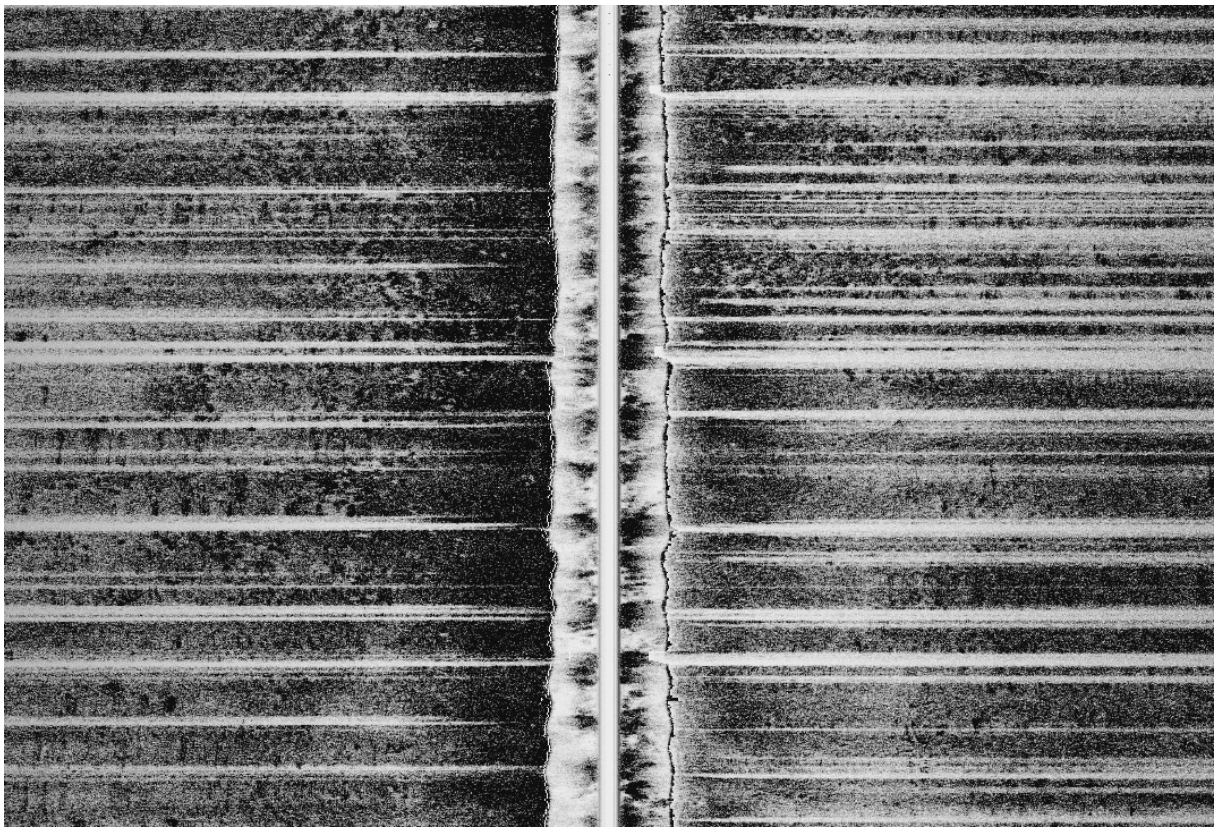
Anomali 8



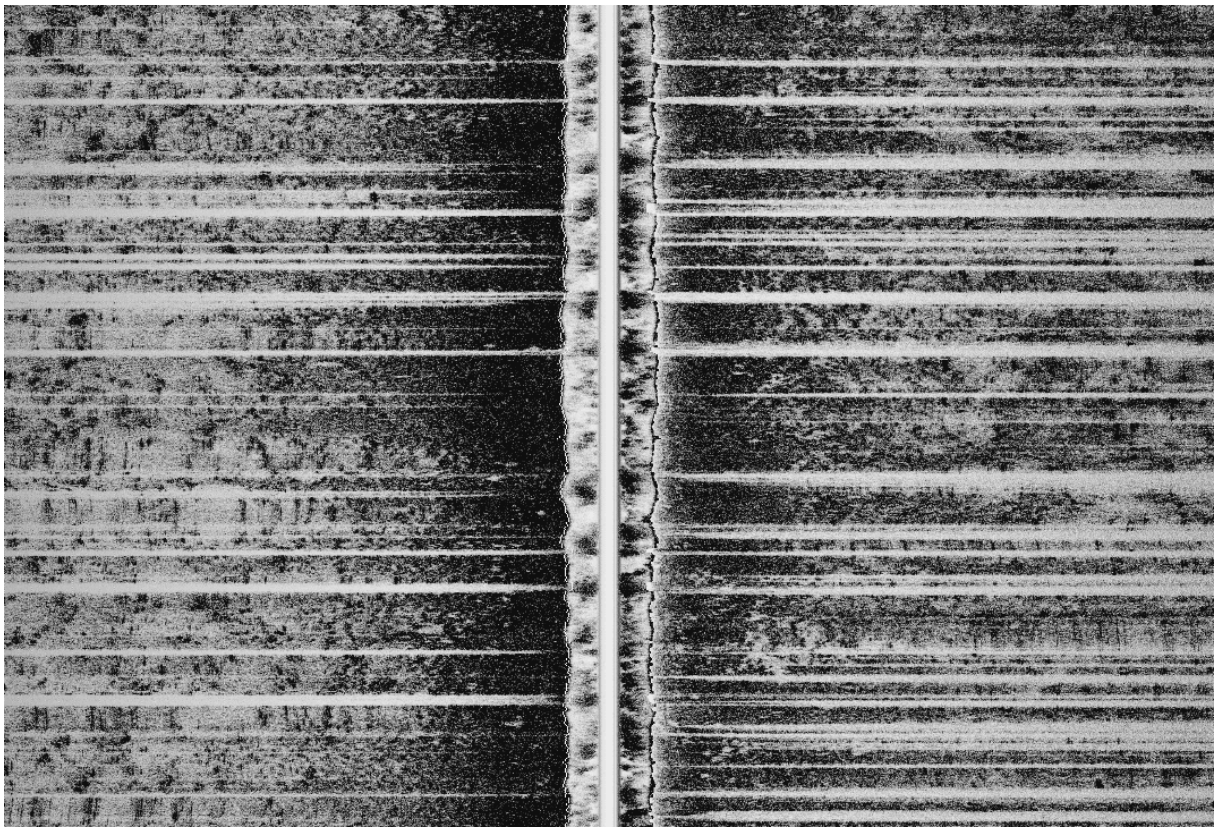
Anomali 9



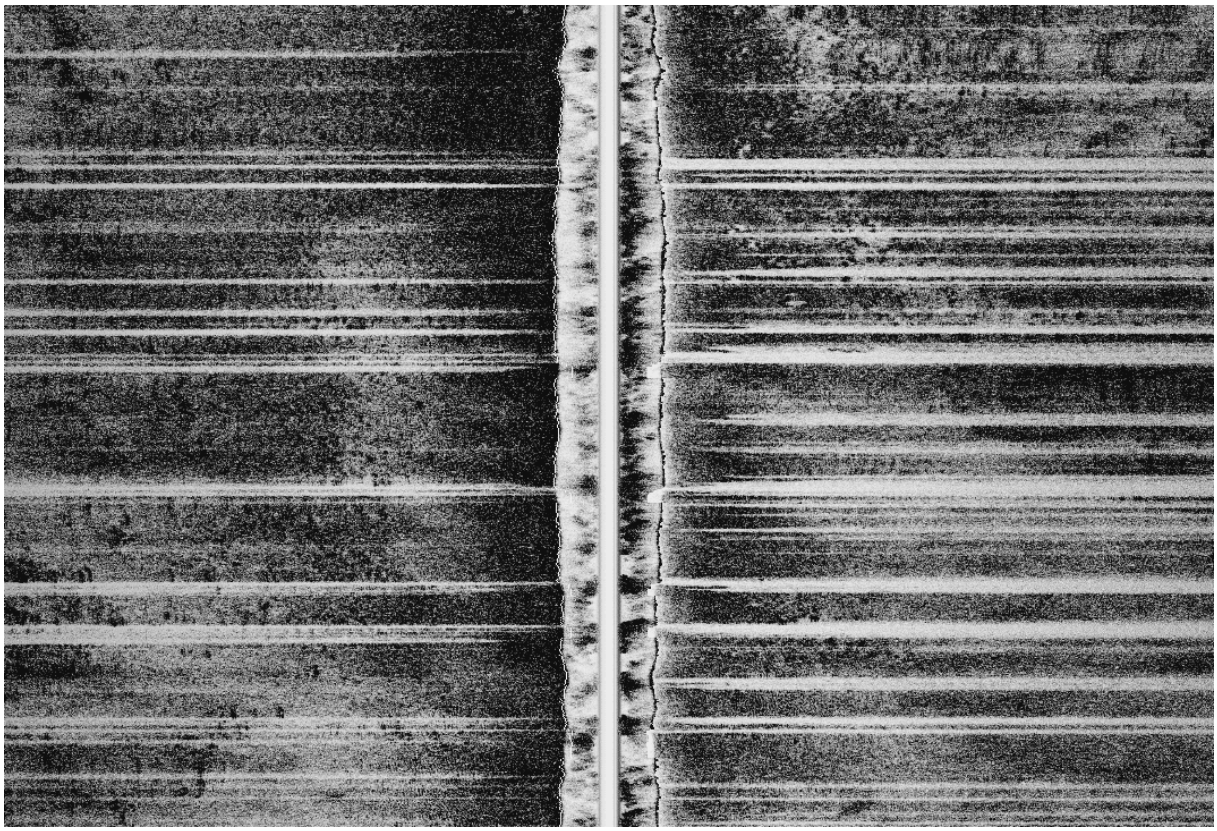
Anomali 10



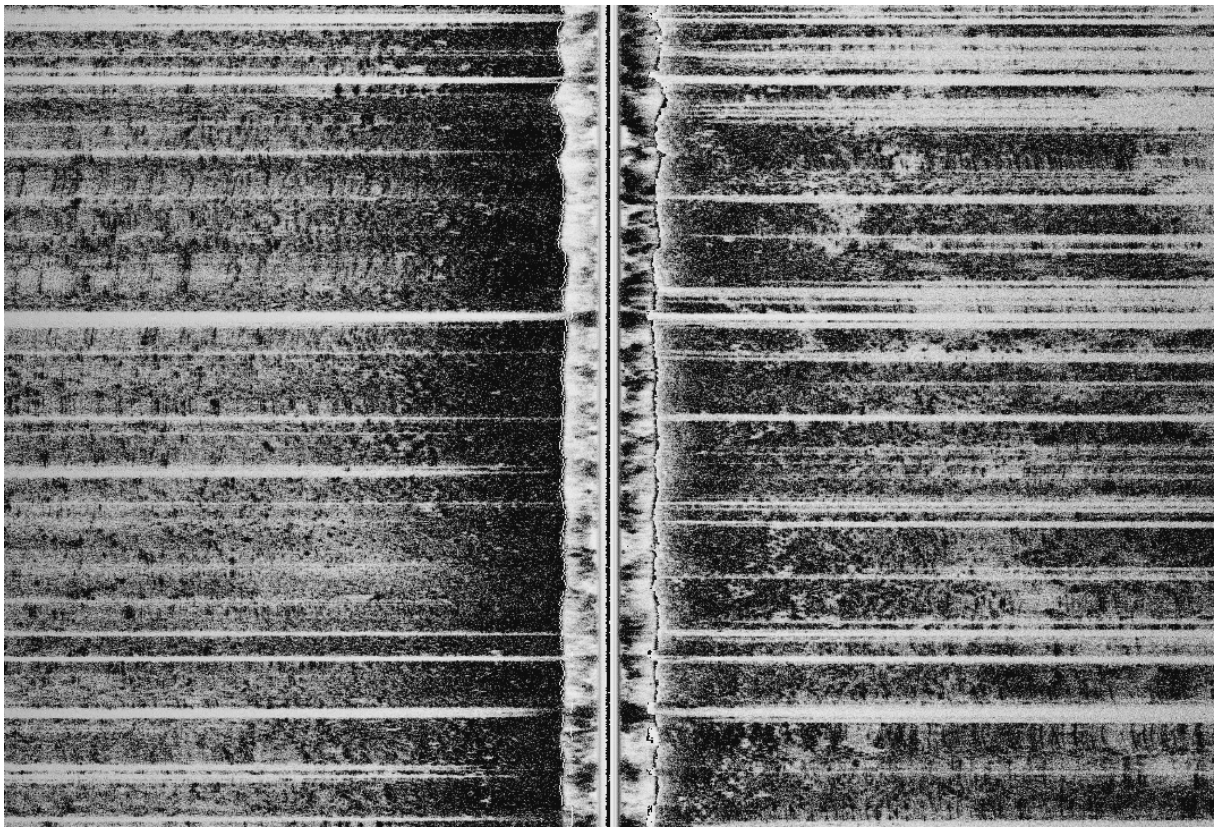
Anomali 11



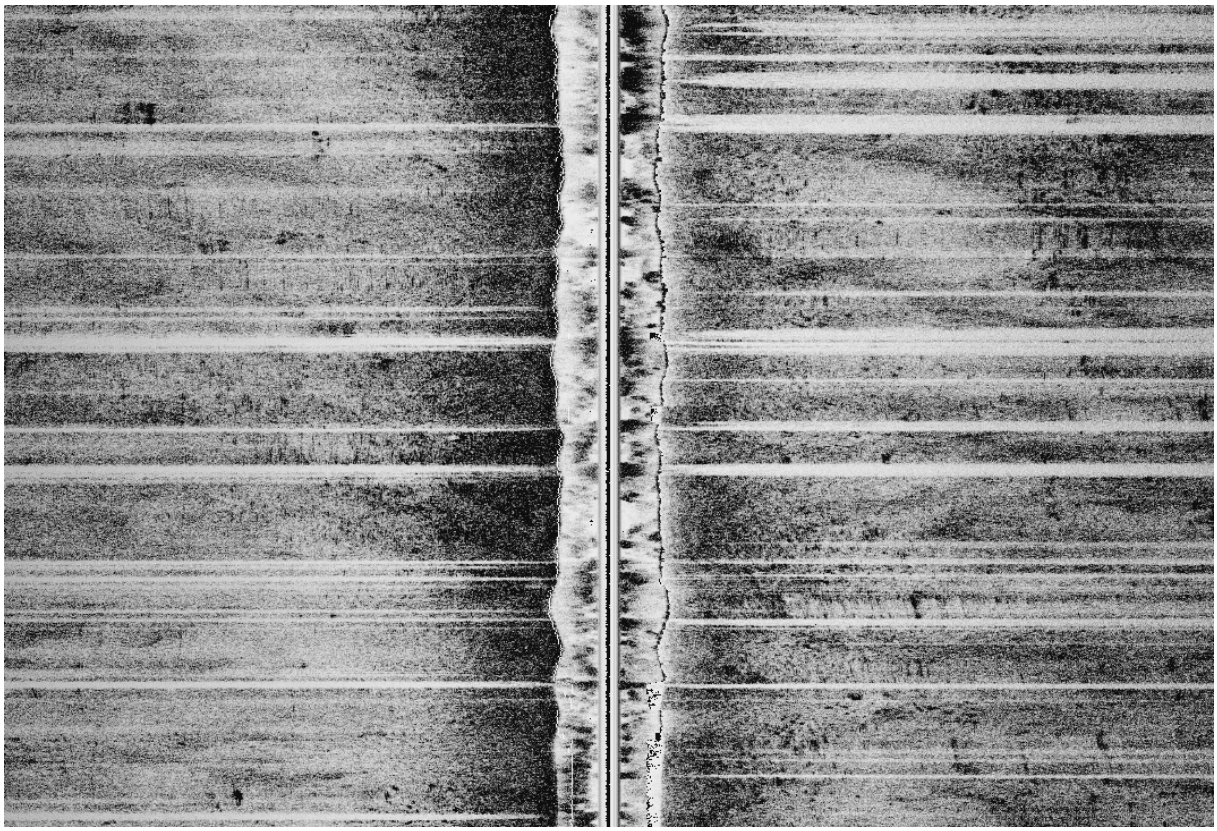
Anomali 12



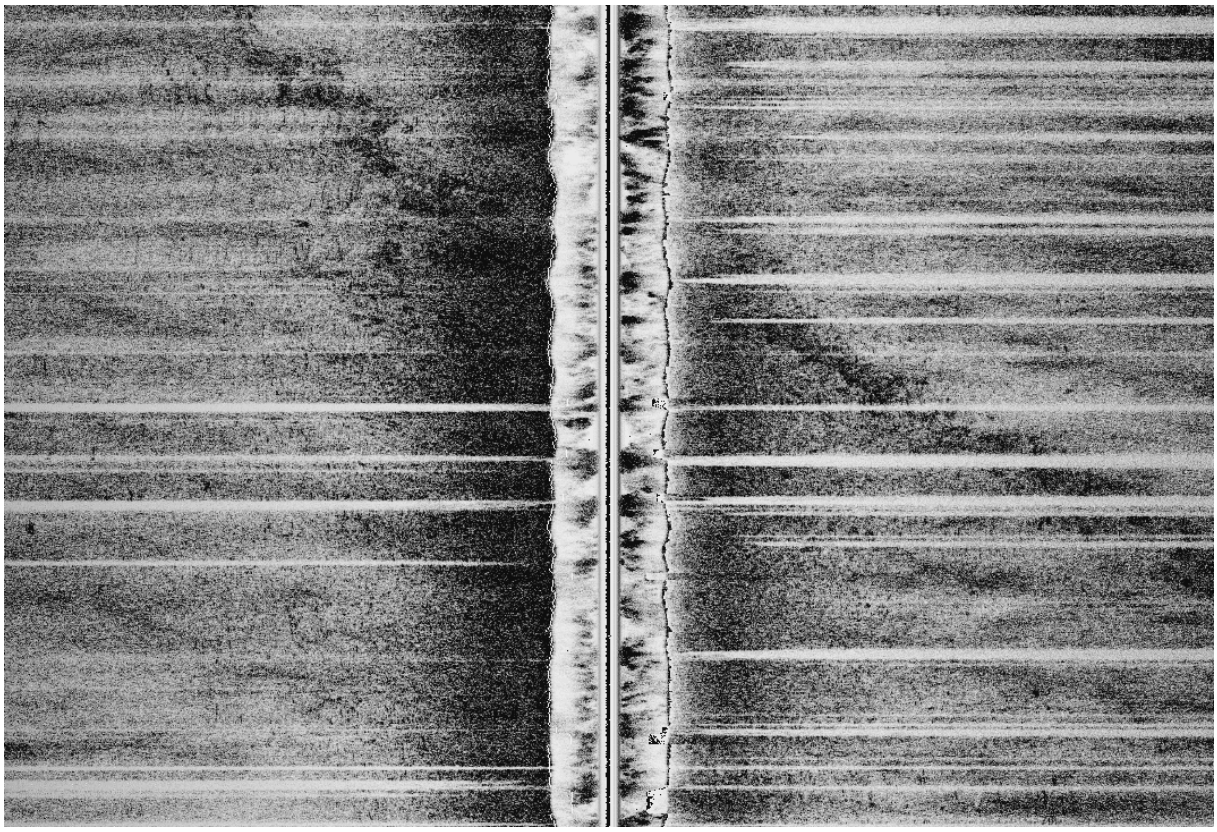
Anomali 13



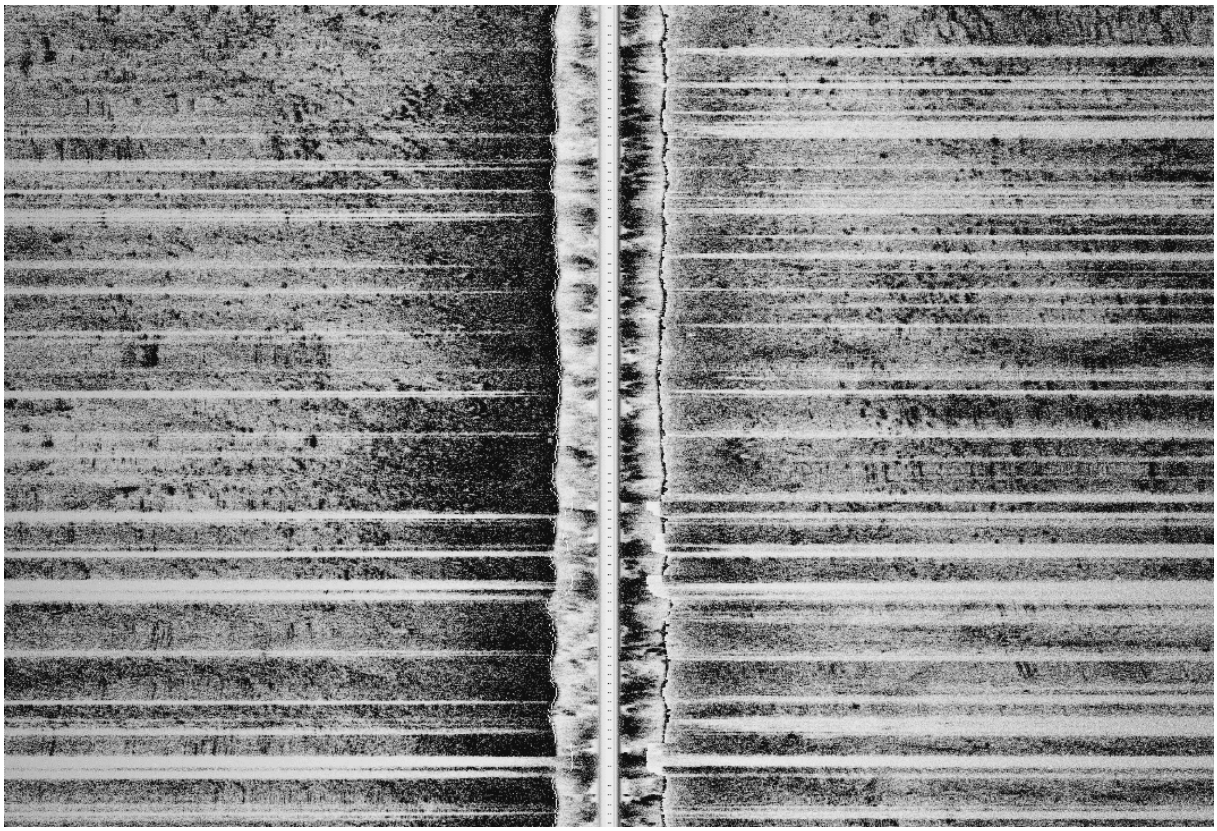
Anomali 14



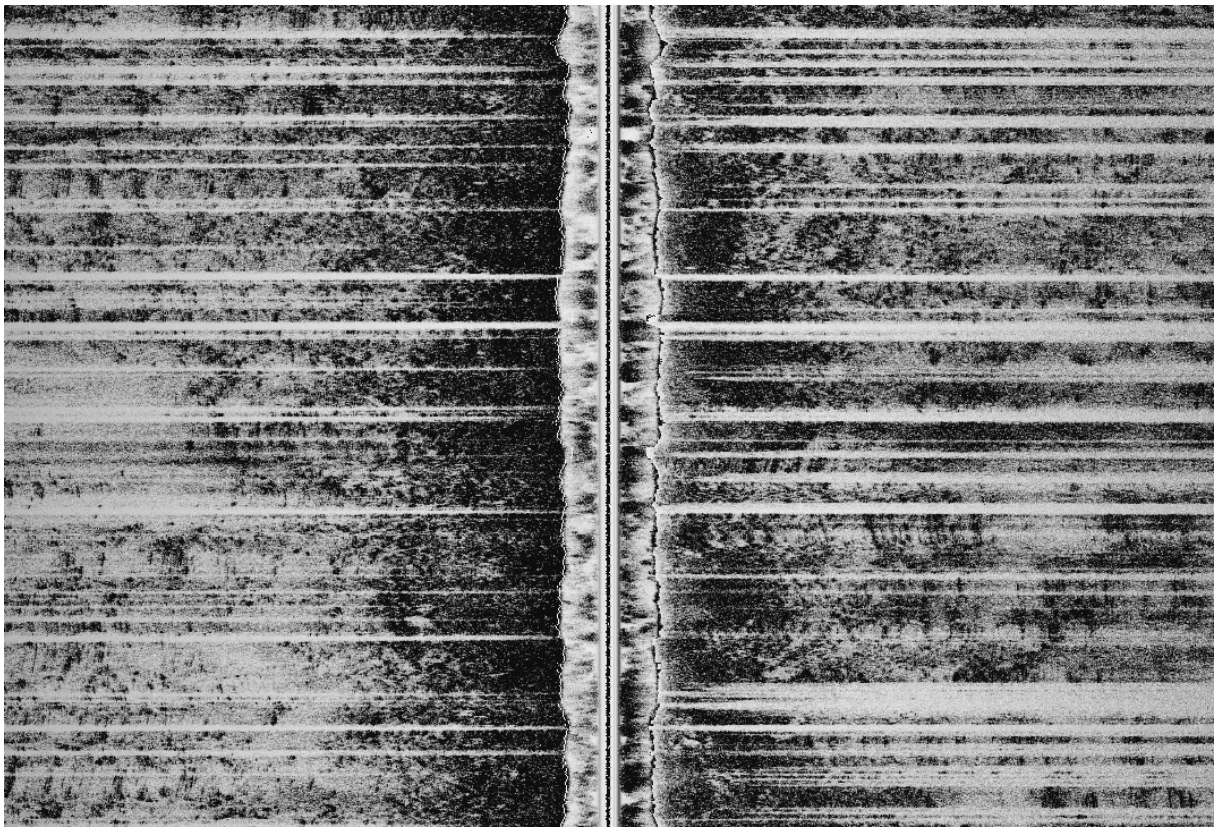
Anomali 15



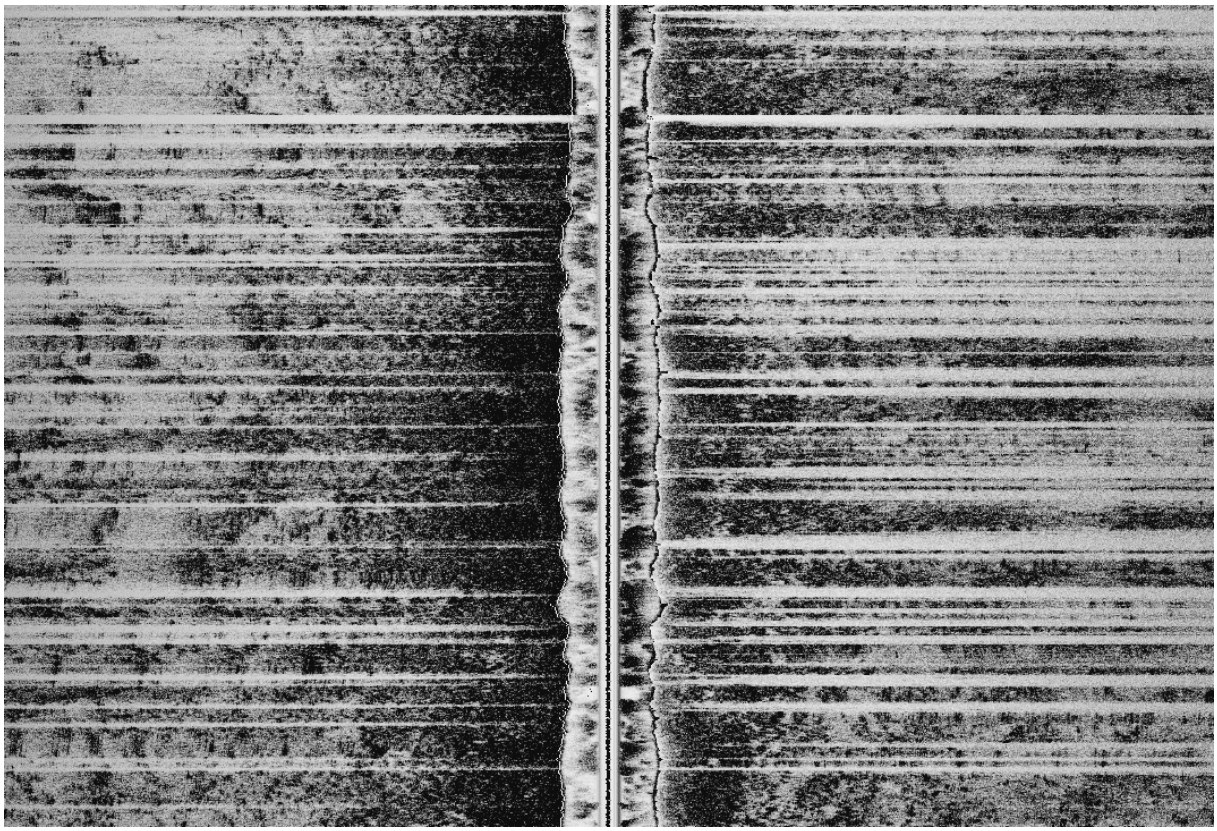
Anomali 16



Anomali 17



Anomali 18



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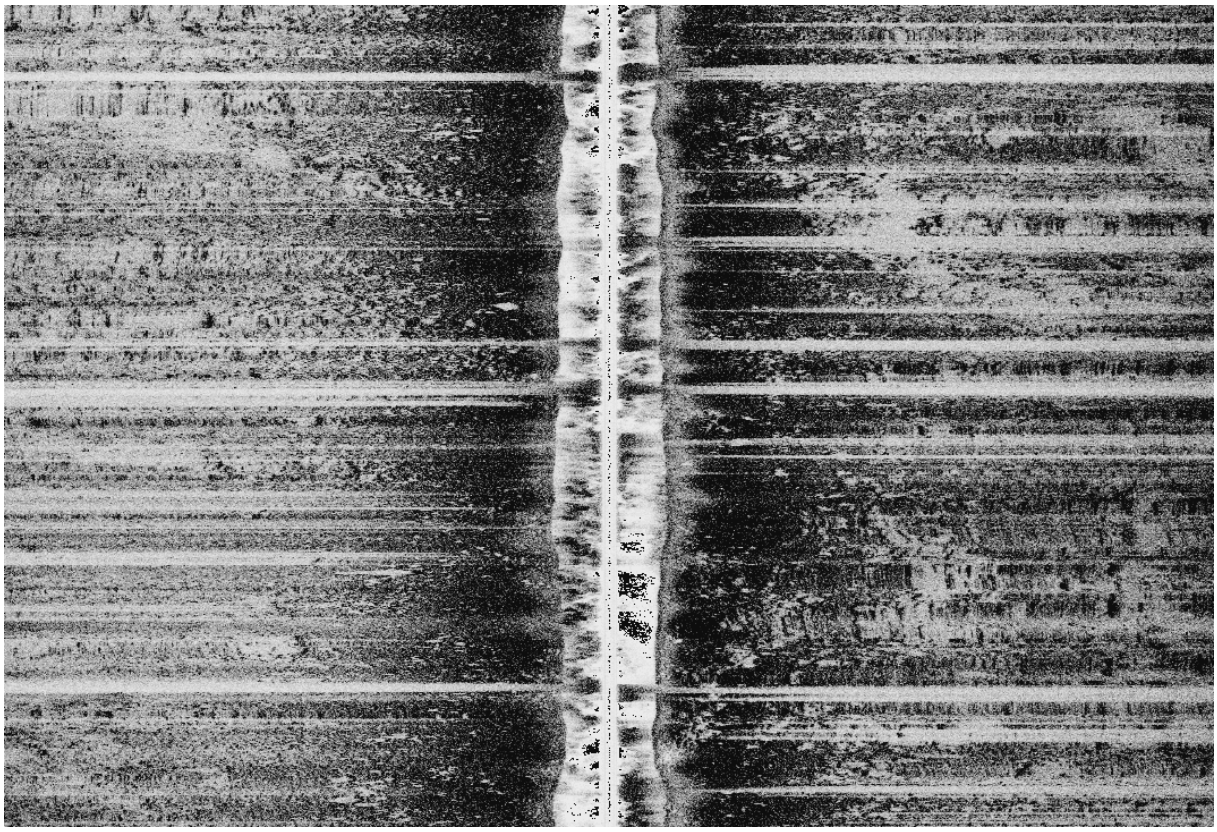

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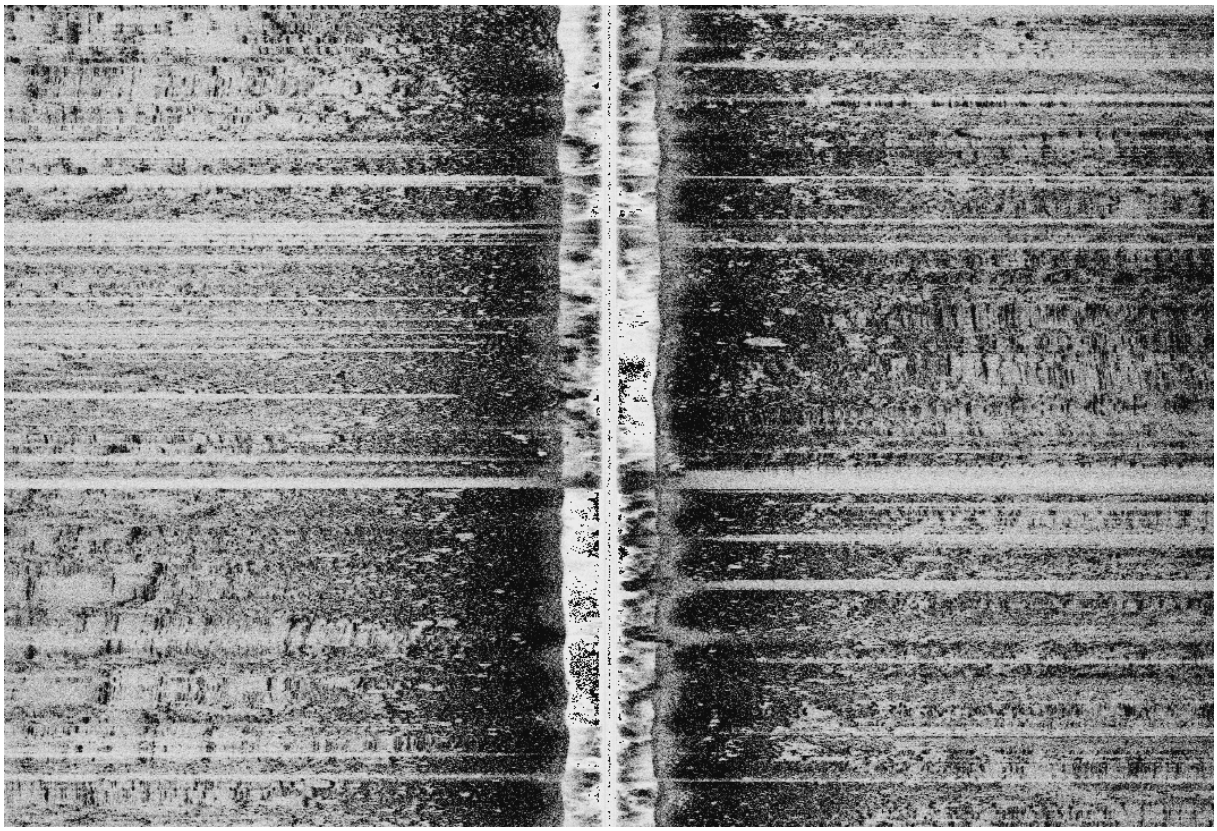

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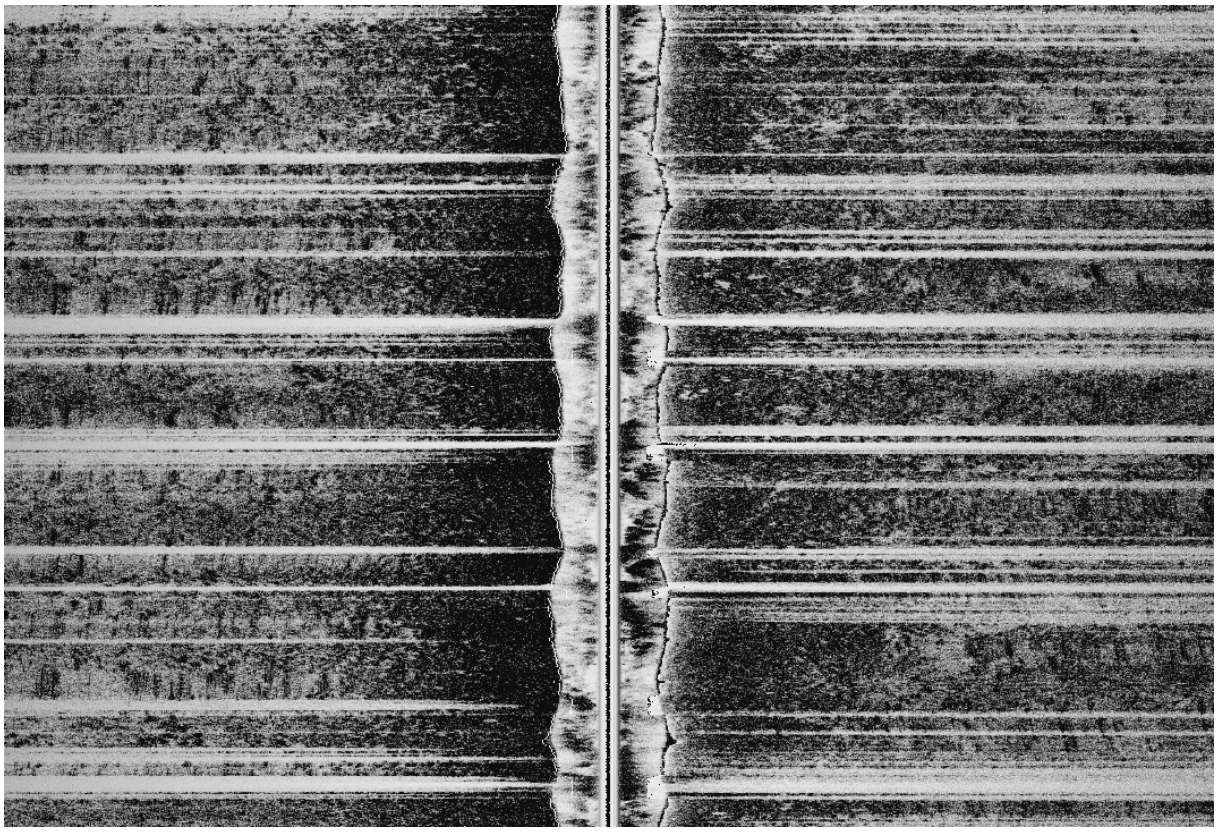
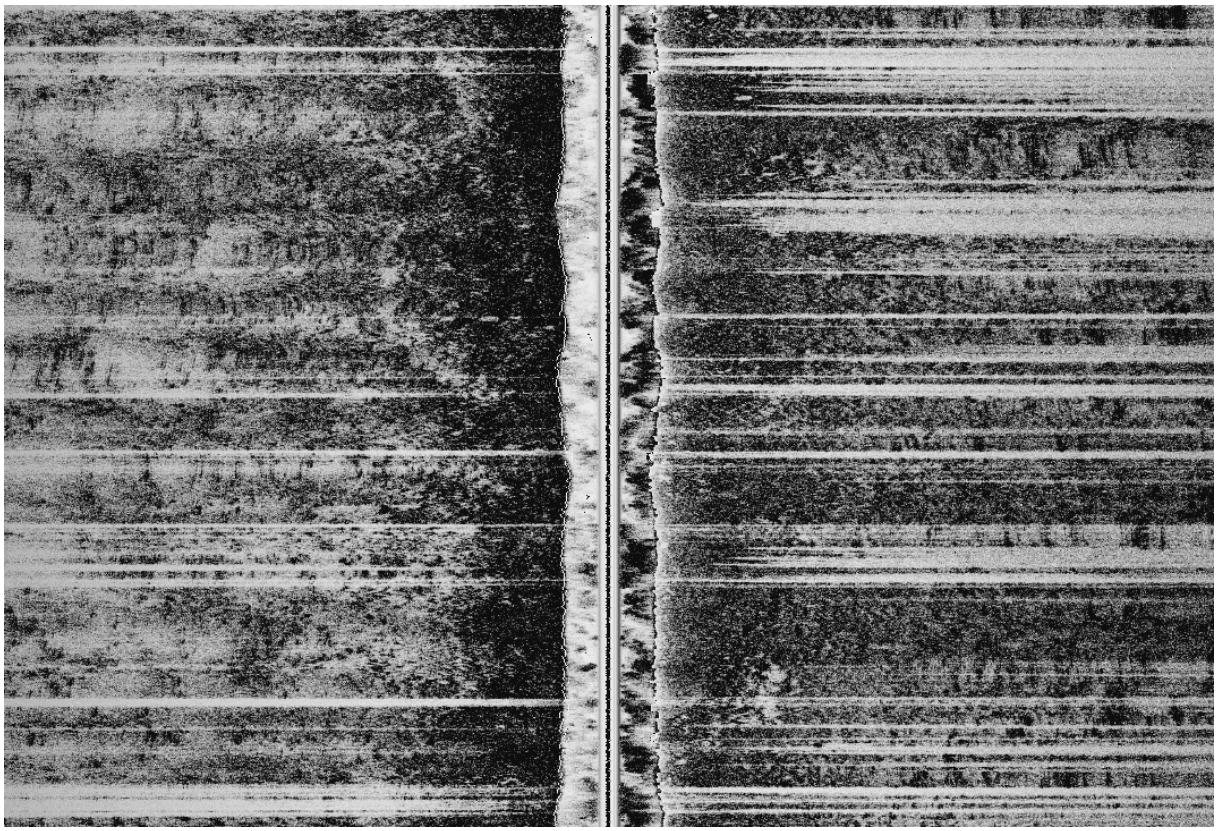
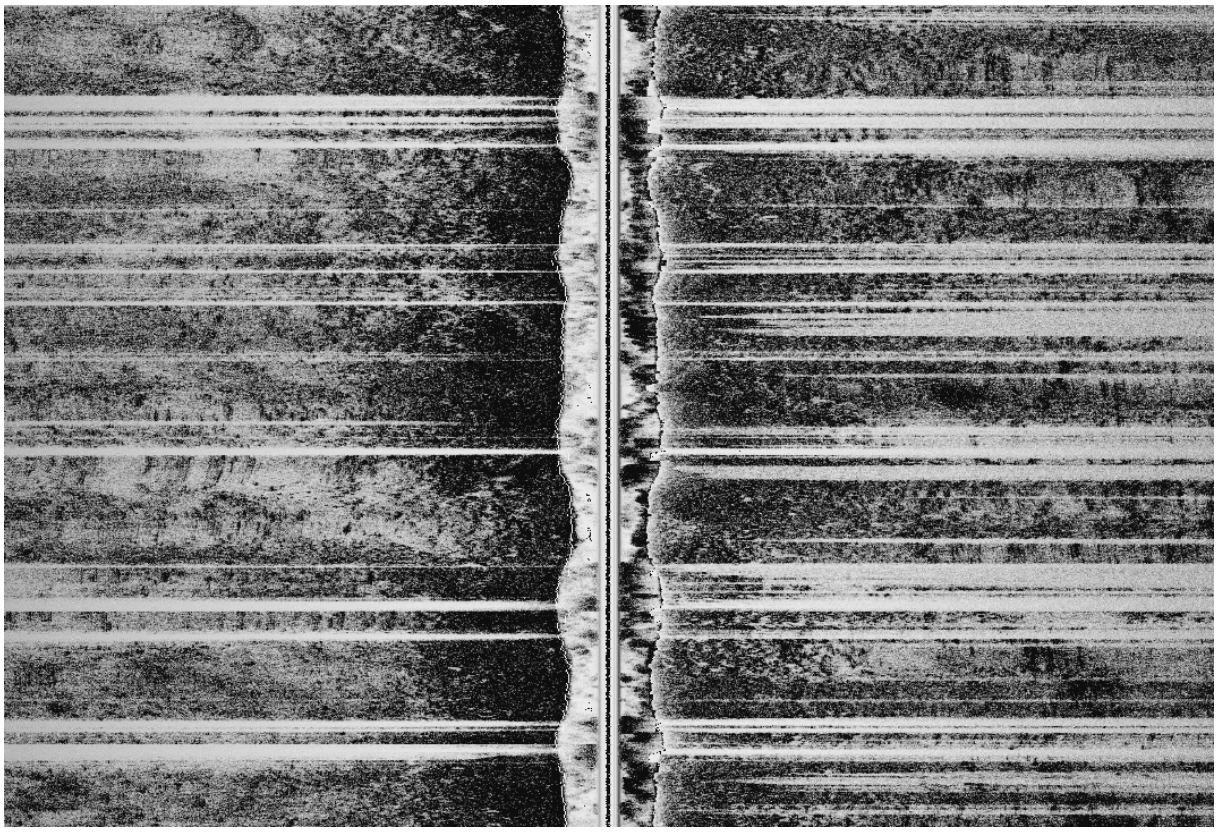


Anomali 22



Anomali 23



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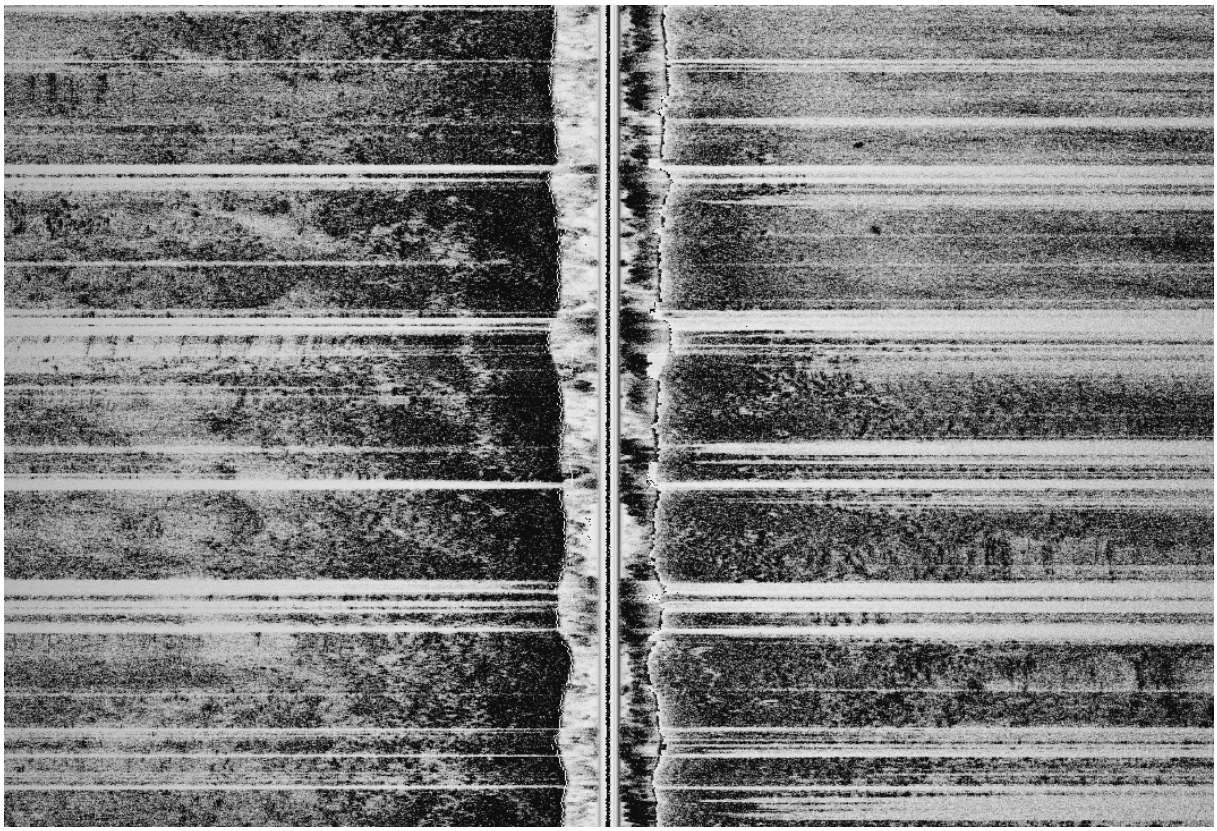

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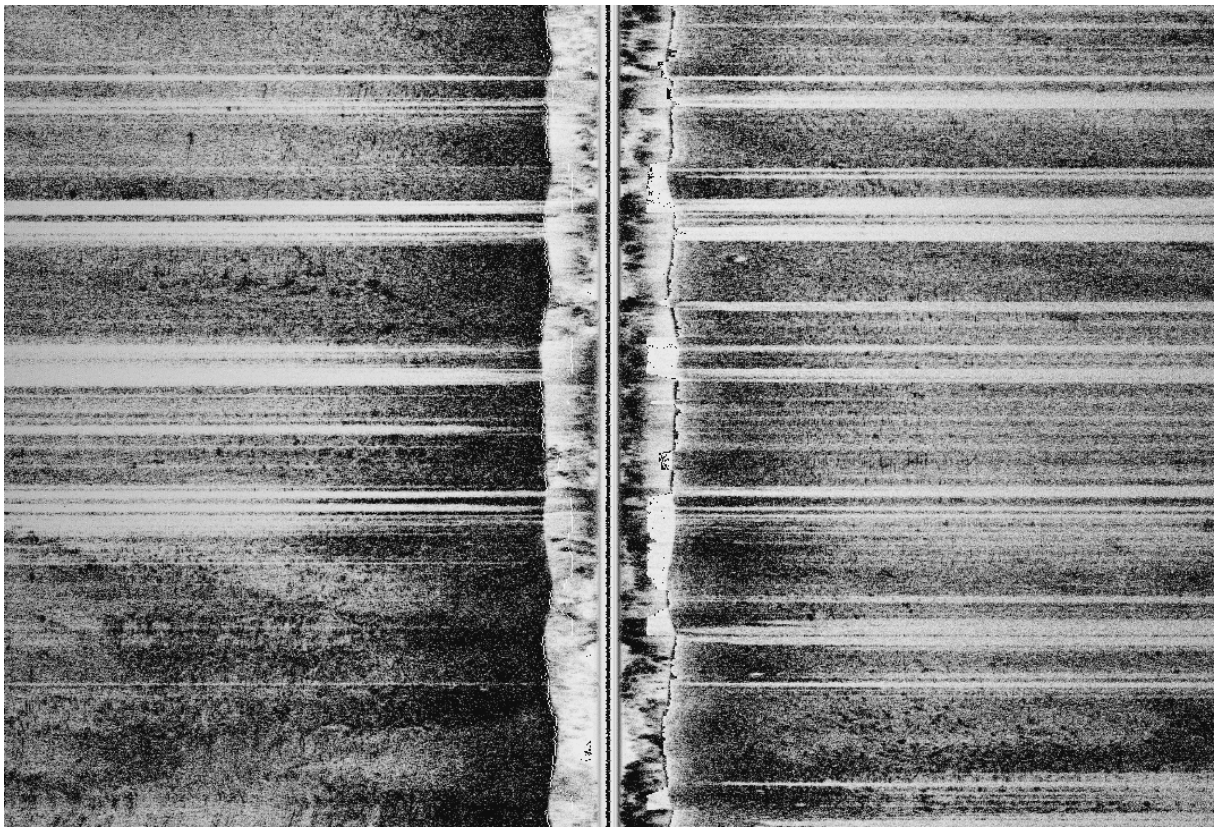

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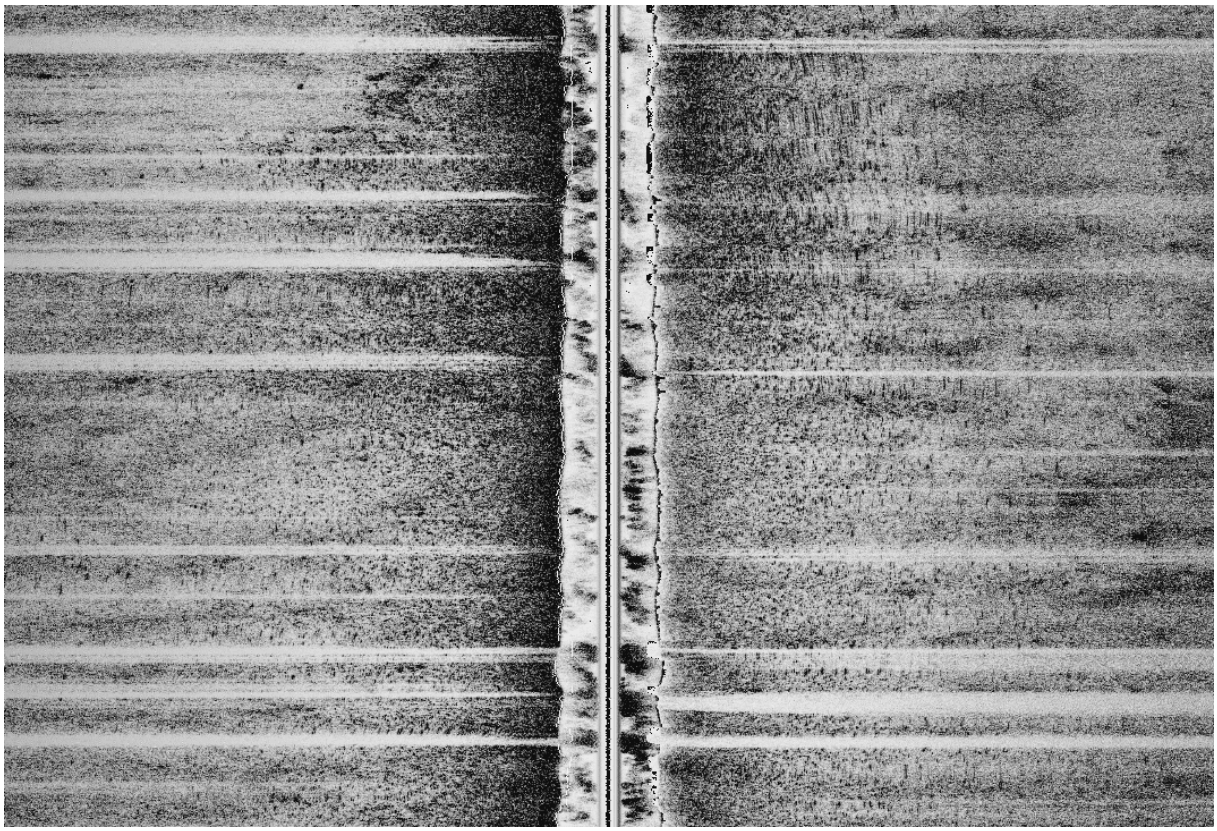

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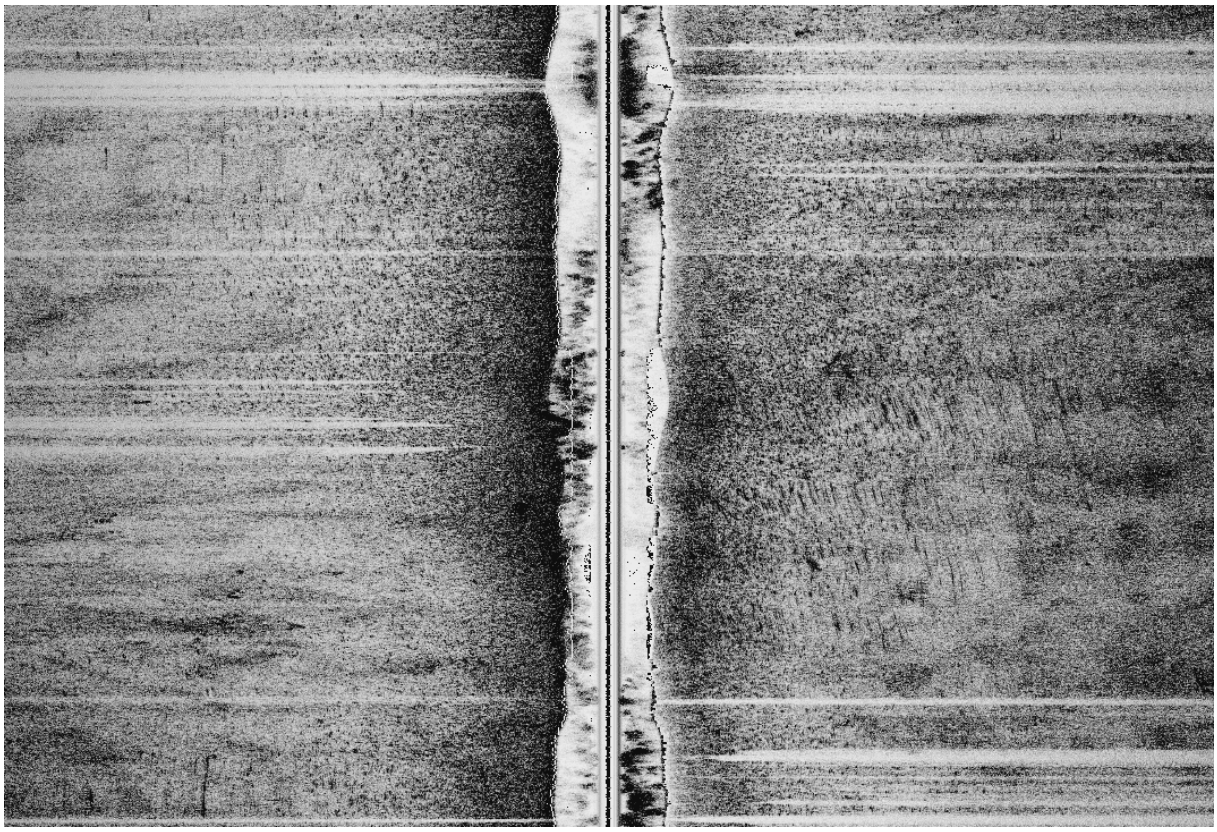

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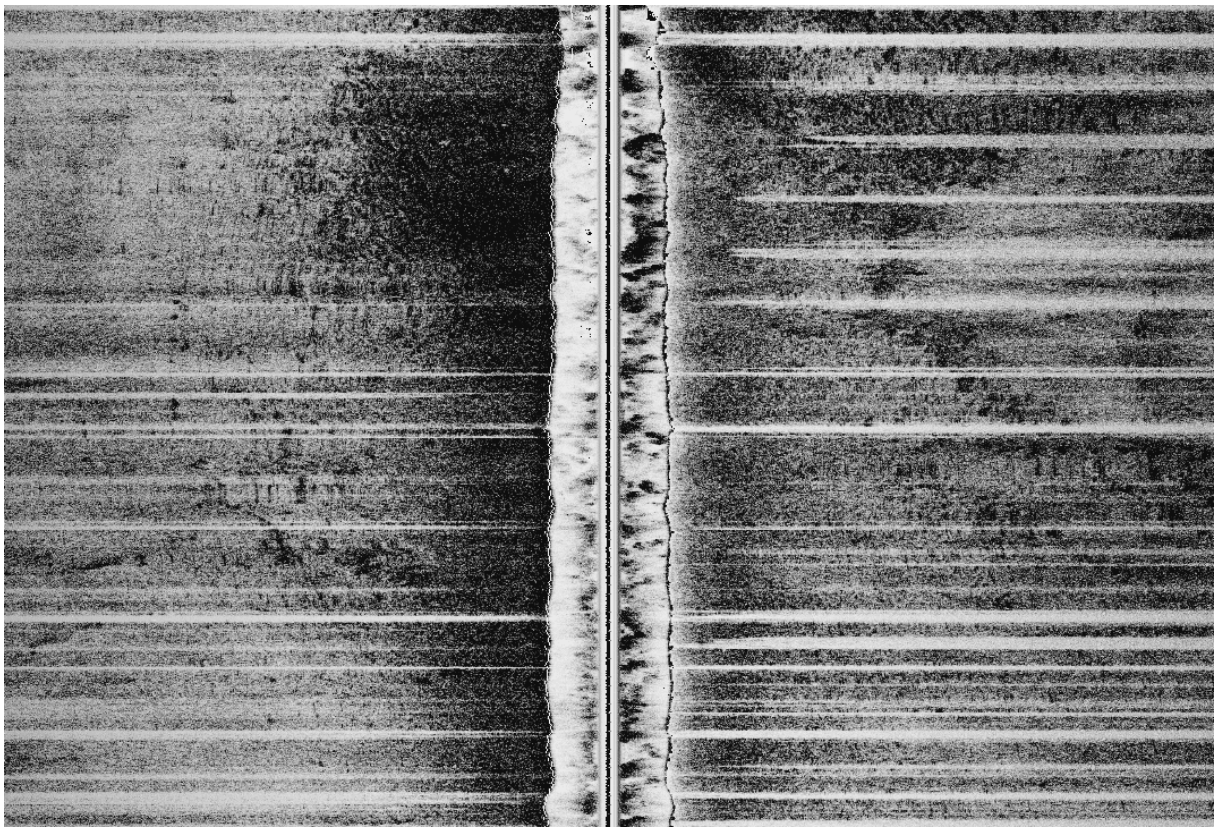
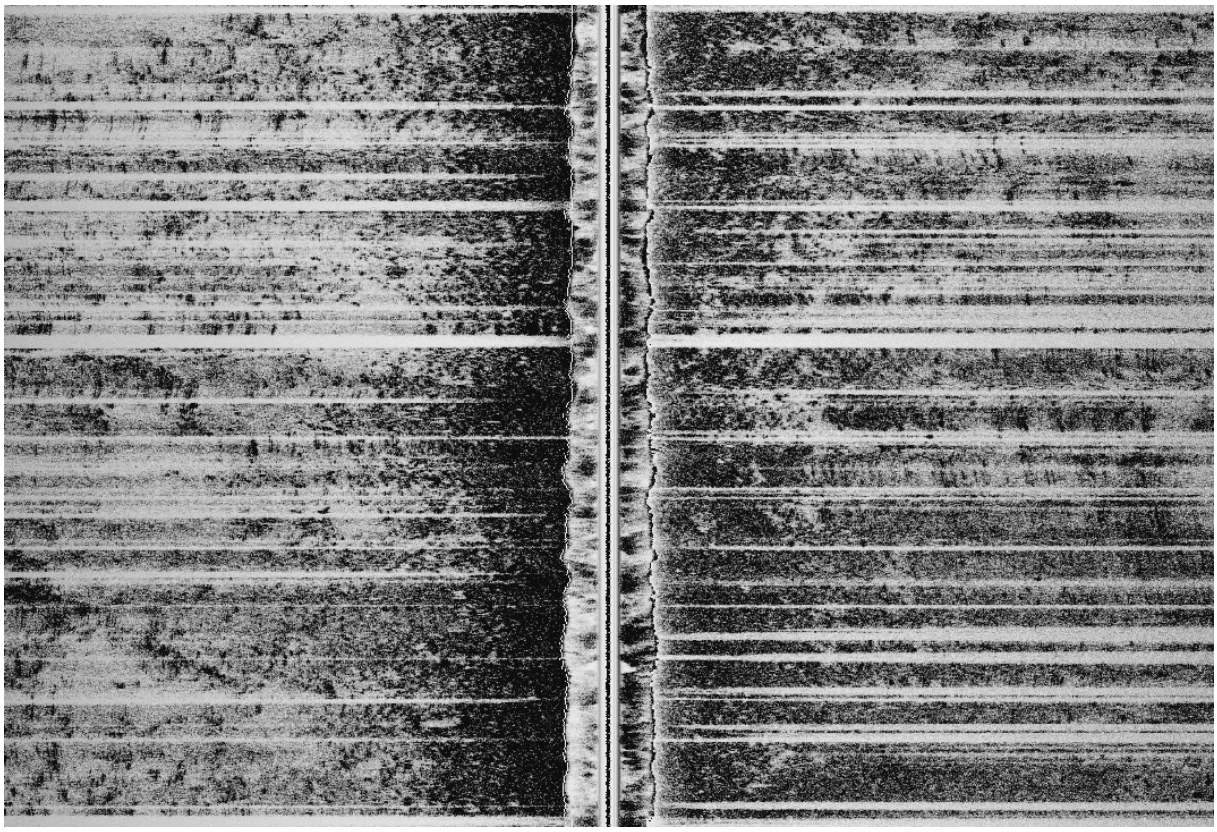


Anomali 29



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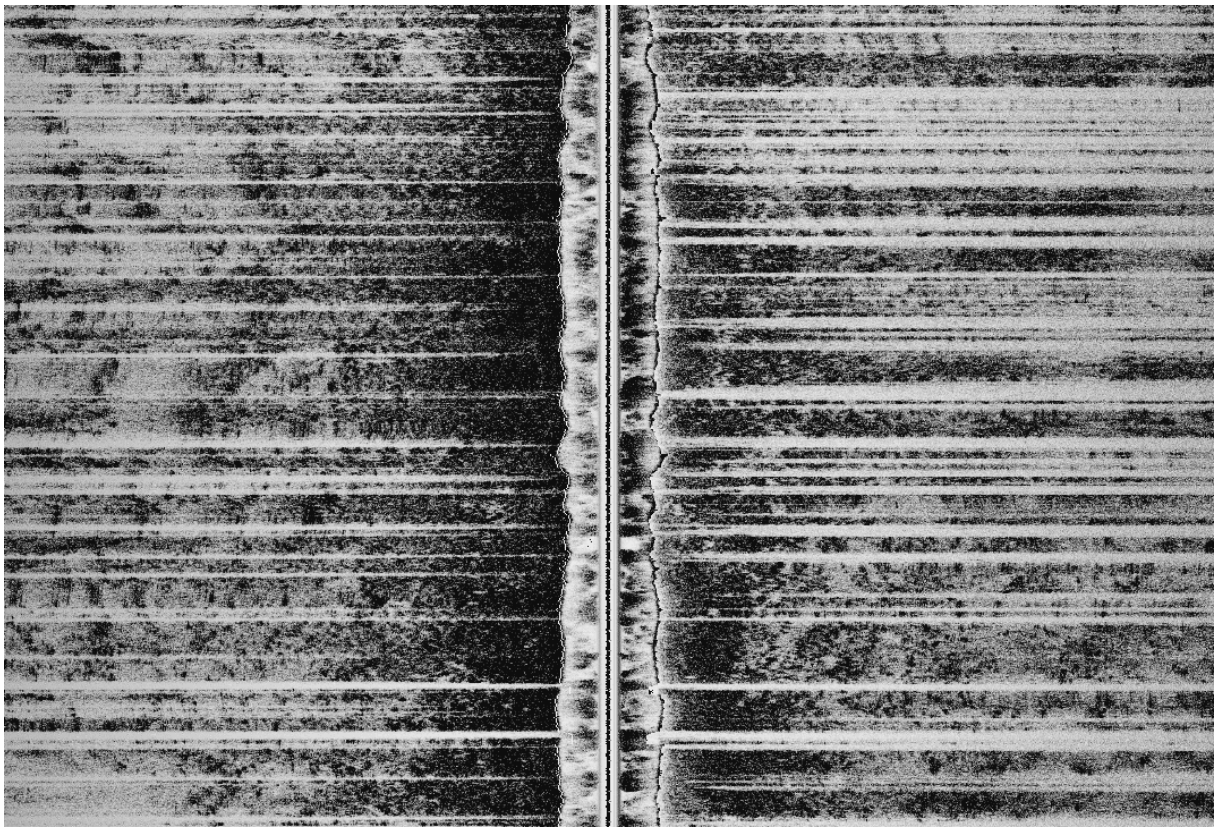

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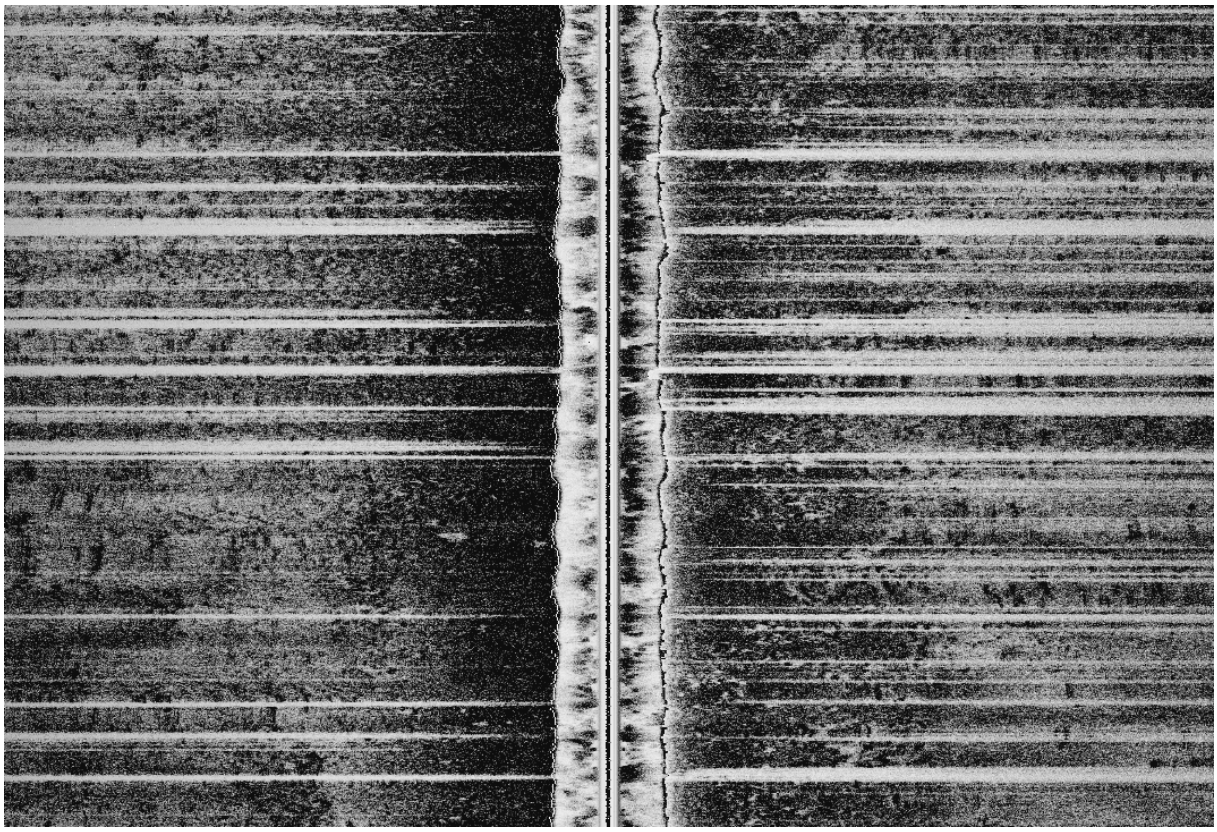

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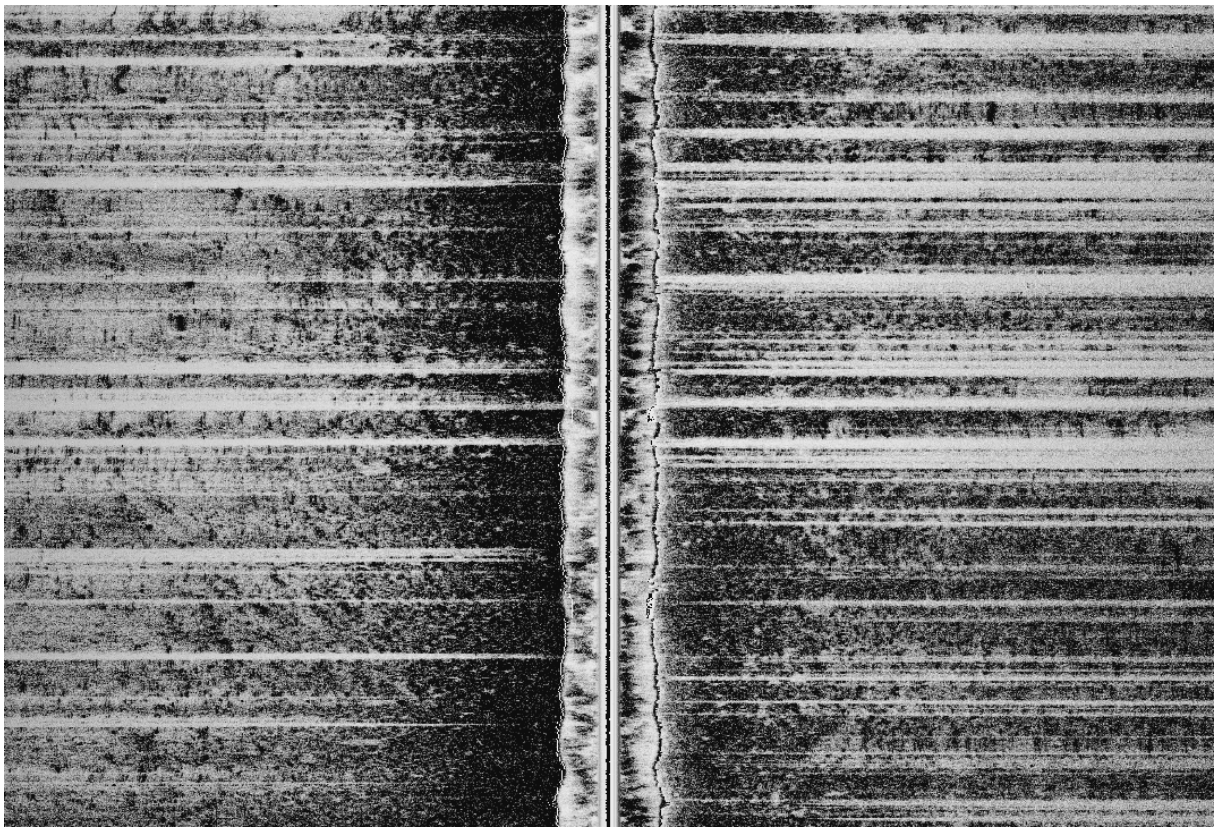

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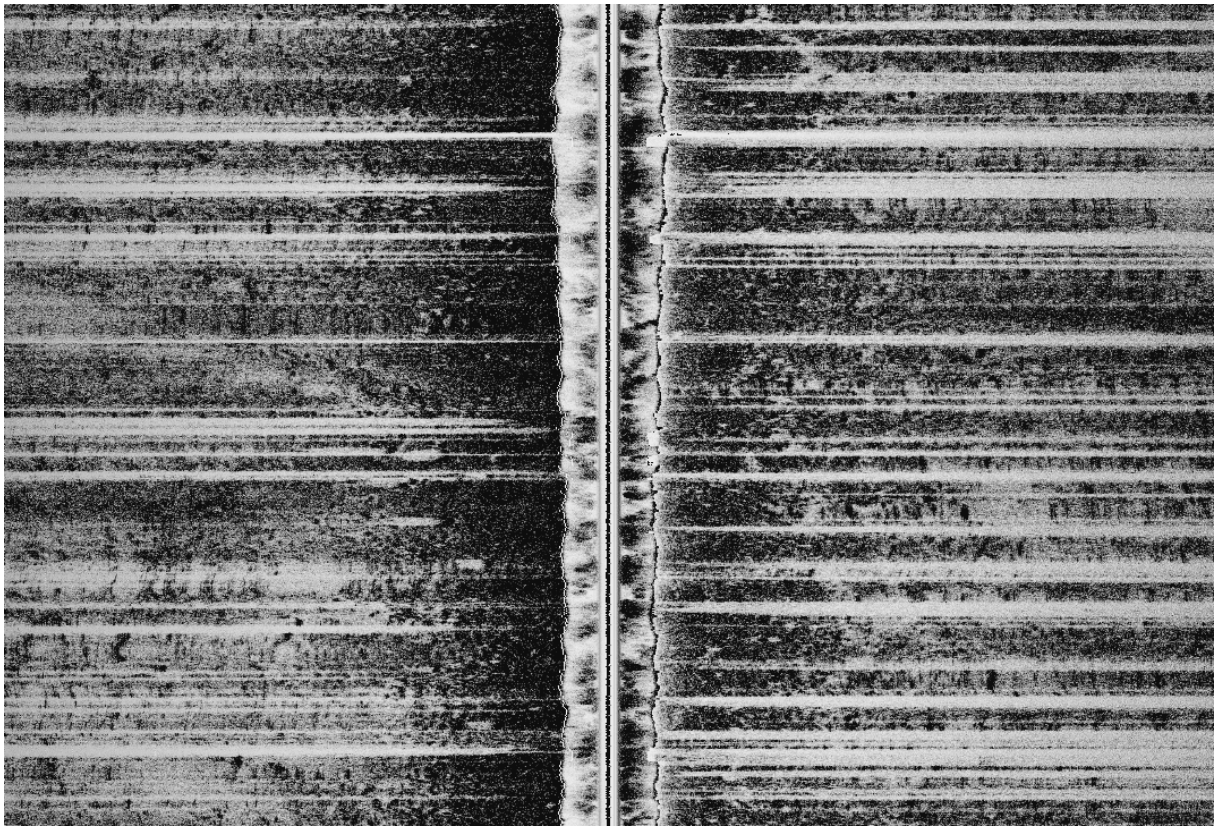

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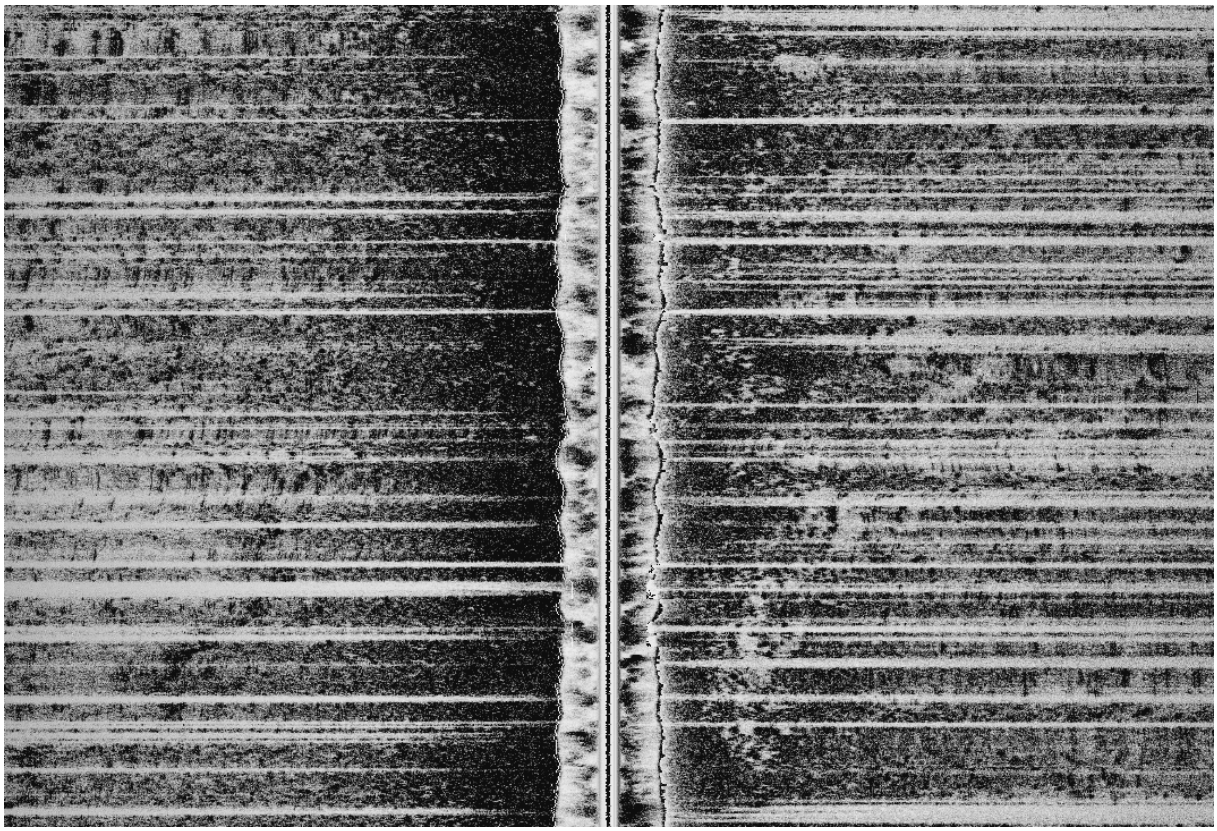

Anomali 35