MR 5 - Avanços da hidrometria e hidrografia

Coordenador: Luiz Henrique Maldonado – Itaipu

Palestrantes:

Fabrício Vieira Alves – **ANA**

David Mueller – **USGS**

Luiz A. Pereira de Souza - IPT

Sísmica/acústica aplicada à investigação de rios e reservatórios de água

INVESTIGAÇÃO GEOFÍSICA EM RIOS E RESERVATÓRIOS

SUPERFÍCIE

BATIMETRIA

24,28,30,33,38,50,100,200, 400 e **550 kHz**

Monofeixe - Multifeixe
Interferometria - Multifase

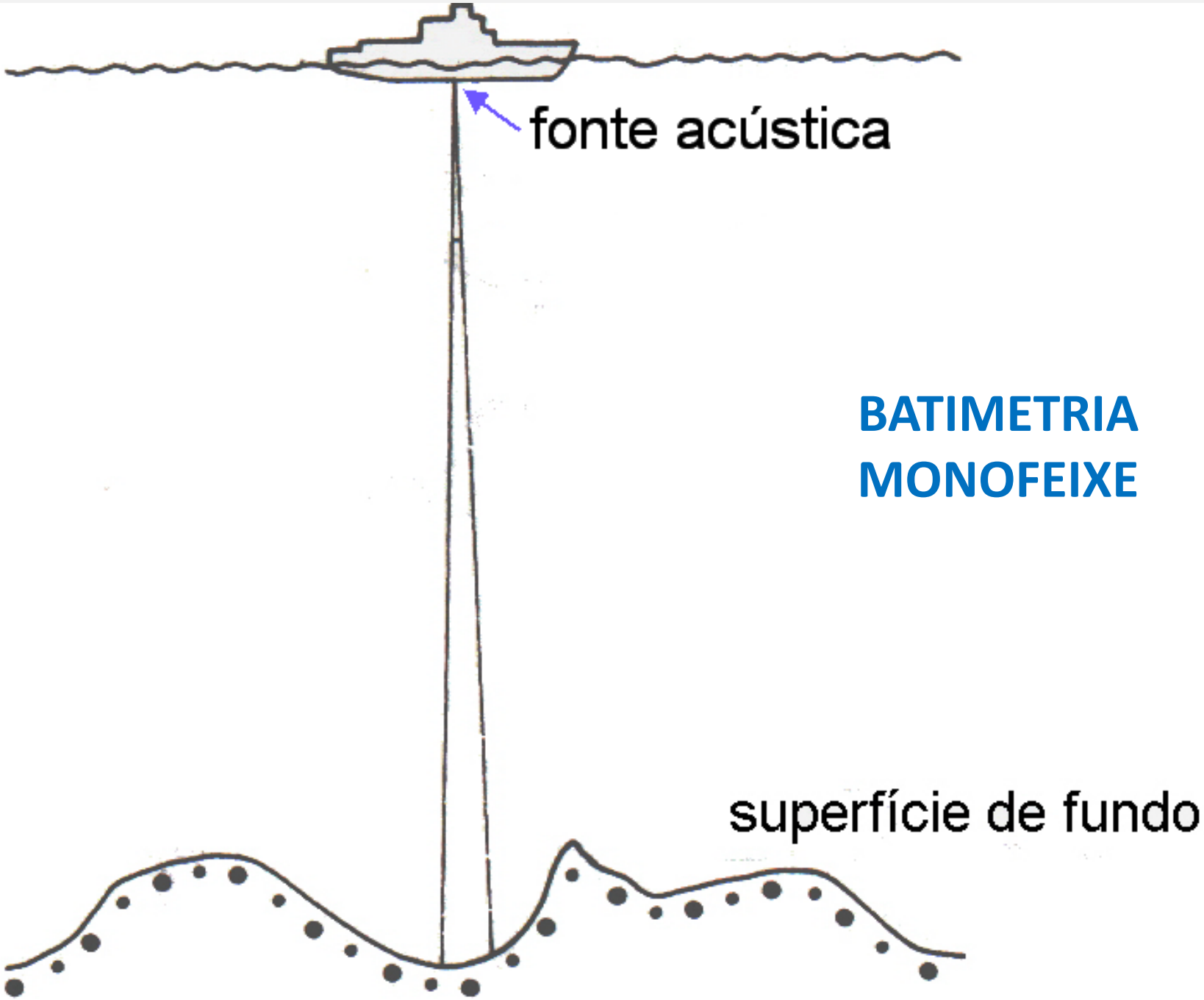
(... 700 kHz)

IMAGEAMENTO

SUBSUPERFÍCIE

PENETRAÇÃO

RESOLUÇÃO



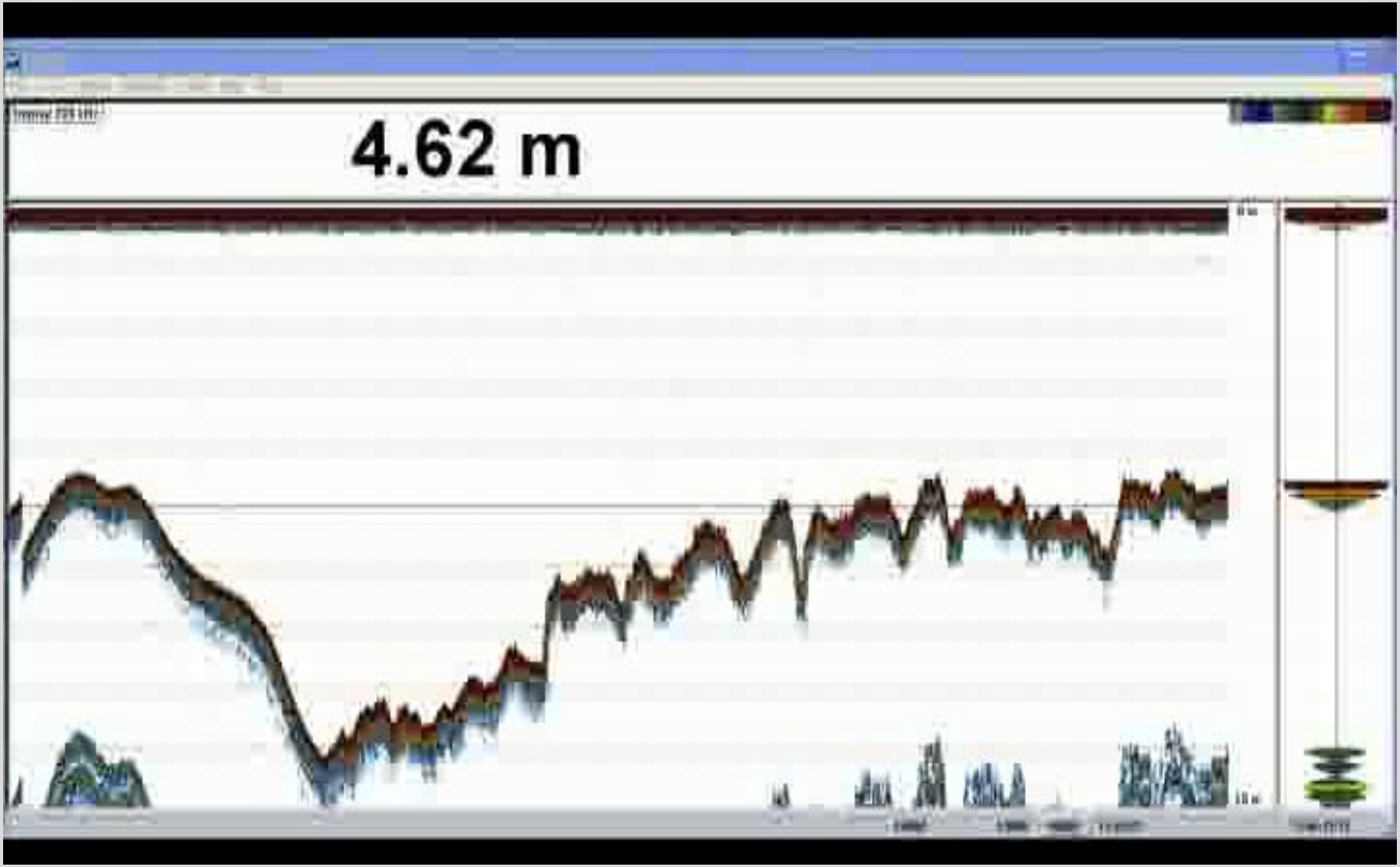
BATIMETRIA MONOFEIXE

Batimetria monofeixe

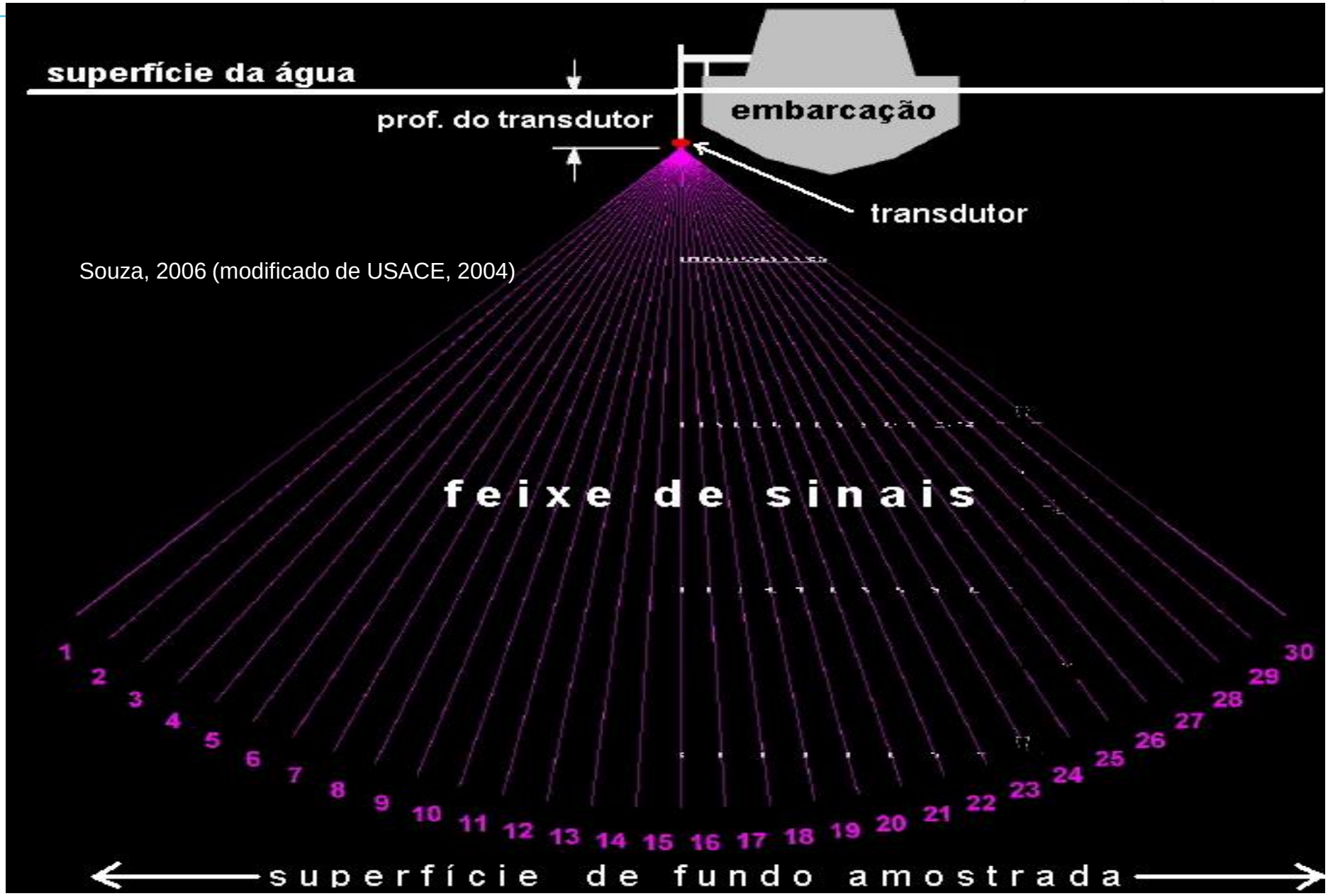
Reservatório de Porto Primavera – SP/MT

200 kHz

Batimetria monofeixe



BATIMETRIA MULTIFEIXE

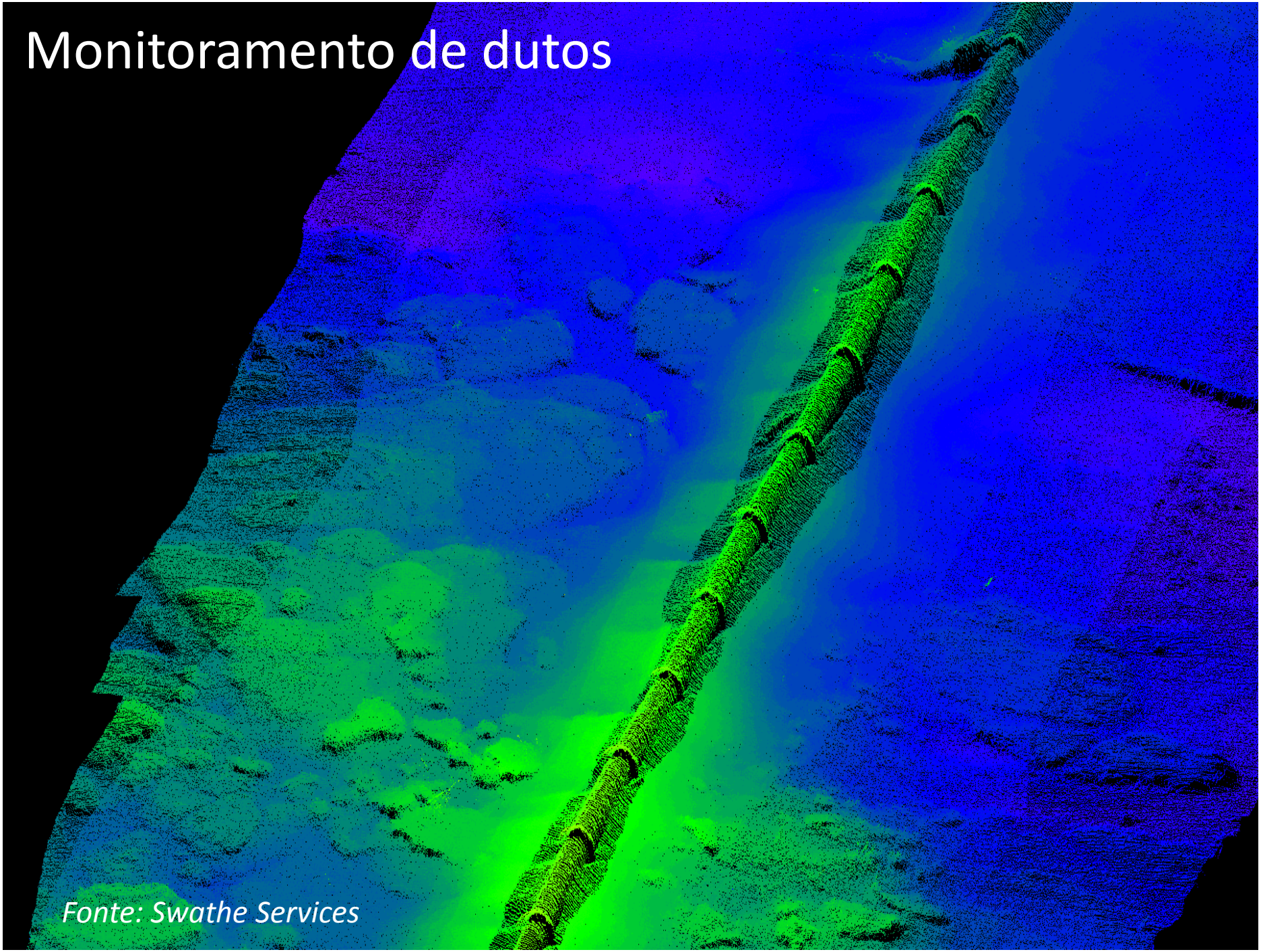


Souza, 2006 (modificado de USACE, 2004)

Fonte: https://www.youtube.com/watch?v=8ijaPa-9MDs

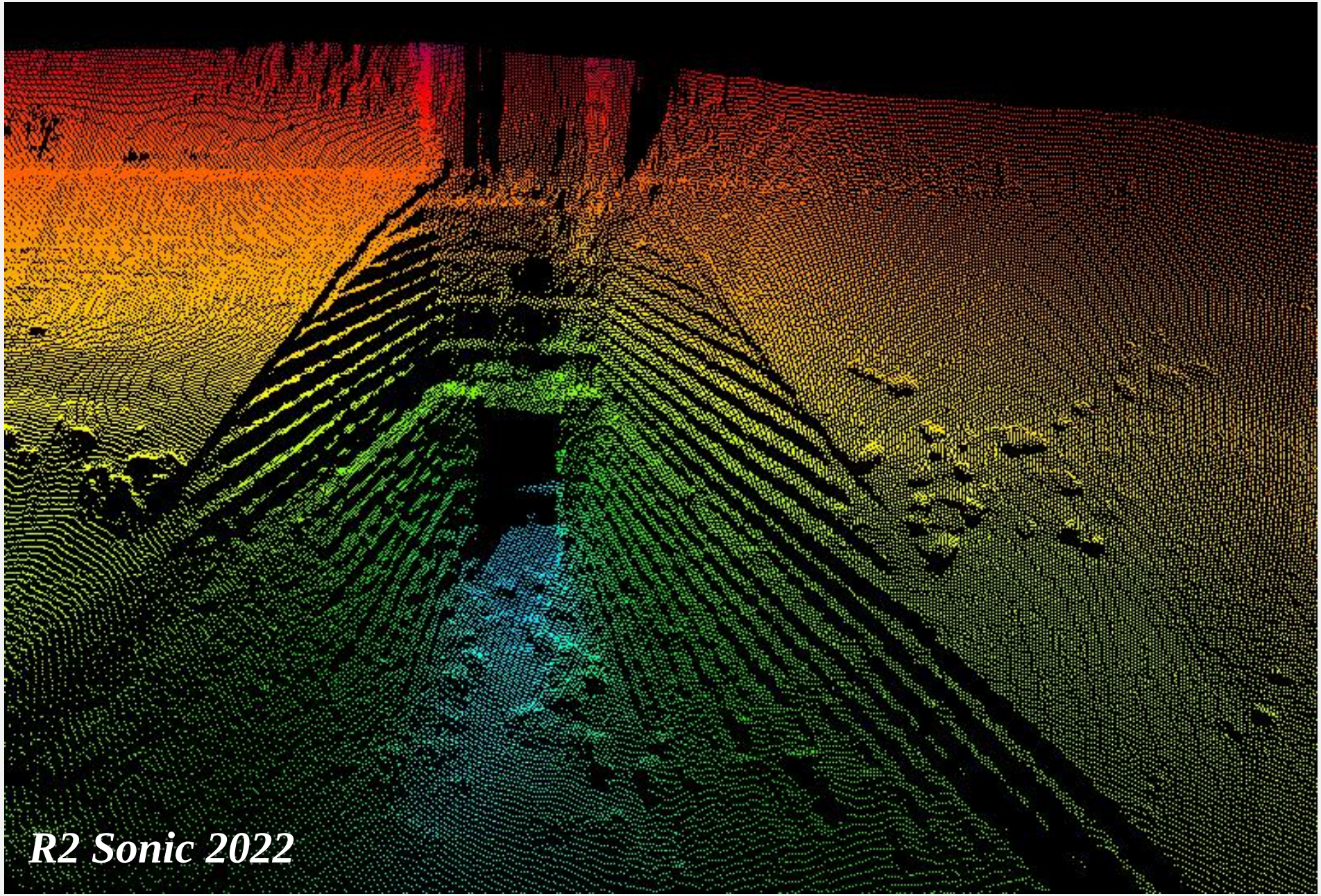

RuralTech

Monitoramento de dutos



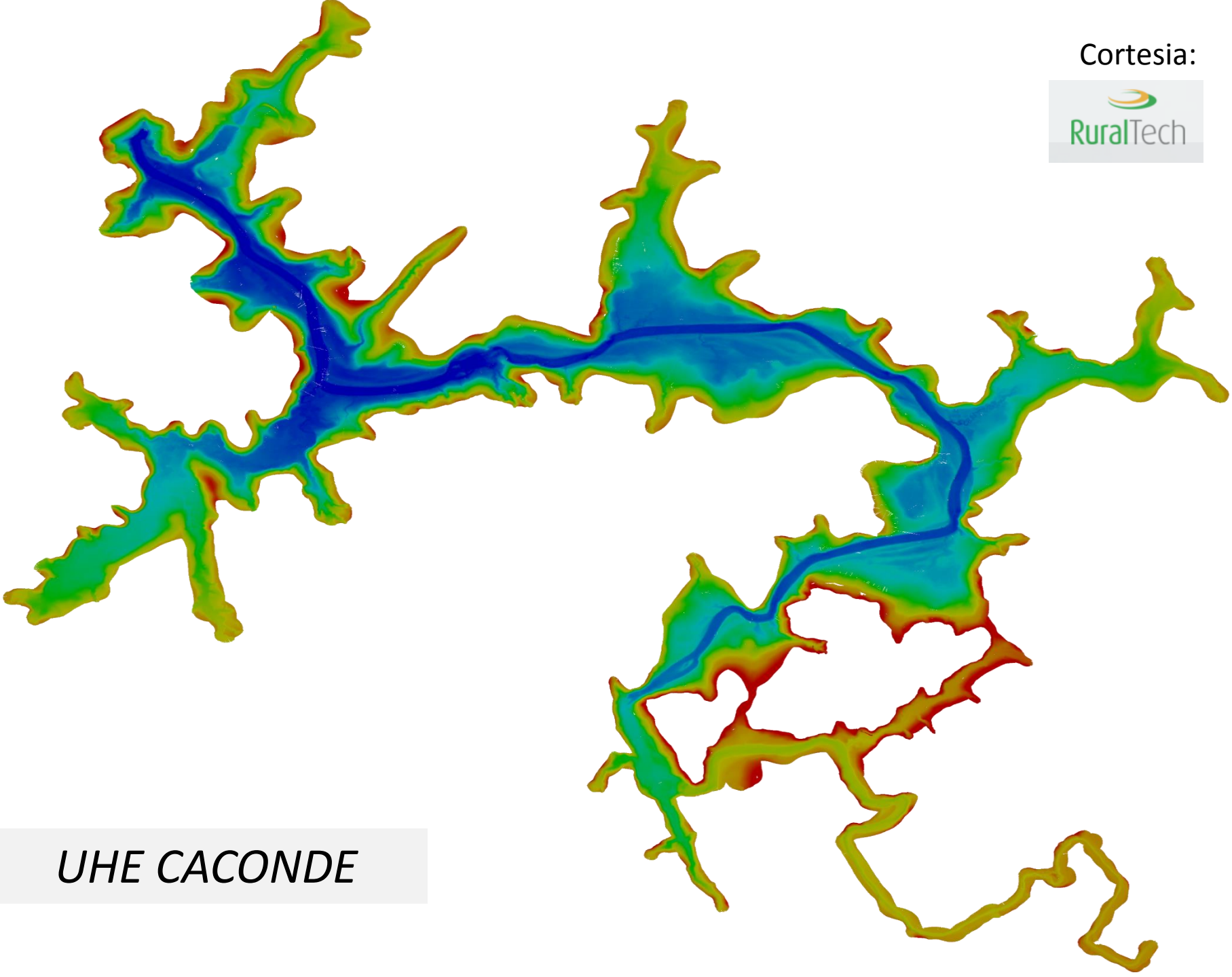
Fonte: Swathe Services

Monitoramento de Barragens

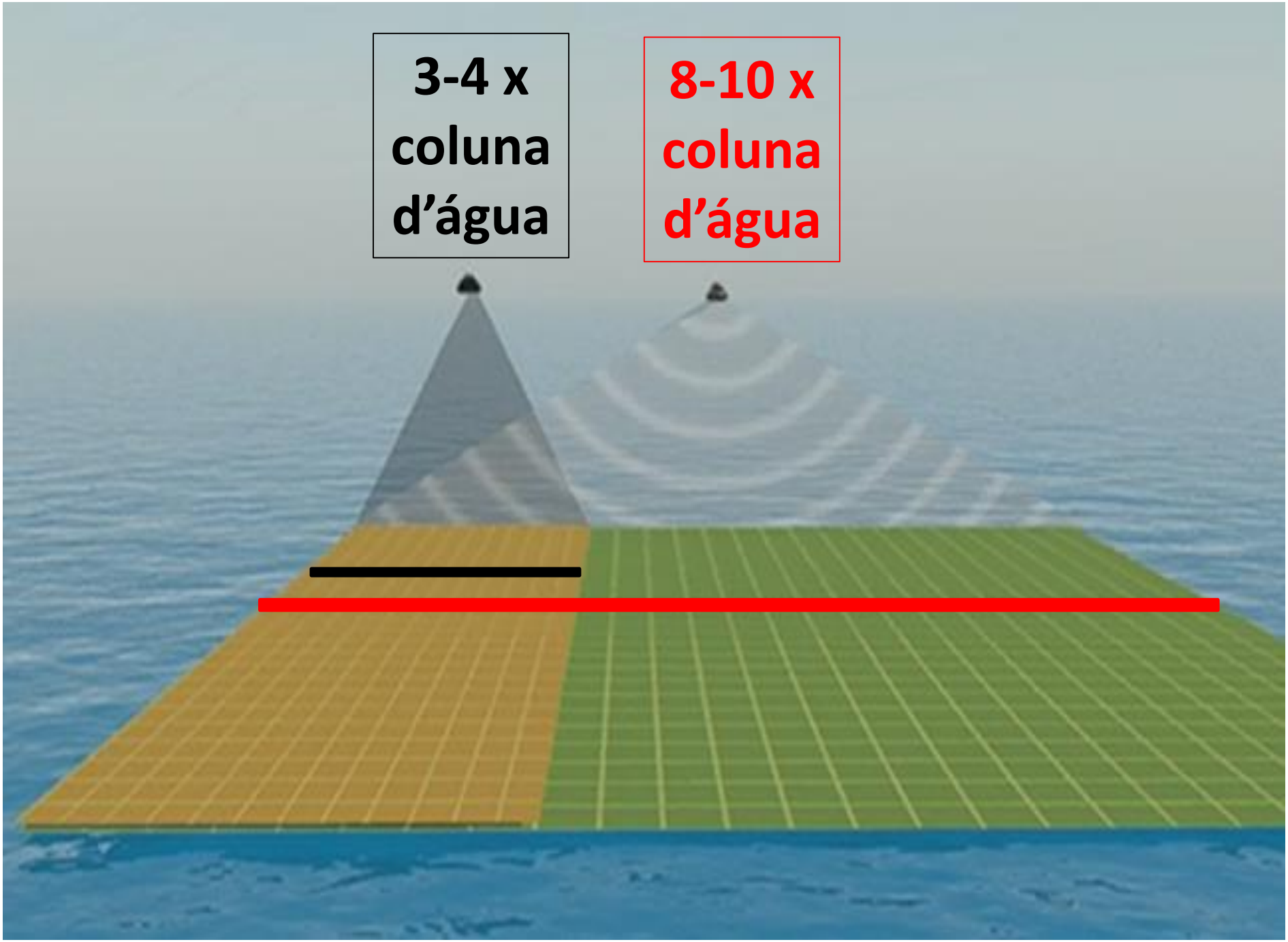


Cortesia:

RuralTech



UHE CACONDE


3-4 x coluna d’água
8-10 x coluna d’água

EDGETECH 6205

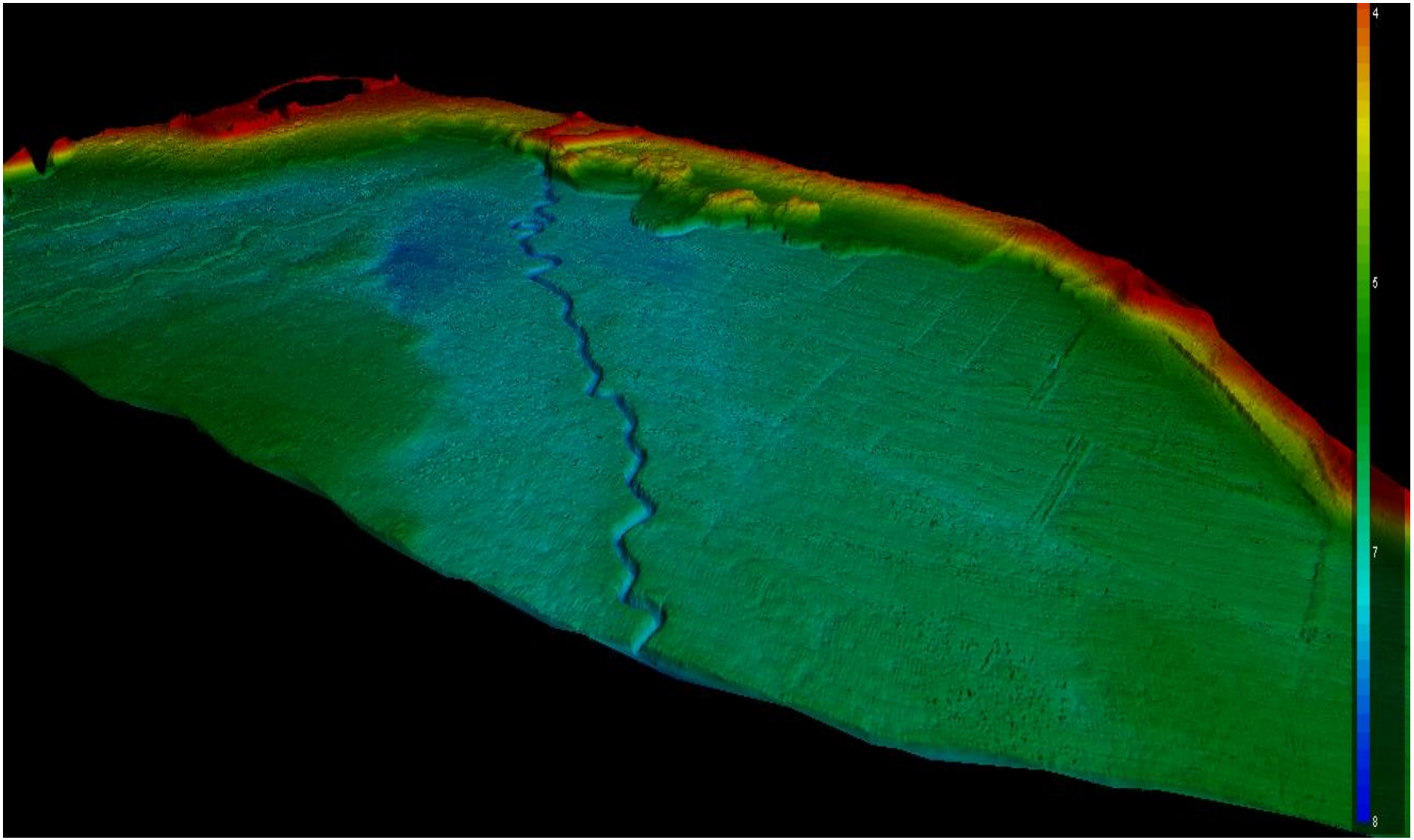
Side Scan + Batimetria Multifase

Batimetria:
250/**550** kHz

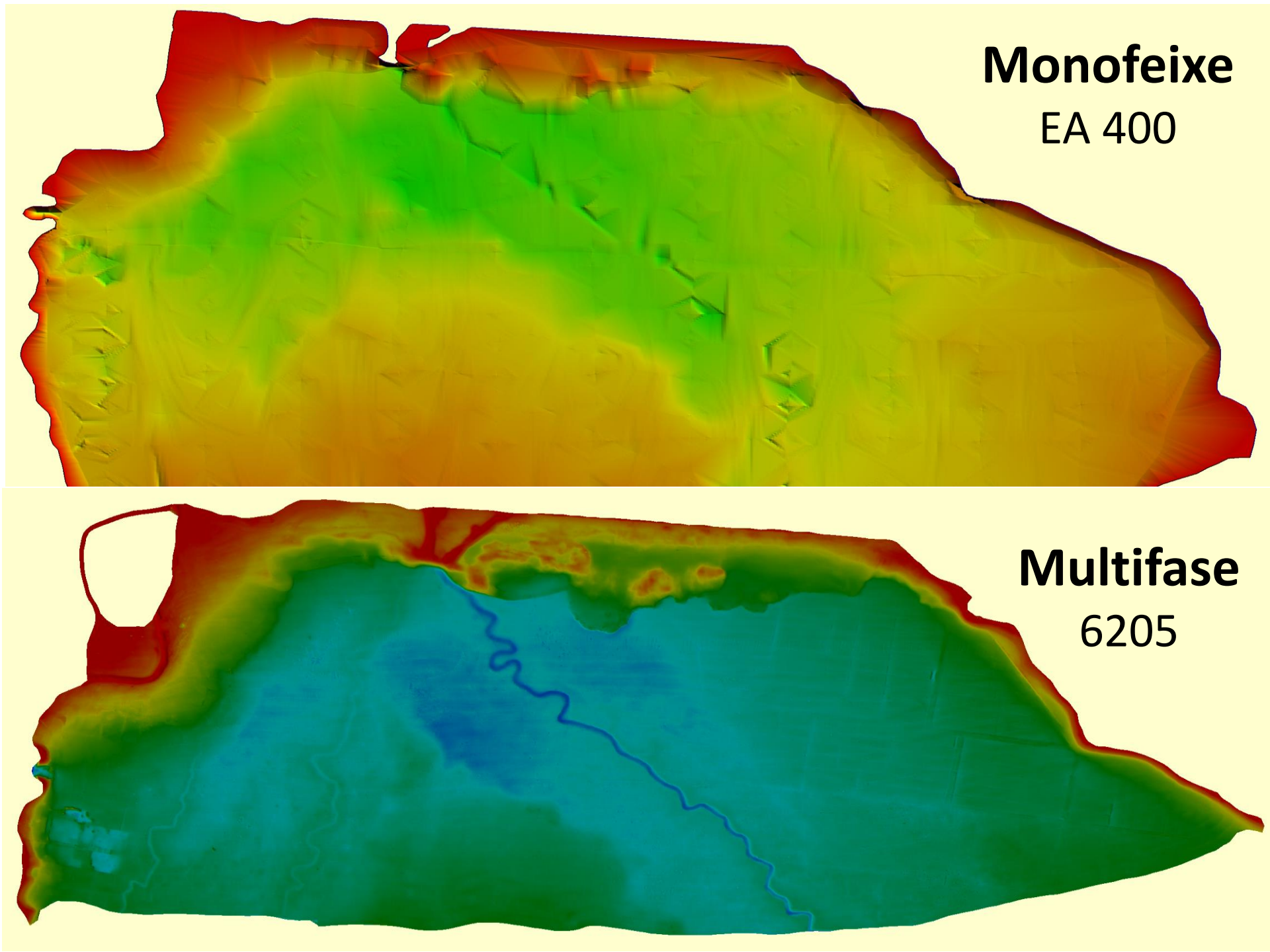
Sonografia:
550/900 kHz
ou
900/1600 kHz

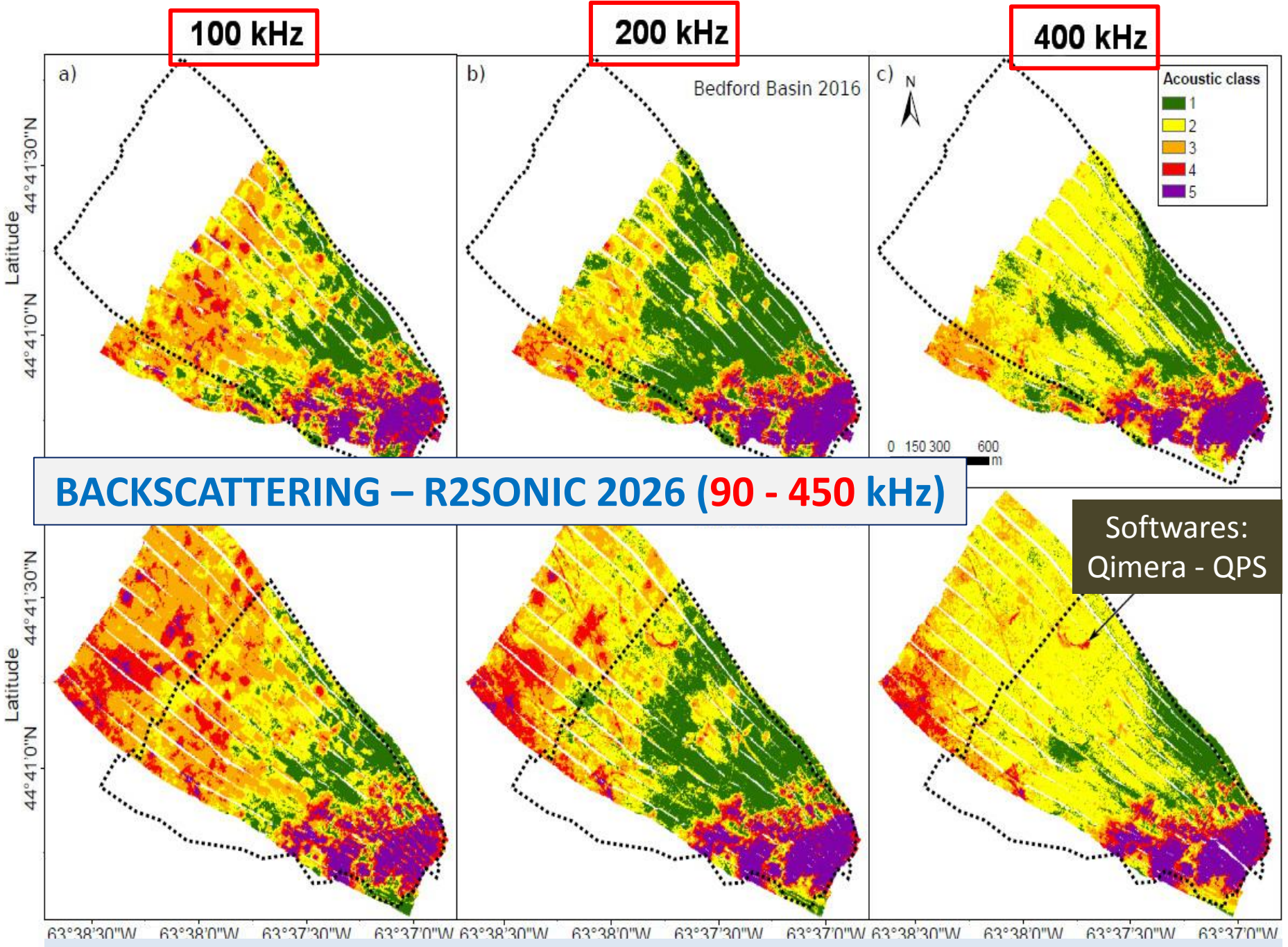
Foto: Laps

ipt INSTITUTO DE PESQUISAS TECNOLÓGICAS



Mapa Batimétrico (3D) de alta resolução (!) do Reservatório Taiaçupeba, SP (*IPT – Sabesp – Fehidro*)


Monofeixe
EA 400
Multifase
6205



Craig J.Brown, Geosciences 2019, 9, 126 & Timo C. Gaida, Geosciences 2018, 8, 455

INVESTIGAÇÃO GEOFÍSICA EM RIOS E RESERVATÓRIOS

SUPERFÍCIE

BATIMETRIA

24,28,30,33,38,50,100,200, 400 e **550 kHz**

Monofeixe - Multifeixe
Interferometria - Multifase

(... 700 kHz)

IMAGEAMENTO

100,200,300,400,500 e **900 kHz**

Sonar Varredura Lateral

(... 1600 kHz)

Multifeixe

SUBSUPERFÍCIE

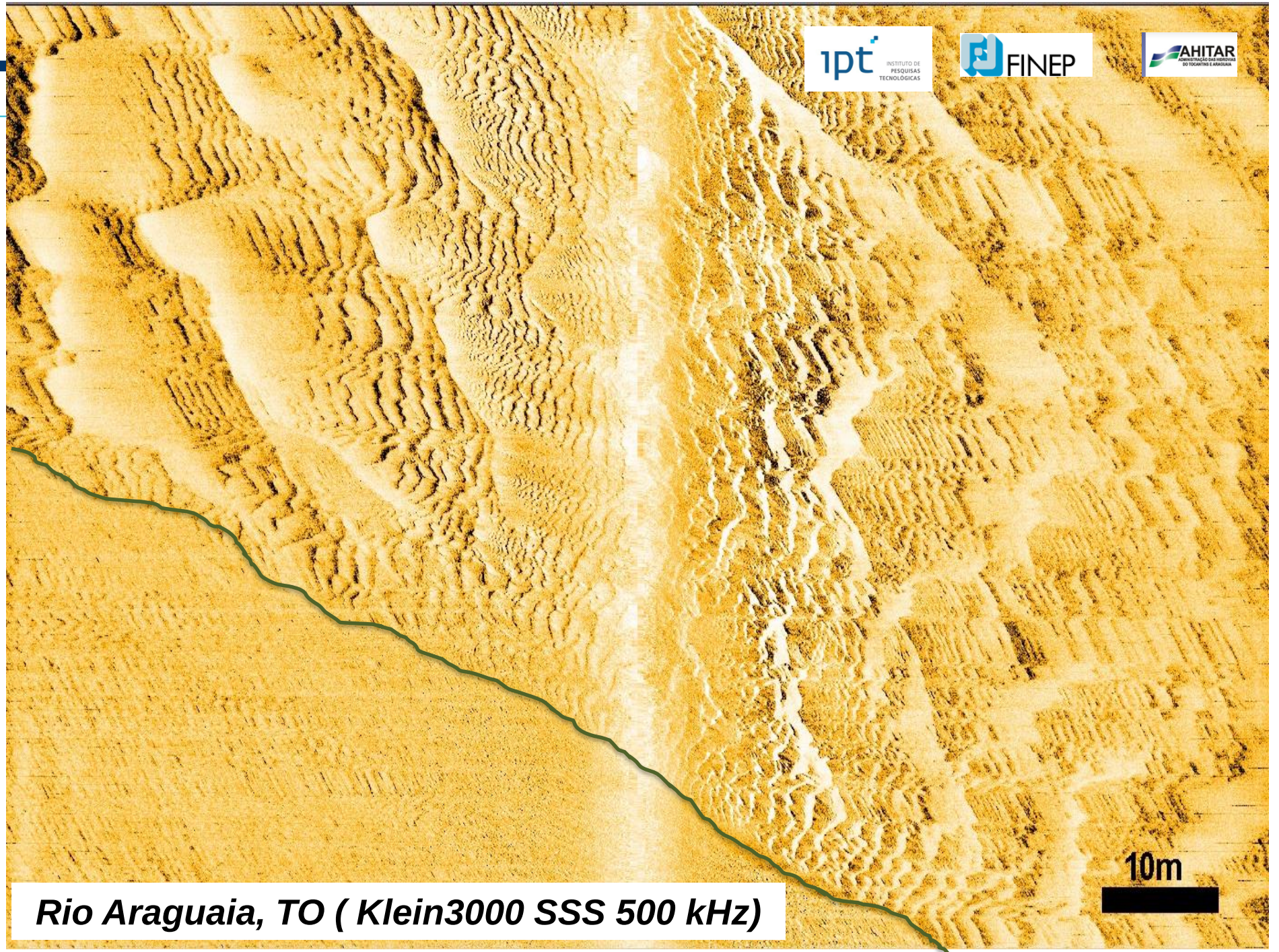
PENETRAÇÃO

RESOLUÇÃO

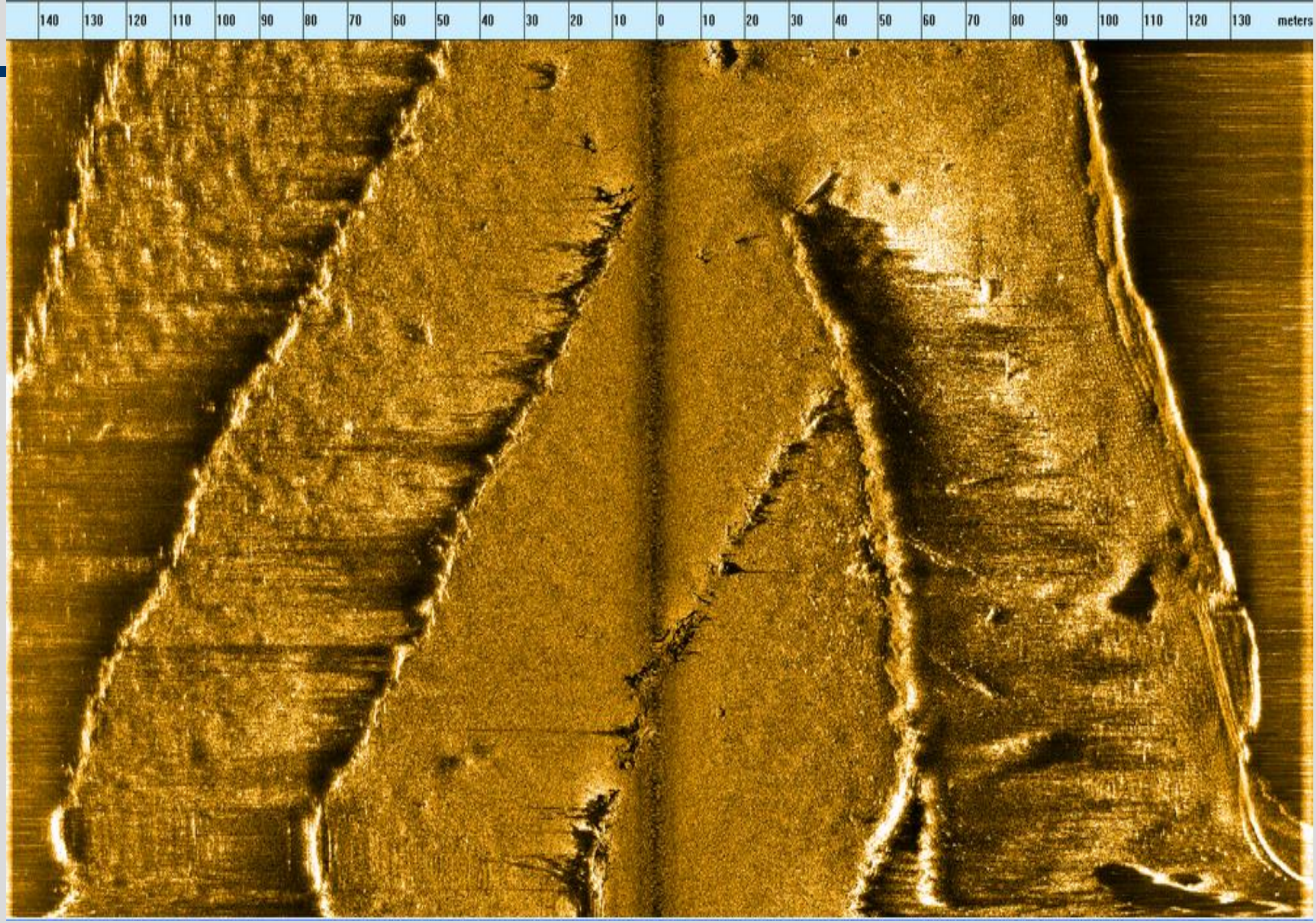
Klein 3000

100/500 kHz

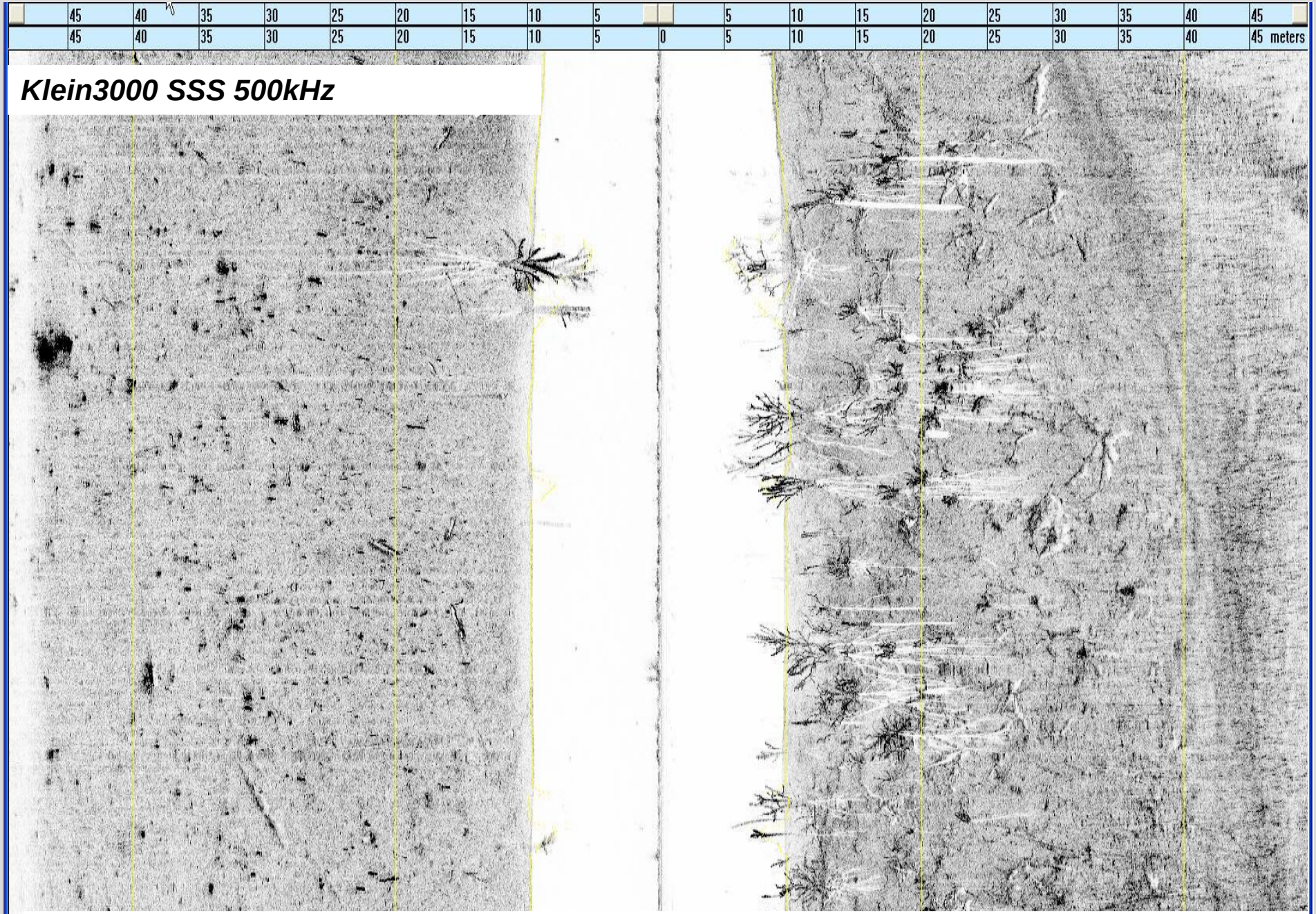
IPT



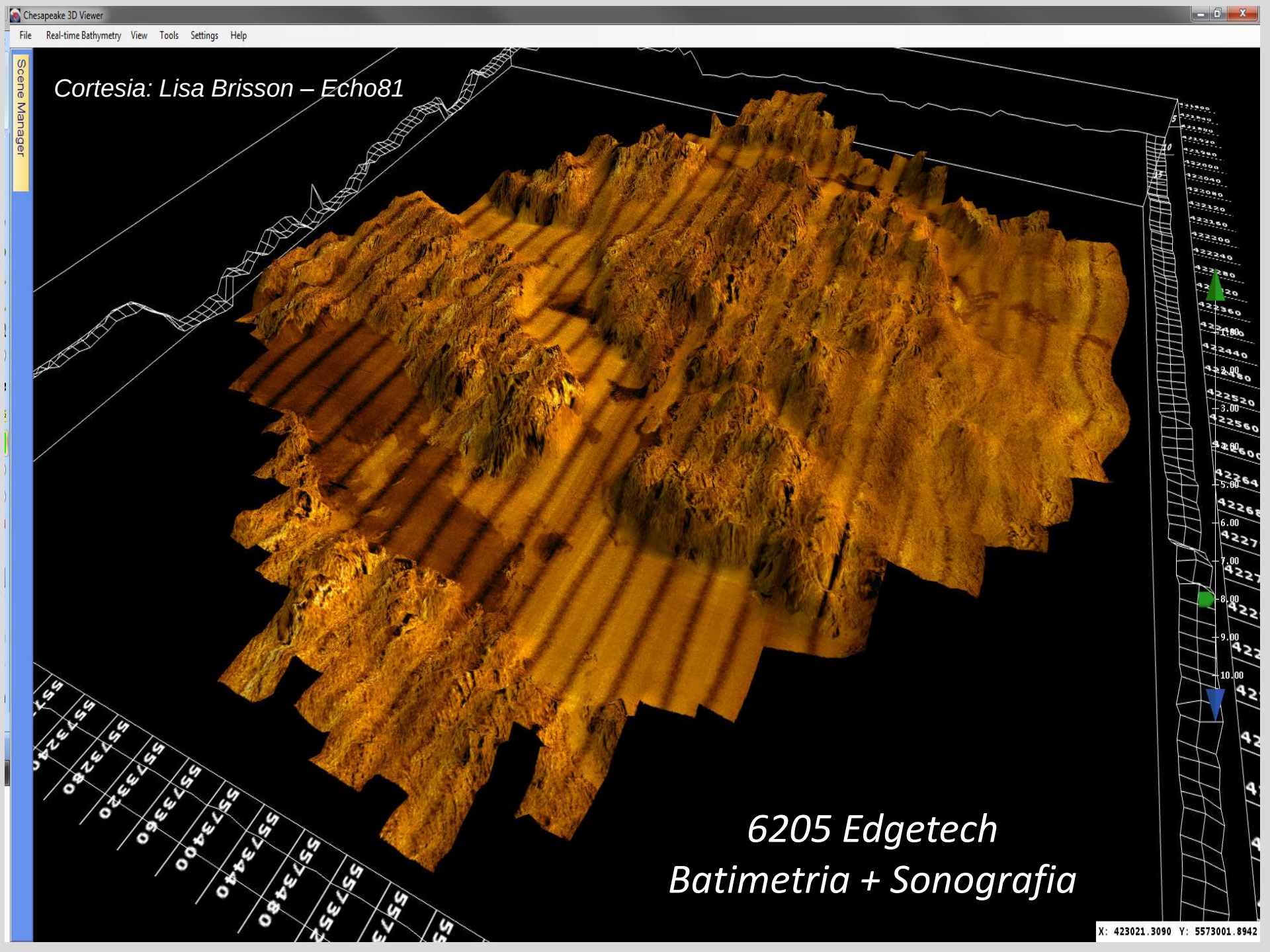
Rio Araguaia, TO (Klein3000 SSS 500 kHz)



*Reservatório de Lajeado – Palmas – TO (**Klein3000 SSS 500 kHz**)*



Superfície de fundo do Reservatório Porto Primavera - SP/MS


Chesapeake 3D Viewer
File
Real-time Bathymetry
View
Tools
Settings
Help
Scene Manager
Cortesia: Lisa Brisson – Echo81
6205 Edgetech
Batimetria + Sonografia
X: 423021.3090 Y: 5573001.8942

INVESTIGAÇÃO GEOFÍSICA EM RIOS E RESERVATÓRIOS

SUPERFÍCIE

BATIMETRIA

24,28,30,33,38,50,100,200, 400 e **550 kHz**

Monofeixe - Multifeixe
Interferometria - Multifase

(... 700 kHz)

IMAGEAMENTO

100,200,300,400,500 e **900 kHz**

Sonar Varredura Lateral

(... 1600 kHz)

Multifeixe

SUBSUPERFÍCIE

PENETRAÇÃO

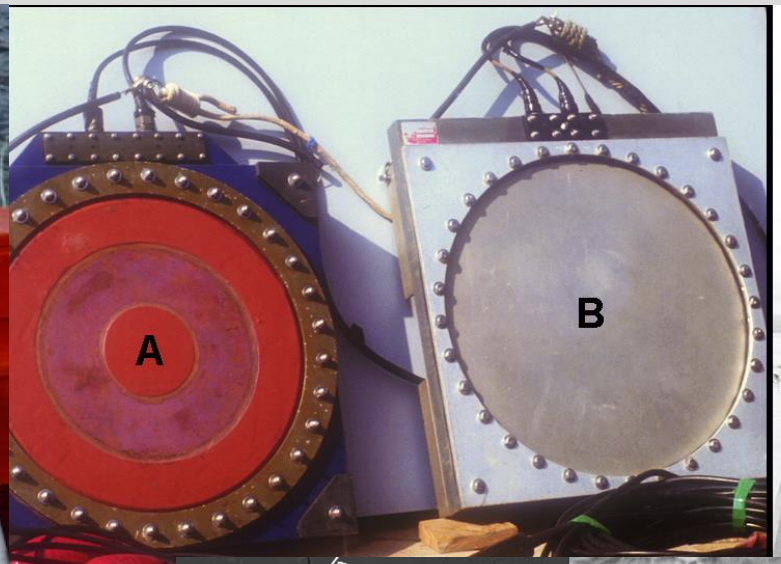
500 – 2000 Hz

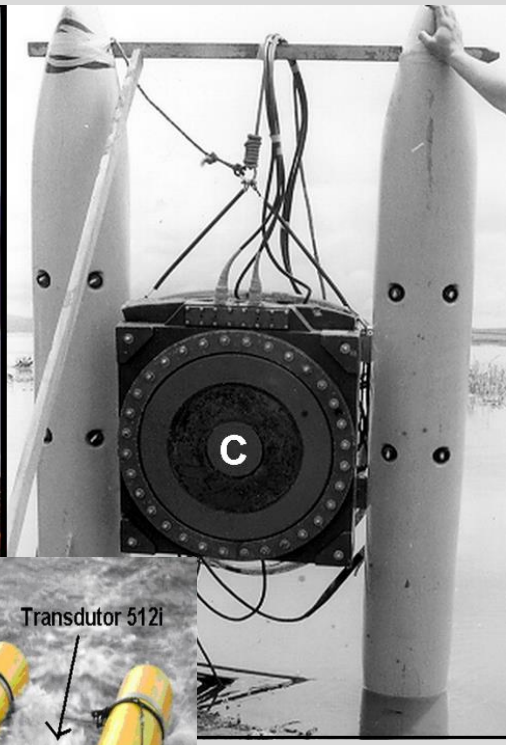
Boomer, sparker, chirp LF

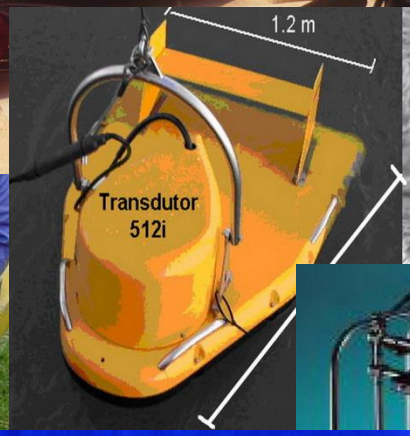
Bubble-gun

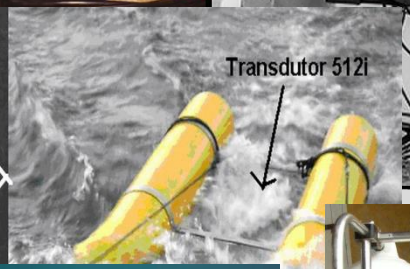
(70 < 300 Hz)

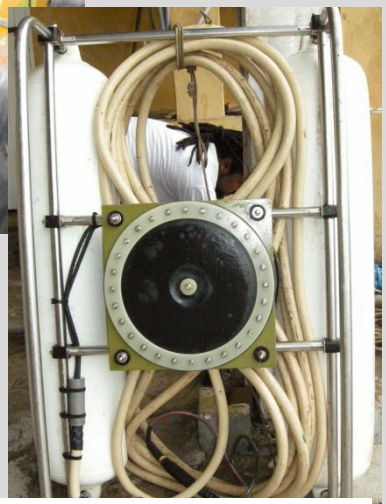
RESOLUÇÃO

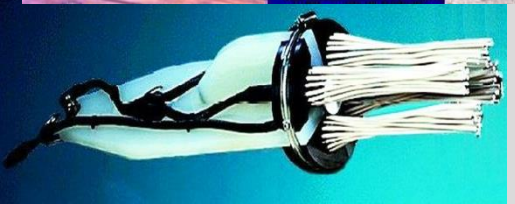








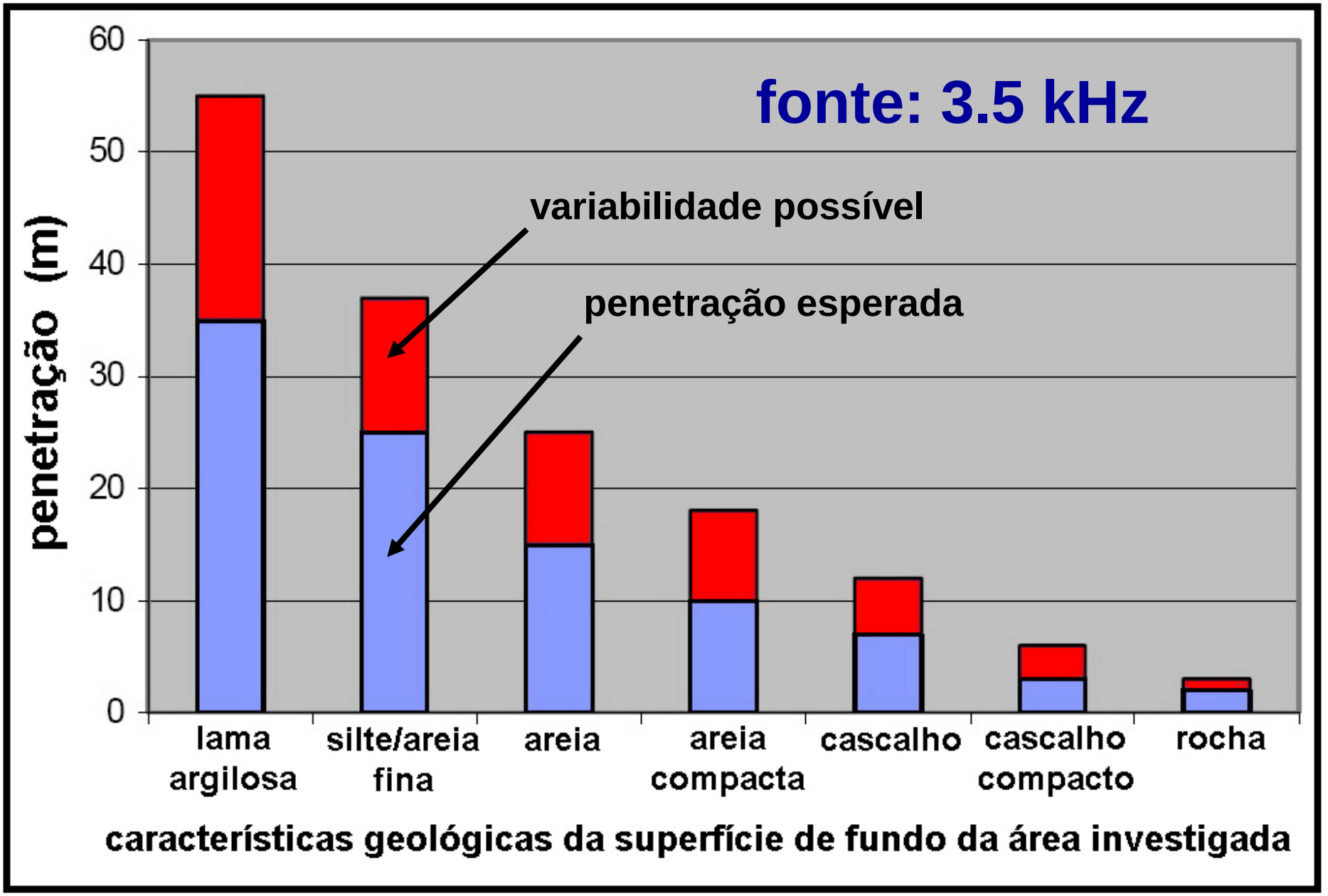




Penetração

SIG – Boomer

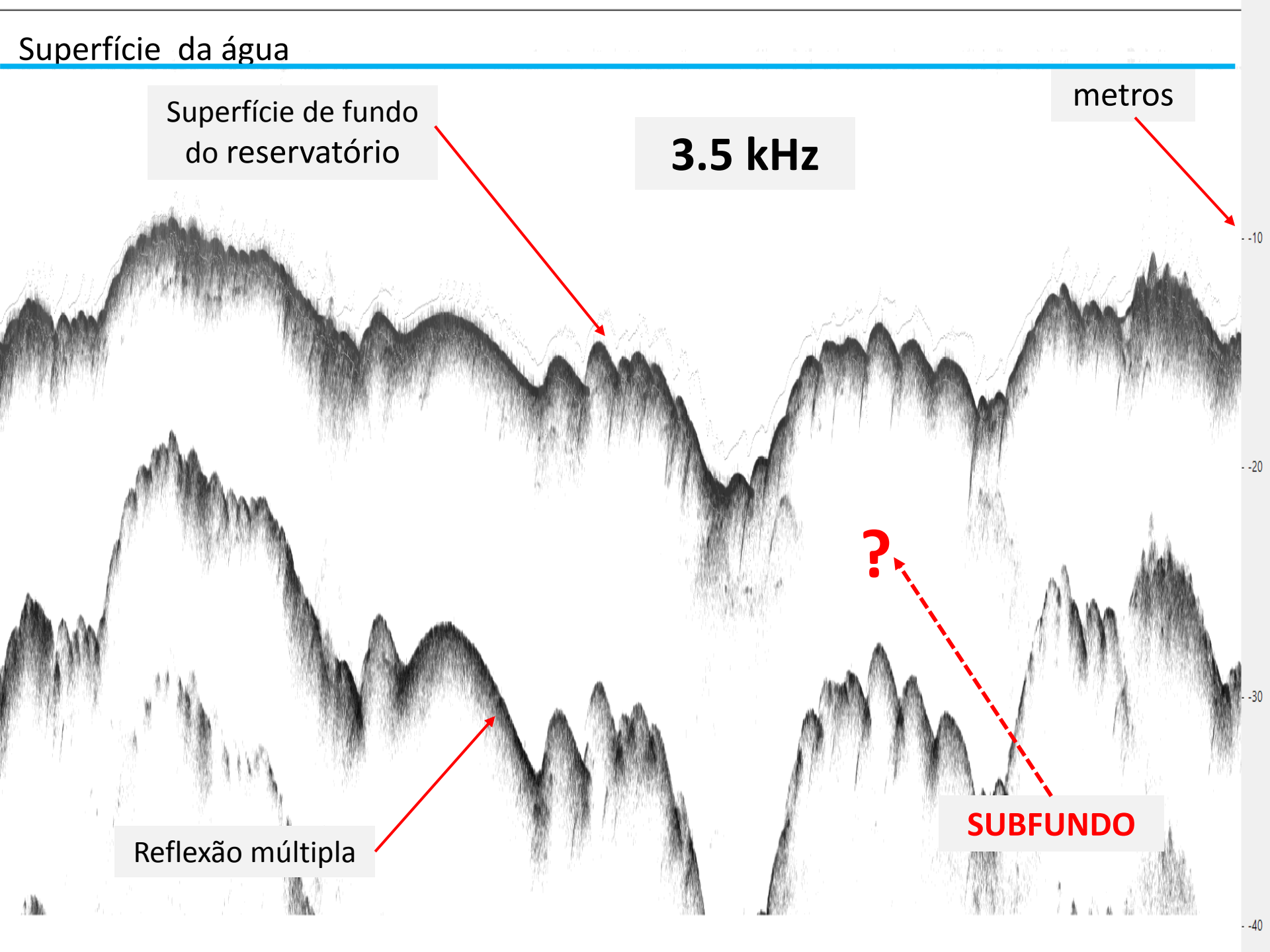
Rio Paraná, São Paulo, Brasil (Sistema de Perfilagem Sísmica Meridata do IPT)

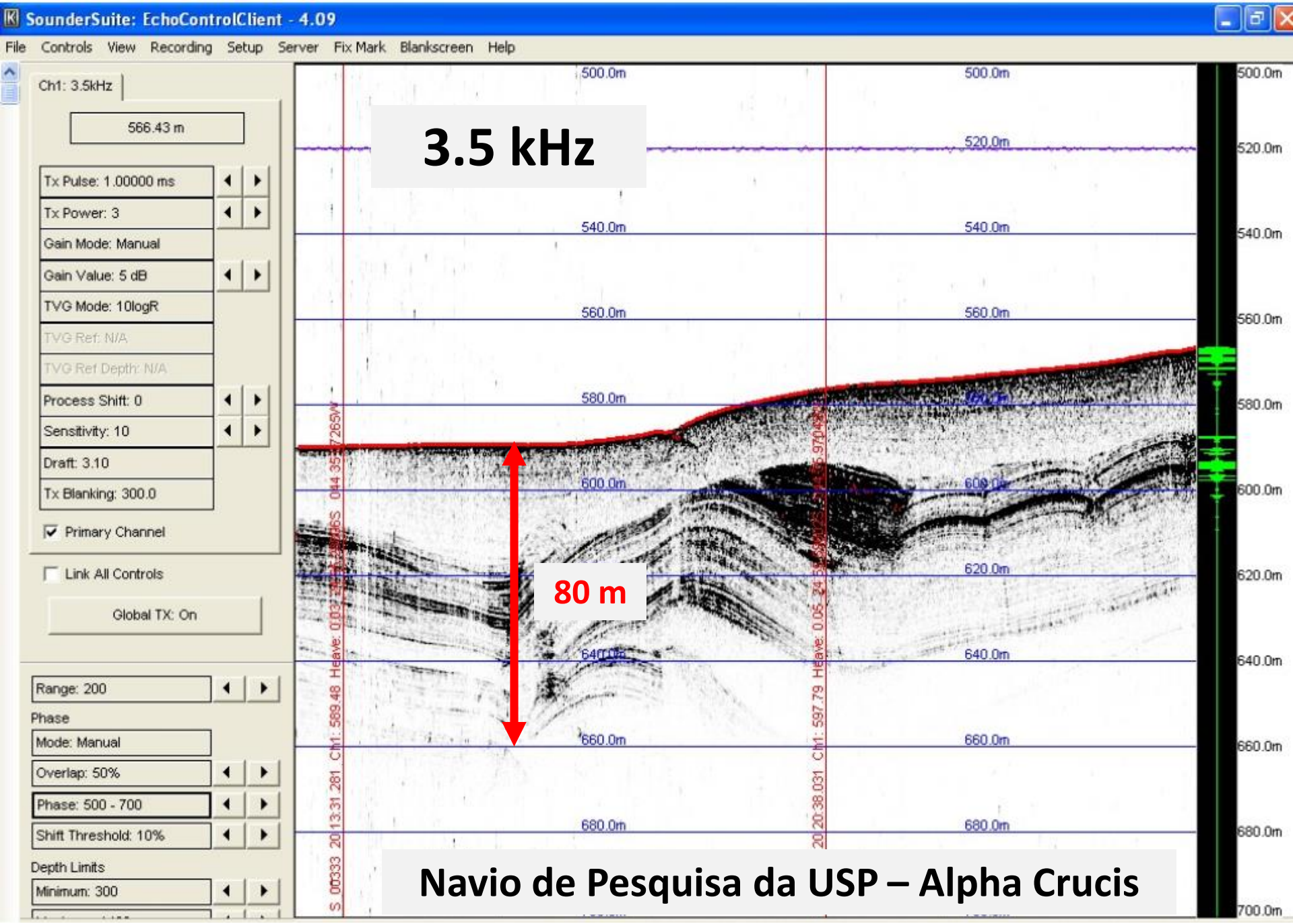


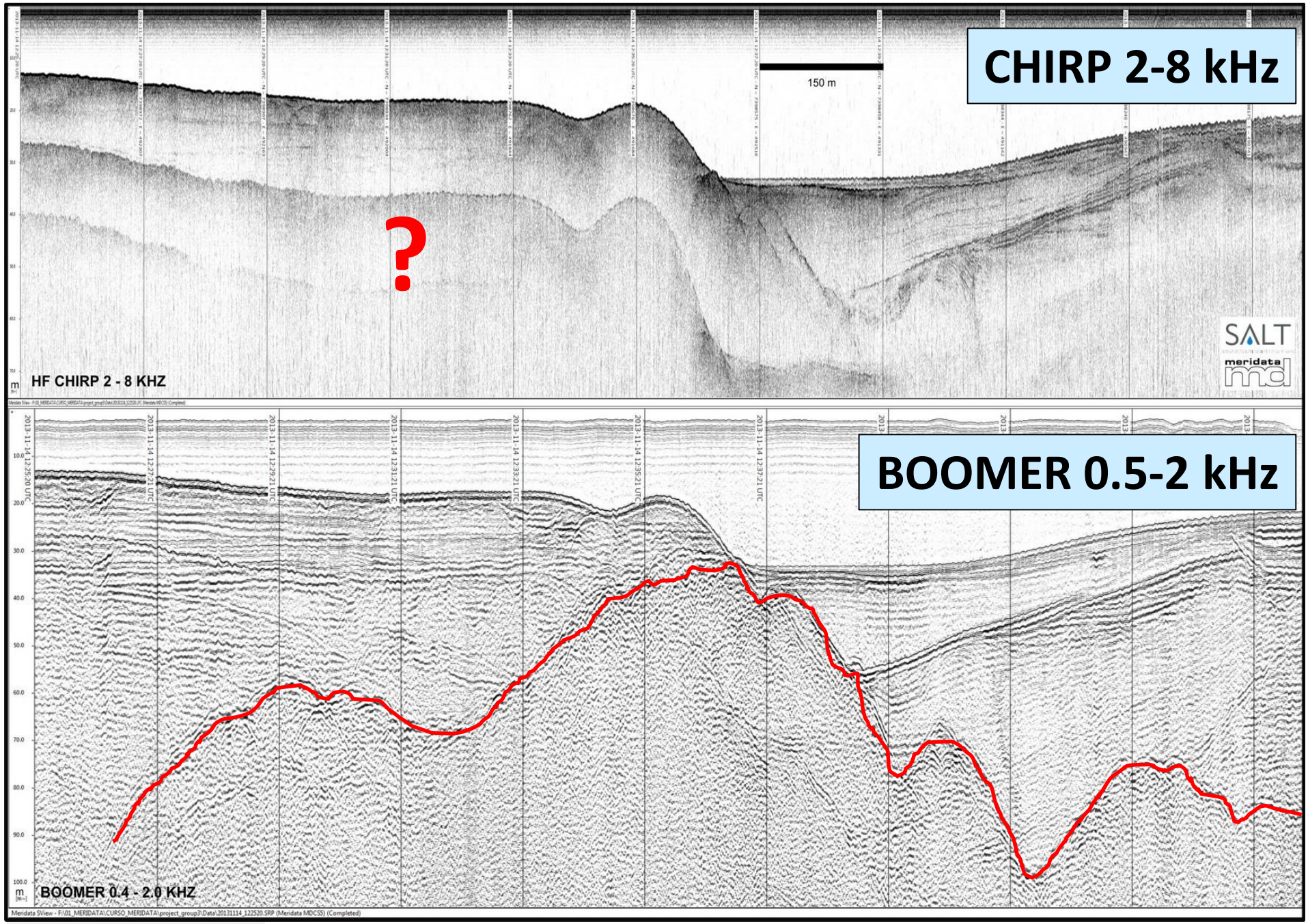
fonte: www.geoacoustics.com (abril 2006)

ipt

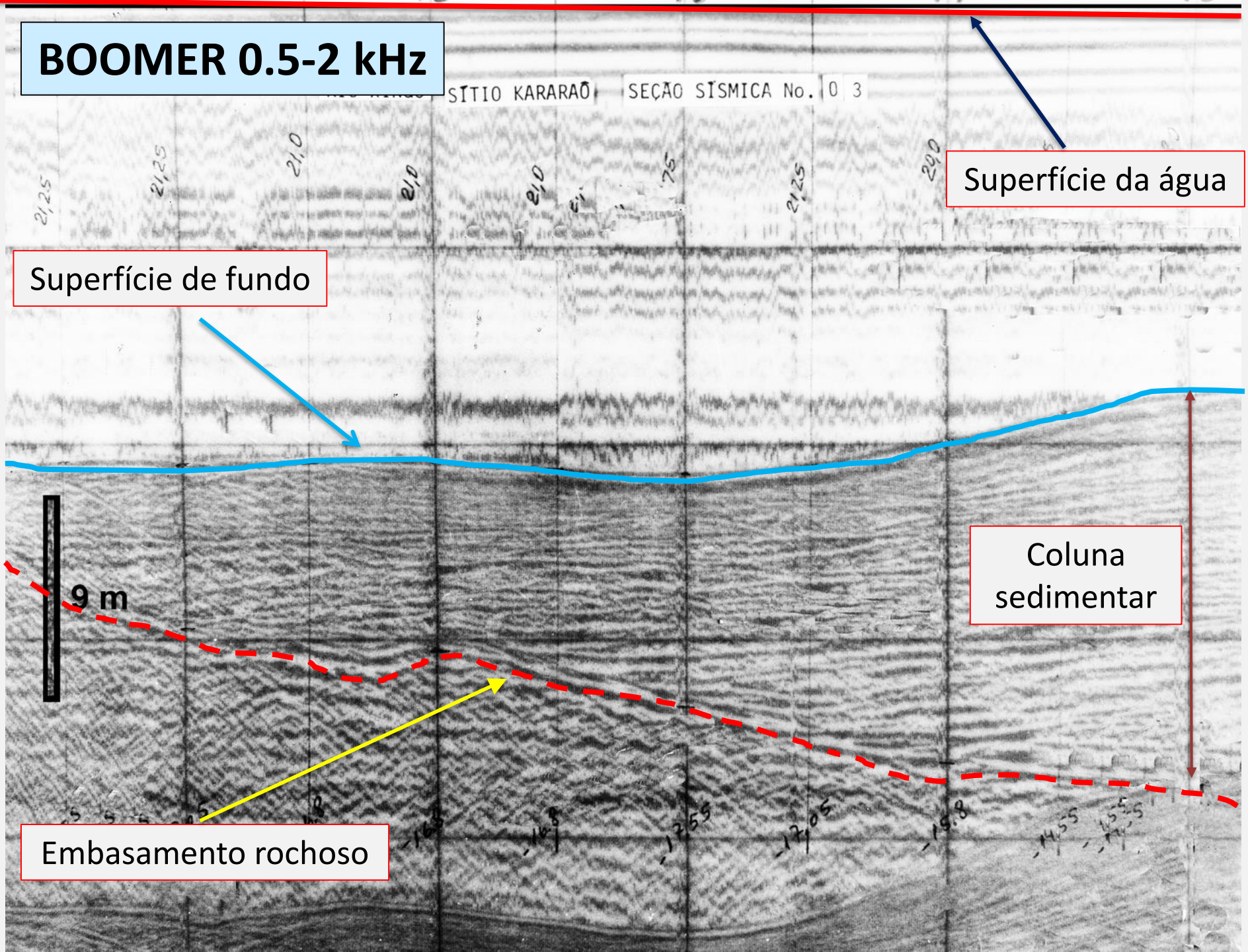
Superfície da água




SounderSuite: EchoControlClient - 4.09
File Controls View Recording Setup Server Fix Mark Blankscreen Help
Ch1: 3.5kHz
566.43 m
Tx Pulse: 1.00000 ms
Tx Power: 3
Gain Mode: Manual
Gain Value: 5 dB
TVG Mode: 10logR
TVG Ref: N/A
TVG Ref Depth: N/A
Process Shift: 0
Sensitivity: 10
Draft: 3.10
Tx Blanking: 300.0
Primary Channel
Link All Controls
Global TX: On
Range: 200
Phase
Mode: Manual
Overlap: 50%
Phase: 500 - 700
Shift Threshold: 10%
Depth Limits
Minimum: 300
3.5 kHz
80 m
500.0m
520.0m
540.0m
560.0m
580.0m
600.0m
620.0m
640.0m
660.0m
680.0m
700.0m
Navio de Pesquisa da USP – Alpha Crucis



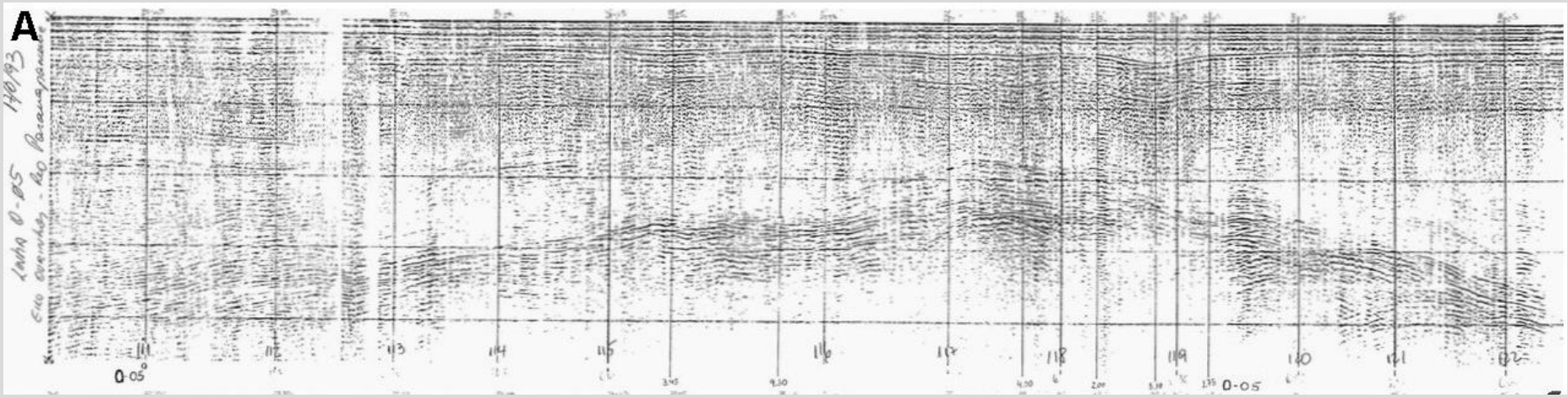
Litoral Norte de SP

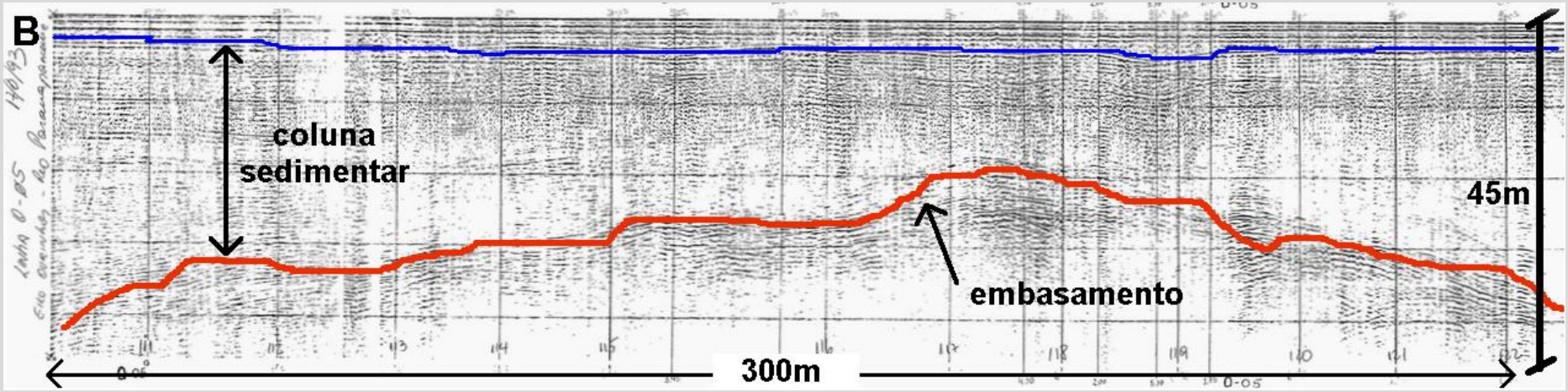

BOOMER 0.5-2 kHz
SÍTIO KARARAÔ
SEÇÃO SÍSMICA No. 0 3
Superfície da água
Superfície de fundo
9 m
Coluna sedimentar
Embasamento rochoso

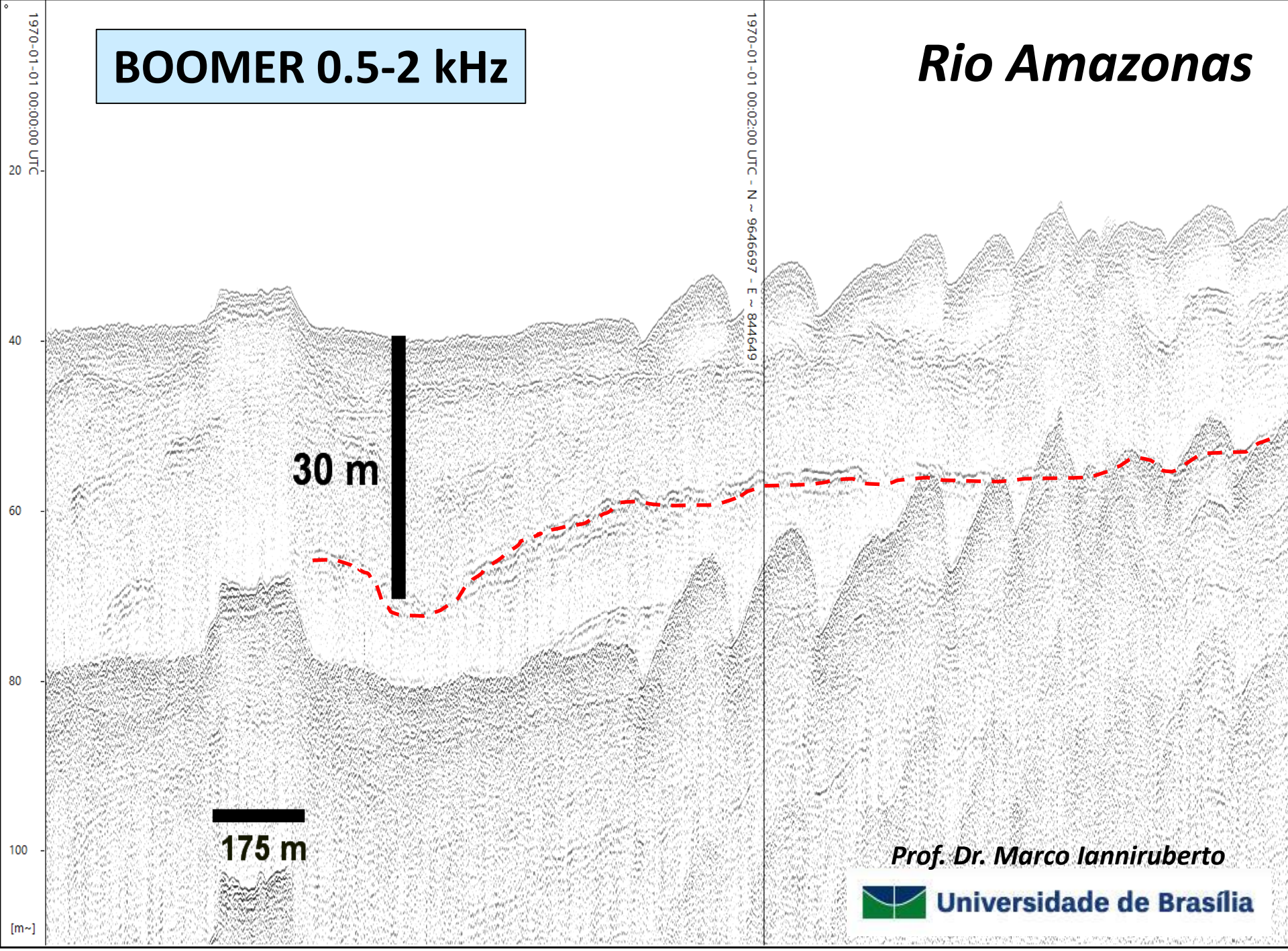
Investigação de subsuperfície : penetração

BOOMER 0.5-2 kHz

Rio Paranapanema, SP







Meridata SView - K:\Linhas Novas Amazonas\x10-CH-1.sgy (Meridata SEG-Y)

INVESTIGAÇÃO GEOFÍSICA EM RIOS E RESERVATÓRIOS

SUPERFÍCIE

BATIMETRIA

24,28,30,33,38,50,100,200, 400 e **550 kHz**

Monofeixe - Multifeixe
Interferometria - Multifase

(... 700 kHz)

IMAGEAMENTO

100,200,300,400,500 e **900 kHz**

Sonar Varredura Lateral

(... 1600 kHz)

Multifeixe

SUBSUPERFÍCIE

PENETRAÇÃO

0.5 – 2 kHz

Boomer, sparker, chirp LF

Bubble-gun

(70 < 300 Hz)

RESOLUÇÃO

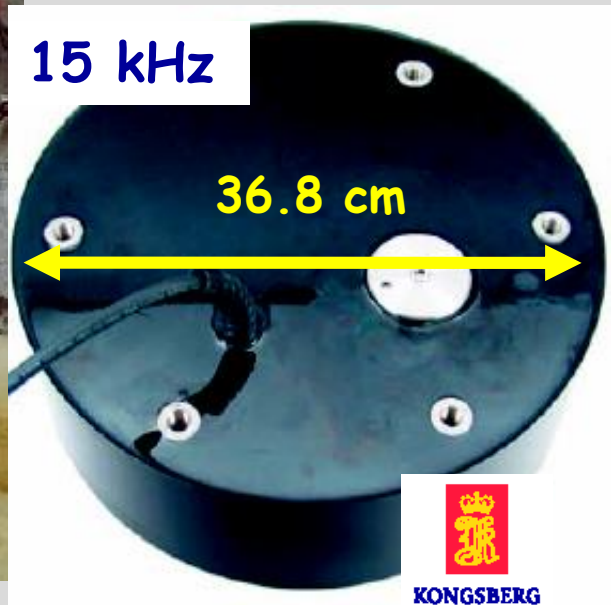
2 – 20 kHz

SBP 3.5, 7, 8, 12, 15, 24,
Chirp 2-8/10-20 (kHz)

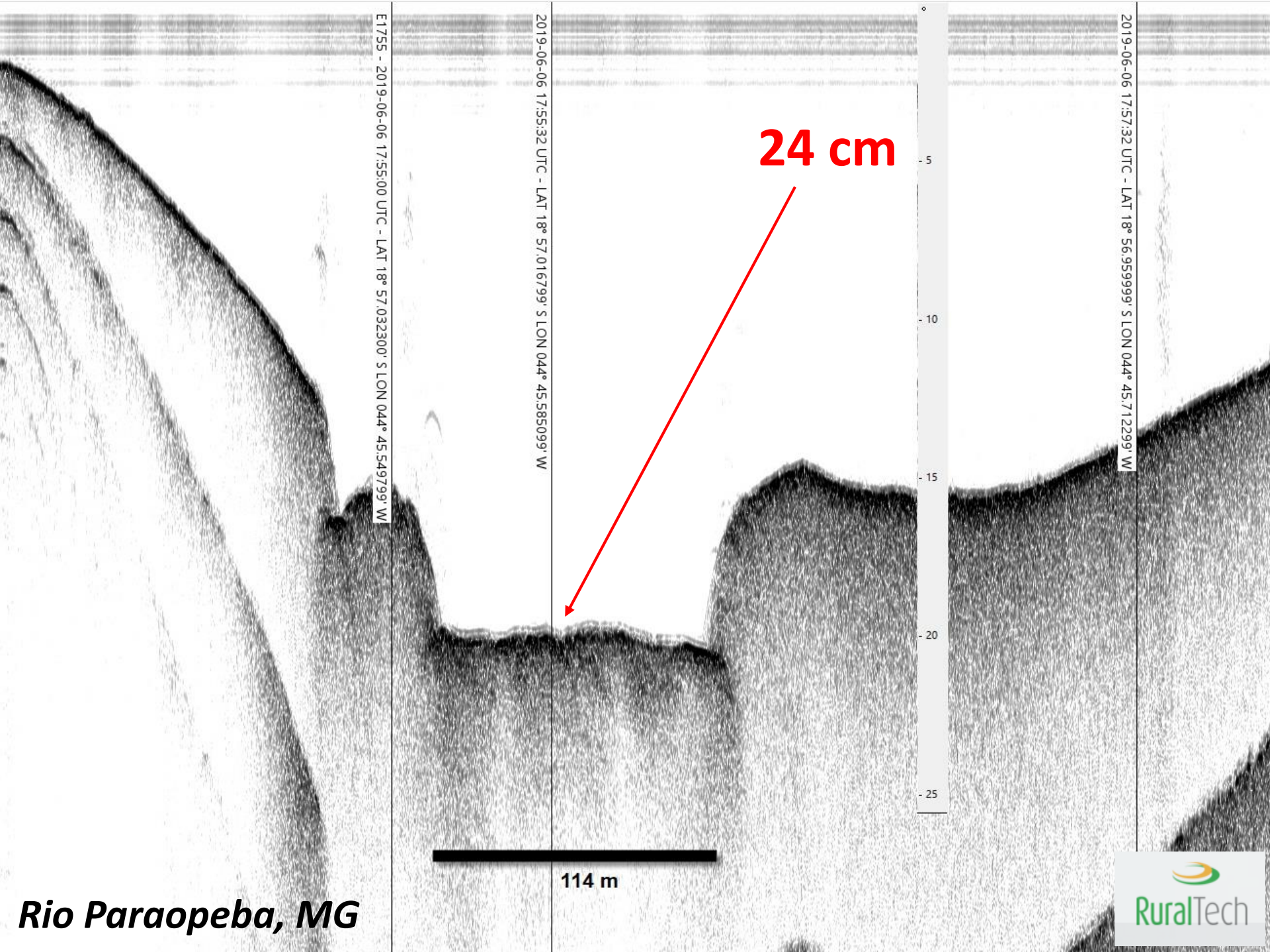
(Chirp 20 - 50 kHz)

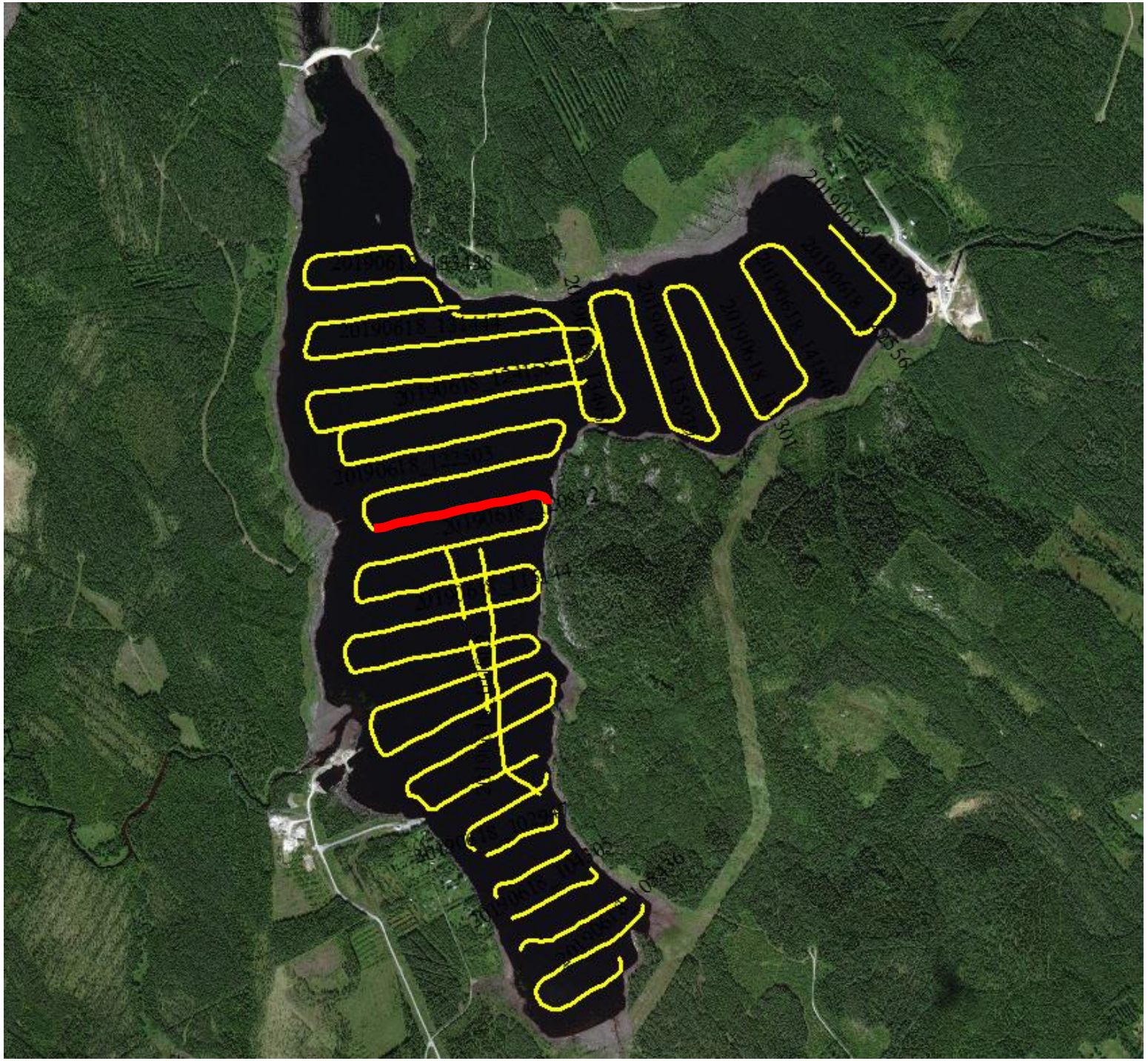
Resolução

15 kHz



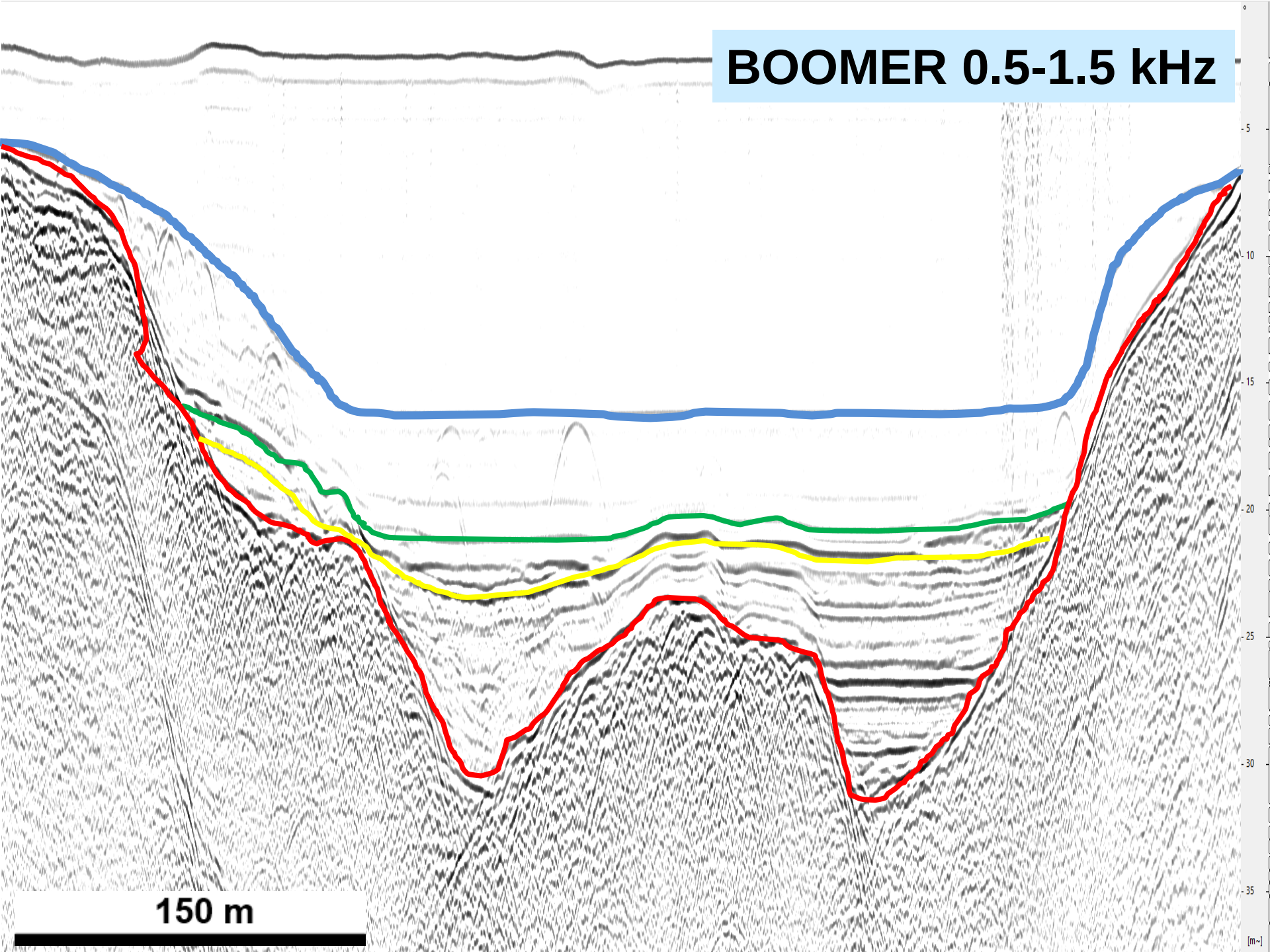
2 – 20 (50)kHz

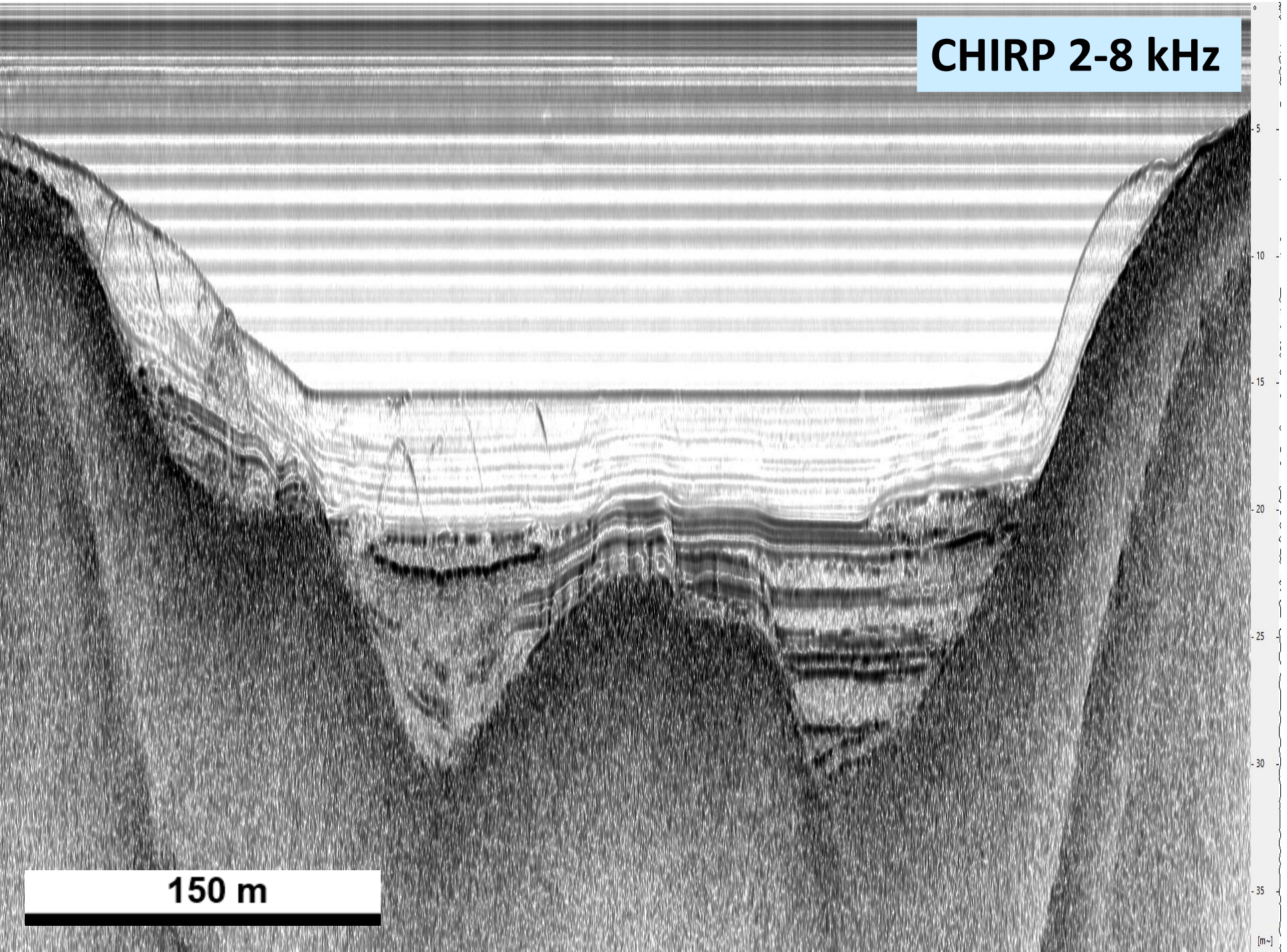

E1755 - 2019-06-06 17:55:00 UTC - LAT 18° 57.032300' S LON 044° 45.549799' W
2019-06-06 17:55:32 UTC - LAT 18° 57.016799' S LON 044° 45.585099' W
2019-06-06 17:57:32 UTC - LAT 18° 56.959999' S LON 044° 45.712299' W
24 cm
5
10
15
20
25
114 m
Rio Paraopeba, MG
RuralTech

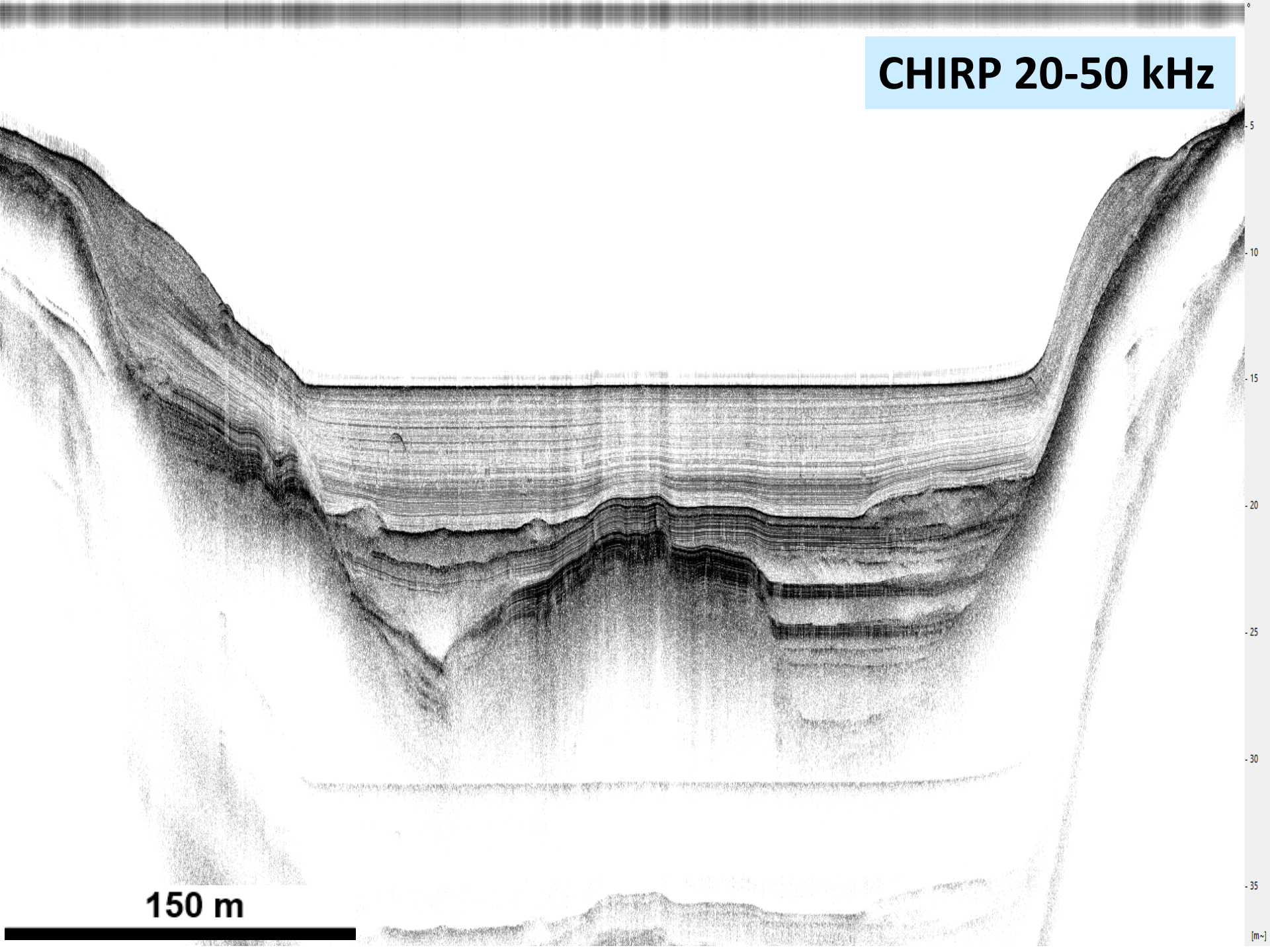


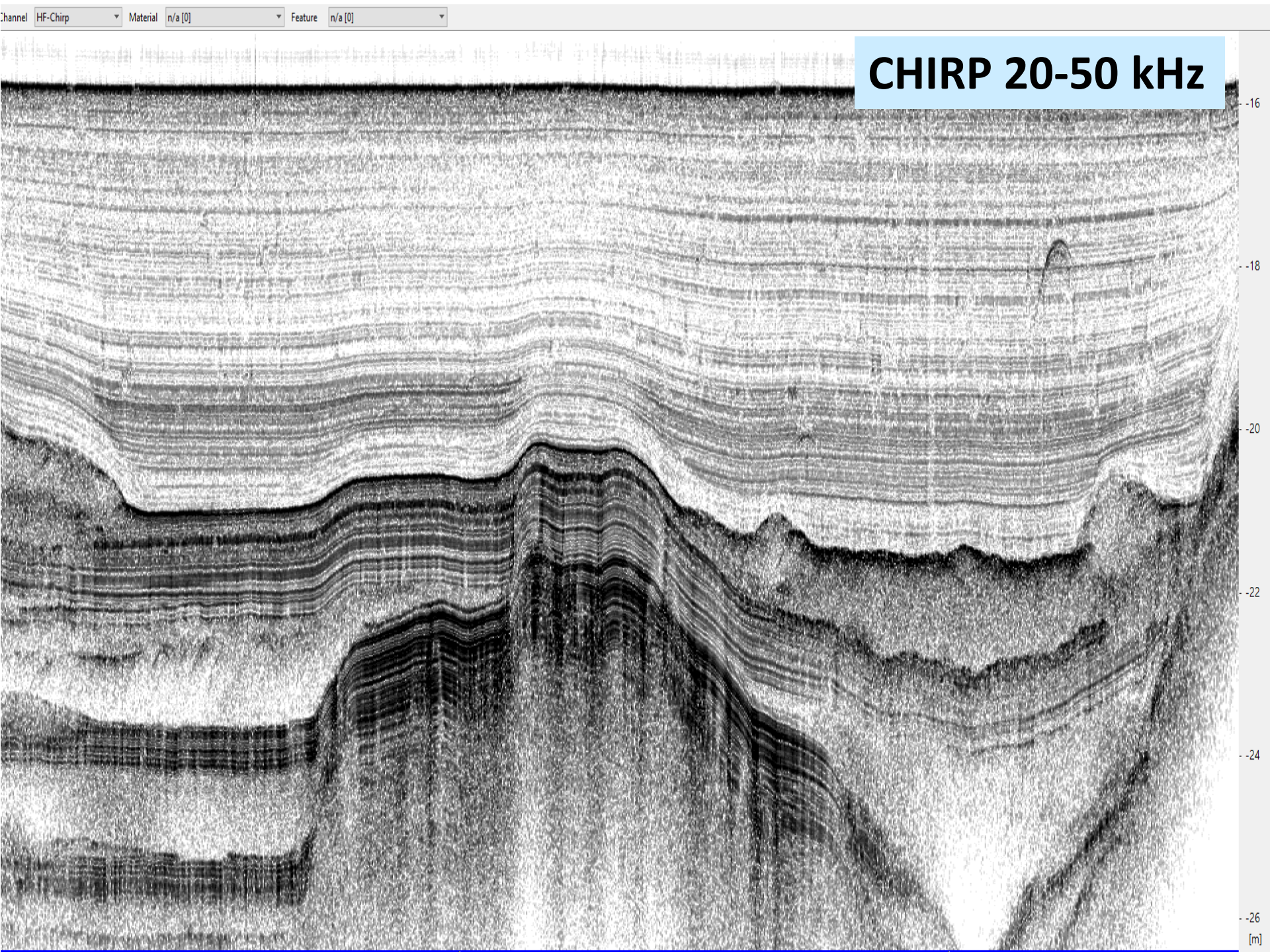
Lago Mitta, Finlândia

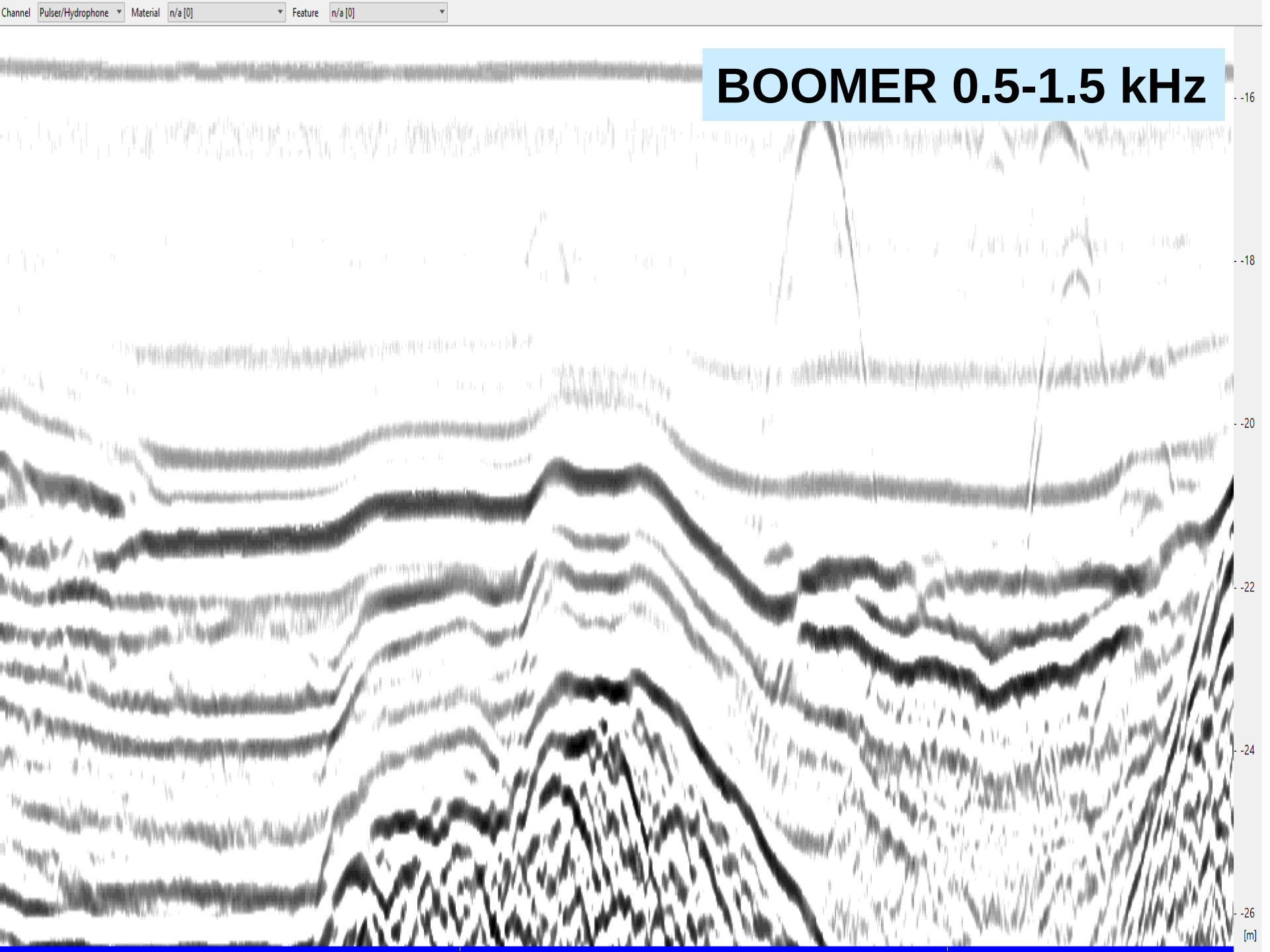
Sistema MDCS–Meridata


BOOMER 0.5-1.5 kHz
150 m
5
10
15
20
25
30
35
[m~]


CHIRP 2-8 kHz
150 m
5
10
15
20
25
30
35
[m~]

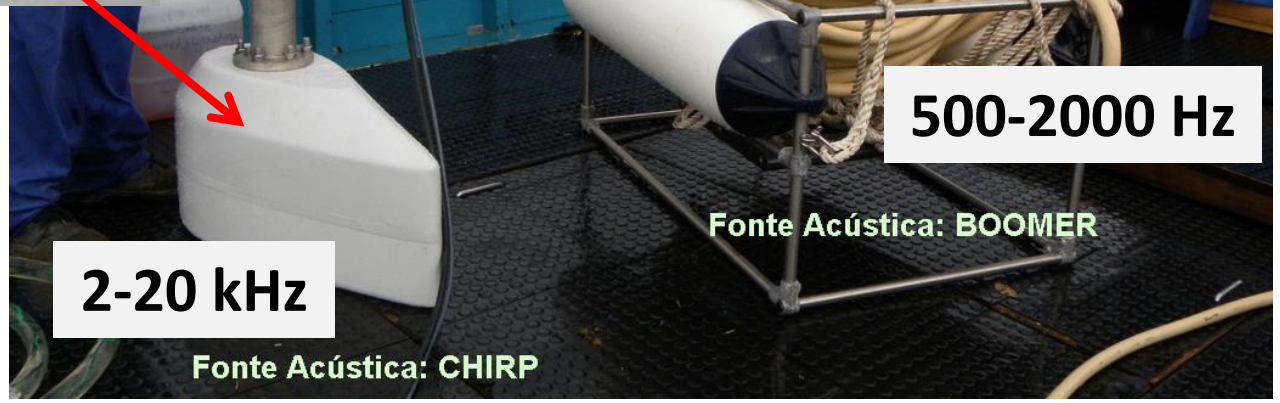

CHIRP 20-50 kHz
150 m
5
10
15
20
25
30
35
[m~]


Channel
HF-Chirp
Material
n/a [0]
Feature
n/a [0]
CHIRP 20-50 kHz
-16
-18
-20
-22
-24
-26
[m]

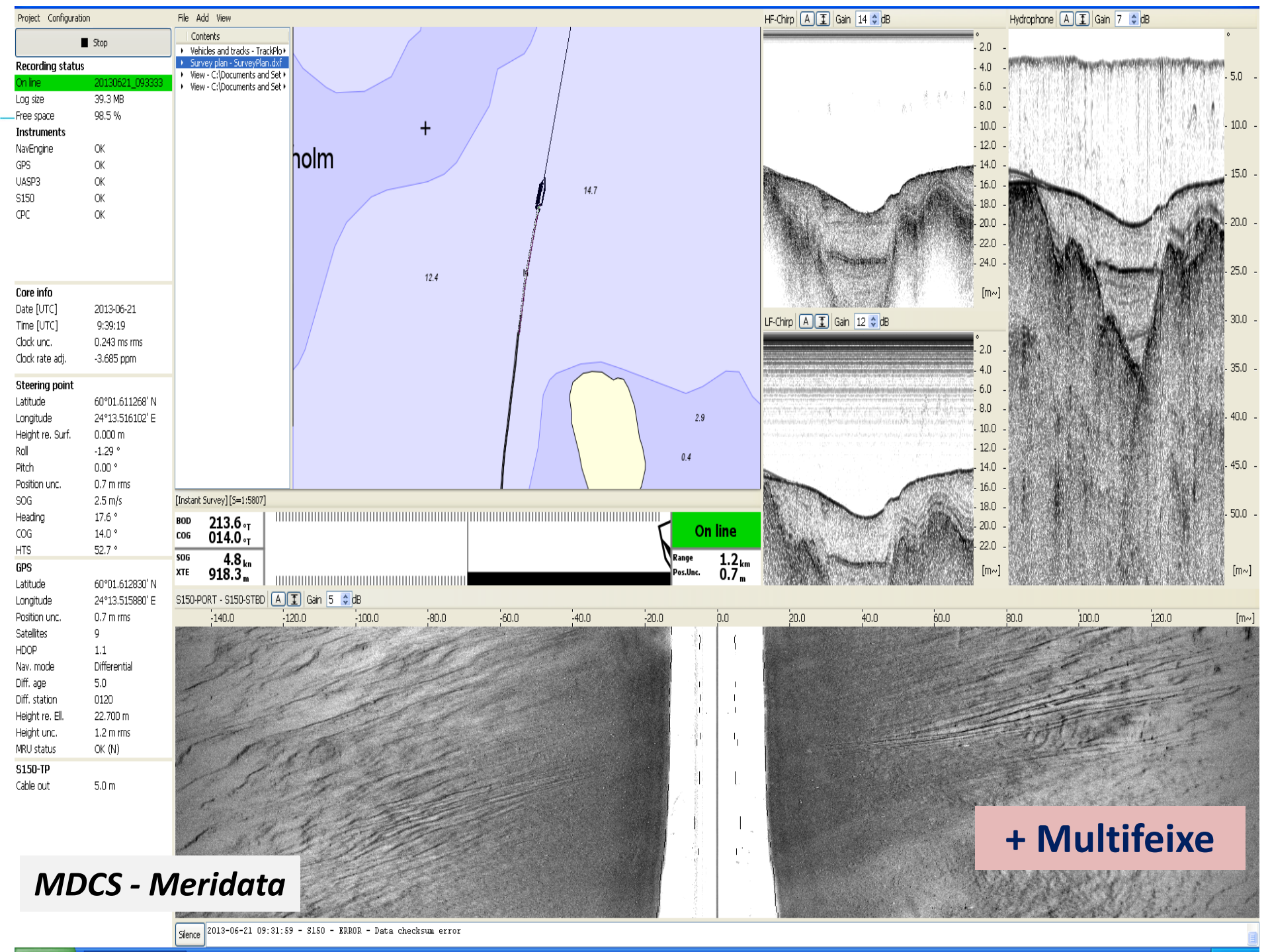

Channel
Pulser/Hydrophone
Material
n/a [0]
Feature
n/a [0]
BOOMER 0.5-1.5 kHz
-16
-18
-20
-22
-24
-26
[m]

38/200 + 100/500/1600 + (2 - 8) / (10 - 18) / (0,5 - 2) kHz

eco sssonar chirp boomer/sparker



MDCS - Meridata


Project Configuration
Stop
Recording status
On line 20130621_093333
Log size 39.3 MB
Free space 98.5 %
Instruments
NavEngine OK
GPS OK
UASP3 OK
S150 OK
CPC OK
Core info
Date [UTC] 2013-06-21
Time [UTC] 9:39:19
Clock unc. 0.243 ms rms
Clock rate adj. -3.685 ppm
Steering point
Latitude 60°01.611268' N
Longitude 24°13.516102' E
Height re. Surf. 0.000 m
Roll -1.29 °
Pitch 0.00 °
Position unc. 0.7 m rms
SOG 2.5 m/s
Heading 17.6 °
COG 14.0 °
HTS 52.7 °
GPS
Latitude 60°01.612830' N
Longitude 24°13.515880' E
Position unc. 0.7 m rms
Satellites 9
HDOP 1.1
Nav. mode Differential
Diff. age 5.0
Diff. station 0120
Height re. Ell. 22.700 m
Height unc. 1.2 m rms
MRU status OK (N)
S150-TP
Cable out 5.0 m
File Add View
Contents
Vehicles and tracks - TrackPlo
Survey plan - SurveyPlan.dxf
View - C:\Documents and Set
View - C:\Documents and Set
14.7
12.4
2.9
0.4
[Instant Survey] [S=1:5807]
BOD 213.6 °T
COG 014.0 °T
SOG 4.8 kn
XTE 918.3 m
On line
Range 1.2 km
Pos.Unc. 0.7 m
HF-Chirp A Gain 14 dB
LF-Chirp A Gain 12 dB
Hydrophone A Gain 7 dB
[m~]
S150-PORT - S150-STBD A Gain 5 dB
-140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 [m~]
Silence
2013-06-21 09:31:59 - S150 - ERROR - Data checksum error
MDCS - Meridata
+ Multifeixe

CONCLUSÕES

Sísmica/acústica à investigação de rios e reservatórios de água: estado da arte

INVESTIGAÇÃO DE SUPERFÍCIE

- **Sistemas multifeixes/sonar de varredura lateral:** permitem gravação simultânea de dados de diferentes frequências
- **Altas frequências mapeamento de detalhe (200<700 kHz)**
- Baixas frequências mapeamento de **grandes** áreas (<100 kHz)
- **Sistemas multifase: grande cobertura em águas rasas (8-10x)**

INVESTIGAÇÃO DE SUBSUPERFÍCIE

- Emprego simultâneo de sistemas multifrequenciais garantindo **RESOLUÇÃO** + **PENETRAÇÃO** … = Chirp (**2-50** kHz) + boomer (**500 – 2000** Hz) ou bubble-gun (**70-300** Hz) + Multibeam + Sonar de V. Lateral

SISTEMAS AUTÔNOMOS & SOFTWARE

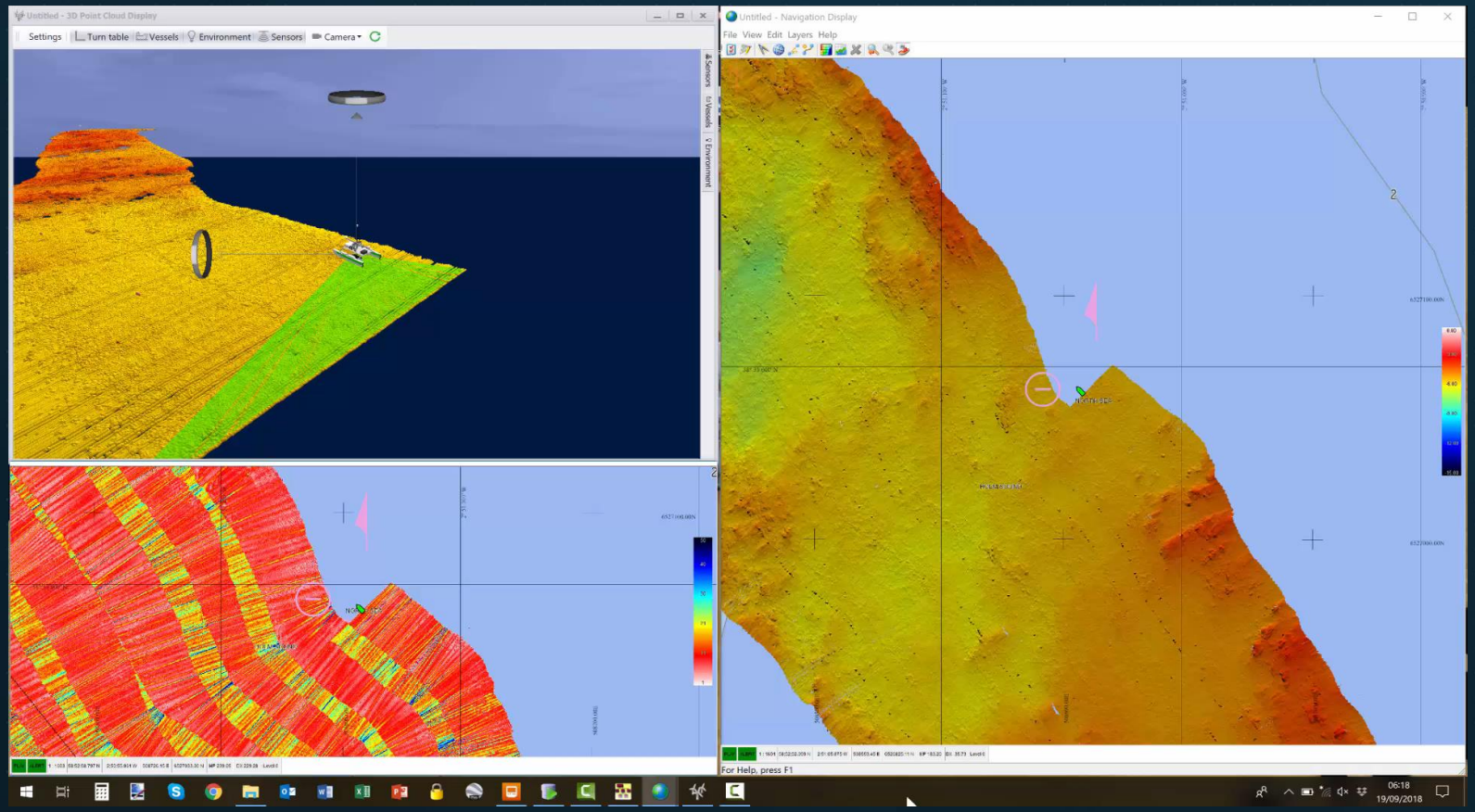
- **ASV** – Veículos autônomos de superfície


Seafloor
EchoBoat-ASV


TECHNICAL SPECIFICATIONS
• Length: 8m
• Beam: 2.2m
• Height: 2.3 / 4.4m (mast down/up)
• Draft: 0.7m
• Weight: 4,200kg – ready to operate
• Propulsion: 125hp Steyr diesel engine with fixed pitch propeller
• Speed: 12 knots (max)
• Endurance: Up to 20 days @ 4 knots
• Payload power: > 4 kW @ 4 knots
• Control: K-MATE autonomy engine for direct, supervised and autonomous operation
• Communication: Maritime Broadband Radio/Iridium (VSAT optional)
KONGSBERG
AUTONOMOUS VESSEL
SOUNDER
Sounder Unmanned Surface Vehicle - USV System

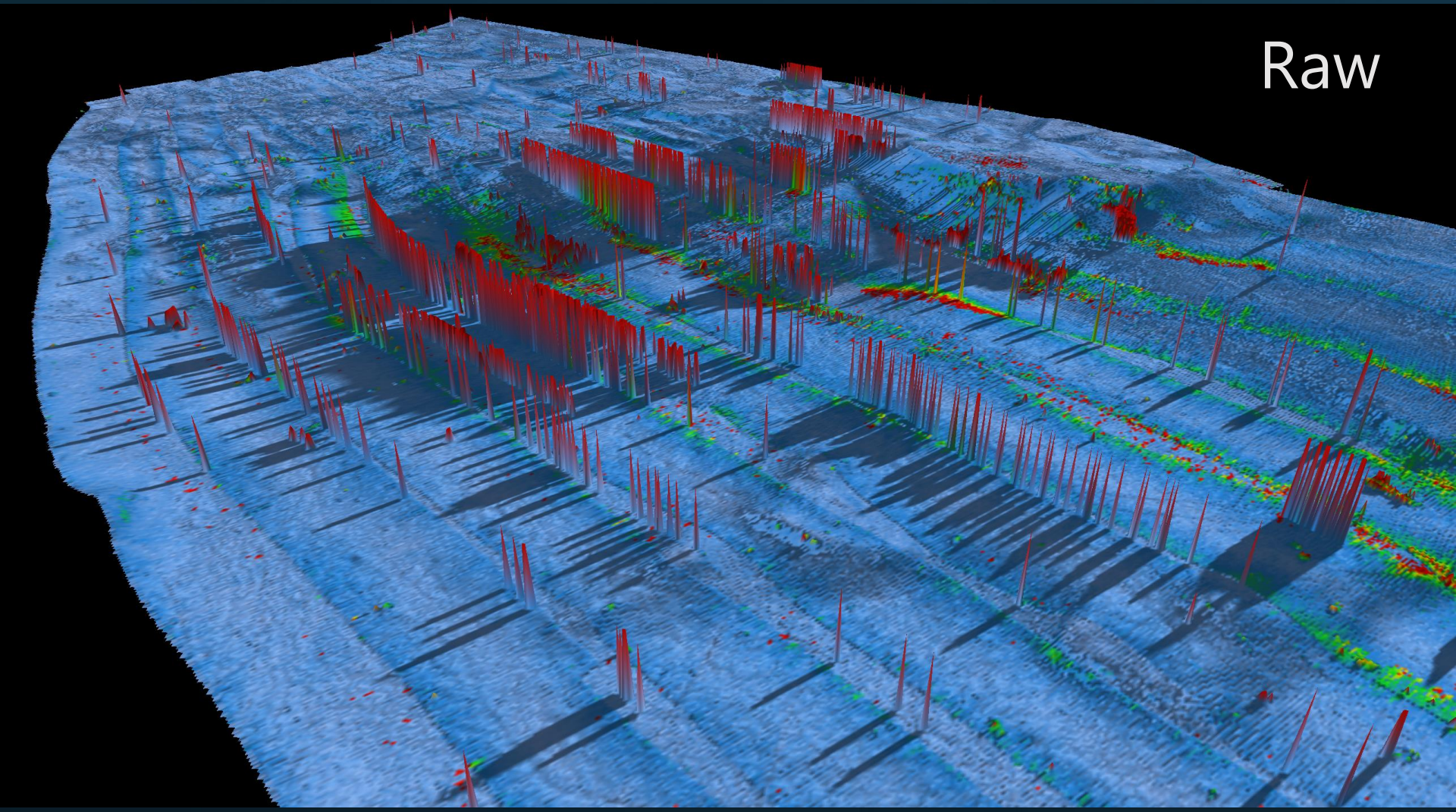
Echo81 & ASV GLOBAL *(SEAWORKER 5)*

Veículos autônomos (ASV) & Software



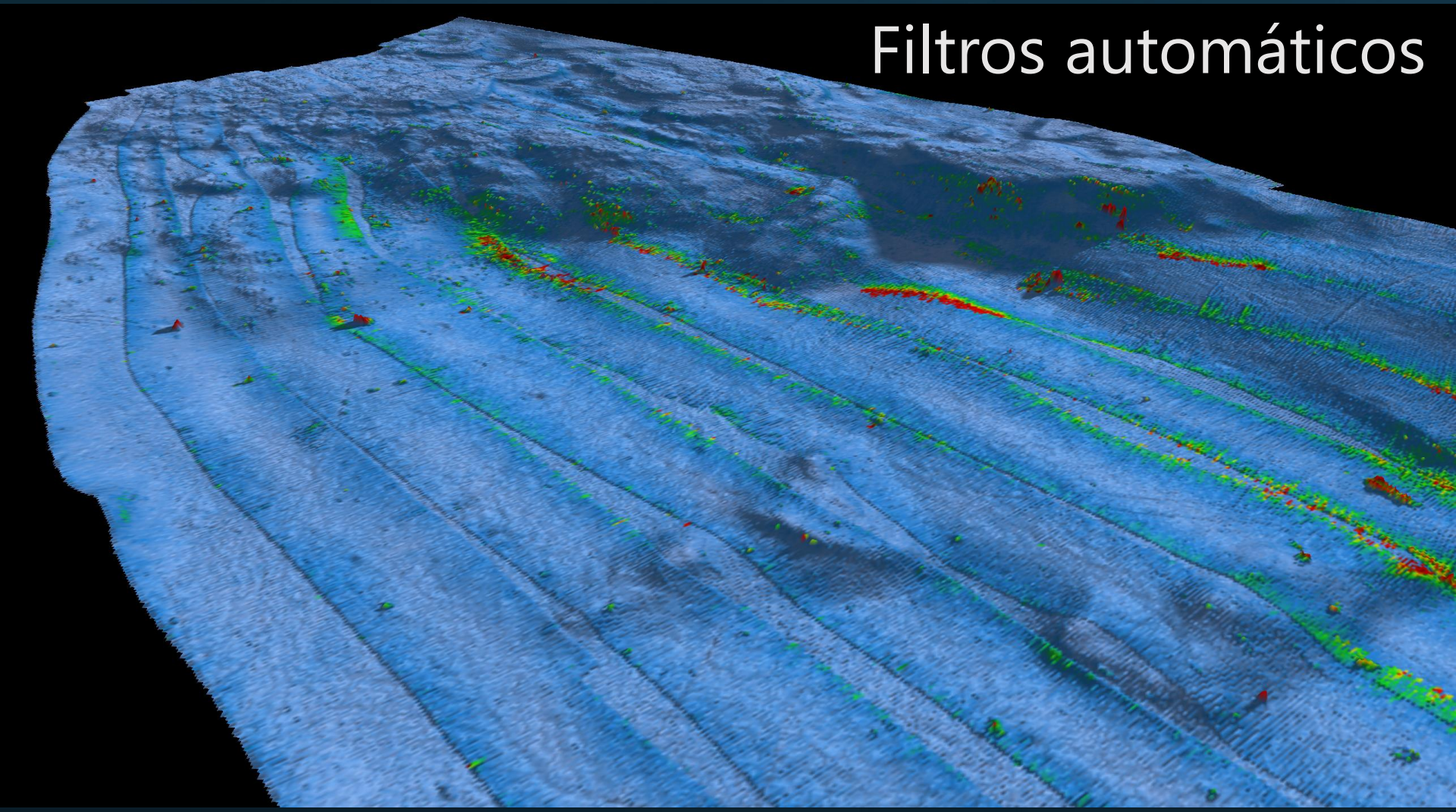
Fonte: QPS

Software ...



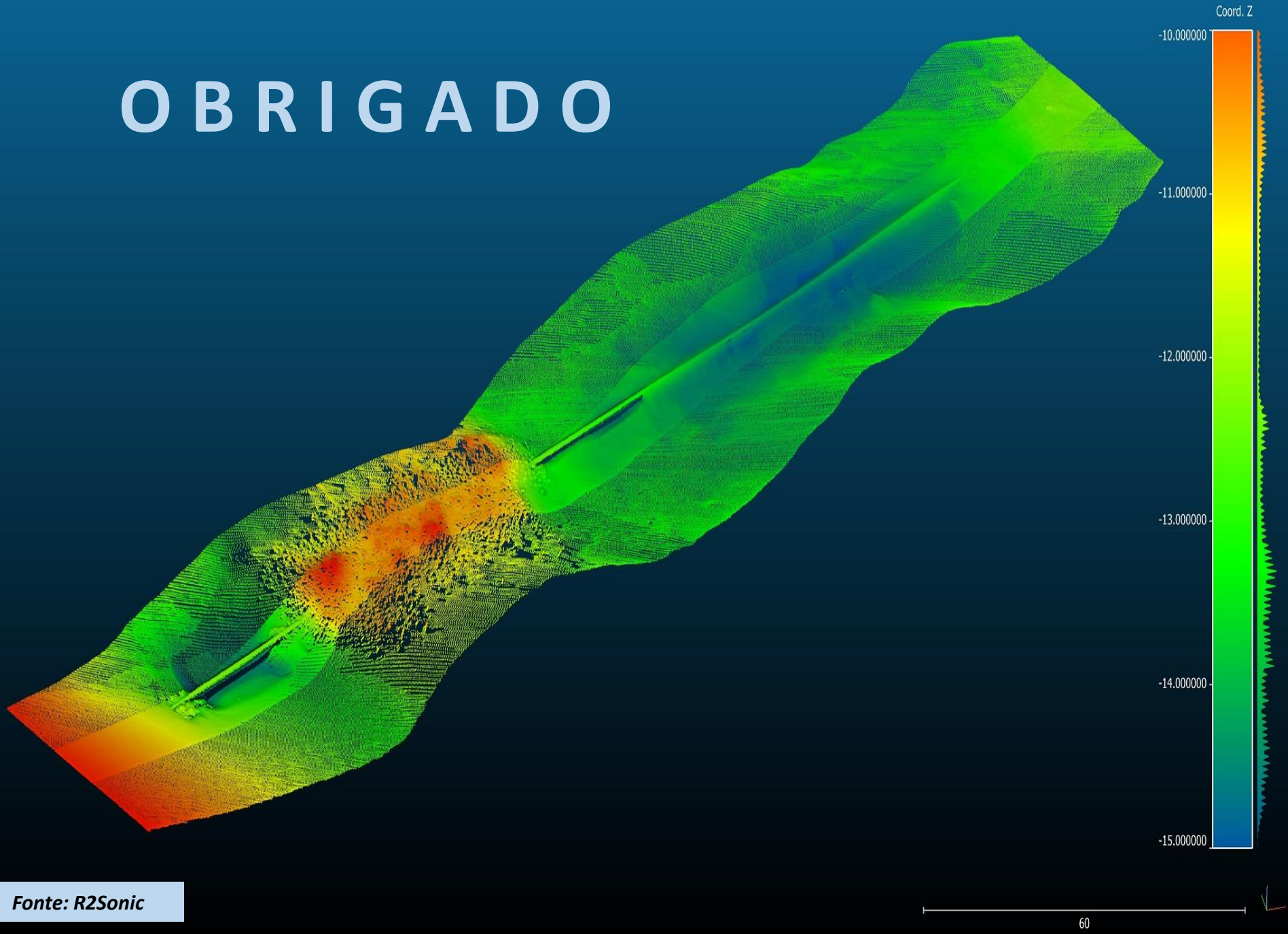
Fonte: QPS

Filtros automáticos



Fonte: QPS

O B R I G A D O



Fonte: R2Sonic