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FloatSeis™

Free Float Recording System Seismic Survey – Efficient and Cost Effective Solution for Depth Imaging in Complex Geological Environment

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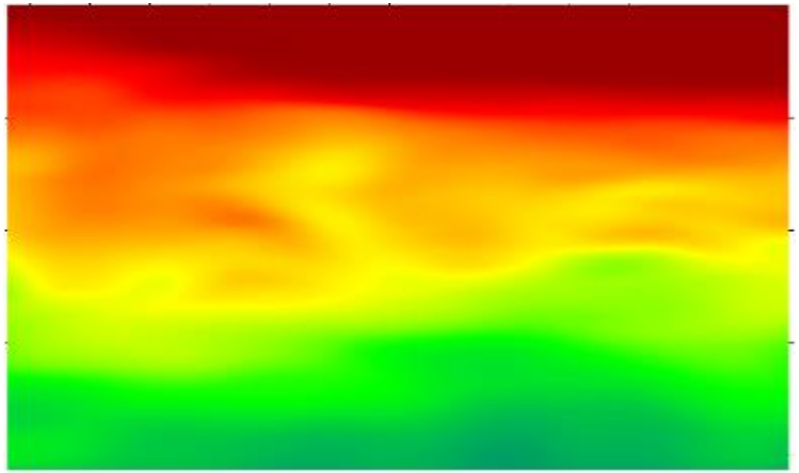
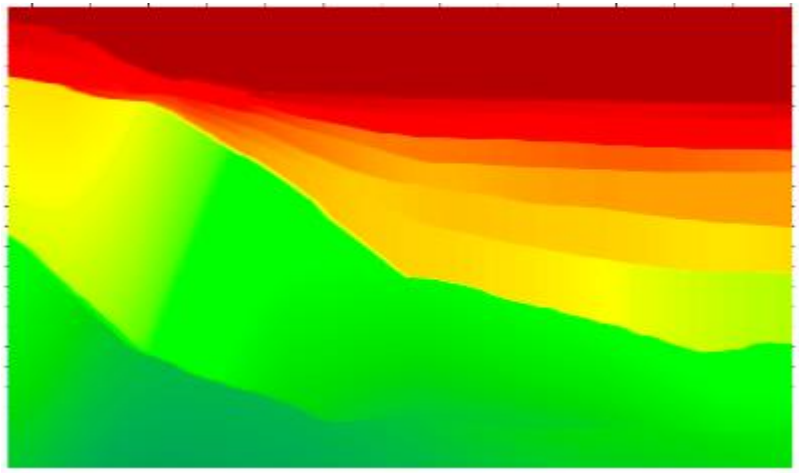
FloatSeis™

is a new marine seismic technology that enhances 2D/3D CDP reflection data with velocity model derived from recorded long-offset refracted wave data



Conventional velocity model



FloatSeis™ velocity model

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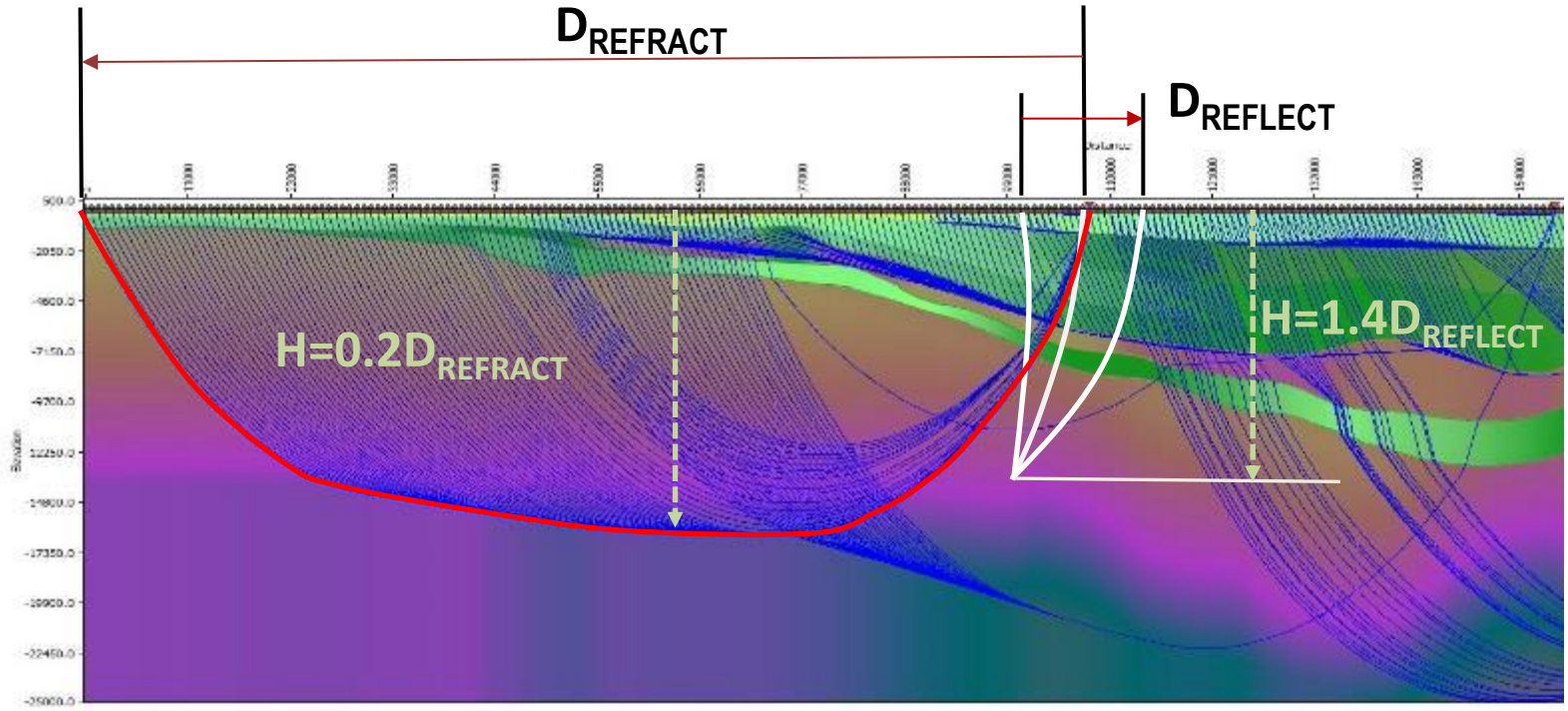
Key Geological Environments Where Conventional CDP Seismic Velocity Model Fails:

FACTOR	EFFECT	FloatSeis™
Irregular bedding	CDP velocities is not exact estimate of real velocities due to effect of ray bending in a real medium	Ray bending is taken into account with high accuracy on stage of ray tracing
Discontinuous fault	Diffraction has same peak on coherency diagram as reflection. It is always complicated to distinguish one from another	Effect of diffraction does not impact on first breaks events
Screening layer (salt, intrusion, etc.)	Main part of energy of reflected waves is reflected and scattered by surface of the screening layer. It impairs quality of velocity spectra for reflections from underlying layers. Effect of ray bending on this surface may be also significant	Refracted waves have high penetration capability by virtue of lower frequency and diverse geometry of ray paths to bend an obstacle
High-velocity formations	Low accuracy of velocity analysis because of interference of adjacent reflections	Evaluation precision of velocities does not depend on their absolute meanings

Refracted waves – an alternative source of information on velocities in the earth allowing to build accurate velocity model



A CDP refraction survey for depths down to **10 km** depth requires **7-10 km** offsets .
To acquire refracted waves from that same depth, **50 km** offsets are required, that being not feasible with towed streamer facilities.

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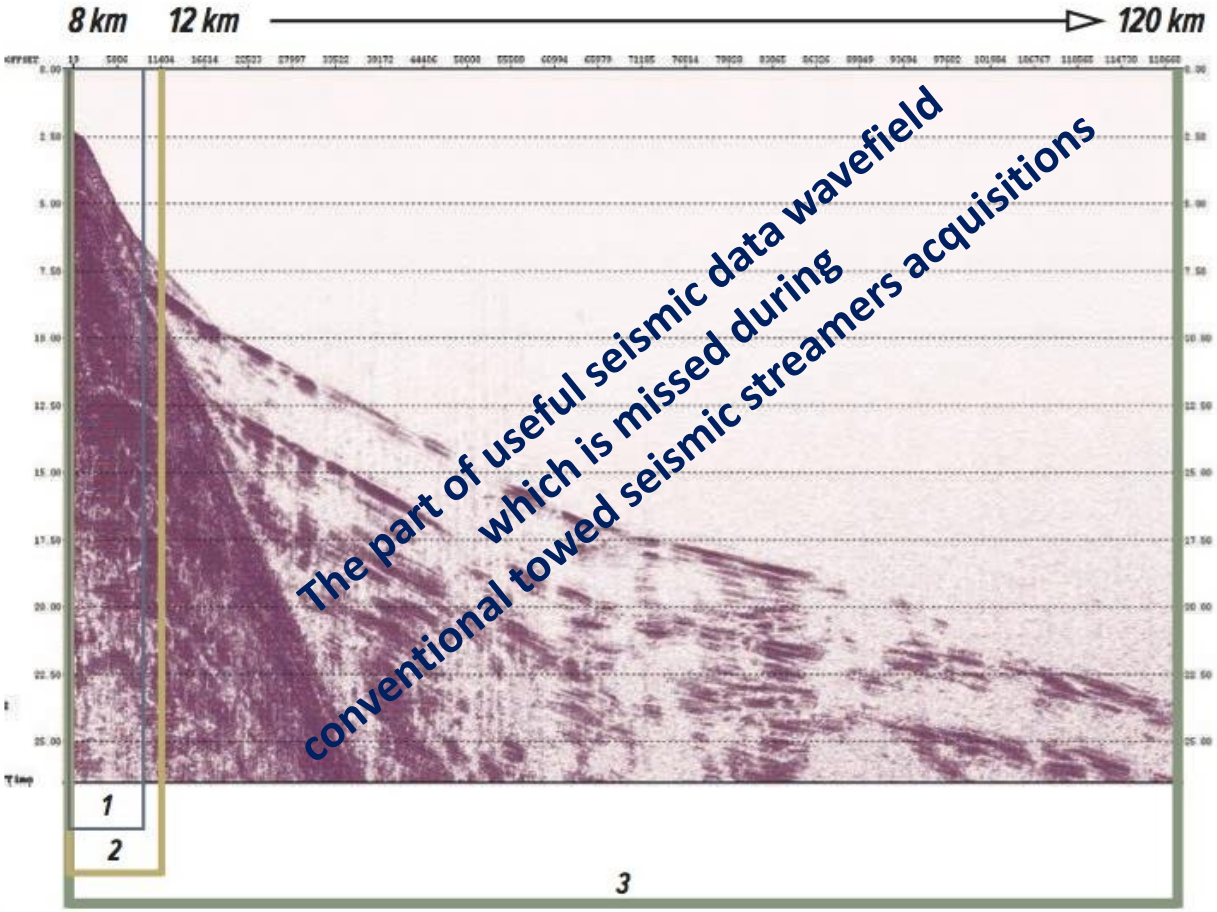
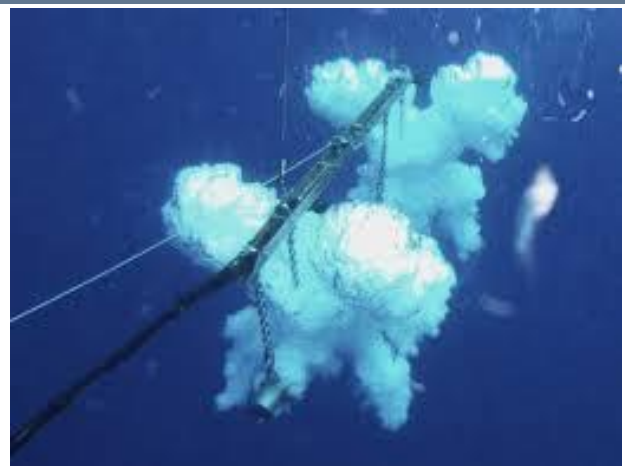
Why lose seismic data when you've already fired the guns?





1
Offset range of a standard seismic streamer (8 km)

2
Extended streamer length for recording of deep reflections when performing regional studies GWL (12.4 km)

3
Maximum offset range for recording of refracted waves, to build a reliable velocity model using FloatSeis™ (120 km)

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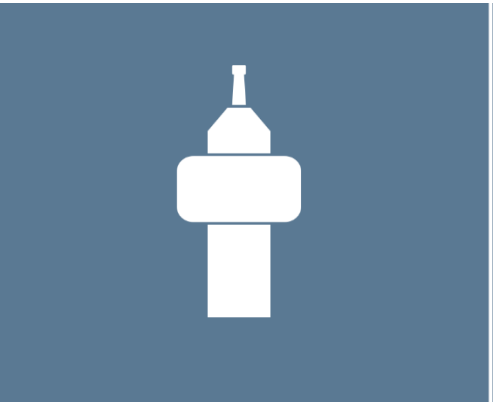
How to record missing seismic data

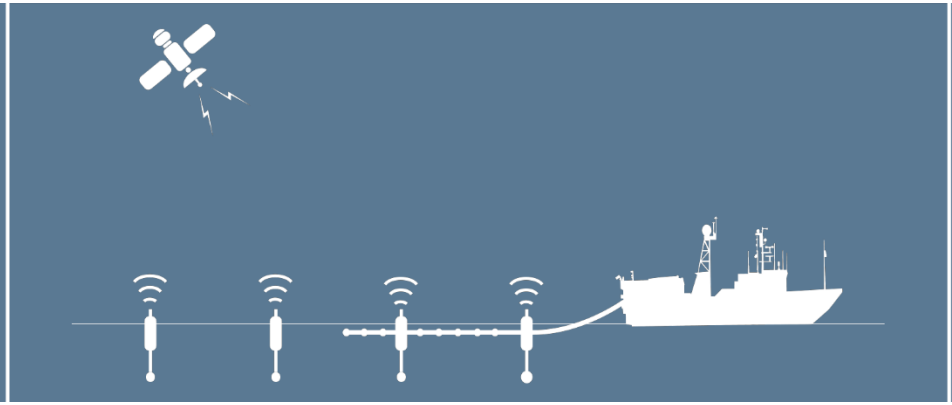
FloatSeis™ Components

FloatSeis™ is a combination of seismic equipment, acquisition method, party and processing technique



GWL Seismobuoy™

Records refracted waves at offsets up to 120 km



FloatSeis™ field operations

Provides fast Mob/Demob, high speed and safety of acquisition

TrueVelocitySolution (TVS)™ processing technique

Performs diligent processing of FloatSeis™ data

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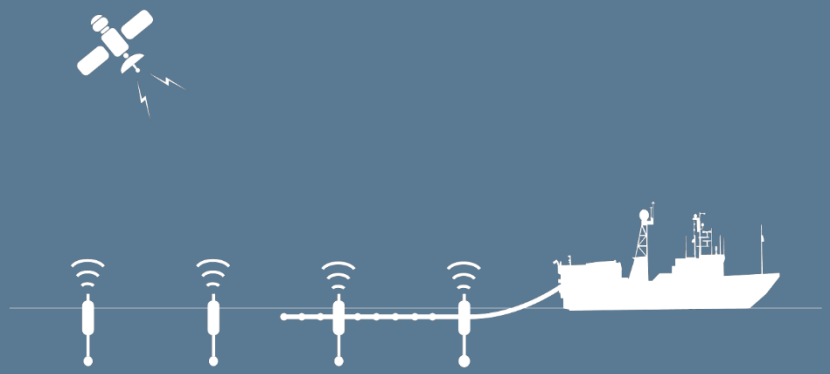
ACQUISITION METHOD



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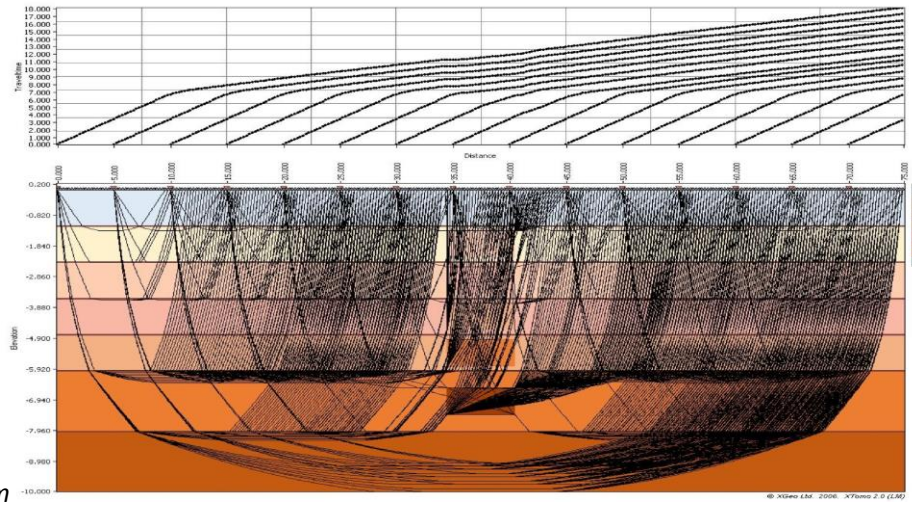
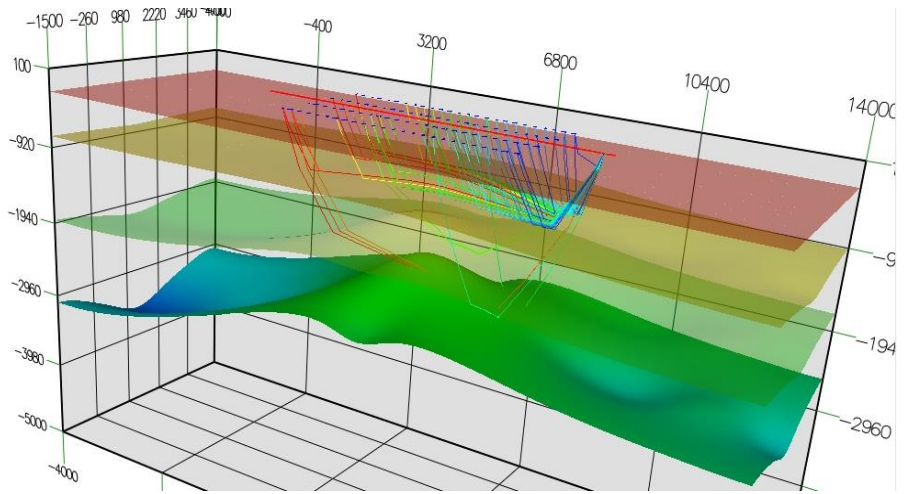
Modeling is performed prior to acquisition to define the optimal acquisition parameters



2D Survey Modeling



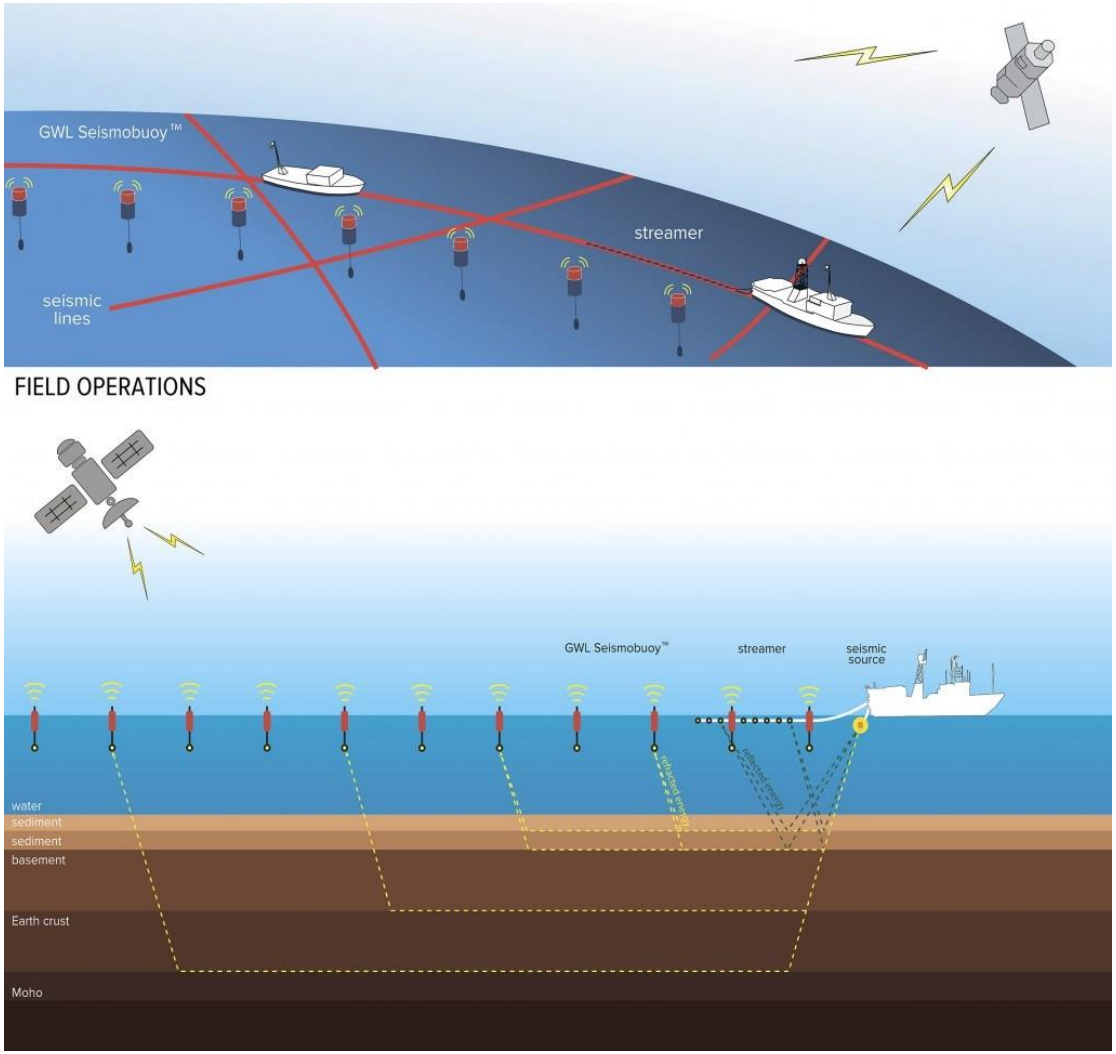
3D Acquisitions Survey Modeling

Basic* parameters for:

- Regional Survey – Receiver point interval - 10 km, max offset - 120 km, depth 25-30 km
- Exploration Survey - Receiver point interval - 3-5 km, max offset - 30 km, depth 5-6 km

* - meanings given as an example. The firm parameters are defined individually

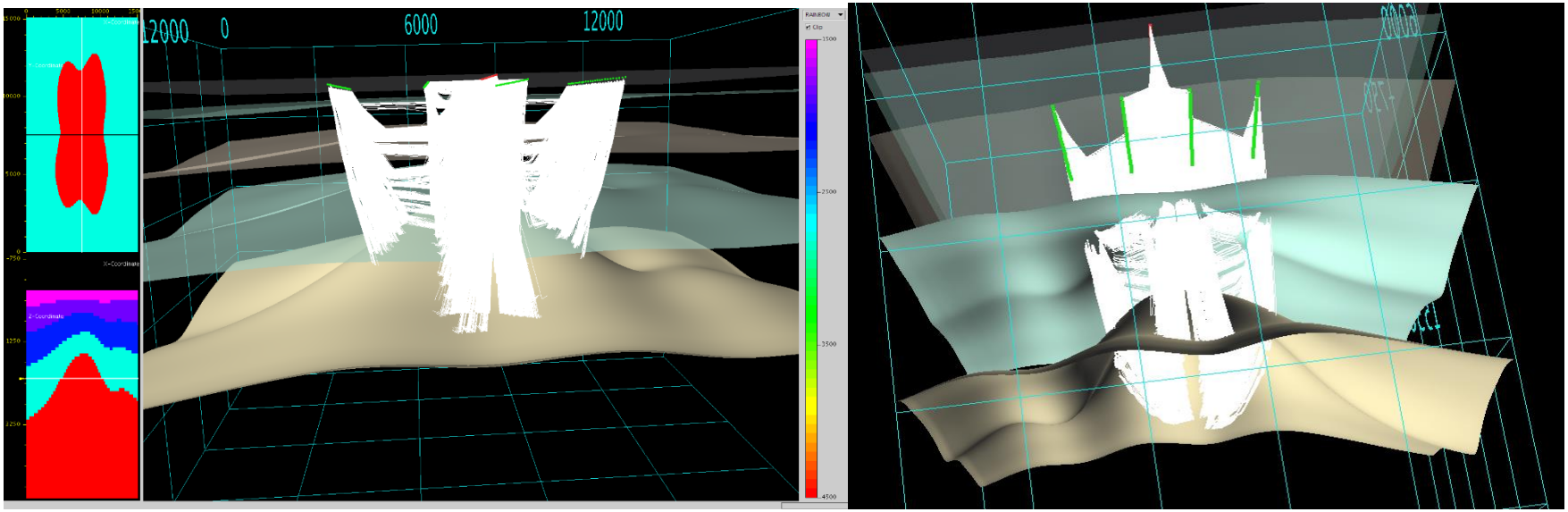
FloatSeis™ 2D Acquisition Method



- Seismic vessel performs acquisition using streamer
- GWL Seismobuoy™ are deployed along the line and recovered by support vessel
- GWL Seismobuoy™ units are real-time controlled and positioned

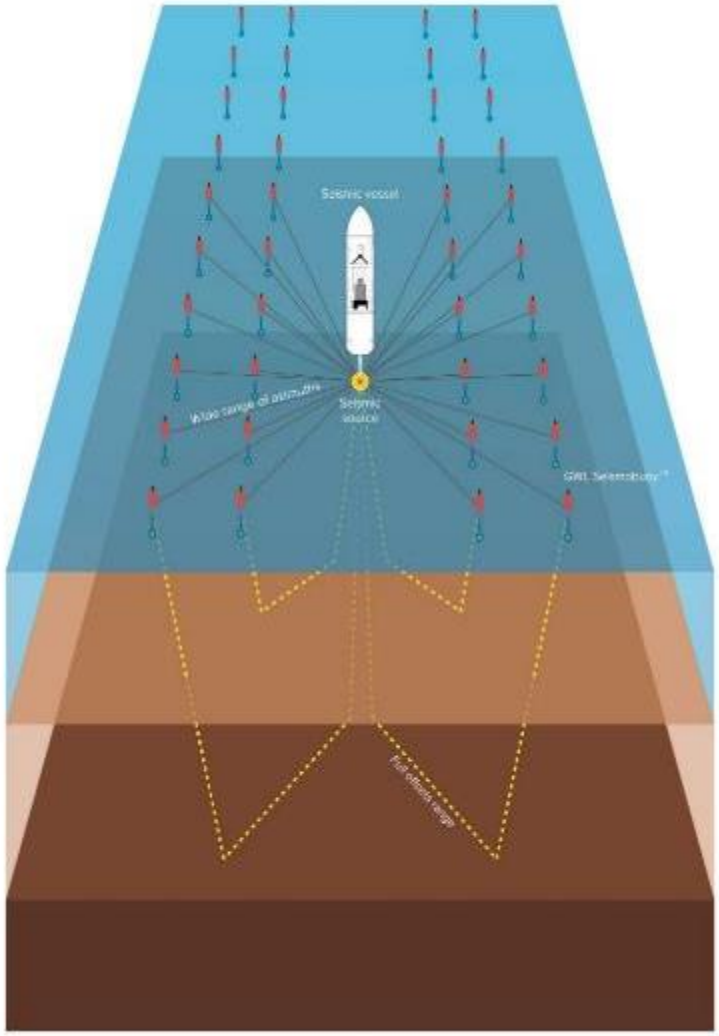
FloatSeis™ production rate equals production rate of 2D CDP towed streamer surveys

Having preliminary geological information we can perform survey design modeling to come up with optimized survey geometry for the most suitable subsurface illumination.



Refracted wave can penetrate salt bodies densely illuminating them and even restore velocity data under salt domes

FloatSeis™ 3D Acquisition Method



- 3D FloatSeis™ surveys are performed right after conventional 3D streamer data acquisition reducing total time for the complete cycle of the license area investigation.
- FloatSeis 3D is wide-azimuth and ultra-long offsets survey.
- Tomographical inversion reconstructs velocity model with no distortions typical for CDP data.
- As a result, FloatSeis™ based velocities models are better suitable for PSDM stage of data processing

Meeting World's Environmental Standards

World environmental standards are at a premium at GWL

Environmental safety is guaranteed by the use of modern technologies with only minor negative effect on the environment and ensure no-failure operations also due to a high performance of control systems

- All projects are executed in accordance with JNCC 2010 (UK) standards. At all times during field works the risks of trauma and any hindrance to the wellbeing of marine life are minimized.

- GWL cooperates with Federal State Unitary Enterprise Russian Federal Research Institute of Fisheries and Oceanography (FSUE VNIRO) and follows its recommendations as an agency providing ecological/environmental certification in Russia.

- GWL conforms to the the IAGC safety rules of conduct of geophysical works.

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EQUIPMENT

GWL Seismobuoy™

Seismic Complex

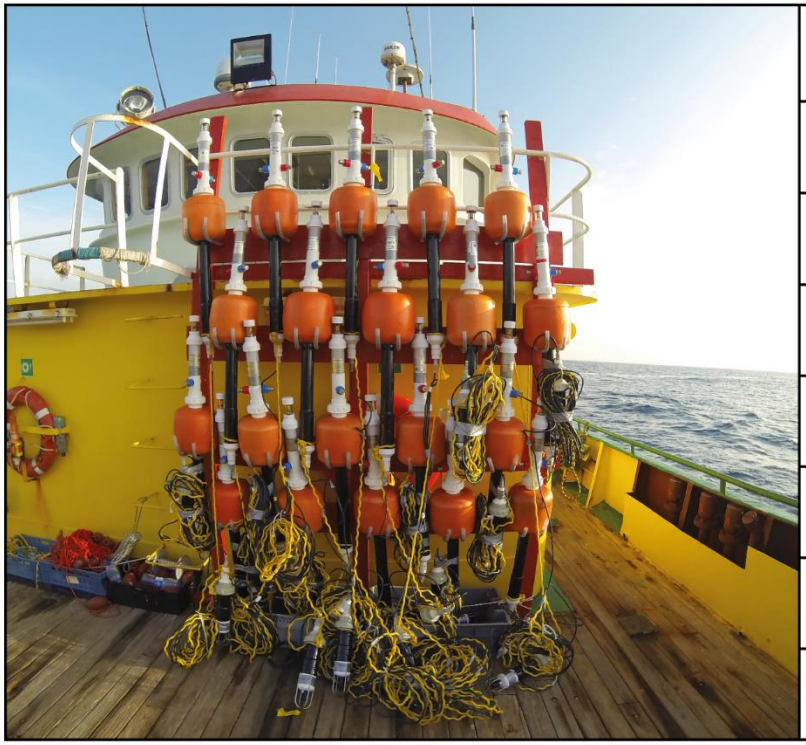
Accommodation of a GWL Seismobuoy™ recording equipment in a special container

The equipment is placed into special transport containers, ensuring:

- Quick mobilization/ demobilization
- Possible accommodation even on the deck of any non-specialized vessel, which allows quick mobilization of a party at any place in the world

GWL Seismobuoy™ Equipment

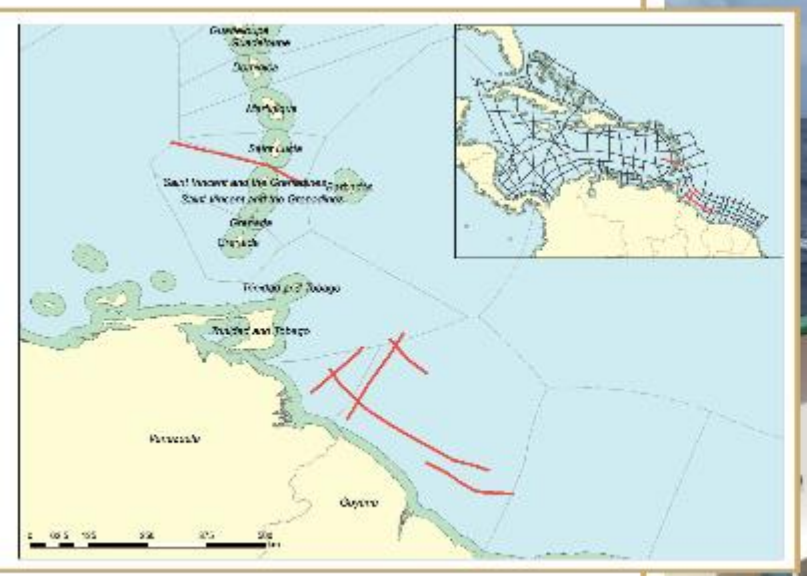
FloatSeis™ is based on an autonomous recording device, GWL Seismobuoy™, which allows recording refracted waves within offsets of up to 120 km.



Technical Parameters	
Frequency Range	1–1000 Hz
Hydrophone Sensitivity	-191-/+ dBV re 1 µPa @ 20°C, 27.22 V/bar
ADC Resolution	24 bits
Sample Interval	8; 4; 2; 1; 0.5; 0.25 ms
Timing accuracy	80 µs
Real-time Location Tracking	Data channel
Operating Life	Up to 11 days of continuous record

Equipment and technology are patented and meet industry standards

FloatSeis™ Field Operations



Q1 2016,

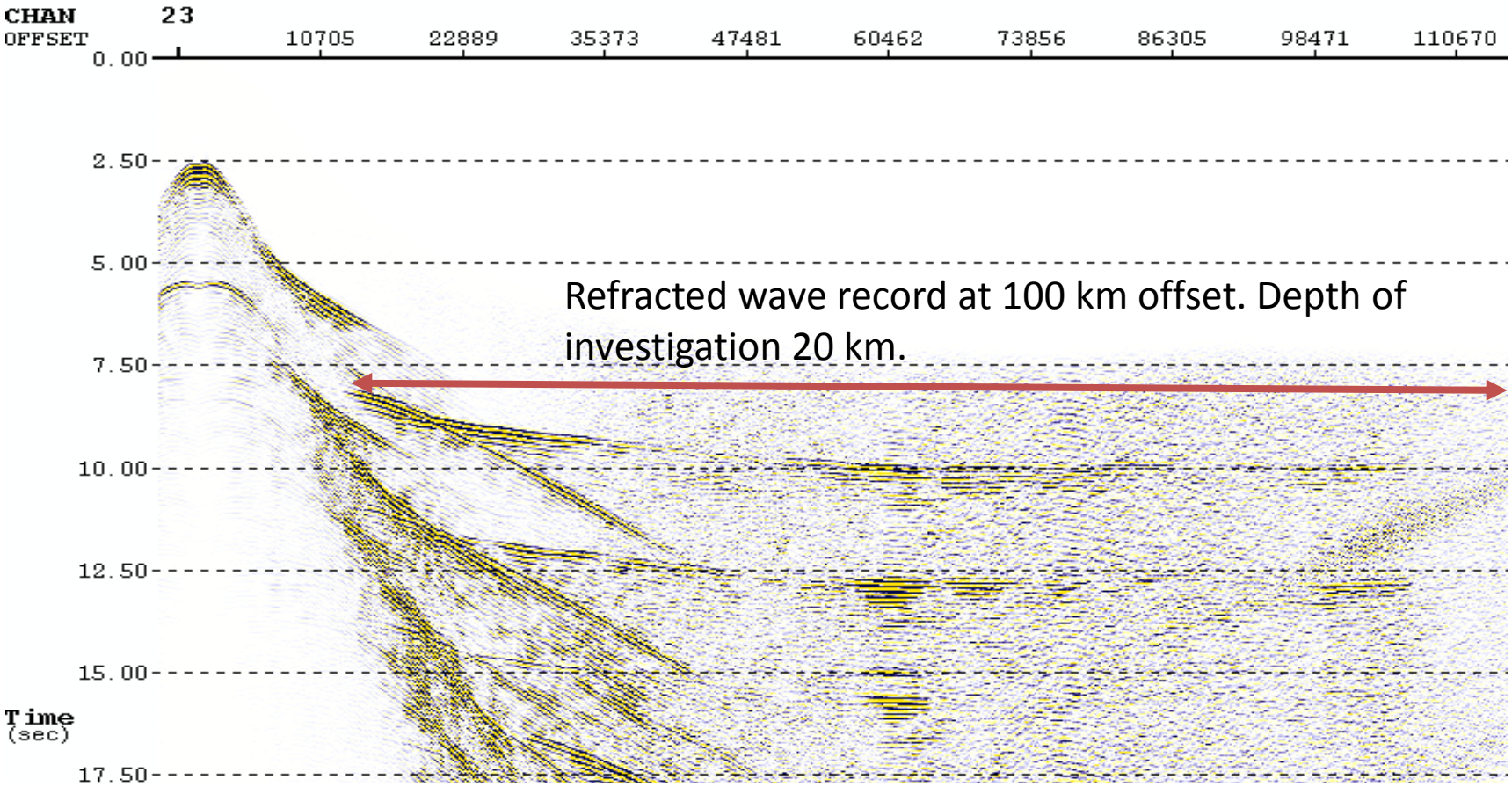
one of GWL's Programs (the Caribbean Basin and the Guyana — Suriname Basin)

Over 1000 km of seismic data were acquired using FloatSeis™

FloatSeis™ in Bjørnøya Basin (The Barents Sea, Norwegian Sector)

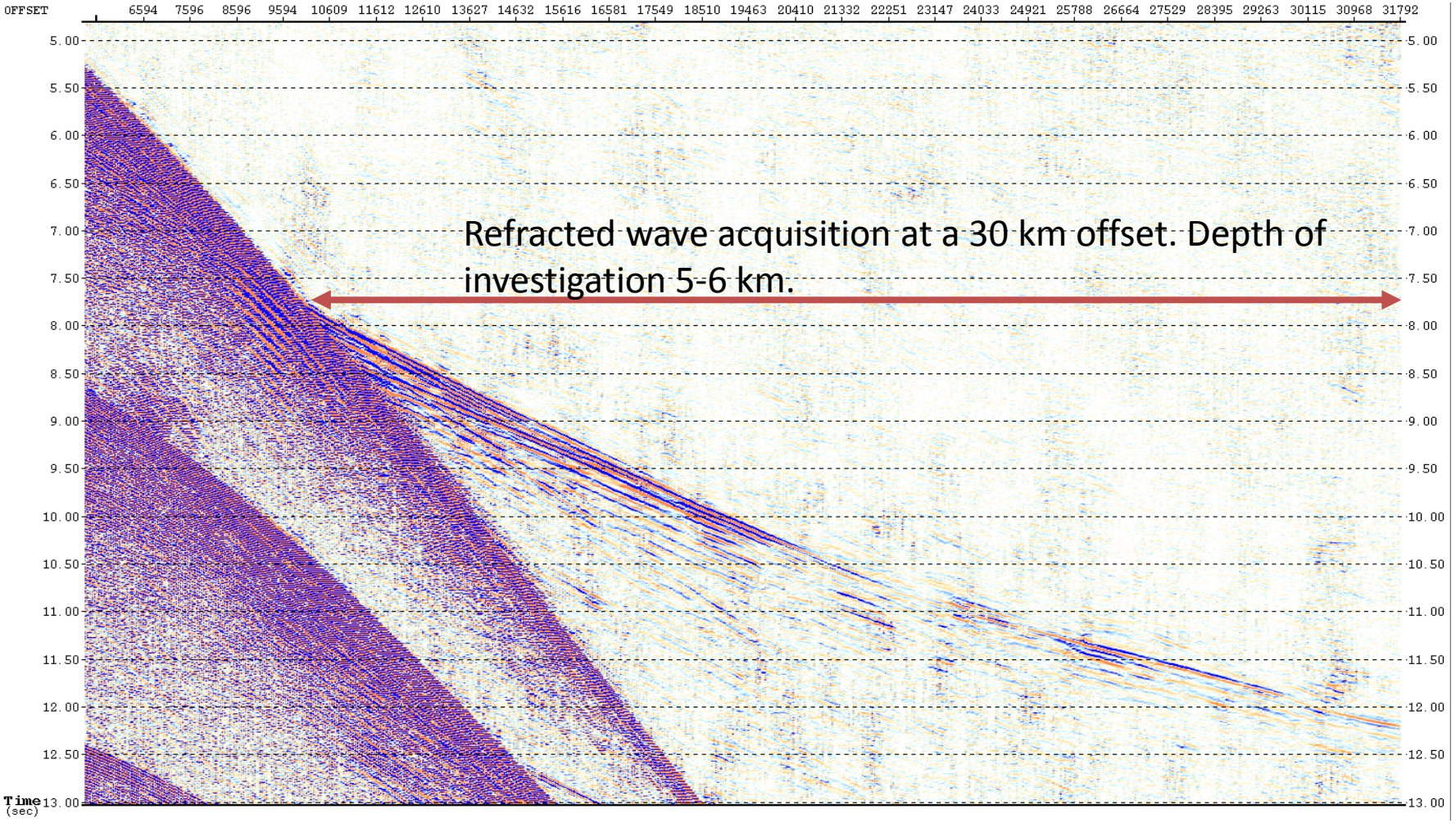
GWL Seismobuoy™ Records

Example of GWL Seismobuoy™ CRP gather – raw data



Data from the Caribbean and Guyana-Suriname Basins Program

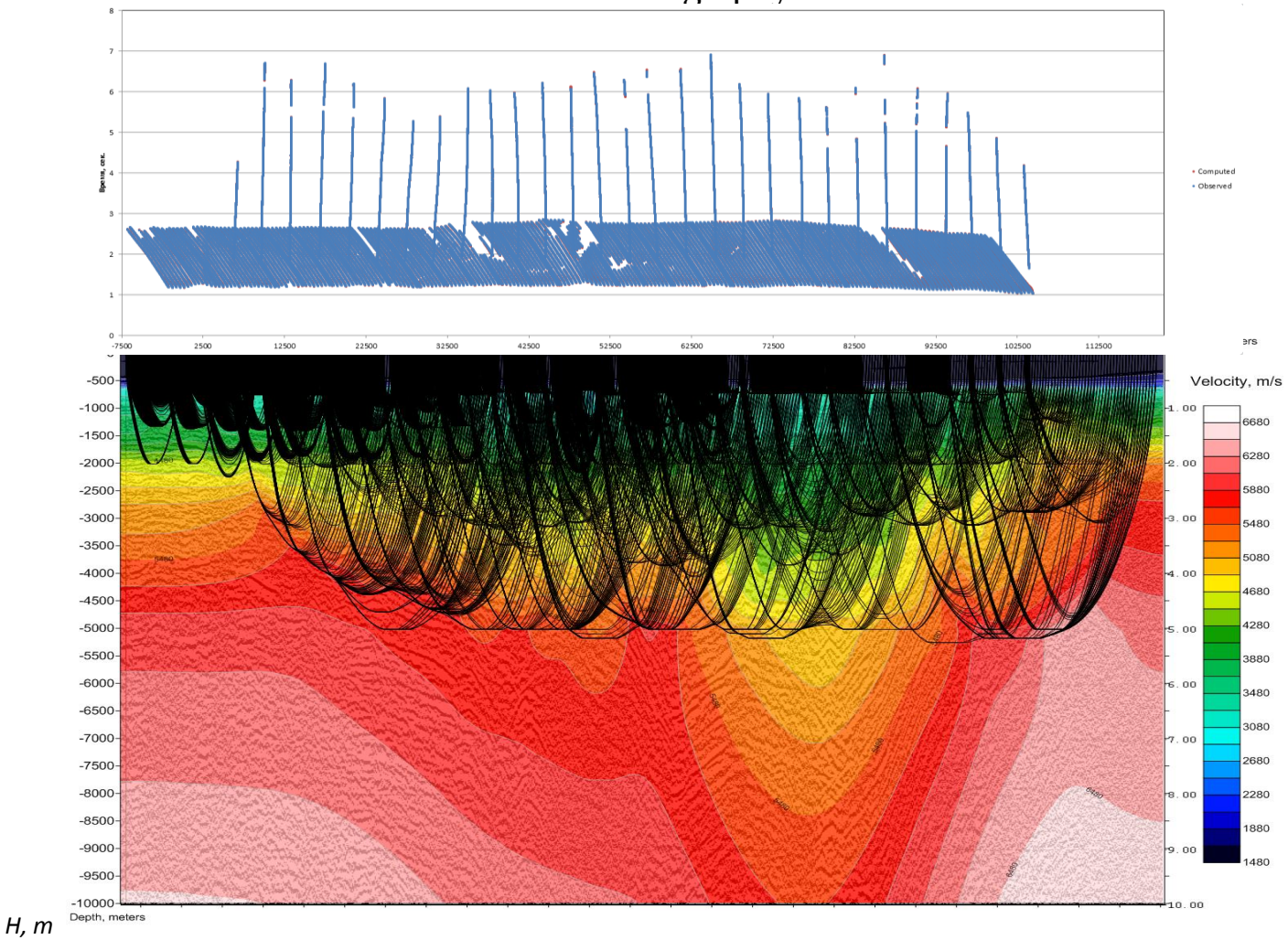
GWL Seismobuoy™ Records



Data from The Barents Sea (Norwegian Sector)

Tomographic Inversion – Velocity Model Construction

Observed time-distance curves (black) and calculated (green) arrival times are perfectly matched after seismic tomography



Each 50th ray was traced on final velocity section (bottom figure)

FloatSeis™ Application Example

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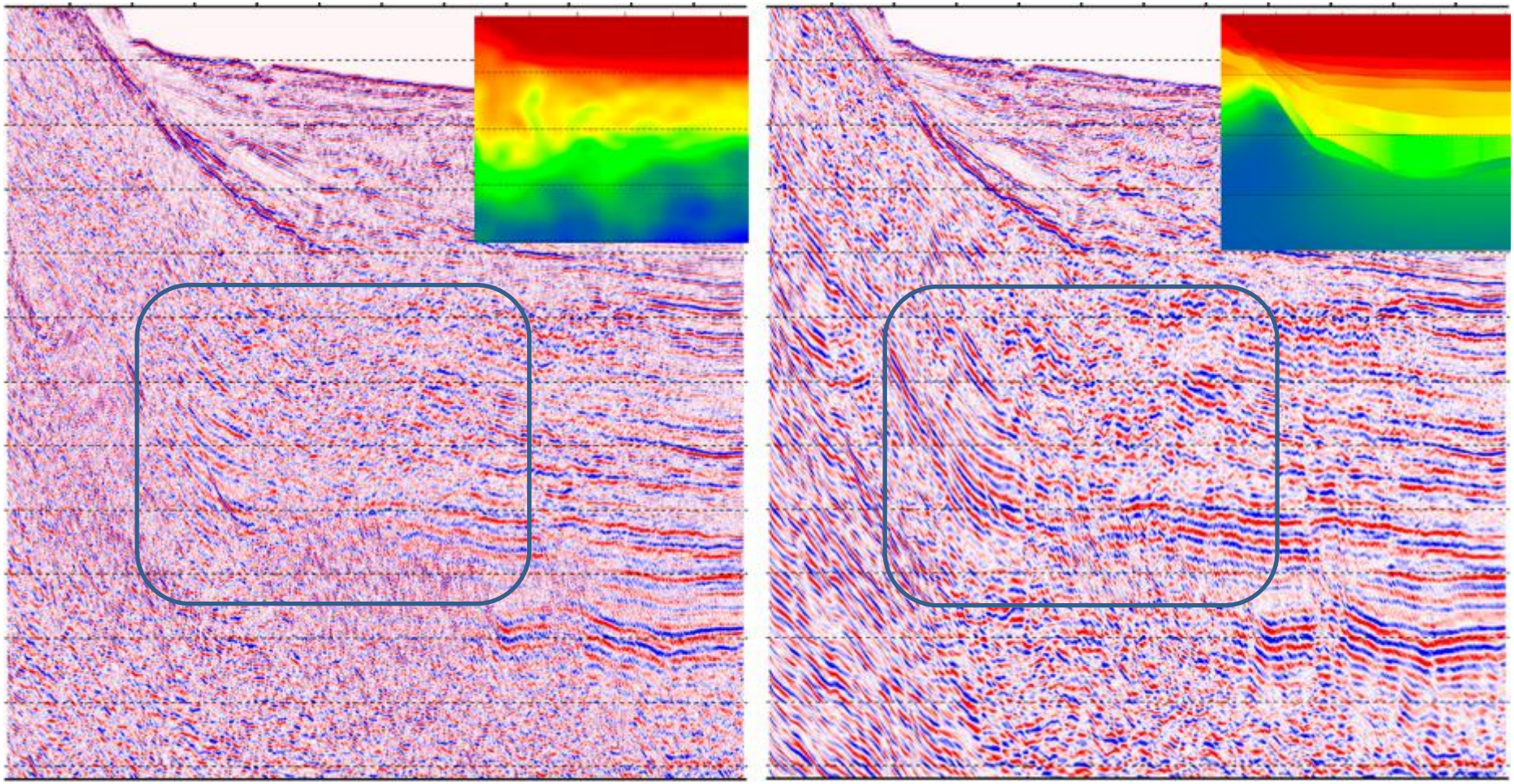
PSTM based on CDP velocities

PSTM based on FloatSeis™ velocities



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FloatSeis™ Application Results

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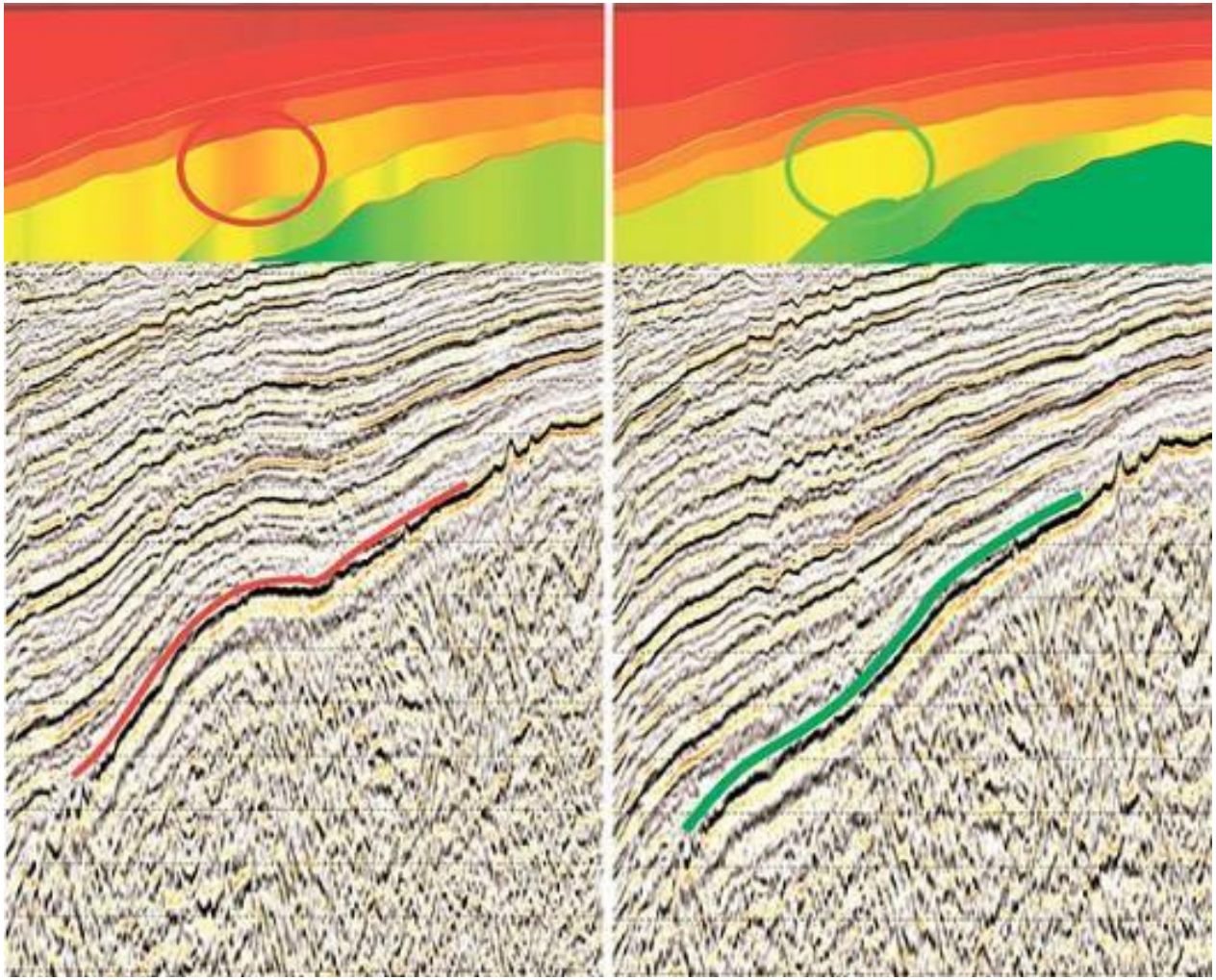
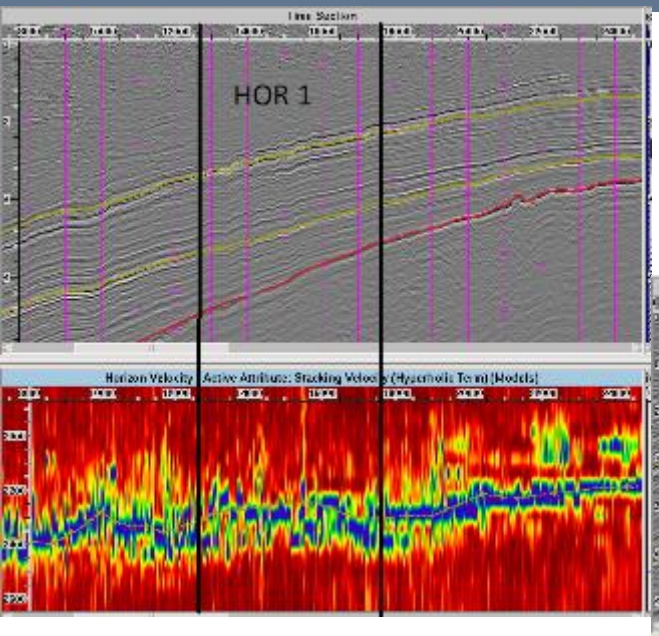
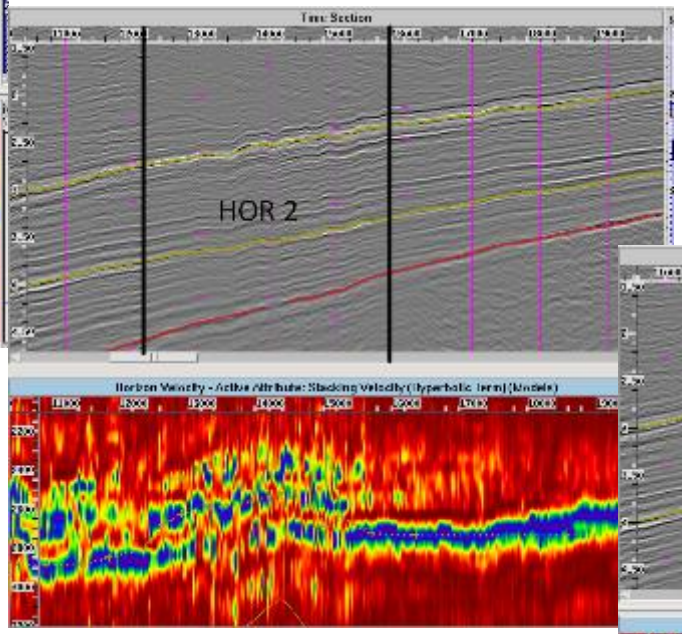
PSDM based on CDP velocities ***PSDM based on FloatSeis™ velocities***

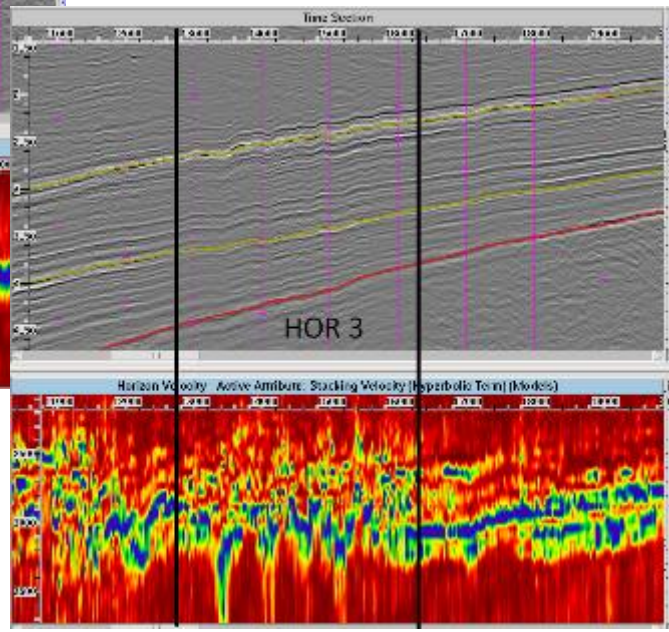


Regardless of a high-velocity layer in the upper part of the section, utilization of the FloatSeis™ technology had helped to correctly calculate velocities for the underlying layers, that allowed to refine the structural geometry of the layer (an example form the Guyana-Suriname Basin Program)

CDP Horizontal Velocity Spectras

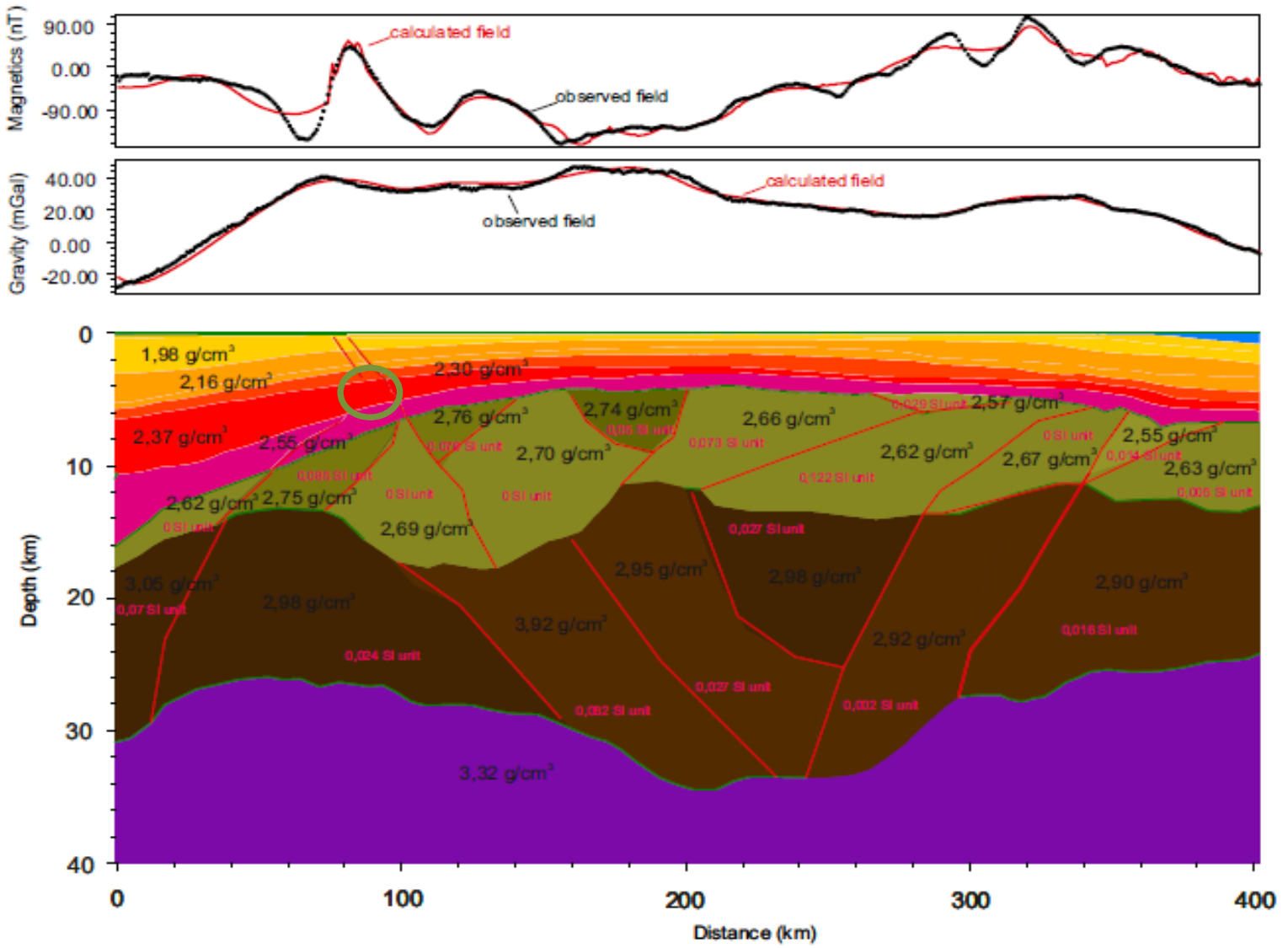






Horizontal CDP Velocity Spectras are loosing coherence in the area of the velocity anomaly, meaning that it's nature is artificial and has nothing in common with geological aspects

Gravity Field Inversion



Gravity field aligns with the basement's structural geometry not revealing any decompression zones which can be linked with the low velocity anomaly zone typical for a CDP velocity model

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Advantages of FloatSeis™ Surveys

- **Cost effective, especially in comparison to other know long-offset and wide-azimuth acquisition techniques;**
- **FloatSeis™ velocity model is more accurate and reliable for a PSTM and PSDM stage;**
- **Environmentally Safe Surveys.** No contact with seabed in contrast to bottom stations and bottom cables destroying the benthic ecosystem.
- **No Restrictions on Acquisition Geometry.** Wide-azimuth, full-azimuth, spiral and ring arrays;
- **No limitation on offsets.** Arbitrary spacing and offsets up to 120 km.

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Thank you for your attention!