EGU22-9189:

HYDROACOUSTIC EXPRESSION OF OFFSHORE TSUNAMI DEPOSITS ON THE ALGARVE SHELF

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This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

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OVERALL AIM OF THE STUDY

RV METEOR cruise M152 “Lisbon 1755” 2018:

- to analyse the shelf’s Holocene sedimentary record in the most tsunamigenic earthquake-prone region in Atlantic Europe
- to identify sedimentological features of offshore tsunami deposits

HRV FISÁLIA Algarve Survey 2020:

- to support the results obtained from cruise M152
- to extend the collected hydroacoustic profiles further towards the coast into shallower water depths

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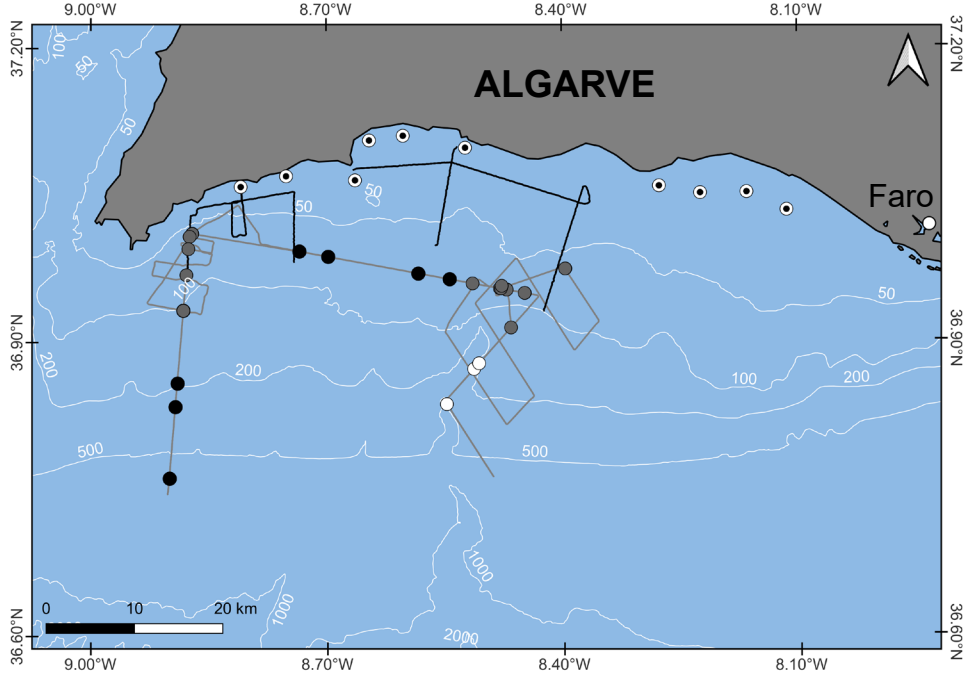


Sample/Coring stations

M152

- grab samples
- gravity cores
- vibracores

Algarve Survey

- grab samples

Hydroacoustic profiles

M152

- all parasound

Algarve Survey

- all sparker & innomar

LOCATION OF THE STUDY AREA

- the **continental shelf** and shelf break off the **southwestern Algarve** coast of Portugal

- in the study area the coast is characterized by
  - steep **sea cliffs**, **bays with sandy pocket beaches** in the western part
  - a variation between **small cliffs** and **long sandy beaches** in the eastern part

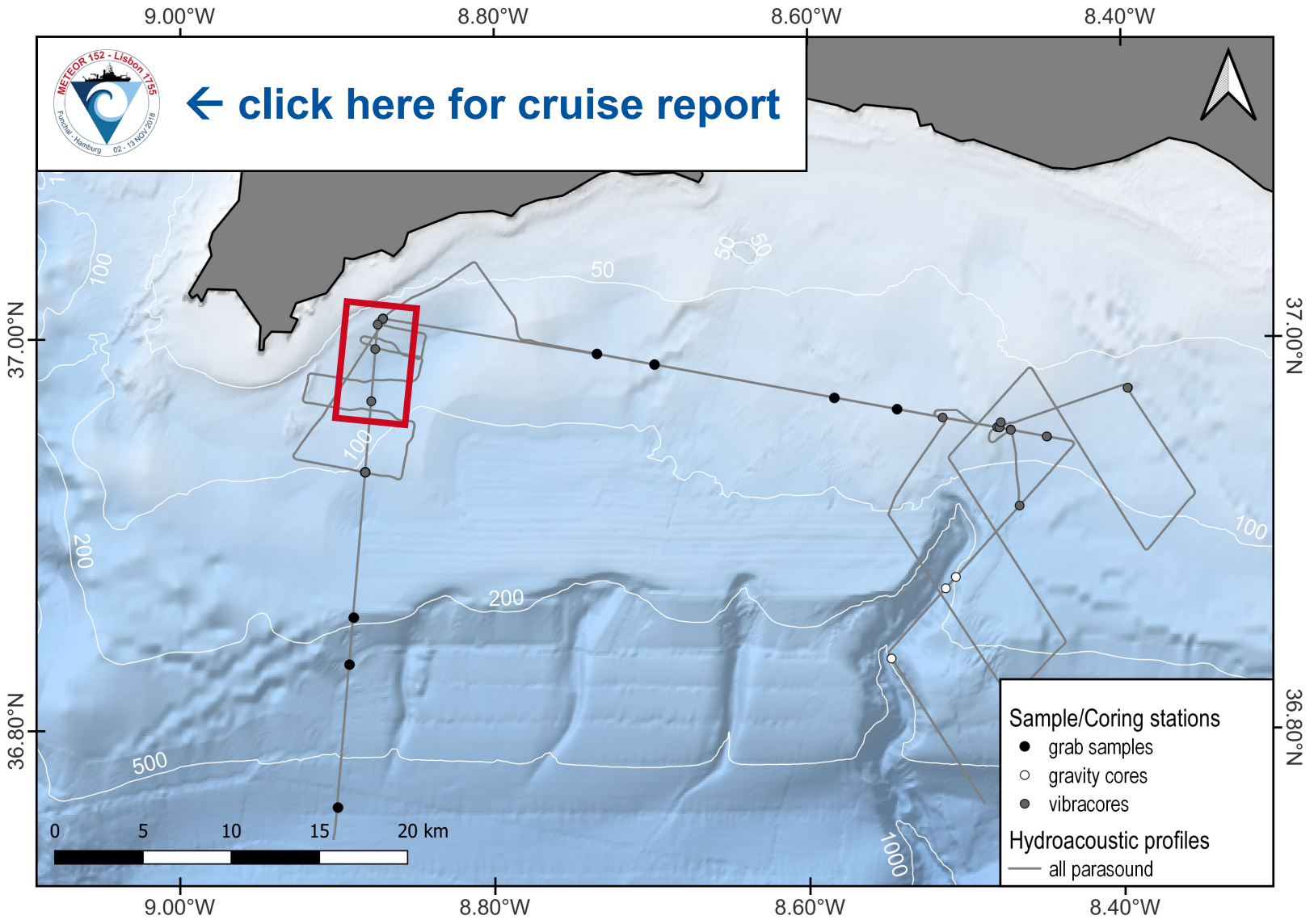
- the Algarve shelf has
  - an average **width of ca. 17 km**
  - a **gentle slope**
  - a **well-defined margin** located 110-150 m below sea level (all Lopes and Cunha, 2010)

- during the **last glacial maximum** (LGM), at ca. 18 ka BP, the Portuguese coastline was located closer to the present-day shelf break (Dias et al., 2000 and references cited therein)

M152 – PARASOUND SUB-BOTTOM

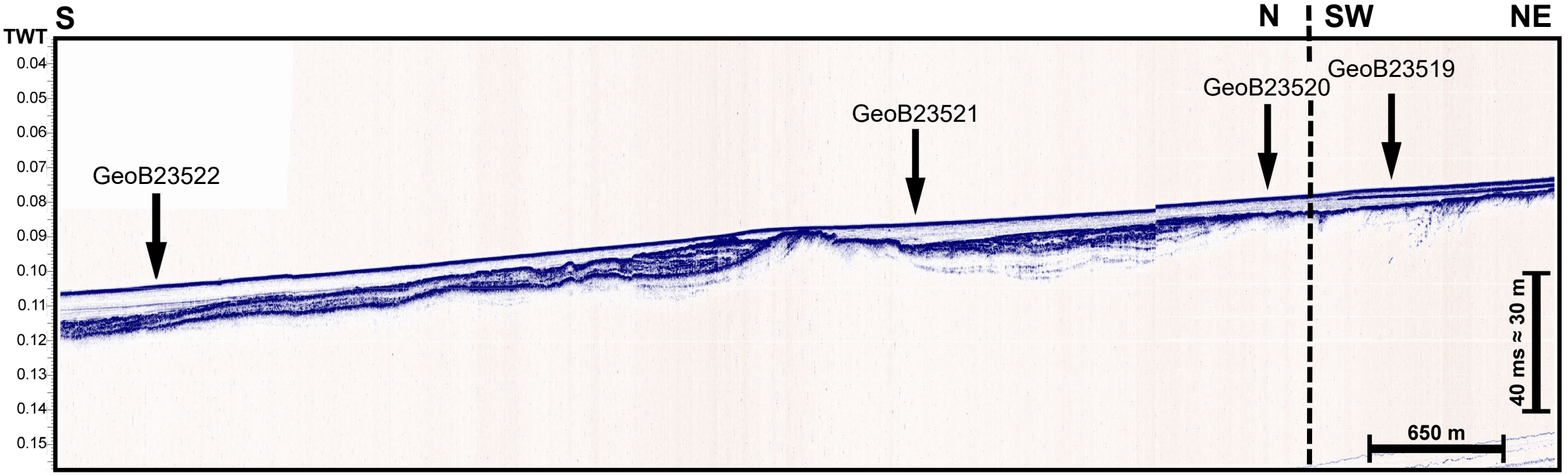
RV METEOR cruise M152 “Lisbon 1755”

- sub-bottom profiling (Atlas Parasound P70 system)
- bathymetric survey (Kongsberg EM122 & EM710 systems)
- gravity coring in 221-476 m water depth & vibracoring in ≤113 m water depth
- grab samples (Van Veen sampler)



M152 – PARASOUND SUB-BOTTOM

Sub-bottom profile obtained with Atlas Parasound P70 system



TWT = two-way traveltime → a TWT of 0.1 s corresponds to ca. 75 m water depth

VE = vertical exaggeration ≈ 22

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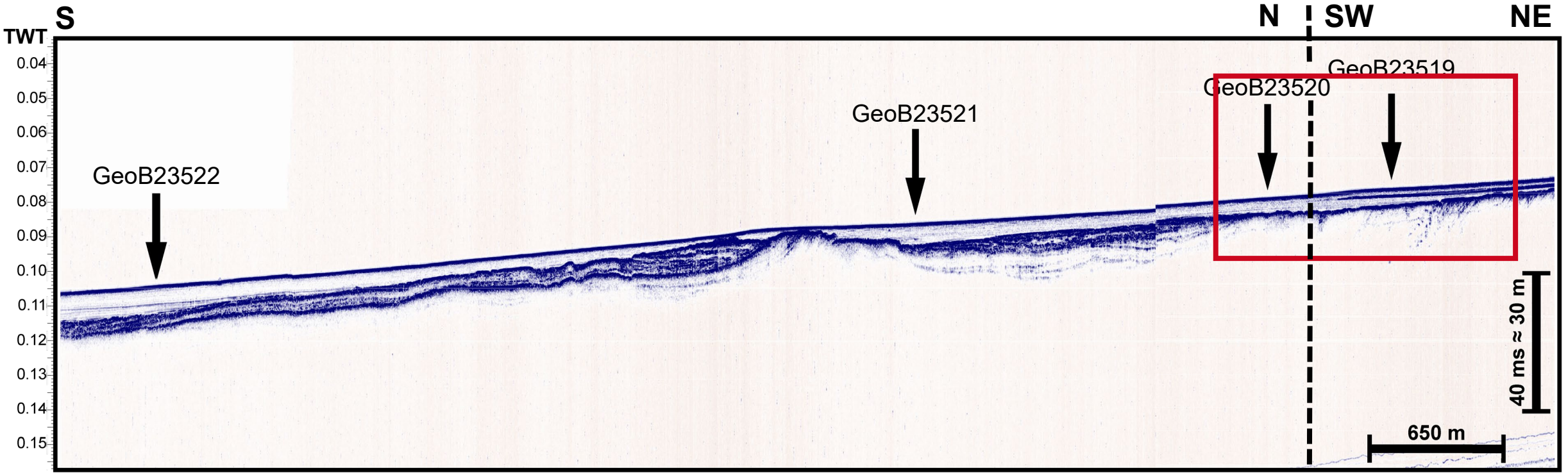

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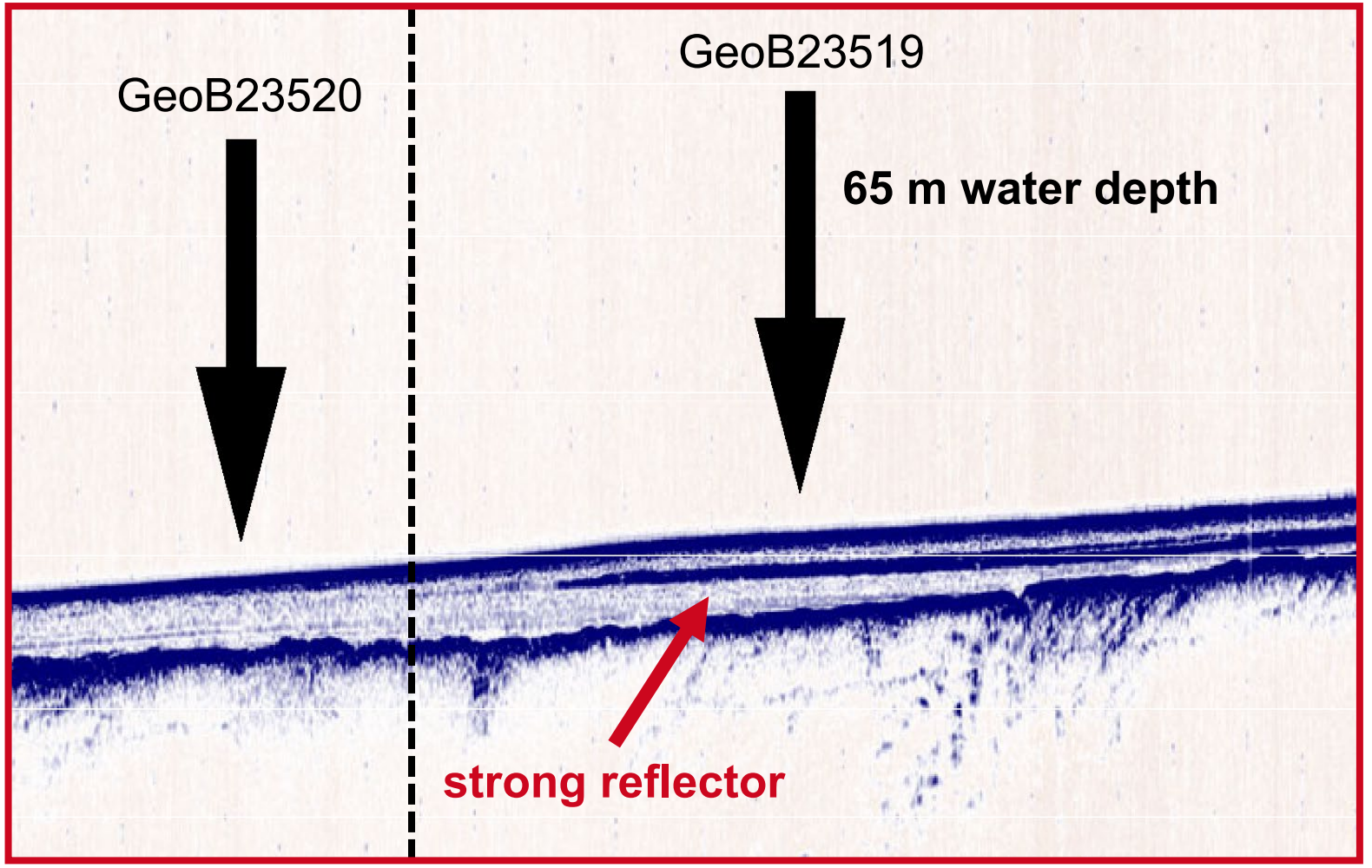


M152 – PARASOUND SUB-BOTTOM

Results from the sub-bottom profiles (RV METEOR M152)

- in general, the study area is marked by **rough erosional seafloor** and **frequent exposure of bedrock**
- the **sedimentary coverage** usually amounts to **a few meters**, while at sedimentary hotspots this figure may reach occasionally up to 20 m
- a **great contrast between fine- and coarse-grained units** is noticed in the profiles by clear marker beds
- there is a **different geomorphological setting** for the western and eastern part of the study area:
  - west: sediment-starved shelf, gentle slope with small sedimentary basins
  - east: also sediment-starved but with a higher sediment input compared to the west (due to rivers), isolated sedimentary basins and a thicker sedimentary prism that thins out to the east and south
- the profiles from the shelf's shallower part reveal a **distinctive strong reflector** within the sedimentary cover

→ this strong reflector indicates a **strong contrast in materials**, e.g. coarse or compacted material intercalated in the homogenous (finer) background material

→ this strong reflector occurs in water depths **shallower than ca. 70 m**

M152 – PARASOUND SUB-BOTTOM

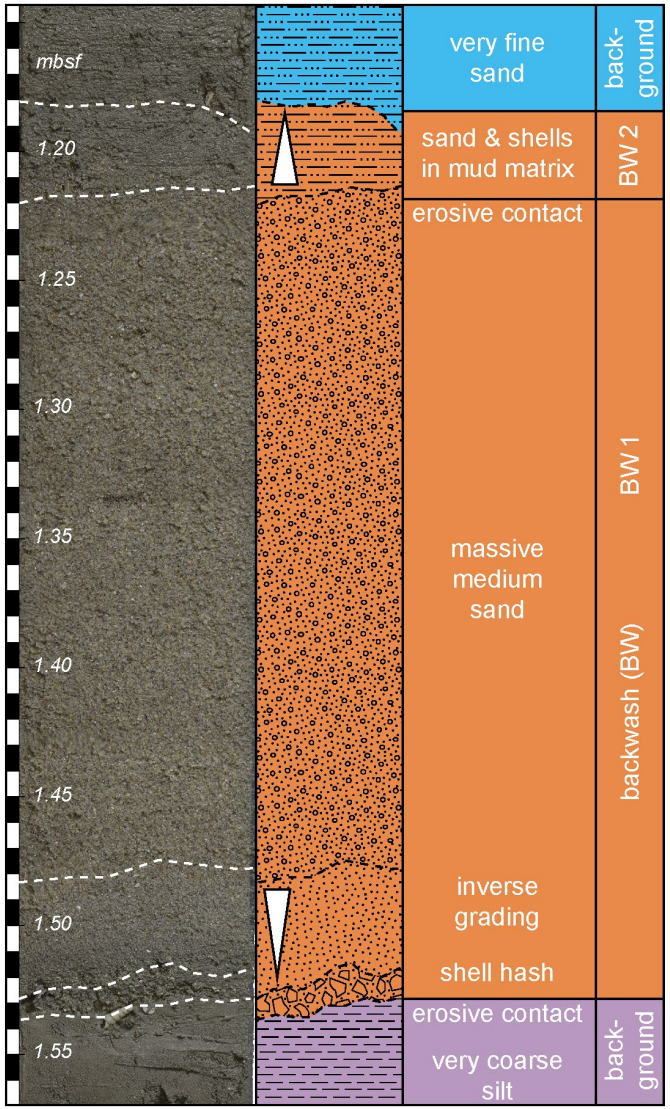
Vibracore GeoB23519-01

- contrasting sediment unit between 1.53-1.18 mbsf **correlates to the strong reflector** of the sub-bottom profiles

- the unit consists of **4 distinctive sub-units**:
  I. an erosive base followed by a shell hash layer (1.53-1.52 mbsf)
  II. inversely graded fine sand (1.52-1.48 mbsf)
  III. visually structureless medium sand (1.48-1.22 mbsf)
  IV. another erosive contact followed by sand-sized grains and shell (fragments) in a mud matrix (1.22-1.18 mbsf)

- the core and contrasting deposit was analysed by a **multi-proxy approach** including grain size, XRF, magnetic susceptibility, P-wave velocities, X-ray CT, foraminifera, organic geochemistry and interpreted as a **tsunami deposit**, displaying two subsequent backwash phases

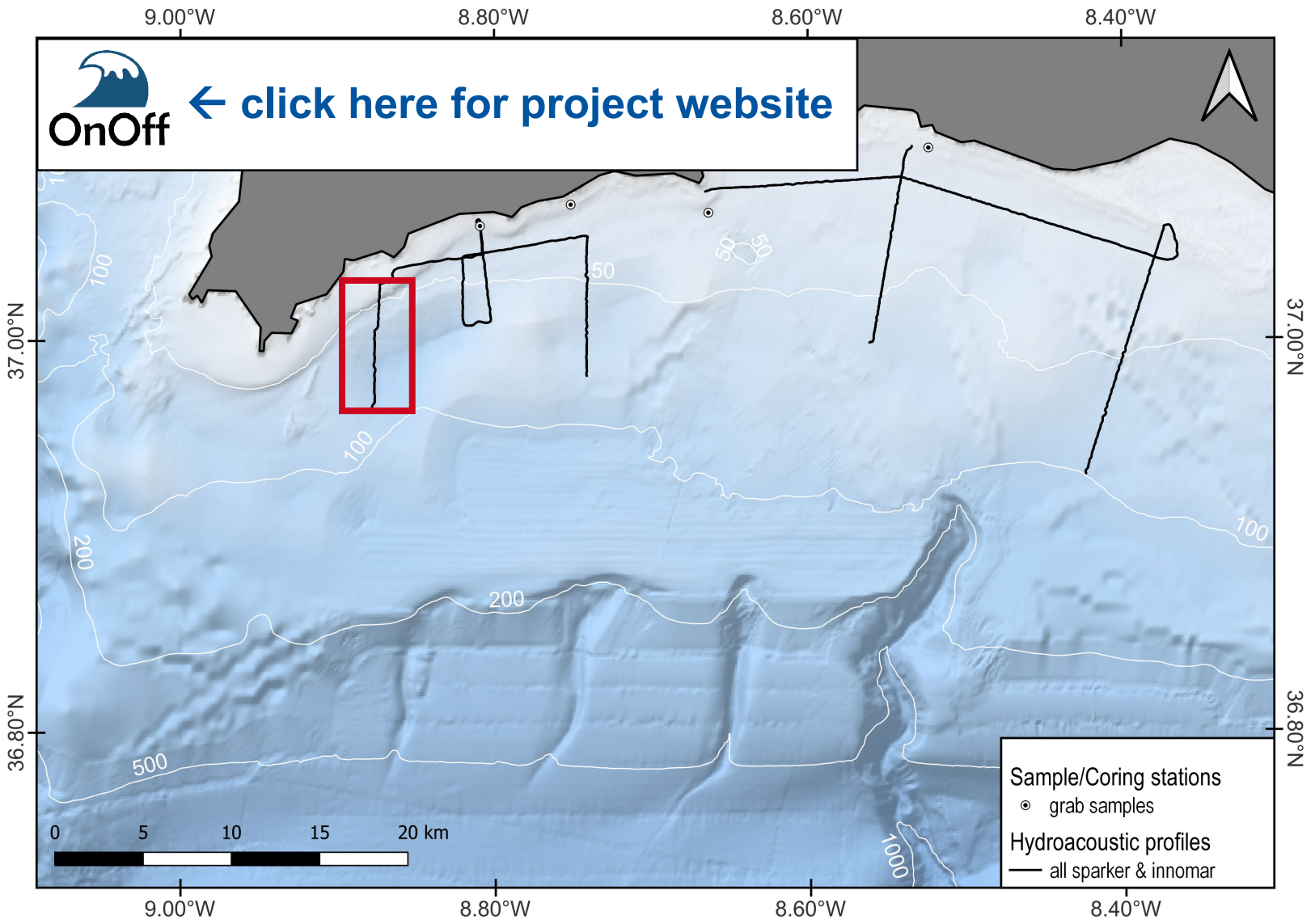
- the tsunami deposit was **dated to ca. 3400 cal. yrs. BP** (radiocarbon)



AS 2020 – SEISMIC & SUB-BOTTOM

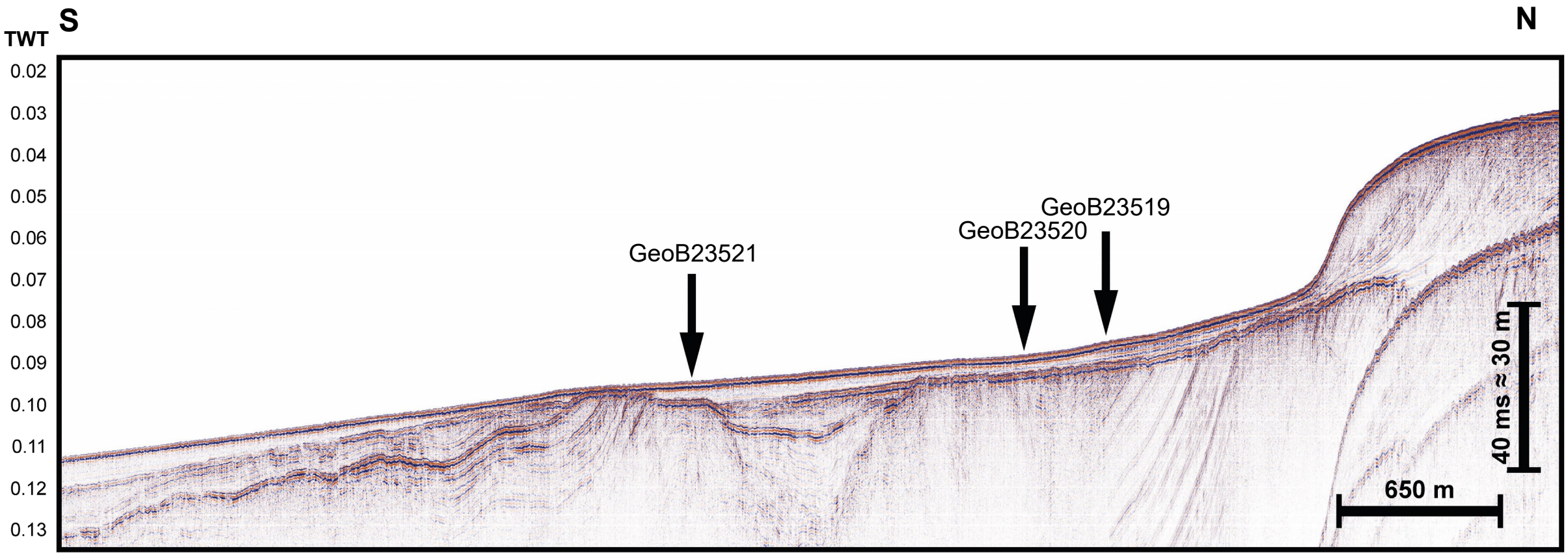
HRV FISÁLIA cruise "Algarve Survey 2020"

- 2D single channel seismic survey (centipede sparker RCMG design)
- sub-bottom profiling (Innomar SES-2000 quattro system)
- grab samples (Smith-McIntyre sampler)



AS 2020 – SEISMIC (SPARKER)

2D single channel seismic profile obtained with centipede sparker (RCMG design)



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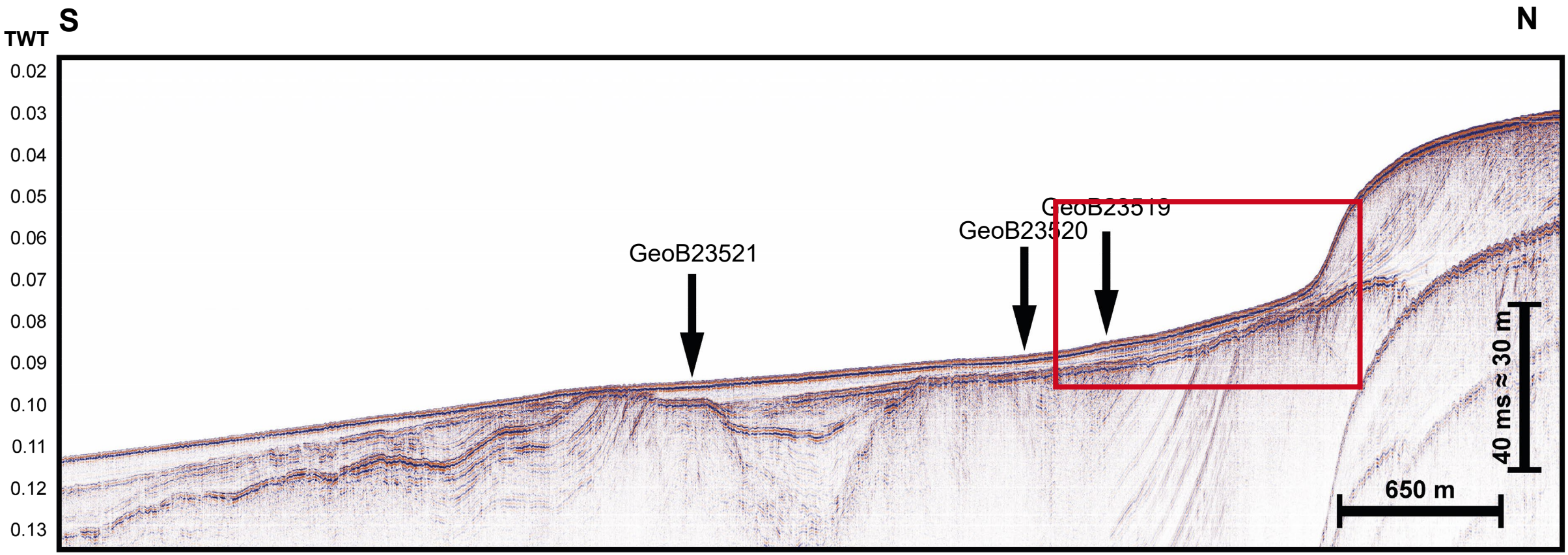

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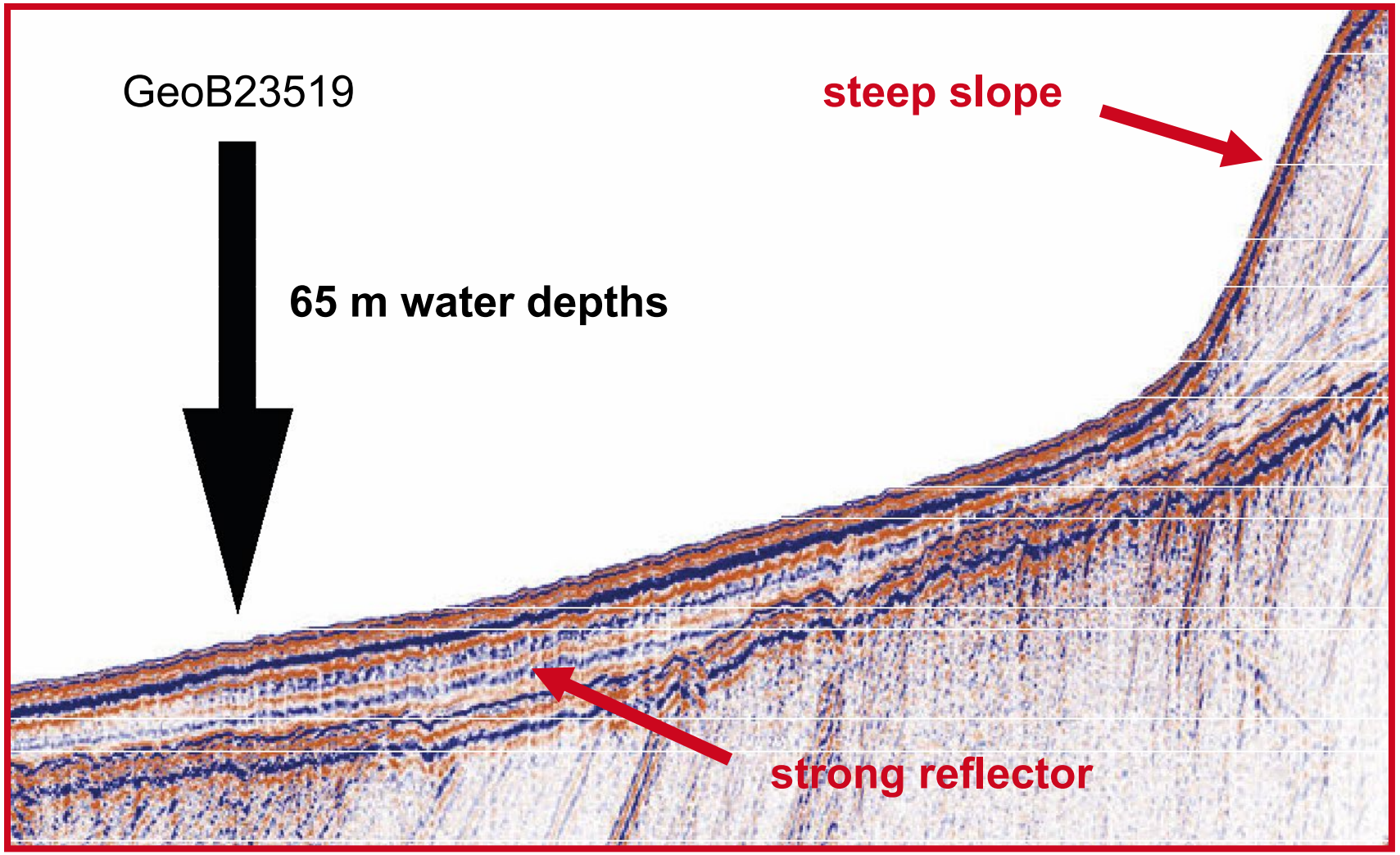
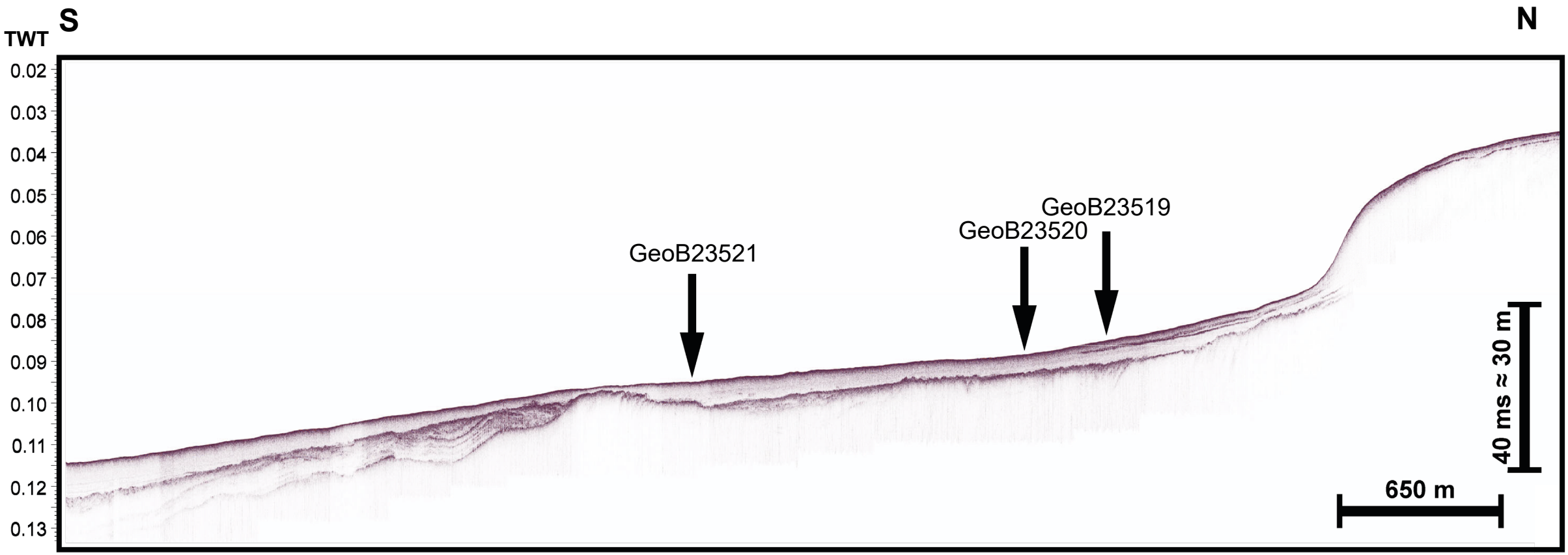


AS 2020 –SUB-BOTTOM (INNOMAR)

Sub-bottom profile obtained with Innomar SES-2000 quattro system



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AS 2020 –SUB-BOTTOM (INNOMAR)

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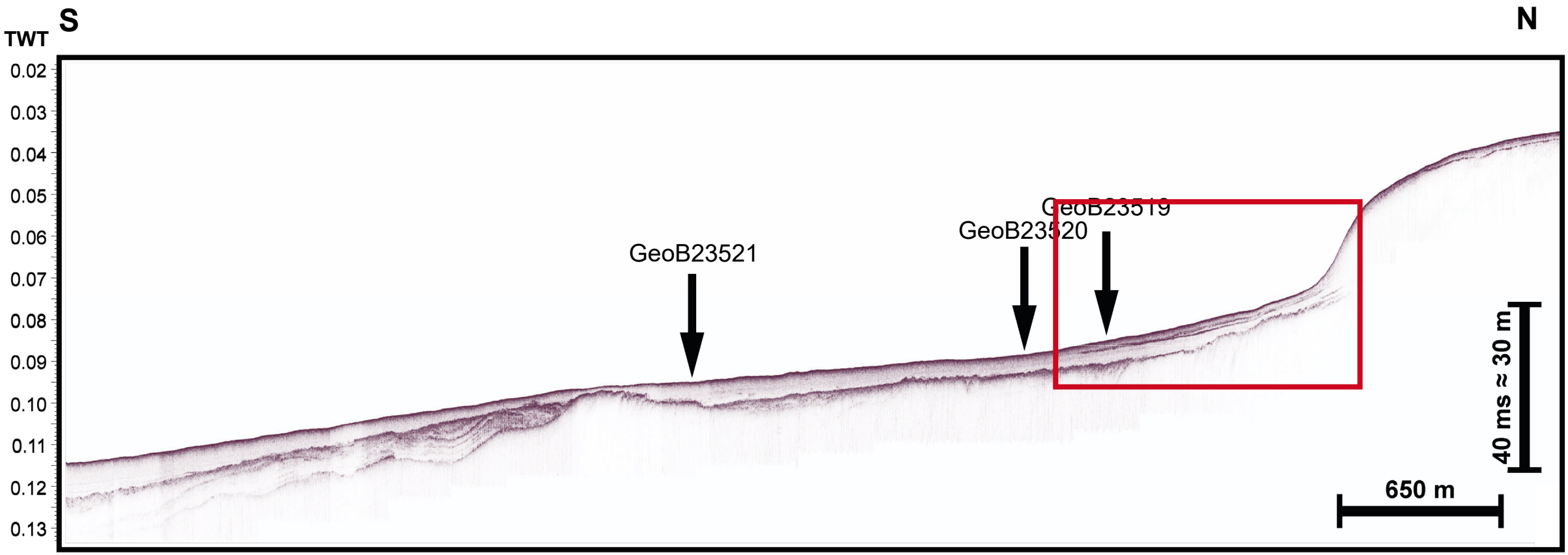

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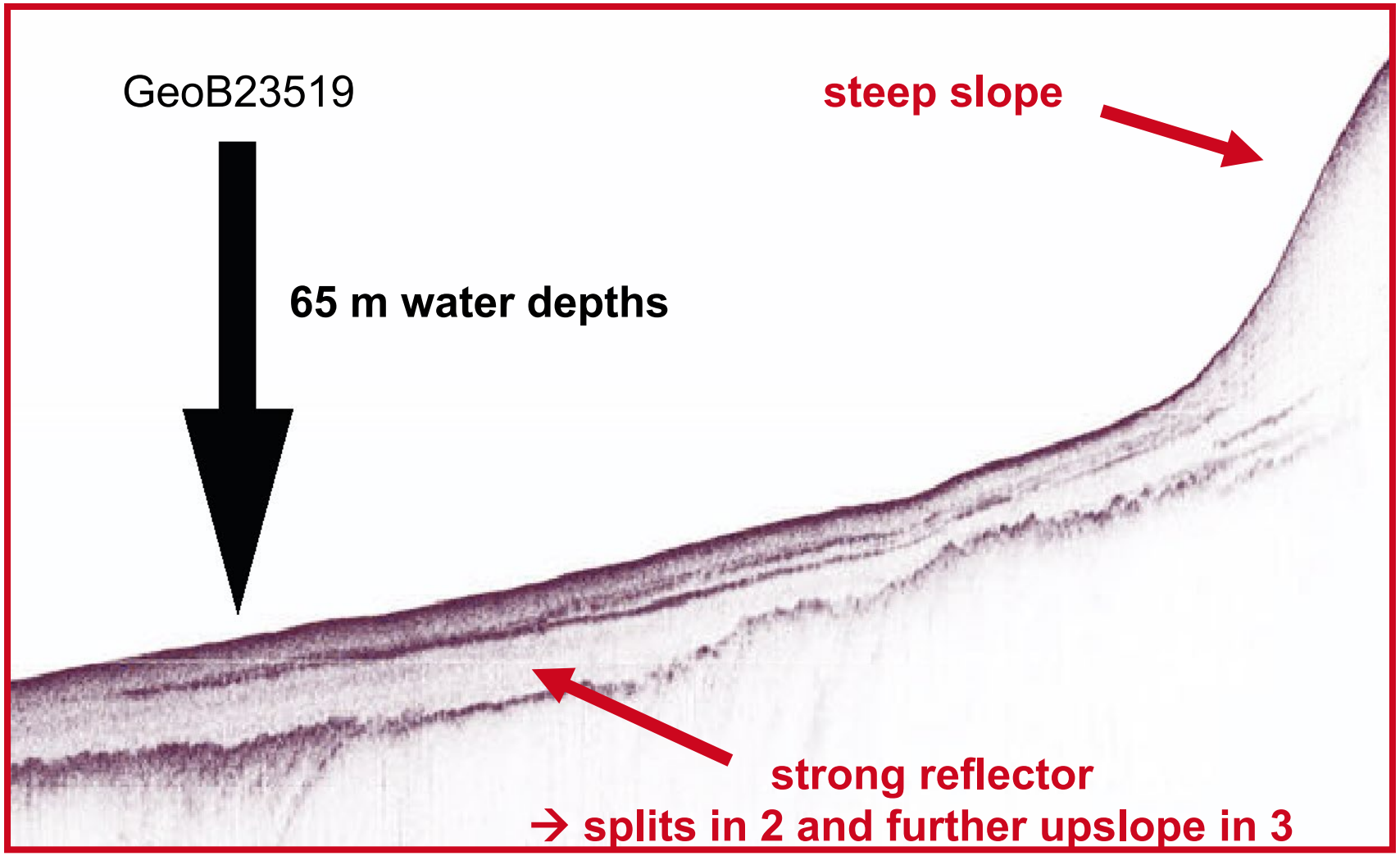
AS 2020 –SUB-BOTTOM (INNOMAR)



AS 2020 – SEISMIC & SUB-BOTTOM

→ **both:** reveal a relatively **steep slope** in shallower waters between **ca. 30-55 m water depth** just in front of core location GeoB23519 including the contrasting deposit with 4 distinctive sub-units

Results from seismic profiles (Algarve Survey 2020)

- reveals structures in the **bedrock** in detail, but we are more interested in the thin sediment cover above
- also shows the **strong reflector**, but not as well pronounced as the other methods
- shows **progradational internal structures** of the steep slope (ca. 30-55 m water depth)

Results from sub-bottom profiles (Algarve Survey 2020)

- the **most suitable method** for our purpose, but required a high amount of processing
- shows the **strong reflector** and reveals that it splits up into **2 reflectors** around core location GeoB23519 and into **3 reflectors** in shallower waters further towards the steep slope

CONCLUSION & OUTLOOK

- sub-bottom and seismic profiles show different **geomorphological conditions** and **sediment dynamics** in the study area, especially between the western and eastern parts of the study area

- a particularly **strong reflector** correlates to a ca. 3400 cal. yrs. BP **tsunami deposit** found in the sediment cores (very well pronounced in core location GeoB23519)

- the **local setting** is highly important for tsunami offshore processes

  → influences **transport mechanisms**

  → determines the **deposit configuration**

  → **this is the case of the steep slope and the deposit in cores GeoB23519**

We invite you to use the comment function for your questions and remarks!

REFERENCES & ACKNOWLEDGEMENTS

Lopes, F.C. & Cunha, P.P. (2010) A plataforma continental algarvia e províncias adjacentes: uma análise geomorfológica, In Ciências Geológicas: Ensino e Investigação e sua História – Volume I, Geologia Clássica (Associação Portuguesa de Geólogos & Sociedade Geológica de Portugal, Lisbon), pp. 479-489.

Dias, J.A., Boski, T., Rodrigues, A. & Magalhães, F. (2000) Coast line evolution in Portugal since the Last Glacial Maximum until present – a synthesis. Mar. Geol. 170, 177-186.

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