[PS]Sedimentary Dynamics and High-Frequency Sequence Stratigraphy on the Slope of Great Bahama Bank*

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Abstract

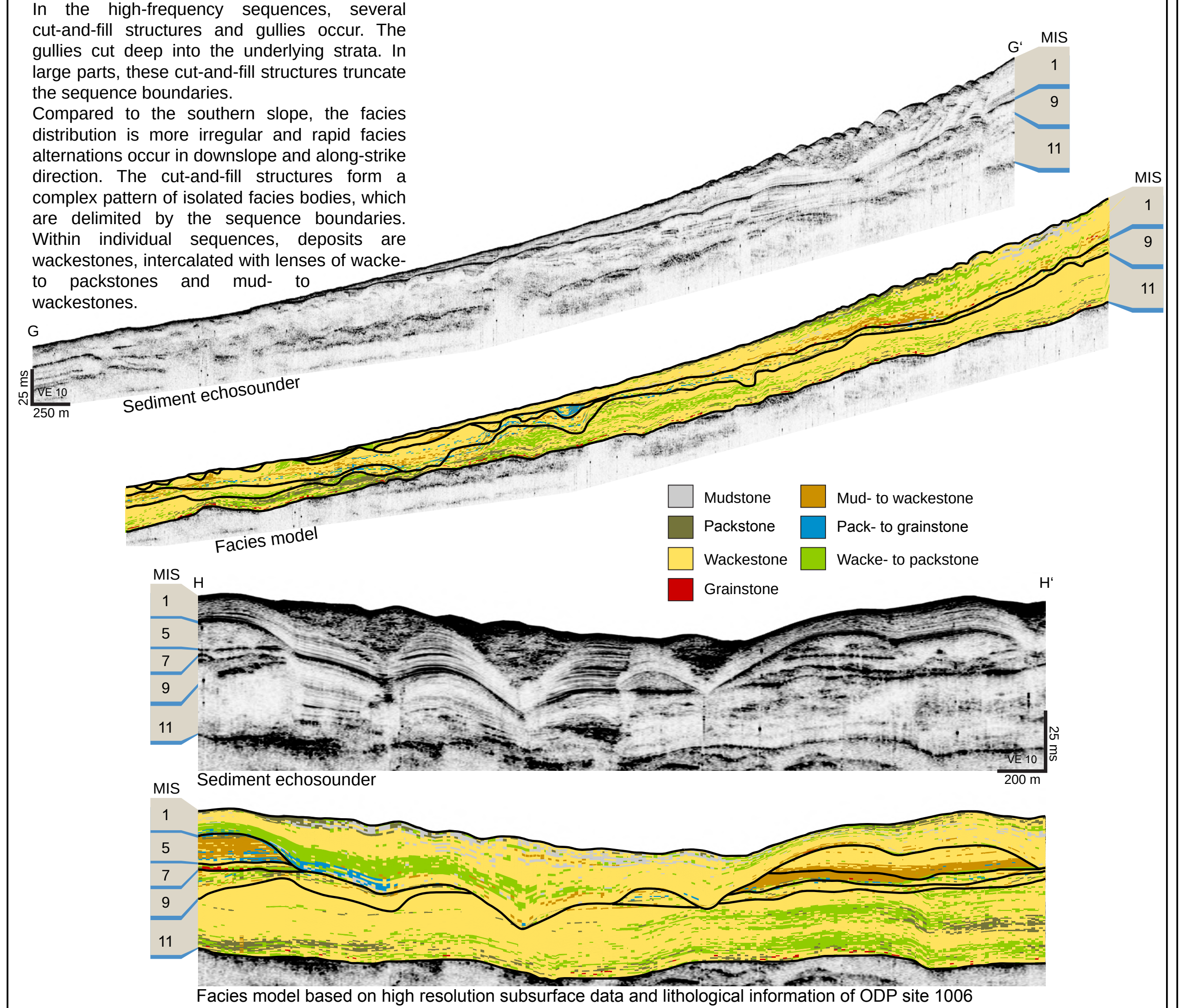
The interplay of depositional and erosional processes and their evolution in time are unraveled by the correlation of new high-resolution hydroacoustic data with sediment- and isotope data from ODP Leg 166 cores on the slope of Great Bahama Bank, providing new insights into sedimentation patterns of carbonate platform slopes through time. In result, a high-frequency sequence stratigraphic scheme encompassing the Marine Isotope Stages (MIS) 1 to 11 (the last 400 ka) is presented. High-frequency sequences consist of sea level highstand sediments bound by well-lithified lowstand intervals. The sequences display, however, considerable variations in morphology along strike and through time. In the northern part, all sequences contain mass transport complexes and channels accompanied by a lateral variable sediment thickness. In the southern part, by contrast, sediment thickness along the slope is controlled by off-bank transport and bottom currents. Large mass transport complexes leveled the slope morphology during MIS 11 to 9, whereas younger sequences (MIS 7 to 1) show a uniform along-strike thickness of the sequences without evidence of large gravity mass movements. A geological model was developed, based on the sedimentological data of two ODP cores and the hydroacoustic reflection patterns. This model evaluates how the changes in slope morphology influence the lateral facies distribution. Sequences of MIS 11 to 9 show a downslope and along strike facies variability, whereas younger sequences (MIS 7 to 1) are characterized by downslope variations only. The encountered changes in slope morphology and sediment distribution along the slope of Great Bahama Bank provide implications on established slope models and allow improved prediction of sediment heterogeneities in such sedimentary successions.

Northern slope: higher current velocities

High-frequency sequences

In the high-frequency sequences, several cut-and-fill structures and gullies occur. The gullies cut deep into the underlying strata. In large parts, these cut-and-fill structures truncate the sequence boundaries.

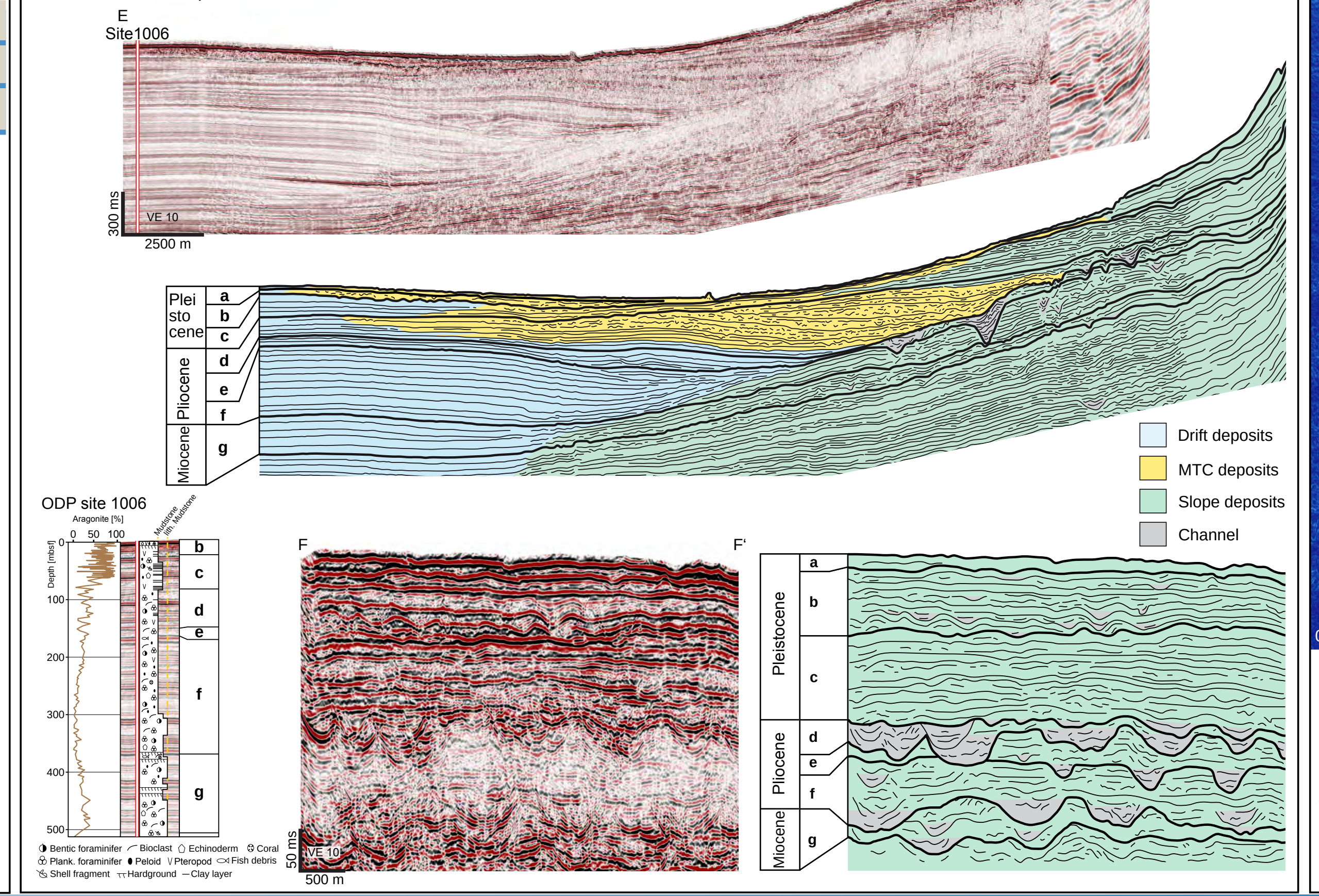
Compared to the southern slope, the facies distribution is more irregular and rapid facies alternations occur in downslope and along-strike direction. The cut-and-fill structures form a complex pattern of isolated facies bodies, which are delimited by the sequence boundaries. Within individual sequences, deposits are wackestones, intercalated with lenses of wacke- to packstones and mud- to wackestones.



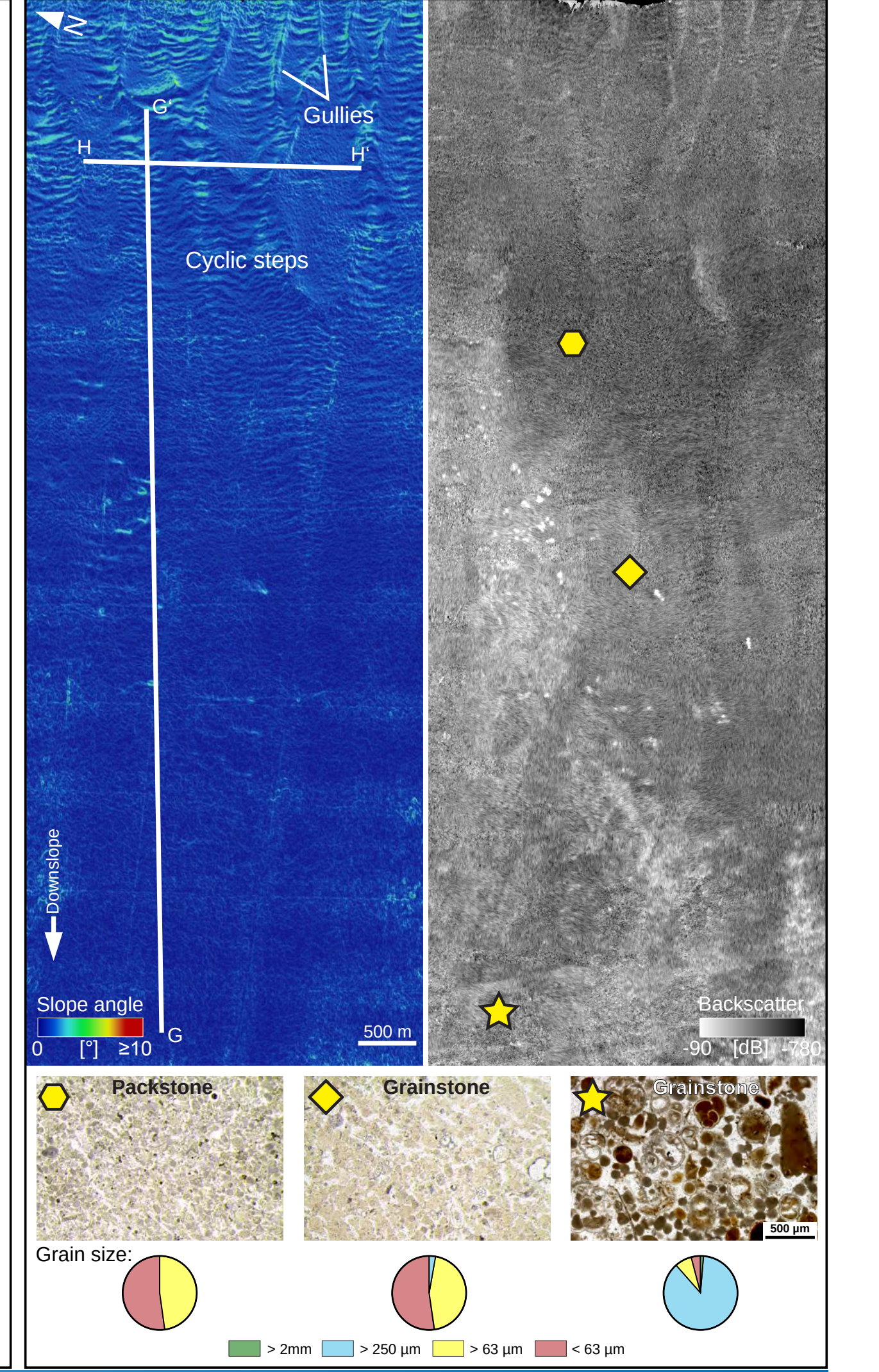
Facies model based on high resolution subsurface data and lithological information of ODP site 1006

Sequences

Compared to the southern slope, channels are more frequent on the northern slope. Major channels occur along the sequence boundaries d and f. Since Sequence f, a continuous upslope migration of the drift deposits took place. In Sequence d, MTC deposits interfinger with the drift deposits and backfilled the depression at the toe of slope.



Sea-floor characteristics



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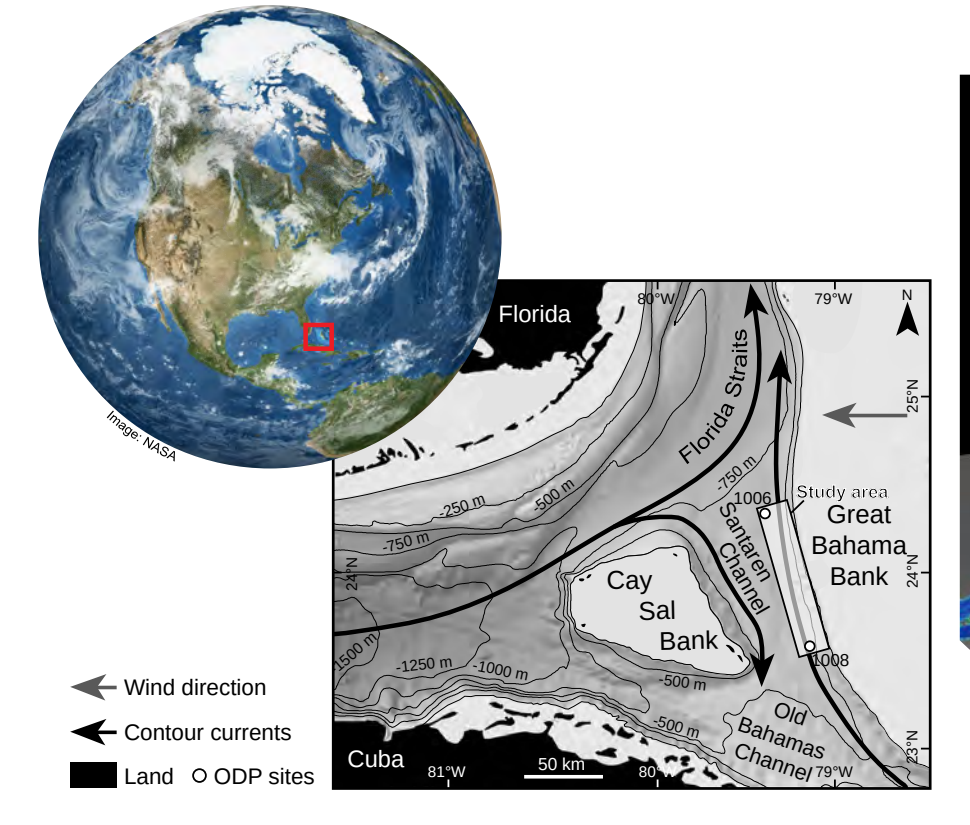
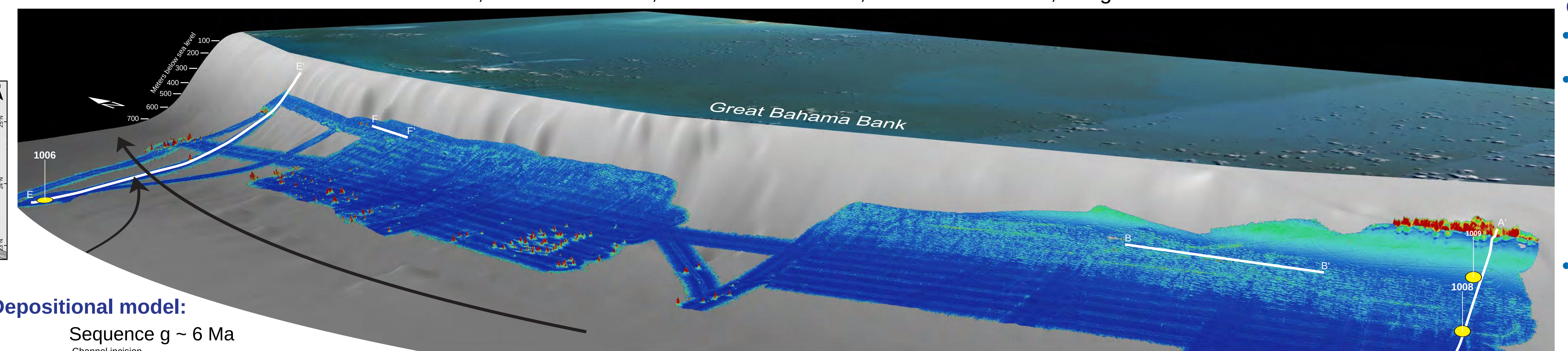




Outcomes:

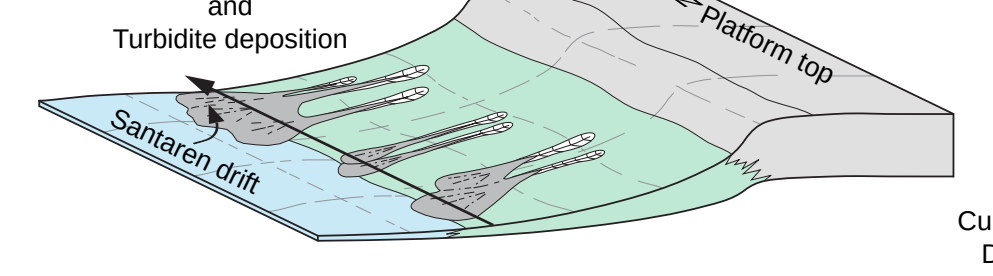
- Since the Late Miocene, the slope geometry is increasingly controlled by currents.
- During the formation of high-frequency sequences, processes acting along the southern and northern slope are different:
  - In the south, the sedimentation is undisturbed and characterized by wedge formation.
  - In the north, an interplay between erosional and depositional processes results in a complex slope morphology.
- Facies distribution reflects differences in slope forming processes:
  - In the south, the facies distribution is homogenous along the strike of the slope, and major changes occur only in downslope direction.
  - In the north, a repeating pattern of erosion and filling formed isolated and disconnected facies bodies, which are separated by depressions.

Study aims:

- To document the current imprint on the slope evolution since the late Miocene
- To resolve the slope architecture at a sub-seismic scale
- To unravel the processes, which influenced slope sedimentation and facies distribution

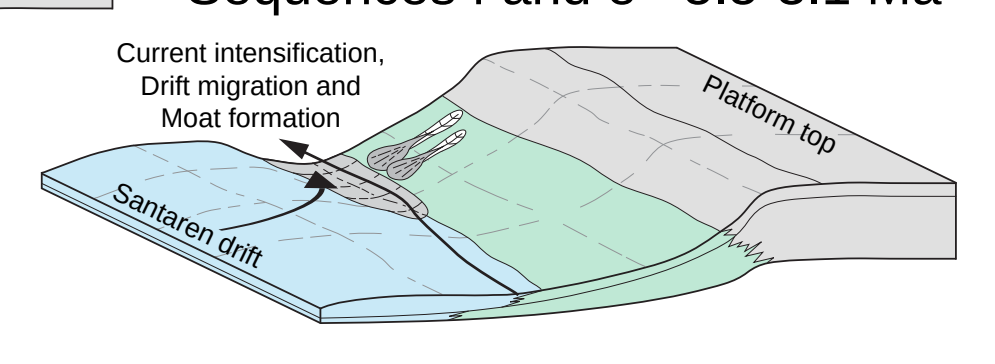
Depositional model:

Sequence g ~ 6 Ma



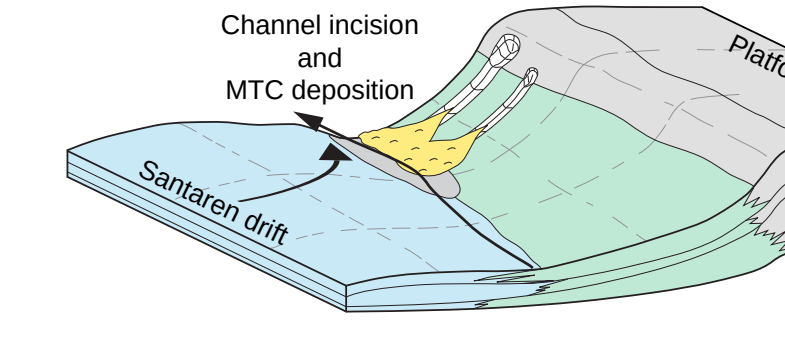
During the deposition of Sequence g the current influence is restricted to the basin. The upper sequence boundary is formed during a major sea-level fall, which triggered channel incision. These channels bypassed turbidites to the lower slope.

Sequences f and e ~5.5-3.1 Ma



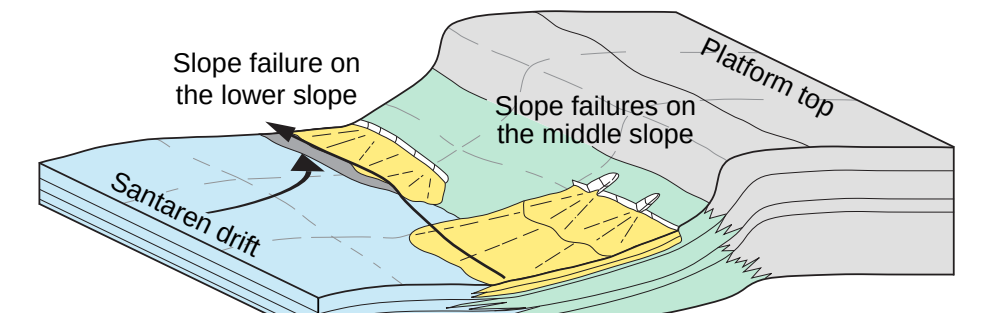
An intensification of currents in the Florida Straits caused changes in the bottom current regime. The drift deposits of the Santaren drift started to migrate eastwards. At the northern slope, where the Florida currents merge with the north-directed contour currents of the Santaren Channel, eroded sediment formed a wide moat along the toe of slope. Continuous erosion oversteepened the toe of slope and triggered the incision of minor channels.

Sequence d ~3.1-2.0 Ma



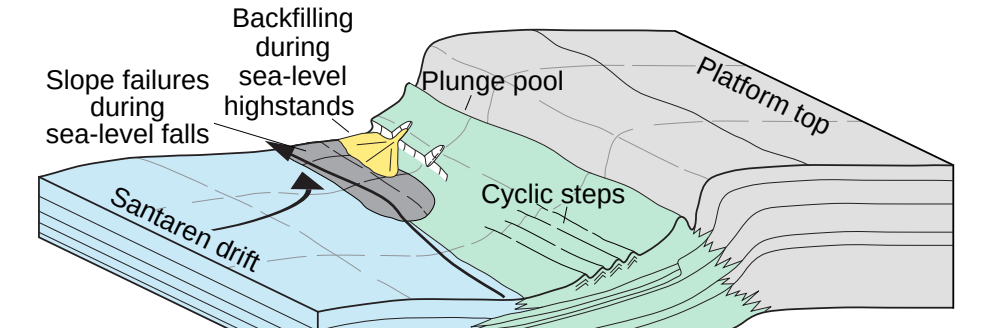
During the formation of Sequence d, the moat was backfilled by large mass transport complexes (MTCs). The material of the MTCs is derived from the upper slope and the platform margin. MTC material was transported in the channels, which were incised during the previous sequence. The deposition of the MTCs stopped after the moat was filled and the slope profile was leveled. The incision of a new moat was prevented by the coarse grain size of the MTC deposits. By contrast, the southern slope is characterized by formation of a coeval extensive slope progradation.

Sequence c ~2.0-0.6 Ma



During deposition of Sequence c, the progradation of the southern slope is disturbed by the occurrence of large slope failures. These slope failures were triggered by sea-level fluctuations during the Mid-Pleistocene transition. At the termination of Sequence c, a large slope failure occurred along the toe of the northern slope, which was triggered by current erosion.

High frequency sequences ~0.6-0 Ma



The high frequency sequences within Sequence b show clear differences between the northern and the southern part. Along the southern slope, the deposition was undisturbed and every sequence is represented by a sedimentary wedge. Along the northern slope, large slope failures occurred predominantly during sea-level falls. These slope failures created a complex slope morphology with depressions and gullies; leveled and refilled during subsequent sea-level highstands.

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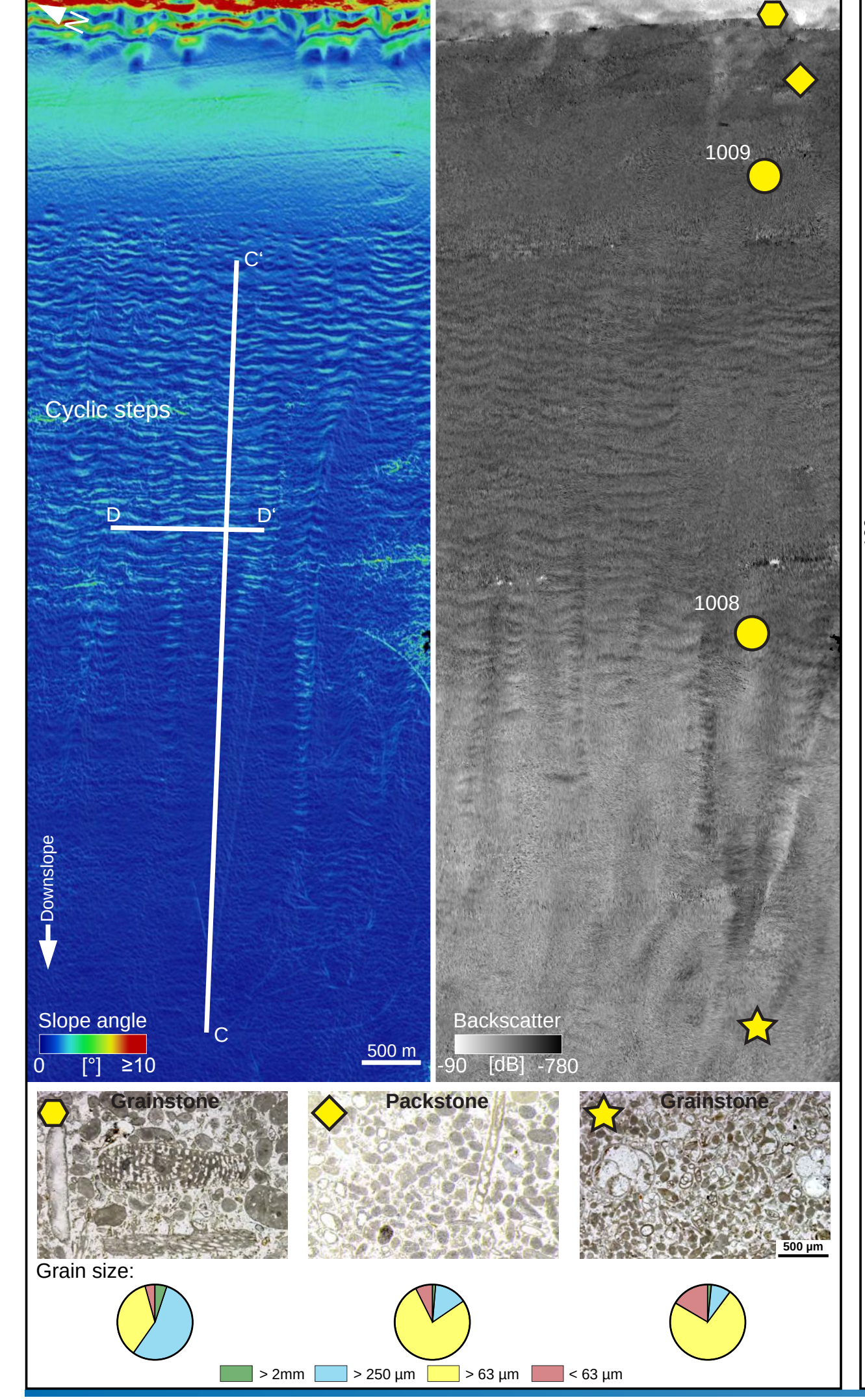
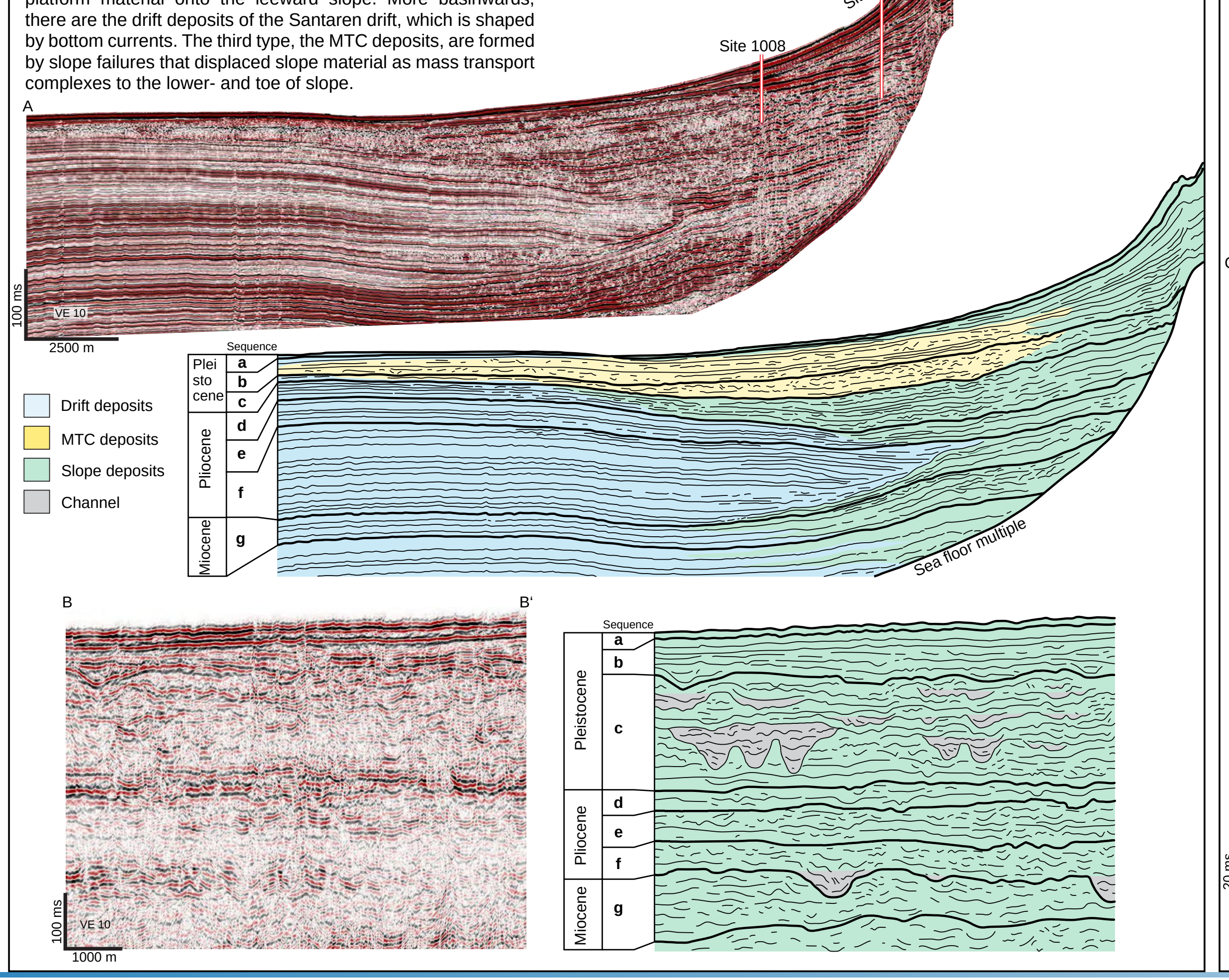
Southern slope: lower current velocities

Sea-floor characteristics

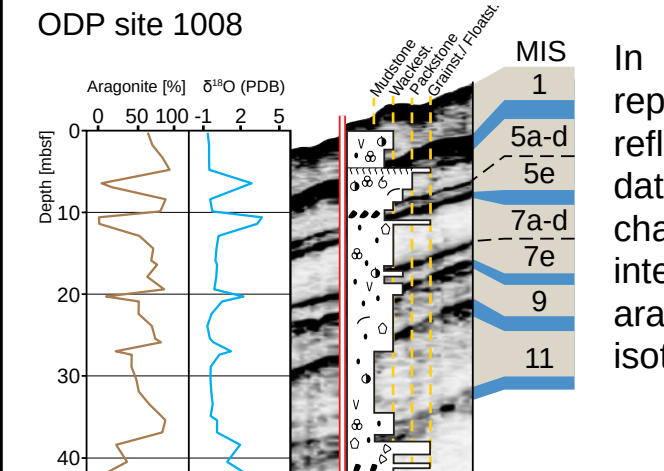


Sequences

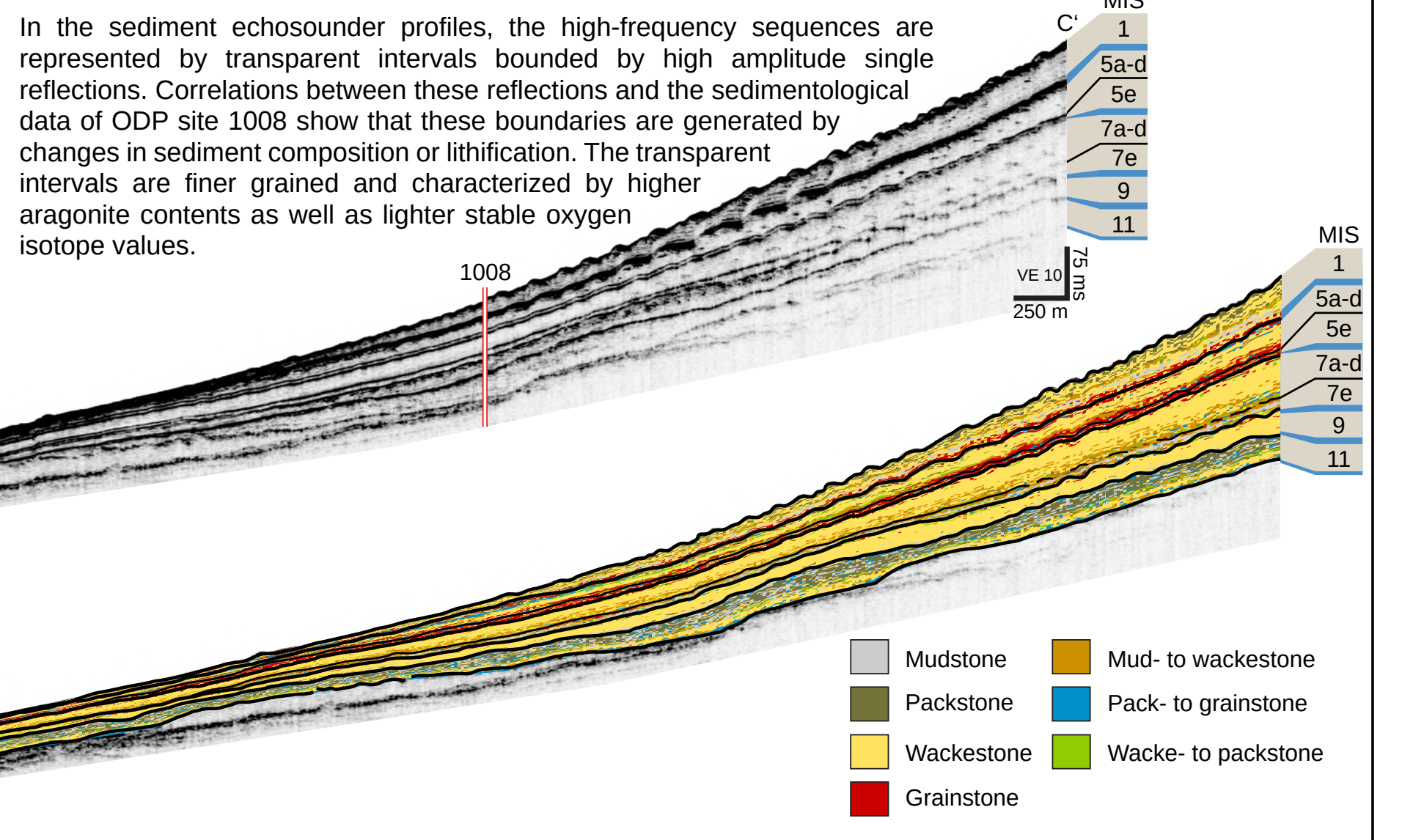
Based on the seismic reflection pattern, the slope-to-basin transition consits of three major types of deposits. The first are the prograding slope deposits, which document the deposition of platform material onto the leeward slope. More basinwards, there are the drift deposits of the Santaren drift, which is shaped by bottom currents. The third type, the MTC deposits, are formed by slope failures that displaced slope material as mass transport complexes to the lower- and toe of slope.



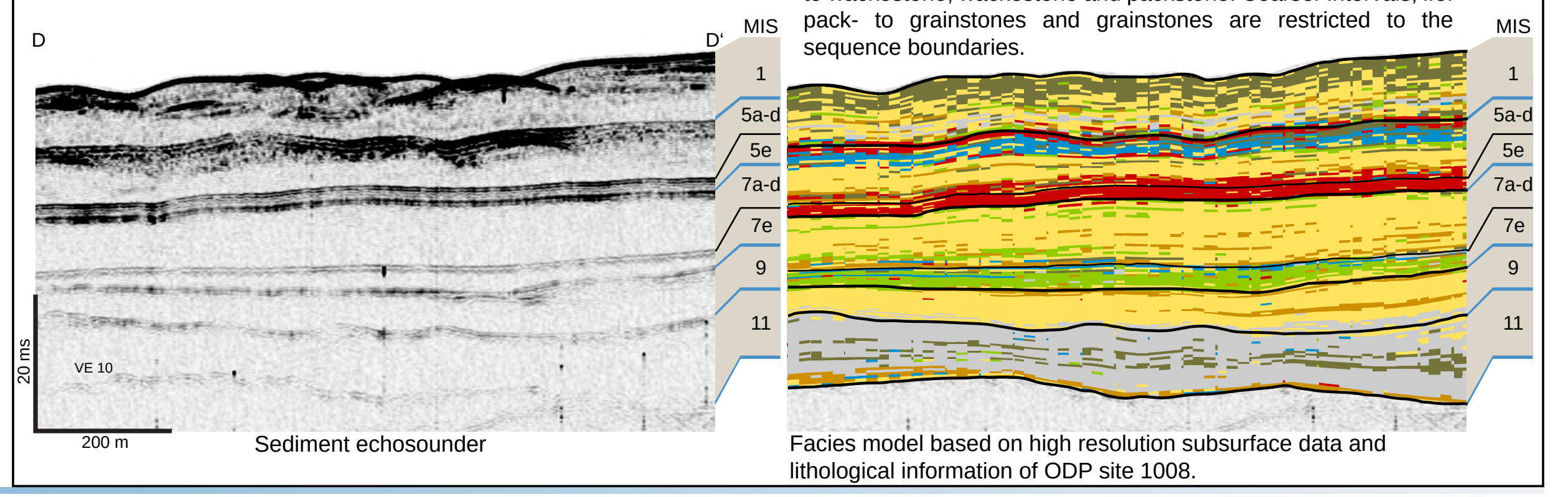
High-frequency sequences



In the sediment echosounder profiles, the high-frequency sequences are represented by transparent intervals bounded by high amplitude single reflections. Correlations between these reflections and the sedimentological data of ODP site 1008 show that these boundaries are generated by changes in sediment composition or lithification. The transparent intervals are finer grained and characterized by higher aragonite contents as well as lighter stable oxygen isotope values.



The facies distribution is continuous along the strike of the slope. Facies changes occur predominantly in downslope direction. Within the sequences, the dominating facies are mudstone, mud- to wackestone, wackestone and packstone. Coarser intervals, i.e. pack- to grainstones and grainstones are restricted to the sequence boundaries.



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