Organic geochemical analysis of multiple tsunami deposits of the last century at the Aomori coast (Northern Japan)

Mike Frenken[1], Piero Bellanova[1], Yuichi Nishimura[2], Jan Schwarzbauer[1] and Klaus Reicherter[1]

[1]RWTH Aachen University, Germany [2]Institute of Seismology and Volcanology, Hokkaido University, Japan

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LEK Institute of Geology and Geochemistry of Petroleum and Coal

Teaching and Research Area Neotectonics and Natural Hazards

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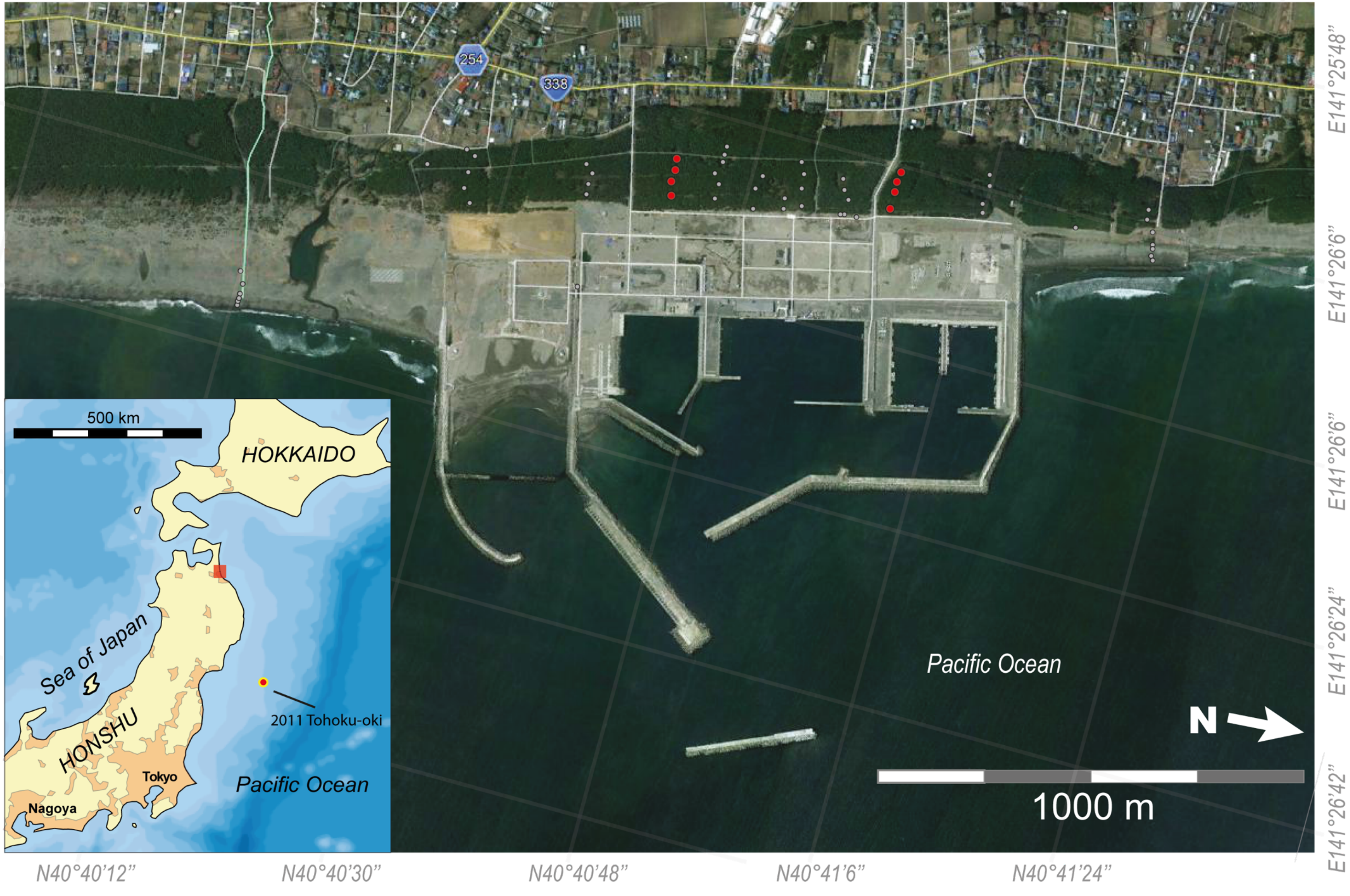
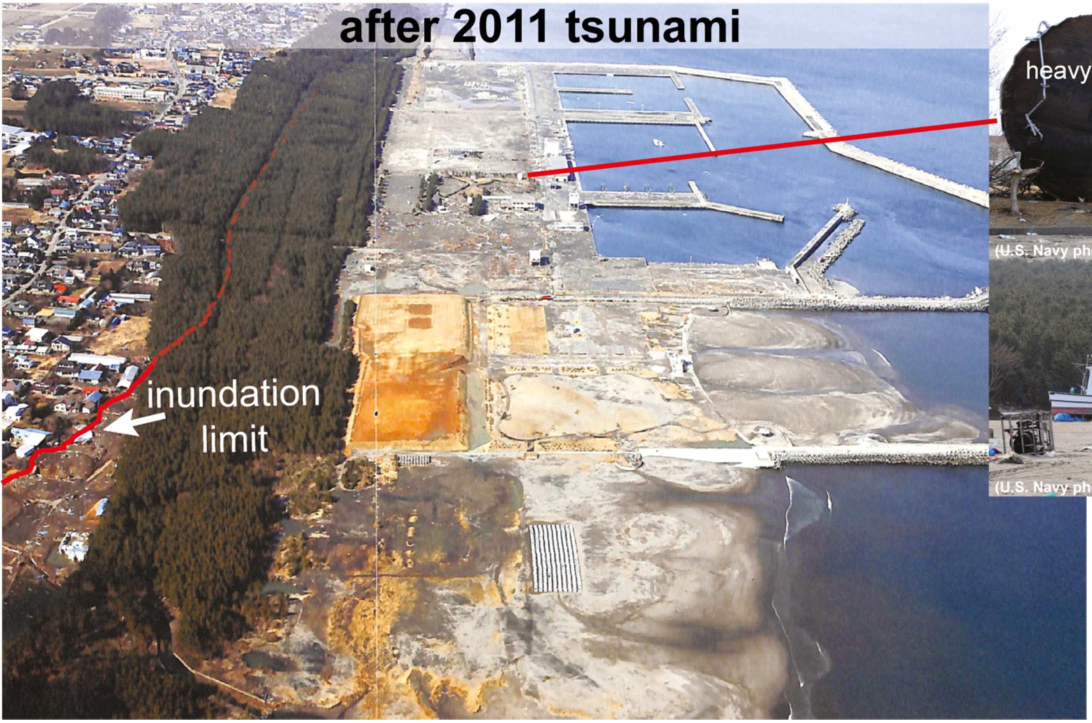
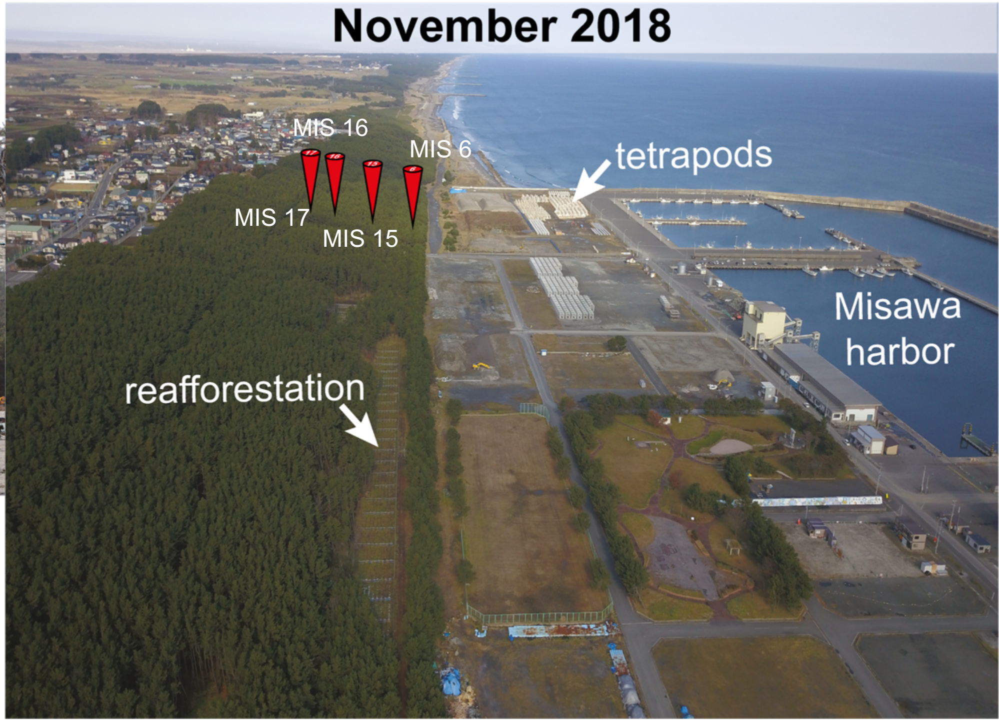
Field Site



- Northern Japan
- Aomori prefecture
- Misawa Harbor

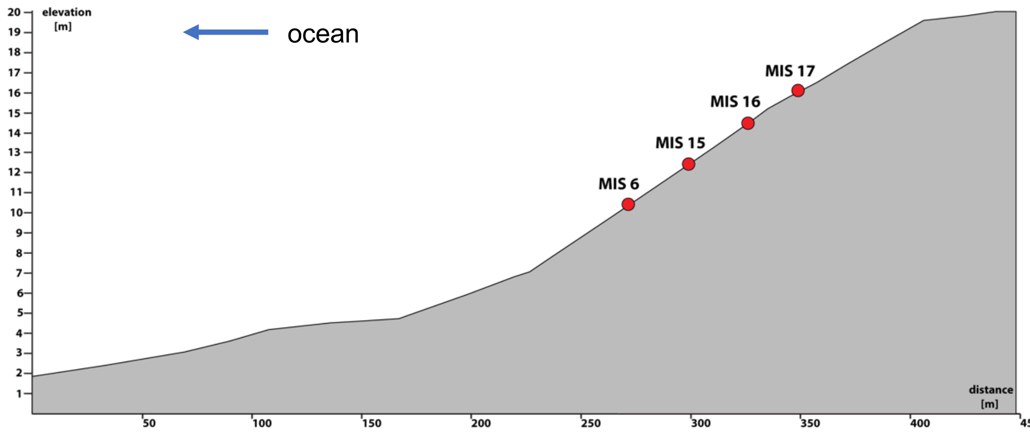
Field Site





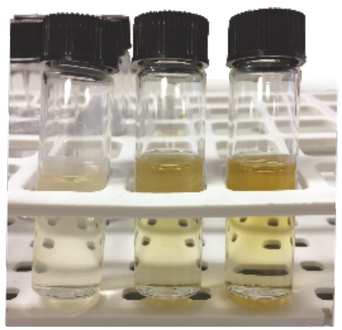
- report of 6 – 10 m wave height (Nakamura et al., 2012)
- heavy oil tank leakage
- destruction of > 37 vessels
- loss of fishery facilities

- sampling in control forest
- elevation increasing
- detected layers
  - top soil
  - sand
  - soil
  - dune



Method

Extraction



- 10 – 100 g sediment material
- extraction:
    - twice 110 ml acetone (4 h & 24 h)
    - 110 ml *n*-hexane (24 h)

Fractionation & GC-MS measurement

- chromatic fractionation in six fractions
  (B1) 5 ml n-pentane (n-p)
  (B2) 8.5 ml n-p/DCM 95/5 v/v
  (B3) 5 ml n-p/DCM 90/10 v/v
  (B4) 5 ml n-p/DCM 40/60 v/v
  (B5) 5 ml dichloromethane
  (B6) 5 ml methanol
- addition of internal standard
- measurement at gas chromatography-mass spectrometry (GC-MS)

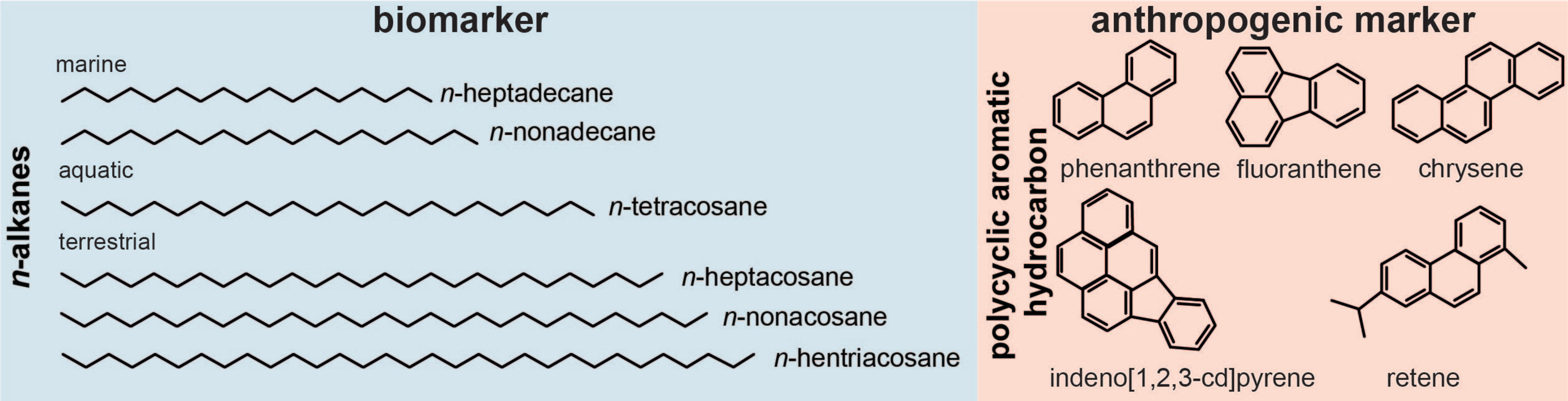
Total organic carbon – LiquiTOC II

- 100 mg grinded material
- ignited at 550°C for 30 min

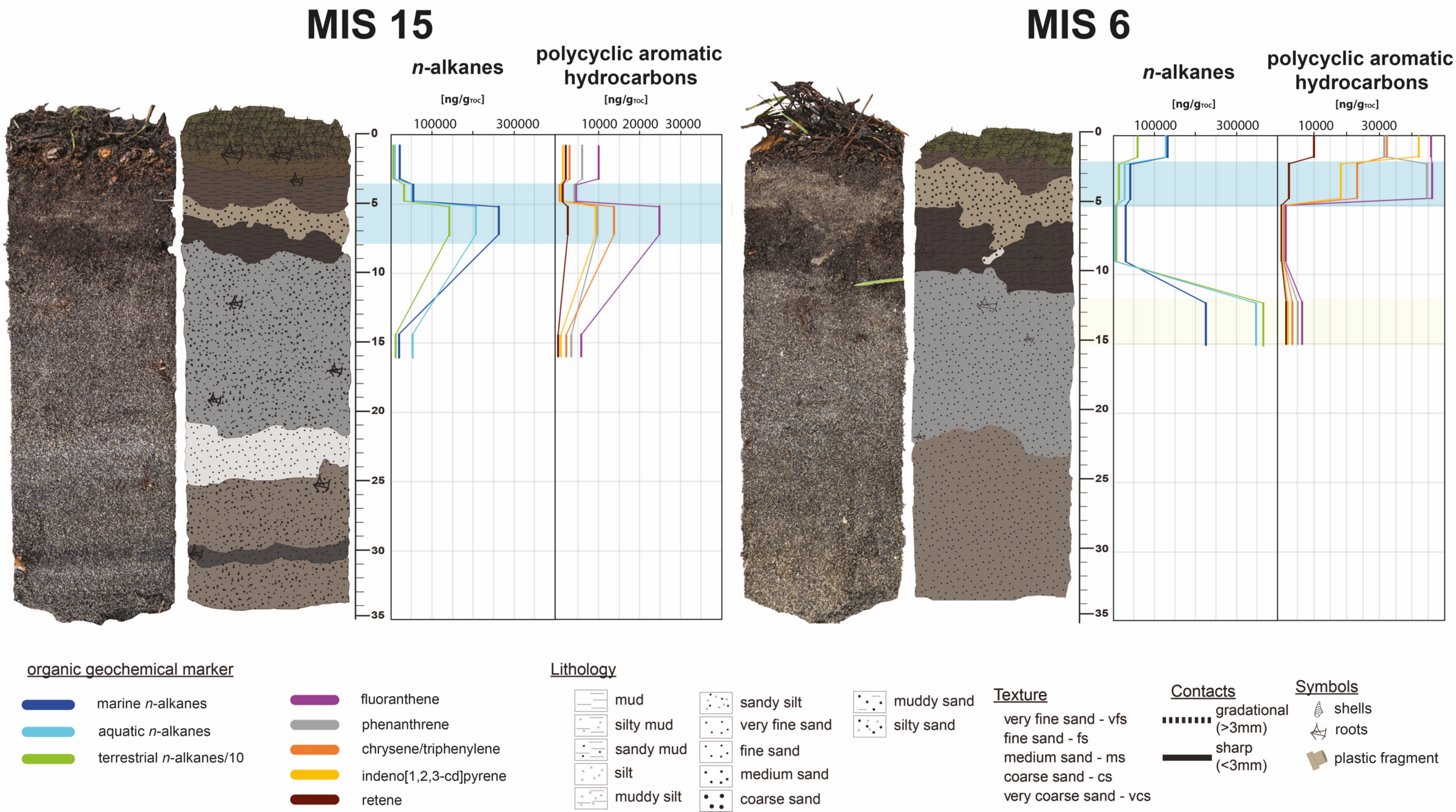
Identification of compounds

- homologue series of *n*-alkanes
- parent polycyclic aromatic hydrocarbons
- alkylated polycyclic aromatic hydrocarbons

structure of some organic compounds in this study

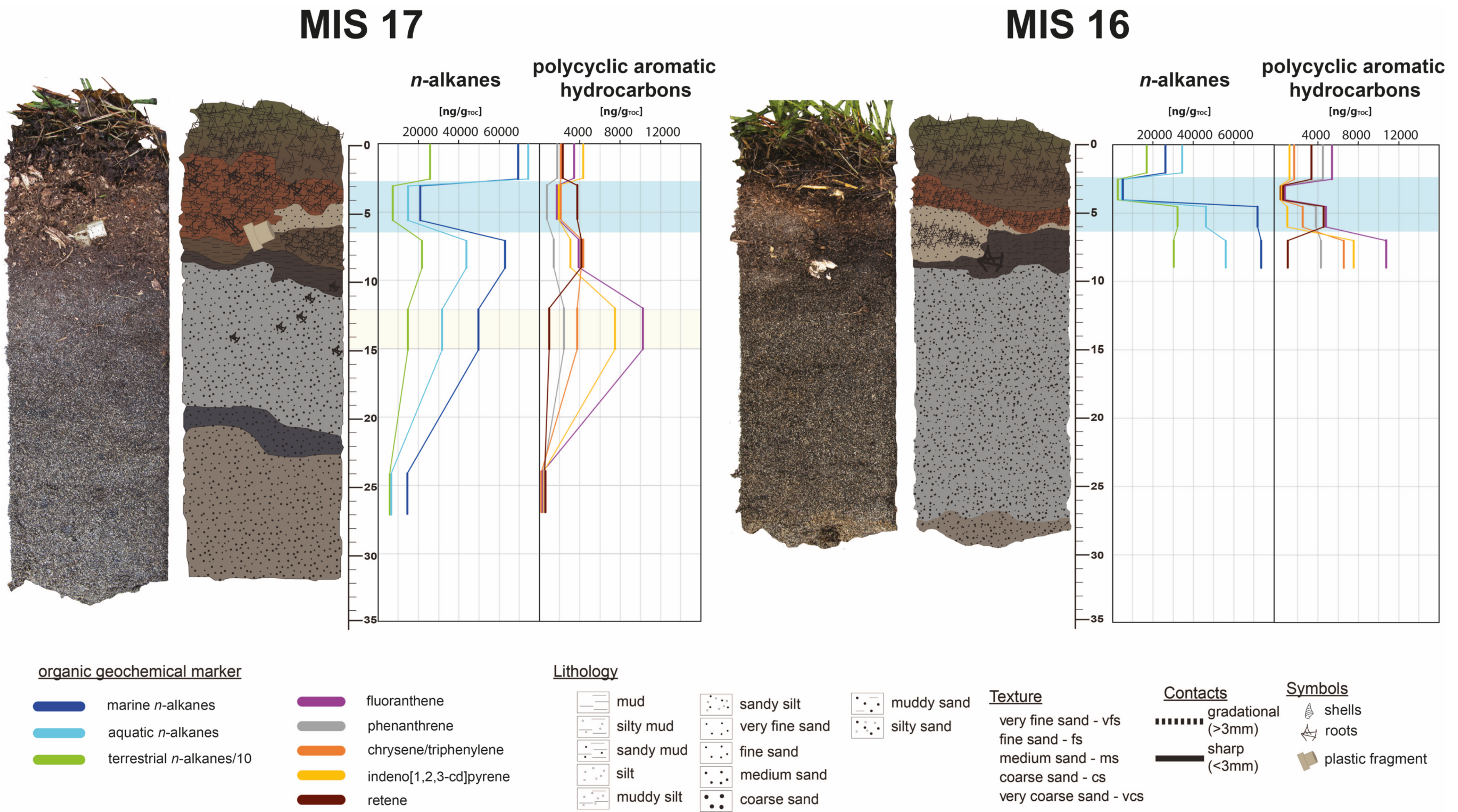


Results



MIS 15
MIS 6
n-alkanes
polycyclic aromatic hydrocarbons
[ng/gTOC]
100000
300000
10000
20000
30000
0
5
10
15
20
25
30
35
organic geochemical marker
marine n-alkanes
aquatic n-alkanes
terrestrial n-alkanes/10
fluoranthene
phenanthrene
chrysene/triphenylene
indeno[1,2,3-cd]pyrene
retene
Lithology
mud
silty mud
sandy mud
silt
muddy silt
sandy silt
very fine sand
fine sand
medium sand
coarse sand
muddy sand
silty sand
Texture
very fine sand - vfs
fine sand - fs
medium sand - ms
coarse sand - cs
very coarse sand - vcs
Contacts
gradational (>3mm)
sharp (<3mm)
Symbols
shells
roots
plastic fragment

Results



MIS 17
MIS 16
n-alkanes
[ng/gTOC]
20000 40000 60000
polycyclic aromatic hydrocarbons
[ng/gTOC]
4000 8000 12000
0
5
10
15
20
25
30
35
organic geochemical marker
marine n-alkanes
aquatic n-alkanes
terrestrial n-alkanes/10
fluoranthene
phenanthrene
chrysene/triphenylene
indeno[1,2,3-cd]pyrene
retene
Lithology
mud
silty mud
sandy mud
silt
muddy silt
sandy silt
very fine sand
fine sand
medium sand
coarse sand
muddy sand
silty sand
Texture
very fine sand - vfs
fine sand - fs
medium sand - ms
coarse sand - cs
very coarse sand - vcs
Contacts
gradational (>3mm)
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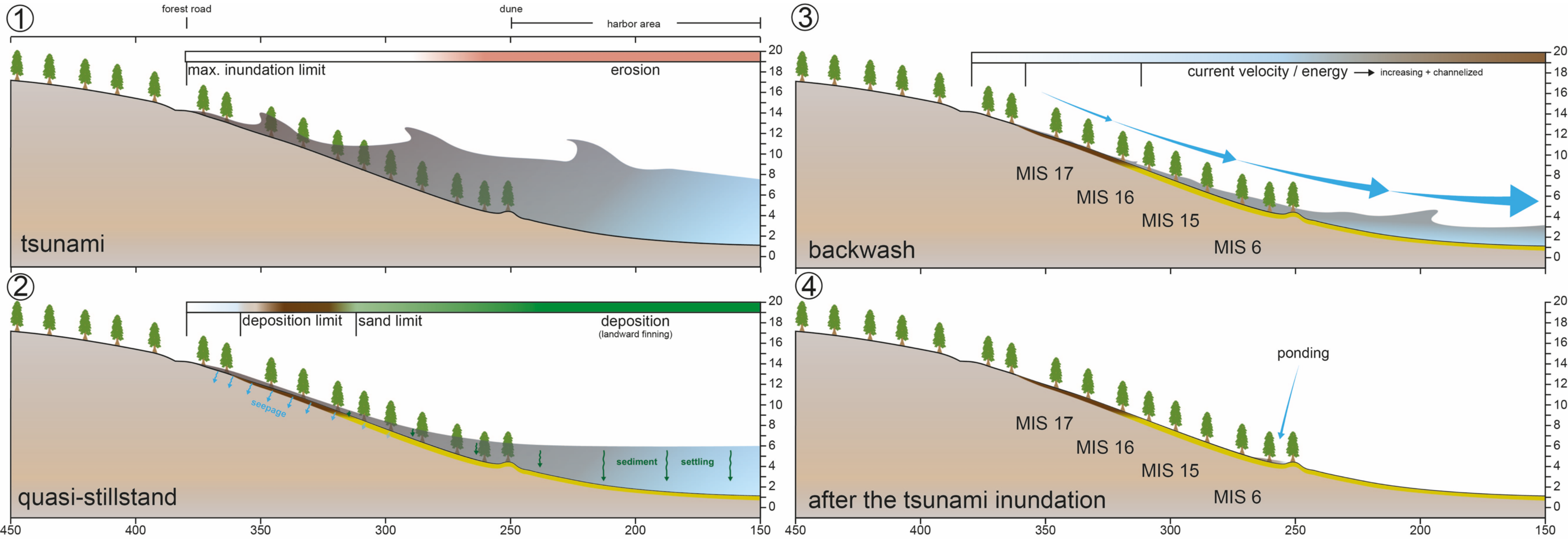
Interpretation

- higher concentrations of *n*-alkanes and PAHs in the lower part of the tsunami deposits
- lower concentration of *n*-alkanes and PAHs in the upper tsunami part (sand and organic-rich material)
  - except of MIS 6 the most proximal core to the coast
- MIS 17 has no tsunami sand layer, but organic-rich material, which differs from surrounding soil

- *n*-alkanes and PAHs have distinctive peaks in the dune sand (MIS 6 and MIS 17) at the same depth

Discussion

- concept of the tsunami processes of the 2011 Tohoku-oki tsunami in Misawa



Discussion

- distinct changes in organic geochemical markers in the tsunami layer
  - tsunami inundation transports marine material (*n*-alkanes) and pollutants from the ocean and harbor into the control forest
  - tsunami inundation deposited the pollutants and biomarker in the lower part of the tsunami layer and reworked the underlying sediments
  - backwash transports sediment back to the ocean, but without or less organic geochemical marker
  - MIS 6 has special features due to the ponding after the event → higher concentrations

- identification of tsunami deposition beyond sand limit
    - transition of sand to organic-rich deposit

- second distinct changes in organic geochemical markers could be indicator for historical tsunami
  - most likely one of the three Sanriki-oki tsunamis (1896, 1933, 1968)

Conclusion

- geochemistry is applicable on tsunami deposits and extend the tsunami tool kit
- high source specificity for better investigation of the tsunami process
- possible identification of historical tsunamis even if no sedimentological change is apparent