Anthropic pollutants and biomarkers for the identification of 2011 Tohoku-oki tsunami deposits (Japan)

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Abstract

Organic geochemistry is commonly used to track environmental change. However, it is not the only reliable and validated technique. Tsunami deposits may also be able to be characterized by organic geochemical parameters. However, tsunami deposits are not only geological evidence for tsunami activity, they are also a rich source of information about the surrounding environment. Recently, more attention has been given to the subject of tsunami sediments due to their potential to provide proxy data for past tsunamis. This study has therefore been motivated by the need to understand the depositional processes of tsunami sediments, and the potential of using organic geochemical proxies to characterize the environment prior to the 2011 Tohoku-oki tsunami event. The study was conducted in Sendai, Japan, where the city was affected by the tsunami event. The study aimed to provide a comprehensive characterization of the depositional processes of the tsunami sediments and the potential of using organic geochemical proxies to characterize the environment prior to the tsunami event.

Location

Sendai Plain airport transect - located in Miyagi prefecture - 5000 m coastal lowland - 200 m wide coastal forest control - coastal dune ridge

For why organic geochemistry?

- affected by the 2011 Tohoku-oki tsunami
- well-studied by prior studies
- multiple pollution sources
- good preservation potential

Extraction

- 10 - 100 g sediment material
- extraction: 110 ml acetone (4 h 24 h)
- -110 ml in hexane (24 h)

Methods

- dehalogenation with ammonium sulfate
- chromatographic fraction in 1 fractions
- GC/MS analysis in injection of 110 µl

Results

Biomarkers

- distinct differentiation between tsunami and non-tsunami deposits
- indication of marine input (e.g., n-alkanes)

Anthropic markers

- n-paraffins generally enriched in tsunami deposits
- n-alkanes indicate variations in the tsunami
- n-heterocyclic compounds enriched in tsunami

Conclusion

- two types of organic geochemical compounds detectable:
  - biomarker & anthropogenic marker
- anthropogenic marker useful for tsunami characterization
- pollution sources
- soil erosion
- high source specificity of anthropic markers
- good preservation potential of organic compounds
- new insights + additional proxy for future tsunami studies

Fig. 1: (A) location of Sendai in Japan; (B) detail of Sendai Airport field site showing the Sendai airport as well as study’s sampling locations; orange dashed line = tsunami inundation limit; (C) sample depth and grain size

Fig. 3: Overview of various sources were eroded, transported and deposited across the area. This led to the distribution of biomarkers from different sources across the Sendai marine to terrestrial areas (and vice versa), but also associated organic material. Recently, more attention has been given to the usage of natural organic markers as biomarkers for tsunami identification. We present results of biomarkers and anthropogenic markers detected in deposits of the 2011 Tohoku-oki tsunami event. The study was conducted in Sendai, Japan, where the city was affected by the tsunami event. The study aimed to provide a comprehensive characterization of the depositional processes of the tsunami sediments and the potential of using organic geochemical proxies to characterize the environment prior to the tsunami event.

Fig. 2: Specific anthropogenic starters, isomers, and compound groups analyzed in this study