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A late Holocene Tephrochronology for the Maya Lowlands, Central America

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Introduction and aim

The Maya Lowlands in southern Mexico, Guatemala and Belize were densely populated for thousands of years, and have been the subject of intensive studies on the interaction between humans and their environment. Accurate radiocarbon dating of proxy records and disrupting events has proved to be difficult due to the lack of organic material in many deposits and the 'old carbon effect' related to the calcareous geology of the Yucatan Peninsula.

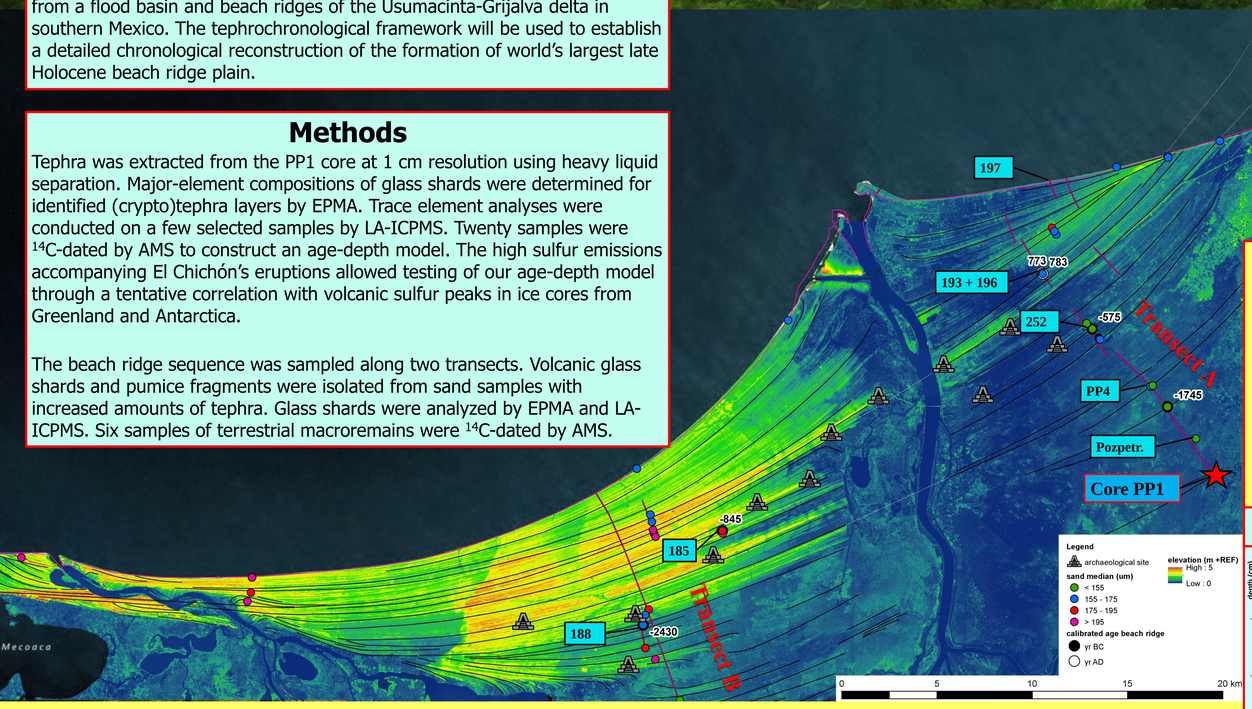
Tephrostratigraphy offers a unique but still unexplored method to define time markers for palynological, limnological and archaeological studies in this region, due to the frequent occurrence of tephra-fall.

In this project we are developing a tephrochronology using sediment cores from a flood basin and beach ridges of the Usumacinta-Grijalva delta in southern Mexico. The tephrochronological framework will be used to establish a detailed chronological reconstruction of the formation of world's largest late Holocene beach ridge plain.

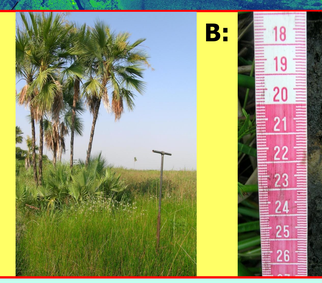
Methods

Tephra was extracted from the PP1 core at 1 cm resolution using heavy liquid separation. Major-element compositions of glass shards were determined for identified (crypto)tephra layers by EPMA. Trace element analyses were conducted on a few selected samples by LA-ICPMS. Twenty samples were ^{14}C-dated by AMS to construct an age-depth model. The high sulfur emissions accompanying El Chichón's eruptions allowed testing of our age-depth model through a tentative correlation with volcanic sulfur peaks in ice cores from Greenland and Antarctica.

The beach ridge sequence was sampled along two transects. Volcanic glass shards and pumice fragments were isolated from sand samples with increased amounts of tephra. Glass shards were analyzed by EPMA and LA-ICPMS. Six samples of terrestrial macroremains were ^{14}C-dated by AMS.



Location of the PP1 core, ~140 km NE of El Chichón volcano.



B:

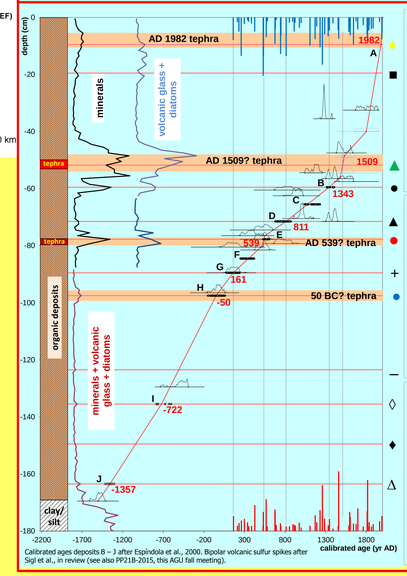
C:

D:

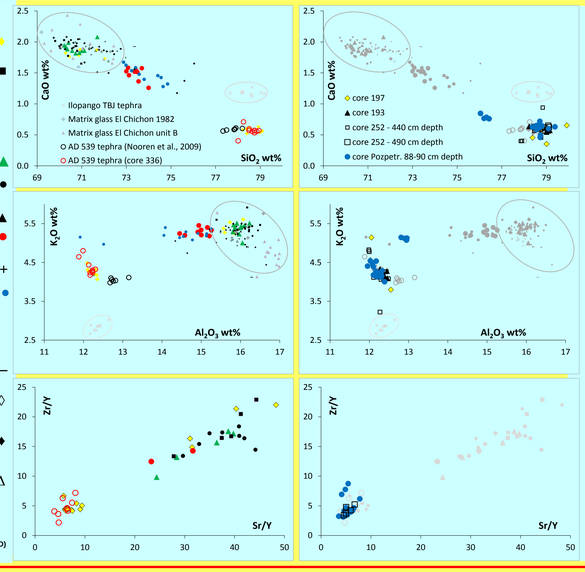
E:

A: Core retrieval flood basin
(location core PP4);
B: Rhyolithic AD 1509 tephra
(core PP4: 17 - 26 cm depth);
C: Sampling of beach ridges with Van der Staay suction corer
(core 197);
D: Debris layer with abundant pumice and glass shards
(core 193: 497 – 515 cm depth);
E: Organic debris layer contain ^{14}C datable leaf fragments
(core 185 (469 - 483 cm depth).

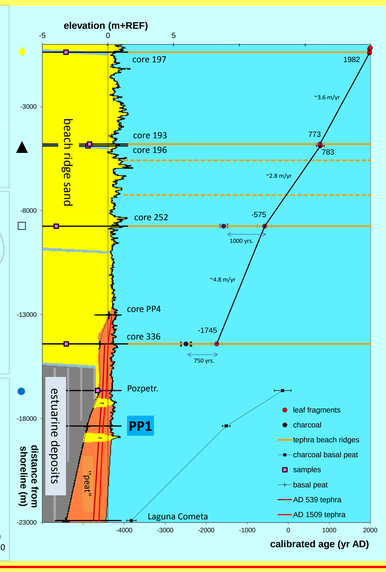
PP1 Tephrostratigraphy



Major and trace element composition



Beach ridge sequence chronology



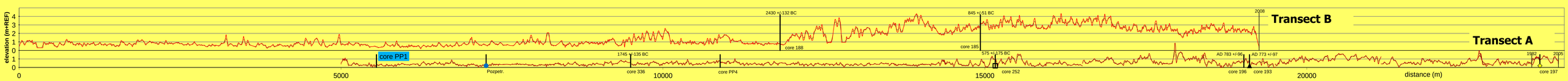
Results / Conclusions

PP1 core

- Initially twelve (crypto)tephralayers were identified in the PP1 core;
- Major-element compositions indicate El Chichón as the source volcano;
- Most notable tephra-fall occurred around 50 BC, AD 539, AD 1509 and AD 1982; only the AD 1509 tephra lacked a bipolar match to volcanic sulfur spikes in the ice core records;
- El Chichón tephra-fall can be bimodal in grain size with a relative high Si-content for the coarser mode;
- Individual eruption events are not easily distinguishable by major and trace element analyses.

Beach ridge sequence chronology

- Five beach ridge sections with increased amounts of tephra were identified during the first fieldwork campaign;
- Major and trace element compositions of the large tephra glass shards are comparable to the composition of glass shards from the coarse mode of El Chichón's ash-fall deposits found in the flood basin;
- A preliminary age-distance model suggests tephra deposition after eruptions of El Chichón around 2000 BC (unit K?), 722 BC (unit I), 50 BC (unit H), AD 811 (unit D) and AD 1982 (unit A) when the Usumacinta and Grijalva rivers supplied large amounts of tephra;
- The beach ridge sequence host promising new data for improving the tephrochronological framework for the Maya Lowlands.



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