Can FTIR Spectroscopy identify past high severity fires in the sediment record?

Natural Hazards Research Australia

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Reconstructing a >50-year Record of Past High-Severity Fires Using FTIR Spectroscopy

Bushfires have been present in the Australian landscape for millennia. However, as fire regimes continue to alter in the face of climate change, there is an urgent need to develop new tools that can extend our existing fire record to improve understanding of the evolution of fire characteristics.

Background and Aims

The 2019-20 Bushfires were considered unprecedented in their severity and extent across south-eastern Australia. However, existing records are largely historically limited (remote sensing) or do not distinguish fire characteristics such as severity and intensity (charcoal analysis and dendrochronological reconstructions). FTIR identifies changes in chemical bonds through their unique interactions with infrared light. During a fire, bonds are typically created, destroyed or transformed which can be identified in the FTIR spectra.

Aims:

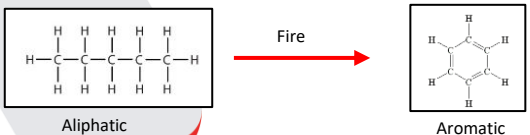
- To determine the resolution at which individual fire events can be identified within the sediment record
- To create a >50-year record of past high severity fires in the Blue Mountains.

Methods

Sediment samples were collected from swamps in the Blue Mountains with different fire return intervals and analysed by potassium bromide (KBr) pressed disc FTIR spectroscopy.

Results

Aliphatic compounds are the first to be decomposed when exposed to higher temperatures. This results in a relative increase in aromatic compounds. Aliphatic compounds are absorbed at 3000-2800 cm^{-1}, whilst aromatics are absorbed at 1750-1500 cm^{-1}. The ratio of these two compounds can inform of high severity fire occurrence (Fig 1).



Aliphatic Aromatic

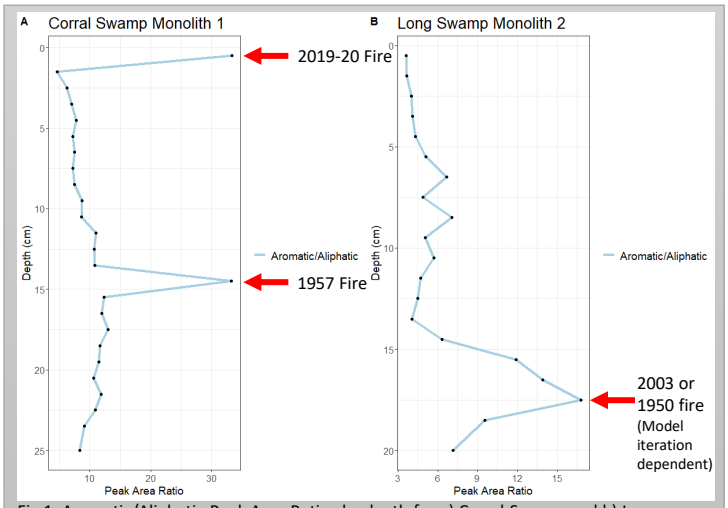


Fig 1: Aromatic/Aliphatic Peak Area Ratios by depth for a) Corral Swamp and b) Long Swamp. Arrows denote known fire events determined from a radiocarbon-based age-depth model and paired with NPWS fire history data.

Conclusions and Next Steps

Pairing the results in Fig 1 with a radiocarbon-based age-depth model allows for the determination of the fire year and average return interval. Changes in the aromatic/aliphatic ratio clearly identify past high severity fire events in the sediment record.

Other bands of the spectra can also be used to determine the temperature of the fire (using the destruction of compounds such as cellulose or lignin) and the occurrence of pyrolysis conditions (bonds formed under a nitrogen atmosphere).

Next steps: Analysing shorter fire return intervals and longer time scales to determine resolution.

Further information

For additional information scan the QR code or contact:

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