Boron isotope fractionation in combusted plants during wildfires

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1. Introduction & Rationale

Wildfires are increasingly a prominent hazard due to climate change. It is difficult to model variations in fire characteristics in order to predict future wildfire behavior, because we lack knowledge of how wildfires behaved in the past. We investigate boron isotopes as a potential novel proxy for past fire severity. In the soil profile, biochemical cycling is the greatest factor that controls the boron budget. It is therefore likely that disturbances to this biological cycling during wildfires could impart boron signals in the soil. Our experiments have shown that boron isotopes in the soil correlate with fire severity (Figure 2; Lu et al 2022), thus boron isotopes could possibly be used as a novel proxy for fire severity in past wildfires. However, it is unclear how this correlation may arise. This study aims to decipher how different fire severities may impart boron isotopic signals in the soil during and after wildfires.

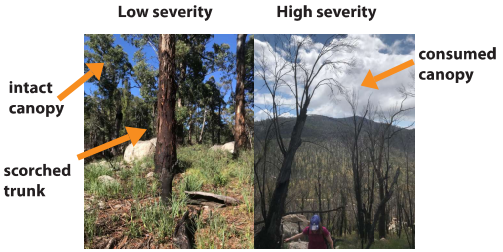


Figure 1. Differences between low and high fire severity. Fire severity is an important metric that measures the impact on the environment. More biomass is consumed in a higher severity wildfire.

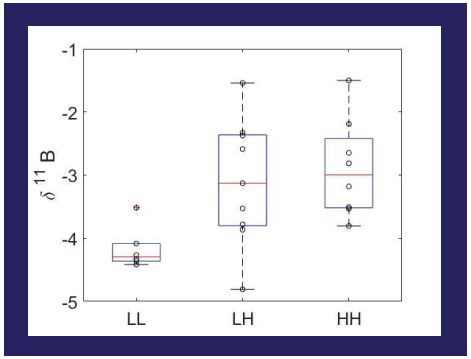
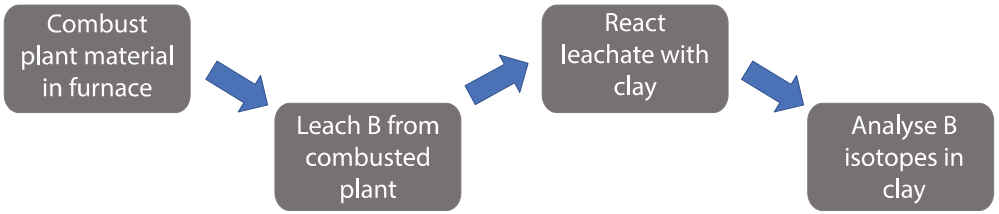


Figure 2. Our previous study shows that soil from sites (in Yengo National Park, NSW, Australia) that experienced at least one high severity fire (H) tend to have heavier boron isotope composition compared to those that only experienced low severity fires (L) (Lu et al. 2022).

2. Experiment set up

In this study, we analyse water-exchangeable boron in bark charcoals collected from wildfire sites. We also react clay with leaching solutions of artificially combusted barks and leaves to test how this interaction may alter the boron isotope compositions of clays.



3. Results

Boron is an essential micronutrient for plants. Trees strongly fractionate boron isotopes, since the lighter ^{10}B is preferentially incorporated by plant cells. This leads to leaves having heavier boron isotope compositions than barks (Figure 4).

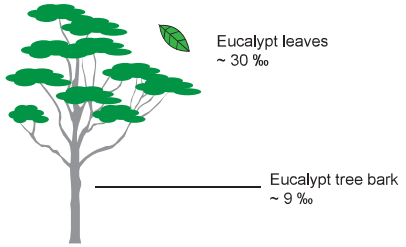


Figure 4. Boron isotope compositions of eucalypt leaves and barks measured in this study

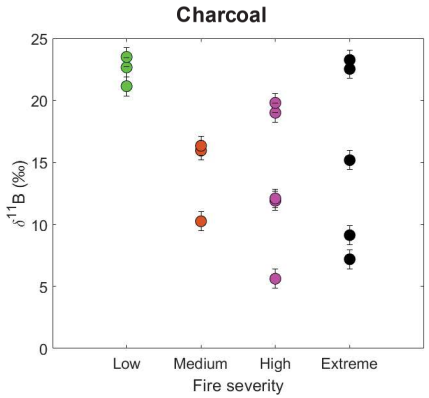


Figure 5. Boron leached with hotwater from natural bark charcoals have lighter isotope composition for samples from sites of higher fire severity

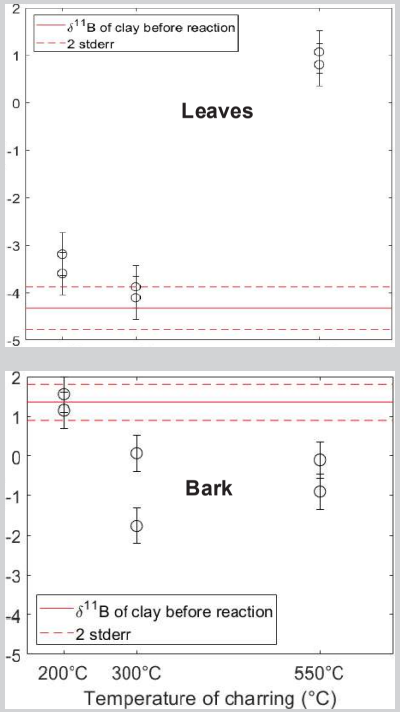


Figure 6. Clays that react with leaves combusted at high temperatures gain heavier boron isotope compositions. Those that react with combusted bark contrastingly gain lighter boron isotope compositions.

4. Conclusions

- Charcoal from higher fire severity sites leach lighter boron isotope compositions into solution (Figure 5).
- At high enough temperature, combusted leaves increases the boron isotope composition of clay, while combusted bark decreases it (Figure 6).
- Input from combusted leaves is the likely cause of heavier boron isotope composition of soils in higher severity wildfires.