Ringless tropical trees as archives of environmental change.
Experiment Report Form EC-802

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This project employed synchrotron radiation (ID21) to explore the environmental signals preserved within tree-ring archives. The overall aim was to obtain evidence for environmental controls on the Calcium and Sulphur (Ca and S) elemental composition of tree-rings:
Aim 1.To use the annual control on Ca content within a tree-ring to establish a technique for determination of chronology in ringless tropical trees.
Aim 2. To use variations in sulphur concentration as an indicator of past volcanic events, thereby building the first record of sulphur volcanic forcing from trees, verifying the ice-core records and developing alternative forcing datasets for climate models.

Initial investigations demonstrated that it was possible to obtain a suitably smooth surface for synchrotron analysis, although the size and cellular structure of some samples meant that it took a long time to degas/pump down prior to analysis. Importantly, it was identified early in the experiment that the Zaponlak mounting resin proposed for mounting samples and selected for its lack of S actually contained S and was therefore replaced by adhesive tape as the mounting medium.

Three tests were conducted to explore the variaiblity of Ca in the tree ring samples. Analysis of ringed temperate trees (Oak and Pine) and the analysis of ringed tropical trees (Teak) provide a baseline for comparison with ringless tropical trees (Suriah and Belian). The ringed trees reveal a periodicity in their Ca content that we hypothesise reflects the difference in wood structure between early-wood and late-wood or seasonal changes in the availability of Ca in the ecosystem. This clear rhythmic pattern was not so well expressed in the ringless trees (eg: Poussart *et al.* 2005 *Geophysical Research Letters*.33:17 L17711). Further investigation, replication and data processing are required, but we provisionally suggest that this might indicate that lack of seasonality across the sampling region precludes expression of Ca rhythmic variability.

XANES analyses were used to confirm the state of which Ca is present in the tree rings. Previous studies have postulated the dominant form of Ca occurs as calcium oxalate, but this has not been proven until this investigation. This is a significant finding as it will assist in the monitoring and development of models for Ca signal expression in tree rings, and a manuscript reporting this is in early preparation (Loader, Wynn, Castillo).

Analysis of the S content of the trees across large explosive volcanic events yielded encouraging results. Analysis of oak and pine samples demonstrate some variability (and annual periodicity). Of particular note was the analysis of S across the precisely dated rings of oak trees for the period AD1760-1820 (Figure 1). This period covers the 1783/1784 Lakí fissure eruption in Iceland; an event that led to widespread famine and death across northwestern Europe. A period of enhanced S concentration is clearly visible in the oak record. This increase is smoothed over time, perhaps reflecting a residence in the environment, buffering or recycling in leaf litter. This result, we believe, is the first example of a volcanic signal expressed in the S composition of European tree rings. A joint paper will be presented on this work at the European Geosciences Union Congress in Vienna 2012 (Wynn *et al.*) and a publication based upon this presentation is in preparation.

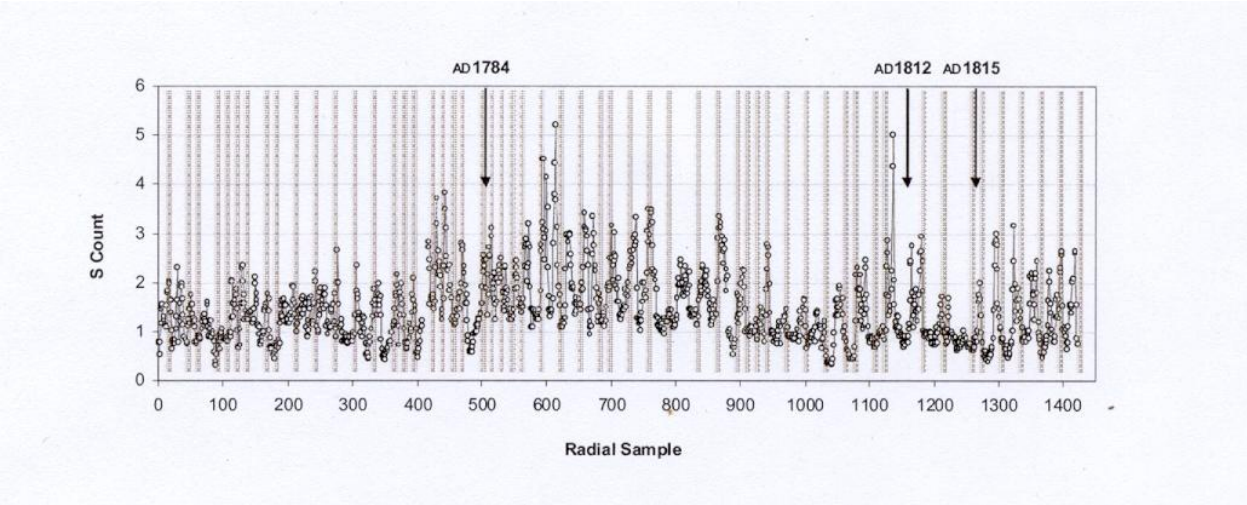

Figure 1: Provisional distribution of S variability (counts) through Oak sample (WOB06) AD1760-1820. Major volcanic events 1783/84 (Lakí), 1812 (Soufrière) and 1815 (Tambora) exhibit post-event elevations in S. Ring boundaries marked by vertical shaded bars

These pilot investigations at ID21 have provided very valuable data and experience to us. In addition to these two key results, we have been able to explore the potential of the tree-ring archive as a record of Ca and S variability and how better to design and execute the next phase of this research; the long-term analysis of S in tree-rings as a record of past volcanism.

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