Tracing volcanic eruptions and anthropogenic pollution in tree rings: preliminary results from synchrotron-light chemical analyses

Davide Frigo[1], Don Baker[2], Jacopo Dal Corso[3], Sara Callegaro[4], Manfredo Capriolo[4], Daoliang Chu[3], Yiran Cao[3], Kalotina Geraki[5], Andrea Marzoli[1], Marco Carrer[1]

FIG. 1: Illustration of the sampling site, Ventina valley (SO) Italy (46° 18' N, 9° 46' E). Larch samples have been collected at the treeline at 2000 m above sea level.

1 Background

- Tree ring records are the most widespread and important late-Holocene climate proxy[1]. Trace elements, including highly and moderately volatile elements can be efficiently stored and preserved in wood.
- Synchrotron-light XRF analyses and mapping of elements like S, Zn, Mn, Cu have been attempted in a few cases and provided potentially interesting, but inconclusive results[2-3].
- Recently completed analyses at the I18 line at the Diamond Light Source allowed us to recognise that about 50% of the analysed wood samples seem to preserve at least partial records of volcanic or anthropogenic pollution.

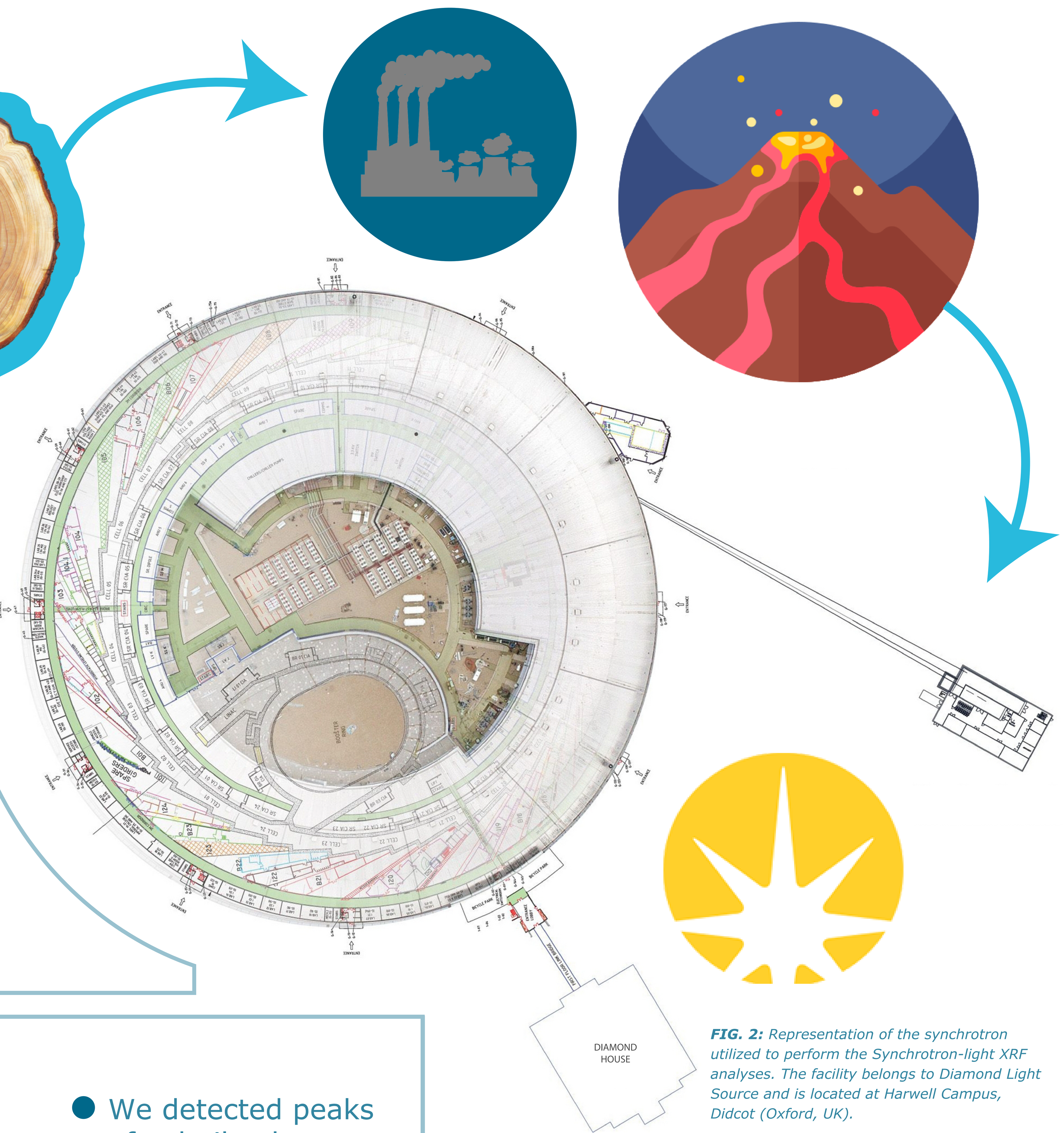


FIG. 2: Representation of the synchrotron utilized to perform the Synchrotron-light XRF analyses. The facility belongs to Diamond Light Source and is located at Harwell Campus, Didcot (Oxford, UK).

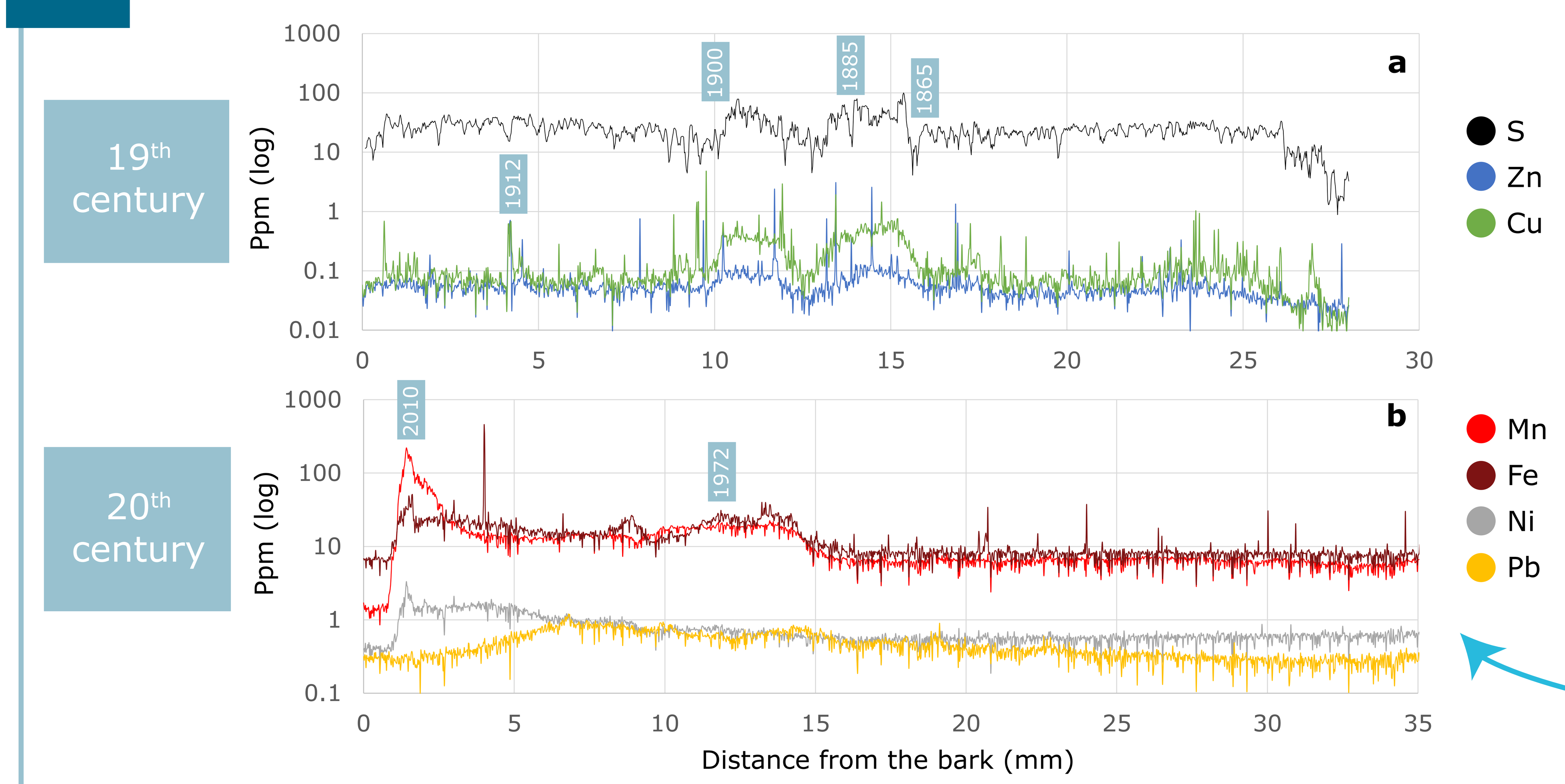
2 Research goals

- **Investigate major eruptions of the Middle ages combining elemental analysis with xylem anatomical features.**
- **Using the same method to highlight timing and intensity of anthropogenic pollution over the northern hemisphere.**

3 Materials and methods

- Synchrotron-light XRF was used to quantify and determine the distribution of the elements S, Zn, Cu, Ni, and Pb.
- The synchrotron analyses were carried out on timeseries of up to 150 years with a maximum replication of 5 samples.

4 Results



- We detected peaks of volatile elements (Zr, Cu, S, Pb) in tree rings in periods of repeated volcanic eruptions (1875-1886) with high volcanic explosivity indices (VEI 5-6).
- Results show a monotonic long-term increase of the elements Pb, Ni, Zn and Cu associated with a reduction of the tree-ring widths, possibly reflecting anthropogenic pollution (leaded gasoline)[4].
- Notably, the chemical contamination in the analysed wood decreases significantly in the first decade of the XXI Century, when Pb-rich fuels were substituted by unleaded gasoline[5].

FIG. 3: The diagrams show trace element contents (in parts per million) vs distance from the bark (mm) for the period 1840-1920 and 1930-2015, respectively. Significant tree ring years are shown and correspond to VEI 5 or 6 eruptions (a) or to changes related to anthropogenic pollution (b).

5 Conclusion

- **The brilliance of synchrotron light proved to be effective in analysing extremely low concentrations of elements at high spatial resolution.**
- **Such approach seems promising in detecting hidden effects of volcanic eruption or anthropogenic pollution when other tree-ring traits do not show any other peculiar feature.**

6 References

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[1]Dipartimento Territorio e Sistemi Agro-Forestali, Università di Padova, 35020 Legnaro, Italy.
[2]McGill University, Department of Earth and Planetary Sciences, 3450 University St., Montreal, Quebec, Canada.
[3]State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences Wuhan, No. 388 Lumo Road, Wuhan, China.
[4]Centre for Earth Evolution and Dynamics (CEED), University of Oslo, 0371 Oslo, Norway.
[5]Diamond Light Source, Harwell Science and Innovation Campus, Didcot, OX11 0DE, U.K