

Program and Abstracts

**“International Workshop of Isotope Dendroarchaeology”
on 14-15 March, 2026 at Lecture Hall in Graduate School of
Environmental Studies, Nagoya University, Japan**

On-Line (Zoom) Information

“Day 1” (14 March) 10:00-17:30 (Japanese Time)

<https://us06web.zoom.us/j/86513780364?pwd=giRbf0KSVA6NIcHtnofw4HG7r47K>

[SI.1](#)

Meeting ID: 865 1378 0364

Passcode: 272389

“Day 2” (15 March) 09:00-17:00 (Japanese Time)

<https://us06web.zoom.us/j/84859829813?pwd=YCEngF7Q2QIFj9OjQsuVhpbXH4>

[NaxA.1](#)

Meeting ID: 848 5982 9813

Passcode: 651564

On-Site Program

14 March, 2026 (Saturday)

09:30-10:00 (Japanese Time)

Registration at Lecture Hall of Graduate School of Environmental Study in Nagoya University (Higashiyama Campus)

10:00-10:15

NAKATSUKA, Takeshi (Nagoya University, Japan)

“Opening Remark”

[Overview of isotope dendroarchaeology]

Chair: Takeshi Nakatsuka

10:15-10:40 <Oral 1>

NAKATSUKA, Takeshi (Nagoya University, Japan)

“Development of isotope dendroarchaeology in Japan: Overview for last 15 years”

10:40-11:05 <Oral 2>

LOADER, Neil (Swansea University, UK) et al.

“An overview of oxygen isotope dendrochronology in Europe”

11:05-12:00

Short (5 min) Talks (in-person or video) for Poster Presentations

12:00-14:00

Lunch Break & Poster Session

[Establishments of multi-millennial oxygen isotope chronologies]

Chair: Neil Loader

14:00-14:25 <Oral 3>

SANO, Masaki (National Museum of Japanese History, Japan) et al.

“The potential and limitations of tree-ring oxygen isotope dating for the last 5000 years in Japan”

14:25-14:50 <Oral 4>

ZHAO, Yesi (Jiangsu Second Normal University, China) et al.

“A medieval tree-ring oxygen isotope chronology based on coffin timbers from central East China”

14:50-15:15 <Oral 5>

DOMINGUEZ-DELMAS, Marta (Cultural Heritage Agency, the Netherlands)

“Reconstructing post-medieval timber use and supply in the continental Euro-Atlantic region through $\delta^{18}\text{O}$ dendrochronology”

15:15-15:40 <Oral 6>

SEO, Jeong-Wook (Chungbuk National University, Korea) et al.

“An overview of tree-ring oxygen isotope chronologies established in Korea”

15:40-16:10

Coffee Break

16:10-16:35 <Oral 7>

DAVIES, Darren (Swansea University, UK) et al. (**On-line**)

“The challenges and potential of developing $\delta^{18}\text{O}$ oak reference chronologies in the UK for the last 5,000 years”

[Climate implication of the long isotope chronologies]

Chair: Takeshi Nakatsuka

16:35-17:00 <Oral 8>

YANG, Bao (Nanjing University, China) et al.

“Multiple tree-ring proxies suggest an intensification of the Asian monsoon at 4.2 ka”

17:00-17:25 <Oral 9>

LI, Qiang (Xi'an Jiaotong University, China) (**On-line**)

“Regional climatic controls on tree-ring $\delta^{18}\text{O}$ in Northeast China: Implications for extending isotope records using subfossil wood”

18:30-20:30

Workshop Dinner

15 March, 2026 (Sunday)

[Archaeological applications of isotope dendrochronology]

Chair: Masaki Sano

09:00-09:25 <Oral 10>

SHI, Jiangfeng (Nanjing University, China) et al.

“Tree-ring dating tombs using stable oxygen isotopes in the lower and middle reaches of the Yangtze River basin”

09:25-09:50 <Oral 11>

INOUE, Tomohiro (Osaka Center of Cultural Properties, Japan) et al.

“Prospects for Oxygen Isotope Ratio Dendrochronology in Japanese Archaeology: Case Studies of Archaeological Excavations in Osaka Prefecture”

09:50-10:15 <Oral 12>

SHO, Kenjiro (Nagoya Institute of Technology, Japan) et al.

“Dating of wooden piers of the medieval Yahagi Bridge, central Japan, using inter- and intra-annual tree-ring oxygen isotopes”

10:15-10:40 <Oral 13>

RODRIGUEZ-MORATA, Clara (Naturalis Biodiversity Center, The Netherlands) et al.

“PACHACUTI - Climate and conflict in the Eastern Pacific: exploring a possible catastrophic coastal El Niño event and its impact on ancient Peruvian societies (320-200 BCE) through an interdisciplinary approach”

10:40-11:10

Coffee Break

[Methodological developments in isotope dendrochronology]

Chair: Takeshi Nakatsuka

11:10-11:35 <Oral 14>

LOADER, Neil (Swansea University, UK) et al.

“Laser ablation oxygen isotope analysis in stable isotope dendrochronology: initial results and future applications”

11:35-12:00 <Oral 15>

KIMURA, Katsuhiko (Fukushima University, Japan)

“Various hardwood samples are required to extend tree-ring oxygen isotope chronology”

12:00-12:25 <Oral 16>

SAKAMOTO, Minoru et al. (National Museum of Japanese History, Japan) et al.

“Single-year radiocarbon dating of Japanese tree rings of the past three thousand years”

12:25-14:00

Lunch Break & Poster Session

14:00-15:30

General Discussion and Closing Remark

15:30-17:00

Laboratory Tour in Nagoya University

[Poster]

<Poster 1>

LOADER, Neil (Swansea University, UK) et al

“Stable isotope dendrochronology in Aotearoa New Zealand: developing an oxygen isotope reference chronology for Kauri (*Agathis australis* D.Don)”

<Poster 2>

HAKOZAKI, Masataka (National Museum of Japanese History, Japan) et al.

“Verification for the absolute age of Millennium Eruption at Mount Baitoushan”

<Poster 3>

LIN, Xin (National Museum of Japanese History, Japan) et al.

“Tree-ring dating and dendroprovenancing for woody remains from the Gazenbodani site in Minato Ward, Tokyo, Japan”

<Poster 4>

SHO, Kenjiro (Nagoya Institute of Technology, Japan) et al.

“Construction of intra-ring oxygen isotope chronologies in Japan”

<Poster 5>

KATO, Yoshikazu (Nagoya University, Japan) et al.

“Reconstructing the history of early-modern architecture using oxygen isotope ratio dendrochronology - The case of Shōeidō (Kōta Town, Aichi Pref., Japan)”

<Poster 6>

LI, Zhen (Nagoya University, Japan) et al.

“Dating the pillars from Yata remain, Ishikawa prefecture, Japan and exploring the influence of the climate change on the social transition of late Yayoi period”

<Poster 7>

WANWEY, Sakshi (Nagoya University, Japan) et al.

“Comprehensive tree-ring dating of wooden remains from the Atsuta B site, Nagoya: A comparison of ring-width and oxygen isotope dating”

<Poster 8>

DOMINGUEZ-DELMAS, Marta (Cultural Heritage Agency, the Netherlands) et al.

“Pioneering stable oxygen isotope dendrochronology in the Netherlands: the case study of Jerome’s church in Noordwijk”

<Poster 9>

KOLAR, Tomas (Mendel University, Czech Republic) et al.

“Potential of carbon and oxygen Isotope Master Chronologies for Dating Historical and Archaeological Oak in Central Europe”

<Poster 10>

MEIR, Lise (Ghent University, Belgium) et al.

“Reconstructing medieval hydroclimate in Flanders (Belgium) using oxygen isotopes in oak tree rings”

<Oral 1>

Development of isotope dendroarchaeology in Japan: Overview for last 15 years

Takeshi Nakatsuka¹ and all researchers on isotopic dendroarchaeology in Japan

1: Graduate School of Environmental Studies, Nagoya University, Japan

In 2010, the field of isotope dendroarchaeology did not exist in Japan. However, over the past 15 years, the dating archaeological materials using oxygen isotope ratios of tree-ring cellulose has spread throughout Japan, opening the door to a variety of new researches in archaeology and related fields. Behind this development are the unique characteristics of Japanese archaeology, dendrochronology, and isotope geochemistry, as follows: 1) Japanese archaeology has traditionally relied on precise relative chronologies based on pottery type, with intervals of approximately 10–100 years. However, in order to discuss relationships with foreign history and environment changes such as climate, it was necessary to assign calendar dates to pottery chronologies using dating methods with higher temporal resolution than radiocarbon dating. 2) Traditional dendrochronological methods based on tree-ring width can only be applied to long-aged conifers, which is less susceptible to ecological disturbances in warm and humid forests of Japan. Therefore, a method for determining the dendrochronological ages of small-diameter hardwoods, which account for the majority of wood excavated with pottery, was eagerly awaited. 3) In Japan, there are far more researchers in isotope geochemistry than in dendrochronology, and so from the beginning, research into isotope dendrochronology, which lies in the boundary area between the two, has seen technological innovations applicable to analyze large amounts of samples, making it possible to analyze a huge number of woods excavated from archaeological sites in Japan. In this talk, I will introduce the situation and history of this research field in Japan chronologically.

<Oral 2>

An overview of oxygen isotope dendrochronology in Europe.

N.J. Loader¹, R. Bale¹, C. Bronk Ramsey², D. Davies¹, M. Dominguez-Delmas³, K. Haneca⁴, D. McCarroll¹, D. Miles², C. Mills⁵

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The simultaneous development of stable isotope dendrochronology in Asia and Europe has already had a significant impact upon the dating of timber structures and wooden artefacts. Whilst the underpinning science is the same across regions, there are differences in the type of structures being dated and the problems which isotope dendrochronology is attempting to address. This talk will provide an overview of “typical” applications of isotope dendrochronology across Europe and consider potential areas for future development.

<Oral 3>

The potential and limitations of tree-ring oxygen isotope dating over the last 5000 years in Japan

Masaki Sano¹, Zhen Li², Masataka Hakozaiki¹, Yoshikazu Kato², Minoru Sakamoto¹, Takeshi Nakatsuka², Katsuhiko Kimura³

1: National Museum of Japanese History, Japan

2: Nagoya University, Japan

3: Fukushima University, Japan

Oxygen isotope dendrochronology has advanced rapidly in Japan over recent decades. Five millennial-scale $\delta^{18}\text{O}$ chronologies have been established, covering the past 5,120 years (3115 BCE to 2005 CE). Since the hydroclimate that controls tree-ring $\delta^{18}\text{O}$ differs between northern and southern Japan, spatially distributed chronologies are required to improve the accuracy of tree-ring dating. Currently, two of these chronologies are located in northern Japan, while three are in southern Japan. Our tree-ring dates were successfully verified by reproducing the rapid ^{14}C increases observed in 665–663 BCE and 774–775 CE, providing independent support for our dating. In this presentation, we will discuss the applications of isotope dendrochronology in Japan, focusing on degraded wooden samples, short ring sequences, and tree species with indistinct ring structures. We will also explore the potential and limitations of utilizing these reference chronologies to date wood samples excavated across Japan.

<Oral 4>

A medieval tree-ring oxygen isotope chronology based on coffin timbers from central East China

Yesi Zhao^{1,2}, Bao Yang², Takeshi Nakatsuka³, Zhen Li³, Pengyu Lin², Hongyan Zhang², Feng Wang⁴,
Huayu Lu²

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2. Frontiers of Critical Mineral Cycling Center, School of Geography and Ocean Sciences, Nanjing University, Nanjing 210023, China
3. Graduate School of Environmental Studies, Nagoya University, Nagoya 464-8601, Japan
4. School of Earth, Environment, and Sustainability, University of Iowa, Iowa City, IA, 52242, USA.

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The medieval period was characterized by significant global climate anomalies. However, tree-ring records covering this era remain scarce in the subtropical monsoon region of China. Here, we present a medieval tree-ring oxygen isotope ($\delta^{18}\text{O}$) chronology developed from coffin timbers in central East China. This chronology was constructed through a three-step process. First, we used radiocarbon dating to confirm the presence of medieval tree rings. Then, the $\delta^{18}\text{O}$ timeseries from individual timbers were cross-matched. Finally, the floating chronology was cross-dated against the absolutely dated $\delta^{18}\text{O}$ chronology in central Japan. The final chronology spans from 941 to 1388 CE, and its accuracy is further supported by the detection of the 993 CE radiocarbon event. Preliminary analysis indicates that the timbers likely originated from south-central China, based on a comparison between the oxygen isotope chronology and gridded drought/flood grades. A decline in $\delta^{18}\text{O}$ around the 11th century suggests a weakening of the summer monsoon during the Medieval Climate Anomaly, a period when monsoon conditions were traditionally considered strong. We also describe two technical improvements: an updated cellulose extraction device for radiocarbon analysis and a new software for missing-ring identification in oxygen isotope-based cross-matching.

Key words: Coffin timbers; Medieval Climate Anomaly; Central East China; Tree-ring oxygen isotope; Radiocarbon dating

<Oral 5>

Reconstructing post-medieval timber use and supply in the continental Euro-Atlantic region through $\delta^{18}\text{O}$ dendrochronology

Marta Domínguez-Delmás^{1,2*}

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In the continental Euro-Atlantic region (from northwest Spain to northwest Germany), approximately 70% of oak (*Quercus* sp.) timbers in historic buildings and archaeological sites dating from around 1300 to 1600 contain few tree rings or exhibit complacent growth (i.e., minimal year-to-year variation), making them undatable with conventional ring-width dendrochronology. As a result, knowledge gaps about domestic supply of timber persist, distorting perceptions about historical deforestation and building activities, and overemphasizing the role of timber trade in sustaining construction.

The WoodCulture project (2025–2029) funded by the European Research Council addresses this issue through the development of $\delta^{18}\text{O}$ reference chronologies along the continental Euro-Atlantic façade for the period 1300–1600 CE. Preliminary results from the Netherlands demonstrate that $\delta^{18}\text{O}$ can successfully date timbers with as few as 30 rings when reference isotope chronologies are available for the source area of the wood. Additionally, the first $\delta^{18}\text{O}$ chronology for northwest Germany exhibits strong correlations with $\delta^{18}\text{O}$ data recently produced in Belgium, though this correlation seems to decrease with distance (UK and French $\delta^{18}\text{O}$ chronologies) and continentality (Czech Republic $\delta^{18}\text{O}$ data). These findings demonstrate the great potential of $\delta^{18}\text{O}$ dendrochronology to date previously unstudied and undated timbers and highlights the need to expand reference chronologies across the continental Euro-Atlantic region.

<Oral 6>

An Overview of Tree-Ring Oxygen isotope Chronologies Established in Korea

Jeong-Wook SEO, En-Bi CHOI, Masaki SANO, Yun-Ji KIM, Takeshi NAKATSUKA

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National Museum of Japanese History, Sakura, Japan

Graduate School of Environmental Studies, Nagoya University, Nagoya, Japan

To construct a long ring-width chronology, it is essential to have old living trees as well as wooden structures, artifacts, or wood from different periods that can be cross-dated to extend the chronology. Furthermore, successful cross-dating of historical timbers generally requires at least 50 tree rings. However, in Korea, such wood is often difficult to obtain, which limits the ability to construct extended ring-width chronologies and to date archaeological wood. To overcome these limitations, we began developing tree-ring oxygen isotope chronologies in 2017. Because annual variations in oxygen isotope values reflect climatic variability, trees growing under similar environmental conditions exhibit highly similar patterns in their tree-ring oxygen isotopic chronologies.

Our research group is extending or dating tree-ring oxygen isotope chronologies in Korea using two main methods. The first is to build a tree-ring oxygen isotope chronology from living trees and then extend it by cross-dating with tree-ring oxygen isotope chronologies constructed from tree-ring samples collected from historic wooden structures. The second approach is to date calendar years to old timber in Korea, which cannot be dated using domestic tree-ring oxygen isotope chronologies, by cross-dating them with the long-term Japanese tree-ring oxygen isotope chronology. In this presentation, I will show the current status of the Korean tree-ring oxygen isotope chronologies developed through these two approaches.

<Oral 7>

The challenges and potential of developing $\delta^{18}\text{O}$ oak reference chronologies in the UK for the last 5,000 years

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In the United Kingdom (UK) stable oxygen isotope ($\delta^{18}\text{O}$) dendrochronology has revolutionised the science of dating timbers. Routinely, it is now possible to date with precision samples that traditionally would be considered impossible (i.e. short, and complacent series) that were felled within the second millennium of the Common Era. As part of the QUERCUS project, oak reference chronologies are now actively being developed for the UK beyond the Common Era and into pre-history to cover the last 5,000 years. However, several challenges (i.e. sample availability, wood degradation) have been encountered that have hindered progress, but early results also show great potential. This talk will provide an overview of the practical challenges faced and the significant progress that has already been made.

<Oral 8>

Multiple tree-ring proxies suggest an intensification of the Asian monsoon at 4.2 ka

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The 4.2 ka BP abrupt event was a widespread climatic shift occurring roughly between 4.2 and 3.9 ka BP, characterized by severe drought in many regions of the Northern Hemisphere. It particularly affected mid- and low-latitudes, including the Mediterranean, West Asia, and India. It was suggested that this event caused significant reductions in rainfall, disrupted monsoon systems, and led to the collapse or transformation of several ancient civilizations, including the Akkadian Empire, the Egyptian Old Kingdom, and the Indus Valley Civilization. Recent studies highlight regional variability, with some areas experiencing floods while others faced prolonged droughts. In China, divergent views have been put forward on the basis of different proxy records: some argue for drought, others for wetter conditions, and no consensus has been reached. The main reasons are the equivocal nature of the proxies employed and the chronological uncertainties. Here, using tree-ring samples collected in the Delingha area of Qinghai, we measured a suite of parameters including ring width and stable isotopes. Annually resolved chronologies were developed for each parameter, and their cross-comparison allowed us to reconstruct a high-resolution, detailed picture of climatic change during this interval.

<Oral 9>

Regional Climatic Controls on Tree-Ring $\delta^{18}\text{O}$ in Northeast China: Implications for Extending Isotope Records Using Subfossil Wood

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Northeast China contains an abundance of subfossil wood preserved in lakes, peatlands, and other sedimentary archives, providing exceptional potential for extending tree-ring oxygen isotope ($\delta^{18}\text{O}$) chronologies far beyond the limit of living-tree records. Such long-term, high-resolution isotopic sequences are essential for bridging dendroclimatology with archaeology, enabling reconstructions of past climate conditions that influenced ancient human activities, settlement dynamics, and cultural development in Northeast Asia. However, a fundamental prerequisite for exploiting these sedimentary wood resources is a clear understanding of the climatic and physiological mechanisms controlling $\delta^{18}\text{O}$ variation in modern trees across the region. In this study, we analyzed tree-ring $\delta^{18}\text{O}$ from eight groups of multiple tree species distributed across Northeast China to systematically examine isotope fractionation processes and spatial climate response patterns at the regional scale. Our results reveal that: (1) tree-ring $\delta^{18}\text{O}$ shows coherent interannual variability over distances up to 850 km, demonstrating a strong and regionally consistent climatic signal; (2) $\delta^{18}\text{O}$ values display a distinctive latitudinal “sandwich” pattern, with minima north of 50°N, aligning with large-scale $\delta^{18}\text{O}$ gradients observed across Asia; (3) temperature emerges as the dominant control of $\delta^{18}\text{O}$ at most sites, although several locations are more strongly influenced by atmospheric moisture, indicating spatial heterogeneity in fractionation mechanisms; and (4) $\delta^{18}\text{O}$ exhibits strong spatial correspondence with CRU gridded climate data, confirming its reliability as a regional climate proxy. By establishing the mechanistic foundation and spatial behavior of tree-ring $\delta^{18}\text{O}$ in Northeast China, this study provides essential baseline knowledge for future archaeological and paleoenvironmental research. The results lay the groundwork for incorporating subfossil and sedimentary woods into extended $\delta^{18}\text{O}$ chronologies, ultimately enabling long-term reconstructions of climatic variability relevant to understanding past human–environment interactions in Northeast Asia.

Keywords Tree-ring oxygen isotope, Sandwich pattern, Temperature effect, Amount effect, Northeast China

<Oral 10>

Tree-ring dating tombs using stable oxygen isotopes in the lower and middle reaches of the Yangtze River basin

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A 670-year-long tree-ring stable oxygen isotope chronology was built in the lower reaches of the Yangtze River (YR). Its exact calendar date was determined to be from 671 BCE to 2 BCE by both comparing with a central Japan tree-ring oxygen isotope chronology spanning the past 2827 years which has fixed dates, and radiocarbon wiggle matching. The chronology built a foundation to cross-date archaeological woods in the YR basin where there are abundant tombs with wooden chambers.

Firstly, it was used to date the construction of the Yinshan tomb, the first excavated royal mausoleum of the Yue State, in the lower reaches of the YR. The outmost ring of our samples was formed in 490 BCE, the 7th year of the reign of King Goujian of Yue, meaning that the completion of the tomb construction was after 490. The dating ruled out the possibility of Yunchang, the first king of Yue and the father of Goujian, as the tomb owner because he died in 497 BCE.

Secondly, it was also used to date the tomb of Zeng Houyi in the middle reaches of the YR. The outmost ring of our samples was formed in 435 BCE, extremely close to the inscription “In the fifty-sixth year of the king’s reign” (that is, 433 BCE) on the *Bo* Bell presented by King Hui of Chu to Zeng Houyi, providing strong evidence for the reliability of the dendroarchaeological dating.

Generally, precise dendroarchaeological dating in the middle and lower reaches of the YR basin provides a great help to archaeologists in terms of time framework of archaeological sites.

<Oral 11>

Prospects for Oxygen Isotope Ratio Dendrochronology in Japanese Archaeology: Case Studies of Archaeological Excavations in Osaka Prefecture

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Abstract: The chronological framework of Japanese archaeology is based on relative dating using pottery chronologies. Oxygen isotope ratio dendrochronology is effective for assigning calendar dates to this chronological framework. Furthermore, by reconstructing the formation process of archaeological sites using geoarchaeological methods and assigning dates to these processes, it is also possible to reconstruct past human activities on a detailed temporal scale. This presentation introduces findings from the analysis of a water control structure discovered in the channel (5th century) of the Miyakenishi Site in Osaka Prefecture. At this site, we attempted to reconstruct the formation process of the water control structure through stratigraphic analysis and oxygen isotope ratio dendrochronology of the timber piles.

<Oral 12>

Dating of wooden piers of the medieval Yahagi Bridge, central Japan, using inter- and intra-annual tree-ring oxygen isotopes

Kenjiro Sho¹, Shota Yumiba¹, Youichi Miyagawa², Zhen Li³, Takeshi Nakatsuka³

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2. Nishi-Mikawa Construction Office, Aichi Prefecture, Okazaki 444-8551, Japan
3. Graduate School of Environmental Studies, Nagoya University, Nagoya 464-8601, Japan

This study attempted to estimate the felling dates of four cypress wood piles, believed to be the remains of bridge piers buried in the right-bank riverbed of the Yahagi River in Yahagi-cho, Okazaki City, Aichi Prefecture, Japan. Yahagi Bridge is known as the longest bridge in Japan during the Edo period (1603–1868 CE) and believed to have been first constructed around 1601 CE (Keichō 6) according to historical documents and maps. However, some descriptions in chronicles or tales such as “Taiheiki” and “Heike Monogatari” suggest a bridge existed in the medieval period before the 16th century. Our tree ring oxygen isotope dating revealed that three of the four piles were felled in the late Heian to Kamakura periods (late 12th to early 14th centuries). By comparing the intra-ring variations in oxygen isotope ratios, it was found that the fourth pile was approximately 100 years earlier than the other three. These findings suggest that the medieval Yahagi Bridge, previously known only through tales and folklore, actually existed for at least a period around the 12th to 13th centuries.

<Oral 13>

PACHACUTI - Climate and conflict in the Eastern Pacific: exploring a possible catastrophic coastal El Niño event and its impact on ancient Peruvian societies (320-200 BCE) through an interdisciplinary approach.

¹Rodríguez-Morata Clara, ^{2,3,4}Ghezzi Iván, ⁴Rodríguez-Arismendiz Rodolfo, ^{1,5}Domínguez-Delmás Marta

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Abstract:

Coastal El Niño (CEN) events have affected the northern half of Peru's coast for millennia bringing warm climate conditions that lead to heavy rainfall and floods. In the central Peruvian desert of Casma, the presence of numerous fortified settlements dating from around 320-200 BCE suggests that their construction occurred during a period of warfare and regional instability. However, the reasons behind this instability remain unclear. Well-preserved wooden lintels in Chankillo's structures, the larger of these fortresses, provide an opportunity to study the environmental past. A preliminary tree-ring width study revealed an anomalous wide ring in timbers from the lintels just before Chankillo's construction, which could be the result of a CEN-induced catastrophic episode of heavy rainfall. This extreme CEN may have sparked instability and warfare, shaping central Peruvian history around 2,300 years ago. PACHACUTI aims to determine whether a CEN event took place around 320-200 BCE, before Chankillo's construction, by combining dendroarchaeology, annually-resolved stable oxygen isotope analysis and radiocarbon wiggle-matching. Chankillo's architectural timbers will be used to develop an $\delta^{18}\text{O}$ annual chronology capturing hydroclimate variability over the 120 years before Chankillo's construction. This novel record is expected to reflect the occurrence and frequency of past CEN events during this period.

<Oral 14>

Laser ablation oxygen isotope analysis in stable isotope dendrochronology: initial results and future applications.

N.J. Loader¹, D. Davies¹, D. McCarroll¹, E. Sahlstedt², G. Boswijk³, D. Miles⁴, C. Bronk Ramsey⁴.

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A significant challenge facing stable isotope dendrochronologists is sample preparation. Often samples laths or cores need to be prepared which may preclude the sampling of works of art and cultural artefacts. This paper presents results obtained using a recently developed technique for analysis of stable oxygen isotopes in wood by UV laser ablation*. Whilst there is a need to explore the strength and stability of the dating signal in wood relative to that of alpha-cellulose, initial results are encouraging and highlight the potential of the technique for dating narrow-ringed series. Tests also identify however, limitations in this technology relating to sample preservation and sample handling that will require further investigation.

*Sahlstedt *et al.* (2025) DOI:10.1021/acs.analchem.4c06896

<Oral 15>

Various hardwood samples are required to extend tree-ring oxygen isotope chronology

Katsuhiko Kimura

Fukushima University, Japan

Long ring width chronologies in Japan have been constructed almost exclusively by warm temperate conifers, *Cryptomeria* and *Chamaecyparis*. Even after the development of oxygen isotope chronology, which is applicable for various tree species including hardwoods, current isotope master chronology is still composed of these two conifer species. As these conifer samples are limited, hardwood samples are important for extending and strengthen oxygen isotope chronology. However, hardwood samples have several drawbacks such as unclear tree rings especially for diffused porous woods, vulnerability at cellulose extraction, and poor preservability in long-term storage. Several methods of hardwood treatment will be shown.

<Oral 16>

Single-year radiocarbon dating of Japanese tree rings of the past three thousand years.

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To determine the age using radiocarbon dating, it is necessary to compare the radiocarbon ages of materials with a calibration curve that consolidates known-age data. 'IntCal' is a calibration curve used in the Northern Hemisphere terrestrial regions, and the current IntCal20 has, for the first time, incorporated radiocarbon data from Japanese tree rings. Currently, work is underway to revise the next version of IntCal. Data from Japanese tree rings accumulated over the past 3,000 years will also be provided.

<Poster 1>

Stable isotope dendrochronology in Aotearoa New Zealand: developing an oxygen isotope reference chronology for Kauri (*Agathis australis* D.Don).

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The tree-ring dating of historic buildings and wooden artefacts in Aotearoa New Zealand is challenging. Climate-growth relationships are often variable and complex wood anatomies can preclude secure cross-dating and ring identification in many native species. Even where reliable tree-ring chronologies have been developed, these may not represent the species most commonly found in the cultural/archaeological record.

This paper describes the development of a stable isotope reference chronology for Kauri (*Agathis australis* D.Don) and presents a preliminary assessment of the technique for precision dating in Aotearoa New Zealand.

<Poster 2>

Verification for the absolute age of Millennium Eruption at Mount Baitoushan

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The Millennium Eruption refers to the volcanic eruption that occurred in 946 AD at Mount Baitoushan, located on the border between China and North Korea. This eruption is estimated to have a Volcanic Explosivity Index (VEI) of 7 and is considered to have been the largest eruption worldwide in the past 2000 years. The absolute age of this eruption remained unknown for a long time. Using “Carbon-14 spike matching” with the 775 Miyake event as a chronological marker, the year of death for a tree engulfed by pyroclastic flows was identified as 946 AD. Applying Oxygen isotopic dendrochronology to the same tree and cross-dating them against Japan's master chronology also pinpointed their death year as 946. The results were reproduced using two different methods, confirming the occurrence date of the Millennium Eruption.

<Poster 3>

Tree-ring dating and dendroprovenancing for woody remains from the Gazenbodani site in Minato Ward, Tokyo

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Edo, that an early-modern metropolis was sustained by a sophisticated logistics network. Edo received vast quantities of timber from various regions. The primary timber sources changed over time. Large-scale timber sources in central and northern Japan gradually depleted, leading Edo to begin repurposing wood. Timber from areas surrounding Edo also came into use. This study examines the age and origin of timbers excavated from the Gazenbodani Site in Minato Ward, Tokyo, by Oxygen isotopic dendrochronology.

<Poster 4>

Construction of intra-ring oxygen isotope chronologies in Japan

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The oxygen isotope ratio of tree-ring cellulose is a useful tool for estimating relative humidity (precipitation) at the time of ring formation. We found that the temporal resolution of the estimation can be improved down to the monthly level by measuring the variation of oxygen isotopes within rings, and continue to build intra-ring oxygen isotope chronologies by dividing each ring into six (or sometimes twelve) segments using long-living trees with continuously broad annual rings. Currently, we obtain Shiga cypress (1704–1993 CE), Amami pine (1788–2013 CE), Tono cedar (1609–2020 CE) and Tsugaru cypress (1796–2001 CE) chronologies covering northern to southern parts of Japan. These are used to reconstruct the local history of climate disasters such as droughts and long rains. Also, we found that some of these exhibit strong correlations with ocean-atmosphere climate indices such as the PDO.

<Poster 5>

Reconstructing the history of early-modern architecture using oxygen isotope ratio dendrochronology - The case of Shōeidō (Kōta Town, Aichi Pref., Japan)

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Recent advances in oxygen isotope ratio ($\delta^{18}\text{O}$) dendrochronology have made it possible to determine the age of early modern buildings using wooden materials.

Shōeidō (Kōta Town, Aichi Pref.) is the early-modern mausoleum-style tomb of Tadatoshi (1582–1632), the fifth head of the Fukouzu Matsudaira clan who governed this region. We conducted $\delta^{18}\text{O}$ dating analyses for building materials obtained during Shōeidō's 2022 renovation and preservation works, with the cooperation of the Kōta Town Board of Education. As the results, most samples indicated ages ranging from several years to several decades prior to the construction year (1633), yielding valid results. These findings will provide crucial information for future studies examining the construction process of Shōeidō.

<Poster 6>

Dating the pillars from Yata remain, Ishikawa prefecture, Japan and exploring the influence of the climate change on the social transition of late Yayoi period

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Six pillars in a prehistoric building in Yata remain, Ishikawa prefecture, Japan, were precisely dated using the 2600 year-long tree-ring $\delta^{18}\text{O}$ master chronology. The building was previously thought to have been constructed in the first half of 2nd century CE (i.e., the late Yayoi Period). Tree-ring $\delta^{18}\text{O}$ and $\delta^2\text{H}$ data of these *Cryptomeria japonica* and *Styrax japonicus* trees show that negligible influenced by physiological effects and the tree-ring $\delta^{18}\text{O}$ chronology can reveal the climate variations. It appears that a significant humidification of the summer climate (long-term decrease in oxygen isotope ratios) occurred, by the end of the middle Yayoi period in the first half of the 1st century BCE. At the same time the movement of human settlements to the highlands occurred.

<Poster 7>

Comprehensive tree-ring dating of wooden remains from the Atsuta B site, Nagoya: A Comparison of ring-width and oxygen isotope dating

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In dendroarchaeology, oxygen isotope ratios ($\delta^{18}\text{O}$) of tree ring cellulose have emerged as a highly reliable proxy. The ($\delta^{18}\text{O}/\delta^{16}\text{O}$) ratio is considered a novel approach in chronological studies for accurate dating, even for the short ring sequences (<50 rings) with a high degree of statistical confidence. In this study, first, we conducted $\delta^{18}\text{O}$ analysis on 64 cypress artefacts (>4500 rings) excavated from the Atsuta B site, located between Atsuta Shrine and the port of Miyanowatashi along the Tokai-do route of Nagoya city, Japan. These wooden remains were precisely dated using 2600 year long tree ring $\delta^{18}\text{O}$ chronology. In parallel, traditional ring-width-based dating is also one of the reliable methods for determining the calendar years, by matching the variation patterns in annual ring widths were applied in this study. We measured the ring-widths of the samples and, after arranging them according to the calendar dates derived by $\delta^{18}\text{O}$ analysis, we compared the tree growth patterns and sliding correlations with the reference 2000-year ring-width chronology. Comparison between two proxies shows that 23 samples were accurately dated, consistent with $\delta^{18}\text{O}$ analysis, and the remaining 41 samples showed discrepancies in ring-width dating. Growth pattern comparisons and sliding correlation analyses further reveal inconsistent matching trends and variable correlations among samples. These findings suggest that ring-width dating alone may be unreliable for certain archaeological sequences and that greater robustness of $\delta^{18}\text{O}$ dating, emphasizing the application of integrating both methods for overall dating reliability.

<Poster 8>

Pioneering stable oxygen isotope dendrochronology in the Netherlands: the case study of Jerome's church in Noordwijk

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Jerom's Church in Noordwijk, located on the western coast of the Netherlands, is one of the best-preserved late medieval village churches in the region and is exceptional in scale relative to the size of the village. Although its origins date back to the late 10th century, the earliest surviving masonry likely dates to around 1260 CE, with a major expansion into a large three-aisled pseudo-basilica occurring between the late 14th and 15th centuries. Part of the church caught fire in 1450 CE, but the history of construction and repairs following the fire is unclear. In 2021, dendrochronological research was commissioned to understand the construction sequence of the church in relation to the fire, focusing on timber elements from multiple roof structures across the monument. While dendrochronological dates of some timbers, coupled with assembly marks through most of the roof structures, reveal consistency of the building sequence in and after 1450, with some timbers being recycled from the previous structure, three undated timbers that had few tree rings for conventional dendrochronology were analysed by isotope dendrochronology. Using two of the dated timbers to produce an $\delta^{18}\text{O}$ isotopic reference, the $\delta^{18}\text{O}$ series of the three undated ones could be dated, demonstrating that $\delta^{18}\text{O}$ can successfully date timbers with as few as 30 rings when a reference for the source area of the wood has been developed.

<Poster 9>

Potential of carbon and oxygen Isotope Master Chronologies for Dating Historical and Archaeological Oak in Central Europe

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Across Europe, dendrochronology is an established and reliable dating technique that is routinely used to date timbers in historical buildings and wooden artefacts unearthed during archaeological excavations. Although ring-width dendrochronology has proven extremely useful, it has several limitations, which mean that the technique is not always able to return a 'robust' date (e.g. minimum number of tree rings, fast or unconstrained growth, abrupt changes in ring widths). It has long been recognised that the stable (carbon and oxygen) isotope ratios of tree rings generally exhibit much stronger correlations between trees than is the case with ring widths and that this might allow stable isotopes to be used for cross-dating, in a similar way to ring-width-based dendrochronology. Here, we test potential of oak stable isotope master chronologies for dating of historical timber constructions and archaeological wood. We have developed $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ isotope master chronologies from oak tree rings sampled in the Czech Republic and Germany. The reference master chronologies replicated by at least six samples ranges from 6000 BC to the present. We randomly selected three dendrochronologically dated samples from medieval oak relicts and tried them date according the new references using ISODATE 2.0.2 software. All three samples were dated using $\delta^{18}\text{O}$ isotopic chronology to the same year as using ring-width-based dendrochronology, even though one of them did not show sufficient statistical values and was classified as erroneous by the software. Using $\delta^{13}\text{C}$ isotopic master chronology, two of the three samples were dated correctly and one incorrectly. Our results indicate the potential of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ isotopic chronologies for accurate dating of historical and archaeological wood samples in Central Europe.

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<Poster 10>

Reconstructing medieval hydroclimate in Flanders (Belgium) using oxygen isotopes in oak tree rings.

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In the Late Middle Ages, Flanders (Northern Belgium) was one of the most densely populated and economically dynamic regions in Europe. This historical prosperity is reflected today in a remarkable abundance of medieval timber structures. While many of these historical oak timbers have been precisely dated through conventional ring-width dendrochronology, their potential as annually resolved oxygen isotope archives remains largely unexplored. Our ongoing project uses these precisely dated historical timbers to reconstruct past summer hydroclimate variability by analysing oxygen isotope ratios ($\delta^{18}\text{O}$) from oak tree-ring cellulose.

First, to establish a robust interpretative framework, a modern calibration was developed based on living *Quercus robur* sampled along a 350 km west-east transect, stretching from the North Sea coast to southwestern Germany. The resulting $\delta^{18}\text{O}$ series show strong coherence between individual trees and sites ($\bar{r} = 0.47$) and significant correlations with summer (July-August) hydroclimatic conditions (e.g., precipitation: $r = -0.52$, vapour pressure deficit: $r = 0.70$, relative humidity: $r = -0.70$), confirming that oak $\delta^{18}\text{O}$ reliably records hydroclimatic variability.

Building upon this calibration, a regional $\delta^{18}\text{O}$ master chronology is currently being developed from dendrochronologically dated historical timbers, covering the period from 1100 CE onwards. Preliminary results from $\delta^{18}\text{O}$ series for the 14th and 15th centuries already reveal coherent interannual patterns and provide a high-resolution dataset for assessing regional hydroclimate variability. This reconstruction will allow for systematic comparison with historically documented climate events and weather-related societal impacts recorded in historical sources, providing a detailed perspective on the hydroclimatic history of Flanders. Furthermore, this well-replicated chronology will contribute to the expanding international network of tree-ring $\delta^{18}\text{O}$ records, supporting multi-laboratory efforts to reconstruct high-resolution, spatial hydroclimatic patterns across Europe.