LABORATOIRE INTERDISCIPLINAIRE DES ENVIRONNEMENTS CONTINENTAUX

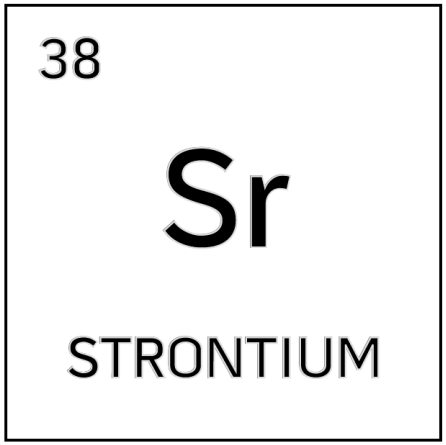
UNIVERSITÉ DE LORRAINE

Fadi HAJJ

Geochemical fingerprinting of the geographical origin of wood from shipwrecks

ForSEAdiscovery

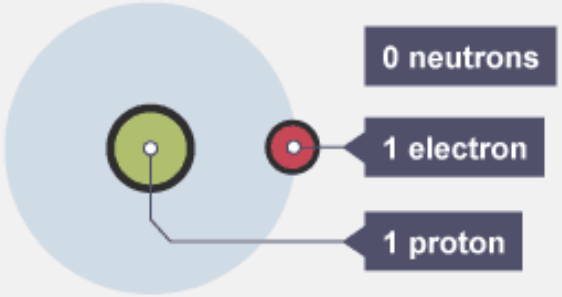
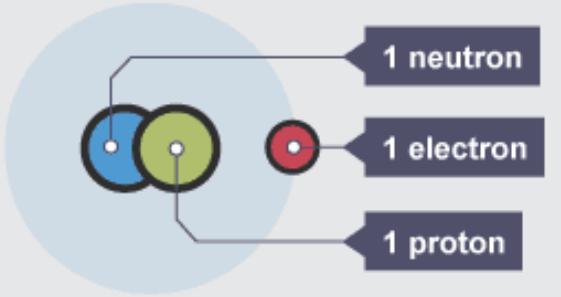
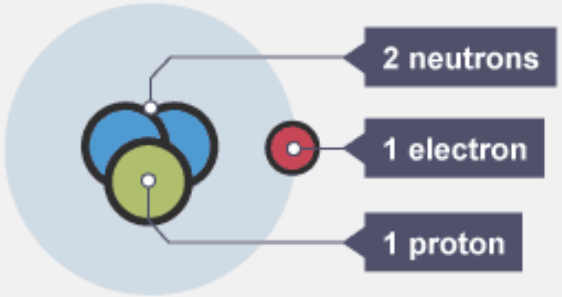
Main approach



To trace the wood provenance: Use a well known tracer in geology, strontium (Sr) isotopic ratios

Sr: an element analogous to calcium (Ca).

What is an isotope?

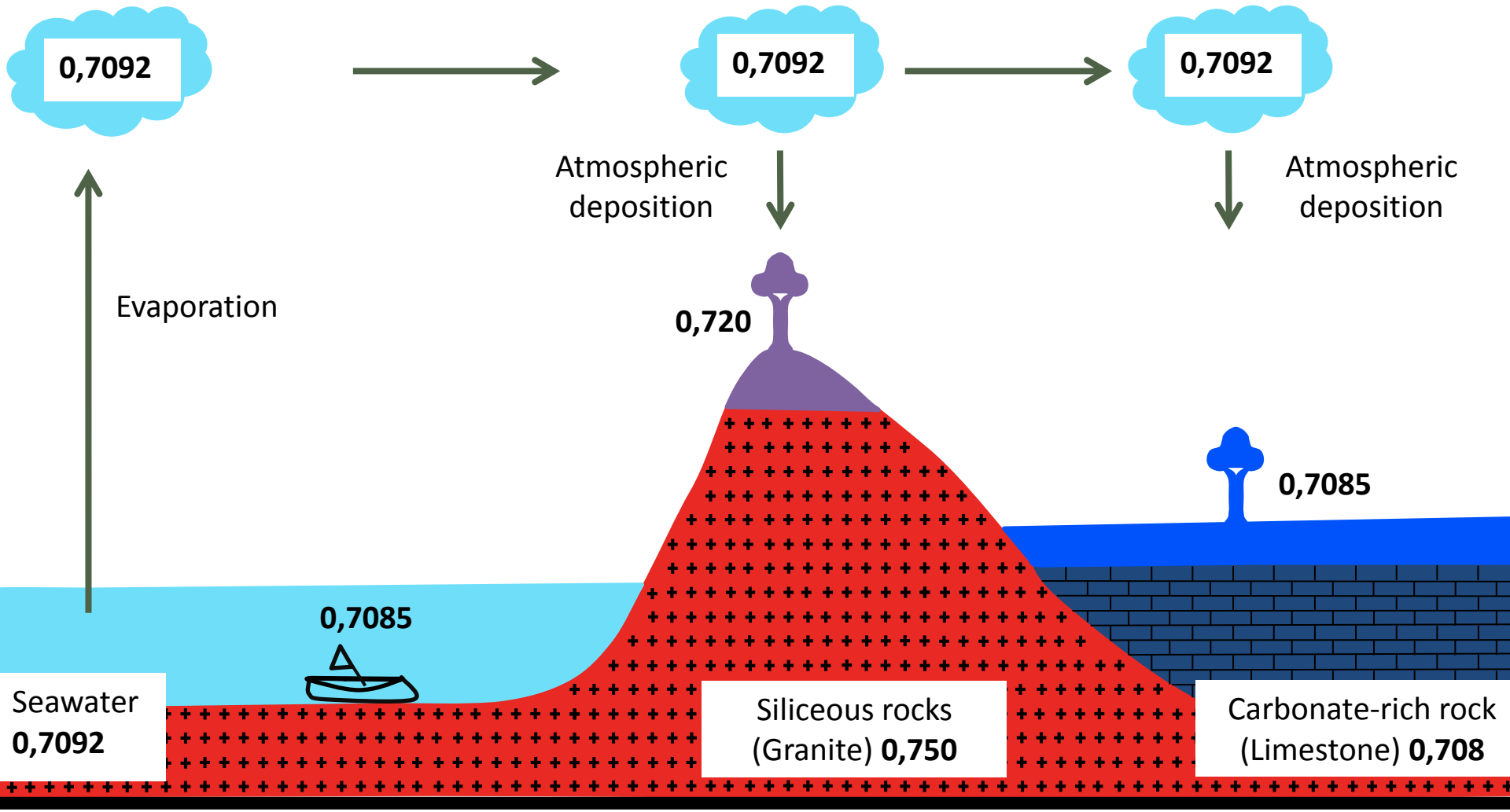
Isotope	Atomic structure	Symbol
Hydrogen-1		$^{1}_{1}H$
Hydrogen-2		$^{2}_{1}H$
Hydrogen-3		$^{3}_{1}H$

Strontium isotopes

- stable isotopes used:
  - ^{86}Sr (9.86%)
  - ^{87}Sr (7.02%)

$^{87}Sr/^{86}Sr$ in rocks is variable with
- the type of rocks
- the age of rocks

Variation of $^{87}Sr/^{86}Sr$ ratios between different sites



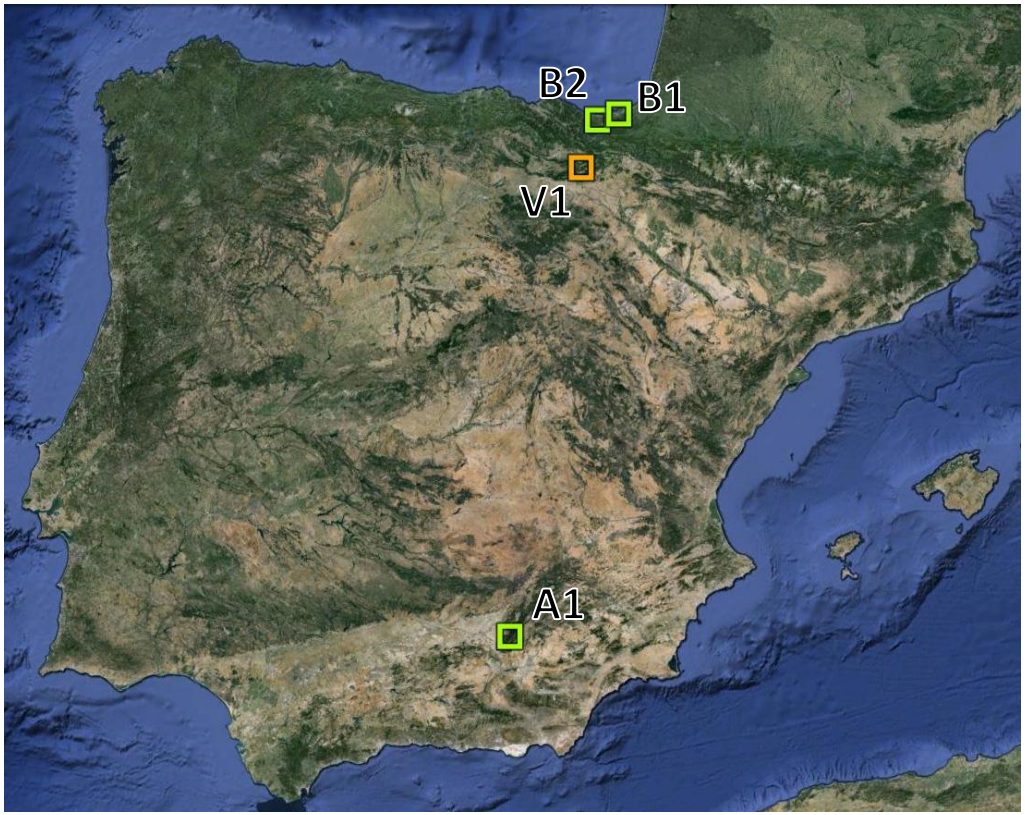
Main results

1. Are the signatures of modern trees site specific?

Sampled sites

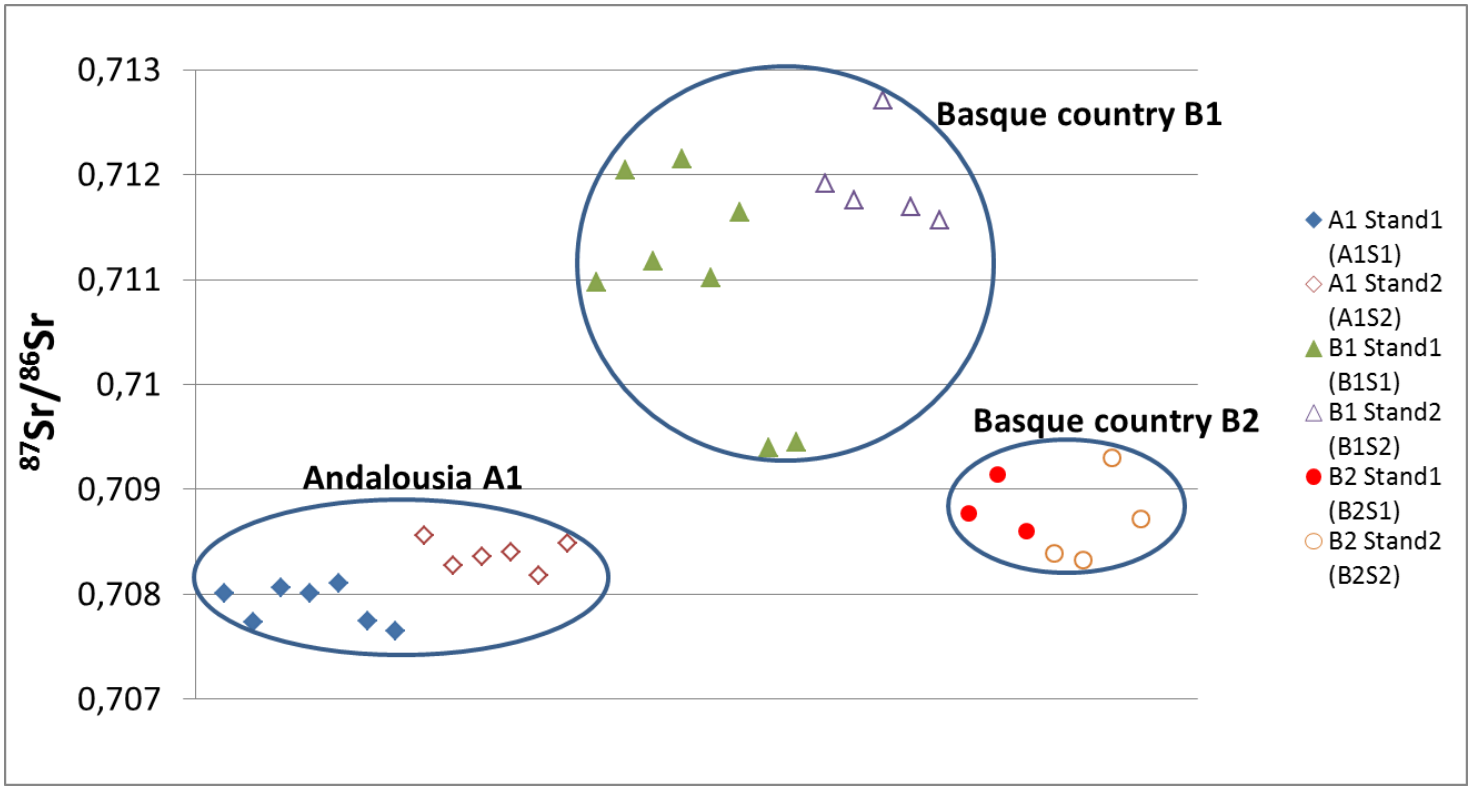
Four sampled sites
Three analyzed sites

Different species
Different rock types



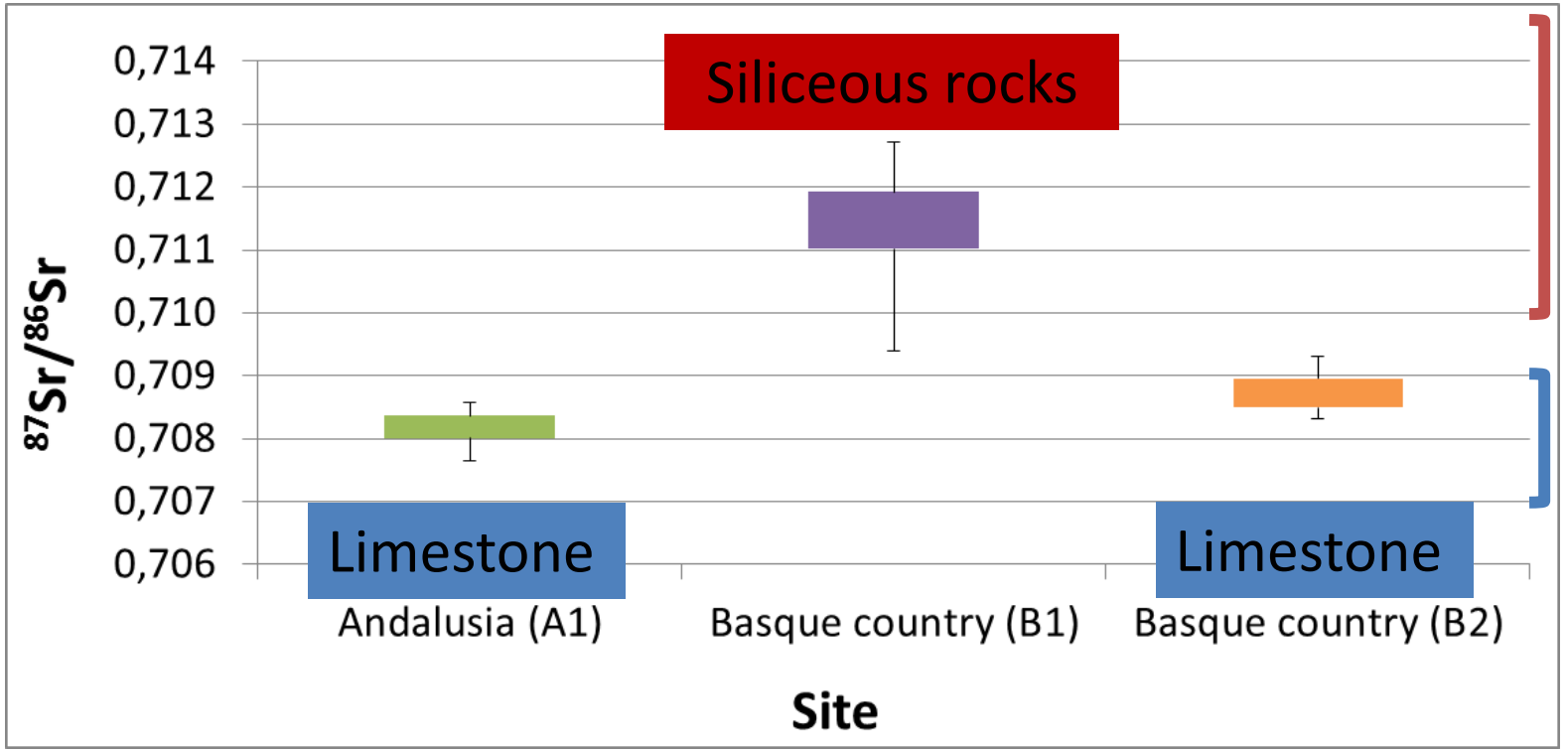
Sites	Andalusia (A1)	Basque country (B1)	Basque country (B2)
Sampled Species	*Pinus nigra*	*Quercus robur*	*Quercus robur*
Rock Types	Limestone	Granite / Sandstone / Limestone / Silts	Limestone

Isotopic signature measured in living trees from sampling sites



Very small $^{87}Sr/^{86}Sr$ ratios variations within each stand of the studied sites, except for B1S1 (green triangles)

Box plots of the modern trees isotopic signature



Box plots represent 50% of the values.

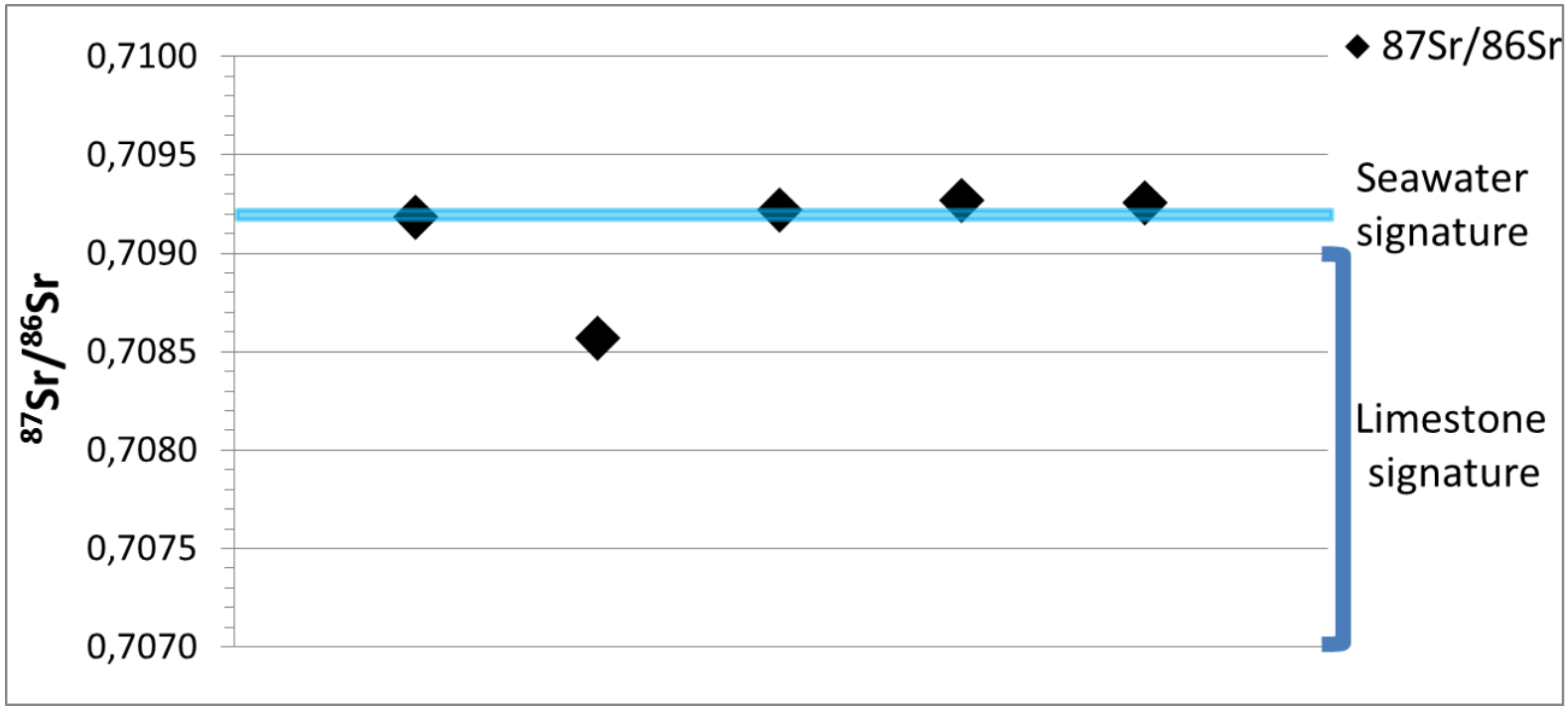
Whiskers represent 100% of the values.

Specific signature for each site → linked to rock type

Main results

2. What is the original isotopic signature of wood from the Ribadeo shipwreck?

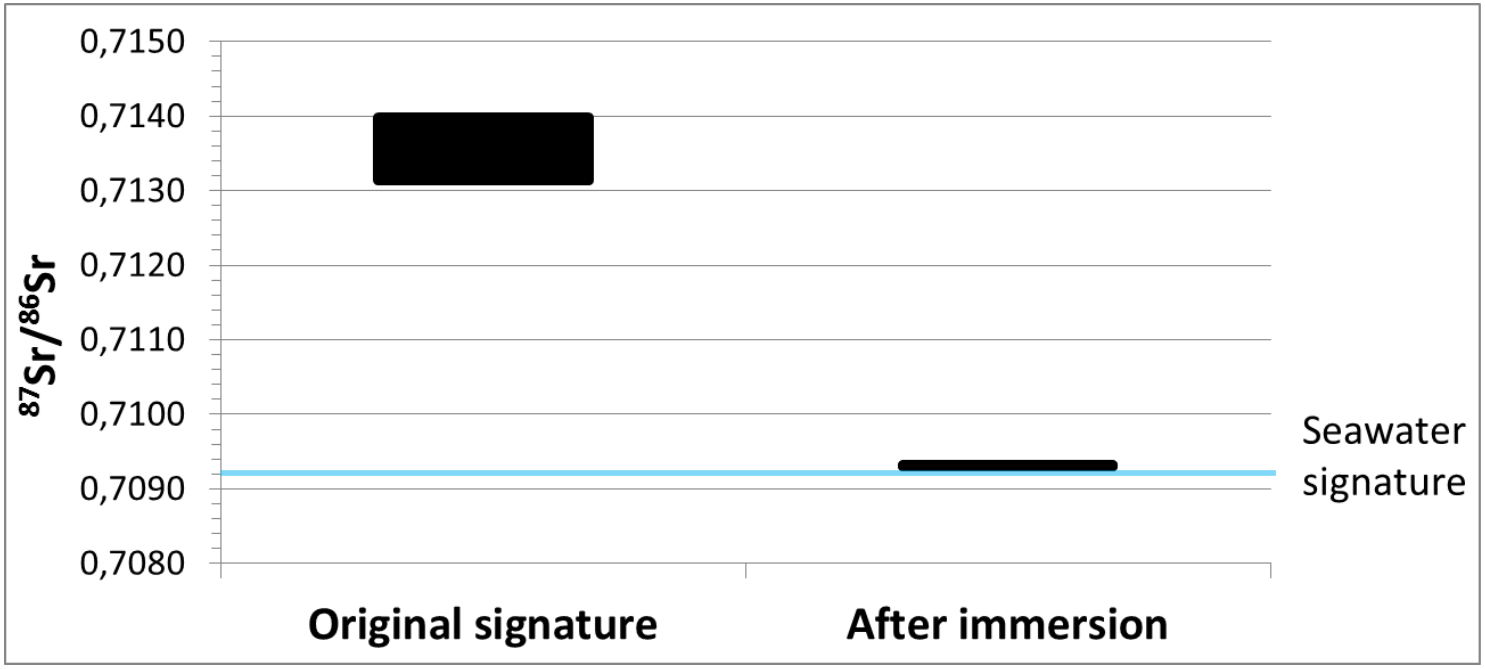
First analyses of wood from Ribadeo shipwreck



Do these wood signatures reflect sea water or limestone signature?

Is it a result of marine contamination?

Comparison of wood isotopic signature before and after immersion in seawater

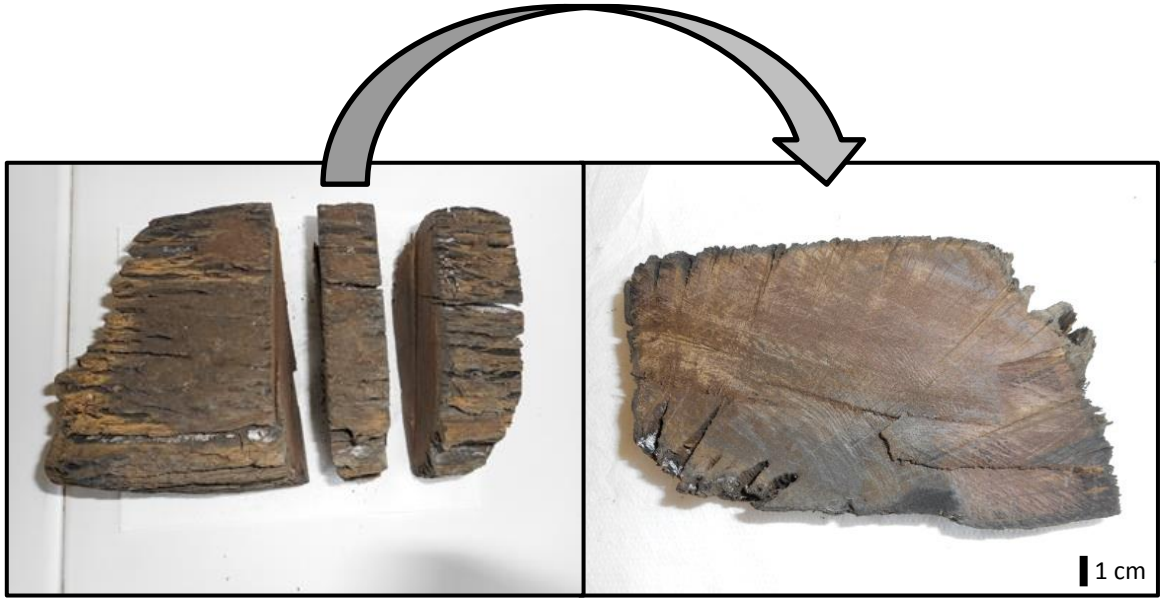


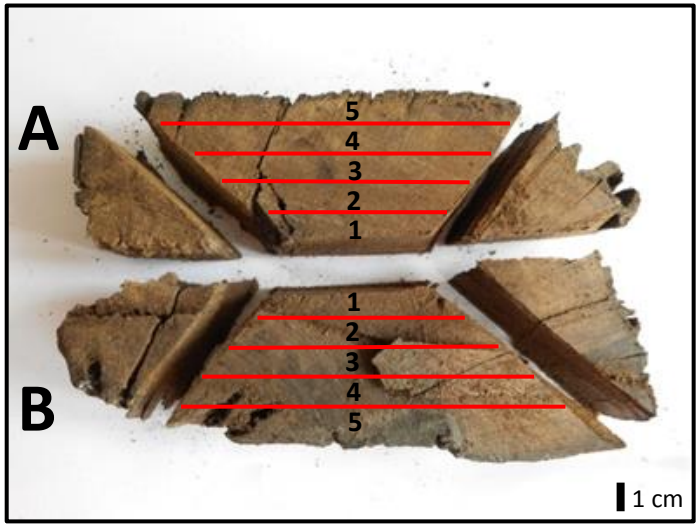
	Initial wood	After the immersion in sea water
Sr concentration (ppb)	300	3000
Isotopic ratio $^{87}Sr/^{86}Sr$	>0.7130	±0.7093

≈ seawater signature (0,7092)

So…. Marine contamination proved

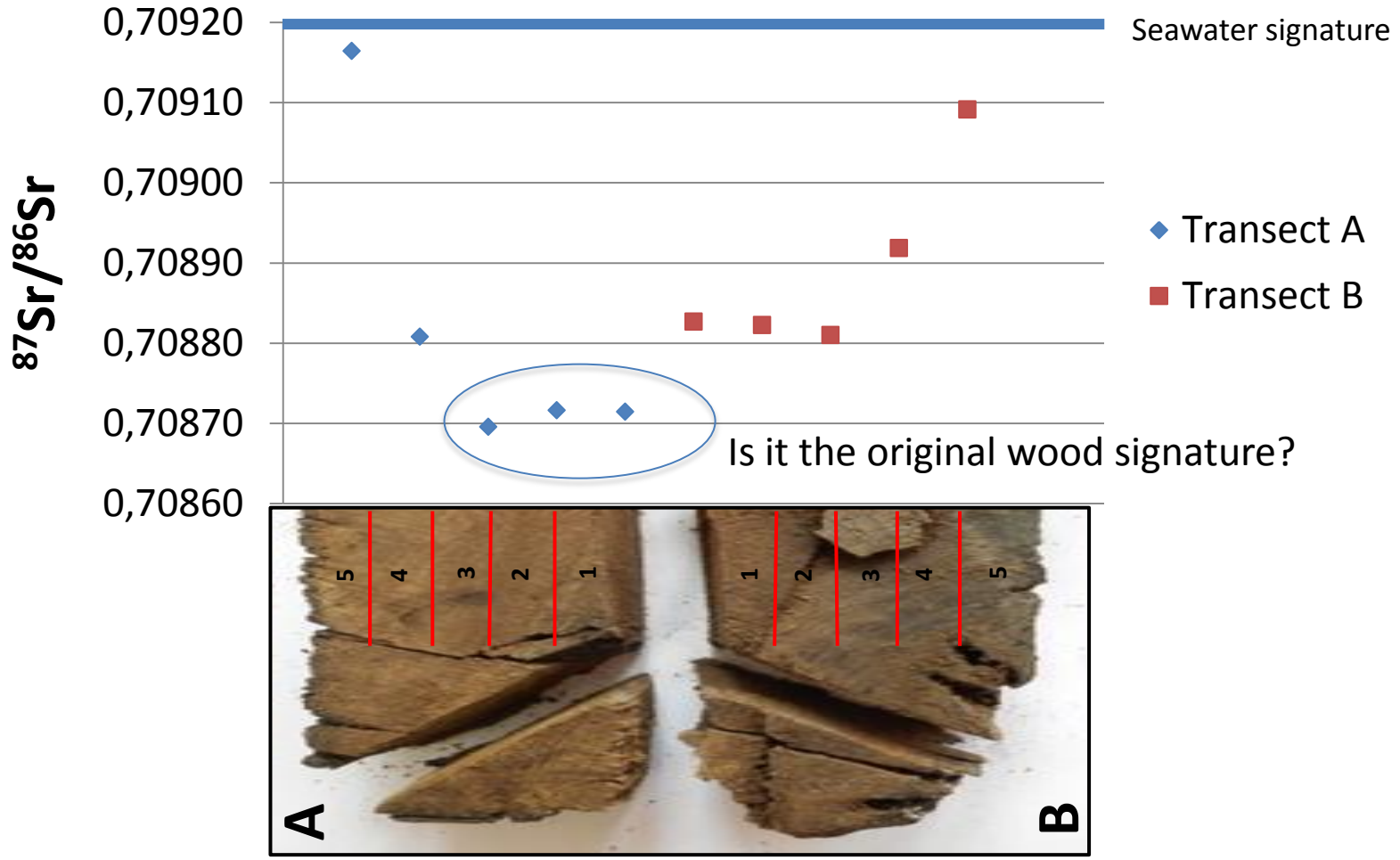
Could the marine contamination be only on the surface of the samples?





Separation of archeological wood from surface to center of the sample

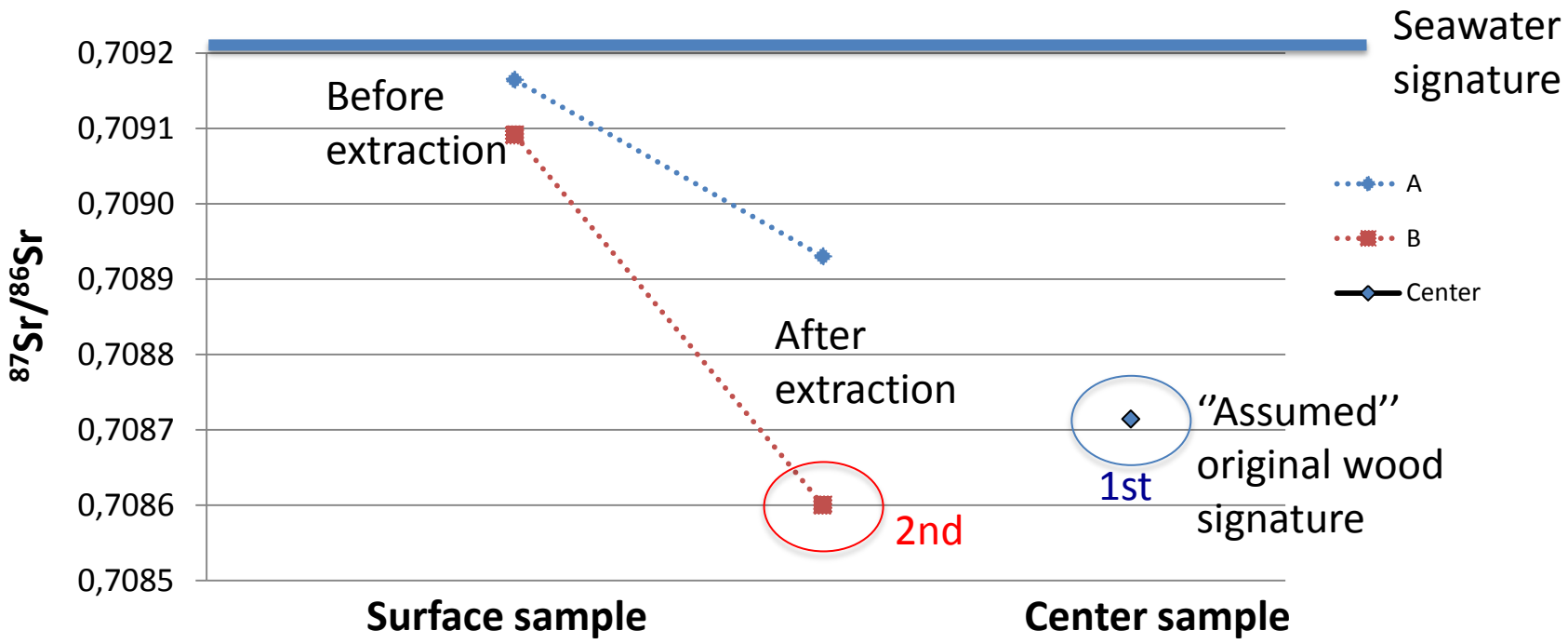
Isotopic signature measured in wood from surface to center of the sample



Surface of the sample is more contaminated by sea water than the center of the sample

Could we “wash” the wood samples?

Isotopic signature of surface wood sample after extraction



- Wood isotopic signature is modified after extraction

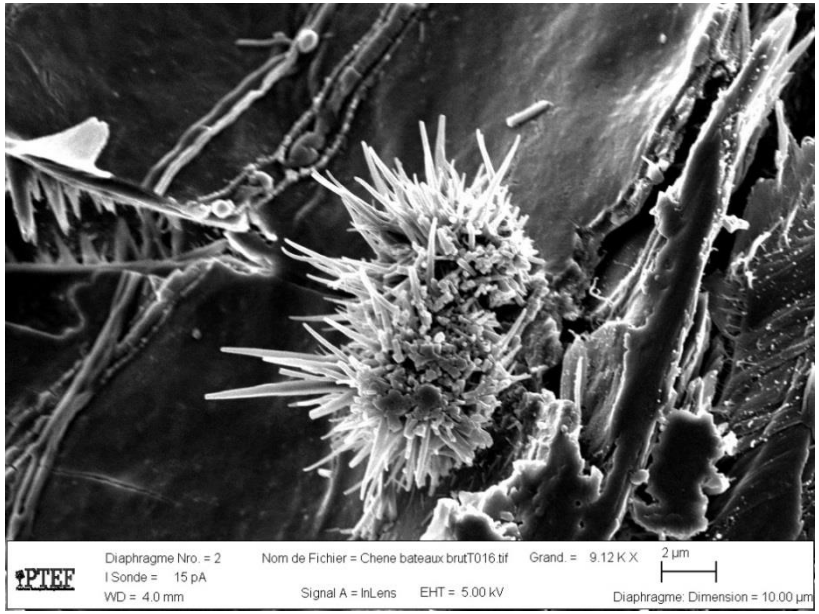
- “new” isotopic signature of wood closer to that measured in the center of the sample

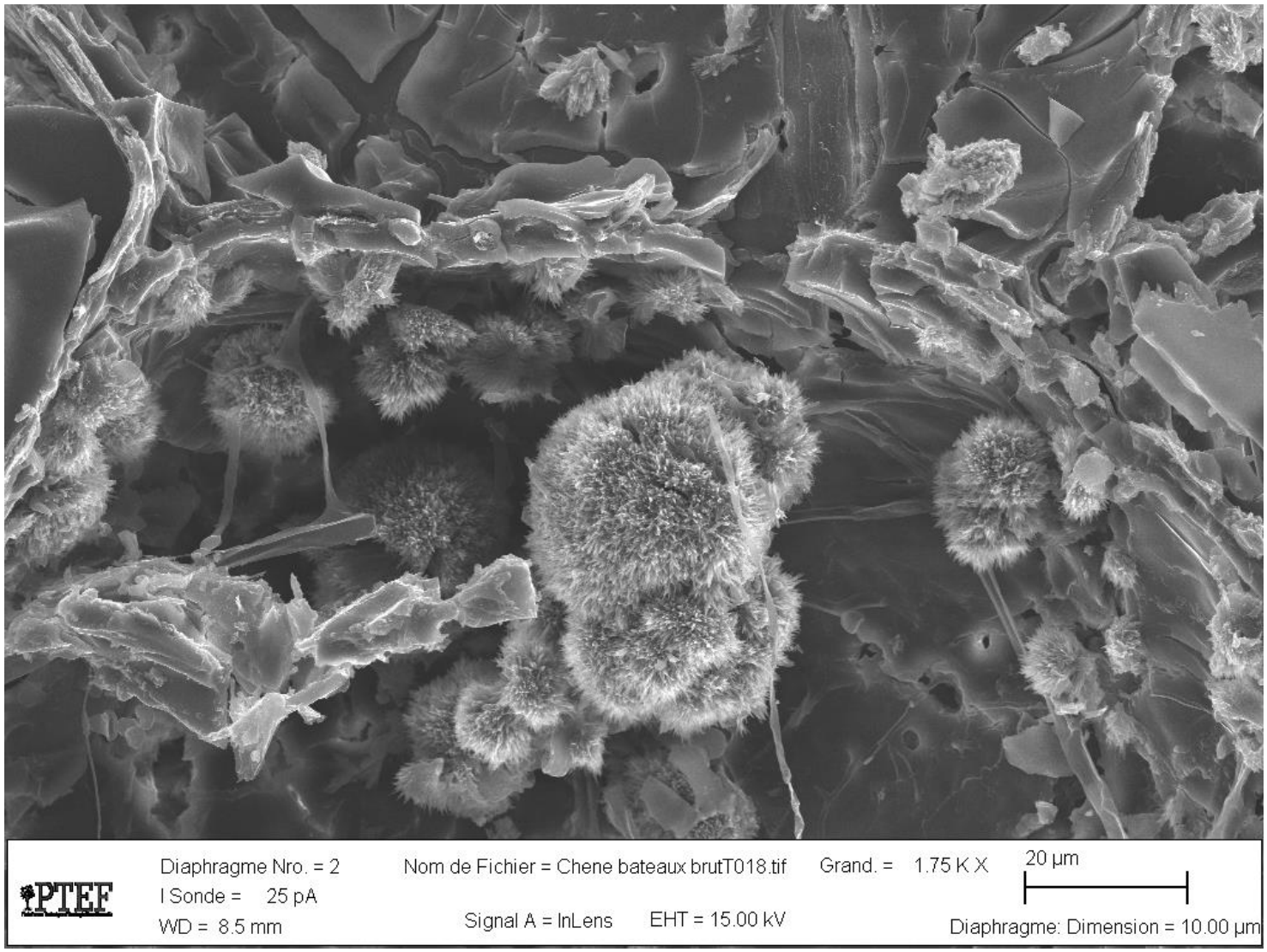
  - one with incomplete extraction

  - one given another assumed original signature!

Future work

Living trees	Archeological wood
Analyze of living tree samples from other sites	Better characterize the marine contamination
Analyze the soil and rock samples correspondent to our tree samples	Validate a method to extract all marine elements in archeological wood

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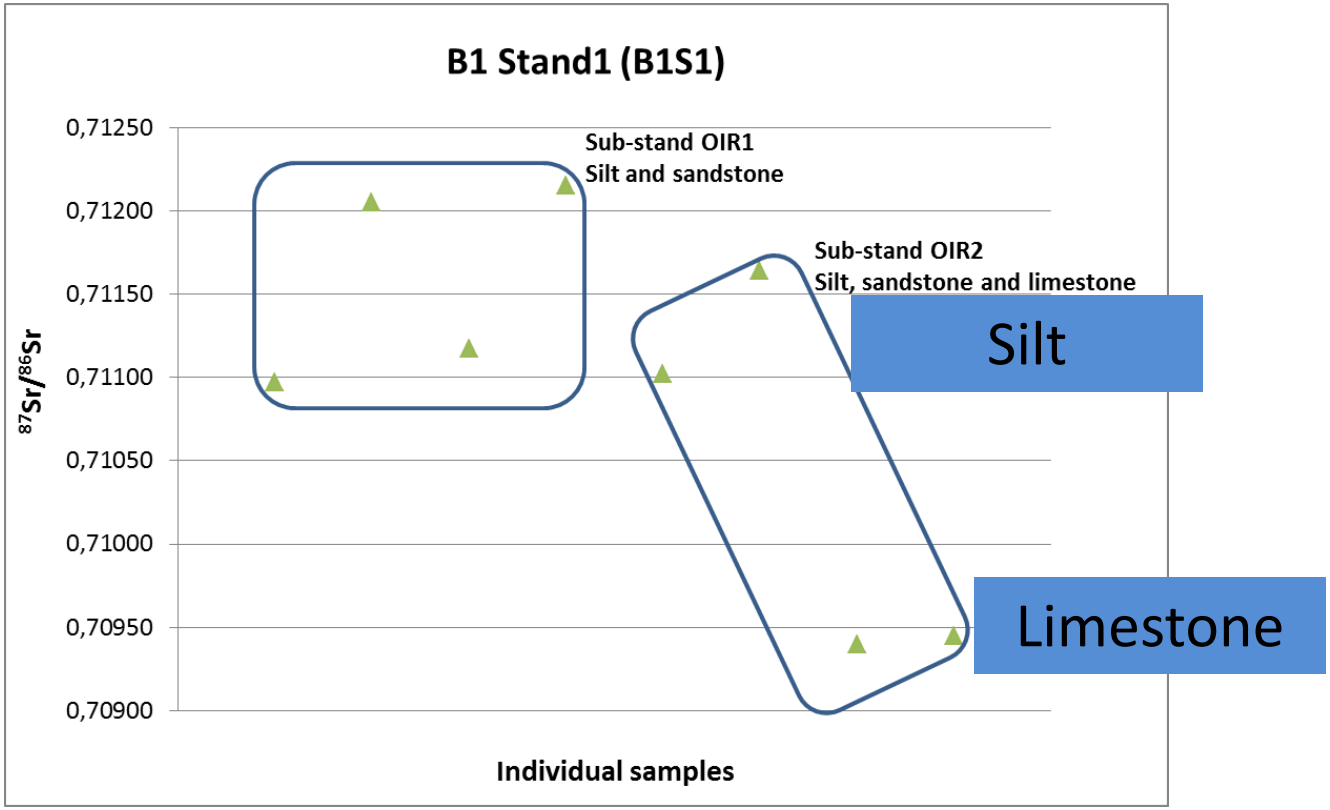
EHT = 15.00 kV
Grand. = 1.75 K X
20 µm
Diaphragme: Dimension = 10.00 µm

Thank you!

Question slides

Stand B1S1 isotopic values

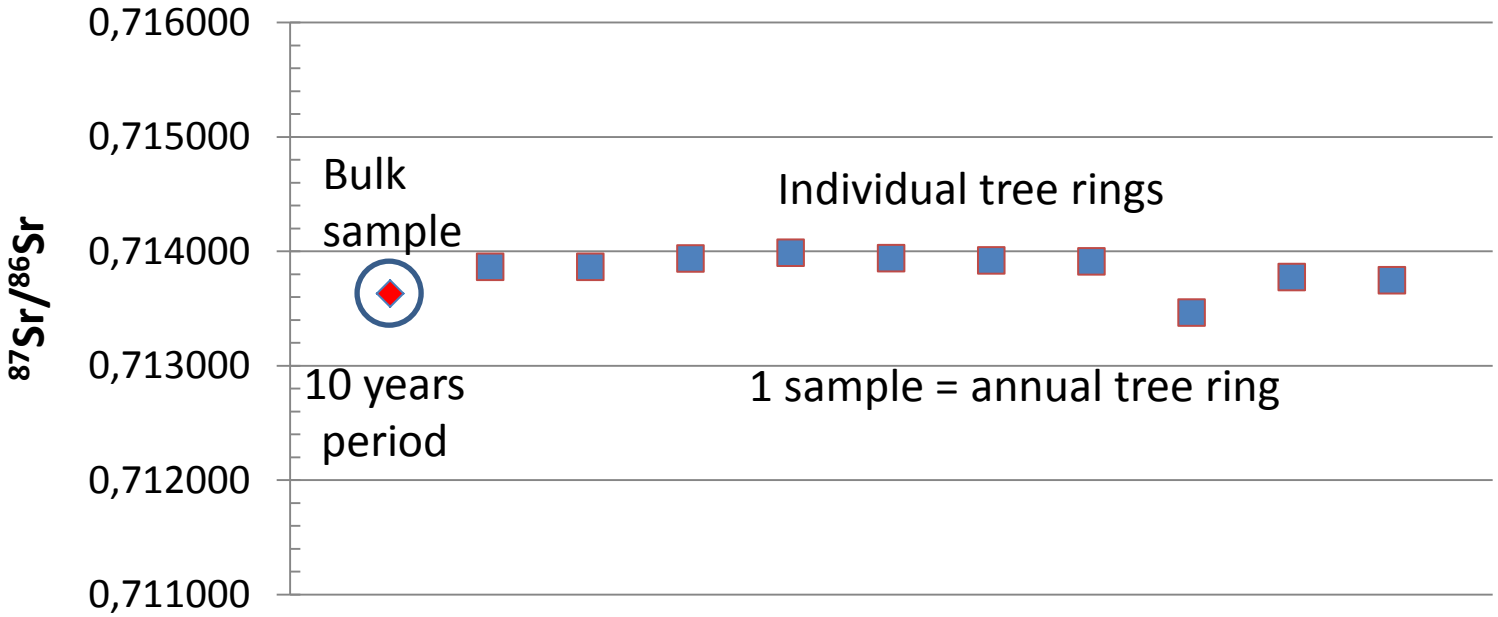


'Acid test': drop of dilute hydrochloric acid on the rock samples and watching for bubbles of carbon dioxide gas to be released → presence of carbonate minerals

Trees that grow on different lithology

Is the isotopic signature of one tree ring equivalent to a group of tree rings?

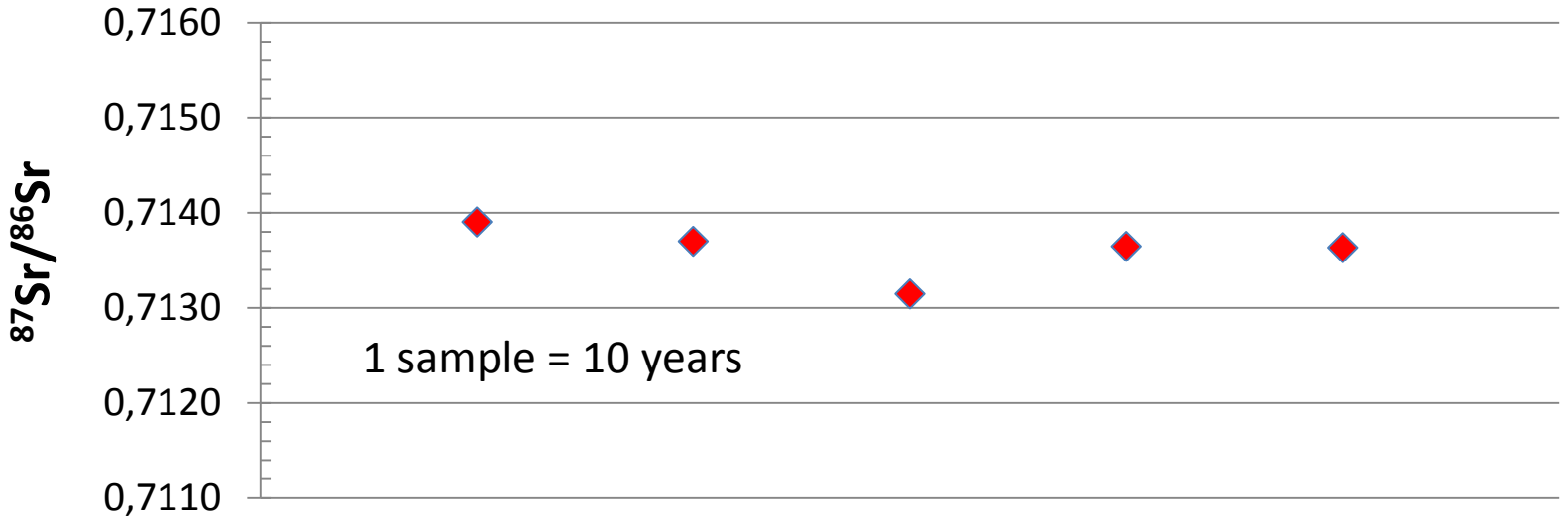
Results from Segovia cathedral archaeological wood



No clear difference between bulk and individual tree rings → Group of 10 tree rings will be taken for analysis

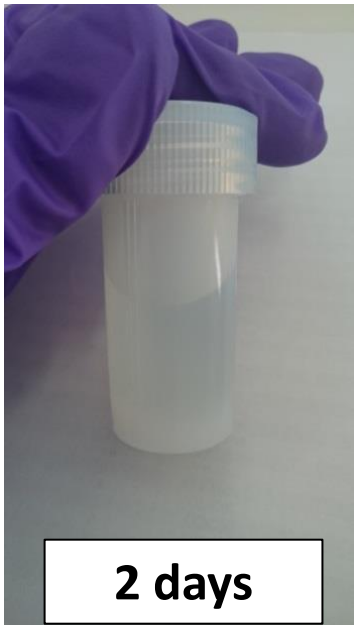
Is there a variation in the Sr isotopic ratios on a time period of 50 years?

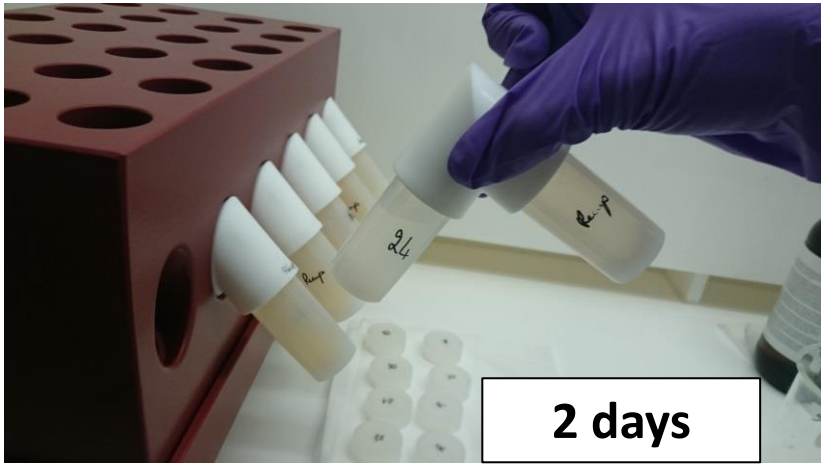
Results from Segovia cathedral archaeological wood

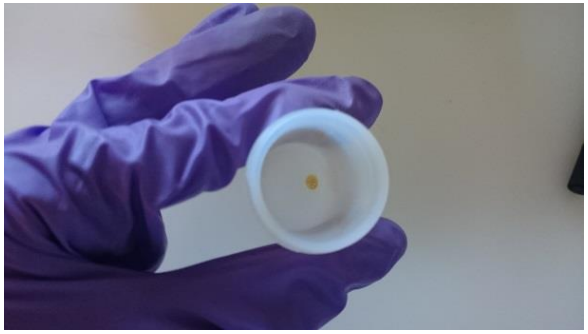


No clear variation on a 50 years period → One sample per individual tree is representative of the tree

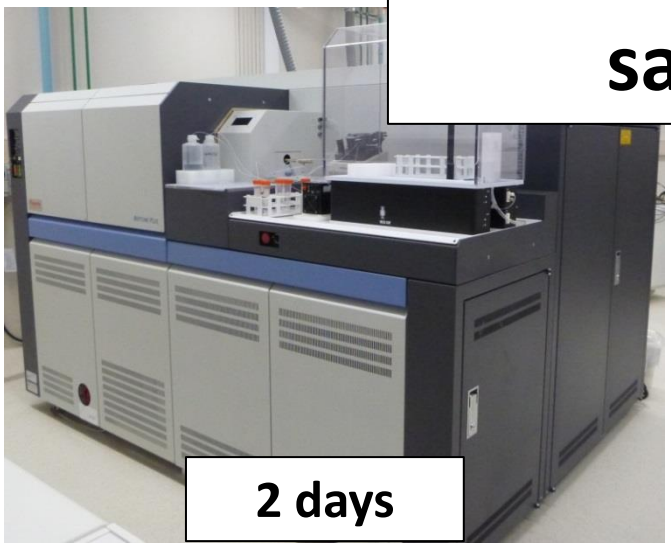
My work in the lab to prepare samples for analysis

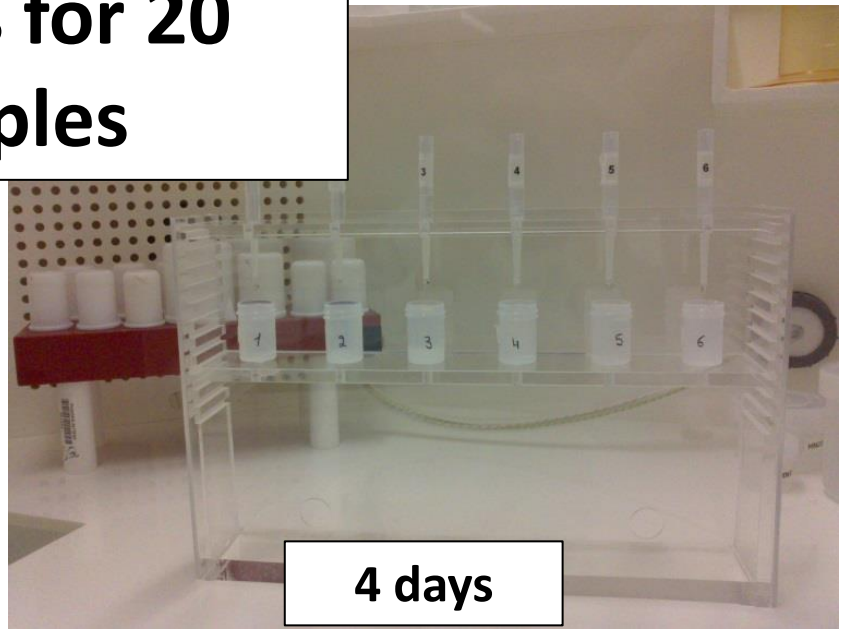


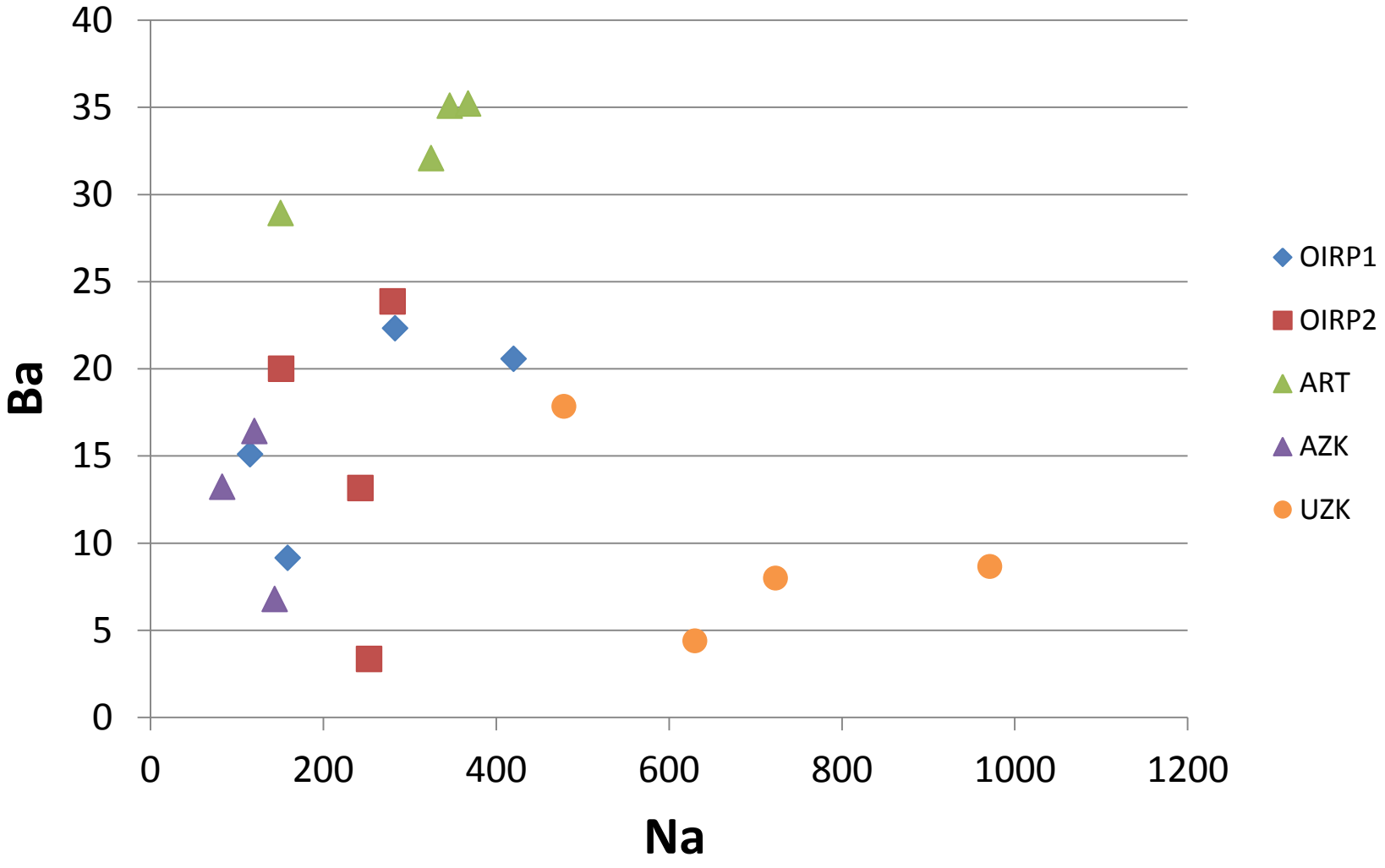




10 days for 20 samples



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800
1000
1200
Na
OIRP1
OIRP2
ART
AZK
UZK