



Timothy Jull

Radiocarbon dating of art works and artifacts

Ady Endre Gimnázium
Debrecen, 2013. március 6.

www.meetthescientist.hu



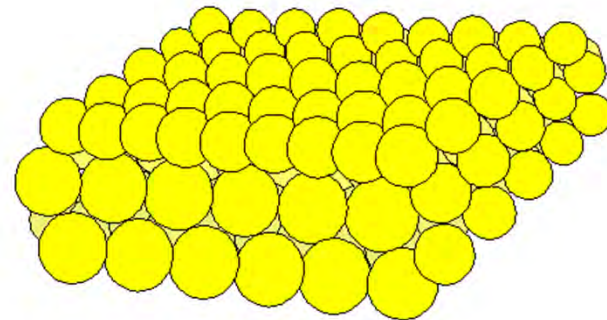
What are carbon isotopes

- ▣ Carbon-12, 99%
- ▣ Carbon-13, 1%
- ▣ Carbon-14, 0.00000000012%
- ▣ *Carbon-14 is radioactive and decays with a half-life of 5,730yr*
- ▣ *“Radiocarbon”*
- ▣ The same atom (protons) but with more neutrons.
- ▣ If you get too many extra neutrons, the nucleus is unstable

Carbon (^{14}C) decaying to Nitrogen (^{14}N)

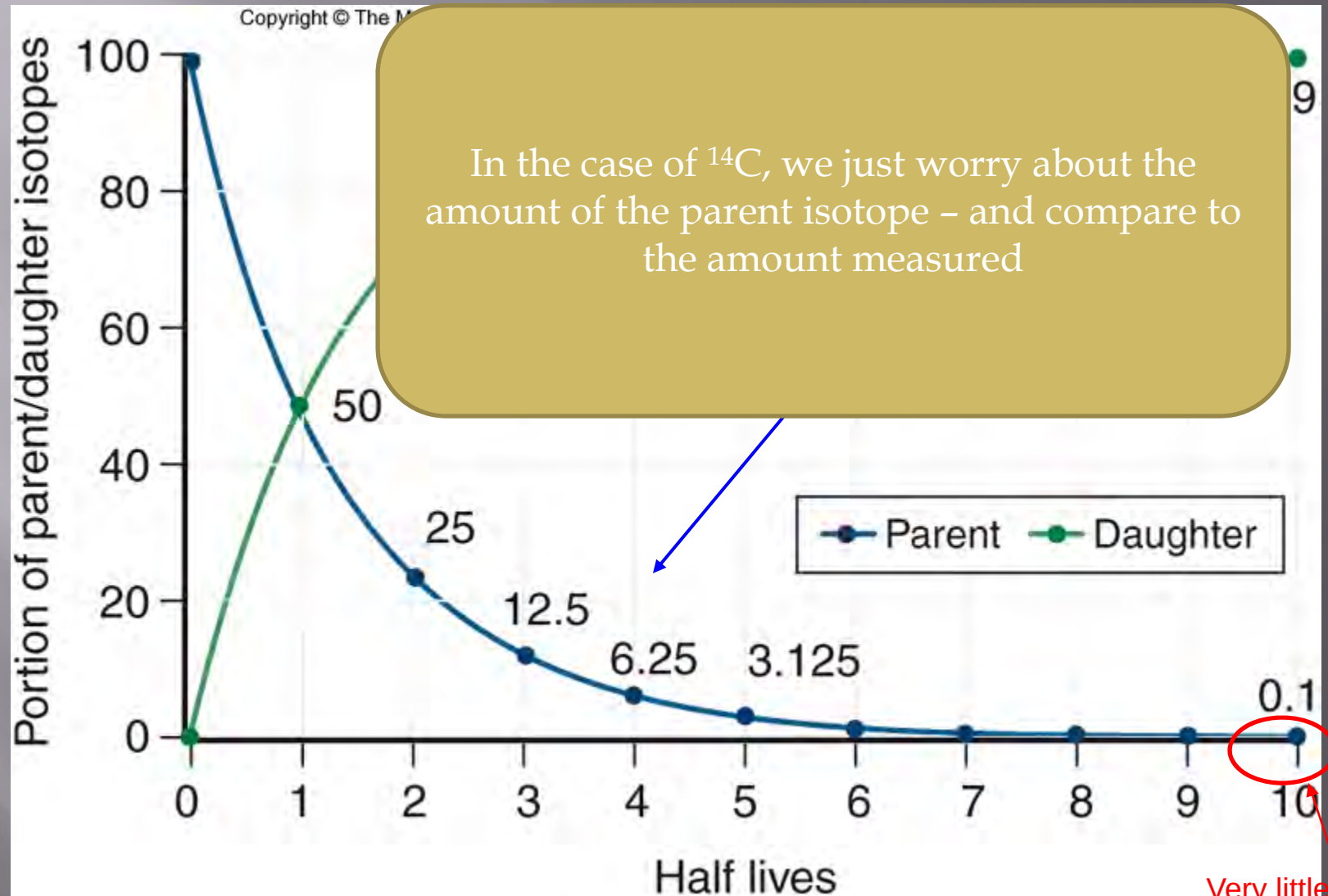
β^- decay: a **neutron converts to a proton** while emitting an electron*.

Half-life of $^{14}\text{C} = 5,730 \pm 40$ years



* and another small particle (anti-neutrino) but it's very small and we won't worry about this here.

Numerical Time

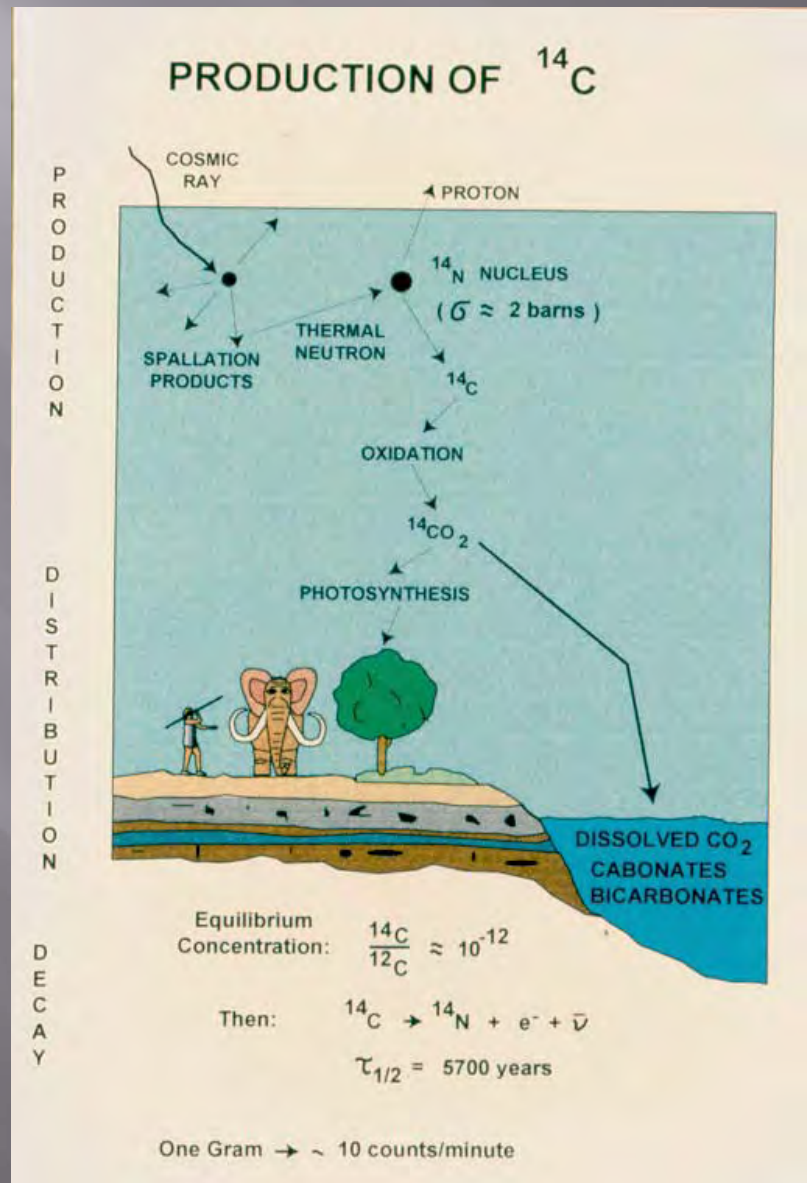


The amount of carbon-14 left tells how many half-lives have passed, and therefore tells us age!

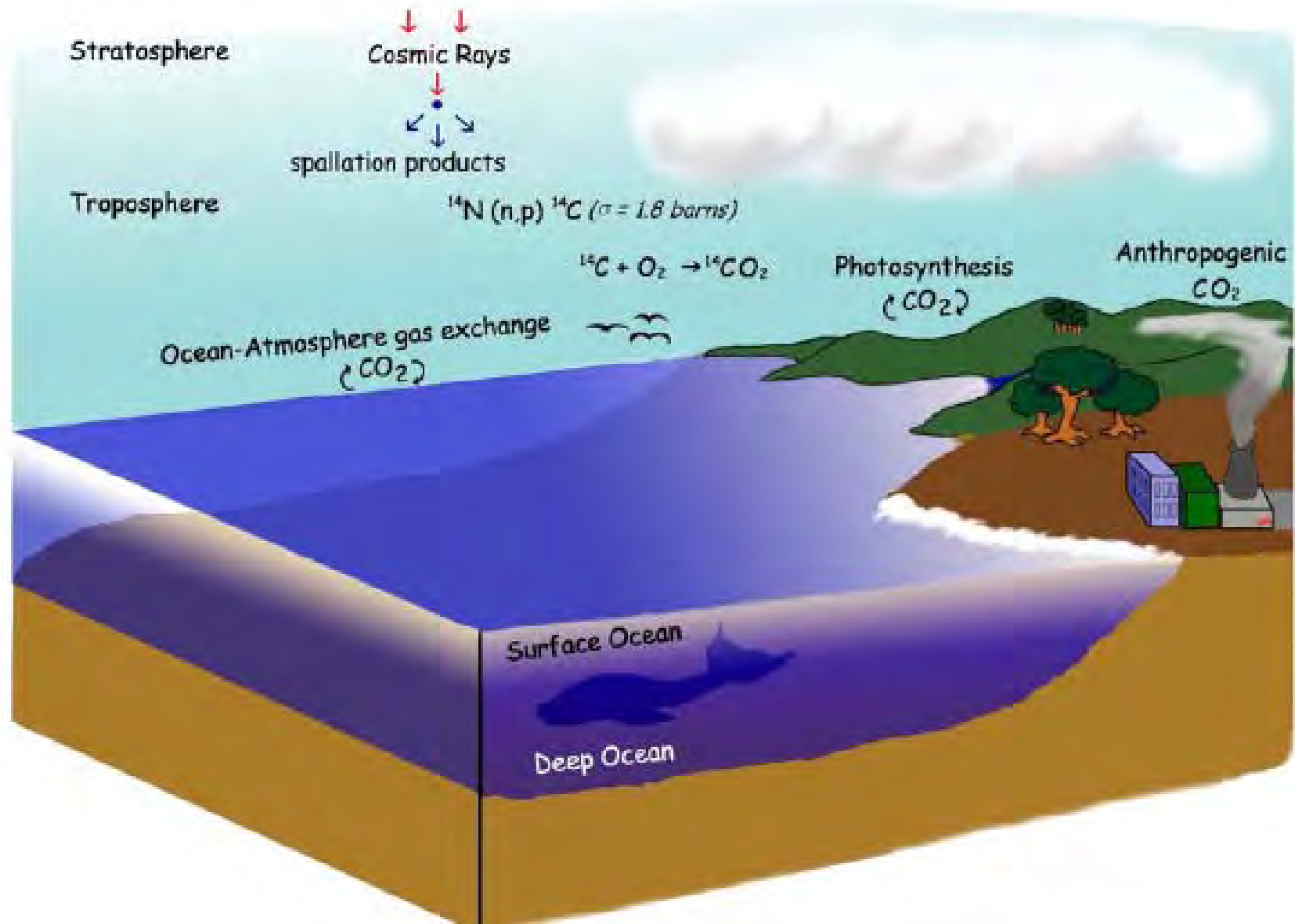
Accelerator Mass Spectrometry

- ▣ After about 1978: Use an accelerator combined with a mass spectrometer to measure the atoms directly.
- ▣ 1950-1978: Earlier methods counted the decay of the atoms, not the atoms themselves.
- ▣ With AMS, we can date very small samples (0.3-1mg carbon)

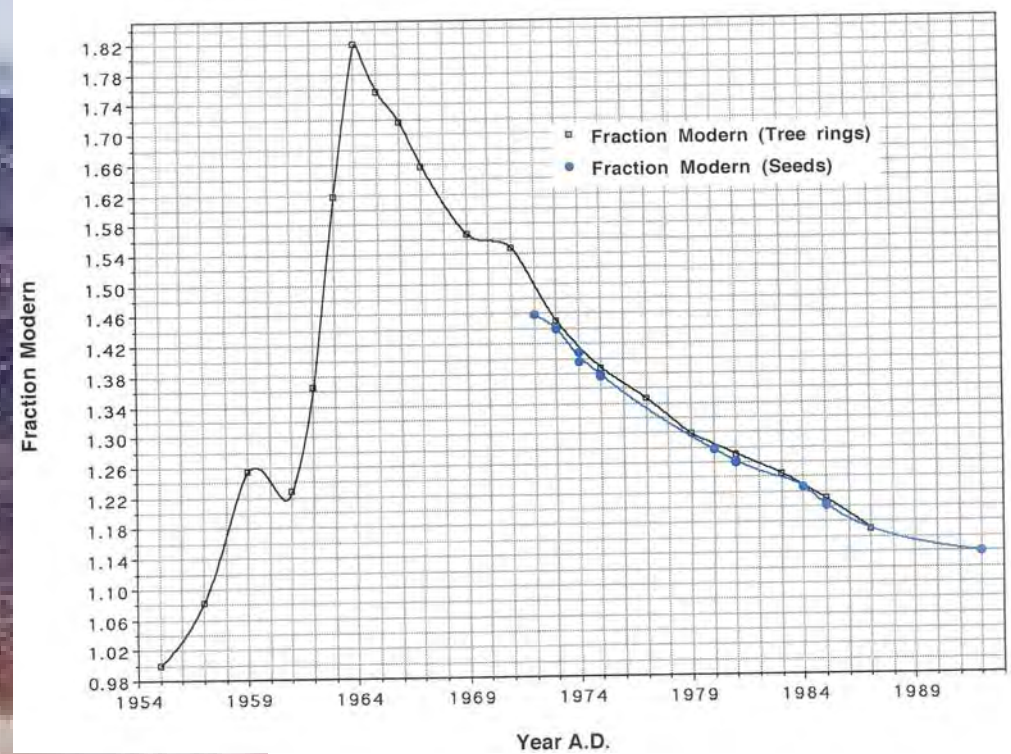
Radiocarbon dating

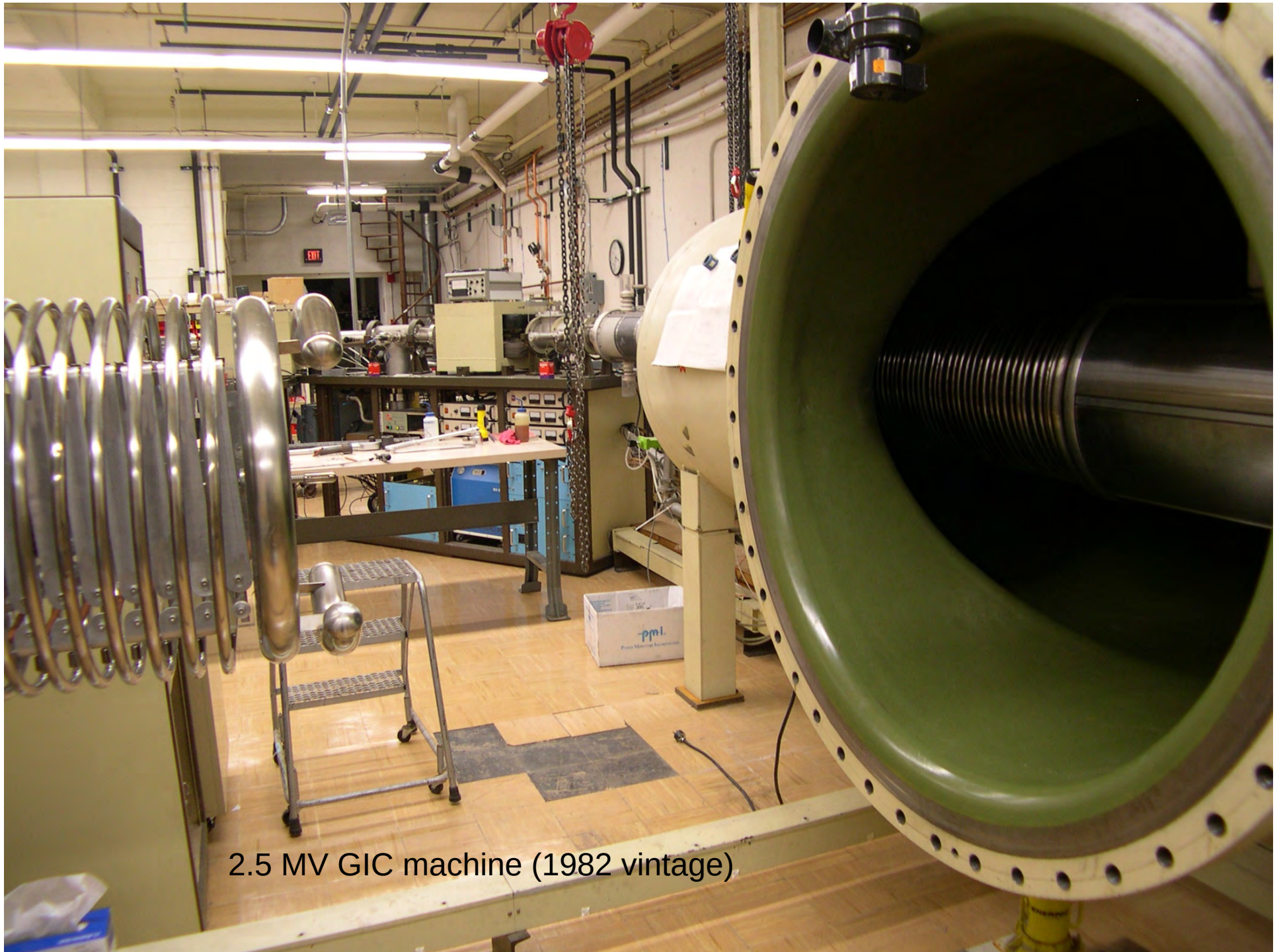


Carbon cycle



Since 1950AD, an additional source of ^{14}C is from atmospheric nuclear testing.





2.5 MV GIC machine (1982 vintage)

The 3MV Pelletron at Arizona



Low-energy end showing ion source and accelerator.



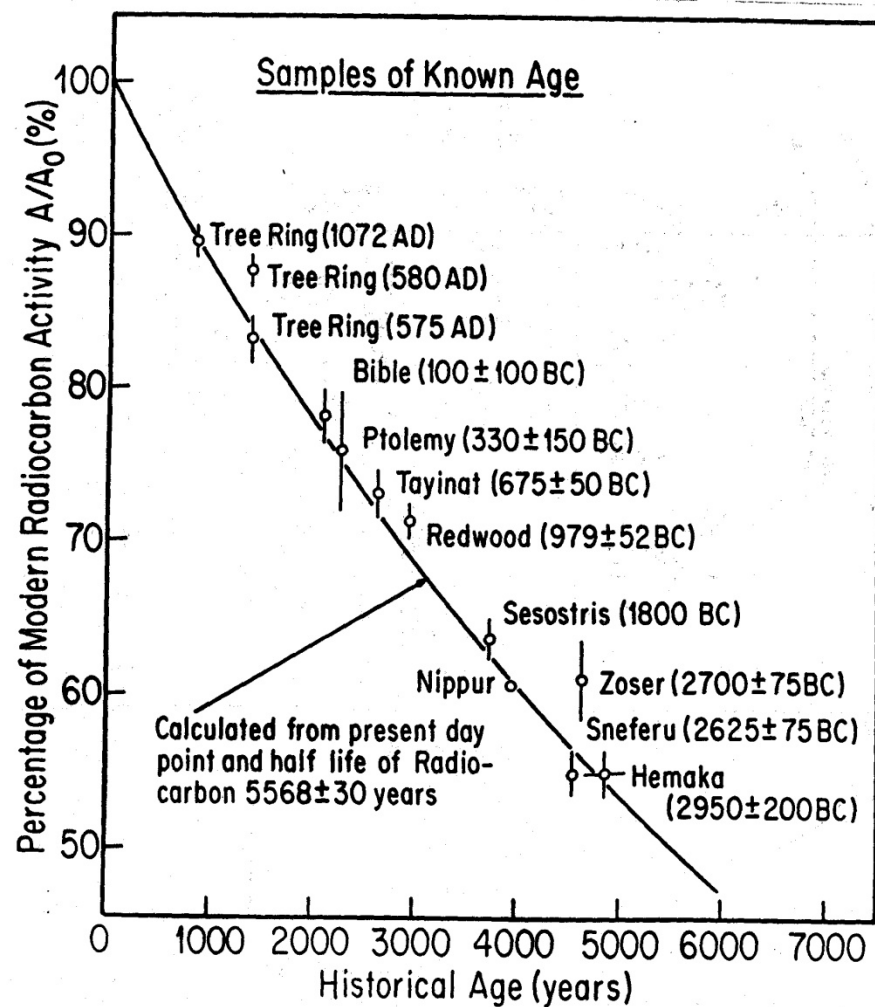
High-energy mass spectrometry





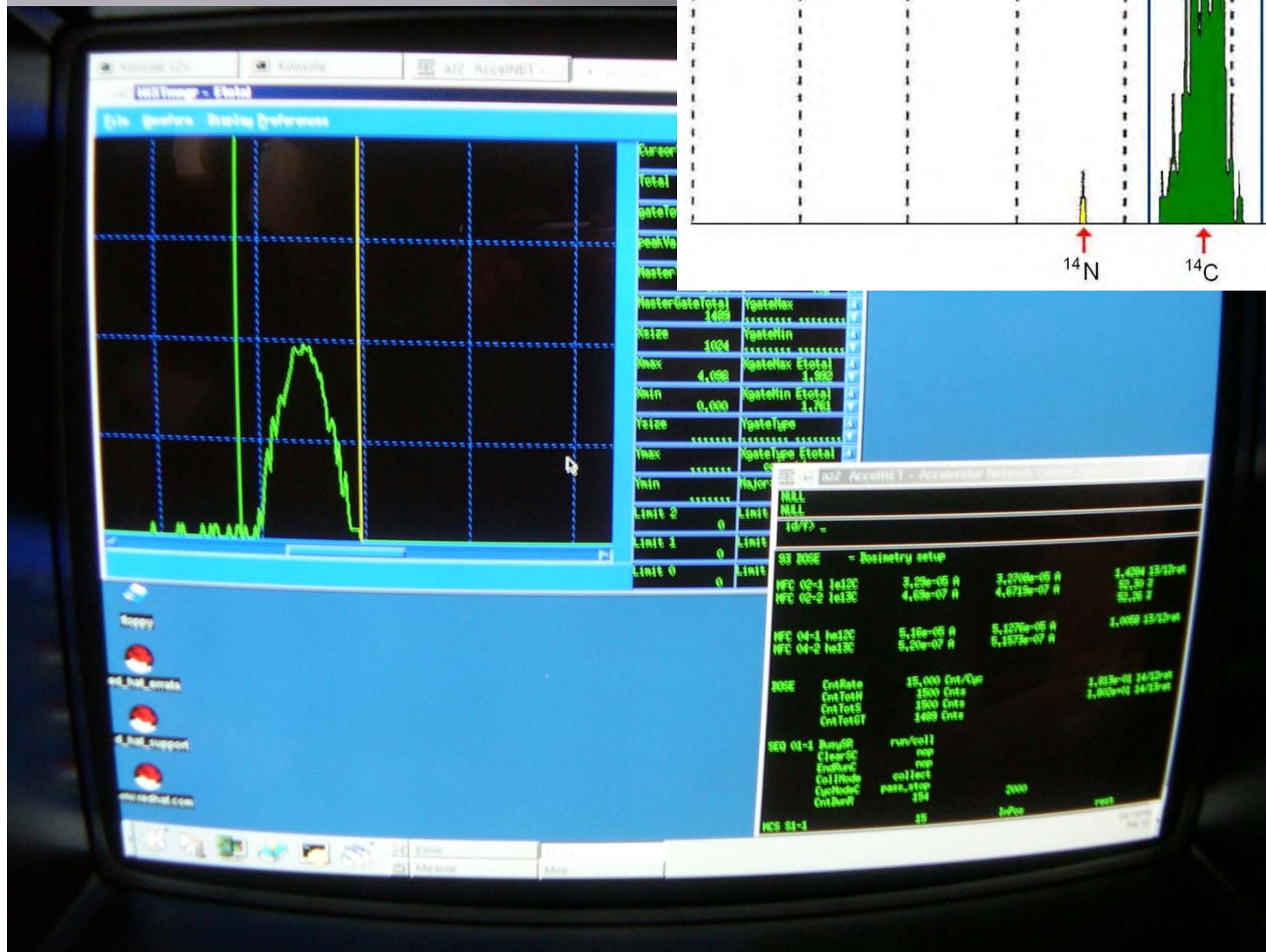
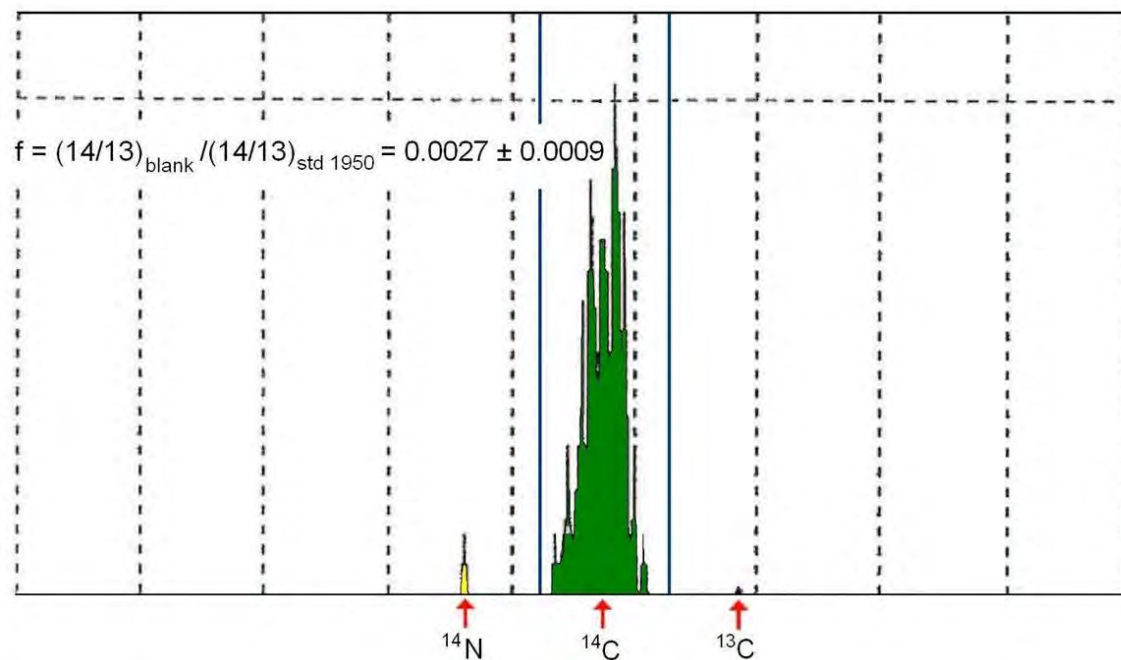
The smaller (200kV) machine at ATOMKI Debrecen. Note difference in scale.

Libby's "curve of knowns"



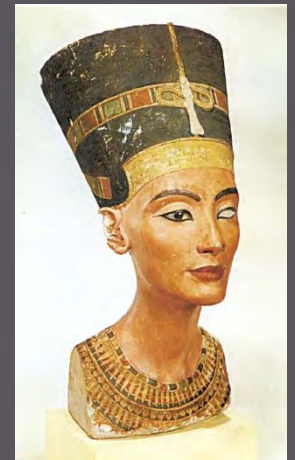
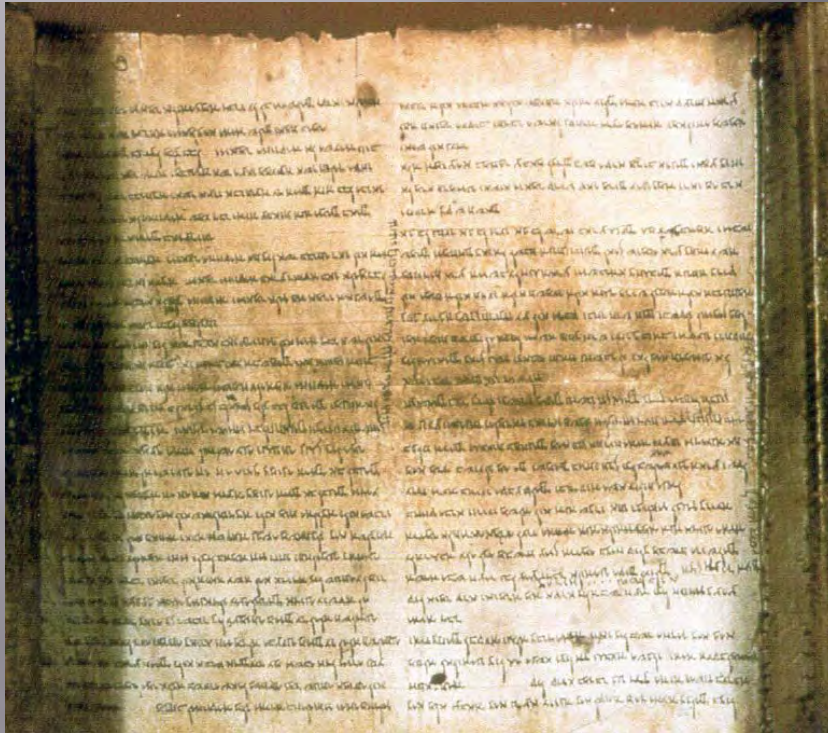
William Libby received the Nobel Prize in Chemistry, In 1960 for the development of radiocarbon dating.

$$f = (14/13)_{\text{blank}} / (14/13)_{\text{std 1950}} = 0.0027 \pm 0.0009$$





Interesting objects can be dated





Which one is old?



Field work in Qinghai Lake region

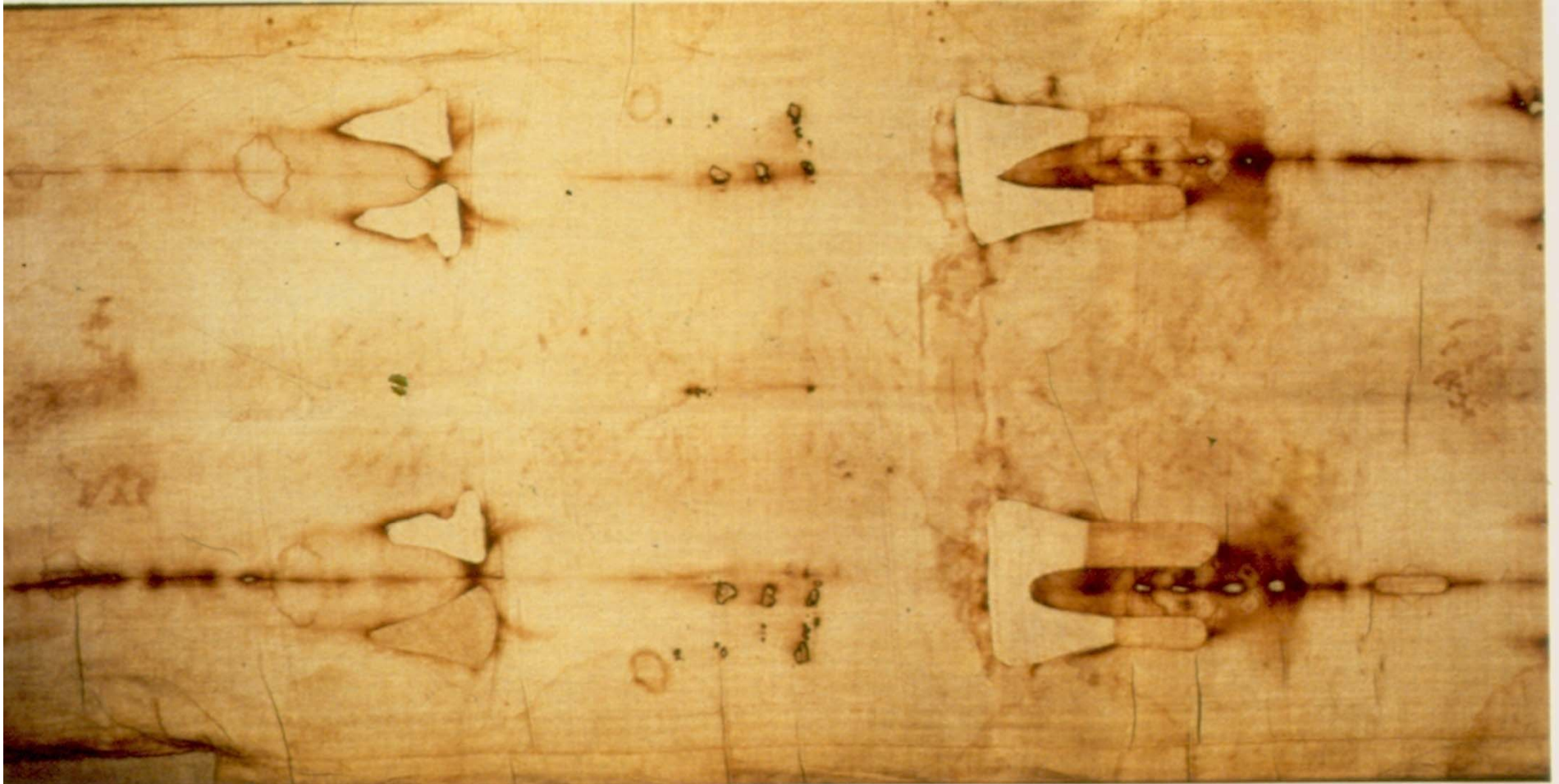


Easter Island
1200-1600AD

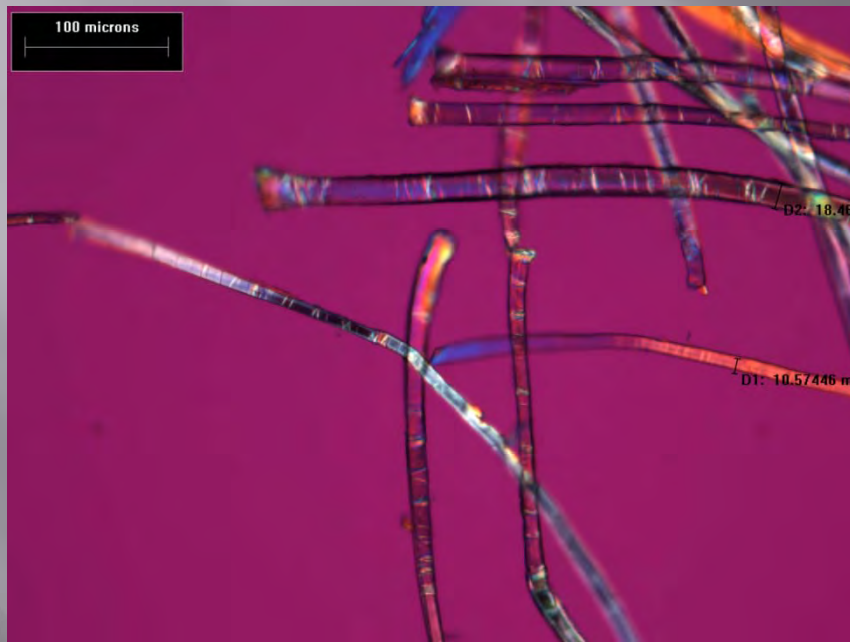


New Guinea Art
800AD to recent

and how about more
controversial samples?...



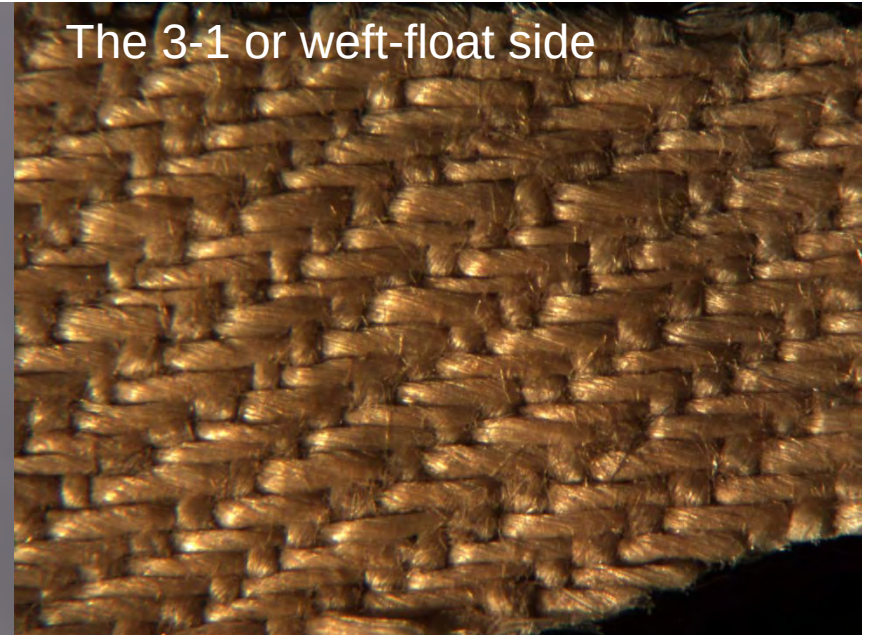
Most famous sample dated by ^{14}C



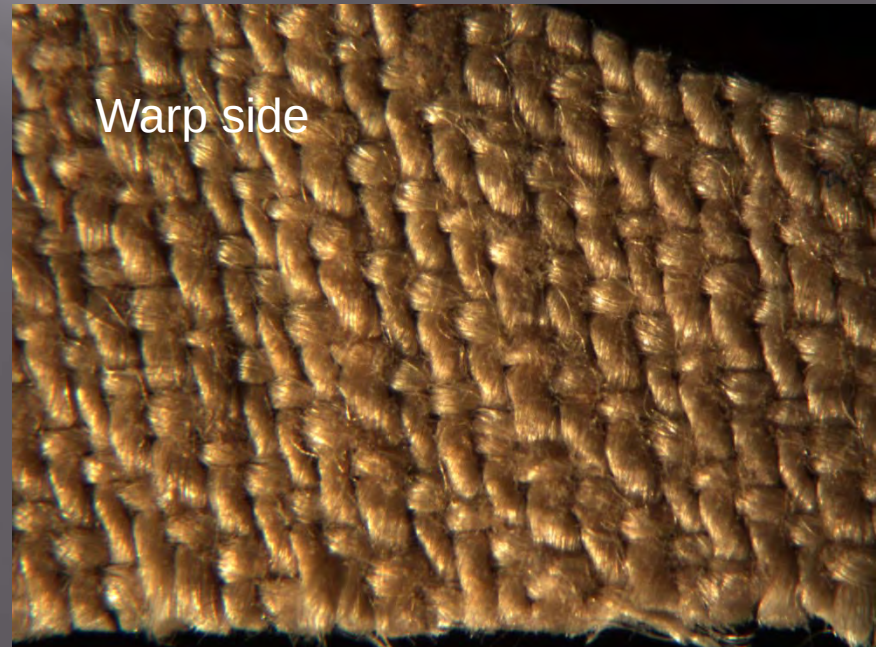
Flax fibers from Shroud linen

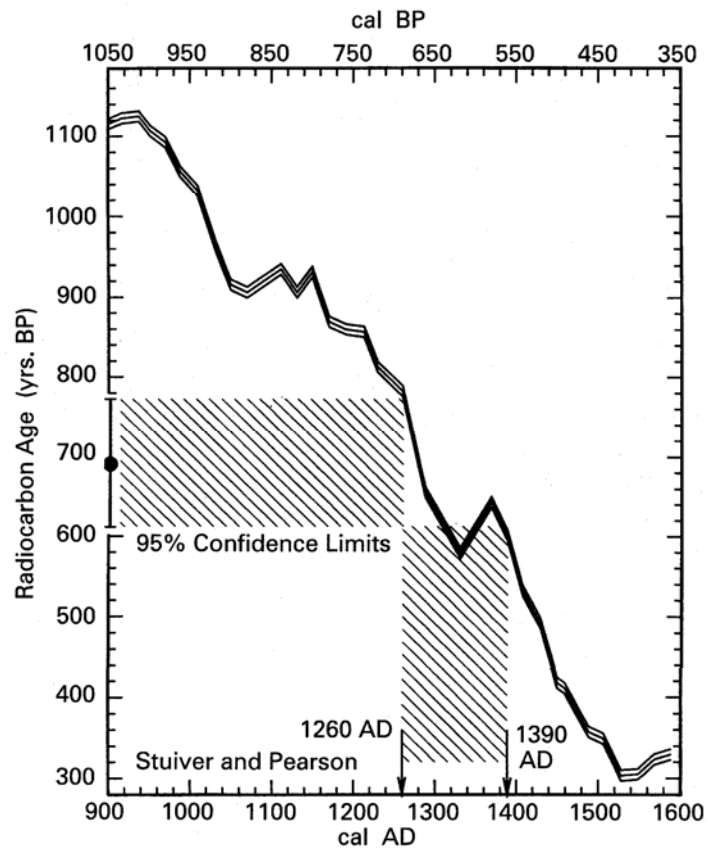
Number of Google hits on this dating study:
>1,460,000

The 3-1 or weft-float side



Warp side





nature

INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

Volume 337 No. 6208 16 February 1989 £1.95

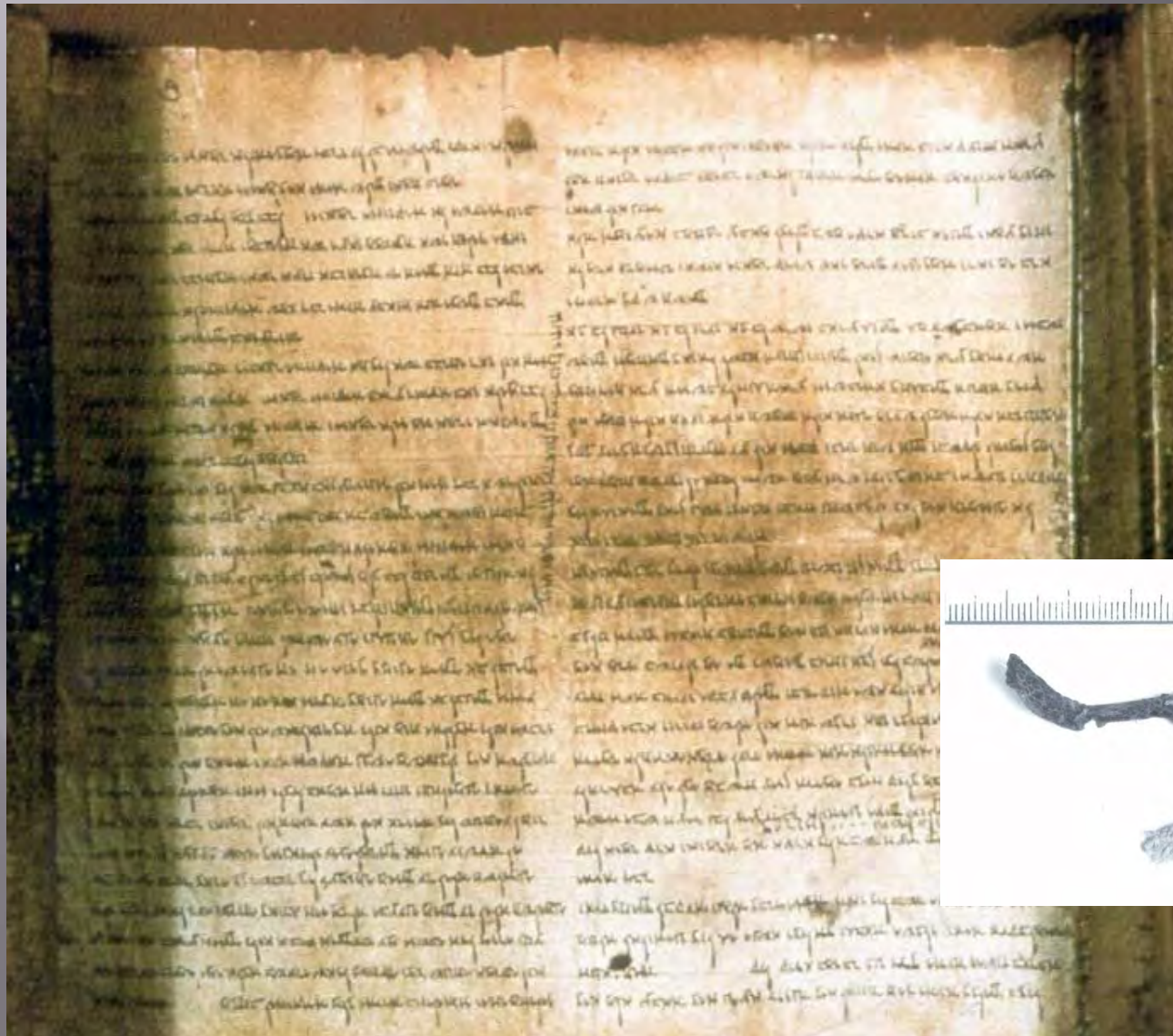


DATING OF THE TURIN SHROUD
SCIENTIFIC SOFTWARE REVIEW

Dating the Dead Sea Scrolls

Page from the
Book of Isaiah

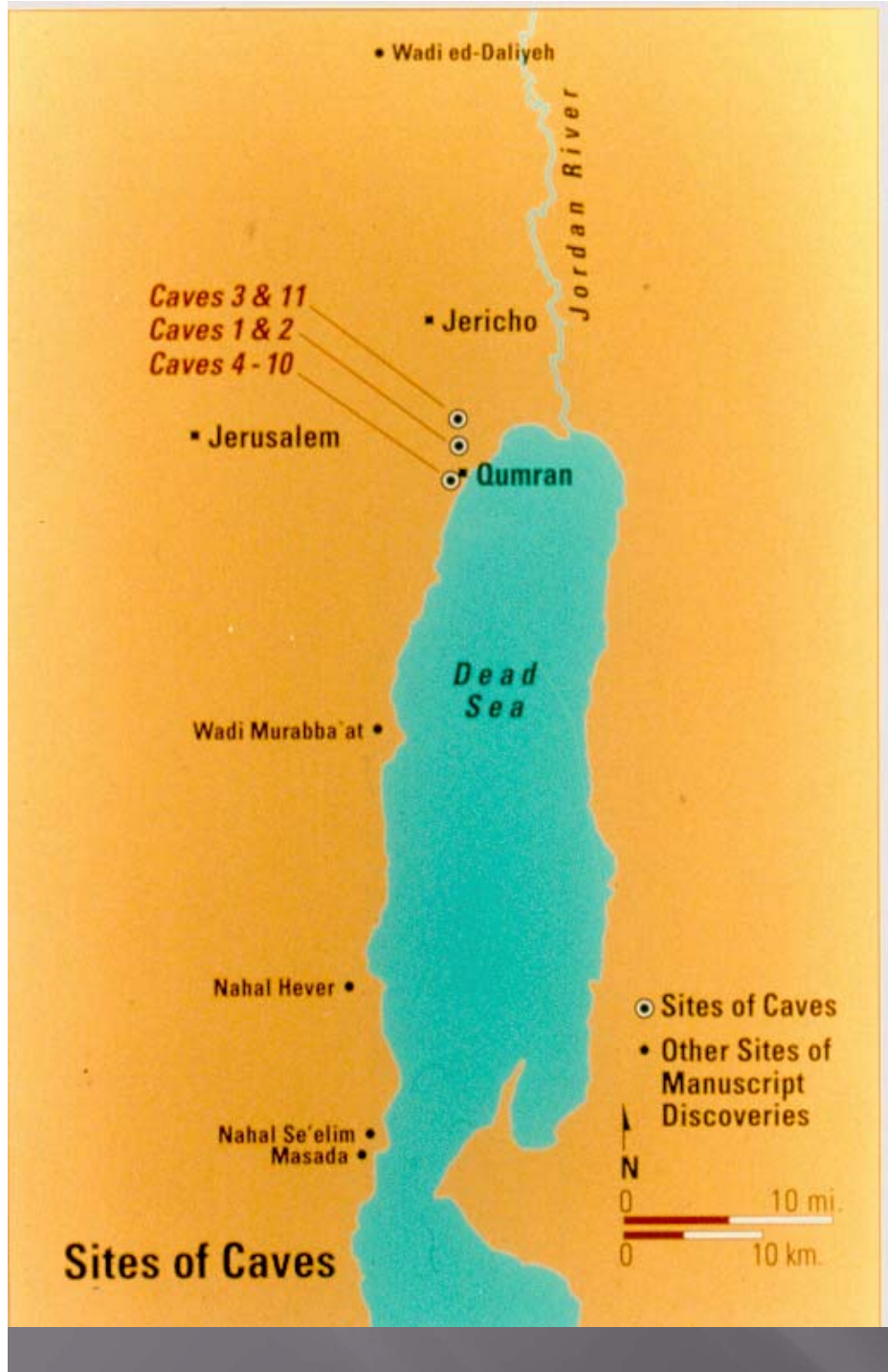
On display in the
Shrine of the Book,
Israel Museum



What are the Dead Sea Scrolls?

- ▣ Various parchment and papyri recovered from the Dead Sea region.
- ▣ Associated with Qumran settlement







First Scrolls discovered in 1947:
“by some shepherd boys tending their flock”
Eventually sold to a Bethlehem art dealer
And eventually by
Samuel (Syrian Catholic Archbishop of Jerusalem)

MISCELLANEOUS FOR SALE

"The Four Dead Sea Scrolls"

Biblical Manuscripts dating back to at least 200 BC, are for sale. This would be an ideal gift to an educational or religious institution by an individual or group.
Box F 206, The Wall Street Journal.

FOR RENT

Summer rental 1
pletely private
hours from New
room modern co
blazing riding
woods, private
month.
Box F-185, The

ideal for broker
state corporate
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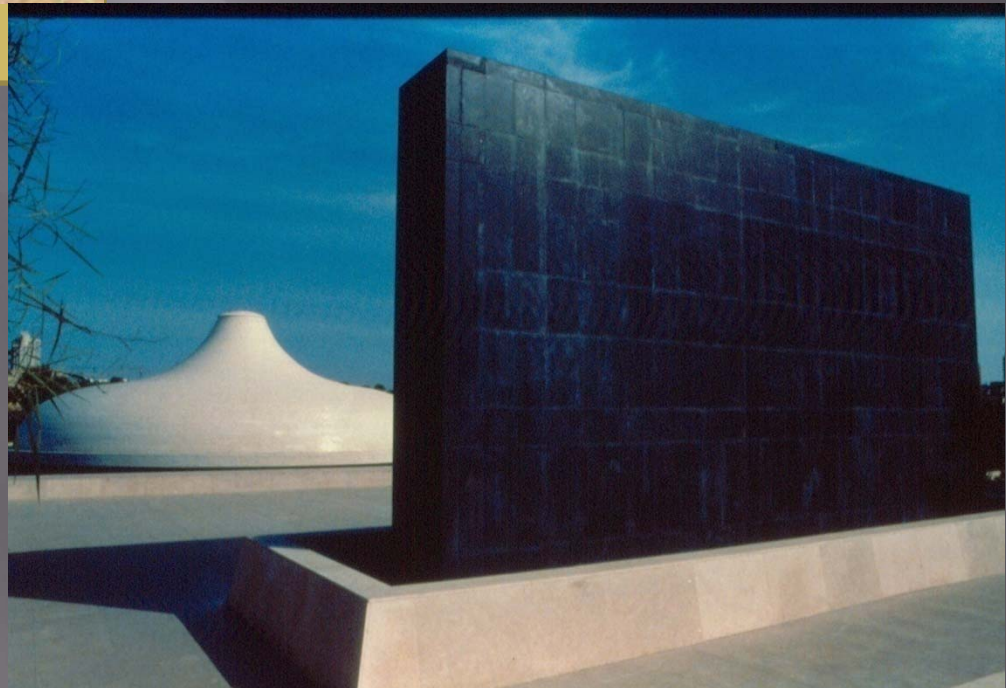
REAL EST

YACH

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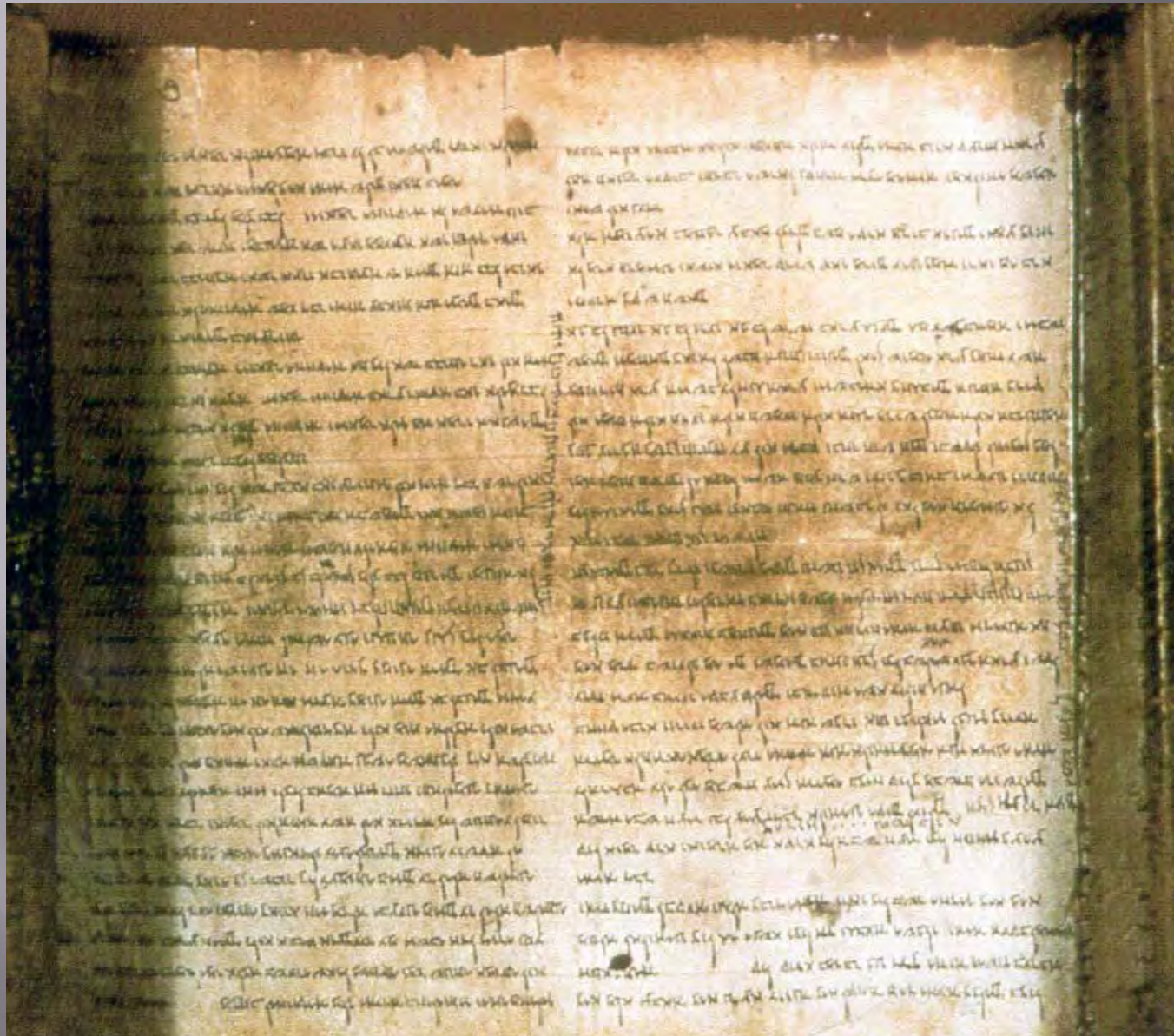


Wall Street Journal, 6/1/54



Types of documents grouped as Dead Sea Scrolls

- ▣ Books of the Hebrew bible.
- ▣ Commentaries on books of the bible in the view of this group.
- ▣ Rules of the Community.
- ▣ Historical documents.
- ▣ Business documents.
- ▣ Other (younger) documents.



Book of Isaiah

2141±32 yr BP
(Arizona)

2128±38 yr BP
(ETH Zurich)

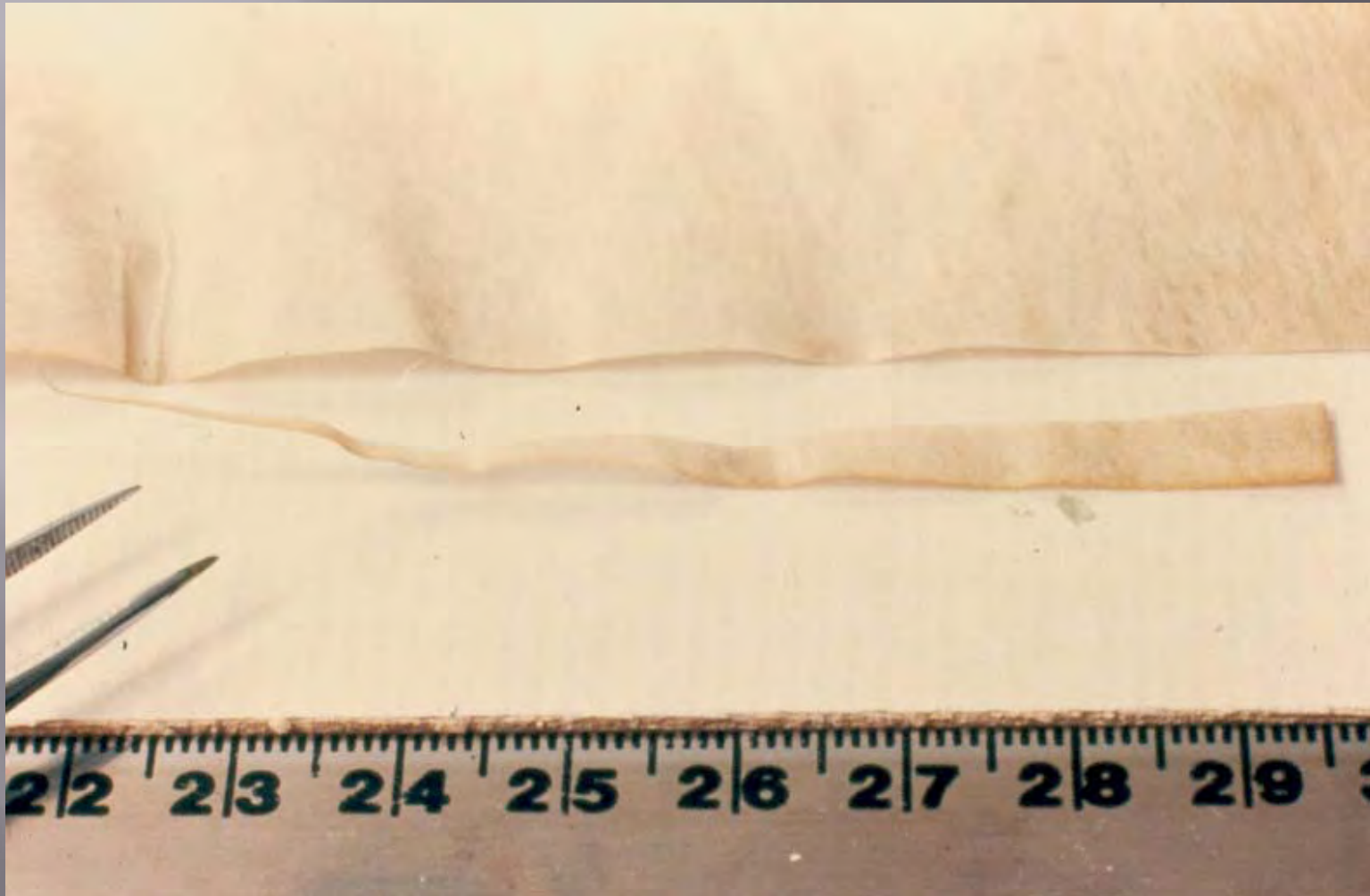
Calibrated age:
250-103BC

Paleography:
150-125BC

Vinland Map



Vinland Map sample removal (1995)



Results of Arizona studies of the Vinland Map

- ▣ Radiocarbon age:

467±27 radiocarbon yrs BP

- ▣ Calibrated age range:

1423-1445 AD (1 sigma, 68.3% confidence)

1411-1468 AD (2 sigma, 95.4% confidence)

“Gospel of Judas”

- ▣ A gnostic text referred to by Irenaeus (Bishop) in his treatise, “Against all heresies” in 180AD
- ▣ Coptic manuscript apparently recovered in 1980’s – circulated in antiquities market
- ▣ Stored in US for a number of years
- ▣ Re-acquired by Swiss art dealer in 2000





Radiocarbon age:
 1767 ± 16 yr BP

220-340AD
95% confidence





Voynich Manuscript

Current owner: Beineke Library, Yale University

Obtained from: Ethel Voynich, widow of Wilfred M. Voynich (1969).

Voynich had obtained the book from the Jesuit College in Frascati (1912), which had the book since about 1666.

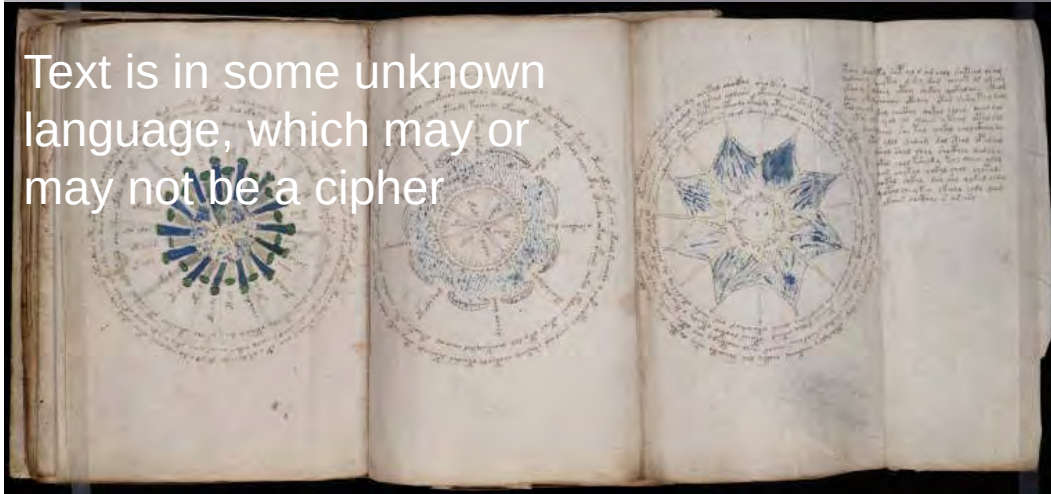
Known history:

- Belonged to Emperor Rudolph II of Germany (Holy Roman Emperor, 1576-1612), who purchased it for 600 gold ducats and believed that it was the work of Roger Bacon.
- It is very likely that Emperor Rudolph acquired the manuscript from the English astrologer John Dee (1527-1608).
- Dee's son noted that Dee owned:

"a booke...containing nothing butt Hieroglyphicks, which booke his father bestowed much time upon: but I could not heare that hee could make it out."

A strange document?

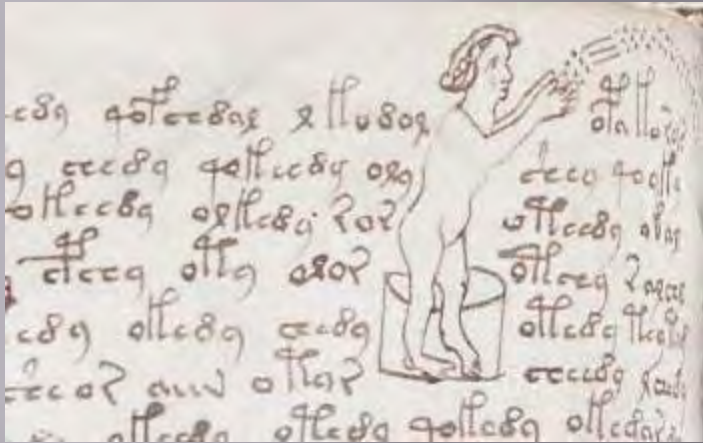
Text is in some unknown language, which may or may not be a cipher



Many people have tried to decipher it, with no success at all...



How old is it?



Radiocarbon dating shows the manuscript Vellum is 1404-1438AD

Much older than known history.

So, we are left with the puzzle:

Who wrote it and why?

What does the text mean?

What was the point in writing something no-one can read, or has the code?

Is it just some medieval joke?





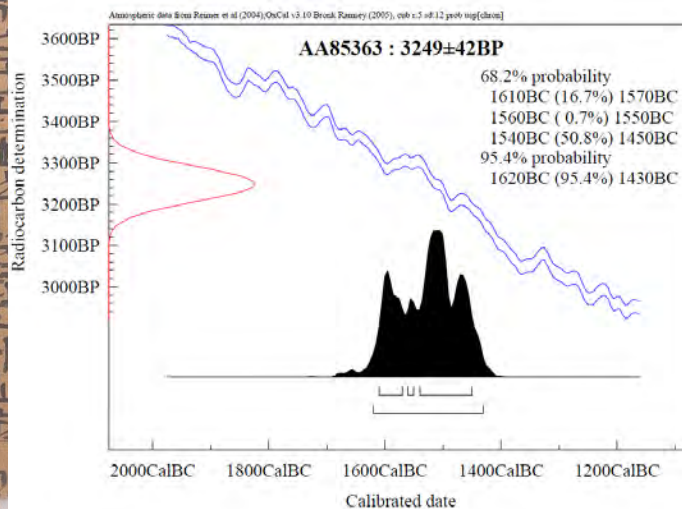
Reported to be Raphael, Madonna and Child

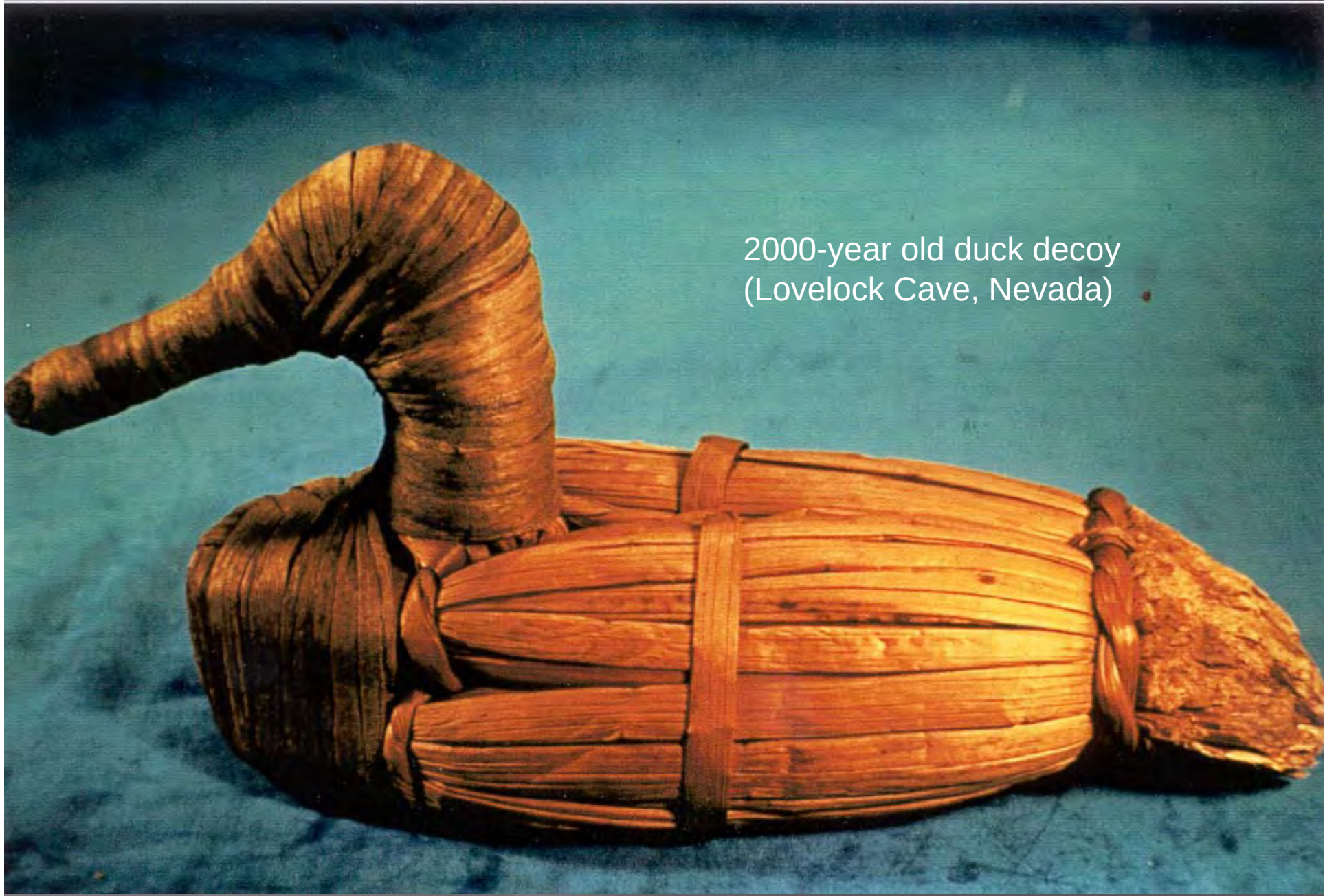
Dates to after 1680AD and
Before 1950AD

Separate tests in Arizona and
Debrecen gave same result

So, NOT a Raphael!

Egyptian Book of the Dead
Brooklyn Museum
1620-1430BC





2000-year old duck decoy
(Lovelock Cave, Nevada)

Ahmedabad Silk (16-17 cent.)



Chinese silk textiles



Song dynasty



Yuan dynasty

Do you spend all your time in
the lab?

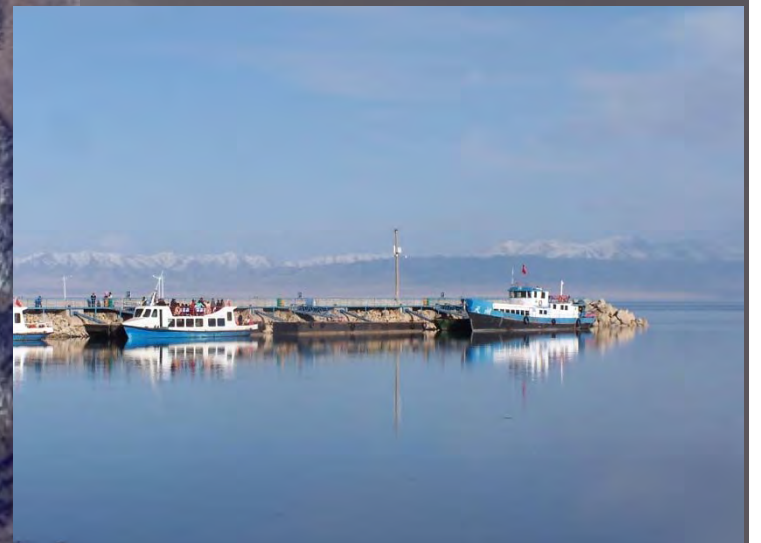


Geology and Lake Studies
In China





Qinghai Lake









Köszönöm szépen!



Hoba iron meteorite
Largest known meteorite find.

www.meetthescientist.hu

