Data recovery from historic shipwrecks: corrosion layers reveal the past, present & future

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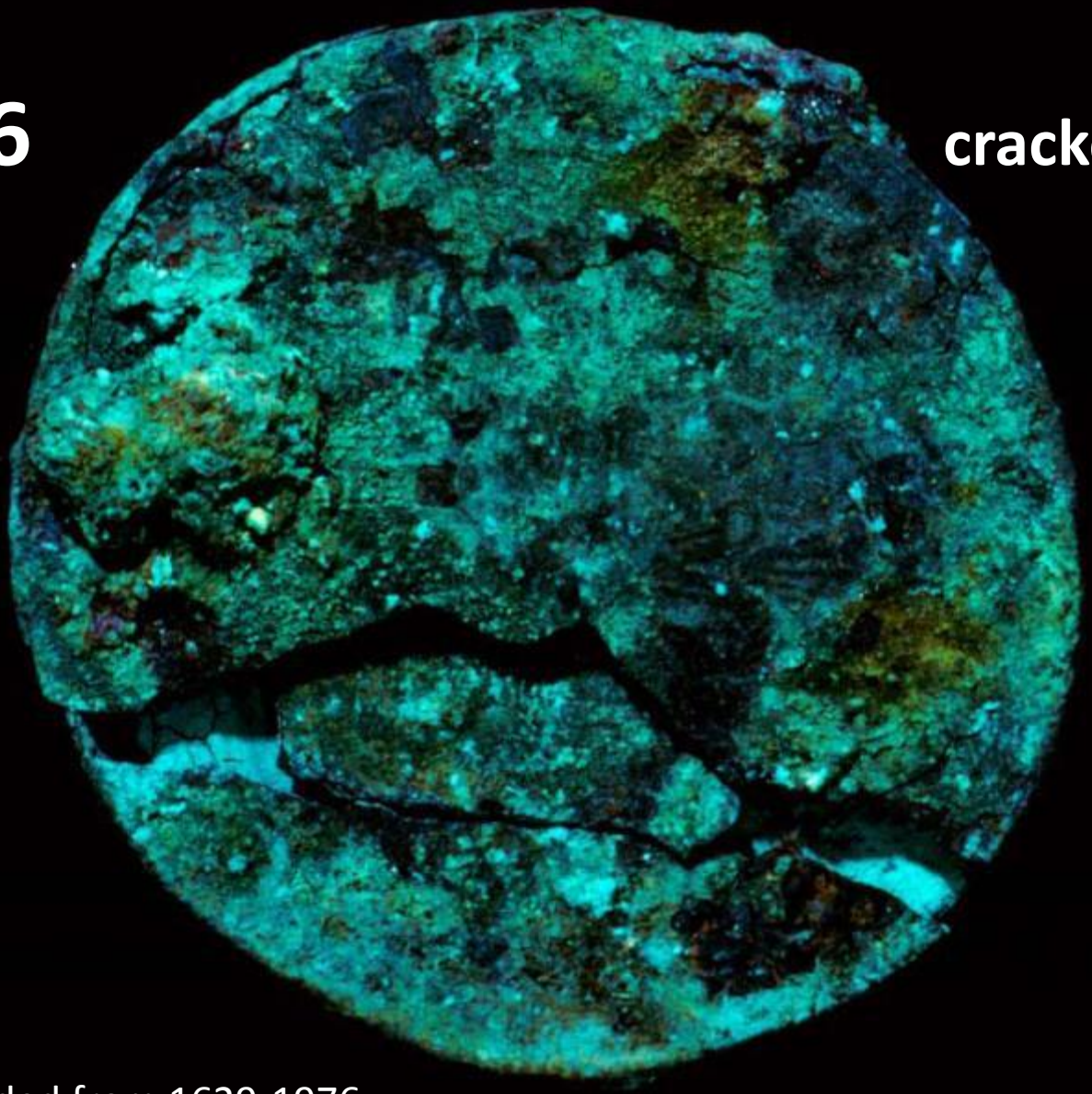
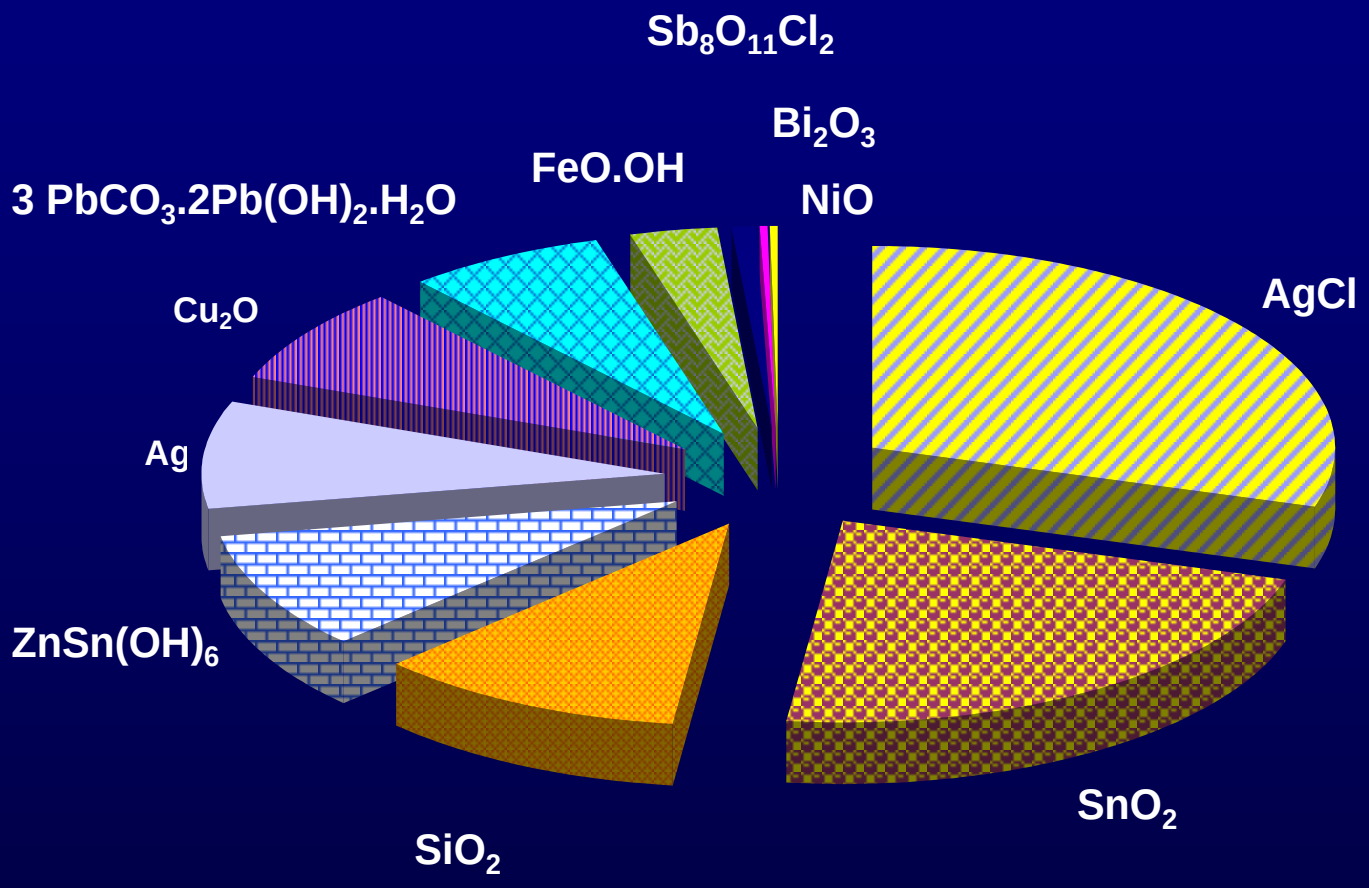
BAT 916

cracked coin



Batavia corroded from 1629-1976

Bat 916 corrosion products

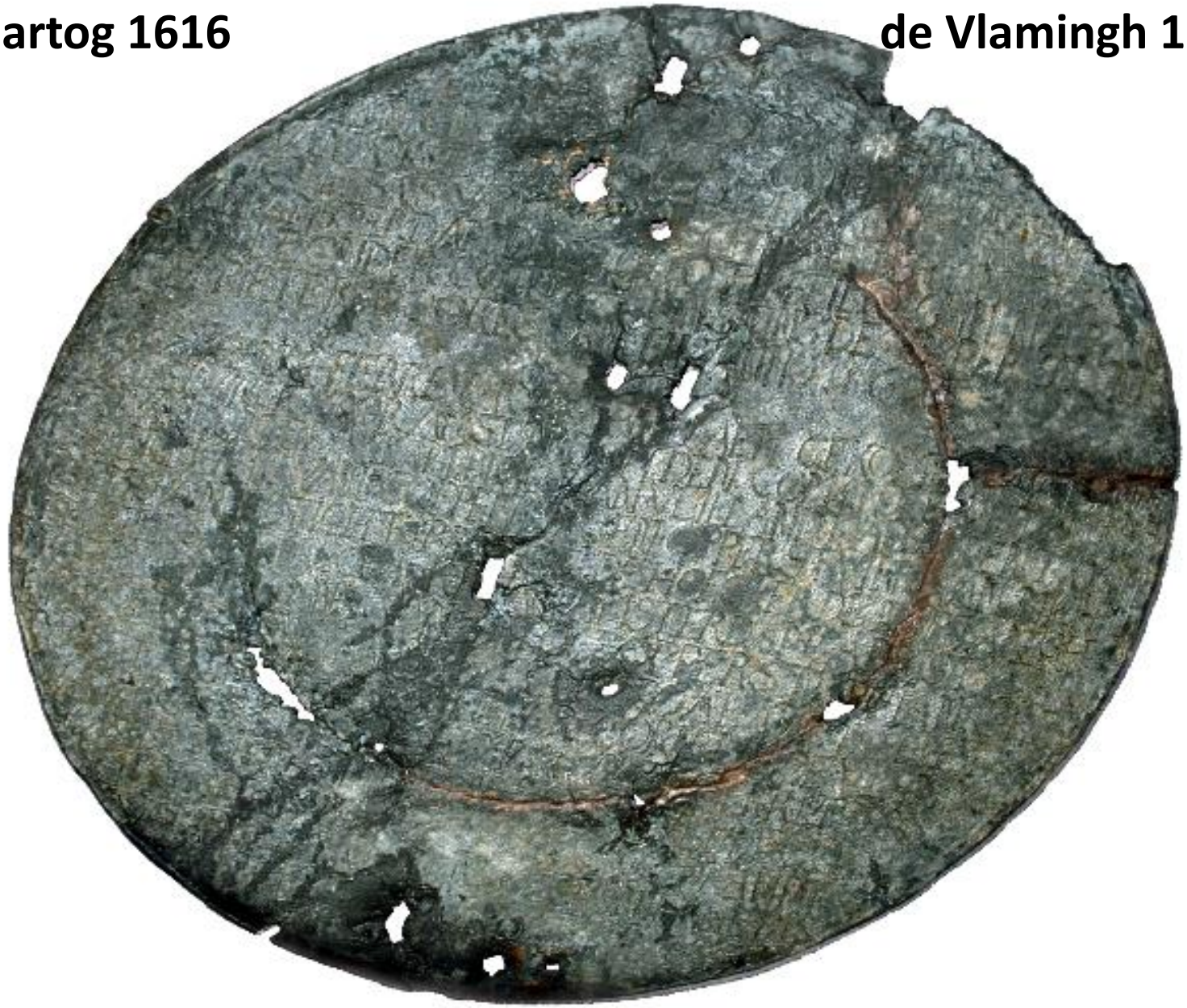


Corrosion products trapped inside the hollow coin provide the clues

Batavia 1629

- **hollow coin**
- **minted in Gelderland 1568**
- **why?**

Dirk Hartog 1616 **de Vlamingh 1697**



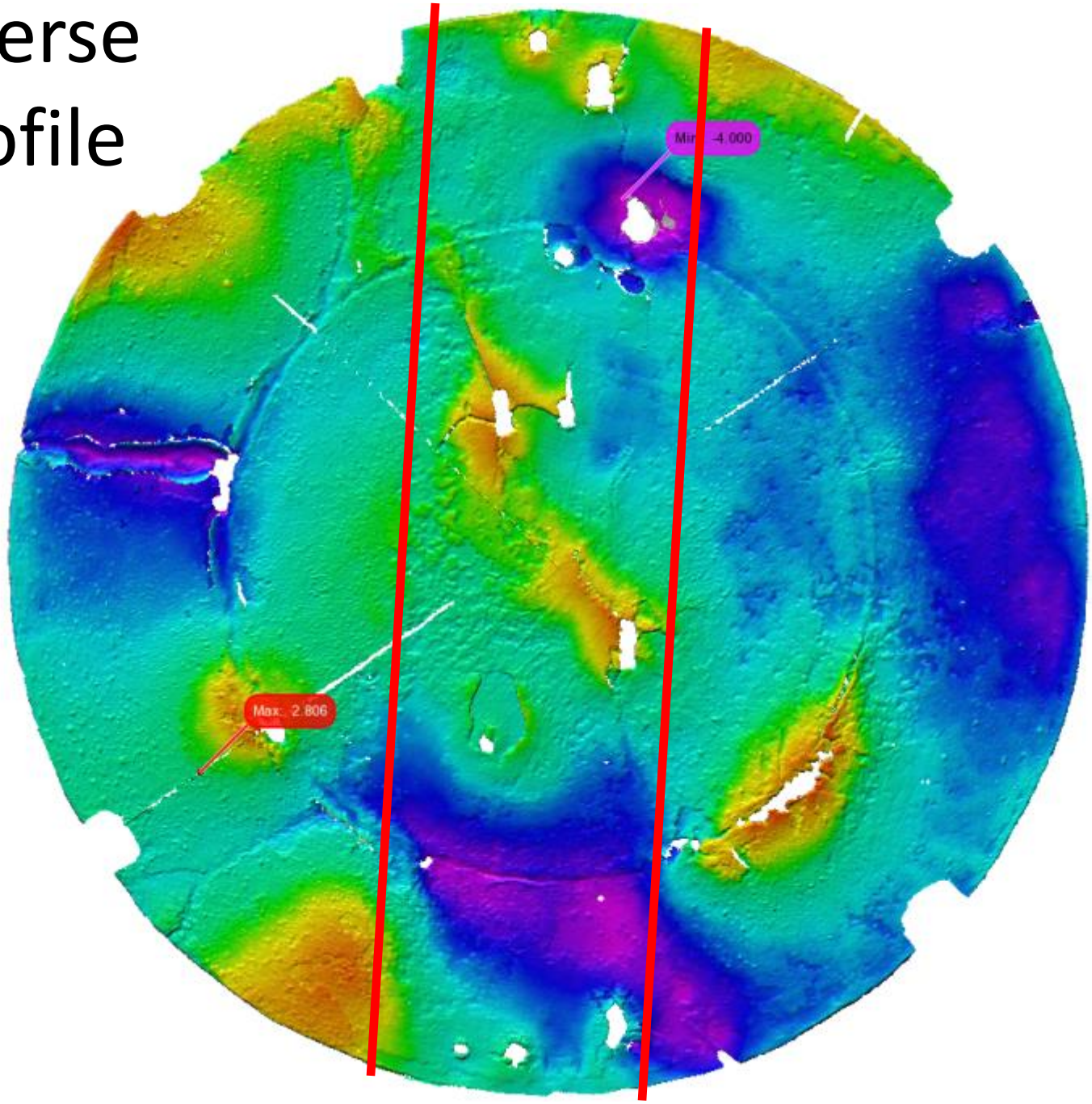
1445 gram, 370 mm diameter, 5.55 mm thick **very fragile & precious**


Mobilisation of surface from crystallisation of liquid matrix
Letters are made with a punch

Radiating stress lines from Fe & Cu nail holes

60 kV 2 minutes

reverse profile




knife marks

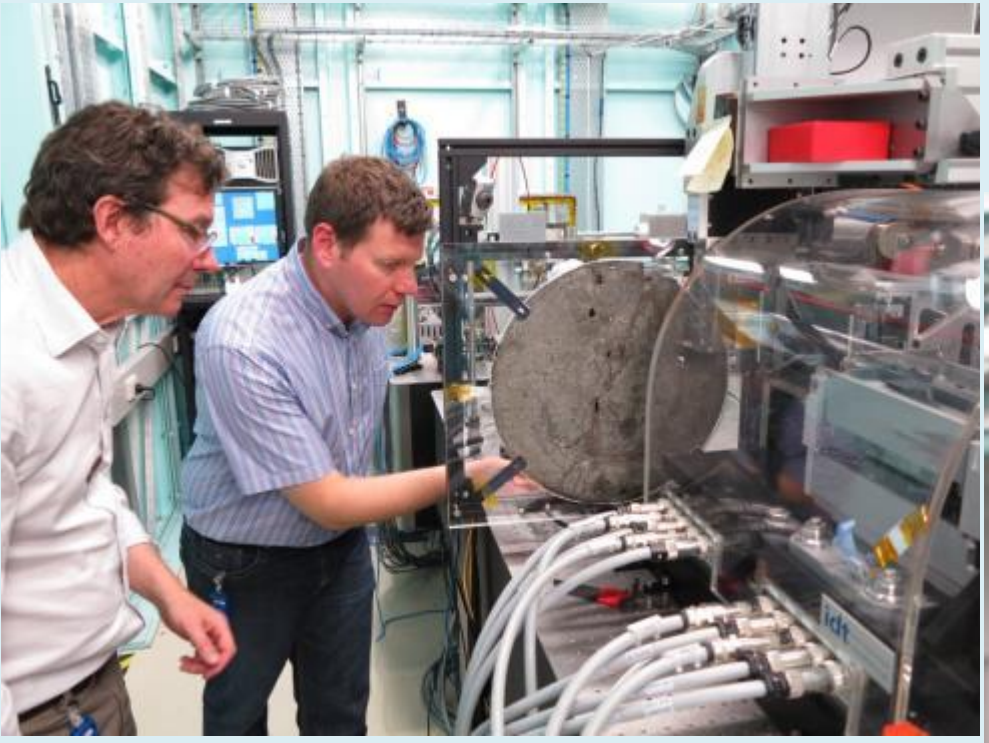
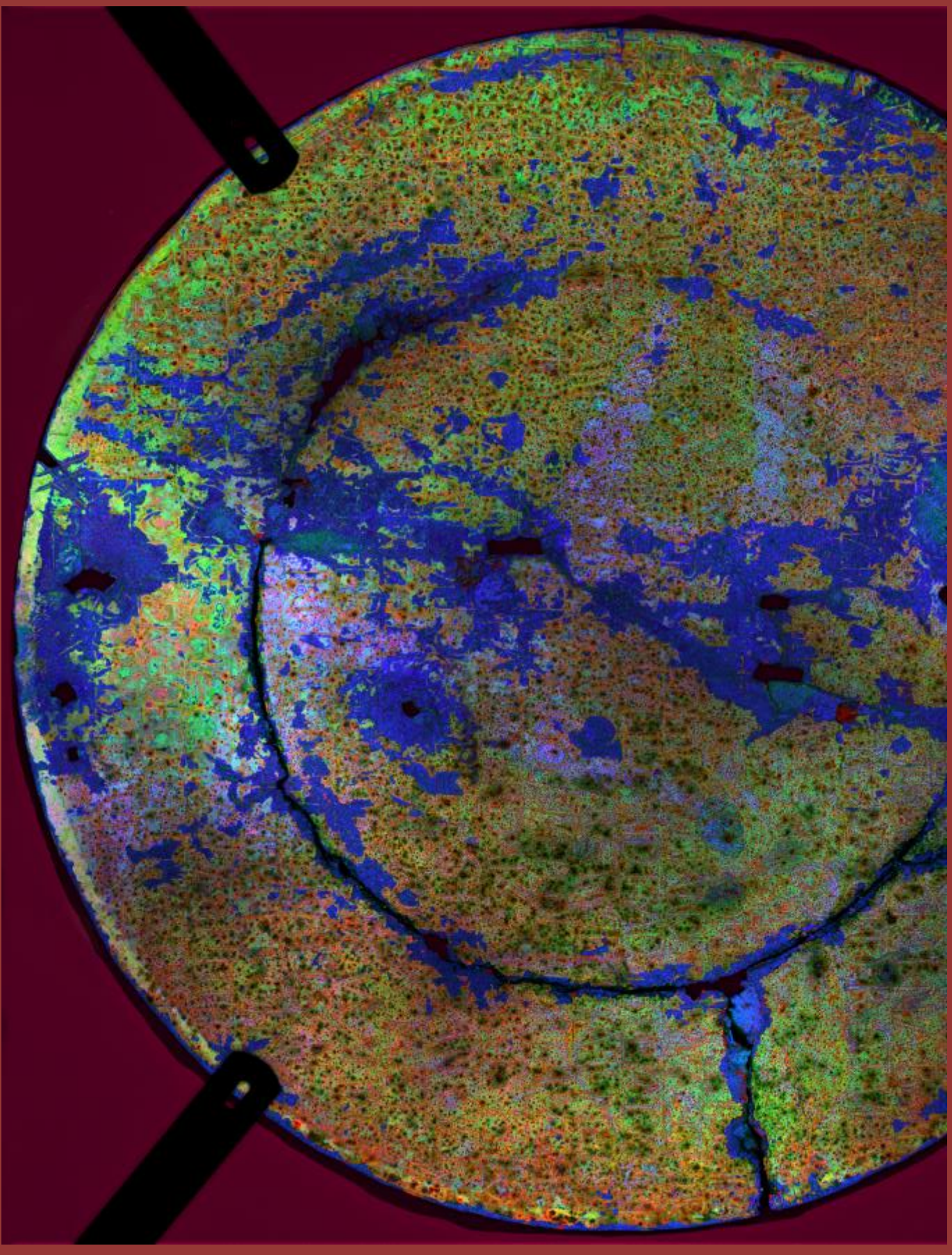


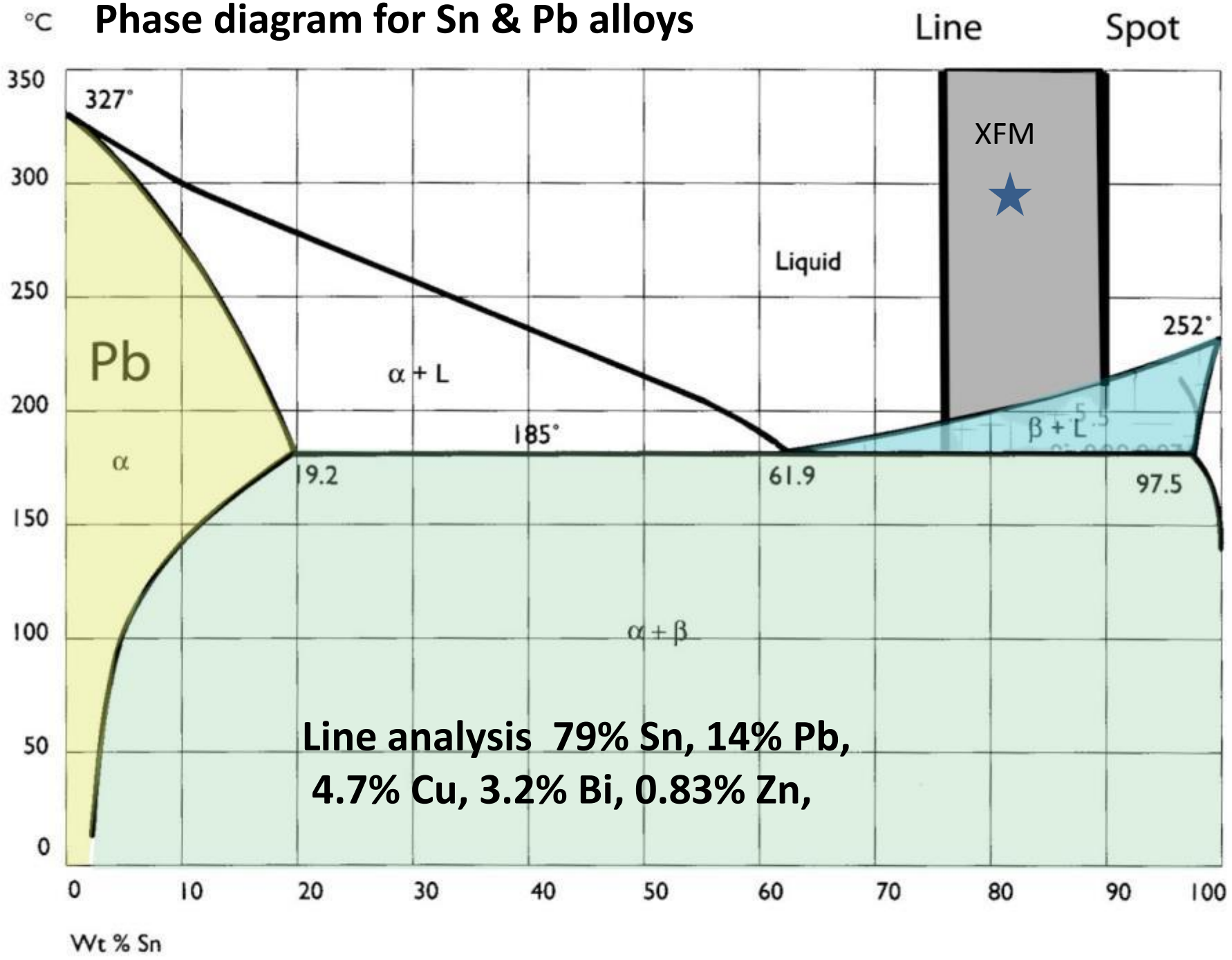
plate very fragile
corroded pewter

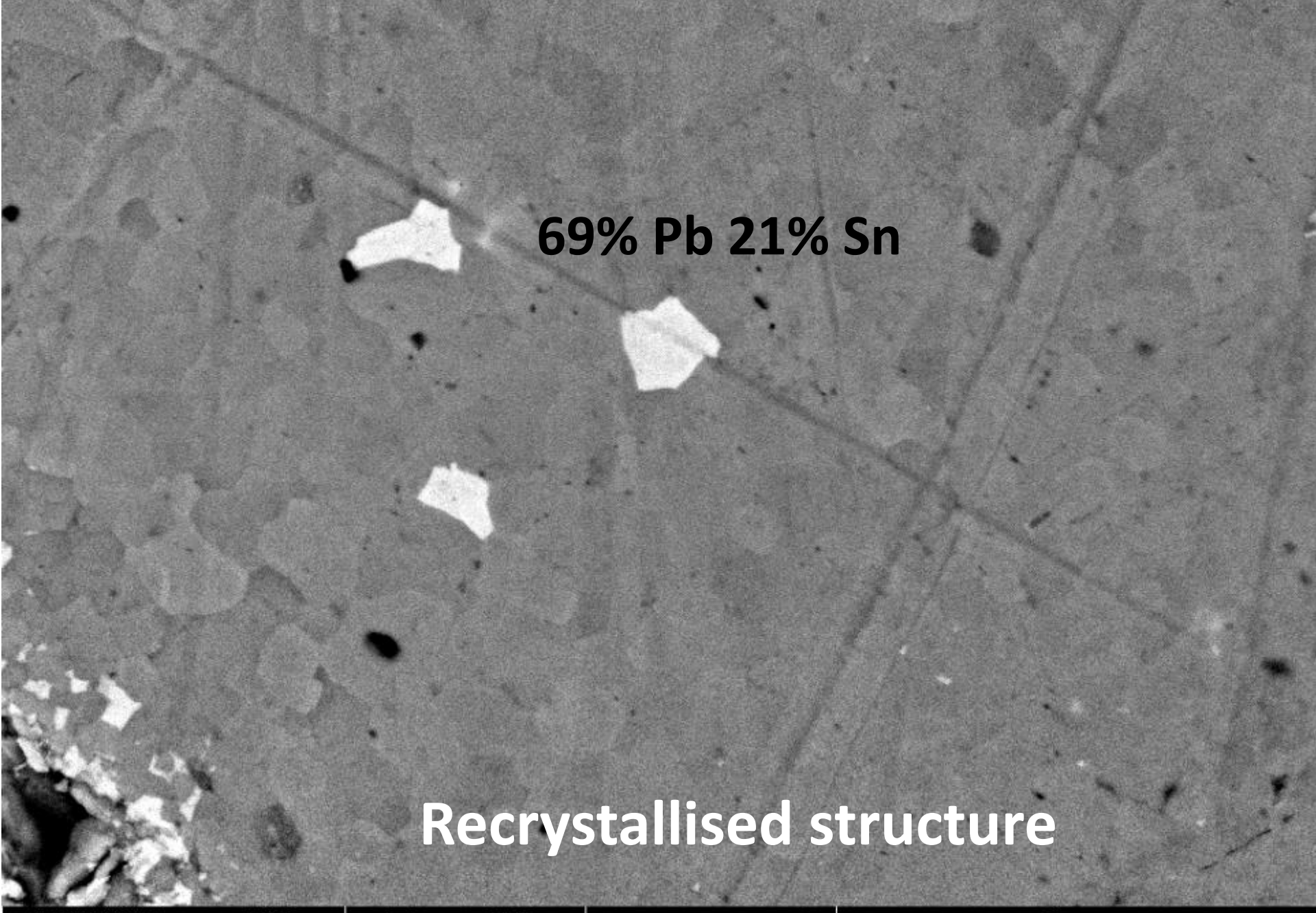
Perspex mount
foam isolation under
spring steel holders

combined Pb, Cu, Zn

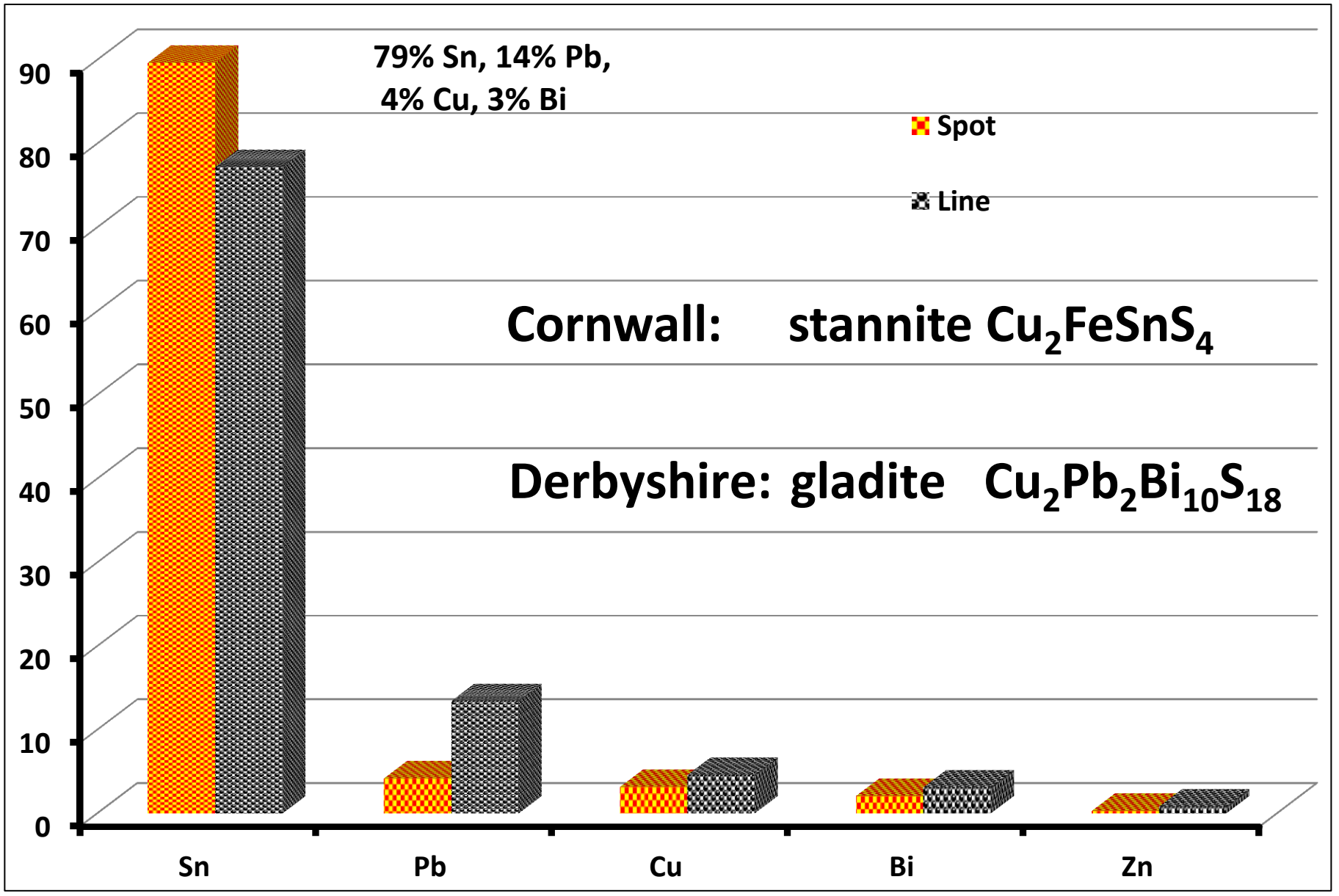


Phase diagram for Sn & Pb alloys




69% Pb 21% Sn
Recrystallised structure
6/20/2013
4:33:20 PM
HV
10.00 kV
det
CBS
WD
4.8 mm
mag
25 000 x
spot
3.0
3 µm
MCEM Nova NanoSEM 450

ICP-MS analysis of the de Vlamingh plate

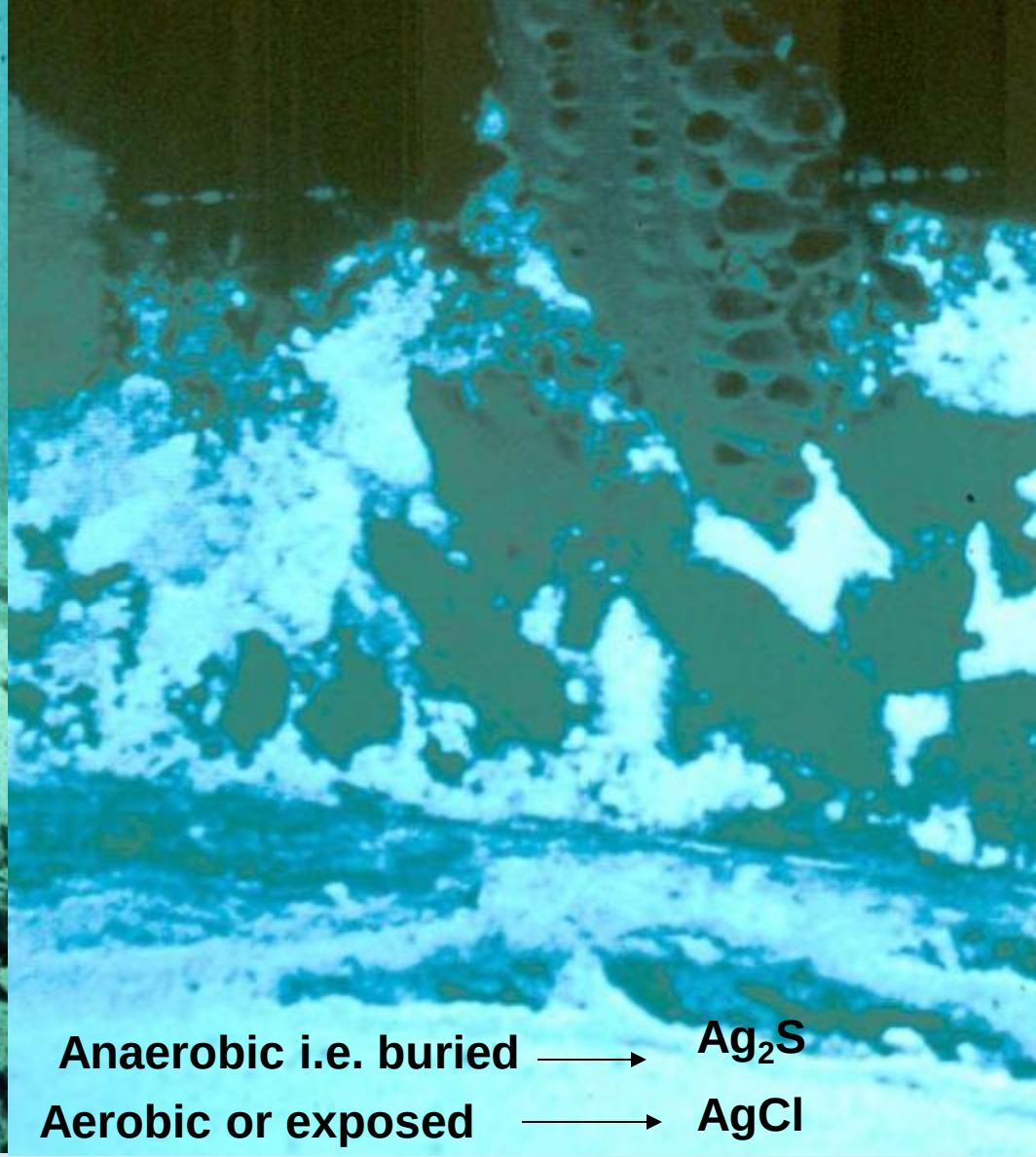


HMS *Sirius* (1790) sank at Norfolk Island

hundreds of ballast pigs,
a few anchors
a couple of cannon


in-situ electrolysis removes chlorides
stabilizes degraded
mushy matrices
3 years of treatment in the surf extracted
78 kg Cl-


8-2-23

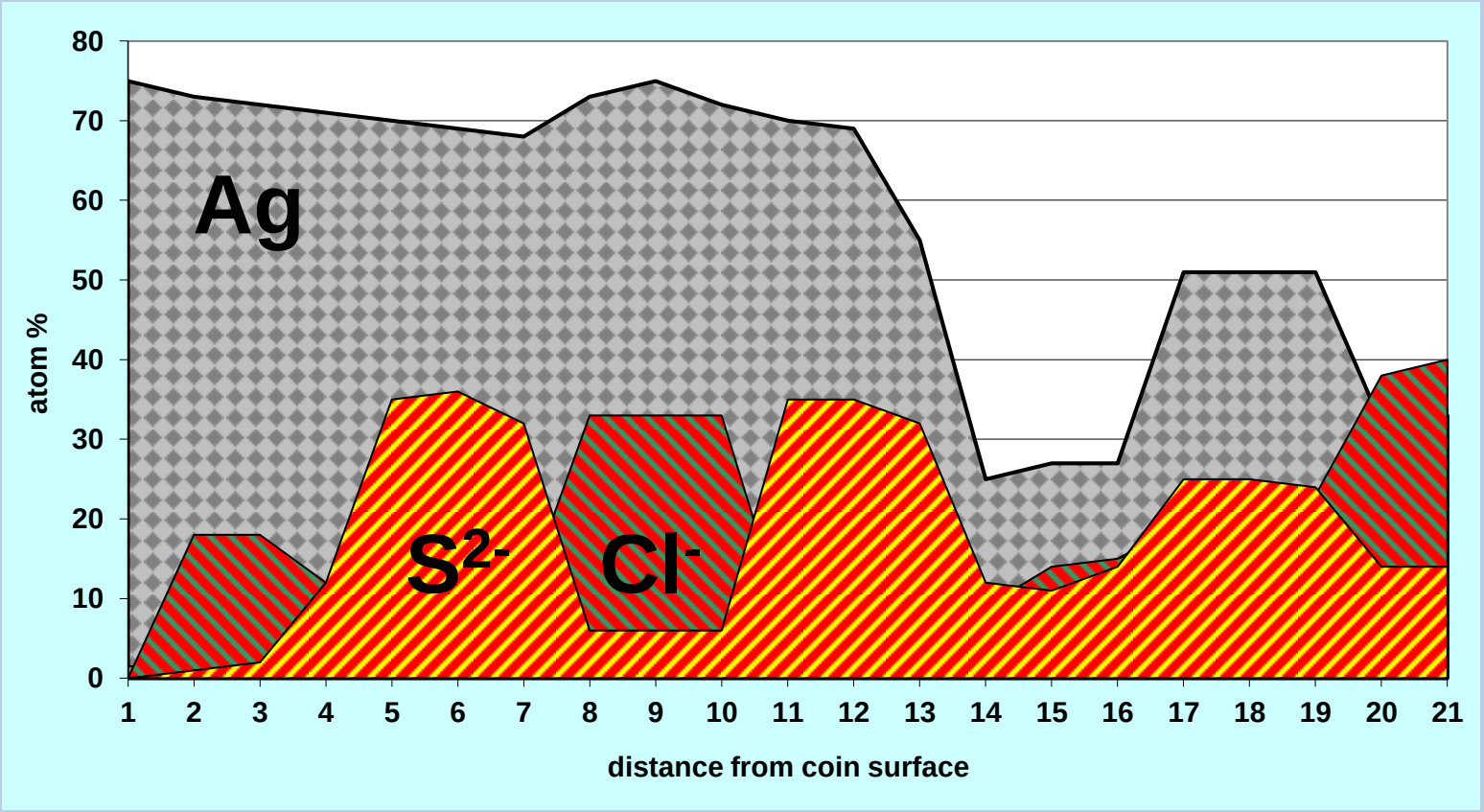


Coins have dates & assayers names

which really helps the archaeologists

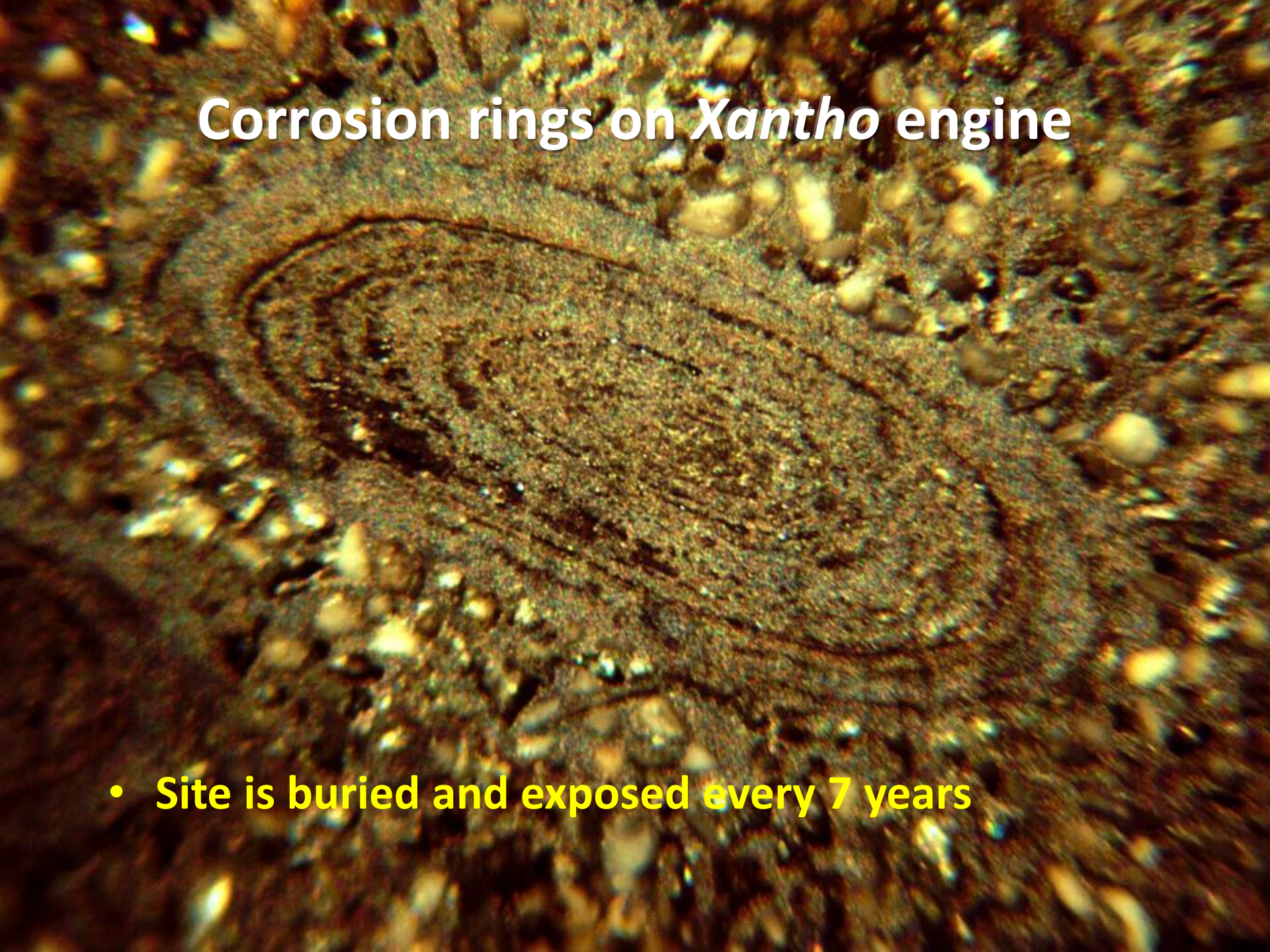
Cyclonic action at the Ningaloo reef

bands of sulphide & chloride



MacLeod & North: E_{corr} and pH measurements on engine in 1983

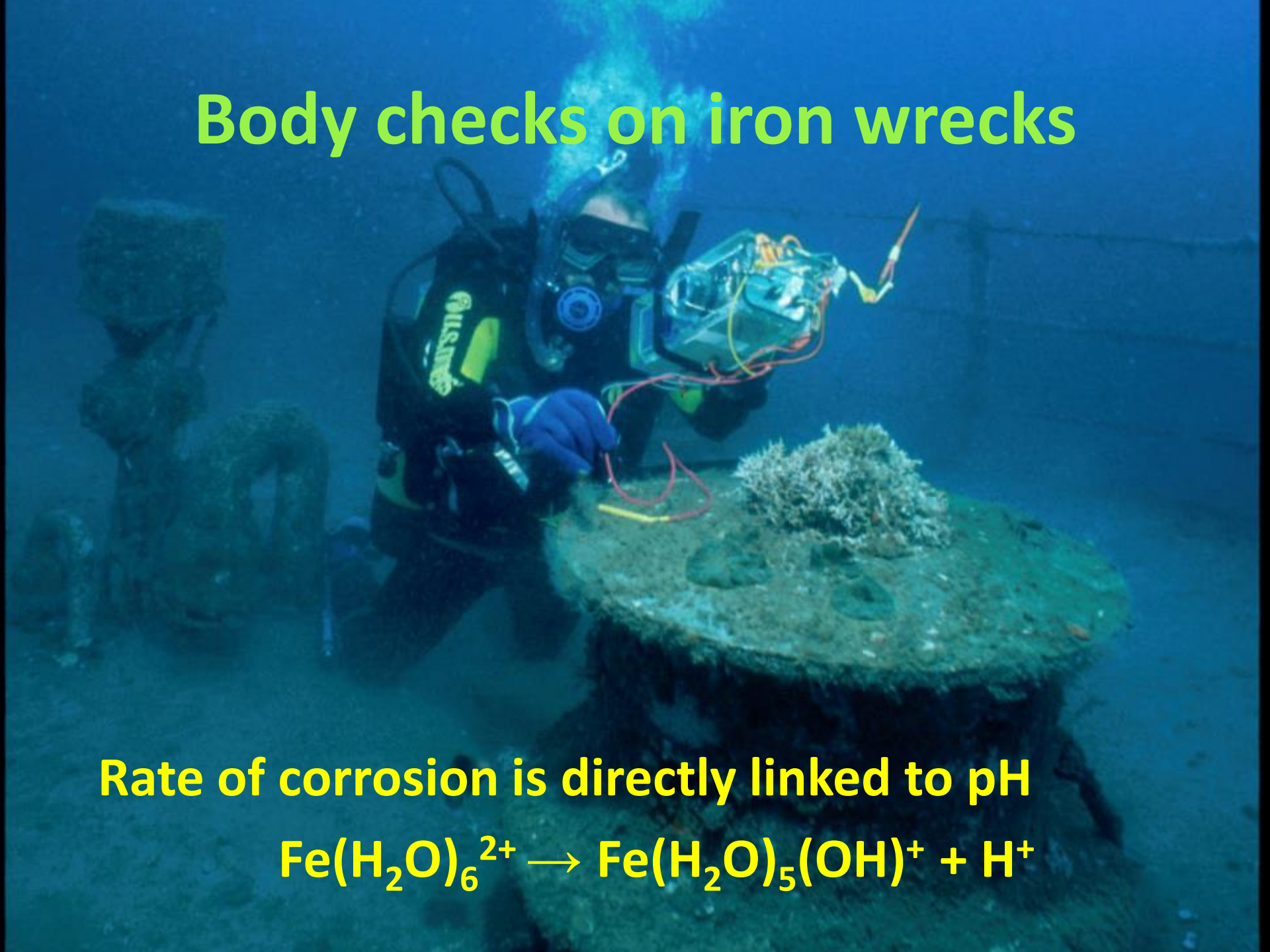
Corrosion rings on *Xantho* engine



- **Site is buried and exposed every 7 years**


recovery angle
the stranding angl
Good casting

Body checks on iron wrecks

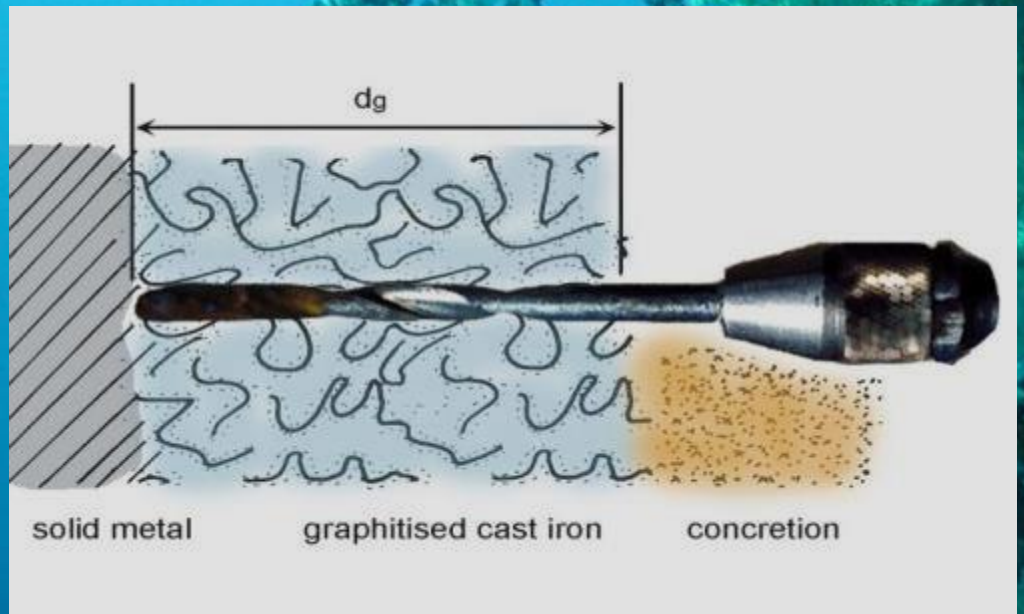


Rate of corrosion is directly linked to pH

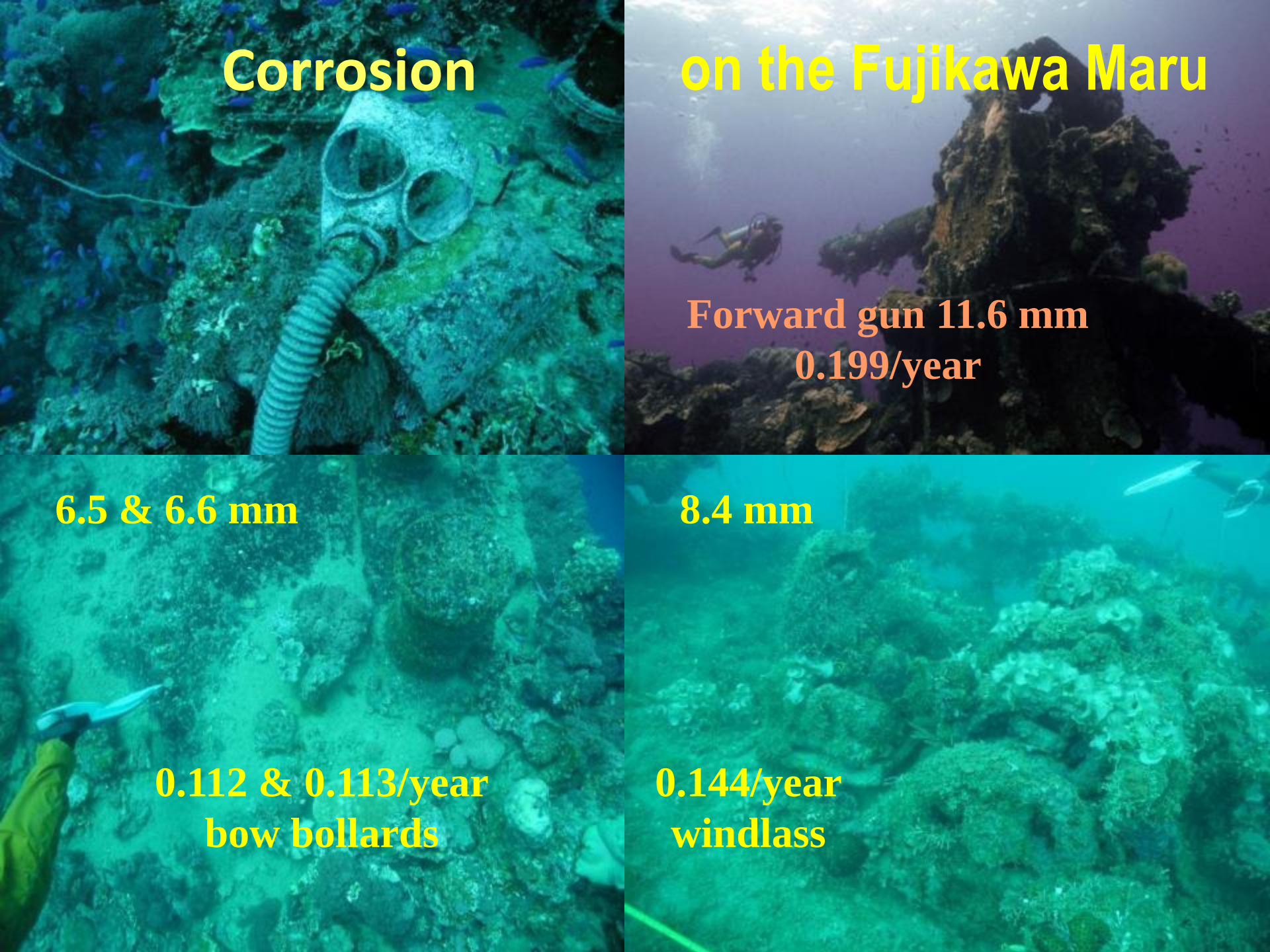
$$Fe(H_2O)_6^{2+} \rightarrow Fe(H_2O)_5(OH)^+ + H^+$$

Graphitisation of cast iron

$$\log d_g = 0.758 - 0.26\ pH$$



Corrosion rate mm/year


Corrosion
on the Fujikawa Maru
Forward gun 11.6 mm
0.199/year
6.5 & 6.6 mm
0.112 & 0.113/year
bow bollards
8.4 mm
0.144/year
windlass

HMS *Pandora* (1791) watch

before & after conservation