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Dating Post Mortem Submersion Interval (PMSI) of mammal bone- initial findings by Micro-CT Scan

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Introduction

Twelve large mammal bones, associated with underwater archaeological excavations on four shipwrecks on the Western Australia coast, were analysed by Micro-CT Scan (Skyscan 1176). They all belong to the collections of the Shipwrecks Museum, a section of the Western Australian Museum in Fremantle, Western Australia.

The aim is the investigation of any physical modifications linked to underwater taphonomy and diagenesis of bone.

The shipwrecks are Batavia (sunk in 1629), Vergulde Draak (Draeck) (Gilt Dragon) (sunk in 1656), Zeewijk (sunk in 1727) and Rapid (sunk in 1811).

The underwater archaeological excavations were conducted between 1968 and 1980.

Western Australian Shipwrecks Museum



Batavia (1629)



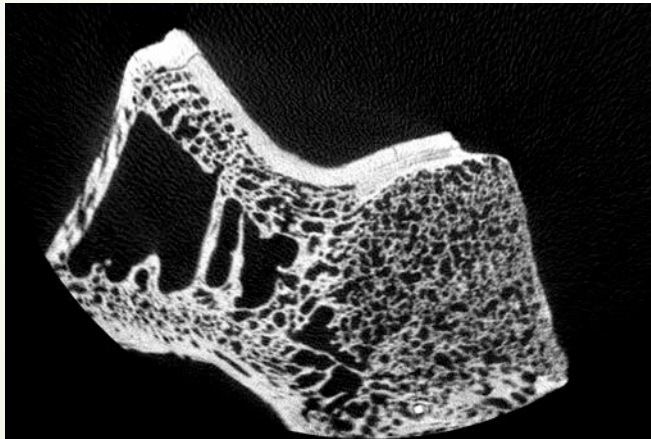
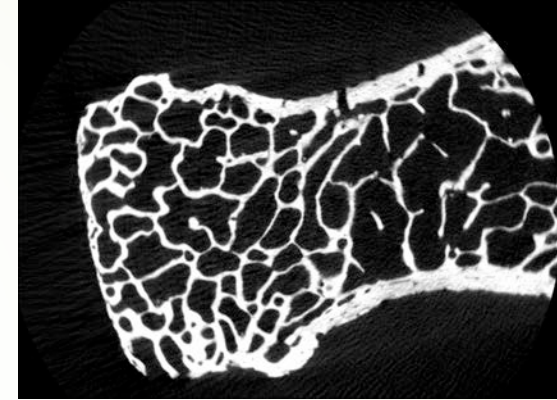
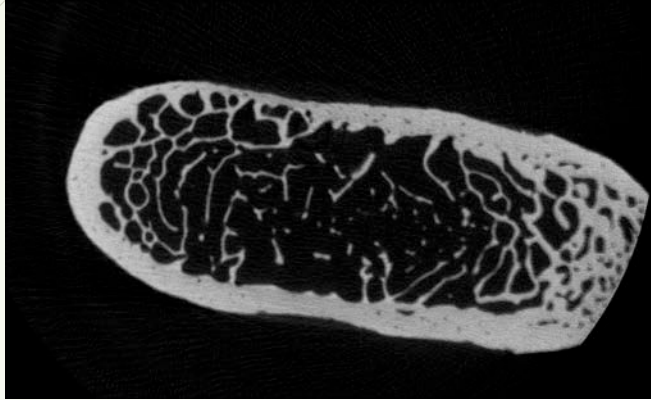
Courtesy of WA Shipwrecks Museum, 45 Cliff St, Fremantle 6160, Western Australia

Batavia (1629)



Courtesy of WA Shipwrecks Museum, 45 Cliff St, Fremantle 6160, Western Australia

Micro-CT Scan



Upper Left

Cortical bone: NO INTERRUPTIONS, DENSE

Trabecular bone: SPARSE HOMOGENEOUS RAREFACTION

Upper Right

Cortical bone: MOSTLY DENSE, INTERRUPTED ON THE UPPER SIDE

Trabecular bone : SPARSE REGULAR MODERATE RAREFACTION

Lower Left

Cortical bone: DENSE WHERE PRESERVED, HAIRLINE FRACTURE INTERRUPTIONS ON THE UPPER SIDE

Trabecular bone: HETEROGENOUS WITH AREAS OF COMPLETE DESTRUCTION IN CONTACT WITH NORMAL TRABECULAR BONE STRUCTURE

MicroCT Scans have been acquired, reconstructed and analysed at the Centre for Microscopy, Characterisation and Analysis (CMCA), The University of Western Australia

Vergulde Draeck (1656)



Courtesy of WA Shipwrecks Museum, 45 Cliff St,
Fremantle 6160, Western Australia

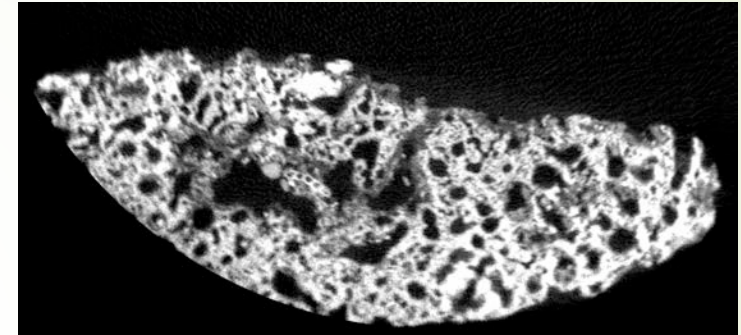
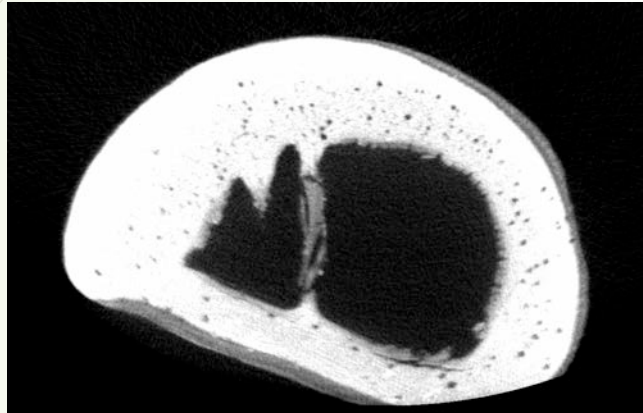


Vergulde Draeck (1656)



Courtesy of WA Shipwrecks Museum, 45 Cliff St, Fremantle 6160, Western Australia

Micro-CT Scan



Upper Left

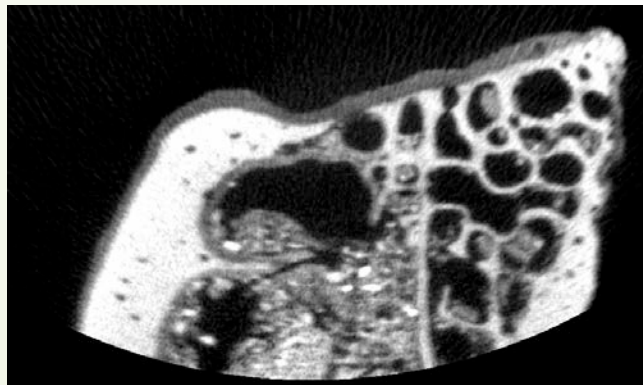
Cortical bone: DENSE AND HOMOGENOUS

Trabecular bone: ALMOST COMPLETELY DISAPPEARED, EXCEPT FOR ONE REMAINING "SEPTUM"

Upper Right

Cortical bone: ABSENT

Trabecular bone: SPARSE RAREFACTION AREAS WITH ENCLOSED FOREIGN BODIES



Lower Left

Cortical bone: HETEROGENEOUS DENSITY, PARTLY PRESERVED AND PARTLY ABSENT

Trabecular bone: LARGE DESTRUCTION MIXED WITH RAREFACTION AREAS ENCLOSING FOREIGN BODIES, ESPECIALLY CLOSE TO THE MID-LINE

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Zeewijk (1727)



Zeewijk (1727)



Courtesy of WA Shipwrecks Museum, 45 Cliff St, Fremantle 6160, Western Australia

Micro-CT Scan



Upper Left

Cortical bone: INTERRUPTED BY FULL-THICKNESS CRACKS, POROUS
Trabecular bone: DIFFUSELY RAREFIED

Upper Right

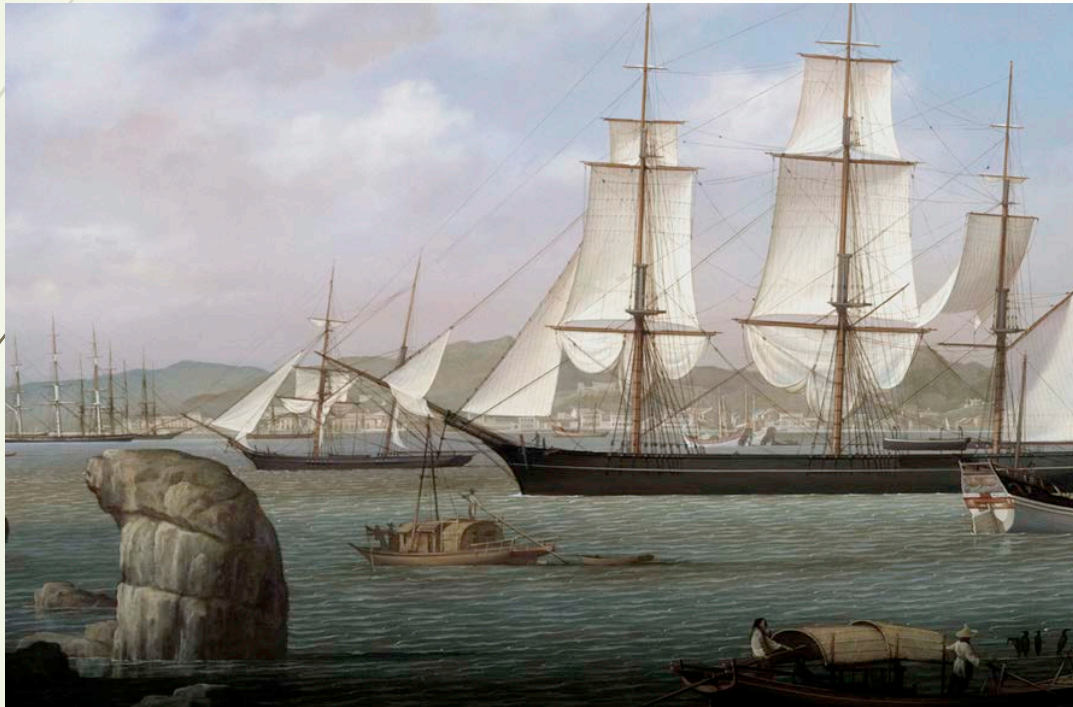
Cortical bone: MOSTLY DENSE WITH FOCAL SPARSE POROSITY
Trabecular bone: DIFFUSELY RAREFIED WITH REMAINING "SEPTA"

Lower Left

Cortical bone: MOSTLY DENSE WITH AREAS OF INCREASED POROSITY
Trabecular bone: ALMOST COMPLETELY ABSENT, TWO FULLY PRESERVED "SEPTA"

MicroCT Scans have been acquired, reconstructed and analysed at the Centre for Microscopy, Characterisation and Analysis (CMCA), The University of Western Australia

Rapid (1811)

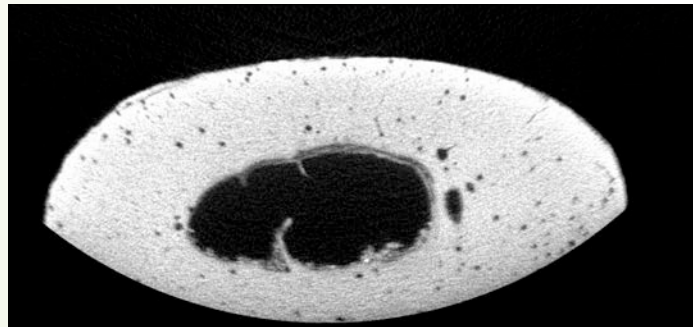
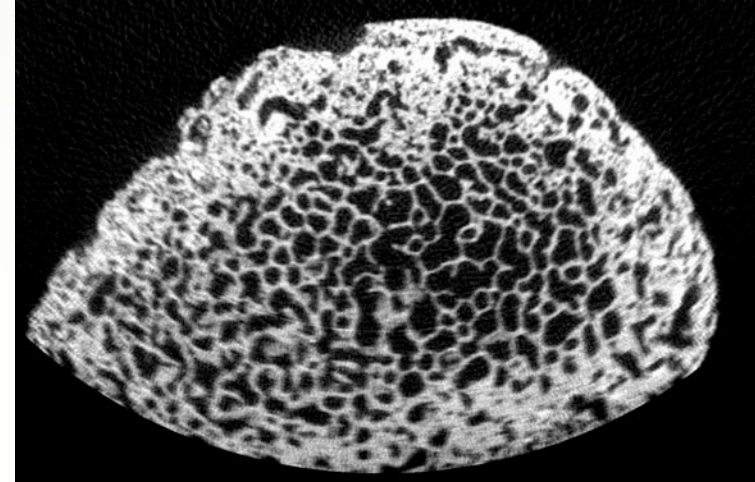
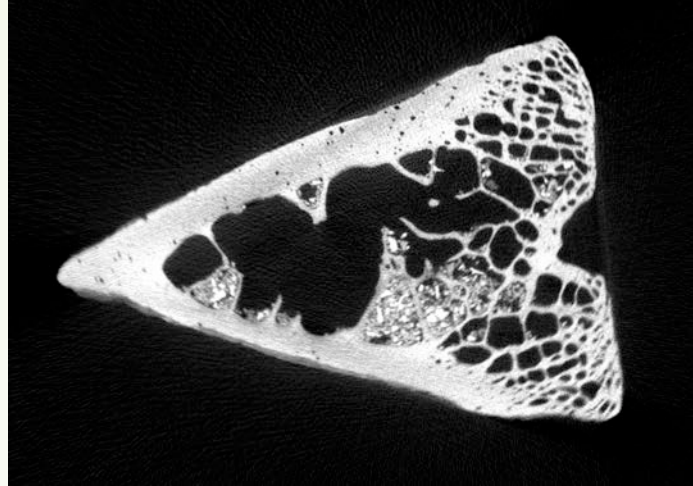


Rapid (1811)



Courtesy of WA Shipwrecks Museum, 45 Cliff St, Fremantle 6160, Western Australia

Micro-CT Scan



Upper Left

Cortical bone: COMPLETELY ABSENT ON ONE SIDE, SPARSELY POROUS ON THE REMAINING TWO SIDES

Trabecular bone: AREAS OF ALMOST COMPLETE DESTRUCTION IN CONTACT WITH DENSER TRABECULAE AND ENCLOSED FOREIGN-BODIES

Upper Right

Cortical bone: ABSENT IN MOST OF THE SECTION

Trabecular bone: MINIMAL DESTRUCTION IN CENTRAL AREAS OF THE SECTION. OTHERWISE HOMOGENEOUSLY MODERATELY RAREFIED

Lower Left

Cortical bone: PRESENT ON THE WHOLE SECTION, WITH PARTLY POROUS CONFIGURATION

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Conclusions

- Large mammal bones aboard historical ships were contained in barrels, as part of preserved meat.
- The time of uninterrupted submersion of the analysed bones in saltwater and sediment spans between 169 years (Rapid) and 347 years (Batavia).

Taphonomy (macroscopic)	Absence of soft tissues (dry bone), longitudinal and network cracks, artefacts of sample preparation (glue prints), metal concretions, perimortem and postmortem fractures, rodent teeth marks, cutting and chopping marks
Diagenesis (macroscopic)	Abrasion with fragmentation and extensive damages to the cortical bone, stains of different colors
<u>Micro-CT Scan</u>	<p>-<u>Increase in total porosity</u> due to full-thickness cracks and holes in the cortical bone, rarefaction of trabecular bone, areas of complete destruction</p> <p>-<u>Foreign bodies</u> enclosed among septa of the trabecular bone</p>
Ongoing research	<p>-Microscopic investigation of collagen degradation and of bioerosion</p> <p>-Elemental analysis</p>



References

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