



# Natural History Museum

## The Cold Truth: What happens to specimens after freezing?

Can low-temperature IPM treatment cause detectable physical changes to certain material types?

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### Introduction

In preparation for the relocation of approximately 28 million specimens to a new storage facility in Reading, the Natural History Museum (NHM) Conservation Team is reviewing integrated pest management (IPM) protocols for its collections. Many specimens are considered at risk due to their material composition, storage environment, or proximity to other vulnerable collections. However, for certain object and specimen types, limited or no published guidance exists regarding their suitability for low-temperature IPM treatment.

### Types of materials analysed

#### Archaeozoological Osteology



Specimens are more brittle than recent osteological material due to lost organic matrix. Teeth are at risk from their structure and weak enamel-dentine junction. Some retain soft tissue which is a pest risk.

#### Recent Echinoderms



Sea urchins have mineral plates and spicules bound by organic tissue, which may crack or disarticulate when frozen due to uneven expansion and shrinkage. Their delicate surface details are also prone to warping or damage.

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### Scope

Since June 2024, a selection of unregistered, representative specimens identified as potential IPM risks has been borrowed for a series of controlled tests. The primary objective is to detect physical changes associated with low-temperature exposure, using high-magnification imaging to identify signs of potential material damage.

Additionally, the study is evaluating the effectiveness of different packing methods during freezing (see methodology). Findings from this research will inform both move-specific and wider NHM IPM protocols, ensuring material-appropriate risk management strategies are in place for future collections care.

#### Recent Gastropods and Bivalves



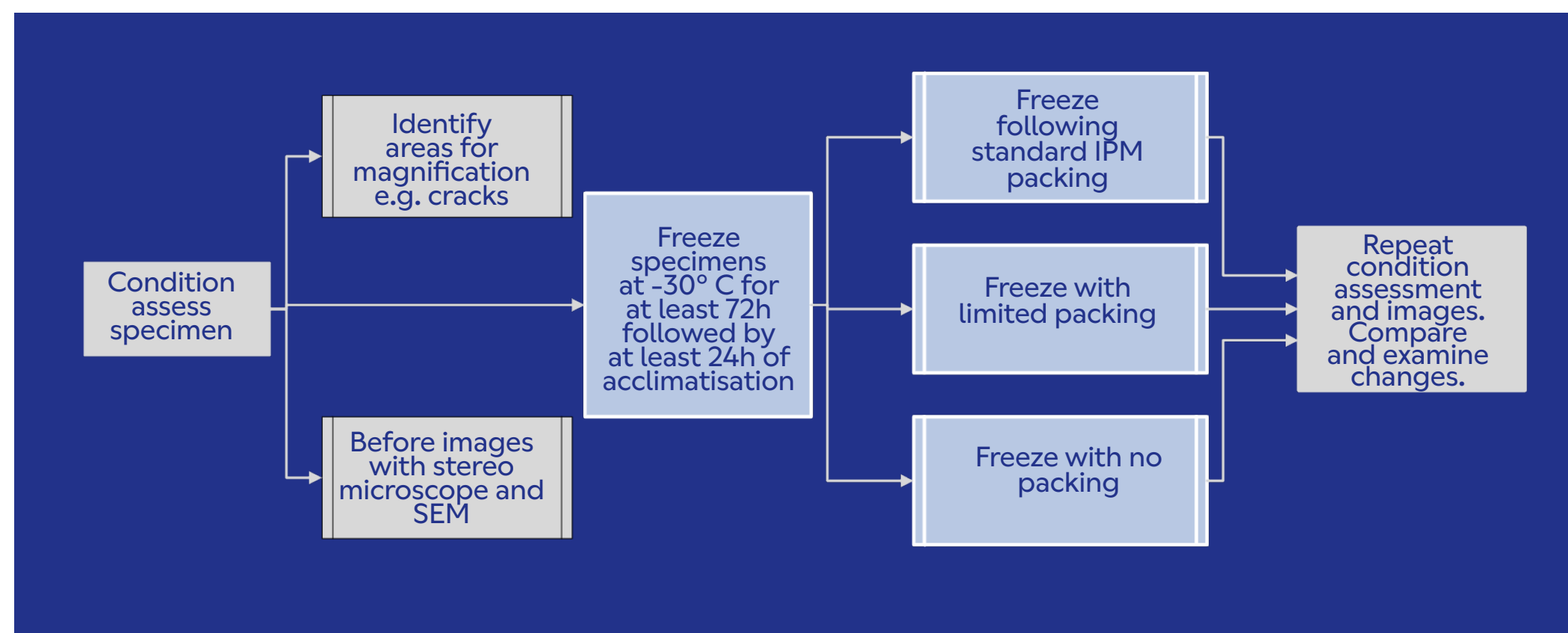
Shells with a periostracum (thin, organic coating that is the outermost layer of the shell) are at particular risk to freezing as they might have different rates of expansion and shrinkage which can lead to cracking.

#### Ivory



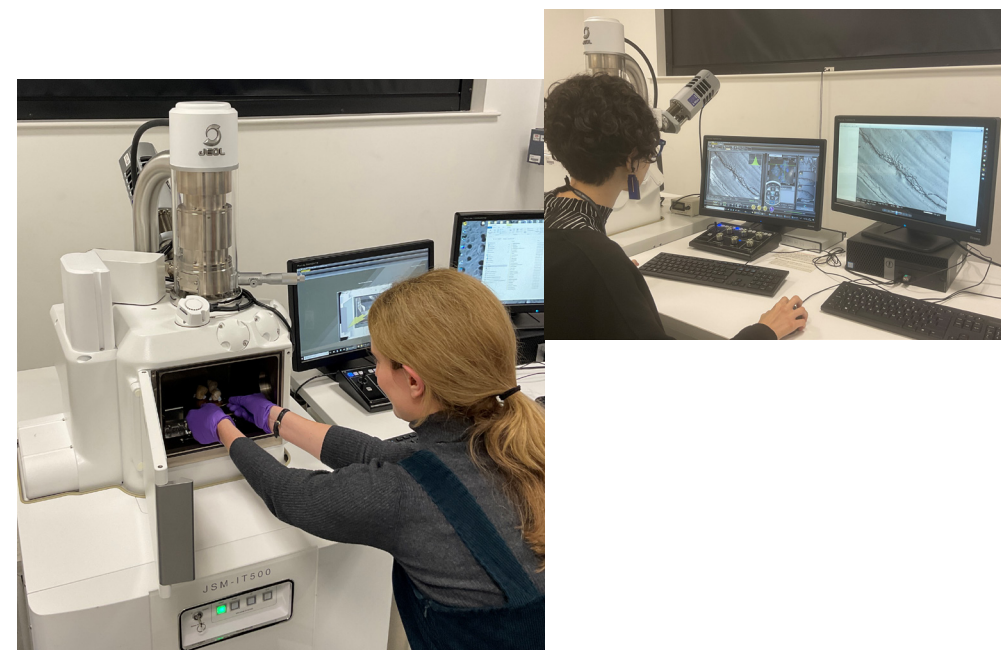
As well as containing organic and mineral components, ivory has a very porous microstructure and is likely to harbour internal moisture. This moisture can expand when frozen causing cracks. Ivory's lamellar structure can also be at risk of delamination and cracking. Worked ivory will also have areas of existing stress where carved.

### Methodology



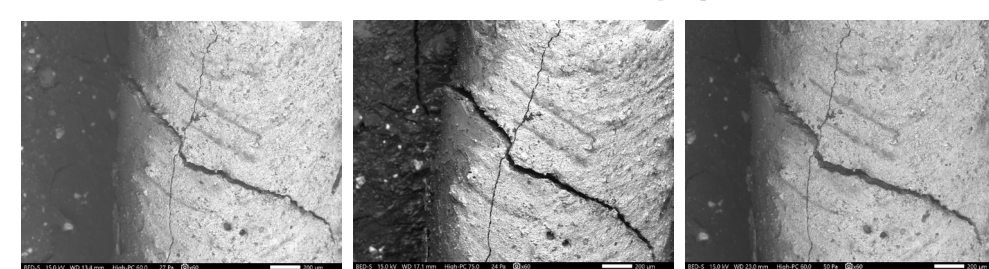
### SEM process

An environmental SEM (JEOL IT500) was used for the tests and set on low vacuum between 30 and 70 Pascals, depending on the sensitivity of the object.



### Results

#### Archaeozoology

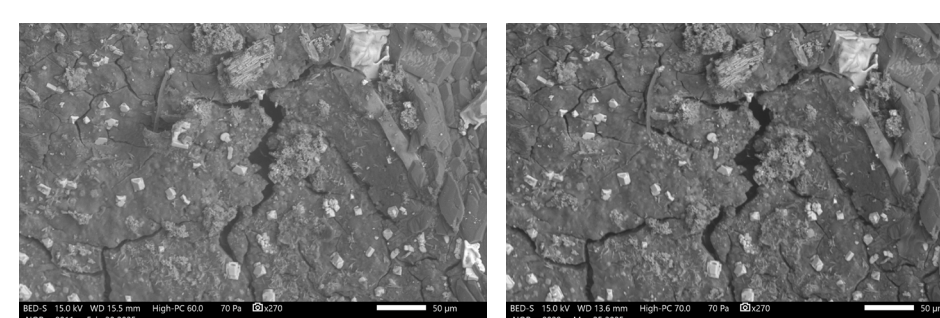


Images above: An area of cracked tooth on the left jaw showed no obvious changes after 2 freeze cycles following standard packing, (middle) and limited packing (right).

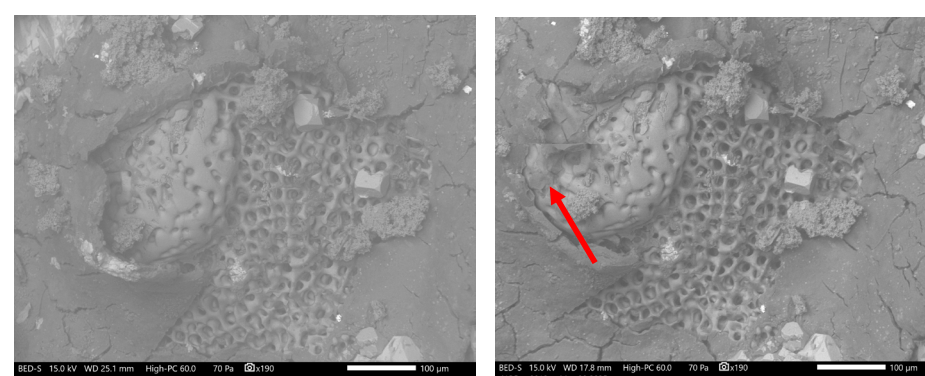


Images above: An existing crack showed no difference after being frozen following standard packing (middle) but expanded after being frozen using no packing materials (right).

#### Echinoderms



Images above: No changes on existing deep cracks before (left) and after (right) freezing.



Images above: Despite not being frozen, the control sample showed areas of minor loss which could be due to handling and/or the SEM process.

### Conclusions and future plans

Findings so far show that cracking and delamination can occur when specimens are exposed during freeze treatment, but most material types are protected from damage when adequately wrapped. More research into ivory is required, as observed damage may have resulted from the SEM.

Future plans:

- Re-test ivory rings using alternative imaging techniques
- Expand testing to include more material types.

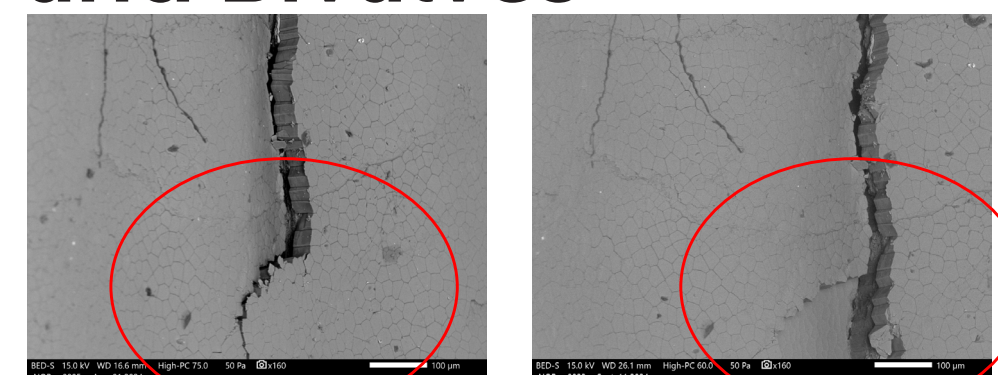
**Pre-freeze:** Areas of interest were mapped and documented using the SEM, with a focus on existing micro-fractures, cracks and delamination.



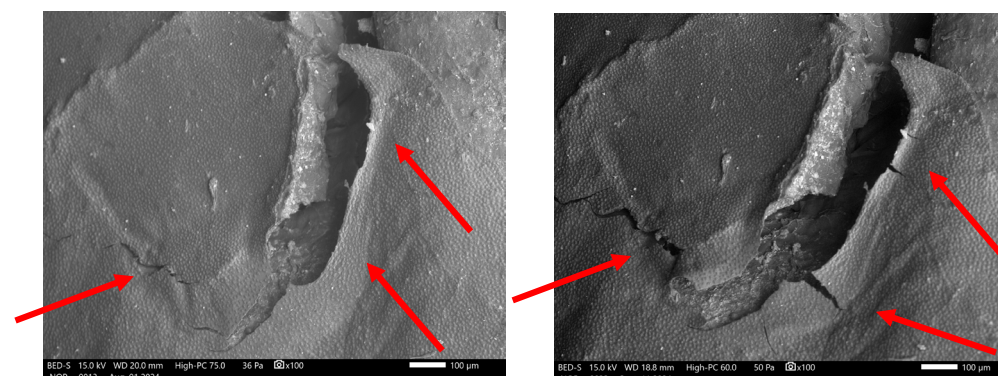
**Post-freeze:** After ensuring the specimen is aligned in the same orientation, areas of interest were examined and compared against the pre-test images.



#### Shells: Gastropods and Bivalves



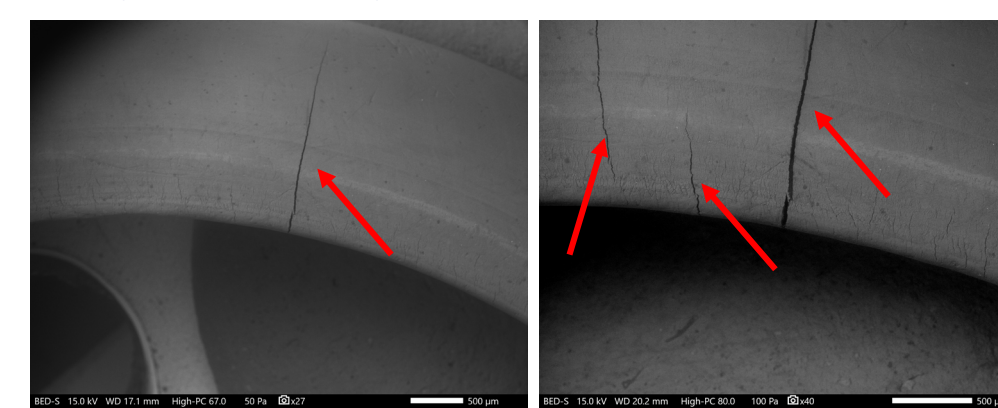
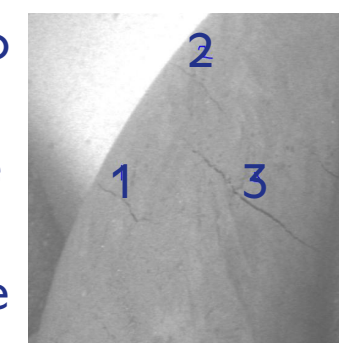
Images above: Atrina bivalve with clear area of loss between images of before (left) and after (right) freezing.



Images above: Gastropod shell with new cracks after freezing clearly present between images before (left) and after (right).

#### Ivory

3 worked ivory rings were tested (standard packing, no packing and one kept as a control). The cracks in all the rings were mapped under SEM before testing (example image on the right).



Images above: All the rings, including the control, presented new or expanded cracks following the second examination under SEM.

### Acknowledgements

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### Existing Literature

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