Experimenting with anoxic microenvironments

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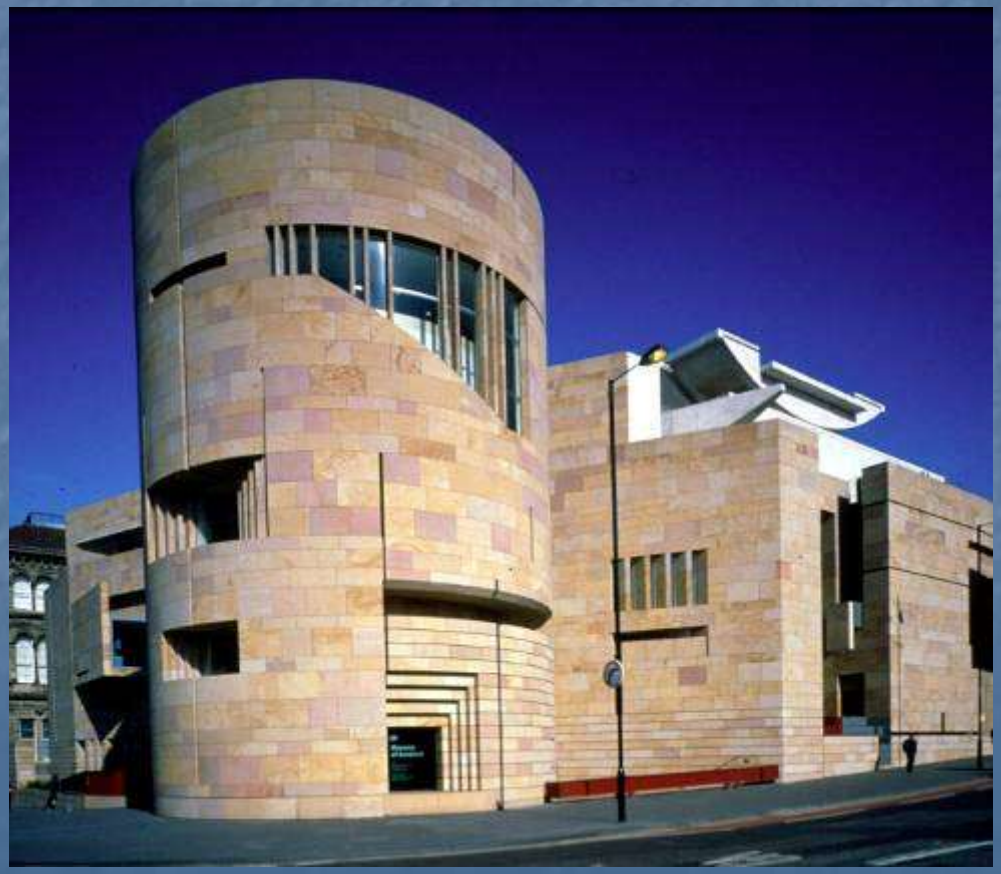


I propose to deal with the topic in three parts

1. Firstly introduction to NMS geology collections
2. Then our anoxic microenvironment experiments and the results
3. And finally, looking to the future

NMS geological specimens

- Fossils
  - Invertebrates approx. 200,000
  - Plants 10,000
  - Vertebrates approx. 22,000

  Around 6% of the fossils will need special conditions with low humidity and oxygen free environments (e.g.: Lothian coal fields)

- Rocks approx. 40,000

  Around 25% will need special conditions:
  - Low Humidity for those with organic material
  - High Humidity for shells, cores, etc.
  - Storage with easy accessibility for large specimens

NMS geological specimens

- Minerals approx. 75,000
  - Minerals needing high RH and high T
    e.g.: Epsomite need T 25 °C and RH 36 to 53%
  - Minerals needing high RH and low T
    e.g.: Borax, Laumontite, Morenosite.
  - Minerals needing high RH and only stable T below 32°C
    e.g.: Mirabilite (At low RH and temperatures will melt)
  - Minerals needing low RH
    e.g.: Carnallite, Halite, Sodium minerals or associates (as photo)
  - Low RH in amber causes surface deterioration

NMS Geology Section actions

- At the moment, only specimens considered to be at risk of pyrite decay or specimens that have been treated for pyrite decay are stored in laminated low-oxygen enclosures.

  Oxygen levels are kept at 0.1% (maintained by the use of oxygen scavengers within the enclosures)

  Relative Humidity between 30–35%

- The treatment used for Pyrite Decay is explained in Waller 1987: minerals and fossils are exposed to an ammonium hydroxide and polyethylene glycol (PEG 400) solution in a sealed container.

Pyrite Decay in COAL

Pyrite without ammonia treatment

Pyrite with ammonia treatment

Anoxic Microenvironment Experiment

- Existing low-oxygen enclosures in storage did not give uniform readings.
- An experiment was designed to test combinations of materials and processes.
- Experiment was to test materials only therefore specimens were not included.

Materials and equipment

- Cardboard boxes
- Barrier films
  - Escal: ceramic-deposited gas and moisture barrier polymer film
  - BDF 200: oxygen and moisture barrier film
- Oxygen scavengers:
  - Ageless Z: removes oxygen
  - Ageless RPA-5: removes oxygen, moisture and corrosive gases
- Oxygen Indicator Eye is an in-package colour change monitor for oxygen levels
- Sealers:
  - Electric heat sealer: Audion Sealmaster 620
  - Escal clip
- Humidity indicator cards

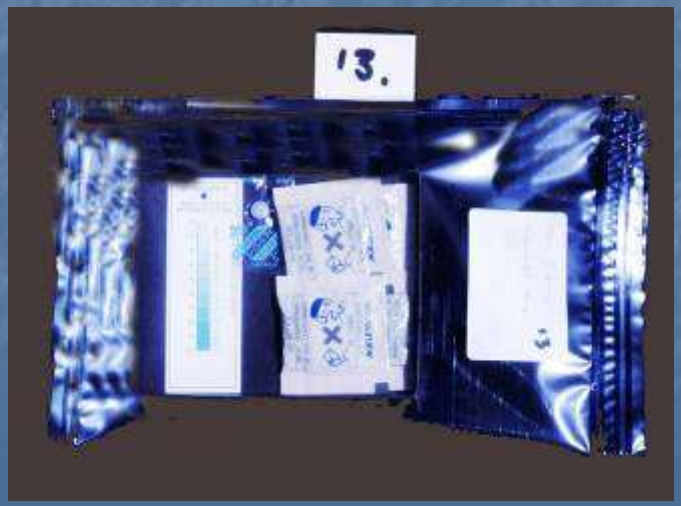
Experimental Method

- Select a container and estimate its oxygen volume
- Select oxygen barrier film, cut and make a bag to enclose the container
- Heat-seal three sides of bag
- Place container in bag
- Choose type of oxygen scavenger and calculate the number required. Place them inside bag
- Put oxygen indicator eye(s) and humidity indicator card inside bag
- Heat-seal bag, leaving a small gap for possible flushing with oxygen-free nitrogen
- Purge oxygen from bag using oxygen-free nitrogen for around 30 seconds
- Seal bag using heat or clip

BDF 200 and clip

Escal and clip

BDF 200 and seal

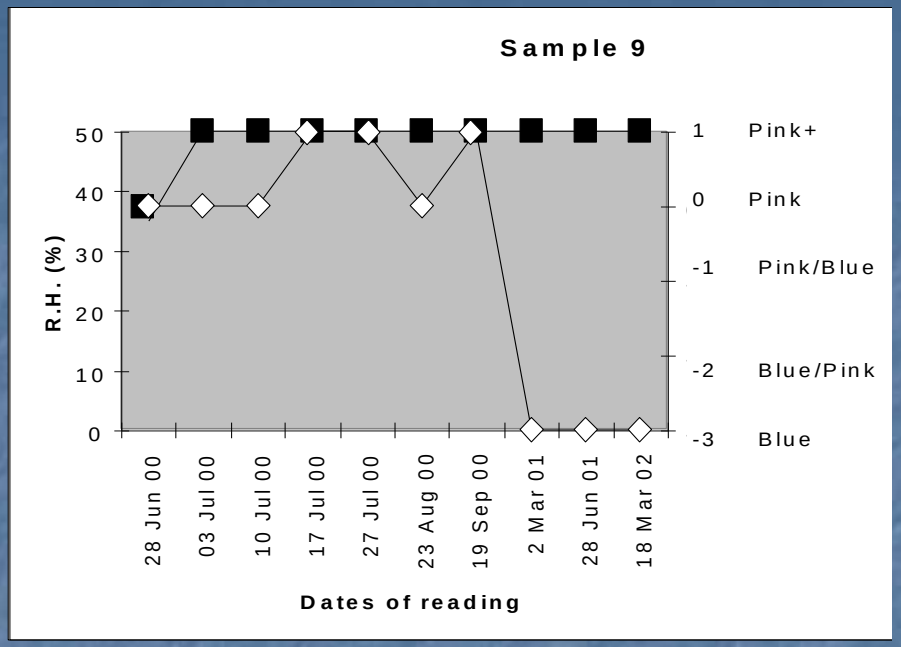


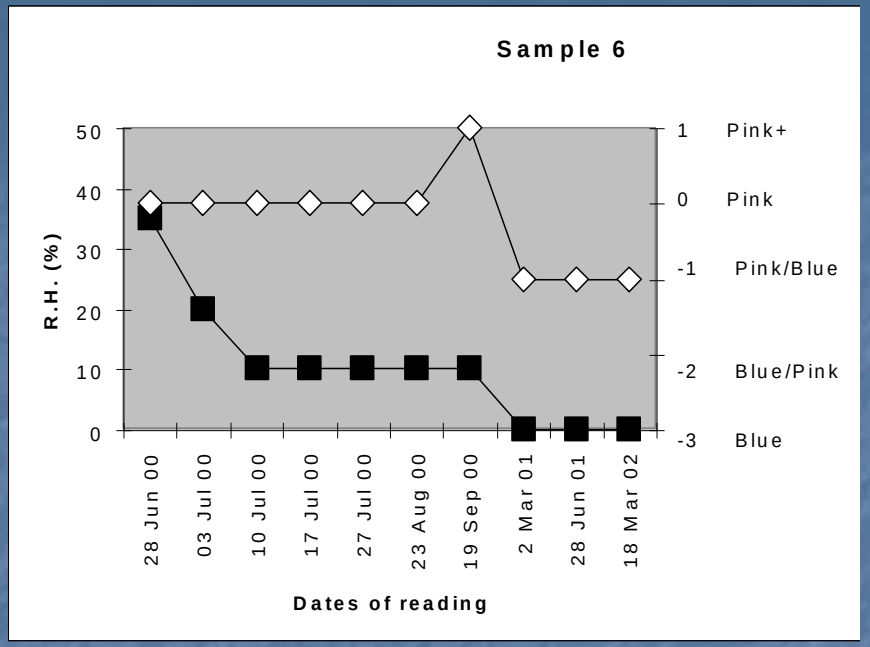
Escal and seal

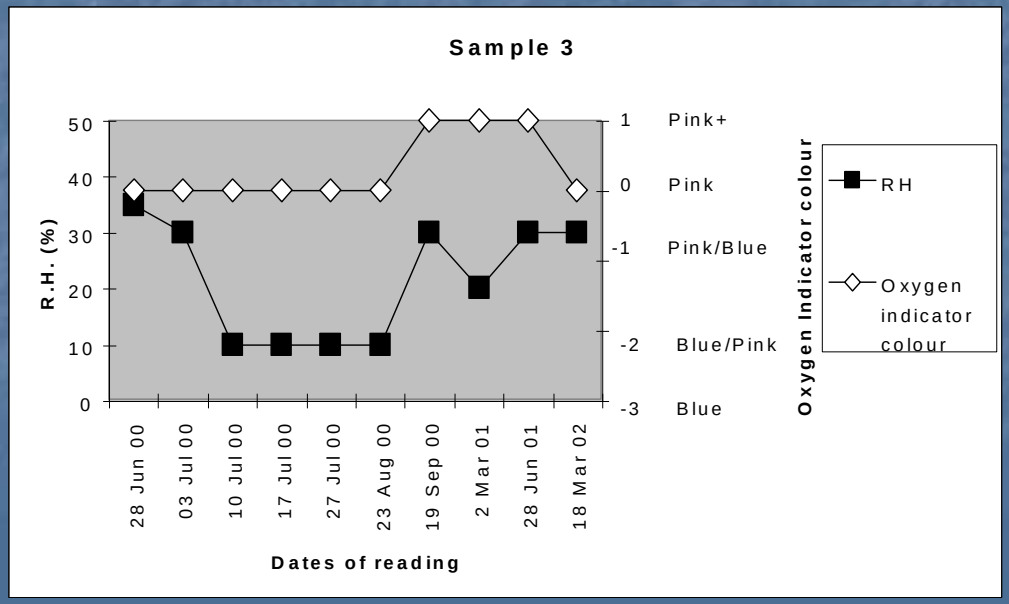
Combination of materials

Starting date and sample numbers **28 June 2000**	Presence (1) or absence (0) of **ESCAL** ceramic barrier film	Presence (1) or absence (0) of **BDF 200** barrier film	O_2 Scavenger **Ageless Z** Number of sachets used	O_2 Scavenger **Ageless RPA-5** Number of sachets used	Presence (1) or absence (0) of **N_2**	Presence (1) or absence (0) of **Escal Clip**	**Heat Sealer** Setting	**Ageless eye** Colour when started
1	0	1	2	1	0	0	5	Pink
2	0	1	2	1	1	1	5	Pink (eye broken)
3	0	1	2	1	1	0	5	Pink
4	0	1	0	1	0	0	5	Pink
5	0	1	2	0	1	1	5	Pink
6	1	0	0	1	1	1	5	Pink
7	1	0	0	1	1	1	5	Pink
8	1	1	2	1	1	1	5	Pink (eye broken)
9	1	0	2	0	1	1	5	Pink
10	0	1	4	0	0	0	5	Pink
11	1	0	0	2	0	0	5	Pink
12	0	1	0	2	0	0	5	Pink
13	1	0	4	0	0	0	5	Pink

RH at start 30-40%



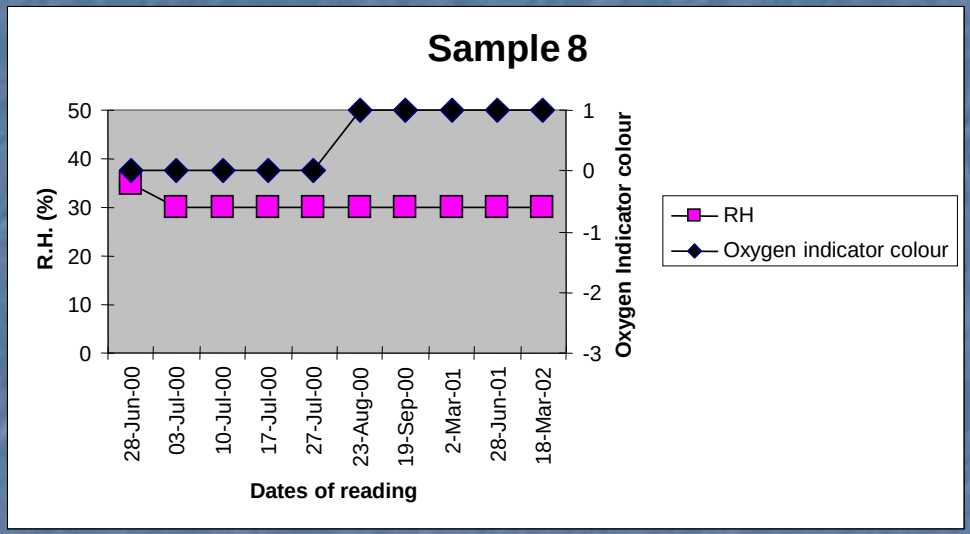




P+= 1, intense pink (as received in manufacturer's enclosure)
P = 0, oxygen-free;
P/B = -1, slight oxygen presence;
B/P= -2, intermediate oxygen presence;
B= -3, full oxygen presence.

Escal and BDF 200 Barrier Films

- Bdf 200 internally and Escal externally produced the best enclosure with RH 30-35% (Sample 8)
- Both films perform similarly
- Escal appears to maintain the RH levels suitable for pyrite decay treated specimens
- Bdf 200 does not appear to keep humidity stable for long periods
- Films must be completely flat for perfect sealing
- Possible problems:
  - damaged or faulty film
  - exposure to UV light
  - creases on seal area
  - breach of the barrier films by sharp objects



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Oxygen Indicator eyes

- Eye colour indication
  - Pink: 0.1% or less oxygen
  - Bluish: 0.5% or more oxygen
- Colour change is often not as suggested by the manufacturer's literature. It is important to include more than one eye in any enclosure
- Estimation of the colour change was recorded by a single observer
- Eyes could be faulty or colour indication incorrect
- Broken eyes gave results consistent with unbroken eyes

Oxygen scavengers: Ageless Z and RPA 5

- Both types of scavengers worked well
- The addition of extra scavengers produced faster oxygen absorption
- Exposure to oxygen prior to use could make scavengers ineffective
- Scavengers may have been faulty
- Inappropriate quantities may have been used

Boxes, Sealers, Humidity indicators, etc

- Boxes could have had different humidity levels
- Escal clips seal efficiently
- Audion Sealmaster 620 also sealed efficiently
- Estimation of the colour shown by humidity indicators can vary from one observer to another
- Purging oxygen-free nitrogen appeared to have no significant benefit to either the speed or efficiency of oxygen absorption
- The use of nitrogen may decrease the risk of abrasion
- Speed and effectiveness of oxygen absorption will differ when specimen are included

Caring for collections

- Collections are built up in different ways: whether by purchase, fieldwork donation or exchange all need to be stored in the most appropriate way.

- Many museums and private collectors set acquisition goals, but may not consider the importance of environmental storage conditions.

- Correct handling of specimens is important.

- Educational activities should be monitored to avoid damage to specimens.

- Remember that specimens kept in specific conditions will need extra care.

- Private collectors are at the forefront of rescuing and collecting specimens. Good conservation practice is important to collectors too as many private collections are donated to museums.

CONSIDERATIONS

- Minerals and fossils do not reproduce! We should preserve our collections using microenvironments when appropriate!
- Objects must be stored at their appropriate RH. Combination of materials used will depend on the purpose of the enclosure
- Humidity indicator cards are a simple and relatively inexpensive method of monitoring RH in microenvironments
- Monitoring microenvironments regularly is COMPULSARY in order to check for deterioration in materials and/or breach of the enclosures
- REMEMBER that fluctuations in humidity will be potentially more harmful than high or low humidity
- Consultation and collaboration between curators and conservators will be of benefit to all