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with those expected if the ammonium group was present, and these were absent in the untreated specimen, thus confirming my suspicion of a complete replacement. I thought that I should bring this to other people's attention, although I suspect that others may have had a similar experience but not published.

The questions that now arise from this are: Has anyone else had similar problems with ammonia when treating mineralogical specimens that contain other important minerals in addition to pyrite or marcasite? Is this reaction reversible? Does anyone know of any research in this area, and if so, where it is published?

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References

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Pollutants in Museums

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Pollutants take two forms, gaseous and particulate - or simple terms: smells and dirt.

Prevention of contamination by particulate pollution and the removal of such contamination is perhaps the most common concern amongst conservators. Strangely, gaseous pollutants have tended to receive less attention

and were, at least until the last twenty years or so, perhaps perceived as less of a concern.

The Oddy tests were developed at the British Museum (see Lee & Thickett, 1996 *Selection of Materials for the storage or Display of Museum Objects*, British Museum Occasional Paper 111: 60pp.) as an accelerated test to determine if materials to be used in the construction of displays would give off copper, silver or lead tarnishing compounds, principally hydrogen sulphide, other sulphides and carboxylic acids. Modifications and assessments of these tests indicated that they are a valuable testing method, provided the test is carried out correctly.

The Oddy test combined with a range of other test strips provided the basis for my own research project done in 1991 in Canada on pollutants in mineral collections. The findings of this research project, carried out in conjunction with Rob Waller of the Canadian Museum of Nature and Jean Tetreault of the Canadian Conservation Institute will appear in the next edition of Collections Forum, spring 2000. A summary of the method employed was published by SSCR in Vol 4, no 1 Feb 1993, one of three papers concerned with gaseous pollutants in the museum environment. The project detected a range of pollutants within systematic mineral collections and set out to compare the effects of cabinet furniture on internal pollutants. Some of the pollutants were generated by the specimens themselves: mercury and sulphur vapour due to the low vapour pressure; reduced sulphide gasses by decaying sulphide minerals and carboxylic acids emitted from the wood of cabinet furniture.

For biological specimens, Brimblecoome, who spoke at the very first Natural Science Conservation meeting in Ipswich, gave a paper on biological materials as sources of air pollution in museums, which was written up in Life after Death. The very first recorded natural science conservation problem was Byne's disease; the papers describing the efflorescence on modern mollusc collections were published in the 1880s. It was not until 1985, when Norman Tennant, working initially with Baird, started to analyse the efflorescence's that the were cause of the problem - thus, carboxylic acid emission from wood cabinets was identified.

For those interested in choosing wood products to avoid acidic emissions, or to reduce emissions through coatings, CCI's 1999 technical bulletin provides all the information you need. (English oak generates a pH of 3.3 to 3.9). Coating for display and storage in museums, Canadian Conservation Institute Technical Bulletin no 12, by Jean Tetreault. ISBN 0-662-27955-7

Pollutants in Collection Stores-

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Pollutants can manifest in collection stores in two main forms: -

- *Gaseous*
  - *From the outside environment* e.g. sulphurous and nitrous oxides, ozone, hydrogen sulphide.
  - *From the storage* e.g. carbonyl volatiles such as formaldehyde.
  - *From the specimens* e.g. acetic acid, formic acid, radon, mercury vapour, sulphur dioxide.
  - *From pesticide residues* e.g. mercuric chloride, naphthalene, dichlorvos.

- *Particulate* e.g. spores, dust, dirt or chemical deposits.

Within the older parts of the NMGW, in this case the east wing where the botany stores and offices are located, the air conditioning is controlled and maintained by the air-handling unit. This provides environmental control but does not incorporate a filtering system. The remainder of the building is air conditioned and filtered to the standard 80% efficiency. There are dust filters and carbon filters installed within the vents that the air passes over, which removes the greater part of the pollutants. The standard filtration recommended for a museum collection is Eurovent 4/5 with coarse and fine filter grades in the categories EU1 to EU9 (Cassar, 1995). For more sensitive collections a higher specification is required. The ARC,

which is a custom designed archive store situated approximately five miles from the main building, is installing a filter of Eurovent 8/9 which will filter material down to 90-95% efficiency.

Dust and dirt within the botany stores is a problem, collections are always boxed or bagged, and good housekeeping is implemented to keep dust from building up. Sensitive collections are housed within filtered and air conditioned environments.

Botanical material brings with it its own supply of dirt, which has usually been accumulated at the time of collecting. This can spread onto the herbarium sheet or packet and can often obscure the data. Dust and dirt will also provide an hygroscopic environment to attract mould growths that are far more difficult to remove. Loose, dry dirt can be brushed away using a soft bristle brush, and this will remove a surprisingly large amount. Old, ground in dirt can be removed quite easily with a rubber, but it must be stressed that plastic erasers are best and Staedtler Mars Plastic are recommended (available from most good stationers). This method of cleaning paper is termed surface or mechanical cleaning. It is recommended that the back of the label or paper article is cleaned first so that the upper surface is not introduced to further dirt once it has been cleaned. The dirt can be removed using small, gentle circular movements remembering to clean the rubber frequently against a clean surface so as not to introduce more dirt on to the paper. Old and dirty paper is usually quite delicate and to protect friable edges it is often advisable to hold the paper down with a clean piece of melinex that is inched along as each small area is completed at a time. Particularly delicate labels can be cleaned using grated up rubber, this is a very gentle method that will not damage the paper, but may not be as effective as basic surface cleaning. Paper tears should be tackled by cleaning from where the tear ends down to the edge of the paper. This is working with the paper grain and will prevent further stress.

Gaseous pollution from storage, specimens and from the outside will be reduced by filtering. 10% of clean air is incorporated hourly and within this hour there will be 6-8 complete air changes. Gaseous pollutants such as nitrous and sulphurous oxides should be kept below $10\mu g/m^3$ (this should be reduced to $5\mu g/m^3$ and $1\mu g/m^3$ respectively for sensitive collec-