GUIDELINES FOR THE CURATION OF GEOLOGICAL MATERIALS

Geological Society

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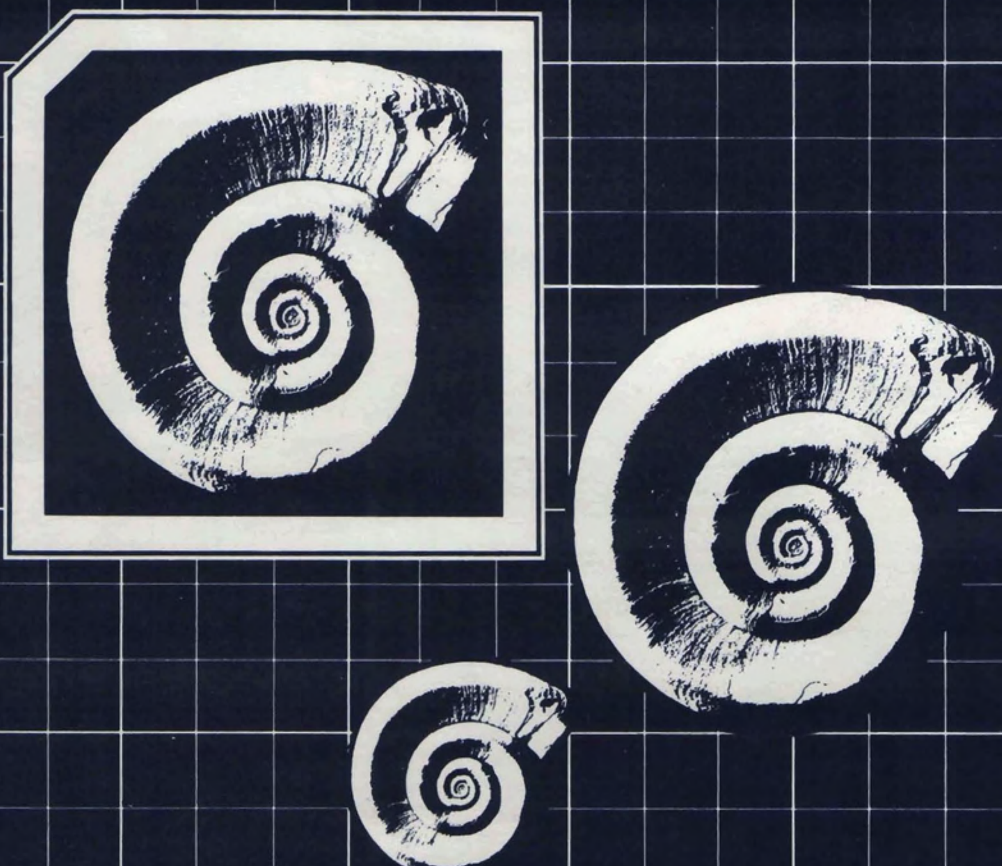

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prepared by the GEOLOGICAL CURATORS' GROUP

FOREWORD

The Geological Curators Group, which is affiliated to the Geological Society, was founded in May 1974 by geologists concerned about the poor standard of geological curation and consequent plight of geological collections in many of the museums in Britain. The situation was documented and reported upon by Doughty (1981), who illuminated the extent of the problem and provided impetus towards achieving one of the Group's initial aims – the improvement of geological curatorial standards by the 'preparation of a code of practice for curation and development of collections'. While the need for such a code has been recognised for several years, it has been difficult for the Group, with widely scattered members and no permanent address, to start gathering the necessary scripts. However, when I became Chairman of the Group, I saw this objective as a priority in which the Group could make a significant contribution, and that the time was opportune to push ahead with 'Guidelines for the Curation of Geological Materials'. What follows is an imperfect first edition; it should be read as such and constructive comments are welcome.

C. H. C. Brunton
December 1984.

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GUIDELINES FOR CURATION OF GEOLOGICAL MATERIALS

INTRODUCTION

The good curation of geological material begins in the field. These Guidelines start at the site of collection and develop an unbroken thread of curation that continues in the museum, where the handling, preservation, documentation, storage and display of specimens is considered in detail.

The question of why we collect geological material in the first place falls outside the remit of these Guidelines, but is one to which every curator should address himself in the context of his institution's acquisition policy. However, the reason why we attach such importance to keeping geological material is central to these Guidelines, and perhaps at the heart of geological curation.

To the casual observer, most geological specimens appear relatively indestructible and are presumed, in any case, to be replaceable with easily collected material. To those familiar with the nature of geological material such assumptions could not be further from the truth. On the first count all geological specimens have a composition reflecting a physico-chemical environment at the time of formation which was very different from that obtaining in the museum. This may result in the kind of instability which can all too easily lead to the progressive degeneration of the specimen. On the second count, every geological specimen is in some sense unique. By the time a specimen reaches the museum it has been subjected to a rigorous four-stage selection process: first it is preserved by nature in rock; second, it is made accessible by nature or man; third, it is found and fourth, it is collected by man. Such considerations make the re-collection of an identical specimen, in most cases, an extremely remote possibility.

Indeed, once the specimen has entered the museum together with its collection documentation and has been the subject of physical development, academic research, etc., its documented subsequent history of association can only reinforce its inherently irreplaceable nature. It is, therefore, of paramount importance to preserve specimens with all their associated information in conditions allowing easy access for research, education and display both now and in the future.

Some geological localities, especially in the UK, have become so damaged by collecting over many years, that collecting is now severely restricted, totally prohibited or simply no longer possible. Other localities are no longer accessible because of development such as building or 'restoration' of quarries and because of natural erosion and slip. Collections and field records from such localities are precious and contain the only sources of our geological knowledge of these sites. Some collections are the result of old, manual quarrying techniques and, because of modern methods of rock extraction, would not easily be replaced. Other collections have been made by expeditions to remote places unlikely to be revisited, or by people who became eminent in their fields, so that such collections may contain 'gems' of information – perhaps currently undiscovered – which will fuel research activity in the future.

The curation of geological specimens is not to be undertaken lightly. In common with all fields of museum collecting, the geological curator would do well to remember, when he accepts an addition to his institution's collections, that he lays an obligation on that institution and on his professional successors to ensure the well-being of that specimen "in perpetuity". Curators should be familiar with the 'Code of Conduct for Museum Curators' (Duggan *et al.* 1984, published by the Museums Association annually in the 'Yearbook'. Whatever rules, regulations or guidelines are formulated to assist the curator in fulfilling his professional obligations to the material entrusted to his care, the day-to-day exercise of his trade will always demand of the geological curator the application of common sense. In so doing he should apply the highest standards of personal responsibility and morality, albeit in an informed manner. Ultimately the value and quality of the collection will reflect the integrity of the curator.

These Guidelines are presented as a practical guide to good housekeeping for the geological curator. Conceived and edited within a carefully planned framework, they comprise a compilation of edited essays by a number of authors who have contributed the component sections. Inevitably we are addressing these Guidelines to curators having varied experience with geological materials and who will be looking for different types of information at different levels of detail. We have attempted to provide necessary information in the text, with references to publications extending on the topics. The Summaries at the beginning of each Part bring together the most important points and recommendations, and should provide introductory reading for the curator unfamiliar with geological procedures. Paine (1984) provides excellent notes on a wide variety of museum methods, far beyond those covered in these Guidelines. Much of what is written here can only be opinion because a consensus view on many topics remains unknown, elsewhere we provide recommendations when we believe there to be reasonably widespread agreement.

Definitions

The terms 'geological curator' or 'curator' are used to denote any person charged with the care of geological material in a museum, irrespective of formal title. Following the usual convention, where the curator is referred to by pronoun, the masculine form is used, without prejudice to gender. The word 'museum' is used to refer to any insitution formally charged with the care of collections. 'Geological material' includes both natural objects ('specimens') and associated documentation, manuscripts, published works, maps, plans, drawings, prints and photographs. It also includes the equipment and personalia associated with significant figures in the history of geology, but these will seldom be dealt with here (see for instance Doughty *in* Thompson 1984).

References

The text is divided by coloured cards into five major Parts, each separately paginated and distinguished by its code letter A to E. Cross-references within the text are always to paragraph numbers, including their Part Letter, and never to page numbers. Text references to other publications are given as author plus date of publication and are listed fully in the References.

The main Contents page provides access to the major subjects and the Contents lists at the start of each major Part provide a detailed subject index using paragraph and page numbers.

We recognise that the way in which we have arranged these Guidelines is only one of a number of possibilites, and that good collection management should be involved at all stages of curation from acquisition policy-making, through documentation, conservation, valuation etc. etc.

These Guidelines represent a first attempt at drawing together guidance or standards for geological curation. They should be read with tolerance and flexibility of mind, as if reading a discussion document, for the editors anticipate they they will develop over the years. The editors, who as individuals also contributed to the text, take responsibility for the contents as a whole.

Howard Brunton, Chairman
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ACQUISITION: SUMMARY AND RECOMMENDATIONS

General Principles

A1.	Publish an Acquisition Policy as part of an overall Management Policy for your institution.
A1.	Temper rigorously disciplined acquisition with flexibility bearing in mind historical criteria and future needs. Distinguish requirements of Primary from Secondary Acquisition.

Primary Acquisition

A.2.1.	Field collection in the service of geology: good collecting preserves specimens; bad collecting destroys sites. Good standard of documentation in the field is the essence of good collecting.
A2.1.1.	Evaluate the specimen according to defined criteria at every stage.
A2.1.2.	Good collecting practice based on 3 R's: Restraint, wRapping and Recording.
A2.1.2.1.	Exercise self-discipline in equating collecting activities to scientific requirements.
A2.1.2.2.	Wrap every specimen individually. Avoid using cotton wool. Recommended materials listed. Document and mark every specimen individually.
A.2.1.2.3.	Field records to include detailed geographical and geological context data, date and collector's name.

Secondary Acquisition

A2.2.1.1.	Donations received 'in perpetuity'. Transfer documentation must be signed by donor. Beware conditions imposed by donor.
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A2.2.2.1.	Responsibilities of receiving institution to source institution: legality of transfer; cultivate good relations with university to ensure compatibility of documentation/collection procedures.
A2.2.2.2.	Cultivate good relations with private collectors to ensure good standards of documentation and collecting ethics.
A2.2.2.3.	Be informed of current markets, and cultivate good relationship with local dealers. Never acquire material from a dealer which has been procured by breaking any country's national laws, or which has come from an otherwise protected or vulnerable site.

A. ACQUISITION

PREAMBLE

In this Part we discuss the methods and systems by which material is gained for the collections; the means of documenting that material is covered in Part B.

1. GENERAL PRINCIPLES

In these Guidelines acquisition is defined as:

the process by which material is added to collections within a curator's care.

Acquired material will become catalogued and hence a 'permanent' part of a museum's collections. What follows, however, in terms of the care a curator must provide for specimens, extends also to material for which he may only have temporary responsibility, such as loans to the museum. In the next Part, in which the processes of documentation are discussed, the term 'Entry' is used for anything coming into the museum on either a permanent or temporary basis; the term 'Acquisition' is restricted in Part B to the more legal aspects of accepting material permanently into the museum. Here, we are concerned with how material for use in the museum and added to its collections is acquired.

The process of acquisition is at the 'sharp end' of curation in as much as all other curatorial activities will, to some extent, flow from this activity. This can be summed up as:

'What you acquire dictates what you do.'

It is important for the curator to recognise the implications of such an axiom, since it can put the curatorial cart before the horse. The often randomly acquired collections of the past, which are a fact of every curator's life, will inevitably continue to influence curatorial activity. If, however, the curator gives considered direction to his present acquisitive behaviour, his (and his successors') subsequent curatorial activities will also have direction. To take control of the reins, today's curator, displaying professionalism, has created an alternative axiom:

'What you want to do must dictate what you acquire.'

It is this notion which underlies the generally accepted view that every professionally-run museum should have a published statement of its aims and activities, of which an *acquisition policy* is an integral part. The first guideline of the Museums Association's 'Code of Conduct for Museum Curators' (Duggan *et al*. 1984) states that:

> "An appropriate and detailed acquisition policy is recognised as essential to the orderly management of a museum. It implies the acceptance of responsibility for the curation and physical accommodation of collections as defined in the policy for as long as they are held."

The acquisition of an object – however acquired – represents a commitment of resources which has to be justifiable. It is no longer professionally defensible for a curator to accept, say, a donation, if neither the object nor its associations are remotely relevant to the activities of his institution.

The acquisition policy should state the broad subject areas in which the museum will acquire material. It should also discourage the acquisition of material where the act of acquisition may conflict with the interests of environonemental (i.e. site) conservation, or may contravene international codes or conventions. See also Nicholson (1974a).

In cultivating a clearly thought-out collection philosophy which can be translated into practical policy, curators of collections with long histories must accommodate the guiding principles of their predecessors and those of the collectors represented in the collections. For collecting philosophies and user needs demonstrate a steady evolution through time, and rigorous modern scientific criteria unsympathetically applied to very early collections could deprive museums and the scientific community of vital links in the development of geology and its practice in museums. It is vital also to remember that the quality

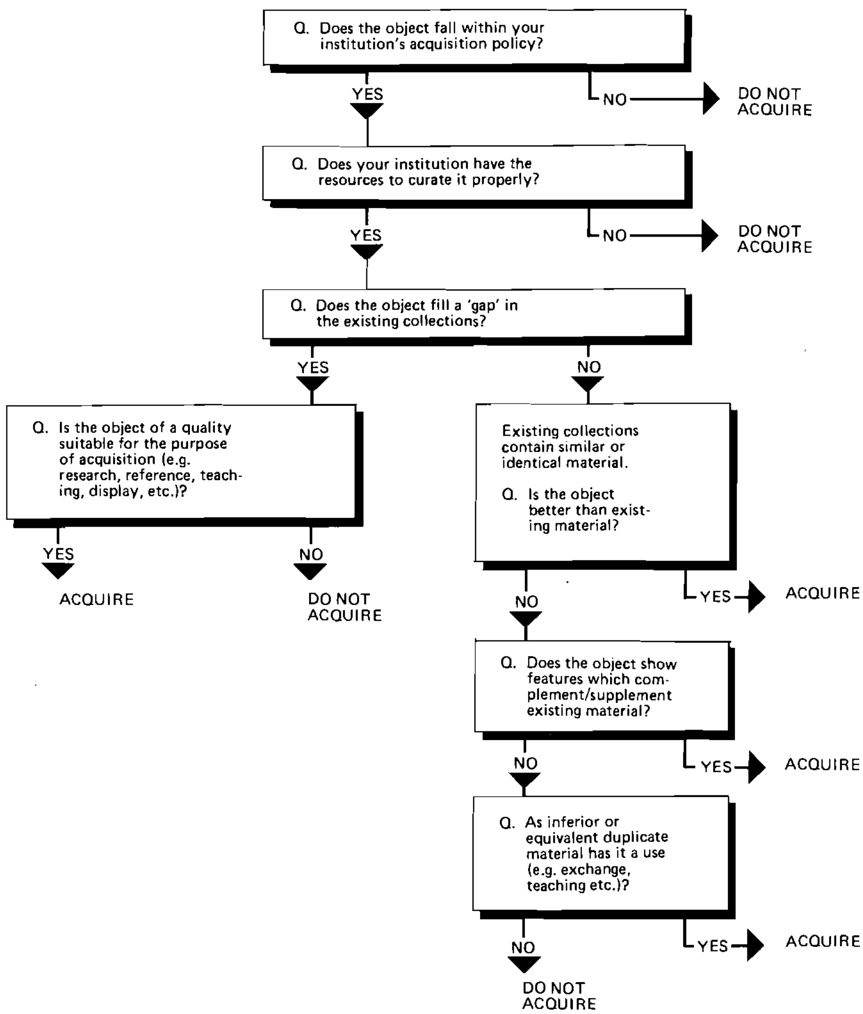

Fig. 1. Acquisition Flow chart.

of documentation associated with specimens from old collections cannot be judged by the same criteria as would be used for recently collected material; such material, and its documentation, must be considered by contemporary rather than currently accepted standards.

The flow-chart in Figure 1 represents a much simplified scheme of questions which a curator should ask himself when considering an acquisition. It is broadly applicable to any method of acquisition. Where the steps of question-and-answer lead to 'ACQUIRE', this should not be taken as in any sense an absolute – it is merely an indication that having satisfied himself on that series of points the curator may then justifiably consider acquisition. By the same token, 'DO NOT ACQUIRE' may prompt further action such as contacting another institution for which the 'object' may be more appropriate.

It must be stressed that common sense and a rational flexibility of approach should prevail when applying these criteria. It is important, for instance, to acquire material from a locality that is in danger of destruction, or to 'rescue' a collection that is being discarded and would otherwise be lost. Action in such circumstances may have to be swift. Such material may, at the time, appear marginal to your museum's acquisition policy, but may in the fullness of time attain greater relevance. If not, the museum can at least keep the material safely until the opportunity arises to pass it on to a more suitable institution. Similar considerations apply to the acquisition of 'duplicate' material, that is acquired with a view to eventual disposal, for example by exchange or allocation to a teaching load service, etc. Such material falls within your museum's acquisition policy, but in the view of the geological curator, adds nothing of value to the existing collections either in quality or information.

Material obtained by the museum which the curator knows will only temporarily be in his care (such as loans-in) should be the subject of a holding procedure only i.e. Entry Documentation (see B2). Due allowance for such activities could be made in your institution's management policy. See also Nicholson (1972b).

2. ACQUISITION METHODS

PREAMBLE

In the past, it has been customary for some curators to distinguish between 'active' (field collection and purchase) and 'passive' collecting (receipt of donations and bequests). This classification is rejected in these Guidelines, since as the previous section demonstrates, a rigorously disciplined and actively selective approach to acquisition should be adopted by the curator for all forms of acquisition.

Instead, two major categories of acquisition are recognised, which are particularly relevant to the natural sciences:

- PRIMARY ACQUISITION, in which the object passes from the natural or other field occurrence to an artificial context for the first time,
- SECONDARY ACQUISITION, which includes all the ways in which material passes from the possession of one human agency to another.

2.1. PRIMARY ACQUISITION: COLLECTING AND DOCUMENTATION IN THE FIELD

General principles

The prime consideration must be that collecting is done in such a way as to maintain or further the best interests of Geology as a science. This does not mean that individual specimens or suites of material that are collected must in themselves show great scientific interest – other criteria may apply. Collecting should be done with a clear purpose in mind, whether by institution or private collectors (Section A1). However, it must be recognised that chance will always play a major role in determining what is found and what is collected.

Collecting, at its best, is the prime form of geological specimen conservation, and at its worst a prime threat to other forms of geological site conservation. These conflicts of interest need to be reconciled. Collecting represents a serious, but necessary violation of the intimate relationship between the potential specimen and the natural situation/association in which it is found. To mitigate the consequences of this violation the curator should collect specimens with exhaustive field records to ensure the optimum potential scientific use of the material.

2.1.1. Scientific evaluation

It is clear that in the field, in the laboratoy, and in the museum there must be evaluation of geological specimens. It is recognised that such evaluations will be subjective to a greater or lesser extent. The criteria of value given below are those that the collector should consider while in the field. They may be applicable to all stages of geological curation, in particular at the stage of Acquisition Documentation (B3).

2.1.1.1. *Value based on the function of the specimen*

Is it a . . .

- specimen with specific research potential, such as a possible new species or variety, a rare species, or species with other research potential?
- species from a particular location, horizon or geological situation of special interest?
- specimen showing exceptional preservation, features, or association of features?
- specimen filling a gap in the collections, for reference purposes?
- a duplicate specimen which may be disposed of by exchange of sale?
- specimen that may be used for education or display?

2.1.1.2. *Value of the specimen by association*

For example is it part of a suite of specimens –

- from a particular locality, horizon, palaeoecological situation, association, etc?
- from a borehole, or temporary section?
- from or associated with the collections of an important worker?

It must be remembered that the value of the specimen as defined here is directly proportional to the precision and completeness of the associated field data (see A2.1.2.3).

2.1.2. Fundamental principles of primary acquisition

Good collecting practice in the field consists of the three R's – (i) restraint, (ii) wrapping and labelling, (iii) recording.

2.1.2.1. *Restraint*

Before setting hammer to rock the following points should be considered:

- Assess and evaluate the purpose of the collecting – is it necessary?
- If you are collecting for a special purpose, do you know the collecting techniques that are required?
- Will the material be used and can you assume proper accessibility of the material in the future?
- Assess and evaluate the collecting site; will it yield the specimens appropriate for the purpose you have in mind?;
- Respect vulnerable sites. Respect sites where special collecting restrictions exist;
- How may specimens are required? Can you reconcile your requirements with the abundance of the specimens?
- Will loose *ex situ* material do?
- Avoid unnecessary destruction in the process of collecting. In particular:
- Avoid trying to collect the 'uncollectable';
- Avoid, particularly in the case of fossils and minerals, trying to 'develop' the specimen in the field;
- Seek expert advice where a particular specimen is beyond your collecting skills (e.g. from some members of the GCG).
- Follow the fieldwork codes produced by the Geologists' Association and that distributed through the Committe of Heads of University Geology Departments (CHUGD) by the GCG (1982).

2.1.2.2. *Wrap and label*

All specimens and parts of specimens need to be individually wrapped and packaged to prevent bruising and breakage. This should be done at the collecting site. Linen bags are good but expensive. Newspapers offer a suitable alternative. Self-sealing plastic bags, while suitable in the field, may pose problems for the long-term stability in storage of certain types of material. Use cellulose wadding, for delicate specimens, or, less satisfactorily, domestic soft tissue. Never use cotton wool (removal of loose fibres may damage the specimens and the decay of cotton under conditions of high relative humidity (rh) and temperature may produce organic acids which attack calcareous specimens). Delicate specimens should be individually wrapped and packed firmly into protective containers, such as card or plastic boxes. Large specimens may require wood or metal boxes or crates and are likely to require special handling techniques (see Croucher & Woolley 1982, and consult the GCG).

At the time of collecting, each specimen or group of specimens should be clearly and indelibly labelled with a unique field reference number. Preferably, the number should be on the specimen either directly using indelible waterproof ink, or on a piece of sticking plaster. Use of metal, plastic or synthetic paper tags for field labels will reduce the chances of loss of data. Beware of damaging the specimen itself or of obscuring important details. It may be preferable to number the wrapping. Any field numbering system should be well considered so that it can be understood by others, avoiding unnecessarily complex coding. Research

Fig. 2. The documentation and protection of vertebrate remains in the field. In the centre background is the plan onto which all specimens are plotted. Skrim and plaster are being used to cocoon specimens.

programmes may require other procedures for numbering that may vary depending on the purpose. It may, for instance, be useful if the field reference number itself contains certain information, such as an indication of the collector, and the date of collection. The following is a well-tried format:

ABC.1983.XY.12

(where ABC = initial of collector, 1983 = year, XY = code letters for locality or region, 12 = serial number unique within locality or region category).

For many purposes it is useful if the specimen is clearly marked to show its original orientation in a geological and topographical context when *in situ*. This includes way-up, younging direction, dip and strike.

2.1.2.3. *Record*

The following information should be entered into your field notebook at the time of collecting (Ensure that the collector's name and address are clearly entered into the field notebook so that it can be returned if lost.):

- Field reference number and convenient field identification/description of the specimen.
- Detailed and complete geological localisation, including a clear indiction of whether it was collected loose or *in situ*, etc. Thus, for example, a specimen may be referred to a specified part of a numbered bed in a measured section, or to a particular part of an igneous intrusion, etc. Aim to achieve millimetre scale precision. In addition, it is often useful to indicate the location of collected specimens on sketches. See Palmer (1983) for practical advice.
- Detailed and complete geographical localisation expressed clearly and unambiguously including, if possible, parish, district or county. Remember also to record the full National Grid Reference (or other appropriate co-ordinates), which should be determined on site. This information may also be supplemented by annotated field sketches or photographs, especially important when collecting vertebrate remains.
- Any other pertinent data, such as orientation, associations with other specimens, cross-cutting relationships, etc.
- If the field reference number does not include the date, this must be recorded, as should the names of any other collectors. Documentation must be as complete as possible to allow for other unforeseen uses of the material.

2.1.3. Collecting hints

Both the nature of the material, and the purpose for which it is being collected determine the precise nature of the collecting techniques that are required. It is far beyond the scope of the present work to go into details. The following are merely hints that will help the non-specialist collector avoid some of the more common pitfalls, but it is advisable to seek the advice of experts before any major collecting is undertaken.

2.1.3.1. *Petrology*

- Orientation is usually important, particularly way up/younging direction on sedimentary rocks.

- Collect specimens of sufficient size to represent the lithology (normally at least 7.5 cm × 10 cm).
- Collect specimens showing 'fresh' (unweathered/unaltered) rock
- Sometimes it is also useful to collect specimens to show the weathered appearance of the rock.

2.1.3.2. ***Geochemistry***

- Normally requires 'fresh' rock.
- Avoid contamination during and after collecting.

2.1.3.3. ***Geophysics***

- Normally requires 'fresh' rock.
- Normally requires precise orientation of samples.

2.1.3.4. ***Structures***

- Tectonic, sedimentary, primary, secondary, trace-fossils – all require detailed recording of orientation.

2.1.3.5. ***Minerals***

- Often require particular care during extraction.
- Often require very careful wrapping, to prevent physical damage.
- Can require careful choice of wrapping materials to prevent longer term physico-chemical damage.

2.1.3.6. ***General palaeontology***

- Delicate fossils may require the use of consolidants in the field.
- Fossils require precise detail of geological horizon.
- Orientation, articulation/disarticulation, associations, etc. are all relevant information to be recorded.
- Collect part and counterpart of specimens – particularly for small vertebrates, plants and invertebrate material. Wrap part and counter-part separately, but in association.

2.1.3.7. ***Large vertebrates***

- Often require very specialised techniques – get advice.
- Extraction, preparation, and conservation of large vertebrates is very expensive.
- Always record the exact geological horizon.
- Record the orientation and disposition of the remains as a whole and of the individual parts.
- Record in detail the interrelationships of individual bones – this can sometimes be done on a transparent overlay.
- Number everything.
- Record everything, including details of preservation and palaeoecology.
- Collect associated macroinvertebrates, plants, and samples for micro-fossil analysis.

2.1.3.8. *Micropalaeontology*

- Record exact horizon of each sample.
- Sample only a narrow stratigraphic thickness of sediment – never more than 15 cm – preferably much less. A quantity of 1 Kg is usually sufficient.
- Avoid contamination during collecting. Clear away all surface material from the part of the rock face to be sampled. Collect preferably coherent blocks of 'fresh' rock.
- Normally avoid decalcified or over-weathered material. Use suitable strong clean bags to avoid post-collecting contamination.

2.2. SECONDARY ACQUISITION

2.2.1. Methods

Five methods of secondary acquisition can be identified, for which the documentation procedures are set out in Part B.

2.2.1.1. *Donation*

When deciding to accept a donation, a curator must be aware that the object(s) concerned fall under the laws of public trust. As a result unless clearly stated in the conditions of transfer of title, the assumption, in law, will be that the receiving institution has taken on custodial or fiduciary responsibility for the object on behalf of the public 'in perpetuity'. Consequently the institution's freedom to use or dispose of such an object is strictly curtailed (see B6.2.2. under Disposal).

It is vital that documentation relating to the transfer of title (i.e. ownership) is clear and unambiguous. Some form of documentary declaration of transfer signed by the donor, must be retained in the receiving institution, in case title is ever challenged. (Too often the only documentary evidence of transfer is some form of receipt or a letter of thanks, signed only by representatives of the receiving institution.)

2.2.1.2. *Bequest*

Very similar legal implications apply to the receipt of a bequest as to a donation. Rarely does the opportunity arise for the curator to discuss conditions with the testator before he dies, and the executors' powers to negotiate are limited!

A curator may feel a moral obligation to accept a bequest because to do otherwise might cause distress or outrage to the family of the deceased. Again this is a situation which calls for immense tact. However, the curator's first moral obligation is to his profession and if the material or any conditions attached thereto make it professionally unacceptable then he must not acquire it.

When a bequest is accepted, documentary proof of transfer of title should, ideally, include a letter from the executors (usually solicitors) describing the bequest and, if possible a copy of the will as signed by the testator.

2.2.1.3. *Purchase*

It is a fact of life that, like it or not, there is a roaring trade in geological specimens, with the aesthetically appealing end of the market, including fossils and minerals, commanding very high prices indeed.

As with anyone trying to sell him anything, the curator would be sensible to bear in mind the warning 'buyer beware'. The curator, as the prospective purchaser, should also beware his own limitations. Market pricing is a speciality of its own, and unless he is buying regularly the curator would be well-advised to consult a specialist colleague in, say, a national museum who may be familiar with the current market value of a well-preserved Monte Bolca fish, a 500 gm lump of Allende meteorite or a fist-sized cluster of crocoite crystals from Tasmania.

The documentary record of the transaction must include a receipt signed by the seller to certify that the purchase price has been paid.

2.2.1.4. *Exchange*

This term refers to an institution that swops 'duplicate' material (see A1.1) in order to acquire new material. It is important to ensure that duplicate material held by the museum which is earmarked for exchange, is of a quality that will attract specimens suitable for your museum, and that it is held in Entry Documentation short of full cataloguing (see B2.1). Such material is relatively freely disposable ethically and legally.

Fully catalogued material is not available for exchange at the curator's discretion alone (B.6.2).

Within those contraints, exchange of material can, if responsibly conducted, be a very sensible way of spreading resources – both of collecting time and material – around, to the benefit of institutions and the scientific community. Documentation should record the exchange with the transfer of title signed by both parties to the transaction.

2.2.1.5. *Loans*

Although seldom the means by which material is acquired, we include comment here since curatorial responsibility is involved. See B6.1.1.

Loans are often said to be more trouble than they're worth. This has more than a little truth in it. The institution receiving a loan has all the normal custodial responsibilities (plus any extra imposed by the lender) without any of the rights of ownership.

Generally speaking, loans are justifiable for specific finite schemes – such as a research project or temporary exhibition. For this kind of arrangement the length and nature of the loan is clearly defined, and documentary evidence signed by both parties must exist to witness the fact. It is also normal for the receiving institution to indemnify or insure the lender against the accidental loss of, or damage to, the loan. (Though in the case of irreplaceable scientific material, values may be considerable. See B4.4.8.3.)

Open-ended or 'permanent' loans (the last is a meaningless term) should be avoided. The practical problems of maintaining such material and its documentation discrete from the institution's own collections can be considerable. The separate identity of a long-term loan can all too easily gradually disappear as successive curatorial members of staff come and go over a span of decades. In general, a curator is advised not to accept material on long-term loan except where his refusal might lead to the loss of scientifically significant material. Then it is advisable to arrange the loan for a finite term of say, 5 or 10 years, on a renewable basis. (See B2.3.5.)

2.2.1.6. ***Conditions of transfer***

Some people may attempt to hobble the receiving institution with a 'donation', (here, meaning any presentation) hedged around with conditions, such as 'must always be on public display'. Such attempts must be strongly resisted and most donors are amenable to logical persuasion on this. Except perhaps where material of outstanding scientific importance is concerned, is is probably better to refuse a donation than accept it with conditions that circumscribe for ever the receiving institution's freedom to exercise responsible curatorial choice over its use.

On the other hand, it may be possible to accept the donation on conditions that increase the receiving institution's freedom of choice over the use of the object. It could, for instance, be explained to a donor that his material would be useful in the collections, but should better material be obtained later, the donor be asked if he would agree to the disposal of his material at the museum's discretion. This is a situation which must be handled with immense tact and diplomacy. If the donor agrees to such conditions, then a document drawing up these conditions, signed by the donor (and preferably witnessed) must be retained by the receiving institution.

2.2.2. **Acquisition sources**

The secondary acquisition methods outlined above may each involve one of the following three categories of source:

2.2.2.1. ***Institutions***

This category might commonly include other museums, universities, libraries, colleges and schools, societies and clubs.

Where acquisition by exchange, purchase or donation of specimens from other museums is involved, it is the duty of the receiving curator to take reasonable steps to assure himself that the source institution is disposing of the material both legally and ethically (see B6.2.2. – disposal). It is also possible that material held in a school or society 'museum' may be subject to trust law, so similar professional safeguards should be applied.

The acquisition of material from universities may involve individuals' research collections. In fact the curator should develop an active relationship with a local university geology department, for many of these lack the resources to curate research collections which may, as a result, be put at risk. Ideally the curator should liaise with a researcher at the outset of his project so that field and lab. data standards are adopted consistent with the requirements of the museum. The curator should encourage the staff of the university department to require all research students to read and comply with the recommendations of 'A Curatorial policy for biological and geological research collections', NERC (1982), the recommendations of the GCG (1982a.) or Tunnicliff's paper 'I am beginning my research: what shall I do with my specimens? A note of advice' (1983).

2.2.2.2. ***Private collectors***

This category includes a complete spectrum from the casual 'one-off' find donated by a schoolboy, at one end, to the idiosyncratic and possibly scientifically important collection amassed over a lifetime of amateur but dedicated activity at the other. Both forms of source can yield significant material. Where possible, the curator should encourage the collector to adopt good standards of curation, especially documentation.

2.2.2.3. ***Commercial dealers***

It is tempting for the curator to take a lofty view of the activities of dealers who can be seen as peddling that very material which curators are dedicated to caring for. Such an intolerant view is, perhaps a little shortsighted. An enlightened local dealer befriended by a curator can be a good friend indeed and may, when interesting material comes in, give the curator first refusal on the objects. It is better for the curator to know about what is coming in and out of the sale room than to be ignorant, and miss the chance of a fine acquisition.

Several of the larger dealers - particularly in the USA and in London - regularly publish catalogues of the material they have available. These are useful as current price indexes, with the reservation that they represent the seller's view of the market. However, the curator is strongly advised against buying 'blind' material from abroad except, perhaps, for teaching purposes, since quality can be unpredictable! One of the best ways to gain an up-to-date knowledge of the current market is to attend dealers' shows. So, to restate the obvious, the curator should have a healthy suspicion of any dealer, but temper such an attitude with the awareness that a dealer can be a useful ally.

Finally, it must be said that the area in which curatorial objectives conflict head-on with those of the dealer is that which concerns scientifically significant material 'pillaged' from well-known but sensitive sites. Where the removal of this material from the site, and/or its export to the dealer's showrooms contravenes the national law of the country of origin, or the 'Convention on the means of prohibiting and preventing the illicit import, export and transfer or ownership of cultural property' UNESCO 1970, then the curator must be aware that to purchase such material boosts the market and hence encourages pillage. The curator has a clear ethical duty to take reasonable steps to establish the provenance of material offered him by the dealer, and if in doubt, to refrain from purchase.

B. DOCUMENTATION

B. DOCUMENTATION

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2. ENTRY DOCUMENTATION

PREAMBLE

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SPECIMEN DOCUMENTATION: SUMMARY AND RECOMMENDATIONS

The information about specimens in museum collections.
The crucial key to efficient specimen management.

Principles

B1. Be able to locate every specimen.
Accurately record and retrieve all relevant information.
Ensure that every specimen bears a number.
Classify and identify every specimen as far as is possible.
Record the past and continuing history of each specimen.

Marks and Labels

B1.3. Marks are on or applied to specimens.
Labels are kept with specimens.

B1.3.1. Field collecting requires simple and convenient labels and/or marks which link specimens to a field notebook containing locality and collection details.

B1.3.2. Material 'entering' a museum should have temporary labels recording basic information, including an Entry Number. Take care not to lose! Do not mark the specimen at this stage.

B.1.3.3. For 'permanent' documentation put a unique number on every specimen using an appropriate method. Write out a label giving basic information about the specimen.

B1.3.4. Methods of marking and labelling have varied. For marks, use India Ink for writing directly on specimens, or glue the number, written on a tag of paper, on to the specimen using an appropriate adhesive: check up on which to use. Use a simple loose label with a specimen and ensure the specimen number is on each label.

Entry documentation

B2. The recording of specimens arriving in the museum.
It is important to note down basic information about the specimen on arrival – quick and easy methods are best.
Complete an 'Entry Form' or use a bound 'Daybook' or similar register and allocate a temporary Entry Number.
Write out temporary labels including the Entry Number.
Store 'entry' material separately until ready for further processing and documentation. Do not delay further work too long.

Acquisition documentation

B.3. The recording of the process by which specimens formerly come into the ownership of the museum authority.

B.3.2. Use a 'transfer of title' form signed by the depositor of a specimen or collection to confirm the transfer of ownership.

Specimen Cataloguing

B4.2. Get a unique number on to every specimen.
Some specimens pose problems e.g. very small; several identical etc. Check on handling methods.

B4.3. Against the corresponding number in a catalogue or other medium, record all the information required. Consideration should be given to:

B4.3.2. Terminology control:
use a carefully compiled vocabulary of defined terms for the most important pieces of information.

B.4.3.3. Classification:
group your terms into a hierarchical classification where possible and useful. Follow advice given.

B4.4. Record information about specimens under the following headings:
B4.4.1. Classification: type of object or what class or group.
B4.4.2. Identification: what name(s) the specimen has been given.
B4.4.3. Description: what is the specimen's constitution, appearance etc.
B4.4.4. Provenance: geographic and geologic origins.
B4.4.5. Acquisition: from whom, how and when was the specimen obtained.
B4.4.6. Processes: what has happened to the specimen.
B4.4.7. Documentation: other relevant written information,
B4.4.8. Housekeeping: storage, cataloguer, value etc.
B4.4.7.3. Where information about specimens exists and which cannot be detailed in the catalogue entry, it should be collated and kept in Specimen History Files. These may, for example, contain photographs, reprints, correspondence etc.

B4.5. If you are thinking about applying computer technology to your documentation processes, obtain advice personally from other geological curators with experience.

Moving Specimens

B5. The location of every specimen should always be known.
Any event affecting a specimen should always be recorded.

B5.1. Specimen records should make it clear where each specimen is normally stored.

B5.2.1. When a specimen is moved from store, leave a 'Removal Slip' in its place, saying where it has gone, why and who removed it.

B5.2.2. Take great care not to lose or dissociate labels from specimens. Copy original labels when required. All labels should bear the specimen number.

B5.3. The removal of specimens for specific purposes e.g. display, conservation, research, implies certain recording procedures: check on these.

B5.4. In particular, take care to record carefully any preparation or conservation process applied to specimens.

Material Leaving the Museum

B6. The curator is responsible for the proper administration and care of specimens leaving the museum either temporarily or permanently.

B6.1.1. **Loans**
Devise a loans policy defining what may be lent and what provisos apply.
Define a set of conditions under which the borrower of specimens must act. A specific loan agreement may be necessary in some cases.

B6.1.1.4. Devise and use a 'loan form' to document the process of lending a specimen. Check on the various methods available.

B6.2. **Permanent removal**
Accidental or deliberate removal, transfer or destruction of material.
Deliberate actions may have considerable legal and ethical implications.

B6.2.1. Missing or destroyed material must be included in specimen documentation: the negative information is of value.
Circumstances of loss must be recorded.

B6.2.2. There is a 'strong presumption against the disposal of any items in the collection of a museum'. In some circumstances, disposal is ethically and legally legitimate.
Disposal may be constrained by law or certain international conventions.
Procedures for the disposal or partial or complete destruction of a specimen should be followed. Check on these.

B. DOCUMENTATION

1. GENERAL INTRODUCTION

A museum curator is in essence a warehouseman, whose job it is to receive, store and safeguard objects, to locate them accurately and to make them available. As a customer of a warehouse, one would normally expect to receive any item from a list of thousands within minutes, or to be told it is out of stock, on order, or discontinued.

Though a geological curator performs similar duties there are certain differences that make his work more complicated. Where the good warehouseman ensures the efficient turnover of commercially disposable goods, the curator is the permanent custodian of material which has been acquired without any profit motive. Moreover, all his specimens are different in some respect (and do not arrive conveniently labelled) and the categories of information about his collections are far greater in number than any warehouse material.

Though these differences are important, the parallels remain and in their analagous position we should expect of a curator all that we expect of a warehouseman, as a minimum requirement. Good documentation is the key to fulfilling such an expectation.

1.1. DOCUMENTATION IN THE MUSEUM

Specimen documentation has been defined by the Museums Documentation Association as "the information about the items in a museum collection". (MDA 1981). Roberts (1982) lists 73 component activities, many overlapping, which may contribute to this information. Wherever possible, the use of terms in these Guidelines, and in particular in this Part, is consistent with the definitions provided by Roberts but in some cases differs.

It should be emphasised that these Guidelines are not intended to be line-by-line instructions to a documentation system; but should be read as guidance to a principled approach to good practice. Therefore do not look for decisions on the exact implementation of the recommendations made, except where such decisions reflect directly on specimen or information security.

1.2. THE PRINCIPLES OF DOCUMENTATION

Proper documentation ensures that a curator can quickly discover the complete history of a specimen, its identity and its whereabouts. In practice, these concepts can be embodied in a list of 'musts'.

- It must be possible to locate every specimen.
- Any information about each specimen must be recorded and its accurate retrieval ensured.
- Every specimen must be uniquely identifiable by means of a permanently attached number.
- Every specimen must be identified and classified to degrees appropriate to circumstances.
- Every significant event affecting a specimen must be recorded.

All aspects of geological curation relate to these five points, which should form the basis for solutions to the diverse problems commonly encountered. In order to produce a set of guidelines from this list, that will be useful to the working curator, it is necessary to classify in some way the complex inter-relationships of curator and specimen. An analysis of the documentary activities surrounding any museum specimen will show a frightening number of permutations of information flow. In order to aid practicality, five stages of documentary activity are identified in this Part:

- material entering a museum both temporarily and permanently: Entry documentation
- material being processed into the museum's "permanent" collections by transfering ownership: Acquisition Documentation
- curating individual specimens: Cataloguing
- material being moved within the museum
- material leaving the museum both temporarily and permanently

Before giving consideration to these stages, however, we shall look first at processes common to all: marking and labelling.

1.3. MARKING AND LABELLING

Definitions and introduction

For the purpose of these Guidelines the term MARKING is used to describe the process of recording information **on a specimen itself** either directly by pen, brush or tool, or indirectly by a tag or other device 'permanently' attached by an appropriate glue.

The term LABEL is used to describe any unattached document which carries information about a specimen and which is designed to be maintained in intimate, and, when required, permanent association with the material to which it relates.

Specimen marks and labels serve joint purposes. They provide immediate access to important information about a specimen, or the key by which further information may be obtained. Furthermore, they reinforce the security of data. John Woodward (1728), advocated the fixing "by means of Paste, Starch, or some fit Gum . . . a bit of Paper, with a Number upon it . . .". Labels and notebooks were extra to this process. Palmer (1977) advocates the direct marking of data on specimens as being the ultimate form of data security. This is undoubtedly true and no safer method of specimen documentation can be practised. However, in view of the practical constraints that apply, most curators now agree that specimen **marks** should normally be confined to numbers or codes which act as unique indicators relating to data stored elsewhere and tagged by the same numbers or codes, though physically distinct and separate from the specimen. In contrast, **labels** accompany the specimen and provide instantly accessible information. Remotely stored data, such as catalogues, registers or history files, contain more detailed or substantial information. This method of linking data to specimen through the same number on the specimen, on the specimen label and on remotely stored data, Palmer (1977) calls a 'triple-bond' system of data security. "This is the method of most professionals and virtually all proper scientific institutions". (In practice there may be more than three bonds:

measurements, descriptions, photography, etc., all contributing to the strengthening and safeguarding of links between specimens and their data).

The application of marks or the preparation of labels can occur at three stages in the processing of a specimen into a museum. First, when it is collected from the field (B1.3.1); secondly, when it enters the museum (B1.3.2); and thirdly when it is catalogued (B1.3.3). Whilst these three sections contain advice on labelling and marking techniques appropriate to each stage, there follows a more detailed technical discussion (B1.3.4). Finally, we consider the uses of marks and labels (B1.3.5).

1.3.1. Primary documentation: field labels and marks

Section A2.1.2.3 gives some advice concerning the documentation of specimens collected in the field. A number or other code should relate a specimen to a field notebook entry containing all necessary data pertinent to its field collection. The number may be a simple sequential site number or one which is modified by a date or a code identifying a particular survey or expedition. Elaborate codes can be developed, for example, those of William Smith 1769–1839 (Cox 1930 p. 285) or Barrande 1799–1883 which safeguard the authenticity of recorded information available with specimens, but which can lead to misinterpretation. Simple abbreviations, in general, are better.

Field recording necessitates simple, speedy but none the less effective methods of linking specimens to their data. These requirements are best served by the use of self-adhesive tags, 'Elastoplast', or similar material, capable of receiving written numbers or codes and which will withstand field conditions. Some geological materials will accept writing direct from a pen; a waterproof felt or fibre tip marker is easiest to use.

Many field collectors rely on labels rather than marks to link specimens to notebooks. Although this is certainly a convenient method it provides very weak data security. The method is recommended on the condition that great care is taken to minimise the risk of data loss by wrapping or bagging the specimen with its field label and to ensure that the labels clearly relate to entries in a field notebook. Field labels may be simple pieces of paper bearing nothing else but a field number or, preferably, in addition, locality, date and stratigraphic information. The preparation of labels carrying full field documentation is time-consuming; in some circumstances, pre-printed labels may be appropriate. Fabric collecting bags with attached card labels and resealable polythene bags which include a writing panel, are recommended for use in the field.

1.3.2. Entry documentation

Section B2.1 advises on the methods of documenting specimens on first entering the museum. Entry documentation entails the preparation, gathering or compilation of data in some form or other, held against a unique Entry Number (see B2.2). This number is the **only** link between specimens and data about their entry into the museum. (Accompanying field notes and field numbers for instance would not be expected to record the date material came to the museum, who delivered it, etc.). The Entry Number should be recorded on a label (here termed the 'Entry Label') and not marked on the specimen. For this reason data security must unfortunately remain weak. The application of a permanent Entry Number marked on a specimen pre-supposes a wish or entitlement to retain a specimen, and the time taken for the process reduces curatorial impetus for cataloguing. The guidelines concerning the operation of entry documentation must be followed carefully. The need for special temporary storage areas, and rapid cataloguing is especially important.

The preparation of Entry Labels linking material albeit weakly to its entry documentation is none the less crucial. The labels probably need carry little else but an Entry Number or equivalent. This is especially true for material collected in the field, as much of the important data is preserved in field notebooks. Field marks and field labels should be kept intact. Entry Labels may also carry sufficient information so as to provide immediately available information concerning the origin of the material for casual inspection. Tie-on tags or labels are advantageous where the specimens are suitable. Where practical we recommend that specimens, together with their labels should be stored in a sealed container. Self-sealing polythene bags, plastic boxes with sliding or slip-on lids and stoppered glass tubes are all useful, the choice depending on the specimen. Ensure that labels are not damaged by the specimen during storage.

1.3.3. Cataloguing: specimen marks and labels

Probably the first job of a curator engaged in specimen cataloguing is to give each specimen a unique number. In all practical circumstances it is recommended that this number be marked on the specimen. The techniques by which this can be done are discussed in the next section (see also MDA 1981 pp 127–135). Some principles to be observed are:

- take care not to obscure or destroy significant features of the specimen;
- apply numbers with sympathy for the aesthetic appeal of specimens, yet in readily accessible positions;
- beware of ambiguous numbers, e.g. 10891 is 16901 upside down: underline to indicate correct interpretation;
- the size of the number and figures should be commensurate with the size of the specimen.

Other marks may be necessary. In particular, type, figured and cited specimens (see also E2.4) should be marked with coloured spots. A recommended convention is that all type and figured specimens should be marked in green, referred and cited specimens in red, and that primary types, in addition, should have yellow Specimen Labels. Some museums mark such specimens with the institution's name or code to provide further visual documentation. Others use highly coloured (e.g. pink) specimen trays which show up more clearly in storage drawers.

Marks which amount to labels glued on to a specimen are not recommended since any fixed material of any size obscures features of specimens (unless very large or where the label may be fixed to the matrix) and are in any case subject to deterioration especially from wear to tear. In the case of large specimens (e.g. some vertebrates) the value of locality and horizon data written directly on the specimen has been emphasised by Palmer (1977) and where appropriate is recommended here, in addition to specimen labels (see below).

A specimen being processed into the permanent collections of a museum may

Fig. 3. Cataloguing a specimen using preprinted specimen identity numbers and record sheets. Identification and classification are carried out at the same time.

already be accompanied by a variety of documents and labels. In all practical circumstances these should remain with the specimens (fragile labels might, for instance, be stored in a History File). An old 'original' label does not necessarily make the best 'working' Specimen Label. A 'working' Specimen Label should exhibit the following standardised features:

- consistency of format
- consistent use of data standards
- legibility

The information which accompanies a specimen comes originally from its field associations and continues to accumulate during its subsequent history. A Specimen Label provides the opportunity to present this information in summary form and for immediate use. No information should appear on a label which is not recorded elsewhere in the specimen's catalogue entry, except, of course, that intrinsic to the label itself (handwriting, style, colour, etc.).

The Specimen Label should allow for the recording of the following information:

- specimen identification (at any level)
- stratigraphical information
- geographical information
- collector/acquisition information

- storage location
- Specimen Identity Number
- status (type, figured or cited material)
- name of cataloguer/recorder/identifier, etc. as appropriate, and date
- name of institution and/or its unique MDA code (see B4.4.2.1).

These minimum requirements may, of course, be exceeded if necessary or according to practice. It is, however, necessary to avoid the accomplishments of the miniaturist who endeavours to squeeze the maximum information into the smallest space. Such a practice is not one generally appreciated by users. It is good practice to record a lack of specific information in one of the foregoing categories, e.g. *non-loc*, *non-det*.

1.3.4. Methods of marking and labelling

1.3.4.1. *Marking the specimen*

(1) Direct engraving. Where the size and nature of the specimen are suitable (i.e., fist-sized or larger and non-friable) marks on specimens may be made using a pneumatic or an electric engraver. Normally, only the matrix would ever be marked in this way.

(2) Inscription: direct. Some slightly absorbent geological materials of a pale colour will accept writing direct from a pen, a waterproof permanent ink such as India ink being best. Felt or fibre tip pens have been used, but the permanence of their ink has yet to be confirmed and therefore they cannot be recommended. Hard, non-absorbent surfaces may be marked using a brush and lacquer paint or enamel chosen to give maximum colour contrast with the specimen.

(3) Inscription: on a painted ground. Often the most satisfactory results of inscription rely upon applying a daub of fast drying white paint (e.g., acrylic) or a spirit-based correcting medium (e.g. 'Snopake' or 'Tippex') on to the specimen. The number is then written on this white ground in black India ink or other permanent waterproof medium.

Marks applied either directly or on a painted ground (2 and 3 above) should be varnished over, using a spirit soluble varnish (polyurethane varnish should be avoided as irreversible). The major advantage of all three foregoing methods is great security. This is also their potential major disadvantage, in that should it become necessary for study purposes to remove the mark it may not be possible to do so without damaging the specimen. Also, these methods are impracticable on very rough surfaces. However, in the spirit of Palmer's (1977) philosophy, we recommend these methods. Desipite this, we recognise the widespread and usually successful method of marking the specimen by the following method.

(4) Affixing a paper 'tag'. The required mark, (usually a Specimen Identity Number) is written on a small rectangle or disc of acid-free paper in waterproof drawing ink. 'Rotring' pens with inks of the same brand are widely used and approved. 'Tags' with pre-printed numbers, etc. have the distinct advantage over handwritten information of greater legibility, One method (King 1966) used with great success requires the rather tedious job of typing out a quantity of numbers, sufficient to last the curator a reasonable length of time. With the more recent developments in computing, a better method is to employ a small program to generate numbers automatically through a high quality printer. (Not all styles of

Specimen Identity Numbers may be suitable for this treatment.) Whatever is the case, the resultant pages of numbers can be processed photographically and reduced or enlarged thus providing a choice of 'tags' of different sizes suitable for different specimens. (For dealing with very small specimens see B4.2.2.1.) The thinnest photographic paper available for this task is Ilford 'Document'. An alternative stragegy is to photocopy each page of numbers, again with the options (on suitable machines) of reduction and enlargement. In this case 45g/m2 acid-free paper has been used successfully for copying though care is required with the paper feed as this weight of paper is outside the normal operating range of photocopiers. Photocopying is clearly an easier solution than photographic processes though a check must be made to see that the type of copy is suitable (see C3.8.2.3): the permanence of photocopies remains uncertain, though the indications so far are good.

Whatever the method of 'tag' production, each 'tag' must be glued to the specimen securely. The choice of glue is important and not made easy by the very large range of products available. Appendix I gives details of those most commonly encountered. In the present context, water-soluble glues should be avoided: they are prone to attack by damp, mould and insect attack. Aqueous emulsions, e.g. polyvinyl acetate are much better, as are the various non-aqueous glues. Irreversible epoxy glues must never be used. Paper should be thin enough to allow a 'tag' to mould itself to the surface texture of the specimen whilst under light finger pressure, and be held in that position by the glue. Dampening the 'tag' can help in this process. On rough surfaces a good bond can be achieved by sandwiching a small piece of cotton wool, soaked in glue, between the paper and the specimen. Applied 'tags' are frequently sealed against damage by a smear of the glue used for the initial application.

The major advantage of paper 'tag' marking is that it is fully removable. By the same token, the disadvantage is that such 'tags' may drop off, be knocked off or become so physically damaged by wear and tear as to become illegible. Sealing, as described above, will help prevent damage from light abrasion. The convenience of this method also recommends it.

1.3.4.2. *Specimen labels*

The nature of labels varies greatly, particularly in terms of the range of methods and techniques used over the last two centuries. Perhaps the only general rule that should normally apply to modern labels is that they be made from acid-free rag-based paper or card and written in a permanent medium. In certain situations, the curator may justifiably compromise this ideal, for example in the use of labels generated by computer. In no circumstances should flimsy paper or newsprint be used.

Labels vary considerably in size, though a 3″ × 2″ format is widespread and sufficient to accommodate the required information in most circumstances.

These characteristics aside it is true to say that there are as many different styles of label as there are museums. The paragraphs below briefly assess the most common.

(1) Loose labels. The convenience and simplicity of writing out a label and placing it with a specimen in its container explains the widespread use of the system. A major disadvantage, that cannot easily be overcome, is that a label will usually be obscured by the specimen, or vice versa. Other problems can be guarded against; wear and tear, particularly abrasion by the specimen, can be avoided by placing the label in a transparent bag or by covering it with acetate sheeting. Dissociation of label from specimen is reversible by the label bearing the Specimen Identity Number of the specimen (this is true for all labels).

(2) Folded or pinned labels. Various devices have been used to render labels more easily visible. The folding of labels into an upright 'L' or a 'V' is common and in some institutions they are pinned to the side of the tray. Such methods are not recommended: the price paid for improved visibility is inconvenience, greater wear and tear and inflexibility.

(3) Labels fixed to mounting boards. This includes all those methods involving the fixing of a specimen by glue, pins or other means to a board, frame of plaque on to which is applied a label. Such methods are generally regarded as antiquated and undesirable because, on conservation grounds, they frequently lead to damaging conditions for the specimens as well as obscuring certain portions of them. The labels, i.e. the boards and labels, are unwieldy and inflexible. However, certain types of specimens must necessarily continue to have labels of this sort: miscroscope slides, mounted skeletons, small or delicate specimens, historic specimens, etc. Commonsense dictates the appropriateness of particular methods. If specimens are to be detached from boards, ensure that all labels bear the Specimen Identity Number and are then carefully removed, dried and kept preferably with the specimen or alternatively in the History Files (B4.4.7.3).

(4) Machine-produced labels. Modern methods of museum documentation offer certain facilities for the production of labels.

Data recorded on computers can be manipulated in order to provide specimen labels automatically though not as yet always with very satisfactory results. Whilst these are unlikely to satisfy all the criteria of good labels (e.g. acid-free paper) the ease with which large numbers of labels can rapidly be produced and replaced makes their use attractive.

Photocopying has been used to produce labels, and the use of acid-free paper in photocopiers is recommended. Index cards, used as catalogue records, can be copied and the copies used not only for indexes as such but also, if size allows, as labels. For smaller specimens, reduction photocopying is used. Any curatorial technique employing photocopying must be approached with caution since the long term stability of photocopies is questionable (see Section C3.8.2.3).

(5) Self-adhesive labels. These should never be used on a specimen: adhesion is gradually lost with age and with some types the glue migrates and damages the specimen in a similar fashion to 'Sellotape'. They can prove useful in circumstances where their loss is not significant. For example a specimen, properly numbered and labelled may be enclosed in a polythene bag: a self-adhesive label bearing an Entry Number or Specimen Identity Number *repeating* that with the specimen may prove useful when stuck to the bag.

1.3.4.3. *Special labels*

The labels described above (B1.3.4.2. (1)–(5)) are styles of labels defined according to their physical characteristics. Labels may also be defined according to their content.

(1) The Examination Label is specifically designed to record an opinion, identification or other judgement of a specimen by a named person. It is useful and sometimes crucial to know if a specimen has undergone specialist study, and

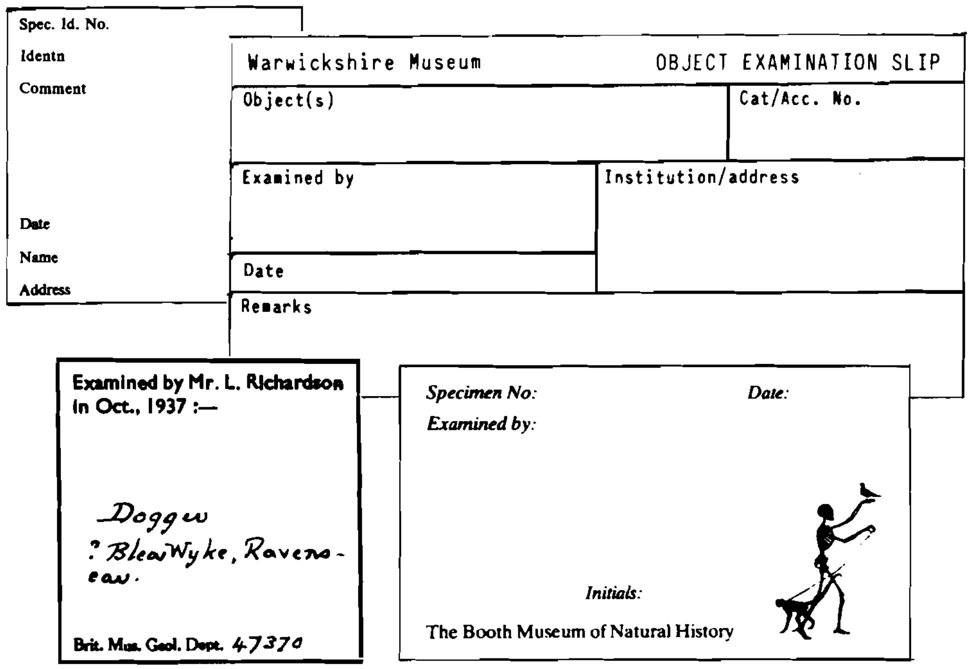

Fig. 4. Examples of Examination Labels from several museums.

to know which workers have previously consulted a specimen. Evidence of a consultation is in the form of the examiner's own handwriting, initials and/or signature, thus enhancing the scientific status of the data.

Examples of Examination Labels are given in Fig. 4. Ideally they should be pre-printed and made from acid-free paper. Space should be provided for the recording of the Specimen Identity Number, date of examination, name and institution of examiner, comments and signature or initials. A 'visitors book' used in conjunction with Examination Labels provides further opportunity to record, perhaps more fully, names and addresses.

The curator of a collection is, of course, at liberty to use Examination Labels. Furthermore, he may usefully be able to add to the content of those already in the collections by inferring data (e.g. names given to initials; enclosed in square brackets) or similarly dating an otherwise undated label. He may also use them for recording a person's verbal opinion.

An Examination Label should always remain with the specimen to which it refers. The catalogue should always be amended in the light of new information, or should point to the presence and location of such information.

(2) The Removal Slip is a specifically designed label provided for the purpose of indicating that a specimen has been temporarily removed from store, display or other location. As such it cannot be regarded as a label in the sense of providing information to accompany a specimen; rather the opposite. The use of the Removal Slip is described in Section B5.2.1.

(3) Other labels. Museums have provided for themselves a wide variety of special labels which they have found convenient for certain purposes. While they can be said to serve these purposes well, they cannot be described as necessary for every museum. Such labels have included:

- Type and figured labels
- Named collection labels
- colour-coded labels

1.3.5. The uses of marks and labels

The primary use of any specimen label is clear; *viz* the immediate availability of associated data in summary form. As specimens pass from the field through collectors, dealers and museums, so labels and marks accumlate and in so doing become in themselves valuable sources of information. Indeed, they may provide the only surviving source of information for cataloguing purposes. Retrieval may be made in two ways, direct transcription of written information and inference of data from some characteristic of an old label or mark. It is very important that in either of these two processes the curator first makes it quite clear that in the production of a new document or label, transcription of an old label or mark has occurred (also recording when and by whom) and secondly that where new information is inferred its status is indicated by being enclosed in square brackets [ ] and its origin indicated. In both cases the sources of such information should always be preserved. In the past, too much reliance has been placed on information which, when original evidence is consulted, turns out to be based on erroneous subjectivity or interpretation. A user must be made aware of which elements in a record he can have confidence in and why.

The following paragraphs touch upon some of the ways in which old or historic labels may yield more information than might be apparent at first glance.

1.3.5.1. *Content*

The label can be used to provide information relating to the circumstances in which a specimen was collected, for example, the availability of an exposure, the period of interest in a particular type of fossil, the activity of the collector, etc.

The style and terminology of the label will reflect contemporary trends in the history of taxonomic or stratigraphic nomenclature and may be conditioned by the stage of development of scientific knowledge, all of which can indicate a general date for the label (though not necessarily for the specimen!).

1.3.5.2. *Handwriting*

In some instances it is possible to identify the handwriting on a label or mark and thereby establish aspects relating to the collection, curation, identification, or other history of the specimen. Photocopies of handwriting samples can usefully be collated into a file, thus providing a ready source of comparison. Cleevely (1982a,b) discusses the methods and techniques.

1.3.5.3. *Distinctive, or personal labels*

The use of a particular printed or decorative label or marks by certain collectors leads to instant recognition of their material, even though there is no other evidence as to the provenance of the material – see Cleevely (1982a), Cleevely &

Cooper (1982), Mayer (1974, 1976), e.g. William Bean's distinctive brown-inked rectangles; BN(NH) yellow disks; Geological Society green rectangles.

Dealers' labels are commonly distinctive but the data contained has been shown sometimes to be inaccurate, so do not accept information uncritically.

1.3.5.4. *Nature of materials*

By establishing the nature of the ink, or paper used for labels and marks, it is sometimes possible to gain some clue to their general provenance.

2. ENTRY DOCUMENTATION

PREAMBLE

The procedures which are used to record the receipt and onward passage of any material coming into a museum have been collectively termed initial or Entry Documentation. At this stage, there is no distinction between material which is to be permanently acquired by the museum and catalogued and that which is only temporarily in the possession of the museum. Entry Documentation therefore represents both a holding record of an item, and the first phase in the documentation system which leads to the full acquisition and cataloguing of a specimen.

For excellent general and specific advice on Entry Documentation, refer to the MDA's Practical Museum Documentation, 2nd Ed. 1981 pp. 13–24.

2.1. INTRODUCTION AND GENERAL PRINCIPLES

The ways in which material may enter the museum are as follows:

- collected from the field;
- material received for identification;
- other donations and bequests of individual specimens or collections;
- purchase;
- loans;
- exchanges.

We would expect the larger museum to have developed, at some previous date, separate procedures for the documentation of inward loans and for material left for identification (see B2.3). Smaller museums, or any other redesigning its documentation procedures should consider processing such material as part of normal Entry documentation.

The actions required of a museum curator in order to deal with material entering museums can be summarised as follows:

1. Completion of a numbered record in order to establish specimen identity, origins and circumstances of entry.
2. Preparation of temporary labels equating specimens with written records. Duplication guards against loss.

3. Placing of specimens held under Entry Documentation in special storage areas with care taken to avoid confusion of specimens.
4. Rapid processing of those items which are to be kept by the museum into Acquisition Documentation and Cataloguing.

Entry Documentation provides the means for rapid, accurate and flexible processing and is important not only as a requirement of museum organisation but also, for those items to be subsequently acquired by the museum, as a means to achieving the full and more detailed specimen cataloguing of the highest quality. It represents a holding device whilst safeguarding identity and associated data.

It also allows the following:

- the efficient processing of large groups of associated material;
- the recording of any item received irrespective of its eventual fate, e.g. specimens on approval, specimens on loan; cabinets; documents; etc.
- the recording of specimens to be prepared prior to value judgements.

It should be clear that at this stage in the museum life of a specimen, there is a shortfall in the quality of documentation compared to the highest principles of museum work: there are no permanent specimen markings, no detailed account of specimen identities, and inadequate precautions against specimen loss, abuse or non-recognition. To this extent, Entry Documentation must be seen as a necessary but temporary evil and operated with great care and foresight to avoid potential problems.

A note of warning: bear in mind the possibility that the person who subsequently undertakes a specimen's Acquisition Documentation and cataloguing may not be the same individual who completes its initial Entry Documentation. The latter must, therefore, be written clearly, unambiguously, legibly, objectively and fully.

2.2. METHODS AND TECHNIQUES OF ENTRY DOCUMENTATION

When an object or a group of objects enters the museum it becomes the responsibility of the museum and as such must be properly accounted for. This is simply achieved by allocating a unique Entry Number to the item and recording basic information against this number is a suitable format.

The Entry Number may be in any form so long as it is clearly distinct from the current style of Specimen Identity Number allocated during cataloguing (B4.2). We recommend using a serial number, perhaps distinguished by style, format or prefix from the Specimen Identity Number.

e.g. G.12; G146

Many museums use a serial number and year thus:

1982.45

G1981/12, etc.

Ideally, however, no Entry Number should contain actual data such as a date since errors can mislead. The Entry Number is a crucial link between the entry record and item, and a label bearing this number must accompany each specimen or group of specimens. An extreme and undesirable practice is to permanently attach an Entry Number to each specimen; this may imply a museum's wish or even its entitlement to retain a specimen and also reduce the curatorial impetus for further documentation. The Entry Number must always be recorded in any documentation prepared for an item if it is permanently acquired.

The following information should be recorded during Entry Documentation:

- Entry Number
- Date of Receipt
- Donor/vendor/enquirer/lender's name and address
- Number of objects
- Description of item(s)
- Action taken (e.g. passed to Geology Dept)
- Storage location (if appropriate)
- Intended purpose of depositor (e.g. item for identification, donation, etc.)

This information should be completed as soon as items enter the museum. A receipt should be given to the person bringing the items.

2.2.1. The Daybook

The traditional format for recording the comings and goings of specimens is the Daybook. Generally, the Daybook is a bound register and contains entries listing the information outlined in B2.2 against the "Daybook" (i.e. Entry) Number. The ways in which Daybooks are used varies, not only from museum to museum but also from department to department. We do not recommend that a Daybook is used to record a wide variety of events such as staff changes, accidents, visitors, etc.

2.2.2. The Entry Form

The modern and recommended format for recording the arrival of specimens in the museum is the Entry Form, first devised by the MDA. This is a triple, self-duplicating document acting as receipt, entry record and temporary specimen record, which is completed by the person who receives items on behalf of the museum. The use of this form is detailed, together with an example, in MDA 1981 (p. 15–16; p. 43).

2.3. EXPLANATORY NOTES ON MATERIAL ENTERING MUSEUMS

2.3.1. Field collections

Specimens collected through fieldwork should arrive in a museum together with good quality information concerning locality, stratigraphy, dates, etc. For guidance on the methods of field collecting see Section A2.1 of these Guidelines.

It may be advisible for collections from different localities or horizons to be numbered separately in Entry Documentation, according to the field collection methods used, irrespective of the fact that other data are shared (collector, date, etc.). This course of action is likely to ease the future handling, preparation and disposal of specimens concerned. Any shortcomings in the field recording of specimens should be resolved during study associated with later cataloguing and should not be allowed to hold up Entry Documentation.

2.3.2. Identification services

Specimens for identification by museum staff may enter the museum and be recorded by a Daybook, Entry Form or a specifically designed Enquiry Form. The latter is widely used, being a form acting as both receipt and answer sheet, numbered sequentially. Any item donated to the museum via such an identification service should pass through Entry Documentation if it has not already done so, and the facts noted accordingly. The use of an Entry Form, as outlined in B2.2.2 renders an Enquiry Form redundant.

2.3.3. Other donations

If possible, list all the items given as a donation together with details of identity, type and origin. The greater the amount of information the better, subject to the efficient operation of the Entry Documentation system. If a full list or other catalogue exists separately, refer to it in the documentation and file for consultation.

2.3.4. Purchase

The price of a specimen, together with the vendor's name and address must be recorded.

2.3.5 Loans into the museum

Every museum should have a formal procedure for the proper reception of material on loan to it. The use of an Entry Form (B2.2.2) satisfies this requirement. A separate list of all current loans to the museum enables a regular check of returns to be made. In the case of valuable specimens or others at special risk, loans-in should be photographed for security purposes.

The subject of loan control is an important one and is covered more fully in the MDA 1981 Practical Museum Documentation and other publications noted therein.

2.3.6. Exchanges

The exchange of geological specimens between museums is established practice. The documentation of exchange specimens requires that each museum takes precautions to preserve all the evidence of their previous history. Always ensure that entry documentation records details of the whole transaction. (See also Disposal of Specimens, Section B6.2.2.4.)

3. ACQUISITION DOCUMENTATION

3.1. INTRODUCTION

Items which are recorded using some form of Entry Documentation are subject to varying fates. Some are returned to the owners having been identified, displayed or otherwise borrowed. Those which are of interest here are the specimens which the museum decides it wants to keep and incorporate into its permanent collections. This process has been called "Acquisition" and Acquisition Documentation constitutes the second phase in the recording of specimens and collections, occuring subsequent to Entry Documentation. The term Acquisition directly relates to Acquisition Policies which have been dealt with in detail in Part A. We assume that prior to the making of a decision to acquire a specimen, consideration be given to its evaluation in terms of an Acquisition Policy. The term "Accession" has also been used to mean the same thing, i.e. the formalized processing of material into the museum's permanent collections. The procedures for this formalised process vary considerably and may involve Accession Registers, Acquisition Registers, etc. We do not propose here to discuss these detailed procedures because they apply generally across all museum disciplines and have no specifically geological implications. Readers are advised to consult various MDA publications including MDA (1981) pp. 18–24 and Roberts (1985 in press). We will consider briefly, however, perhaps the most important feature of the acquisition process and that is the question of specimen ownership.

3.2. Title in the specimen

The Museums Association Code of Practice for Museum Authorities (Boylan 1977) states in its paragraph 4.5:

> "A museum should not acquire, whether by purchase, gift, bequest or exchange, any work of art or object unless the governing body or responsible officer as appropriate is satisfied that the museum can acquire a valid title to the specimen in question . . ."

The methods by which a museum curator satisfies himself that he *can* acquire a valid title are multifarious. The actual transfer of title in most instances has not been a formalised process and has only been evidenced incidentally, for instance by correspondence such as a letter of acknowledgement, or by a financial order from a museum to a seller. In cases where such evidence is lacking, dispute over the ownership of an item may lead to any claim to title by the museum being rejected.

The Museum Documentation Association, recognising this problem, advocates the use of a standard transfer of title form which should be sent to the depositor of a specimen or collection. This form is a self-duplicating triplet. The top copy is incorporated in a transfer of title file for security purposes, the second copy is signed by the depositor, returned to the museum and added to the specimen or collection History File and the third copy is retained by the depositor. MDA (1981) gives more detail.

4. SPECIMEN CATALOGUING

4.1. INTRODUCTION

Any overall view of the processes of curation inevitably runs into problems of terminology. The strategy of this Part of the Guidelines has generally been to follow the concepts of museum work as defined by the Museum Documentation Association whose definitions are rapidly becoming accepted as the norm. In this section, however, we differ a little. What the MDA calls the "post-acquisition stage" consists of the development of existing acquisition records as a precursor to the preparation of detailed, individual specimen records. This last stage, the MDA calls "item documentation" and is considered to be roughly equivalent to cataloguing, i.e. the production of individual specimen records. Rather than follow this line exactly, we ignore "post-acquisition documentation" as a concept and concentrate on cataloguing – hence the title to this section.

While the formal entry and acquisition records remain basically unchanged after their initial preparation, catalogue records are subject to long-term development, reflecting the growing knowledge about a collection. The methods by which a museum catalogues its specimens must account for this feature. We shall not here be discussing these methods as they form too broad a topic for inclusion. Nevertheless, no discussion of geological specimen cataloguing can ignore those methods advocated by the MDA and evidenced by the "Geology Specimen Card Instructions" (MDA 1980). Although these Guidelines do not form a part of the MDA Documentation System, which provides a set of integrated solutions to problems encountered across all museum disciplines, we do recommend the "Instructions" as at least, background information. It is hoped that our more specific recommendations will complement those general, and as a result, less practical conclusions.

For more discussion on cataloguing, numbering objects and many other relevant subjects see "Practical Museum Documentation" (MDA 1981) and Roberts (1985 in press).

4.2. THE ASSIGNATION OF SPECIMEN IDENTITY NUMBERS

4.2.1. General recommendations

A Specimen Identity Number acts as a link between an object and its documentation. The term Specimen Identity Number is here used to embrace the various terms in use in different museums, such as accession number, catalogue number, registration number, etc.

We also need to define the term 'specimen'. For the present we take it to mean any single geological object **including its matrix** (but see B4.2.2. below).

A Specimen Identity Number should uniquely identify a specimen and should not appear on more than one specimen without qualification. Further, no number should ever be re-used should the specimen to which it refers be lost, destroyed or even re-assigned to another correct number. Ideally a number should not mean anything other than a serial indicator. Codes, prefixes and suffixes have been used, often successfully, to indicate a specimen's stratigraphic horizon, systematic position or even storage location. However, changes in stratigraphic nomenclature, identification or storage location, etc. can clearly make any such system difficult to apply. In practice we would advice strongly against instituting such a system since it confuses the main role of the identity number (as a dumb but effective data-specimen link), with quite separate processes, such as classification, which involve inference and deduction and may be subject to change and error.

Some identity numbers incorporate the year of processing. The year in question must be that in which a specimen is catalogued so as to maintain a sequence and not the year acquired (unless it is part of a collection already assigned a series of numbers or otherwise being extended). A year date should always be written in full.

The assignation of Specimen Identity Numbers to old, ill-documented collections is a situation commonly met. Where a collection has been partially catalogued and the numbering system is being retained there should be no problem. In other cases, collections may be catalogued but in a system or variety of systems which are unacceptable. If the circumstances permit, there is merit in assigning new Specimen Identity Numbers in the same order as the old ones. Specimens known to be present at some time in the past but now missing or unrecognised should be accounted for; advice on this is given in Section B6.2.1.1.

Any number assigned to a specimen must be applied securely but reversibly. See Section B1.3.4 for guidance on methods and practices.

Great care must be taken in the use of number separators. Full stops (e.g. 1983.43.1) should be emphasised, so as not to be missed, and oblique strokes (e.g. 1983/43/1) should be truly oblique and longer than the numbers to avoid confusion with the numeral 1.

4.2.2. Special cases

The golden rule of one number, one specimen must be followed whenever possible. There are, however, various situations calling for solutions in which the principle has to be applied in modified form:

4.2.2.1. *Small specimens*

The attachment of a number to a small specimen may be impossible or undesirable. Contain the specimen in a suitable receptacle (e.g. cavity slide, plastic/glass tube), write the number on the container and on a slip within the container. Do not number the stopper alone.

4.2.2.2. *Multiple, identical specimens*

Various strategies have been adopted to cope with this typically palaeontological problem. A common factor is that the specimens should be stored together in a suitable container.

The number of specimens may be reflected in a range of Specimen Identity Numbers written on the label without necessarily stipulating individual specimen allocations. If any one specimen is chosen for special treatment (e.g. type, thin sectioning), the first number in the range can be allocated to it and the specimen then stored separately, individually numbered and the documentation amended accordingly.

e.g. 10542–10641 *Nummulites sp* 100 Foraminifera from the
Upper Bracklesham Beds, Eocene,
Lee-on-Solent, Hampshire

becomes:

10542 *Nummulites variolarius* (Lamark) Thin Section
plus
10543–10641 *Nummulites sp* 99 Foraminifera, etc.

Where bulk population and similar large samples are involved this strategy may be impractical. A single number may be allocated to cover all the specimens and should any single specimen be chosen for special treatment then a sub-number derived from the first may be allocated.

e.g. 104/1979 *Rostreulima macrostoma* (Charlesworth)
Sample of hundreds of gastropods from the Barton Beds

may produce

104/1979/1 Figured specimen
104/1972/2 Thin-section
etc.

If a bulk sample has not been sorted into genera and species, it may nevertheless be treated in the same way.

A pragmatic, though not altogether principled, solution to such problems has been devised by at least one major museum which falls between the two strategies previously described. By allocating a small range of numbers (say 10, depending on circumstances) an allowance for individual number allocation is made without the encumberance of a very large range of numbers.

If it is ever necessary to allocate an entirely new number to a specimen from a large sample, or indeed even a derived number as described, ensure that all original associations are scrupulously recorded in the specimen documentation.

4.2.2.3. *Part and counterpart specimens*

This and other situations (consider also right/left valves; broken specimens; paired aptychi, etc.) bring into question again the definition of 'specimen'. For some curators, part and counterpart equals a single specimen, for others, two. Principles dictate that both part and counterpart should bear a number, and furthermore, since a number on a specimen should be unique, these numbers should be different. The options therefore are for one number sub-divided into /a and /b or two different numbers, perhaps consecutive but not necessarily so. The first option is recommended since the number indicates that a second related specimen exists should the parts become separated. If the specimens are given unrelated numbers and all documentation is lost, there is nothing to suggest that they belong to the same individual. Whichever course is chosen, the documentation of each specimen must cross-refer to the other.

4.2.2.4. *Multi-part specimens*

An extension of the arguments concerning part and counterpart specimens could be applied, say, to a skeleton of *Iguanodon*; to what extent are individual bones individual specimens and therefore individually documented? The argument is broadened by the added significance of bone names which, in a sense, act as a sub-number, e.g. 1982. 17/left tibia. (However this is not a practice to be recommended, and in any case breaks the rule of the Specimen Identity Number being essentially non-diagnostic.)

Furthermore, many cases will arise when bones are not identifiable nor will it always be clear whether the remains represent one animal or more.

No single recommendation can cover all situations and some commonsense must be used. An extendible numbering system would seem best placed to deal with many problems. Thus an *Iguanodon* could be referred to as simply 1974/195 and individual components 1974/195/1,2,3, etc. All bones should be so marked. It may be better to refer to the whole as the sum of its parts, e.g. 1974/195/1–64. Should any elements turn out to be from another individual, documentation can be amended thus:

1974/195/1–16; 21–64	Individual 1
1974/195/17–20	Individual 2

4.2.2.5. *Artificially derived specimens*

Where a catalogued specimen is further prepared, e.g. by thin-sectioning, development, etc., specimens may be derived from the original which themselves require cataloguing. The original number, assigned to a single specimen will not suffice alone for a second. It must be extended in some way (as in B4.2.2.4 above) or less usefully, given another number, always recording carefully the original association. Complex specimen preparation may result in a wide variety of derived specimens; see for example Rushton *in* Bassett, M. G. (1979).

4.2.2.6. *Multi-species blocks*

Many examples of this problem occur in geological curation, e.g. Chalk epifauna, Dudley limestone, mineral associations, etc. In the last case, it will almost certainly be impossible to point out individual 'specimens' for special numbering: the block must be allocated one number, and each mineral noted in the documentation. An index to mineral species is of major importance for retrieval in such cases.

In the other examples, distinguishing between individual taxa on a single block or specimen is simple. We do not recommend that each is given an individual Identity Number, nor do we recommend an extended number, e.g. 194/1982/1: the block may itself already bear such a number. There remains, however, the need to point out on the block itself, each individual species: their appearance in an index whilst necessary, is alone, not enough. We recommend therefore the use of alphabetic suffixes, e.g. 194/1982/1a, 1b, 1c etc. where each species can be marked with a paper tag bearing the suffix alone, either on the fossil or nearby. If it is necessary to use the alphabet more than once, double the letters, e.g. aa, ab, or aa, bb, etc. Do not mix upper and lower case: they are difficult to distinguish when handwritten. Do not use the letters 'i', 'l' or 'o' to avoid confusion with numerals when handwritten.

The identity number of the whole specimen or block should be marked according to normal practice.

4.3. THE DETAILED RECORDING OF GEOLOGICAL SPECIMENS

4.3.1. Objective

The objective of detailed specimen recording is to provide an efficient means of making all the information about a specimen available for use. This is achieved by realising the following aims:

- to provide a secure written copy of data embodied in or accrued to a specimen
- to provide thereby a means of accurate recognition of a specimen within a collection.

4.3.2. Terminology control

The natural sciences fortunately possess several sets of classifications which apply to museum specimens. Stores, catalogues or indexes can be arranged according to these classifications. Thus, their use among museum geologists has become an established convention, but sensitive to change. As attitudes to documentation practices have evolved and particularly since computerised information systems have come into use, curators have recognised the value of controlling all terms used to describe and record specimens. Initially, this has meant the emergence of conventions (referred to generally as 'data standards'), for the recording of personal names, bibliographic references and dates, data which many disciplines have in common (MDA 1980). Latterly, museum geologists have published keyword lists, thesauri and descriptive classifications in an attempt to allow a greater accuracy and unambiguity in item recording (e.g. Pettigrew & Holden 1978, McInnes 1978, Harrison & Sabine (eds) 1970; MDA 1980). Whilst data standards to control the use of the primary categories of specimen information are vital, these published lists seem to create more problems than they solve and the MDA, at present advise against the production of wide-ranging and extensive terminologies. Nevertheless, solutions to all these problems must be found, and future work through the Geological Curators' Group is necessary. Until that time, it has to be enough for us to recommend, in those areas where we are unable to be more specific, that all geological curators obtain, follow or devise standard terminologies and classifications and draw up 'authority lists' or data standards for every primary category of information within a record. (See also MDA 1981, pp. 62–67.)

Care and forethought given to the preparation and implementation of a good system of data standards will increase the quality of the information recorded, and hence, obviously the quality of information retrieved, 'GIGO' (Garbage In – Garbage Out) applies to any data-capture retrieval system whether in electronic or card index form. The rule of thumb philosophy which every curator should apply when devising a system of terminological control is continually to ask "What kind of information am I going to want to get out of this system?" and hence, "Am I arranging that information in the most efficient way to provide the answers to the kind of question I shall want to ask?"

4.3.3. Classifications – advice

Many of the information categories used in museums can be and often must be classified. The following notes should be borne in mind when choosing or erecting classifications:

- *Hierarchies*
  Choose hierarchical classifications (e.g. Taxonomic and stratigraphic) which allow general as well as specific determinations to be made.

- *Multiple classifications and cross-referencing*
  Allow for the placement of certain specimens (e.g. mineral associations, pyritized ammonities, derived fossils) into two or more classes and ensure accurate cross-referencing thus enabling the retrieval of all specimens or information.

- *Completeness*
  Ensure that any specimen you are liable to meet in the collections of a museum has a class into which it may be placed, general or specific. Account for trace fossils, artificial minerals and their waste products, meteorites, personalia, etc., etc. If necessary, make sensible use of classes such as *Incertae sedis*, *Miscellanea*, or *non-det*.

- *Changes to classifications*
  Use or erect classifications which are likely to stand the test of time and be subject to minimal academic changes due to re-interpretations or fashion. Favour those which, even assuming change, will continue to be meaningful to workers for many years to come, e.g. published works. A classification which continues to be useful and valid evidently needs no change. On the other hand, a curator should be prepared to change or adapt a classification that has become so out of data as to be un-workable.

- *Appropriate classifications*
  Avoid over academic classifications which may prove cumbersome to the curator and unusable by an enquirer. A detailed classification is inappropriate for a very small group of specimens. A simple, gross classification is better than a detailed one, if it means greater efficiency of documentation input and retrieval.

- *Use of classifications*
  Bear in mind how you intend to apply a classification. If, for instance you are going to store a collection according to a classification, is it appropriate (see C3.5.1)?

4.4. THE PRIMARY CATEGORIES OF GEOLOGICAL SPECIMEN INFORMATION

4.4.1. Museum systematics

Information about geological collections must be classified according to systems which best express the various similarities that rocks, minerals and fossils possess. It is the geological curator's task to produce these systems in order that curators, researchers and all other users of museums can usefully retrieve such data. In biology, the process of producing systems of classification is termed 'systematics' and 'museum systematics' seems an appropriate description of this task. There are two major fields of systematics, classification and nomenclature, and in the museum it is important to emphasise that, as in biological research, classification precedes nomenclature. Classification is both the process and the result of establishing and defining systematic groupings. Nomenclature concerns the naming of species and groups, a process which, in palaeontology certainly, and to a lesser extent in petrology and mineralogy is subjective, though signficant as a vehicle of communication. Whilst we give some advice on how one may seek help in the naming of specimens (see B4.4.2.2) here we discuss only classifications.

A museum intent on developing or choosing classifications for all or part of its geological collections must consider several factors:

- size and significance of collection;
- expertise of available staff;
- available resources, especially books;
- completeness of groups represented.

Clearly, the requirements of a small local museum with collections from several disciplines are going to be quite different from those of a department of the British Museum (Natural History); classifications must be chosen accordingly. In the case of the former, curators are urged to seek specialist advice where expertise is lacking. Officers and members of the GCG will be pleased to help.

Classifications for Fossils, Minerals and Rocks are covered below.

4.4.1.1. *Fossils*

(1) Classification based on simple names. Non-academic terms for specimen groups may serve a useful purpose where academic expertise is lacking. Unspecialised museums or others with small geological collections nevertheless require indexes. Generally, a classification system of simple names based on taxonomic groups is the most attractive since it offers direct comparison, e.g. brachiopods/Brachiopoda; sea-urchins/Echinoids. Unfortunately for every higher taxon there is not always a simple name and vice versa, e.g. Cephalopoda; lobsters. The abilities and knowledge of incumbent curators in charge will to some extent dictate the academic level chosen, since it is those qualities that will be used to assign new specimens to their correct position in the classification. Geological curators, when called upon to give advice in such circumstances, must use their judgement. Simple names have a function within the identification section of a specimen record (see B4.4.2.3).

(2) Taxonomic classifications. The processes of biological systematics has produced a hierarchical system of classification which like any other starts at the bottom with individuals and proceeds upwards into one all-embracing group. In between there are various groups at different levels, each subordinate to the immediately higher group. This framework is known as the taxonomic hierarchy, its levels are taxonomic ranks, and the groups of organisms themselves are taxonomic units (taxon, pl. taxa).

The classification of fossils has proceeded along the same route as that of living organisms. Since specialists communicate in terms of fossil taxa, clearly taxonomic classifications are of major significance to a museum. Hence, their use is to be highly recommended where sufficient expertise is available and great importance is attached to the placing of fossils within the various taxa. The paragraphs below discuss how taxonomic classification can be applied to fossils. The processes of nomenclature and the documentation of Linnean names is discussed in Section B4.4.2.2. See also Jeffrey 1973.

Invertebrate fossils The most widely accepted scheme for invertebrate fossils is that in the 'Treatise on Invertebrate Paleontology' (Moore & Teichert 1953 onwards), the first edition of which is now nearing completion and which sets itself the task of describing, figuring and arranging all genera. In its final form this will be a 32 volume work and it is strongly recommended to all curators seeking taxonomic classifications. Be warned, however, that the 'Treatise' can never be expected to achieve finality: all classifications change with time.

Using the 'Treatise', hierarchical and all-embracing classifications can be devised according to requirements. Thus:

Tabulata (sub-class)
  Favositida (order)
    Favositina (sub-order)
      Favositicae (super-family)
        Favositidae (family)

(Source: Treatise F supplement 1 Vol. 2 1981.)

Such a record of the full taxonomic classification of a specimen, with indexes to match, allows easy access to information at any taxonomic level. Since the actual writing of a long string of taxa can be rather long-winded, it is further possible to codify the 'Treatise'. Thus:

3000 Invertebrate Palaeontology
  3100 Porifera
  3200 Archaeocyatha
  3300 Coelenterata . . . etc.
    3340 Anthozoa
      3342 Zoantharia
        3342–04 Tabulata

(Source: Leicestershire Museums and Booth Museum, Brighton, after 'Treatise'.)

Vertebrate fossils. No equivalent of 'The Treatise' exists for vertebrate fossils, and treatments here are patchy and uneven due to difficulties in the subject matter and differences of approach by the various editors and authors. For fossil fishes, the most comprehensive classifactory work is the 'Handbuch der Paläoichyologie' edited by Schultze (1978). At present the proposed ten volumes are incomplete, but see Dension (1978, 1979) and Zangerl (1981). For Palaeozoic fishes, a more general but up-to-date work is 'Palaeozoic Fishes' by Moy-Thomas (1971 revision by Miles). Also useful are Davis's 'Carboniferous Fishes of the British Isles' (1883), Woodward's 'Catalogue of the Fossil Fishes in the British Museum (Natural History)' in 4 parts (1889–1901) and Obruchev's (1964) account of the Agnatha in 'Osnovi Palaeontologii' (English translation, 1967).

For amphibia and reptiles the most authoritative work is the 'Handbuch der Paläoherpetologie' edited by Wellnhofer (1969) and to date, 11 of a proposed 19 parts are available, most in English. More general is Romer's 'Osteology of Reptiles' (1956). There are no general works on birds and expert help in their curation may be required.

For Mammals the most useful general works are the 'Traité de Paléontologie' edited by J. Piveteau, Tome 6 (Vols. 1 and 2 1961) and Tome 7 (1957), G. G. Simpson's 'The Principles of Classification and a Classification of Mammals' (1945) and the 'Mammalian Palaeofaunas of the World' by Savage & Russell (1983). For the many museums with Pleistocene bone material, A. J. Stuart's 'Pleistocene Vertebrates in the British Isles' (1982) is of particular value.

The foregoing references are essentially of a specialist nature and make any attempt at an overall classification of fossil vertebrates difficult. Even these, however, are not sufficient to allow accurate identification, for which specialist help must be sought. A general work which, though flawed in detail, offers a comprehensive and tabulated classification is A. S. Romer's 'Vertebrate Palaeontology' 1966 (3rd ed.), and is recommended for most museum collections. In a similar fashion to the 'Treatise on Invertebrate Paleontology', it offers opportunities for multi-level classifications and for codified systems of classification. Thus:

4000 Vertebrate Palaeontology
4100 Agnatha
4200 Pisces . . . etc.
  4221 Elasmobranchii
    4221–01 Selachii

(Source: Leicestershire Museums and Booth Museum, Brighton, after Romer 1966.)

Palaeobotanical classifications. Palaeobotanical classification is difficult and identification at the higher taxonomic levels a matter for the specialist. For the majority of museum collections, it is probably sufficient for a fossil plant to be classified simply as just that. The classification of large collections should be considered a job for the specialist. A simple but useful approach for the non-specialist might be to group specimens according to their gross morphology, e.g. foliage, stems/roots, 'fruits', etc. A further strategy is to adopt geographical subdivisions within a broad stratigraphical framework as a means of classification. For the Upper Carboniferous, for example, this would be by coalfield or even individual pits, if the quantity of material warrants it.

Any curator proposing palaeobotanical curation may benefit from the following reading list:

- General Introductions:
  THOMAS, B. A., 1981 'The Evolution of Plants and Flowers'
  OPEN UNIVERSITY, 1981
  'The Evolution of Land Plants'
- Texts (mainly palaeobotanical):
  STEWART, W. N. 1983 'Palaeobotany and the Evolution of Plants'
  TAYLOR, T. N. 1981 'Palaeobotany: an Introduction to Fossil Plant Biology'
  This includes a working classification on pp. 22–28.
- Text (mainly neobotanical):
  BIERHORST, D. W., 1971 'Morphology of Vascular Plants'
- 'Treatise' equivalent:
  BOUREAU, E. (ed.) 'Traité de Paléobotanique' (4 of 9 proposed volumes published 1964–1975.)

(3) Stratigraphic classifications. Classifications based on stratigraphy are of significance to collections management, in particular for the arrangement of collections in storage (see C3.5.1).

A stratigraphic classification is of the greatest importance for fossil material because of the value of fossils in providing biochronological information. Information retrieval systems may provide detailed stratigraphic data but they are only as accurate as the original information itself. Biostratigraphers generally need to see specimens and stores organised according to a stratigraphic classification are therefore useful to them.

Stratigraphic classifications are usually confined to chrono- and lithostratigraphic terms which reflect the more traditional divisions in stratigraphy, as encountered on specimen labels. Frequently they are tailored to meet the requirements of individual museums, according to the make-up of the collections.

Curators requiring a simple classification for small collections are advised to use the stratigraphical tables found in each of the three handbooks on British Fossils published by the British Museum (Nat. Hist.) (1975, 1983). These tables may also suffice for bigger collections but curators may wish to derive their own classification from the detailed framework they develop for cataloguing purposes (see B4.4.4.2).

4.4.1.2. *Minerals*

The primary classification of mineral collections is normally achieved on a chemical or crystal structural basis (Doughty, 1981). Most mineralogists prefer to follow Dana's 'System of Mineralogy'. The 6th edition was the last complete edition (1892), since the 7th edition does not include the silicate minerals, For these, Deer, Howie & Zusseman (1962–3) is invaluable.

Most non-specialist curators require a classification in which every mineral known to mineralogy is named and placed in a logical group. In practical terms, for predominantly English-reading curators, this has meant that Hey's 'Chemical Index of Mineralogy' (1955) with its two appendices (1963, 1974) has been employed because it uses Dana's system. Once a mineral is named the curator using the 'Index' can readily group it with chemically similar material and when a particular mineral is required, a simple consultation of the index leads directly to the specimens.

4.4.1.3. *Rocks*

There is less standardisation in the classification of rocks than in the previous sections and no classification is dominant. Perhaps only Murray's summary of rock classification (1981) can be recommended as an excellent and cost-effective solution in its field.

Small collections of specimens are usually arranged in the three primary divisions, igneous, sedimentary and metamorphic; and this normally suffices. Geographical subdivisions may also be useful.

(1) Igneous rocks. These are classified in many ways employing texture, grain size, colour, mineral content, chemical composition, occurrence and origin. Until recently, in Britain, rocks were commonly classified by their mineral contents (e.g. Hatch, Wells & Wells, 1972). Different systems have been developed in several countries resulting in the same names being used for rocks of differing composition. Following a series of papers in the 1960's Streckeisen's proposal for a standard classification of igneous Rocks was accepted by the Subcommission on the Systematics of Igneous rocks of the International Union of Geological Sciences (IUGS). The resulting system uses only well-known names without geochemical connotations, and the actual (modal) mineral content and texture are the sole factors employed in allocating names; it is thus ideal for coarsely grained plutonic rocks, and for use by the non-specialist lacking laboratory support. See also Streckeisen (1976) on plutonic rocks, summarised in the appendix of Cox *et al.* (1979).

Fine grained volcanic rocks present problems for non-specialists since chemical methods of classification are now used and recommended by the IUGS, based upon the total alkali silica (TAS) diagram (see Le Maitre, 1984, or Zanettin, 1984). Although too old to include the most up-to-date methods, Murray (1981) present a valuable digest of classificatory systems for igneous and other rocks.

(2) Sedimentary rocks. Classifications of sedimentary rocks tend to be markedly affected by the specialist interests of the author. A good overall classification which has proved useful however is in Greensmith (1978): chapter 4 is useful for creating data standards for the structures seen in hand-specimens.

Terrigenous sedimentary rocks are generally classified on grain size after Wentworth (1922) but a modified form requiring little laboratory support is that of Krynine (1948). For normal museum purposes descriptive schemes such as these are preferable to generic classifications. Volcanic sediments present fundamental problems since there is still much debate on terminology. For contrasting approaches to the problems Fischer (1966) and Wright & Bowes (1963) are worth reading. A useful summary classification is included in Murray (1981). Carbonaceous deposits have been neatly classified by Pettijohn (1975), and a useful rank series for coals has been produced by Teichmuller & Teichmuller (1968).

Limestone classification is still controversial, particularly in view of the ready diagenesis of these rocks (Bathurst 1971), but two classifications of primary lime sediments have gained favour over the last two decades. Folk's classification (1959, 1962) is purely descriptive based on the types and proportions of carbonate particles, carbonate mud, and void filling cement. Dunham's classification (1962) and its extension by Embry & Klovan (1971) is again descriptive but by placing emphasis on mud-sized material and determining whether the rock is mud-supported, grain-supported, or bound by organic remains in primary deposition, gives useful sedimentological information. Neither can be recommended over the other but the extended classification of Dunham incorporates more useful information. Pettijohn (1975) includes a simple working classification of dolomitic limestones and dolomites. Murray (1981) includes a summary of natural chemical precipitates and deep-sea sediments but museum collections of this type are relatively few and for the large ones expert advice should be sought.

(3) Metamorphic rocks. The complexities of metamorphic petrology have led to no generally accepted classifications. British students still labour in the shadow of Harker's work (1950) but since 1960 the influence of Turner & Verhoogen has been strongly evident. The most recent summary classification however is that of Winkler (1979), whilst Spry's (1969) work on metamorphic textures has been a valuable addition. All the systems are descriptive, depending on mineral recognition and texture, but these are notoriously difficult rocks to identify accurately and hence a problem for the non-specialist.

4.4.1.4. *Meteorites*

These natural objects that survive their fall to Earth from space are uncommon in museum collections. A meteorite is named after a locality near to which it fell or was found. Classification is on a chemical basis, initially into stony, stony-iron and iron types. Storage is normally based on these characteristics, but see also C3.7.1 for special requirements.

4.4.2. Identity and identification

In this section we deal with the unique identity of specimens (B4.4.2.1) and the means by which specimens are identified and named (B4.4.2.2–B4.4.2.6).

4.4.2.1. *Specimen number*

A record of the Specimen Identity Number must precede any other statment in a written record. The assignation of numbers to specimens has been discussed in B4.2.

A Specimen Identity Number should at least be assumed to be prefixed by the appropriate museum code letters assigned by the MDA (their Institution Number) and should, if possible, be printed on any pro-forma recording format. Rubber stamps may help. In any published reference, this code should always appear. MDA (1984) lists nearly one thousand codes currently assigned. (It should be noted the 'Index Herbariorum' (Stafleu ed. (1981) lists codes for herbaria internationally, which differ from the MDA codes. In addition, the British Library has a list of codes for all libraries in the British Isles.)

Numbers previously allocated and attached to a specimen should always be left in place and recorded. Of particular importance are the apparently meaningless numbers found on specimens from old collections: familiarity with numbering styles and discoveries of other information may lead to their interpretation. In particular, the computer processing of records including these numbers may reveal a sequence previously unsuspected. More recently allocated numbers (e.g. Entry Numbers, loan-in numbers, identification service numbers) should also be recorded; though if not actually stuck on the specimen (and these should rarely be so) such numbers are better recorded in a more appropriate section of the catalogue entry (e.g. Acquisition).

4.4.2.2. *Full name*

Section B4.4.1 briefly discussed the relative roles of classification and nomenclature as applied to museum collections, and went on to describe classification systems alone. We now turn to nomenclature, first as it applies specifically to fossils and secondly as it applies more generally to minerals and rocks. We do not give advice on how to identify particular specimens but here further emphasise the importance of obtaining specialist assistance. A curator cannot expect to identify accurately all the species in his care and we recommend that a policy be adopted whereby museums engage specialists from university departments or other museums, to examine, identify and otherwise research collections within their own fields of interest. Travel expenses, at a minimum, should be provided.

It may be useful to define a name as a statement of opinion about the identity of a specimen; the opinion may be more or less accurate and acceptable. In the case of objects like microscopes, cabinets, photographs, etc. the name is very likely to be of wide currency. The curator must nevertheless establish the names and formats *he* is going to use for such objects and draw up a standard list so as to allow for accurate indexing.

e.g. instrument (microscope)
furniture (slide cabinet)
photograph (portrait)
etc.

(1) Fossils. It is the names of fossils which are the most subjective of all and which perhaps, whilst sometimes posing problems for the curator, can give vital information to researchers. Curators are not expected to become taxonomists but they must be aware of certain conventions which are commonly used. Nor is it expected that curators, when identifying fossils outside their special field of interest, should use these conventions to the full – (it is of course important that their name as identifier is recorded – see B4.4.2.5). The following summary of some of the more important points in taxonomic nomenclature may be useful.

Codes of Nomenclature for fossils. The naming of most living organisms and fossils is governed by two major international codes:

ICZN, International Code of Zoological Nomenclature, 1985
ICBN, International Code for Botanical Nomenclature, Stafleu, 1983

The two codes differ in approach and format but in general are similar: both consist of a series of numbered rules or articles, some of which are supplemented by recommendations. The provision of the rules are mandatory; recommendations indicate the best procedure. Both codes require that scientific names are Latin in form and subject to the rules of Latin grammer. They stipulate standardised endings for the names of all taxa of a given taxonomic rank, e.g. ICZN families must end in -idae (N.B. that there are important differences between the codes, e.g. ICBN families must end in -aceae).

The codes stipulate that generic names are a single term (uninomial) and are single nouns written with an upper case initial letter. They stipulate that species names are binomial, the specific name following the generic and in grammatic agreement, using a lower case initial letter. The rules, recommendations and conventions of the codes allow for the incorporation of considerable information with a name. Qualifying punctuations, authorities and dates add to this information. (See also Jeffrey 1973.)

In addition to these rules there are other conventions (Open Nomenclature) for concisely expressing opinions about a specimen whose identity cannot be precisely determined. Similarly, conventions exist which allow the expression (in published synonomy lists) or opinion of earlier taxonomic judgements. These conventions entail the use of several qualifying punctuations, abbreviations, etc., details of which can be found in Matthews (1973).

The recording of scientific names for fossils. It should be clear that the scientific names given to museum specimens by others may be of great significance and should be transcribed and attributed with great care. Qualifying signs must not be omitted.

With the majority of fossils, scientific names will occur in the general form of *Genus-species* – Author(s) – Date though it should be noted that technically the Authority and Date are not part of the name but form an abbreviated bibliographic reference, aiding nomenclatural precision. Nevertheless, record these in full. By convention, the binomial should appear in italics but where this is not possible underlining is used instead. When the genus has been determined, but not the species, the convention of using "sp." after the genus name has wide recognition, e.g. *Gryphea* sp.. Similarly, the term "cf.", meaning "compare with", is used for a specimen which is similar to, but not identical with, a given genus or species. The term "aff.", meaning "affinity with", is used for specimens with a greater degree of similarity to a given genus or species than "cf.", e.g. aff. *Caninia*, cf. *Crassatella*.

The MDA Geology Specimen Card allows for the recording of a 'classified identification'. Thus, the curator may clarify the position of a binomial by preceding it with elements from the taxonomic hierarchy or the classification in use in the museum.

e.g. Brachiopoda-Articulata-Strophomenida-*Productus productus* Martin 1809

Alternatively, its position may be codified (see B4.4.1.1.(2)).

(2) Minerals and rocks. The names of minerals and rocks provide curators with greater difficulties. They tend to be more subjective, and many species are merely arbitrarily defined members within gradations from one extreme to another, based on grain size, colour, chemical composition, matrix type, etc., all of which may require considerable technology to determine.

For minerals, Hey (1955, 1963, 1974) provides the best arbiter of accepted mineral names through the 'alphabetical index of accepted mineral names and synonyms'. Curators are advised to use the following format to record varieties (as defined by Hey):

Quartz var. Chalcedony
Microcline var. Amazon stone

or perhaps

Gypsum (Selenite)

In addition it may be necessary to use group names which are often required retrieval headings for curators or for use when further determination cannot be made, e.g. feldspar, garnet, mica, pyroxene, etc. For example:

Garnet (Pyrope) var. Vogesite
Feldspar (indet)

There are numerous inconsistencies, errors and omissions in Hey which will occasionally be met and which must be solved by amendments or conventions as required. For example:

Ruby:	listed as a variety of Corundum but given its own 'Hey Number'
Crocidolite:	listed as a variety of Riebeckite in alphabetical index, but as a synonym in the text.

The nomenclature of rocks in particular is not well formalised and several qualifying descriptions may be required. This is true to a lesser extent for minerals. Again, the curator must establish for himself a standardised approach and terminology to ensure the accuracy of information retrieval. Thus, he may draw on lists incorporating names such as:

Gneiss (Augen)	Gypsum (Selenite)
Limestone (Crinoidal)	Quartz (Rutilated)
Gabbro (Layered)	Garnet (Almandine)

The instructions for the MDA's Geology Specimen Card (MDA 1980) give other examples such as:

"Sandstone & well sorted & green"

4.4.2.3. *Common, simple and alternative names*

Common or vernacular names may take many forms.

e.g.	Devil's toe-nail	'Osses 'Ed	Fool's Gold
	Shepherd's Crown	Bull's Heart	Kidney Ore
	Thunderbolt	Lampshell	Cat's-eye

Whilst a knowledge of local and folk-lore names is of considerable interest, such a name should only be recorded in documentation when it has been specifically referred to a specimen by the donor or finder. Simple names may be specific to particular types of specimen but not scientifically formalised.

e.g. flexible sandstone
Fontainebleau sandstone
emerald pearl
giant gabbro

Alternative names may be firmly based on informed scientific opinion, but indicating uncertainty, inability or unwillingness to proceed further with the identification,

e.g. cheirurid trilobite
actinopterygian fish
stigmarian axis
chelonian scute

In certain cases, such names may be used in place of the full name where a binomial or other name has not been determined. In addition, alternative names may include synonyms, especially in mineralogy where, unlike palaeontology, a new name does not imply a change of indentification, merely a formalization of terms.

The curator should also be aware that in palaeontology, Linnean nomenclature is not the only one in current or recent use. Alphanumeric identifiers have been used for fossil pollen and spores and a pseudo-Linnean system is used for trace fossils. In certain cases such names might be regarded as 'full names', in the absence of others.

4.4.2.4. *Previous identifications*

A record of any name that has ever been given to a specimen should be made. Previous names are part of the history of a specimen and are of value in linking them to old and re-discovered records. They are of particular importance to palaeontology since the opinion of an early worker may be of significance to a modern one.

4.4.2.5. *Identifier and date*

The emphasis placed on the recording of any name that has been given to a specimen applies equally to the recording of the name of the person who has identified the specimen, and the date on which the identification was made. Identifications may link with Examination Labels (see B1.3.4.3(1)), and other documentation such as correspondence, visitors' book, etc.

4.4.2.6. *Status*

A specimen acquires a 'status' when its existence is in some way specifically recognised in a publication. The recognition may be of several kinds.

In taxonomy, the definitions and descriptions of a taxon are published and the name given to the taxon is determined by means of nomenclatural types. As far as species are concerned, the 'type' of the species is a specimen (Holotype) (or group of specimens – Syntypes and Paratypes) which provides a fixed point of reference against which the application of species names can be unequivocally decided.

The type concept is complex and rigidly governed by the Codes of Nomenclature (see B4.4.2.2(1)). The terms applied to palaeontological types are governed by the same rules and they should be used with the utmost care. Many type-terms have been used loosely in the past, or have had no valid status at all. With minerals, nomenclature has not been governed by a code, and the type concept is poorly defined and not strictly applied, but nevertheless is expressed by many of the same terms. Further explanation of the type concept is given in E2.4 (see also Jeffrey 1973; Torrens 1974; Roberts 1981).

The list of taxonomic terms for Palaeontology is given below, together with those for Mineralogy, where their usage may be different.

Fossils	*Minerals*
Holotype	Holotype
Syntype	Cotype
Lectotype	Metatype
Neotype	Ideotype
Paratype	Plesiotype
Topotype	Neotype
	Topotype

Specimens also acquire a degree of status by being figured in scientific journals. Type specimens are commonly figured with their original descriptions and definitions. Other specimens may be illustrated at the same time for comparative purposes; yet others may appear subsequently. Any such illustrated specimens are classed as FIGURED.

Some curators accord an informal status to specimens illustrated in popular works, text-books, etc. These may be recorded as FIGURED: POPULAR.

Specimens in museum collections may be consulted by workers who, in their final publications may draw attention to them. Where a specimen has been specifically referred to (by identity number or other unambigous parameter) the specimen is given the status of being CITED. Where a specimen is referred to in only general terms, and is not uniquely identifiable, it is termed as a REFERRED specimen, (e.g. "a small group of associated teeth from Lewes in the Willett Collection"). The documentation of 'status' geological specimens is arguably the most important part of a curator's job. Copies of all the publications referring to them should be obtained and filed in History Files (see B4.4.7.3). Recommendation 72G of the ICZN (1985) states that:

> "Every institution in which name-bearing types are deposited should
> (1) ensure that all are clearly marked so that they will be unmistakably recognised as name-bearing types;

(2) take all necessary steps for their safe preservation;
(3) make them accessible for study;
(4) publish lists of name-bearing types in its possession or custody; and
(5) so far as possible, communicate information concerning name-bearing types when requested by zoologists."

4.4.3. Description

4.4.3.1. *Dimensions*

A record of the size of any museum object serves two functions; one to enable the construction of a mental image of the specimen from a written record, and the other to assist the accurate recognition of the specimen, should it lose its identity number or specimen label.

In this regard, however, we must turn again to a clarification of the term 'specimen'. For the present purposes, a specimen is the whole object, for example the fossil fish and its matrix. The length of the fish, whilst undoubtedly of importance palaeontologically (and of value in the recognition of the specimen) is of less immediate significance for the curator engaged in specimen documentation. Moreover, the curator, perhaps unschooled in the finer points of palaeontological interpretation need not make specialist measurements, e.g. for a gastropod, apical angle, whorl height, etc. However, when measurements of this type are taken, such as for a research project, they can be kept in the History Files and referred to in the catalogue as appropriate.

In the example of a fish in matrix, the length of the fish itself may be recorded in the general description, or as a second entry under 'Dimension' according to the data standards in operation.

By avoiding interpretative or specialist measurements, the curator can use a simple, commonsense method for recording dimensions.

The weight of a specimen is rarely recorded though this practice might be of value in object recognition. It is recommended as an appropriate parameter for precious metals and cut gems.

4.4.3.2. *Condition/completeness*

These two terms are to a greater or lesser degree subjective and there are arguments against their inclusion as information headings, as opposed to inclusion, when appropriate, in a generalised description. Certainly, internal conventions should govern the use of formal, qualitative terms such as good, excellent, poor, etc., etc. Some curators prefer to record formal information about condition only when a specimen is about to be conserved, and then to record it in prose (rather than in a classified form using 'keyword and detail' – see MDA 1980 p. 2–10).

Similarly, the completeness of a specimen, expressed as keyword and detail, can be considered as information of value as an aid to object recognition though more specific information would perform the same function better in prose.

In the case of missing specimens, record under this heading the term 'MISSING' together with a date and name. The date is that when the curator established that the specimen was indeed missing. Details such as 'probably destroyed by enemy action 1940', can be added here or under 'Notes'. (See also B6.2.1.1.)

4.4.3.3. *Colour*

Colour is a notoriously elusive quality to record objectively, since individual perception of its two components of hue and tone varies greatly, and, in any case, cannot be readily quantitified.

Its most frequent use is for minerals, for which colour can be a diagnostic feature, and to distinguish varieties of gemstones and more common minerals such as tourmaline and fluorite. Colour may also be useful in rock and fossil descriptions, particularly for decorative or building stone collections. The latter may be consulted when replacement stone is required to repair an historic building. Standard colour charts, e.g. Kornerup & Wanscher (1978) may be useful in this context. As a general recommendation, make a formal note of the colour of a specimen only when of particular significance. An informal note as part of the general description may be helpful.

4.4.3.4. *Form, format and number*

Several terms, particularly **form** and **format**, have been used to mean 'a description of the nature of a museum object'. They have been considered as part of the identity record (Gemstone, Photograph, Peel) or the description record (Skeletal, Cut/polished, Acicular). They have described the specimen only (Crystalline, Cast, Pseudomorph) or (and sometimes in addition) the whole object (in Matrix, Framed, Mounted). 'Form' has sometimes been restricted to mean 'Mineral Form'.

It is difficult to recommend a single approach that could be said to be superior to others. Certainly, all the aspects noted here as examples should be recorded somewhere, for example in the general description. A separate record of form and format using keywords should be carefully considered from the viewpoint of real, practical value. It is undoubtedly useful to be able to extract from an index or catalogue, say, all 'replicas', all 'microscope slides' or all 'models'. It is of dubious value to be able to extract all 'nodules', 'hand specimens' or 'blocks'. These are terms of interest in prose, not in analysis. Nevertheless, much effort has been expended on the formulation of keyword lists in connection with the MDA Geology cards and the 'Part: Aspect: Description Keyword/Detail' analysis method. Particularly wide-ranging are McInnes (1978) and Pettigrew & Holden (1978), but see B4.3.2 for cautionary advice.

The **number** of objects comprising a specimen is clearly of importance to its documentation. The question of the assignation of Specimen Identity Numbers to a group of multiple specimens has already been considered in B4.2.2. Assuming that all necessary decisions have been taken, a record of the number of objects, specimens or parts held under one identity number should be clearly made. If the parts of the items are two halves, part and counterpart of otherwise intrinsically related, a clear note should be made in the general description, as keyword and detail, or under 'Notes'.

4.4.3.5. *General description*

It is by no means a universal practice for curators to describe a specimen in prose at any stage of the documentation process, but it is a practice to be thoroughly recommended. Many of the information categories recording specimen data do so minimally, are often coded or abbreviated and are not easily assimilated to provide an immediate image of a specimen to the curator or researcher. Further, whilst such categories may include a record of size or weight they could not realistically be expected to cope in any standardised way with the infinite variety of shape, colour, texture, composition, and appearance of museum specimens. They are the data which tell a curator how to recognise a particular specimen rather than a 'sort' of specimen. Information analysis cannot entirely replace the information packed into sentences constructed using the rich vocabularly and syntax of the English language, scientific or not. A description should briefly summarise the important aspects of a specimen usually including:

- simple or alternative name (see B4.4.2.3 above)
- colour
- shape
- general appearance
- obvious features
- associated labels, etc.
- size statement (e.g. approx. 6")

Some of this information may actually duplicate the analysed information elsewhere in the specimen documentation but if it serves a purpose, no matter.

4.4.4. Primary provenance

4.4.4.1. *The Geographic locality*

The purpose of data concerning geographic origins is primarily to assign accurately a particular specimen to its original location. Naturally, accurate data of this type are of fundamental significance to any research involving specimens, so indexes to collections by their geographic origins are of great value. It is also in that category of 'original' data which, if lost, cannot usually be deduced or inferred with accuracy or certainty. The method a curator uses to record the location of a specimen is to some extent dictated therefore by the style of index he wishes to adopt. For this reason, we shall consider some aspects of indexing here as well as later (see E1.3).

Index headings may be drawn from any level of locality data, from the specific National Grid Reference to the country of origin. Every level has its difficulties for the index compiler and hence for the cataloguer. Probably the main source of difficulty concerns the poor quality of locality data accompanying the vast majority of collections in the care of British museums: they do not lend themselves to rational analysis, are not readily reducible to a common denominator useful for an index and in detail are frequently absent altogether.

Whilst it is relatively simple to advise on the recording of locality data for collections made now, it is much more difficult to offer practical guidance for the documentation of older collections. An important point to remember is that, like fossil names, geographical localities are open to interpretation, particularly in conjunction with stratigraphic data. Where interpretation is being made, use the square bracket convention and record the authorship of the interpretation. One common pitfall requires that curators be critical of locality data. Some well-known localities (e.g. Lyme Regis and Whitby) become over emphasised and submerge other nearby, but distinct localities in the same strata (e.g. for Lyme

Regis, Charmouth; for Whitby, Saltwick, Black Nab and even Kettleness). In general, whilst it is recognised that by today's standards the majority of locality data is poor, it must also be recognised that by those of the last century and even later, it was adequate. Old collections cannot be judged too harshly against modern requirements.

The documentation of localities is a subject separately considered in Appendix III.

(1) The catalogue entry. The MDA Geology Specimen Card Instruction (MDA 1980) give advice on the recording of place names and much of it is generally applicable. The 'address' of a locality may be very long or very short but whichever, all place names necessary or pertinent to a locality should be recorded, preferably in the order specific to general. Detail (e.g. relative positions, and other qualifiers) should of course be recorded according to the system in use (MDA card or other). Pertinence of necessity is of course a matter of judgement, relying in part on the index requirements (and also on the simple necessity to locate a place geographically). Restricted areas of particular interest, perhaps up to the size of a country, may be indexed by the most specific place name; in such cases (and probably in many others) recording must be carried out in conjunction with a map, ideally to a standard scale, and preferably a standard edition. Thus, only those names occurring on the map would be permissible as index headings. Furthermore, if one wishes to index by Parish or District for example, clearly these must be listed systematically and exhaustively.

Similarly, an index may be required to distinguish between specimens from the five countries of the British Isles. The care with which locality data are recorded is of special value to any computer processing of information. The end result of this may be an alphabetical listing of all place names at every hierarchical level, a very powerful tool for research (see E1.3.2). Curators should consider carefully their documentation techniques with future machine processing in mind.

(2) The National Grid Reference (NGR). The National Grid was established to provide a reference system for the whole of the British Isles and every locality is referable to it. A detailed explanation can be found in Harley (1975). A brief summary is available in Cooper *et al.* 1980, p. 45, and on the back of many Ordance Survey maps. A NGR defines an area, the size of which is determined by the length of the reference. A 10-figure reference (with its additional 2-letter prefix) defines 1 square metre; a 6-figure reference defines 100 square metres and a 4-figure defines 1 square kilometre. In practice 6-figure references are the most commonly used, being easily obtained from 1 inch or 1:50000 scale maps and sufficiently accurate for most purposes. Whenever the geographic origin of a specimen is precisely known (in terms of the accuracy of the NGR system) it is recommended that a 6-figure NGR is recorded.

In addition to their use as a finding device, NGRs have been used as index headings (see for example Cooper *et al.* 1980, p. 29) though there are difficulties. A particular problem concerns the documentation of older collections where precise locality data are unavailable. A system of 4-figure references, used purely as an index, has been used successfully in conjunction with the 1972 Ordnance Survey Gazetteer of Great Britain which lists all place names occurring on the "1/4 inch" maps together with their 4-figure NGRs. Specimens with poor documentation may unhelpfully be recorded as coming from Dudley, Bath, Matlock or Torquay; a 6-figure reference for such place names is unacceptable since it introduces false accuracy. However their 4-figure references, as given in

the Gazetteer, provide a standard reference, a means of roughly locating a place and a slot in an index. Place names not listed in the Gazetteer can be found on a suitable map and the nearest place listed used as the reference. A 4-figure NGR may duplicate a 6-figure reference and may indeed be slightly different but it is better to apply the system in full, rather than to mix accuracy and approximation. Place names recorded and used for a 4-figure reference should be indicated by underlining or by square brackets. This system provides a practical means of creating a useful NGR index for a far greater proportion of a collection than might otherwise be possible.
(3) Problems. A large number of difficulties arises during the documentation of old collections in connection with their geographic origins. Some of these are noted below, together with the briefest of indications as to how they might be solved, if at all.

- *No locality information*
  No solution; file under Non-Loc or similar heading. Curators may wish to include under this heading those place names which, in the absence of further qualification, are simply impossible to pinpoint, e.g. Newport; Stoke; Seaton; Stainton.

- *Place names known but unlocated*; *U.K.*
  A wide variety of gazetteers is available:
  Ordnance Survey 1975 1/4"
  Ordnance Survey 1:50000, available as computer print-out, fiche, film or tape from the Survey in Southampton.
  Bartholomew 1914 (and later editions).
  Ordnance Survey old series, usually available for reference in Record Offices, particularly useful to check for redundant place names, or those which have changed over the last century.

- *Place names known, but unlocated*: *other countries*
  Brookes Gazetteer "of every known country in the World" 1876 or Johnston's (1853) Dictionary of Geography.
  The Times Atlas: new and old editions.
  Other National Gazetteers, e.g. Thorntons 1857
  Gazetteer of . . . the Native States on the Continent of India.
  Reference libraries will help.

- *County boundary changes*
  The 1974 (1975 in Scotland) re-organisation of Local Government altered the boundaries of many counties as well as both creating new counties and removing others. The effects of this on indexes based on the former boundaries are considerable, and integration is difficult. Pre and post-1974/75 sections to indexes might be considered worthwhile. Conversion of old country names to new ones is possible though tedious. Old names should never be discarded entirely (inferred information is by convention enclosed in square brackets). The Ordnance Survey (1975) has published a map of administrative areas in Britain showing boundaries before and after the reorganisation. Standardised recording on the system of 'vice-counties' devised by Watson (see Perring & Walters 1976) or even using the National Grid has much to recommend it.

- *Redundant or shifting countries and regions*
  e.g. Schleswig-Holstein
  Pomerania
  Damaraland

  Use an old edition of the Times Atlas, e.g. 1895, to translate an old term into its modern counterpart(s); use square bracket convention to indicate inferral. If locality data is poor, and a place name goes unrecorded, it may not be possible for this translation to be performed. It is necessary to know, for example, from which part of Poland a specimen comes in order to place it within a modern political boundary. In such cases, record the date of collection in brackets after the country name, implying the historical context.

4.4.4.2. *The stratigraphic locality*

Stratigraphic data are clearly of major importance with regard to specimen recording and may be used as the basis for collection indexes, and for the arrangement of collections in storage and, in order to be useful, must therefore be recorded according to a recognised and established system. Such a system must incorporate a terminology which allows retrieval using an index on lithostratigraphic, chronostratigraphic and biostratigraphic bases, should all three prove to be applicable to particular collections. Furthermore, it must allow for the great disparity in the quality and amount of stratigraphic information inherited with museum collections varying from no more than a Period name, to the fine stratigraphic detail of bed numbers (though not all possible levels would normally be regarded as potential index headings).

The primary difficulty facing a curator determined to establish a new stratigraphic framework for recording specimens is to decide on what published basis he should erect an authoritative system. Secondly, he must discover how such a system can be made to allow sufficiently detailed recording and indexing for useful retrieval without entering the complexities of localised stratigraphies, other than perhaps that of his own area of special interest or responsibility. It is probably true that no single solution to these difficulties represents a satisfactory system flexible or comprehensive enough to fill the requirements of all museums.

(1) Sources of information and guidance. For British geology, the Geological Society's 'Special Reports' on stratigraphic correlations (Nos. 1–15, 1971–1980) represent the standard reference, being comprehensive and with extensive bibliographies. The correlation charts are particularly useful.

The Society has also produced other special publications of value:

- Spec. Pub. No. 1 'The Phanerozoic Time Scale' Harland, Smith & Wilcock (eds) (1964);
- Spec. Pub. No. 2 'The Fossil Record' Harland *et al.* (eds) (1967)

both of which contain standard stratigraphical sequences (the latter, however, has received considerable criticism).

Another useful publication is:

- Spec. Rep. No. 11 'A Guide to Stratigraphical Procedure' Holland *et al.* (1978).

The British Geological Survey (the late Institute of Geological Sciences) has through its maps and other publications set standards for stratigraphical procedures, but the time that has elapsed between their many publications means of course some unevenness in coverage and standards. There is recognition within the Survey of the wide potential for a standard stratigraphic terminology and for some years work has been progressing towards a computer-compatible, codified system for the United Kingdom. A provisional edition was prepared in 1977 and has since been updated though never published (see Roberts 1980). The task has not been completed and although the key on new maps of the Survey will soon carry parts of this system, there are no immediate plans to publish the system itself as a reference work. Nevertheless, curators with contacts in the Survey may be able to obtain some assistance.

International stratigraphic guides may also be of value to U.K. based museums. In particular institutions with large foreign collections will require published guidance. The following are some of the major references:

- 1956 (continuing) Lexique Stratigraphique International, CNRS, Paris
- 1967 The IUGS 'Proposed recommendations for the world-wide Geochronological scale'.
- 1970 Amer. Comm. on Strat. Nomen. 'Code of Stratigraphic nomenclature'
- 1979 Robison & Teichert (eds) 'Treatise on Invertebrate Paleontology' Part A Introduction: Fossilization (Taphonomy) Biogeography and Biostratigraphy
- 1982 Harland *et al.* 'A Geologic Time Scale' [includes a particularly useful Appendix listing all published Stage, Series and System names]

(2) Stratigraphic information recording systems. Possibly one of the most workable systems was developed at the Sedgwick Museum, Cambridge, through its association with IRGMA (Information Retrieval Group of the Museum Association, the predecessor of MDA). The result of this was the MDA Geology Specimen Card. The Instructions (MDA 1980a) give details but essentially the card provides a 4-fold division (Complex, Rock, Zone and Age) in three lines: on any or all of these three lines, the three divisions that do not apply can be crossed out and one or more stratigraphic terms recorded as required. (Fig. 5)

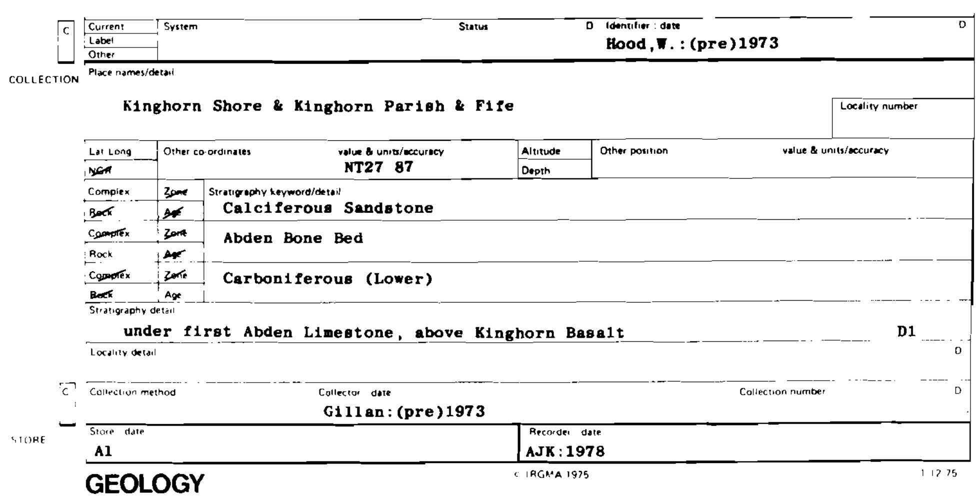
COLLECTION
Current / Label / Other
System
Status
D Identifier : date
Hood,W.:(pre)1973
Place names/detail
Kinghorn Shore & Kinghorn Parish & Fife
Locality number
Lat Long / NGR
Other co-ordinates
value & units/accuracy
NT27 87
Altitude / Depth
Other position
value & units/accuracy
Complex / Rock
Zone / Age
Stratigraphy keyword/detail
Calciferous Sandstone
Abden Bone Bed
Carboniferous (Lower)
Stratigraphy detail
under first Abden Limestone, above Kinghorn Basalt
D1
Locality detail
Collection method
Collector : date
Gillan:(pre)1973
Collection number
STORE
Store : date
A1
Recorder : date
AJK:1978
GEOLOGY
© IRGMA 1975
1.12.75

Fig. 5. Part of a MDA Specimen Card showing stratigraphical recording.

This system, although not rigorous, is very flexible and allows terms to be organised for indexing. A disadvantage is that many stratigraphic terms are not easily assigned to any particular division. The MDA suggest choosing the 'most appropriate' which appears to be inadequate advice. A far better solution has emerged from curators with considerable experience of using MDA cards who record lithostratigraphic, chronostratigraphic and biostratigraphic terms, each type on one of the three lines provided on the card. See for example the stratigraphic format described by Brunton (1980 p. 627). This amounts to an internal convention. Indexes may be produced using all or one of these terms, again governed by convention. Appended to this system is 'Stratigraphy detail' where any notes (excluding index headings) can be made. Qualifying minor details associated with particular stratigraphic terms should, however, accompany the term itself, and follow it in brackets,

e.g. *pilula* Zone (lower part)

Particularly vital advice is that stratigraphic terms should be recorded in 'inverted' fashion to allow useful alphabetic indexes to be constructed.

e.g. Jurassic (Lower)
Chalk (Middle)

Following this convention, it makes sense, intellectually and practically to record stratigraphic terms in order from major division to fine detail, e.g. Jurassic (Lower): Lias (Lower): Hettangian.

Whilst the retrieval of detailed stratigraphic information would normally be expected of a large institution, a much more generalised stratigraphic classification would be more appropriate for the small museum. Thus a specimen whose label gives the information that it was collected from the Forest Marble of Oxfordshire might, in a large museum, be recorded and indexed under several stratigraphic headings,

e.g. Jurassic (Middle)
Bathonian
Great Oolite (Forest Marble)
Clydoniceras hollandi Zone

The same specimen, in a small museum might justifiably be recorded as simply Jurassic (Middle).

Gross stratigraphic classifications have an important function for the larger museum too, however. We argue in C3.5.1 that a stratigraphic arrangement for the storage of collections is desirable. Clearly, a specimen cannot be stored simultaneously in lithostratigraphic, chronostratigraphic and biostratigraphic sequences. For this reason, a simple classification derived from a more specialised framework is of value to both large and small museums. Stratigraphic classifications of this kind are discussed in B4.4.1.1(3).

4.4.4.3. *Collection*

Collection information in the present context concerns data about the act of finding a specimen in the field, i.e. its primary documentation. The methods of collecting and documenting specimens in the field has been covered in Section A2.1 of these Guidelines.

Broadly speaking the catalogue entry of a specimen obtained from the field should include information collected at the same time; it represents therefore the final stage in the basic process of documentation which may have begun with field reference numbers, field identification, locality details, bed numbers and descriptions, etc. Whilst it is not always practical or advantageous to include all available field information in a specimen's catalogue entry, certain data are vital:

- Name of Collector (recorded in full, with appropriate title)
- Date of Collection (recorded in full, e.g. 3 April 1979 – never just '79)
- Method of Collection, e.g. borehole, sieved
- Field Collection number
- Field Notebook reference
- Reference to other documentation, e.g. Maps, Locality Files, Photographs,

It is assumed that the details of geographic and stratigraphic position of a find will be noted in the appropriate section of the catalogue.

4.4.5. Acquisition

There are many reasons why details of how a specimen came to be in the possession of a museum are important. Such information:

- may provide proof of legal title to the specimen
- provides an historical context for a specimen
- provides a means of establishing the authenticity of a specimen and its provenance
- provides a framework against which future action concerning a specimen can better be judged.

Information about the field collection of a specimen is not pertinent to this section, other than as appropriate keywords. Procedure for the documentation of specimens entering the museum are detailed in Section B2. The following information should be extracted for inclusion in the specimen catalogue:

- the manner in which a specimen was acquired: use an acceptable keyword list:
  e.g. Bequest
  Donation
  Field collection
  Exchange
  Transfer
  Purchase
  Loan
- the precise (where possible) date on which acquisition took place (use a date convention)
- the identity of the person or institution from which acquisition took place together with any address, etc.
- any detail or documentation as necessary, e.g. price, conditions of bequest, catalogue, etc. (refer to History File if appropriate – see Section B4.4.7.3).

4.4.5.1. *Collection names*

If a group of specimens acquired by a museum is of sufficient size, interest, quality or other worth it is generally acceptable to refer to the collection by name, e.g. G. A. Mantell Collection, T. Davidson Collection, C. Moore Collection. Indeed, much of the thrust of research among museum geologists has been aimed at tracing the history and fate of historic collectors and their collections: this is the first and most obvious method for tracing material from a collection when it has gone missing.

If a collector donates his collection to a museum the collection name is easy enough to record and understand. If, however, acquisition was made from a third or further party (executors, relatives, dealers or other collectors) the picture becomes more confused (the distinction between field collectors and armchair "collectors" is yet another issue). Collectors have always tended to exchange and swap specimens which, as components of an original collection, may be of greater significant than as components of a more recent collection. Unfortunately, techniques of documenting these complex relationships by any shorthand method are virtually impossible; certainly that advocated by the MDA has little to commend it. Here we suggest the following approach (see also E1.3.1.1-2):

- The collection name should be that of the person who last actively accumulated specimens together unless he too maintained the separate identities of earlier collections in his ownership.
- The name of all those persons who, at different times, kept a particular specimen in actively maintained collections should be recorded and their roles made clear. This may be achieved, for example, by recording these persons under a heading of 'Associated names', and by establishing a file for each name (see B4.4.7.4). In this file, the detailed relationships of collectors and specimens may be recorded in full.
- In any case, the documentation, indexing or storage of a named collection, whether dispersed or not, should be such that it is possible to work backwards and reconstitute that collection either physically or on paper.

We recommend that, in general, collectors are referred to by both surname and initials, and in some cases (publications, etc) also by their dates.

4.4.6. Processes

The fifth in the Principles of Documentation listed in these guidelines (B1.2) states that proper documentation ensures that "every significant event affecting a specimen must be recorded". The recording of many events, e.g. loans, identification and exhibitions, are covered elsewhere in these Guidelines. Here, we are concerned with the documentation of some of the most significant events to which specimens may be subject, these being the various physical processes they undergo from time to time. They may include for example:

repair
cleaning
preparation/development
analysis
conservation
reproduction

However, the detailed documentation of laboratory processes is not covered here but in Section B5.4 where it is presumed to be performed whilst specimens are under laboratory conditions and subject to separate conservation recording. These records will ultimately enter a History File. It is those specimen records which are then summarised in the catalogue entry, as an element in its "long term dynamic nature" (MDA 1981).

The following information should be recorded in the catalogue:

- Reason for process (if appropriate)
- Nature of process
- Dates of process
- Name of operator
- Cross reference to History File or Conservation Records

The requirements of indexing will control the degree to which the recording of these items is governed. The MDA Instructions (1980) provide a system with certain indexing potential but is arguably clumsy to operate. The usefulness of conservation indexes to anyone but a full-time conservator is questionable, and such a person would keep more detailed records and indexes than the MDA card allows for. (In some situations, such as the conservation of specimens with pyrite decay, a record of treatment is valuable in reminding the curator when treatment should be repeated, or the specimen inspected.)

Nevertheless, systems in operation, based on the MDA scheme as outlined in the Instructions, e.g. Pettigrew & Holden (1978), McInnes (1978), will give valuable assistance towards the design of documentation conventions concerning processes.

4.4.7. Documentation

4.4.7.1. *Supporting evidence*

Documentation in this sense refers to all the documentary material which forms supporting evidence for the identity, history or scientific value of a specimen or collection. Such evidence can be of a great many types:

- Works supporting specimen identity
- Bibliographies
- Photographs
- Old labels
- Old record cards
- Copies of papers containing a citation or figure
- Copies of popular publications referring to a specimen
- Letters about the specimen
- Catalogues and lists including the specimen
- Notes about the specimen
- Copies of collectors field note books, etc.
- Conservation records
- Exhibition records
- Loan records
- Examination slips
- Locality data, perhaps cross-referring to a locality Records Centre.

The MDA Instructions (1980) usefully discuss documentation both in its introductory section (Other Conventions p. 11–13) and in its line-by-line instructions (p.43).

Of immediate concern is the question: which pieces of documentary evidence should be specifically referred to in the catalogue entry, and which should be merely available as background information, perhaps in the History File (see B4.4.7.3)? Palmer (1977) refers to the latter as 'stored data', recognising both the dangers and impracticality of storing all relevant data with a specimen. The importance of any stored data is the measure by which a curator determines whether or not it is mentioned in the catalogue entry or indeed written on a label with the specimen. It is difficult, therefore to recommend which particular kind of documentary supporting evidence should be directly referred to. In general, however, there are two significant classes of document:

- a document used in the production of a record,
  e.g. field note book
    old catalogue listing
    examination label
- any published document specifically referring to an object, particularly fossils with a taxonomic status.

Both these classes should be recorded in the catalogue, using standard bibliographic conventions whenever possible. It should be made clear in what way a document referred to in such a record relates to the specimen. The MDA Geology Specimen Card achieves this by the use of code letters L (link), D (document) and H (history); see the MDA 1980 Instructions for details. The documents concerned should have their relevant parts copied and placed in the History File, or, where this is impossible, their location recorded.

4.4.7.2. ***Cross references***

In addition to bibliographic references, others may be required which link specimens with records kept in other filing systems. The MDA distinguishes between two kinds of cross-reference.

Explicit references are those which correspond to information held under a special number, e.g. a site file number in a geological locality record centre. Such references should always be recorded in the catalogue entry. **Implicit** references are those corresponding to information held under numbers or headings already given in the catalogue (e.g. Specimen Identity Number for History Files, donor's name for Collection Files, etc.). Implicit references need not necessarily be specifically recorded; their existence is implied.

4.4.7.3. ***Specimens history files*** (see Fig. 6)

It is frequently the case that item recording about a specimen will result in the accumulation of an archive both during and after the processing of that specimen into a museum collection: detailed conservation records, photographs, correspondence, etc. – may of those items to which only brief reference might be made in the catalogue. This archive is difficult and time-consuming to use if split between the various filing systems of a museum, conservation department files, correspondence files, etc. History Files are large envelopes or wallets designed to contain all the two-dimensional material or copies of it, relevant to individual specimens. Each envelope should be marked with the Specimen Identity Number, specimen name, collection name, date of file opening and name of responsible curator. Any

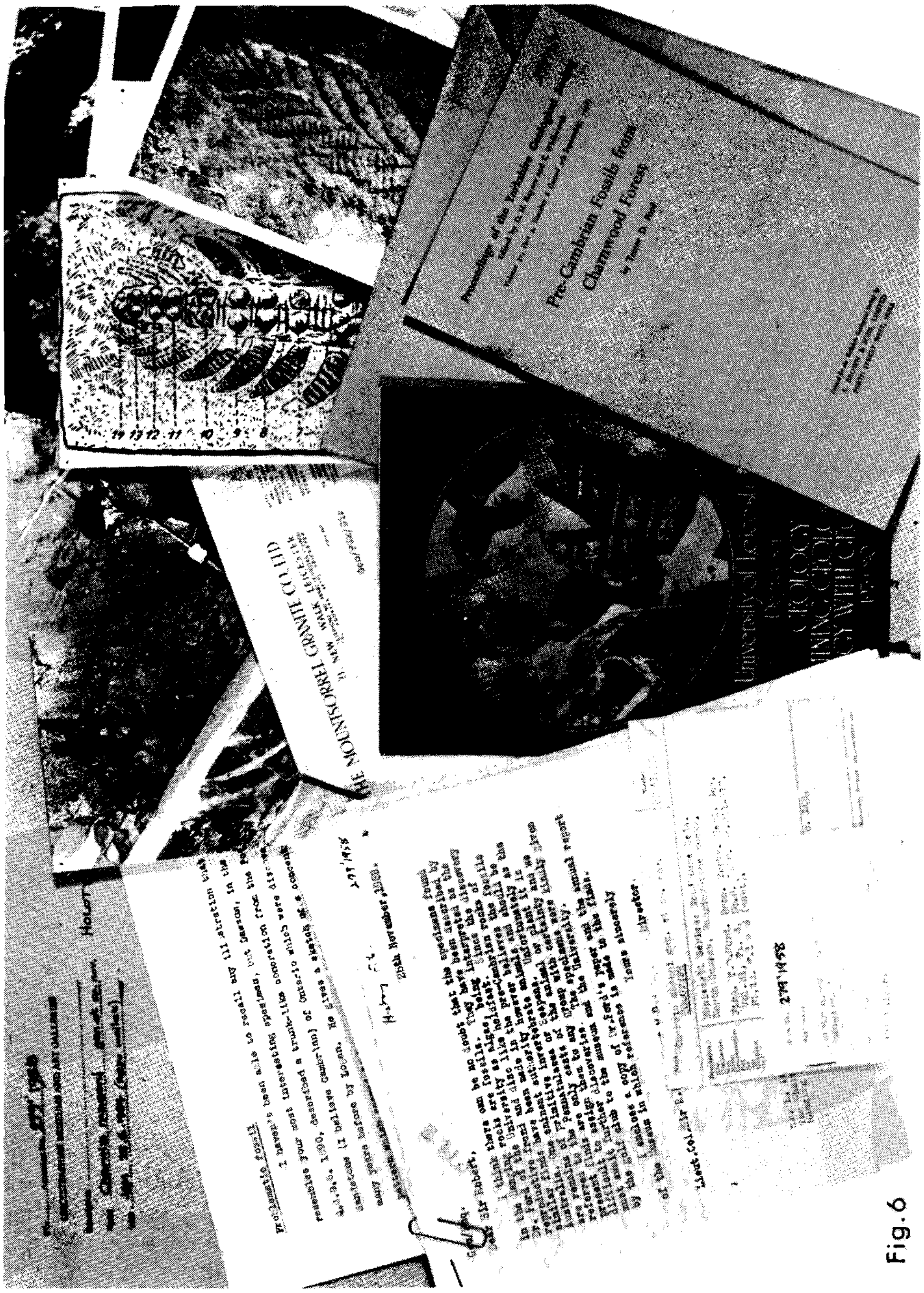

Fig. 6. An example of a Specimen History File containing correspondence, photographs, information and publications about the specimen.

other information of significance may be marked on the envelope, e.g. taxonomic status. The files should be stored in Specimen Identity Number sequence.

Where information is pertinent to a consecutive range of numbers (e.g. a collection of thin-sections, each individually numbered) this range may be marked on a single History File envelope. Where information is pertinent to two or three specimens with disparate identity numbers (e.g. two parts of a femur, separately documented but found to belong to the same bone) mutual cross-referencing must be made. Where other files exist which contain information about events concerning a wide range of specimens, e.g. large loans, exhibitions, insurance, etc., copies of the documents can be placed in the History File of each of the specimens concerned, or, where the number of specimens makes this impractical, reference made to the appropriate file on a cross-referencing sheet in the History Files (but see B4.4.7.4).

There is no doubt that the convenient availability of photocopying facilities makes the operation of a History File system much easier.

History Files are particularly important in the work of documenting Type and Figured specimens. It is recommended that copies of all publications containing scientific reference to a specimen should be made and filed. All items in a History File should be marked with the Specimen Identity Number of the specimen to ensure successful re-filing. Reference to History Files in a catalogue entry may be explicit or implicit as required.

4.4.7.4. *Collection/collector files*

In parallel with the specimen History Files, information concerning collections and their collectors should be collated and maintained in collection or collector files. The relationship between the two systems of files is similar to the traditional approach of 'Index of Donors' and 'Index of Specimens'. The maintenance of a separate information filing system for collections is recommended because so much interest and research surrounds the collectors themselves and moreover because such information provides authenticity, meaning and point to the specimens concerned.

Information peculiar to individual specimens should be filed in History Files and the specimens belonging to a collection or of a collector should be listed in a Collection File. Other information that may accrue might include:

Collection catalogues
Biographies
Obituaries
Correspondence
Photographs
Research papers
etc.

Collection/collector files should be held in an alphabetic sequence, using the collectors' names, initials and dates. The existence of such files is usually to be regarded as implicit, following the recording of names under 'Donor', 'Associated names' or other similar divisions of the catalogue.

4.4.8. Housekeeping information

4.4.8.1. *Storage*

The storage of geological specimens may be organised according to the various systems in which they have been classified (see B4.4.1). Storage equipment is covered in Section C3. The need to be able to locate every specimen has already been emphasised and we recommend that the catalogue entry of a specimen should include a note of its storage location. This note may be its cabinet and/or drawer number. Alternatively, if collections are stored according to a classified system, its storage location may be implicit elsewhere in the record. Beware, however, of the outcome of this logic; minerals stored by Hey's 'Index' (Hey 1955 – see B4.4.1.2) for example might provide, say, 10 or 20 drawers full of quartz specimens, posing a considerable problem to the searcher of one particular specimen. In some circumstances, there is considerable benefit in writing the specific location of a specimen on a label, or on the polythene bag in which a specimen is placed, facilitating easy relocation. The disadvantage of relying on this idea is that when collections are re-organised, all the labels have to be altered, a considerable effort when large numbers of specimens are involved. Furthermore, the use of Removal Slips (see B5.2.1) may make such a method redundant.

It is perhaps worth adding here that experience of computerised documentation systems has shown how valuable storage indexes can be: they permit the production of specimen lists per drawer and thereby enable rapid inventories and checks to be made, thus improving standards of security and audit. They may also permit rapid alterations to be made to records of storage locations subsequent to a reorganisation. The development and spread of computerised systems throughout museums will improve the management of museum collections enormuously on this basis alone. Any practical manual system that approaches this ideal should be actively developed.

4.4.8.2. *Cataloguer (recorder, curator, etc.)*

Whatever the title given to a person responsible for the generation of a catalogue entry, that person's name must be recorded together with the date on which the record was produced. Amendments or additions to a record by second or third persons may or may not require similar identification: judgement is required. Old practice was simply to write one's initials after any new observation or alteration on a record card, ledger, etc. The more sophisticated modern systems prove to be more demanding in this connection. The complete re-curation of a specimen might entail the recording of a new cataloguer's name on a record with a note that the old card or other document was used as an information source and kept in a History File.

The principle involved must be recalled when judgement is being exercised; curators have proved to be sources of both wisdom and fallacy – the ability to identify the authors of any statement within a catalogue entry, especially if it concerns identity, description, or provenance, is vital to an appraisal of the value of that data.

4.4.8.3. *Valuation*

Most curators are well aware of the monetary value of the finest of geological specimens: gemstones, large, rare or beautiful minerals and fossils, meterorites, etc. Perhaps less appreciated is the fact that even relatively dull specimens have a market value. Whilst it is tempting to assess the value of geological specimens based on this market, it is becoming more professionally and ethically acceptable to price specimens according to the cost of re-collection plus their enhancement by documentation, development, technical processing, etc. This philosophy recognises that money *can* buy specimens, or the resources to replace them. Curators may not always find it easy to assesss values on this basis, and some may find the entire process distasteful. Nevertheless, valuations should be realistic and allow for the acquisition of new collections of equivalent merit. On a political note, committees or museum directors of non-geological persuasions are more liable to accept requests for improved storage, environmental controls, etc. when they are informed of the financial value of a geological collection.

When recording a valuation, record also the date on which the valuation was made and, if appropriate, the valuer. It is important to remember that the value of a specimen may best be regarded as confidential, and kept in its History File.

4.4.9. Miscellaneous information: Notes

The long and varied origins, identities, histories and descriptions of geological specimens have proved difficult to analyse into the convenient slots of any information storage system, manual or automated. Much of this information defies systematic treatment. The 'Notes' section of a catalogue record forms a repository for information valuable as background to more formal parts of the document. Notes should be just that; whereas lengthy, detailed or anecdotal material is best kept within a History File. The MDA suggests that 'tracings' (a list of the index cards produced from the record may be recorded under 'Notes'). Further, a drawing or photograph may be attached.

4.5. THE COMPUTERISATION OF GEOLOGICAL SPECIMEN DATA

Throughout these Guidelines references have been made to computers and their handling of museum information. A discussion of this subject is worthy of several chapters, if not books, though most of what could be said would apply generally to most museum disciplines and not to geology alone. Where particular aspects of the subject area have been relevant to computers, e.g. indexes, terminology control, then appropriate mention has been made. We do not propose to enter into these areas any more deeply here but instead present brief advice for anyone contemplating the use of computers to aid geological cataloguing. Generalised information and advice on computers in museums is best sought first from available literature in particular Roberts & Light (1980), Chenhall (1975) and Orna & Pettitt (1980). More practical help should be sought from the Museum Documentation Association, the premier body for museums in this field whether or not you or your museum intend to use their facilities or methods. The Association has recently extended its advisory capabilities. In particular see MDA (1981), and Roberts (1985 in press) for a guide to planning the documentation of museum collections.

There is an extensive reference list on the application of computerised documentation methods to geological collections, and the GCG and its members have played a major role in their development. Sharpe (1983) provides an extensive reference list in the application of computerised documentation to geological collections under the keywords "Computer Cataloguing". Of more recent publications, Price (1984) is an important addition.

4.5.1. Sources of advice

No one contemplating the computerisation of data on geological collections should rely on the printed work alone for information or advice. The rapid development of both hardware and software, together with progress in methodologies, renders at least some aspects of published accounts out-of-date. Amonst the membership of the GCG there is a growing body of first-hand knowledge which should be tapped both for the good of the individuals and institution concerned, but also for the development of the profession as a whole. The following institutions may be able to offer advice:

Department of Geology, Ulster Museum, Belfast
Booth Museum of Natural History, Brighton
Department of Geology, Bristol Museum & Art Gallery
Department of Geology, Sedgwick Museum, Cambridge
Royal Scottish Museum, Edinburgh
Hunterian Museum, University of Glasgow
Earth Sciences Section, Leicestershire Museums, Leicester
British Museum (Natural History), London
The Manchester Museum, Manchester University
Derbyshire Museum Services, Matlock
Hancock Museum, University of Newcastle
Sunderland Museum, Tyne & Wear Museum Service

There are, in addition, other institutions in the process of re-defining their documentation systems which are in contact with the MDA. Up to date information is available through that Association.

Any institution considering computerisation is strongly advised to become a subscribing member of the MDA, if they are not already. An initial visit and appraisal by an experienced member of MDA staff is offered free of charge, and subsequently, of course, there is the option to use the MDA's considerable resources in developing your system.

In addition, the recently formed "Museums Computer Group" provides a useful, informal programme of meetings, and aims "to improve communications between museum staff who are active or interested in using computers in their work". At present, the co-ordinator of this group is Dr. A. Fletcher, Leicestershire Museums, though contact can always be established through the MDA.

5. MOVEMENT OF MATERIAL WITHIN A MUSEUM

PREAMBLE

The list of "musts" in Section B1.2 included the following:

- It must be possible to locate every specimen;
- Every significant event affecting a specimen must be recorded.

These two items form touchstones for the proper housekeeping of collections within a museum and should dictate the procedures required for the control of specimen movement.

The movement of a specimen is an event and should be recorded, at least temporarily. Usually, however, it is not the event itself which is significant; what is important is for the curator to know the present or intended location of the specimen concerned. Thus, a specimen absent from its normal storage position must have with it information allowing for its correct, re-location. Conversely, an empty position in a cabinet or display must, where practical, carry information telling a curator where the specimen is. This section of the Guidelines gives recommendations on the methods available to the curator by which these requirements can be met.

5.1. THE BASIC REQUIREMENTS OF SPECIMENS IN STORE

The documentation of specimen storage is covered in Section B4.4.8.1 and the principles underlying the physical storage of specimens covered in Section C3. Both sections discuss methods which have resulted from a consideration of the ways in which specimens are used and are therefore of great significance here. It is therefore worth emphasising the following points:

Specimens in store should:

- bear a unique identity number;
- be enclosed in a tray or other container, where practical;
- be accompanied by relevant and appropriate labels, each of which bears the unique Specimen Identity Number.

In addition storage location information may be recorded explicitly by drawer or cabinet number, etc. (but see B4.4.8.1). Alternatively, this information may be implied if specimens are stored according to a classification. In the latter case, the classifying term(s) concerned, should be written on a suitable label, usually the Specimen Label.

5.2. THE REMOVAL OF SPECIMENS FROM STORE

When a curator is faced with the task of temporarily moving a specimen from store to another location he should be concerned with the following problems:

- How can he ensure the eventual correct re-locations of the specimen back in storage?
- How can he ensure that the existence of the specimen elsewhere is signposted in the store?
- How can he preserve the association of labels and data?

The strategy which has been developed to solve all of these problems utilises the Removal Slip.

5.2.1. **The removal slip** (see Fig. 7)

Where specimens are being removed for any purpose, for example loan, exhibition, conservation, research, etc., this formalised device is recommended.

The Removal Slip should be a pre-printed label, ideally self-duplicating, on

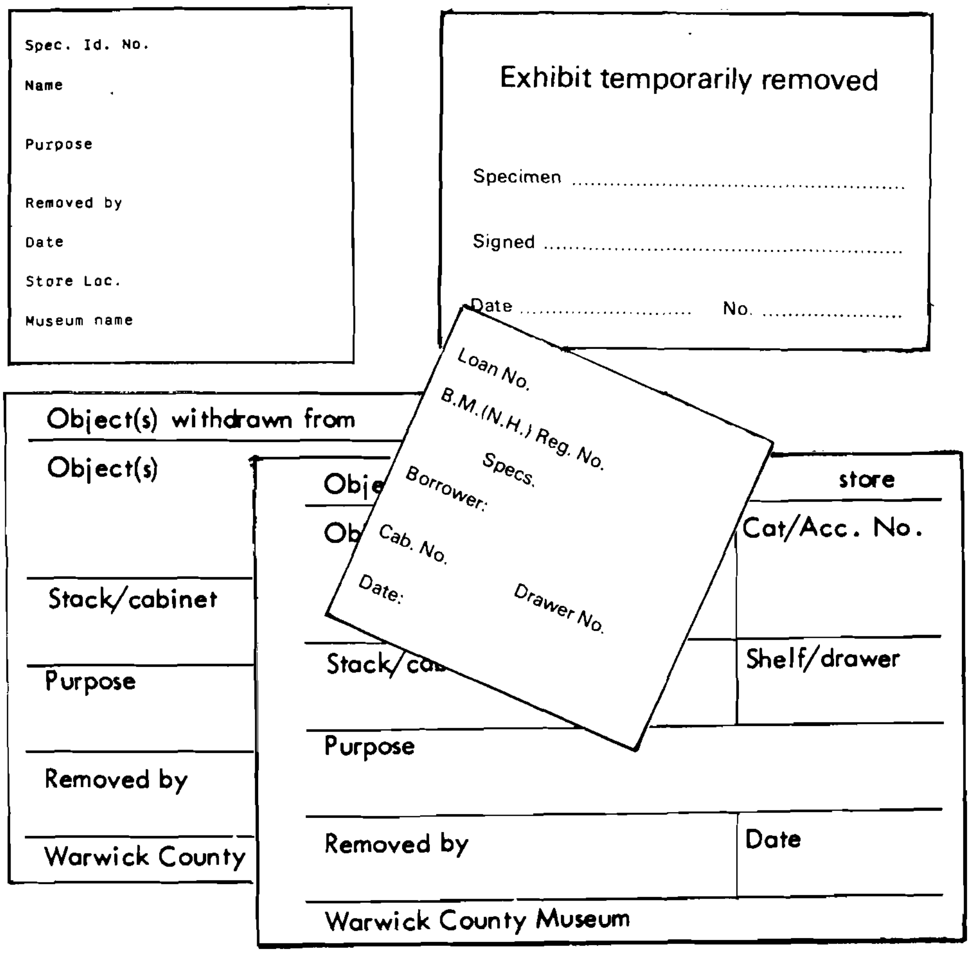

Fig. 7. Examples of Removal Slips. Two are used for special purposes; removal for exhibitions and for loans. That at the top left is of a general nature, while the lower pair are self-duplicating and of different colours.

which may be recorded the information necessary when moving an object or specimen from store or indeed any other location. One copy of the slip should remain in the location normally occupied by the specimen, be it in store, or exhibition or elsewhere, and the other should accompany the specimen for the duration of its removal, except when on display. A useful practice is for the copy remaining in the storage location to be of a bright colour, making re-location easier.

Certain minimum information should be recorded on a Removal Slip and this includes: the Specimen Identity Number, the location of the specimen, the reason for removal (e.g. 'research by A. W. A. Rushton, BGS' or 'Jurassic display'), the name of the member of staff responsible for removing the specimen, and the date of removal.

When a specimen is replaced in its normal storage position, the bottom copy of the slip is discarded. If no record of the specimen's movement is required the top copy may also be discarded. If, however, a record is required, simply cancel the slip by striking through with a pen and initialling the cancellation, and either keep it with the specimen concerned or place it in its History File.

A curator may be tempted on occasion to abandon the use of a Removal Slip when, for instance, specimens are required to be removed for very brief periods. The completion of 20 or 30 slips for specimens removed for use in a one hour teaching session can sometimes appear tedious and unnecessary. We would argue most strongly, however, that although initial completion is time-consuming, the time saved on specimen replacement and the accuracy this system ensures is well worth the effort. In addition, although curators always intend to replace specimens immediately after use, circumstances may alter and what was an easy job on the same day can become a nightmare a week later. Always use Removal Slips and ensure that a supply of them is liberally spread throughout the store.

5.2.2. Label security

The removal of a specimen from store raises questions as to the fate of associated labels. The dangers of losing the labels or at least dissociating labels from specimens are clear. The loss of labels can be avoided by simply not removing them: basic data, sufficient for most purposes, can be copied on to a Removal Slip. In other circumstances, the labels may in fact be required, because they aid research. Loss or dissociation in this case should be guarded against, though the risks are in any case mitigated by each label bearing the Specimen Identity Number concerned. Where a specimen is being removed to other parts of the museum and especially to other museum buildings, no original 'collector' labels, or others associated with the original acquistion of the specimen should be released (except of course when they are 'marked', i.e. glued, on to the specimen). Where necessary, photocopies or transcriptions of labels should accompany the specimen.

5.3. THE DOCUMENTATION OF SPECIFIC CASES OF SPECIMEN REMOVAL

The paragraphs below give advice concerning some of the more commonly occuring situations.

5.3.1. Exhibitions

- Complete Removal Slip.
- Replace all storage bags, boards and labels in the specimen tray in the normal storage position, together with the bottom copy of the Removal Slip.
- Collate a list of specimens on display, their Identity Numbers and storage location for future reference, together with the top copies of the removal slips.
- In the case of a need temporarily to remove specimens from a display, place a second removal slip in place of the specimen and keep the copy with the specimen.

- After exhibition, replace specimen in its storage tray, withdraw Removal Slip and either keep with specimen or place in History File.

5.3.2. Loans-out

Normally, loans are made to bodies outside of the museum. We include loans-out here however to cover those situations where specimens are lent to other departments, perhaps in other buildings yet still within the same authority. For further details of loans-out see B6.1.1.

- Complete Removal Slip
- Complete loan-out documentation (see B6.1.1).
- Record Loan number on Removal Slips, and attach specimen's copy to the museum's copy of the loan form.
- Photocopy or transcribe labels accompanying specimen and send with loan to borrower.
- Replace all labels in the specimen tray in store, together with the bottom copy of the Removal Slip.
- On return of loan, replace specimen, cancel Removal Slip and either leave with specimen or place in History File.

5.3.3. Conservation

- Complete Removal Slip.
- Maintain a record of conservation work carried out including drawings, photographs, labels, etc (see B5.4) and place either in a conservation file or the History File.
- Replace specimen, cancel Removal Slip, and either leave with specimen or place in History File.
- Amend or add to the catalogue entry as necessary.

5.3.4. Research

- Complete Removal Slip, loan-out documentation, etc. following B5.3.2 as necessary.
- Provide and use Examination Labels (see B1.3.4.3(1)).
- On replacement, store Examination Label with specimen. Amend or add to the catalogue entry as necessary.

5.3.5. Reorganisation of storage in absence of specimen

- Remove specimen tray with labels and Removal Slip to new storage position.
- Locate specimen Removal Slip, loan form and exhibition lists as appropriate and amend storage location record.
- Amend the catalogue entry.

5.4. THE DOCUMENTATION OF SPECIMENS DURING PREPARATION AND CONSERVATION

At almost any stage in the life of a museum specimen it may be necessary to initiate conservation or preparation measures. Both processes necessarily affect the nature of a specimen and within the context of documentation principles, must be considered "significant events" and therefore be recorded in full.

The quality and degree of treatments vary enormously and the implications for documentation are similarly diverse. The principles of treatment are dealt with in Section C2 of these Guidelines.

As for documentation, the majority of cases offer no difficulties, and the following paragraphs indicate the general rules to follow. Subsequently, consideration will be given to a more complex situation requiring rather more attention.

5.4.1. The general rules for laboratory documentation

The following information should be recorded:

- Entry/Specimen Identity Number
- identification
- condition on receipt (including photograph where appropriate)
- treatment given and techniques used
- dates of receipt and return
- name of conservator.

In many museums which regularly prepare and conserve geological specimens, laboratory records sheets or cards have been devised which enable this information to be entered against the appropriate heading. These records stay with the specimen during its treatment and form a diary of the work as it is carried out. On completion, the card or sheet should be placed in the specimen's History File or equivalent and be available for consultation, especially for the information of future conservators should further treatment be required. A typical record appears in Rixon (1976, p. 236) and a similar example is shown in Fig. 8.

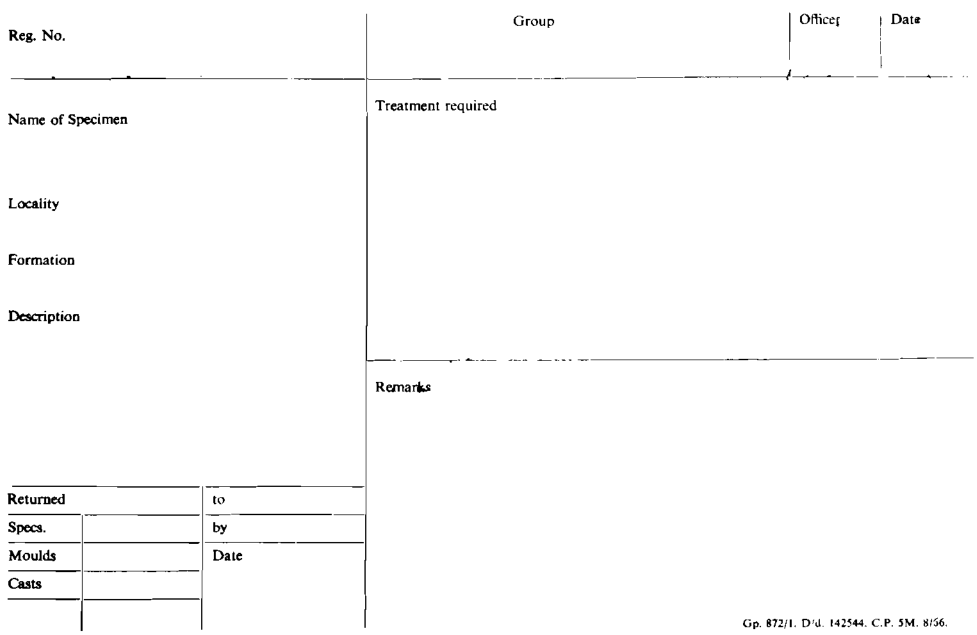
Reg. No.
Group
Officer
Date
Name of Specimen
Treatment required
Locality
Formation
Description
Remarks
Returned | to
Specs. | by
Moulds | Date
Casts
Gp. 872/1. D'd. 142544. C.P. 5M. 8/56.

Fig. 8. Example of a conservation/laboratory card. The back is used to record details of laboratory treatments.

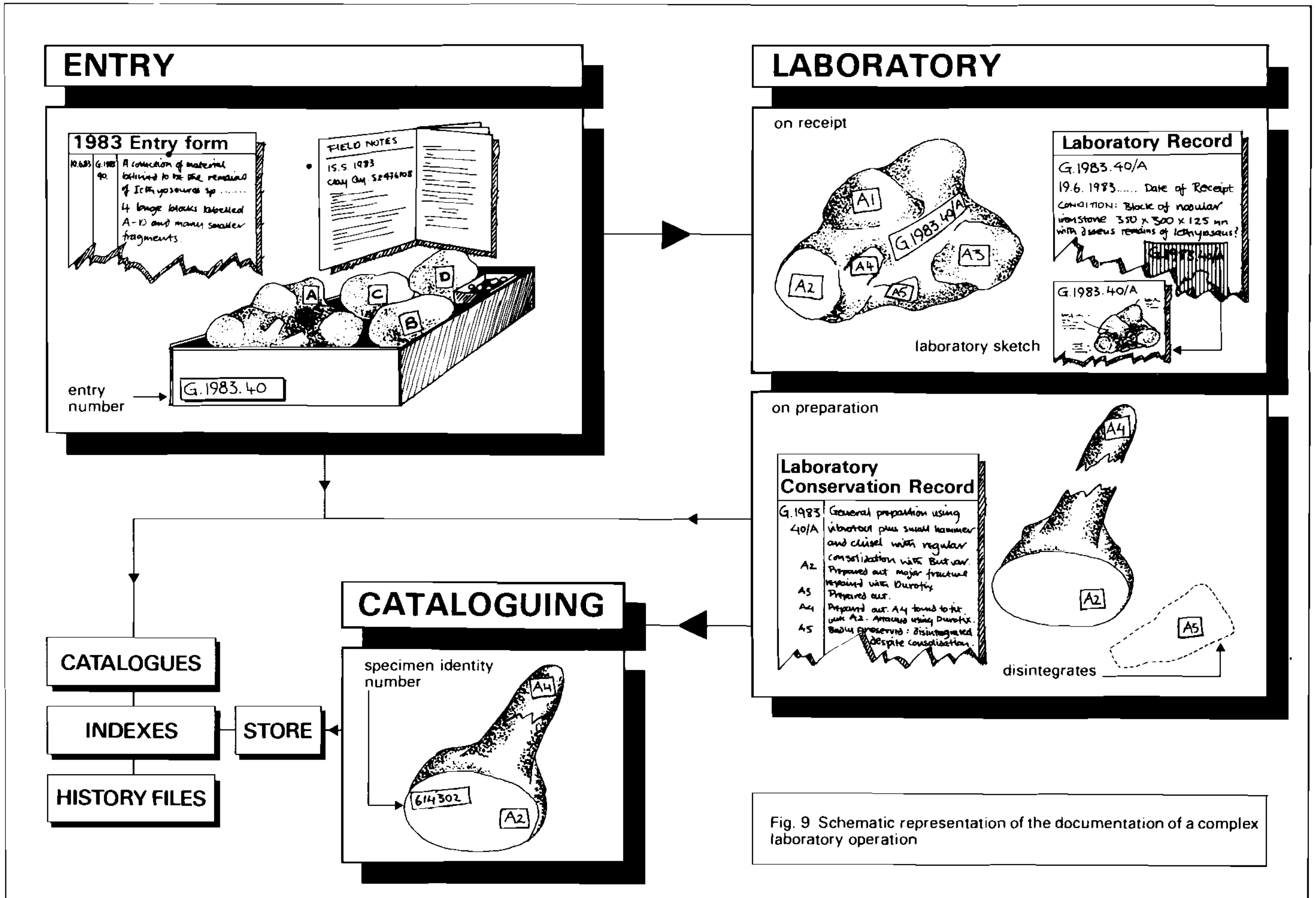

Fig. 9 Schematic representation of the documentation of a complex laboratory operation

5.4.2. The documentation of complex operations

The many techniques of fossil preparation in particular are aimed at the acquisition of new information. The information which survives preparation may be preceded by information revealed by the preparatory techniques but lost as treatment proceeds. Included in the latter might be: the original disposition of specimens in matrix; the association of specimens as they are revealed; the original nature of fossil surfaces; the nature of matrix adjoining fossils, etc. – all potentially valuable data. Preserving some of this information can be achieved by selected methods; for example by leaving some specimens in matrix only partly developed, or by taking matrix samples. However, much can be gained by the careful employment of documentation devices. As an illustration of what can be considered to be the most complex situation likely to be faced in a provincial museum the following case history is presented. Solutions to the various problems discussed are schematically outlined in Fig. 9.

5.4.2.1. *A case history* (see Fig. 9)

A substantial portion of a large vertebrate is discovered preserved in a hard nodular ironstone. The nodules are collected and examined in the museum. Whilst vertebrae, girdle and limb bones are clearly present, they are poorly exposed and defy immediate identification as to genus, species or even bone element. The remains vary in size from nodules 1 m long to bone fragments up to a few millimetres in length.

There are alternative strategies for Entry Documentation: the material may be generally described under one number or string of numbers, or more specifically listed with each nodule, crate or bag given a sub-code (e.g. G 1983.40/A). The latter strategy offers better security but may be a lengthy process and difficult to apply to the whole collection. In practice, a combination of the two may be the best compromise, with the largest nodules or blocks being given sub-codes or numbers, the smaller pieces being described in merely general terms until careful examination or preparation.

Figure 9 schematically shows the path a large block may follow during preparation. A laboratory record should be initiated for the block, which, by virtue of its Entry Number, can be referred to by its sub-code. Similarly, the various bone elements present, must be individually referable, in order to describe their history during preparation: therefore label obvious elements (e.g. A1, A2, etc) before work starts. Sketches must be made to record original associations. Any elements separately numbered, but later found to match, can be thus documented. Note also the fate of elements which disintegrate. It is important to collect, document and catalogue any invertebrate specimens encountered, as well as taking matrix samples from appropriate points. These may be of great scientific value and may enhance that of the vertebrate remains. Similarly, look out for gut contents, gastroliths, skin impressions, etc. The end result of preparation may be several bones, fully developed, some of which may have been recognised initially and numbered appropriately, some discovered to match up and re-joined, some discovered during preparation. In any event, all numbers, etc. must remain permanently marked on to the specimens which are now fit for cataloguing and storage.

Copies or originals of all written records produced should be placed in History Files for the specimens concerned (see B4.4.7.3).

6. MATERIAL LEAVING THE MUSEUM

PREAMBLE

The responsibilities of a curator for the specimens in his care extend to any situation in which they leave his immediate control. (This may include the transfer of material to another section within your museum.) Below, we consider the two basic situations that occur – material temporarily leaving the museum (B6.1), and material permanently leaving the museum (B6.2), and give advice on the necessary procedures and documentation required.

6.1. MATERIAL TEMPORARILY LEAVING THE MUSEUM

6.1.1. Loans-out

6.1.1.1. *Loans policies*

In contrast to the less formal procedures for the control of specimen movement within a museum, procedures for the lending of specimens to outside individuals or institutions should be strictly supervised. Specimens are lent for a variety of reasons: education, display, research, conservation, etc. More often than not such loads are "preceded by a clarification of the acceptability of the recipient, the suitability of the item as a loan and appropriate insurance or indemnification arrangements" (Roberts 1985 in press). An alternative strategy which is recommended as a first stage in loan supervision is the establishment of a Loans Policy which should, as far as possible, pre-establish those 'clarifications'. Such a policy should also answer the following questions:

- What classes of material shall be available for loan?
- What restrictions on these classes need be applied?
- Who shall be eligible to receive loans?
- How long should loans be made for?
- For what purposes should material be made available?

Certain recommendations can be made here which should be considered for inclusion in a Loans Policy:

- Loans to schools should not normally contain catalogued specimens but should draw on an expendable collection of 'school loan' material.
- Type, figured and cited material must be lent under the most stringent of conditions, with particular safeguards taken with regard to borrower, packing, transport, further preparation, etc.
- No 'original' labels or other documents should accompany specimens; photocopies must be supplied if necessary.
- Loans should not be made to non-permanent (e.g. research) members of staff of an institution but through research supervisors who must have responsibility for specimens should their students disappear.
- The *bona fides* and identity of a borrower should be confirmed prior to specimen dispatch. A useful security procedure is to have the borrower write

a letter of request on his institution's letterhead. If necessary, a curator can double-check with a letter or telephone call.

6.1.1.2. *Conditions of loans*

Whilst a Loans Policy should be formally stated, the conditions which apply to the borrowers of specimens must be **legally** stated. This is an area of expertise beyond the curator and advice should be sought from an appropriate legal representative, e.g. local authority solicitors. A recently prepared set of general conditions runs to a full A4 sheet of small print under the following headings:

- *Definitions*
  Legal definitions of persons concerned: the Keeper, the Borrower, etc.
- *Period of Loan*
  As specified on the loan form, etc.; extensions.
- *Return of Specimens*
  After loan period expires, etc.; to where specimens are returned.
- *Preservation of Specimens*
  All necessary steps to ensure good condition, etc.; obligations of Borrower; protective measures, including security and environment.
- *Inspection of Specimens*
  Keeper may inspect specimens borrowed to check condition, etc.
- *Possession of Specimens*
  Borrower must always possess or control specimens; use of other agents by permission only, etc.
- *Insurance*
  All-risks policy required of Borrower, values as stated by Keeper, etc.
- *Indemnification of authority*
  Borrower indemnifies against loss, damage, deterioration, costs, claims and proceedings.
- *Property in the Specimens*
  Specimens remain the property of the authority; borrower has no interest.
- *No works to Specimens*
  No works without prior consent, etc.
- *No Execution or Distress*
  The specimens shall not suffer any legal process, etc.
- *No Reproduction*
  No reproduction (i.e. photography, casts, etc.) without prior consent; copyright remains with Authority, etc.
- *Acknowledgement*
  Full acknowledgement to owning authority in publications as directed, etc.
- *Notification of Loss or Damage*
  Notification to authority of loss, damage, etc.; borrower to bear costs.

- *Authority's Remedies*
  Entitlement of Authority to recover specimens in case of breach of conditions, etc.
- *Costs of Recovering Specimens*

  The Authority is entitled to recover from Borrower all costs of specimen recovery.

The brief notes accompanying the headings above serve to give the reader some idea of what is being said in the full document. Curators wishing to enter this area more fully may contact the Editors with queries.

If possible, the conditions of loans should be printed on the reverse of the borrower's copy of a Loan Form.

A further condition that some museums stipulate is that when photographs of borrowed specimens are to be published, a copy of the publication should be lodged with the museum. Many researchers are able to comply with this but in the case of large monographic works, it may be an unreasonable request, and photocopies of the relevant parts of the publication must suffice (see also E2.3.1).

6.1.1.3. *Loan agreements*

Some institutions insist that before any material is lent to anybody a Loan Agreement form is completed on which the potential borrower signs his name to an agreement concerning the safety and return of specimens. In addition such an Agreement form may specify the name of a supervisor or head of department who must sign his willingness to take responsibility for the loan to the specified borrower (of value in the cases of research students or other individuals borrowing via an institution). A Loan Agreement should be in duplicate, the borrower and the museum each keeping a copy. A summary of the agreement may be printed on the loan form. Subsequently loans should be made only to those having signed a Loan Agreement form.

6.1.1.4. *Loan-out documentation*

(1) Removal Slip. At the time a specimen is removed from store prior to lending, a Removal Slip as detailed in B5.2.1 should be completed. An indication (perhaps by deleting inappropriate words) should be made on this slip that the specimen is being loaned, and the loan number recorded (see below). One copy of this slip should be attached to the copy of the loan form kept by the museum, whilst the second copy remains in the storage position normally occupied by the specimen together with any documents, labels, etc. as appropriate. See also B5.3.2.

(2) Loan-out forms. A variety of documentation has been used in the past to record the loan of material to borrowers. A modern loan form should ideally be a self-duplicating triplet, A4 size, and serially numbered document, such as the MDA Exit form (MDA, 1981, p. 45). Other similar forms are in use at many museums. The form should allow the following to be recorded:

- loan or exist number
- borrower (name and address)

- description of borrowed items (including quantity, identity number and condition)
- insured value (if appropriate) (see B4.4.8.3)
- date for return
- signature of borrower
- notes for special conditions of loan (if appropriate)
- appropriate authorisation of the loan and its receipt on return.

There are a number of different systems for Loans-out which incorporate these procedures (see for example MDA 1981, p. 38, describing the MDA Exit form).

There are a number of ways in which copies of the loan-out form can be used. Ideally, procedures should theoretically permit the following:

- A copy held as a permanent record, preferably bound, and thus in the loan order, and retained by the lending museum.
- A copy to remain with the specimens while on loan and returned to the museum with them as a check for the borrower.
- A copy to act as confirmation of safe arrival of the loan with the borrower.
- A copy to act as confirmation of safe arrival in the museum to be returned to the borrower for his permanent record.

In practice, these requirements can be met by using two loose copies and one permanent copy, the latter left in the museum's loan book. The two loose copies accompany the specimens to the borrower, (either in the museum or by post), one being signed and returned to the museum as proof of safe receipt. It is important that the museum retains the signed copy since signatures duplicated or copied in any way have no legal validity. The second loose copy is issued to the borrower with the specimens and returned to the museum at the end of the loan period with the loan. The museum has, at this stage, three copies. One (preferably the bound copy remaining in the museum) should be preprinted with a perforated section which acts also as proof of safe receipt of the loan back in to the museum. The tear-off section is signed and returned to the borrower after checking that the number and condition of specimens is correct. In this way the museum retains permanent records of all stages of its loans out and the borrower has a record of material lent to him.

Except in the cases of unusually short-term loans, such as for type specimens, the order of the loan forms in the book generally represents the order in which the loans are to be expected back; checking for outstanding loans is, therefore, easy. Where loan periods are very variable, some museums have a fourth copy of the loan form, or a card, kept in a file which contains all outstanding loans in loan number order. On return of a loan, the appropriate copy is removed and destroyed or filed separately.

When a computer is available, large numbers of loan records can be maintained and administered with ease. With suitable equipment it is possible to arrange for standard reminder letters to be produced automatically, together with lists of outstanding loans, loans due back in a particular month, etc.

(3) Other documentation. Further procedures should exist for implementation when applicable:

- Reminders to borrowers when expiry date of loan is passed.
- Extension of loans beyond expiry date.

- Standard (legal?) letter sent out after a set period of time has elapsed since expiry date.
- Recovery processes.
- The catalogue entry for each specimen lent should be updated to include a note about the loan. Copies of relevant documents can be stored in the relevant History File if necessary.

6.1.1.5. *Loan transport*

The removal of any material on loan from a museum necessarily involves certain risks, not least those associated with the transport of specimens. The risks are largely of two sorts. First, damage to specimens, countered by appropriate methods of packing, particularly if specimens are to travel any distance and especially if they are to be posted. Second, there are risks of loss, countered by the use of personal hand transport only, particularly if type specimens are involved, or by the use of high security postal or courier services. These areas are covered in more detail in Section C2.5.

6.2. MATERIAL PERMANENTLY LEAVING THE MUSEUM

The following paragraphs concern material which is permanently removed from a museum's possession, either accidentally or deliberately. The latter involves issues of great sensitivity and a substantial section (B6.2.2.2) is devoted to consideration of the ethical, legal and procedural aspects of deliberate disposal. The former situation includes material that is missing, by either being mislaid or stolen, and also material which disintegrates or is otherwise accidentally destroyed.

6.2.1. Missing and destroyed material

6.2.1.1. *Missing specimens*

A specimen is defined as missing when it is absent from its normal storage position and cannot be located, for example in the laboratory, exhibition of other place, as indicated by a Removal Slip. A note of the fact that it is missing must be made out, dated and signed, and placed in the position formerly occupied by the specimen. A temporary note should also be made in the specimen's catalogue entry. The missing specimen may turn up again, in which case it is simply returned to the store and the 'missing' notes removed and destroyed. In cases where the specimen remains missing there must eventually be a decision made that the specimen is permanently lost. The timing of this decision depends upon the importance or value of the specimen and the amount of searching that has been undertaken. When the 'lost' decision is reached, all catalogue and index entries should be updated to include a note of the fact. All the labels that accompany the specimen should be placed in the History File and the file marked 'Lost' followed by a date and curator's signature.

The re-curation of old collections frequently entails the use of a new system of Specimen Identity Numbers superimposed on a redundant system (see Section B4.2.1). Inevitably, over the years, specimens will have gone missing or will have become separated from their accompanying data and thus remain unrecognised. It is important that where a missing specimen can be shown to have been in the museum's collections it should be allocated an Identity Number. There are two reasons for this: first, the negative information itself may be of value to future research, and second, in the case of unrecognised specimens, good detective work can often remedy the situation. Furthermore, should any labels, photographs, etc. of a missing specimen exist, they can be referred to an allocated Identity Number and be thus stored in the appropriate History File.

The number assigned to a missing specimen should be from the sequence normally applicable to the specimen if it existed. Some curators, however, use another series of 'missing specimen numbers' apart from the normal series. In both cases, the specimen documentation must include the fact that the specimen is 'missing' and we recommend use of the 'condition' section of the catalogue record for this purpose (see B4.4.3.2). An index of missing specimens is useful.

Specimens which are known to have been stolen must be investigated as a case of theft. Especially valuable material or that at special risk should, ideally, have been photographed to permit police work to progress properly and to allow accurate valuation for insurance claims, if the specimens were not individually covered. The documentation of material lost through theft is the same as for any other loss.

6.2.1.2. *Destroyed specimens*

Specimens which are found to have deteriorated beyond salvage for one reason or another are essentially lost. (This situation does not cover material that is deliberately destroyed for other reasons: see B6.2.2.5.) Clearly the reason for a loss of this type is known and in contrast to the documentation of a specimen that is simply missing, that of a specimen lost by deterioration should have the circumstances of the loss carefully noted. In the case of once valuable or important material, a witness to the facts may be a useful addition to the records. In addition to the labels, etc. being placed in a History File, any label or number fixed or marked on the specimens should, if at all possible, be saved and filed – such evidence is useful confirmation of the facts, which, in time, may prove to be elusive. All documentation against the Specimen Identity Number must be preserved for future enquiry.

6.2.2. **Disposal of materials**

The activity of disposal is at odds with the generally perceived role of museums. In the U.K., it is commonly accepted that museums in the public domain (museums funded out of taxes, rates or under charitable status) are not the owners of the material they hold, but are the custodians, holding it in trust, in perpetuity, on behalf of the true owners, the public. "There must be a strong presumption against the disposal of any items in the collections of a museum" (Boylan 1977) is the ethic fundamental to both the Museums Association's 'Code of Practice for Museum Authorities' (Boylan 1977 para. 5.1) and its 'Code of Conduct for Museum Curators' Duggan *et al.* (1984) (para. 1.4). These policy statements purposely do not "prohibit" or "preclude under any circumstances" disposal, but voice a "strong presumption against" disposal. These are carefully chosen words and allow the museum the flexibility it needs in the discharge of its custodial duties. It is suggested that the philosophical approach of all curators should be firmly rooted in the ethic that disposal under certain circumstances can be legitimate but should only be considered as a last resort.

Accepting that as the basic premise, it is essential to consider and to validate ethically situations which may arise when disposal may actually be desirable. Museums are in the business of not only acquiring but also looking after objects and information, and so, in the interests of the collection as a whole, or significant parts of that collection, it may be possible to justify disposal of certain objects or collections, in certain ways.

This kind of ethical approach has been developed to an even greater practical extent by various North American institutions (see Nicholson 1974a & b, Neal *et al.* 1978, Malaro 1979, Hitchcock 1980, Nat. Mus. Canada 1981). For these institutions the disposal of specimens is considered to be an integral part of a good collections management policy.

This section is concerned with the disposal of material which has been formally acquired by the institution, or in other words has been fully catalogued as part of the main collections, as well as material that has entered the museum and has some form of Entry Documentation, short of full acquisition, and material that has no formal documentation at all. (Curators who acquire material specifically for exchange or sale to other institutions must maintain such material discrete from the main collections and maintain separate documentation for it.)

Similarly, the inadvertent loss by destruction, theft, etc. of fully acquired material falls outside these considerations (but see B6.2.1). Full documentation should be maintained for all classes of material removed from the museum.

6.2.2.1. *Situation covered by the guidelines*

The disposal of collections or specimens from a museum justified on the basis of good collections management may be by gift, exchange, sale or destruction. Reasons for disposal may be by means of:

- improving the collection by exchange;
- improving the collection by the disposal of inferior material made obsolete by the acquisition of better or more relevant material;
- improving the collection by applying the proceeds of the sale of specimens;
- protecting the collection by deliberate destruction of inferior material or material that has deteriorated too greatly to be of use, or therby endangering other materials;
- gaining scientific information by the deliberate, controlled, partial or complete destruction of specimens for the purposes of research;
- placing collections where they can be properly cared for, thus safeguarding important material.

6.2.2.2. *Ethical and other general considerations*

In museums, the public interest (in a legal and ethical sense) is of major importance. This should be interpreted to include consideration of both scientific and lay communities.

Subject to these legal and ethical constraints, in formulating these Guidelines we have taken the best interest of the science, geology, as pre-eminent.

The good interest of the collections themselves is seen to be subject to the two paragraphs above. It should be noted, however, that a geological collection (or part of a collection) may not only have purely scientific interest and importance, but may also be of historic significance which can equally well validate its preservation in the public interest.

Museums are custodians of an heritage (collections – the fundamental geological data base) and are not owners of the collections they maintain.

The governing body of a museum acts as the trustee of its collections, and has, *ipso facto*, the executive power of decision over the fate of the material in the museum; it equally has the duty to make these decisions in the light of the above. The curator's role is to make recommendations to the governing body concerning disposal, and to make such decisions independently. The curator does have the responsibility to initiate such moves where appropriate. He should, however, be aware that his recommendations may create a precedent and that his judgement today may, in the fullness of time, be found to have been wanting.

The proper storage and maintenance of a geological collection represents an investment of resources. There is a clear duty to make optimum use of these resources.

In situations where resources are fully deployed or inadequate the disposal of specimens must be regarded as a justifiable part of collection management. In such circumstances controlled, deliberate disposal of collections is preferable to random loss of material resulting from ignorance, neglect, and local lack of resources.

All museums with or starting geological collections should develop and publish an Acquisition Policy defining the nature of the material to be held in their collections (see Section A.1).

All museums with or starting geological collections should develop a policy on collections management which includes full consideration of disposal of materials.

In framing these guidelines certain other principles have been adopted:

- All discussions and decisions relating to the fate of geological collections should be undertaken openly.
- Where the disposal of significant material is being considered, there should always be suitable publicity in the appropriate press.
- Decisions should be taken after wide consultation with appropriate experts.
- Adequate documentation must be maintained permanently in the institution from which the material is removed.

The conjunction of responsibly conceived disposal policies and acquisition policies should benefit geology as follows:

- Resources can be re-allocated following the removal of inappropriate or obsolete inferior material from collections.
- Better collaboration on the deployment of available resources between institutions will be facilitated.
- A framework will be provided for developing procedures to rescue collections at risk.

Where a governing body is free to decide how it shall allocate money from the sale of material, the curator should do all in his power to ensure that such monies should normally be used to improve the museum's collections.

6.2.2.3. *Disposal constrained by law and international conventions*

(1) Statutory constraints. Museums in the U.K. come under the statutory provisions of either English or Scottish Law. It can be stated unequivocally that the governing body of a museum cannot legally dispose of any material donated, bequeathed or subject to any other trust deed unless

(a) permission for disposal was specifically granted to the museum (for which there must be documentary evidence) by the donor, testator, or trust executors when the material was originally acquired by the museum; or
(b) permission for disposal is obtained by the donor (if still living) or the surviving relations and legally recognised representative of the donor, testator, or trust.

If such permission does not exist or cannot be obtained, the governing body must apply to the Charity Commissioners for permission to dispose of the material. They will adjudge the case on its merits, and, if consenting, will almost certainly make stringent conditions concerning the means of disposal and allocation of disposal revenue. These must, of course, be scrupulously observed.

The legal status of material acquired by the museum, for example by purchase or by field collection by staff 'in museum time', is ill-defined and has not as yet been the subject of case-law.

More detailed statements concerning the legal status of collections in U.K. museums are set out in the Museums Association's 'Code of Practice for Museum Authorities' (Boylan 1977).

(2) Non-statutory constraints

Museum registration scheme. At the time of writing, this scheme has yet to be introduced Discussions between the Museums and Galleries Commission and the Museums Association are in progress on the feasibility of introducing a scheme whereby provincial museums must be 'registered' to be eligible for receiving central government funding. A prerequisite for registration will be a professionally acceptable policy on disposal. The absence of, or non-adherence to, such a policy would preclude a museum from registration (and hence suffer the sanction of ineligibility for central government funds).

International conventions. Minerals and objects of palaeontological interest receive specific mention in the 'Convention on the means of prohibiting and preventing the illicit import, export and transfer of ownership of cultural property' UNESCO (1970). The U.K. has yet to ratify this 'Convention' but is being urged to do so by the Museums Association. The Association also urges individual museums to adopt the principles of the 'Convention'. Due account should therefore be taken of this and other international conventions that may be produced by UNESCO, and the International Council of Museums (ICOM), etc.

International codes. The 'International Code of Zoological Nomenclature' (ICZN 1985) has placed particular responsibilities on the museum or other institution for the care of type palaeozoological material it may have. See in particular Recommendations 72G (B4.4.2.6) and 72C(g) of that Code. Recommendation 7A of the 'International Code for Botanical Nomenclature' (Stafleu 1983) (ICBN) seeks to provide similar control for palaeobotanical types. An informal concept of types for mineralogical species is also generally recognised, with the implication that institutions again have a responsibility to the international scientific community for the care of such specimens. (See Bassett, 1979; Embrey & Hey, 1970).

6.2.2.4. *Outline procedure for disposal of material from a museum collection*

1. Present a preliminary report to the museum's governing body recommending that a decision be made in principle to allow the curator to investigate further the implications of disposal of specified material. This report could include a preliminary appraisal of the legal, ethical, scientific and historical status of material. This will normally be done after informal consultation with interested parties in the museum and scientific communities.
2. Seek advice to determine legal constraints on any proposed course of action (see B6.2.2.3(1)). What legal instrument is necessary to effect disposal?
3. Obtain independent (i.e. from outside the museum) and appropriate expert advice on the significance of the material under consideration, and the implications of disposal.
4. If applicable, contact the donor, or as appropriate the surviving relatives or legally recognised representatives of the donor, testator or trust executors.
5. If applicable, apply to the Charity Commissioners (see B6.2.2.3(1)) for permission to dispose of the material.
6. On the basis of these consultations present a full report to the governing body for a final decision on disposal. The report, which ideally should be open for inspection by interested parties, might include the following points:

   - Permissions and conditions relating to disposal.
   - If unconstrained by the above the curator should recommend a course of action clearly stating its implications from one of the following alternatives listed here in order of preference:
     (a) retention by museum
     (b) transfer by gift, exchange, or sale to another museum (or similar institution)
     (c) transfer by gift, exchange or sale to a non-museum institution, with possible change of use of the material
     (d) transfer by gift, exchange or sale to private companies or individuals
     (e) destruction of otherwise undisposable material.
7. Publish details of the final decision in the appropriate press.
8. The disposing museum should ensure that all the appropriate original documentation accompanies the material to its destination. The disposing museum should keep copies of all such documentation plus a full documentary record of the circumstances of disposal in a permanently accessible form.

6.2.2.5. *Outline procedure for partial or complete destruction of specimens for the purposes of scientific study* (see discussion by Scrutton, 1979)

1. Carry out steps 1–5 as set out in B6.2.2.4;
2. Present full report to governing body for final decision, which might include recommendations on some or all of the following points:
   - Clear specification of what can and what cannot be done to the specimens involved. In the case of loans, follow the general conditions for the borrowing of specimens (see B6.1.1.2).
   - Production of a replica and/or high quality photographs prior to any work being undertaken. Copies to be retained by the institution.

- Publicity for the agreed action in the appropriate scientific press.
- An undertaking that the results of the study will be prepared for publication, and copies lodged in the source institution.

3. A full documentary record of the treatment and fate of the material must be made and retained in a permanently accessible form in the institution.

C. PRESERVATION

C. SPECIMEN PRESERVATION

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SPECIMEN PRESERVATION: SUMMARY AND RECOMMENDATIONS
The physical security and maintenance of specimens.
Protect the investment of collecting, acquiring and storing specimens by keeping them safely in conditions which minimise their rate of deterioration.

Field material

C1. This should be stored for a minimum of time before being treated (if necessary) and catalogued.
Ensure that field labelling and packing are not damaged through damp or pests.

Conservation

C2. Specimen conservation and processing are specialist subjects, so always seek advice.

C2.2.2.1. Never clean minerals when to do so may alter or destroy them or surface associated minerals, such as iron oxides.
Processing specimens should be kept to a minimum.
Repairs should be reversible so that a mend can easily, without damage to the specimen, be undone.

C2.1. Maintain notes on all procedures and file them for later reference.

C2.4.1.1. Specimens found to be decaying, smelling sulphureous or becoming covered in fine white crystals should be placed in a dry stable atmosphere and treated as soon as possible. Advice from a museum's geology department or the GCG.
Old dirty material should be cleaned only with long, fine-haired brushes (plus dust extraction e.g. vacuum cleaner).
Keep specimens and paper work (labels etc.) together in, if everything is dry, self-sealed polythene bags, but these may be bad for long-term storage.

Environment and storage

C2.4. A storage environment with stable (non-fluctuating) relative humidity and temperature is most important. Aim at 50% rh and 15°C to 20°C.
Avoid also atmospheric pollutants (including dust), vibration, continuous strong light and, of course, careless handling.

C3.3. Well designed wooden storage units (not oak or birch ply) help protect specimens from these threats.

C3.4. Aim to keep individual specimens, or identical ones from the same detailed locality together in specimen trays or boxes with their data labels, each bearing its unique specimen identity number.
Prevent breakage of large and/or fragile specimens by providing physical support.

C2.4.2. Aim at temperature and rh control.
Dust extraction or prevention by good seals.
Avoid storage near machinery or drainage and water systems liable to flood.
As a minimum, keep specimens and data together in clean dust free conditions and arranged in an understood fashion so that they can be found and used.

C3.5.3. There is an internationally agreed obligation to store status material (that used as the basis for publications) safely, and available for scientific study.

C3.6. Have well understood procedures to minimize the deal with risks, such as theft, flood or fire.

C2.5. the packing of specimens for transport requires great care: Specimens must not be able to move within the packing. Provide outer crush-resistant and waterproof protection. Specialist advice is available for large specimens.

Archives

C3.8.1. The care and maintenance of these materials is important and may be an obligation for your museum. Papers, books, maps, etc. deteriorate rapidly in damp or high fluctuating temperatures.

Aim at a storage environment between 13° and 18°C and rh of 50% to 60%, free of dust, chemicals or bright light.

C. SPECIMEN PRESERVATION

PREAMBLE

In this Part we discuss the ways in which specimens are kept safely, once collected, and enhanced by preparation. It includes sections on the preservation of field material in temporary storage (C1), and on the complex subject of conservation (C2) including the processing of fossils and minerals (C2.2). This however is a vast topic, mostly beyond the scope of these Guidelines, and the tasks should not be undertaken by the unaware, the untrained or the unskilled. Publications exist which provide much information, for example Kummel & Raup (1965) or Rixon (1976), while the bibliography 'Geology in Museums' compiled by T. Sharpe (1983), provides lists of authors and subjects.

The physical, permanent storage of specimens (C3) is vital to curation and these paragraphs should be read in conjunction with those on environmental control (C2.4). Also within this Part some suggestions are made on the ways in which specimens might be arranged in museum collections (C3.5), on collection security (C3.6) and on the storage and preservation of archives (C3.8).

1. THE PRESERVATION OF FIELD MATERIAL IN TEMPORARY STORAGE

Field-collected material in temporary store must be in weather- and pest-proof conditions. This minimum protection should prevent loss of or damage to specimens, field labelling, packaging materials and bags etc., through damp, fungus, insect or rodent activity. It may be advisable to incorporate a wide spectrum fungicide in collecting bags (if plastic) and plaster or polyurethane foam jacketed material during field packing to prevent fungal (including mould) growths, which might otherwise destroy specimens and associated field labels. Every effort should be made to reduce the length of time material remains in poorly protected conditions.

Field collections containing unstable minerals or fossils, e.g. pyritic material, shales, clays, sub-fossil bone and hydrated or moisture-sensitive minerals (see C2.2.2.1) should be processed as soon as possible after excavation. Damp pyritic material, exposed to the air will, even over very short periods of time, decompose. Slow drying (over even a few weeks) of sub-fossil bone or enamel, some shales or clays and hydrated minerals may cause serious deterioration or loss. The uncontrolled drying out of hydrated materials can be prevented by artificially maintaining a high relative humidity (rh) environment around packages by double-bagging in polythene.

2. SPECIMEN CONSERVATION

2.1. GENERAL PRINCIPLES

Geological material in the safekeeping of a museum is prone to decay. Conservation can be defined as embracing those measures which are designed to arrest or retard the deterioration of specimens by means of environmental protection and specific treatments, with the aim of prolonging the useful life of the material. Conservation begins in the field and continues throughout the long term storage of materials. Particular problems may arise during stages of collection (A2.1) and processing (C2.2), but later problems may be avoided by careful siting, design and planning of storage or exhibition facilities.

Of the 3,500 or so mineral substances discovered, over 300 are known to be unstable when exposed to the atmosphere, and a small number of these are extremely common as individual or aggregated minerals, replacing, infilling or encrusting specimens, and in supporting ground mass or matrix. (Waller 1980). These substances are variously affected by exposure to light, high, low or fluctuating relative humidity or temperature, atmospheric pollutants or vibration. To apply basic conservation criteria it is necessary to know the susceptibilities of the materials concerned and over the past century information describing both the stability parameters of many susceptible minerals and fossils, and the applicability or advisability of treatment has been gathered. (Howie 1984 and in press). A general principle often applied in conservation technology, is that the treatments applied to specimens should be reversible. This is often extremely difficult to guarantee and in the case of physical or chemical development may be impossible.

For the application of conservation processes, geological materials fall into two categories. First, there are the vulnerable, unstable and metastable minerals and associations which by their chemical nature require special treatment to ensure their survival. Second there are those specimens which because of their physical state require protection using adhesives, support, consolidation, etc., for processing, storage, handling, exhibition etc. In all cases the chief criterion for the long term preservation of geological material is environmental control. Any specimen treatment should be kept to a scientifically appropriate level as defined by the requirements of the constituent minerals present. Work carried out during the cleaning, preparation, conservation, restoration and replication of specimens often involves the use of hazardous substances or equipment and it is incumbent upon both employee and employer to take all necessary steps to reduce the risks to safety and health. (See Part D).

A requirement of good curatorship is that all conservation work carried out on specimens is fully documented and subsequently written into the master catalogue or History Files. This important aspect is dealt with in B5.3.3. All conservation techniques require specialist knowledge and should be carried out with care. When in any doubt seek the advice of the GCG or United Kingdom Institute for Conservation (UKIC).

2.2. PROCESSING SPECIMENS

PREAMBLE

The processing of geological material can be defined as the physical or chemical processes to which specimens are subjected to stabilise and prepare them for use in the museum. During processing, some types of material may suffer unless adequately protected from large variations in humidity or temperature (see C2.4). This applies as much to old stored material as to freshly processed specimens. Laboratories, studios, workshops and areas set aside for processing should be adequately heated and ventilated. Where inappropriate conditions are suspected, such as major temperature fluctuations (i.e. 5–10 centigrade degrees over two to three hours), relative humidity (rh) below 35% or above 65% for any but very short periods, atmospheric pollutants presents, gases or dust, environmental monitoring and control should be introduced. It may be advisable to utilise some form of environmentally controlled chamber for storage of specimens in the work area. For sulphides that are easily oxidised, and other materials sensitive to high rh, the use of silica gel (either dry giving 10% rh, or conditioned to give up to 60%) as desiccant or moisture buffer may be necessary. Conversely where a high relative humidity is required, this can be achieved in a simple chamber using water or a saturated salt solution (see Howie 1979b and Waller in press) The latter gives greater control of humidity but requires constant maintenance to prevent salt creep within the chamber, which may cause contamination. Where humidities are kept in excess of 65% to 70% a vapour phase fungicide, e.g. thymol, may be used to control mould growth within the chamber. Processing areas require a good level of lighting, although certain photo-sensitive materials may required protection (see C2.4.1).

Within the definition of processing we include the preparation of geological material which can be described as the physical modification of specimens for the purpose of realising the maximum potential use of the material. The extraction of microfossils, cleaning of minerals, cutting and grinding thin sections, mechanical and chemical development of macrofossils are all forms of preparation designed to enhance the scientific, educational or display value of the specimens. The researcher or curator should always maintain a responsible balance between the objectives of specimen preparation and the requirements of conservation. (See E2 Preamble).

In the interests of specimen preservation, the use of non-destructive methods of examination (e.g. radiography) should be considered, whenever possible, as alternatives to specimen preparation. Removal of supporting matrix often weakens specimens and necessitates the use of consolidants or other synthetic supporting media, which may themselves cause conservation problems at a later stage.

The objective of specimen preparation, including cleaning of minerals, should be carefully considered. The type of material selected and the nature of the preparatory treatment adopted should reflect the requirements of the use to which the specimens will be put. The visual enhancement of a macrofossil for display, for example, may involve a different approach from the exposure of its diagnostic features for taxonmic research. The preparator should understand the characteristics of a specimen, and its intended use since the material is at greatest risk while in his hands.

2.2.1. Fossils

2.2.1.1. *Preparation*

(1) Field methods. The conservation of fossils should start during their excavation. Damage caused by poor procedures or materials may be diffcult to rectify during later laboratory processing. It is most important to use reversible treatments for the consolidation of wet or loose sediments and specimens in the field. The excavation of unstable fossil material presents special problems, (e.g. sub-fossil tusks, teeth, lignitic material, pyritic specimens, etc). With pyritic material (see C2.4.1.1) processing should be carried out as soon as possible after collection. To prevent warping, splitting, etc., of hygroscopic material it is essential to prevent drying out during storage of cocoons etc. and again early processing may prevent deterioration. A variety of techniques are recommended (see Dowman 1970, Rixon 1976) for field work conservation.

(2) Mechanical methods. The mechanical preparation of fossils essentially involves the physical removal of matrix attached to or enclosing them, in order to expose the specimen. Very rarely it may be necessary to remove some portion or even all of an original specimen to expose hidden features (e.g. brain casts). The prime requirement is to enhance the information value of the specimen with a minimum of risk or damage to the fossil. As little work as possible should be carried out since preparation invariably causes the specimen to become more fragile, less easy to handle and difficult to store safely. Experience becomes the guiding principle in deciding the type and extent of preparation that is acceptable for a particular specimen and matrix. In practice there should be consultation between preparators and researchers or curators at all stages.

Mechanical methods include the use of hammer and chisel, pneumatic or electric engraver, abrasive wheel, diamond saw, etc. for the rough reduction of matrix; for finer work, where matrix and specimen separate easily, fine pneumatic or electric, percussive or rotary tools with diamond burrs, air-abrasive equipment and ultrasonic probes may be employed; the finest work on fragile and delicate material may be carried out using powered delicate diamond burrs, brushes, fine pins and animal bristles. All these methods require much time for preparators to develop the necessary skills and manual dexterity. These techniques misused or misapplied can be disastrous!

(3) Chemical methods. Chemical preparation relies on the differential action of a reagent, or mixture of reagents, upon the matrix and the specimen. In general the objective is to dissolve away or soften the matrix from the fossil without risk to the specimen. In very rare instances where, for example, rotted bone is enclosed in a particularly intractable matrix, a reagent is selected which will dissolve away the specimen cleanly from the matrix leaving the option of taking a cast from the external mould so formed. The use of chemicals is less labour intensive and more subtle than mechanical preparation and is usually more complete in terms of the extent of specimen exposure. However most of the reagents in use now act by being corrosive (acid or alkaline) and thus present problems of storage and safe handling or application by the user. In addition, steps are necessary to provide support and protection for the progressively more fragile specimen whilst it is undergoing preparation. A suitable plastic may be used. The reactive reagent must be neutralised and removed meticulously from the specimen otherwise conservation problems will be caused. Last but not least, acid-prepared material is always fragile and many specimens require permanent support; whilst in storage, all large specimens require some form of cushioning using a suitable plastic foam (never cotton-wool, see A.2.1.2.2) such as cut pieces of polyethylene foam or expanded polystyrene. Polyester and polyurethane may not be stable over the long term and tend to stick to the surfaces with which they are in contact, so impermeable separator membranes must be used.

A fire inhibitor must always be added during the production of polyurethane, and note that in fires toxic fumes are given off.

(4) Adhesives. The adhesives, consolidants and supports used during preparation should all be reversible, both in the short term and, since their later removal may be necessary, also in the long term. Many commonly used natural and synthetic resins become unstable or are liable to become intractable after even a few years exposure to the atmosphere. In particular the use of shellac, animal glues, cellulose nitrate, epoxy resins, and polyesters, and products containing them, should be avoided. Cyano-acrylates ('Superglue'), although in common use, require careful application, and their aging characteristics are poorly known. It is always advisable to consult the manufacturer or supplier about the durability of their products before using them on irreplaceable specimens. The use of new materials should always be checked by reference to current conservation literature (e.g. Art and Archaeology Technical Abstracts of the International Institute of Conservation, published by the Conservation Center of the Institute of Fine Arts, New York University. See Appendix 1 for notes on various adhesives.

(5) Specimen support. Specimens undergoing mechanical preparation are exposed to percussive shock and vibration during development and therefore time and effort should be expended in providing adequate support and protection. Temporary supporting media (e.g. water-soluble wax, thermo-plastics with a low temperature melting point, sand bagging and embedding techniques, etc.) can be used but the selection of the most appropriate is dependent upon the characteristics of the specimen and this must rely upon the judgement of an experienced preparator.

(6) Conclusion. Even the most basic preparation, chemical or mechanical, requires both specialist knowledge and considerably time if it is to be carried out effectively. Of paramount importance during preparation is the maintenance of records of the processes and materials involved; these together with drawings, photographs and notes or observations should be properly filed and not stored with the specimen concerned. (See B5.3.3). While in the laboratory, specimens not being actively worked upon should be kept in a location that is both secure and meets the environmental requirements of the material or returned to the main collection, store or exhibition.

2.2.1.2. *Repair and consolidation*

The consolidation and repair of fossil specimens requires adequate facilities for storing, handling and applying a variety of resins and solvents and, in specialised laboratories dealing with fossil vertebrates, access to vacuum impregnation equipment, large sand trays etc.

Repairs to badly damaged specimens often require considerable experience and patience and this type of work does not suit all individuals. With simple repairs to fresh breaks it is often necessary to prime both sides of the break by consolidation, using a hardener which is compatible with the adhesive to be applied. When repairing fractured old breaks it is important to ensure that all old glues, waves, etc. are removed from the joint areas as these may impede the setting of modern adhesives. When setting up complex repairs use should be made of a sand tray, sand bags and such supporting rigs as are necessary, for example, laboratory scaffolding. Fractures in large of heavy specimens may need dowelling, this however usually necessitates destruction of some of the original specimen and should be avoided wherever possible. Consideration could be given to storing the broken pieces unassembled. When producing a glue line in a join always ensure that excess glue is removed during the last stage of setting. As mentioned earlier, the use of 'permanent' adhesives such as epoxies and polyesters is generally condemned. Large repaired specimens, such as limb bones, are best stored mounted or supported upright. Horizontal storage can bring about collapse of specimens under their own weight, unless carefully prepared pre-formed plastic foam cushioning, affixed to a rigid substrate (e.g. strutted board) is provided.

The consolidation of fossil specimens has been common practice. In many cases the need for consolidation, hardening or impregnation is unnecessary especially where consideration has been given to the provision of vibration and jolt-free storage, a good storage environment and, above all, careful handling. Indeed as a good general principle, the use of consolidants should be kept to a minimum. Certain categories of material (e.g. friable clays, sandstones, paper shales, some sub-fossil osseous material and decayed pyritic specimens) do require the use of consolidants to render specimens both storeable and handleable. Such consoldiation should not, however, be considered adequate to give long term stability, where variations in known environmental factors, like relative humidity, have a deleterious effect. (See C2.4). The type of consolidant required and its mode of application is dependent upon the permeability of the specimen or its matrix. The need to remove old consolidants before re-treating can cause considerable problems; but failure to remove them thoroughly may result in rejection or failure of modern synthetic materials. Specific adhesives are required for particular applications.

Acid-prepared material, both vertebrate and invertebrate (e.g. silicified material), is generally so friable and fragile that consolidation is carried out whilst the material is being developed. Final storage may require further appropriate consolidation. Enhanced storage and handling characteristics are endowed where fragile material is supported on some form of easily removable substrate (see C3.7.5). Water-soluble or low-temperature thermo-plastic waxes may also be used for this purpose. Methods employing the practice of fixing thin plastic (e.g. perspex) strips to weak or fragile exposed elements should only be carried out by experienced preparators or conservators since these methods require considerable expertise to be successfully employed.

2.2.2. Minerals

2.2.2.1. *Cleaning and processing*

Chemical and mechanical methods for cleaning and preparing mineral specimens are not generally recommended. Of utmost importance is the preservation of unstable, fragile or delicate original assemblages (e.g. secondary weathering products, like iron staining, or minute encrusting minerals which may be water soluble or easily removable) and it is considered unethical, knowingly, to clean a specimen in a way which removes them. The cleaning of mineral specimens using aqueous or organic solvent-based preparations should only be carried out when it is known that the specimens will remain unchanged.

A large number of minerals may suffer damage during cleaning so researchers, curators, preparators and conservators should acquaint themselves with current published data on these (see King 1982, 1983; Sinkankas 1972; Waller 1980 and in press).

In general those minerals that formed in surface or near surface aqueous environments are also the most soluble and most sensitive to alteration by hydration or dehydration.

Both hydrous minerals and those containing loosely bound water molecules can deteriorate so rapidly and so intractably as to become worthless. Sealing in containers to retain or exclude moisture is often only partially or temporarily successful, because the phase stability is outside those conditions that can normally be achieved in the museum.

The following groups are vulnerable to washing in water:

Sulphates. Most of the simple sulphates (with the fortunate exception of several of the commonest) of sodium, potassium, magnesium, zinc, copper, aluminium, iron and manganese. These are both soluble and liable to hydration state changes.

Carbonates. Those of sodium and potassium are most vulnerable.

Nitrates. A small group, vulnerable to hydration changes, and also soluble.

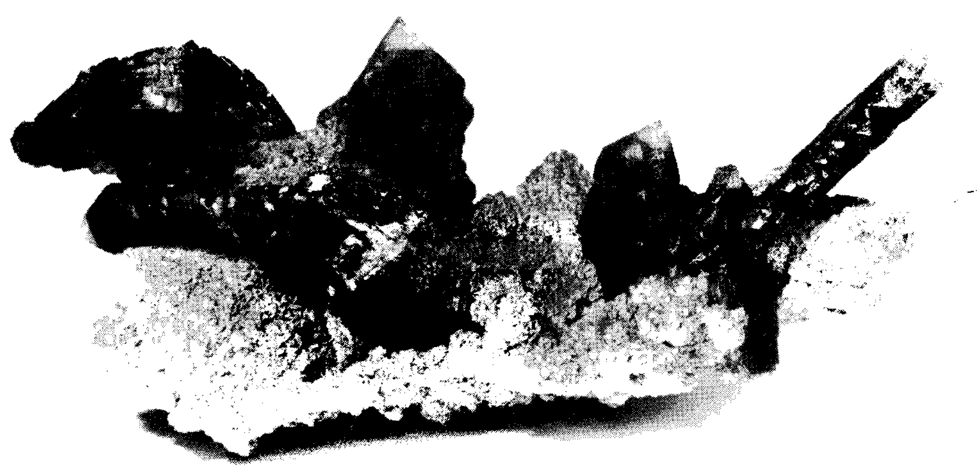

Fig. 10. A fine example of baryte crystals on a dolomite groundmass. The specimen measures 20″ × 12″ × 12″, is very heavy and requires careful handling and support. The lustrous baryte crystals are soft and possess good cleavage, so dust accumulations, poor storage or rough handling could easily cause damage. The specimen came from the Goosegreen Mine, Frizington, Cumberland (Cumbria) and was aquired in 1899 by the Department of Mineralogy, British Museum (Nat. Hist.) and is number BM 84006.

Borates. Most alter (dehydrate) to simpler chemical forms which totally disintegrate the specimens.

Phosphates and related groups. A few are vulnerable including the rare acid and alkaline phosphates and the uranium micas groups.

Halides. The chlorides especially are liable to deliquescent changes and are highly soluble.

Silicates. A few zeolites and similar silicates are liable to dehydration changes. Most zeolites have a variable water content but this is rarely problematical.

Another common form of deterioration is that suffered by pyrite and similar iron and iron copper sulphides (C2.4.1.1). Fortunately mineral specimens with their coarse grain size are not as vulnerable, or as rapidly attacked, as fossil specimens. Another form of alteration that affects many copper minerals of the sulphide and related groups is the formation of a powder or surface crust of covelline, resembling soot. The reason for this is not fully known but no great damage is done, except to the appearance of the specimens.

2.2.2.2. *Consolidation*

The use of physical methods to hold fragile or damaged mineral specimens and assemblages together are generally not recommended. Where necessary repair should be effected using well-tested stable adhesives that are known to be easily reversible without the application of harsh reagents or heat.

Impregnation of weakened minerals or assemblages is best carried out by an experienced conservator. Problems may arise where applied resins react directly with the mineral, or during their removal for simple scientific examination (e.g. refractive index determination). Similarly, coating reagents present potential problems for future analytical work, as well as obscuring fine surface features.

Mineral specimens comprising individual crystals weakly attached to friable substrates or matrices, or those that are extremely brittle and fragile, need particular care in handling and storage. Where the substrate can be strengthened with a modern consolidant, such as polyvinyl acetate which has known durability and potential long-term reversibility, the work should be carried out by a trained conservator. The use of irreversible plastics (epoxy or polyester) as embedding media for thin weak, or unstable substrate is recommended, provided that a film of separator (again one which is readily removable) is applied to the matrix first. The use of plastics as consolidants or supports for fragile or brittle minerals should not be attempted. Such work, as well as, for example, the repair of fractured individual minerals, should be referred to the specialist conservator.

Where environmentally unstable minerals or assemblages of minerals (e.g. moisture sensitive hydrates, zeolites, pyritic material etc.) require consolidation this should be carried out using approved current techniques and materials (Howie 1984) and it should be born in mind that even after treatment subsequent storage under the same hostile conditions that caused the problem will soon bring about a recurrence (see C2.4).

2.2.3. **Specialised processing**

Geological specimens are subjected to a wide range of laboratory processes too specialised for inclusion in these Guidelines. Some, such as cutting and polishing, thin-section preparation and micropalaeontological preparations, are conceivably within the scope of provincial museums. Others, such as X-ray diffraction, SEM preparations, Radiometric determination etc., are the realm of the highly equipped laboratories of major research institutions. Information about many of these processes may be found in Allman & Lawrence (1972), a good starting point for further reading.

2.3. REPLICATION

The preparation of peels from specimens, and the moulding and casting of geological material present few problems for the majority of specimens if effective measures are taken to protect friable or delicate surface structure. Peels, pulls and moulds should not be considered as permanent records, although modern glass reinforced plastic casts are extremely robust and long-lasting, and can faithfully replicate the finest surface detail. For many purposes, e.g. exhibition, study, exchange, casts of fossils may be acceptable in placed of the real thing. Detailed methods for the preparation of peels, moulds and casts are given by Rixon (1976) and Waters (1983).

2.3.1. Safeguarding specimens during moulding

Specimens must be very carefully inspected before any attempt is made to begin the moulding process. Those with a porous or highly indented surface will need some form of superficial hardening, to prevent the moulding compound from adhering. The same applies to those with a flaky or chalky surface. One of the most useful temporary surface hardener/separators is a 5% aqueous solution of polyvinyl alcohol, which combines both in one application, and can be painted on thinly enough not to obscure surface detail of the specimen. It also has the advantage of being water-soluble and so can be simply washed off afterwards. It is available both in a clear form and with a fugitive blue dye which is useful on, for example, large, dark or flat surfaces in order to indicate whether or not total coverage has been achieved. Any cracks or holes in the specimen must be filled so as to prevent the moulding compound from running in and breaking off when the mould is removed and home-made 'water soluble plasticene' can be used for this purpose. This is basically a mixture of water soluble carbo-wax (polyethylene glycol 1500), precipitated chalk and glycerol. This too can be washed off after use. Teepol (a neutral pH, liquid detergent) can be used on robust specimens and as this acts as a surface-wetting agent, rather than a real separator, care must be exercised to ensure the surface of the specimen is strong enough to accept the moulding material it is desired to use.

2.3.2. Materials

Cold cure (or RTV) silicone rubbers, in various forms, make up the majority of moulding compounds most readily used today. Dow Corning RTV 9161 Silastomer is an old favourite and still widely employed on slightly fragile specimens as it tends to tear easily, which is preferable to breaking the specimen. Wacker RTV 533 is much stronger and can be used on robust specimens. RTV 533 is useful for skin-moulds as it does not need the application of a gauze bandage for added strength. Dental silicone moulding agents, such as 'Reprosil', are extremely expensive but very useful if a mould or impression is required quickly; the cure time is about 20 mins. Unlike the previous two produces mentioned, 'Reprosil' cannot be used to take numerous resin casts since it breaks down, particularly with epoxy resins. Rubber (e.g., Dunlop A600) Latex is useful for peels and for field work but is quite incompatible with resins; casts should not be taken from peels or moulds composed of latex. Hot, melted polyvinyl chloride-based moulding compounds such as 'Vinamould' are seldom used now, the detail is not good and the concept of pouring a very hot (150°C) liquid over fossil material is not a good one; in addition their use poses a health hazard.

2.3.3. Storage of moulds

Dow Corning and Wacker moulds appear to last up to about 5 years before showing signs of deterioration, usually becoming increasingly brittle. It is thought that this can be improved by heat-curing moulds, but this is not yet adequately proved. Latex peels store indefinitely but become tacky and brittle. They are best stored dusted with talc and with polythene between them to prevent sticking to each other. Plaster and glass-reinforced plastic (GRP) casts store indefinitely.

Moulds and casts are stored in the same conditions as the fossil collections (temperatures range 15°C–25°C and rh 30% to 60% though this may prove to be slightly too warm an environment for silicone rubber. A cool, dry dark place is the optimum environment for the storage of all moulds composed of silicone rubber.

2.4. ENVIRONMENTAL CONTROL

A large number of geological materials are sensitive to certain components of the environment viz:

Relative humidity (rh)
Temperature
Atmospheric chemicals
Light
Vibration

Section C2.4.1 will detail the kinds of problems that can be encountered when variations or excesses of any of the above occur; Section C2.4.2 will specify those environmental conditions which should prevent the problems arising. Environmental monitoring is also considered. Many of these topics are dealt with by Thomson (1978).

2.4.1. The problem areas

2.4.1.1. *Relative humidity (rh) variation*

The mineral constituents of geological material can be susceptible to chemical or physical changes in which rh plays an important role, in two kinds of reaction:

- Oxidation/corrosion (from simple oxidation product surface tarnishing to the

more extensive and complex corrosion of specimens involving acid reagents derived from the atmosphere or from mineral breakdown products)
- Hydration/dehydration (resulting in destructive dimensional changes and including efflorescence, deliquescence and hydrolysis)

The corrosion of native metals, such as silver, copper, antimony, etc., or of metallic iron in some meteorites (see also C3.7.1) is brought about by a combination of factors, the principal of which is high relative humidity. The extent of corrosion ranges from surface tarnishing to serious pitting: the latter may be brought about by the presence of hygroscopic salts in intimate contact with the metal concerned or by storage in contaminated air containing traces of acid i.e. vapour. Thus acidic material must never be used in cleaning native metals.

The oxidation of many common sulphides, and rarer arsenides and sulphosalts will occur readily at high or fluctuating relative humidity. The case of reactive pyrite deterioration has received much attention lately and the mechanisms involved in the oxidation of this mineral, together with other sulphides such as chalcopyrite, pyrrhotite, sphalerite and chalcocite, have been described by Howie (1979a,b), and Steger & Desjardins (1978, 1980). Pyrite decay manifests itself by the loss of surface shine, powdering of the surface with the development of white or yellow crystals and the presence of a sulphurous smell. Eventually paper below specimens turns brown and crumbles, whilst the specimen itself disintegrates, commonly from the base. The prevention of sulphide oxidation is achieved overall by the storage of material at low rh. The storage of reactive types at relative humidities of 50% or less appears satisfactory over periods of several years, whereas short periods of storage at 60% or higher results in rapid deterioration (Howie 1979, 1984). The treatment of oxidised pyrite is detailed by Rixon (1976), Howie (1979) and Cornish & Doyle (1983, 1984), the last of whom recommend the use of ethanolamine thioglycollate.

Several minerals and fossilised substances are both hygroscopic and dimensionally unstable. Well known examples include sub-fossil ivory and enamel, some shales, certain clay minerals, such as montmorillonite, and the silicate chrysocolla. The alternating swelling and shrinking of clays and shales containing fragile fossil specimens will ultimately cause considerable deterioration and loss, and with hygroscopic minerals, sub-fossil bone and some high-lignite plant fossils, shrinkage, cracking, distortion and spalling off of surfaces will occur when exposed to low relative humidities. Some work on the limits of rh for such material has been done and the concensus is the storage of organic-rich materials below 40% rh is not satisfactory. Material from coastal exposures may develop surface salt crystals when in fluctuating rh. These can be washed off using de-ionised water, but with particularly fragile material, first coat the specimen with a dilute solution of PVA (see Howie 1979a). A similar looking problem with calcareous specimens is the development of a calclacite type of thread-like crystals on their surfaces (see C2.4.1.3 – Byne's disease). The crystals should be removed by gentle mechanical means and the specimen impregnated with a dilute consolidant, such as Butvar (see Howie 1979a).

There are large numbers of hydrated minerals, commonly halides, which undergo constitutional changes when exposed to varying rh (see C2.2.2.1). Several water-soluble minerals tend to absorb moisture or deliquesce where rh levels are at a higher water vapour pressure than that exerted by a saturated solution of the particular mineral. Here, minerals such as halite, melanterite and trona will dissolve away quite rapidly if left unchecked in conditions of over-high rh. Efflorescence occurs through loss of water from a hydrated mineral caused by decrease in rh to a level below its equilibrium water vapour pressure. Such changes may bring about decomposition and changes in the mineral's crystal structure. Conversely hydration, the uptake of water from air to form a higher hydrate, often causes the formation of an outer crust of new mineral on sensitive specimens. Hydrolysis, which occurs comparatively rarely, is a chemical reaction between the mineral and atmospheric water with the formation of new products. With certain halides and sulphates acid gases may be liberated during hydrolysis and these can be harmful to minerals stored nearby. The stabilization of rh in exhibition areas is dealt with by Thomson (1977).

2.4.1.2. *Temperature variation*

The temperature of any environment is intimately associated with its relative humidity.

Within the museum it is unlikely that variations in temperature alone bring about any important physico-chemical change in geological material. Some minerals, such as fluorite or native sulphur, are sensitive by virtue of their poor conductivity and are liable to cracking or parting along cleavages. As the rate of chemical reaction increases with rising temperature, mineral oxidation, effluorescence, deliquescence etc. will progress more quickly in warm environments. Conversely, an uncontrolled drop in temperature may result in an unacceptably high rh with all the attendant problems outlined in C2.4.1.1.

2.4.1.3. *Atmospheric pollutants*

Untreated urban atmospheres contain sulphur dioxide, carbon monoxide, ammonia and traces of mineral acids. Whilst some of these caused considerable damage to external surfaces, there have been no reports of their causing damage to geological specimens stored indoors. As a precaution, acid vapour-sensitive minerals should be protected from untreated air. The effects of another pollutant, airborne dust, however, are considerable. First, dust affects the appearance and value of a specimen perhaps irretrievably. Secondly, the various methods employed to remove dust may prove harmful either by their very nature (e.g. ultrasonics) or by their careless operation (e.g. nylon brushes).

A particular atmospheric problem in museums concerns the organic acid vapours which may emanate from the wood or adhesives used in cabinet construction. These may have damaging effects on minerals and matrices. The most serious problems arise with oak (and perhaps birch ply) where both fresh and seasoned timber slowly evolve acid vapour. High temperatures and rh accelerate the hydrolysis of hemicellulose in wood to acetic acid (Donovan & Struger 1971), which may attack calcareous fossils and matrices, minerals, metals etc. In severe circumstances, acidic vapours, in conditions of high rh, may cause deterioration in calcareous specimens with the development of fine white crystals of a mineral similar to calclacite, on the specimen surfaces (a condition known as Byne's disease – see also C2.4.1.1). Note also that formaldehyde vapours, which irritate the eyes of some people, even at very low concentrations, may be given off from the urea formaldehyde glues used in some chipboards, blockboards etc., although good ventilation should remove the problem. Certain plastics will give off both acidic vapour and otherwise harmless compounds which may undergo reactions in air to form corrosive substances (e.g. the rapid auto-oxidation of aldehydes to organic acids in air). The table (Fig. 11) shows some of the major pollutants encountered during the use of everyday materials.

Properly constructed cases and cabinets made of safe timber or other materials can provide considerable protection against dust and buffer external changes in relative humidity (Howie 1979). (See also C3.3.2). Be alert to possible dangers which may result from insecticides and fumigants used in biological storage areas shared with geological specimens. Fumigants such as methylbromide are hazardous to some biological materials, will react with some geological materials and must be used only within the regulations of the Ministry of Agriculture and Fisheries. See also Health & Safety Commission (1984).

2.4.1.4. *Light*

Some ninety minerals are known which are altered or decomposed by the action of light. Many of these are sulphides, halides and chromates which suffer deterioration through the combined effects of light and oxygen. There are several categories of damage: physical breakdown e.g. realgar; permanent colour loss e.g. proustite; temporary colour loss e.g. some nepheline. Some of these changes can occur even at very low levels of light and total protection is advisable. Light sensitive minerals should not be exhibited.

Few, if any, fossils are directly affected by exposure to light though of course labels and other documents most certainly are. (See also C3.8.1(d)).

2.4.1.5. *Vibration*

All specimens are susceptible to damage by inadvertant shock or by sustained exposure to vibrations. In so far as vibration can be considered a product of the environment e.g. from road or rail traffic, machinery etc. the problems are slight, and only the most fragile of specimens are at risk. Exacerbation of these problems occurs when metal storage cabinets are used, in which some resonance readily develops. These problems can be solved by constructing wooden storage units and by using cellulose wadding, quick-setting polyurethane foam (for relatively short-term storage), plaster, carved expanded polystyrene, wood or metal supports for individual specimens. (Beads of expanded polystyrene can be cast to shape using suitable heat or adhesive treatment.)

2.4.2. Solutions to environmental problems

The following recommendations concern the storage environment, rather than processes to the specimens themselves.

2.4.2.1. *Environmental criteria*

In general most geological specimens are secure from damage in environments that meet the following parameters:

- adequately heated in winter; a steady 15° ± 5°C is acceptable;
- cooling in summer where temperature exceeds 25°C by the use of commercial chiller units, not fresh air ventilation;

Fig. 11. Table of materials which may give off corrosive volatiles. (From Donovan & Struger 1971 and Howie in press)

Material	Industrial processing etc.	Corrosiveness	Volatiles evolved
1. Timbers			
a. Oak, birch, sweet-chestnut and some tropical and Australian woods.	Natural seasoning i.e. air-drying at ambient temps.	High, increasing with rising temp. & rh.	Acetic acid.
b. Other woods. NB. mahogany is one of the most stable timbers.	Natural seasoning, kiln-drying, steam treatment of hot-bonded.	Low to high Artificially dried wood & high temp. or rh increases activity.	Acetic, formic & traces of higher carboxylic acids.
2. Plastics			
a. Nylon, epoxies, poly-ethylene, polypropylene, PVC (at ambient temps), polyurethanes, formaldehyde condensation polymers.		None, unless filed with non-inert fillers, e.g. wood flour. Under-cured formal-dehyde polymers are corrosive.	
b. Polyesters	Cured with non-oxidising catalysis, e.g. gamma radiation.	None.	
c. Polyesters	Peroxide or hot-cured.	Some.	Acetic or formic acids.
d. Poly(vinal acetate)	Without additives.	Some.	Acetic acid.
e. Poly(vinal acetate)	With stabilisers & inhibitors.	None.	
f. Polyformalde, with acetate end groups.			
g. Polyformaldehyde co-polymerised with 10% ethylene oxide.		Acetate group slightly cor-rosive at low temps, both corrosive at over 40°C	Formic Acid
h. Polyacrylates, e.g. Perspex.		None.	

3. Rubbers:			
a. non-vulcanised		Corrosive when old	Acetic & formic acids
b. Vulcanised		Slightly corrosive.	Hydrogen sulphide & sulphur dioxide.
c. Synthetic	Fully cured.	None.	
d. Silicone rubbers	Acetic acid solvent, if catalysed	Some, none.	Acetic acid
e. Polysulphides	Peroxide cured	Some.	Formic acid.
4. Paints & Lacquers:			
a. Oleo-resinous	Freshly applied to 18 months.	Slight.	Mainly formic acids & aldehydes
b. Solvent based;			
chlorinated rubber		Some if exposed to high temp. or UV light.	Hydrogen chloride
PVA emulsion based		Slight.	Acetic acid.
nitrocellulose		None.	
shellac		None.	
acrylics		None.	
poly(vinyl butyral) 'Butvar'		None.	
poly(vinyl acetal) 'Alvar'		None.	
poly(vinyl alcohol)		None.	
c. two-pack epoxies & polyurethanes		None.	
d. cyanoacrylates		None.	
5. Adhesives:			
a. Animal, vegetable, casein, starch & dextrin, waxes, shellac	Some may degrade with age	Slightly corrosive decay products.	Organic acids, aldehydes.
b. Elastomers, solvent based. (e.g. rubber impact glues)		None to some	Formic & acetic acids.
c. Formaldehyde condensation polymer based.		None to some. Acids evolved on & after curing may be absorbed by components to be released later.	Acetic acid & various aldehydes (formaldehyde).

- all exterior doors and windows require adequate dust sealing to prevent ingress of insects, as well as dirt;
- avoid situations where storage is shared with machinery (e.g. ventilation equipment) to minimise vibration;
- avoid situations prone to possible flooding from e.g., drainage systems, mains water pipes.

However, where circumstances allow, higher standards of environmental control should be applied. In particular, the standards of heating; humidity control, and dust (particulate) filtration should be those of the RIBA (Royal Institute of British Architects) for museums and galleries (see Thomson 1978). Fresh air intake should be kept to between 5% and 10% of total ventilation volume turnover; temperatures maintained at 20°C ± 2°C using a 'heater battery' (i.e., a heated air, ducted) radiator system, not electrically heated air (since without added humidification it is too drying); particulate removal via filters to BS 3831 No. 1 (The Methylene Blue Test) gives removal of particulates down to 0.5 μm; and removal of acid gases (e.g. sulphur and nitrogen oxides) should be via activated charcoal, water scrubber systems or other efficient means. For buildings lacking an air-conditioning system, rh can be controlled using electrically-powered humidifiers ('Fecon' is a make used extensively in museums and galleries), or where high rh is a problem, through the use of de-humidifiers (e.g. 'Haydon').

Full air-conditioning includes temperature and relative humidity control, particulate and gaseous pollutant filtration and fresh-air ventilation control, all to a high, usually specified level. The normal architectural standards may not be appropriate, particularly for humidity control. Specialized collections or specimens may require high or low regimes of humidity. In general the requirement is 50 ± 5% with some form of automatic control to prevent summer levels of rh rising above 60% and adequate humidification in winter to prevent levels dropping below 40%. For the latter water vapour injection methods are the most efficient. Dust filtration to BS 3928 (Sodium Flame Test) for removal of particulates down to 0.3 μm, coupled with filters for removal of gaseous pollutants – acid and alkaline – may be desirable for highly susceptible or valuable collections. Maintenance of stores, partially enclosed stores, exhibition areas or cases at slight positive pressure with air-conditioned air affords extra protection, but may present engineering difficulties. Air-conditioning systems to the standard required in museums are both expensive and energy intensive. Alternatives such as micro-climate control of susceptible specimens both in storage and on exhibition should be considered. The environment of individual cases and cabinets can be modified using for example, silica gel; micro-climate control does not rely upon complex electro-mehcanical systems and thus is not prone to breakdown or serious maintenance problems.

2.4.2.2. *Storage environments*

Advice on the design and construction of storage units together with guidance on the use of specimen trays is given in sections C3.2–3.4 and many of the recommendations made there have resulted from environmental considerations. It is perhaps worth emphasising three points here. First, as already mentioned oak or birch should be avoided as constructional timber in storage units: better use a cheap hardwood. Secondly, good cabinets will incorporate good dust seals, and thirdly, wooden cabinets will form a buffer against changes in external relative humidity, smoothing out short-time fluctuations. Cycles of rh approach an acceptable average in good cabinets. Additionally, timber buffers against vibration. Closed storage environments offer the possibility of emergency treatment for material suffering from short-term humid conditions (see C2.2 Preamble). Conditioned silica gel is recommended for its buffering capacity which exceeds that of timber, especially below 50% rh (Thomson 1978, Howie 1979).

2.4.2.3. *Environmental monitoring*

All areas where it is intended to house general collections of geological specimens should receive occasional temperature and relative humidity checking. Where important collections and known vulnerable specimens are stored or exhibited, continuing monitoring is advisable. In particular, data on rh should be reliable and the use of adequate equipment by appropriately trained operators is necessary. Humidity sensors of the hair-hygrometer or electronic (resistivity or capicitance) type are better than those of the coiled paper or colourimetric paper strip type. Calibration of the hair-hygrometer types should be carried out every few months using a wet and dry whirling or Masons hygrometer; electronic types generally require the manufacturer to recalibrate and paper types cannot be recalibrated. Chart recording thermo-hydrographs based on weekly or monthly change are adequate. Special alarms may be fitted to give warning that pre-determined high or low thresholds of rh are being exceeded.

Where the installation of an air-conditioning system is being considered, the selection of a system to meet your requirements of temperature, rh and pollution control should be undertaken with the specialist advice of an appropriate consulting engineer.

2.5. PACKING AND TRANSPORT

The key to packing specimens is to ensure that they are firm and unable to move within any layer of their packing. Failure to prevent vibration and movement of specimens against one another or hard surfaces is the cause of most damage to material in transit. Specimens should never be sent loose within a container however well that container is packed. The best method of packing gives three-layer protection: soft inner coccoon; rigid box for impact resistance; soft outer wrap as shock-absorber and weather-proofer (see Stolow 1981).

Individual specimens should be wrapped in soft lint-free tissue or cellulose wadding (not cotton wool, see A2.1.2.2) and packed firmly into rigid containers, either as individuals or in groups, using crushed paper or cotton wadding to provide resilience between individuals. These containers should be wrapped in the outer protective container with similar firmness. Polyether foam or expanded polystyrene chips are good at this stage. Outer wrappings should be at least shower-proof and tied with twine as well as adhesive strips at all margins of the wrapping paper. Bubble-lined outer wrapping material is particularly good in providing both moisture-resistance and impact protection. Particularly if being sent overseas, ensure that all labelling of both sender and addressee, is clear, and if possible use on at least one label and language of the recipient country.

The packing of large vertebrate specimens requires special techniques of support and crating, and advice should be sought from a major museum. Large blocks of rock, for later laboratory treatment, can be sent by surface transport wrapped in sacking, having first removed sharp corners or spikes of rock most likely to cut the sacking. Label and number each block within a consignment both on the block and the wrapping.

There is no entirely sure way of transporting material over long distances. Transport by hand is probably the safest, and might be considered as the only way of sending delicate or type specimens to another institution. Sheets of foam rubber, cut to fit into a rigid small case, protect specimens well, provided they are packed firmly within their own containers (Silicified fossils, see C3.7.5). The increasing number of courier or security services might be considered for important material since there is a poor record of loss or damage to parcels in the postal services of some countries. The merits of recorded and registerd postal services are questioned since the monetary value of a specimen, stated on the parcel, may render it at greater risk from theft, but an insurance value, based upon a realistic costing of the acquisition of a similar specimen may go some way towards recollecting or purchasing a replacement topotypic specimen (see B4.4.8.3). Recorded delivery can provide a useful check on the arrival of postings.

The transport of large and heavy specimens by road, rail and sea requires specialised packing techniques to ensure their safety.

3. PERMANENT STORAGE

PREAMBLE

There is little that is more disheartening to anybody wanting to work on specimens than to find them in dust-laden assorted boxes. The clean, ordered storage of specimens in containers is the physical basis of a good collection. The ability to see and handle specimens easily is fundamental, and the use of suitable storage containers and logical arrangements for collections may allow them to be found and used with a minimum of descriptive indexes.

The fundamental aim of good storage design is the provision of optimum conditions for specimen conservation (details of these conditions are given in C2.4.2). Clearly, most curators are saddled with the buildings, rooms, and furniture in their museums with few opportunities to improve existing arrangements. Should these occur however then the following paragraphs should be borne in mind. (See also Stansfield 1971).

This section of the Guidelines sets out the theoretical basis for providing good storage and does not attempt to cover the myraid situations requiring special considerations. We concentrate on general aspects of storage environments, storage furniture and storage arrangements.

3.1. BUILDINGS

These should be accessible to all, from independent wheelchair users and the blind, to pregnant mothers and the old. There should be adjacent parking for the severely disabled. Access should be step-free and by single wide opening doors with, internally, an absence of no-go areas barred by steps or narrow doors (including cloakrooms and toilets). These conditions are needed by staff in transporting large specimens on trucks etc. Where standard-width doors are in normal use, extra width can usefully be made available by providing a second door or removable panel alongside to allow for the passage of extra-large materials. Where fire-regulations dictate the presence of double doors in sequence, enough space must be left between them for trollies, wheelchairs etc.

To provide safe and secure housing for geological materials, which tend to be heavy, buildings must be soundly constructed with floors built to withstand heavy loads – especially important if movable compacting units are used. Flammable materials should be minimised.

When adapting an existing building, or designing a new one, due consideration must be given to long-term needs of storage accommodation, since subsequent structural alterations are prohibitively expensive. In general terms, the most flexible arrangement is to acquire space on an open-plan basis, with maximum floor area interrupted by the minimum of barriers such as walls, partitions or steps. Ideally the building's ventilation, heating and humidity are controlled centrally by an air-conditioning plant. A filtered air supply is recommended for all museum storage as a means of eliminating dust, a potentially destructive agent for geological materials (see C2.4.2). Larger collections sometimes have to be split, with some materials being housed away from the museum. Out-station storage should fulfil all the needs of safety, access, environment control, and, if research materials are stored, an area in which it is possible to study specimens with good lighting and heating.

3.2. ROOMS

Attention must be given to the health and safety aspects of storage; ceiling heights, ventilation, temperature, relative humidity, adequate lighting (including emergency and security lighting) and the widths of passages (including aspects of fire regulations).

Rooms containing specimens, books or archive materials should not be subject to temperature or humidity fluctuations, as these cause damage even leading to loss (see C2.4.1). Commonly old buildings with thick walls provide better insulation and are subject to less fluctuation then some modern buildings lacking specific environmental control. Avoid the use of through-routes as storage areas, since these are difficult to control for security or environmental conditions.

3.3. STORAGE UNITS

3.3.1. Principles

The availability of security and environmental control in the building, its rooms and in storage areas will influence the type of storage units used. A secure, air-conditioned building need have less well insulated units, but a breakdown in the air conditioning may have dire results upon the materials in store if they are in poor quality units.

Both the nature of the geological materials and their uses will dictate the choice of storage. Mobile racking systems provide solutions to the storage of large collections in a small space, provided that the floor loadings will accept the extra weight. While expensive to instal, they utilise space very efficiently.

Remember the need to trasport large specimens on trucks or trolleys. Place heavy material where it can be handled safely. Pallets and small hand-operated fork-lifts are useful in handling heavy objects.

Special storage arrangements should be made for particularly important materials, including specimens (type and figured) and archives. Recommendations exist (e.g. Bruton 1979; Torrens 1974; Bassett *et al.* 1979; Embrey & Hey 1970 etc.) for the separate storage of type specimens in secure accommodation, a concept accepted by many museums. Some large institutions however may find this practice unweildy. See also C3.5.3.

3.3.2. Choice of material

When designing storage units from scratch or selecting a ready-made storage system, it is important to consider the kind of material of which the unit is constructed. In practice the choice will be between wood, metal or plastics. A simple comparison of the merits of these materials shows wood to be a clear leader:

	Vibration resistance	Thermal insulation	Tensile strength	Anti-static	Non-flammability	Protection against fire	inertness	Noise
Wood	√	√	√	√	○	√	√ or ○	√
Metal	○	○	√	○	√	○	√	○
Plastics	○	○	○	○	○	○	√ or ○	√

√ = good acceptable
○ = poor to unacceptable

The fire resistance of wood can be improved significantly by painting the exterior of cabinets with fire-resistant solution (the local fire-prevention office can advice). The major variable with timber is inertness, both physically and chemically. It is vital that fully seasoned and dried wood be used, and that it be maintained at a relative humidity of between 50% and 55%, otherwise dessication or hydration will cause warping and distortion of drawers. Timbers such as oak and birch should be avoided since their high acid content will result in the direct damage of specimens and paper documentation. Ideally one of the imported mahogany timbers, with acceptable pH, should be used. (See also C2.4.1.3.)

3.3.3. Design of units

In principle try to provide storage units including flexibility both in the style of storage (i.e. shelves, drawers, etc.) and in the variety of drawer or shelf depths. Ideally drawers of different sizes, suited to the specimens contained, should be interchangeable with no structural alteration, so as to allow for additions and changes in the order of the collections without loss of storage space. Such a system requires careful design, but several systems are in use which approach this

Fig. 12. Purpose-built palaeontological storage units with their outer casings removed to show, on the left, drawers which may be 60 mm, 90 mm or 120 mm deep. On the right are pull-out narrow shelves on which heavy specimens can be stored on their supports.

ideal (e.g. BM(NH) London; Nat. Mus. Wales, Cardiff; Oxford University Museum).

Vibration from the movement of drawers is one of the main hazards to specimens so construction of cabinets, etc. must be to a sufficiently high standard to ensure the smooth running of drawers. Quality timber and good construction normally lead to satisfactory results. Unlike materials, such as wooden drawers on metal runners, can give good results, although differential wear can cause problems which are diminished if the metal runners are coated with plastic, such as polythene. Sticking drawers can be eased by rubbing the stub of a candle on the running surfaces.

Open or closed shelving or drawer units which are mounted on rails ('roller racking') and can be manually or mechanically moved sideways, so as to fit close

Fig. 13. Purpose-built shelving for vertebrate fossils. The specimens are supported in a variety of ways to reduce the risk of breakage. On shelf 1 the skull is partially cocooned by quick setting foam, providing good support. On shelf 2 skulls are set on boards and supported by metal wires and suitably sized cut block of foam. On shelf 3 boards, plaster and metal wires are used, while on shelf 4 timber supports are used alone.

to each other, save a great deal of space. Several manufacturers produce these compactable units and, while they require very strong floors, they can provide excellent high-density bulk storage, such as for non-accessioned specimens from the field or those held for disposal. These systems may provide good security if the units can be locked on their tracks. A disadvantage is that they may be prone to vibration when moved and thus may damage delicate materials if inadequately packed.

3.4. SPECIMEN TRAYS

Individual, or essentially identical specimens with their data, should be kept in individual boxes or trays, stored in drawers or on shelving, so as to prevent abrasion or mixing of the specimens. Boxes or trays should be packed in drawers leaving no spaces, thus preventing sliding as the drawers are opened or shut; unused upturned trays can be used to fill gaps. Trays should be deep enough to be lidded, in dusty atmospheres, or to prevent specimens from 'jumping' out.

Trays and boxes are commonly of cardboard or plastic. The former is better in most conditions, other than the undesirable condition of dampness: Card trays which are paper lined can be purchased in colours, which may be helpful in the arrangement of specimens in the collections, or in their identification e.g. type or figured specimens in differently coloured boxes. Acid-free boards and papers should be used in the construction of trays or boxes. Specimens too large for boxing should have labels tied to them and placed on polyurethane foam sheeting on shelves. Some large specimens may need extra support by special bracing, e.g. cut foam blocks, semi-cocooning in poured urethane foam, timber or plaster work. Care must be taken if supporting with a closed-cell foam or with plaster, lest moisture be trapped against the specimen causing deterioration. Specimens supported by coccooning should be inspected regularly for support or specimen damage. Other specimens, such as microfossils, sea-floor sediments, cores, meteorites or delicate silicified specimens are unsuitable for open trays and require special storage (see C3.7). Specimens within trays or on shelves may be kept in ventilated polythene bags, which, if closed using a resealable strip or simply by folded over, give good protection from dust.

Small specimens, of a few mm in diameter, can be kept in cavity slides or in small glass or plastic bottles or vials. These should be capped and loosely packed with lint-free cellulose wadding (not cotton-wool – A2.1.2.2) to minimise movement of the specimens. Bottles or vials should be kept in trays with the labelling, the containers being marked as if the specimens. The labels with unmarked specimens should always include a note of the number of specimens in each container, for collection checking purposes.

3.5. STORAGE ORGANIZATION

PREAMBLE

It is the responsibility of the curator to ensure that every specimen in the collection is worthy of its place. The maintenance of museum collections requires a considerable commitment from the owning authority in the provision of curatorial and technical support and facilities, of appropriate furniture, and of space, ideally with a measure of environmental control. The cost of this basic resource is such that all retained specimens should meet the criteria of the institution's acquisition and collections management policy (see A1 and B6.2.2).

3.5.1. Arrangement of collections

There are no hard-and-fast rules on the arrangement of geological collections except that any system employed should be appropriate to the collection, completely understood by the curator responsible for the material (whether or not a trained geologist), and convenient to him and other users. This may appear to be an 'anarchist's charter', but examination of the extremes of collection type illustrate the need for a flexible approach.

In the case of collections consisting of only a few hundreds of specimens it is unlikely that the diversity of specimen type will be such as to justify an elaborate arrangement, and simply sorting into rocks, fossils, and minerals may suffice. At the other end of the spectrum, however, there are very large and highly specialized collections being actively worked by curators who may be authorities in their field. In these circumstances, where taxonomic research is continuous and energetic, to confine the arrangement of material to a fixed classification would appear almost to be a limitation on the progress of science. However, curators in this position should be alert to the problems that their work could pose to their successors and always publish findings or, at least, leave full manuscript accounts of work in progress.

The most useful starting point in establishing any new system of arrangement is an analysis of the use of the collection, which should not simply take account of past and present use but of potential use also. For example, it may be that most enquiries for minerals in a particular institution take the form of requests for the loan of a single, or small groups of cited, figured or similar 'status' material but that a handful of requests on a regular basis from, say, gemmologists, jewellers or lecturers demonstrating material for specialist courses will require the handling of hundreds of specimens exhibiting crystal systems, and evident crystal morphology. In these circumstances where the greatest volume of work centres on a few enquiries there may well be practical advantages in an arrangement where, say the crystal system is prominent or paramount.

In this analysis, curators' use of their institution's collections should not be overlooked since many employ them for reference and comparative purposes. Routine identifications of specimens for the public involving direct use of the collection could well be its major use, although identification enquiries are not immediately seen as a demand on the collection.

Most curators cannot hope to be fully conversant with developments in every field affecting geological specimens and ultimately most seek some existing classification as a basis for the arrangement once they have determined the commonest uses. The manner of arrangement of specimens in the collection may reflect a classification such as discussed in section B4.4.1.

For fossils we strongly recommend the use of a stratigraphic classification (see B4.4.1.1(3)) as the primary basis for arrangement of all but the most specialised collections. Where the collections are large they may merit further division using appropriate stratigraphic subdivisions (e.g. for the Jurassic (middle): Great

Oolite; Inferior Oolite etc.). Where large numbers of specimens are still to be found in the finest of these sub-divisions, they should be sorted on a taxonomic basis: thus all ammonites from the Great Oolite of the Middle Jurassic would be stored together.

For the arrangement of minerals we recommend Hey's Index (Hey 1955) as described in section B4.4.1.2.

The organisation of rock storage can be problematical, reflecting the difficulties of classification expressed in B4.4.1.3. Most museums have small collections, and the storage of individual species (granites, syenites, limestones, gneisses) within an igneous, metamorphic and sedimentary framework is usually quite adequate. Other additional arrangements may be required according to circumstances: a locality-based collection (for the immediate vicinity); a chronological collection (for complex terrains); a display and/or teaching collection; a 'structures' collection (for folds, lineations, textures etc.). Larger rock collections may require arrangements based on counties or countries. As with other collections, however, the physical arrangement of a rock collection may be insufficient to satisfy the more sophisticated enquiries and thoroughly cross-referenced indexing, using appropriate classifications, is the key to answering such enquiries.

3.5.2. Collections within the collection

A problem commonly met in arrangement is whether or not to disperse a particular named collection into the general collection. There are no firm rules in these cases and curatorial judgement is important. The freedom of the curator to use his judgement may be constrained by the conditions under which such a collection was presented to the museum. A collection should be maintained as such if it has a strong identity or integrity, represents a fine collection of its kind, has particularly extensive associated documentation, or is one of special historical significance. The individual parts, however, of such a collection, must be documented separately.

It is perhaps worth stressing here that we are reaching a point in curatorial practice where, regardless of which arrangement is adopted, if the data for well documented collections are stored in computer files, the rapid retrieval of collections or ordering of data according to any system embraced in documentation concepts will always be possible (see also B4.4.5.1 and B4.5). In such circumstances it may prove more useful to disperse items from a collection, knowing that they can be reassembled from the stored data.

3.5.3. 'Status' material

Museums with large numbers of type and figured specimens may wish to consider storing them separately from the main collection. The main arguments in support of this practice are the meeting of the requirements of the International Commissions on nomenclature (see also E2.4), the convenient access it allows, the additional protection against fire, water, theft, etc. that a higher grade of storage furniture may afford, and their ready access for evacuation in an emergency. There are two major disadvantages: first that they could be overlooked by researchers working through the systematic collections, although there are simple means of countering this possibility, and secondly the total loss of all of these specimens in the event of a disaster affecting the storage location. This latter risk can be mitigated by the application of especially stringent measures to safeguared type collections such as fire-resistant cabinets, high security locks etc.

3.5.4. Postscript

Whatever method of arrangement is adopted within geological collections, there is an obligation of the curator to manage it efficiently, and to ensure that a full description of it is available for all users, and his curatorial successors.

3.6. SECURITY OF COLLECTIONS AND RELATED DOCUMENTATION

PREAMBLE
The security of collections and records includes the prevention of damage or loss by theft, vandalism, fire, flood, environmental failure (e.g. air-conditioning breakdown) and human or natural catastrophe during storage, transit, study or processing and exhibition. A fundamental precaution is the maintenance of duplicate documentation (e.g. accession records) on separate premises. Detailed coverage of security measures applicable in museums is contained in Johnson & Horgan (1979), to which those involved are referred, as this section gives only a bare outline.

3.6.1. The risks

Even in store, geological material is at risk from theft, failure of environmental control equipment, flood and fire. These risks can be minimised by taking the standard precautions such as the use of locking fire-resistant cabinets (particularly for rare and valuable materials) and more generally by ensuring that buildings are well maintained, sound and secure. It is important periodically to inspect all storage areas, giving particular attention to those which are more isolated. Various security measures can be adopted which warn against fire (smoke detectors, alarms), flood (alarms) and theft (intruder alarms and monitors). Security advice is available from local police (Crime Prevention Officer) or fire service (Fire Prevention Officer) or from the National Museum Security Adviser (Appendix 2B).

3.6.2. Theft

Loss through theft can be minimised by restricting and controlling access to collections and ensuring that all visitors are supervised unless they are known and trusted. Certain types of material such as gems and other collectable or valuable objects may require special protection whether in store or on display. In general it is prefereable to provide a good physical barrier against theft than to install surveillance equipment which may detect or deter rather than prevent theft.

3.6.3. Flood

Flood damage is best avoided by locating stores away from water and waste pipes and not in basements. In areas known to be at risk, raise cabinets on suitable plinths to give a margin of safety. Effective building maintenance, especially of gutters, drainpipes and damp-proof courses is a necessity.

3.6.4. Fire

Fire precautions in museums are governed by statutory fire regulations, though these are designed principally to safeguard people rather than the fabric or content of the building. Fire extinguishers are specific to particular types of fire and so advice must be sought for particular circumstances. In addition to your local fire officer or Fire Brigade, the Fire Protection Association can provide literature or advice on procedures. The National Fire Protection Association of Boston, USA has published a book on the protection of museum collections. It is necessary to test and maintain all fire-fighting and fire-detection equipment at frequent and regular intervals. Staff should be trained in the proper use of fire-fighting equipment and in evacuation procedures. Liaison with the local fire station may, in the event of fire, reduce damage from water drenching which can cause as much loss to museum collections as the fire itself.

3.6.5. Material in transit

Security for material in transit is dealt with in section C2.5. However, consideration should be given to protecting original material by sending replicas, copies or photographs in their place. This may have to be considered particularly for type and figured specimens, and for rare or fragile material.

3.7. SPECIAL STORAGE

Some geological specimens present unusual problems in storage. Many minerals are unstable at room temperatures and pressures (Waller 1980) while others may be hazardous (see D2). We deal briefly here with meteorites, sea-bed samples, cores, thin-sections and silicified fossils.

3.7.1. Meteorites

- For scientific purposes, they should be stored in conditions as free from terrestrial contamination as possible.
- The presence of abundant metallic iron in meteorite renders them susceptible to rusting. The rust problem usually increasing with the abundance of metallic iron.
- Meteorites have a market value. Like gemstones, meteorite storage should be secure.

To combat both contamination and rusting, meteorites should be stored, as far as is possible, in dry, dust-free, anaerobic conditions. Samples should be stored in sealed, or glass-topped drawers in locked cabinets (preferably fireproof).

Stony meteorites should be doubly bagged in polythene (one inside the other) and sealed or tied.

Stony-iron and iron meteorites with a high percentage of metallic iron should be enclosed in two individually sealed polythene bags (one inside the other). The inner bag (containing the meteorite) should be vacuum packed, to remove all air, or should contain a tube of dessicant such as silica gel. If rusting persists, the silica gel and packaging should be changed at regular intervals.

Certain components of stony meteorites are prone to decay caused by temperature-related solid-state reactions. In order to guard against such changes in freshly fallen stony meteorites a fragment should be kept refrigerated in cold storage. To avoid contamination of research material these meteorites are broken, not cut.

3.7.2. Sea-bed samples

3.7.2.1. *Grab, dredge and scoop samples*

The special problems of curating soft sea-bed samples arise from two important requirements:

- The sample must be maintained in a hydrated condition,
- The sample must be kept free from contamination (by air-borne pollen etc).

The following procedures are recommended:

- Samples should be stored in air-tight 'Kilner' type jars, the rubber washers being replaced when they show signs of perishing.
- Jars should be clearly labelled with sample locality (coordinates as latitude and longitude) depth, date of collection, name of ship, method of collection, brief description of the deposit.
- Labels should be typed or written in waterproof ink, glued to the bottom with non-water soluble glue. If wet, nothing should be placed in the bottle with the sample.
- Bottles should be stored in cupboards or on shelving in a dust-free environment.
- Each sample should be accessioned in the normal way and stored in numerical order. In addition, numbering and storage systems based on units of 10° latitude and longitude may be found helpful if large numbers of samples are involved.

3.7.2.2. *Cored samples*

The special requirements for cored sea-bed samples are:

- Depth and way-up data must be recorded and kept with the sample.
- The sample must be kept free from contamination.
- Soft materials should be kept in a hydrated condition.

With soft cores, it is recommended that:

- they be cut as soon as possible (to avoid movement of sediments) into lengths about 10 cm long, using a wire cheesecutter.

- each length be cut into at least two sections lengthwise, one for research and one for reference/storage, and that each section be placed in polythene bags in horizontal, sealed storage jars, labelled as for sea-bed samples above.

With hard cores the same problems of keeping depth and way-up data with the cores, and of keeping the cores correctly orientated, exist as with soft cores. Label and store as for soft-cores. Cut and section as for land rock cores, avoiding contamination of sections by dust, if cut while dry.

3.7.3. Land rock cores

Large collections of bore-hole material are stored by the British Geological Survey which has statutory responsibilities in this area of work, although small collections are commonly found in museums. Rock cores are heavy and should be stored in stoutly made wooden trays, made to hold the cores neatly. Curation, labelling and care about orientation apply as for the previous paragraphs. Special rock-cutting equipment is needed to section these cores. (See Pettigrew, (1982 for 1981) for simple display technique).

3.7.4. Thin-sections and micromounts

Thin-sections are used, in conjunction with a polarising microscope, for studying geological specimens, meteorites and archaeological artifacts made from stone, pottery or furnace slag. Polished thin sections are required for making analyses of minerals with the electron microprobe. Micromounts are used to contain a variety of small geological specimens including microfossils, mineral grains etc., and may be made of glass, metal, card or plastic.

Mounts of all kinds are easily broken and should not be kept in the same tray as the specimen from which they were cut. Specially constructed cabinets containing shallow, compartmentalised, felt-lined drawers may be purchased, and range from large cabinets of over 100 drawers, each capable of housing more than 50 slides to more modest cabinets of a dozen or so drawers holding perhaps 20 or 30 slides per drawer. On a smaller scale, boxes are available of wood or cardboard construction in which the slides are held in vertical slots, while in another type, the slides lie in cardboard trays with flaps to hold them firmly, and the trays are stacked tighly in a box, usually of cardboard. For further details see Appendix 2 and the catalogues of some laboratory suppliers and geological specimen dealers.

Polished thin sections for electron microprobe work are usually smaller than normal thin sections, so that the cabinets and boxes described above are not so suitable. These sections are easily scratched and should be kept in small envelopes of cellophane or paper. These may be stored either lying flat in cabinets or boxes of the type described above, or on edge in a small filing cabinet of the type used for card indexes.

Thin sections and mounts should be clearly labelled with a number corresponding to, or cross-referenced with, that of the specimen from which it was made together with details of rock type, species etc. and locality. Some glass slides are frosted on one side so that such details can be written onto them directly with pencil or pen, but the most satisfactory and usual procedure is for a paper label to be glued to each end of the top surface of the slide, care being taken not to obscure the sectioned material. By the same token, the specimen label (and all other documentation) accompanying the original specimen from which the section or mount was made should indicate clearly the existence and location of the slide.

Polished sections pose a greater problem as they are normally too small for a paper label to be attached. The accession number should be carefully scratched into the glass, using a diamond-tipped stylus, and this number, together with other relevant information, written onto the envelope in which the section is kept.

3.7.5. Silicified fossils

These, when developed from the rock, are very fragile and require special treatment. Depending upon the quantity and nature of the specimens, the technical expertise of staff and the availability of materials, the specimens may be hardened or supported (see C2.2.1.2) to reduce the likelihood of breakage. Storage should be in lidded boxes with the specimens resting on cellulose wadding covered with soft tissue next to the specimen, to prevent fibres from catching in the silica. If the specimens are to be moved, a second soft tissue, with a large upturned flap to grasp, should cover them, followed by more cellulose wadding. Specimen labels should not rest directly above specimens, since in lifting off the label the specimen may be broken. They should either be placed down the side of the box or fixed to the outside surface.

Smooth running drawers should be used to prevent jarring and they should be marked to show that they contain fragile specimens (see C3.3.3).

Visitors must be instructed not to handle silicified specimens, except under supervision. Commonly, it is impossible to mark individuals, so boxing and labelling with data are especially important.

Transport of particularly fragile specimens may be made safer by partially setting individuals in paraffin wax or by placing in small jars of glycerine solution. Generally, it is recommended not to send such specimens, other than by hand.

3.8. ARCHIVES

PREAMBLE

Archives may be defined as papers, or records, regardless of their physical form, which accumulate over a period of time in any organisation whether a major institutions or a family. In museums these records commonly contain information of value and may have been accumulated over the years by individuals who may or may not have been staff members. (For further reading use Schellenburg 1956; 1965.)

The Public Records Act of 1958 and 1967 lay down regulations for archives of all institutions funded by central government. The same or amended versions of the Acts are followed by many local authorities in dealing with their archives. In a nutshell the regulations are tied to the 30 year rule of access to documents and work in the following way:

- Papers covering a particular project are filed together.

- Five years after the closure of the file (i.e. after the end of the project) the whole file is reviewed for relevance and may be discarded; the review normally being done by the people who generated the file.
- If retained, the file is kept for 25 years after its opening date and reviewed with the involvement of an archivist. The whole file may be discarded at this stage.
- If retained, the file becomes a public record archive, and it will be about 30 years old, and must remain intact in perpetuity.

A basic principle is that files are kept complete or not at all. The pruning of files is bad practice for all sorts of reasons, leading to incomplete archives.

In this section the Guidelines covers 'Papers' (C3.8.1), in which are included books, true archives and manuscripts, maps and prints, and 'Photographic Materials' (C3.8.2).

Advice and information can be obtained from (full addresses in Appendix 2B):

- British Library, Reference Division;
- Public Record Office,
- India Office Library and Records,
- any County or City Records Office,
- Eastman Kodak Co., for storage and preservation of microfilm or other film.

3.8.1. Papers

Most collections of geological specimens will have with them, or in time will gather about them, related collections of books, archives (both official and private), maps, film and, nowadays, even video and optical discs. Many of these records will be valuable and call for special, often expert, attention. Since this is a subject which tends to lie either outside or on the fringe of curatorial expertise (despite its importance) we treat it more fully than some sections.

The ideal climatic conditions in which to store books and documents are a steady temperature between 13°C (55°F) and 18°C (65°F) and a steady relative humidity between 55% and 65% (it may be as low as 50% if parchment or vellum is not present). There should also be constant air circulation. Such conditions are rarely attainable and it is often necessary to find a good compromise between what is needed and what can be achieved with the resources available. In the storage and use of books and documents the following points should be borne in mind:

- What books and documents are made of and how intrinscially they are liable to deteriorate. Some papers contain residual chemicals from the manufacturing process (such as alum), or unstable components of the raw material (such as lignin), which will make those papers prone to rapid deterioration.
- What the enemies of the materials are in terms of:
  - (a) Physical and mechanical damage, e.g. when a book is dropped, not propertly supported, or wrongly removed from the shelf. Physical damage will also result from an excessively dry atmosphere, e.g. parchment will cockle, the covers of a book will curve or warp and paper will become brittle.
  - (b) Biological enemies e.g. insects, micro-organisms (many of which like

mould, fungi or bacteria, fluorish in damp conditions), animals, including rats, mice, bats and even cats if they are shut up in a document or book store, and not least, people.

(c) Chemical damage. The chemicals most damaging to books and documents are the acids which may be present in a polluted atmosphere (see C2.4.1.3) in particular, sulphuric acid. It is strongly absorbed by lignin and therefore books made from mechanical wood-pulp paper will show a pronounced brown border to the paper. It should be remembered, however, that with many papers deterioration can be very far advanced before it is apparent. It would be desirable to deacidify all potentially acid papers but some processes are both costly and time consuming. Other approaches are being investigated. Alum, used in paper making, since it is an acid, attacks the cellulose breaking down long molecules, weakening the fibre and thus weakening the paper.

(d) Photo-chemical damage. Light can also be regarded as a form of chemical damage. The most dramatic effect of light is that colours will fade, bindings of books and inks both being especially susceptible. Serious damage can be done, for instance, to prints and drawings left too long or unprotected on exhibition. The ultra violet light should be screened and not only in exhibition show cases but in normal book storage where a high level of light is unavoidable e.g. in offices or other working areas.

- How to aim for ideal conditions (particularly through environmental control) and how to minimise everyday neglect and rough treatment. The effects of too high temperatures and relative humidities on library materials can be startling. For example, an increase in temperature of even 5°C can more than double the rate of deterioration. At high humidities moulds and bacteria will flourish and foxing (brown spotting) will frequently occur when the relative humidity is around 75%. High humidities also cause softening of adhesives and therefore damage to bindings. Library materials will also suffer, in large cities – particularly, from greasy dust and dirt which, for instance, infiltrates the pages of books.

3.8.1.1. *Books*

In a clean atmosphere, storage on open (preferably wood) shelves in a cool temperature will usually be sufficient. French-polished mahogany is recommended as being acid-free. In a very polluted atmosphere closed cases should be considered, with wooden rather than glass doors, and in any atmosphere books should be kept away from sunlight or other bright light. Valuable or fragile books often require special storage, and expert opinion should be sought. Very large books should be laid flat on their sides.

Books should not be removed from the shelf by pulling on the top headband. The books either side can be pushed in slightly and the required volume then removed carefully by the centre of the spine.

Books should not be placed face down when open, nor should one open book be placed on top of another open book. Care should also be taken not to lean on open books since this may break the binding. (See Baynes-Cope 1981, Cave 1976, and the Libraries Association 1972).

3.8.1.2. *Manuscripts and archives*

These, by their nature, are more varied and complex than books, presenting greater storage problems and difficulty in establishing hard and fast recommendations.

Documents that are foolscap, or half or twice that size, may be placed in boxes, or made up into parcels. Boxes must be strong and made of good quality board of low acidity. If wrapped in a parcel, acid free paper and boards must be used and the paper tied with tape (Government-issue white cotton tape) not string, and never rubber bands. Should a collection contain parchment or vellum, expert opinion must be sought.

Large documents can be kept in specially made flat boxes (lined with good quality paper applied with acid-free paste) or in wooden map or plan cases. Large documents should not be folded, but if there is absolutely no alternative use a few folds as possible, do not cross fold, and never fold through anything of importance.

Manuscripts and archives must not be annotated directly. The component parts of archival series must not be separated nor should they be re-ordered for the convenience of current users or research. Manuscript collections relating to one individual should not be broken up or separated along 'subject' lines. (Advice on the proper listing of archive series can be obtained from the Public Record Office, County or City Records Offices. For the treatment of both archives and manuscripts see Jenkinson 1966, Schellenberg 1965 and Taylor 1980. The British Standards Institution (1977) also makes recommendations on storage.)

Original material should not be lent – a copy can be made if the item is sufficiently robust. Copies should also be made for everyday use of material much in demand. Manuscripts or books should not be interleaved with newspaper cuttings, since newsprint is highly acid and the acidity will migrate and spoil adjacent paper.

3.8.1.3. *Maps and prints*

Special storage furniture for maps is still relatively new but already many containers are on the market. (See Nichols 1982 and Larsgaard 1978).

Maps vary greatly in size, format, age and purpose, and consequently may be stored in different ways. For most maps drawers or horizontal storage probably provides better protection than vertical storage, since hung maps can bend or curl and the scale can distort. However, horizontal filing can create problems in handling and it is important that good equipment is used. The face and character of the map, in particular of engraved and manuscript maps, must be preserved. One way of ensuring this is to keep a number of related maps in a folder, each map being guarded along one edge which is sewn into the folder. The friction on the surface of each map is thus reduced to a minimum.

For modern maps which may come out in series or a number of editions, or which are easily replaced, it is perfectly acceptable (and more economical) to keep the maps stacked in drawers or to use a vertical suspension type of filing. The latter has the advantage of providing ease of accessibility to single sheets. (For maps in series which may be subjected to heavy use it is important to establish the whereabouts of a permanent reference set.) Working copies of maps (e.g. those used in the field) may be protected by plastic laminate.

The storage of large maps not fitting into available drawers must be given special attention and care. They may be folded once or even twice but not cross-folded since the map is likely to break at the cross fold. As with manuscripts, the fold should not be through anything of importance. Maps that have been folded should never be rolled. Maps that have always been rolled should usually be kept so, since flattening frequently causes them to crack at intervals. Large flat maps that cannot be folded should be rolled round the outside of a strong cardboard tube, covered by good quality paper, and then protected by an outer layer. Prints, of course, should never be folded. Specialist advice is obtainable from the British Museum, Department Prints and Drawings, or the India Office Library & Records Department.

3.8.1.4. *Repair*

The repair of books, manuscripts, archives, maps, prints and drawings is something which cannot and should not be carried out without special knowledge, skill and training. When in doubt seek advice (see Preamble to C3.8).

Geological collections commonly contain maps, so it is worth mentioning two points. Maps before 1850 (i.e. before the introduction of lithography) should be traditionally repaired and not laminated. Since most maps will be on acid paper they will need to be deacidified if they are to be preserved in the long term. This should be carried out using non-aqueous deacidifying agent, since the scale will be stretched if the map is wetted. Some basic principles of general repair are:

- As far as possible replace missing material with repair materials of the same kind, e.g. paper with paper, parchment with parchment.
- Leave the nature and extent of the repair unmistakably evident.
- Never do anything which cannot be undone without damage to the original material, e.g. do not use self-adhesive tapes on anything, because it is a non-reversible process and they are damaging to many materials.

The following provide both interesting and useful information on repair work:

B.S.I. BS 4971 1973; the journal 'Restaurator'; Plumbe (1964) and Cunha (1971) (in which see particularly p. 241 of Vol. I where Roger Ellis's '. . .principles of archive repairs. . .' are reproduced).

3.8.1.5. *Binding*

For the binding of books see Horton (1969) and Middleton (1972). For other material, such as runs of journals etc., advice can be obtained from the major museums or the British Library or suitable binding firms such as Dunn and Wilson.

3.8.2. Photographic materials

Photographic materials including netatives, various types of prints, transparencies and other forms of copy such as microfilms, fiche and photocopies, will all deteriorate with time and so present problems of storage and conservation. There is no clear official distinction between archival and non-archival materials so we recommend that the criterion of repeatability be applied. Thus special care should be taken of prints with no original negatives and also of negatives or transparencies of subjects no longer available for rephotography. It is good practice to make copy negatives of unique prints from which working prints can be made.

3.8.2.1. *Storage*

The storage criteria for black and white safety film (including microfilm, silver-gelatin on cellulose or polyester base), have been defined by the American National Standards Institute (1979) while the preservation of colour film and transparencies is covered by Eastman Kodak publications (1979, 1980). Spontaneously flammable materials like cellulose nitrate ('celluloid') film require special storage. See also Swann (1981). The following general points will help lower the rate of deterioration:

- avoid direct handling
- only use acid free materials and Japanese tissue for mounting and storage,
- store in the dark in clean, dry, non-polluted conditions, free from the fumes of paints, preservatives etc.
- maintain a temperature below 20°C and rh at levels between 30% and 50%,
- do not stack old prints.
- for long-term storage of colour transparencies maintain a temperature of 0°C and rh levels between 25% and 30%.
- avoid mounting transparencies between glass plates.

3.8.2.2. *Film cleaners*

Proprietary film cleaners can damage some photographic materials, including transparencies, and should be used with the utmost care. Similarly a specialist photographic conservator should be used for any repair etc. to damaged old prints or negatives. Advice on the care of photographs is found in Collins & Young (1977), Collins (1983) and Weinstein & Booth (1977).

Mircofilm and microfiche/fiche storage procedures are described by manufacturers or suppliers and their instructions should be followed. In general, avoid touching surfaces other than by provided finger-grip and do not expose to intense light or chemicals.

3.8.2.3. *Photocopying*

Photocopying has become a relatively inexpensive and simple method for collecting data from specimen labels, archival works, and even specimens.

Several types of photocopy systems are in use, and most are not intended to give copy of permanent or even semi-permanent quality (see Swartzburg 1980 and Sung 1982). The durability of photocopies depends upon several factors, but two are of special importance. First the quality of the paper used in the copier (Atlantis Paper Co. produces an archival quality photocopy paper), secondly the proper functioning of the copier. Most modern copiers produce a relatively stable image; the wet-tone copiers (using a quick-drying 'ink') are perhaps better in this respect than the dry-tone copiers (e.g. Xerox) which must operate at high temperatures in order to fix the images. Theoretically, if quality acid-free paper is used and the copies are kept in suitable conditions for books, the copies should last very well – but there is no long term experience of this! Photocopies should be stored away from light and where feasible, should be freshly copied periodically.

The National Reprographic Centre for Documentation can offer advice. The copyright situation for photocopies remains unclear. Copies from books of more than 50 years old can be made freely. Otherwise whole copies, especially for general use, can only be made after gaining the permission of the copyright holder (see Aslib 1984).

D. OCCUPATIONAL HAZARDS

D. OCCUPATIONAL HAZARDS

SUMMARY AND RECOMMENDATIONS

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OCCUPATIONAL HAZARDS: SUMMARY AND RECOMMENDATIONS

Museum safety

D1.1. Be aware of Health and Safety legislation and of local organisations concerned with safety and prevention of accidents at work.
Remember that your collections may include large, heavy and physically dangerous materials requiring special techniques or equipment to handle.

D1.1.2. Be aware of the dangers resulting from noisy equipment etc. Try to eliminate, or provide ear protection.

D1.1.3. Be aware of the dangers resulting from dusts or chemicals and vapours,
D1.1.4. and where necessary use fume cupboards and extraction equipment.
Good housekeeping and tidy practice helps to prevent accidents, as do suitable levels of illumination and the provision of adequate lifting and handling equipment and protective clothing.

Hazards from specimens

D2.1. Hazards from Museum specimens containing radioactive minerals are not normally high and simple measures provide protection.
Potentially dangerous minerals are listed; D2.2.4 for radioactivity; D2.2.1.1 for toxicity.
Hazards from specimens can be reduced considerably by simply wearing protective clothing, including rubber gloves, and routine washing.
When in any doubt about the safety of specimens have them checked by experts and, if necessary, provide continuous monitoring.

D. OCCUPATIONAL HAZARDS

PREAMBLE

With the normal range of responsibilities of a geological curator there are a number of hazards. Failure to acquaint oneself with the inherently dangerous properties of all the materials handled in the museum, to foresee those situations where risk of injury is likely, or to observe the simple rules of safety could lead to substantial damage to property and person. Current health and safety legislation to some extent controls those aspects of a work environment which are the responsibility of employers and stresses the requirement for the employee's individual responsibility for safety in the workplace. This part aims to cover the major area of general safety (D1) radioactivity (D2.1) toxic materials (D2.2) and physically dangerous materials (D2.2.2).

1. MUSEUM SAFETY

Accidents to people are mostly restricted to physical damage resulting from falls, dropping heavy objects or strains in consequence of attempting to lift something incorrectly or which is too heavy. Many of these accidents could be avoided by care and attention to the various recommendations of the Back Pain Association (for lifting), the Health and Safety Commission or Local Environmental Health committees.

There is a great variety of special handling and lifting equipment available on the market and by planning storage with such equipment in mind it is possible to eliminate the need to lift heavy objects by hand. It has to be remembered that certain equipment needs to be certificated at regular intervals by local councils, the DOE, etc. The British Standards Institute issues standards of safety for equipment.

Accidents can be reduced by adequate lighting, appropriate to the area concerned, including emergency lighting. The Illuminating Engineers Society published (e.g. 1977) specifications for lighting levels. Discipline in keeping corridors and spaces between storage units free of objects, the marking of particularly heavy objects or drawers, and the putting away of specimens into proper storage all help in reducing accidents both to people and the specimens.

1.1. HEALTH AND SAFETY LEGISLATION

The field of occupational health and safety is now so extensive that it would be inappropriate to attempt more than a brief introduction to the subject here. Extensive bibliographies on health hazards, their relevant legislation and protective equipment are readily available from a number of sources. For further information the safety officer of the local authority should be consulted, and the curator should be aware of the Safety Policy of his authority. See also the Barbour microfile and Fife & Machin (1982).

1.1.1. Safety legislation

The 'Health and Safety at Work, etc. Act 1974' deals with the safety and welfare of all those at work, the functions of the Employment Medical Advisory Service, gives regulations for the design and inspection of buildings and deals with fire regulations, radiation legislation and a host of other miscellaneous items. Part I of the Act deals with the health, safety and welfare of those at work whether employers, employees, contractors etc. and covers the control of dangerous substances used and emitted to the atmosphere. All establishments with more than five employed persons are required by law to have written or agreed Safety Policy statements. Where staff have union representation safety respresentatives should be appointed and procedures for inspecting established premises for hazards.

The Health and Safety Executive is the enforcement arm of the Health and Safety Commission and, through its inspectors, has the power to cause employers and employees to cease or modify dangerous occupations. Approved codes of practice and regulations now cover almost every hazardous activity and it is up to persons at work to be aware of these. See also the TUC Guide (1978), Jones *et al.* (1981), Bateman & Langhelt (Eds), (1978).

1.1.2. Noise

Noise-induced hearing-loss can be brought about by exposure to levels above 90 dBA (Leq) over an 8 hour day; it is progressive and may not become apparent until some time after exposure. Simple activities with grinding and cutting equipment and percussion engravers etc., can generate noise levels well in excess of this figure. Ear plugs provide good general protection against noise but improperly used may damage the ear or cause infection. Ear defenders (ear muffs), which completely cover the ears, have particular characteristics protecting against different frequencies of sound and can, therefore be satisfactory. Audiometric surveying, to check hearing loss, may be required in areas where noise is a continuous hazard. There are no official standards for ultrasonic equipment, but the Health & Safety Executive suggest that high-frequency sound can be reduced by using 6 mm perspex sheet as a cover or shield for the equipment. It is best to avoid the purchase of noisy equipment.

1.1.3. Chemical hazards

With volatile chemicals, toxic vapours, gases, etc., the removal of the hazard at source (i.e. before contact with the operator) is the best course of action. This can be achieved by the use of fume cupboards, or extraction hoods. The use of respirators is always second best. The handling of corrosives requires the utmost care and the use of goggles, gloves, etc., which must be to the correct British Standard, is advised. The use of highly toxic chemicals, scheduled poisons and carcinogens is covered by official guidelines and legislation. See also Bretherwick (1981), and for fumigants etc. the proposals of the HSC (1984) (see also C2.4.1.3).

1.1.4. Dusts

Many geological processing methods produce dust and a variety of equipment is available to remove the dangers at source. New equipment may be provided by the supplier with built in vacuum attachments; it is always worth asking.

Respiratory protection for individuals to a very high degree of efficiency is now available. A vacuum cleaner can be useful for cleaning dusty materials. It should be fitted with a microfilter to prevent dust from getting into the exhaust. 'Nilfisk' produce such machines.

1.1.5. Work-place monitoring

This activity should always be carried out by a trained operator, safety officer, occupational hygienist etc. The use of monitoring devices by inexperienced persons can lead to accidents through over-exposure.

2. HAZARDS FROM THE SPECIMENS

Hazards that arise from inherent properties of geological specimens are few, but the curator of such material should be aware of their nature and potential. These hazards are: radioactivity, chemical toxicity, and 'physical' toxicity (airborne dust and fibre particles and irritation or injury from handling some substances), and some practical advice follows. An important principle in preventing contamination of persons by specimens is cleanliness in the storage and conservation areas and the practice of hygenic working methods. Dusty or friable materials should be kept in covered containers or sealed bags, protective clothing (e.g. laboratory coats, disposable gloves) should be worn and hand-washing routine practice.

2.1. RADIOACTIVITY

Atoms of uranium break down spontaneously to form a series of lighter, 'daughter' products which also break down, ultimately to form atoms of non-radioactive lead. These breakdown steps involve the emission of alpha and beta particles – small fragments of the nucleus, and gamma rays – like X-rays but more penetrating. These emissions constitute 'ionising radiations' for which upper levels of exposure, both for staff and public, have been specified by the National Radiological Protection Board (NRPB).

If the upper level of exposure to staff (presently 7.5 μSv per hour) is exceeded, special precautions may be needed including the assignment of a 'radiation area' for the store and the need for the curator to become a 'designated' radiation worker. The upper level of exposure to the public (presently 5 μSv per hour) must not be exceeded. (See Henderson 1982; Health & Safety Executive 1976; NRPB 1973.) It cannot be stressed too highly that although the figures above are of permissible levels of exposure, the curator responsible for radioactive specimens should adopt the attitude expressed by the NRPB that "all doses of radiation should be kept as low as is reasonably possible". If in the slightest doubt, have your specimens checked for radioactivity.

Generally speaking, half-a-dozen or so specimens present a negligible risk. Dixon (1983), of the NRPB, has recently reported on geological specimens containing radioactivity and shows that, with various assumptions about the duration and nature of handling of the specimens, the radiation exposure and consequent risk is only a small fraction of the public limit.

While it may be reasonable to extrapolate these findings to moderate numbers of radioactive specimens, a curator responsible for public displays, or collections with numerous, or large, radioactive specimens, especially of uraninite (pitchblende) should take steps accurately to determine the levels of radioactivity. If proper metering is unavailable locally the NRPB should be approached for help.

Assuming that the tolerance limit values are not exceeded, the following precautions should be taken to minimise the risks from radioactive specimens.

2.1.1. Storage

The hazard from stored radioactive specimens is largely from gamma radiation, as alpha radiation is very rapidly absorbed and beta radiation relatively rapidly absorbed. At 50 cms distance a fist-sized specimen can be regarded as a point source, hence the strength of radiation is according to the inverse square law.

If consideration is given to maximise the distance between the specimens and people, and minimise the exposure time to radioactivity, a sensible storage site should be easy to locate. The ideal would be an unoccupied room with an inaccessible outside wall against which the store is sited. Always consider the occupancy of the space on the far side of the wall! Further, there should be little or no reason to visit the store except to examine the specimens. Facilities for examination, a bench say, should be kept at a sensible distance from the actual store. It can even help to put the specimens at the back of the storage drawers or cabinets. Warning notices should be fixed to the store and entrance door and it may be necessary to have a lock on the entrance door and storage unit.

Generally these simple measures will be sufficiently effective to render the use of lead shielding unnecessary. However, simple shields of a half dozen thicknesses of roofing lead may be worthwhile, especially for uraninite, the most radioactive uranium mineral. Without accurate radiation measurements, the precise effectiveness of such shields (or any other measures taken) cannot be determined.

2.1.2. Display

The range and size of specimens that can be displayed in a typical shallow desk display case (say 20 cms deep) is very restricted because even a small number of ordinary 'secondary' uranium minerals will often exceed the low radioactivity level specified for the public. Here again the inverse square law applies and specimens with greater radiation risk can be displayed in deeper cases. An accurate meter is needed to determine the exact levels of radioactivity. If the curator is in any doubt, proper measurements must be made. To display strongly radioactive specimens special methods must be used. An effective technique using a graduated thickness lead wall to shield the specimens, and an inclined mirror to view them has been devised (Hicks 1982). Public displays involving 'ionising radiations' must be properly labelled, both in regard to their contents and the conformity to the safety requirements.

A potential problem with both displays and storage is the hazard from radon accumulation. Radon is a radioactive gas which breaks down quickly (half-life of 3.8 days), but its longer-lived daughter products are also hazardous, if allowed to accumulate. They cause internal irradiation when inhaled. The simplest procedure here is to allow adequate ventilation (not necessarily a forced draught), so that radon cannot accumulate.

2.1.3. Handling

The hazards involved during handling radioactive minerals are: external irradiation, internal irradiation.

External irradiation is by beta and gamma radiation (alpha particles are absorbed harmlessly in the outer layer of skin). This can be minimised by keeping the duration of specimen handling as short as possible. Dixon's (1983) study assumed that the handling duration of the significantly radioactive samples did not exceed one hour per year, but maximum limits have been specified and the proper procedures must be followed for higher levels of contact.

Internal irradiation arises from radon inhalation (though this is not normally considered hazardous at the level of exposure concerned here).

A more likely hazard is from the inhalation and ingestion of particles. Inhalation follows the production of airborne dust both by abrasion of the specimen during handling, and by disturbance (resuspension) of dust particles in trays and drawers. Ingestion occurs by the direct transfer of particles from the fingers to the face and, presumably, indirectly *via* contaminated surfaces and objects. This has been shown (Dixon 1983) to be a very small risk, and one for which measures for reduction are obvious. Minimise handling, wear washable rubber or plastic disposable gloves if handling is likely to be excessive, especially if handling powdery specimens. Always wash hands thoroughly afterwards (if possible before touching anything else). Avoid breathing in over freshly opened drawers or where disturbance of specimens has produced airborne dust. Wear a face mask if dust is excessive.

Specimens are generally kept in open shallow trays, this is probably the best method, but bags or containers can be used if the purpose warrants it. A possible advantage would be where the storage is prone to accumulate ordinary 'house' dust which can become contaminated with radioactive matter. If for any reason, specimens are removed from the vicinity of the storage small radiation warning labels should be attached to the containers. Experience of uranium minerals in large collections has made it possible broadly to list an 'order of radioactivity' for the numerous mineral species. This list is only a guideline, as experience has shown numerous exceptions. As would be expected, for any given species the larger the specimens the more the radioactivity.

2.1.4. Check-list of Radioactive minerals – in order of decreasing radioactivity

Uraninite and its varieties (pitchblende is the most common). As this mineral commonly contains over 80% uranium it is strongly radioactive. Specimens should be treated with due caution.

Uraninite alteration products; 'gummite'. These are crusts and rinds on cores of uraninite. They are brightly coloured red orange and yellow and are sensibly 'heavy' (uraninite cores). These specimens are marginally less radioactive than pure uraninite but merit the same caution. Additionally, the alteration surfaces are often powdery.

Uranium oxides. These are not very common minerals, they are brightly coloured, as above. They are inherently strongly radioactive and commonly occur as crusts and layers on uraninite substrate. Many of these come from Zaire (Congo) localities. Treat as for uraninite.

Secondary uranium minerals. These tend to contain less uranium, and tend not to occur on uraninite substrates. Where these are large or massive in habit they can still be strongly radioactive. Small specimens and ones on which the actual mineral is a minor constituent are not so hazardous. These minerals comprise the common phosphates, arsenates and vanadates along with carbonates, sulphates and silicates.

In addition some fossil bone material and its enclosing rock may be radioactive, such as from the following localities: Upper Jurassic of Tendaguru, Tanzania; the Tertiary of the Cyprus Hills formation, Saskatchewan; or of the Siwalik Hills in northern India.

2.2. TOXICITY HAZARDS

This is not a detailed evaluation of the toxic character of minerals (or their synthetic counterparts) but gives some simple advice on precautions and indicates those minerals (excluding radio-active minerals) whose physical or chemical composition make them dangerous (see also Puffer 1980). Fortunately for the curator there are no minerals so toxic that normal handling will produce dramatic poisoning, but several are highly toxic by ingestion (adult lethal dose about 0.5 gram) and others of sufficient toxicity to warrant care in their handling and curation.

2.2.1. Chemical

Toxic effects are due to a number of factors, such as:

Chemical composition: Many minerals contain known poisonous elements, such as the heavy metals.

The state of aggregation and solubility: Fine powders may easily be transferred and swallowed, and soluble minerals are readily absorbed in the stomach. Any mineral that is water- (or stomach fluid-) soluble is more hazardous than a non-soluble type, for example witherite is highly toxic but barite is only slightly so.

Physiological factors: A person's susceptibility to a given poison is affected by their weight, age, health and sensitivity (which is not readily predictable).

The dose consumed: This is the only factor that is controllable and all precautions are intended to prevent the intake of poisonous substances.

Safety is as much an attitude as an activity. If all minerals are thought of as unknown chemical compounds, the appropriate degree of care in handling should be automatic. Who would enter a chemical store, handle an unidentified compound, then eat or drink without washing?

If a mineral is a known strong poison, such as the arsenic oxides, rubber gloves should be worn; normally however, cautious handling followed by washing is sufficient. All minerals should be treated cautiously but more so if they have finely divided or powdery surfaces, or look or feel sticky to the touch (a situation occuring rarely in good storage conditions, but nevertheless one which can develop through decomposition). Do not leave specimens lying around where others may touch them. Use warning labels for known toxic minerals. Designate all areas where specimens are present as 'no smoking' areas.

Licking minerals as an aid to identification is ill-advised especially as some exotic and highly toxic substances turn up as enquiries. Mineral enquiries have yielded explosives, industrial process materials and waste products, weedkillers, rodent killers, metal processing additives and even deliberately grown (on matrix) fake minerals. These include some of the most toxic substances ever likely to be encountered so great care is essential, especially if the curator is inexperienced.

2.2.1.1. *Known or suspected toxic minerals*

Minerals containing the following chemicals;

Antimony – native and combined as sulphides, antimonides etc., and antimonates.

Arsenic – native and sulphides, realgar and orpiment; as oxides, claudetite and arsenolite (highly toxic); and chemically combined in a number of arsenate minerals.

Barium – witherite, nitrobarite and frankdicksonite (rare) are soluble and toxic.

Bismuth – native and combined.

Boron – all boron minerals should be treated carefully as they are often soluble.

Copper – has a number of very soluble minerals known to be toxic.

Fluorine – any fluoride mineral that can dissociate in the stomach will be highly toxic.

Lead – a large group of minerals, the more hazardous soluble members include the arsenates, carbonates, chlorides, oxides, phosphates and sulphates. Galena is not normally considered hazardous.

Mercury – native (also its vapour), and its sulphide minerals.

Oxalates – a rare group of minerals.

Selenium – native and the oxide selenolite are toxic; other selenium minerals should be treated with care.

Thallium – an extremely toxic metal occurs as a number of rare sulphide minerals and an oxide. Decomposition products are highly soluble and toxic.

Uranium – in addition to its radioactivity it is toxic and causes kidney damage.

Zinc – native (rare), and its minerals kottigite, zincite and goslarite are toxic.

In addition, dusts from many minerals, if inhaled, can cause a varying degree of inflammation and injury (see below).

Information may be obtained from a number of Government departments. especially the Health and Safety Executive.

2.2.2. Physical toxicity hazards

Included here are those hazards arising from the inherent physical characteristics of some minerals, i.e. sharp edges, fibrous habit etc., and the potential hazards of skin contact, i.e. allergic sensitivity, dermatitis.

If a specimen is glassy or spiky or covered with brittle needles it is likely to cause injury if handled carelessly. Always look carefully before handling, and wear gloves if necessary. This applies more to collecting as close examination may not be possible. The obviously hazardous minerals are the fibrous zeolites, fibrous or acicular forms of amphiboles (tremolite, actinolite etc.), pectolite, epidote, okenite and scholzite. Almost any mineral can have sharp edges.

Skin contact with some substances can cause irritation or, in certain individuals, severe dermatitis. If an individual shows such a reaction medical advice should be taken. Petroleum oil, bitumen and hydrocarbon mineral substances may be hazardous in this way, as well as possibly being carcinogenic by absorption.

A greater potential hazard is from the fibrous asbestos minerals which are recognised human carcinogens and no truly safe level of exposure is acceptable. It appears to be the dimensions of the airborne fibres that give these minerals their harmful character, but any inhaled fibres and dust may cause, at the very least, irritation or inflammation of the delicate internal membranes. At worst they can be carcinogenic or lead to pneumonoconiosis. Clay and quartz dusts are recognised industrial hazards and if exposed to these in collections then masks should be worn and advice heeded of the Environmental Health Officer or Safety Officer.

Exposure to dusts can occur during laboratory specimen preparation and there are regulations concerning the extraction of dusts produced in workshops and laboratories (see section 63 in Health and Safety in Factories (Fife & Machin 1982) or consult with the Environmental Health Officer of the local authority or your institutions's Safety Officer.)

E. USES OF COLLECTIONS

E. USES OF COLLECTIONS

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PREAMBLE

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USES OF COLLECTIONS: SUMMARY AND RECOMMENDATIONS

Collections must be usable, i.e. accessible for study.

Information

E1. They must, therefore, be ordered, documented and indexed to facilitate use; there should be an efficient information retrieval system, whether it be via the specimens themselves or via documentation methods.
For large and important collections catalogues and indexes are most important, and published versions allow a wider knowledge of the specimens.

E1.3. Consider carefully the uses made of the collections, and available resources, before deciding upon the range of indexes necessary for your particular situation.

Study

E2.1. Provide access and study facilities for visiting scientists, as well as the necessary security for the specimens.

E2.1.2. Always record visits and allow scientists to provide comments, preferably on separate slips, about items in the collections.

E2.2. Establish and enforce a loans procedure for specimens lent out and for specimens temporarily in the museum.

E2.3. Update all relevant documentation when specimens have been utilized in a publication.

E2.3.2. Be alert to the need of biographical and historical research, as well as geologically based topics.

E2.4. You shoulder great responsibilities when housing type and figured specimens. Be aware of the international codes of nomenclature, their rules and regulations dealing with type and other status specimens, their documentation, safe housing and access.

E2.4.7. Beware of pre 20th Century specimens and labels marked "type". Check thoroughly the evidence for specimens being type of figured and record your findings.

Exhibitions

E3. Successful exhibitions require much dedication, skill and, commonly, resource.

E3.1. Have a clear concept of the objectives, including consideration of the visitors, the budget and timetables. Evaluate these plans.

E2.3. Prepare a brief for the designer, including information on objects to be included.

E3.3. and 3.4 Select objects and illustrations.

E3.5. Prepare script for headings, text, labels, etc. A difficult job!
Consider the possible needs of information at two levels, or of a separate booklet about the exhibit which allows the provision of extra information.
Monitor response by the public to a new exhibit and try to learn from the results.
Experience in mounting displays resides in many museums and helpful advice is usually freely provided.

E. USES OF COLLECTIONS

PREAMBLE

In this Part we consider the uses to which specimens and their data may be put. Information about geological collections must be readily available to the curator himself, and to the museum visitor, layman or specialist, directly or indirectly. In addition this information may be required by colleagues in other museum disciplines with which geological sciences impinge e.g. building stones (Fine Art), gemstones (Decorative Art), petrology (Archaeology and Ethnography).

In the first section of this Part we consider Information Retrieval and indexes to specimens and data. This is a subject particularly suited to the application of automated systems, especially with the current advances in handling capabilities of micro-computers, but it is fraught with problems of applicability and of suitability of apparatus and programs. In section B4.5 we do no more, therefore, than present some general advice.

In the second section, we briefly consider the responsibilities of having collections which are used for scientific study, the importance of specimens used in publications and, particularly, of the various sorts of type specimens.

In the third section, the use of material in exhibitions is discussed and an outline for the preparation of an exhibit is presented.

1. INFORMATION RETRIEVAL

PREAMBLE

The procedures outlined in these Guidelines for the acquisition, documentation and preservation of geological materials, though crucial to the role of a curator, are essentially the means to an end: to make data acquired *via* these procedures, efficiently and permanently accessible in the service of geology. Good curation is therefore the servant of information retrieval. Bearing this in mind, the curator must constantly check to ensure that he is arranging information in a catalogue, file or index in such a way as to provide easily retrievable answers to the kind of questions that are likely to be asked of his collections. These questions will emanate from himself, from geological colleagues in his own and other institutions, from specialists in other fields, from auditors and from laymen.

We do not intend to give a definitive guide to information retreival. The theory of the subject is large and its application to museum situations better covered elsewhere. See, for example, many of the MDA publications, e.g. MDA (1981) and also Roberts, (in press); Orna & Pettitt (1980) and Chenall (1975). In these Guidelines, we shall concentrate on those aspects of the subject pertinent to the work of a geological curator, essentially reviewing his requirements for catalogues and indexes.

1.1. DEFINITIONS

A *record* comprises all the available information relevant to a particular specimen or suite of specimens. A *catalogue* is a file of such records, usually serially ordered according to specimen identity numbers. A catalogue that includes records of all the material in a collection forms the 'master catalogue' providing the full, formal description of that collection.

An *index* is an ordered sequence of entries acting as a directory to one or more aspects of a catalogue. Each entry can comprise a heading and a description. The *heading* is the information from a catalogue record by which the index entry is ordered. The *description* may be all or part of the catalogue record and may be the specimen identity number only.

1.2. CATALOGUES

1.2.1. The Master Catalogue

It is convenient both in theory and practice to consider the catalogue of a museum collection as being the master record of all the specimens in that collection. This 'Master Catalogue' then is the ultimate source of all available information concerning the specimens in the collection, including cross-references to additional information which may be found in a variety of forms, e.g.:

- History Files
- Labels
- Collection Files
- Conservation Records
- Photographic Files

etc., etc.

The information in a catalogue is not usually organised in ways which suit the retrieval of that information, except by identity number. The enquirer may gain access to this information using the specimen identity number in a number of ways: from the specimen itself, from a published reference which cites a specimen number, or from an index entry, listing specimen numbers. This last method is perhaps the most imporant.

The form of the catalogue is variable. In recent years greater use has been made of record cards or sheets completed for specimens, which are then arranged and stored by Specimen Identity Number. These records may be maintained as file cards, or, if in sheet form, may be bound into a register. The qualities of permanence, completeness and importance, inherent in bound register have proved highly acceptable to museum curators schooled in the same qualities. Though the merits of a catalogue in this form are clear, the minds of curators should also be open to the many benefits of other systems, particularly those brought about by machine processing, e.g. multiple indexing, computer tapes, typesetting, microfiche, etc.

1.2.2. Other catalogues

In addition to the concept of the 'Master Catalogue', there is another, that of a catalogue whose records form only a part of the complete collection and which have been selected for a particular reason. Most commonly these are published catalogues and may not contain all the available information about a specimen. In this sense such a catalogue may be an abstract or summary of specimens and is perhaps more comparable to a rather full index.

The criteria for selection of specimens to be included in such a catalogue vary:

- Collector e.g. King (1981). Catalogue of the R. J. King Mineral collection.
- Taxonomic e.g. Woodward (1889–1901). Catalogue of the Fossil Fishes in the BM(NH).
- Status e.g. Crane (1980). Catalogue of type, figured and cited fossils in the City of Bristol Museum and Art Gallery.
- Stratigraphic e.g. Jackson (1925). A catalogue of Eocene and Oligocene Fossils in the Museum of Isle of Wight Geology.
- Mixture of above e.g. Pattison (1977). Catalogue of the type, figured and cited specimens in the King collections of Permian Fossils.

The preparation of such catalogues is strongly recommended even if they are for informal use only. However, publication ensures that the information becomes more widely available. The publication of type, figured and cited material is a duty under nomenclatorial rules (ICZN 1985) (see B4.4.2.6).

1.3. INDEXES

The requirements of information retrieval can be met by various devices according to the size and scope of a collection. A small museum with few geological specimens may find that the collection itself, in conjunction with the catalogue, is sufficient for a researcher to find the material he wants. A larger collection, stored according to a sensible plan, e.g. taxonomy, stratigraphy, chemistry, may by virtue of its arrangement be self-indexing. When specimens are numbered in many thousands, however, no storage system will ever be able to satisfy any but the most general enquiries. It is the production of indexes from the records within the catalogue which allows the retrieval of specific information.

In a manual system there are various ways of generating indexes and various ways of organising information within them. One of two methods is generally used: either a card is made out for each specimen in each index, or a single card is made out for each index heading on which is written a list of appropriate specimen numbers. Thus by the first method, 20 index cards may be made out for 20 specimens of *Dactylioceras commune* (Sowerby), each card recording a description of a specimen, or, by the second method, one card headed *Dactylioceras commune* (Sowerby) is made out, listing the 20 specimens. Such indexing methods are interdisciplinary, and no method is particularly suited to geological curation. Rather than enter into further discussion here, therefore, the reader is referred to MDA (1981) pp 78–97 for more detailed help and advice.

In a computerised system, the production of indexes is a rather less daunting task. The careful design of data standards and the control of terminologies will ensure that useful indexes are produced automatically with a minimum of effort. Additionally, many more indexes can be produced by machine than can realistically be produced manually. Indeed the potential of computers is not limited to the machine equivalent of an index heading followed by a string of specimen identity numbers, though this alone may be a substantial tool. Indexes may be designed so as to list specific information about specimens extracted on a particular basis. For example, all specimens of hematite may be indexed with each record extracted listing not only the specimen number but also the collector, locality and storage position. Moreover, such procedures can be designed to produce output on paper or on a screen where it can be interrogated on-line. Though these sophisticated methods are impressive, they are expensive. Contrarily, it has been claimed that computer generated indexes to large collections are too expensive and too wasteful, as well as rarely satisfying enquiries, and that on-line systems are more cost-effective. It appears to this writer that there are no clear-cut answers. Each computerised system quoted as a model seems to have developed in its own unique set of circumstances and generalisations are dangerous. The curator intending to follow the avenue of computerisation must seek good advice and help (see B4.5).

1.3.1. Useful geological indexes

The indexes described below are given as examples of those which have been found most appropriate in a range of museum geology departments. Although they are all useful, a single department operating a manual documentation system could hardly expect to produce them all.

1.3.1.1. *Acquisition index*

Traditionally, a donor index was always prepared by a museum, perhaps more as a tribute to its many benefactors than as a management or curatorial tool. In the modern museum world, the acquisition history of a specimen is an important part of its documentation (see B4.4.4.3 and B4.4.5). There may be many individuals, all playing different roles, involved in the presentation of an object to a museum (executors, trustees, collector's spouse, etc., etc.). In the old-fashioned sense of a 'donor index' a museum might contemplate an index of those people or institutions actually responsible for the transfer of material to the museum, i.e. those who should receive an acknowledgement. Far more useful is an index containing the name of every person or institution who has played a role in a specimen's history, e.g. buyers, sellers, exchangers, collectors, donors, etc. with all entries cross-referenced. Such an index would need to be closely linked to documentation methods.

1.3.1.2. *Collectors index*

Museologically speaking at least, perhaps the most significant part of a specimen's history concerns its collector, and an index should be collated containing entries for each collector with each specimen in that collection listed at least by its identity number. In this way, whether by manual or automated methods, it should be possible to reassemble a collection, or its data (see B4.4.5.1 and C3.5.2). In part, a Collectors index may duplicate an Acquisition index. A collection may be defined as a single specimen, i.e. a unit of collection: a single specimen collected by an important worker may be more valuable than a true 'collection' of thousands.

1.3.1.3. *Locality index*

The term 'locality' is used here in the sense of a rough location, and not exact place names (see E1.3.2.3 below). A locality index might be used to answer queries such as "What specimens do you have from Shropshire?" Clearly the definition of a locality here is difficult and standardised references based on administrative boundaries, Ordnance Survey 1/4" Gazetteer, or other National Grid divisions are recommended (see B4.4.4.1 for further discussion). With the smallest geographic unit chosen for an index, organise entries by specimen identity number.

1.3.1.4. *Stratigraphic index*

Again, a difficult index to arrange, especially at the finer levels of stratigraphy (see B4.4.4.2 and B4.4.1.1.(3) for discussion and suggestions). An authoritative stratigraphic framework should be used to erect a classification from which standard headings can be derived. Commonly these are first, period name and secondly the generally accepted chronostratigraphic or lithostratigraphic divisions,

e.g., Jurassic, Lower: Lias.
Cretaceous, Upper: Red Chalk.

Biostratigraphic indexes (zones, sub-zones etc.) may be required by the larger or more specialised institutions. Within the finest sub-division, entries are arranged by specimens identity number, or, more rarely, by systematic classification.

1.3.1.5. *Classified index*

Where authoritative classifications of palaeonotolgy, mineralogy and petrology have been devised and are in use, they can form the bases for indexes. Naturally, since most classifications, if not all, are hierarchical, indexes are relatively easy to produce and organise. For example, a mineral classification using Hey's 'Index' naturally follows the grouping therein; similarly taxonomic classifications, in full or coded form, provides index headings by taxon. One must, however, choose from amongst the various taxonomic levels the most suitable for the collections concerned and expand into the finer levels only where necessary. There is considerable practical advantage in arranging entries alphabetically within the lowest branch of a hierarchical index (for example, at genus level) rather than by Specimen Identity Number.

1.3.2. Other indexes

The large number of categories in which information about geological specimens can be recorded implies the possible production of a large number of corresponding indexes. Since index preparation is so labour intensive, in practice very few, and usually only those detailed in the preceding paragraphs, are ever prepared. In special circumstances, however, others may be generated which can be of great value. Moreover, the computerisation of data on geological collections has meant that other indexes are as 'affordable' as those considered above. In particular, 'multi-indexing', becomes a routine proposition, e.g. a collection index, each collection being divided taxonomically and then organised by specimen number. The following notes summarise some of the more useful indexes that can be prepared either manually, or more likely, by machine.

1.3.2.1. *Storage location index*

Arguably a 'must', even in a manual system, a storage index itemises the contents of all storage units drawer by drawer, shelf by shelf and thereby permits rapid checks, inventories and audits of collections. Manually, this is a tedious and difficult index to compile although computers make this task straightforward. On-line systems make such an index of great benefit during collection re-organisation.

1.3.2.2. *Alphabetic index*

Alphabetic indexes of rocks and minerals may be found helpful, since their use requires no knowledge of formal classifications. However, the exhaustive cross-referencing (consider for example entries for 'syenite' 'tonalite' and 'microtonalite') required by the complexities of geological terminology may outweigh the advantages.

An alphabetic index of fossils can be compiled by species and by genus, within a framework of higher taxa, say at class or phylum level, which can also be arranged alphabetically.

1.3.2.3. *Place names index*

In contrast to a locality index, this index is compiled at the finest level of geographic information and includes perhaps quarry names, village names, farm names, etc., etc. The size of such an index almost certainly means that manual compilation is impossible. A place name index can incorporate a locality index in that it can be divided into the standard locality units, e.g. counties, grid squares, though it may be less useful in this form if enquiries are directed to the finest level of place name. The specific arrangement chosen should reflect the needs of the institution.

2. THE SCIENTIFIC USES OF COLLECTIONS

PREAMBLE

One of the prime uses of collections and their associated information lies in their scientific value.

Following the international codes on nomenclature, specimens used in original descriptions of new species, or other taxa, have particular importance (see E2.4), but additionally, older collections can provide much valuable information for the biostratigrapher about localities no longer available, and for the historian or biographer. The specimens described and illustrated in the scientific literature formed the bases of those works and should be available for any revisionary studies.

The scientific use of collections can impose conflicts since, at times, the use may necessitate the development, 'dissection' or loss of part of a specimen through processes, such as serial sectioning. Normally, it will be the curator's responsibility to give or withhold permission for such treatments, but with particularly important specimens, especially type of figured material or otherwise unique specimens, the advice of specialists is strongly recommended when the specimens are beyond the curator's own detailed knowledge. In all events an agreement between the museum and researcher must result in photographs and/or replicas of affected specimens, together with full documentation, being available to the museum on completion or abandonment of the project. A full account of the ethical and legal position is set out in B6.2.2, with specific guidance on the procedure to be followed for the complete or partial destruction of specimens for the purpose of scientific study being given in B6.2.2.5.

The curator must always remember that he is the temporary custodian of the materials in his care and that they must be preserved for inspection and study both now and for perpetuity. Thus, when conflicts arise between the conservation and scientific study of specimens, careful thought must be given to an evaluation of the arguments:

- Can an alternative, near identical but less important, specimen be used?
- Can the possible harm be justified by the likely scientific gain of information?
- Are there less harmful means of studying the specimen?
- Can harm be minimised by restricting processing to less important areas?
- Will the proposed action render the specimen of little use to future study, (which may utilise techniques yet to be devised)?
- Can parts of the specimen be preserved in their original form?
- Can the museum be furnished with a replica and photographic record of the specimen before (and perhaps during) the proposed treatment?
- Should the museum's own technical services staff carry out the proposed work rather than the researcher concerned?

The continued availability of the material in its original form should normally be uppermost in the curator's mind, especially when type or figured material is concerned.

2.1. ACCESS TO COLLECTIONS

Curators, by the arrangement and storage of their collections (C3.5) and by the documentation techniques (B4.4.1) they employ, should ensure reasonable access to their materials by *bona fide* scientists and by the public known to the museum or colleagues. Preferably there should be a room or area in which materials can be inspected; it should be clean, furnished with adequate table or bench space for spreading out reference material for study, be well lit and have a low-power binocular microscope available.

2.1.1. Security

Curators are responsible for the safety of materials being inspected by visitors, but whether material is always taken to the visitor or whether the visitor is allowed into the collections area with or without a member of staff, are practices which vary according to the 'worth' of the materials and reliability of the visitors. No unknown visitors should be let into collection areas unescorted, and known risk visitors should be identified discreetly to colleagues outside their own institution, with due regard for the laws of libel. Be very clear in your own mind as to what material may or may not be handled by visistors, remembering the delicacy, unique nature or hazards of some specimens.

2.1.2. Visitors' comments

Specialist visitors should be encouraged to comment upon specimen documentation, preferably using pro-forma Examination Labels on which their remarks, names and dates should be written (see B1.3.4.3(1)). Such comments can, for instance, lead to the correction of specimen identifications or stratigraphic interpretations, or to suggestions about locality, where this had been in doubt. The writers of any comments should be identifiable from the Examination Label and their addresses recorded in a visitors' book, which they should be obliged to sign on each visit.

2.2. LOANS AND ENQUIRIES

2.2.1. Loans

There should be a strictly enforced loan procedure, both for specimens being lent outside the museum (see B6.1.1) and for their transfer to different parts of the museum, e.g. for exhibition or for preparation in separate laboratories (see B5). In addition, there should be a regular procedure for the documentation of loans into the museum (see B2.3.5).

2.2.2. Enquiries

If facilities and staffing permit, the running of an enquiry service will be appreciated by the public and may lead to the acquisition of new material. Staff dealing with on-the-spot identifications as well as receiving specimens for later examination by curators should record names, addresses, details of the specimen and its origin, the information required, and the name of the person from whom an identification is expected or was given. This should be done on a special enquiry form. It is important that staff dealing with enquirers personally are courteous and sympathetic, and that answers and identifications are explained in simple terms. If some questions commonly recur it might be worth considering the preparation of simple explanatory leaflets to augment enquiry answers.

For further guidance on this important subject see Sharpe & Rolfe (1979) and Clarke (1984).

2.3. PUBLISHING

Publishing is the end product of much curatorial or research endeavour. It may be entirely museum orientated, prepared and written by curators, or it may only have involved curators at the stage of lending material to a researcher and in the documentation consequential upon the material being referred to in the literature.

The publication of any information about museum collections enhances the scientific value of those collections for two reasons. First, it usually results from considerable research into the material which commonly adds to the collected information associated with specimens. Secondly, the publication itself advertises and disseminates information about the material; it enhances the importance of the material upon which it was based.

2.3.1. Specimen-based publications

Published information on specimens in museum collections, and its consequent wide availability, adds to geological knowledge and provides a strong reason for allowing access to and loan of material to established researchers and their associates. A condition of lending or otherwise giving access to researchers should be that a copy of any publication which cites those specimens, or, failing that, full bibliographical details, should be sent to the museums concerned. In addition, full documentation of any specimen preparation, together with all replicas, derived specimens or remaining parts of sectioned specimens must be returned to the originating museum.

It is important that curators amend their specimen documentation in the light of publications in which material is figured or cited. Specimens, and their labels or containers should be marked in an identifiable way, showing their status (see B4.4.2.6). Files of information about such specimens should be collated and maintained and eventually used as the basis of a type, figured and cited specimen catalogue. In general, it is very important that museums let the world at large know what they have in their collections. This is partly achieved by exhibitions (see E3), partly by word of mouth, and partly by popular publications. Published museum catalogues usually include only the most important specimens, such as type and figured specimens, but these are of great value to researchers unable easily to visit the particular museum. The compilation of catalogues should increase the accuracy and completeness of the museum's own records and may expose specimens of great scientific value, previously unrecognised.

2.3.2. Biographical and collection-based publications

In publishing a collection it is important to include historical information on both the collection and collector. Biographical research is a major subject on its own, and beyond the scope of these Guidelines. Sources and advice are available through Records Offices and from library services with relevant local history reference sections. Published sources specific to geology and related subjects are listed below:

Bassett, M. G. 1975 'Bibliography and indexes of catalogues of type, figured and cited fossils in museums in the British Isles'.

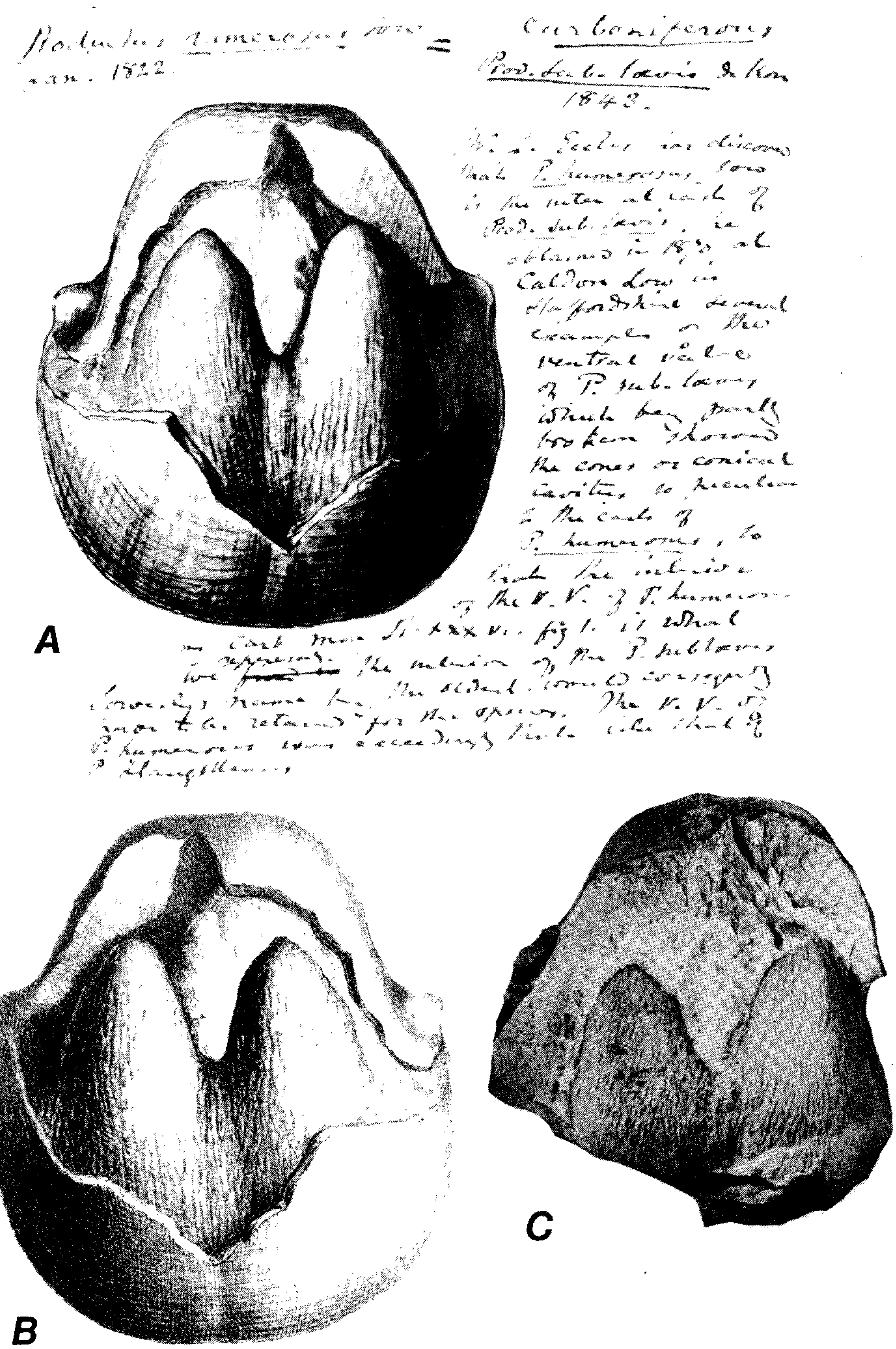
Bridson, G. D. R., Phillips, V. C. & Harvey, A. P. 1980. 'Natural history manuscript resources in the British Isles'.

Chalmers-Hunt, J. M. 1976 'Natural History Auctions 1700–1972'. A chronological listing of auctions of natural history collections, detailing name of collector/institution selling, contents of sale, auctioneer and where the catalogue may be found. A useful index lists names of collections, vendors and collectors in alphabetical order.

Cleevely, R. J. 1983 'World Palaeontological Collections'. A major work comprising an alphabetic listing of major fossil (and some mineral) collectors and societies, giving brief biographical notes. A useful introduction includes a 'History of Earlier Guides to Geological Collections'.

Desmond, R. 1977. 'Dictionary of British and Irish botanists and horticulturalists'. Includes palaeobotanists.

Doughty, P. S. 1981 'The State and Status of Geology in U.K. Museums'. A survey of museums with geological holdings, including a list of collectors in Appendix 2.


A
B
C

'Geological Curator' 1974 – (formerly the GCG Newsletter). A roughly quarterly journal containing major articles on collectors and collections as well as the invaluable 'Collections Lost and Found' section. Published by the Geological Curators' Group.

Gilbert, P. 1977. 'A compendium of the biographical literature on deceased entomologists'.

Sarjeant, W. A. S. 1980. 'Geologists and the history of geology'. Five volumes of biographical entries and indexes.

Sharpe, T. 1983. 'Geology in Museums: A Bibliography and Index'. Includes a Keyword Index entry under 'Collections'.

Sherborn, C. D. 1940. 'Where is the . . . Collection'? An alphabetical list of collectors and institutions giving brief details of field of interest, location or sale of general natural history collection including geology.

Zwann, P. C. & Petersen, O. V. 1977. 'World Directory of Mineral Collections'. Less biographical, and more concerned with institutions, not collectors, than might be useful, this work is nevertheless a good starting point for research.

2.3.2.1. *Collections research units*

Since the late 1970's natural science curators, organised in major geographical regions, have been collecting data on the whereabouts and nature of collections in the British Isles. This data has been fed into a central database on the Manchester University Computer, where it can be accessed directly. So far, only the N.W. Region has published a catalogue, but Yorkshire & Humberside, and the North-East are to follow shortly.

Enquiries should be addressed to: C. W. Pettitt, Computer Cataloguing Unit, The Manchester Museum, Oxford Road, MANCHESTER M13 9PL.

2.4. TYPE AND 'TYPES'

The importance of type specimens in geology is immense; their safety and proper documentation (B1.3.3) is an internationally agreed requirement (see B4.4.2.6).

Fig. 14. (a–c). *Levitusia humerosa* (J. Sowerby), a brachiopod from the late Chadian, Lower Carboniferous of Caldon Low, Staffordshire, collected in 1870 by James Eccles and denoted to the Geological Survey in 1873, now in the BGS collections, number 34382.x1. (a) Thomas Davidson's original drawing and notes which read "Mr. J. Eccles has discovered that *P. humerosus* Sow is the internal cast of *Prod. Sublaevis*. He obtained in 1870 at Caldon Low in Staffordshire several examples of the ventral valve of P. Sub-laevis which being partially broken, showed the cones or conical cavities so peculiar to the casts of *P. humerous*, so that the interior of the v.v. of P. humerosus my Carb. Mon. Pl. xxxvi. fig 1, is what we supposed the interior of the P. Sublaevis. Sowerbys name being the oldest would consequently have to be retained for the species. The v.v. of P. humerosus was exceedingly thick, like that of P. llangollesis."

(b) Davidson's 1880, Pl 36, fig. 2 (not 1, as above). Note the reversal of the illustration as compared to the original drawing and the actual specimen as it is today (c). Brunton (1982, Lethaia) illustrated the specimen (c) in his demonstration that *P. humerosus* was a synonym of *P. christiani* de Koninck, while *P. sublaevis* was a distinctive species. Note that since Davidson had the specimen in 1870 the shell from the right side and bottom (anterior) of the specimen has been broken away, perhaps in an attempt to expose more of the internal cast.

For details of palaeontological nomenclature see the ICBN code (Stafleu 1983) and the ICZN code (Stoll *et al.* 1964) or the revised edition (ICZN 1985) which states in article 72C(g) that "Holotypes, syntypes, lectotypes, and neotypes are the bearers of the scientific names of all animal taxa. They are international standards of reference that provide objectivity in zoological nomenclature. They are held in trust for science by all zoologists and by persons responsible for their safe keeping." Torrens (1974) provided an excellent summary of palaeontological type specimens, and Frizzell (1933) an exhaustive list of definitions. Mineralogical nomenclature is 'controlled' by the International Mineralogical Association Commission on New Minerals and Mineral Names. Some of the terms for types are used similarly in mineralogy and palaeontology, but differences are noted below and there is no international mineralogical codification comparable to that for zoology. Embrey & Hey (1970) defined type specimens in mineralogy, and although not universally recognised, their use of terms is recommended here.

2.4.1. Primary types

The above four categories of types make up in part what are known as 'primary types', which may be defined briefly as follows:

(a) Types defined by the original author of the species name at the time of its first published description.

(i) *Holotype* (Used in the same way for minerals)

(a) If the new species name is based only on a single specimen, that specimen is the holotype.

(b) If the author, in his description, selects a specimen as 'the type', that specimen is the holotype.

(ii) *Syntypes*

If no single specimen was eligible for or selected as holotype, as in (i) above, all the specimens used by the authors are syntypes of equal value in nomenclature.

(iii) *Paratypes*

Paratypes are the remaining specimens used by the author after a holotype has been selected.

(iv) *Cotypes* (As used by mineralogists and some palaeontologists)

Specimens other than the holotype used in making the original description. They should in mineralogy be from the same locality. (Equivalent in palaeontology to syntypes and paratypes). The ICZN recommend this term should not be used by zoologists.

(b) Types defined by an author subsequently to the original definition of the species.

(v) *Lectotypes* (used in the same way for minerals)

If no holotype exists, or has been lost, a specimen from the syntypes may be selected as lectotype, the remaining syntypes becoming paralectotypes.

(vi) *Neotypes* (used in the same way for minerals)

If it can be demonstrated that all original specimens, holotype, syntypes, paratypes, are lost or destroyed a competent taxonomist may select a specimen as neotype to act as a type for the species. Important conditions must be met in the selection of a neotype and reference should be made to the ICZN (1985, Article 75).

The ICZN makes specific recommendations regarding the custody,. labelling, publication of information and institutional responsibility for the safekeeping of type specimens (ICZN, 1985, Articel 72D–G). See B4.4.2.6.

2.4.2. Secondary types

Numbers i–iii and v–vi above (E2.4.1) are the only internationally agreed 'primary types'. Other sorts of type designations are also used. Some are specifically not recommended, such as 'cotype' (in palaeontology, where it has been used in different, confusing ways, but commonly as syntype) or 'hypotype' (found principally in N. American literature, meaning little more than conspecific, in the view of a specialist). Others have value as so-called 'secondary types'.

- 'Topotype' – a specimen of a species from the same locality and perhaps zone as the primary types of the species. (Used in the same way for minerals.)
- 'Metatype' – a specimen identified by the original authors as conspecific with his species, and from the same locality. (Used in the same way for minerals.)
- 'Plesiotype' (as used mainly by mineralogists) – a specimen upon which subsequent or additional description is based. A plesiotype may become a neotype.
- 'Ideotype' (as used mainly by mineralogists) – a specimen identified by the original author as conspecific with his species, but from a different locality.

There is danger in using terms like 'Plastotype' (a replica specimen made from the type) because different categories of type may be used and it is better to mark the label as 'replica of' whichever category of the five recognised types the original specimen belonged to. Similarly 'Iconotype' (the illustration of the original type, substituting for the specimen if its is lost) can be ambiguous.

2.4.3. Figured specimens

Specimens which have been figured in whole or in part in scientific literature take on an importance second only to that of primary types. These 'Figured specimens' must be uniquely identifiable with the illustrations, and documented accordingly. Beware leaping to the wrong conclusions, particularly with specimens in old collections that may have written on them (or their old label) a detailed reference to a figure in the literature. This may well be no more than a record of the basis upon which the identification of this particular specimen was made. It may be worth keeping records of specimens figured in popular publications, but this will depend upon the uses made of your collections (see B4.4.2.6).

In rare instances, normally involving microfossils, the figures (e.g. electron micrographs) may be all that remain of a specimen which was destroyed in the preparation of the illustration(s), despite its possible type status.

2.4.4. Cited specimens

'Cited specimens' are those specifically mentioned in the literature and uniquely identifiable by description or by reference to their unique identity numbers. They are also of importance and should be documented.

2.4.5. Referred specimens

When an author has not uniquely mentioned specimens, but makes reference to individuals or groups of specimens in a specific collection they may be termed 'Referred specimens'. No individual specimen is recognisable from the publication, but it will be clear to which group of specimens the author referred. For instance a group of specimens known to have been measured for a biometrical study might well be 'Referred specimens'. The term 'mentioned specimens' has been used in the same way, but we prefer that this term be used in a more general way without any specific meaning.

Some authors or curators use the term 'voucher specimen' in much the same way, or for specimens useful in some geological interpretation. We do not recommend this term in the formal sense of figured, cited or referred specimens.

2.4.6. Replica 'status' material

It has been, and to some extent still is, the habit of palaeontologists and curators to make replicas of particularly significant specimens. This has been done for good security reasons, for the beneficial supply of educational or display material and, less laudably, for sheer vanity. As a result, curators are commonly faced with the problem of how to curate replica 'status' material. Generally, the rule is that all replicas entering museum collections should be accessioned as specimens in their own right. Replicas of type and other 'status' specimens should, in particular, be treated as if the specimens themselves and accorded due significance i.e. marked with the appropriate coloured spots, stored separately and appear in published lists. They must however, be *clearly* documented as replicas.

As a matter of good documentation, the curator should endeavour to discover the existance and location of the original specimens from which his replicas were made. Success in this does not diminish the importance of his replicas: the curator is not to know if his own are the only replicas in existance, nor can he assume the continued well-being of the originals. Replicas may prove to be the only representations of some original specimens. Furthermore, replicas have been made of potential type material before its thorough development, as a guard against loss during the process. These too are important.

In the case of museums preparing replicas of their own 'status' material (or indeed any other) perhaps for sale, exchange or gift, accessioning should only take place for those specimens specifically produced for entry into the originating museum's collections. In this circumstance, the replicas should be given specimen identity numbers derived from the original, or where this is not possible, at least exhaustively cross-referenced to them. Where replicas are known to enter the collections of other museums, record the facts. The process of replication should be recorded in the appropriate part of a specimen's documentation (see B4.4.6 and B5.4.1).

2.4.7. Validity

According to the international rules for zoological and botanical nomenclature, a newly described species or higher taxon, together with its designated types, is invalid unless the script has been officially published; university theses, for example, do not constitute a publication (see ICZN (1964) especially articles 7 to

11, 23, 24 or 1985 articles 8, 9). See Sections B1.3.3 and B4.4.2.6 respectively for the marking and documentation of type specimens.

2.4.8. Problems of status determination

It is very important to appreciate that there may be difficulty in stating with absolute certainty that a specimen is a type, or that it has the status of one of the other categories.

The type may not have been figured and the documentation associated with the supposed type(s) may be inadequate for positive identification. Even where a specimen is illustrated the figure may be inadequate – the 'reversal' which resulted from drawing directly onto lithographic stone, or later onto printing plates (Fig. 14) is well-known and rarely causes problems, but the illustration may be restored, diagrammatic or even composite.

The type concept and 'rules' date from early in the 20th century, so beware of the word 'type' on older specimens or their associated labels, since it may mean no more than that a particular specimen was considered to belong to the same species as another so named.

2.4.8.1. *The qualification of status*

The problems of status identification make it desirable to qualify a status determination in some cases. At a basic level most people would qualify the statement of status with, for example, '?' or 'possibly'.

It would be more useful to give some indication for the basis of the qualification, in order that the user may assess the degree of confidence to be placed on the comment. The status. document type (if not a published work), status identifier, date and full reference (to a published work) should all be recorded. When a curator has no taxonomic skills in the group concerned he should seek expert advice.

Full notes setting out the evidence upon which a status determination is made would appropriately be stored in the specimen's History File, with a brief comment on the Specimen Label which would give a researcher the necessary 'lead' to this information. Not only do such notes support any published conclusions, but they may also provide the only evidence for a status determination, should the research never be published.

3. EXHIBITION AND DESIGN

PREAMBLE

Of all the uses of geological collections, exhibitions probably give curators the most trouble. Exhibitions must be the most problematical medium of mass communication there is – imagine trying to explain the meaning of a lump of stone to a non-geologist without even being there. Think of the multiplicity of skills needed to produce an exhibition, as well as the drain on resources.

A good exhibition could be defined as one which inspires and/or increases the understanding of the audience. As such, it is a potent and effective means of communication. Bad exhibition is at best boring and at worst incomprehensible to the visitor. Either way, it fails to communicate anything of value. Anyone can produce a bad exhibition. Good exhibitions are very, very difficult to achieve.

If there is no clear consensus on what constitutes a good exhibition then the following must be read as some personal views on recognizing and tackling the problems of exhibition production.

In this section, a 'single-subject' exhibition is envisaged for simplicity. Where exhibitions consist of a number of independent or loosely related topics, some of the planning stages described here would have to be repeated.

Although the procedure outlined was developed over the years at a museum with geology curators and designers, a small museum with one curator and no designers can use it just as profitably.

3.1. SYNOPSIS – WHAT SORT OF EXHIBITION?

The exhibition synopsis marshalls your ideas of what you want to do and gives justifications for your decisions. It is the document that you should submit to the relevant museum authority for approval to continue with the preparation of detailed plans of your exhibition. It should contain:

3.1.1. Background

Where the idea, or the initiative for the exhibition, came from. This can be helpful when you come to decide on the characteristics of the audience you wish to reach.

3.1.2. Statement of objectives

This is the most important element of all exhibition planning and production. Your objectives should be stated in "behavioural" terms; this is not because it is fashionable to do so but because it really is helpful. As a summary of what the exhibit is meant to communicate to the visitor the objectives must include a prediction of the effect the exhibit produces on the visitor.

Once you have stated your objectives, you have provided yourself with points of reference to which all stages of planning and production must relate. During production and after the exhibition is open, this approach provides a means by which you can measure your success in meeting your objectives.

Some examples:

(a) To create visitor awareness of the inherent beauty and variety of form in minerals.

(b) To put the concept of 'the present being the key to the past' in such a way as to involve visitors in the same logical processes as those used by geologists.

(c) To help visitors identify their own finds by providing a reference series of common local fossils.

(d) To enhance visitors' knowledge of the ecology and appearance in life of the organisms preserved as commonly-found local fossils.

(e) To create visitor awareness of the likely appearance and total environment (including climate, temperature, and smells) of this area (specified) in, say, Upper Carboniferous times.

The predicted behaviour of visitors can be active (b) or passive (a). Exhibits can have several objectives, but obviously these must be compatible (as examples (c) and (d)); it would clearly be difficult or impossible to fulfil objectives (c) and (e) together.

3.1.3. The visitors

Your objectives contain an implicit hint of your intended target audience. It is, however, valuable to describe them more formally. When planning a major exhibit you may benefit by a visitors' survey, which may help in pitching the appropriate level of information (see for example Alt, 1980).

Relevant visitor characteristics to be considered are:

- Age and concept comprehension: adults, children at different levels.
- Age and reading comprehension (see for example Sorsby & Horne 1980).
- Previous knowledge of geology, or of the subject of the exhibition.
- Physical characteristics: height of labels, line of vision etc. important for the children in target audience and for the benefit of people with various disabilities (see Keen 1984).
- Numbers – single visitors, families or larger groups.

Also bear in mind the special needs of certain people; visitors from outside your local area, the elderly, families with prams, pregnant women, the blind, the deaf, etc., and provide seating and places where those wishing to sketch can lean their paper.

3.1.4. Description

The way in which you plan to fulfil your objectives in the exhibition should be described very briefly. This section records how you envisage its general appearance. You should consider and decide upon:

- The scale and duration of the exhibit
- The relative importance of specimens compared with two-dimensional material
- The use of graphics
- The amount and level of text
- The use and suitability of photographs
- The story sequence (if any) in relation to visitor flow.
- The need for a supporting publication expanding on the exhibit, which should also be of value in its own right.

If yours is a museum with in-house designers, or if you are employing outside designers, this is your opportunity to explain the subject of the exhibit in prose to professional 'surrogate visitors'.

3.1.5. Budget

At the synopsis stage you should estimate costs (you may need professional help with major projects). It is beyond the scope of these Guidelines to detail costing methods but do remember the need for a contingency fund. The detailed planning of your exhibit will be constrained by finance and it is therefore important to determine whether you are in a position to bid for finance on the basis of what you calculate the exhibition to cost or (as in most cases) if you are operating within an allocated budget.

3.1.6. Timetable

If, as curator, your are also coordinator of the exhibition you will need to timetable the project in cooperation with your Designer. Only experience can make this easy. The following elements, not necessarily in chronological order, should be in your timetable:

- Brief writing
- Selecting, obtaining and preparing specimens
- Selecting and obtaining photographic originals
- Design – initial
- Design – detail
- Copy writing, editing, rewriting
- Production processes – printing, screen printing, photography
- Construction of show cases etc.
- Preparation of the gallery space
- Case dressing
- Completion on site

These elements can be graphically represented in a flow chart which experience has shown to be a useful way of efficiently organising your timetable and monitoring progress.

It is also advisable to add a nominal 10% overall to take account of unforeseen circumstances – obtaining specimens or photographs from outside sources can take a surprisingly long time, for example.

At a stage in the middle of the schedule there will almost certainly be an apparent hiatus whilst you wait for specimen photographs and product information to arrive. You should allow for this in the timetable and take advantage of this period to stand back with the designer and assess the project while other work is in progress. You can then return to the project fresh, in a position, and with time, to consider practical alternatives to details on your first brief.

3.2. THE BRIEF

Where a designer is to be responsible for exhibition production, the brief provides the means by which the curator defines to the designer the practical and conceptual framework within which the exhibit must be prepared. It should supply the designer with the following information:

- the synopsis (as defined in 3.1 above)
- details of specimens etc. to be included.
- first drafts of display labels and graphic sketches
- details and constraints of specimen/label relationships requiring design solution.

In presenting the brief a narrative style may be suitable to explain the overall thematic content but a simple tabulation may be the most effective way of setting out the detailed specification of the brief.

Furthermore, the designer must be provided with individual "object sheets" giving him details of each specimen, graphic, photograph etc. In the case of specimens each 'object sheet' should contain the following information:

Simple name
Scientific or full name
Specimen Identity Number
Dimensions and weight
Security and environmental requirements
Other special considerations
Conservation needs
Date available
A sketch or photograph of the specimen

A pre-printed sheet setting out these categories is useful (see example Fig. 15).

3.3. SELECTING AND OBTAINING SPECIMENS

In selecting specimens for display consider the following:

- Specimens can be used in two, possibly mutually restricting, ways.
  As inspirational objects of beauty, wonder or importance in their own right.
  As illustrations or examples of an idea, concept or theme.
- Type specimens, and other irreplaceable material, should be given special consideration. Open display is not recommended for such material. The use of high quality replicas may be an appropriate alternative.
- Important, rare, valuable or irreplaceable specimens can be displayed as such ("on a velvet cushion") or they may be used, with no apparent special treatment, alongside more ordinary specimens, in a didactic exhibition. Interpolation of a "velvet cushion" into the middle of a thematic display may be confusing for visitors (perhaps because it compromises an interpretative objective) and should be considered with circumspection.
- Open display should be used with care. It is almost always desirable interpretatively, because it removes a barrier between the specimen and the visitor, but it presents problems of theft, vandalism, dust, finger marks, abrasion and environmental control. Whenever possible, specimens should be collected specifically for open display and may have to be regarded as disposable.
- In thematic exhibitions, it is important to use specimens which are wholly compatible with your interpretative objectives. If specimens in your care are only second-best, you should either modify your objectives or obtain better material from elsewhere.
- Most museums, universities, botanical gardens etc. in the UK and abroad will lend specimens for exhibition purposes, but ample time must be allowed in your schedule. The exchange of letters, insurance confirmation and transport of material can take many weeks.

EXHIBITION TITLE "LOST WORLDS"

UNIT NUMBER	ITEM NUMBER	ACCESSION NUMBER
1	18.1–2	(1) 1234' 1951/34d (2) 1234' 1951/34e

NAME, DESCRIPTION (1) Partial skull of woolly rhinoceros
(2) lower jaw of " "

SOURCE/LOCATION (1) Earth sciences store B45.3 DATE 23 OCT. 1981.
(2) " " " B45.2

DIMENSIONS (1) Max: 605mm WEIGHT (combined) 15kg.
(2) Max: 430mm

SPECIAL INSTRUCTIONS, NOTES mount together in approximate "life" position. A supporting cradle is availiable if required. MUST BE CASED.

LINK WITH: Graphic 18.2, text 18.3.

TEXT (18.3)

N.B. Combined height when mounted together = 440mm.

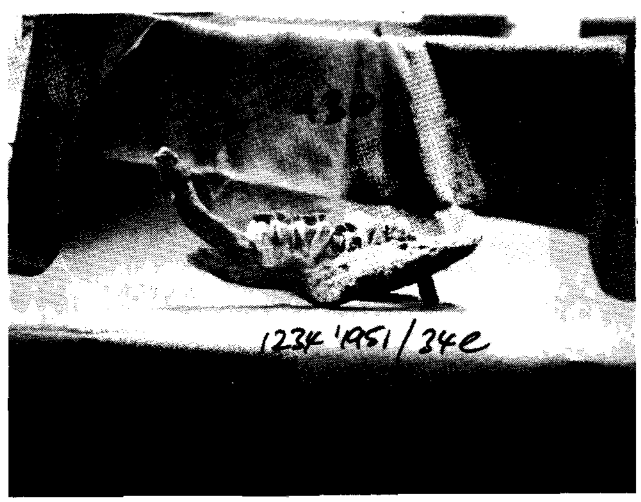


Fig. 15. Example of a Specimen Object Sheet with information about a specimen which is to be exhibited.

- Where partial or complete replicas are used in a display this information should be stated clearly.

3.4. SELECTING AND OBTAINING PHOTOGRAPHS

The other interpretative media with which visitors are familiar (TV, books, magazines etc.) use photographic images of very high quality. Museum visitors will make a subconscious comparison with your exhibition; second-rate photographs will communicate your objectives less effectively. Good quality photographic originals, usually in the form of 35 mm or 5″ × 4″ colour transparencies, are obtainable from specialist photograph agencies and a few other official institutions – you should provide them with as full details as possible of your requirements, preferably by letter, so that their researchers can choose the closest image to the one you want. A reproduction fee is payable to Agencies; however, with non-profit making exhibitions it may be possible to negotiate a small discount. Good black and white photographs remain an effective medium for certain applications.

The processing technique (and the price) should be matched to the length of time the exhibition is to run. Only travelling, 'permanent' or outdoor exhibitions justify the use of permanent colour printing, which is expensive. Remember, however, that prolonged exposure to strong light, especially sunlight, will eventually cause fading and discolouration of all colour prints.

3.5. COPY WRITING

Despite years of research and many words of advice, the written material – title, headings, script, labels, captions etc. – remains the least agreed and most difficult part of the job.

Research shows (Falk 1982; see also Alt 1980; Shettel 1968) that visitors spend less than 30 seconds per display 'unit' and that they seldom spend longer than about 15 minutes in an exhibition. However, a note of caution should be sounded about applying such statistics too literally: museums have a duty to inform the occasional more serious visitor as well as entertaining the casual majority. This evidently relates to the characteristics of the identified target audience, but a possible resolution lies in the provision of more than one level of text or of books aimed at the more serious visitor.

3.6. THE CURATOR AND THE DESIGNER

If you are lucky enough to have in-house designers, or can afford to pay for the services of commercial exhibition designers, make the most of them. The other major interpretative media, TV and publishing, recognise the value of design as a way of improving the effectiveness of what they do. The development of a co-operative relationship between curators and designers, and the recognition of the importance of design in museums, is a valid goal for all curators.

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APPENDICES

APPENDIX 1

ADHESIVES

The large numbers and variety of adhesives make selection difficult for the inexperienced curator. Here adhesives are grouped according to their components, including their solvents. They are all cold-setting adhesives. Adhesives considered particularly unsuitable for museum use are not included.

In curation one needs an adhesive with a strong bond, capable of gripping to smooth or rough surfaces, which is simple and non-hazardous in use but which, after setting, is re-soluble with minimum danger to curator or specimen. Water soluble glues can be softened in conditions of high humidity or dissolve altogether in wet conditions; so data security is at risk. The water-based emulsions, such as Tenaxatex, fit the above specifications and can be dissolved much more readily than cellulose glues such as 'Durofix' (no longer available).

COLD-SETTING ADHESIVES – WATER SOLUBLE*

Animal glues; (most formulations are for application as hot solutions, but cold liquid glues are available): Used for bonding wood, paper, leather and cloth. Strong bonds possible, limited resistance to water, mould growth and vermin attack. Preservatives may be added to improve resistance to these agents.

(R) **Croid,** cold. Croid Ltd., Berkshire House, High Holborn, London WC1. 01-836 7777.

Kay, animal glue. Sam Kay & Co. Ltd., P.O. Box 22, Elton Fold Mills, Bury, Lancs. 061-734 4821.

(R) **Duroglue.** The Rawlplug Co. Ltd., Rawlplug House, 147 London Road, Kingston, Surrey. 01-546 2191.

(R) **Stegrip.** Henry C. Stephens Ltd., Britannia House, Drayton Park, London N5. 01–226 4455.

Union glue. Union Glue & Gelatine Co. Ltd., Station Road, Gillingham Gillingham 771.

Fish glues; supplied in cold-setting liquid form. Similar in properties to animal glue, and mainly used for gluing wood and paper, etc. May smell of preservative.

Lepage's liquid fish glue. Hunter Pemrose Supplies Ltd., 32 Southwark, London SE1 1TU. 01-407 5051.

Certofix, fish glue. Certofix Ltd., St Andrews Dock, Hull, Yorks. 0482-27361.

Albumenoid. The Albumenoid Products Co. Ltd., G.P.O. Box 76, Albert Quay, Aberdeen. Aberdeen 20202.

Samson liquid fish glue. Samuel Jones & Co. Ltd., Butterfly House, Dingwall Road, Croydon, Surrey. 01-686 5588.

Seccotine. Henry C. Stevenson Ltd. Availabe in 4 oz bottles from Primrose Repair Services, Dunstable Road, Dagnall, Berkhamstead, Herts. HD4 1RQ. 044284 2394.

* (R) indicates that the product is available in retail packs. The lack of the symbol does not necessarily mean that the product may not be available in retail as well as industrial sized packs.

• Museum use. NB. These glues cannot be used in wet or humid storage conditions, as adhesion will fail due to re-solution of the glues or microbiological breakdown.

Polyvinyl alcohol; thermoplastic, synthetic resin, used for bonding porous materials, such as leather cloth, paper (in food packaging) and as a re-moistenable adhesive. Available as a water or water/alcohol solution with good wet tack. Flexible transparent bond with good resistance to oils, solvents and mould growth but poor resistance to water. Useful 'separator' in moulding/casting.
Also as powder (general purpose reagent) from chemical suppliers, e.g. BDH. No details available of supplies of p.v. alcohol as an adhesive. Apart from making up one's own solution (using a grade soluble in a water/i.m.s. solvent for quicker drying), 'separator' solutions (coloured or natural) are sold by:
Trylon Ltd., (as Liquid release agent) Freepost, Wollaston, Northants, NN9 7QJ. Wellingborough (0933) 664275.
Strand Glassfibre Ltd. (as Release agent no. 2) Head Office, Brentway Trading Estate. Brentford, Middx. 01-568 7191.

Gum Arabic; Natural gum, water soluble. A general purpose glue, but mainly used in stationery. Plasticisers (e.g. glycerine) may be incorporated to improve flexibility of dried film.
Lion Gum. Lion Ink Ltd., Century Works, Booth Street, Walkden, Manchester. 061-790 2328.
Sellobond Gum. Sellotape Products Ltd., Sell House, 54/58 High Street, Edgware.
Samson no. 1. Samuel Jones & Co. Ltd., Middx. Edgware 2345.

Dextrines; of vegetable origin (derived from starch), mainly used in water solution as adhesives for paper. Good tack, fast-setting, but low bond strength (adequate for paper), and susceptible to microbiol attack. Low water resistance.
Lion glue. Lion Ink Ltd.
AA 9659. Associated Adhesives Ltd., Knights Road, London E16. 01-476 1414.
Samson 5942. Samuel Jones & Co. Ltd.

Sodium carboxy methyl cellulose; used as general purpose and decorating adhesive, for paper corrugated board and multiwall sacking. Liquid (solution in water).
Cellofas B. ICI Ltd., ICI House, Millbank, London SW1. 01-834 4444.

Hydroxy propyl methyl cellulose; as for Cellofas, but employed where lime resistance is required. Also as a thickener for polyvinyl acetate emulsion-adhesives.
Methofas P. ICI Ltd.
Polycell. Polycell Products Ltd., Polycell House, Broadwater Road, Welwyn Garden City, Herts. Welwyn 28131.
A closely related product to Cellofas B or Methofas, a neutral adhesive, non-staining and inert toward metallic printing (gold or bronzes) in paper.
Heavy duty Polycell (Powder) and Methofas SA contain a fungicide.
• Museum use. NB. There are a number of water soluble mountants, for which see the GURR Catalogue, which are often good, if rather expensive, adhesives

for small jobs. Water soluble adhesives are frequently useful in "transfer techniques" in preparation used counter to organic solvent/adhesive solutions.

COLD-SETTING ADHESIVES – WATER BASED EMULSIONS

There are several advantages in using these adhesive emulsions; economy, a high solids content (ca. 50% polymer) without the high viscosity of the same polymer content in solution, a higher molecular weight polymer can be used, because of the lower viscosity, with an increase in the tensile strength of the final film, and finally the use of flammable or harmful solvents is avoided. The final film may also be highly resistant to water, but generally re-soluble in the appropriate solvent (reversibility *is* important), eg. acetone, methyl ethyl ketone. Most of the well known polymers are available as emulsions giving a good choice of final properties.

Polyvinyl acetate; used for non-structural bonding of wood, paper, leather, cloth, metals, glass, ceramics and many plastics (not pvc, polyethylene or rubber). Milky white emulsions, clean to use, high initial tack and fairly quick setting. Strong bond, good resistance to oils and mould growth, moderate resistance to water but poor resistance to solvents. The emulsions in storage must not be allowed to freeze. Plasticized forms retain a flexibility. Emulsion slightly acidic.

Samson 8100 Resimul. Samuel Jones & Co. Ltd.

Resistance to water, rapid setting heavy cream emulsion. May be diluted with water. High mould resistance. Slightly acid in reaction.

Wood-lok 140-0212. National Adhesives & Resins Ltd., Slough, Bucks. Slough 33494.

51% solids (w/w), non-gap filling, resistant to humid environments, and biodeterioration. Freeze-thaw stable!

Cobond & Coflex. J. & G. Cox Ltd., Grogie Mills, Edinburgh 11 031-337 6222/4.

Marley 130. Marley Floor Tile Co. Ltd., Bath Road, Beenham, Reading, Berks. Woolhampton 2331.

Clam 7. London Adhesive Co. Ltd., Maxwell Road, Borehamwood, Elstree, Herts. 01-953 2992.

Spencobond 22/2. The Albumenoid Products Co. Ltd.

Cascore 2 VN-1. The Borden Chemical Co. (UK) Ltd., North Baddesley, Southampton, Hants. Rownhams 2131.

Dufix. ICI. Ltd.

Resistant to acids and alkalis.

Unibond. Unibond Ltd., Glebeland Road, Camberley, Surrey. Camberley 3135.

Unitimb. Unibond Ltd.

Faster setting than Unibond.

Evostik W. Evode Ltd., Industrial Adhesives Div., Common Road, Stafford. Stafford 2241.

Bexol 657. BXL Industrial Products Group Ltd., Manningtree, Essex. Manningtree 2401.

Croid 843. Croid Ltd., Berkshire House, High Holburn, London WC1. 01-836 7777.

Polystik. Croid Ltd. pH-6.5.

National 233-0553. National Adhesives & Resins Ltd.

Tufskin. Alfred Adams & Co. Ltd., Reliance Works, West Bromwich, Staffs. 021-553 0263.

Aerocol 4501. CIBA/GEIGY Ltd., Duxford, Cambridge. Sawston 2121.

Tenaxatex W.S. 3956. Williams Adhesives Ltd., 247 Argyll Avenue, Trading Estate, Slough, Berks. Slough 24343.

Plasticised emulsion used by BM(NH) Palaeo. Lab. in place of Vinamul N.9146.

Vinamul 6815. Vinyl Products Ltd. but obtainable from Frank W. Joel Ltd., Oldmedow Road, Hardwick Industrial Estate, King's Lynn, Norfolk PE30 4HA. 0553 60851.

15% plasticiser content. Used in many museums, particularly the archaeology sections.

COLD-SETTING ADHESIVES – NON-AQUEUS SOLVENT BASED

Thermoplastics in solution. NB. Thermoplastics are subject to cold flow and are therefore not used as structural adhesives. In the museum they should not be used to cement weighty objects, e.g. large, heavily mineralised dinosaur limb-bones, without the aid of dowelling.

Acrylic. **Tensol cement no. 6.** ICI Ltd. Solvent: 1–2 dichloroethane (ethylene dichloride), highly flammable, FP. 13°C. For bonding acrylic sheet, moderate strength bond, limited gap filling.

• NB. May be used to repair fossil bone, where weights of no more than a few grammes are involved. In small sectional contacts, setting (solvent evaporation) is moderately rapid, handling possible in 1–15 minutes.

Scrap 'perspex' (clean) may be dissolved in dichloromethane (non-flammable, but harmful), dichloroethane, or ethyl acetate (highly flammable, FP. −5°C) to provide a cheap, effective alternative to a retail product.

Cellulose acetate. (R) **PUK-KA Balsa cement.** M. Marcel Guest Ltd., Riverside Works, Collyhurst Road, Manchester 9. 061-205-2644. For balsa wood, paper, and polystyrene.

Lepage's Balsa cement. Henry C. Stephens Ltd., Britannia House, Drayton Pk., London N5. 01-226-4455.

Joyplane cement. Turnbridges Ltd., 72 Longley Road, London SW17. 01-672-6581/3.

The cellulose esters (i.e. acetate, acetate-butyrate, caproate and nitrate), are commonly used as adhesives, setting by evaporation of their solvent. Cellulose nitrate should be avoided for museum use, due to its flammability, rapid discolouring on exposure to light (particularly sunlight) and its general instability over time. Cellulose acetate is the most commonly used as an adhesive and as the "peel material" in serial sectioning, but the acetate-butyrate does have better water and heat resistance and is compatible with a wider range of plasticises. Both of these esters have resistance to weak acids and certain solvents, oils and mould attack.

Polystyrene. Transparent and colourless, good resistance to water and mould growth. Strong bonds may be obtained, but there is a tendency to brittleness and crazing. Very soluble in most of the commonly used solvents. Used for joining polystyrene parts (not expanded polystyrene), wood, cork and paper, and has been used to seal museum specimen jars, and to cement fossil bone in acetic acid preparations.

(R) **HMG Polystyrene cement.** H. Marcel Guest Ltd.

(R) **Revell "S"** cement. Revell Ltd., Cranbourne Road, Potters Bar, Herts. Potters Bar (77) 58261.

(R) **Joy polystyrene cement.** Turnbridges Ltd.

• NB. Dissolve polystyrene granules (from BDH, or other chemical suppliers) in acetone, toluene, ethyl acetate, or dichloromethane. Scrap, clear, polystyrene may also be used, but cross-linking may have occurred leading to an insoluble gel in the solvent.

Polyvinyl acetal. **Alvar 1570** – Shawinigan Ltd. Monsanto Ltd. No longer obtainable although once a popular adhesive and hardener used in palaeontolgy and archaeology.

Polyvinyl butyral. Supplied in fine granular form and readily soluble in ethanol, industrial methylated spirit, Cellosolve, ethyl acetate, etc. forming clear, colourless solution.

Butvar B90 or **B98.** Monsanto Ltd. (mnfrs – see Appendix 2B) B98 supplied by F. W. Joel Ltd. Unit 5, Oldmedow Road, Hardwick Industrial Estate, King's Lynn, Norfolk, PE30 4H. 0553-60851. Also, TAAB Laboratories Equipment Ltd., 40 Grovelands Road, Reading, Berks. 0734 588033.

Butvar B76. Monsanto Ltd,. U.K. agents Cairn Chemical Ltd., 60 High St., Chesham, Bucks HP5 1EG. Chesham 786066.

• NB. Cairn Chemicals Ltd. will answer queries, but are not always able to supply small quantities, and B76 is not supplied by F. W. Joel.

For use as an adhesive the Butvars should be dissolved in the more volatile solvents such as ethyl acetate. Butvar B76 may be dissolved in acetone, unlike B90 or B98.

Polyvinyl formal. Similar to above but insoluble in the alcohols & ketones but soluble in some chlorinated hydrocarbons. Used in electron microscopy.

Polyvinyl acetate.

(R) **Joy plastic cement.** Turnbridges Ltd.

Sellobond Clear. Sellotape Products Ltd., Elstree Way, Borehamwood. 01-953-1655.

(R) **UHU.** Liberta-Imex Ltd., 37–38 Margaret Street, London W1 01-629-9668.

• A useful, easily re-soluble general purpose adhesive for use in museum work. May be diluted for use as a consolidant (but not for acid preparations).

Rosin (Colophony). A natural resin, soluble in a wide range of organic solvents, e.g. alcohols, ketones, turpentine. Good water resistance, but brittle. Used in can labelling, felt, cork, etc. to metal. Still in favour in conservation of wood. Low bond strength. Supplied in lump form by F. W. Joel Ltd *or* A. F. Suter & Co. Ltd. Susan Wharf, 60 Dace Road, Bow, London E3 2NQ. 01-986-8218/9.

Shellac. Similar characteristics to Rosin. May be sold as solid, e.g. Shellac, Brillac, Button-lac, etc. or in alcoholic solvent solution. Once in common use in museums as cement and consolidant, but its low bond strength, brittleness, poor penetration and re-solubility problems (particularly if used as a hot-melt glue), as well as increasing cost, have reduced its use.

Silicones and *thermosetting resins* such as the epoxies and polyesters, etc. come outside this incomplete review, but if use is made of this type of adhesive, attention must be paid to their lack of re-solubility and health hazards.

References

FELLER, R. L., STOLLOW, N. & JONES, E. H. 1971 (Rev. ed.) On picture varnishes and their solvents. Press of Case Western Reserve Univ., Cleveland, Ohio. 251pp.

HURD, J. 1959 (repr. 1960, 1962). Adhesives guide. BSIRA Research Report M.39. Cable Printing & Publishing Co. Ltd., London. 138pp.

SHIELDS, J. 1970. Adhesives handbook. Butterworths, London. 355pp.

AAT Abstracts. London (IIC & Getty Trust), (Art & Archaeology Technical Abstracts). Include author and subject index plus occasional special supplements. e.g. polymers.

APPENDIX 2

APPARATUS, EQUIPMENT AND MATERIALS

Please note that the names and addresses listed have not all been checked with the firms concerned; so inaccuracies may exist. The inclusion of a firm's name does not necessarily mean that it will be prepared to supply, especially in small quantities. Appendix 2A lists products with their manufacturer and supplier and their addresses can be found in Appendix 2B, arranged alphabetically.

APPENDIX 2A

PRODUCTS

Where differentiated, manufacturers' names are given first, set to the right, with supplier's names aligned to the left.

'ACETATE' SHEET
Smith Bros. Asbestos

AIRBRASIVE and accessories. (See also Sandmaster)
G.E.C. Mechanical Handling

A.J.K. Dough, & Fibrenyle ingredients.
F. W. Joel

ALGINATE moulding compounds, including Blueprint.
F. W. Joel
Dentsply
Cottrell & Co.

ALOPLAST "Plasticine" recommended for use with the polyester resins.
Trylon

ALUMINIUM foil and sheet.
Star Aluminium
J. Smith & Sons

ANTHOGYR POWER MALLET (Dental) No. 2650 (see also Techdent 2650)
Marcel Courtin

ARCHIVAL AIDS
Atlantis Paper Co.

BARBOLA MODELLING PASTE
Alec Tiranti

BEDACRYL 122*X* See under Synocryl

BLUEPRINT, De Trey (See Alginate . . .)

BUTVAR (Monsanto)
Cairn Chemicals
F. W. Joel
Taab Laboratories

CABINETS (see under, Storage cabinets and units)

CARBOWAX 4000 (See also Polyethylene glycol)
Union Carbide
Taab Laboratories

CELLULOID sheeting
Money Hicks

CELLULOSE THINNERS
Hardware, ironmongery and paint stores

CHISELS, cold or stone-carving.
Hardware and ironmongery stores
Alec Tiranti
E.L.E.
C. A. Pisani & Co. (Sales)

CLAY, modelling
Alex Tiranti Ltd

CUPBOARDS, metal
Matthews & Sons

CYANO-ACRYLATE ADHESIVES (see "Powabond")

DEHUMIDIFIERS
Haydon-Air Distribution Ltd

DENTAL HAND TOOLS
Cottrell & Co.
Dentsply

DENTAL MALLETS (See under Anthogyr)

DENTAL WORKSHOP MOTORS, flexible drives and controls

Citenco (Part Products)
The Foredown Electric Co.
Derotor (John Quayle)
Park Products
Morrisflex
John Quayle Dental Manufacturing Co.

DETACHABLE ROTARY HANDPIECES FOR DETAL MOTORS, e.g. Foredom; 'Derotor'; W and H; KaVo (respectively)

Morrisfiex
John Quayle Dental Mfg Co.
J. & S. Davis
KaVo Dental

DUST CONTROL

Spencer & Halstead

ENGRAVERS, dental (see under Anthogyr)

ENGRAVERS, electric

Burgess Power Tools
Dremel Mfg Corpn.
Jensen Tools Inc.
Burgess Power Tools
Toolrange
Southern Watch & Clock Supplies
Griffin & George
Gallenkamp
Special Products Distributors
F. W. Joel

ENGRAVERS, pneumatic.

Desoutter
C. A. Pisani & Co. (Sales)
Desoutter

ENGRAVERS, vacuum.

GRS Corporation

ETHANOLAMINE THYOGLYCOLLATE

Robinson Bros

FIBRENYLE (see A. J. K. Dough)

FIMO modelling compound, oven curing.

F. W. Joel

GAUZE, cotton (B.P.B. Absorbent Gauze).
John Bell & Croyden
various pharmacies

GLASSFIBRE materials.
Strand Glass Co.
Alex Tiranti
Trylon

GOGGLES, safety.
F. W. Joel
Alex Tiranti
ARCO (Hollman Nicheolls)
Payne Scientific
and some ironmongers, D.I.Y. stores

HAMMERS, club and lump.
Alex Tiranti
and some ironmongers

HAMMERS, geological.
Gregory Bottley & Lloyd
The Geological Museum
E.L.E.
Griffin & George
Lapidary (D.I.Y.) shops
some ironmongers

HANDLING equipment.
The Paul Corbett Co.
Slingsby

LABORATORY ware.
Astell Hearson
Baird & Tatlock
Gallenkamp
Griffin & George
Jencons (Scientific)
Patterson Scientific
Payne Scientific Apparatus
Philip Harris
Richardsons of Leicester
Scientific Furnishings

LAPIDARY materials
Macfarlane Robson

MAGNIFIERS
Payne Scientific Apparatus
Gregory, Bottley & Lloyd

MICROSCOPES
Carl Zeiss (Obankochen)
A. Gallenkamp & Co.
E. Leitz (Instruments)
Nikon (Instrument Division) U.K.

MESH, woven metal.
R. Cadisch & Sons

MODELLING tools, etc.
Alec Tiranti

MOD-ROC, a plaster impregnated bandage.
Alec Tiranti

MONITORING EQUIPMENT, for environmental control.
Casella London

N.H.P. mounting & modelling plastic (2 part).
Howmedica

PINS, steel, headless 15 swg
Armstrong World Industries
Specialist flooring shops
Ashmount Flooring Supplies

PIN VICES, various, inc. *Eclipse* range.
Hardware and ironmongery stores
Laboratory suppliers

PLASMOLEGNO, wood pulp modelling material, air drying.
Alec Tiranti

PLASTER OF PARIS, casting grades,
Builders' merchants
Strand Glass Co.
Trylon
Alec Tiranti

PLASTERERS' SCRIM (inc. jute scrim pipe lagging in 90 mm wide rolls) See also "*Mod-Roc*"
Builders' merchants
Strand Glass Co.
Trylon
Alec Tiranti

PLASTICINE
Alec Tiranti
Toy shops

PLASTONE self-hardening modelling material.
Alec Tiranti
Toy shops

POLISHERS AND GRINDERS
Banner Scientific
Logitech

POLYBUTYL METHACRYLATE (see Bedacryl & Synocryl)

POLYESTER RESINS
Scott Bader
British Industrial Plastics, etc.
Strand Glass Co.
Alec Tiranti
Trylon

POLYETHYLENE GLYCOL (see also 'Carbowax')
B.D.H.

POLYMETHYL METHACRYLATE powder, solutions, emulsions
F. W. Joel

POLYMETHYL METHACRYLATE two-part, cold-setting resin (see N.H.P.)

POLYSTYRENE FOAM
Smith Bros. Asbestos

POLYTHENE bubble-pack.
'Sancell'
M. Laurier & Sons

POLYURETHANE ELASTOMERS two-part, cold curing, e.g. Tryflex, Smooth-On, PMC-704, Flexane
Trylon
W. P. Notcutt
Buck & Ryan

POLYURETHANE FOAM, two-part, cold setting systems.
Strand Glass Co.
Trylon
F. W. Joel

POLYVINYL ACETATE, powder or granules, various molecular weights.
B.D.H.
F. W. Joel

POLYVINYL ACETATE, emulsions (e.g. Evostik Resin W., Tenaxatex WS 3956. Vinamul 6815)
Builders' Merchants and ironmongers

Williams Adhesives
F. W. Joel

POWABOND, cyano-acrylate adjesives & Q.F.S. aerosol.
H. H. International Marketing

H. H. International Marketing

REPROSIL, fast curing silicone dental moulding liquids, pastes and putty.
De Trey

Dentsply
Cottrell & Co.

RESPIRATORS (check for relevant British Standard compliance)
3M
Siebe Gorman North
Martindale

ARCO Ltd.
Collins & Chambers
Alec Tiranti
F. W. Joel
some laboratory suppliers
some ironmongery and D.I.Y. shops

ROCK CUTTING
Banner Scientific Ltd.
Logitech Ltd.
Metallurgical Services Laboratories

RUBBER LATEX, various formulations, fillers, pigments.
Revertex
Dunlop

Bellman, Ivey & Carter
Stand Glass Co.
Trylon
D. B. Shipping
F. W. Joel

SAFETY APPARATUS clothing, disposal cans, eye protection, first-aid boxes, fire blankets, fire-resistant cabinets, etc.
Payne Scientific Apparatus
Hearing Protection – ear protection.

SANDMASTER and accessories (alternative to Airbrasive)
Unitool A.G.

Bevis Control Systems

SCREWS, NUTS, BOLTS, FASTENERS
B. F. Wade
Ironmongery & D.I.Y. stores

SEPARATORS and *RELEASE AGENTS* Refer to data sheets supplied with moulding compounds

SHELVING metal. (See under Storage shelving)

SIEVES

Endecotts

Endecotts
laboratory suppliers
hardware and ironmongery stores

SILICONE cold-cure silastomers (moulding compounds).

Dow Corning (Silastics)
Ambersil (RTV's & ICI's Silcosets)
General Electric (RTVs)
De Trey (Reposils)
Wacker Chemie
Compounding Ingredients (Por a Mold)

Ambersil
Croylek (for G. E. RTV)
Cottrell & Co. & Dentsply (for Reprosils)
Micro Products Co. (for Wacker)
Compounding Ingredients
B.D.H. Chemicals (for Silastics)
Alec Tiranti (for G.E. RTV)
F. W. Joel (for Rhodorsil RTV)
Strand Glass (for Por a Mold)
Trylon

SILICONE FLUID e.g. M.S. 200/350 c.s.
B.D.H. Chemicals
Alec Tiranti
and several of the suppliers of silastomers

SLIDES cavity, single and multi-celled, etc.
E. K. Hull Microslide Co.
Whitehead Lapidary
Northern Biological Supplies

SOLVENTS and other reagents

B.D.H.
Hopkin & Williams

for smaller quantities:
F. W. Joel
John Bell & Croyden, and
some other pharmacies

SPECIMEN TUBES

Griffin & George
Henleys Medical Supplies
Solmedia

STORAGE BAGS, polythene, paper, etc.

The Airbourne Paper & Packaging Co.
Gallenkamp & Co.
R. Mitchel (Grantham)
E. J. Page & Co.
Transatlantic Plastics

STORAGE BOXES, cardboard, wood and plastic

William Allen & Co.
W. G. Boon & Son
Bury Box Making Co.
Clemson & Harper Packaging
Henleys Medical Supplies
High Speed Carton Supply Services
J. E. Ingham & Son
Nicholls Maxwell
Newdigate Boxes
Plastic Box Co.
Pressboard Ltd
G. Ryder & Co.
Sandhill Ltd
Simpkin & Icke
Alfred Stanley & Son
The Worcester Box Co.

STORAGE CABINETS & UNITS

B & R Builders
Bristol Storage Equipment
John Cochrane & Co.
C. H. Gillman & Sons
Gregory, Botley & Lloyd
Matthews & Sons
Oxford University Surveyors Office
Remploy Ltd
T. Scrafton & Sons
Stephenson Blake & Co.

STORAGE, COMPACT/MOBILE

Bruynzeel Storage Systems
The Paul Corbett Co. Ltd
Dexion Ltd

STORAGE DRAWERS

B & R Builders
C. H. Gillam & Sons
John Williams (E.C.C.)
Oxford University Surveyors Office

STORAGE SHELVING

Bruynzeel Storage Systems
Dexion
Forme Storage
Libraco
Link 51
Shrub Hill Fabrication
SOS Display (Fabrication)
Stratford Storage Systems

STORAGE TRAYS, cardboard specimen trays

W. G. Boon & Sons
Bury Box Making Co.
Clemson & Harper Packaging
Robert Cullen
Ferry Pickering Boxes
London Fancy Box Co.
S. E. Milbourne
Newdigate Boxes
North Western Boxmakers
Remploy
Robinson of Chesterfield
A. Stephens & Co.
Philip Ziege & Sons

STEEL, tube, rod, bar and flat – bending quality.
See *Yellow Pages* for local stockists

STICKS, wooden (for mixing resins, etc.)
Trylon

SYNOCRYL, 9122 × (formerly Bedacryl 122 ×)

Cray Valley Products

F. W. Joel
BDH

TECHDENT Power Mallet No. 2650 (see Anthogyr)

THIN-SECTION production.
Logitrech
Banner Scientific

TONGUE DEPRESSORS, wooden (for use as disposable spatulas, etc.)
John Bell & Croyden
and some other pharmacies.

TOOLS, woodworking, etc.
Local ironmongers & builders' merchants
Toolrange (catalogue)
Toolmail (catalogue)
Southern's
Some laboratory suppliers (limited range)

TUBING, flexible, rubber and plastics.
Laboratory suppliers
Esco Rubber

TUBING, rigid, resin/glassfibre, e.g. Primatube.
Ogden, Smith & Hussey

U-V LAMPS etc.,
U-V Products

VIBROTOOL (See Engravers)

WAXES, *RESINS*, *GUMS* (natural)
R. F. Suter & Co.

APPENDIX 2B

ADDRESSES

Alphabetical list of names and addresses of manufactuers, suppliers, and other useful addresses.	Telephone Nos.
AIRBORNE PAPER & PACKAGING CO. LTD, Pegasus House, Beatrice Road, Leicester, LE1 9FH	
ALLEN, WILLIAM, & CO. LTD, Anchor Works, Lower Parliament Street, Nottingham, NG1 1GH.	
AMBERSIL Ltd, Whitney Road, Daneshills, Basingstoke, Hants.	0256 28086
AMERICAN ASSOCIATION FOR STATE AND LOCAL HISTORY, 708 Berry Road, Nashville, Tennessee 37204, U.S.A.	
ARCO LTD P.O. Box 21, Waverley Street, Hull, HU1 2SJ.	0482 27678
ARCO LTD P.O. Box 7, Milner Way, Ossett, West Yorks, WF5 9JG.	0924 276131
ARCO LTD P.O. Box 22, Portrack Lane, Stockton-on-Tees, Cleveland, TS18 2PD.	0642 617441
ARCO LTD P.O. Box 8, Tundry Way, Chainbridge Road Estate, Blaydon-on-Tyne, Tyne & Wear, NE21 5TP	0632 447721
ARCO LTD P.O. Box Western P.D.O. No. 3, Glaisdale Drive West, Nottingham, NG8 4GS.	0602 286411
ARCO ATHOLL LTD, Heatherhouse Industrial Estate, Irving, Ayrshire, KA12 8LG.	0294 72811
ARCO ATHOLL LTD, Newby Road, Industrial Estate, Hazel Grove, Stockport, Cheshire, SK7 5EZ.	0614 565000
ARCO ATHOLL LTD, Hooton Road, Hooton, Ellesmere Port, South Wirral, Merseyside, L66 7PA	051 327 6666
ARCO ATHOLL LTD, Avon Mill Industrial Estate, Mill	

Road, Linlithgow Bridge, Linlithgow, West Lothian, EH49 7QY.	050 684 4661
ARCO HOLLMAN NICHOLLS, Orpington Industrial Estate, Station Road, Sevenoaks Way, Orpington, Kent, BR5 3SR.	0689 75411
ARCO HOLLMAN NICHOLLS, Unit B, Oakcroft Road, Chessington, Surrey, KT9 1TW.	01 397 6171
ARMSTRONG WORLD INDUSTRIES LTD, 351a, Caledonian Road, London, N.1.	01 607 2777
ASHMOUNT FLOORING SUPPLIES LTD, 77 Garman Road, London, N.17.	01 808 2158
ASTELL HEARSON, 172 Brownhill Road, London, SE6 2DL	01 697 8811
ASTELL HEARSON, Unit 1, Brickfields, Huyton Industrial Estate, Huyton, Merseyside, L36 6HY.	051 480 4014
ATLANTIS PAPER CO., Gulliver's Wharf, 105 Wapping Lane, London, E1 9RW.	01 481 3784
BACK PAIN ASSOCIATION, 31 Park Road, Teddington, Middx.	01 977 5474
BAIRD & TATLOCK (LONDON) LTD, P.O. Box 1, Freshwater Road, Chadwell Heath, Romford, RM1 1HA	01 590 7700
BAIRD & TATLOCK Millbuck Industrial Estate, Moston Road, Sandbach, Cheshire, CW11 9YA.	Sandbach 7411
[Other distribution centres, see Davidson & Hardy, Ferris & Co., MacFarlane Robson and M. W. Scientific]	
BANNER SCIENTIFIC LTD, Binns Close, Torrington Avenue, Tile Hill, Coventry, CV4 9TB.	0203 471411
BDH CHEMICALS LTD, Broom Road, Poole, BH12 4NN.	0202 745520
BELLMAN IVEY & CARTER LTD, 358b, Grand Drive, West Wimbledon, London, S.W.20.	01 540 1372
BEVIS CONTROL SYSTEMS, 25 Moorfield Road, Orpington, Kent.	0689 38790
BOON, W. G. & SONS, 8 Mewnham Road, Plymouth.	
B.I.P. LTD, Oldbury, Warley, Eest Midlands, B69 4PD.	021 552 1551
B & R BUILDERS, 7A Balfour Street, Leicester.	
BRISTOL STORAGE EQUIPMENT LTD, Cambridge House, Waterloo Street, Old Market, Bristol, BS2 0PH.	0272 555211
BRITISH LIBRARY, REFERENCE DIVISION, Great Russell Street, London, WC1B 3DG.	
BRUYNZEEL STORAGE SYSTEMS LTD, Stocklake, Aylesbury, Bucks, HP20 1DG.	0296 5081
BUCK & RYAN LTD, 101 Tottenham Court Road, London, W.1.	01 636 7475
BURGESS POWER TOOLS LTD, Sapcote, Leicester, LE9 6JW	045 527 2292
BURY BOX MAKING CO. LTD, Badger Street, Bury, Lancs. BL9 6AD	061 764 4502
CADISCH, R. & SONS, Arcadia Avenue, Regents Park Road, Finchley, London, N3 2JZ.	01 346 8562

CAIRN CHEMICALS LTD, 60 High Street, Chesham, Bucks, HP5 1EG.	Chesham 786066
CASELLA LONDON LTD, 109 Britannia Walk, London, N.1.	01 253 8581
CLEMSON & HARPER PACKAGING, Kingston Works, Forman Street, Derby, DE1 1JQ.	0332 48130 or 45112
COCHRANE, JOHN, & CO. LTD, 70 Dobbies Loan, Glasgow, G4.	041 552 3328
COLLINS & CHAMBERS LTD, 197–199 Mare Street, London, E8 3QF.	01 985 9970 01 985 0752/3
COMPOUNDING INGREDIENTS LTD, Byrom House, Quay Street, Manchester, M3 3HS.	061 832 3035/6 061834 8492-5
CORBETT, THE PAUL, CO. LTD, 77 London Road, East Grinstead, Sussex RH19 1EJ.	0342 25033
COTTRELL & CO., 15 Charlotte Street, London, W.1.	01 580 5500
COURTIN, MARCEL, Courtin House, Horsham Road, Capel, Surrey.	Dorking 711278
CRAY VALLEY PRODUCTS LTD, St. Mary Cray, Orpington, Kent, BR5 3PP	Orpington 32545
CROYLEK LTD, 23 Ullswater Crescent, Coulsdon, Surrey, CR3 2UY.	01 668 4820/6980
CULLEN, R., 98 Commerce Street, Glasgow, G5.	041 429 3443
DAVIDSON & HARD (LABORATORY SUPPLIES) LTD, 453–455 Antrim Road, Belfast, BT15 3BL.	776235/6/7
DAVIS, J. & S. LTD, Cordent House, Friern Park, London, N.12.	01 446 2391 01 445 1072
D. B. SHIPPING LTD, Monument House, 16 Monument Street, London, E.C.3.	01 632 2316
DENTSPLY LTD, 9 Madleaze Trading Estate, Bristol Road, Cloucester, GL1 5SG.	0452 424351
DESOUTTER LTD, 319 Edgware Road, Colindale, London, NW9 6ND.	01 205 7050
DEXION LTD, Maylands Avenue, Hemel Hempstead, Herts, HP2 7EW.	0442 42261
DOW CORNING LTD, Reading Bridge House, Reading, Berks.	Reading 57251
DUNLOP SEMTEX LTD, Chester Road, Erdington, Birmingham, B35 7AL	021 373 8101
DUNN & WILSON GROUP LTD, Glasgow Road, Camelon, Falkirk, FK1 4HP.	0324 1591
E.L.E. INTERNATIONAL LTD, Eastman Way, Hemel Hempstead, Herts, HP2 7HB.	0442 50221
ENDECOTTS LTD, 9 Lombard Road, London, S.W.19.	01542 8121
ESCO (RUBBER) LTD, 43 Broad Street, Teddington, Kingston-upon-Thames.	01 977 0806
FERRIS & CO. LTD, Kenn Road, Hillside Road, St. George, Bristol, BS5 7PE.	0272 551601

FERRY PICKERING BOXES LTD., 53 Meadow Lane, Loughborough, Leics.	
FIRE PROTECTION ASSOCIATION. 140 Aldersgate St., London EC1A 4HX	01 606 3757
FORME STORAGE, Scotland Street, Birmingham, B1 2RL.	021 233 1297
GALLENKAMP, A. & CO. LTD, P.O. Box 290, Technico House, Christopher Street, London, EC2P 2ER.	01 247 3211
GALLENKAMP, A. & CO. LTD, Frederick Street, Birmingham, B1 3HT.	021 236 2552
GALLENKAMP, A. & CO. LTD, P.O. Box 19, Victoria House, Widnes, Cheshire, WA8 0NL.	051 424 2040
GALLENKAMP A. & CO. LTD, Portrack Lane, Stockton-on-Tees, Cleveland TS18 2PT.	0642 63441
GALLENKAMP, A. & CO. LTD, Braeview Place, Nerston, East Kilbride, Glasgow, G74 3XJ.	035 52 22281
G.E.C. (MECHANICAL HANDLING) LTD, Birch Walk, Erith, Kent, DA8, 1QH.	Erith 36933
GEOLOGICAL MUSEUM BOOKSHOP, Exhibition Road, London, SW7.	01 589 3444
GILLAM, C. H. & SONS, Harland Road, Sheffield 11.	
GREGORY BOTTLEY & LLOYD, 8–12 Ricketts Street, London, SW6 1RU.	01 381 5522
GRIFFIN & GEORGE LTD, 285 Ealing Road, Alperton, Wembley, Middlesex, HA0 1HJ.	01977 3344
GRIFFIN & GEORGE LTD, Braeview Place, Nerston, East Kilbride, Glasgow G74 3XE.	035 52 22281
GRIFFIN & GEORGE LTD, Ledson Road, Wythenshawe, Manchester M23 9NP.	061 998 5221
G.R.S. CORPORATION, P.O. Box 748, Emporia, Kansas 66801, U.S.A.	316 343 1084
HAYDON-AIR DISTRIBUTION LTD, 221 Old Christchruch Rd., Bournmouth, Dorset, BH1 1PG.	0202 24592
HEALTH & SAFETY EXECUTIVE, IAS2, Rm. 414, St Hugh's House, Bootle, Merseyside, L20 3QA	
HEARING PROTECTION LTD, 2 Tenter Rd., Moulton Park Ind. Estate, Northampton, NN1 1PZ.	
HENLEYS MEDICAL SUPPLIES LTD, Clarendon Rd., Hornsey, London, N8 0DL.	01-889 3151
HH (DOUBLE H) INTERNATIONAL MARKETING LTD, 33 Clarence St., Staines, Middx. TW18 4SY.	01-759 9981 or Staines 0784 5545
HIGH SPEED CARBON SUPPLIES SERVICES, Units 1 & 2 Mill Lane, Alton, Hants.	
HOWMEDIA INTERNATIONAL, 622 Western Avenue, London, W3 0TF	01-992 7045 8044
HULL, E. K. MICROSLIDE CO, 24 Lynmouth Gardens, Perivale, Middx. UB6 7HR	01-935 3777 01-998 2256

CAIRN CHEMICALS LTD, 60 High Street, Chesham, Bucks, HP5 1EG.	Chesham 786066
CASELLA LONDON LTD, 109 Britannia Walk, London, N.1.	01 253 8581
CLEMSON & HARPER PACKAGING, Kingston Works, Forman Street, Derby, DE1 1JQ.	0332 48130 or 45112
COCHRANE, JOHN, & CO. LTD, 70 Dobbies Loan, Glasgow, G4.	041 552 3328
COLLINS & CHAMBERS LTD, 197–199 Mare Street, London, E8 3QF.	01 985 9970 01 985 0752/3
COMPOUNDING INGREDIENTS LTD, Byrom House, Quay Street, Manchester, M3 3HS.	061 832 3035/6 061834 8492-5
CORBETT, THE PAUL, CO. LTD, 77 London Road, East Grinstead, Sussex RH19 1EJ.	0342 25033
COTTRELL & CO., 15 Charlotte Street, London, W.1.	01 580 5500
COURTIN, MARCEL, Courtin House, Horsham Road, Capel, Surrey.	Dorking 711278
CRAY VALLEY PRODUCTS LTD, St. Mary Cray, Orpington, Kent, BR5 3PP	Orpington 32545
CROYLEK LTD, 23 Ullswater Crescent, Coulsdon, Surrey, CR3 2UY.	01 668 4820/6980
CULLEN, R., 98 Commerce Street, Glasgow, G5.	041 429 3443
DAVIDSON & HARD (LABORATORY SUPPLIES) LTD, 453–455 Antrim Road, Belfast, BT15 3BL.	776235/6/7
DAVIS, J. & S. LTD, Cordent House, Friern Park, London, N.12.	01 446 2391 01 445 1072
D. B. SHIPPING LTD, Monument House, 16 Monument Street, London, E.C.3.	01 632 2316
DENTSPLY LTD, 9 Madleaze Trading Estate, Bristol Road, Cloucester, GL1 5SG.	0452 424351
DESOUTTER LTD, 319 Edgware Road, Colindale, London, NW9 6ND.	01 205 7050
DEXION LTD, Maylands Avenue, Hemel Hempstead, Herts, HP2 7EW.	0442 42261
DOW CORNING LTD, Reading Bridge House, Reading, Berks.	Reading 57251
DUNLOP SEMTEX LTD, Chester Road, Erdington, Birmingham, B35 7AL	021 373 8101
DUNN & WILSON GROUP LTD, Glasgow Road, Camelon, Falkirk, FK1 4HP.	0324 1591
E.L.E. INTERNATIONAL LTD, Eastman Way, Hemel Hempstead, Herts, HP2 7HB.	0442 50221
ENDECOTTS LTD, 9 Lombard Road, London, S.W.19.	01542 8121
ESCO (RUBBER) LTD, 43 Broad Street, Teddington, Kingston-upon-Thames.	01 977 0806
FERRIS & CO. LTD, Kenn Road, Hillside Road, St. George, Bristol, BS5 7PE.	0272 551601

FERRY PICKERING BOXES LTD., 53 Meadow Lane, Loughborough, Leics.	
FIRE PROTECTION ASSOCIATION. 140 Aldersgate St., London EC1A 4HX	01 606 3757
FORME STORAGE, Scotland Street, Birmingham, B1 2RL.	021 233 1297
GALLENKAMP, A. & CO. LTD, P.O. Box 290, Technico House, Christopher Street, London, EC2P 2ER.	01 247 3211
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G.E.C. (MECHANICAL HANDLING) LTD, Birch Walk, Erith, Kent, DA8, 1QH.	Erith 36933
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APPENDIX 3

NATIONAL SCHEME FOR GEOLOGICAL SITE DOCUMENTATION

The National Scheme has its origins in the constitution of the Geological Curators' Group which was drafted in 1974. Article 2 states that "The purpose of the Group shall be to improve the status of Geology in museums and similar institutions, and the standard of geological curation in general by:–

2.5 the advancement of the documentation and conservation of geological sites".

This statement reflected the growing awareness that museum geologists have a responsibility to the geological environment generally as well as for their collections and visitors. Indeed most collections held in museums contain specimens from the local area and willy nilly site information has been documented ever since specimens began to find their way into museum collections.

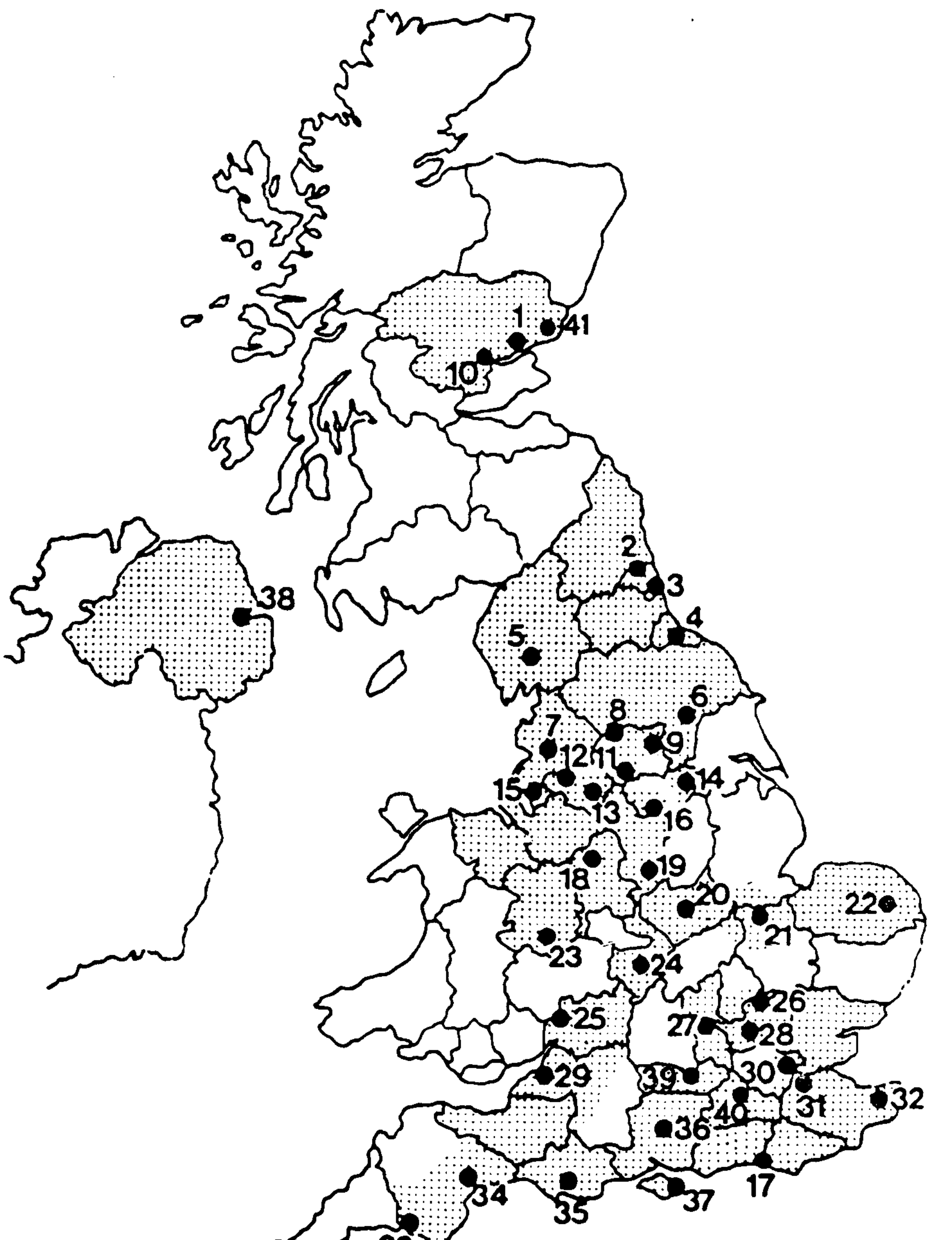
Many museum services, since local government reorganisation, have undertaken responsibility for environmental recording and systematically accumulated information relating to geological sites. The GCG proposed a National Scheme in 1975 in order to ensure that the local initiatives would contribute effectively to the Nature Conservancy Council's conservation policy of reducing the burden of educational use on the relatively small number of SSSI's. The scheme, initiated in 1977 with the aid of NCC finance and in close co-operation with the Geology & Physiography Section of NCC, is based on 40 Record Centres, almost all museums, each collecting and recording information on sites according to recognised methods and standards laid down in the *Geological Record Centre handbook* published to accompany the scheme in 1980.

Each centre is responsible for its own records, covering a specified area usually of County status, and the dissemination of information. There are no plans for a centralised data bank although this is certainly feasible. The 1983 Annual Report of the Scheme shows that over 19,000 site records are held in Centres. These include data on boreholes, mines, disused and active quarries and pits, restored sites, geomorphological features and natural and temporary exposures. Each site has a site file containing information obtained initially through fieldwork and/or literature searches plus all additional material known, i.e. site maps, photographs, sections and photocopied publications. From the site file a Summary Record sheet is produced, which, as its name implies, gives a convenient summary of the contents of the file. The sheet provides an ideal document for copying and distribution and saves considerable time and duplication of effort in repeated searching and collating of site information.

The work undertaken by museum curators in recording geological sites is seen as a most important part of their work within the science of geology and as an invaluble resource for their work within their museum.

Site information is used by Centres to provide:

- a consultancy service for NCC, County Trusts, County Planning Departments, researchers and others concerned with site conservation management and use.
- an advisory service to teachers regarding the educational potential of sites and to direct these users away from over-used SSSI's, research and other vulnerable localities.



Appendix 3 Map. Map showing recording centres of the National Scheme for Geological Site Documentation. The numbers refer to the address list and are of no other significance.

- a resource for internal use supplying easy access to local geological information for specimen documentation, collecting policies and research for exhibitions and publications.

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Recording Centres

1. TAYSIDE REGION Mr D. S. Henderson, Museum & Art Gallery, Albert Square, Dundee. DD1 1DA.
2. NORTHUMBERLAND (North of Tyne). Director, Hancock Museum, The University, Barras Bridge, Newcastle upon Tyne. NE2 4PT.
3. NORTHUMBERLAND (South of Tyne) DURHAM. Mr T. Pettigrew, Museum & Art Gallery, Borough Road, Sunderland. SR1 1PP.

4. CLEVELAND Mr K. Sedman, Cleveland County Museum Service, Cleveland Gallery, Victoria Road, Middlesborough.
5. CUMBRIA Mr S. Drinkwater, National Park Centre, Brockhole, Windermere, Cumbria. LA23 1LJ.
6. NORTH YORKSHIRE Miss B. Pyrah, The Yorkshire Museum, Museum Gardens, York. YO1 2DR.
7. LANCASHIRE Mr J. D. Blundell, Lancashire Museum Service, Stanley Street, Preston. PR1 4YP.
8. BRADFORD DISTRICT (West Yorkshire) Miss A. Armstrong, Cliffe Castle Museum, Spring Gardens Lane, Keighley. BD20 6LH.
9. LEEDS DISTRICT Mr J. Nunney, City Museum, Municipal Buildings, Leeds. LS1 3AA.
10. PERTH DISTRICT Mr M. A. Taylor, Museum & Art Gallery, George Street, Perth. PH1 5HR.
11. KIRKLEES (West Yorkshire) Director, Bagshaw Museum, Wittong Park, Batley, Yorkshire, WF17 OAS.
12. BOLTON BOROUGH Mr A. Howell, Museum & Art Gallery, Le Mans Crescent, Bolton. BL1 1SA.
13. GREATER MANCHESTER Dr R. M. C. Eager, The Manchester Museum, University, Manchester. M13 9PL.
14. DONCASTER BOROUGH Miss A. Pennington-George, Museum & Art Gallery, Chequer Road, Doncaster. DN1 2AE.
15. MERSEYSIDE, CHESHIRE, CLWYD, LANCASHIRE. Dr G. Tresise, Merseyside Country Museum, William Brown Street, Liverpool, L3 8EN.
16. SHEFFIELD DISTRICT Mr T. H. Riley, City Museum, Weston Park, Sheffield.
17. SUSSEX Mr J. A. Cooper, Booth Museum, 194 Dyke Road, Brighton. BN1 5AA.
18. STAFFORDSHIRE Mr D. I. Steward, City Museum & Art Gallery, Bethesda Street, Hanley, Stoke-on-Trent. ST1 3DW.
19. DERBYSHIRE Mr J. Crossling, Museum & Art Gallery, The Strand, Derby. DE1 1BS.
20. LEICESTERSHIRE Mr J. G. Martin, Leicestershire Museums, 96 New Walk, Leicester. LE1 6TD.
21 PETERBOROUGH DISTRICT Director, Museum & Art Gallery, Priestgate, Peterborough. PE1 1LF.
22. NORFOLK Ms D. Smith, Norfolk County Museum Service, Castle Museum, Norwich. NR1 3JU.
23. SHROPSHIRE Mr J. Norton, Shropshire Country Museums, Old Street, Ludlow. SY8 1NN.
24. WARWICHSHIRE Mr J. Crossling, Warwickshire Museums, Market Place, Warwick. CV34 4SA.
25. FOREST OF DEAN Mr B. V. Cave, Royal Forest of Dean Centre for Environmental Studies, Mitcheldean, Gloucestershire. GL17 0HA.
26. NORTH HERTFORDSHIRE Mr B. Sawford, North Hertfordshire Museum Service, Paynes Park, Hitchin. SG5 1EQ.
27. BUCKINGHAMSHIRE Miss J. Royston, Buckinghamshire County Museum, Church Street, Aylesbury. HP20 2QP.
28. SOUTH HERTFORDSHIRE Director, City Museum, Hatfield Road, St. Albans. AL1 3RR.

29. AVON, SOMERSET, GLOUCESTERSHIRE, WILTSHIRE. Dr M. K. Curtis, Museum & Art Gallery, Queens Road, Bristol. BS8 1RL.
30. ESSEX Mr G. R. Ward, Passmore Edwards Museum, Romford Road, Stratford, London. E15 4LZ.
31. WEST KENT Department of Geological Sciences, Queen Mary College, Mile End Road, London. E1 4JS DEFUNCT
32. EAST KENT Mr R. J. Anderson, City Museums, High Street, Canterbury. CT1 2JF.
33. WEST DEVON Mr D. Curry, Museum & Art Gallery, Drake Circus, Plymouth. PL4 8AJ.
34. EAST DEVON Mr K. J. Boot, Museum & Art Gallery, Queen Street, Exeter. EX4 3RX.
35. DORSET Mr P. Ensom, Dorset County Museum, High East Street, Dorchester. DT1 1XA.
36. HAMPSHIRE Mr T. Cross, Hampshire County Museum Service, Chilcomb House, Chilcomb Lane, Bar End, Winchester. SO23 8RD.
37. ISLE OF WIGHT Dr A. N. Insole, Museum of Isle of Wight Geology, High Street, Sandown, Isle of Wight.
38. NORTHERN IRELAND Mr P. S. Doughty, Ulster Museum, Botanic Gardens, Belfast. BT9 5AB.
39. BERKSHIRE Mr H. Carter, Museum & Art Gallery, Valpy Street, Reading. RG1 1QH.
40. SURREY Dr R. B. Stokes, School of Geology, Kingston Polytechnic, Pehrhyn Road, Kingston Upon Thames. KT1 2EG.
41. ANGUS DISTRICT Margaret King, Montrose Museum & Art Gallery Panmure Place, Montrose, Angus. DD10 8HE.