Natural Environment Research Council

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Specifications for the preparation of 1:10 000 scale geological maps

Second Edition

Compiled by K Ambrose

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Preface to Second Edition

These instructions and lists of symbols will replace all existing instructions in use within the Onshore Surveys Division. They are bound in loose leaf form so that amendments, new procedures and new symbols can be incorporated. The Curator of the Symbols Scheme will be responsible for maintaining the relevance and reliability of this report. Any proposed amendments or additions should be routed to him through line management using the form at Appendix B.

Although these instructions are meant specifically to cover the preparation of 1 10 000 scale maps, the symbols presented, and the rules for their use, should also be used on 1:25 000 and 1:50 000 scale maps.

This new edition incorporates changes (additions, deletions and alterations) which have been approved in the past three years.

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Curator of the Symbols Scheme

April 2000

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1 INSTRUCTIONS

1.1 Introduction

1.1.1 This specification is aimed primarily at the preparation of 1:10 000 geological maps meant to be available for public inspection and for sale after approval by the Programme Managers, BGS Integrated Geoscience Surveys, when they are normally referred to as standards. It should also be used for 1:25 000 scale geological maps prepared as standards and, as far as practicable, for thematic maps prepared at these scales, although some changes may be necessary to meet customer requirements.

1.1.2 The use of the specification is mandatory for the preparation of standards. The standard will normally be a Solid and Drift map of the area of an Ordnance Survey 1:10 000 sheet. It is the synthesis in map form of the geologist's findings for a particular area and is the product of a full or partial survey or subsequent revision. Approval as standards may be given for maps of parts of 1:10 000 sheets and for Solid or Drift only sheets.

1.1.3 The geological map is an interpretation of data recorded on field slips, borehole records and derived from other sources, some of which may be confidential at the time the map is being compiled. Where confidential data, for example commercial borehole logs, have been used to make an interpretation, no clue must be left on the map as to the source.

1.1.4 A newly approved standard is intended to supersede and replace earlier standards of the same area and so, where appropriate, will include data from the earlier editions.

1.1.5 Information given in the side margins includes:

i A Key to geological lines, symbols, colours (on paper prints and digitally produced maps) and abbreviations.
ii A Generalized Vertical Section of stratified rocks present at outcrop and proved at depth (where it is practicable to do so).
iii Brief notes, which may be general or specific.
iv Information about present and previous surveys, approved disclaimers and copyright note.

The map is not meant to be the repository of all the information held for an area, but it should indicate to the user how to acquire more data.

1.1.6 The instructions for preparing standards given below should generally be adhered to but it must be borne in mind that the purpose of the standard is to present geological data in an easily interpretable form, so the geologist should not be inhibited about experimentation in new ways of presenting his data. Should new ideas prove, after testing, to be useful, then they can be put through the Programme Managers to the Divisional Map Manager and Symbol Scheme Curator for approval to be used on maps.

1.1.7 These instructions have been drawn up primarily to provide guidance for geologists in the preparation of **hand-drawn maps**. However, they also form the basis for the 1:10 000 digital map production system. Specific instructions for the preparation of maps for digitisation are presented in Appendix C. The symbols will also be used on 1:50 000 scale maps but there is a separate drawing guide for these maps.

1.2 General instructions for preparing geological maps

1.2.1 The map must be drawn so that it is interpretable in black and white on paper dye-line copies. Solid and Drift symbols should be placed so that there is no ambiguity in reading the map.

1.2.2 Maps must be drawn in permanent, black ink on a plastic topographical base. This applies whether or not the map is to be digitised. The Drawing Office will order the base from Ordnance Survey with the OS panels removed. The Drawing Office will keep the master and give the geologist a stable transparent copy with wide marginal wings for side margin data. A panel for recording map progress through preparation and approval stages will also be added. The map will be screened to 50% to reduce the density of the topographical detail.

1.2.3 Before drawing the map, the geologist should establish whether or not it is intended to produce a full digital version of it. Some maps, for which the linework only will be digitised in the 1:50 000 map production process, may not in the short term become available in digital form; for these the geologist's hand-drawn map may remain the master copy for several years. The geologist should ensure that the base map is of the appropriate quality (sharp topographic detail of even density across the map area) and must always produce neat and legible manuscript work. Where an impermanent map is produced, with, for example, stick-on lettering or separate computer-generated margins, then a photographic copy is taken. After approval this becomes the standard. Where a map is to be digitised the geologist should check with the Divisional Map Manager for any changes in procedure before starting work.

1.2.4 Where two maps join, the geologist must check the join and, where he is able to fit the maps together, indicate that he has done so by writing the word 'fitted' at the margins of both maps checked and initialling. Where a Correction Copy of the 1:10 000 map (Onshore Surveys QC Procedure 3) has been prepared, the refitting of the adjacent standards should be indicated by writing 'Refitted, (initials), (date)' at each refitted margin. The absence of 'fitted' along a margin shows that the map cannot be properly joined to its neighbour. Where a batch of maps is to be digitised it is essential that all internal map boundaries are checked and fitted.

1.2.5 Depths and thicknesses must be in metres; depths are to the base of a unit, borehole depths are given with respect to surface or underground level, which is indicated relative to OD (+ for above; - for below).

1.2.6 Full stops are omitted in notes (except where their absence would cause confusion) and in the key to symbols (e.g. Geological boundary, Drift). They are included at the end of sentences (e.g. Depths and thicknesses are given in metres.).

1.2.7 Words should be given in full wherever space is available. In exceptional circumstances abbreviations may be used and listed in the map margin.

1.2.8 A paper print of the plastic standard will be hand coloured for deposition in BGS Library; traditional colours will be used as far as practicable. Note that on such prints (and on digital prints) natural Quaternary Deposits carry their own colour (e.g. yellow for alluvium; the 'colours' for Landslips and Foundered Strata are rulings on a white background). The colours of the underlying Solid or natural Quaternary Deposits should be extended beneath the rulings or other symbols for Artificial Deposits and Worked, Landscaped and Disturbed ground (see Sections 2.2 and 2.3).

1.2.9 On completion of a map, the original MS map, accompanied by a hand-coloured paper dye-line copy, Map History form, component document record and codes form is checked by the Divisional Map Manager and then, after corrections have been made, it is checked and signed by the Programme Managers. A record is made of its availability on the MAPS database (by Publications Production) and necessary copies are made for the library and the Programme Manager; then the standard is lodged with Geoscience Data and Information Management.

1.2.10 Where a map is deemed unfit to be copied and sold to the public it will be classed as not approved. Public inspection in BGS libraries may, however, be permitted.

1.3 Guidelines on the layout

1.3.1 The map contains the following information:

i Title panel with sheet number, name and history of survey
ii Map
iii Key
iv Generalized Vertical Section (GVS) or Stratigraphical Succession where appropriate
v Geological notes related to localities on the map
vi General notes
vii Ordnance Survey source data
viii Approved disclaimer(s)
ix Copyright details
x Acknowledgement of funding sources, if any

1.3.2 The title panel and the Key to symbols and colours are put on the left of the map. The Generalized Vertical Section or equivalent, and notes related to sites, are put on the right. OS source data and general notes can be put where there is space on either side of the map. Copyright details are placed in the title panel; approved disclaimers and acknowledgement of funding source will normally be placed below the map. The sheet number appears in the title panel, but should also be repeated in large print beneath the bottom right-hand corner of the map.

1.3.3 In compiling the Key to symbols and colours and the Generalized Vertical Section, chronostratigraphical data are put on the left of the boxes containing symbols; lithological and lithostratigraphical data are on the right. Lithological descriptions follow lithostratigraphical names which are situated next to the boxes or the GVS. The lithostratigraphical names are arranged from left to right in the order Bed, Member, Formation, Group, Supergroup. Right-hand brackets read from the top down; left-hand from the bottom up.

1.3.4 The concepts of lithostratigraphy and chronostratigraphy must not be confused in preparing the map. Only lithological and lithostratigraphical units are shown on the face of the map. These may include distinctive fossil marker beds. Biostratigraphical interpretations of these data may be presented in the side margins. Guidance is provided in a paper of the BGS Stratigraphy Committee 'Usage of stratigraphical nomenclature in BGS' by P M Allen, *Technical Report*, No. WA/95/27R.

1.4 Detailed instructions

1.4.1 Title panel

Here should be given details of all surveys of the area, listing officers involved and dates, together with the name of the Programme Manager at the time of approval, and the Director at the time of publication. [Note that reference to previous geological surveys must relate to the edition being prepared; separate Solid and Drift editions may require different wording.] The words 'Released 19…' should precede the Director's name. All copyright details are given below the Director's name. An example of a title panel is given in Section 8 (Figure 3).

1.4.2 The map

i Solid (i.e pre-Quaternary, except for some Crag deposits) and Drift (i.e. Quaternary and artificial) geology are normally combined on a single map.
ii Drift boundaries are pecked lines; Solid geology lines are continuous where observed, and broken where they are concealed by Drift or are otherwise inferred. (An observed boundary is one that can be defined to ±10 m on the basis of field observations, either visual or instrumental or both.) Solid boundaries should be continued across bodies of water wherever possible; where no information is available about the bed of areas of inland water they should be left unattributed. The thicknesses of the lines should be drawn in accordance with instructions given in Section 8. Lines should be drawn right to the edge of the map and not ended at a peck. Lines should join at a point and not at a gap in a broken line.
iii Underground information may be given, for example in the coalfields and metalliferous mining areas. It is normally selective and used primarily to illustrate the geology.
iv Coal seams, fossil horizons and other such named units are represented by standard line symbols with the name written on the stratigraphically higher side (see Section 7). Other useful, but very thin, marker beds may also be shown as a single thick line at the discretion of the Programme Manager, although this will be exceptional. The name of a fault is usually placed on the down-throw side of the line. All such names should be written the right way up.
v Wherever possible the nature of the materials underlying the Drift should be indicated, as precisely as possible. Solid concealed by natural Quaternary Deposits is indicated by putting the Quaternary symbol over a horizontal bar above

the appropriate Solid symbol for the rockhead; if more than one Quaternary deposit is present only the one at surface is shown. Multiple fractionated symbols should not be used. For Landslips and Foundered Strata the Solid at rockhead is shown by symbol with the rulings broken around it (see Section 2.3). Similarly, the natural Quaternary deposit or Solid rock immediately below Made Ground, Infilled Ground, Landscaped Ground and Disturbed Ground is shown by symbol with the rulings broken around it (See Section 2.2). Explanatory notes should be used to clarify any ambiguity.

vi Schemes of approved symbols for Drift and Solid rocks follow (Sections 2 to 7). Full up-to-date schemes are maintained by the Symbol Scheme Curator; no new symbols are to be used without his approval. Proposals for changes must be made on the appropriate form (Appendix B) and approved by the Programme Manager before being forwarded to the Curator.

vii For Drift deposits in those few areas where a Drift lithostratigraphy can be mapped, the symbols may be assigned following procedures normally used for stratified rocks. Where a Drift lithostratigraphy cannot be mapped, the Drift symbols will represent lithology or type of deposit, as indicated in the scheme in Section 2.

viii For Solid rocks, the symbols may be lithostratigraphical or lithological or lithodemic. For sedimentary rocks the symbol normally used on the map will be the computer code for the lithostratigraphical unit concerned (this will be held in the central Index of Computer Codes) unless an alternative map code is approved by the Programme Manager; the symbol is written in Roman (upright) lettering. For igneous and metamorphic rocks, the main symbol is lithological but the stratigraphical affinity may be shown by a suffix, in Roman characters, which is normally a simplified derivative of the lithostratigraphical computer code, approved by the Programme Manager. The main symbol for igneous rocks is in Italic and for metamorphic rocks it is in Quill font characters. In sedimentary rocks, in a formation with beds of different lithology, the lithostratigraphical symbol for the formation is written on outcrops of undifferentiated or major lithology, while lithological symbols are used on subdivisions picked out because of their distinctive lithology. For example, the Lower Border Group (LBo) is largely mudstone with subordinate cementstones (cm), limestones (ls) and sandstones (sa). Undifferentiated or mudstone outcrops carry the symbol LBo while cementstone outcrops will be symbolised cm, or LBo (cm) in areas where confusion is likely to arise. Under no circumstances should chronostratigraphical symbols be used on the map.

ix Since the map is uncoloured, every mapped unit should be labelled individually; several small units may be labelled by arrows from a single symbol, where appropriate.

x Structural symbols (Section 6) should be used sparingly. In complicated areas, only a selection will be shown. Where several measurements of different structural elements have been made at the same point, the bedding symbol will be placed at the point of observation. If the bedding is not measured, the symbol of the earliest structure is placed there.

xi Other symbols, including geological boundaries and those related to mining, boreholes and localities with photographs in the BGS collection, are given in Section 7. Only a selection of non-confidential boreholes and shafts will be marked on the map, where they will be indicated using their BGS Records number.

xii Where there is space, notes describing the geology at specific localities, such as natural sections, quarry faces, boreholes and shafts, may be put on the face of the map and arrowed in to the locality. Such notes should be used sparingly. Only in exceptional circumstances should the notes be put in the margin; they should be identified by numbers relating to the locality or, in the case of sections, by letters. Notes should not cross geological boundaries. Do not overload the face of the map with too much detail. General notes relating to extensive outcrops are written horizontally; notes referring to narrow or linear crops or other elongate geological features are aligned with the features or boundary lines. All notes should preferably be written in upright capitals; for notes on specific localities the lettering should be about 1.5 mm high and for general notes about 2 mm to ensure that they are legible on the dye-line prints of the standards.

xiii The principal ores in a mineral vein should be indicated by the chemical symbol for the significant elements placed near the vein, the symbols being arranged in alphabetical order and explained in the side margin in the form:

F Fluorine (fluorspar)
W Tungsten (wolfram and scheelite)

xiv Where a map sheet covers parts of two or more 1:50 000 map sheets the boundaries of the latter should be shown, by a line or lines across the map face and with sheet numbers in the margins.

1.4.3 Key

The Key explains all the symbols and abbreviations used on the map. **They are listed in the order, from top to bottom: Artificial Deposits (and Worked Ground) Quaternary Deposits, Solid (where appropriate), all geological line types, faults, mineral veins, structural symbols, landforms, other symbols, abbreviations, notes and disclaimers**. An example is given in Section 8.2.2. Within each group of tablets and symbols, they should be listed in the order that appears in these specifications. Geological line types should be in the order:

Artificial Deposits and Worked Ground[1]
Geological boundary, Quaternary Deposits[1]
Geological boundary, Artificial and Quaternary Deposits
Geological boundary, Solid
Coal etc. (Section 7)
Incrop of coal seam
Marine band etc. (Section 7)
Fault etc. (Section 6.9)
Mineral vein

1 Note: these are separated on digital maps where they are shown in different colours.

Note that proper names/titles of both Drift (e.g. Alluvial Terrace Deposits) and Solid (e.g. Loch Tay Limestone; Aberdeen Granite) are capitalised in the Key; lithologies are not (e.g. Granitic pegmatite).

i Drift symbols for the deposits and features shown on the map are arranged in the order given in the approved list of symbols for the Drift (Section 2). Where practicable, the tablets may be joined in groups which relate to the classification of the deposits used in Section 2. Where a substantial part of the Drift is divided into formal lithostratigraphical units it may be desireable to show these, in stratigraphical order, below the remainder of the Drift units. A brief description of all drift units shown in the key should be given wherever possible, beside each tablet, as illustrated in Section 8, Figure 4. Made Ground and other man-made deposits are now treated as Drift deposits except that the natural Drift boundaries must be drawn beneath them where known. At the end of the Drift boxes place a note; 'The Drift deposits listed above are not necessarily in order of superposition'. A table or figure may be added in the left or right hand margin to show stratigraphical details and/or relationships of Drift deposits, as illustrated in Figure 5.

ii Solid symbols are taken from the approved lists (Sections 3–5) and listed under the following headings in the order:
Sedimentary rocks
Extrusive igneous rocks
Intrusive igneous rocks
Metamorphic rocks
Within each group symbols are arranged in stratigraphical order, the oldest at the bottom, where possible. Accepted variations applicable to igneous and metamorphic rocks are:
- Extrusive igneous rocks — in the order acid–intermediate–basic from the top down.
- Intrusive rocks — within an overall stratigraphical order, these rocks are divided according to form; i.e. dykes, sheets and/or sills, plutonic intrusions. In each group the tablets are arranged in order of intrusion, or by composition from acid to basic from the top down. Intrusive rocks of unknown age are listed first.
- Metamorphic rocks — tablets are arranged into appropriate lithological groupings e.g. meta sedimentary, metavolcanic, gneisses etc. as in the symbol scheme (Section 5).

Symbols appearing in the Generalized Vertical Section (GVS) or Stratigraphical Succession should not be duplicated in tablets.

iii Structural and other symbols are shown in Sections 6 and 7. Those used on the map should be listed in the order in which they appear in those sections and should be described in the wording given there.

iv Abbreviations. These should be listed in alphabetical order.

v New structural and other symbols may be introduced from time to time. Existing and new symbols will be recorded on a master list maintained by the Symbol Scheme Curator.

vi Descriptions of stratigraphical and lithological units in the Key or in the GVS should be concise and follow the normal structure of other map notes; i.e. in the order: lithology, colour, qualifying lithological adjectives, bedding/foliation character, fossil content.

1.4.4 Generalized Vertical Section

A Generalized Vertical Section (GVS) should be drawn if it is appropriate and informative. It is drawn to scale and shows the overall succession and average thicknesses of the sedimentary and volcanic rocks at outcrop and proved at depth. Parts of the succession proved only in boreholes should be indicated. The scale used should be indicated both in the form 1:10 000 and (1 cm to 100 m) at the head of the section. The conventions to be followed in drawing a GVS are illustrated in Figure 6. Coal seams, ironstone, gypsum beds etc. should be illustrated by a line of minimum thickness (about 0.5 mm). When using detailed large scales, they should be drawn at the scale's true thickness, including coal seam splits. Intrusive igneous rocks may be shown on the GVS if the relationships are easy to illustrate. Where sills or other concordant intrusions are particuarly complex, an indication of their position, composition, thickness and name may be given by a comment on the right hand side of the GVS written against a bracket showing the stratigraphical horizon(s) and range of the intrusion(s) (see Figure 6, example 3). In cases where the intrusive bodies show complex relations with each other and the host rock these may be illustrated diagrammatically in a panel separate from the GVS. In metamorphic terrains and thick sedimentary sequences containing little variation, or in areas where thicknesses cannot reliably be determined because, for example, of tectonic complication, a section, not to scale, may be given showing the general relationships between the rocks. It is important to realise that the GVS is generalised and should not attempt to show every variation in stratigraphy. Thickness of units should be given wherever possible, after the lithostratigraphical name at the side of the GVS (Figure 6). Quaternary (glacial) deposits may also be shown in the GVS. While on most maps one GVS should suffice, it may be necessary on some to show a particularly detailed section on a separate diagram.

Brackets on GVSs are closed only when the top or bottom of a lithostratigraphical unit, or beginning or end of a chronostratigraphical unit, is present. Brackets will be open at top and bottom of the GVS, at faults and below unconformities. Above unconformities the lithostratigraphy bracket will be closed and the chronostratigraphy bracket will usually be open.

In areas of complex Drift, where the data are good, it may be useful to explain relationships between deposits in a tabular or schematic form; this panel should appear at the bottom of the right-hand margin if room allows. They should preferably be drawn to fit a box of size 120 × 60 mm. Examples are shown in Figure 5.

1.4.5 Geological notes related to sites on the map

These are commonly measured from streams and other natural exposures, abbreviated logs from boreholes and

shafts, lists of numbered thin sections of rocks and lists of fossils found at a locality. All notes should be brief and they should be used sparingly; they should be placed in the right margin. They should be identified both by a number or letter (see Section 1.4.2 xii) and a brief locality name, and by an eight-figure grid reference. The description of the rocks should be in the order: lithology, colour, qualifying lithological adjectives, bedding or foliation character, fossil content.

1.4.6 Ordnance Survey source data
These include a diagram showing the sheet in relation to its neighbours on the 1:10 000 grid and the equivalent County six-inch sheets, if relevant, and give details of the topographical survey. In addition there will be the OS copyright statement given in the title panel (see Section 8, Figures 3, 10).

1.4.7 Disclaimers
We are required for legal reasons to have disclaimers on all the maps that we display or release to the public. These disclaimers may change from time to time and individual commissioning bodies may require specific wording. The standard form, suitable for most purposes is: 'This map gives an interpretation of the geological data available at the time of compilation. Additional information may be available in BGS files'. It is usual to give the title and authors of the relevant Technical Report, if any, beneath the disclaimer.

1.4.8 Others matters
Every map must have the copyright symbol ©; the convention is to write, 'Geological map © NERC (year). All rights reserved'; this should be placed in the title panel (see Section 8, Figure 3). Where a map was produced as a result of commissioned funding, this must be acknowledged by writing 'Production of this map was supported by ……' along the south-eastern margin of the map.

The following BGS map copyright statement should be included in the map marginalia separate from the NERC and Crown copyright marks, preferably at the bottom left.

Copyright of BGS Maps

The copyright of materials derived from the British Geological Survey's work is vested in the Natural Environment Research Council [NERC]. No part of these materials may be reproduced or transmitted in any form (analogue or digital), or by any means, or stored in a retrieval system of any nature, without the prior written permission of the BGS Copyright Manager, British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG. Telephone 0115 936 3100.

Thicknesses in the GVS and notes and depths are in metres written without the symbol 'm'. A note should be placed in the key saying: 'Depths and thicknesses are in metres'.

1.5 Procedures for gaining approval of new codes and symbols

New codes and symbols will be needed from time to time, but must be approved before use.

1.5.1 Each named map unit requires a unique computer code. If it does not exist in the Index of Computer Codes, permission to use a new one must be sought from the Lexicon Manager using the form and instructions in Appendix A. Where these codes are long or are not mnemonic, a shortened version approved by the Programme Manager may be used on the map. A definition is also required for the Lexicon of BGS Named Rock Unit Descriptions for each unit above Bed rank; i.e. Member to Supergroup, and for named lithodemic and allostratigraphical units. The form and instructions for registering a Lexicon entry and/or a computer code entry are given in Appendix A.

1.5.2 For other symbols, including lithology and structure (i.e. for additions and modifications to Sections 2–8), the appropriate form (Appendix B) should be completed and forwarded via the Programme Manager (for recommendation) to the Symbol Scheme Curator who will issue approval.

2 DRIFT

2.1 Introduction

The entries in this scheme are listed below in the order in which they should appear in the Key of 1:10 000 maps. The numbered headings and the notes given in the right-hand column of Sections 2.2 to 2.15 are for guidance only and should not be included. The scheme is applicable to all 1:10 000 maps produced by BGS onshore survey divisions with the exception of some thematic productions.

No attempt has been made here to define the different types pf deposit. For definitions users should refer to the *BGS Rock Classification Scheme, Volume 4. Classification of artificial (man-made) ground and natural superficial deposits* by A A MacMillan and J H Powell (BGS Research Report), RR 99-04, which is also available on BGS website.

2.1.1 Artificial [man made] ground

The boundaries to these areas, which include Made Ground, Worked Ground, Infilled Ground [formerly Worked Ground and Made Ground], Landscaped Ground and Disturbed Ground [as listed in Section 2.2], should be shown by pecked lines [see Section 8.1]. Boundaries of underlying natural Quaternary deposits should be shown within such ornamented areas where feasible and appropriate.

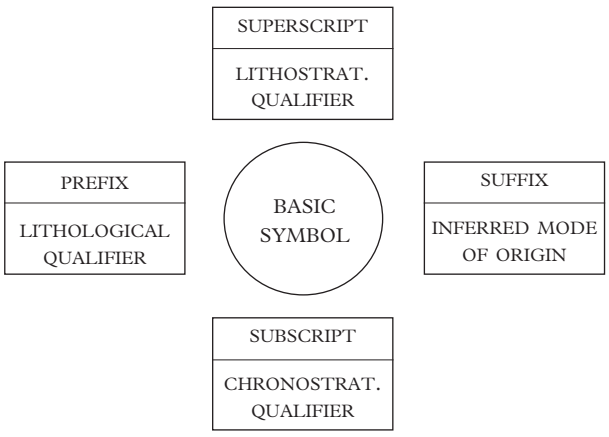
2.1.2 Natural Superficial deposits

These deposits, listed in Sections 2.3 to 2.13, are almost exclusively of Quaternary age and are referred to subsequently simply as Quaternary deposits. They should also be bounded by pecked lines [see Section 8.1].

Where appropriate, normal lithostratigraphical practice should be applied, with deposits classified on a formational basis, and represented by specific approved alphabetical symbols.

Where such practice cannot be followed, the graphic symbol scheme as listed below should be used. The basic graphic symbols listed are in most cases unchanged in style and meaning from those in traditional usage.

The basic graphic symbols may be embellished as appropriate using the following guidelines:



Prefix As a general rule an attempt should be made to incorporate information on the lithological character of the deposit within the symbol if it is inadequately covered in the legend. In some cases, such information is implicit in the meaning of the basic graphic symbol, for example, Shell Marl. Where this is not the case, and where the predominant lithology is known, or has been interpreted with confidence, that lithology (or , if necessary, lithologies) should be indicated as a letter prefix to the graphic symbol, using small capitals according to the following code for the common lithologies:

C	clay
Z	silt
M	silt and clay (mud of marine usage)
S	sand
G	gravel
B	boulders

Combinations of the letter codes may be used as appropriate, for example:

SG	sand and gravel
CB	clay and boulders

Superscript If named lithostratigraphical units can be recognised only locally, then the approved letter symbol for that unit (or an abbreviation) should be a superscript. The superscript may also be used to identify specific terrace deposits by number or letter symbol as appropriate.

Subscript Where there is a need to convey information on the inferred age of a deposit, this may be shown as a subscript, e.g. F for Flandrian LD for Late Devensian, in small capitals.

Suffix If the depositional environment is not implicit in the basic graphic symbol and not explained in the legend, then this information may be conveyed by the use of a suffix in small capitals according to the following codes.

A	Active
B	Bank
BA	Basin
BL	Blanket
BU	Buried
C	Channel
CB	Coastal Barrier Complex
D	Deformation
DV	Dry Valley
E	Estuarine
F	Fen
FT	Flat
FL	Fluvial
FW	Flow
GS	Gravitational Slide
H	Hill
I	Inactive
IC	Ice Contact
IM	Ice Marginal
IN	Intertidal
IT	Ice Thrust
L	Lodgement
M	Marine
MO	Melt-out
O	Overflow
PG	Proglacial
R	Regolith
RI	River or Creek
S	Shoreface
SB	Storm Beach
SF	Submerged Forest
SG	Subglacial
SM	Saltmarsh
ST	Sheet or Tabular

SU	Subtidal
T	Terrace
W	Warp
WO	Washover
Δ	Fan or Delta

2.1.3 Fractionation

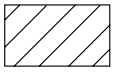
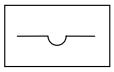
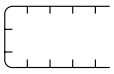
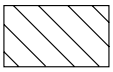
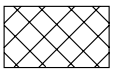
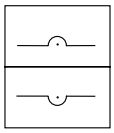
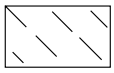
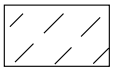
Fractionated symbols (Section 1.4.2 v) should be explained in the following way at the bottom of the Key:

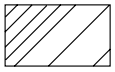
Symbol indicates Quaternary deposit at surface and the Solid formation at rockhead; other Quaternary deposits may intervene

2.1.4 Computer codes

The lithostratigraphical (lexicon) computer code for each main drift unit is given below, beside the appropriate symbol. Other symbols will be needed e.g. Older Alluvium; all formalised lithostratigraphical names for Quaternary deposits will also have their own code e.g. Oadby Till (ODT), Taplow Gravel Formation (TPGR). For all such codes, users will need to consult the lexicon.

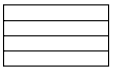
2.2 Artificial deposits, worked and landscaped ground

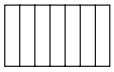
Computer code			
WGR		Worked Ground	Areas where the ground is known to have been cut away by man: quarries, pits, cuttings, cut-away landscaping, dredged channels
		Small quarry or pit	Alternative symbol for use when limits of small excavations are visible
		Small area of Worked Ground	
		Limit of quarry or opencast working in Solid rocks at time of survey. May be partly or wholly backfilled (See Drift edition for details)	FOR USE ON DIGITAL SOLID PRIORITY MAPS ONLY to indicate workings in Solid rocks. It may be necessary to displace the quarry edge symbol to avoid conflict with accurately positioned geological boundaries in the quarry wall
MGR		Made Ground	Areas where the ground is known to have been deposited by man: road, rail, reservoir and screening embankments; flood defences; spoil heaps; coastal reclamation fill; offshore dumping grounds
WMGR		Infilled Ground	Areas where the ground has been cut away and then had artifical ground deposited: a partly or wholly backfilled working; landfill sites. (Formerly called Worked Ground and Made Ground)
		Small area of Made Ground, above surface. Small area of Worked and Made Ground; backfilled pit	Alternative means of indicating small areas of Made Ground and Infilled Ground, where diagonal ruling would be inadequate or would obliterate other geological linework and symbols. They may be placed in the Key below the appropriate ruled symbols
LSGR		Landscaped Ground	Areas where the original surface has been extensively remodelled, but where it is impractical or impossible to delineate areas of cut and Made Ground
DDGR		Disturbed Ground	Areas where ill-defined subsidence, areas of excavations and Made Ground are complexly associated with one another

Note: where practicable areas of Worked, Made, Landscaped and Disturbed Ground should be indicated by use of the diagonal rulings shown. For narrow and/or small areas the spacing between the rulings may be decreased, and for large areas increased, and such variation indicated in the boxes e.g.  The orientation of the rulings may also be varied (NW or NE ±15°).

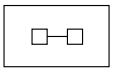
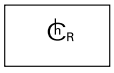
The symbols above should be used as overlays on Solid and Quaternary deposit units, the nature of which should be indicated by inserting the appropriate symbol with the rulings broken around it. Where the nature of the underlying Solid or Quaternary deposit is uncertain the rulings or 'bowler hats' may be shown on a white background on manuscript maps, or overlying Undifferentiated Solid or Drift on digital maps. Multiple fractionated symbols should not be used.

2.3 Mass-movement, gravitational accumulates and residual deposits

FOUN		Foundered Strata	Collapsed strata. This should be used for areas subjected to natural or man-induced subsidence where no new deposits are produced, for example areas of collapse resulting from evaporite dissolution or extraction. Extensive areas of subsidence, such as coalfields, should not be shown as foundered strata, but a general note can be added in the margin

SLIP		Landslip Deposit	Includes mud flows and slides, rockfalls and rotational slips. Note that 'landslip' is the deposit only, it does not include any undisturbed back face or scarp

Note: the spacing of the rulings may be varied for large and small areas, and this variation should be shown in the boxes. The nature of the Solid at rockhead beneath Landslip and Foundered Strata should be shown, if possible, by inserting the appropriate symbol with the rulings broken around it.

SCRE		Talus	Clast-supported accumulation of angular rock fragments derived from a cliff or steep rocky slope. May be qualified as A – active or I – inactive
TCON		Talus Cone	Matrix-supported or matrix-rich accumulation of rock fragments of any size or shape at the foot of a gully or chute in a cliff or steep slope. Formed by mass movement — rainwash, sheetwash, debris flow, mudslide or avalanche. May be qualified as A – active or I – inactive
			In lower relief areas alluvial transport is more important at the mouths of tributaries and the deposits are lower-angle Alluvial Cones.
BLOC		Blockfield	In-situ or nearly in-situ rock debris of mountainous areas. Openwork, clast-supported accumulation of blocks (>64 mm) without a cliff or steep slope above as an apparent source
BHED		Blanket Head [Regolith]	Sheets of in-situ or nearly in-situ or partially moved weathering products of mostly <64 mm grain size. May be qualified: Rf — frost-susceptible (clay/mica-rich), cohesive deposits
			Rg — non-frost-susceptible, granular, non-cohesive deposits
			These deposits commonly have a surficial block-rich layer caused by frost heave

Note: Alternative titles are shown in square brackets; optional inclusions are shown in rounded brackets.

HEAD		Head	Poorly sorted and poorly stratified deposits formed mostly by solifluction and/or hillwash and soil creep. Superscript may be added (e.g. 1, 2 etc.) to indicate order of deposition
COD		Coombe Deposits	Scree and solifluction deposits in some chalk valleys ('Coombe Rock' where cemented)
CWF		Clay-with-flints	Residual deposit of chalk areas

2.4 Aeolian deposits

LOES		Loess	Wind-transported, mostly silt-grade material
BSA		Blown Sand	Present-day or Recent deposits; may include older deposits where these cannot be distinguished
BSO		Older Blown Sand	Includes coversand of some lowland areas. The age, where known, may be indicated by subscript (e.g. D — Devensian; P — Pleistocene)

2.5 Organic deposits

PEAT		Peat	Includes blanket, hill, basin, and fen peat which can be differentiated by the suffixes BL, H, BA and F respectively, where appropriate
PFLO		Peat flow	Mass movement of peat resulting from a bog burst
SUF		Submerged Forest	
SLM		Shell Marl	Soft, calcareous deposit formed in rivers and freshwater lakes mainly from shell debris and plant encrustation
DIAT		Diatomite	Soft, siliceous, lacustrine deposit consisting mainly of opaline diatom frustules
FLDI		Diatomite, fluvial	

2.6 Chemical/organic deposits

TUFA		Tufa (or Travertine)	Inorganic or organic calcium carbonate or silica deposited at or near springs
BIO		Bog iron ore	

2.7 Fluvial deposits

ALV		Alluvium	Deposits of modern floodplains
DVY		Dry Valley Deposits [Nailborne Deposits]	Alluvial deposits of some at-present dry or intermittent wet valleys
WARP		Warp	Artificially induced alluvium
ALF		Alluvial Fan Deposits	Low-angle cones developed at the mouths of tributary valleys
RTD		River Terrace Deposits	Dissected remnants of former floodplain deposits, mostly at higher levels than the modern floodplain, but can be at lower levels in coastal and estuarine areas where graded to lower sea levels. Numbered informally 1, 2, 3 etc. (as superscript) in order of increasing age. Alphabetical superscript should be used for named terraces as appropriate. Where there are no lithological variations between the terrace deposits, they may be illustrated in the form:  River Terrace Deposits, 1 to 5, 7 to 10, as numbered Number river terraces are coded RTD1 (First Terrace) up to RTD9 (Ninth Terrace); RTDX = Tenth Terrace, RT11 = Eleventh Terrace, TR12 = Twelfth Terrace etc.
RTDU		River Terrace Deposits, undifferentiated	In valleys where terraces cannot be numbered consistently. Multiple terraces should be indicated by the use of back-feature symbols (see Section 2.14 below)

2.8 Lacustrine and coastal zone deposits

LDE		Lacustrine Deposits	Number 1, 2, 3 (as superscript) in order of increasing age
LADD		Lacustrine Delta Deposits	Number 1, 2, 3 (as superscript) in order of increasing age
LSBD		Lacustrine Shoreface and Beach Deposits	Number 1, 2, 3 (as superscript) in order of increasing age

2.9 Marine and coastal zone deposits

The deposits represented by these symbols are products of the Holocene marine transgression and comprise all deposits accumulated under the direct influence of the marine environment; they thus include marginal marine coastal deposits (littoral, estuarine, supertidal etc.) and include those accumulating at present. The symbols should be used for all sediment bodies greater than 1 m thick. If not adequately described in the legend, the general lithology of the body and its inferred mode of formation should be shown where feasible by a letter prefix and suffix respectively. Raised marine deposits are dealt with in Section 2.10 below. Where relatively older (or younger) subdivisions can be mapped within a sediment body these may be shown by use of the superscript p (or y).

MDU		Marine Deposits, undifferentiated	Marine deposits where subdivision is impractical, undesirable or impossible
TFD		Tidal Flat Deposits	Indicate lithology by prefix as appropriate (also in the categories following)
SABD		Shoreface and Beach Deposits	
STOB		Storm Beach Deposits	
TOSD		Tabular or Sheet Deposits	

BANK		Bank Deposits	
TRD		Tidal River or Creek Deposits	
SAMD		Saltmarsh Deposits	
COBD		Coastal Barrier Deposits	These comprise various marine ± terrestrial (aeolian) deposits in a coastal barrier situation
WDEP		Washover Fan Deposits	Material, mostly sand, deposited by overwash on the landward side of a bar or beach barrier; produced by storm waves overtopping or breaching a bar or barrier

Miscellaneous Marine Ornaments

	Area of general acoustic turbidity (gas blanking) in sediments	
	Area of restricted acoustic turbidity (gas blanking) in sediments	
	Shell Bank	Includes banks containing coral and lithified algae
	Chenier Shell Bank	
	Carbonate-rich Sand	
	Pockmarks	Active, inactive and buried can be differentiated by the suffixes A, I and BU
	Ice Scouring	Includes iceberg plough marks

2.10 Raised marine deposits

Isostatically uplifted Marine (including Coastal) Deposits, which crop out in part above the present high water mark. Raised shorelines, where marked by clifflines or distinct features, are indicated by the 'Backfeature marking former coastline' symbol (see Section 2.14 below). Individual beach ridges associated with raised marine deposits may be shown by the 'Crestline of linear feature' symbol. Subscripts may be used to indicate the age of a raised marine deposit (F — Flandrian; D — Devensian). Any of the suffixes used with Marine Deposits (FT, C, S, SB etc.) may also be used with Raised Marine Deposits. Some examples are given below.

RMD		Raised Marine Deposits	Use 'Raised Marine Deposits of unspecified age' if marine deposits of specific age also appear on the map. Number 1, 2, 3 (as superscript) in order of increasing age
RTFD		Raised Tidal Flat Deposits of Flandrian age	
RMDD		Raised Marine Delta Deposits	

2.11 Interglacial deposits

IGD		Interglacial Deposits, undifferentiated
IGFD		Interglacial Fluvial Deposits
IGLD		Interglacial Lacustrine Deposits
IGMD		Interglacial Marine Deposits, undifferentiated
IMSB		Interglacial Marine Shoreface and Beach Deposits

2.12 Glacial deposits

GFDU		Glaciofluvial Deposits, undifferentiated	
GFDD		Glaciofluvial Deltaic (and/or Subaqueous Fan) Deposits	
GFIC		Glaciofluvial, Ice-contact Deposits	Glaciofluvial deposits laid down on, under or against a glacier or ice sheet; moundy topography is characteristic, but flat-topped mounds are common
GFSD		Glaciofluvial Sheet Deposits	For example, sandur and valley trains. Numerical superscripts may be added to show relative age if terraced; alternatively terrace back-feature symbols may be used

Note: The deposits commonly form a continuum, and it may be necessary at some localities to draw an arbitrary line at the proximal limit of terraced spreads, where these pass into moundy deposits.

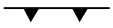
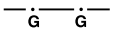
GMDU		Glaciomarine Deposits undifferentiated	
GLLD		Glaciolacustrine Deposits	Delta deposits shown by suffix delta
HMGD		Hummocky [Moundy] Glacial Deposits	Lithologically diverse and complex glacial deposits that form moundy topography. Composed of rock debris, clayey till and poorly to well-stratified sand and gravel
TILL		Till	Can be qualified by a suffix where appropriate: MO — melt-out till, FW — flow till, L — lodgement till, D — deformation till
GDU		Glacial Deposits, undifferentiated	Heterogeneous glacial deposits lacking constructional form

Note: End-moraines may consist of one or more categories of deposits which should be distinguished where possible; the landform should be shown by the appropriate symbols.

2.13 Miscellaneous

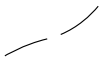
		Sand and gravel of uncertain age/origin	
		Erratic	X is a letter explained in the key e.g. Ⓐ Erratic of Cairngorm Granite, G_{C1} Ⓑ Erratic of Netherly Diorite, *H*

The following note should be placed below the last Drift box: 'The Drift deposits listed above are not necessarily shown in order of superposition.'

	Thrust or slide	Can be used to indicate boundaries of large thrust or slid blocks. The type of structure may be indicated by adding suffixes e.g. IT — ice thrust; GS — gravitationally slid. Small thrust or slid masses should be indicated by a note or by use of the suffixes above, e.g. x IT — Ice thrust mass of (e.g.) bedrock
	Limit of glacial advance	Letter indicates which advance and is written within the advance. G — Gosforth Oscillation Limit S — Scottish Readvance Limit

2.14 Landform and buried landform symbols

	Form line	
	Mound [Drumlin, Dune] (spot at highest point)	Form lines at base of mound. Dashes c.5 mm long; spot may be omitted
	Crestline of elongate mound [Drumlin, Dune (spot at highest point)	May be combined with mound symbol; spot may be omitted

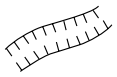
	Crestline of linear feature	May be used for ridges in various deposits or for ice-moulded bedrock ridges; dashes c.10 mm long
	Axis of large scale glacial flute	
	Axis of large scale glacial gouge	
	Crestline of esker	
	Area of fluted deposits, showing orientation of fluting	No boundary required; dashes c.5 mm long
	Closed hollow [Kettlehole]	Form lines at margin of hollow; dashes c.5 mm long
	Outer edge of terrace	May be used for flat-topped kames (constructional topography), or for remnants of dissected glaciofluvial or river terraces
	Marked break in slope, arrowheads denote uphill side	Used where the break in slope has not been classified
	Backfeature of terrace, arrowheads denote uphill side	For use within, but not at the margins of, glaciofluvial or river terraces
	Backfeature marking former lake margin, arrowheads denote uphill side	May be shown independently of any related deposit margin; not to be used at deposit margins where no well-marked feature exists
	Backfeature marking former coastline, arrowheads denote uphill side	
	Glacial striae, bar shows orientation	
	Glacial striae, arrow shows inferred direction of ice flow	The direction of ice flow is inferred solely from inspection of the striae at the point represented by the symbol and does not relate to any other evidence in the district. Unless the direction of ice flow is unmistakable from the striae alone this symbol should not be used
	Crag and tail feature, arrow shows direction of ice flow	
	Roche moutonnée, the rounded edge of the symbol towards the direction from which ice flowed	If sufficiently large use Mound form line to define feature and place symbol within; otherwise position symbol over feature
	Roche moutonnée with striae, arrow shows inferred direction of ice flow	

Note: The symbols for Glacial striae, Crag and tail and Roche moutonnée should be placed with the symbol centred over the point of observation (not with the head of the arrow there).

	Glacial meltwater or overflow channel centre line, showing inferred direction of flow; intermediate arrow shows direction of fall of channel floor profile	Birfurcations in channel systems should be shown by branching channel symbols; intermediate arrows may be omitted. The type of channel may be indicated by adding suffixes, e.g. IM — Ice Marginal, SG — Subglacial, O — Overflow

Single-sided glacial meltwater channel, showing inferred direction of flow; intermediate arrow shows direction of fall of channel floor profile

Where a channel changes from two-sided to one-sided, or vice versa, the following practice should be used



Glacial meltwater channel margins

May be used alone or in conjunction with centre line symbols

Approximate centre line of buried (sediment-filled) channel, arrow shows direction of fall of channel floor

Approximate margin(s) of buried (sediment-filled) channel or valley

Buried cliffline; crossmarks on the seaward side

Bedrock at or near surface, or beneath Artificial Deposits or Worked Ground [For use on Drift-only maps]

2.15 Marine bedforms and bathymetric features

Transverse Bedforms

Sandwaves

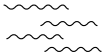
Sandwave, arrow indicates direction of travel

Sandwave crest line, showing amplitude and wavelength of sandwave; tick on steep or lee side

Crest line of sandbank

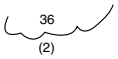
High point of sandbank or other feature, with depth (m)

Longitudinal Bedforms

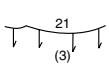


Sand ribbons

Bathymetric Features



Cliffline in pre-Quaternary units, showing depth of crest and height (m)



Scarp feature in Quaternary deposits, showing depth of crest and height of feature (m)

3 SEDIMENTARY ROCKS

The usual way of representing sedimentary rocks is with lithostratigraphical symbols. Lithologies separated out from the main lithostratigraphical units should be labelled with the following symbols, which are for use on both 1:10 000 and 1:50 000 maps. They must be written in lower case letters. Rock units composed of more than one interbedded rock type may be depicted by combining symbols with a slash (/), as in md/sa.

New symbols must use nomenclature that is consistent with *BGS Rock Classification, Volume 3. Classification of sediments and sedimentary* rocks by C R Hallworth and R W O'B Knox (BGS Research Report, RR 99-03).

ag	agglomerate
bb	blackband ironstone
br	breccia
c	coal
cg	conglomerate
ch	chert
cl	clay
cm	calcareous mud/mudstone ('marl')
do	dolomitic limestone
fc	ferricrete (laterite)
fe	fuller's earth mudstone
gl	grainstone
gn	mudstone with gypsum nodules
gtl	glauconitic limestone
gts	glauconitic sandstone
im	iron-mudstone ('clayband ironstone')
krl	knoll reef limestone
lc	limestone (calcrete)
lcg	limestone conglomerate
li	lignite
lm	micritic limestone/lime-mudstone
ln	mudstone with calcareous nodules
ls	limestone
lsa	sandy limestone
mc	mudstone with calcrete glaebules
md	mudstone
ml	muddy limestone ('cementstone')
mmr	mud-mound reef
mrl	marginal reef limestone
ol	ooidal limestone
os	oil shale
pl	pebbly lime grainstone
pn	mudstone with phosphatic nodules
rl	reef limestone
sa	sandstone
si	silt
sl	siltstone
sn	mudstone with sideritic nodules
sv	volcaniclastic sandstone
w	wacke
wl	packstone or wackestone

4 IGNEOUS ROCKS

4.1 Introduction

The scheme is based primarily upon lithology. It uses the classification and nomenclature adopted by the *BGS Rock Classification Scheme, Volume 1: Classification of Igneous Rocks* by M R Gillespie and M T Styles, 1997 (BGS Research Report, RR 99-06), which is based broadly upon the International Union of Geological Sciences (IUGS) Subcommission on the Systematics of Igneous Rocks (Le Maitre, R W et al. (1989) *A classification of igneous rocks and glossary of terms*. Blackwell Scientific Publications). The classification is based upon modal composition whenever possible and hence is generally suitable for field use, backed by examination of thin sections as necessary. Some rock types require chemical analysis for a complete classification, but general terms can be asigned where analyses are not available.

Most 'root names' (i.e. those names which appear on key classification tables and diagrams) have been incorporated into the BGS symbol scheme. These include rock-types which are not known to occur in the UK, to allow for possible future use and to enable the scheme to be used for overseas maps if required. Some non-root names are also included. Symbols for other rock-types can be generated as required by adding mineralogical and/or textural qualifiers (given in Section 4.4) as prefixes to existing symbols. Rock-names that have become obsolete, or which are regarded as unnecessary synonyms, or have a local use only, have all been excluded from the BGS classification and symbol scheme. Suggested alternatives for many of these are given in Section 4.5. A range of general terms and symbols can be used for rocks which cannot be identified precisely.

4.2 Symbols

The symbol scheme is intended for use on maps of all scales. Although colours are used on 1:25 000, 1:50 000 and smaller scale maps, 1:10 000 maps are currently reproduced as line copies only; hence the symbol scheme is designed to be independent of colour. It is flexible and suitable for systematic extension. Individual symbols can be extended if desired to represent a near-complete lithological description or they can be simplified for use on small-scale maps. However, on all maps the symbols chosen should be as simple as is practicable without ambiguity. Detailed descriptions and additional information are given in the map Key.

4.2.1 Summary

The complete symbol takes the form: aB^{c}_{D} where:

- *a* = textural or mineral qualifier (italic)
- *B* = primary lithological class (italic capitals)
- *c* = division of primary lithological class (italic small capitals), so that ***B*^C^ defines names approved by the IUGS and BGS classifications only**
- D = additional qualifiers to indicate local names, phases or age or mode of emplacement of an intrusion (in italic small capitals), or lithodemic/lithostratigraphical name (in Roman small capitals)

Clearly there is scope within the symbol for a very comprehensive and complicated description. However, **authors must endeavour to keep the symbol as simple as possible** (see Section 4.2.6). **It is recommended that the symbol be restricted to a maximum of three elements** if at all possible, i.e. do not try to write the memoir in the symbol.

All the igneous symbols will be shown in italics in the map Key or explanation. When new symbols are required the principles adopted in the scheme should be followed.

4.2.2 Primary symbol

The main lithological class is represented by an italic capital letter e.g. *B* — basaltic rocks, *P* — microdioritic rocks (see list in Section 4.3). The exception is π — pegmatite. These primary symbols are used on their own where subdivision is impossible or unnecessary and on small-scale maps, e.g. *G* — granitic rocks (unclassed). They do not distinguish between extrusive or intrusive or different types of intrusive rock.

4.2.3 Superscript suffixes

Within the primary classes, variations in composition (modal or chemical) are indicated by superscripts, either a single italic capital or a capital followed by a lower case, e.g. B^{A} — alkali basalt, P^{M} — micromonzodiorite. *This combination of Primary symbol + superscript constitutes the fundamental base symbol.* It must be reserved strictly for formally approved rock names as listed in the IUGS and BGS classifications.

4.2.4 Prefixes

Descriptive prefixes may be used to indicate characteristic minerals or textures, usually one or two lower case italic letters (see separate lists of standard abbreviations in Section 4.4). Examples are gG^{G} — granophyric granite, wZ^{R} — welded rhyolitic tuff. Textural prefixes should precede mineral prefixes (e.g. vfR^{D} — glassy, feldspar-phyric dacite) and phenocryst phases should be listed in order of increasing abundance (e.g. phA^{A} clinopyroxene-hornblende andesite). In some cases it is appropriate to use the mineral prefix to define a root name, e.g. *afG* — alkali-feldspar-granite, *qE* — quartz-gabbro, *nS* — nepheline-syenite. A few examples are listed in the scheme, others will be obvious e.g. *oD* — olivine dolerite. Note that a mineral prefix can refer either to a characteristic mineral, possibly present in only minor amounts, e.g. *qD* — quartz-dolerite or to an abundant phenocryst phase, e.g. fF^{G} — feldspar-phyric microgranite. The symbol scheme cannot differentiate between different applications of the prefix, but this will be clear from the description of the rock in the map Key. Similarly the symbol *nS*, for example, is not capable of distinguishing between the root names nepheline-syenite and nepheline-bearing syenite and hence must be qualified in the map Key.

4.2.5 Subscript suffixes

Subscripts may be used at the geologist's discretion for several purposes:

i Local names In some areas varieties of dyke-rock or lava have been given local names, e.g. inninmorite and leidleite — varieties of andesitic dyke in the Hebrides; basalt lavas of Dunsapie-, Markle-, Dalmeny-

type etc. in central Scotland. Such rocks can be described adequately using the BGS classification and symbol scheme; e.g. a basaltic lava of Dunsapie type is a macroporphyritic olivine-clinopyroxene-feldspar-phyric alkali basalt — symbol *maopfB*^{A}. Since the lava commonly occurs in close proximity to other lavas in the same sheet which could be described as *maopB*^{A}, *mafB*^{A}, *mifB*^{A}, *mioB*^{A}, (all named types), some form of simplification is desirable. Two possibilities are suggested, which may be used at the author's discretion:

- Use abbreviations of the local type names (italic capital ± lower case) appended to the symbol as a subscript suffix; e.g. the lavas quoted above would be B_{Du}, B_{Ck}, B_M, B_J, B_D and B_H respectively. The local names and full descriptions in approved terms must be indicated in the map Key.
- Use numbers in the subscript suffix position which are keyed to full descriptions (and names if appropriate) in the Key, e.g. B_1 to B_6.

ii Names, age and phases of intrusions In most cases it will be sufficient to indicate the lithodemic name and age of an intrusion in the map Key. Where necessary, abbreviations of the lithodemic name (roman not italic letters), can be appended in the subscript suffix position, e.g. G_{L} —Lochnagar Granite. Different phases of the same intrusion can also be indicated in this position, either by more detailed lithodemic codes or by combinations of capital letters and/or numbers, e.g. G_{GY} —Glengairn Younger Granite; G_1, G_2, G_3 — numbered phases of a granite; G_{L1} — Lochnagar Granite, phase 1.

Ages of dyke swarms should be indicated in the map Key and, where necessary, by a simple, one-letter code in the subscript position on the symbol e.g. D^{A}_{D} — alkali-dolerite of Dinantian age, L^{C}_{P} — camptonite of Lower Permian age.

iii Mode of emplacement The primary symbol indicates lithology, but some rock types occur in both extrusive and intrusive forms, e.g. alkali basalt (B^{A}) dykes and lavas. These may be distinguished by using a symbol in the subscript suffix position indicating mode of emplacement e.g. B^{A}_{s} — alkali basalt sill; hA^{A}_{d} hornblende andesite dyke; D^{A}_{e} — alkali dolerite lava. These symbols are necessary only when both intrusive and extrusive forms of the same rock type occur on one map, or when it is not obvious from the map what the form of emplacement is, say in the case of sills. Similarly, pyroclastic vent deposits can be distinguished from extrusive pyroclastic rocks by use of the symbol Z_v.

4.2.6 General comments

Most lithologies can be fully described by a combination of prefix, primary symbol and superscript and on some large-scale maps with a wide variety of related rock types this may be necessary. However, efforts should be made to keep the symbol as simple as possible, particularly on 1:50 000 and smaller-scale maps. Provided that the rock is uniquely defined on the map, the detailed lithology can be fully explained in the map Key; e.g. if all of the andesitic dykes on a sheet are glassy hornblende andesites — *vhA*^{A}, and there are no andesite lava flows the only symbol necessary is A^{A}, which can be defined as 'porphyritic hornblende andesite with glassy groundmass' in the Key.

Special provision has been made where field separation of lithologies has been impossible or has been neglected. Thus, in addition to the 'unclassed' use of primary symbols, *A*, *B*, *C*, *E* etc., there are symbols representing vaguely identified rocks, i.e. *J* — felsic or semifelsic rocks (unclassed) and *K* — mafic or semimafic rocks (unclassed). Hyphenated symbols may be used to indicate a compositional range, where a more precise identification is not possible, e.g. *B-W* — rocks with the range basalt–hawaiite. Different rock types may also be 'lumped' together where necessary using combined symbols, e.g. *AB* — andesite plus basalt, E^{AT} — anorthosite plus troctolite, U^{CD} —clinopyroxenite plus dunite. Lithologies transitional between two types may be indicated by a combined symbol with a slash, conventionally in the superscript suffix, e.g. $R^{R/D}$ — rhyodacite, $L^{V/Sp}$ — lamprophyre transitional between vogesite and spessartite. Some examples are listed in the symbol scheme, others can be derived as required.

4.2.7 Pyroclastic rocks

The range of symbols listed for pyroclastic rocks, together with textural prefixes where appropriate, should be sufficient to categorise most lithologies on the map. Further information (e.g. on the nature of clasts — vitric, crystal or lithic) can be given in the map Key. Terms which reflect a genetic interpretation (e.g. ignimbrite, ash-fall, ash-flow, base-surge etc.) are not appropriate in the symbol and should be confined to the Key. Authors should consult the *BGS Rock Classification Scheme* for detailed nomenclature.

4.2.8 Volcanic rocks — lithostratigraphy

Volcanic rocks are an important part of many stratigraphical sequences and hence, wherever possible, units should be assigned formal lithostratigraphical names at least down to member level. Such names should have unique lithostratigraphical code symbols (in Roman capitals), allocated through the same process as for sedimentary rock units. Lithological symbols, as described in this document, will also be essential in most sequences, for example to show the lithology of individual flows in varied sequences.

On most large-scale maps it will be sufficient to show the lithological symbol on the map with the lithostratigraphy indicated on the generalized vertical sections. On small-scale maps, which do not show individual flows, the lithostratigraphical symbols will be more appropriate. In circumstances where identical lithologies occur in more than one formation or member on the same map it may be necessary to show both lithostratigraphical and lithological symbols. In most cases they are probably best used separately, but they can be combined in the same way as lithodemic symbols at the authors discretion e.g. W^{M}_{CPL} — mugearite lavas of the Clyde Plateau Volcanic Formation. [Note that the lithostratigraphical symbol is always in Roman lettering, not italic.]

4.3 Alphabetical list of igneous symbols (all italic)

A Andesitic rocks (unclassed)
A^{A} Andesite
A^{B} Basaltic andesite
A^{Bo} Boninite
vA Andesitic pitchstone

B Basaltic rocks (unclassed)
B^{A} Alkali basalt
B^{B} Basalt
B^{Bn} Basanite
B^{C} Calc-alkali basalt
B^{P} Picrobasalt and/or picrite
B^{T} Tholeiitic basalt
B^{Tp} Tephrite

C Carbonatites (unclassed)
C^{C} calcite-carbonatite
C^{D} dolomite-carbonatite
C^{F} ferroan carbonatite
C^{N} natrocarbonatite

D Doleritic/microgabbroic rocks (unclassed)
qD Quartz dolerite
D^{A} Alkali dolerite
D^{D} Dolerite
D^{G} Microgabbro
D^{M} Micromonzogabbro
D^{T} Tholeiitic dolerite

E Gabbroic rocks (unclassed)
E^{A} Anorthosite
E^{G} Gabbro
E$^{G/N}$ Gabbronorite
E^{M} Monzogabbro
E^{N} Norite
E$^{M/N}$ Monzonorite
E^{T} Troctolite

F Medium-grained microgranitic rock (unclassed)
F^{G} Microgranite
F^{Gd} Microgranodiorite
F^{T} Microtonalite

G Granitic rocks (unclassed)
afG Alkali-feldspar-granite
G^{D} Granodiorite
G^{G} Granite
G^{M} Monzogranite
G^{S} Syenogranite
G^{T} Tonalite

H Dioritic rocks (unclassed)
H^{D} Diorite
H^{M} Monzodiorite

I 'Foidite' (unclassed)
**I*^{B} Basanitic foidite
**I*^{P} Phonolitic foidite
**I*^{T} Tephritic foidite
⋆ prefix to indicate type of foid, e.g. a, l or n
I^{A} Analcimite
I^{L} Leucitite
I^{N} Nephelinite

J Felsic or semifelsic fine- to medium-grained rocks (unclassed) 'felsite'
**J* Felsic porphyry (⋆ prefix to indicate phenocryst phase(s) e.g. *fJ* feldspar porphyry)

K Mafic or semimafic fine- to medium-grained rocks (unclassed) 'mafite'
**K* Mafic porphyry (⋆ prefix to indicate phenocryst phase(s) e.g. *hK* hornblende porphyry)

L Lamprophyres (unclassed)
L^{C} Camptonite
L^{K} Kersantite
**L*^{L} Lamproite (⋆ prefixes to indicate essential mineral qualifiers)
L^{Mi} Minette
L^{Mo} Monchiquite
L^{Sa} Sannaite
L^{Sp} Spessartite
L^{V} Vogesite

M Monzonite

N Trachyandesite
N^{B} Benmoreite
N^{L} Latite
N^{P} Tephritic phonolite/tephriphonolite

O Microsyenitic rocks (unclassed)
O^{M} Micromonzonite
O^{S} Microsyenite

P Microdioritic rocks (unclassed)
P^{D} Microdiorite
P^{M} Micromonzodiorite

⋆π Pegmatite (⋆ prefixes to indicate essential minerals)

Q Quartz-rich granitic rocks (quartzolite)

R Rhyolitic and dacitic rocks (unclassed)
R^{C} Comenditic rhyolite
R^{D} Dacite
R^{P} Pantelleritic rhyolite
R^{R} Rhyolite
R$^{R/D}$ Rhyodacite
vR Acid pitchstone; obsidian

S Syenitic rocks (unclassed)
afS Alkali-feldspar-syenite
qS Quartz-syenite
nS Nepheline-syenite
S^{M} Monzosyenite (always a foid-monzosyenite, e.g. *nS*^{M})
S^{S} Syenite

T Trachytic rocks (unclassed)
T^{D} Trachydacite
T^{P} Phonolite
T^{T} Trachyte

U Ultramafic rocks (unclassed)
U^{A} Hornblendite
U^{C} Clinopyroxenite
U^{D} Dunite
U^{H} Harzburgite
U^{L} Lherzolite
U^{M} Melilitolite
U^{O} Orthopyroxenite
U^{Pd} Peridotite
U^{Px} Pyroxenite
U^{S} Serpentinite
U$_{V}$ Fine-grained ultramafic rock (unclassed) 'ultramafitite', e.g. komatiite, meimechite, melilitite
U^{Wb} Websterite
U^{Wh} Wehrlite

V Tuffaceous sedimentary rock/tuffite (unclassed); 25–75% pyroclastic material
V^{A} Andesitic tuffaceous sedimentary rock/tuffite
V^{B} Basic tuffaceous sedimentary rock/tuffite
V^{R} Acid tuffaceous sedimentary rock/tuffite
(Use standard clastic sediment symbols as prefixes if necessary to indicate clast size, e.g. *saV* — tuffaceous sandstone)

W Trachybasalt and basaltic trachyandesite (unclassed)
W^{A} Basaltic trachyandesite
W^{B} Potassic trachybasalt
W^{BN} Phonolitic basanite
W^{H} Hawaiite

W^{M}	Mugearite
W^{S}	Shoshonite
W^{T}	Potassic trachybasalt
W^{Tp}	Phonolitic tephrite/phonotephrite
X	Tuffisite and intrusive breccia with little or no juvenile igneous material
Y	Foidolite (unclassed)
Y^{A}	Analcimolite
Y^{L}	Leucitolite
Y^{N}	Nephelinolite
Z	Pyroclastic rocks (unclassed); >75% pyroclastic material
Z^{A}	Andesitic pyroclastic rocks
Z^{B}	Basaltic pyroclastic rocks
Z^{D}	Dacitic pyroclastic rocks
Z^{R}	Rhyolitic pyroclastic rocks
Z^{T}	Trachytic pyroclastic rocks
$\star Z\dagger$	*Prefix to indicate clast size and shape (small capitals):

A	Agglomerate	>64 mm
B	Pyroclastic breccia	>64 mm
L	Lapillistone and lapilli-tuff	2–64 mm
C	Coarse tuff	0.032–2 mm
F	Fine tuff	<0.032 mm

† Superscript to indicate overall composition as in above list: e.g. $^{L}Z^{A}$, andesitic lapilli-tuff

Volcaniclastic rocks with <25% of pyroclastic material — nomenclature and symbols as for appropriate clastic sedimentary rock.

4.4 Textural and mineral qualifiers for use as prefixes in igneous and metamorphic rock symbols.

The abbreviations shown here are mostly in lower case Roman letters. The font used on maps should be the same as that in the main symbol, i.e. italic for igneous and Quill for metamorphic. A few Greek letters are used, mainly for deformational features. The more commonly used abbreviations are single letters, others are double. There is some duplication of abbreviations between the two lists for 'textures' and 'minerals'. This should not normally present any problems, since all prefixed symbols will be fully described in each map Key. Where ambiguity is possible, alternative abbreviations are suggested, (e.g. it is possible that a banded pelite ^{b}P and a biotite-bearing pelite ^{bt}P need to be identified on the same map. However, in general it is advantageous to retain a single letter, b, for both 'biotite' and 'banded'). Exceptionally, authors may need to devise other options to avoid similar clashes, but where possible prefixes should be as listed here.

4.4.1 Textures and compositional variations

aplitic	α
appinitic	a
banded or striped	b
brecciated or cataclastic	β
charnockitic	ck
coarse-grained	cg
composite	co
contaminated	ct
felsic	fs
fine-grained	fg
flaggy	f
flinty crush or pseudotachylite	κ
flow-banded or fluxioned	fl
foliated	ϕ
gneissose	gn
granophyric or micropegmatitic or micrographic	g
granulitic	γ
hornfelsed	h
hyaloclastitic	ha
hybridised	hy
hydrothermally altered	ht
layered (igneous)	la
leucocratic	j
macroporphyritic	ma
mafic	mf
melanocratic	k
microporphyritic	mi
migmatitic	m
multiple	ml
mylonitic	μ
myrmekitic	my
palagonitic	pa
pegmatitic	π
phacoidal	ph
phyllitic	p
pillowed	pw
schistose	s
sheared	σ
slaty	sl
spherulitic or variolitic	sp
spilitic	s
vitric or glassy	v
welded	w
xenolithic	x

4.4.2 Minerals

actinolite	at
aegirine	ac
albite	ab
alkali feldspar	af
amphibole	am
analcime	a
andesine	ad
andalusite	al
anorthite	an
anorthoclase	ar
anthophyllite	ah
antigorite	ag
apatite	ap
augite	au
arfvedsonite	av
axinite	ax
barite	ba
bastite	bs
beryl	be
biotite	b (or bt)
bronzite	bz
brucite	br
bytownite	by
calcite	ca
carbonate	c
cassiterite	cs
chiastolite	ch
chlorite	cl
chromite	cr
chrysotile	cy
clinopyroxene	p

cordierite	cd
corundum	co
cummingtonite	cm
chloritoid	ct
datolite	da
diopside	di
dolomite	do
enstatite	en
epidote	ep
fayalite	fa
feldspar	f
forsterite	fo
garnet	g (or gt)
glaucophane	gl
graphite	gr
haematite	he
hornblende	h (or hb)
hypersthene	hy
ilmenite	il
kaemmererite	ka
kaolinite	ko
kyanite	ky
labradorite	la
leucite	l
lizardite	lz
magnetite	mt
melilite	me
mica	m
microcline	mc
microperthite	mp
mullite	ml
muscovite	ms
nepheline	n
nosean	no
oligoclase	og
olivine	o
orthoclase	or
ortho (rhombic) pyroxene	r
plagioclase	pl
potash feldspar	k
pyrite	py
pyroxene	px
pigeonite	pi
quartz	q
riebeckite	ri
sanidine	sa
scapolite	sc
sericite	se
serpentine	sn
shimmer aggregate	sg
siderite	sd
sillimanite	si
sodalite	so
sphene	sh
spinel	sp
staurolite	st
talc/steatite	ta
topaz	tz
tourmaline	to
tremolite	t
vesuvianite	ve
wollastonite	wo
zircon	zr
zoisite	zo

4.5 Obsolete and local rock names and symbols formerly included in the BGS symbol scheme for igneous rocks

Former symbol	*Former name*	*Suggested modern name (and logical full symbol not recommended)*	*Suggested symbols (others may be possible)*	
		(All parts of the symbols shown are usually italic; only stratigraphical suffixes are to be Roman font)		
α	Aplite	aplitic microgranite (or other rock type)	αF	αF^{FG}
A^{I}	Icelandite	hypersthene-augite andesite pigeonite-augite andesite	rpA^{A}	
B^{Ak}	Ankaramite	macroporphyritic olivine-pyroxene basalt/basanite ($maopB^{Bn}$)	opB	opB^{Bn}
B^{Ck}	Basalt lava (Craiglockhart type)	macroporphyritic olivine-pyroxene basalt/basanite ($maopB^{Bn}$)	opB	B_{Ck}
B^{C}	Basalt lava (crinanitic)	analcime-bearing olivine-basalt	aB^{A}	
B^{D}	Basalt lava (Dalmeny type)	microporphyritic olivine-phyric alkali basalt ($mioB^{A}$)	B^{A}_{D}	
B^{Du}	Basalt lava (Dunsapie type)	macroporphyritic olivine-augite-plagioclase- phyric alkali basalt ($maopfB^{A}$)	B^{A}_{Du}	
B^{H}	Basalt lava (Hillhouse type)	microporphyritic olivine-augite-phyric alkali basalt or basanite ($miopB^{A}$, $miopB^{Bn}$)	B^{A}_{H}	B^{Bn}_{H}
B^{He}	Basalt lava (Hebridean type)	olivine-phyric alkali basalt	oB^{A}	B^{A}_{He}
B^{J}	Basalt lava (Jedburgh type)	microporphyritic feldspar-phyric alkali basalt or hawaiite ($mifB^{A}$, $mifW^{H}$)	B^{A}_{J} W^{H}_{J}	BW
B^{L}	Limburgite	vitric basanite	vB^{Bn}	
B^{M}	Basalt lava (Markle type)	macroporphyritic feldspar-phyric alkali basalt or hawaiite ($mafB^{A}$, $mafW^{H}$)	B^{A}_{M} W^{H}_{M}	fBW
B^{Mn}	Monchiquite lava	porphyritic nephelinite or analcimite	$_{*}I^{N}$ with appropriate prefix (⋆)to indicate phenocrysts	$_{*}I^{A}$
B^{S}	Spilitic basalt	spilitic basalt	sB	
B^{V}	Dolerite lava (Vaternish types)	coarse-grained alkali olivine-dolerite	D^{A}_{I} D^{A}_{V}	B^{A}_{V}
C^{F}	Fourchite intrusion	(olivine-free) augite-phyric monchiquite or analcimite	pL^{Mo}	pI^{A}
C^{K}	Basanite intrusion (Kidlaw type)	poikilitic analcime basanite	aB^{Bn}	
C^{O}	Ouachitite intrusion	biotite-rich monchiquite	bL^{Mo}	
D^{D}	Bekinkinite intrusion	melanocratic barkevikite nepheline-dolerite	knD	$amnD$
D^{Ck}	Dolerite intrusion (Craiglockhart type)	melanocratic olivine-pyroxene-phyric basanite or dolerite ($maopD^{Bn}$)	kD^{Bn} D^{Bn}_{Ck} D^{A}_{Ck}	kD^{A} D_{Ck}
D^{C} $+K^{C}$	Dolerite intrusion (Crinanite)	analcime-bearing olivine-dolerite	aD^{A}	
D^{D}	Dolerite intrusion (Dalmeny type)	microporphyritic olivine-phyric alkali dolerite ($mioD^{A}$)	D^{A}_{A}	D_{D}
D^{Du}	Dolerite intrusion (Dunsapie type)	macroporphyritic olivine-augite-plagioclase-phyric alkali dolerite ($maopfD^{A}$)	D^{A}_{Du}	D_{Du}
D^{E}	Essexite	nepheline-micromonzogabbro nepheline-micromonzodiorite	nD^{M} nP^{M}	
D^{F}	Ferrodolerite	dolerite and mineral qualifiers or dolerite, iron-rich	$famtD$ feD	

D^{H}	Dolerite intrusion (Hillhouse type)	microporphyritic olivine-augite-phyric alkali dolerite or basanite (*miopD*^{A}, *miopD*^{Bn})	D^{A}_{H} D^{Bn}_{H}	D_{H}
D^{J}	Dolerite intrusion (Jedburgh type)	microporphyritic feldspar-phyric alkali dolerite or hawaiite (*mifD*^{A}, *mifW*^{H})	D^{A}_{J} W^{H}_{J}	DW_{J}
D^{M}	Dolerite intrusion (Markle type)	macroporphyritic feldspar-phyric alkali dolerite or hawaiite (*mafD*^{A}, *mafW*^{H})	D^{A}_{M} W^{H}_{M}	fDW_{M}
D^{S}	Spilitic dolerite	spilitic dolerite	*sD*	
D^{Te}	Teschenite	analcime-dolerite/gabbro	*aD aE*	*aD*^{D} *aE*^{G}
D^{Th}	Theralite	nepheline-dolerite/gabbro	*nD nE*	*nD*^{D} *nE*^{G}
E^{E}	Eucrite	bytownite gabbro	*byE*	*byE*^{G}
E^{E}	Essexite	nepheline-monzogabbro nepheline-monzodiorite	*nE*^{M} *nH*^{M}	
E^{F}	Ferrogabbro	gabbro and mineral qualifier or gabbro, iron-rich	*mtE* *feE*	
F^{C}	Craignurite (acid)	acicular microgranodiorite	F_{C}	F^{Gd}_{C}
F^{Pt}	Porphyrite (acid)	leucocratic, porphyritic andesine trachyandesite, dacite or micrograno-diorite.Phenocrysts of albitised plag ±hbl or bi	*jA* *jN* *hF*^{Gd}	*jA*^{A} *hR*^{D} *fF*^{Gd}
H^{F}	Ferrodiorite	diorite and mineral qualifiers diorite, iron-rich	*mtE* *feH*	
G^{A}	Adamellite	monzogranite, syenogranite, granite	*G*^{M} *G*^{G}	*G*^{S}
G^{A}	Alaskite	leucocratic alkali-feldspar-granite (***jaf****G*^{G})	*jG* *jG*^{G}	*afG*
G^{B}	Banatite	quartz-diorite	*qH*	*qH*$_{D}$
G^{Tr}	Trondhjemite	leucocratic tonalite/leucotonalite	*jG*^{T}	
I	Granophyre	granophyric granite/granodiorite etc.	*gG*$_{G}$	*gG*^{Gd}
J^{F}	Felsite, rhyolite, trachyte or trachy-andesite minor intrusions (undefined)	felsic or semi-felsic rocks (unclassed)	*J*	
$L^{L/A}$	Transitional rock; lamprophyre/appinite	macroporphyritic or coarse-grained lamprophyre	e.g. *maL*^{V} *cgL*^{Sp}	
M^{K}	Kentallenite	melanocratic olivine monzonite	*oM* *M*$_{K}$	*kM*
O^{A}	Ailsyte	riebeckite microgranite or microsyenite	*riF*^{G} *riO*^{S}	*O*$_{A}$
O^{B}	Bostonite	leucratic albite-trachyte/ microsyenite	*abO*^{S} *abT*^{T}	*abO* *abT*
O^{G}	Grorudite	peralkaline microgranite	*acF*^{G}	
O^{N}	Nordmarkite-porphyry	porphyritic quartz-bearing alkali-feldspar-microsyenite	*afO*^{S}	
O^{O}	Orthophyre or alkaline porphyry	orthoclase-phyric trachyte or microsyenite	*orT*^{T} *orO*^{S}	*orT* *orO*
P	Porphyrite	porphyritic andesite or microdiorite	$_{*}A^{A}$	$_{*}P^{D}$ (with approp. phenocryst prefix)
P^{C}	Craignurite (basic)	acicular andesite	*A*^{A}	*A*$_{C}$
P^{D}	Basic porphyrite transitional to dolerite or basalt	porphyritic basaltic andesite	$_{*}A^{B}$ (with phenocryst prefix)	
P^{H}	Helsinkite	albite-epidote rock (metabasalt?)		
P^{I}	Inninmorite	glassy anorthite-pigeonite andesite	*vA* *A*$_{I}$	*piA*^{A}
P^{L}	Leidleite	glass-rich andesite	*vA* *A*$_{L}$	*spA*

P^P	Plagiophyre	highly altered andesitic or microdioritic rock	*A*	*P*
$\pi^\star$	Granite/diorite pegmatite etc.	pegmatitic granite/diorite etc.	πG πH πS πE	
π^Q	Quartz vein or lens	quartz vein or lens	*Q*	
Q^A $+K^A$	Andesitic or tholeiitic quartz-dolerite	quartz andesite, quartz-microdiorite, tholeiitic quartz-dolerite	qA^A qD^T	qP^D
Q^B	Quartz-basalt intrusion	quartz basalt	qB^B	
R^F	'Felsite' lava	Fine-grained acid rock (unclassed)	*R*	
S^A	Akerite	leucocratic microsyenite or micromonzonite	jO^S jO^M	
S^B	Borolanite	melanite-bearing nepheline-syenite	*gnS*	S_B
S^F	Fenite	metasomatic alkali-feldspar-syenite (explain* in Key)	*afS**	
S^F	Foyaiite	nepheline-syenite	*nS*	
S^{Ma}	Malignite	mesocratic (?mafic) nepheline-syenite	*mfnS*	*nS*
S^{Mi}	Miaskite	leucocratic biotite nepheline-monzosyenite ($jbinS^M$)	nS^M	
S^N	Nordmarkite	quartz-bearing alkali-feldspar-syenite	*qafS*	
S^P	Pulaskite	nepheline-bearing alkali-feldspar-syenite	*nafS*	
S^{Pe}	Perthosite	leucocratic alkali-feldspar-syenite	*jafS*	*afS*
S^{Sh}	Shonkinite	melanocratic nepheline-syenite	*knS*	
S^U	Umptekite	nepheline-bearing alkali-feldspar-syenite	*nafS*	
T^K	Keratophyre	albitised felsic extrusive rock	*abR*	*abT*
U^A	Allivalite	bytownite-troctolite	byE^T	E^T_A
U^C	Cortlandtite	olivine-pyroxene hornblendite	opU^A	
U^E	Eulysite	fayalite-hedenbergite-grunerite rock — metamorphic in UK — probably an iron-formation	$\mathcal{Y}$ (Quill font)	
U^{Ha}	Harrisite	bytownite troctolite	byE^T	E^T_H
U_L	Ultrabasic layered rocks (undefined)	— see 'layered' prefix	*laE*	*laU*
U^S	Scyelite	olivine hornblendite	oU^A	
W^{Bh}	Basaltic hawaiite	hawaiite	W^H	
Y	Appinite/coarse-grained lamprophyric rocks	appinitic diorite/monzonite/granodiorite etc. or if heterogeneous mixture	*aH* *aM* aG^D *aHM* etc. and give full description in Key	
Y^D	Appinite (dioritic; i.e. relatively felsic	appinitic diorite	*aH*	
Y^H	Appinite (basic; near hornblendite)	appinitic gabbro or hornblendite	*aE*	aU^A
Z^P	Palagonitic pyroclastic rocks	devitrified basaltic vitric tuff etc.	$pacZ^B$	$paLZ^B$ etc.

Notes:
1. The symbols in the right-hand column are suggestions. Other possibilities exist and authors should select symbols, which are as simple as possible, to suit individual maps.

2. Local names and symbols (e.g. B_{Du}, F_C, A_I, E^T_A) should not be used outwith the areas for which they were originally defined; e.g. Carboniferous–Permian province of Southern Scotland; British Tertiary Igneous Province; Rum Central Complex. They should always be qualified by full petrological names in the index; e.g. Basalt of Dunsapie type = macroporphyritic olivine-augite-feldspar-phyric alkali basalt.

4.6 Alphabetical list of approved rock names

V^{R}	Acid tuffaceous sedimentary rock/tuffite
B^{A}	Alkali basalt
D^{A}	Alkali dolerite
afG	Alkali-feldspar-granite
afS	Alkali-feldspar-syenite
aS	Analcime-syenite
I^{A}	Analcimite
Y^{A}	Analcimolite
A^{A}	Andesite
A	Andesitic rock (unclassed)
Z^{A}	Andesitic pyroclastic rock
V^{A}	Andesitic tuffaceous sedimentary rock/tuffite
E^{A}	Anorthosite
aH	Appinitic diorite
aM	Appinitic monzonite
B^{B}	Basalt
A^{B}	Basaltic andesite
Z^{B}	Basaltic pyroclastic rock
B	Basaltic rock (unclassed)
B^{Bn}	Basanite
I^{B}	Basanitic foidite
V^{B}	Basic tuffaceous sedimentary rock/tuffite
N^{B}	Benmoreite
A^{Bo}	Boninite
B^{C}	Calc-alkali basalt
C^{C}	calcite-carbonatite
L^{C}	Camptonite
C	Carbonatitic rock (unclassed)
U^{C}	Clinopyroxenite
R^{C}	Comenditic rhyolite
R^{D}	Dacite
Z^{D}	Dacitic pyroclastic rock
C^{D}	Dolomite-carbonatite
H^{D}	Diorite
H	Dioritic rock (unclassed)
D^{D}	Dolerite
D	Doleritic rock (unclassed)
U^{D}	Dunite
J	Felsic or semi-felsic fine- to medium-grained rock (unclassed) 'Felsite'
**F*	Felsic prophyry
C^{F}	Ferroan carbonatite
E^{G}	Gabbro
E	Gabbroic rock (unclassed)
$E^{G/N}$	Gabbronorite
G^{G}	Granite
G	Granitic rock (unclassed)
G^{D}	Granodiorite
U^{H}	Harzburgite
W^{H}	Hawaiite
U^{A}	Hornblendite
X	Intrusive breccia
L^{K}	Kersantite
U_{V}	Komatiite
L^{L}	Lamproite
L	Lamprophyre (unclassed)
N^{L}	Latite
IS	Leucite-syenite
I^{L}	Leucitite
Y^{L}	Leucitolite
U^{L}	Lherzolite
K	Mafic or semimafic fine- to medium-grained
**K*	rocks (unclassed) 'mafite'
	Mafic prophyry
U^{M}	Melilitolite
P^{D}	Microdiorite
P	Microdioritic rock (unclassed)
D^{G}	Microgabbro
F^{G}	Microgranite
F	Microgranitic rock (unclassed)
F^{Gd}	Microgranodiorite
P^{M}	Micromonzodiorite
O^{M}	Micromonzonite
O^{S}	Microsyenite
O	Microsyenitic rock (unclassed)
F^{T}	Microtonalite
L^{Mi}	Minette
L^{Mo}	Monchiquite
H^{M}	Monzodiorite
E^{M}	Monzogabbro
G^{M}	Monzogranite
M	Monzonite
$E^{M/N}$	Monzonorite
S^{M}	(foid) Monzosyenite
W^{M}	Mugearite
C^{N}	Natrocarbonatite
nS	Nepheline-syenite
I^{N}	Nephelinite
Y^{N}	Nephelinolite
E^{N}	Norite
vR	Obsidian
U^{O}	Orthopyroxenite
R^{P}	Pantelleritic rhyolite
$\|\pi$	Pegmatite
U^{Pd}	Peridotite
T^{P}	Phonolite
I^{P}	Phonolitic foidite
W^{Tp}	Phonolitic tephrite/phonotephrite
D^{P}	Picrite
B^{P}	Picrobasalt
vR	Pitchstone
W^{T}	Potassic trachybasalt
Z	Pyroclastic rock (unclassed)
U^{Px}	Pyroxenite
Q	Quartz-rich granitic rock
qD	Quartz-dolerite
qS	Quartz-syenite
Q	Quartzolite
$R^{R/D}$	Rhyodacite
R^{R}	Rhyolite
R	Rhyolitic and dacite rock (unclassed)
Z^{R}	Rhyolitic pyroclastic rock
L^{Sa}	Sannaite
U^{S}	Serpentinite
W^{S}	Shoshonite
L^{Sp}	Spessartite
S^{S}	Syenite
S	Syenitic rock (unclassed)
G^{S}	Syenogranite
N^{P}	Tephritic phonolite/tephriphonolite
B^{Tp}	Tephrite
I^{T}	Tephritite foidite
B^{T}	Tholeiitic basalt
D^{T}	Tholeiitic dolerite
G^{T}	Tonalite
N	Trachyandesite
W^{T}	Trachybasalt (potassic)
W	Trachybasaltic rock (unclassed)
T^{D}	Trachydacite
T^{T}	Trachyte
T	Trachytic rock (unclassed)
Z^{T}	Trachytic pyroclastic rock
E^{T}	Troctolite
V	Tuffaceous sedimentary rock (unclassed)
X	Tuffisite
V	Tuffite (unclassed)
U_{V}	Ultramafic fine-grained rock (unclassed) (Ultramatitite)
U	Ultramafic rocks (unclassed)
L^{V}	Vogesite
U^{Wb}	Websterite
U^{Wh}	Wehrlite

5 METAMORPHIC ROCKS

5.1 Introduction

This scheme should be used in conjunction with the *BGS Rock Classification Scheme, Volume 2. Classification of metamorphic rocks* (by S Robertson, BGS Research Report, RR 99-02).

A G MacGregor developed a symbol scheme in 1950 for BGS, primarily for the Scottish Highlands, based on a main lithology symbol with additional suffixes and prefixes to refine further the rock-type description. The scheme presented here builds on the general principles of the MacGregor scheme but seeks to resolve various anomalies which have arisen during its usage subsequently. MacGregor's innovative concept of giving metamorphic rocks a unique font is retained; it is imaginative and of practical value, notably on maps with a combination of metamorphic and unmetamorphosed lithologies. The main lithology symbol is based, as far as it is practicable, on the original pre-metamorphic lithology and is independent of the metamorphic state. The latter can, however, be indicated by the use of prefixes showing diagnostic textures (Section 5.4) or metamorphic minerals.

When new symbols are required the principles adopted in the scheme should be followed.

5.1.1 The new scheme

The symbol scheme for metamorphic rocks ideally has two main components which are related to the metamorphic lithology and to the stratigraphical (lithostratigraphical or lithodemic) position of the rock unit, as follows,

$$\mathcal{B}_{\mathrm{D}}$$

where $\mathcal{B}$ relates to the metamorphic lithology and D to the stratigraphy. The basic symbol above may be supplemented by prefixes and/or suffixes to provide additional information, giving a complete symbol in the form

$$a\mathcal{B}^{c}_{\mathrm{D}}$$

(Lower Case Quill) a = textural or mineral qualifer

(Capital Quill) $\mathcal{B}$ = main lithology

(Small Capital Quill) c = division of the main lithology

(Small Univers Roman) D = stratigraphical identifier

The symbol shown on the map should be simplified if covered adequately in the key; e.g. '$\mathcal{P}$ – garnet-mica schist' may be adequate where all the pelites are garnetiferous but $g\mathcal{P}$ may be required to distinguish garnetiferous schist from $si\mathcal{P}$ sillimanite-bearing schistose pelite. The Quill font has been selected for the basic lithology symbol. Table 1 shows the capital and lower case versions. The font is distinctive enough to be readily recognisable as metamorphic and yet has some continuity with previous Lutheran letters selected by MacGregor. The stratigraphical identifier, as a suffix to the main lithology letter, is in capital Univers Medium Roman letters.

Table 1 The Quill font.

Quill 10pt: *ABC BCD CDE DEF EFG FGH GHI HIJ IJK JKL KLM LMN MNO NOP OPQ PQR QRS RST STU TUV UVW VWX WXY XYZ YZA ZAB Abc Bcd Cde Def Efg Fgh Ghi Hij Ijk Jkl Klm Lmn Mno Nop Opq Oqr Qrs Rst Stu Tuv Uvw Vwx Wxy Xyz Yza Zab*

All the metamorphic symbols which follow will be placed in tablets in the map legend or explanation.

5.2 Metamorphic lithology

5.2.1 Metasedimentary rocks

Principal lithological groupings are recognised. MacGregor's original selection of major metasedimentary groups, based on his wide experience of mapping and producing geological maps in Scotland, remains sound and is essentially retained. Modern interpretations of the sedimentary protolith can still be accommodated within these groupings; such notes should be included in the unit description or in the related account of the geology. The main lithological divisions are detailed in Tables 2 to 9 inclusive; the subdivisions are based on broad compositional ranges with greater detail provided in the map legend for each mapped unit.

Gneissose metasedimentary rocks may be indicated by the use of the prefix 'gn' to distinguish them from non-gneissose rocks, e.g. gneissose semipelite $g\mathcal{S}$ from schistose semipelite $\mathcal{S}$. However, where all of a class of rocks are gneissose the 'gn' prefix may be omitted from the map symbol and covered by the legend description, e.g. $\mathcal{S}$ — gneissose semipelite containing kyanite and/or sillimanite in places.

'Meta-ironstones' are given the symbol $\mathcal{Y}$ irrespective of whether they are altered sedimentary rocks or magnetite-rich rocks associated with basic/ultrabasic igneous complexes.

Table 2 Dominantly quartzofeldspathic or quartzose rocks and rock groups.

Symbol	*Metamorphic lithology*
$\mathcal{Q}$	Psammitic rocks or groups
$\mathcal{Q}^{\mathcal{M}}$	Micaceous psammite
$\mathcal{Q}^{\mathcal{Q}}$	Quartzite
$\mathcal{Q}^{\mathcal{G}}$	Quartzofeldspathic rocks with coarse clasts (2–16 mm)
$\mathcal{Q}^{\mathcal{C}}$	Metachert

Table 3 Dominantly semipelitic rocks and rock groups.

Symbol	*Metamorphic lithology*
$\mathcal{S}$	Semipelites (unclassed)
$s\mathcal{S}$	Schistose semipelite
$p\mathcal{S}$	Phyllitic semipelite
$sl\mathcal{S}$	Slaty semipelite
$b\mathcal{S}$	Banded units with semipelite as the main constituent

Table 4 Dominantly pelitic rocks and rock groups, including graphitic varieties.

Symbol	*Metamorphic lithology*
$\mathcal{P}$	Pelites (unclassed)
$b\mathcal{P}$	Banded or striped pelite
$s\mathcal{P}$	Schistose pelite or mica schist
$p\mathcal{P}$	Phyllitic pelite
$sl\mathcal{P}$	Slaty pelite
$\mathcal{P}^{\mathcal{B}}$	Graphitic pelite (unclassed) Banded or striped graphitic pelite, graphitic mica-schist, graphitic phyllite/slate (and banded or striped equivalents) shown by relevant prefix, as in first part of the table

Table 5 Dominantly impure metacarbonate and/or calcsilicate rocks and rock groups containing up to 50% carbonate and/or calcsilicate minerals.

Symbol	*Metamorphic lithology*
$\mathcal{C}$	Calcareous/dolomitic metasedimentary rocks (unclassed) containing appreciable interstitial carbonate, and calcsilicate-rocks
$b\mathcal{C}$	Banded or striped rocks and rock groups containing up to 50% carbonate and/or calcsilicate minerals
$s\mathcal{C}$	Schistose rocks and rock groups containing up to 50% carbonate and/or calcsilicate minerals
$p\mathcal{C}$	Phyllitic rocks and rock groups containing up to 50% carbonate and/or calcsilicate minerals
$sl\mathcal{C}$	Slaty rocks and rock groups containing up to 50% carbonate and/or calcsilicate minerals
$\mathcal{C}^{\mathcal{Q}}$	Carbonate-quartz rocks
$\mathcal{C}^{\mathcal{G}}$	Coarse-grained metaclastic rocks containing up to 50% carbonate and/or calcsilicate minerals
$ca\mathcal{C}$	Rocks and rock groups containing up to 50% carbonate and/or calcsilicate minerals where calcite is a prominent constituent
$do\mathcal{C}$	Rocks and rock groups containing up to 50% carbonate and/or calcsilicate minerals where dolomite is a prominent constituent

Table 6 Dominantly metacarbonate-rocks.

Symbol	*Metamorphic lithology*
$\mathcal{L}$	Dominantly crystalline metacarbonate-rocks (unclassed)
$ca\mathcal{L}$	Dominantly calcitic crystalline metacarbonate-rocks
$do\mathcal{L}$	Dominantly dolomitic crystalline metacarbonate-rocks
$\mathcal{L}^{\mathcal{L}}$	Metalimestone
$do\mathcal{L}^{\mathcal{L}}$	Dolomitic metalimestone
$\mathcal{L}^{\mathcal{D}}$	Metadolostone
$ca\mathcal{L}^{\mathcal{D}}$	Calcitic metadolostone

Table 7 Metaconglomerates, metabreccias and tillites.

Symbol	*Metamorphic lithology*
$\mathcal{Z}$	Metaconglomerates (unclassed)
$\mathcal{Z}^{\mathcal{B}}$	Metabreccia
$\mathcal{Z}^{\mathcal{D}}$	Metadiamicton
$\mathcal{Z}^{I}$	proportion of pebbles of igneous origin
$\mathcal{Z}^{\mathcal{S}}$	pebbles of sedimentary origin
$\mathcal{Z}^{\mathcal{L}}$	pebbles of limestone origin

Table 8 Heterogeneous metasedimentary rocks, including unclassed units and groups of various contrasting lithologies

Symbol	*Metamorphic lithology*
$\mathcal{K}$	Metasedimentary rocks and heterogenous striped or banded groups (unclassed) comprising various contrasted lithologies but no, or very minor carbonate-bearing rocks (No single lithology is dominant)
$\mathcal{K}^{\mathcal{L}}$	Heterogenous striped or banded groups comprising various contrasted lithologies including carbonate-bearing rocks

Table 9 Units of metasedimentary rocks comprising two major lithologies which are too finely interlayered to be separated on the geological map. The table shows some pairs used on existing maps. (See the central Shetland map for the best use of paired lithologies.)

Symbol	*Metamorphic lithology*
$\mathcal{QP}$	Mixed assemblages of psammite and pelite
$\mathcal{QS}$	Mixed assemblages of psammite and semipelite
$\mathcal{SQ}$	Mixed assemblages of semipelite and psammite
$\mathcal{CS}$	Mixed assemblages of calcsilicate-rock and semipelite
$\mathcal{CQ}$	Mixed assemblages of calcsilicate-rock and psammite
$\mathcal{DQ}$	Mixed assemblages of hornblendic rocks and psammite

Note: If one lithology is dominant its symbol is placed first. The description in the map legend should highlight the relative importance of the two major lithologies. (Colour should follow that of the first-placed symbol).

Within the groupings any major composition variations are indicated by superior suffixes in capital Quill font letter as shown in the tables. The principal of confining superior suffixes to major composition variations follows the igneous rock symbol scheme. Table 9 shows the symbol scheme for mapped units consisting of two major lithologies which are interbedded on too fine a scale to be shown separately on the map. These units have two-letter symbols corresponding to the individual letters of the constituent lithologies.

5.2.2 Meta-igneous rocks

As a general rule it is proposed that if an igneous rock has been metamorphosed after its emplacement, its letter font is changed from Univers Medium Italic to the Quill. For example, a metagabbro takes the symbol $\mathcal{E}^{\mathcal{G}}$, a metabasalt $\mathcal{B}^{\mathcal{B}}$, and a metadiorite $\mathcal{H}^{\mathcal{D}}$. In practice it will usually be possible and desirable to reduce these symbols to their simplest root form, e.g. $\mathcal{E}$, $\mathcal{B}$, $\mathcal{H}$. Section 4.3 of the section on igneous rock symbols provides a list of igneous rock symbols upon which the meta-igneous rock symbols should be based. Table 10 of the metamorphic scheme gives examples of many of the meta-igneous names noted on maps covering metamorphic terrains. On some maps there is the possibility of a duplication of symbols between meta-igneous and metasedimentary rocks, e.g. if schistose semipelites and metasyenites (unclassed) occur together. In this case

one of the symbols would have to be modified, e.g. $\mathcal{S}$ for the schists and $\mathcal{S}^{S}$ for the metasyenites.

In some cases the original rock cannot be exactly specified. For these meta-igneous rocks a more general symbol has to be used. For example $\mathcal{D}$ is used for amphibolites of uncertain origin and composition whereas the symbol $\mathcal{B}$ can be used for amphibolites known to be derived from basalts. For orthogneisses the symbol O is used for undifferentiated orthogneisses with the prefix *mf* or *fs* added to distinguish mafic and felsic orthogneisses respectively. Otherwise, for orthogneisses with specified compositions it is recommended that the appropriate meta-igneous rock symbol is used with the prefix *gn* used to denote the gneissose texture (see sections on prefixes). For example, $gn\mathcal{G}$ for a gneissose granite. If it cannot be established whether a quartzofeldspathic gneiss is a paragneiss or orthogneiss it is given the symbol $\mathcal{F}$. Units known to be composed of intimately mixed metasedimentary rocks and meta-igneous rocks are given the symbol $\mathcal{X}$.

$\mathcal{V}$ is used for all types of metamorphosed volcaniclastic rocks with full descriptions of individual units provided in the map legend. The composition of the metavolcaniclastic rocks can be indicated by the use of prefixes, e.g. *fs* for felsic rocks and *mf* for mafic rocks.

Amphibolites of uncertain origin are given the symbol $\mathcal{D}$, irrespective of whether they are altered sedimentary rocks, volcanic rocks or basic intrusions. If an amphibolite is known to be derived from a basalt then the symbol $\mathcal{B}$ can be used with a full description in the legend, i.e. amphibolite derived from a basaltic lava/sill etc. $\mathcal{Y}$ is used for all types of 'meta-ironstone' including magnetite-rocks associated with basic/ultrabasic complexes.

Combinations of letters, as for metasedimentary rocks, again reflect units composed of two major lithologies which are too finely interbanded or intermingled to be separated on the geological map.

Note: There will be cases where the primary igneous texture has been modified other than by regional metamorphism; for example, by late-stage hydrothermal alteration. In these cases the geologist will have to decide whether to give the rock an igneous or meta-igneous letter font. Hydrothermal alteration can also be shown by the prefix, *ht*, as for example *htB* for hydrothermally altered basalt dyke. A stipple can be used to show large areas of hydrothermal alteration.

Table 10 Examples of symbols for meta-igneous rocks and rocks of mixed or doubtful origin. Most meta-igneous rocks take their symbol from the precursor igneous rock. Compositional variations in the rocks listed as unclassed in the table are indicated by superscripts as shown in Section 4.3 of the igneous rock symbol scheme.

Symbol	*Metamorphic lithology*
$\mathcal{A}$	Metamorphosed andesitic rocks (unclassed)
$\mathcal{B}$	Metamorphosed basaltic rocks (unclassed)
$\mathcal{D}$	Amphibolites; hornblende schist (igneous and sedimentary origin)
$\mathcal{D}^{D}$	Metadolerite
$\mathcal{E}$	Metamorphosed gabbros (unclassed)
$\mathcal{F}$	Quartzofeldspathic gneisses of uncertain origin
$\mathcal{G}$	Metamorphosed granites (unclassed)
$\mathcal{H}$	Metamorphosed diorites (unclassed)
O	Orthogneiss (unclassed)
fsO	Felsic orthogneiss
mfO	Mafic orthogneiss
O^{M}	Mixed mafic and felsic orthogneisses
	Examples of orthogneisses of more specific composition:
$gn\mathcal{G}$	Gneissose granite
$gn\mathcal{H}$	Gneissose diorite
$\mathcal{R}$	Metamorphosed fine-grained acid rocks (unclassed)
$\mathcal{S}^{S}$	Metamorphosed syenite (unclassed)
$\mathcal{T}$	Metamorphosed trachytic rocks (unclassed)
$\mathcal{U}$	Metamorphosed ultramafic rocks (unclassed)
$ta\mathcal{U}$	Talc schist, talc-chlorite schists
$\mathcal{V}$	Metamorphosed volcaniclastic rocks
$\mathcal{W}$	Metamorphosed fine-grained rocks of intermediate composition (unclassed)
$\mathcal{X}$	Intimately mixed metasedimentary and meta-igneous rocks
$\mathcal{Y}$	Metamorphosed 'ironstones', including magnetite schists
$\mathcal{Y}ta\mathcal{U}$	Combination of letters denote mixed units e.g. Magnetite-rock with talc-chlorite-schist

5.3 Stratigraphy

Stratigraphical subdivisions are shown as suffixes in capital Univers Medium Roman letters. It is proposed that formalised lithostratigraphical or lithodemic units, irrespective of stratigraphical status (e.g. member, formation, subgroup, group), should have unique codes allocated through the same process as for sedimentary rocks. Informal stratigraphical units should be allocated single letter codes which should be consistent on adjacent sheets.

In some cases, notably structurally complex terrains, e.g. parts of the Moine, mapped lithological units cannot be given any stratigraphical status. This means that only a lithology symbol can be used on the map. This option must be retained. If it is necessary, perhaps for a commissioned survey, to introduced a local separation of lithologically similar units, it could be possible to number the units e.g. $\mathcal{L}_1$, $\mathcal{L}_2$ etc. with a heading or footnote to stress that the numbers have no stratigraphical significance.

In weakly metamorphosed areas where there is an established stratigraphy, the symbol scheme should follow that for sedimentary and/or volcanic rocks.

5.4 Prefixes to the main metamorphic lithology symbol

An integral part of the scheme is the use of various prefixes to provide more information, directly or indirectly, on lithology, primary and secondary textures, mineralogy and metamorphic grade. However, it is stressed that their use should be kept to a minimum and they should not be used to repeat information obvious from the descriptions in the map legend. It is important that the map symbols are kept as simple as possible. The symbol should unambiguously define the particular unit on a map (but not necessarily be unique). Simple symbols are easier to read, more aesthetically pleasing and make the work of the drawing

office easier. This also helps ensure quicker map production with fewer mistakes.

The prefixes for textural and mineralogical qualifiers used for both metamorphic and igneous rocks are given in Section 4.4 of the Igneous Rock scheme. The font used for the prefixes in the metamorphic rock scheme should be Quill, i.e. the same as that of the main symbol. A few Greek letters are used, mainly for deformational features and locally these Greek letters can be used on their own, e.g. μ for a mylonite zone thick enough to be differentiated on the map and in which the tectonic fabric obscures the original rock composition. Textural prefixes should precede mineral prefixes where both are necessary and porphyroblast phases should be listed in order of increasing abundance, e.g. *gstP* for a garnet-staurolite pelite. In almost all cases one mineral descriptor should be sufficient for a map symbol. Where ambiguity is possible, alternatives are suggested. For example it is possible that a banded pelite *bP* and a biotite-bearing pelite *btP* need to be identified on the same map. However, in general it is advantageous to retain a single letter, *b*, for both biotite and banded. Authors may well need to devise alternatives to avoid similar clashes, but otherwise the prefixes shown in Sections 4.4.1 and 4.4.2 should be used.

5.5 Hornfels

Hornsfelsing may be shown by adding the prefix 'h' to the main letter symbol, e.g. for hornfelsed metasedimentary rocks. Alternatively, the main symbol letter font can be changed to Quill where previously unmetamorphosed rocks are hornfelsed. This second option has been used on some Lake District maps. For hornfelsed metamorphic rocks the prefix '*h*' must be used.

5.6 Unusual lithologies

Occasionally a rock possesses an unusual physical property to form a mappable horizon. For example, magnetic schists form marker beds mapped by magnetometer traverses. These are shown on maps by the suffix ('), e.g. $\mathcal{P}^r$ showing a magnetic pelite. This option is retained. (A thin magnetic layer may be shown as –·– mt –·– mt.)

5.7 Subsidiary lithologies

5.7.1 Isolated mapped lithologies

Mapped minor lithologies, e.g. a calcsilicate-rock layer in a dominantly pelitic unit, should be given the appropriate Quill font symbol.

5.7.2 Uniformly distributed minor lithologies

The presence of uniformly distributed layers of a minor lithology within a single mappable unit, which are too small to show individually on the map face, should be recorded in the map legend. For example, '$\mathcal{L}$': Metalimestone with thin graphitic schist seams.

5.7.3 Irregularly distributed minor lithologies

These may be shown as a cross with the appropriate symbol to indicate an exposure. Alternatively, a superior Quill prefix can be added to the main symbol to show the general distribution of a minor lithology over part of a map, e.g. $^{L}\mathcal{P}$ for a pelite with thin metalimestone seams. This is an undesirable option and should be avoided whenever possible. A third possibility is to put a note on the map face, e.g. metalimestone seams common in this area.

5.8 Mechanically broken and reconstituted rocks

As far as is practicable these should be indicated by use of the appropriate prefix (*br* — brecciated, β — cataclastic, μ — mylonitic) to the protolith symbols. Where the protolith is unknown the prefixes β, μ and κ are used as main symbols. The font of these symbols should be the same as for the main symbol, i.e. Roman for sedimentary rocks, Italic for igneous rocks and Quill for metamorphic rocks.

5.8.1 Rocks without primary cohesion (random fabric)

Intensely fractured rock (including fault breccia where mappable).

△ △ △ [This symbol is used as an overprint on the protolith and may be labelled e.g. *brQ*. It may be used in combination with a fault line to indicate wide zones of brecciation, e.g. ]

5.8.2 Rocks with primary cohesion; foliated

Sheared rock; protomylonite

~~~ [This symbol is used as an overprint on the protolith and may be labelled, e.g. $\mu\mathcal{D}$. It may be used in combination with a fault or thrust line to indicate a wide zone of associated shearing, e.g. ]

μ Protomylonite; mylonite; phyllonite; 'tectonic schist'; 'platy rock' [Protolith uncertain]

μ^1 Blastomylonite

μ^2 Ultramylonite

[The suffixes 1, 2 etc. are used only where it is necessary to distinguish between e.g. mylonite and blastomylonite or between mylonites].

5.8.3 Rocks with primary cohesion: isotropic (random) fabric

Sheared rock; protocataclasite

~~~ [This symbol is used as an overprint on the protolith and may be labelled e.g. βQ. It may be used in combination with a fault or thrust line].

β Cataclasite [protolith uncertain].

β Ultracataclasite

[The suffix is used only when it is necessary to distinguish between e.g. cataclasite and ultracataclasite or between cataclasites].

5.8.4 Glassy (or devitrified glassy) fault rocks

κ Pseudotachylyte [Fault rock with glassy matrix].

6 STRUCTURAL SYMBOLS

6.1 Introduction

Symbols should be placed on the map as close to the point of measurement as is practicable. Symmetrical symbols (e.g.) should be placed symmetrically at the point of observation. For asymmetrical symbols, those of planar features (e.g.) should be placed with the intersection of the strike bar and barb at the point of observation. Those of asymmetrical linear symbols (e.g.) should be placed with the point of the arrow at the point of observation.

Section titles and all notes in small font and in square brackets are for guidance and should not be written on the map. All other notes and explanations should be used as shown and the symbols should be used in the order shown.

6.2 Bedding

Horizontal strata

Inclined strata, dip in degrees

Inclined strata

Undulating inclined strata

Highly inclined strata

Symbols without dip amount to be used only when derived from old maps.

Vertical strata

Undulating vertical strata

Horizontal overturned strata

Inclined strata known to be overturned, dip in degrees

Inclined strata, way up uncertain, dip in degrees

Strike of strata, dip direction unknown

Gently undulating strata, general disposition of bedding horizontal

Note: Bedding symbols take precedence over all others; where possible the locality for the measurement should be at the mid point of the strike bar.

Direction of younging indicated by F-cross-bedding/G-graded bedding/S-sole markings/ GP-geopetal* structures

[* Select the appropriate term from the alternatives]

Direction of younging in vertical strata

Cross-bedding, inclination of foresets, dip in degrees

Dune-bedding, inclination of foresets, dip in degrees

Inclined strata measured underground [in seam named where appropriate], dip in degrees where known

Generalised dip of inclined strata, in degrees

Generalised dip of inclined strata underground, in degrees

Note: On maps where confusion between planar and linear structures cannot occur the following symbols may be preferred:

Gently inclined strata

Inclined strata, dip in degrees

6.3 Foliation or layering of unspecified origin in metamorphic rocks

Horizontal foliation/layering* of unspecified origin

Inclined foliation/layering* of unspecified origin, dip in degrees

Vertical foliation/layering* of unspecified origin

Strike of foliation/layering* of unspecified origin, dip direction is unknown

[* Select appropriate term]

6.4 Cleavage/schistosity

Horizontal cleavage/schistosity*

Inclined cleavage/schistosity*, dip in degrees

Undulating cleavage, inclined

Vertical cleavage/schistosity*

Strike of cleavage/schistosity*, dip direction unknown

[* Select the appropriate term]

Note: Types of cleavage by: S — slaty or continuous**, C — crenulation, F — fracture, P — pressure solution. The type of cleavage is indicated by a letter and its relative age by a number in the form:

Vertical cleavage (C — crenulation); deformation episode given by number after code for cleavage type

Note: The symbols for different types of cleavage should be used with care and no attempt should be made to use them where there is uncertainty or to generalise with a single symbol where the cleavage changes across a fold.

[** The term continuous cleavage is now preferred for the older term penetrative cleavage.]

Where it is required to indicate cleavage/schistosity in different lithologies (for example, in mudstone and sandstone in a mixed formation) this may be done *either* by use of open and filled symbols:

inclined cleavage in mudstone, dip in degrees

Inclined cleavage in sandstone, dip is degrees

Vertical cleavage in sandstone

or by adding *an abbreviation* of the lithology:

Inclined cleavage, dip in degrees, in lithology indicated

Inclined cleavage, dip in degrees

Direction of cleavage facing [symbol placed immediately adjacent to relevant cleavage, schistosity or foliation symbol]

sheared rock

Note: The relative age, as indicated by the symbol, is only valid locally and may not relate to regional deformation sequence.

6.5 Joints

Horizontal joint

Inclined joint, dip in degrees

Vertical joint

6.6 Linear structures

Horizontal lineation

Plunging lineation, plunge in degrees

Vertical lineation

Type of lineation is indicated by:

L	Mineral lineation (with relevant mineral abbreviation as prefix, e.g. qL for quartz
R	Rodding
M	Mullion
B	Boudins
SP	Spindles
I	Intersection lineation
E	Extension lineation
C	Crenulation
SL	Slickensides, grooves or striations

The type of lineation is indicated by a letter and its relative age by a number in the form:

Plunging lineation (B-boudins), deformation epidsode shown by number after the lineation code; plunge in degrees

The relative ages of two intersecting surfaces may be shown in the form:

use 0 to indicate bedding, e.g.

6.7 Igneous rocks

Horizontal primary planar fabric (layering or flow foliation*) in igneous rocks

Horizontal relict (*schlieren or enclave) planar fabric in plutonic rocks

Inclined primary planar fabric (layering) in igneous rocks, dip in degrees

Vertical primary planar fabric (layering) in igneous rocks

Inclined (*schlieren or enclave) planar magmatic crystallisation fabric in plutonic rocks

Vertical (*schlieren or enclave) planar magmatic crystallisation fabric in plutonic rocks

Inclined primary planar fabric, overturned

Strike of primary planar fabric (layering or flow foliation*) in igneous rocks, dip direction is unknown

[*Select the appropriate term.]

Horizontal welding foliation

Inclined welding foliation, dip in degrees

Vertical welding foliation

Dip of igneous contact, dip in degrees

Dip of igneous contact, in degrees

Dip of inter-igneous contact, in degrees

Strike of welding foliation, dip direction unknown

Horizontal primary crystal alignment in igneous rocks

Inclined primary crystal alignment in igneous rocks, plunge in degrees

Vertical primary crystal alignment in igneous rocks

Inclined flow jointing, dip in degrees

Vertical flow jointing

Horizontal flow jointing

Axis of trough structure in igneous rocks [intrusive or extrusive] [defined by .....], plunge in degrees

6.8 Folds and related structures

6.8.1 Major folds

Note: A major fold is one that significantly distributes the rock outcrop on the scale of the map in use; on the 1:10 000 scale they have wavelengths measurable in hundreds of metres.

Note: The dashes between symbols may be made longer than those illustrated.

Axial plane trace of major anticline

Axial plane trace of major syncline

Axial plane trace of major syncline underground in seam named

Axial plane trace of major anticline underground in seam named

Axial plane trace of major antiform

Axial plane trace of major synform

Axial plane traces for closely spaced major anticline/syncline pair

Axial plane traces for closely spaced major anticline/syncline pair

Trace of upper hinge of major monocline (barbs on steep limb)

Trace of lower hinge of major monocline (barbs on steep limb)

Axial plane trace of major reclined or vertical fold (▶ to closure).

Axial plane trace of major recumbent fold (▲ to closure). [Add facing direction if known.]

The phase of deformation is shown by adding a number to the axial plane trace symbol in the form:

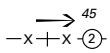
Axial plane trace of major anticline, 2nd phase

The attitude of the axial plane is shown by modifying the symbol for the axial plane trace to show inclined or vertical. The symbol is described in the form:

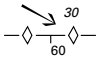
Axial plane trace of major anticline showing direction and amount of dip at axial plane

Axial plane trace at major syncline with vertical axial plane

The plunge of major fold axes is indicated by adding the symbols ⟷, ⟶ 45 or ◊ respectively to the symbol for axial plane trace. It is described in the form:



Axial plane trace of major syncline with vertical axial plane, showing direction and amount of axial plunge, 2nd phase



Axial plane trace of major anticline, axial plane dip in degrees, showing direction and amount of plunge of axis

6.8.2 Minor Folds

Note: A minor fold causes little or no modification of the outcrop pattern at the scale of the map in use; on a 1:10 000 map they have wavelengths of no more than tens of metres.

Horizontal axial plane of minor fold

Inclined axial plane of minor fold, dip in degrees

Vertical axial plane of minor fold

Strike of axial plane of minor fold, dip direction unknown

Minor folds are described as IS — Isoclinal, T — Tight, CL — Close, U — Open, K — Kink. The type of minor fold and the phase of deformation are described in the form:

Vertical axial plane of minor fold (T tight), 2nd phase

Direction of facing (see Section *6.8.3*)

Note: The axial plane as depicted here is the surface which passes through the hinges of all the beds in the fold.

Horizontal axis of minor fold

Axis of minor fold, plunge in degrees

Vertical axis of minor fold

Axis of minor anticline, plunge in degrees

Axis of minor syncline, plunge in degrees

Horizontal axis of minor anticline

Horizontal axis of minor syncline

Horizontal axis of minor monoform

Locality with refolded minor folds

The type of fold and phase of deformation are described in the form:

Axis of minor anticline (U = Open), plunge in degrees, 3rd phase

Direction of vergence of minor fold

Dextral vergence (looking down the plunge of the fold axis)

Sinistral vergence (looking down the plunge of the fold axis)

Neutral vertgence (looking down the plunge of the fold axis)

The direction of vergence may be shown by modifying the fold axis symbol as follows:

Axis of minor fold, plunge in degrees, showing direction of vergence

6.8.3 Facing

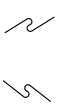
Definitions: (1) Fold facing — the direction, normal to the fold axis, along the fold axial plane, and towards the younger beds. (2) Cleavage facing — the direction, normal to the bedding plane intersection, along the cleavage plane, and towards the younger beds. (3) Fault facing — the direction, normal to the bedding plane intersection, along the fault plane and towards the younger beds (after Holdsworth, 1988). The stereographic analysis of facing. *Journal of Structural Geology*, Vol. 10, 219–223.)

(See Figure 1.)

6.8.4 Vergence

Vergence is the direction of overturning or inclination of a fold or microfold (crenulation).

Direction of vergence of minor fold [used in association with fold axis or bedding/cleavage intersection or cleavage/schistosity intersection lineation symbols and showing the direction, in the horizontal plane and normal to the fold axis, in which the hinge of a major antiform is to be expected]



Dextral, sinistral and neutral sense of vergence of minor folds [used in association with bedding or foliation symbols and showing the symmetry of folds in plan i.e. the fold profile projected on the horizontal plane] (see also Bell, A M. 1981. Vergence: an evaluation. *Journal of Structural Geology*, Vol. 3, No. 3, 197–202).

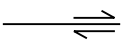
(See Figure 2)

6.9 Faults and related structures

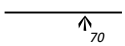
Note: Broken lines denote location inferred, this should be indicated by a note in the appropriate place in the Key.

Fault at rockhead, crossmark on downthrow side, throw in metres

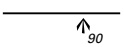
Termination of fault



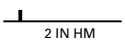
Sense of relative movement on strike-slip fault



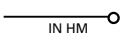
Dip of fault plane, in degrees



Vertical fault plane

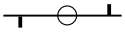


Fault underground in seam (or stratigraphical level, or at level relative to OD in metres) indicated; throw in metres [notes written on side from which fault was proved. Faults at unspecified stratigraphical or OD levels should not be shown without explanatory note, e.g. 2 in tunnel.]



Termination of fault underground in seam (or stratigraphical level indicated)

Incrop of fault at unconformity [e.g. Fault in Carboniferous, at base of Permian]



Point of zero throw on scissors fault

Faults may be described with the letters; NF — Normal fault, RF — Reverse fault, SF — Strike-slip fault, OF — Oblique-slip fault.

Thrust (T★), slide (S★) or ductile shear zone (D★), barbs on hanging-wall side

Dip of thrust (T★), slide (S★) or ductile shear zone (D★), in degrees

[★ Select the appropriate term]

The barbs on thrusts and slides are intended to indicate the original hanging wall side. Where the thrust or slide is overfolded it may be preferable to omit the barbs.

Zone of brecciation associated with fault

Zone of shearing associated with fault

Lineament, probably fracture-related [can be defined from field or aerial photograph observations]

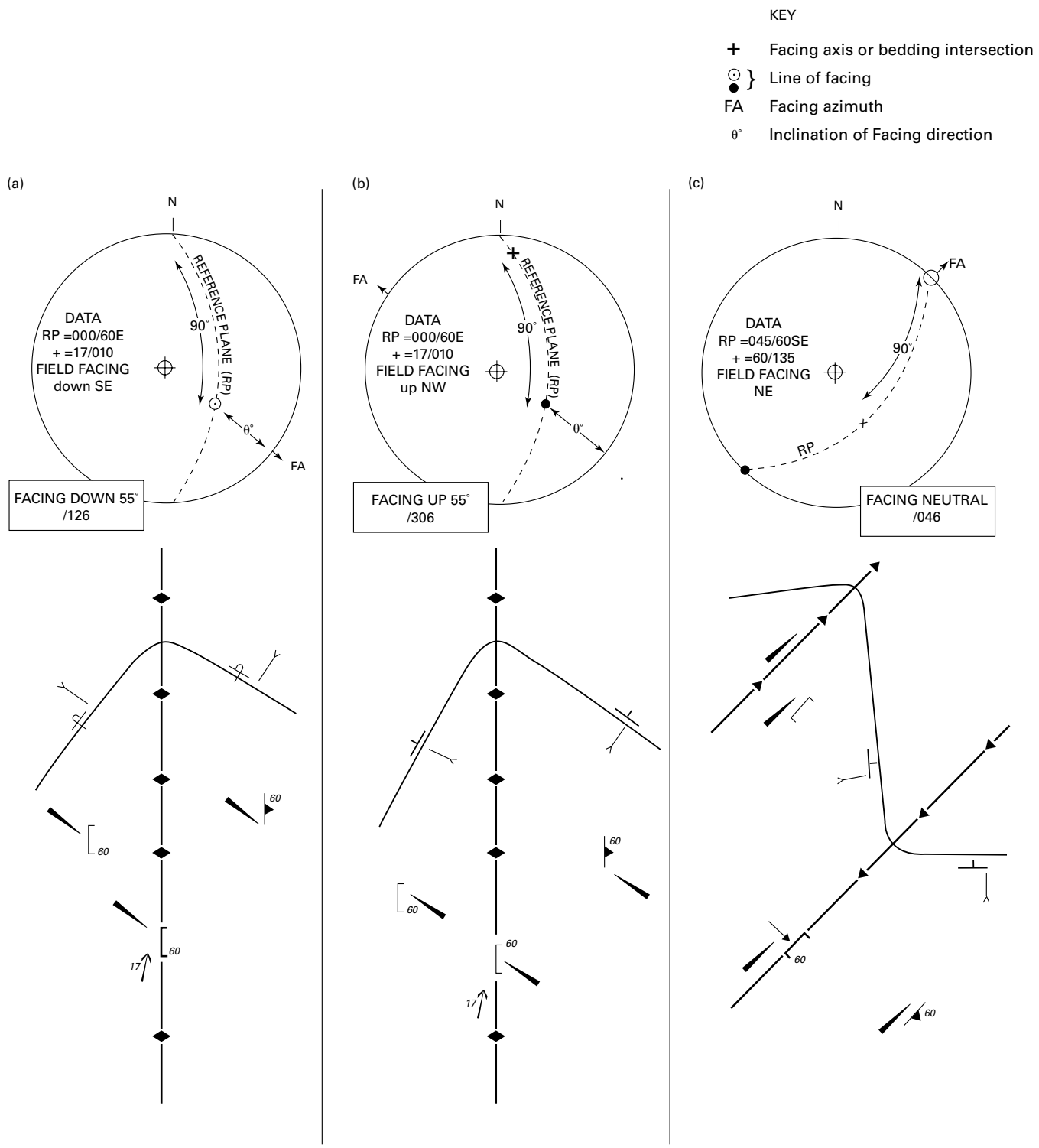
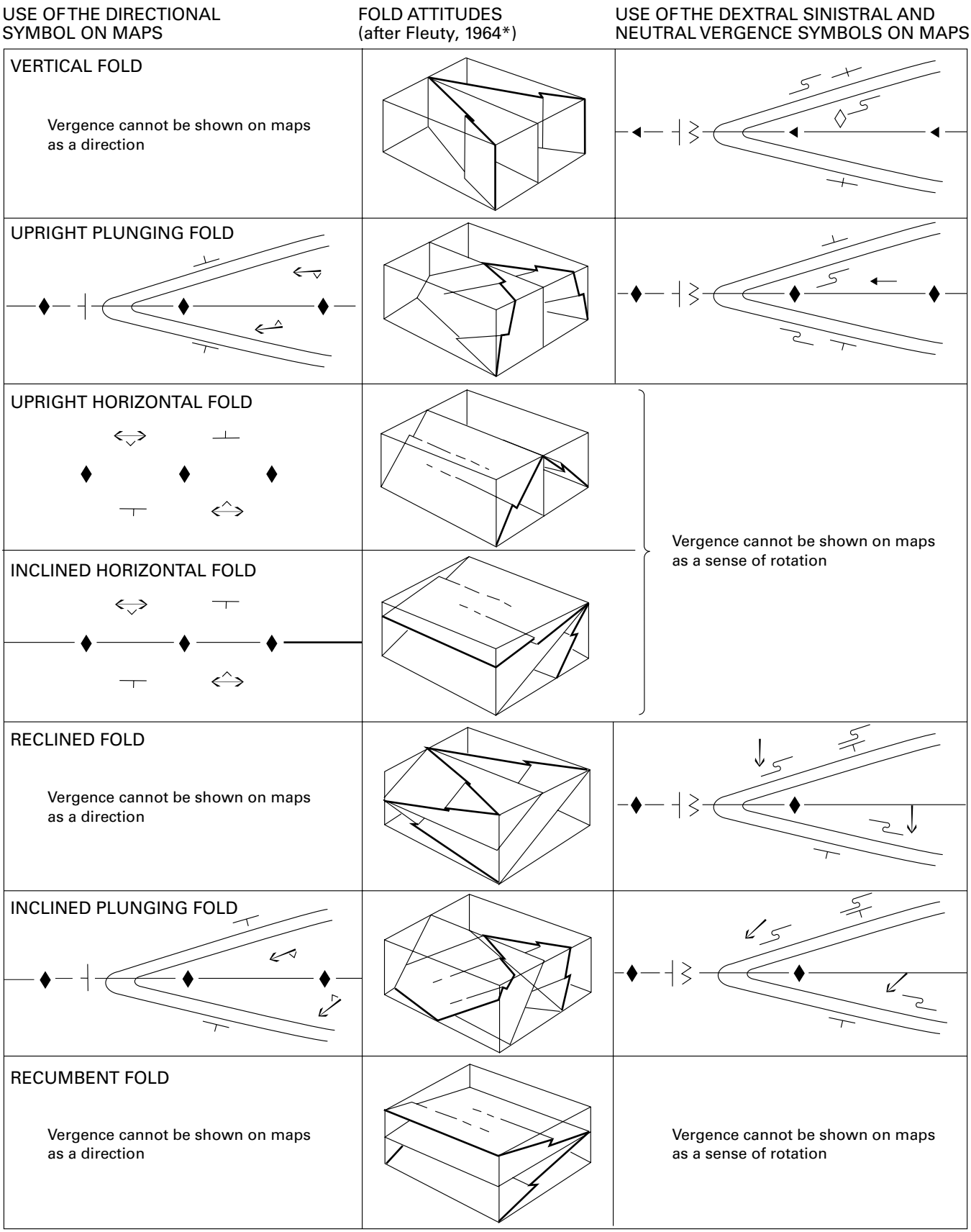


Figure 1 Stereographic projections and map symbols showing examples of (a) downward-facing, (b) upward-facing and (c) neutral-facing. The facing symbol is used in association with axial trace, axial plane, cleavage or schistosity symbol (reference plane).



* Proceedings of the Geologists' Association, Vol. 75, 461.

Figure 2 Illustration of vergence on maps.

7 OTHER SYMBOLS

Notes in small fonts or in square brackets are for guidance and should not be written on the maps. Unbroken lines denote a boundary that has been observed or can be positioned by other methods with an accuracy of ±10 m; broken lines denote inferred boundaries. This should be indicated with a note in an appropriate place in the Key — See the end of this section.

Geological boundary, Solid

Geological boundary, Artificial or Quaternary Deposits
[on digital maps where the Artificial Deposits line is in a different colour, both need to be shown in the key, in the order Geological Boundary, Artificial Deposits, Geological Boundary, Quaternary Deposits]

Gradational boundary

Intended for use primarily in plutonic complexes where there are lateral gradational transitions between lithologies. Also used to indicate boundaries of metamorphic aureoles, migmatisation and vein complexes; see below.

LOWER FOOT — Coal (ironstone, oil shale, gypsum or pebble bed*) [name on the younging-direction side of the outcrop]

[*Select the appropriate term.]

DUNSIL (D) — Incrop of bed at concealed unconformable surface [e.g. Carboniferous coal seam at unconformity at base of the Permian]

Note: The dashes between the fossil symbols may be made longer than those illustrated below.

Mussel band

Marine band

Lingula band

Euestheria band

Planolites band

Brachiopod band

Coral band

Algal band

Incrop of band at concealed unconformable surface [e.g. Marine band at unconformity at base of the Permian]

Magnetic layer or boundary

Base of lava flow

Margin of one igneous rock cutting another, crossmarks on side of younger rock

Margin of metamorphic aureole; + towards intrusion

Limit of migmatisation. ^ towards migmatites

Limit of transgressive pegmatite veins; ττ within areas of veining

Limit of granite/pegmatite vein complex; × ττ within area of veining

Limit of granite vein complex; x within area of veining

Limit of diorite or granodiorite vein complex; ɔc. within area of veining

Metamorphic zone boundary with mineral (al andalusite) or zone number. [pecked line as geological boundary]

Line of split in seam, ornament on split side

Washout in seam indicated [sometimes only one side may be shown]

-1600 IN MD — Seam contour, value in metres above or below OD, written on up-dip side of line

X -330 IN HM — Underground level in seam named

Pb SIKE 60 — Mineral vein, dip in degrees [with name of vein]

The principal ore is shown by the chemical symbol for the significant element, and this is explained in the form:

Pb Lead (galena)

Where a vein coincides with a fault the vein takes precedence.

K2 IN LM — Dyke, showing orientation, dip in degrees, thickness in metres and lithology [lithology according to igneous rock symbol scheme; width of symbol may be exaggerated]

F4 80 — Underground position of dyke in horizon named, width in metres [width of symbol may be exaggerated]

Gull, showing true width [To be used only where the true width may be mapped

Gull [To be used when the true width cannot be shown]

Swallow hole or dissolution hollow [small]

Margin of [large] subsidence hollow corresponding to geological boundary (Drift)

Margin of subsidence hollow not corresponding to geological boundary

Borehole

Borehole, exact site uncertain

Water well or borehole

Borehole, underground

Pit or mine shaft

Pit or mine shaft, abandoned, or Denehole (shaft in Chalk)

Pit or mine shaft, abandoned, site uncertain

Pit or mine shaft commencing underground (staple pit or blind shaft)

Adit or mine mouth, with orientation showing direction of entry

Adit or mine mouth, abandoned; with orientation showing direction of entry

Adit or mine mouth, abandoned; orientation unknown

Entrance is at the tip on the arrowhead.

Area of subsurface mining; tick mark towards mined area. Symbol indicates resource mined.

Margin of [large] subsidence hollow corresponding to geological boundary (Solid)

Only a selection of boreholes, shafts and adits should be shown and the BGS registered number, or Site Investigation Report reference number, should be given. Add, if appropriate 'For details see Open File Report, Number'.

Where the positions of some or all boreholes and/or adits are uncertain, this should be indicated either on the face of the map against individual symbols ('Precise position uncertain') or at an appropriate position in the Key ('The true position of some boreholes/ adits is uncertain'). Note that there is a separate symbol for uncertainly positioned pit shafts.

If required, the material worked at a pit, adit, quarry or Worked Ground may be indicated by note or symbol beside the appropriate pit, adit etc. symbol.

Trench [alignment shown by orientation of lines; numbers may be added if relevant]

Photographs of, or taken from, this locality in BGS collection

Rock slice number in BGS collection

Locality of special geological interest [including fossil locality]

[Letter in circle]. Surface section
[Add, where appropriate 'for details see Open File Report (Number)' or 'for details see right margin']

Small, isolated exposure [e.g. of Solid in an area of Drift; label with the appropriate symbol]

Unconformity (or disconformity) [used only on GVS]

Major folds, faults, boundaries, the outcrops of individual beds and other linear symbols are drawn unbroken if observed and broken if inferred. All should be covered by a single disclaimer.

Broken lines denote inferred boundaries

Thicknesses (and depths) are in metres

8 LAYOUT AND DRAFTING SPECIFICATIONS

8.1 Drafting specifications

These specification are intended for use by Drawing Office staff and are reproduced here only as a guide for geologists.

Geological boundary Drift — LINE 0.2 MM

Geological boundary Solid — LINE 0.25 MM

Coal — -1600 IN MD — LINE 0.55 MM

Marine band — LINE 0.20 MM

Mineral vein — Fe — LINE 0.45 MM

Fault — MERCOTT FAULT — LINE 0.35 MM

Incrop of fault at unconformity — MERTON FAULT — LINE 0.35 MM

Incrop of coal at unconformity — DUNSIL (D) — LINE 0.55 MM

Seam contour — -1600 IN MD — LINE 0.25 MM

Washout in seam — LINE 0.15 MM

Line of split in seam — LINE 0.15 MM

Landslip

Foundered strata

Worked Ground

Made Ground

LINE 0.20 MM

The spacing of the rulings of 2.5 mm shown above may be decreased for small areas to a minimum of 1 mm or increased for large areas to a maximum of 4 mm. To cope with long narrow areas of Worked Ground and Made Ground the orientation of the rulings may be varied by up to 15° from the nominal NW or NE. (See note at the end of Section 2.2)

General notes:

Approximate outer margin of metamorphic aureole — Dot 0.4

Tablets and Vertical Section outlines Line 0.2 mm — SPECIMEN TABLET — 18 × 10 mm

In the Key and Section align the base of the lettering to the base of the symbols or lines, e.g. ⊙ Borehole — Coal

Exception: where the symbol is larger than half the distance between the text descriptions place the text centrally e.g.

Made Ground

8.2 Model layouts

BRITISH GEOLOGICAL SURVEY

1:10 000 Series

SHEET SE 13 SE

(City of Bradford)

SOLID AND DRIFT EDITION[1]

Included in 1:50 000 Geological Sheets
69 (Bradford) and 77 (Huddersfiedl)

Original geological survey on the 1:10 560 scale by J V Stephens and G H Mitchell in 1924–37.
Published 1926–49.

Resurveyed on the 1:10 000 scale by C N Waters in 1994.

P J Strange, Programme Manager[2].

Released 2000.

David A Falvey PhD, Director, British Geological Survey[3].

'A __ edition of this sheet is also available'[4]

ORDNANCE SURVEY OF GREAT BRITAIN

The 1:10 000 topographic base was derived from large scale surveys dated 1955–80.
The representation on this map of a road, track or path is no evidence of the existence of a right of way.
Heights are in metres. Contours are surveyed at 5 metres vertical interval.

1 Insert 'SOLID EDITION', 'DRIFT EDITION', 'SOLID AND DRIFT EDITION' as appropriate
2 Programme Manager at time of approval
3 Director at time of release
4 Where more than one edition is produced the following note may be added:

__ insert 'Solid', 'Drift' or 'Solid and Drift' as appropriate

Figure 3 Title panel for 1:10 000 Series map.

KEY

ARTIFICIAL DEPOSITS AND WORKED GROUND

	Worked Ground	Mainly sandstone quarries and cuttings
	Made Ground	Mainly colliery spoil and embankments
	Infilled Ground	Backfilled clay pits

QUATERNARY DEPOSITS

	Landslip		
h	Head	Reddish brown, silty clay	
	Peat		
	Alluvium	Greyish brown, humic clay	
△	Alluviul Fan Deposits	Poorly sorted sand and gravel	
u T	River Terrace Deposits, undifferentiated	Limestone gravel	
	Marine Deposits, undifferentiated	Mainly mud	
ST	Glaciofluvial Sheet Deposits	Chalk and flint gravel	Glacial Deposits
	Glaciolacustrine Deposits	Laminated silt and clay	
H	Hunston Till	Pale brown, silty, pebbly clay	
C	Cambridge Till	Dark grey, chalky clay	

The drift deposits listed above are not necessarily shown in order of superposition.

SSG	Symbol indicates Quaternary Deposit at surface and Solid formation at rockhead; other Quaternary Deposits may intervene
----------	Geological boundary Artificial and Quaternary Deposits
——— – –	Geological boundary, Solid
———	Coal
— M — M —	Marine Band
15	Fault at rockhead, crossmark on downthrow side

Broken lines denote inferred boundaries

12	Inclined strata, dip in degrees
15	Generalised dip of inclined strata, dip in degrees
	Axial plane trace of major anticline
	Glacial striae, arrow shows inferred direction of ice flow
	Glacial meltwater channel, showing inferred direction of flow
	Swallow hole
	Borehole

Numbers are those of the BGS 1:10 000 record system in which they are preceded by the 1:10 000 series sheet number. Depths and thicknesses are in metres

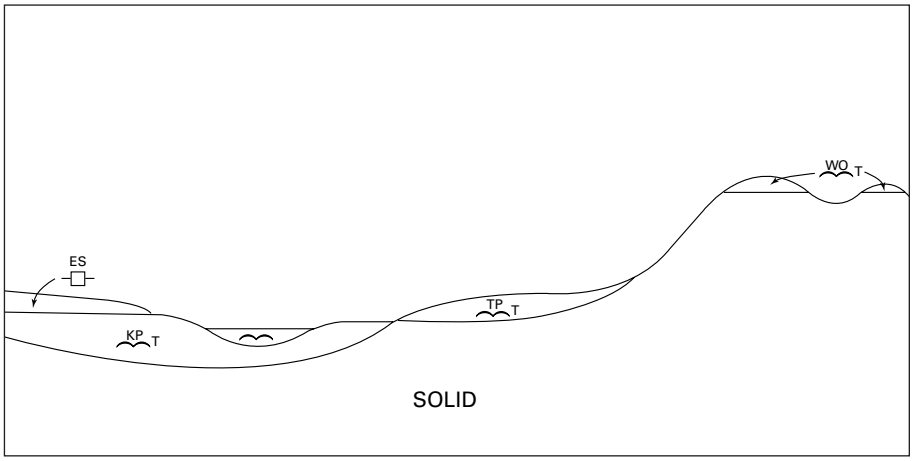
Figure 4 Key for the drift deposits.

GEOLOGICAL AGE AND RELATIONSHIPS OF DRIFT DEPOSITS

PERIOD	EPOCH	STAGE	DEPOSIT
QUATERNARY	RECENT	FLANDRIAN	Alluvium Peat, Shell Marl, Lacustrine Clay (Cold–Temperate)
		10 000 years	
	PLEISTOCENE	DEVENSIAN	Head; Holme Pierrepont Sand and Gravel, Leen Sand and Gravel, Bunny Sand and Gravel (Periglacial)
		?40 000 years	
		LATE WOLSTONIAN–IPSWICHIAN–EARLY DEVENSIAN	Beeston Sand and Gravel, Basingfield Sand and Gravel (Periglacial–Interglacial–Periglacial)
		?200 000 years	
		WOLSTONIAN or ANGLIAN	Till (Boulder Clay), Cropwell Sand and Gravel (Glacial)

Geological relationships of Drift deposits may alternatively be shown schematically as below:

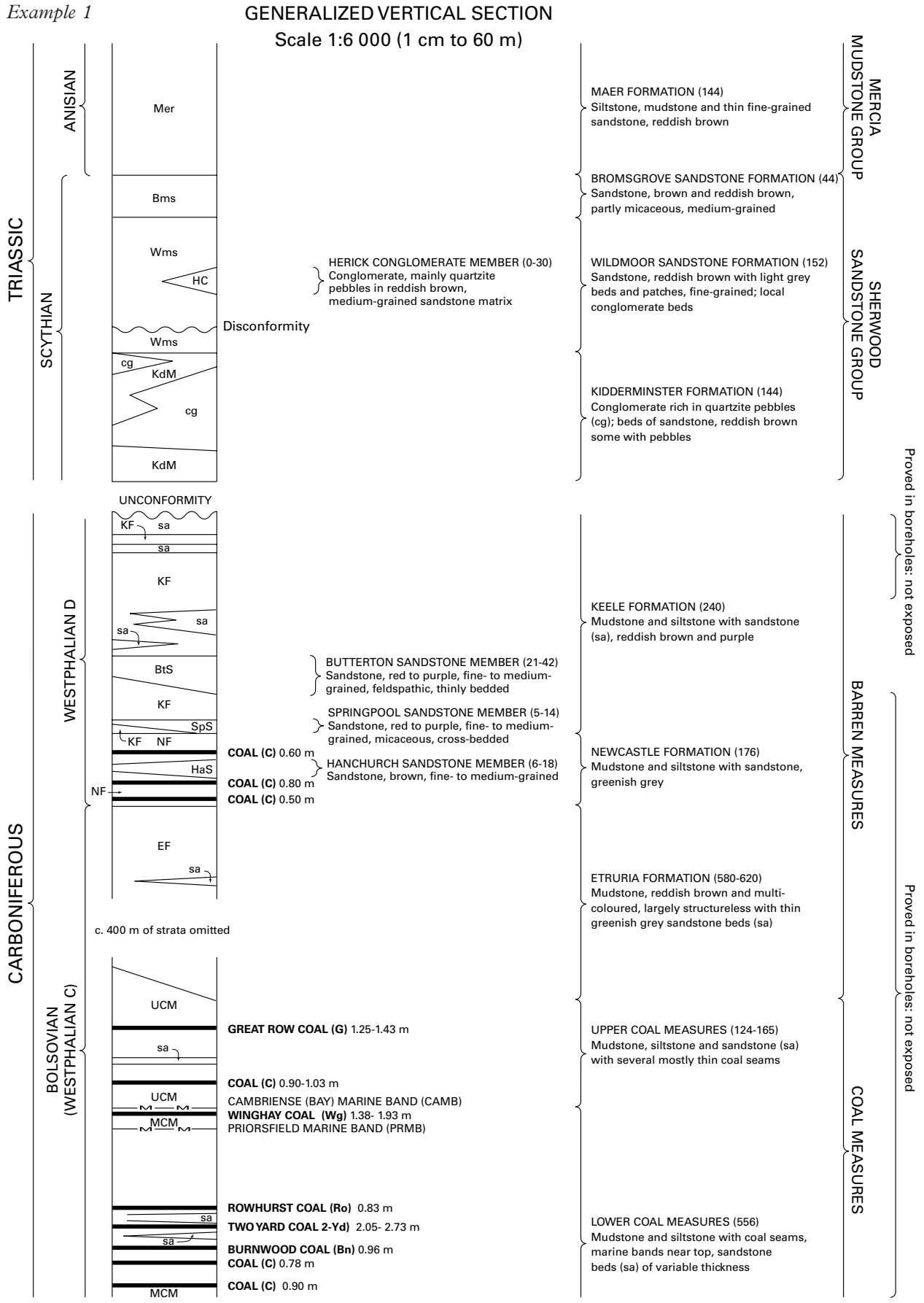
SCHEMATIC INTERRELATIONSHIPS OF THE DRIFT DEPOSITS (not to scale)



The schematic interrelationships figure should be shown in a box measuring 120 mm x 60 mm, as illustrated.

Figure 5 Illustration of drift stratigraphy using two different layouts.

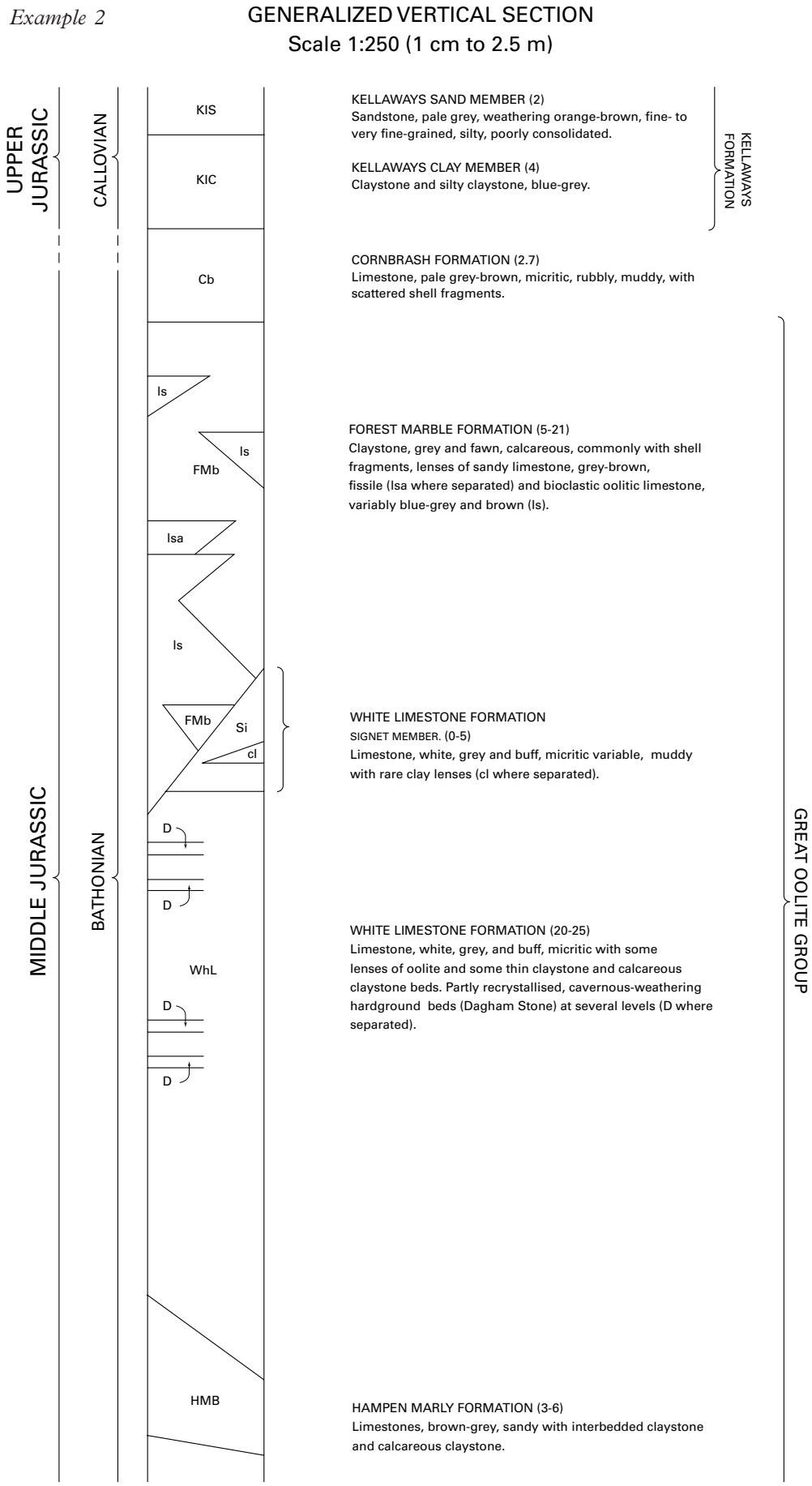
Example 1



Note: If there is any potential difficulty in relating names to the graphic section, then the symbol should be repeated after the name.

Figure 6 Generalized vertical section for sedimentary rocks.

Example 2



Add the following note if appropriate:
Intrusive igneous rocks are not shown.

Figure 6 (*continued*).

Example 3

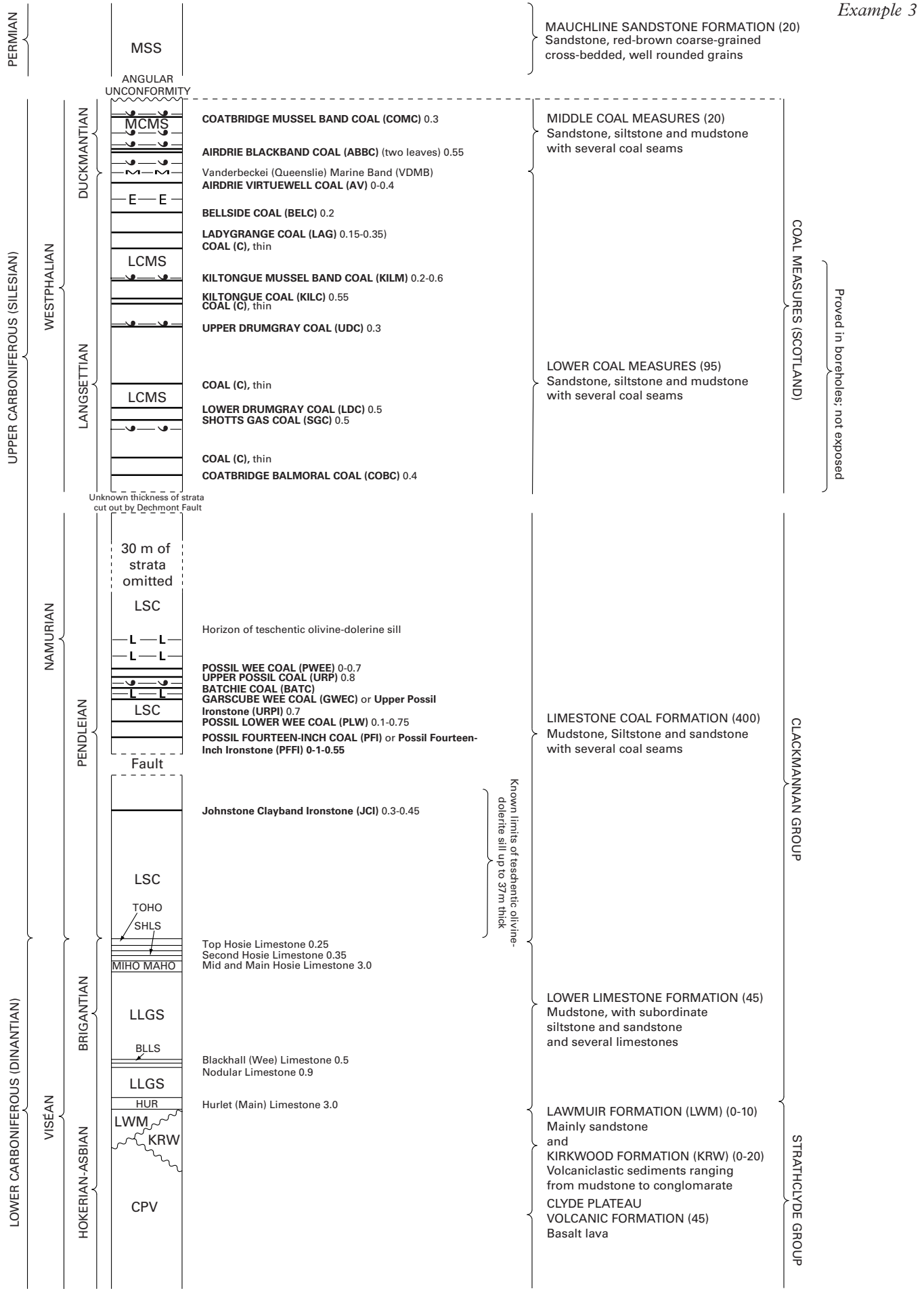


Figure 6 (*continued*).

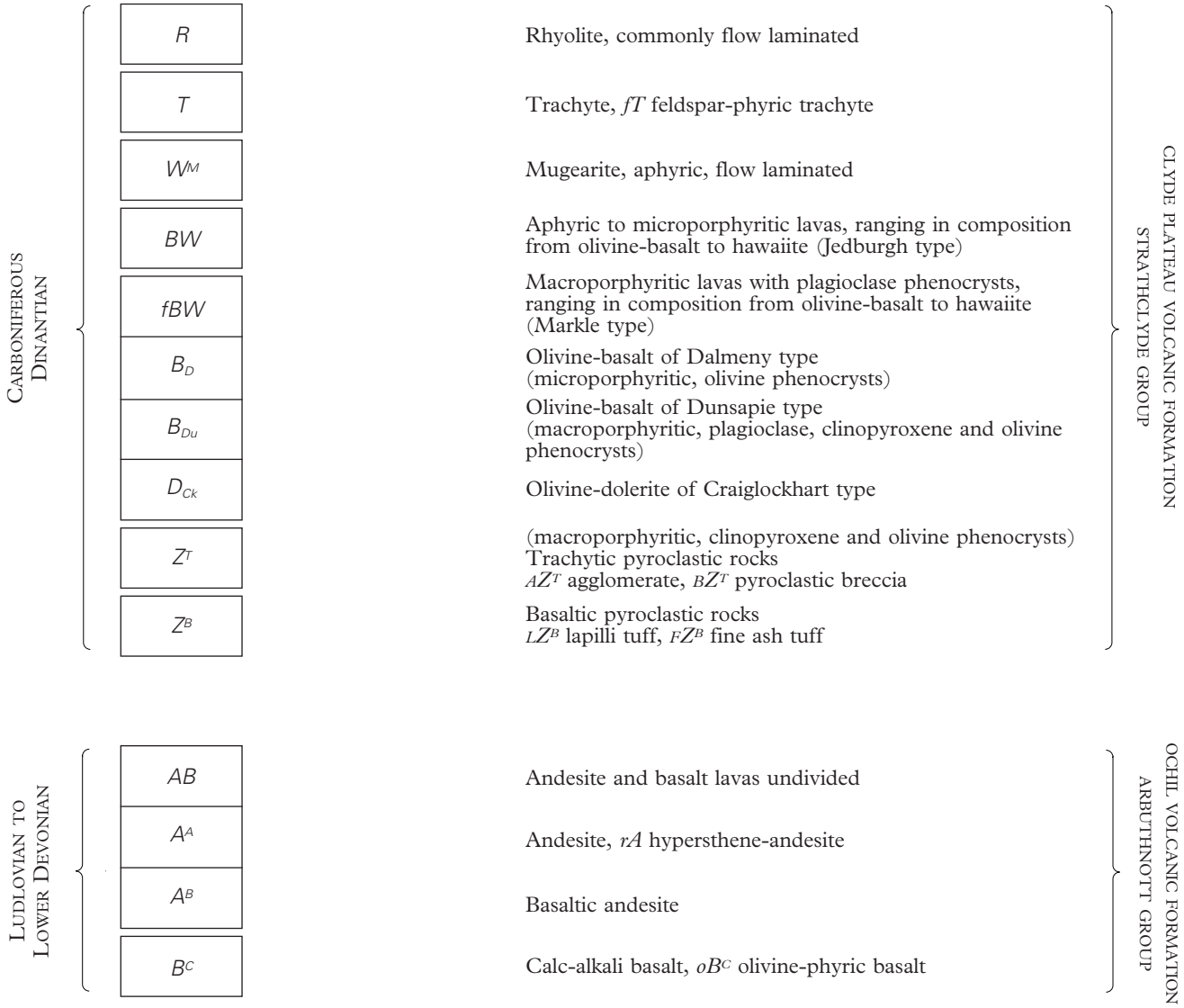


Figure 7 Example of key for extrusive igneous rocks.

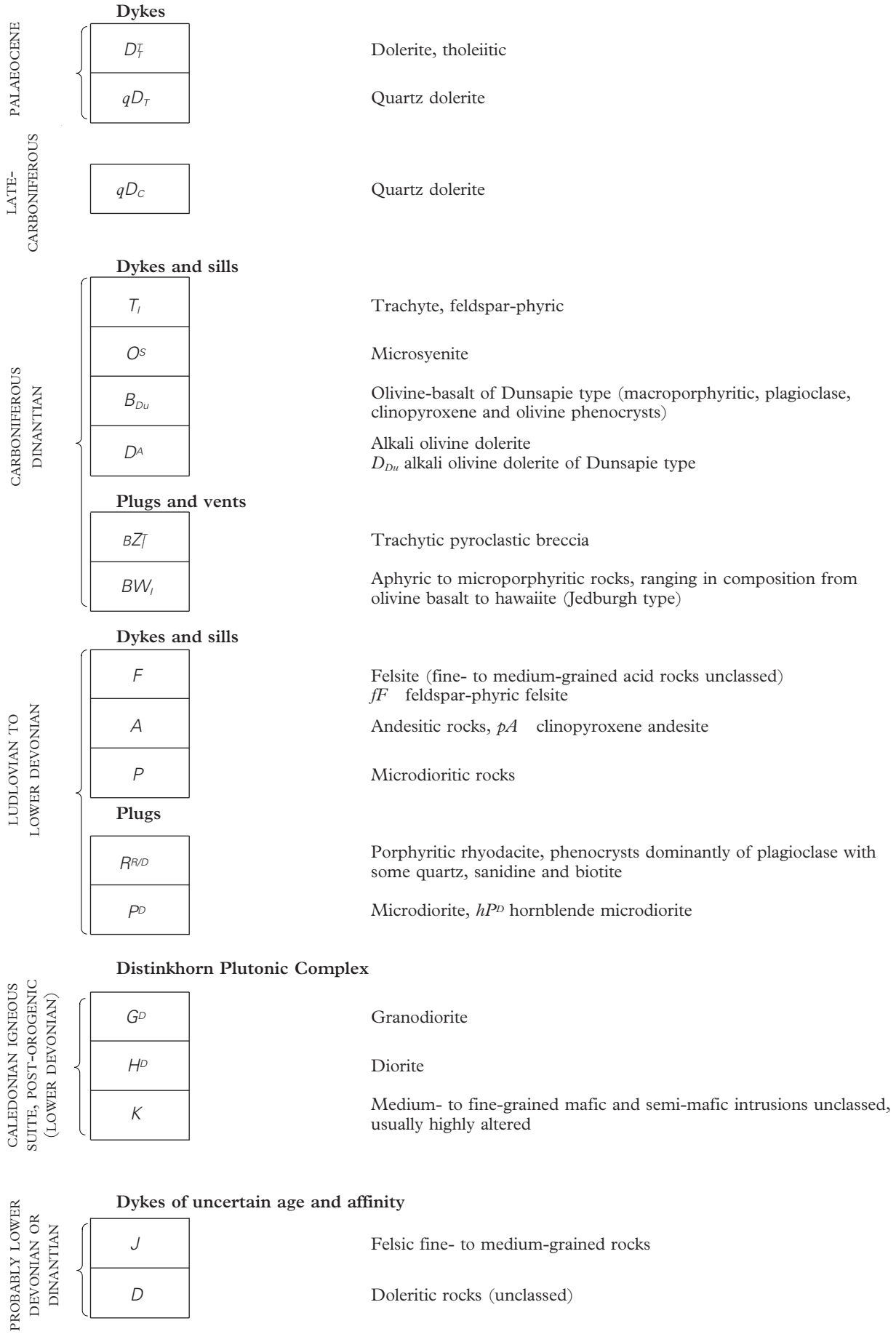


Figure 8 Examples of key for intrusive igneous rocks.

Example 1

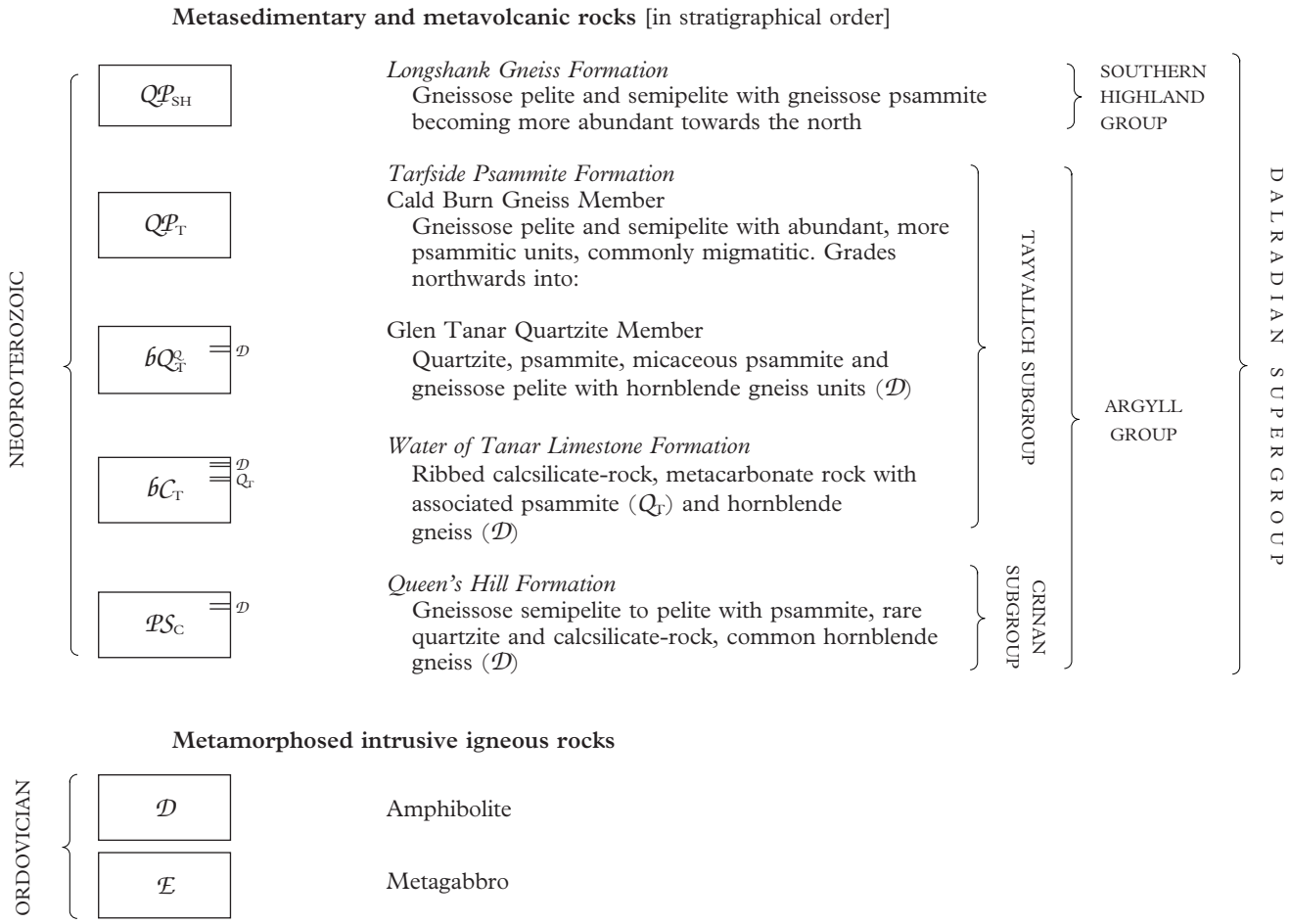


Figure 9 Example of key for metamorphic rocks.

Example 2

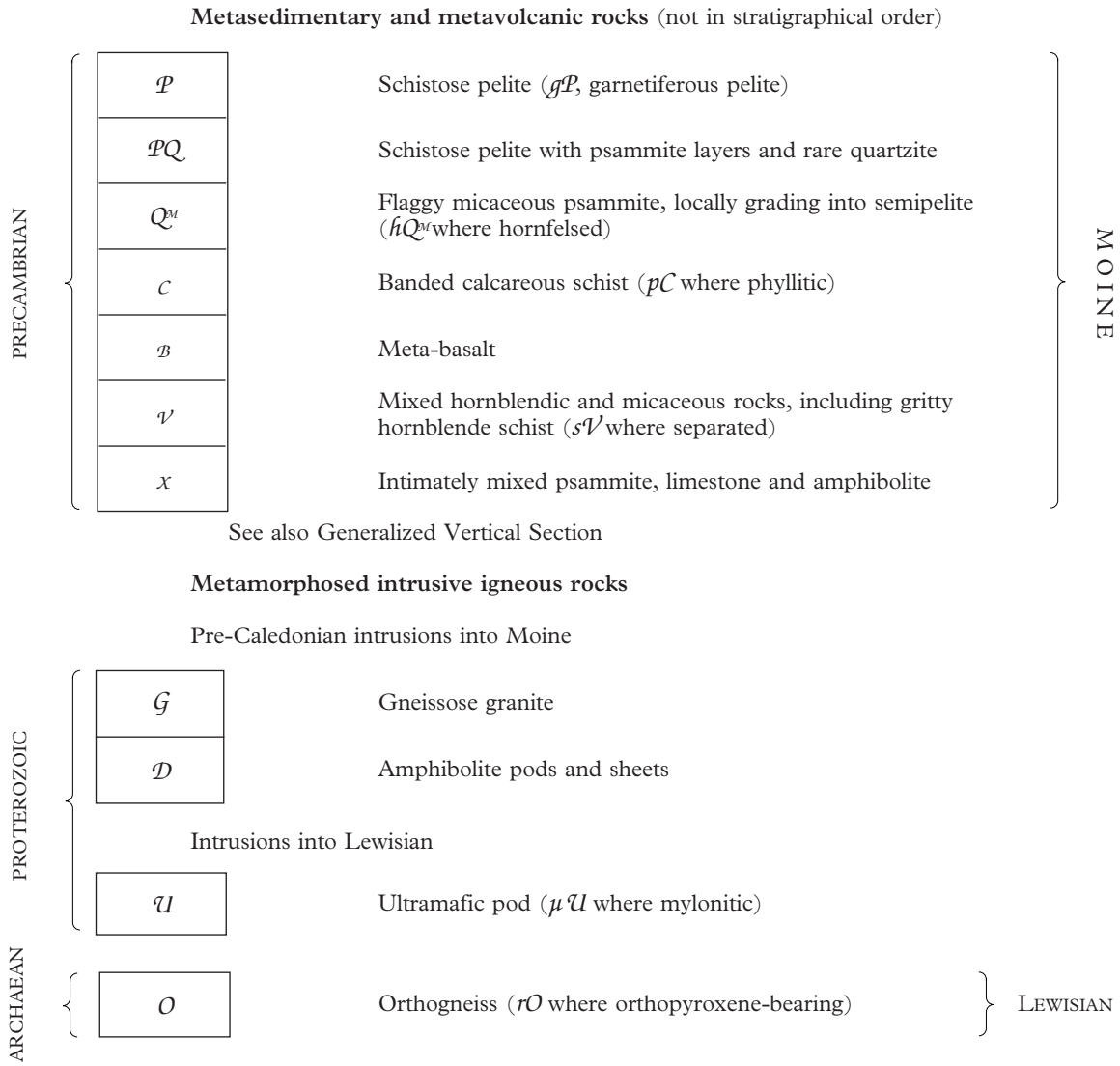


Figure 9 (*continued*).

Diagram showing incidence of 1:10 560 County Northumberland (N) and Durham (D) in relation to NZ 16 SW

N 93 SW	Durham 1 SE
D 5 NW	Durham 5 NE

Diagram showing adjoining 1:10 000 and 1:10 560 National Grid Sheets

NZ 06 NE	NZ 16 NW	NZ 16 NE
NZ 06 SE	NZ 16 SW	NZ 16 SE
NZ 05 NE	NZ 15 NW	NZ 15 NE

NZ 16 SW

Figure 10 Example of Ordnance Survey map index and disclaimer.
These are normally placed in the lower right margin.

Appendix A Index of Computer Codes and BGS Lexicon of Named Rock Unit Definitions

The Index of Computer Codes and the BGS Lexicon of Named Rock Unit Definitions are distinct, but related, data collections. New entries to both are made using a single form.

Most Computer Code/Lexicon entries will be for **lithostratigraphical** units, but the same form should be used for **lithodemic** units (e.g. named granite or complex of deformed igneous and metamorphic rocks) and **allostratigraphical** units (e.g. named river terrace deposits).

Index of Computer Codes

Computer Codes are solely for use in computer operations. They enable information about formal and informal rock unit names to be stored and retrieved in a consistent and abbreviated form. They consist of UPPERCASE letters (and, more rarely, numbers) only. Entries in the Index of Computer Codes need not be in the Lexicon: the codes are for use in database work and digital map production, and have no necessary connection with publications. Computer Codes need not be used on maps, so the Map Code (see below) of a unit need not be the same as its Computer Code.

If only a Computer Code is needed, fill in page 1 of the form (Figure 11) and pass the form to the Lexicon Manager. Once a code is assigned, a copy of the form will be passed back to you. Guidance on how to complete the form is given below, under Section 1 (p.48).

BGS Lexicon of Named Rock Unit Definitions

This is concerned with publications: it is intended to provide a formal record, containing details of all named **lithostratigraphical** units of member rank and larger (and equivalent **lithodemic** and **allostratigraphical** ranks) quoted in 1:50 000 maps and memoirs. A complete set of Lexicon definitions, for old names as well as new, must accompany each 1:50 000 map at its compilation stage. For Provisional maps a different application form should be used to provide partial sets of information required by the Lexicon (see Provision of Lexicon Entries for 1:50 000 Provisional Sheets).

The recommended course of action is for the Programme Manager to save all new names until a full set (old plus new) can be assembled for the 1:50 000 compilation. This will minimise the need for alterations and deletions (see also interim names, below).

All named rock units defined in the Lexicon must also have been assigned Computer Codes. The Lexicon Manager will arrange for provision of a report on the status of any Lexicon entries and Computer Codes, and will provide copies of existing entries if these are required.

If a new or significantly revised Lexicon entry is needed, the whole form (five pages) (Figure 12) is filled in and passed to the Lexicon Manager for Computer Code allocation. The originator is informed of the Computer Code when it has been assigned. The appropriateness of each new application must be confirmed by the nominated representative of the relevant BGS Stratigraphical Framework Committee where such a committee exists. The form is then sent to the Group Manager for approval. Liaising with other research groups if necessary, the Group Manager verifies that the definition conforms with the requirements of the North American Stratigraphic Code. The form is passed to the Lexicon Curator for checking and approval. She/he is responsible for maintaining a consistent BGS-wide approach. After approval, the form is returned to the Lexicon Manager for entry in the Lexicon, and copied back to the Programme Manager for reference. The need for copying at several stages necessitates the use of **black** ink throughout.

New names

These will normally be formal names. They should be entered using the guidelines below. In the case of definitions of lithodemic units (cf. Mendum *in* Allen, 1995), parts of the form relating to thickness and boundaries of units may be filled in as "not seen", "not applicable" or "not defined" where appropriate, and generally only a "Type Area" rather than type sections need be supplied.

Old names

Names that already exist, but lack Lexicon definitions, may be either formal or informal.

Informal names (i.e. those not meeting some requirements of the North American Stratigraphic Code) should be entered unchanged, if possible. Include lithological description, reference sections, etc. exactly as for a new name. Informal names can be made formal later, or renamed and formalised, if/when suitable type areas are mapped.

Some formal names, such as pre-existing names used on adjacent sheets, may lack current Lexicon definitions. These should be entered as for new names, giving the full reference of the document in which the name was used formally for the first time. It will be feasible only to specify a broad "Type Area" for some units (particularly lithodemic units), based on the name of the unit, plus reference sections based on the area being resurveyed. Details of other reference sections or an actual Type Section can be added for different areas as survey proceeds, if required and if appropriate. In general, if an existing formal definition does not meet present standards, the Lexicon entry for each new sheet should make up the deficiencies.

Interim names

Names coined during field survey may be used on a 1:10 000 Standard as an interim measure without a Lexicon entry. However, if an interim name is not formalised at 1:50 000 compilation stage, it should be removed from the Standard(s) and the revised nomenclature substituted, even if the 1:10 000 map has been approved. Note that a 1:10 000 map cannot be digitized until every name used on it has a Computer Code.

Map Codes

Abbreviations identifying named rock units on maps need not be the same as the units' Computer Codes. Currently, Computer Codes are mnemonics or near-mnemonics allocated on a "first come, first served" basis. They consist of up to 5 uppercase letters and numbers, which in some cases may be unsuitable for map face use. Decisions on suitability of Computer Codes for map face use are made by the appropriate Programme Manager, who also approves a **Preferred Map Code** (see below) if the Computer Code is unsuitable. Codes with final M, F or G (Member, Formation, Group) etc. are now considered unsuitable because they inhibit subsequent revisions of rank. In future there will be only one valid (preferred) Map Code for each named rock unit and alternative, pre-existing Map Codes will be considered obsolete. Programme

Managers should liaise with the Lexicon Manager over this. Section 3 of the application form (p.55) should be filled in for each Lexicon entry and the **Preferred Map Code** for future use should be selected and approved by the Group Manager.

Revisions

Changes of rank, or minor changes in one or both boundaries of a unit (see Article 19 of the North American Stratigraphic Code) can be made using a Revision Sheet. Minor name changes (as in Article 19f) can also be dealt with in this way. More extensive changes may need new, full Lexicon entries. The Lexicon Curator should be consulted if in doubt. The approval route for revisions is the same as for a full Lexicon entry.

How to use the application form

The paragraph numbers below refer to those on the Application Form for Computer Code or BGS Lexicon of Named Rock Unit Definitions entry (Figure 12).

Section 1

This must be filled in whether a Computer Code or a Lexicon entry is required.

1.1 Names used on BGS maps should normally be the formal hierarchical names for **lithostratigraphical**, **lithodemic** or **allostratigraphical** units, conforming to the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983; Allen, 1995). The **full name** must be supplied, **including the unit's rank**, even though this might not normally be used (e.g. insert Mercia Mudstone *Group*, not simply Mercia Mudstone*)*. Existing names (formal or informal) may be used where there is insufficient information within the mapping area to justify alteration of existing terminology (see Old names, above). Named units of lower rank than Member (or Allomember) require a Computer Code but not a full Lexicon entry, though details of the next higher (parent) formally defined unit (generally Member, Formation, Allomember or Alloformation) should be supplied where possible (see 1.3).

1.2 Give the **rank** (Supergroup, Group, Formation, Member, Bed, or equivalent lithodemic or allostratigraphical rank) of the unit. The North American Stratigraphic Code allows lateral change of rank and the structure of the Lexicon allows such hierarchical differences to be accommodated. This confirms the rank information in 1.1.

1.3 Give the **full name** (including rank) of the next higher (parent) unit in the hierarchy (e.g. the parent Formation of a Member or the parent Suite of a Lithodeme). State "nil" if appropriate. This requirement applies to Computer Code applications as well as to full Lexicon applications.

1.4 Give the rank (Supergroup, Group, Formation, Member or equivalent lithodemic or allostratigraphical rank) of the next higher (parent) unit in the hierarchy ("nil" if appropriate). If the unit being described changes its rank laterally it may be necessary to provide details of more than one parent name and rank. This confirms the rank information in 1.3.

1.5 Enter the chronostratigraphy of the unit, ideally at "Stage" level, but otherwise to the finest known division (Stage, Series, Subsystem or System). The current digital database cannot accommodate details of "Zone" or "Subzone". These may be included with "Stage" data, on the form. If the named unit spans more than one chronostratigraphical unit, give the range, using terms of the same status (e.g. Asbian to Brigantian [stages], Namurian to Westphalian [series] or Devonian to Carboniferous [systems]). Radiometric age or age range may be stated for lithodemic units, but a chronostratigraphical value should also be given where possible, even if the value is broad or uncertain.

1.6 State whether the name is currently formal or informal. If in doubt concerning the use of these terms, ask the Lexicon Curator for advice. If only a Computer Code is required this field may be left blank (the Lexicon Manager will allocate a "Code only" identifier) pending any subsequent Lexicon application.

1.7 When first provided some definitions will be of only local applicability (reflecting the current status of mapping); other definitions may be recognised as having national validity within the UK or, more rarely, a wider validity. The originator and/or Stratigraphical Framework Committee representative should give a realistic assessment of the extent to which the entry (as provided) is valid. The assessment may be revised if the definition is improved at a later date.

1.8 Some rock unit names are used only in onshore areas, some only in offshore areas, and others are applicable **both** onshore and offshore. Past Lexicon practice has been to adopt a "default" value of onshore. Originators and/or Stratigraphical Framework Committee representatives should now specify the known current extent of the name's usage.

1.9 A suitable Computer Code will be inserted by the Lexicon Manager. Originators may "pencil-in" preferred codes but, if these are unavailable, the Lexicon Manager will provide alternatives.

Section 2

To be filled in **only** if a Lexicon entry is required.

2.1 A brief geological description of the named rock unit should be given here. For old names, which are being included to complete a set of Lexicon entries for a 1:50 000 sheet, it will be necessary to give short bibliographical references (i.e. in the form: Bloggs, 1980) in various parts of the description. However, the aim of any Lexicon entry should be to lead the reader into the literature, not to provide a full history of the name. Full bibliographical references should be given in 2.3.

2.1a Give a brief free text account of the characteristic lithologies (a fuller account can be provided on additional sheets, if required, but will not necessarily be included in the digital database) and provide a listing of Main, Subsidiary and Trace lithologies. The latter information is required to facilitate digital map operations and need not be exhaustive. For instance, in the English Coal Measures, mudstone and siltstone would be Main lithologies, sandstone and coal Subsidiary lithologies and tonstein a Trace lithology.

2.1b and 2.1c Give a brief account of the lithological basis for recognising the upper and lower boundaries, where applicable, with due reference to the contrasting lithologies of the overlying and underlying units. This need not be restricted to any one section. State "faulted

off", "not exposed" or "not applicable" etc, if appropriate. A fuller account, including discussion of any reasons for changing the unit's boundaries, can be included on additional sheets.

2.1d Indicate the general range of thickness, quoting the thickness in selected sections where possible. For lithodemic units, state "unknown" if appropriate.

2.1e Give the previous name(s) of the unit, if any, plus short reference(s). Where the new unit constitutes all or part of an earlier named unit or units, indicate what has been included in the new unit. If a fuller description of this is required, use additional sheets.

2.1f Short reference(s) to the original definition and upgradings should be included. If introducing a new name, this may be left blank until the place of publication has been decided, but indicate this by a phrase such as "not yet published".

2.2 A geographical description of the unit stratotype(s) should be given. Three boxes are provided so that more than one section or area can be included. Use more sheets if more sections are needed. A detailed geological log of nominated sections is **NOT** required. A Type Area (or areas) is acceptable for lithodemic units.

The stratotype(s) should illustrate the best representation of typical lithologies. A borehole sequence is acceptable, preferably one for which a full representative slice is curated. Quote the BGS registration number of any borehole used (e.g. NT29NW/162), and the depth range of the unit being described. If the log is in feet and inches, quote feet and inches. If no single section is suitable, reference may be made to a group of sections (making a composite-stratotype), or to a Type Area.

Reference sections may be proposed to supplement the type section or area, where the latter is not representative of the full range of lithologies. Sections showing typical upper or lower boundaries (if appropriate) are particularly useful.

2.2d If possible indicate:

i the known extent of the unit as mapped
ii the likely extent of the unit/name beyond the mapped area
iii the nature of the lateral boundaries, if known

These items, defining the lateral boundaries of the rock unit, are important elements of the definition, but at an early stage of mapping it may only be possible to indicate item (i).

2.3 All bibliographical references quoted on the form should be listed here in full, using the format specified in the BGS *"Notes for Authors"*. If there is an obvious **Principal Reference** (as cited in 2.1f above) it should be placed in the separate box provided.

Section 3

This information is needed to establish a database of Map Codes.

Enter the numbers (including the appropriate prefix for Scotland, Northern Ireland or England/Wales) of all 1:50 000 (or 1-inch) sheets (not 1:10 000 components) where the name is known to have been used, and the Map Code that was used on each. If more than one code was used (e.g. on different 1:10 000 components), enter all of them. If the unit was or will be identified by another means on the map face, e.g. a Drift symbol or composite metamorphic symbol, that cannot be accommodated in the map codes dictionary, state "SYMBOL". In other cases the Programme Manager should select and approve a single, preferred Map Code for future use.

Revision sheets

Enter the existing name and Computer Code at the top and indicate the nature of the changes below. Follow the normal Lexicon entry approval path (Figure 13).

Additional sheets

Each additional sheet should be in a similar layout to those supplied, with the name of the proposed named rock unit at the top of each sheet. Please indicate the appropriate paragraph numbers (e.g. Section 2.2d should be quoted if giving extra information on the geographical limits) on any additional sheet.

References:

ALLEN, P M. 1995. Usage of stratigraphical nomenclature in BGS. *British Geological Survey Technical Report WA/95/27R.*

NORTH AMERICAN COMMISSION ON STRATIGRAPHIC NOMENCLATURE. 1983. North American Stratigraphic Code. *American Association of Petroleum Geologists Bulletin,* Vol. 67, No. 5, 841–875.

MENDUM, J R. 1995. Terminology of lithodemic units. *In* Allen, P M, 1995. Usage of stratigraphical nomenclature in BGS. *British Geological Survey Technical Report WA/95/27R.*

Computer Code Approval:

Originator	*A Geologist*	Date	*10/6/1992*
Lexicon Manager	*D J Lowe*	Date	*11/6/1992*

Lexicon Approval:

Originator		Date	
Stratigraphical Framework Committee		Date	
Programme Manager		Date	
Lexicon Curator		Date	
Lexicon Manager		Date	

Section 1:

1.1	Full name of rock unit *(e.g. Mercia Mudstone **Group**)*	*Mercia Mudstone Group*					
1.2	Rank of rock unit *(e.g. Group)*	*Group*					
1.3	Full name of parent unit *(state nil if appropriate)*	*New Red Sandstone Supergroup*					
1.4	Rank of the parent unit *(state nil if appropriate)*	*Supergroup*					
1.5	Chronostratigraphy (**or** *range, if appropriate*)	*Scythian to Rhaetian*					
1.6	Status of entry (*tick one box*)	Full Formal ❑		Full Informal ❑		Code only ☑	
1.7	Range of **Full** entry definition (*tick one box*)	UK Local ❑		UK National ☑		Wider ❑	
1.8	Extent of current use of the name in the UK (*tick one box*)	Onshore ❑		Offshore ☑		Both ❑	

Figure 11 Application form for Computer Code or BGS Lexicon of Named Rock Unit Definitions entry. Example of code only entry

1.9 Computer Code: (assigned by Lexicon Manager)	*MMG*

Computer Code Approval:

Originator	*A Geologist*	Date	*10/6/1992*
Lexicon Manager	*D J Lowe*	Date	*11/6/1992*

Lexicon Approval:

Originator	*A Geologist*	Date	*10/6/1992*
Stratigraphical Framework Committee	*A Member*	Date	*12/6/1993*
Programme Manager	*A Manager*	Date	*15/6/1993*
Lexicon Curator	*A Curator*	Date	*17/6/1993*
Lexicon Manager	*D J Lowe*	Date	*19/6/1993*

Section 1:

1.1	Full name of rock unit *(e.g. Mercia Mudstone **Group**)*	*Hollington Formation*				
1.2	Rank of rock unit *(e.g. Group)*	*Formation*				
1.3	Full name of parent unit *(state nil if appropriate)*	*Sherwood Sandstone Group*				
1.4	Rank of the parent unit *(state nil if appropriate)*	*Group*				
1.5	Chronostratigraphy (**or** *range, if appropriate*)	*Scythian to Anisian*				
1.6	Status of entry (*tick one box*)	Full Formal	☑	Full Informal	❑	Code only ❑
1.7	Range of **Full** entry definition (*tick one box*)	UK Local	☑	UK National	❑	Wider ❑
1.8	Extent of current use of the name in the UK (*tick one box*)	Onshore	☑	Offshore	❑	Both ❑

Figure 12 Application form for Computer Code or BGS Lexicon of Named Rock Unit Definitions entry. Example of full application.

1.9	Computer Code: (assigned by Lexicon Manager) *HOL*

Section 2 Description of the named rock unit

Please expand on separate sheets if necessary; whilst ensuring that the information supplied is strictly relevant to the application; give full bibliographical references in Section 2.3.

2.1 Geological description of the named rock unit

a) Lithology
(free-text description)

Major rock type(s)

Subsidiary rock type(s)

Trace rock type(s)

b) Definition of lower boundary

c) Definition of upper boundary

d) Thickness

e) Previous name(s)
(*cite references if known*)

f) Where definition published
(this should correspond to the principal reference in **2.3***)*

Figure 12 (*continued*).

2.2 Geographical description of unit stratotype(s)

a) Nature of stratotype
(type section, partial type section, reference section or type area)

b) Description and location of stratotype
(e.g. waterfall 50 m upstream of Hillside House)

c) National Grid Reference
(e.g. NZ 1234 5678) (to)

---

a) Nature of stratotype
(type section, partial type section, type area, reference section)

b) Description and location of stratotype
(e.g. waterfall 50 m upstream of Hillside House)

c) National Grid Reference
(e.g. NZ 1234 5678) (to)

---

a) Nature of stratotype
(type section, partial type section, type area, reference section)

b) Description and location of stratotype
(e.g. waterfall 50 m upstream of Hillside House)

c) National Grid Reference
(e.g. NZ 1234 5678) (to)

---

d) Geographical limits

Figure 12 (*continued*).

2.3 Bibliographical references:
(Give the full reference: see BGS "Notes for Authors")

Principal reference *(if any; as cited at* **2.1f***):*

Charsley, T J, 1982. A standard nomenclature for the Triassic formations of the Ashbourne District. Report of the Institute of Geological Sciences, No. 81/14.

Additional references:

Hull, E, 1869. The Triassic and Permian rocks of the Midland Counties of England. Memoir of the Geological Survey of Great Britain.

Figure 12 (*continued*).

Section 3 Map Codes previously used for the named rock unit on 1:50 000 scale or 1-inch sheets *(state "symbol" if appropriate.)*

England/Wales (**E**) Norhern Ireland (**NI**) or Scotland (**S**)	Sheet No:	Date of Publication	Map Code
E	*124*		*HOL*

Preferred Map Code: *HOL*

Group Manager approved: *A Manager*

Figure 12 (*continued*).

Revision sheet

Existing name of rock unit *Keele Formation*

Existing Computer Code *KE*

Revision approval

Originator	*A Geologist*	Date	*19/4/1993*
Stratigraphical Framework Committee	*A Member*	Date	*21/4/1993*
Programme Manager	*A Manager*	Date	*22/4/1993*
Lexicon Curator	*A Curator*	Date	*26/4/1993*
Lexicon Manager	*D J Lowe*	Date	*27/4/1993*

Nature of changes

Definition of upper boundary: Now defined at base of overlying Radwood Formation

Revision Sheet Number *1*
(to be entered by Lexicon Manager)

Figure 13 Application form for revision of computer codes and/or BGS Lexicon.

Appendix B Changes and/or additions to the BGS 1:10 000 scale map specification and symbol schemes

Proposals for such changes and/or additions must be approved by the appropriate Programme Manager and forwarded to the Curator of the Symbols Scheme (currently K Ambrose, Keyworth).

	NAME	SIGNATURE	LOCATION	DATE
Proposer				
Approval of Programme Manager				
Curator's Approval				

Change(s) and/or additions proposed	Justification

Appendix C Specification for the preparation of digital 1:10 000 scale geological maps

The specification is divided into the following sections:

Introduction
1. Manuscript stage
2. Digitisation stage
3. Revision stage
4. Default map types
5. Colour schemes and conventions
6. Map notes, marginal notes and symbols
7. Adapting manual manuscripts
8. Geological attribution

Introduction

1:10 000 scale geological map production using a geologically attributed digital system will retain most practices employed in the manual system, revise others and establish totally new procedures relevant to the digital environment. In this specification a general introduction to the process is followed by more detailed descriptions of procedures. This specification does not describe the basic drafting of a geological map, since this process will mirror traditional methods, though details may differ. In cases where pre-existing maps drawn to manual specifications are to be digitised, different procedures are specified according to the type(s) of map edition. Brief notes to assist in adapting existing manuscript maps for digitisation are described in sections 5 of this appendix. Section 6 covers the new requirement of geological attribution.

The production cycle of a digital 1:10 000 geological map comprises three stages. The *manuscript* stage compares closely with existing manual practices within GHS, though minor changes to drafting and approval procedures have been made. The *digitisation* stage replaces previous conventional processes carried out within the Drawing Office. As yet the *revision* stage can be developed only in outline. All the current procedures will be evaluated and modified as necessary, as expertise develops and the digital system evolves.

A number of abbreviations are used repeatedly within this document:

(A)DM	(Approved) Digital Map
ASTC	Approved Subject To Correction
CSDM	Cartographic Services Data Manager
DMM	Divisional Map Manager
GCM	Geologist's Colour Model
GHS	Geological and Hydrogeological Surveys
GLM	Geological Lines Master
(M)DMFS	(Master) Digital Map File Suite
(M)PF	(Master) Plot File

1 MANUSCRIPT STAGE

1.1 Each new start on surveying a 1:10 000 sheet identified for digitising should be notified by the Programme Manager to the Divisional Map Manager (**DMM**). The DMM is responsible for documenting progress, by maintaining a Map History Database, and for providing a single point of contact and efficient liaison between GHS staff and Cartographic Services.

1.2 After field survey the geologist, in consultation with Project Leader, Programme Manager and the DMM, decides the appropriate format for default digital map output (Appendix C, section 2). S/he produces a Geological Lines Master (**GLM**), using a topographical base. A paper copy of the completed linework is taken from the plastic for each proposed edition, before the addition of symbols and geological notes (see below).

1.3 The guidelines below use as an example the complementary output of Drift and Solid priority editions (Appendix C, section 2). They are not intended to lead directly to the default production of any other map option. If other editions are specified different procedures will apply.

1.3.1 Draw a plastic master according to the GHS 1:10 000 scale Specifications, showing all geological lines but with no other map-face data. Marginal material including the title box, key, disclaimer(s), GVS and any illustrative 'cartoons' should also be fitted into the format at this stage, though wordings etc. can be omitted, pending *mock-up* on paper copies.

1.3.2 Obtain two paper copies from the lines-only plastic.

1.3.3 Using the DMPI colour charts (Appendix C, section 3) as a guide and with reference to any precedents for colour allocations in the area, decide a suitable colour scheme to be used on the first proof. Reference should also be made to any default colour schemes already created and held in the Drawing Office, in particular for Quaternary Deposits. Pencil in the DMPI colour code for each unit (cf. section 3) and record the values on a colour Quality Control form (Figure 14, Form 3). Colour allocations for each 1:10 000 sheet must be recorded on separate colour QC forms.

1.3.4 Colour the Drift deposits on one paper copy (the Drift colour model), including Drift index tablets (and, if included, elements of the Drift relationships 'cartoon') using crayons which approximate to the DMPI colours chosen.

1.3.5 Colour Solid outcrops on the other paper copy (the Solid colour model), including relevant parts of the GVS and key.

1.3.6 As in the traditional system, adding colour at stages 1.3.4 and 1.3.5 provides a useful check on the completeness of the lines; amendments should be sketched onto the colour models (which will not be used as digitising masters) and added accurately to the lines master.

1.3.7 Add any additional data relevant to the Drift geology to the Drift colour model. General and specific notes, minimal symbolisation which is considered essential to the understanding of even a colour-printed map and any other feature symbols etc., should be added (Appendix C, section 4). Since this is only a rough guide to the Drawing Office the notes can be added in pencil/biro/fibre-tip etc., as preferred by the geologist. Marginal text should also be added to the colour model at this stage.

1.3.8 As in 1.3.7, add necessary Solid data to the Solid colour model.

1.3.9 When all necessary map-face data have been inserted on the colour models and all lines are complete on the lines master, add the written data to the lines master. As the lines master might have to serve as a provisional dyeline master, pending approval of the digital map, lettering should be inserted neatly.

1.3.10 Obtain a copy (in simple areas) or copies (in complex areas) of the GLM and carry out geological attribute annotation (Appendix C, section 8).

1.3.11 The GLM, supporting GCMs and attribution copy are then submitted for approval for digitisation, together with the completed Map History Form, Component Document

Record, colour Quality Control Form (Figure 14, Form 3) and Named Structures form. This last form is not needed for maps with no named structures. Copies of all forms are obtainable from Programme Managers' secretaries or the DMM.

1.4 The Project Leader checks the GLM and GCM(s) for geological acceptability, edge-matching and colour scheme suitability. If approved, the documents are signed/dated on the map history form and passed to the DMM, otherwise they are cycled back to the geologist, as currently, and resubmitted for approval after amendment.

1.5 The DMM checks consistency with the BGS 1:10 000 scale Specifications, marking any amendments required. If there are any changes to the map face or GVS, the map is recycled back to the geologist for alteration of the GLM and resubmitted to the DMM.

1.6 The Programme Manager checks overall accuracy and approves the sheet for digitisation (and as a provisional dyeline master for sale or consultation under suitable caveat[1]). If no amendments are required the GLM is signed/dated, on the map history form, as approved for digitisation. Otherwise it is returned to the geologist for amendment and the cycle repeated. The Programme Manager informs the DMM that the sheet has provisional approval for public release as a dyeline.

1.7 Approved models are retained by the DMM until a batch of edge-matched maps is ready for digitisation

2 DEFAULT MAP TYPES

2.1 Basic map types

The digital map production system is inherently flexible and is capable of delivering many types of output to illustrate clearly a variety of geological terrains. However, there are great advantages, in terms of consistency and GHS and Drawing Office efficiency, in recognising a limited number of default map options. Although it is possible to generate a map which is a digital facsimile of a modern Solid plus Drift manuscript 'standard', the prioritised options described below are potentially more intelligible and informative. The term 'Drift' as used below refers to all recent deposits, i.e. natural Quaternary and Artificial deposits, and Worked Ground.

2.2 Solid Priority editions

2.2.1 All Solid geological divisions are shown coloured, with black boundaries, and symbolised only where necessary.

2.2.2 The Drift/Solid boundary is shown, in a contrasting colour (usually green) where feasible, but boundaries between different Drift units, including Worked, Landscaped and Disturbed Ground are omitted.

2.2.3 The Drift deposit-covered side of the Drift/Solid boundary is indicated by the use of a coloured edge zone, usually in green, denoting 'Drift, undifferentiated' which is keyed to a similarly edged ellipse in the Key. Alternatively, the Drift may be represented by a 1:50 000 scale box in the side margin, depicting the extent of undifferentiated Drift at outcrop, and titled 'Distribution of Drift (undifferentiated)'. Either of these two options can be adopted, but preference should be stated before the first maps are submitted and must be consistent for the whole project area. The 1:50 000 scale box option is preferable for areas of complex Solid geology.

2.2.4 Artificial Deposits and Worked Ground are not shown on the Solid Edition. However, the limits of all known quarries and opencast workings in the Solid, including those wholly or partially backfilled, are indicated by the appropriate symbol shown in Section 2.2 of the main report (p.7).

2.2.5 Additional data relevant to the Solid geology (feature symbols, structural data, map face notes etc. — cf. Section 6 of the main report) may be included in black.

2.2.6 All Solid units on the map face are shown coloured and symbolised on the Generalized Vertical Section. Units (or part units) which have only been proved underground or from boreholes are shown symbolised but uncoloured.

2.3 Drift Priority editions

2.3.1 All natural Quaternary deposits are shown coloured, with dark green (or black) boundaries and symbolised only where necessary. Landslip and Foundered Strata are shown respectively by horizontal and vertical ruling on a screened black colour.

2.3.2 Solid boundaries are not shown. Quaternary-free Solid areas are shown as 'Bedrock at or near surface', which is symbolised where appropriate and indicated by a single colour or left uncoloured, and shown as a tablet in the key. The uncoloured option can only be used if there are no areas attributed as 'unknown' beneath water, Artificial Deposits or Worked Ground (Appendix C, sections 2.5 and 6) which are left uncoloured by default.

2.3.3 All areas of Artificial Deposits and Worked Ground are shown, usually with a black boundary line and ruled ornament. A unique colour may be used if desired; Cartographic Services and the DMM will advise. The ruled ornament is shown on the underlying natural Quaternary deposit or 'Bedrock at or near surface' colour. For small areas of Artificial Deposits and Worked Ground, the appropriate symbol should be used (see Section 2.2 of the main report) and added to the key. The DMM will advise on the requirement for symbols. The nature of the underlying Quaternary geology must be indicated, annotated and attributed (Appendix C, section 6). A 'Quaternary undifferentiated' category can be used where Artificial Deposits or Worked Ground are known to overlie two or more types of Quaternary deposits but the boundaries between them cannot be delineated. Where natural Quaternary deposits and outcrops of Solid rock underlie Artificial Deposits and Worked Ground and a boundary cannot be drawn between the two, they should be attributed (Appendix C, section 6) and annotated as 'Unknown'. Areas of water should also be annotated in exactly the same way.

2.3.4 Additional data relevant to Drift geology only [notes, landform symbols and general map-face comments etc.] may be included in black.

2.3.5 The Drift priority map does not usually include a Generalized Vertical Section.

2.3.6 A cartoon or cartoons showing the schematic relationships of Drift deposits may be included in the map margin if appropriate. They should be drawn to fit a box of size 120 × 60 mm.

2.3.7 An inset map at 1:50 000 scale to show 'Sub-Drift distribution of the Solid rocks' may be included in the marginalia. This is normally generated in the Drawing Office by reduction of data captured at 1:10 000, but some generalisation by the geologist may be required to ensure a readable map at small-scale.

2.4 Combined Solid and Drift editions

The map category most likely to be required as a default product is one which includes both Solid and Drift information. A combined Solid and Drift map should be specified in areas where separate maps are not justified, e.g. where limited Drift overlies the Solid or a simple Solid sequence underlies extensive Drift.

1 Caveat — 'Draft copy, subject to amendment'.

2.4.1 All Solid and Quaternary deposits at outcrop on the map face are shown fully coloured. There is an option to show Quaternary deposits by use of appropriate colour edgings.

2.4.2 All Solid boundaries are shown in black; all Quaternary boundaries are shown, usually in green (or black); all Artificial deposits and worked ground are shown with black boundaries and ruled ornament (see also Appendix C, section 2.3.3) superimposed on the underlying Solid or Quaternary colour.

2.4.3 The Quaternary deposits and Quaternary-free Solid areas carry symbols; fractionated symbols to identify Quaternary-covered Solid outcrops are kept to the minimum required to facilitate reading the map.

2.4.4 The map should carry a Generalized Vertical Section (in which only deposits present at rockhead are coloured), a Drift relationships cartoon (or cartoons) where they are informative, and an inset map at 1:50 000 scale showing the sub-Drift distribution of the Solid rocks (Appendix C, cf. sections 2.3.6 and 2.3.7). This inset map reduces the need for fractionated symbols. Diagrams showing the relationships between Drift deposits should be drawn to fit a box of size 120 × 60 mm.

2.4.5 The nature of the underlying Solid or natural Quaternary geology beneath Artificial Deposits and Worked Ground must be indicated by the use of appropriate boundary lines and colours, or, exceptionally, they may be left uncoloured if doubt exists regarding the depth of infilled excavations etc. In such cases the area beneath the Artificial Deposit or Worked Ground must be annotated and attributed (Appendix C, section 6) as 'unknown' or 'Quaternary undifferentiated'. The latter is to be used where Artificial Deposits or Worked Ground are known to overlie two or more types of natural Quaternary deposits but the boundaries between them cannot be delineated. Areas of water should also be annotated in exactly the same way.

2.5 Artificial Deposits and Worked Ground

2.5.1 These deposits are shown only on Drift Priority editions and on combined Solid and Drift maps.

2.5.2 The boundaries of Artificial Deposits and Worked Ground are shown in black. There is an option to use a unique colour if required. Cartographic Services and the DMM will advise.

2.5.3 Ruled ornament in the same colour as the Artificial Deposit and Worked Ground boundary should follow the same format as manuscript 1:10 000 maps. On digital maps, it will be superimposed on the underlying Solid or Quaternary colour.

2.5.4 The nature of the underlying Solid or Quaternary geology must be indicated as outlined above in sections 2.3.3 and 2.4.5.

3 COLOUR SCHEMES AND CONVENTIONS

The colour schemes and conventions presented here are guidelines. The overriding aim should be the clear exposition of the geology of any area.

It must be stressed that the colour output from the Versatec plotter is variable. Variations occur due to the effects of colour toner exhaustion, temperature and humidity variation, paper type, condition of the plotter and quality of maintenance. The colour charts discussed below provide only a general indication of a selected range of colours.

3.1 Colours for geological divisions

3.1.1 Advisory sets of Versatec plotter colours should be held by Programme Managers, Cartographic Services and the DMM.

3.1.2 It is not possible to be prescriptive about the application of colours to sedimentary sequences (lithostratigraphical, lithodemic, allostratigraphical and lithological units). However, there are a number of pre-existing colour schemes within BGS which incorporate established conventions. The principles of precedent and consistency should be followed wherever possible. Geologists should be guided by advice from Programme Managers and Drawing Office staff (who hold charts of Versatec tones which equate closely to Scheme C colours).

3.1.3 Be guided by colours which have been used for similar rocks elsewhere (e.g. on recent 1:50 000 sheets). A wider range of related tones is available where needed to accommodate the extra detail (finer subdivision) at 1:10 000 scale. If 1:50 000 conventions are followed the colour links to segments of the geological column, well known to many users, will be safeguarded.

3.1.4 Existing conventions for specific lithologies (e.g. limestone, sandstone, or evaporite beds) in different parts of the stratigraphic column should be mimicked by shades of the established colours wherever possible.

3.1.5 Advisory colours for common Quaternary deposits, igneous and metamorphic rock divisions are included on charts held by Programme Managers. Additional colours may be used to separate different but related units (e.g. tills of different ages or derivations, river terrace gravels, igneous rocks, etc.). Cartographic Services or the DMM will advise if necessary.

3.1.6 A limited number of Drift, igneous and metamorphic divisions have traditionally been shown with an ornament. Subject to the capability of the plotter to produce these the practice will continue.

3.1.7 Careful use of various tones and ornaments will reduce the need for separate symbols for many igneous rocks.

3.1.8 Colour usage, once allocated, should be maintained as far as possible, at least to the limit of Research Group boundaries. This necessitates reference to previous colour schemes in adjacent areas before allocating colours to new sheets (see 3.1.9).

3.1.9 Rigorous recording of the colours used (by means of their Versatec code) is necessary to provide a starting point for later colour allocations. All colour allocations, including alterations based on revision/correction, should be recorded on a QC/QA form (Figure 14, Form 3).

3.2 Colours for component geological data

The digital system has the potential to use colours to differentiate the components of a geological map. Recommended guidelines are given below, but clarity of the map is paramount and use of the colours is not mandatory.

3.2.1 Black for Solid, Artificial Deposit and Worked Ground boundaries, green for Quaternary deposit boundaries.

3.2.2 Red for faults and fold axes. Associated text (e.g. fault names) should be in black.

3.2.3 All other symbols will be in black. The inclined strata, dip in degrees symbol will usually be indicated by a dip arrow rather than a strike bar as the latter does not show up clearly on the colour-printed digital maps.

3.2.4 Landform symbols such as glacial drainage channels or drumlins should be shown in dark green (the same colour used for Quaternary deposit boundaries).

3.2.5 Underground data (faults, folds, dips) should be in dark blue; coal seam contours and other structure contours will be in purple. Any text, such as dip values, symbols etc. will be in black.

3.3 The topographical backcloth

Geological data are plotted with a scanned Ordnance Survey topographical backcloth. This is screened in order to minimise its interference with the geological data. The default colour of the topography will usually be either grey or brown depending upon the geological colours, but the Drawing Office will advise on more suitable alternatives if the first proof is unacceptable.

4 MAP NOTES, MARGINAL NOTES, SYMBOLS

Some practices which were necessary or appropriate in the manual, monochrome, map production system are not relevant to full colour 1:10 000 digital map plots.

4.1 Map face notes

4.1.1 General notes which refer to undefined areas (e.g. **WIDESPREAD VENEER OF COVER SILT** or **MANY DISSOLUTIONAL FEATURES ON DIP SLOPE OF CHEE TOR ROCK**) may be applied as in the manual system. In the case of prioritised maps the notes should be specific to the map type and should be written across appropriate areas on the GCM.

4.1.2 Specific notes relating to notable exposures may be used as in the manual system, if they are of simple type (e.g. **FAULT VISIBLE IN WALL OF CUTTING** or **BLOCKY RED MUDSTONE 5**). The required wording should be shown, with a pointer, on the appropriate GCM.

4.1.3 Lists of data, such as measured sections, should be kept to a minimum. Sections including Drift and Solid data should be generalised according to the edition, e.g.:

Solid Priority

DRIFT (undifferentiated) 4.5
RED SANDSTONE 4.5
RED MUDSTONE

Drift Priority

MADE GROUND 2.5
PEAT, thin
GREY CLAY WITH PEBBLES 2
SOLID (undifferentiated) 4.5+

On the single GLM compilation these two notes would revert to a conventional full format.

4.2 Marginal notes

In accordance with current instructions for 1:10K scale map production, these should be kept to a minimum.

4.3 Symbols

4.3.1 On manually produced monochrome 1:10 000 maps it is necessary to symbolise each polygon on the map face, even though adjacent polygons may display identical Drift and/or Solid relationships. On a map showing Solid and Drift deposits, the Solid at rockhead beneath natural Quaternary deposits is indicated by fractionated symbols.

4.3.2 The use of colour to distinguish map units means that there is no need to symbolise all polygons and a minimal number of symbols should be used. Symbols should as far as possible be of one size, but different sizes may be used to eliminate the need for more than one symbol in large polygons and to minimise the need for arrowing-in symbols to small polygons.

4.3.3 Fractionated symbols should be used sparingly. In simple geological situations colour and single symbols, backed up by marginal inset maps will suffice to make the map readable. In more complex areas the use of fractionated symbols may be required, but they should be kept to a minimum.

4.3.4 Other conventional symbols (dip arrows, landscape features etc.) should be used as required on the appropriate map edition.

5 ADAPTING MANUAL SYSTEM MANUSCRIPTS

5.1 At times maps drawn to pre-existing manual specifications will be digitised. Some reformatting will be necessary, depending upon the map edition(s) required:

5.1.1 The most suitable map edition(s) should be decided, either prioritised Solid and Drift editions or a combined edition (Appendix C, sections 2.2 to 2.4).

5.1.2 The procedures are similar to the process of producing manuscripts specifically for the digital system. Paper copies of the approved map are obtained, on which to produce colour models. If prioritised versions are specified, each version is coloured as required and the appropriate text, symbols etc. indicated for each map. If additional data, such as a Quaternary relationships cartoon, are required, indicate the edition to which they apply and attach a fair-drawn copy, on plastic, to the manuscript.

5.1.3 As in the full digital system the map must be annotated to allow attribution. In areas with simple geology the annotation may be added to the colour model copies, but if this is impractical, additional paper copies should be used. Attribution guidelines are included in Appendix C, section 6.

5.1.4 If a sheet selected for digitisation has full approval the materials supplied to the DO for digitisation require no further authorisation, but the DM(s) produced must be approved in the same way as other digital maps. Directorate approval is not required to initiate digitisation of diverted sheets (as in the general procedures this approval for digitisation is granted at Programme Manager level), but the full approval chain to Directorate level (Appendix C, section 2) must be followed by the digital product(s).

5.1.5 Some existing maps which have been fully or partially approved within the manual system will include abundant notes and/or boreholes on the map face or in the map margins. Only those which are essential to interpretation of the map will be retained. All others and the related map face symbols should be marked for deletion. The Drawing Office will omit all but minimal map face rock unit symbols on the first proof. The geologist should insert any additional symbols felt to be necessary when checking the first proof. At least one symbol is necessary on most outcrops (cf. Appendix C, section 4.3).

5.1.6 All appropriate paperwork should be submitted to the DMM with the maps i.e. map history form, Quality Control Form (Figure 14, Form 3) and a list of all named structures with codes (see Appendix C, section 6.2). One 'master' quality control form can be submitted for the whole sheet/project area before or with the first batch of maps. This latter document is vital for the Drawing Office. It is not necessary to submit a component document record for maps drawn prior to the introduction of the Map History Database, in April 1993. Maps compiled after this date will already have map history forms.

6 GEOLOGICAL ATTRIBUTION

6.1 Introduction

6.1.1 Geological attribution is the process which ensures that the geological information the map contains is captured and stored in a database. The database can then be queried on the basis of the attributes and a variety of output produced. It involves labelling the map elements — points, lines and areas (polygons). These are then held in the database within a standard data structure. The Quality Control Form (Figure 14, Form 3) provides the Drawing Office with much of the information necessary for labelling the polygons. Any questions or queries regarding attribution should be addressed to the DMM. Examples of attributed maps can be made available.

6.1.2 A geologically attributed line segment may be identified in the database as an inferred stratiform base or observed unconformable contact, for example, rather than merely as a pecked line within the existing cartographic system. A polygon between a number of geological boundaries and/or faults will be attributed, held and recognised as, for instance, a sandstone of Langsettian age within the Lower Coal Measures, rather than as an area of Scheme C colour 156. Additional data relating to geological structure may be attached to lines (e.g. the orientation of major folds and faults or the mineral content of veins) or points (e.g. cleavage or dip values and fault displacements).

6.1.3 Attribution is ideally carried out by the geologist who surveyed or compiled the map. Attribution is achieved by annotating map features unambiguously, even those which are concealed. For instance, deposits beneath Artificial Deposits, Worked Ground and water must be identified and delineated if possible — or declared 'unknown' or 'Quaternary, undifferentiated' (Appendix C, sections 2.3.3 and 2.4.5).

6.1.4 The digital data used to produce the final map output are held within four files. The files ('maps'), contain data appropriate to either 'SOLID', 'DRIFT' (Quaternary Deposits), 'MAN-MADE' (Artificial Deposits and Worked Ground) or 'MASS MOVEMENT' Deposits (Landslip and Foundered Strata). Each file is internally consistent and could be used to generate output specific to the individual map element contained, with all its boundaries closed. One advantage of this system is that logical relationships between the various elements are held explicitly rather than being implied cartographically. Thus, for instance, where Solid and Drift boundaries are locally coincident, both boundary types will be held in the appropriate 'map' file, ensuring that each set of boundaries is complete. Prioritising at plot stage ensures that, in this example, a Solid boundary is produced rather than a Drift boundary along the shared line. Similarly, an Artificial Deposit and Worked Ground boundary will be produced rather than a Quaternary deposit boundary. The complete integrity of the separate 'map' files allows chosen elements from more than one 'map' to be amalgamated to generate plots of any desired combination of data.

6.1.5 To realise this versatility geologists must produce annotated attribution models. These models explicitly identify for the cartographer items which are to be held in the database.

6.2 What must be annotated?

These procedures have been revised, but they are still under review and subject to further revision. The dictionaries referred to below are lists of data items and related codes which are recognised by the computer. All named structures — faults, folds, mineral veins (Appendix C, sections 6.2.3, 6.2.10, 6.2.22 below) should be listed on the appropriate *Named Structures* form (Appendix C, section 1.3.11) and submitted to the DMM with the maps. One form is required for each map; all named structures should be listed including those already documented on adjacent sheets.

The following types of information (not in order of importance) must be annotated to allow geological attribution:

6.2.1 Any landforms (areal or linear) need to be clearly marked as to their type and the relevant codes must be entered to the dictionaries.

6.2.2 Any text notes that are to be entered to the database must be marked and the feature to which they are attached clearly indicated. Notes can be attached to landforms or mapped unit boundaries, including areas of Artificial Deposits and Worked Ground. In the case of mapped unit boundary segments the extent of line segment to which the note refers should be marked[1].

6.2.3 Any named fault has a unique mnemonic identify. The geologist must submit a list of all named faults on the *Named Structures* form (Appendix C, section 1.3.11). The list should be submitted to the DMM with the maps. It will be passed to the dictionary manager who will allocate unique mnemonic codes to each fault and enter them into the dictionary. The fault segments to which the mnemonic (name) applies must be marked unambiguously[1].

6.2.4 The type of each fault (normal, reverse etc.) should be marked and the extent of fault segment to which the classification applies indicated[1]. If the fault type is unknown this should be indicated. Single fault lines that include more than one type of movement (e.g. normal and reversed) or with changing throw directions, should be clearly annotated as separate segments for each type or throw direction. The boundary between the segments may, if necessary, be arbitrary.

6.2.5 Where a general fault throw value is to be entered the fault segment(s) to which the value applies must be marked[1]. (see Appendix C, 6.2.6 below).

6.2.6 Where a fault displacement value is to be recorded at a point rather than along a segment of the fault line, the point must be marked clearly. For this point the following information can be recorded if available:

Unique fault identity mnemonic, if any (essential for named faults)
Whether the value is inferred or observed (essential)
The type of fault (normal, reverse etc.)
The throw value
The downthrow side (as a compass quadrant)
The side proved, if any (as a compass quadrant)
If the fault displacement is recorded sub-surface, the computer code of the unit in which the observation was made.

6.2.7 The downthrow side of a fault should be indicated by a tick mark where possible and the length of fault to which a particular downthrow direction applies clearly marked[1]. It is essential to ensure that the downthrow side of all fault segments is annotated. If this information cannot be deduced, the appropriate segments must be annotated as 'downthrow side unknown'.

6.2.8 If indicating which side of a fault was proved in workings, the length of fault to which the observation applies must be clearly marked[1].

6.2.9 Any sub-surface fault, vein or fold shown on the map should also carry the lithostratigraphical [computer] code of the buried unit within which it was proved[1]. If the detailed

1 Since the computer holds boundaries not as continuous lines but as a series of related line segments, it is crucial to indicate only that part of the boundary (etc.) to which an attribute attaches.

lithostratigraphical unit is not known, then a broader heirarchical unit should be indicated, e.g. 'in MCM(S)' (see also Section 6.9 of the main report).

6.2.10 Any named fold has a unique mnemonic id. The geologist must submit a list of all named folds on the *Named Structures* form (Appendix C, section 1.3.11). The list should be submitted to the DMM with the maps. It will be passed to the dictionary manager who will allocate unique mnemonic codes to each fold and enter them into the dictionary. The fold segments to which a mnemonic (name) applies must be marked unambiguously[1].

6.2.11 The type of each fold (syncline, anticline etc.) should be marked if this information is not explicit from its symbol.

6.2.12 The lithostratigraphical [computer] code of fossiliferous horizons should be indicated if they have a distinct classification [e.g. named marine bands as opposed to un-named Lingula bands].

6.2.13 All areas on the Solid map will be classified as either lithostratigraphical (including lithodemic) areas or rock type areas (including those beneath water, Artificial Deposits and Worked Ground, which must be noted as 'unknown' if appropriate). Lithostratigraphical, lithodemic and lithological areas must be clearly differentiated and appropriate computer dictionary codes indicated. All lithostratigraphical and lithodemic areas must have a specified rock type (lithology —e.g. Cropwell Bishop Formation, CBP — MDST). At present, the system only caters for one lithology code. In many cases, this will necessitate a simplification and the predominant lithology should be coded. The DMM will advise on lithology (rock type) codes and requests for new codes. Most, but not all, rock type areas will lie within a lithostratigraphical or lithodemic area and such relationships must be made explicit (e.g. SDST in MCM). The smallest unit of classification is a single polygon, although if a geologist wishes to provide the system with lines delimiting lithological areas which are sub-divisions of lithostratigraphical or lithodemic areas shown on the manuscript map this can readily be handled. Not all lines provided by the geologist need appear on the digitally produced map. (Note: the codes used for attributing maps are not the same as the lithology symbols listed in sections 3, 4 and 5 of the main Specifications.

6.2.14 All areas on the Drift map will be classified by the appropriate computer code, e.g. KES — Kesgrave Formation; ALV — alluvium). The type of any area of Artificial Deposits or Worked Ground and its computer code (e.g. MGR — made ground) should be clearly shown. All such areas must have a specified rock type (lithology) code, e.g. alluvium, ALV — CLAY. Artificial Deposits and Worked Ground may be attributed to indicate different types, if required, e.g. gravel pit, clay pit etc. for Worked Ground; domestic refuse, colliery spoil etc. for made ground. There are currently no designated codes for these subdivisions, but the system is under review.

6.2.15 Where dates of excavation or fill are to be shown for areas of Artificial Deposits and Worked Ground, the area to which they apply must be clearly indicated.

6.2.16 Where an area of Artificial Deposits or Worked Ground has a name, the area to which the name applies must be clearly indicated.

6.2.17 The date of last movement of a Landslip or Foundered Strata deposit should be shown if known.

6.2.18 The type of all mapped unit boundaries must be clearly marked along with the extent of line to which each particular classification applies[1]. Drift (i.e. Artificial Deposits and Worked Ground, and Quaternary) boundaries each have only a single classification but Solid maps include a wide range of boundaries. The most common are undifferentiated stratiform contacts, but unconformities, intrusive contacts etc. should be distinguished where feasible.

6.2.19 Where lines of measured sections are shown each should be given a number unique to the map and this entered in the appropriate dictionary. The numbers of all such sections must be shown on the map. Eventually accession numbers to a Sections Database will be used in this context.

6.2.20 The lithostratigraphical unit to which a structural contour refers must be indicated [by its computer code].

6.2.21 The elevation (in metres relative to OD) must always be shown for structural contours.

6.2.22 A named vein has a unique mnemonic identity. The geologist must submit a list of all named veins on the *Named Structures* form (Appendix C, section 1.3.11). The list should be submitted to the DMM with the maps. It will be passed to the dictionary manager who will allocate unique mnemonic codes to each vein and enter them into the dictionary.The exact vein segments to which a mnemonic (name) applies must be marked unambiguously[1].

6.2.23 Up to two elements and two minerals can be marked against any particular vein segment. The extent of vein to which these apply must be clearly shown[1].

6.3 The process of geological attribute annotation

The exact method of map attribution will vary depending upon complexity and individual project specifications. The overriding factor is that the annotation must be readily understandable to the cartographer. For maps with complex areas of Artificial Deposits and Worked Ground, Quaternary and Solid geology it is necessary to annotate separate copies of the GLM for each type of map component. In less complex areas the process may be feasible on a single copy or combined with the GCM(s).

6.4 Attribution on the map face

6.4.1 On simple geological maps much of the attribute annotation will be on the map face.

6.4.2 Generally it should be possible to adopt an *'unless specified otherwise*' (USO) approach, e.g.:

> Solid boundaries are stratiform sedimentary contacts (USO)
>
> Faults are normal (USO)
>
> Fault throw direction [shown by tick] applies to all segments of a fault (USO)

6.4.3 Lines on the map face which depart from, or do not readily fit into, the USO protocol must be identified by overscribing in coloured ink or a highlighter pen, and providing a suitable key. Lines other than geological lines on the map face (e.g. limits or components of geomorphological symbols) are more suitably annotated in the map margin (section 6.5 below), but may be cross-referenced on the map face if desired.

6.4.4 The other major element of map face information is the identity of components within each Solid, Quaternary, Artificial Deposit and Worked Ground polygon. Mass Movement Deposit (Landslip and Foundered Strata) polygons must also be clearly indicated from other Quaternary deposits as they are put into a different file in the database. Artificial deposit and worked ground areas normally need no further attribution. It is essential that Solid or Quaternary deposit lines and associated polygons beneath Artificial Deposits, Worked Ground and water are complete or that the polygon

1 Since the computer holds boundaries not as continuous lines but as a series of related line segments, it is crucial to indicate only that part of the boundary (etc.) to which an attribute attaches.

beneath them is marked as 'unknown' or 'Quaternary undifferentiated' (Appendix C, section 2.4.5). The lithostratigraphy of each polygon should be apparent from the colour scheme (and symbol where present). Lithostratigraphical (including lithodemic and allostratigraphical) computer codes and lithology (current format subject to revision) must be indicated and, though relating to map face polygons, these data are more simply shown in the map margins (section 6.5 below) and /or with colour allocations (Figure 14, Form).

6.4.5 Other aspects of map face information (e.g. notes, symbols and items such as fault or fold names) should be annotated using highlighter pens and an explanatory key.

6.5 Attribution in the map margins

6.5.1 The map marginal data exist in the digital map system mainly as cartographic rather than geologically attributed database information.

6.5.2 Much of the marginal information is of index type, and these elements can be used to provide the cartographer with geological attribute data applicable to aspects of the map face.

6.5.3 For instance, each unit shown in the Generalized Vertical Section or key tablets will normally include a name, whether formal (such as the Cropwell Bishop Formation) or general (such as till, for spreads of glacial deposit with no specific name)). The GVS or key box will also include the map code (e.g. CBp for Cropwell Bishop Formation) or symbol used on the map face. In most cases a brief summary of the lithology of each unit is also present. To aid the cartographer the named rock unit (lithostratigraphical, allostratigraphical or lithodemic) computer code and lithological code for each unit is added to the index data, viz:

Unit	Cropwell Bishop Formation	Till
Map Code	CBp	symbol
Computer Code	CBP	TILL
Lith.	MDST	DMTN

Variations in lithology of a particular named rock unit can be shown and should be suitably indicated on one of the annotated copies. They should be marked as polygons with the appropriate lithology code in each one. The dividing line will be 'hidden' in the database, and will be highly conjectural in most cases.

6.5.4 The format for attribution of lithology is under review and will eventually utilise codes from a new Petrological Code related to the new BGS Rock Classification Scheme. Such data may become accessible directly via new-style Lexicon entries. Units such as till and head are given computer codes for other purposes and exist informally within the Named Rock Unit Lexicon. These entries do not include details of lithology, so that where such terms remain in use local lithological data must be supplied explicitly.

Appendix D Forms that must be submitted with each 1:10 000 map

The forms shown in Figure 14 record the history of each of the 1:10 000 Series geological maps from survey to publication.

Figure 14: Form 1 Map compilation and production, with accompanying notes.

Form 2 Component document record.

Form 3 Rock unit and lithological codes. For digital maps, a separate form needs to be completed for each map submitted; for manuscript maps, one form for the whole 1:50 000 sheet is sufficient.

Form 4 Application for mnemonic codes for named structures on 1:10K sheet. This form is only required for maps that have any named structure shown on the map face. A separate form is required for each map.

FORM 1 MAP COMPILATION AND PRODUCTION

Map type SOLID ☐ DRIFT ☐ SOLID & DRIFT ☐ THEMATIC[1] _____ OTHER[1] _____

Map No. _____ Scale[2] _____ Base Material PAPER ☐ PLASTIC ☐ Version No.[3] _____

Included 1:10K sheets[4] _____ 1:50K map(s) _____

Survey Type[5] PRIMARY ☐ REVISION ☐ DESK ☐ Extent[6] FULL ☐ PARTIAL ☐

Project name _____ Code _____

Personnel involved _____ _____

_____ _____

Survey started[7] _____ Linework completed[9] _____ GLM completed[10] _____

Survey completed[8] _____ GCM completed[11] _____

Edges fitted[12] E ____ N ____ S ____ W____ Component document record completed[13] _____

Approval of GLM/GCM

	Date received	Name	Signature	Date approved
Project Leader				
Divisional Map Manager				
Programme Manager				

Full attribution ☐ Partial attribution ☐

Date forwarded to DMM _____ (Digital maps) Date forwarded to CS _____

DIGITAL MAP PRODUCTION	1st Proof	2nd Proof	3rd Proof
Proof received by DMM			
Forwarded to geologist			
Received by geologist			
Forwarded by geologist			
Received by DMM			

Approval (subject to correction)

	Date received	Name	Signature	Date approved
Compiler				
Project Leader				
Programme Manager				

Forwarded to DMM _____ Received by DMM _____

Corrections forwarded to CS _____ _____ _____

Corrected proof received by DMM _____ _____ _____

Approval of final proof

	Date received	Name	Signature	Date approved
Programme Manager				

Final approved proof sent to CS _____

Figure 14 History of 1:10 000 series geological map.

NUMBERED NOTES TO ACCOMPANY FORM 1

1 Specify thematic (e.g. Artificial Deposits) or other map type.

A separate form is required for each type of map.

2 Normally 1:10 000, but may be other scales in some instances e.g. 1:25 000.

3 Version (Phase) No. This will always be version 1.0 for new starts. Subsequent alterations under 'continuous revision' will be version 1.1, 2.0, etc.

4 Included 1:10 000 Sheet(s). This relates to small areas on adjacent 1:10 000 sheets which may be included in the one being surveyed as an insertion, e.g. where the adjacent sheet has only a small land area or an offshore island which does not warrant a full 1:10 000 sheet, and compilations made from more than one 1:10 000 Sheet (thematic maps etc.).

5 Tick the appropriate box; tick two boxes where necessary if more than one type of survey has been carried out on any 1:10 000 map, e.g. revision and desk where a mainly desk revision is accompanied by some fieldwork.

6 This refers to the area mapped.

7 Enter the date fieldwork/desk revision starts. It need not be to the nearest day but if known this should be recorded. In many retrospective cases, this will not be possible, therefore, the nearest month or year will suffice. Where work is carried onto an adjacent map, the date started should be taken as the first significant piece of mapping. The overlap to the nearest convenient point, usually a field boundary, should not be recorded as a new start.

8 Enter the date fieldwork finishes. Leave blank for desk revisions and continuous revision.

9 On completion of the linework, lines only prints are required for each output type (solid, drift, etc.), or one only for a combined solid and drift map.

10 GLM (Geologist's Lines Master) is the plastic master which contains **all** of the linework, notes and side margin information.

11 GCM — Geologist's Colour Master; one required for each output type. These will be 'rough' versions to which are added the relevant notes and side margin information specific for the particular output type. A new GCM may not always be necessary for maps produced under continuous revision.

Attribution of maps should be done on the colour model if possible. For more complex maps, separate copies will be necessary, showing different features.

More detailed instructions for these stages are given in Appendix C of the specification for the preparation of 1:10 000 scale standards.

12 Enter F for fitted, N for not fitted.

13 The Component Document Record sheet should include **all** documents used in the compilation of the 1:10 000 map, such as fieldslips/standards from previous surveys; borehole/opencast records (one reference to the file is sufficient rather than list every borehole used, **but the range of numbered boreholes consulted should be given**); seismic and other geophysical data sets; biostratigraphical reports; field notebooks; miscellaneous documents etc. For continuous revision maps, list all new data sources used to compile the map. Boreholes consulted should be listed by registered numbers or range of numbers.

Figure 14 (*continued*).

FORM 2 COMPONENT DOCUMENT RECORD

1:10 000 Sheet number | name

Compiled by surname | initials | code

List all data sources and number sequentially

No.	Document	Origin	Scale	Date

Figure 14 (*continued*).

FORM 3 ROCK UNIT AND LITHOLOGICAL CODES FOR 1:10 000 AND 1:50 000 SCALE MAPS

Page ☐ of ☐

1:50K Sheet No. _____ Name _____

1:10K Sheet No. _____ Name _____

Geologist _____ Date _____

Rock unit name	Map Code	Computer Code	Lithology Code	Versatec Colour number*

* For use by Drawing Office.

Figure 14 (*continued*).

FORM 4 APPLICATION FOR MNEMONIC CODES FOR NAMED STRUCTURES ON 1:10 K SHEET:

.....

Page ☐ of ☐

Name of structure	Dictionary	Code

Geologist: Data Manager:

Date: Date:

Figure 14 (*continued*).