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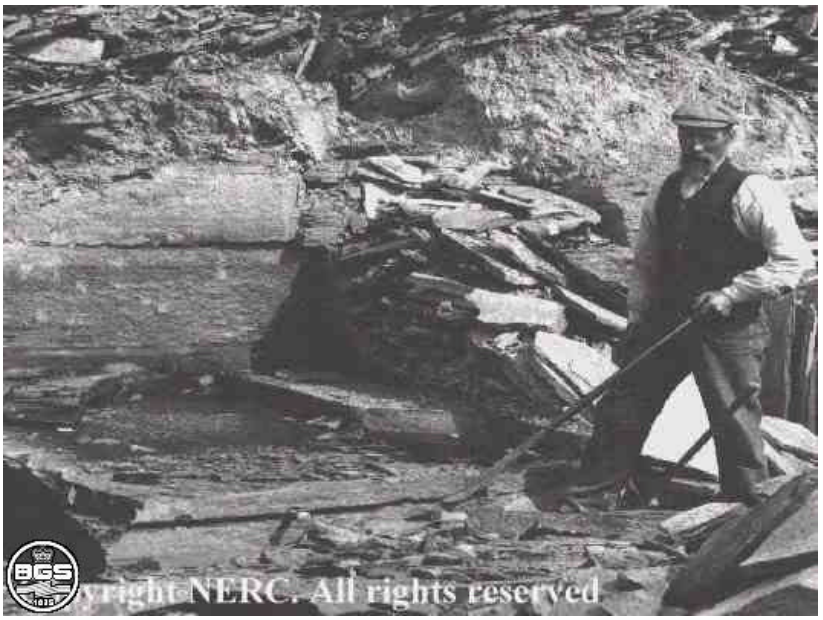
Logical design and prototype implementation of a BGS Building Stones Database

Information Management Programme

Internal Report IR/02/144



BRITISH GEOLOGICAL SURVEY

INTERNAL REPORT IR/02/144

Logical design and prototype implementation of a BGS Building Stones Database

J S Coats, G K Lott and D G Cameron

Key words

Building stones; buildings; quarries.

Front cover

Historic working at Stonegunn Quarry, Caithness (BGS photograph).

Bibliographical reference

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The British Geological Survey is a component body of the Natural Environment Research Council.

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Foreword

This report is the product of a study by the British Geological Survey (BGS) Information Management Programme headed by J R A Giles and led by J S Coats. Much of the stimulus for this work came from other Commissioned Research and Science Budget Projects in the Onshore Minerals and Energy Resources Programme, now the Economic Minerals and Geochemical Baseline Programme, managed by M G Petterson.

Acknowledgements

A number of other individuals in BGS have contributed to the project, notably staff such as Emma Bartlett and Sue Hobbs who have entered and managed data into Minerals databases. David Highley, Andrew Bloodworth and a number of individuals have given advice and discussed this topic and it is hoped that this report reflects their views and wishes. Stephen Brearley reviewed an early draft and his contributions to the design and report are gratefully acknowledged.

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Summary

This short report describes the design of a prototype database to hold information on UK Building Stones, which has been partly funded by the BGS Information Management Programme on the Management of Minerals and Geochemical Data Project (ESB91900085).

A brief introduction provides information on BGS' current data holdings on building stones and gives reasons why they need to rationalised and coordinated. The nature of the BGS data on building stones is analysed and the logical entities and enterprise rules defined before a logical design is presented. The design has been implemented in Microsoft Access 2000 and has links to ORACLE databases for Mines and Quarries (BritPits) and rock samples (BritRocks). Some of the database tables have been populated but at present many of the linking tables are empty and require population. Finally a short discussion and recommendations for further work is provided.

1 Introduction

People have been building houses and monuments out of locally available stone for many centuries and the built environment of our villages, towns and cities is often determined by the nature of local materials. Natural stone is a characteristic, defining feature of the appearance of cities, such as Aberdeen, Edinburgh, York, Bath, Bristol and London, Buildings in villages and small settlements may be even more distinctive, because of the concentration of structures crafted from locally available stone.

BGS has recently published a map of the Building Stone Resources of Britain (BGS, 2001) and this map is just one of a number of sources of information) about building stones available from the Survey. These sources include:

- Building Stones Map compilation based on a dataset assembled by G K Lott
- Economic Minerals and Geochemistry Baseline Programme BritPits database of mines and quarries, which includes information on building stone quarries
- A collection of building stone samples in the National Geoscience Data Centre (NGDC)
- The BritRocks collection database of rock samples and thin sections in the NGDC.
- Test results derived form a variety of petrographic, geotechnical, geochemical and geophysical methods

Further details concerning the above datasets is illustrated by the relevant web pages on the BGS website as of March 2002, which are reproduced in Appendix 1.

1.1 REQUIREMENTS ANALYSIS

The British Geological Survey (BGS) receives many enquiries about sources of building stones from architects planning new buildings or restoring existing ones. These requests for information are answered by a variety of people, who may give different answers depending on their discipline or experience. Frequently asked questions are "Where does it come from?" or "Where can I get some more of the same stone or something similar?" A central database or reference source will clearly be advantageous in answering these enquiries.

At present there is information available to the public on the BGS website at http://www.bgs.ac.uk/services/buildingstones/buildstn.htm displayed in Appendix 1, which details BGS services and directs further enquiries to the correct person in BGS. However, BGS staff may be using widely variable databases and information sources. Without a central point of data access, the staff will likely give inconsistent and possibly incomplete advice. A centralised corporate database would provide a common resource for all interested users and could combine information from a number of currently disparate sources. This is essential because no single Programme within BGS manages or controls these datasets, and whilst individual databases may be well organised and corporate in structure, often there are no easy means to link between sources.

BGS probably has one of the largest collections in the country of data about building stones of the UK but this is probably under-utilised because of a lack of integration. A number of contracts have been received from central government and other agencies and there is scope to increase income in this area if we can offer a comprehensive, one-stop solution rather than just answer individual small enquiries. Examples of previous contracts were preparing a definitive list of Building Stone quarries for the Department for Transport, Local Government and the Regions

(DTLR) and identifying sources of a red building stone for the architects designing the House of Commons extension.

We also tendered unsuccessfully (March 2002) for a contract on Building Stones for DTLR. A comprehensive database of UK building stones may have given the Survey a competitive advantage over other consultants.

The general requirements of a Building Stone Database are:

- A single source of data on UK building stones
- The data source to be accessible to all BGS staff
- An index of data holdings available to the general public
- Data actively managed and quality controlled, to be fit for purpose
- The ability for BGS to answer queries efficiently and to meet existing business objectives

2 Data Analysis

Before proceeding to create a database it is important to go through a process of user interviewing and data analysis in order to define the area of interest, the logical data entities and their interrelationships. As the database will coexist with, and link to, several other BGS databases, the enterprise rules that govern their design will also have to be clarified and incorporated in the design. The two major BGS corporate databases with links to the proposed building stones database are BritPits and BritRocks. The designs of these two databases are not considered in this report and no changes to them are proposed.

2.1 LOGICAL ENTITIES

The following logical entities and definitions have been identified from available data sources:

1. Building
   A house or other construction, normally with walls and a roof.
2. Building Stone
   A natural rock material quarried for the purpose of obtaining blocks or slabs that can be subsequently dressed or sawn for general building purposes.
3. Building Stone Sample
   A physical sample of a building stone, that can be incorporated into a sample collection or tested.
4. Quarry or Pit
   An excavation or working at surface or underground, for the purpose of extracting rock material.
5. Worked Body
   A particular rock or 'unit' that is worked in whole or in part within a quarry.
6. Operator
   The commercial firm or organisation that currently works, or formerly worked in the case of closed quarries, the quarry or pit.

Full definitions of these entities and their attributes are given in Appendix 2 and only a brief discussion is provided here. A Glossary of technical terms and definitions is provided.

Buildings in the envisaged database are limited to those incorporating stone in their construction and there are a variety of purposes for which such materials may be employed. Stone can be used

as cladding for non-load bearing walling material, usually to shed water or to protect from frost. Walling stone is used in the form of non-dressed or rubble blocks and may be unbonded, as in dry stone walling, or cemented. Most building stone used in load-bearing situations is dressed (shaped) or sawn to a regular size and shape. Dressed or sawn rock material may also be known as Dimension Stone, because it is usually supplied in a range of fixed sizes or dimensions. Flagstones are rocks sawn or split specifically for flooring or paving. Slate is a naturally occurring material that can be split into thin sheets that can be used for roofing, cladding and flooring. Stone slates are fissile limestones or sandstones used in roofing applications and need to be distinguished from true 'slates', which are metamorphosed, fine grained pelites. Many building stone quarries will produce a range of the above products.

For the purposes of this database the term 'buildings' also includes constructions such as bridges, arches and other man made monuments. This may include prehistoric monuments, henges, barrows, crosses, standing stones, etc. Related objects such as statues and gravestones may also be included, but the database is not intended to be a worldwide directory of cut and polished stone used in cemeteries, which come from a very wide variety of sources. Dimension stone has also been imported into this country. For example, Caen Stone was used in the construction of many Norman cathedrals.

Building stone is a particular type of rock material that usually comes from a well-defined bed or body of rock. It is differentiated by a name, which is normally derived from a type location such as a quarry, but may also refer to a distinct colour or texture. Some of these names may have a general application and include material from a number of quarries over a wide area e.g. Portland Stone. In other cases the names may identify stone coming from one particular bed in one single quarry.

Various trade or commercial names are given to building stones. With expert knowledge a building stone sample can be attributed to a particular source or geological formation. The trade names may be similar to geological terms but often include words such as 'marble' or 'granite' used in a descriptive rather than a geological sense.

The database does not include details of 'artificial' buildings stone, which may resemble natural materials but are made from crushed rock and a binder. Bricks, tiles and other man made constructional materials are also not included in the scope of this database.

For the purposes of this database a sample of a building stone is taken to be a physical sample, assumed to be representative of the rock unit. Any physical sample must come from a particular location, which should be known. However in many cases building stone samples included in collections have imprecise location details, such as only the name of the quarry is listed.

A sample collected from a building stone quarry can be tested for a variety of physical or chemical properties, which are often reported as an average rather than referencing a particular sample. Common physical tests reported are: porosity, saturation coefficient, water absorption, bulk specific gravity, salt crystallisation, compressive strength, flexural strength, slip and abrasion resistance Examples are given on the Hanson Bath & Portland Stone website at http://www.hansonuk-commercial.com/, 2002. At present the database design does not contain tables to hold experimental data, although it could easily be extended to include a suitable table linked to the building stone entity. However, it is recommended that this information is systematically collected.

A quarry or mine, collectively known as a 'pit', is the location where a rock body is worked. An underground excavation is normally known as a mine and a surface excavation as a quarry or pit. In this national database both are considered to be point locations, normally the centroid of the quarry or the mine entrance. Large quarries should ideally be described as polygons, but for ease of data management they are defined here as generalised point objects. The accuracy of the centroid position may vary greatly depending on the size of the quarry and exactly how it was measured, such as estimation from a map or computer calculation in a GIS etc. A sample of

building stone is also a designated point object because it was collected at a particular 3D point in the quarry. The sample position may therefore differ from the quarry location.

2.2 ENTERPRISE RULES

1. A quarry or pit can only have one operator. This rule may be broken in large quarries where a small portion may be worked for building stone by one operator and the remainder by a large aggregate producer. In this case it should be considered as two pits.
2. A pit can work one or more pit bodies.
3. A pit body is whole or part of only one formation.
4. A particular building stone may come from one or more quarries. It may come from an unknown quarry or even from loose rock at the surface.
5. One or more building stone samples can be taken from one pit or worked body.
6. A test or examination may be carried out on a single sample or a series of samples of the material. In a few cases where the test is non-destructive it may be applied to the building stone whilst still part of the building.
7. Several samples may be tested and an average value given for the quarry. In this case the results relate to the worked body rather than a specific rock sample. Published data on quarry products is usually an average of several measurements or derived from a bulk sample.
8. A building may be constructed from one or more types of building stone.
9. A building stone may be used in one or many different buildings.

3 Logical Design

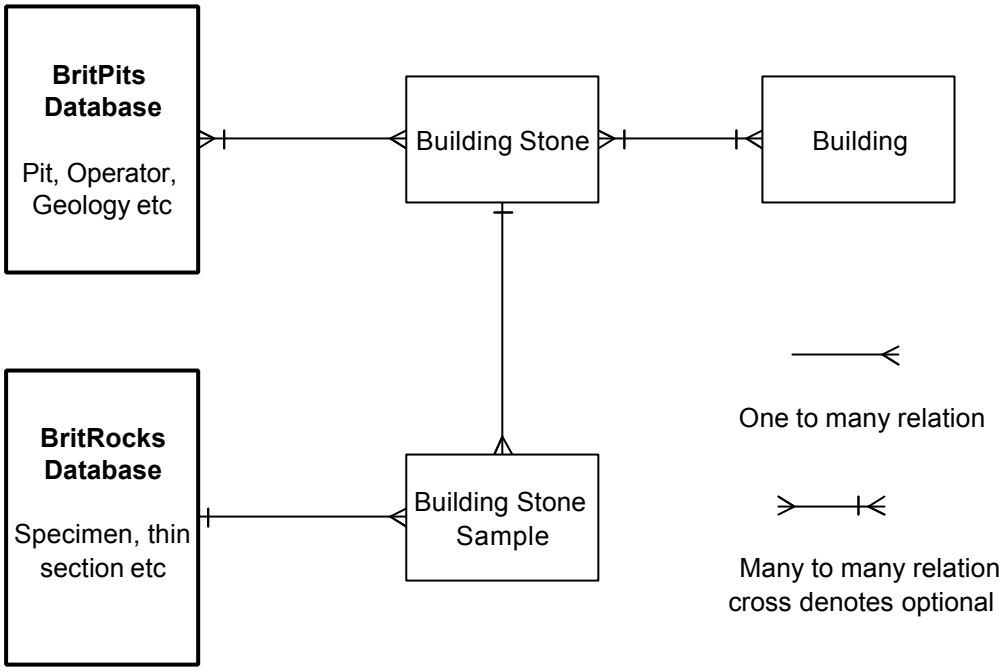


Figure 1 Generalised entity-relationship diagram indicating the proposed links between the BritPits and BritRocks databases and the major new entities in the Building Stones database.

The logical overview of the database design is illustrated in Figure 1. The entities are derived from the sources of available data and analysis of the BGS Corporate ORACLE BritPits database (Bain, 1994), the BritRocks database and an Access database created by G K Lott.

The relationships between the entities are generally many-to-many. However, these relationships can be simplified by introducing intermediate entities to create one-to-many relationships in the physical design.

4 Physical Implementation

A prototype database has been created in Microsoft Access, which incorporates the data held in G K Lott's database and has links to the BGS corporate databases. It is intended to be a working prototype to assess the practicalities of the design and usefulness. The report authors are familiar with using Access databases and linking to ORACLE databases and integration with GIS products. When the prototype has been shown to meet its design objectives the data tables, can be migrated to the BGS corporate ORACLE system. Full details of the table design are given in Appendix 2.

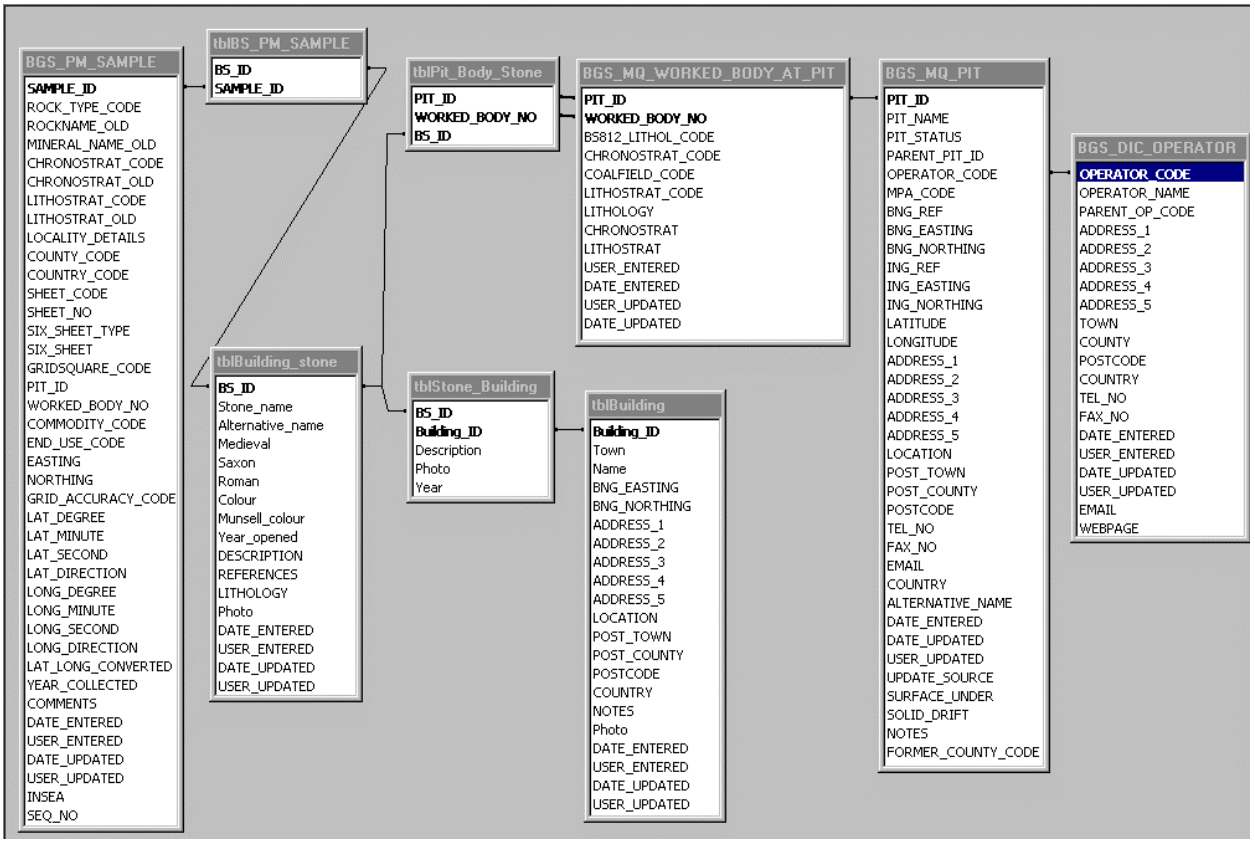


Figure 2 Entity - Relationship diagram for the prototype Access database

Much of the geological information referencing building stones can be stored in the existing BritPits database. Information on the geographic location of the quarry, its address, present pit status, etc can be stored in the BGS.MQ_Pit table. In the related table BGS.MQ_Worked_Body_At_Pit details of the lithology, lithostratigraphy and chronostratigraphy are stored referencing look-up tables, which specify coded field domains. The look-up tables are not shown in Figure 2 for simplicity. Fuller details of the BritPits design are given in Bain (1994). The BGS.MQ_Pit table is also linked to BGS.Dic_Operator table, which holds details of the current operator of the quarry or former operator in the case of a closed quarry. The concept of a worked body in a pit was created to take account of quarries where several different geological units are present. This design can easily be extended to encompass building stone quarries, where distinctive worked beds in a quarry may have been ascribed different names.

In the proposed database the table tblPit_Body_Stone references the primary keys of the BGS.MQ_Worked_Body_At_Pit and the tblBuilding_Stone tables. This models the many-to-many relation between a building stone and beds within quarries. At present this table contains no other fields.

The table tblBuilding_Stone contains much of the information about the individual building stone. The primary key will be a unique integer number allocated by Access (Autonumber in data type). The name of the building stone could have been used as the primary key, however two operators may give the same name to their products even though they are distinctly different in appearance and come from different quarries. A single alternative name field is provided for different trade names to the same stone. It is thought to be unnecessary to create a separate alternative name table. Other fields describe the building stone, such as Munsell colour, a photo or a link to a photo library, and when the stone was first used. A references field describing the original bibliographic sources is included, which is currently unnormalised. The lithology field is

provided for a more detailed description of the building stone, and which may duplicate the generalised description of the rock body stored in the BGS.MQ_Worked_Body_At_Pit table.

The tblBuilding_Stone table is linked to the BGS.PM_SAMPLE of the BritRocks database by an intermediate table, tblBS_PM_SAMPLE, which references the two primary keys of both tables. This new table enables several samples of a building stone, which may have been collected from different locations, to exist in the BritRocks database. The present design does not directly link BritRocks samples and BritPits quarries. However, the association between samples and quarries can be displayed in a GIS using the grid coordinates because both the quarry and the sample should be in close proximity.

The link between tblBuilding_Stone and tblBuilding is established via an intermediate table tblStone_Building. Besides referencing the primary keys of both tables, tblStone_Building also holds information on where a particular stone is used in the building, the year of use in a building contructed during multiple time periods, such as a church built over many centuries, and a photo of the stone construction in the building. Although this table provides the link between the building and the building stone it does not define a relationship between quarry and building. The latter relationship may be known for modern and well documented buildings but not necessarily for ancient ones.

The tblBuilding table has a numeric primary key and records information such as building name, address, town and geographical location, together with a photograph and reference to a bibliographic source. It is not intended that all stone built buildings in Britain should be recorded but it should hold a reference set of outstanding buildings illustrating the use of natural stone.

The prototype database Building_test_v2000.mdb can be accessed over the network from the shared V: drive in the V:\LR\EMGB\BRITPITS directory.

5 Database Population

Creating a new database populated with new data is much simpler than attempting to load data from existing datasets. The three datasets, which will be linked to form the Building Stones Database, have different origins and defining attributes relating to quarries, building stones and rock samples. All three repositories hold similar information, such as names, location and lithology, and it is difficult to reconcile these data entries. An attempt has been made to match the building stone quarries in BritPits and in Graham Lott's dataset using the grid locations. Many of the currently operating building stone quarries were taken from the BritPits database and nearly 400 matches were identified. There is some duplication and about 350 quarries, or more accurately pit bodies, could be linked to specific building stones. The total number of UK building stones is believed to be about 2100-2200, so between 1700-1800 records remain to be linked to the BritPits database or new quarry sites need to be added to the main table.

The Buildings table includes 1524 records, and as yet no attempt has been made to lnk these to the Building Stone table. Much of the detailed information on the buildings is missing, such as address and location, which it might be obtainable from English Heritage and other similar organisations.

No attempt has been made to populate the table linking the BritRocks database to the Building stones table. The former database contains only about 300 samples with the word "building" in the comments field, but it is likely that many more building stones have been collected but not identified as such in the comments. It is pertinent to note that the Geological Museum's collection of building stones was passed to the Natural History Museum when the BGS moved to Keyworth. Such an important collection would have been of great value to the development of the new Building Stones database.

6 Discussion and Conclusions

The following recommendations can be drawn from this study:

1. Resources should be allocated to the development of a Building Stones database. Part funding may be available from any successful Office of the Deputy Prime Minister (ODPM) contract bids. ODPM have take over these functions from the former-DTLR

2. The prototype Access database should be populated as resources allow.

3. A decision about migrating tables to an ORACLE database can be made in 2-3 years time in the light of experience gained with the prototype.

4. Links to other sources e.g. English Heritage, Natural History Museum, Buildings Research Establishment, Historic Scotland, National Stone Centre, etc. should be explored.

5. Database links to other BGS tables, such as the Photographic collection, geotechnical and geochemistry databases, should be considered.

6. Publication and data licensing issues need to be evaluated.

7. Dissemination of knowledge about the database within BGS needs to be carried out.

8. A building stones theme needs to be created on the internet GDI to inform the general public.

The creation of a building stones database is not going to provide an immediate source of income for BGS. Data licences may provide a small, regular income but will barely cover the management costs. The main benefit of such a facility is a useful resource for answering enquiries from the public and internal customers. The database will provide an extremely useful tool for marketing BGS expertise providing a one-stop-shop for building stone enquiries. The availability of a comprehensive UK database will give BGS a competitive advantage over other consultancies, and will assist with winning further contracts.

Appendix 1 BGS Building Stone Services

A copy of the information on building stones services available on the BGS website at: http://www.bgs.ac.uk/services/buildingstones/buildstn.htm is shown below.

Building Stone Services for Construction and Conservation

The British Geological Survey, as the UK's national centre for earth science information and expertise, is uniquely placed to answer enquiries about the identification of the original stone used in the fabric of a building and the location of suitable stone-types for replacements or new buildings.

Experts from many parts of the BGS are able to answer questions asked by architects, quarry owners, stone masons and conservationists concerned with building stones and their use in both the historic and modern buildings of the UK.

Historic working at Stonegunn Quarry, Caithness (BGS photograph).

What stone is it? The accurate description of a building stone is a prerequisite for assessment of its suitability. Aesthetic considerations, such as colour and appearance, are not alone sufficient. Compositional and performance characteristics need to be determined to ensure that the stone is appropriate for its intended application and can withstand the long-term effects of weathering. This is particularly important when choosing replacement stone for existing buildings. Petrological thin-section analysis enables any stone to be classified (as a limestone, sandstone or igneous rock etc.) and characteristics such as grain structure, mineral content and cementation to be determined.

Physical properties such as density, compressive strength and porosity are measured in order to determine its durability.

Where does it come from? The source of many of the stones used in older buildings is commonly problematical. When the fabric of a building is being restored, it is clearly important to use a stone which matches the original as closely as possible. Otherwise there may be problems over time due to differential permeability and weathering effects. Even if the original source is known, stone matching can be difficult because of variations within the quarry. Moreover, many of the quarries that supplied stone for building in the past are no longer active and may even be filled in. By using its extensive historical archive of records, maps etc. The BGS can locate many of these historic quarry sites. From current geological survey fieldwork, other compatible stone sources can be identified.

BRITISH GEOLOGICAL SURVEY 2001. Building Stone Resources Map of Britain. Lott, G.K. Geological Map © NERC 2001. All rights reserved. Contact the BGS Sales Desk for further details.

Where can I get some more of the same or similar? The BGS offers a professional service based on up-to-date information and advice on the geology of building stones in the UK. Its geologists provide information on the characteristics of currently active and long-disused building stone quarries, as well as advice on the location of potential quarry sites in areas where suitable stone exists. The BGS aims to

assist fully those organisations and companies involved in the conservation of Britain's building heritage and in support of the UK building stone industry.

Data Resources

Databases: The British Geological Survey maintains a comprehensive set of databases which includes past and present quarry sources as well as information on the properties and major characteristics of stone products. These include databases of digital geological maps, quarry locations and reference stone samples, which are directly applicable to locating information about building stones. Detailed information is drawn from 1:10 000 scale geological maps, field descriptions and photographs collated over the past 160 years of geological mapping.

Reference samples: The BGS rock collections contain many thousands of stone samples and thin sections from past and present building stone workings. Use of these resources is made easy by modern Geographical Information Systems at the BGS Nottingham and Edinburgh offices.

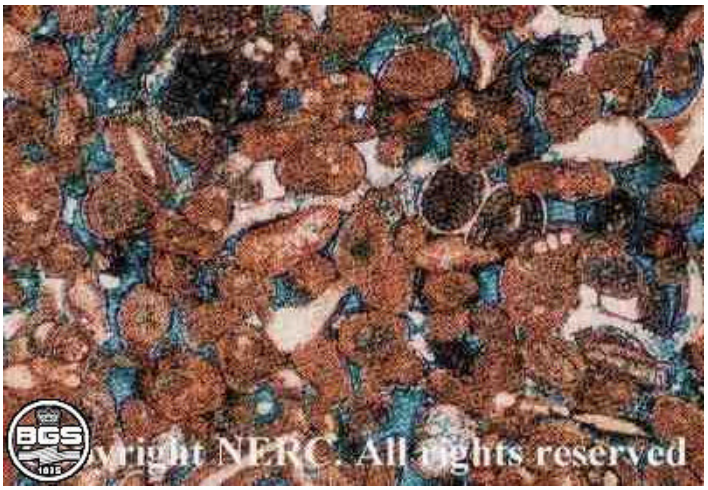
Expert knowledge: Expertise in local and regional geology forms the basis for consultation services by BGS geologists, who will advise on the occurrence of a particular formation or stone type, and pinpoint past and present workings in it. The BGS geological library resource is one of the largest of its kind in Britain, and is open to enquirers. Selected details of currently active quarries are published triennually in the *Directory of Mines and Quarries*.

Laboratory Services

Petrographic testing

Detailed microscopic examination of stone fabrics, minerals, cements, pore structure, alteration, fracturing and staining is provided by:

- A high-quality thin-section cutting service for conventional, blue-dye resin impregnation, polished sections, etc.
- Optical microscopy and modal analysis
- X-ray diffraction
- Cathodoluminescence and ultraviolet microscopy
- Scanning electron microscopy and electron-microprobe
- Image analysis
- Field determination of cement and clay contents by portable infrared analyser



Petrographic analysis of porous limestone.

GEOTECHNICAL TESTING

A suite of testing procedures to determine the physical properties and durability characteristics of building stones are available at the BGS geotechnical laboratories, and includes:

- Compressive strength
- Elastic moduli
- Flexural strength
- Density, porosity, saturation coefficient and water adsorption
- Sulphate crystallisation
- Acid immersion
- Thermal properties
    - Thermal conductivity
    - Thermal expansion
    - Specific heat capacity
- Freeze thaw

GEOCHEMICAL TESTING

The NAMAS-accredited chemical laboratories at the BGS provide a comprehensive yet flexible analytical service for solid materials and fluids. In addition to analysis of bulk samples, selective leaching tests are carried out to determine resistance to weathering and chemical attack.

All tests are carried out in accordance with appropriate current British and International standards or guidelines (BS; ASTM; ISRM; BRE Digest 269) in modern, well equipped laboratories by experienced staff.

In addition, because of its wide range of geoscience expertise and research activities, the BGS offers a variety of specialised services which can help to assess how rocks alter and deteriorate from the effects of natural weathering, exposure to air and water-born pollutants and biological influences.

CHEMICAL WEATHERING

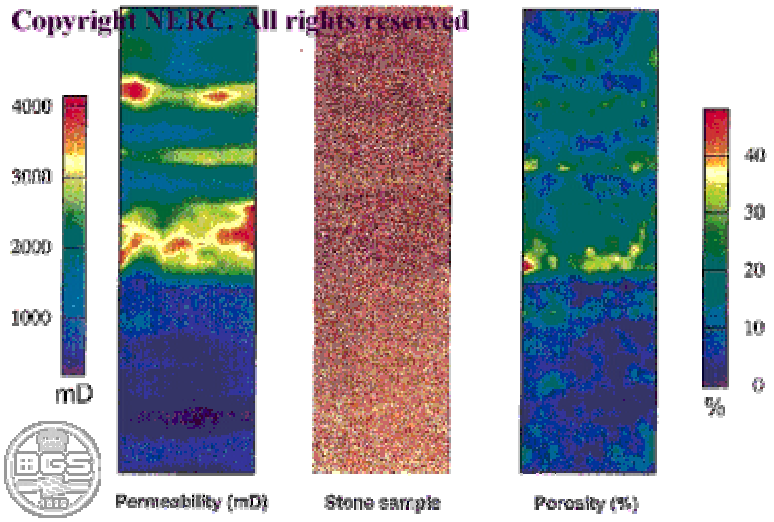
Chemical weathering due to atmospheric pollution, and associated acid rain, can damage building stones by the alteration of minerals within them, causing the stone to deteriorate and crumble. Near-surface groundwater movements can have a similar effect upon foundations. The BGS can investigate the effects of chemical weathering by laboratory methods, and offer advice on building stone reactivity and weathering control.

BIODETERIORATION

Building stones can be damaged by biological action. Specialised microbes can grow on surfaces and in minute fissures, their by-products causing flaking and discoloration. Lichens and plants may also develop causing further damage. Microbiologists at the BGS can identify these organisms, and offer advice on their role in stone weathering and on their control.

NON-DESTRUCTIVE GEOPHYSICAL IMAGING

High-resolution geophysical imaging* utilising electrical and ultrasonic techniques are used to investigate the internal structure of porous rocks, both on existing buildings and in the laboratory. These techniques can be used to determine depth of weathering, moisture content, porosity, strength and chemical alteration in building stones.



Non-destructive geophysical imagery of a core sample of sandstone

** Developed in collaboration with the University of Leicester Borehole Research Group with support from the oil industry and the Natural Environment Research Council.*

CONTACTS

BGS Keyworth

Specialist enquiries

Petrography, geology: Dr Graham Lott

Data, petrography: Dr Neil Fortey

Geotechnical testing: Mr Kevin Northmore

Geochemistry: Mr Mark Allen

Microbiology: Dr Julia West

BGS Edinburgh

Specialist enquiries

Geology: Mr Andrew McMillan

Data resources: Mr Richard Gillanders

Appendix 2 Detailed Database Table Design

Summary list of database tables

V:\LR\EMGB\BRITPITS\Building_test_v2000.mdb 08 August 2002

Table name	Property
BGS_DIC_END_USE	Linked ODBC
BGS_DIC_MPA	Linked ODBC
BGS_DIC_OPERATOR	Linked ODBC
BGS_MQ_PIT	Linked ODBC
BGS_MQ_PIT_BODY_COMMOD_END_USE	Linked ODBC
BGS_MQ_PIT_BODY_COMMODITY	Linked ODBC
BGS_MQ_PIT_COMMODITY	Linked ODBC
BGS_MQ_PIT_COMMODITY_END_USE	Linked ODBC
BGS_MQ_WORKED_BODY_AT_PIT	Linked ODBC
BGS_PM_SAMPLE	Linked ODBC
tblBS_PM_SAMPLE	Access
tblBuilding	Access
tblBuilding_Stone	Access
tblPit_Body_Stone	Access
tblStone_Building	Access

Summary list of relationships

Table name	Linked table	Attribute	Type
BGS_DIC_OPERATOR	BGS_MQ_PIT	Not Enforced	One-to-many
BGS_MQ_PIT	BGS_MQ_WORKED_BODY_AT_PIT	Not Enforced	One-to-many
BGS_MQ_WORKED_BODY_AT_PIT	tblPit_Body_Stone	Not Enforced	One-to-many
BGS_PM_SAMPLE	tblBS_PM_SAMPLE	Not Enforced	One-to-many
tblBuilding	tblStone_Building	Not Enforced	One-to-many
tblBuilding_Stone	tblBS_PM_SAMPLE	Not Enforced	One-to-many
tblBuilding_Stone	tblPit_Body_Stone	Not Enforced	One-to-many
tblBuilding_Stone	tblStone_Building	Not Enforced	One-to-many

Note: At present all the relationships are not enforced whilst data loading is in progress.

Table: BGS_DIC_OPERATOR

Properties

Attributes:	Linked ODBC	Connect:	ODBC;DSN=kwdbase;DBQ=KWA;ASY=OFF;DATABASE=
Date Created:	20/09/2001 15:48:20	Last Updated:	20/09/2001 15:48:21
RecordCount:	-1	Source Table Name:	BGS.DIC_OPERATOR
Updatable:	False		

Columns

Name	Type	Size
OPERATOR_CODE	Text	6
OPERATOR_NAME	Text	78
PARENT_OP_CODE	Text	100
ADDRESS_1	Text	40
ADDRESS_2	Text	40
ADDRESS_3	Text	40
ADDRESS_4	Text	40
ADDRESS_5	Text	40
TOWN	Text	30
COUNTY	Text	50
POSTCODE	Text	20
COUNTRY	Text	50
TEL_NO	Text	15
FAX_NO	Text	15
DATE_ENTERED	Date/Time	8
USER_ENTERED	Text	10
DATE_UPDATED	Date/Time	8
USER_UPDATED	Text	10
EMAIL	Text	40
WEBPAGE	Text	40

Relationships

BGS_DIC_OPERATOR BGS_MQ_PIT

BGS_DIC_OPERATOR	**BGS_MQ_PIT**
OPERATOR_CODE	OPERATOR_CODE

Attributes:	Not Enforced
RelationshipType:	One-To-Many

Table: BGS_MQ_PIT

Properties

Attributes:	Linked ODBC	Connect:	ODBC;DSN=kwdbase;DBQ=KWA;ASY=OFF;DATABASE=
Date Created:	20/09/2001 15:48:21	Last Updated:	05/11/2001 13:27:27
OrderByOn:	False	RecordCount:	-1
Source Table Name:	BGS.MQ_PIT	Updatable:	False

Columns

Name	Type	Size
PIT_ID	Long Integer	4
PIT_NAME	Text	100
PIT_STATUS	Text	3
PARENT_PIT_ID	Long Integer	4
OPERATOR_CODE	Text	6
MPA_CODE	Text	4
BNG_REF	Text	8
BNG_EASTING	Long Integer	4
BNG_NORTHING	Long Integer	4
ING_REF	Text	8
ING_EASTING	Integer	2
ING_NORTHING	Integer	2
LATITUDE	Long Integer	4
LONGITUDE	Long Integer	4
ADDRESS_1	Text	100
ADDRESS_2	Text	100
ADDRESS_3	Text	100
ADDRESS_4	Text	100
ADDRESS_5	Text	100
LOCATION	Text	100
POST_TOWN	Text	100
POST_COUNTY	Text	50
POSTCODE	Text	20
TEL_NO	Text	20
FAX_NO	Text	20
EMAIL	Text	100
COUNTRY	Text	100
ALTERNATIVE_NAME	Text	100
DATE_ENTERED	Date/Time	8
DATE_UPDATED	Date/Time	8
USER_UPDATED	Text	10
UPDATE_SOURCE	Text	50
SURFACE_UNDER	Text	10

SOLID_DRIFT	Text	10
NOTES	Text	255
FORMER_COUNTY_CODE	Text	3

Relationships

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Table: BGS_MQ_PIT

BGS_DIC_OPERATORBGS_MQ_PIT

BGS_DIC_OPERATOR	**BGS_MQ_PIT**
OPERATOR_CODE	OPERATOR_CODE

Attributes: Not Enforced

RelationshipType: One-To-Many

BGS_MQ_PITBGS_MQ_WORKED_BODY_AT_PIT

BGS_MQ_PIT	**BGS_MQ_WORKED_B**
PIT_ID	PIT_ID

Attributes: Not Enforced

RelationshipType: One-To-Many

Table: BGS_MQ_WORKED_BODY_AT_PIT

Properties

Attributes:	Linked ODBC	Connect:	ODBC;DSN=kwdbase;DBQ=KWA;ASY=OFF;DATABASE=
Date Created:	20/09/2001 15:48:22	Last Updated:	20/09/2001 15:48:23
RecordCount:	-1	Source Table Name:	BGS.MQ_WORKED_BODY_AT_PIT
Updatable:	False		

Columns

Name	Type	Size
PIT_ID	Double	8
WORKED_BODY_NO	Long Integer	4
BS812_LITHOL_CODE	Text	6
CHRONOSTRAT_CODE	Text	30
COALFIELD_CODE	Text	6
LITHOSTRAT_CODE	Text	30
LITHOLOGY	Text	100
CHRONOSTRAT	Text	100
LITHOSTRAT	Text	100
USER_ENTERED	Text	10
DATE_ENTERED	Date/Time	8
USER_UPDATED	Text	10
DATE_UPDATED	Date/Time	8

Relationships

BGS_MQ_PIT BGS_MQ_WORKED_BODY_AT_PIT

BGS_MQ_PIT	**BGS_MQ_WORKED_BODY_AT_PIT**
PIT_ID	PIT_ID

Attributes: Not Enforced
RelationshipType: One-To-Many

BGS_MQ_WORKED_BODY_AT_PIT tblPit_Body_Stone

BGS_MQ_WORKED_BODY_AT_PIT	**tblPit_Body_Stone**
PIT_ID	PIT_ID
WORKED_BODY_NO	WORKED_BODY_NO

Attributes: Not Enforced
RelationshipType: One-To-Many

Table: BGS_PM_SAMPLE

Properties

Attributes:	Linked ODBC	Connect:	ODBC;DSN=KWDBASE;DBQ=KWA;DBA=W;APA=F;FEN=F;QTO=F;FRC=10;FDL=10;LOB=T;RST=T;FRL=F;MTS=F;CSR=F;PFC=10;TLO=0;DATABASE=
Date Created:	26/03/2002 16:19:04	Last Updated:	26/03/2002 16:24:04
OrderByOn:	False	Orientation:	0
RecordCount:	-1	Source Table Name:	BGS.PM_SAMPLE
Updatable:	False		

Columns

Name	Type	Size
SAMPLE_ID	Text	16
ROCK_TYPE_CODE	Text	6
ROCKNAME_OLD	Text	120
MINERAL_NAME_OLD	Text	50
CHRONOSTRAT_CODE	Text	2
CHRONOSTRAT_OLD	Text	60
LITHOSTRAT_CODE	Text	5
LITHOSTRAT_OLD	Text	60
LOCALITY_DETAILS	Text	240
COUNTY_CODE	Text	6
COUNTRY_CODE	Text	6
SHEET_CODE	Text	2
SHEET_NO	Text	4
SIX_SHEET_TYPE	Text	1
SIX_SHEET	Text	8
GRIDSQUARE_CODE	Text	2
PIT_ID		16
WORKED_BODY_NO		16
COMMODITY_CODE	Text	6
END_USE_CODE	Text	6
EASTING		16
NORTHING		16
GRID_ACCURACY_CODE		16
LAT_DEGREE		16
LAT_MINUTE		16
LAT_SECOND		16
LAT_DIRECTION	Text	2
LONG_DEGREE		16
LONG_MINUTE		16

LONG_SECOND		16
LONG_DIRECTION	Text	10
LAT_LONG_CONVERTED	Text	3
YEAR_COLLECTED		16
COMMENTS	Text	250
DATE_ENTERED	Date/Time	8
USER_ENTERED	Text	10
DATE_UPDATED	Date/Time	8
USER_UPDATED	Text	10
INSEA	Text	1
SEQ_NO		16

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Table: BGS_PM_SAMPLE

Relationships

BGS_PM_SAMPLE tblBS_PM_SAMPLE

BGS_PM_SAMPLE	**tblBS_PM_SAMPLE**
SAMPLE_ID	SAMPLE_ID

Attributes: Not Enforced

RelationshipType: One-To-Many

Table: tblBS_PM_SAMPLE

Properties

Date Created:	26/03/2002 16:52:06	Last Updated:	26/03/2002 16:52:23
OrderByOn:	False	Orientation:	0
RecordCount:	0	Updatable:	True

Columns

Name	Type	Size
BS_ID	Long Integer	4
SAMPLE_ID		16

Relationships

BGS_PM_SAMPLE tblBS_PM_SAMPLE

BGS_PM_SAMPLE	tblBS_PM_SAMPLE
SAMPLE_ID	SAMPLE_ID

Attributes: Not Enforced
RelationshipType: One-To-Many

tblBuilding_Stone tblBS_PM_SAMPLE

tblBuilding_Stone	tblBS_PM_SAMPLE
BS_ID	BS_ID

Attributes: Not Enforced
RelationshipType: One-To-Many

Table: tblBuilding

Properties

Date Created:	05/11/2001 12:13:19	Last Updated:	04/12/2001 12:13:22
OrderByOn:	False	RecordCount:	1524
Updatable:	True		

Columns

Name	Type	Size
Building_ID	Long Integer	4
Town	Text	50
Name	Text	50
BNG_EASTING	Long Integer	4
BNG_NORTHING	Long Integer	4
ADDRESS_1	Text	100
ADDRESS_2	Text	100
ADDRESS_3	Text	100
ADDRESS_4	Text	100
ADDRESS_5	Text	100
LOCATION	Text	100
POST_TOWN	Text	100
POST_COUNTY	Text	50
POSTCODE	Text	20
COUNTRY	Text	100
NOTES	Text	255
Photo	OLE Object	-
DATE_ENTERED	Date/Time	8
USER_ENTERED	Text	10
DATE_UPDATED	Date/Time	8
USER_UPDATED	Text	10

Relationships

tblBuilding **tblStone_Building**

tblBuilding	**tblStone_Building**
Building_ID	Building_ID

Attributes: Unique, Not Enforced

RelationshipType: One-To-One

Table: tblBuilding_Stone

Properties

Date Created:	05/11/2001 11:48:46	Last Updated:	06/11/2001 12:02:22
OrderByOn:	False	RecordCount:	2143
Updatable:	True		

Columns

Name	Type	Size
BS_ID	Long Integer	4
Stone_name	Text	50
Alternative_name	Text	50
Medieval	Yes/No	1
Saxon	Yes/No	1
Roman	Yes/No	1
Colour	Text	50
Munsell_colour	Text	50
Year_opened	Text	4
DESCRIPTION	Text	255
REFERENCES	Text	255
LITHOLOGY	Text	5
Photo	OLE Object	-
DATE_ENTERED	Date/Time	8
USER_ENTERED	Text	10
DATE_UPDATED	Date/Time	8
USER_UPDATED	Text	10

Relationships

tblBuilding_Stone tblBS_PM_SAMPLE

tblBuilding_Stone	tblBS_PM_SAMPLE
BS_ID	BS_ID

Attributes: Not Enforced
RelationshipType: One-To-Many

tblBuilding_Stone tblPit_Body_Stone

tblBuilding_Stone	tblPit_Body_Stone
BS_ID	BS_ID

Attributes: Unique, Not Enforced
RelationshipType: One-To-Many

Table: tblBuilding_Stone

tblBuilding_StonetblStone_Building

tblBuilding_Stone	**tblStone_Building**
BS_ID	BS_ID

Attributes: Unique, Not Enforced

RelationshipType: One-To-Many

Table: tblPit_Body_Stone

Properties

Date Created:	05/11/2001 13:27:21	Last Updated:	05/11/2001 13:27:21
OrderByOn:	False	RecordCount:	357
Updatable:	True		

Columns

Name	Type	Size
PIT_ID	Long Integer	4
WORKED_BODY_NO	Long Integer	4
BS_ID	Long Integer	4

Relationships

BGS_MQ_WORKED_BODY_AT_PIT tblPit_Body_Stone

BGS_MQ_WORKED_B	tblPit_Body_Stone
PIT_ID	PIT_ID
WORKED_BODY_NO	WORKED_BODY_NO

Attributes: Not Enforced
RelationshipType: One-To-Many

tblBuilding_Stone tblPit_Body_Stone

tblBuilding_Stone	tblPit_Body_Stone
BS_ID	BS_ID

Attributes: Unique, Not Enforced
RelationshipType: One-To-Many

Table: tblStone_Building

Properties

Date Created:	05/11/2001 13:23:00	Last Updated:	05/11/2001 13:23:00
OrderByOn:	False	RecordCount:	0
Updatable:	True		

Columns

Name	Type	Size
BS_ID	Long Integer	4
Building_ID	Long Integer	4
Description	Text	255
Photo	OLE Object	-
Year	Integer	2

Relationships

tblBuilding_Stone tblStone_Building

tblBuilding_Stone	tblStone_Building
BS_ID	BS_ID

Attributes: Unique, Not Enforced
RelationshipType: One-To-Many

tblBuilding tblStone_Building

tblBuilding	tblStone_Building
Building_ID	Building_ID

Attributes: Unique, Not Enforced
RelationshipType: One-To-Many

Glossary

Armourstone Natural rock material quarried for the purpose of obtaining large blocks for use in coastal defences etc

Building Stone Natural rock material quarried for the purpose of obtaining blocks or slabs that can be subsequently dressed (shaped) or sawn (ashlar) for general building.

Decorative stone Natural rock material quarried, sawn, worked and polished for ornamentation.

Dimension Stone Natural rock material quarried for the purpose of obtaining blocks or slabs that meet specifications as to size (width, length and thickness) and shape. (USGS definition)

Flagstone Natural rock material quarried, sawn and split (riven) specifically for flooring or paving.

Monumental Stone Natural rock material quarried cut, split, dressed or polished specifically for use in monuments, gravestones or memorial tablets.

Rockery Stone Quarried boulders or natural stone cobbles of varied lithological composition used in landscaping and gardening.

Slate Natural rock material with pronounced metamorphic cleavage allowing it to be split into thin sheets - principally for roofing but also for decorative cladding and monumental use.

Stone Cladding Natural rock material quarried, sawn and polished for non-load bearing walling material.

Stone Slate Natural rock material (other than slate) that is thinly bedded and fissile (easily split or riven into thin slabs), quarried specifically for roofing purposes (can include both limestones and sandstones).

Walling Stone Natural rock material quarried for non-dressed (rubble) blocks and used in making bonded and dry stone walls.

References

Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

BRITISH GEOLOGICAL SURVEY. 2001. Building stone resources of the United Kingdom. 1:1 000 000. (Keyworth, Nottingham: British Geological Survey.) ISBN : 0751833185

BAIN, K A. 1994. Logical model and physical design for the BGS Directory of Mines and Quarries Database. *British Geological Survey Technical Report*, WO/94/5R.