Development of Sustainable Georesources for the Built Environment in the UK

Andrew McMillan
• Use of stone through time
• Construction materials
• Value of the heritage
• Quarry supplies
• Stone selection for repair, conservation and new build
• Identification of indigenous resources
• Stone selection
• Resource information for decision-makers
• Legislation, guidance and education
• Changing perceptions: public and professional
Use of stone through time
21st century New Build
Architectural aspirations, skills and technology
Mineral resources

ECONOMIC MINERALS

- Energy Minerals
- Metals
- Non-metallic Minerals
  - Construction Minerals
  - Industrial Minerals

Building stone
Pavement stone
Slate
Sand & Gravel
Crushed rock aggregate
Cement material
Brickclay
Gypsum
UK: value of mineral production, 2003

Total value £25,441 Million (545455 Million EEK or 34854 Million EURO)
# UK Minerals Production 2002

## Construction Minerals

<table>
<thead>
<tr>
<th>Construction Minerals</th>
<th>Thousand tonnes</th>
<th>Value £ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of which: Land-won sand &amp; gravel</td>
<td>75 401</td>
<td>1 648</td>
</tr>
<tr>
<td>Marine-dredged sand &amp; gravel</td>
<td>19 023</td>
<td></td>
</tr>
<tr>
<td>Crushed rock</td>
<td>144 337</td>
<td></td>
</tr>
<tr>
<td>Cement raw materials (limestone &amp; chalk, clay &amp; shale) (GB)</td>
<td>17 386</td>
<td>227</td>
</tr>
<tr>
<td>Clay &amp; shale and Fireclay (for bricks) (GB)</td>
<td>7 476</td>
<td></td>
</tr>
<tr>
<td>Gypsum, natural</td>
<td>1 700</td>
<td></td>
</tr>
<tr>
<td>Slate</td>
<td>742</td>
<td></td>
</tr>
<tr>
<td>Building (dimension) stone (GB)</td>
<td>696</td>
<td></td>
</tr>
</tbody>
</table>
# Typical maximum trading distances

<table>
<thead>
<tr>
<th>Very short (60 km)</th>
<th>Short (200 km)</th>
<th>Medium (Intra-regional)</th>
<th>Long (trans-oceanic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>aggregate minerals (road)</td>
<td>aggregate minerals (rail)</td>
<td>kaolin (by sea)</td>
<td>coal</td>
</tr>
<tr>
<td>brick clay</td>
<td>bricks</td>
<td>ball clay (by sea)</td>
<td>oil</td>
</tr>
<tr>
<td>cement (rail)</td>
<td>cement (by sea)</td>
<td>natural gas</td>
<td>iron ore</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>metal ores &amp; concentrates</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>dimension stone</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>industrial minerals</td>
</tr>
</tbody>
</table>

*Table 3 Typical maximum trading distances.*
Economic value of the heritage

• Stone forms a major component of the UK pre-1919 building stock

• Stone-constructed buildings are an important part of the heritage: 90% of visitors to the UK cite built environment and scenery as the primary reason for their visit

• Significant spend on building restoration: Heritage Lottery Fund £17m (365m EEK), English Heritage £120m (2573m EEK), Historic Scotland £49m (1050m EEK)

• Construction Industry worth £62b (1330b EEK) in 2001. Of this the repair & maintenance budget was £29b (622b EEK).
Quarry supplies

1. Building Stone quarries in England

Hunt's Statistics (1858)/Natural Stone Directory (2005)

About 1500 active quarries in 1858; 330 in 2007 (BGS Mineral Planning Factsheet)
Quarry supplies

2. Building Stone quarries in Scotland

Hunt’s statistics (1858)

Categories of quarried material in 1858

Rock Type

No. of quarries (total = 674)

- Granite
- Limestone
- Marble
- Sandstone
- Mudstone
- Slate
- Other

Building stone quarries in central Scotland (1858)

No. of quarries

Quarries by County

- Ayrshire
- Berwickshire
- Clackmannan
- Dunbartonshire
- Edinburgh
- Fife
- Forfarshire
- Haddingtonshire
- Kincardine
- Kinross
- Lanarkshire
- Linlithgowshire
- Perth
- Renfrew
- Stirling
Quarry supplies

3. Building Stone quarries in the UK today

<table>
<thead>
<tr>
<th></th>
<th>Scotland</th>
<th>England</th>
<th>Wales</th>
<th>Northern Ireland</th>
<th>Isle of Man</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building sandstone</td>
<td>19</td>
<td>159</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>193</td>
</tr>
<tr>
<td>Building limestone, incl. Chalk</td>
<td>5</td>
<td>117</td>
<td>11</td>
<td>2</td>
<td>2</td>
<td>137</td>
</tr>
<tr>
<td>Granite &amp; other igneous rocks</td>
<td>25</td>
<td>16</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>47</td>
</tr>
<tr>
<td>Slate &amp; marble</td>
<td>1*</td>
<td>23</td>
<td>16</td>
<td>0</td>
<td>4</td>
<td>44</td>
</tr>
<tr>
<td>Ironstone flint, serpentine etc</td>
<td>3</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>18</td>
</tr>
</tbody>
</table>

* marble quarry. There are no slate quarries currently operating in Scotland.

Table 1  Distribution of active building stone quarries in the UK, March 2005.
Source: BGS

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Construction of Scottish towns and cities

- 19th century boom in demand and supply of stone
- Local and far-travelled materials
21<sup>st</sup> century – Built heritage repairs

- Supply and demand – decline in 20<sup>th</sup> century
- Increasing repair requirements for houses, tenements and historic properties

Sandstone quarries supplying 18<sup>th</sup> to 19<sup>th</sup> century Edinburgh (open circles), and currently active quarries supplying replacement sandstone for repair and new build (closed circles).

Sources of replacement sandstone used in Edinburgh over the last 30 years.
Selecting stone

- GeoReports
- Petrographic analysis
Reopening quarries
Earliest reference to the Cullalo quarries, Fife, Scotland in 1822
Building stone resources of the UK
Safeguarding Glasgow’s stone built heritage: Skills and materials requirements

**Façade surveys & building stone analysis**

1. Stone condition surveys of 230 traditional stone facades
2. Petrographic analysis of stone samples from 100 buildings

**Selection of buildings**

- Façade survey methodology
- Quantification & diagnosis of stone decay
- Stone sampling results
- Implication for future repairs
- Availability of matching stone (quarry sources)
- Stone database

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Stone resources

- Archive and literature research
- Quarries databases and GIS
- Geological collections and analysis
- Geological and planning constraints

BGS Historic Quarries GIS
Identification of indigenous resources

Sandstone building stone resources

- Active quarry
- Permian - Palaeogene, inc. New Red Sandstone
- Pennant Sandstone, Carboniferous
- Other Carboniferous Sandstones
- Deccan, inc. Old Red Sandstone

Igneous and slate building stone resources

- Active quarry
- Intrusive igneous rocks, including diorite (finely crystalline)
- Intrusive igneous rocks, including gabbro and dolerite (coarsely crystalline)
- Extrusive volcanic rocks, including basaltic, andesitic and rhyolitic tufts and lavas
- Slate
Minerals information on-line

Web-based regional GIS which shows mineral planning information including:

• Mineral resources, which may be of current or potential economic interest
• Selected nationally-recognised landscape and habitat designations
• Land where minerals are, or have been, licensed for extraction (mineral planning permissions)
• Hyper-linked to text-based information and production statistics.

www.mineralsUK.com
Web user can obtain polygon attribute information
Text-based and statistical commodity information

Carboniferous Limestones

Limestones of Carboniferous age occur extensively in the Peak District and Derbyshire, forming the characteristic and attractive scenery of the White Peak. The limestones occur as thick, flaking, uniform beds that are relatively cheap to extract and process and usually produce strong, low porosity aggregates. Some of the limestones are of high chemical purity (>97% CaCO₃) and these resources are identified separately on the map. The East...
White Sandstones of the English Midlands
Scottish Quarries GIS and future developments

Linking resource information to geology
Legislation, guidance & education

• National Guidance and legislation: Mineral Planning Statements

• Initiating and disseminating research on materials through seminars & technical advice: Scottish Stone Liaison Group, Natural Stone Institute, BRE, English Stone Forum, Welsh Stone Forum, Stone Federation GB, local authorities

• Sustaining traditional skills: National Heritage Training Group (established by CITB-Construction Skills)
Brick clay is the principal construction material of Scotland's pre-1919 building stock and its use can be traced over a period of 6000 years from the early dry-stone constructions of Caithness and the Northern Isles. Traditionally, locally sourced stone was used so that the varied geology of Scotland has had a profound influence on the nation's cultural identity and built heritage. Stone was used for a wide variety of construction purposes including strategically important medieval defences (castles, towers, walls), simple dwellings and farms. From the 16th century onwards there was a burgeoning requirement for stone to supply villages, towns and cities. This demand for stone reached historic properties in Scottish cities during 1960s stimulated a vigorous conservation response from the public and since then planning requirements to maintain the local character of cities, towns and villages have created a demand for local stone. Initially this demand was satisfied by recovery from demolition but as the requirement for repair and conservation has increased, alternative supply options have been promoted. Consequently there has been a noticeable increase in the interest in, and the demand for, new resources of natural stone. Overall there has been a modest increase in the diversity of supply of local stones.

Building, paving and roofing stones,

This factsheet provides an overview of natural building, paving and roofing stone, including slate, supply in Scotland. It is part of a series on economically important minerals that are extracted in Scotland and is primarily intended to inform the land-use planning process. Data and statistics related to the UK are quoted where details are unavailable for Scotland.

March 2006
Natural Stone Institute (www.nsiuk.org) providing a better understanding of natural stone and is use for public benefit. Encouraging good practice through:
- education
- training
- research
- technical innovation
- Information coordination and dissemination
Changing perceptions

- Traditional buildings of many cities, towns and villages are constructed of indigenous stone
- Maintenance, repair and conservation crucial to maintain safe working and living environment
- Maintaining workforce skilled in traditional building techniques is essential
- Selection, identification and safeguarding of indigenous resources is crucial
Thank you to the Geological Society of Estonia

Don’t forget who is your neighbour!