Mineral waste in the UK
Innovation, optimisation and recycling

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Outline of presentation

• Minerals at the British Geological Survey
• What is Mineral Waste?
• Quarry Fines
• Minimisation and utilisation
• Conclusions
British Geological Survey

• National geo-survey for the UK focusing on Public National Good science and geological research.

• Our understanding of the subsurface helps society
  • Use its natural resources responsibly
  • Manage environmental change
  • Be resilient to environmental change

• Over 500 scientists working with other 40 universities & institutes

• More information: www.bgs.ac.uk
BGS Minerals and me

- BGS compiles mineral statistics for UK, Europe and World
- Provides spatial mineral resource information
- Carries out research (metallogenesis, impacts of mineral extraction & resource security)
- BGS minerals information available as FREE downloads via www.mineralsUK.com
- Clive is an industrial Minerals Specialist, 27 years at the BGS, travelled far and wide for mineral evaluation, and based at the HQ of the BGS in Keyworth, Nottingham
What is mineral waste?

- Mineral waste is anything left over from a mining and quarrying operation that cannot find a productive use.

- Large volumes of material of waste are formed of overburden removal, inferior material that does not meet requirements, and oversize material and fines that are produced by processing.

- Much of this waste is used to back fill old pits, create haul roads or bunds, but a lot remains in waste tips or tailings lagoons.

- Waste a poor use of a valuable resource - it can create environmental and safety problems and also can sterilise future resources underneath the tips and lagoons.
UK mineral waste in context

• In 2012 the UK disposed of 200 million tonnes of waste of which 35% was mineral waste (69.2 million tonnes)

• UK legislation is largely concerned with safety of waste tips and their environmental impact, little concerning its potential as a resource.

• The Landfill Tax & Aggregate Levy were introduced to minimise waste disposal by reducing primary production and encouraging the use of recycled & secondary material as construction aggregate

• Mining & quarrying waste is exempt from UK Landfill Tax - if the lower rate of £2.60 per tonne were applied it would cost £180 million a year!
Figure 5.2: Waste generation split by waste material, UK 2012

- Mineral wastes: 34.6%
- Soils: 20.8%
- Household & similar wastes: 13.2%
- Other wastes: 12.0%
- Dredging spoils: 7.4%
- Vegetal wastes: 3.3%
- Wood wastes: 1.2%
- Paper & cardboard wastes: 1.8%
- Glass wastes: 1.1%
- Metallic wastes: 3.0%
- Plastic wastes: 1.6%

UK Statistics on Waste
## UK Mineral Waste 2014, estimated

<table>
<thead>
<tr>
<th>Mineral Product</th>
<th>Production</th>
<th>Mineral Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Million tonnes</td>
<td>Million tonnes</td>
</tr>
<tr>
<td>Limestone &amp; dolomite</td>
<td>65.5</td>
<td>7.3</td>
</tr>
<tr>
<td>Sand &amp; gravel</td>
<td>62.2</td>
<td>15.6</td>
</tr>
<tr>
<td>Igneous rock</td>
<td>44.0</td>
<td>4.9</td>
</tr>
<tr>
<td>Sandstone</td>
<td>12.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Coal</td>
<td>11.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Rock Salt &amp; Potash</td>
<td>7.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Clay &amp; shale</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Silica sand</td>
<td>4.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Chalk</td>
<td>3.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Kaolin, ball clay, fireclay &amp; talc</td>
<td>1.9</td>
<td>17.1</td>
</tr>
<tr>
<td>Gypsum</td>
<td>1.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Slate</td>
<td>1.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Fluorspar, barytes &amp; lead</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>222.7</strong></td>
<td><strong>84.3</strong></td>
</tr>
</tbody>
</table>

Source of production data: UK Minerals Yearbook 2014  
http://www.bgs.ac.uk/mineralsuk/statistics/ukStatistics.html
Focus on fines

• Focus of UK mineral waste research has been on fine-grained waste ("quarry fines") which is seen as the biggest problem

• Quarry fines are typically defined as material finer than 4mm, often referred to as ‘dust’ or ‘fines’, signposted as 0/4mm

• British Standards refer to:
  • BS EN Fine aggregate - <4mm (<2mm for asphalt)
  • BS EN Fines - inherent material <0.063mm
  • BS EN Filler - material <0.063mm added to products
Quarry fines stockpile, Gritstone Quarry
How are fines formed?

- **Extraction** - drilling & blasting, haulage/transfer
- **Primary crushing** - scalping pre- or post-crushing, primary surge pile
- **Secondary crushing (& further stages)** – cone & impact
- **Screening** - production of aggregate products including quarry fines, recirculation/ recrushing of oversize & coarse aggregate
- **Stockpiling** - uncovered or covered
- **Handling/ distribution/ transportation**
- **Fines/ dust management**
Working benches, Gritstone Quarry
Primary crusher (Gyratory), Granite Quarry
Jaw Crusher

Primary surgepile, Limestone Quarry
Process plant, Gritstone quarry
Research outcomes

• Four BGS quarry fines research projects (1998-2007)
• Initial findings revealed that the volume and nature of waste produced is largely unknown
• BGS focused on characterisation of the chemical & mineralogical composition and particle-size distribution of quarry fines
• Quarry Fines Minimisation is a means of optimising production - even if only 1-2 % efficiency it increases saleable product and reduces the amount of waste produced
• Artificial Soil - a promising application where quarry fines are mixed with green waste – this represents a simple, high volume solution
**BARRASFORD QUARRY** (Tarmac Quarry Products North West)

**Location:** Barrasford Quarry, Barrasford, Hexham, Northumberland, UK

**Sample type:** Plant fines  **Rock type:** Dolerite (Whin Sill, Carboniferous)

**Sampling:** Spot sampling  **Sample code:** BBF1 / CJM542  **Date:** 1/12/98

**Mineralogy**

| Dominant | Plagioclase feldspar |
| Major    | Augite               |
| Minor    | Quartz and ilmenite  |
| Trace    | Mica, kaolinite and rutile (TiO₂) |

**Chemistry**

Dominant = >50 wt%; Major = 20-50 wt%; Minor = 7-20 wt%; Trace = <7 wt%

**Particle-size distribution**

Filler (-75µm) content: 90.4 wt%

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**CAULDON LOW QUARRY** (Tarmac Quarry Products West Midlands)

**Location:** Cauldon Low Quarry, PO Box 1, Stoke-on-Trent, Staffordshire, UK

**Sample type:** Filler fines  **Rock type:** Limestone (Mildale Limestone, Carboniferous)

**Sampling:** Unknown  **Sample code:** BCLF1 / F230  **Date:** 16/9/1999

**Mineralogy**

| Dominant | Calcite |
| Major    |        |
| Minor    |        |
| Trace    | Quartz |

**Chemistry**

Dominant = >50 wt%; Major = 20-50 wt%; Minor = 7-20 wt%; Trace = <7 wt%

**Particle-size distribution**

Filler (-75µm) content: 94.1 wt%
Good Practice for crushers

• **Cone crushers**
  • Evenly distributed choke feeding
  • Optimum size reduction ration of 6:1
  • Optimum speed, high speed = better quality but more fines

• **Impact crushers**
  • Uniform feed to ensure full utilisation of rotor width
  • Optimum rotor speed, greater speed = more fines
  • Pre-screening between crusher stages
  • Open discharge to reduce retention times and minimise fines
Impact Crusher

http://www.ami-crushers.com/stock-equipment/impact-crushers/
Growing trial plot, Seisdon quarry, Tarmac
Conclusions

• Mineral waste is a significant national issue

• Understanding the scale of the problem as well as the nature of the waste is a key to unlocking potential solutions

• Waste minimisation is possible by careful consideration and optimisation of the processing plants

• Utilisation of mineral waste in commercial products is possible by exploring the potential markets
Thank you for your attention!

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