UK silica sand resources for fracking

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Outline of presentation

• Minerals at the British Geological Survey
• What is Frac Sand?
• Frac Sand properties
• Potential sources of Frac Sand in the UK
• Is there a future for Frac Sand in the UK?
• Conclusions
Minerals at the BGS

- We compile mineral statistics for the UK, Europe and the World. BGS is one of only two providers of global mineral statistics.
- We are a major provider of spatial mineral resource information in the UK.
- We carry out UK & International research in metallogenesis, land-use impacts of mineral extraction, resource security, industrial minerals and geomaterials.
- We provide BGS minerals information as data tables, reports, maps, profiles and factsheets as FREE downloads via [www.mineralsUK.com](http://www.mineralsUK.com).

Clive carrying out mineral resource assessment in the Middle East

[http://www.bgs.ac.uk/staff/profiles/1159.html](http://www.bgs.ac.uk/staff/profiles/1159.html)

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Welcome to MineralsUK

MineralsUK is the British Geological Survey's Centre for Sustainable Mineral Development. This website has a wealth of information on mineral resources, mineral planning, policy and legislation, sustainable development, statistics and exploration.

Economic minerals — here you will find out what they are, where they come from and why they are important.

Top downloads
1. Cement Raw Materials
2. Rare Earth Elements
3. World Mineral Production 2006-2010

What's new
World Mineral Statistics
Data Download
Data from 1992 to 2011 are now available to download direct to Microsoft Excel format.

What's new
Critical raw materials
A new web page of BGS's critical raw materials publications, advice and research collaborations.

Downloads
Risk list 2012
A newly updated supply risk index for chemical elements or element groups which are of economic value.
What is Frac Sand?

- Silica sand used to ‘prop’ open fractures in oil & gas reservoirs to enhance recovery
- Also known as ‘Proppant’ sand
- Alternatives – resin coated sand and ceramics (made from alumina, kaolin or bauxite)
Silica: The basics

- Silica is chemical compound silicon dioxide (SiO$_2$), 61% of earths continental crust
- Quartz is main form and polymorphs cristobalite & tridymite & cryptocrystalline varieties chert, flint, chalcedony & agate
- Rock forming mineral in granite, gneiss, sandstone, quartzite, pegmatites etc…
- Quartz is hard (Mohs 7), resistant to weathering and concentrated over many erosion cycles to form silica sand
- Silica sand (‘Industrial sand’) contains a high proportion of quartz and mainly for non-construction uses

Quartz specimen from the Royal Geological Society of Cornwall Collection
(held at the British Geological Survey)

http://www.bgs.ac.uk/collections/gallery.html

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Silica sand use in the UK

Main uses (2007 figures *):

- Glass production (39%)
- Foundry sand (11%)
- Horticultural & leisure uses (26%)
- Other industrial uses (24%) including:
  - Abrasive and shot blasting
  - Filter drainage media
  - Production of bricks, ceramics, mineral filler, refractories & rock wool
  - Production of sodium silicate, fused silica, silicon carbide and other silicate reagents

* BGS Mineral Planning Factsheet: Silica sand
UK silica sand resources

- The UK is nearly self-sufficient in silica sand
- 40 quarries produce 4Mt of silica sand (2010 figures*)
- Sandstone (weakly cemented)
  e.g. Carboniferous Passage Fm, central Scotland (glass)
- Glacial sand e.g. Pleistocene Chelford Sand Fm, Cheshire (flat glass)
- Near shore marine/ coastal
  (dune / beach) sand e.g. Lower Cretaceous Sandringham Sands Fm, Leziate, Norfolk (glass)
- Alluvial (river), lacustrine (lake), aeolian (wind blown) sand

* UK Minerals Yearbook www.MineralsUK.com

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Mineral Planning Factsheet

- Factsheet for land-use planners & decision makers
- Economically important, for glass there is no alternative
- Resources may coincide with sensitive environments/nature conservation areas
- Strategic resource subject to ‘Mineral Safeguarding’, consider when deciding on other land use developments

FREE download from: www.MineralsUK.com

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## Frac sand properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica (SiO₂)</td>
<td>&gt;99% (Quartz)</td>
</tr>
<tr>
<td>Particle-size</td>
<td>Narrow size-distribution - 90% within specified size ranges:</td>
</tr>
<tr>
<td></td>
<td>12 / 20 # (1700 – 850 microns)</td>
</tr>
<tr>
<td></td>
<td>20 / 40 # (850 – 425 microns)</td>
</tr>
<tr>
<td></td>
<td>40 / 70 # (425 – 212 microns)</td>
</tr>
<tr>
<td></td>
<td>70 / 140 # (212 – 106 microns)</td>
</tr>
<tr>
<td>Particle-shape</td>
<td>Well-rounded, spherical grains are preferred</td>
</tr>
<tr>
<td>Crush resistance</td>
<td>Withstand compressive stress 4000 - 6000 psi (28 - 42 MPa)</td>
</tr>
<tr>
<td>Acid solubility</td>
<td>Limits on acid soluble material e.g. carbonates such as calcite</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Limits on clay (&lt;2 microns) and silt (2 - 63 microns) content</td>
</tr>
</tbody>
</table>

Frac Sand Particle Size

Cumulative Frequency (% less than)

Particle-size (microns)

- 70/140
- 40/70
- 30/50
- 20/40
- 16/30
- 12/20
- 8/16
- 6/12
Frac sand sporting analogy

**Footballs** = 20/40
(850 – 425 microns)

**Tennis balls** = 40/70
(425 – 212 microns)

**Golf balls** = 70/140
(212 – 106 microns)

NB Ratios are roughly equivalent between the diameters of the balls and those of the sand grains
UK frac sand resources?

• Where will the frac sand come from?
• Foundry sand is the closest equivalent - requires high quartz content (98%), round grains with good sphericity & similar size range (100-500 microns)
• 20 quarries produce foundry sand in UK, the main sources are the :
  • Sandringham Sand Formation (Norfolk)
  • Woburn Sand Formation (Bedfordshire)
  • Folkestone Formation (Surrey & Kent)
  • Chelford & Congleton Sands (Cheshire)
  • Wind blown sand (North Lincolnshire)
Sandringham Sand Formation: Silica sand quarry, Norfolk, UK
Sandringham Sand Formation: Silica sand stockpile, Norfolk, UK
Woburn Sand Formation: Silica sand quarry, Bedfordshire, UK
Mining of Folkestone Formation, Godstone, Surrey, UK (circa 1900)  http://geoscenic.bgs.ac.uk
Folkestone Formation
Congleton Sand: Silica sand quarry, Cheshire, UK
Congleton Sand: Silica sand quarry, Cheshire, UK
Congleton Sand
Congleton Sand
Congleton Sand
Congleton Sand
Congleton Sand
Future for frac sand?

- If a shale gas industry develops in the UK, Frac sand could become a major use of silica sand in the future.
- In the USA, Frac sand was estimated to account for 5% (1.4 Mt) of the industrial sand market in 2002, this leapt to 57% (25.7Mt) in 2012.*

* Sand and gravel (Industrial) U.S.G.S. Mineral Commodity Summary 2013
US Silica Sand consumption 2002-2012

- **Total Consumption**
- **Hydraulic fracturing**
- **Glass sand**
- **Foundry sand**

*Source: USGS* 
*Minerals Information: Industrial Sand & Gravel*
Conclusions

• Frac sand is one application amongst many for silica sand

• There are silica sand deposits in the UK that are suitable for use as frac sand

• There is plenty of silica sand for any future shale gas development in the UK
Thank you for your attention!

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