CLIVE MITCHELL, INDUSTRIAL MINERALS GEOLOGIST

Development priorities & perspectives for industrial mineral resources

British Geological Survey

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Clive Mitchell
British Geological Survey, Keyworth, Nottingham cjmi@bgs.ac.uk

Nations aspiring to achieve sustainable development of their mineral resources focus on mining laws and regulations with the establishment of clear legal, environmental, social and technical boundaries. However, where there is no precedence for mineral resource development, how does a mining industry develop from scratch? This is where the role of government mining departments and geological surveys come into their own. In this presentation, I present my three-point plan for mineral resource development, based on 32 years working with mining departments and geological surveys across the world as an industrial minerals geologist for the British Geological Survey (BGS).

1. Geological Baselines.

A good example of a geological baseline is the 10-year programme carried out in the United Arab Emirates (UAE) with geological mapping, geophysical surveys including aeromagnetic, gravity and seismic, metallic mineral assessment, industrial mineral assessment (construction, aggregate, limestone and dimension stone), geohazard assessments, seismic monitoring and 3D modelling. In the UK, geological information published by the British Geological Survey (BGS) is available via the *OpenGeoscience* portal including maps and cross-sections, data, scans, photos, borehole records and other information. One of the most useful is the *GeoIndex* map viewer www.bgs.ac.uk/geoindex/.

2. Demand-led resource assessment.

A-Z inventory of resources was the mineral resource strategy of national Governments for years. More targeted mineral resource assessments employ a 'minerals for markets' approach informed by local, regional & international market demand/ trade statistics. Experienced minerals geologists, technical specialists & GIS experts engage with industry to get to know their processes and specifications, carry out regional reconnaissance surveys to identify high-purity resources with potential as industrial raw materials and create Minerals Occurrence Databases (MOD) linked to a Geographical Information Systems (GIS).

3. Communicate, engage, support.

Publication of geological and mineral resource information is the next stage with portals providing access to Web Map Services and apps (such as mGeology in the UAE) with all available information on geology, mineral occurrences and land use designations, and online resources for investors including commodity profiles, factsheets and mineral statistics. This needs to be freely accessible online ('Open Access') at no cost and with no access barriers such as account passwords. Direct engagement through exhibition stands and presentation of mineral resource surveys at mineral industry conferences e.g. The Mining Show, Fujairah Forum, Big 5 Dubai highlights the potential and maintains contacts with industry and potential investors. In support of potential investors provide contact details for Government staff involved in mineral resource development, adopt an enquiry service approach with a responsive, timely and informative ethos, and facilitate visits and meetings as investors explore the potential for setting up operations.

In summary, the three-point plan for mineral development: 1. Geological Baselines: Up to date geological line work & information online via web map services and downloadable maps & reports. 2. Demand-led Resource Assessment: Technical evaluation & data for industrial minerals available online as free maps & reports. 3. Communicate, Engage, Support: Freely accessible information & data, regular engagement with industry & potential investors, and enquiry service approach.

Clive Mitchell

Industrial Minerals Geologist

- Thirty two years at the British Geological Survey (BGS)
- Chartered Geologist (CGeol)
- Past work in Afghanistan, Africa, Middle East and Thailand
- Resource assessments including andalusite, brick clay, construction aggregate, dimension stone, dolomite, feldspar, graphite, garnet, gypsum, kaolin, limestone, marble, mica, mineral sand, mineral waste, perlite, quarry fines, silica sand and talc
- Current research:
  - Artisanal & Small-scale Gold Mining (ASGM) in Kenya
  - Graphite resources in East Africa

1992 Zambia

2020 UK

British Geological Survey (BGS)

The BGS is a world-leading independent research organisation providing objective, expert geoscientific data, information and knowledge.

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UK Research and Innovation

Natural Environment Research Council

British Geological Survey

Three point plan for mineral development

1: GEOLOGICAL BASELINES

2: DEMAND-LED RESOURCE ASSESSMENT

3: COMMUNICATE, ENGAGE, SUPPORT

1: GEOLOGICAL BASELINES

2 main geological mapping projects and associated surveys

- 2002-2006 Eastern Emirates and Hajar Mountains
- 2008-2012 Abu Dhabi and the western UAE

Work included:

- Geophysical surveys (aeromagnetic, gravity & seismic)
- Metallic mineral assessment
- Industrial mineral assessment (construction aggregate, limestone and dimension stone)
- Geohazard assessments
- Seismic data
- 3D modelling

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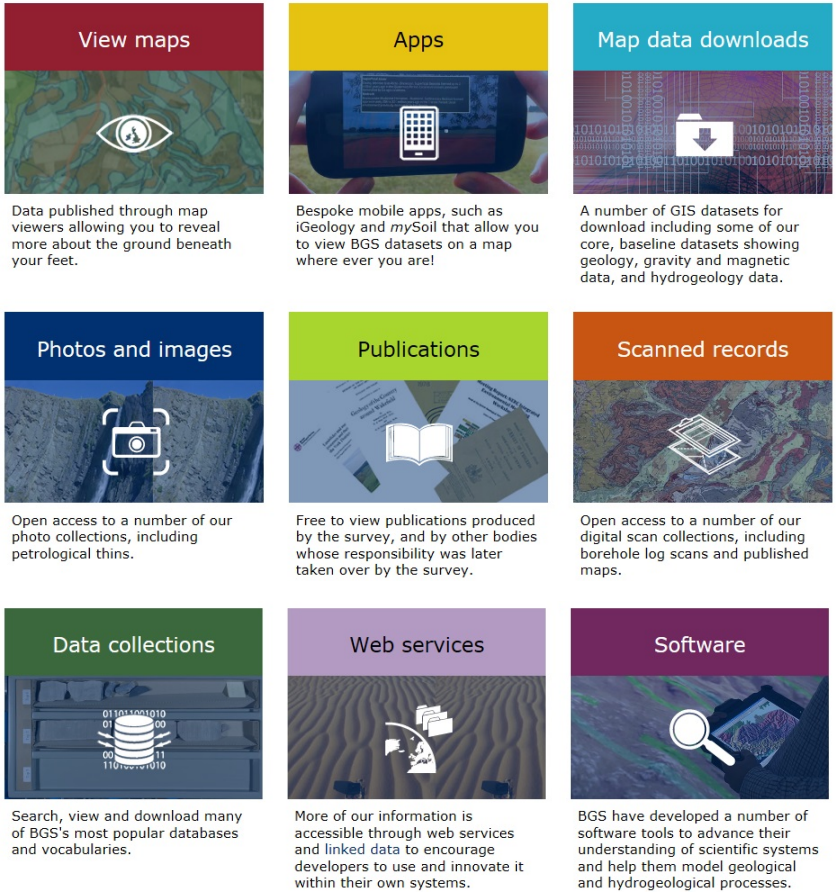
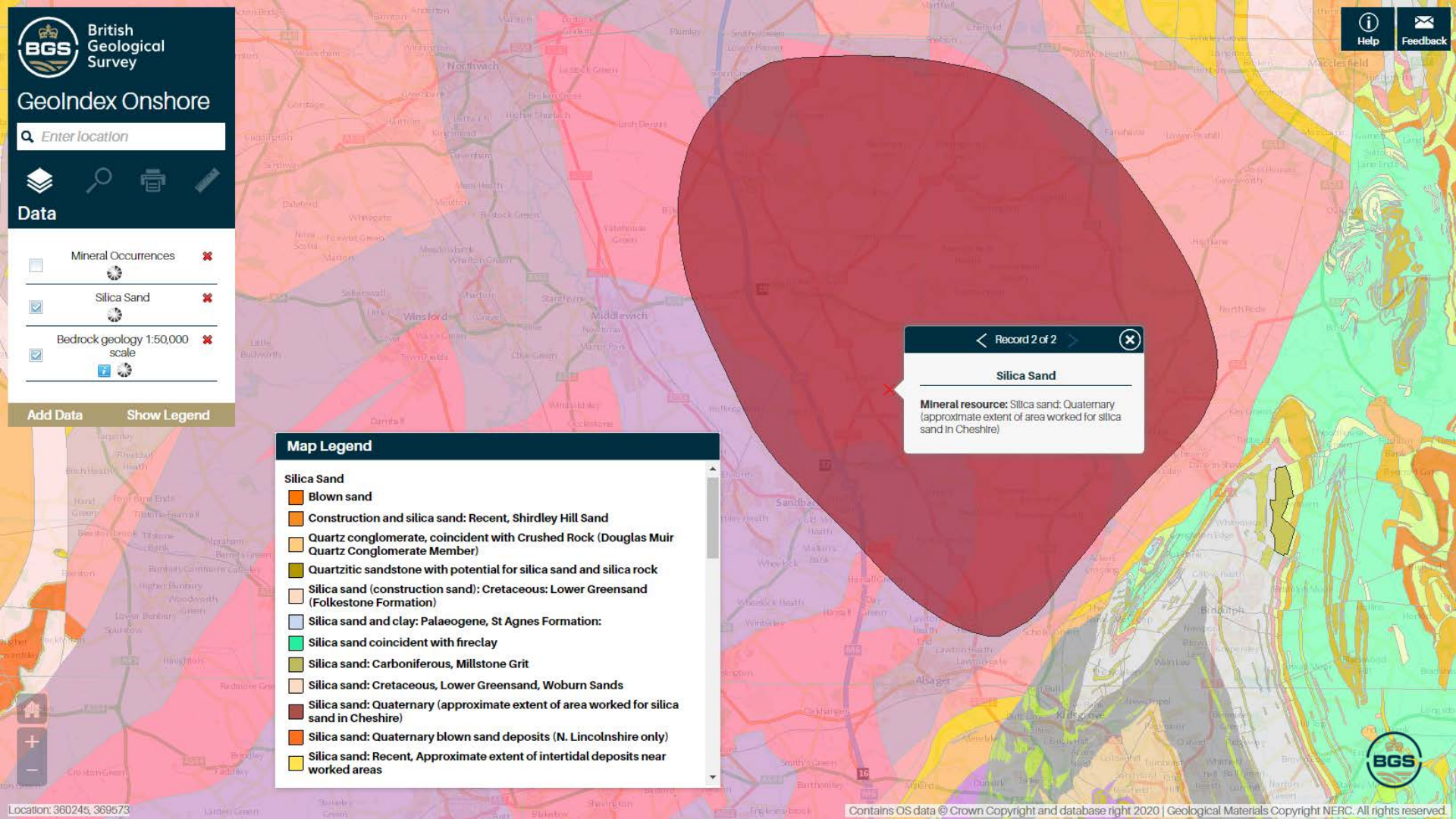


OpenGeoscience is a free service where you can view maps, download data, scans, photos and other information.

GeoIndex is a map-based index for professionals, onshore and offshore viewers, desktop and mobile www.bgs.ac.uk/geoindex/

BGS maps portal contains over 6000 high-resolution maps & sections which can be viewed online including historic maps


British Geological Survey
GeoIndex Onshore
Enter location
Data
Mineral Occurrences
Silica Sand
Bedrock geology 1:50,000 scale
Add Data
Show Legend
Help
Feedback
Record 2 of 2
Silica Sand
Mineral resource: Silica sand: Quaternary (approximate extent of area worked for silica sand in Cheshire)
Map Legend
Silica Sand
Blown sand
Construction and silica sand: Recent, Shirdley Hill Sand
Quartz conglomerate, coincident with Crushed Rock (Douglas Muir Quartz Conglomerate Member)
Quartzitic sandstone with potential for silica sand and silica rock
Silica sand (construction sand): Cretaceous: Lower Greensand (Folkestone Formation)
Silica sand and clay: Palaeogene, St Agnes Formation:
Silica sand coincident with fireclay
Silica sand: Carboniferous, Millstone Grit
Silica sand: Cretaceous, Lower Greensand, Woburn Sands
Silica sand: Quaternary (approximate extent of area worked for silica sand in Cheshire)
Silica sand: Quaternary blown sand deposits (N. Lincolnshire only)
Silica sand: Recent, Approximate extent of intertidal deposits near worked areas
Location: 360245, 369573
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2: DEMAND-LED RESOURCE ASSESSMENT

Minerals for Markets

- A-Z inventory of resources was the mineral resource strategy of national Governments for years. Current modern mineral resource assessment is informed by local, regional & international market demand/ trade statistics
- Employ experienced minerals geologists, technical specialists & GIS experts
- Engage with industry – get to know their processes and specifications
- Regional reconnaissance survey of known mineral occurrences to identify potential high-purity resources with field work and laboratory testing to evaluate their technical potential as industrial raw materials
- Create Minerals Occurrence Database (MOD) linked to a Geographical Information System (GIS)

Industrial properties of silica sand

- **Chemical composition:** Silica (SiO_2), iron (Fe_2O_3), alumina (Al_2O_3), alkalis (Na_20 & K_2O), alkaline earths (MgO & CaO) and heavy metals (Ni, Co, Cu, Cr)
- **Particle-size & distribution:** Fine or coarse particle size? Narrow or wide distribution?
- **Particle shape:** Round, angular, spherical, platy, acicular?
- **Refractory minerals**: e.g. Zircon, chromite & corundum
- **Other contaminants:** e.g. Clay, feldspar, calcite, mica & dust
- **Industrial specifications** are based on these properties as part of a technical agreement between a producer and consumer

Glass sand specifications

Property	Colourless glass containers (Flint)	Flat glass (Float, sheet & rolled plate)	Coloured glass containers (Amber & green)
Silica (SiO_2) content	98.5 to 99%		
Iron (Fe_2O_3) content	<0.035%	0.04 - 0.1%	0.25 - 0.3%
Alumina (Al_2O_3) content	0.5% max.	0.03% max.	0.2 – 1.6%.
Limits on:	Alkalis (Na_2O & K_2O), colourants (Ni, Cu, Co) & refractory minerals (chromite, ilmenite, zircon, rutile, corundum etc...)		
Particle-size	0.1 to 0.6mm (100 to 600 microns)		
Particle-shape	Angular quartz grains may aid melting?		

3: COMMUNICATE, ENGAGE, SUPPORT

Communicate

- Publish all geological and mineral resource information – data, maps, reports, commodity profiles, factsheets and mineral statistics.
- Provide Web Map Services via online portals and apps with access to layers for all available information on geology, mineral occurrences and land use designations
- Create online investment resources to encourage inward investment for the development of mining and quarrying operations
- Make this all freely accessible online (‘Open Access’) to all at no cost with no barriers such as entering contact details or account passwords – if you want contact details of those interested provide an email newsletter subscription service

Engage

- Presentation of mineral resource surveys at mineral industry conferences e.g. The Mining Show, Fujairah Forum, Big 5 Dubai
- Exhibition stands at showcase events to encourage discussion with industry and potential investors
- Develop and maintain a network of contacts
- Provide contact names and details for Government staff and experts involved in mineral resource development with staff profiles and publications

Support

- Adopt an enquiry service approach
- Responsive, timely, informative
- Host visits for investors
- Facilitate discussions and meetings

Conclusions

The Three Point Plan for mineral development:

1: Geological Baselines:

Up to date geological line work & information online via web map services and downloadable maps & reports

2: Demand-led Resource Assessment:

Technical evaluation & data for industrial minerals available online as free maps & reports

3: Communicate, Engage, Support:

Freely accessible information & data, regular engagement with industry & potential investors, and enquiry service approach

Thank you for your attention!

Clive Mitchell, Industrial Minerals Geologist, British Geological Survey

Email: cjmi@bgs.ac.uk Twitter: @CliveBGS

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