Earth Observation Products 
& Services in support of the 
Mining Industry

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Overview of EO Capabilities relevant to Mining / Raw Materials.

- Combination of Radar (SAR) & Optical (multi-spectral) imagery to provide key environmental products:
  - Land Surface Geology / Lithology,
  - Land Cover Classification / Change,
  - Surface Topography,
  - Precision Land Motion Monitoring,
  - Surface Feature Detection.

- **Copernicus S-1(A/B) & S-2(A/B)** are the main work-horses (Global, Frequent Re-visit),

- **European National Missions** for local 'hot-spot' monitoring at VHR (eg. TerraSAR-X, CosmoSkyMed, Pleaides, Deimos, ..)

- Future **Hyper-spectral missions** (eg EnMap) for highly enhanced surface mapping (ie. minerals, rock types, etc).

- Supporting wide range of activities in Mining/Extractives/Raw Materials business processes:
  - Exploration, Site Preparation, Operations, Site Closure, Health & Safety, Sustainable Development, ..
The European EO Service Industry:

- 450 + suppliers (small companies), 6800+ employees,
- 350 + specialised EO information products & services,
- 910 M€ annual turnover in Europe (2014, services + data)

Land Surface Type Mapping
(in support of Operations)

Ferric concentration (Fe3+) from WorldView-3
Precision Land Topography Mapping
(in support of Operations)

Tailings DEM

Open Pit DEM

Precision Land Motion Mapping
(in support of Operations)

Palabora Open Pit Copper mine, S Africa
-> Up to 4cm subsidence in a 24 day period
Precision Land Motion Mapping
(in support of Operations)

Waste Pile monitoring via Persistent Scatterer Interferometry (PSI)

The barren rock and gravel cover of waste piles leads to high densities of PSI points that can be exploited to support displacement measurements with millimetric precision (via Sentinel-1).

Precision Land Motion Mapping
(in support of Post-Closure)

Abandoned Coal Mine monitoring via PSI technique

Issue: subsidence claims raised by those living in areas of abandoned coal mining.
Land Cover Change Mapping
(in support of Sustainable Development)

Unbiased, timed satellite images help building stakeholder trust because they clearly illustrate the activities taking place in our oil sands mine leases; they present clear, accessible visuals to stakeholders such as First Nations people who live in the area; they provide objective information on development and eventual reclamation of our oil sands leases and help us to expand our annual reporting on environmental performance, including future reclamation areas. Using 2006 as a baseline, we intend to repeat monitoring by satellite on a yearly basis, to record our mine development and our progressive reclamation of involved areas.

Ashley Nixon, Sustainable Development Advisor at Shell Canada Ltd

VHR Feature Identification
(in support of Detection of Illicit Mining)

- Three classes of user:
  - International organisations assessing threat from organised crime,
  - National governments monitoring natural resource extraction,
  - Mining companies monitoring their own concessions.

- Basic approach:
  - VHR optical/SAR data to detect vehicles, irregular excavation, changes in tailings pond extent, etc

Irregular mining in VHR imagery: Gold (left), Ruby (right)
Detection of vehicles operating outside license area
**EO to Improve the ‘Billion-Dollar’ Map of Africa**

- African Minerals Geoscience Initiative (AMGI), one of the 7 pillars of the African Mining Vision (AMV) Action Plan, World Bank seeks to assist implementation,
- ESA activity: improve quality, relevance and rapid availability of GIS-standard mapping data using EO (S-1, S-2), geophysical and ancillary data.

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**EO-Based Mineral Mapping**

Darfur, Sudan
Based on Landsat 8

<table>
<thead>
<tr>
<th>Ferric oxides (Fo)</th>
<th>Ferrous minerals (Fm)</th>
<th>Hydroxyl-bearing minerals (Hyd)</th>
<th>Fo and Fm</th>
<th>Fm and Hyd</th>
<th>Fo and Fm and Hyd</th>
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Overlaid on geological map:

previously unnoticed strike-slip faults and dykes
Take-Home Messages........

- Earth Observation (EO) can deliver key environmental information that supports many aspects of operations in the Mining / Extractives / Raw Materials industry.

- EO brings benefits through being globally consistent/coherent (both spatially & temporally), providing access to remote regions, non-intrusive source of information,

- Europe has world-leading capabilities in Earth Observation (both EU, ESA and national EO missions) and a highly skilled and experienced EO information services sector. Developments are complete, ready for operational use. Copernicus is bringing a major step-forward in progress towards operational environmental information services.

-> Take forward through Industrial 'best-practices'?

Oil & Gas: Requirements Consolidation & "Best Practice' industrial Guidelines for EO.

- With Industry Association (IOGP),
  - 25 Case studies in 16 Countries, 24 Oil companies,
  - 96 EO product sheets for on-shore & off-shore,
- www.ogeo-portal.eu
Thank You for your Attention!

Earth Observation
A Necessity