## Product Sheet: Lithology and surficial geology mapping

### Lithology and Surficial Geology Mapping

![Image credit: Arup](image)

### PRODUCT DESCRIPTION

<table>
<thead>
<tr>
<th>Category</th>
<th>Component products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near Surface Geology</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Uses

- Seismic planning – areas of poor coupling
- Seismic planning – identification of adverse terrain for trafficability
- Surface geology mapping – structural interpretation
- Surface geology mapping – lithological discrimination
- Surface geology mapping – terrain evaluation and geo-morphology characterization
- Surface geology mapping – engineering geological evaluation
- Environmental monitoring - baseline historic mapping of environment and ecosystems
- Environmental monitoring - natural hazard risk analysis
- Logistics planning and operations – facility siting, pipeline routing and roads development

### Geo-information requirements

- Lithology, geology and structural properties of the near surface
- Terrain information

### Description
Lithological features, lithology and surficial geology (soils) can be distinguished and mapped utilising a wide range of EO sensors and analytical techniques, often incorporating use of multiple EO datasets.

Products may include:
- Geomorphological analysis including DEM and shaded-relief analysis can be used to identify soils by geomorphic form such as fluvial deposits (river terraces, alluvial fans, deltas) and sand dunes. Surface roughness and moisture content can provide an indication of degree of weathering and soil formation. High-resolution DEM (e.g., derived from VHR1 sensors) are beneficial for mapping geomorphic form related to surficial deposits.
- Hyperspectral data can allow for distinction of finer levels of detail of spectral class and mineral identification allowing for more precise lithological differentiation, including variation within a formation unit (e.g., due to facies change, intrusions such as dykes and sills, hydrothermal alteration, duricrusts and hydrocarbon seepage). Future planned hyperspectral sensors, including EnMAP (2017), are anticipated to have good potential for lithological mapping.
- Airborne geophysics data can be effectively incorporated with EO data analysis for more detailed and accurate lithological mapping. Spaceborne geophysics data currently is not at sufficient resolution to allow for detailed lithological distinction. Data collected from the GOCE satellite (2009-2013) has some benefit for mapping of global and broad regional scale geological structures including mapping depth of crust (depth to Moho) for input to broad regional seismic and tectonic modelling, including thermal gradient modelling.

Known restrictions / limitations
- Lithological mapping is best-suited to arid and semi-arid regions.
- Temperate and tropical regions with deep weathering and dense canopy are more challenging and accuracy of analysis and interpretation is lower, with pattern (e.g., drainage network pattern) and established vegetation associations being important to assist interpretation of underlying lithology.
- For optical imagery, atmospheric effects need to be removed to increase accuracy of interpretation and assist interpretation of underlying lithology.

Lifecycle stage and demand

<table>
<thead>
<tr>
<th>Lifecycle Stage</th>
<th>Pre-license</th>
<th>Exploration</th>
<th>Development</th>
<th>Production</th>
<th>Decommission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-license</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

Pre-license: Information for geology to support decision-making on a prospect.

Exploration: Information to support geological mapping of surface and sub-surface, lithological and stratigraphic relationships, seep identification and seismic surveys (planning, e.g., trafficability, and data interpretation including seismic production modelling and nearsurface modelling).

Development: Information for planning and design of infrastructure, to support site selection and pipeline routing to determine hazards and risks in a proposed development area.

Production: Monitoring of changes in lithology/soils for asset monitoring of facilities and operations including pipeline leakage.

Decommissioning: Not typically required.

Geographic coverage and demand

Coverage is global.

Demand is global.

Demand is in all terrain areas, excluding polar and permanent snow covered landscapes.

Challenges Addressed
PRODUCT SPECIFICATIONS

Input data sources

Optical: VHR1, VHR2, HR1, HR2
Radar: VHR1, VHR2, HR1, HR2, MR1

Supporting data:
- Geological maps
- Published literature and reports
- Field geological mapping, field collected spectra, borehole logs
- Airborne geophysics

Spatial resolution and coverage

Varies depending on input imagery used and client needs.

Minimum Mapping Unit (MMU)

N/A

Accuracy / constraints

Accuracy of interpretation is higher in arid and semi-arid regions. Temperate regions and tropical regions with thick soil cover and dense vegetation canopy have lower accuracy of interpretation.

Spectral libraries are inconsistent across differing geographic and terrain groups.

Thematic accuracy: 70-90% for arid/semi-arid regions where vegetation cover is low.

Spatial accuracy: The goal would be 1 pixel, but depends on reference data and ground-truth data.

Accuracy assessment approach & quality control measures

Professional judgment by comparison with any published geological mapping or reports and ground truth data (geological mapping and collection of field spectra, borehole logs).

Frequency / timeliness

Observation frequency: Typically only one date is required (per dataset/sensor used) and can frequently utilise archive data.

Timeliness of delivery: Depends on the requirements of the client and processing required. Archive data is frequently used and is usually available off-the-shelf.
Availability from commercial suppliers and other agencies.
New acquisitions can be requested globally for higher resolution data.
Archives products available for public search.

**Delivery / output format**

<table>
<thead>
<tr>
<th>Data type:</th>
<th>File format:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Raster</td>
<td>• .tif, .ecw</td>
</tr>
<tr>
<td>• Vector</td>
<td>• Shapefile</td>
</tr>
<tr>
<td>• Digital or paper maps</td>
<td>• PDF files or plots</td>
</tr>
</tbody>
</table>

Download product sheet.

<table>
<thead>
<tr>
<th>Lead author:</th>
<th>HC / Arup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer Reviewer:</td>
<td>OTM / WesternGeco</td>
</tr>
<tr>
<td>Author(s):</td>
<td>Jason Manning</td>
</tr>
<tr>
<td>Document Title:</td>
<td>Lithology and Surficial Geology Mapping</td>
</tr>
<tr>
<td># of Pages:</td>
<td>6</td>
</tr>
<tr>
<td>Circulation:</td>
<td>Internal – Project consortium and science partners</td>
</tr>
<tr>
<td></td>
<td>External – ESA</td>
</tr>
</tbody>
</table>