Satellite Imagery – a valuable tool for the Mining Industry
Deciding which is the best satellite imagery for your application? Geoimage can help.

For your ease we have broken the different types of satellites into 3 categories:
- VHR (Very High Resolution) — sub metre pixels
- High Resolution — 2.5m to 10m pixels
- Mid Resolution — greater than 10m pixels

We will perform free data searches of your area of interest. All you need to do is provide us with enough information about your requirements such as:
- Pixel resolution
- Whether you require multispectral or panchromatic (black and white) images
- Any time constraints, do you need the latest or can we choose scenes from the archive
- What you intend to use the data for
- What stage of the mining lifecycle you’re interested in

Then provide us with a shapefile, kmz/kml file or coordinates for your area of interest and we will do the rest.

### Very High Resolution Satellites

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Panchromatic resolution</th>
<th>Multispectral resolution</th>
<th>Pansharpened resolution</th>
<th>Multispectral Bands available</th>
<th>Swath width</th>
<th>Min area to purchase</th>
<th>Programmable</th>
<th>Stereo available</th>
<th>Largest scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>WorldView-3</td>
<td>0.31m</td>
<td>1.24m</td>
<td>0.31m</td>
<td>8 multispectral bands at 1.24m res</td>
<td>13.1km at nadir</td>
<td>25 sq kms for archive</td>
<td>Yes</td>
<td>Yes</td>
<td>1:1000</td>
</tr>
<tr>
<td>WorldView-2</td>
<td>0.5m</td>
<td>2.0m</td>
<td>0.4m - 0.5m*</td>
<td>4 or 8 bands</td>
<td>16.4km at nadir</td>
<td>25 sq kms for archive</td>
<td>Yes</td>
<td>No</td>
<td>1:1500</td>
</tr>
<tr>
<td>WorldView-1</td>
<td>0.5m</td>
<td>No multispectral band available</td>
<td>0.4m - 0.5m*</td>
<td>None</td>
<td>17.6km at nadir</td>
<td>25 sq kms for archive</td>
<td>Yes</td>
<td>Yes</td>
<td>1:1500</td>
</tr>
<tr>
<td>GeoEye-1</td>
<td>0.5m</td>
<td>2.0m</td>
<td>0.4m - 0.5m*</td>
<td>4 bands</td>
<td>15.2km at nadir</td>
<td>25 sq kms for archive</td>
<td>Yes</td>
<td>Yes</td>
<td>1:1500</td>
</tr>
<tr>
<td>QuickBird</td>
<td>0.6m</td>
<td>2.44m</td>
<td>0.6m resampled</td>
<td>4 bands</td>
<td>16.5km at nadir</td>
<td>25 sq kms for archive</td>
<td>No</td>
<td>No</td>
<td>1:2000</td>
</tr>
<tr>
<td>Pléiades 1A &amp; 1B</td>
<td>0.5m</td>
<td>2.0m</td>
<td>0.5m resampled</td>
<td>4 bands</td>
<td>20km at nadir</td>
<td>25 sq kms for archive</td>
<td>Yes</td>
<td>Yes</td>
<td>1:2000</td>
</tr>
<tr>
<td>IKONOS</td>
<td>0.82m</td>
<td>3.2m</td>
<td>0.8m resampled</td>
<td>4 bands</td>
<td>11km at nadir</td>
<td>25 sq kms for archive</td>
<td>No</td>
<td>Yes</td>
<td>1:2500</td>
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</table>

### High Resolution Satellites

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Panchromatic resolution</th>
<th>Multispectral resolution</th>
<th>Multispectral Bands available</th>
<th>Swath width</th>
<th>Min area to purchase</th>
<th>Programmable</th>
<th>Stereo available</th>
<th>Largest scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPOT 6 &amp; 7</td>
<td>1.5m</td>
<td>6.0m</td>
<td>1.5m</td>
<td>4 bands</td>
<td>60kms at nadir</td>
<td>250 sq kms for archive</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SPOT 5 Archive only</td>
<td>2.5m or 5m</td>
<td>10m at nadir</td>
<td>2.5m</td>
<td>4 bands</td>
<td>60x60kms at nadir</td>
<td>20x20kms</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>ALOS available to May 2011</td>
<td>2.5m</td>
<td>10m</td>
<td>2.5m</td>
<td>4 bands</td>
<td>70x70kms for AVNIR (multispectral) or 35x35kms for PRISM (panchromatic)</td>
<td>Single scene</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>RapidEye</td>
<td>5m</td>
<td>5 bands</td>
<td>7.7kms at nadir</td>
<td>500 sq kms for archive</td>
<td>Yes</td>
<td>No</td>
<td>1:15 000</td>
<td></td>
</tr>
<tr>
<td>SPOT 4 Archive only</td>
<td>10m</td>
<td>20m</td>
<td>10m</td>
<td>4 bands</td>
<td>60x60kms at nadir</td>
<td>Single scene</td>
<td>No</td>
<td>No</td>
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</table>

### Mid Resolution Satellites

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Panchromatic resolution</th>
<th>Multispectral resolution</th>
<th>Multispectral Bands available</th>
<th>Swath width</th>
<th>Min area to purchase</th>
<th>Programmable</th>
<th>Stereo available</th>
<th>Largest scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landsat 8</td>
<td>15m</td>
<td>OLI=30m TIR=100m resampled to 30m</td>
<td>15m</td>
<td>7 OLI bands 2 TIR bands</td>
<td>180 x 180 kms width</td>
<td>Single scene</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>ASTER Swir bands only available up to April 2007</td>
<td>VNIR=15m SWIR=30m TIR=90m</td>
<td>3 VNIR bands 5 TIR bands</td>
<td>60km width</td>
<td>Single scene</td>
<td>Yes (excluding SWIR)</td>
<td>Yes</td>
<td>1:40 000 for VNIR &amp; SWIR</td>
<td></td>
</tr>
<tr>
<td>Landsat 7 SLC Off (up to May 2003) SLC Off (Post May 2003)</td>
<td>TM=30m TIR=60m resampled to 30m</td>
<td>15m</td>
<td>6 TM bands 2 (gains) TIR</td>
<td>180 x 180kms</td>
<td>180 x 180kms</td>
<td>No</td>
<td>No</td>
<td>1:40 000 Pansharpened</td>
</tr>
<tr>
<td>Landsat 5 available to June 2013</td>
<td>TM=30m TIR=60m resampled to 30m</td>
<td>6 TM bands 1 TIR</td>
<td>180 x 180kms</td>
<td>180 x 180kms</td>
<td>No</td>
<td>No</td>
<td>1:80 000</td>
<td></td>
</tr>
</tbody>
</table>
Mining Lifecycle

During the last 27 years Geoimage have developed specialised solutions for the mining industry which assist with integrating, analysing, modelling and visualising the various spatial information datasets mining companies acquire over a mine’s lifecycle.

Spatial information is valuable throughout all stages of the mining lifecycle. No matter what stage a company is at, Geoimage understands and is able to recommend and identify the best data, advise on accuracy, scale, resolution and the requirement most appropriate for your specific needs. Geoimage provides valuable context and information content to your project and business. Our experts will assist you to get the best return on investment from satellite imagery and geospatial solutions.

Geoimage have been the leading independent specialists in satellite imagery and geospatial solutions for the mining industry for over 20 years. We offer our clients professional advice on the supply and application of commercially available satellite imagery, spatial datasets and services.

Whether you are looking to delineate potential exploration targets, optimise planning by reducing risk through making more informed decisions, streamline asset and facility management or reduce expenditure via improved land management techniques, the use of satellite imagery and geospatial solutions from Geoimage can assist your company in achieving these goals.
Exploration

Two key stages of the exploration process are regional-scale area selection and site-scale target generation. Satellite data and its derived products can rapidly provide a plethora of information which can aid this process, especially in remote or hazardous areas where ground-based exploration is challenging.

Exploration remote sensing relies on the interpretation of both raw and processed imagery, particularly through the generation of targeted enhancements and indices that can highlight ore bodies and their respective mineralisation or alteration signatures, variability throughout the exploration site as well as associated structural features such as lineaments and faults.

Having worked closely with the exploration sector for many years, Geoimage can recommend particular sensors and techniques to aid in exploration depending on a client’s area, commodity and requirements.

Spectral processing

The mid resolution Landsat ETM+ and ASTER sensors measure wavelengths useful for the identification of alteration associated with mineralisation. Landsat ETM+ includes a shortwave infrared band in the 2.08-2.35 nm range which can discriminate rock types and map hydrothermal clays whilst the visible bands that can be used to map iron oxides. ASTER senses in two visible, one near infrared, six shortwave infrared and five thermal infrared bands, allowing discrimination of epithermal clay minerals, iron oxides, silica, carbonate, mafics and propylitic alteration. This imagery is best used for regional mapping at scales down to 1:50,000.

With the 8 spectral bands of WorldView-2, regolith mapping down to a scale 1:2,000 is becoming a reality. Using advanced classification techniques along with tried and tested enhancements, indices and principle components, Geoimage is developing techniques that fully utilise this unique, high spectral resolution 50cm imagery.

When combined with satellite derived surface elevation models, the spectral products described above can be used in stereo analysis to delineate structural features. The resolution of the elevation model required depends on the size of the area and the scale of the structures of interest. Again, a two-fold approach is most common, with lower resolution SRTM data being commonly used for the initial analysis and PRISM or very high resolution elevation data consequently being utilised over the areas that show the most potential.

Initial Regional Analysis and Area Selection

The processes of area selection and target identification can benefit from satellite imagery of an appropriate resolution. With a large archive and relatively low entry price, medium resolution data can be used along with their spectral processing derivatives to derive, locate, and designate smaller areas of interest that can be earmarked for further in-depth investigation, field work and potential planning stages.

Once these areas of particular interest have been defined, clients can subsequently task these areas to be captured by the higher resolution satellites. This two-stage approach reduces overall costs by mitigating multiple data capture missions through the use of appropriately scaled datasets.

With our wealth of experience and independent advice, Geoimage is best placed to guide you through the use of satellite imagery in your exploration stage.

GEOIMAGE RECOMMENDS:

- Mid resolution data for the initial, broad-scale study
- Higher resolution data for subsequent analyses
- Integration of different datasets adds value and quality
- Spectral analysis for lithological mapping
- Stereo analysis of imagery with satellite-derived elevation models for structural mapping

Satellite imagery provides a very cost effective means of exploration, especially in remote or hazardous areas.

ASTER study. Mongolia - Left: Relative Band Depth ratio false colour composite. Right: ASTER-derived alteration map. Red indicates alunite-pyrophyllite occurrences, the green kaolinite, the cyan phyllic alteration and the blue propylitic alteration. © Geoimage and JAXA 2011

Iron ore study in the Marra Mamba, Western Australia, using 8-band WorldView-2 data. A: Natural colour image. B: Principle component false colour composite. C: Traditional iron ore ratio, using only the blue and red bands. D: Enhanced iron ore ration, using the blue, yellow and red bands. Ellipse highlights areas of tighter distinction of ore formations. © Geoimage and DigitalGlobe 2010

With our wealth of experience and independent advice, Geoimage is best placed to guide you through the use of satellite imagery in your exploration stage.
Geoimage recognises the value of having an appropriate image source to assist both field survey efforts and planning requirements, and how the value of such datasets can be extended through the integration with previously acquired data. Broad scale feature extraction and medium resolution elevation models and imagery can aid in identification and planning of features such as the location of infrastructure and the proximity of the site to sensitive areas (e.g., environmental zones terrestrial and marine) thereby satisfying government feasibility requirements.

**Site Selection**

Through the visualisation of existing infrastructure, obstacles to the development of the site can be identified, and alternative ways to inform the community of the current and proposed change outcomes of design or feasibility using virtual reality methods can be utilised.

High resolution imagery and elevation data from a large archive to identify broad scale locations for infrastructure planning can be combined with very high resolution imagery for a multi-staged, rigorous approach to best site selection. Stereo PRISM data from the ALOS archive allows for high resolution (5m) elevation models to be generated over larger areas. This can aid both geomorphological interpretation, and the high level location planning decision making process. Areas of reduced size can then be earmarked for very high resolution elevation models (1m).

Using advanced analysis techniques, site layout and route selection can be optimised, ensuring plant and equipment can be relocated without getting bogged or slowed down. The integration of elevation datasets (giving gradient, and slope analysis), with available imagery and advanced processing, can lead to reduced construction time and costs and greater control over risk management. The use of quality spatial data in land coverage mapping and environmental impact planning can reduce rehabilitation and potential relocation expenses.

**Hazard and Risk Planning**

Remote sensing techniques combined with analysis to assist clients dealing with environmental hazards and the risks that may arise from residing, working or developing in the natural world can aid with site selection. Mapping hazards or risks, whether in response to an environmental event, such as flooding, fire or landslide, or in the assessment of the susceptibility of a region to a particular risk, such as bushfire will allow for prior planning to avoid future risk. In some instances, optical imagery is not available if the hazard coincides with cloud cover, such as during flooding events. Geoimage is well positioned to offer alternative suggestions around different resolutions, frequency of coverage, spectral bandwidths and cost to counter any limitations that may arise.

**Geoimage recommends:**

- High resolution imagery for optimal site location planning
- High resolution imagery for base line mapping
- Land coverage classification from datasets acquired in the exploration phase to aid compliance
- Elevation data to aid geomorphologic investigation
- Use of extensive range of archive imagery

Early spatial integration and the use of satellite imagery reduces risks and planning costs.
Construction & Operation

In support of engineering and construction developments, rapidly sourced and disseminated spatially-referenced data can provide valuable information regarding project status. Throughout the various phases of construction and operation, Geoimage can provide a range of data along with specific geospatial services and deliverables to best suit requirements. This information, stored as geospatial data, can lead to benefits in health and safety requirements, asset management and change detection.

Asset and Facility Monitoring
Within the mining industry, remoteness, access to privately owned land and government restrictions can adversely affect the collection of asset and facility information. The rapid collection rate of very high resolution satellites can greatly assist companies in overcoming access to site issues as well as enhance management of multiple construction and operation projects. Satellite imagery can form a valuable baseline for the presentation of both current and proposed assets. Where these assets span extensive areas, a satellite image source is often the most cost- and time-effective option in the planning, design and community consultation phases.

Through the use of very high resolution data and advanced object-based classification techniques, Geoimage can quickly and accurately extract features of interest. During the construction and operation stage, these can encompass infrastructure and facility components, transportation routes, as well as environmental features.

With the vast constellation of very high resolution satellites now in orbit, high frequency monitoring is a reality. As an independent provider, Geoimage can utilise all available sources to assist in the rapid capture of assets at time intervals that best suit the client. When combined with feature extraction, visualisation and simulation, this image-based monitoring can be beneficial for communication to all levels of operation and management regarding the progress of developments.

Environmental Monitoring and Compliance
As the mine operation grows and develops, monitoring of both the natural environment and pre-existing culturally sensitive localities is vital for pre-empting and managing areas of possible long-term damage. Quantifying and controlling these changes during the construction and operation phase is often essential due to reporting requirements and will also save time and money in the subsequent closure and rehabilitation stages.

Using regularly captured imagery, Geoimage works closely with mining companies to develop and generate image-derived products to quantitatively track changes in natural (vegetation, fluvial, marine) and pre-existing manmade features. Topographical analysis, using very high resolution elevation models generated from stereo satellite data, can further highlight landscape changes that could indicate potential areas of subsidence.

GEOIMAGE RECOMMENDS:

✜ Feature extraction to classify infrastructure, facilities and transportation routes
✜ Temporal analysis and change detection using very high resolution satellite imagery
✜ Image-derived products and studies to quantify and monitor environmental changes and aid in the preservation of cultural features

Monitoring temporal changes during construction and operation leads to diminished environmental impacts.

A time series of 50cm resolution WorldView-2 images of a mine plant, captured over a period of 3 months © DigitalGlobe 2011

Dust impact analysis using 8-band WorldView-2 data –
A: Natural colour image  B: Decorrelation stretch using the coastal, NIR1 and blue bands  C: Object-based segmentation results  D: Calculated dust impact areas © Geoimage and DigitalGlobe 2011

Creating a baseline of existing infrastructure and facilities with which to track changes, can allow for reporting to investors and government in a more timely fashion.
Closure & Rehabilitation

Mining is a temporary activity and land use. Initial plans for mine closure and rehabilitation need to be in place before a mining company starts construction. With global archives dating back to the 1970s, satellite imagery is a cost-effective tool that operates at multiple scales to assess pre-development landscape condition and quantify surrounding landscape features. This information can be used to formulate realistic goals in planning for mine closure. Outputs from satellite imagery and satellite-derived DEMs are integrated into landform design projects, land use and landscape planning and inform surface water management and habitat restoration processes.

Rehabilitation Monitoring

As mining comes to a close, earth works and site restoration begin to return disturbed land from mining activities to a stable, productive and sustainable state for both the local wildlife and surrounding communities.

During the rehabilitation process continual evidence-based monitoring and assessments are completed to comply with government legislation for all mining leases. Satellite-derived spatial datasets can assist in identifying and quantifying rehabilitation areas, regions of success and stress, and be used to assess change throughout project areas. Summaries of these compliance monitoring activities are then able to be combined with the evidence and support the completion of mining and rehabilitation compliance reports in a timely manner. This also leads to reduced expenditure via an improved understanding of rehabilitation execution and land management techniques.

Land cover and land use can also be mapped to detect fine-scale landscape patterns at any phase of the project. Integration of on-ground field data enables the extrapolation of endangered vegetation communities across the site which may be used to update state-wide mapping products with greater detail and indicate the location of possible offset sites.

Closure Impact Assessments

Removal of equipment, demolishing of facilities and the safe closure of all mine workings need to be monitored and their impact assessed during mine closure.

Geoimage can arrange for satellite capture at various resolutions of a project area on a high-frequency basis. Comparison of multi-date data can assist in identification of any landscape disturbances. This data enables targeted and efficient management through mitigation before impacts progress to a state which may be more costly to resolve. Derived imagery products will assist in quantifying mining development impacts and can be integrated into management and restoration plans.

Using sophisticated classification processes spectral indices are analysed to identify where mine site pollution, including dust, is impacting a landscape. It is also possible to generate products which assess vegetation health and indicate stress whether it be development associated or due to natural processes.

Let Geoimage advise you as to how satellite imagery and its derived datasets can support closure impact assessments and rehabilitation projects during the mining lifecycle.

GEOIMAGE RECOMMENDS:

- Satellite imagery to assist in formulating rehabilitation and closure goals
- Monitoring project area over the life of the mine to quantify development impacts, landscape and vegetation change
- Land cover/land use mapping to identify offset locations
- Use of derived spatial products as an input into evidence-based reporting

Pre-planning for mine closure and rehabilitation reduces expenditure and improves monitoring of rehabilitation success.
Geoimage is Australia’s leading provider of Satellite Imagery and Geospatial Services

Geoimage has been offering professional and independent advice on the supply, processing, analysis and integration of satellite imagery and spatial datasets since 1988. Geoimage’s unsurpassed reputation for timely delivery, dedicated follow-up and professional customer service is evident from our extensive client list spanning the mining and exploration, environmental, planning, engineering and government sectors.

Data Content Supplier

Established long-term partnerships with the widest range of international satellite suppliers allow Geoimage to provide clients with archive and new capture satellite imagery ranging from 50cm to 30m resolution, suitable to most applications requiring a spatial context, either as a reference or from which to extract derived information.

Extended Remote Sensing and Geospatial Services

The comprehensive services offered by Geoimage provide customers with a coordinated solution for their geospatial requirements. Geoimage is renowned for generating superior satellite imagery derived products and providing spatial services, including orthorectification and spatial correction, colour balancing and mosaicing, Digital Elevation Models, spectral processing, feature extraction and extracting information for better decision making.

Why do clients select Geoimage?

Geoimage’s clients repeatedly return because they appreciate our:

- Professional and independent advice
- Excellent customer service
- Superior processing capabilities
- Breadth of processing, analysis and value added services using remote sensing and geospatial technologies
- Confidential opinions and support from a specialist firm.