PCI GEOMATICS

Innovative Solutions for a Complex World

Case study - Norwegian Geological Survey analyzes Aster imagery in ArcGIS

RASTER NIGHTMARE TURNED GIS INTEGRATION DREAM

Written by Kevin R. Jones, Director – Marketing and Product Management at PCI Geomatics

▲ Saltfjellet-Svartisen Park, Norway – Image Courtesy of NASA/GSFC/METI/ERSDAC/JAROS, and U.S./Japan ASTER Science Team

The Geological Survey of Norway makes use of PCI's new GeoImaging Tools for ArcGIS to reduce the cost of mapping the bedrock in the Rogaland region of Norway.

Satellite-based remote sensing data

The Geological Survey of Norway (NGU) is responsible for deriving bedrock maps as a service to the Bedrock Mapping Unit (BMU). Bedrock maps are essential tools used in the exploration for mineral and hydrocarbon deposits, to evaluate groundwater resources, and to help determine appropriate locations for highways, pipelines, waste disposal and heavy industrial sites. These bedrock maps also serve as the geological framework for environmental assessments, land use plans, forest inventory databases, and similar applications. Creating and updating bedrock information involves a process whereby field work is required to properly identify transition zones and rock types to create accurate maps – with such a large area to cover, the NGU has been assessing the potential for using satellite remote sensing to create preliminary bedrock maps – so that scientists can spend time refining the information by visiting field locations where ambiguous results have been derived. The use of satellite imagery has been found to be very helpful, especially in geologic areas with little soil and vegetation coverage—that is, where there is an unobstructed view of the bedrock from space. In order to collect data for the identification of boundaries between bedrock units and structures in the Rogaland Area of southwestern Norway, NGU selected imagery collected by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER[1]), which provides very good spectral information – including thermal bands – while preserving good spatial resolution. The study area is heavily scoured by Pleistocene ice sheets and, as a result, is largely devoid of significant Quaternary soil cover, making it an ideal testing ground for bedrock mapping using satellite remote sensing.

Raster nightmare

▲ Image Courtesy of NASA/GSFC/METI/ERSDAC/JAROS, and U.S./Japan ASTER Science Team

Despite the potential high quality and value associated with the ASTER data, the NGU found that upon receiving the imagery from the data provider, they struggled a great deal to integrate it into their preferred operational environment, ArcGIS 10. Adding the data directly did not produce a good result because the imagery did not line up with any of the reference vectors or other base maps available in the GIS system.

Before allocating internal resources to analyze the imagery, the NGU had to ensure that the newly collected imagery would be properly aligned with other base map information; otherwise, spending any time deriving information from the new ASTER images would not have been worthwhile. The NGU considered using an existing image processing package to perform corrections to the data, but hesitated doing so because learning how to use a new and different software/GUI environment represented a significant time/cost commitment.

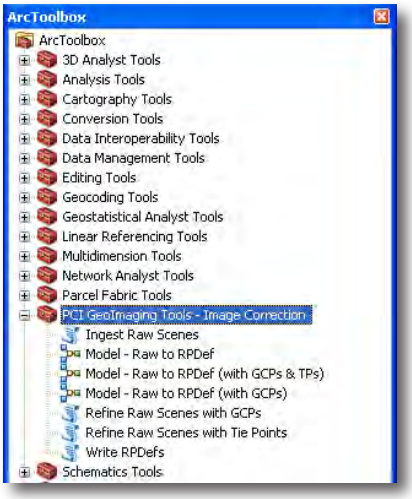
This led to a great deal of frustration: the NGU understood and wanted to exploit the benefits of satellite remote sensing imagery, but the lack of integrated tools to bring the data into their GIS environment halted all progress.

NGU learns of PCI's GeoImaging Tools for ArcGIS

Just as the NGU was getting ready to abandon the idea of using the ASTER imagery, Nils Erik Jørgensen from Terranor (www.terranor.no – PCI reseller based in Norway) contacted the NGU to discuss new technology introduced in the marketplace by PCI Geomatics. The NGU took notice, and discussed their particular case with Terranor.

The NGU knew about PCI's strong reputation for providing rigorous and automated multi-satellite sensor support, and was delighted to hear that PCI had developed an extension to ArcGIS 10 – this meant there was the potential to implement a more streamlined workflow.

In addition, learning how to use an external software package to correct the imagery would no longer be required, as GeoImaging Tools is integrated directly into ArcGIS.



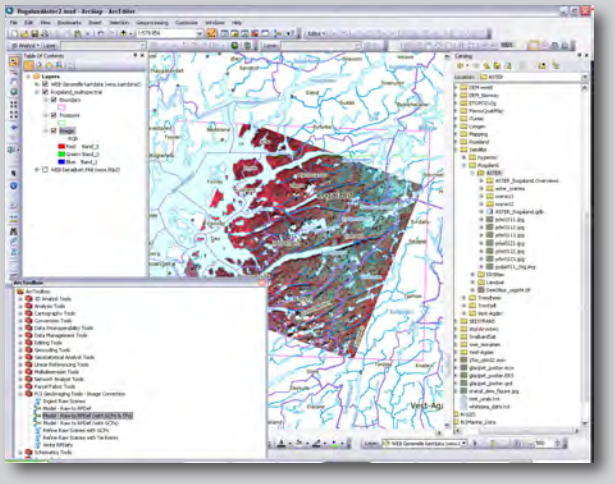
▲ Figure 1 - GeoImaging Tools for ArcGIS GUI integrated in ArcGIS

Table 1: Spectral and spatial band information for ASTER – the sensor used by the NGU for Bedrock Mapping

SATELLITE	SENSOR	BAND #S	SPECTRAL RANGE	SCENE SIZE	PIXEL RES
	VNIR	1-3	0.52 - 0.86 µm		15 meter
ASTER	SWIR	4-9	1.600 - 2.430 µm	120 x 150 km	30 meter
	TIR	10-14	8.125 - 11.65 µm		90 meter

[1] ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) is an imaging instrument flying on Terra, a satellite launched in December 1999 as part of NASA's Earth Observing System (EOS). ASTER is a cooperative effort between NASA, Japan's Ministry of Economy, Trade and Industry (METI) and Japan's Earth Remote Sensing Data Analysis Center (ERSDAC) ASTER is being used to obtain detailed maps of land surface temperature, reflectance and elevation.

Raster data meets its match



▲ Figure 2 - ASTER imagery successfully loaded in ArcGIS10 using GeoImaging Tools for ArcGIS

Prior to integrating GeoImaging Tools into their environment, the NGU evaluated the software to test its functionality, in order to determine if it could indeed use the tools to solve the operational challenges it faced with its ASTER data. Downloading the software was straightforward, simply by going to PCI's website where a fully functional trial version is available. Within a few minutes, the software was downloaded and installed at the NGU's office, and integrated directly into ArcGIS.

The download included a number of resources which the NGU made immediate use of, including a step-by-step tutorial using a demonstration dataset (which is also available for download on PCI's website) and an instructional video accessible over the web. The NGU then got to work in evaluating GeoImaging Tools with its frustrating ASTER data, which up until now was of no use at all. The initial process that the NGU evaluated was correcting the imagery using the nominal model, one of the options available with GeoImaging Tools. GeoImaging Tools is based on PCI's sophisticated Rational Polynomial Function (RPC) sensor model technology, which uses ephemeris information collected by satellites when images are captured, along with a Digital Elevation Model (DEM) to perform very accurate corrections. The NGU followed the instructions from the user guide and within minutes produced a very good result, one that finally aligned with reference vectors and other base information.

Going one step further, in the demonstration tutorial for GeoImaging Tools, the NGU noticed that a series of SPOT images were corrected using a reference Landsat dataset over British Columbia, Canada. Global coverage is available from Landsat through the USGS; therefore, the NGU downloaded the overlapping tiles over the ASTER scene to use as a reference dataset from which to collect ground control points. The same process was executed using GeoImaging Tools, this time with the initial model refined using the reference Landsat dataset. GeoImaging tools includes automatic image-to-image matching technology, which collects reference points that are then used to build a highly accurate model to correct the data. The end result was even better than the nominal correction, and finally, the NGU was able to begin the work of leveraging the valuable information contained in the ASTER imagery – as geologist of NGU, Dr. Ola Fredin put it, "all this took very little time and we could concentrate on Geology".

Space-based derived information used in the field

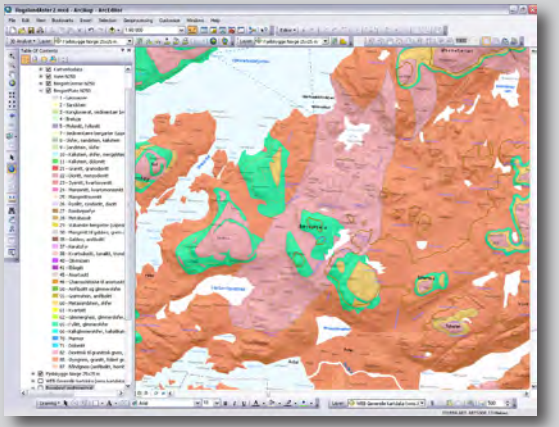
The NGU makes full use of Geographic Information Systems, and the Bedrock Mapping project is no exception. Having used GeoImaging tools to correct the imagery directly within ArcGIS, the NGU began the process of creating preliminary maps, outlining the boundaries and structures using ArcGIS feature editing functionality.

These data, along with reference base maps and vector information are then loaded onto field-ready ruggedized laptops equipped with built-in GPS capability. From the field, NGU scientists can thus load the preliminary information derived from the ASTER imagery and prioritize field checks where ambiguous zones have been identified.

The preliminary information is verified and updated, then synchronized back in the central database when scientists return from the field. This integrated approach represents a considerable amount of savings in terms of time and money, since the NGU can achieve their mandate more efficiently.

▲ Figure 3 - Dr. Ola Fredin updates preliminary ASTER derived bedrock maps in the field using a ruggedized laptop and ArcGIS

Satellite imagery now fully integrated into NGU's GIS workflow



▲ Figure 4 - Preliminary bedrock maps derived from ASTER imagery and field level verification, produced by NGU

The benefits of using satellite remote sensing data are well understood by the scientific community; however some barriers clearly prevent many potential users from leveraging this type of data. Some of these past barriers have included:

* **cost of the data**
* **ease of access (where to go to download, how to obtain data, information on data formats and sensors)**
* **ability to read imagery into a GIS system in a simple manner where further analysis can be carried out**
* **availability of reference elevation models and base mapping data**

Most of these barriers no longer exist – we live in an era of data abundance, especially as it relates to geospatial information.

Data policies have been relaxed by innovators such as United States Geological Survey (USGS) and DLR (German Aerospace Center), collecting, processing and distributing worldwide optical remote sensing imagery and Digital Elevation Models freely through the Internet. The number of earth observation missions is steadily increasing, therefore creating competition and driving prices downwards. Web-based data ordering systems are the norm, where access to newly collected imagery can happen in near real time.

Despite these advances, integrating satellite imagery directly into the GIS continues to represent a significant barrier. Through the partnership between PCI Geomatics and ESRI, products such as GeoImaging Tools for ArcGIS are helping to remove this barrier and leverage the very valuable information that can be derived from satellite imagery.

Dr. Ola Fredin from the NGU has certainly had that experience, stating that GeoImaging Tools "saved us days and days of processing". He further stated that GeoImaging Tools "worked great, it worked exactly as advertised". GeoImaging Tools for ArcGIS has certainly helped the NGU achieve its mandate and integrate a new data source (ASTER) directly in ArcGIS, giving this geologist the ability to do geology more effectively.

Solution and Benefits

PCI's GeoImaging Tools provides ArcGIS users with a suite of tools for processing and analyzing imagery in the GIS. PCI Geomatics is introducing a suite of modules that integrate directly into ArcGIS for achieving common image related tasks.

The release of GeoImaging Tools version 2.0 coincides and integrates directly within ESRI's recently released ArcGIS version 10 software. With the GeoImaging Tools Image Correction Module, ArcGIS users will benefit from rigorous, automated multi-sensor support and be able to correct raw imagery using sensor model information, optionally with automatic GCPs and tie points from reference data such as reference mosaics, or vectors. Higher levels of registration accuracy are achievable via block bundle adjustments. Users also have the option of saving the correction parameters and creating mosaic datasets for direct use with ArcGIS for on-the-fly processing, reducing data duplication.

GeoImaging Tools for ArcGIS version 2.0 is PCI's second GeoImaging Tools product release, and features direct integration within the ArcGIS 10 Arc Toolbox. Upcoming product releases include the Radar Module, which will provide the best tools for Synthetic Aperture Radar (SAR) data processing and analysis, including a comprehensive Polarimetric toolkit and support for all commercially available SAR sensors. For more information about GI Tools, visit our website at http://www.pcigeomatics.com/gitools.

NGU – Norwegian Geological Institute

NGU is an agency within the Norwegian Trade and Development department and is its central national institution for information about bedrock, mineral resources, soils and groundwater. NGU actively contributes to the geoscience knowledge used in an effective and sustainable management of the country's natural resources and environment. Its main tasks are to collect, process and disseminate knowledge about the physical, chemical and mineralogical characteristics of the country's bedrock, soils and groundwater. For more information about bedrock mapping, see http://www.ngu.no/no/hm/Norges-geologi/Berggrunn/

PCI Geomatics

PCI Geomatics, founded in 1982, is the world leader in geo-imaging products and solutions.

PCI Geomatics has set the standard in remote sensing and image processing tools, offering customized solutions to the geomatics community in over 135 countries and with more than 21,000 licenses distributed worldwide.

ESRI/ArcGIS10

Headquartered in Redlands, California, ESRI is a global software development and services company providing Geographic Information System (GIS) software and geodatabase management applications. ArcGIS is ESRI's flagship desktop software application suite, consisting of a set of geographic information system (GIS) software products used to manage data, maps, and geographic information within an interoperable, open, standards-based system. For more information about ArcGIS, visit http://www.esri.com/software/arcgis/arcgis10/index.html

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