ASTER Multispectral Satellite Imagery and Product Coverage, British Columbia – Phase 2[1]

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INTRODUCTION

The second phase of the ASTER Imagery for British Columbia Project, sponsored by Geoscience BC, has included increasing the quantity of Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) imagery available through the BC Ministry of Energy, Mines and Petroleum Resources' MapPlace website (BC Geological Survey, 2006). One hundred new images have been added to the collection for a total of 239 (Kilby *et al*., 2004; Kilby, 2005; Kilby and Kilby, 2006) and they are available for analysis through the MapPlace's Image Analysis Toolbox (IAT). The new imagery fills in gaps between previously obtained imagery and adds coverage in areas where coverage was previously available. Every effort was made to use the latest imagery possible with a number of the images being collected in the summer of 2006. A number of adjustments have been made in the type and quality of the derivative products associated with the ASTER imagery.

The preparation of the ASTER imagery for analysis through the IAT has remained the same as described in Kilby and Kilby (2006). This includes orthorectification and atmospheric correction. The two virtual reality files have been removed from the product suite for the 100 images added during this project. The Keyhole Markup Language (KML/KMZ) file product has been improved to provide simpler delivery with better results. This modification has been made for all the ASTER imagery on the website. In response to user requests, the static mineral map images are now available for download. The static image mask described in Kilby and Kilby (2006) has been replaced by an interactive masking tool in the IAT.

The IAT now provides online image analysis capabilities for 239 ASTER images covering most of the province. The northeast portion of the province still remains sparsely covered due to the relatively low value of ASTER imagery to mineral exploration in this region. Other popular web tools such as Google Earth (Google, 2006) have made some of the earlier IAT products such as the virtual reality files somewhat redundant and they have been discontinued. The increased popularity of the KML format for spatial data delivery and viewing has spurred the enhancement of the KML files provided by the site.

This project provides access to a recent provincial-scale detailed dataset of multispectral imagery that can be freely downloaded or used online in conjunction with the MapPlace to identify alteration zones, geological features and new exposures. The tools in the IAT can be used to generate map images of alteration zones in areas of good exposure or prospect for alteration minerals in isolated outcrops and roadcuts.

IMAGE ANALYSIS TOOLBOX ENHANCEMENTS

Image Coverage and Processing

One hundred new ASTER images were purchased as part of this project. Two previous projects had added 139 images to the IAT. ASTER imagery for this project was obtained from the Land Processes Distributed Active Archive Center operated by the United States Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA) for US$80 per image. Selection criteria for the new imagery were 1) new area coverage, 2) minimal snow and cloud cover and 3) currency of images. Figure 1 shows the distribution of the newly added imagery and the previously existing imagery on the IAT.

The new ASTER imagery was processed in the same manner as previous years. The image data was orthorectified and atmospherically corrected. Orthorectification was performed using the AsterDTM (SulSoft, 2006) add-on to the ENVI image analysis program (ITT, 2006). The orthorectified images were then manually adjusted to fit the TRIM (Terrain Resource Inventory and Mapping) 1:20 000 scale digital base map data displayed on MapPlace. Positional problems exist with the TRIM base in some areas and some positional errors are possible with ASTER. For consistency, the ASTER images were migrated to the TRIM base.

Atmospheric corrections were performed on the VNIR (Visible and Near Infrared) and SWIR (Short Wave Infrared) bands in all the images using the ACORN5 (Atmospheric CORrection Now) program (ImSpec LLC, 2006). This program performs a pixel-by-pixel correction of the image values by removing the effect of water vapour and other gases in the atmosphere using the MOTRAN4 technology. ASTER imagery does not contain enough information to calculate the amount of water vapour found within an image, so an estimated value of 15 mm of atmospheric water was used for all images. The ground elevation is required as input to accurately estimate the thickness of atmosphere above the target area. Each image was examined and

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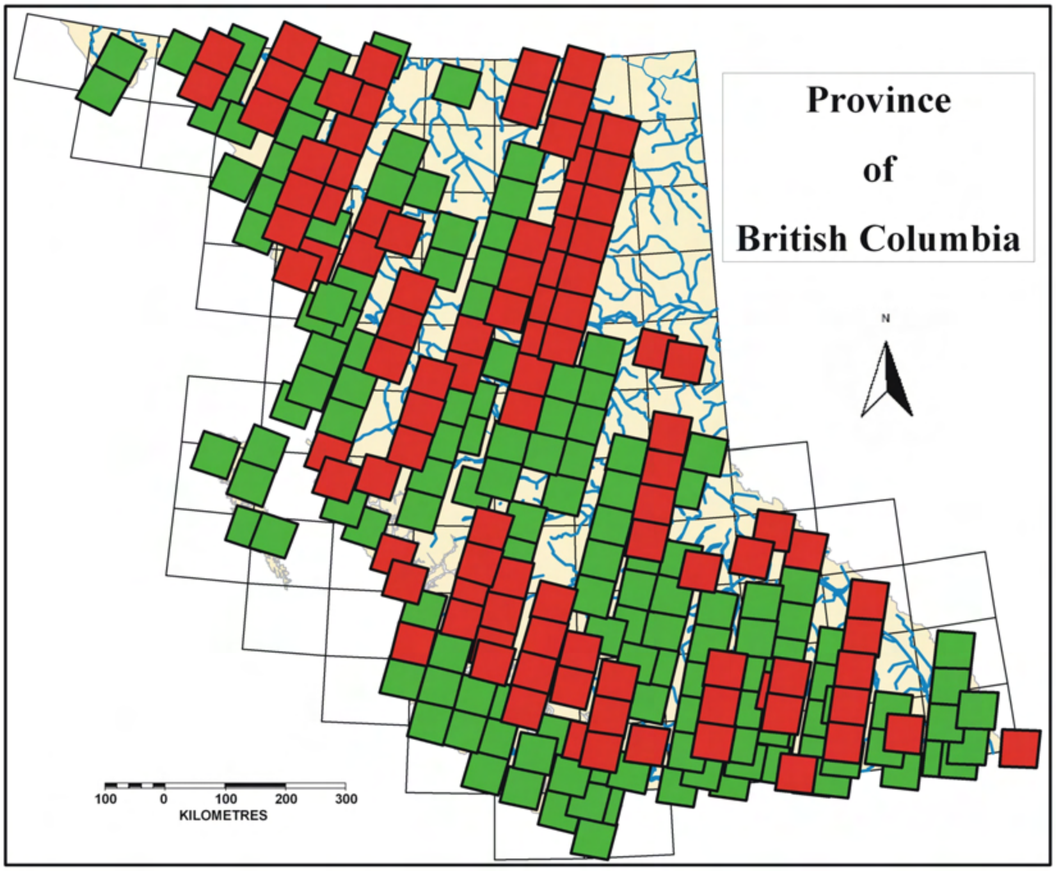

Figure 1. Display of ASTER image footprints in BC. Images added during this project are displayed in dark red and previously available images are displayed in green.

the elevation value for most of the rock exposure was used for this calculation. The atmospheric correction changes the image values from radiance to relative reflectance.

Interactive Masking Tool

The original method used to mask unwanted image pixels out of IAT calculations (Kilby and Kilby, 2006) was precalculated and had limited flexibility given the many possible analysis scenarios. For example, a single mask that included the removal of water pixels from an analysis is of little value to someone interested in looking at the water but not the vegetation or clouds. A new set of interactive masking tools have been added that allows users to apply flexible parameters to deal with variability between images and analysis targets. Figure 2 shows the layout of the masking tool available for all the ASTER analysis tools.

A mask can be built up from three components: vegetation, water and white stuff (snow, ice and clouds). The default values in the input boxes can be changed by users as they see fit. The mask is applied by checking the Apply box prior to digitizing an area of interest on the image. The masked area will appear black and not be included in any of the calculations. The vegetation value is based on the NDVI (Normalized Difference Vegetation Index) value of the pixels that range from 0 to 1. The higher this value the more vegetation (chlorophyll) must be measured in a pixel before it is masked out. Both the white stuff and water parameters use band 3 values to decide if a pixel is to be masked out. The water component masks out all pixels with band 3 values lower than the entered value and the white stuff component masks out all pixels with band 3 values greater than the entered value. Users are encouraged to ex-

Figure 2. Masking tool layout as it appears in all tools used to analyze ASTER images in the Image Analysis Toolbox (IAT). In this case, the Two-Band Ratio tool is shown. The user can change the initial default values and check the Apply box to activate the tool.

periment with values to produce a black mask of recognizable areas, such as vegetation, water, snow and ice, and apply the mask to a specific area of interest.

Alteration Image Download

Four mineral alteration images were prepared for each ASTER image and made available within the IAT. Shortly after an earlier release of this information, users requested the download of these files for use in their own software. As a result, these files are now included on the download page. The images are in portable network graphics (PNG) format with an associated world geo-location file (PGW) and are in UTM projection. The masked-out portions of these images have been made transparent. The four images map the band ratios that have proven useful in identifying siliceous rocks, iron oxides, sericite and illite, and alunite and kaolinite. The band combinations (J.A. Zamudio, pers comm, 2005) used to calculate each of these images are

- siliceous rocks (B10+B11+B12)/3/B13
- sericite and illite (B5+B7)/B6
- alunite and kaolinite (B4+B6)/B5
- iron oxides B2/B1

Virtual Reality Removal

Virtual reality files (WRL format) were produced for the first 139 images loaded on the site. The purpose of these images was to allow users, with the appropriate viewers, to interactively fly around the 3-D terrain models. However, with the availability of easy-to-use viewers such as Google Earth, there is no longer a need for these files. ASTER-related images and products can be draped directly over the Google Earth terrain by the user, making for a very interactive viewing option. In some areas, the Google Earth terrain is not as detailed as the ASTER-derived DEM, but this is likely to change as more detailed elevation data is released.

Keyhole Markup Language (KML/KMZ) Data

The KML format has recently become very popular for distributing spatial data due largely to the success of the Google Earth KML viewer (Fig 3). A number of other viewers and GIS products now can utilize data in KML/KMZ format. KMZ format is essentially a compressed version of the KML file with a few additional capabilities. The KMZ files provided through the Google Earth

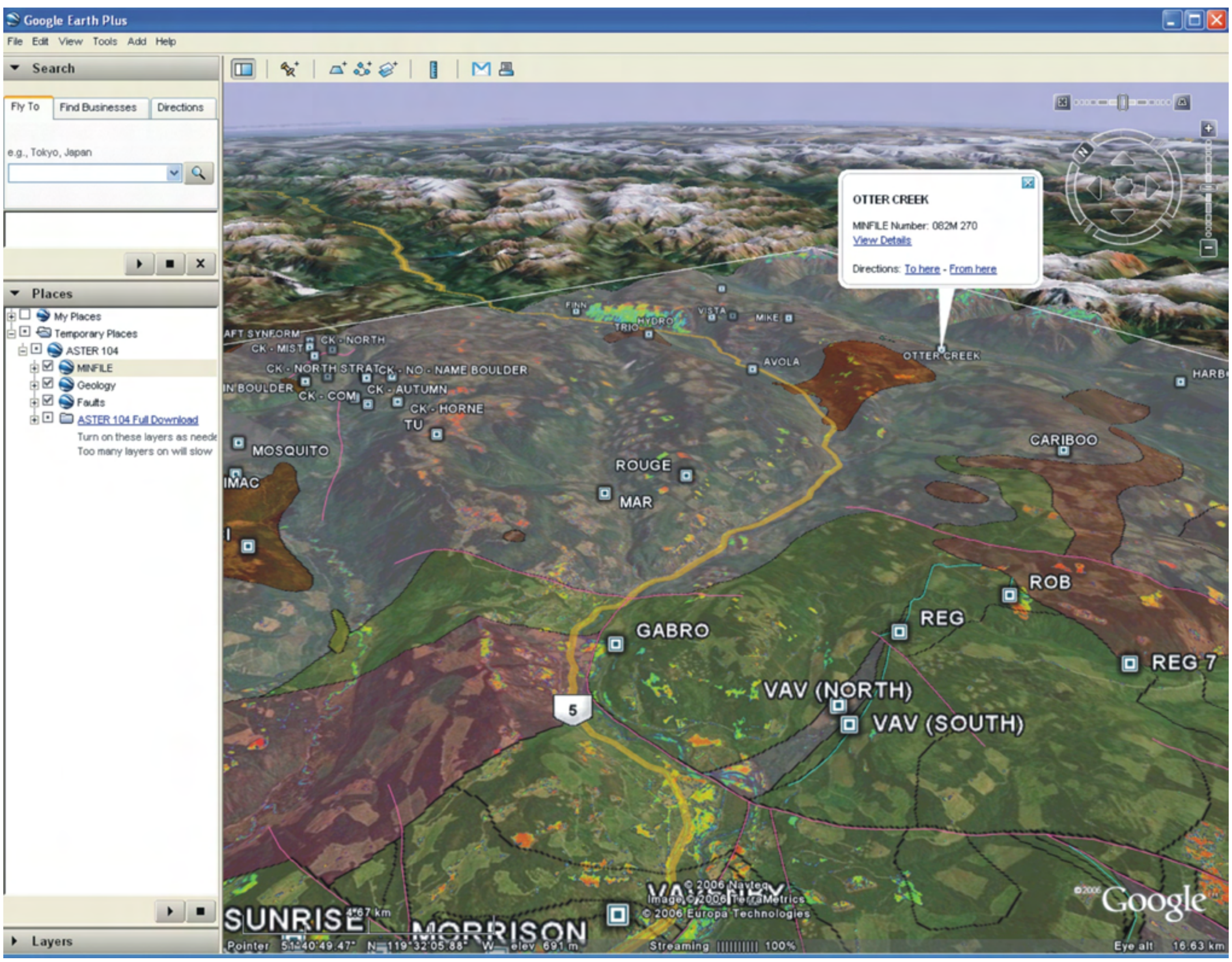

Figure 3. Example of a Google Earth view of a Keyhole Markup Language (KML/KMZ) file for a single ASTER image. Shown in the view are the geology polygons with about 50% transparency, fault lines, iron oxide mineral alteration image and MINFILE points (MINFILE, 2006).

link on the IAT have been modified to simplify their delivery and improve the resultant views.

The original six ASTER-related image overlays and the ASTER image footprint are still included in the KMZ file. These include

- a near-natural colour image
- an anaglyph image
- a siliceous rock image
- a sericite and illite image
- an alunite and kaolinite image
- an iron oxide image
- the imagery and spatial data from Google Earth.

Previously, some geology and mineral occurrence (MINFILE, 2006) information was included from the MapPlace. The delivery of this information was based on WMS (Web Map Service) technology. The result of this form of delivery was very coarse raster linework that required refreshing from the server every time the view moved. The geology consisted of fault lines and formation contacts. The MINFILE data was displayed with poor quality labelling. The WMS style of data delivery in the KMZ files has been dropped in this project in preference for including the actual linework for the faults and geology polygons (Massey *et al*., 2005; Fig 3). As a result, the initial download may take a little longer but the resultant display is far superior. The MINFILE locations are also displayed in a more dynamic form with links to occurrence details, similar to those found on the MapPlace and MINFILE websites. Viewers such as Google Earth, WorldWind and ArcGIS Explorer or GIS systems such as Manifold and FME can read the geology and MINFILE information delivered in this format.

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