TNTmips

Geospatial Analysis for the Development of Your Geological Resources

MicroImages
microimages.com

TNTmips is a low-cost, integrated software package for your organization's use and management of all its spatial information at all levels: from the desktop to the enterprise.

TNTmips provides the tools needed for your detailed analysis of image, terrain, and a wide variety of other spatial information for mineral exploration and geologic mapping, in the field or office. As your projects progress and expand, TNTmips can be used to take them all the way through to the preparation and publication of local, regional, or geological maps.

Mineral, Oil, and Government Organizations That Have Already Purchased TNTmips

ANGOLA
- ODEBRECHT Mining Services

ARGENTINA
- GAMSA (Gencor)
- Provincial Director of Mining

AUSTRALIA
- Advanced Magnesium Technologies
- Aerodata
- Anglogold Australia
- Billiton
- CRA Exploration
- DEMs
- Exploration and Mining (CSIRO)
- Geophysical Imaging Services
- Geo Mapping Technologies
- Kinhill Engineers
- Mt. Leyshon Gold Mines
- Newmont Mining
- Normandy Exploration
- Normandy Poseidon
- North
- North Flinders Exploration
- NSW Geological Survey
- Orpheus Geoscience
- Queensland Metals
- Rio Tinto Exploration
- Spectrascan
- Stockdale Prospecting
- Wakelin Associates

BELGIUM
- Bureau of Geological Consultancy

BOLIVIA
- GeoPlus
- Petrobras Bolivia

BOTSWANA
- Tinto Botswana Exploration

BRAZIL
- Anglo American
- Barrick do Brazil Mineracao
- Empresa Minera
- IAMGOLD Brazil
- Sopemi
- TVX Gold

CANADA
- IAMGOLD Canada
- INCO Exploration & Technology
- Kennecott
- Orvana Minerals
- TVX Gold

CHILE
- Anglo American
- Asarco Exploration Chile
- BHP Billiton
- Center Investigation Minerals
- Codelco
- Empresa Minera de Mantos Blancos
- INCO
- Phelps Dodge Exploration
- Placer Dome
- SERNAGEOMIN
- TVX Gold

CHINA
- BHP Billiton China

ECUADOR
- Gatro Ecuador Minera (GEMSA)
- IMAGOLD Ecuador

FINLAND
- Geological Survey of Finland
- Metsakartoitus
- Outokumpu Mining
- Polar Mining

FRANCE
- Hexamines
- Rio Tinto Zinc
- Total Oil

GREECE
- Institute Geologic Mineral Exploration

ICELAND
- EKRA Geological Consulting

INDIA
- Geology and Mining, Ind. Dir.

INDONESIA
- Lemigas R&D for Oil and Gas

IRAN
- CHKON

IRELAND
- Rio Tinto Zinc

JAPAN
- Geological Survey of Japan
- Japan Oil, Gas and Metals
- Metal Mining Agency of Japan
- MINDECO
- Mitsui Mineral Dev En
- Mitsui Oil Exploration
- Nittetsu Mining

KAZAKHSTAN
- ALTYN-TAS

LAOS
- Ministry Mining and Exploration

MEXICO
- Mexicana de Cobre
- Minera Kennecott

NAMIBIA
- Anglo American
- Erongo Mining
- Rio Tinto Namibia
- Rossing Uranium

PAPUA NEW GUINEA
- Dept of Mining & Petroleum
- Highlands Gold

PERU
- Newmont Exploration
- Billiton Peru
- Instituto Geologico, Memeroy Metalugico

PHILIPPINES
- Philex Mining

PORTUGAL
- Rio Tinto Finance & Expl.

RUSSIA
- Aerogeophysica
- CRRU
- SHANECO
- SOYUZMORGEO

SLOVAKIA
- Geocomplex

SOUTH AFRICA
- Anglo American
- Anglo American Prospecting
- Anglogold Ashanti
- Anglovaal
- AOC
- BHP Billiton
- Central African Gold
- COMRO
- Contract Geological Services
- Mining Technology (CSIR)
- DeBeers
- DeBeers Marine
- Dow South Africa
- Gencor
- GENMIN
- Gold Fields
- Lonmin Platinum
- MSA Geoservices
- O'okiep Copper
- Rand Quest Syndicate
- RandGold Resources
- Rio Tinto Exploration
- ROC Mining
- Shell Minerals
- Teklogic
- TerraMare Remote Sensing
- TOPAC
- Trans Hex Group
- Trojan Exploration
- Vereeniging Refractories

SPAIN
- Repsol Exploration
- Riomin Exploraciones
- Riomin Iberica

SWEDEN
- Swedish Geological

TANZANIA
- Ministry of Mines

THAILAND
- Geologic Survey Division
- Mineral Resources Development

TURKEY
- Maden Tenik Arama Genel Mudurlugu
- Rio Tinto Zinc
- RioTur Madencilik
- Turkish Petroleum (TPAO)

UNITED KINGDOM
- BHP World Exploration
- Grant Tensor
- HOH Oilfield Services
- Nigel Press Associates
- Petro-Canada
- Ranger Oil
- Reynolds Geo-Sciences
- Rio Tinto Zinc

USA
- Applied Geology
- ASARCO
- Autodyne
- BHP
- Gibson Consulting
- Integrated Geoscience & Engineering
- Intrasearch
- Kennecott Exploration
- La Minerals
- Orvana Resources
- Placer Dome
- Silverthorn Exploration
- Union Texas
- USGS
- Western Mining

ZAMBIA
- Independence Gold Mining
- Minerals Resources
- Prospecting Ventures
- Zamanglo Prospecting

ZIMBABWE
- Anglo American
- Rio Tinto Zimbabwe

31 August 2006

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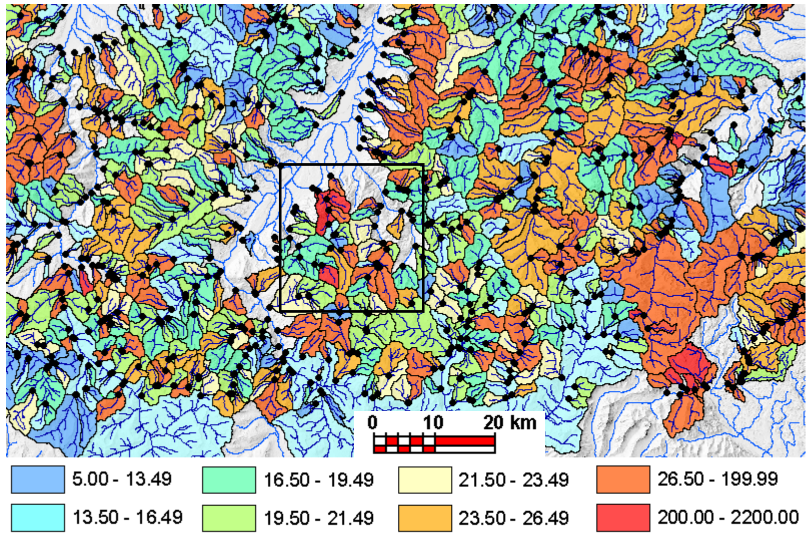
Sample Script

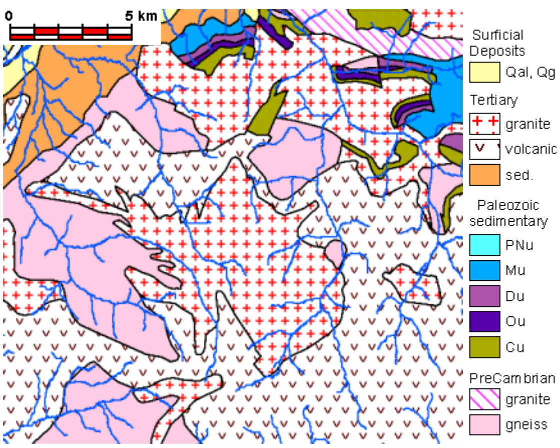
Catchment Analysis for Locating Ore Deposits

Regional surveys of stream sediment geochemistry are a major tool in exploration for mineral resources. Well-chosen sampling locations along major and tributary streams allow reconnaissance characterization of large areas and detection of anomalous elemental concentrations that could signal the presence of an ore body. The SampleCatchment script developed by MicroImages provides initial geospatial processing of geochemical datasets with hundreds or thousands of sample points and creates products that can be used as input for further geospatial and statistical analysis. The script uses a digital elevation model to delineate the upstream watershed catchment area for each sampling point and transfers the point attributes to the appropriate catchment polygons (see the color plate entitled *Sample Script: Mapping Catchment Areas for Sample Points*). Multiple samples within a single watershed generate subcatchments that are attributed to identify the number and identity of adjacent upstream and downstream catchments. The composition of each sample is influenced by all upstream subcatchments, so each catchment is also attributed with the total area of all contributing subcatchments.

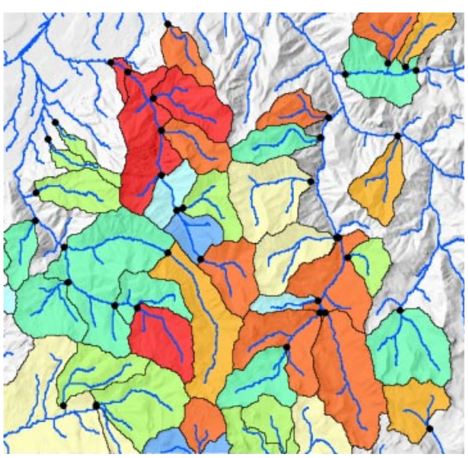


Catchments theme-mapped by copper concentration (ppm) in geochemical stream sediment samples taken at locations marked by black dots. Portion of a 26,000 square kilometer area with over 1200 sample points processed using the SampleCatchments script. Box outlines area shown in illustrations below.

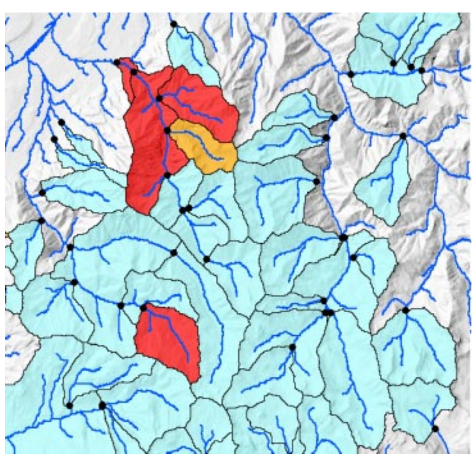
The illustrations on this page provide a hypothetical example of how geospatial analysis of the sample catchments in TNTmips can be used to help solve one of the main interpretive challenges with geochemical data, the identification of anomalous concentrations. Background values of each element, such as copper, can fluctuate from catchment to catchment depending on the relative proportions of different rock types exposed in the contributing area, even in the absence of ore bodies. In order to predict background values of copper, the Polygon Properties process was used to overlay the catchments with a geologic map and determine for each subcatchment the areal extent and percentage of different rock units. A geospatial script (GeolUnitArea, excerpted on the opposite side of this page) was then used to identify for each catchment all of its contributing catchments and to sum the rock unit areas over those catchments. The resulting table of copper concentrations and unit percentages was used in a statistics program to perform a multilinear regression to compute a predicted copper concentration and residual for each catchment. After reimport to TNTmips, the residuals were then weighted by total contributing catchment area using a computed field and theme-mapped to reveal two catchments with anomalously high copper concentrations within the test area.



Geologic map of part of the test area.

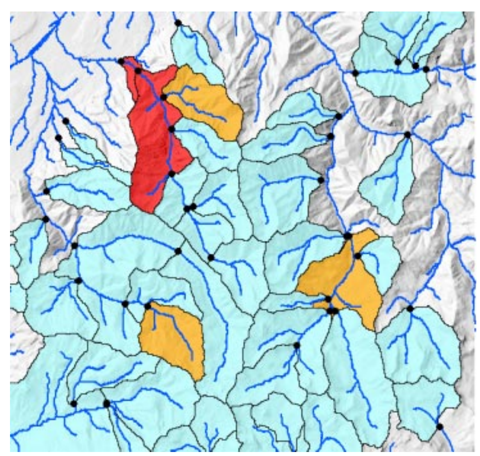


Catchments Theme-Mapped by Measured Copper Concentration
(legend same as upper right map)



Residuals (measured minus predicted value) of Log_{10} Copper Concentration (ppm)

0.00 - 0.19 | 0.20 - 0.89 | 0.90 - 1.20



Residuals of Log_{10} Copper Concentration Weighted by Catchment Area

0.00 - 1.99 | 2.00 - 19.99 | 20.00 - 61.84

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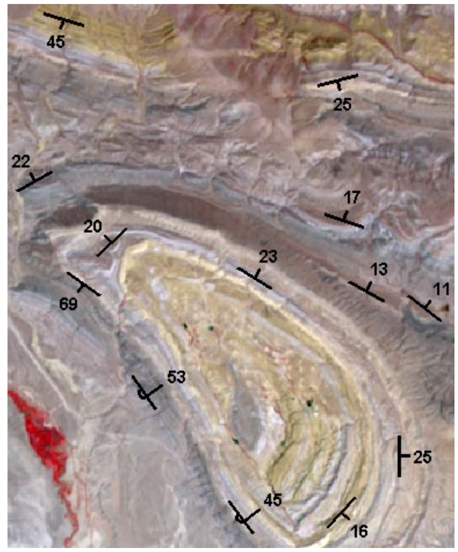
Sample Tool Script

Measure Strike/Dip of Geologic Features

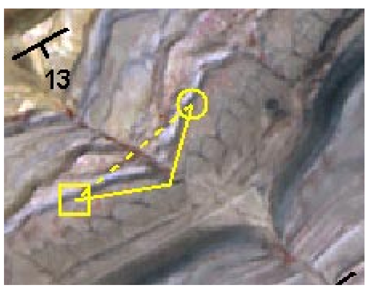
The patterns traced across the landscape by layered rock units provide key evidence about surface and near-surface geologic structure. Geologists can map these surface features remotely using aerial or satellite images, but in order to quantify the structural geometry, they need measurements of the strike and dip (measures of 3D orientation) of the rock layers at many locations. This Tool Script enables geologists to measure and record the strike and dip of bedding or other map-scale planar features (such as joints, faults, dikes, and others) using a reference image overlaid on an elevation raster in the View. Key portions of the script are excerpted on the opposite side of this page. The script solves the classic "3-point problem" of structural geology: given the x-y-z coordinates of three non-colinear points on a plane, compute the strike and dip of the plane.

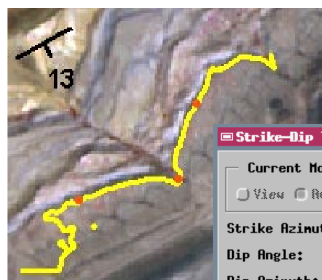


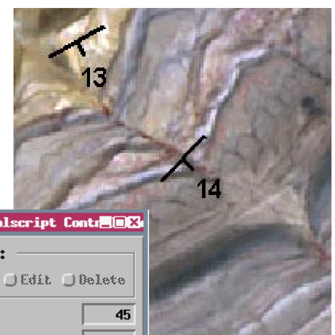
Measurement locations are added as point elements to a vector object and automatically styled using the appropriately-oriented and labeled strike and dip symbol from an accompanying CartoScript.

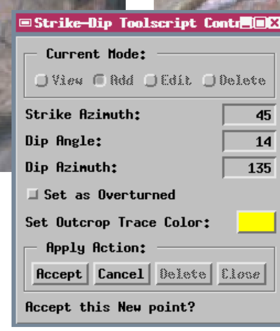
In the Tool Script's default Add mode, you use a standard polygon tool provided by the script to indicate in the View window the locations of the three required points (as triangle vertices) on a planar geologic feature. The script reads the elevation for each point from the elevation raster (which must be the first layer in the group), determines the corresponding plane, computes its strike azimuth, dip angle, and dip azimuth, and shows these values in the script's control window. The script also computes the outcrop trace of the computed plane over the terrain surface in the vicinity of the measurement point and draws this trace in the view. Comparing this trace to the local outcrop pattern shown by the reference image provides you with a visual quality-control assessment of the accuracy of the computed orientation of the plane. The polygon tool remains active to allow you to adjust the triangle vertices, if necessary, yielding a revised set of orientation values and a new outcrop trace. When you accept the orientation measurement, a point element is added to the designated Strike/Dip vector object and the orientation values are stored in an attached record in the associated point database. These points are also automatically styled by CartoScript with the appropriately-oriented and labeled symbol for the strike and dip of bedding. The Tool Script can be revised easily to reference a different CartoScript for styling symbols for other planar geologic features.

CartoScripts for various geologic map features are available for free download from: **www.microimages.com/freestuf/cartoscripts/**









The point symbol is placed at the center of the triangle and styled by CartoScript.

The Tool Script's control window provides View, Add, Edit, and Delete modes.

In Add mode, use the polygon tool to draw a triangle on the desired planar feature (above left). Use the Line/Polygon Edit Controls (left) to adjust the triangle if needed, then press [Apply] or press the right mouse button. The computed values for the plane are shown in the Tool Script's control window (right) and the outcrop trace is drawn in the View in the selected color (above right). Press [Accept] on the control window to store the point and its data.

In the Tool Script's View mode, you can select one or more data points and turn on their outcrop traces for mutual comparison and to help map outcrop patterns.

The outcrop trace line for each measurement location is also added to a separate vector object with your selected line color. In the Tool Script's View mode, you can left-click on any strike-dip symbol to select it and use the Accept button on the Tool Script's control window to toggle the point's outcrop trace on or off. In this manner you can turn on and view several outcrop traces simultaneously. These computed outcrop traces can help you trace outcrop patterns and contact positions through areas of poor exposure (due to vegetation or soil cover) that might surround your measurement points.

The Tool Script's Edit mode allows you to select and edit existing strike-dip measurements. Selecting a point in this mode reactivates the polygon tool with its former vertex locations so that you can adjust its position and compute revised orientation measurements and a revised outcrop trace. You can also delete points and their accompanying outcrop traces using the Tool Script's Delete mode.

Suppressing Vegetation in Multispectral Images

MicroImages has created an SML script that automates processing of multispectral images to suppress the expression of vegetation for geological and soil mapping applications. The script, devegX.sml, implements a “forced invariance” methodology developed by NASA researchers* at the Jet Propulsion Laboratory. Near-infrared and red image bands are used to estimate spatial variations in vegetation abundance. Vegetation suppression can be applied to these bands and to other image bands you select. The script determines the statistical relationship between the values in each band and the vegetation index. Band values are then adjusted so that the average band value for each index level is uniform across all vegetation index levels.

The forced invariance method works well in areas of open-canopy vegetation, such as arid and semi-arid terrains, where many image cells include both vegetation and bedrock or soil. Both bedrock outcrop patterns and the overall contrast of nonvegetative materials are enhanced.

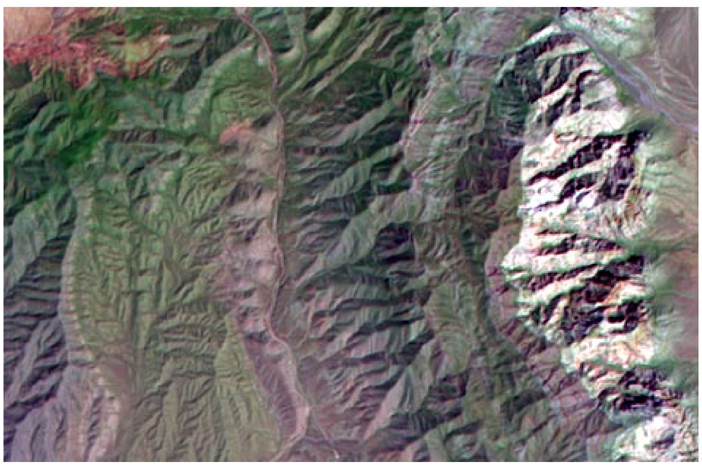
In addition to the adjusted image bands, the script produces a vegetation index raster and, for each devegetated band, a raster scatterplot of band versus vegetation index values and a graph (CAD object) of the smoothed band average versus index values that are used to rescale the band.

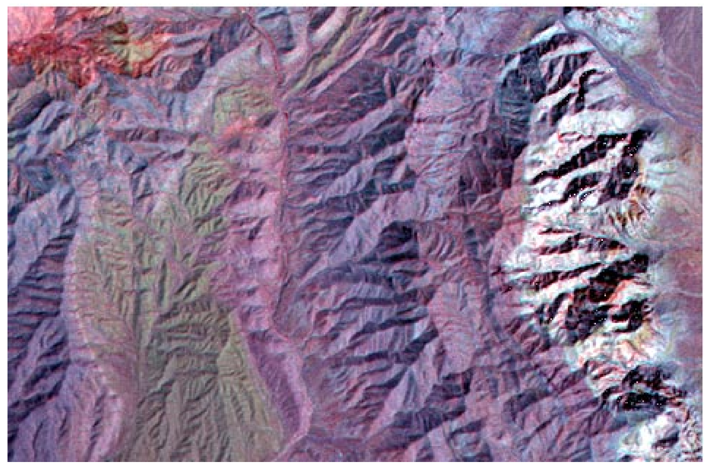
The devegX.sml script is available for free download from:

www.microimages.com/freestuf/smlscripts.htm

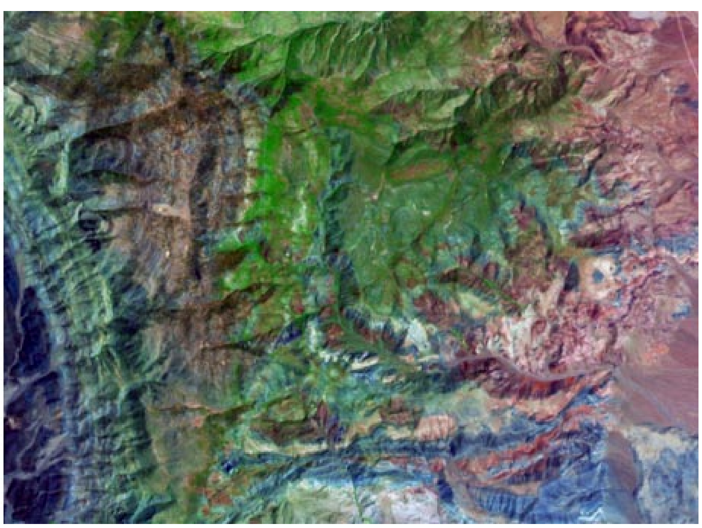
Color displays of Landsat Thematic Mapper images with RGB = Band 7, Band 4, Band 2. Vegetated areas appear green.

Same image areas and band combination after vegetation suppression by devegX.sml. Bedrock outcrop patterns in vegetated areas are much clearer.





Spring Mountains, southern Nevada, USA. Width of scene is 14.3 kilometers.



Inyo Mountains, eastern California, USA. Width of scene is 13.7 kilometers.

*Crippen, Robert. E. and Blom, Ronald G., 2001, Unveiling the Lithology of Vegetated Terrains in Remotely Sensed Imagery, Photogrammetric Engineering & Remote Sensing, Volume 67, No. 8, pp. 935-943.