

EcuadorMap: A mineral occurrence data set for Ecuador Instructions for MapInfo and ArcGIS users

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Introduction

EcuadorMap is a GIS data set for Ecuador. The *Geography* module provides infrastructure (cities, roads, political boundaries, etc.), digital topography (DEM files), shaded relief, and bathymetry. *Geology* provides an up-to-date geologic map and legend in vector format. The *TS Units* module provides a tectonostratigraphic map and legend based on publications from government, industry and academia. *Radiometric Dates* compiles published radiometric ages. The *Prospect* module locates 900 mines and prospects, classifies them according to 18 deposit types, and assembles current figures for past production, resources and reserves. *Land Status* locates 8600 metallic and non-metallic mineral concessions (attributed with ownership and contract date) and plots the locations of 240 national parks, forest reserves, and other areas of restricted mineral entry.

The Ecuador Multielement Geochemical Data set, available separately, assembles geochemical data for 14,000 stream sediment samples in vector format.

EcuadorMap is constantly being revised and updated as new resources are announced for an ever-increasing number of metallic mineral deposits. Geologic and tectonostratigraphic maps are updated or modified to reflect ongoing research. Pricing is covered on the final page of this data set description.

New users should pay special attention to the “Installation” section.

Geography, Geology and TS Unit Modules

The *Geography* and the *Geology* modules of the EcuadorMap data set are displayed by opening “ECGeography” and “ECGeology.” *Geography* includes shaded relief and bathymetry and is accompanied by digital topography (DEM files), infrastructure and a topographic map index. *Geology* provides, in addition, the 2017 published geologic map and legend in vector format. This map displays rock units colored according to age and lithology. *TS Units* is a tectonostratigraphic

map and legend compiled using the published geologic map as a base but colored with tectonostratigraphic rock unit assignments (e.g. plateau basalt of the Caribbean Large Igneous Province) rather than location-specific lithologic descriptions (e.g. Dumisseau basalt). The *Geography*, *Geology* and *TS Units* modules have broad application beyond the mining and exploration industry.

Radiometric Dates Module

The *Radiometric Dates* module compiles published radiometric ages along with sample number, sample location, description, analytical method, mineral dated, error and a reference to the literature. Two additional fields record the original and the current interpretation for each date, e.g. intrusion/crystallization age, inherited age, volcanism/crystallization age, age of metamorphism, exhumation, hydrothermal alteration or age of sedimentation.

Prospect Module

The *Prospect* module, which includes modules for *Geography*, *Geology*, *TS Units* and *Radiometric Dates*, is displayed by opening “ECProspects.” Metallic mineral occurrences are plotted using shapes that correspond to deposit types, colors for each metal, and sizes that reflect gross contained metal value. Selecting a prospect with the info tool will call up attached information including location, source of data, deposit type, owners, partners, past production, current resources, current reserves, status (active mine, inactive mine, prospect), drill results, geologic observations, recent sales and joint ventures, and references to the literature as well as calculated fields for total size (in tons or ounces) and contained metal value in US\$.

Land Status Module

The *Land status* module is displayed by opening “ECLandStatus” which plots over 8600 metallic and non-metallic mineral concessions. Concessions, color-coded and plotted on a shaded relief base map, are attributed with concession type, ownership information, contract date, and contract duration. Only official government records are used to generate the concession map. The map provides a “snapshot” of land status as of the last compilation date. For specific areas of interest, a thorough review of current land status is always necessary.

The land status data set also shows national parks, forest reserves, Indian reservations, national monuments and other areas where mineral exploration and development is restricted or prohibited.

Subdirectories

Concessions subdirectory:

Concession information for Ecuador is stored in the Concessions subdirectory. Each of over 8600 metallic and non-metallic concessions and concession applications is attributed with its registration number, name and contact information for the concession holder, contract date, duration and expiration date. For the most up-to-date concession status in any particular area, the user is referred to the ARCOM (Agencia de Regulación y Control Minero) website: <http://geo.controlminero.gob.ec:1026/geovisor>.

Geology subdirectory:

The Geology subdirectory contains the published (2017), 1:1,000,000 scale geologic map and legend for Ecuador in vector format.

Parks subdirectory:

The Parks subdirectory contains 240 national parks, forest reserves, and protected areas. These are areas where mineral development is prohibited or restricted.

Survey Indices subdirectory:

The files in this subdirectory show the location of stream sediment surveys and geophysical surveys conducted by companies, governments and international aid organizations. Stream sediment survey indices include the number of samples collected, area covered, sample density, list of elements run, and the source of the data. Geophysical survey indices include the type of survey (magnetic and/or radiometric), area covered, and the source of the image or data.

Prospect subdirectory:

The Prospect subdirectory stores published information pertaining to 900 mines and mineral occurrences in an MS Access database (EC_Proc.accdb). The data set includes: name, alternate names, location, reference for location, deposit type, district name, owners, partners, deals, production, production period, production reference, reserve, reserve reference, resource, resource reference, status (active mine, inactive mine, resource, prospect), drilling (best intercepts), geologic observations, overall size (in ounces or tons) and contained metal value.

Mineral occurrences are classified according to 18 deposit types, listed in the following table. MapInfo cannot read MS Access queries, consequently each deposit type has a stand-alone table in the Prospect subdirectory.

Metallic Mineral Deposit Classification

Deposit Type	Symbol
Epithermal veins and stockworks (Au, Ag, Cu, Pb, Zn)	1
Epithermal disseminated (Au, Ag, Cu, Zn)	13
Epithermal veins and stockworks of Hg and Sb	8 (Hg), 10 (Sb)
Volcanogenic massive sulfide (VMS) deposits	2
Sediment-hosted (Sedex) deposits	14
Volcanogenic (Seafloor) manganese deposits	9
Sediment-hosted (U, Th, V) deposits	27
Banded iron formation (Au, Fe, Mn) deposits	21
Porphyry (Cu, Mo, Au, Ag) deposits	5
Skarn (Au, Ag, Cu, Pb, Zn) deposits	3
Iron skarn (Fe) deposits	24
Carbonate replacement (Au, Ag, Cu, Pb, Zn) deposits	22
Iron replacement (Fe) deposits	23
Greisen (Sn, W) deposits	17
IOCG (Iron-oxide copper gold) deposits (Au, Ag, Cu, Mo)	16
IOCG (U, REE, Fe) deposits	25
Alkaline Rocks and Carbonatites (U, Th, V)	18
Alkaline Rocks and Carbonatites (Sc, REE)	26
Orogenic (shear-hosted, mesothermal) deposits (Au, Ag)	4
Magmatic segregation (Cr, Pt, Pd) deposits	11
Lateritic (Ni, Co) deposits	6
Bauxite (Al, REE, Sc) deposits	12
Alluvial (Au, Ag, Pt, Pd) deposits	7
Alluvial (U, Th, REE, Sc) deposits	28
Alluvial (Fe, Sn, W) deposits	29
unassigned	99

Geophysics subdirectory:

The Geophysics subdirectory contains raster images for Reduced to Pole (RTP) and analytic signal aeromagnetic surveys.

Geochemistry subdirectory:

Multielement geochemical survey data for Ecuador has been assembled and digitized (vector format) for over 14,000 samples collected during the 1990's as during programs sponsored by PRODEMINCA and RTZ. This geochemical data set is designed to work with ECMap but is sold separately. Pricing information is provided on the final page of this document.

Shaded Relief and Bathymetry subdirectories:

Shaded relief and bathymetric maps for Ecuador are provided in the Shaded relief and Bathymetry subdirectories. Ninety-meter (3 arc-second) resolution data used to create shaded relief maps comes from version 2 (2005) of the Shuttle Radar Topography Mission (SRTM) (<http://seamless.usgs.gov>).

Regional bathymetry (as DEM grd files) was downloaded from the Marine Geoscience Data System: Global Multi-resolution Topographic Data portal (MGDS: GMRT) at <http://www.marine-geo.org/portals/gmrt/>. The bathymetric map is created from (shipboard) sonar supplemented, between tracks, by gravity and satellite altimetry data using a process described by Ryan et al., 2009: <http://onlinelibrary.wiley.com/doi/10.1029/2008GC002332/full>. MGDS: GMRT data was re-gridded to produce maps at an approximate resolution of 200 meters (up to 240 meters depending on location).

Geography and 50K topo index subdirectories:

The Geography subdirectory includes borders, cities and towns, roads, and major drainages. Indices to published 1:50,000 scale topographic maps are provided in the 50K topo index subdirectory.

Radiometric Dates subdirectory:

The Radiometric Dates subdirectory compiles ages for 60 samples. Each sample is attributed with sample number, location, lithology, sample description, analytical method, rock type, material dated, age, error and source of information. The data set also includes fields both the original and the current interpretation (e.g. inherited age, intrusion/crystallization age, volcanism/crystallization age, age of metamorphism, age of exhumation, etc.)

TS Units subdirectory:

This subdirectory contains files used to create a tectonostratigraphic (TS) map of Ecuador. The TS map uses the published geologic map from the Geology subdirectory as a base. Then, based on government, industry and academic publications, geologic map polygons are assigned attributes and colors according to their tectonostratigraphic setting. For instance, rather

displaying map units according to their age and lithology (e.g. Jurassic Azafran granodiorite), the TS_PGONS file is attributed with origin and tectonic setting (e.g. tholeiitic intrusion from an intraoceanic island arc or calc-alkaline intrusion from a continental margin volcanic arc). The result is a tectonostratigraphic map that is easy to understand and directly applicable to mineral exploration.

Titles and legends subdirectory:

Title blocks, legends, grids, labels, and scale bars are stored here.

UTM subdirectory:

A UTM index is provided for all of Ecuador along with grids for each UTM zone. Grids are provided for the following projections: 1) Latitude/Longitude (Equidistant Cylindrical) projection using the WGS 1984 datum, 2) Lambert Conformal Conic projection (origin latitude 39 degrees north, origin longitude 96 degrees west, standard parallels 33 and 45 degrees north) with the NAD 1927 datum, and 3) MapInfo's Latitude Longitude (Equidistant Cylindrical) projection using no datum.

Ancillary Files subdirectory:

The Ancillary Files subdirectory contains files that modify or supplement the user's GIS software. For ArcGIS users, this subdirectory includes ArcGIS layer files and files for use with ArcToolbox. For MapInfo users, this subdirectory includes picklists and "MapInfoW.fnt" with special fonts. All are described in the following section on Installation.

A file called "deposit_size_calculations_2018.xlsx" lists the formulas that are used in calculating deposit size and gross contained metal value. For instance:

Au and Ag deposit size = past production in ounces + (resource in metric tonnes * resource grade in ppm * 1/31.1034768) + (reserve in metric tonnes * reserve grade in ppm * 1/31.1034768)

Base metal, Aluminum, Nickel, Cobalt and Chromium deposit size = past production in tons + (resource in tonnes * 2204.623 / 2000 * resource grade in percent / 100) + (reserve in tonnes * 2204.623 / 2000 * reserve grade in percent / 100)

Deposit value = deposit size (in ounces for precious metals, in tons for base metals, aluminum, nickel and cobalt) * metal price. Polymetallic deposit values represent the sum of each of the contained metals.

Plots subdirectory:

The Plots subdirectory contains high resolution tiff images for the

metallogenic map and the land status map of Ecuador.

MapInfo Installation

Start by checking that Microsoft Access and MapInfo version 15.0 (or higher) are installed on your computer. If this is an update, backup your previous version before erasing the old data set. Copy the new EcuadorMap data set to the root directory (C:\). Rename the folder EcuadorMap (C:\EcuadorMap).

Fonts

EcuadorMap map uses several customized fonts that are not delivered with standard MapInfo software. Follow these steps to replace your “MapInfo 3.0 Compatible font” with a customized version provided in the Ancillary_Files subdirectory.

- Exit MapInfo if it is running.
- Be sure that you are displaying hidden files and folders.
 - On a machine that is running Windows 10, open Windows Explorer and go to File > “Change Folder and Search Options.” Select the “View” tab. Then, under “Hidden files and folders” select the option to “show hidden files, folders and drives”.
- Locate the file MAPINFOW.FNT on your computer.
 - On a machine that is running Windows 10, it is found in:
C:\Users\YOURUSERNAME\AppData\Roaming\MapInfo\MapInfo\Professional\1500
(for MapInfo version 15)
- Rename MAPINFOW.FNT; call it MAPINFOW_FNT.OLD
- Copy "MAPINFOW.FNT" from the Ancillary_Files subdirectory into the folder where "MAPINFOW_FNT.OLD" is located.

Picklists

EcuadorMap map uses MapInfo Discover picklists to assign colors to tectono-stratigraphic units, parks and concessions. Although neither Discover nor the picklists are required to run EcuadorMap, users who want to edit the picklists (to change colors or add categories) will need to copy the .xml files from the Ancillary_Files subdirectory and paste them to the following subdirectory:
C:\Users\username\AppData\Roaming\Encom\Discover\Picklists

Microsoft Access Database

Mineral occurrence information for MapInfo users is stored in a Microsoft Access database, EC_Proc.accdb, located in the Prospect subdirectory. Prospects, a table in the Access database, compiles relevant information for each mineral occurrence including: location, deposit type, owners, partners, past production,

current resources, current reserves, published sources for past production, resource and reserve figures, status (active mine, inactive mine, prospect), salient drill results, geologic observations, ownership, terms of recent sales and joint ventures, and references to the literature. Calculated fields show the total precious metal content in ounces, base metal content in tons, and total contained metal value in US dollars.

New mineral occurrences can be added and changes can be made to existing mineral occurrence information by using MSAccess to modify the EC_Pro database. EC_Pro.accdb also contains a series of queries that select all deposits for each of the deposit types listed on page 4.

A form in EC_Pro.accdb, "Update Deposit Size and Value" must be used to update gross contained metal values whenever changes are made to production, resources or reserves. This form can also be used to change the metal prices used in the calculation of gross contained metal value.

When adding records to the MSAccess database (EC_Pro.accdb), any nulls (empty fields) should be replaced with zeros (0's) in the entries for production, resource and grade since the calculation of deposit size and value draws numeric values from those fields.

Open Database Connectivity - ODBC Issues

MapInfo connects to the Prospects database (EC_Pro.accdb) via a dsn file (ECPros1.dsn) which resides in the Prospect subdirectory. All changes made to the database in MapInfo automatically flow through to the Access database when the MapInfo table ECPros1.tab is saved. (MapInfo may ask you to browse to the location of the MSAccess database.) Once changes have been saved to the MSAccess database, MapInfo will give you the option to "refresh" the linked MapInfo table. Answer "yes." If inconsistencies arise between the data in the Access database and the data in the MapInfo tables, MapInfo will issue a warning message that prompts the user to resolve the conflict.

It is best to refresh the linked MapInfo tables, including EC_Pro.tab, whenever changes are made to the mineral occurrence information whether from within MapInfo or from within Microsoft Access. After refreshing the MapInfo linked tables, close any open DBMS connections using "file > close DBMS connection" or the "disconnect DBMS" button.

MapInfo cannot read MSAccess queries. For this reason, deposit type selections are saved not only as queries in the MSAccess database but also as linked MapInfo tables in the Prospects subdirectory.

You are now ready to run EcuadorMap. Open the prospects data set and metallogenic map by opening ECProspects. ECProspects_trim is a faster-opening

version of ECProspects. Open the land status data set and concession map by opening ECLandStatus. You can also create your own workspaces (MapInfo) or project files (ArcGIS).

ArcGIS Installation

Install ArcGIS version 10.6 (or higher) on your computer. If this is an update, backup your previous version before erasing the old ECMap directory. Copy your new data set to the root directory of your hard drive (C:\ECMap).

ESRI Geodatabase management

All mineral occurrence information is stored in EC_Pro.s.gdb, an ArcGIS geodatabase located in the Prospects subdirectory. Additions or changes to mineral occurrence information are made directly to the Prospects table in EC_Pro.s.gdb.

Most users will not need to make changes to the information that is stored in EC_Pro.s.gdb. However, if changes are made to production, reserves or resources, then deposit size and value fields should also be updated. These updates are made by running the Python script "UpdateProspects.pyt." The following instructions explain how to add "UpdateProspects.pyt" to ArcToolbox.

- Copy the file "UpdateProspects.pyt" from C:\ECMap\Ancillary_Files\ into the "My Toolboxes" folder. A common path to this folder, for ArcMap 10.6, is:
C:\Users\[your username]\AppData\Roaming\ESRI\Desktop10.6\ArcToolbox\My Toolboxes\
- Start ArcMap, and click on the ArcToolbox button
- In the ArcToolbox window, right-click in open space below the list of toolboxes, and select "Add Toolbox"
- Navigate to the "My Toolboxes" directory and select (single-click) UpdateProspects.pyt, and then click Open.
- Select UpdateDepositSizeandValue > right click in the open space underneath > save settings > to default
- Note that the UpdateProspects.pyt file only needs to be installed once, even if you have more than one data set (e.g. CBMap and MXMap) installed.

Now that "UpdateProspects.pyt" is installed, follow these instructions to update deposit size and value fields in ECPros.gdb:

- Open any ArcGIS mxd file.
- In the ArcToolbox window, if the UpdateDepositSizeandValue toolbox is not present, right click on open space and load settings > from default.
- In the ArcToolbox window, double-click the UpdateDepositSizeAndValue toolbox. A list of update scripts will be displayed.
- Double-click the script appropriate for the database table you have installed (e.g. if you

have installed EMap, double-click on ECProsUpdate). A window will appear.

- Click OK to begin running the script. Calculations may take some time ... a couple of minutes for a thousand prospect records is typical. For more records, a proportionately longer time period is needed.
- Save the mxd

Source File Connections

If the EcuadorMap data set is copied to a location other than the root directory, some mxd files will not open properly. Broken links can be repaired by resetting the links. Select (click on) the “list by source” icon. Right click on the file that is not opening properly, select properties > source > “set data source,” and browse to the source location, for example: C:\EMap\Prospect\EC_Pro.s.gdb.

You are now ready to run EcuadorMap. Open the prospects data set and metallogenic map by opening ECProspects.mxd. Open the land status data set and concession map by opening ECLandstatus.mxd. Use the mxd files provided with the EcuadorMap data set or create new ones.

Ordering information, copyright and disclaimer

The EcuadorMap GIS data set, including the *Geography, Geology, TS Units, Prospect, Radiometric Dates and Land Status* modules (in MapInfo or in ArcGIS format), is available through Recursos del Caribe, S.A. To order the data set or for any questions, write to Carl Nelson at: nelson@cbmap.net.

Information on pricing is provided below. Updates are free for a year and half price for four additional years. Prospective clients are invited to “test drive” the data sets via a screen sharing session before making a purchase. Examples of the maps that can be generated using the data sets currently available through Recursos del Caribe are displayed on the web site at www.CBMap.net.

EcuadorMap is the property of Carl E. Nelson and Recursos del Caribe, S.A. It is intended for the sole use of the purchaser. The data set cannot be copied, sold, transferred, or distributed without express written permission from Carl E. Nelson.

Reasonable efforts are made to ensure that the information contained in the EcuadorMap data set is accurate and up-to-date. Carl Nelson and Recursos del Caribe, S.A. do not warrant the accuracy of information provided in the EcuadorMap data set.

Pricing

EcuadorMap: a GIS data set for Ecuador. Available as a package in **either** MapInfo or ArcGIS format for: US\$30,000
Or in **both** MapInfo and ArcGIS format for: US\$37,500

EcuadorMap is also available in modules as follows:

<i>Geography</i> (infrastructure, DEM, and shaded relief):	\$ 5,000
<i>Geology</i> (<i>Geography</i> plus 1:1,000,000 scale vector geology):	\$10,000
<i>Radiometric Dates</i> (radiometric dates only, with locations):	\$ 5,000
<i>TS Units</i> (<i>Geography, Geology</i> and <i>Radiometric Dates</i> plus a regional tectono-stratigraphic interpretation):	\$20,000
<i>Prospects</i> (<i>TS Units</i> plus metallic mineral mines and prospects):	\$30,000
<i>Land status</i> (<i>Geography</i> plus metallic mineral concessions, national parks, forest reserves and other protected areas):	\$10,000
<i>Plots</i> (high resolution tiff images of the metallogenic map):	\$ 5,000

Ecuador multielement geochemical GIS data set

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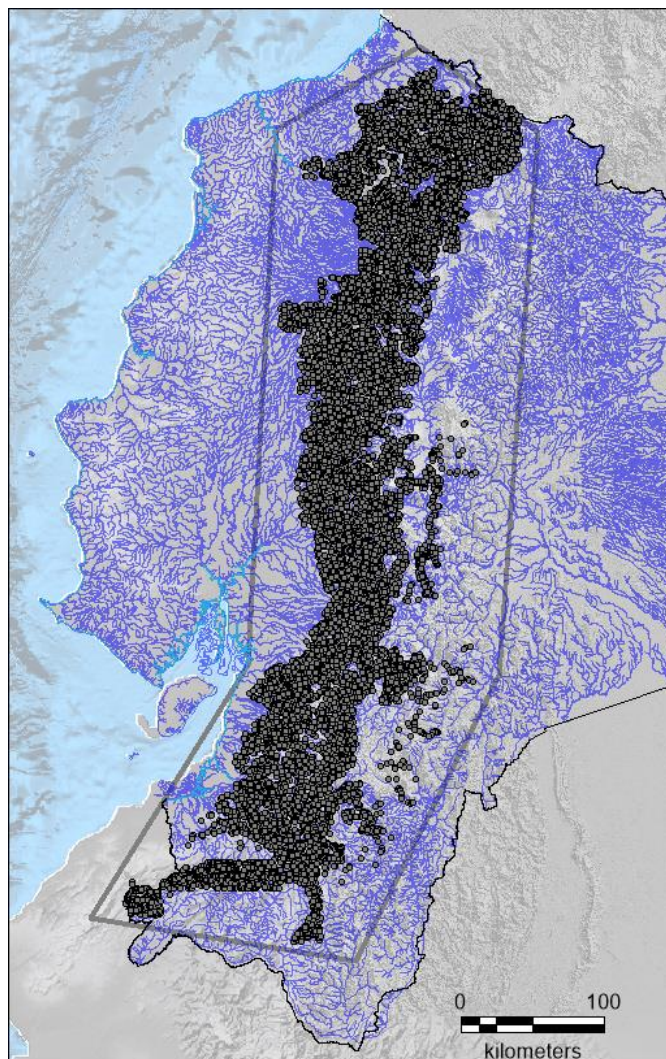
Recursos del Caribe, S.A.

www.cbmap.net

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Multielement geochemical data for a total of 24,294 stream sediment samples has been captured and compiled (in Mapinfo or ArcGIS format) for the cordillera of Ecuador. The data set includes analytical results for Au, Ag, Cu, Pb, Zn, Mo, Ni, Co, As, Sb, Hg, Tl, Cd, Bi, Fe, Mn, Te, Ba, Cr, V, Sn, W, La, Al, Mg, Ca, Na, K, Sr, Y, Ga, Li, Nb, Sc, Ta, Zr, Pt and Pd.



Source of Data:

Multielement geochemical data (29 elements) is provided for 9119 stream sediment collected by RTZ (1986). The RTZ data set is supplemented by 36-element analyses for an additional 15175 stream sediment samples collected by the BGS-PRODEMINCA (1995-2000). The raw data was acquired from GeoMax who compiled it using original published sources.

Sampling and Analytical Procedure:

Stream sediment samples for the PRODEMINCA survey were collected from the active channel and screened on site to minus 80 mesh. Samples were air dried in the laboratory and then disaggregated with a ceramic pestle and mortar. Gold was determined using a fire assay preparation procedure followed by atomic absorption spectrophotometry (AAS). Results for a total of 32 major and minor elements (Ag, Cu, Pb, Zn, Mo, Ni, Co, Cd, Bi, Fe, Mn, Te, Ba, Cr, V, Sn, W, La, Al, Mg, Ca, Na, K, Sr, Y, Ga, Li, Nb, Sc, Ta, Ti, Zr, Pt and Pd) were obtained by inductively-coupled plasma emission spectrometry (ICP-ES) following aqua regia digestion. As and Sb were analyzed by hydride-generation followed by AAS. Mercury was determined by cold-vapor AAS following aqua regia digestion. All analyses were performed at the Bondar Clegg lab in Vancouver.

The RTZ survey provides results for Au, Ag, Pb, Zn, Mo, Ni, Co, Cd, Bi, As, Sb, Fe, Mn, Te, Ba, Cr, V, Sn, W, La, Al, Mg, Ca, Na, K, Sr, Y, Sc, Cu.

Ecuador Multielement Geochemical GIS Data set:

Multielement geochemical data for a total of 24,294 stream sediment samples are provided either as a MapInfo table (.tab) or ArcGIS shape file (.shp). Values reported as less than detection limit have been set equal to one half the detection limit. Values of 0.5 for Ag, Mo, Cd, Sr, Ni, Co, V, La and Y indicate analytical results of less than a detection limit of 1 ppm. Values of 2.5 for Bi, As, Sb and Sc indicate analytical results of less than a detection limit of 5 ppm. Values of 5 for Te and Ba indicate analytical results of less than a detection limit of 10 ppm. Values of 10 for Sn, W and Pb, indicate analytical results of less than 20 ppm. An entry of “-999” means that no analysis was performed for that element.

A drainage map and a shaded relief base map are included to aid with interpretation and application of the data set to exploration.

Pricing:

Ecuador Multielement GIS data set, in ArcGIS or MapInfo format: US \$24,000

Prospective clients are invited to “test drive” the data sets via a screen sharing session before making a purchase.