

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 mineral occurrences and land status of Ecuador. The *Geography* module provides a shaded relief map along with vector files for infrastructure. *Geology* provides a 1:1,000,000-scale geologic map in vector format. *TS Units* module provides a tectono-stratigraphic map based on published research by government, industry and academia. The *Prospect* module locates over 1000 metallic mineral mines and prospects, classifies them according to 18 deposit types, and assembles current figures for past production, known resources and reserves. The Prospect module also includes locations and ownership for over 4800 non-metallic mineral occurrences. *Land Status* locates 8600 metallic and non-metallic mineral concessions and plots the locations of 240 national parks, forest reserves, and other areas of restricted mineral entry.

Two supplementary datasets are described at the end of this readme file. A Multielement Geochemical Data Set assembles 38-element data for 24,294 stream sediment samples. A Radiometric Data Set compiles 1500 isotopic (U/Pb, Ar/Ar, Re/Os, etc.) ages.

EcuadorMap is revised and updated as new discoveries are made, as new resources are announced and as production figures are updated. Geologic maps are updated as new publications come available. Land status is updated periodically. Pricing is covered on the final page of this readme file. New users should pay special attention to the “Installation” section.

Geography, Geology and TS Unit Modules

The *Geography* module of the EcuadorMap data set is displayed by opening “EC_Geography.” Vector files for towns and cities, roads and highways, political boundaries, and railroads are plotted on a base map consisting of shaded relief and bathymetry. The *Geology* module is displayed by opening “EC_Geology.” It displays the published (2017) country-scale geologic map (1:1,000,000 scale) and

legend. The *TS Units* module contains a tectonostratigraphic map and legend compiled using *Geology* module as a base but colored according to a tectonostratigraphic rock unit assignment (e.g., tholeiitic island arc basalt) rather than location-specific lithologic descriptions (e.g., Quebradagrande basalt). These modules have broad application beyond the mining and exploration industry.

Prospect Module

The *Prospect* module, which includes the *Geography*, *Geology*, and *TS Units* modules described above is displayed by opening “ECProspects.” Metallic mineral occurrences are plotted using shapes that correspond to deposit types, a color for each metal, and sizes that reflect gross contained metal value. Each mineral occurrence is attributed with location, source of data, deposit type, owners, partners, past production, current resources, current reserves, status (active mine, inactive mine, resource, prospect), geologic observations, recent deals, and references to the literature along with calculated fields for total size (in tons or ounces) and contained metal value (in US dollars).

The *Prospects* module includes a subdirectory for non-metallic mineral occurrences, displayed by opening “EC_Non-metallics.” Selecting a specific non-metallic mineral occurrence with the info tool will call up attached information including concession name, number, owner, status, commodities, location, and location reference.

Land Status Module

The *Land status* module is displayed by opening “EC_LandStatus” which plots over 8600 metallic and non-metallic mineral concessions. Concessions, color-coded and plotted on a shaded relief base map, are attributed with relevant information including owner (company or individual), contract date, status (exploration or extraction, contract or application), and expiration date. Only official government records are used to generate the concession map. The map provides a “snapshot” of land status as of the 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:

Locations are plotted and ownership and contract dates are provided for over 8600 metallic and non-metallic concessions and concession applications. Each is attributed with its registration number, contract date, name and contact information for the concession holder, commodities under concession, and expiration date. For the most up-to-date concession status in any particular area, the user is referred to the website for ARCOM (Agencia de Regulación y Control Minero): <http://geo.controlminero.gob.ec:1026/geovisor>.

Parks subdirectory:

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

Geology subdirectory:

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

Geography and 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 Topo_index subdirectory.

Prospect subdirectory:

Information pertaining to individual mines and mineral occurrences is stored in a geodatabase (ECPros.gdb) for ArcGIS Pro users or an MS Access database (ECPros.accdb) for MapInfo users. Only public, non-confidential information is provided. ECPros includes the following information for each mineral occurrence: name, alternate names, location, location reference, deposit type, district name, owners, partners, deals, total past production, production period, production reference, reserve, reserve reference, resource, resource reference, status (active mine, inactive mine, resource, prospect), geologic observations, overall size (in ounces or tons) and contained metal value (in US dollars).

Metallic mineral occurrences are classified according to 18 deposit types, listed in the following table. Non-metallic mineral occurrences are stored in the Prospect > Non_Metallic 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

Shaded Relief and Bathymetry subdirectories:

Shaded relief and bathymetric tiff images 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).

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.

Geophysics subdirectory:

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

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 additional attributes and new colors according to their tectonostratigraphic setting. For instance, rather than displaying map units according to 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.

Plots subdirectory:

The Plots subdirectory contains high resolution metallogenic and land status maps of Ecuador.

UTM subdirectory:

A UTM index is provided for all of Ecuador along with grids for each UTM zone.

Ancillary Files subdirectory:

The Ancillary Files subdirectory contains files that modify or supplement the user's GIS software. For ArcGIS Pro users, the subdirectory Default Project Databases contains the home folders for each aprx in the data set. For MapInfo users, this subdirectory includes picklists, "MapInfoW.fnt" with special fonts and the file "add_to_MapInfo_prj_file.txt" with supplemental projections. These files are described in a following section on Installation.

A file called "deposit_size_calculations.xlsx" lists the formulas 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.

ArcGIS Pro Installation

Install ArcGIS Pro 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, a 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 (ArcMap) or “CustomTransformations” folder (ArcGIS Pro). The path to this folder is: C:\Users\[your username]\AppData\Roaming\ESRI\ArcGISPro or Desktop10.8
- Start ArcMap or ArcGIS Pro, and click on the Toolbox button
- In the ArcToolbox window, right-click in open space below the list of toolboxes, and select "Add Toolbox"
- Navigate to the "Toolboxes" directory and select UpdateProspects.pyt, 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., CMap and ECMap) installed.

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

- Open any ArcGIS mxd or ArcGIS Pro aprx file.
- In the Toolbox window, if the UpdateDepositSizeandValue toolbox is not present, right click on open space and load settings > from default.
- In the Toolbox 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 ECMap, 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 or the aprx.

Source File Connections

If the EcuadorMap data set is copied to a location other than the root directory, some project files may open with broken links. Deposit types appear as event layers; each event layer has a distinct definition query. To repair a broken link: 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:\ECMap\Prospect\EC_Pros.gdb.

MapInfo Installation

Start by checking that Microsoft Access and MapInfo Pro 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 ECTMap-MI (C:\ECTMap-MI).

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 11, open Windows Explorer. Select the “View” tab. Then, under “Show” select the option for “hidden items.”
- Locate the file MAPINFOW.FNT on your computer.
 - On a machine that is running Windows 11, it is found in:
C:\Users\YOURUSERNAME\AppData\Roaming\MapInfo\MapInfo\Professional\2300
(for MapInfo Pro version 23)
- 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_Pros.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), 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 EC_Proc.accdb. EC_Proc.accdb also contains a series of tables linked to queries that sort records according to deposit type (e.g., porphyry copper, epithermal gold, etc.)

A form in EC_Proc.accdb, “Update Deposit Size and Value” should 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_Proc.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_Proc.accdb) via a dsn file (ECProc.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 ECProc.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_Proc.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 the “File > Close > Close 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).

Ordering information, copyright and disclaimer

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

Information on pricing is provided below. Updates are free for a year and charged at 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, with the exception of concessions, is updated regularly. 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
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>TS Units</i> (<i>Geography</i> and <i>Geology</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

Descriptions of the Ecuador Multielement Geochemical Data Set and the Ecuador Radiometric Data Set appear, with pricing, on the following pages.

Ecuador multielement geochemical GIS data set

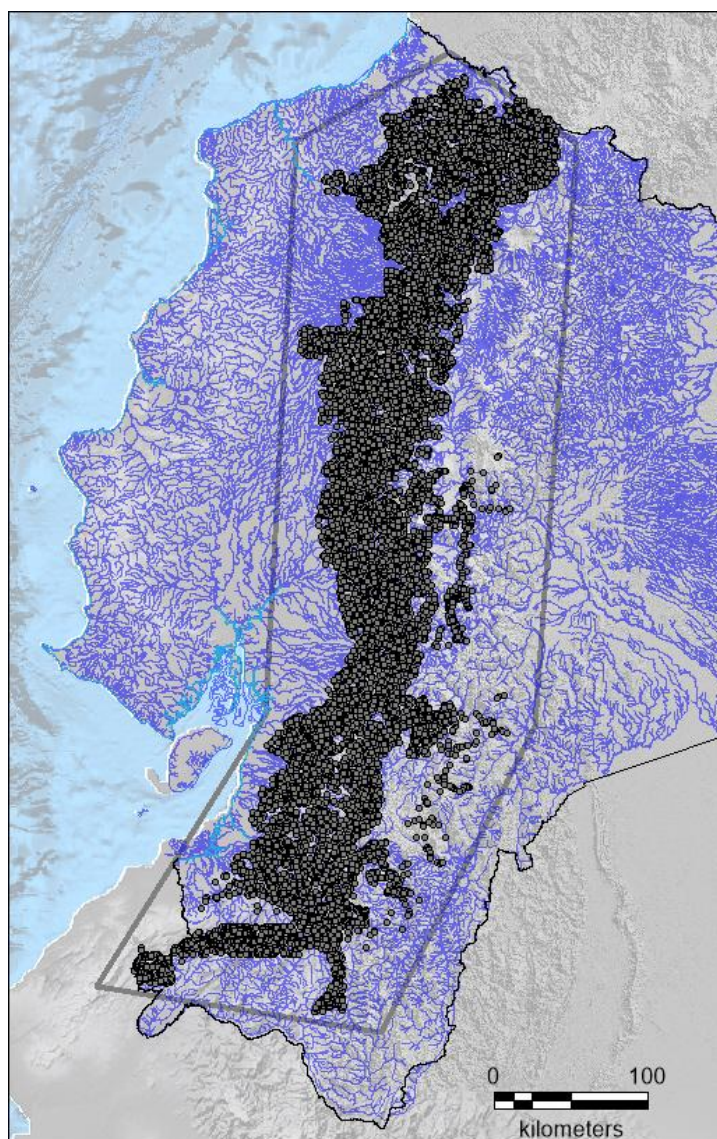
Recursos del Caribe, S.A.

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.

Ecuador Radiometric GIS Data Set

Recursos del Caribe, S.A.

www.cbmap.net

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The Radiometric GIS Data Set compiles 1522 isotopic ages (e.g., U/Pb, Ar/Ar, Re/Os) along with sample number, sample location, sample description, analytical method, mineral dated, analytical error, and reference publication (source of data). Additional fields record the original and the current interpretation for each radiometric date, e.g., age of intrusion/crystallization, inherited age, age of volcanism/crystallization, age of metamorphism, age of exhumation, age of hydrothermal alteration, and age of sedimentation. Cost is US\$10,000.

