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

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Introduction

EcuadorMap is a GIS database for metallic mineral ocurrences and land status of Ecuador. The *Geography* module contains digital topography (DEM), shaded relief, and bathymetry. *Geology* provides up-to-date geology in vector format. *TS Units* provides a tectono-stratigraphic interpretation based on published research. *Prospect* assembles current figures on past production, resources and reserves for 900 mines and prospects. *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.

A separate Ecuador Multielement Geochemical Database, described here, assembles geochemical data for 14,000 stream sediment samples in vector format.

EcuadorMap is available in MapInfo or in ArcGIS format; pricing is covered on the final page of this database description. EcuadorMap is constantly being revised and updated as new resources are announced for an ever increasing number of metallic mineral deposits. Geology is updated to reflect the most recent published geologic map and tectono-stratigraphic units are modified to reflect ongoing research.

New users should pay special attention to the "Installation" and "Microsoft Access Database" sections of this Readme file. After installing EcuadorMap, open "ECProspects" to display mines and mineral occurrences on a tectono-stratigraphic base map prepared from the published country-scale geologic map. Open "ECLandStatus" to display metallic and non-metallic concessions along with national parks, national forests, and other areas of restricted mineral entry.

Geography, Geology and TS Unit Modules

The *Geography* and the *Geology* modules of the EcuadorMap database are displayed by opening the "ECGeography" and "ECGeology" files. *Geography* includes shaded relief and bathymetry and is accompanied by Digital Chart of the World (DCW) files and a topographic map index. *Geology* provides 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 metallogenically-oriented tectonic map compiled using the published geologic map as a base but colored with tectono-stratigraphic rock unit assignments (e.g. plateau basalt of the Caribbean Large Igneous Province) rather than location-specific lithologic descriptions (e.g. Dumisseau basalt). *Geography, Geology* and *TS Units* 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. Additional fields allow the database to be sorted by interpretation: intrusion/crystallization age, inherited age, volcanism/crystallization age, age of metamorphism or age of sedimentation.

Prospect Module

The *Prospect* module, which includes modules for *Geography, Geology, TS Units* and *Radiometric Dates*, is displayed by opening the "ECProspects" file. Metallic mineral occurrences are plotted using shapes that correspond to deposit types, colors for each metal, and sizes that reflect gross contained metal value. Clicking on 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 values for total precious metal content in ounces, total base metal content in tons, and total contained metal value in US dollars.

EcuadorMap can be queried. For instance, one can select:
- all gold deposits with over 500,000 ounces in past production, or
- all porphyry copper occurrences located in Panama and Costa Rica, or
- all mineral occurrences hosted by calc-alkaline volcanic rocks.

Land Status

The *Land status* module is displayed by opening the "ECLandStatus" file. Metallic and non-metallic mineral concessions, color-coded and plotted on a shaded relief base map, are attributed with concession type, ownership information, contract date, and 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 database also shows areas of restricted mineral entry. These are areas such as national parks, forest reserves, Indian reservations, and national monuments where mineral exploration and development is restricted or prohibited.

Subdirectories

Concessions subdirectory:

Concession information for Ecuador is stored in the concessions subdirectory. Each of 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/geo_visor.

Geology subdirectory:

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

Prospect subdirectory:

A Microsoft Access database (ECPros1.mdb) stores published information pertaining to 900 mines and mineral occurrences. The database 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, size in ounces of gold and silver, size in tons of base and other metals, and gross contained metal value.

Mineral occurrences are classified as follows. Symbols can be added and classifications can be modified at the user's discretion.

Metallic Mineral Deposit Classification

Deposit Type	Symbol
Epithermal veins and stockworks (Au, Ag, Cu, Pb, Zn)	1
Epithermal high sulfidation deposits (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
Porphyry (Cu, Mo, Au, Ag) deposits	5
Skarn and carbonate replacement deposits (Cu, Pb, Zn, Fe)	3
IOCG deposits	16
Orogenic (shear-hosted, mesothermal) deposits	4
Magmatic segregation (chromite) deposits	11
Lateritic nickel-cobalt deposits	6
Bauxite (aluminum) deposits	12
Alluvial gold, diamond and Pt group mineral deposits	7
unassigned	99

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.

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 acquired for 14,000 samples. The data has been digitized (as vector files) and is sold separately, as a supplemental geochemical database (final page for pricing).

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 bathymetric data (DEM 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. (The sea surface is higher over subsurface topography.) The process is 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 200m (up to 240m depending on location). DEM grd files are provided.

DCW, Satellite and 50K topo index subdirectories:

The DCW subdirectory includes borders, cities and towns, roads, major drainages, and principal topographic contours from the Digital Chart of the World. Landsat satellite images, compressed using Mr. Sid software, are assembled in the Satellite subdirectory. Indices to published 1:50,000 scale topographic maps are provided in the 50K topo index subdirectory.

Radiometric Dates:

This subdirectory compiles published radiometric dates for rock units of Ecuador. Each record represents a single radiometric date, attributed with sample number, location, lithology, sample description, analytical method, rock type, material dated, age, error, interpretation and a source reference. The database also includes fields for original and current interpretation (inherited age, intusion/crystallization age, volcanism/crystallization age, age of metamorphism, etc.)

TS Units subdirectory:

This subdirectory contains a tectono-stratigraphic (TS) map of Ecuador. The TS map uses the published 1:1,000,000 scale geologic map as a base. Then, using peer-reviewed publications and graduate school theses, geology polygons are assigned colors according to their tectono-stratigraphic setting. For instance, rather than coloring rock units according to age and lithology (e.g. Cretaceous basalt), the TS map identifies the geotectonic setting of that basalt as Pacific ocean floor, Proto-Caribbean ocean floor, intraoceanic island arc or back arc basin. The result is a map that is both easier to understand and more appropriately applied to 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.

Plots subdirectory:

The Plots subdirectory contains high resolution tiff images for the metallogenic map and the land status map of Ecuador.

Installation (MapInfo Users)

Start by checking that Microsoft Access 2000 (or higher) and MapInfo version 10.0 (or higher) are installed on your computer. If this is an update, backup your previous version of the EcuadorMap database and erase the old database. Copy the new EcuadorMap database to the root directory (C:\) of your hard drive. Rename the folder EcuadorMap (C:\EcuadorMap).

Fonts

Follow these steps to replace your "MapInfo Compatible font" with a customized font file provided with the EcuadorMap database.

- 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|Professional\1000
- Rename MAPINFOW.FNT; call it MAPINFOW_FNT.OLD
- Copy "MAPINFOW.FNT" from the EcuadorMap root directory into the folder where "MAPINFOW_FNT.OLD" is located.

Datums

EcuadorMap map uses several local datums that are not delivered with standard MapInfo software. Although the database will continue to function without making changes, it is preferable to add the custom datums provided with EcuadorMap to the MapInfo projection file. To do so:

Use any text editor to open "MapInfow.prj" from:
C:\Program Files(x86)\MapInfo\Professional (for Windows 10)

This file contains all of the projections that ship with your MapInfo software. From the EcuadorMap database, copy the text contained in "add_to_mapinfow_prj_file.txt" and paste it into MapInfow.prj (at the end of the file will work just fine). MapInfow.prj will now provide all local datums called by EcuadorMap.

You are now ready to run EcuadorMap. Open the prospects database and metallogenic map by opening ECProspects. Open the land status database and concession map by opening ECLandStatus. You can also create your own workspaces (MapInfo) or project files (ArcGIS).

Picklists

EcuadorMap map uses a MapInfo Discover picklist to assign colors to tectono-stratigraphic units. Although neither Discover nor the picklist is required to run EcuadorMap, users who want to edit the picklist (to change colors or to add TS units) will need to copy "r_TectStrat_picklist.xml" from the Picklist subdirectory of the EcuadorMap database to:
C:\Users*username*\AppData\Roaming\Encom\Discover\Picklists

Installation (ArcGIS Users)

Install Microsoft Access 2000 (or higher) and ArcGIS version 10.0 (or higher) on your computer. If this is an update, backup your previous version of the EcuadorMap database and erase the old directory. Copy your new EcuadorMap database to the root directory (C:\) of your hard drive. Rename the folder EcuadorMap (C:\EcuadorMap).

If the EcuadorMap database is copied to a location other than the root directory, then some of the project files will not open properly. Broken links can be re-established using the procedure described in a following section, Open Database Connectivity - ODBC Issues (for ArcGIS Users).

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

Microsoft Access Database (MapInfo and ArcGIS Users)

All prospect information is stored in a Microsoft Access database, ECPros1.mdb, located in the Prospect subdirectory. ECPros1, 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 ECPros1 table. ECPros1.mdb also contains a series of queries that select all deposits for each of the deposit types shown on page 4.

A Microsoft Access Form, "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.

The file called "readme_calculatedfields.txt" (located in the Prospects subdirectory,) lists the fields which are used in calculation of deposit size and gross contained metal value.

When adding records to the MSAccess database (ECPros1.mdb), 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.

Deposit size and gross contained metal value are calculated using the following formulas:

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.

Open Database Connectivity - ODBC Issues (MapInfo Users)

MapInfo connects to the Prospects database (ECPros1.mdb) 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. You can also make changes directly to ECPros1.mdb, the Prospects database, via MS Access.

Open Database Connectivity - ODBC Issues (ArcGIS Users)

ArcGIS connects to the Prospects database (ECPros1.mdb) via an Object Linking and Embedding data base (OLE DB) link that is embedded in each mxd file. The OLE DB file, ECPros1.odc, resides in the ODCfile subdirectory of the Prospect subdirectory.

If any mxd files contain OLE DB links that are broken, those links can be re-established using ArcCatalog. Open ArcCatalog, right click on the mxd file that is not opening properly, select "set data source(s)," and set the data source as: C:\CBMap\Prospect\ODCfile\ECPros1.odc. ArcCatalog will then save the modified mxd as a "Copy of" the old filename.

Database Management System - DBMS (MapInfo Users)

All mineral occurrence information is stored in ECPros1.mdb, a Microsoft Access database located in the Prospects subdirectory. Changes made to ECPros1.mdb from within MapInfo are written to the MSAccess database when the MapInfo table 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 all of the MapInfo tables, including ECPros1.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. Workspaces read the linked tables and create MapInfo queries (with a "cb_" prefix). This allows the user to make changes to both the position of prospects and their attached information from within MapInfo.

Database Management System - DBMS (ArcGIS Users)

All mineral occurrence information is stored in ECPros1.mdb, an MSAccess database located in the Prospects subdirectory. Changes to the mineral occurrence information must be made directly to ECPros1.mdb from within MSAccess. Size and gross contained metal value can then be updated using the "Update_size_and_value" form in ECPros1.mdb.

Ordering information, copyright and disclaimer

The EcuadorMap GIS database, including *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 database or for any questions, write to: nelson@cbmap.net.

Information on pricing is provided below. Updates are free for a year and half price for four additional years. Purchasers are encouraged to update their databases regularly.

Examples of the maps that can be generated using the databases 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 database 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 database 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 database.

Pricing

EcuadorMap: a GIS database (in MapInfo or ArcGIS format). Available as a package for: US$30,000

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

Ecuador Multielement Geochemical Database: This database contains multielement geochemical data in vector format for 14,000 samples. The emphasis is on stream sediment data collected by the Ecuadoran government and by the British Geological Survey. Cost is US$15,000.