

MexicoMap:

A mineral occurrence data set for Mexico

Instructions for MapInfo and ArcGIS users

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Introduction

MexicoMap is a GIS data set for Mexico. The *Geography* module provides a shaded relief map along with vector files for infrastructure (rivers, roads, highways, political boundaries, airports, cities, and ports). *Geology* provides a 1:2,000,000 scale geologic map in vector format. The *Radiometric dates* module compiles over 3000 published radiometric ages. *TS Units* provides a tectonostratigraphic interpretation for the entire country based on publications from government, industry and academia. The *Prospect* module locates over 16,000 mines and prospects, classifies them according to 18 deposit types, and assembles current figures on past production, known resources and published reserves. *Land Status* shows over 24,000 metallic and non-metallic mineral concessions as well as areas of restricted mineral entry such as forest reserves, national parks and military reservations.

A separate geochemical data set, described at the end of this readme file, assembles multielement geochemical data for over 150,000 stream sediment samples collected by government-sponsored programs.

MexicoMap is revised and updated as new resources are announced for an ever-increasing number of metallic mineral occurrences. 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 Units Modules

The *Geography* module of the MexicoMap data set is displayed by opening “MXGeography.” Vector files for airports, cities, ports, states, railways, highways, drainages, coastline, lakes and reservoirs are plotted on a base map consisting of shaded relief and bathymetry. The *Geology* module, displayed by opening “MXGeology,” displays, in addition, a 1:2,000,000 scale geologic map and legend.

The *TS Units* module contains a tectonostratigraphic map and legend compiled using the *Geology* module as a base but colored according to a tectonostratigraphic rock unit assignment (e.g. back arc basin MORB basalt) rather than a location-specific lithologic description (e.g. Rio Verde basalt). The *Geography*, *Geology* and *TS Units* modules have broad application beyond the mining industry.

Radiometric Dates Module

The *Radiometric Dates* module compiles 8000 published radiometric ages along with sample number, sample location, lithology, analytical method, mineral dated, error and source (literature reference). Two additional fields list the original and the current interpretation, e.g. the age of: intrusion, volcanism, metamorphism, sedimentation, exhumation, hydrothermal alteration or mineralization. Where two references to the same radiometric date differ on location, both locations are listed. A smaller data set (5876 records with many duplicates) is available from the SGM.

Prospects Module

The *Prospects* module, which includes the *Geography*, *Geology*, *TS Units* and *Radiometric Dates* modules described above, is displayed by opening “MXProspects.” 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 specific mineral occurrence 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, sales and joint ventures, and references to the literature as well as calculated fields for total size (in tons or ounces) and total contained metal value in US\$. Locations were captured from published quadrangle maps, monographs published by the Servicio Geologico Mexicano (SGM), and US Government data sets (MRDS, RASS, Pluto, USBM). Duplicate entries, where they exist, are the result of differences in the location of prospects captured from different sources. The Prospect data set also includes locations for quarries, geothermal areas and oil and gas fields.

Land Status Module

The *Land status* module is displayed by opening “MXLandStatus” which plots over 24,000 metallic and non-metallic mineral concessions. Concessions, color-coded and plotted on a shaded relief base map, are attributed with concession type, ownership, status and contract date. Only official government records are used to generate the concession maps. This map provides a “snapshot” of land status as of the last compilation date. For specific areas of interest, a thorough review of current concession 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 date are provided for over 24,000 metallic and non-metallic mineral concessions. Each concession is attributed with the contract date, ownership and commodities under concession. Expired concessions are not eliminated until they disappear from the official government data set.

Geology subdirectory:

The Geology subdirectory contains the 1:2,000,000 scale geologic map of Mexico originally published by the SGM and modified by Recursos del Caribe to reflect recent research. The published 2007 version of this map is available on the SGM website: <https://www.gob.mx/sgm>.

Survey Indices subdirectory:

This subdirectory shows the location of stream sediment surveys conducted by a joint program of the United States Geological Survey and the Consejo de Recursos Minerales. The index lists the number of samples collected, the area covered, the sample density, a list of elements run, and the source of the data. Geophysical survey indices show the type of survey (magnetic and/or radiometric), area covered, and the source of the image or data.

Prospect subdirectory:

Information pertaining to individual mines and mineral occurrences is stored in an MS Access database (MX_Proc.accdb). Only published, non-confidential information is provided. The Prospect subdirectory includes the following information for each mineral occurrence: 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

Parks subdirectory:

The parks subdirectory contains national parks, forest reserves and other areas where mineral development is prohibited or restricted.

Geophysics subdirectory:

The Geophysics subdirectory is designed to work with the MexicoMap data set but is sold separately. Airborne geophysical survey results including grid files are available for selected areas. Pricing information for these supplemental data sets is available from Recursos del Caribe (nelson@cbmap.net).

Geochemistry subdirectory:

Multielement geochemical survey data was collected during joint surveys conducted by the United States Geological Survey and the Consejo de Recursos Minerals. This data has been digitized and is available in vector format for over 150,000 samples. Elements analyzed include Au, Ag, Al, As, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Sc, Se, Sn, Sr, Te, Tl, U, W, and Zn plus some results for Ga, Ti and F.

This stream sediment survey data set is designed to work with MexicoMap but is sold separately. Pricing information is provided at the end of this document.

Shaded Relief and Bathymetry subdirectories:

A shaded relief map is provided in the Shaded Relief subdirectory. Ninety-meter (3 arc-second) resolution data used to create the shaded relief map comes from version 2 (2005) of the Shuttle Radar Topography Mission (SRTM), available at <http://seamless.usgs.gov>.

Regional bathymetry data (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 200m (up to 240m depending on location).

Geography and Satellite subdirectories:

The Geography subdirectory includes topography, states and municipalities, cities and towns, roads, airports and utility lines, drainages, lakes and reservoirs. A low-resolution satellite image is provided in the Satellite subdirectory.

Radiometric Dates subdirectory:

The Radiometric Dates subdirectory compiles ages for 3000 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 that record both the original and the current

interpretation (e.g. inherited age, intrusion/crystallization age, age of exhumation, volcanism/crystallization age, age of metamorphism, etc.)

TS Units subdirectory:

This subdirectory contains files used to create a tectonostratigraphic (TS) map for Mexico. 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. Cretaceous basalt), the TS_PGONS file is attributed with origin and tectonic setting (e.g. Pacific ocean floor, intra-oceanic island arc, or back arc basin). The result is a tectonostratigraphic map that is easy to understand and directly applicable to mineral exploration.

Titles and legends subdirectory:

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

UTM subdirectory:

A UTM index is provided for Mexico 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:

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

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

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 imaged for the metallogenic map and the land status map of Mexico.

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 MexicoMap data set to the root directory (C:\) of your hard drive. Rename the folder MexicoMap (C:\MexicoMap).

Fonts

MexicoMap 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

MexicoMap 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 MexicoMap, 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

Prospect information for MapInfo users is stored in a Microsoft Access database, MX_Pro.s.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 MX_Pro.s.accdb database. MX_Pro.s.accdb also contains a series of queries that select all deposits for each of the deposit types listed on page 4.

A form in MX_Pro.s.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 (MX_Pro.s.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 (MX_Pro.s.accdb) via a dsn file (CBPros1.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 MX_Pro.s.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 MX_Pro.s.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 MexicoMap. Open the prospects data set and metallogenic map by opening MXProspects. Open the land status data set and concession map by opening MXLandStatus. 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 MXMap directory. Copy the new data set to the root directory of your hard drive (C:\MXMap).

ESRI Geodatabase management

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

Most users will not need to make changes to the information that is stored in MX_Proc.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:\MXMap\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 EMap) installed.

Now that “UpdateProspects.pyt” is installed, follow these instructions to update

deposit size and value fields in MXPros.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 MXMap, double-click on MXProsUpdate). 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 MexicoMap 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:\MXMap\Prospect\MX_Pro.s.gdb.

You are now ready to run MexicoMap. Open the prospects data set and metallogenic map by opening MX_Pro.spect.s.mxd. Open the land status data set and concession map by opening MX_Landstatus.mxd. Use the mxd files provided with the MexicoMap data set or create new ones.

Ordering information, copyright and disclaimer

MexicoMap, including *Geography, Geology, TS, Prospect, Land Status, Geochemistry and Radiometric Dates* modules, is available in ArcGIS or MapInfo format through Recursos del Caribe, S.A. To order or for any questions, write to Carl Nelson at: nelson@cbmap.net.

Information on pricing is provided below. Updates are provided for free for a year and are 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 are displayed on the web site at www.cbmap.net.

MexicoMap 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 MexicoMap 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 MexicoMap data set.

Pricing

MexicoMap: a GIS data set for the *Geography, Geology, TS Units, Prospects, Land Status and Radiometric Dates* of Mexico. Available as a package in **either** MapInfo or ArcGIS format for: US\$30,000
Or in **both** MapInfo or ArcGIS format for: US\$37,500

Also available in stand-alone modules as follows:

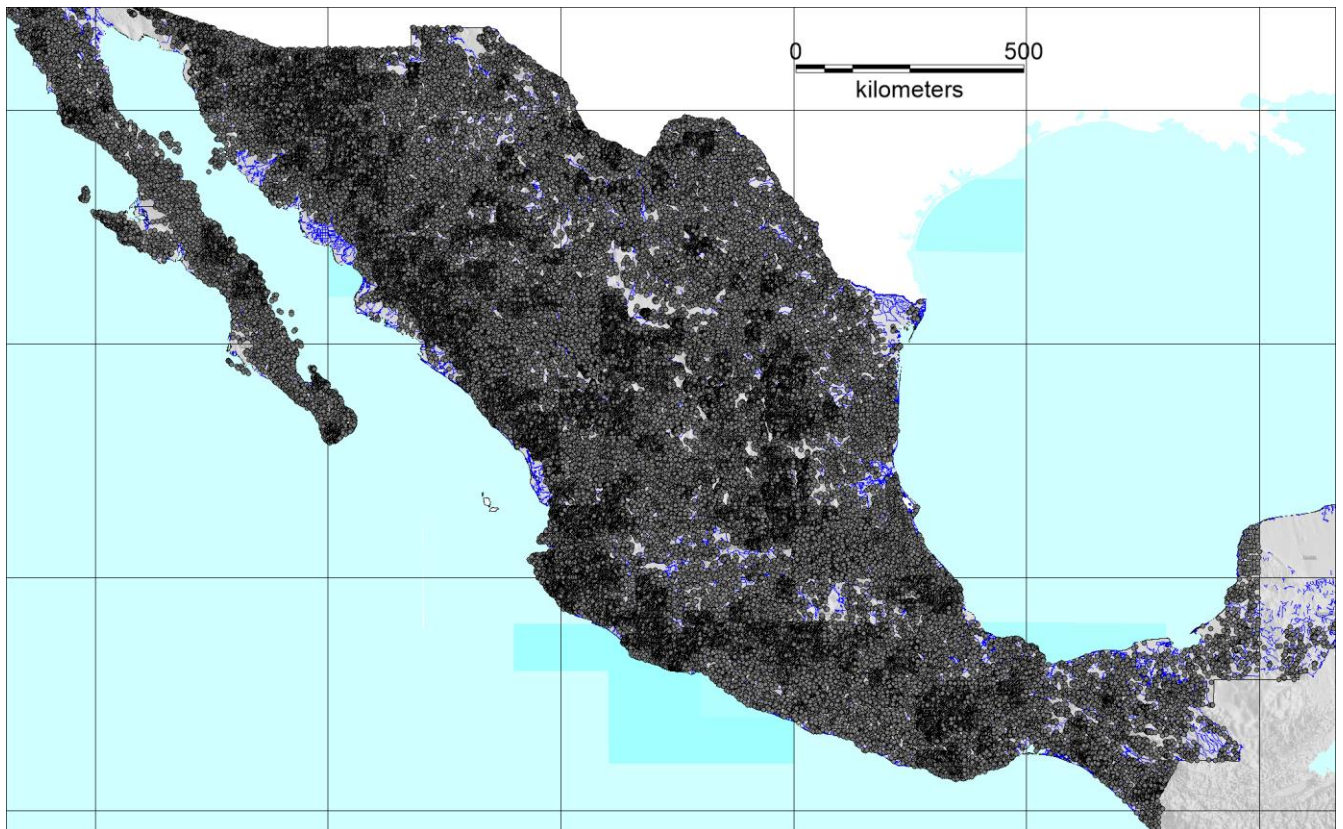
<i>Geography</i> (infrastructure and shaded relief):	\$ 5,000
<i>Geology</i> (<i>Geography</i> plus 1:2,000,000 scale geology):	\$ 5,000
<i>Radiometric Dates</i> (radiometric dates only, with locations):	\$ 5,000
<i>TS Units</i> (<i>Geography, Geology and Radiometric Dates</i> plus a regional tectono-stratigraphic interpretation):	\$20,000
<i>Prospects</i> (<i>TS Units</i> plus metallic mines and prospects):	\$30,000
<i>Land Status</i> (<i>Geography</i> plus mineral concessions and parks):	\$10,000
<i>Plots</i> (a high resolution tiff image of the metallogenic map):	\$ 5,000

Mexico multielement geochemical GIS data set

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Multielement geochemical data for a total of 151,192 stream sediment samples covering all of Mexico has been compiled and is available as vector files (in Mapinfo or ArcGIS format). Sample locations are displayed on the map, below. The data set includes analytical results for Au, Ag, Al, As, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Sc, Se, Sn, Sr, Te, Tl, U, W, and Zn plus some results for Ga, Ti and F. All of the data is available to the public; no confidential mining or exploration company data is included.



Data set description:

Gambusino Prospector de Mexico (www.gambusinoprospector.com), has compiled multielement stream sediment data using, as a starting point, stream sediment data for 134 individual 1:250,000 scale maps, 4 individual 1:100,000 scale maps and 885 individual 1:50,000 scale maps. The original maps and data, as raster images and pdf files, are available for sale from the Sociedad Geologica de Mexico (SGM): <https://www.gob.mx/sgm>.

In addition to analytical data, the data set includes a high-resolution (10-meter) shaded relief base map, major drainages, and infrastructure (e.g. roads, cities, towns). The data set also provides plots showing the location and magnitude of stream sediment geochemical anomalies. The figures on the final page of this handout are sample plots of Au and Cu anomalies in stream sediment samples. These plots demonstrate how the data set can be used to select specific areas for follow-up field work.

The SGM also offers stream sediment geochemical data in MSEXcel and in ArcGIS shp file format. A price list for the SGM data is available at: <https://www.gob.mx/sgm/acciones-y-programas/lista-de-precios-vigentes> and can be purchased, by individual quadrangle, after first registering at: <http://www.sgm.gob.mx/ventas-sgm/EntraCotizacion.jsp>

Sampling and Analytical Procedure:

Samples of active stream sediment, collected according to procedures established by the U.S. Geological Survey and the Canadian Geological Survey, were screened on site to minus 80 mesh.

Geochemical analyses for Au, Ag, Al, As, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Sc, Se, Sn, Sr, Te, Tl, U, W, and Zn (plus some results for Ga, Ti and F) were performed at the SGM lab (formerly the Consejo de Recursos Minerales) by inductively coupled plasma - emission spectrometry (ICP-ES). Gold was first subjected to a fire assay preparation procedure; volatile elements including Sb, As, Te, Se, Sn and Bi were stabilized by hydride prior to analysis. Detection limits were 1 ppb for Au, Se, Te and 0.1 ppm for most other elements.

Pricing for the GIS data set, in either ArcGIS or MapInfo format,

151,192 stream sediment samples (31 elements): US \$50,000

data from a selected area, per sample: US \$ 0.50

