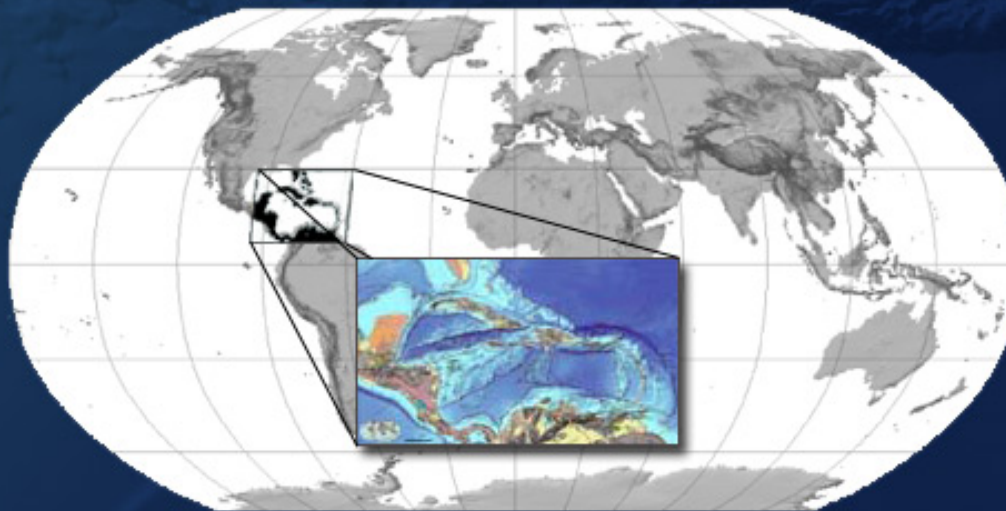


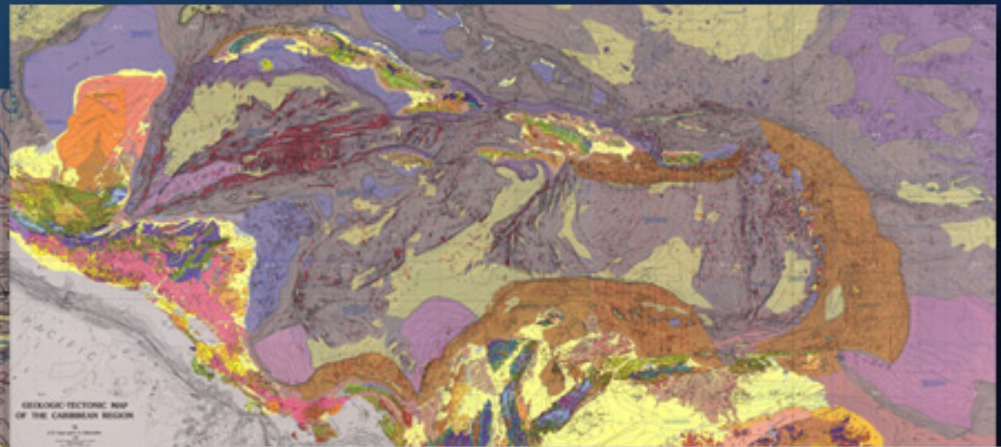
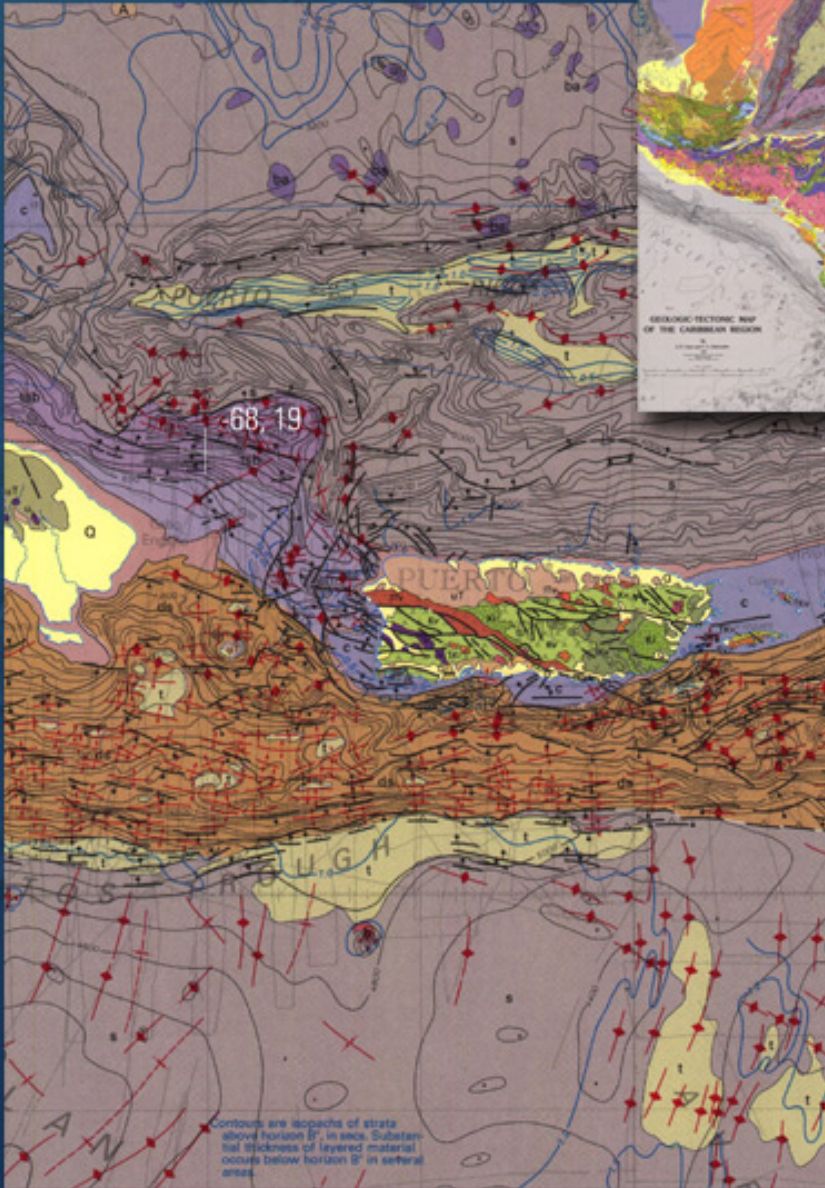
# *Creating a Geologic Dataset of the Caribbean using ArcGIS*

by Christopher D. French  
U.S. Geological Survey, Denver, Colorado



## *Overview*

- **Background of mapping project**
- **Data preparation (i.e. scanning, georeferencing, and digitizing)**
- **Review geodatabase concepts and creation**
- **Discuss topology rules and attributing with coded domains**
- **Share tips to help others**



# GEOLOGIC-TECTONIC MAP OF THE CARIBBEAN REGION

By  
J. E. Case and T. L. Holcombe

1980

BATHYMETRIC CONTOUR INTERVAL 200 AND 1000 METERS  
MERCATOR PROJECTION  
SCALE 1:2 500 000 AT 10° NORTH LATITUDE

## ***World Energy Project***

**The World Energy Project conducts geologic studies that provide an understanding of the quantity, quality, and geologic distribution of world oil and gas resources.**

- **Located within the Central Energy Resources Team in Denver, Colorado**
- **World divided into 8 energy regions**
- **Region 6 includes Caribbean area, Central America, and South America**
- **Digital geologic maps provide reference for geologists and others**

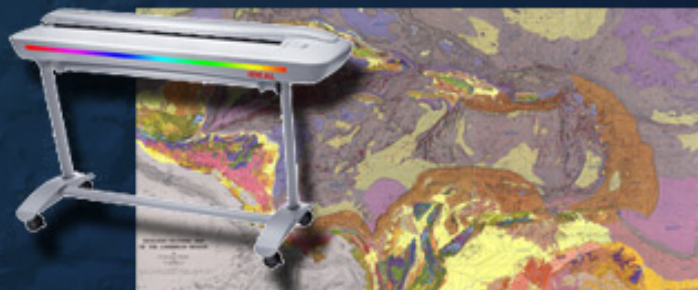
**<http://energy.cr.usgs.gov/oilgas/wep/>**

## Data Sources

<b>Geodatabase Data Layers</b>	<b>Source</b>
Surface Geology	Geologic-Tectonic Map of the Caribbean Region, USGS, 1:2,500,000 (paper) Map of Commonwealth of the Bahamas, 1:1,000,000 (paper) Geologic Units of the Conterminous U.S., USGS, 1:2,500,000 (digital)
Oil and Gas Field Centerpoints	Petroconsultants International Data Corp., Inc., 2002 database
Geologic Provinces	Modified from USGS, DDS-60, World Petroleum Assessment (digital)
Annotation	All labels stored as stand-alone annotation
Topology	For surface geology and provinces
<b>Base Layers</b>	<b>Source</b>
Political Boundaries	Digital Chart of the World, NIMA, 1:1,000,000
Major Cities	ESRI Data & Maps 2000 (CD 1)
Topography and Bathymetry	GTOPO30 and General Bathymetric Chart of the Oceans (GEBCO)

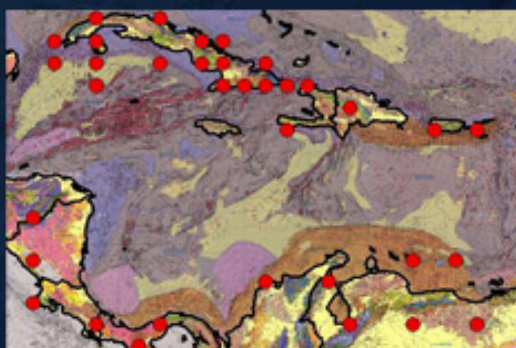
## Data Preparation

### ● Scanning



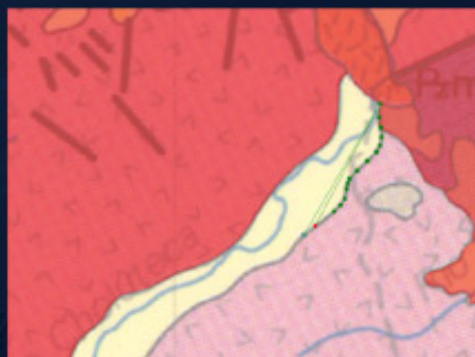
40" Ideal Scanner  
300 DPI, RGB  
JPEG format  
2 plates merged

### ● Georeferencing



ArcMap 8.3  
56 control points  
3<sup>rd</sup> order polynomial trans.

### ● Digitizing




Heads-up digitizing  
ArcMap 8.3  
Zoomed to 1:250,000  
Auto-complete polygon

# Digitizing

Editor ▾ ▶  Task: Auto-Complete Polygon ▾ Target: New\_Shapefile ▾    

- [-] Create Tasks
  - ... Create New Feature
- [-] Modify Tasks
  - ... Reshape Feature
  - ... Cut Polygon Features
  - ... Mirror Features
  - ... Extend/Trim Features
  - ... Modify Feature
  - ... Calibrate Route Feature
  - ... Modify Portion of a Line
- [-] Topology Tasks
  - ... Modify Edge
  - ... Reshape Edge
  - Auto-Complete Polygon**
- [-] Other Tasks
  - ... <none>
  - ... Select Features Using a Lin
  - ... Select Features Using an /

Snapping Environment 

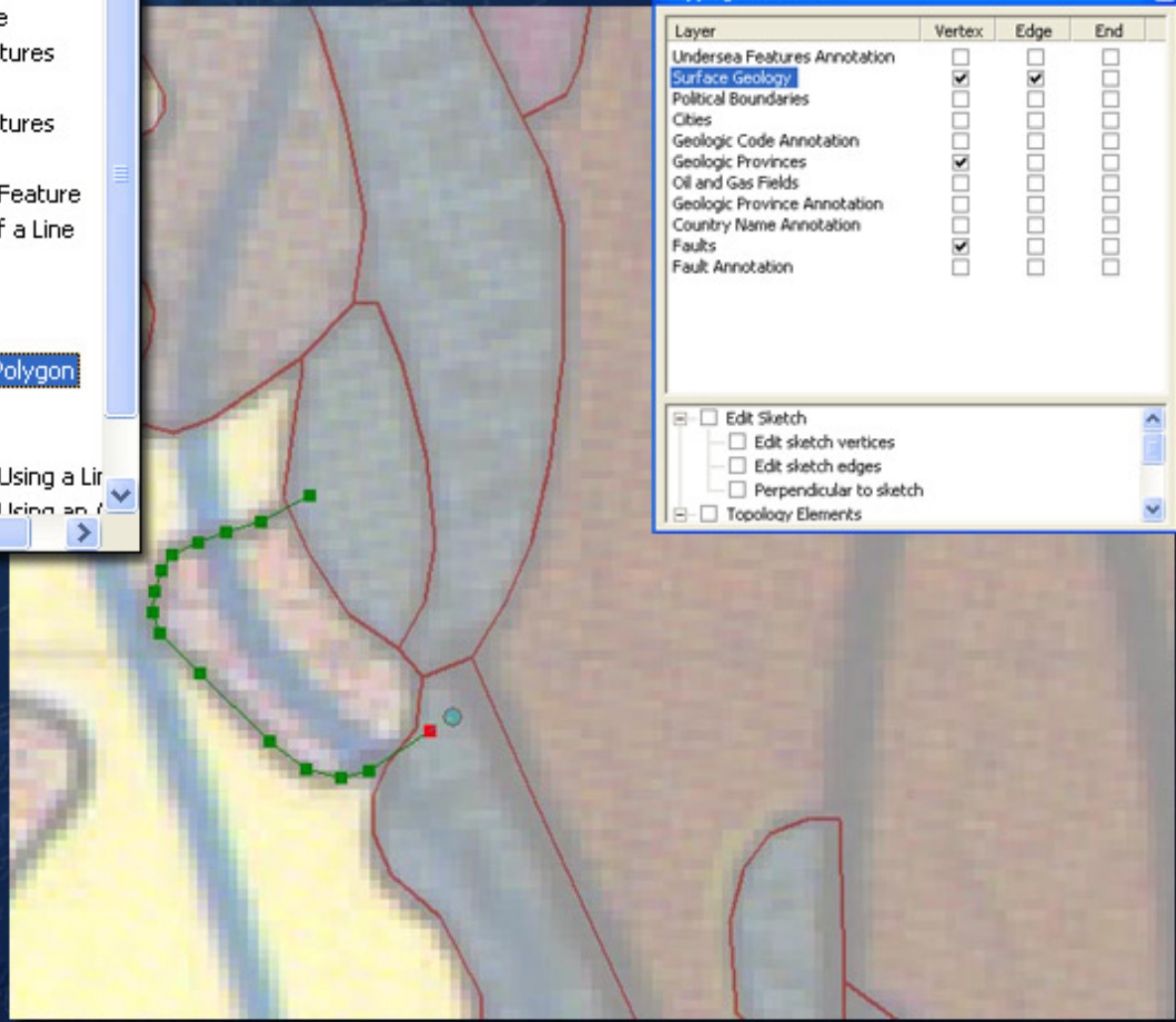
Layer	Vertex	Edge	End
Undersea Features Annotation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Surface Geology</b>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Political Boundaries	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Geologic Code Annotation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Geologic Provinces	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Oil and Gas Fields	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Geologic Province Annotation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Country Name Annotation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Faults	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fault Annotation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Edit Sketch

- Edit sketch vertices
- Edit sketch edges
- Perpendicular to sketch

Topology Elements

6343 polygons



## *Geodatabase Concepts*

### **Why we used a personal geodatabase:**

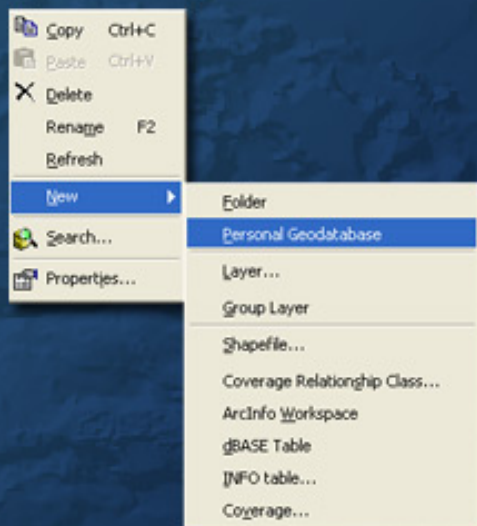
- **Stores feature classes, feature datasets, topology, relationships, and annotation**
- **Advanced functionality (topology; domains)**
- **Distributable**
- **Transferable**
- **Simplifies data storage**
- **Works in ArcGIS and ArcReader**
- **Ensures data integrity**



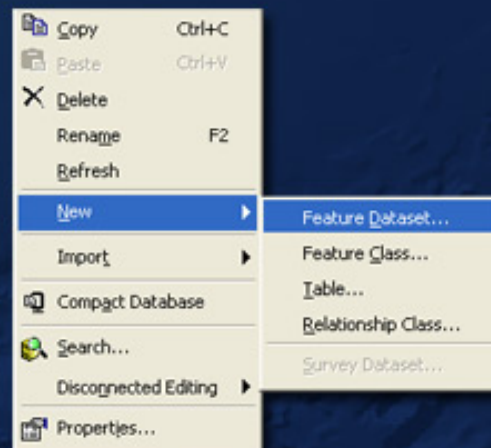
# Geodatabase Creation

Created in  
ArcCatalog

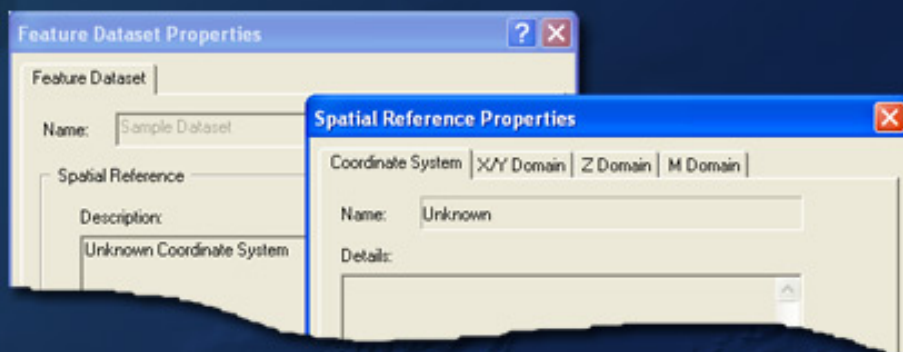
Right-click →



→ Right-click →



Spatial reference set manually in feature dataset properties  
(be sure all feature classes will fit in X/Y Domain)



- OR -

Can be set automatically  
by importing a dataset.

## *Geodatabase Topology*

### What is geodatabase topology?

- **A rule-based method to define spatial relationships between one or more features**
- **Models coincidence, connectivity, and adjacency**
- **Provides editing environment for managing topology**
- **Stored in a feature dataset**
- **More accurately models reality**
- **Improves data integrity**


# Establish Topology Rules

## 26 topology rules available in ArcGIS 8.3 Geodatabase



### 2 used for the surface geology polygon feature class

**Must not overlap**

Polygons must not overlap within a feature class or subtype. Polygons can be disconnected or touch at a point or touch along an edge.



Polygon errors are created from areas where polygons overlap.




*Use this rule to make sure that no polygon overlaps another polygon in the same feature class or subtype.*


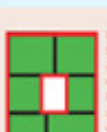
*A voting district map cannot have any overlaps in its coverage.*

**Must not have gaps**

Polygons must not have a void between them within a feature class or subtype.



Line errors are created from the outlines of void areas in a single polygon or between polygons. Polygon boundaries that are not coincident with other polygon boundaries are errors.



*Use this rule when all of your polygons should form a continuous surface with no voids or gaps.*

*Soil polygons cannot include gaps nor form voids—they must form a continuous fabric.*

### To create a topology, using ArcCatalog:

- Right-click on feature dataset
- Choose New > Topology
- Follow Topology Wizard

## Topology Wizard

1) name the topology

2) enter a cluster tolerance

Cluster tolerance is defined as the distance in which all vertices are considered identical and will be snapped when validated.

By default, it is set to precision defined in spatial reference.

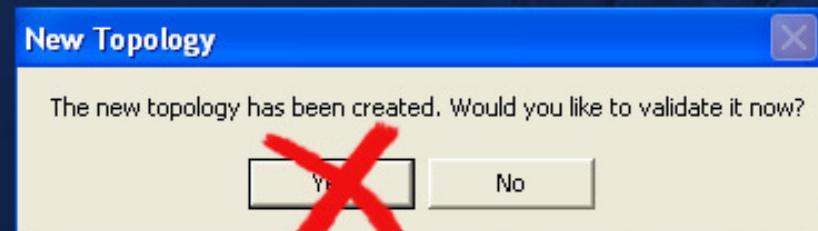
**Rule of thumb:** set cluster tolerance 10x smaller than highest accuracy data.

3) select participating feature classes

4) change ranks (if > 1 feature class)

5) set topology rules

6) review and click finish



**Just say NO!**

Only validate in an ArcMap editing session to undo changes.

# Working with Topology

The screenshot displays the ArcMap software interface with several key components highlighted:

- Topology Toolbar:** Located at the top center, it contains various icons for topology management.
- Validate Buttons:** A group of icons on the right side of the toolbar, used for running validation rules.
- Error Inspector:** A window in the upper right showing a table of errors. It includes a search bar and checkboxes for 'Errors from all rules', 'Enons', 'Exceptions', and 'Visible Extent only'. The table lists one error: 'Must Not Have Gaps' for the 'Surface\_Geology' class, with a shape of 'Polyline' and 0 features in both Feature 1 and Feature 2 columns.
- Snapping Environment:** A window in the lower left showing snapping options for the 'Surface\_Geology' layer, including 'Perpendicular to sketch', 'Topology Elements', 'Topology nodes', 'Miscellaneous', and 'Survey Points'.
- Map View:** The central map area shows a yellow background with black contour lines. A red line segment is highlighted with the label 'Gap error', indicating a break in the topology.

Rule Type	Class 1	Class 2	Shape	Feature 1	Feature 2	Exception
Must Not Have Gaps	Surface_Geology		Polyline	0	0	False

# Working with Topology

The screenshot shows the ArcMap interface with the following components:

- Layers Panel:** Shows 'Surface\_Geology\_Topology' with 'Area Errors', 'Line Errors', and 'Point Errors' sub-layers, and 'Surface\_Geology'.
- Error Inspector:** Displays a table with one error:

Rule Type	Class 1	Class 2	Shape	Feature 1	Feature 2	Exception
Must Not Have Gaps	Surface_Geology		Polyline	0	0	False

- Map View:** A green line with a red vertex. A context menu is open over the red vertex with 'Delete Vertex' selected.
- Annotations:** Three blue arrows point to the map with the text: 'Select feature', 'Right-click', and 'Delete vertex'.
- Status Bar:** Shows 'Deletes a vertex in the edit sketch' and coordinates '90°14'1.25"W 16°1'40.04"N'.

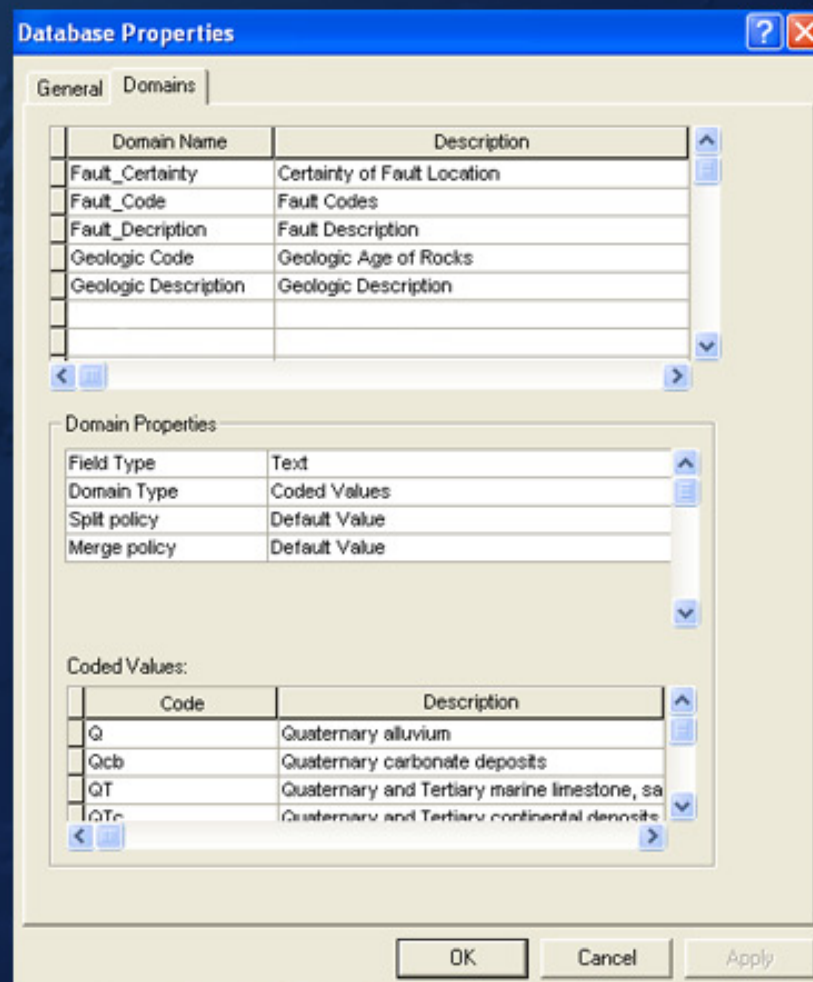
# Complete the Topology Edit

The screenshot shows the ArcMap interface with the following components:

- Top Toolbar:** Includes standard ArcGIS tools like pan, zoom, and a red arrow icon. A text label **Validate in current extent** points to the red arrow icon.
- Editor Toolbar:** Shows the 'Task' dropdown set to 'Create New Feature' and the 'Target' dropdown set to 'Surface\_Geology'. A text label **Save edits** points to the 'Save Edits' button in this toolbar.
- Layers Panel:** Lists 'Surface\_Geology\_Topology' and 'Surface\_Geology'. Under 'Surface\_Geology\_Topology', 'Area Errors', 'Line Errors', and 'Point Errors' are visible. A red square icon is next to 'Line Errors'. A text label **Save edits** points to this red square icon.
- Error Inspector Window:** A floating window with a 'Show:' dropdown set to '<Errors from all rules>'. It contains a 'Search Now' button and checkboxes for 'Errors', 'Exceptions', and 'Visible Extent only'. A text label **Search for new errors** points to the 'Search Now' button. Below the controls is a table with the following columns: Rule Type, Class 1, Class 2, Shape, Feature 1, Feature 2, and Exception.
- Display Panel:** Shows 'Surface\_Geology' with 'Vertex' and 'Edge' checkboxes checked.
- Bottom Panel:** Shows a list of topology rules, including 'Perpendicular to sketch', 'Topology Elements', 'Topology nodes', 'Miscellaneous', and 'Survey Points'.
- Status Bar:** Displays coordinates: 80°15'31.30"W 16°3'49.54"N.

## Attributing with Domains

- Established through properties
- Ensures accurate attributes with a drop-down selection while editing
- Description is displayed in attribute table; also when identifying and labeling
- Note:** exports had code in place of description; fixed by joining LUT (.dbf) with shapefile and re-exporting



Database Properties

General Domains

Domain Name	Description
Fault_Certainty	Certainty of Fault Location
Fault_Code	Fault Codes
Fault_Description	Fault Description
Geologic Code	Geologic Age of Rocks
Geologic Description	Geologic Description

Domain Properties

Field Type	Text
Domain Type	Coded Values
Split policy	Default Value
Merge policy	Default Value

Coded Values:

Code	Description
Q	Quaternary alluvium
Qcb	Quaternary carbonate deposits
QT	Quaternary and Tertiary marine limestone, sa
QTc	Quaternary and Tertiary continental deposits

OK Cancel Apply



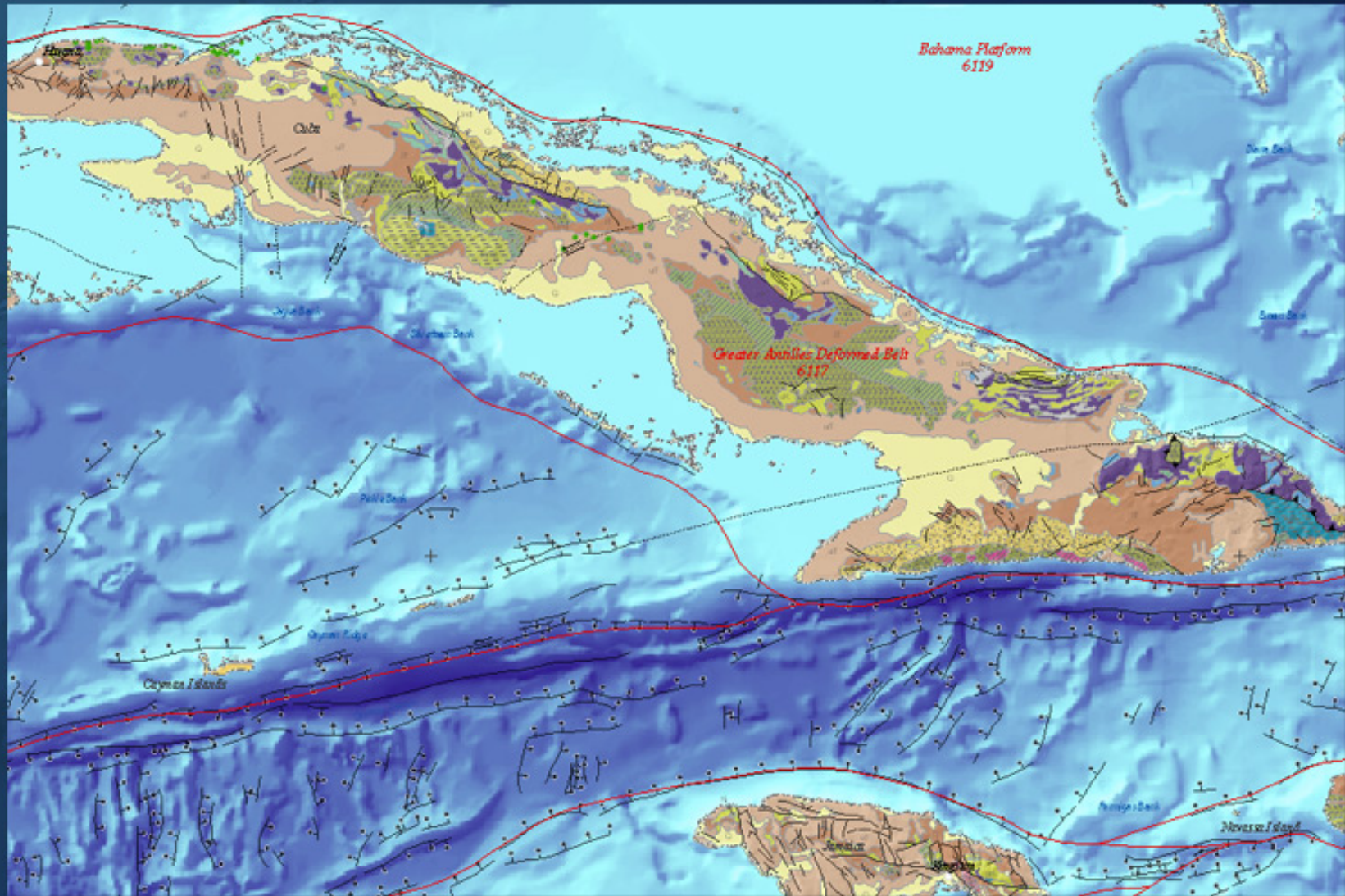
# Attributing with Domains

The screenshot displays the ArcMap interface with the following components:

- Attributes Table:**

Property	Value
OBJECTID	761
Id	0
Shape_Length	0.421680203078601
Shape_Area	1.09032272680911E-02
Geologic Age	kv
Geologic Descrip...	
- Legend (legend\_explanation.txt):**
  - kv **Cretaceous volcanic rocks**
  - kva Cretaceous andesitic to sillicic volcanic rocks
  - lkv Lower Cretaceous flows, breccia, and tuff, partl
  - lv Jurassic volcanic rocks, mostly andisitic to sil
  - Mzva Mesozoic flows and small plutons, mostly intermi
  - Mzv Mesozoic volcanic and sedimentary rocks
  - Pzv Paleozoic volcanic rocks
  - pCv Precambrian sillicic flows, tuffs, and ignimbrite
  - v volcanic rocks
  - T1 Tertiary plutons, mostly intermediate to sillicic
  - TK1 Tertiary and Cretaceous plutons, mostly intermed
  - K1 Cretaceous plutons, mostly intermediate to sillic
  - Mz1 Mesozoic plutons, mostly intermediate to sillicic
  - Pz1 Paleozoic plutons, mostly intermediate to sillicic
  - pCd Precambrian diabase sills and dikes. Ages 1,500
  - pCg Precambrian granitic rocks. Ages 1,000 - 1,550
  - pCf Precambrian granitic rocks. Ages 1,800 - 3,140
  - pCum Precambrian ultramafic rocks
  - i Intrusive rocks, undivided, mostly intermediate
  - u ultramafic rocks
  - g Gabbro and related rocks
  - Km Cretaceous metasedimentary and metaigneous rocks
  - Mzm Mesozoic metasedimentary and metaigneous rocks,
  - Mzb Mesozoic amphibolites and associated metasedimen
  - Mzg Mesozoic metavolcanic and associated metasedimen
  - MzPzm Mesozoic and Paleozoic metasedimentary and meta
  - Pzm Paleozoic and Precambrian metamorphic rocks, und
  - pCm Precambrian metasedimentary and metaigneous roc
  - pCmv Precambrian metamorphic rocks of low grade
  - pCgn Precambrian quartzofeldspathic gneiss, Ferrugino
  - pCsv Precambrian metasedimentary and metavolcanic roc
  - pCs Precambrian amphibolite and associated metasedim
  - pCl Precambrian granulite, migmatite, and iron-form
  - Pzpcu Paleozoic and Precambrian igneous and metamorphi
  - pCu Precambrian igneous and metamorphic rocks, undiv
  - e eclogite

# USGS OFR 97-470-K



Screen-capture of Map Showing Geology, Oil and Gas Fields and Geologic Provinces of the Caribbean Region

# USGS OFR 97-470-K

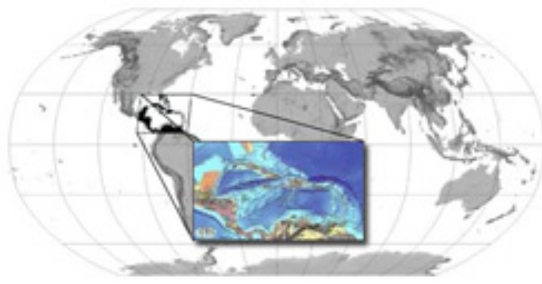
USGS Home  
Ask USGS  
USGS Site Map  
Search USGS  
Advanced Search

125 years of science for America 1879-2004

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## Map Showing Geology, Oil and Gas Fields, and Geologic Provinces of the Caribbean Region

Digitally Compiled by Christopher D. French and Christopher J. Schenk



**Getting Started**

This CD-ROM compilation contains a map and associated spatial data showing surface geology, faults, oil and gas field centerpoints, and geologic provinces of the Caribbean region, draped over a shaded relief image of topography and bathymetry. The map is provided in the Environmental Systems Research Institute, Inc. (ESRI) ArcMap and ArcReader GIS formats, as well as in Adobe Acrobat Portable Document Format (PDF). On this CD-ROM, ESRI ArcReader and Adobe Acrobat Reader software provide a way to view and interact with the maps.

The organization and user-friendly navigation of this CD-ROM ensure easy access to its [maps](#) and [data](#) by using the links on the right side of each page. A link to the USGS World Energy Project website is also provided to access the latest information, updates, and interactive maps, as they relate to this and other world energy products. In addition, [system requirements](#), [permission](#), and [contact information](#) can be found in the [readme](#) section of this product.

CD-ROM Home OFR 97-470-K

U.S. Department of the Interior

Home

Data

Maps

Readme

World Energy Website

## CD-ROM Interface (HTML & Javascript)



### Caribbean Geodatabase

**Description:**  
1:2,500,000 scale geodatabase feature classes for Caribbean region.

- Surface Geology
- Faults
- Oil and Gas Field Centerpoints
- Geologic Provinces
- Annotation

**Download:**  
[caribbean.mdb](#)

**Comments:**  
This personal geodatabase contains all of the geology-related vector files associated with this publication, including: surface geology, faults, oil and gas field centerpoints, geologic provinces, and annotation layers. ArcGIS software version 8.3 and later can utilize this dataset.

Raster layers cannot be stored in a personal geodatabase, therefore the shaded relief image needs to be downloaded separately (see below).

**Surface Geology of the Caribbean Region (geobg)**

Metadata

- Metadata Information
- File Name
- File Path
- File Size
- File Type
- File Date
- File Author
- File Version
- File Description
- File Keywords
- File Contact
- File URL

Download data (.mdb, .shp, and .e00)

View metadata (.html, FAQ, and .txt)

### ArcMap 8.3 Format

This map document file (.mxd) can be opened with ESRI's ArcMap 8.3 or later software. If the ArcMap software is loaded on your machine, simply click the [open.MXD map link](#). Using ArcMap will allow the greatest flexibility for working with the data provided.

[Open MXD Map](#)

[help](#)

**Comments:**  
Map accesses geologic layers and annotation as personal geo-classes. Base cartographic layers are provided in shapefile arcs.

View or download MXD, PMF, PDF or IMS maps

### Install Adobe Acrobat

Windows version 6.0.1	<a href="#">Install</a>	<a href="#">System Requirements</a>
Macintosh version 6.0.1	<a href="#">Install</a>	<a href="#">System Requirements</a>
Macintosh version 5.05	<a href="#">Install</a>	<a href="#">System Requirements</a>
Unix version 5.08 for Sun Solaris	<a href="#">Install</a>	<a href="#">System Requirements</a>
Unix version 5.08 for HP-UX	<a href="#">Install</a>	<a href="#">System Requirements</a>
Unix version 5.08 for IBM AIX	<a href="#">Install</a>	<a href="#">System Requirements</a>
Linux version 5.08	<a href="#">Install</a>	<a href="#">System Requirements</a>



[Link to Internet Map Service](#)  
(Internet connection required)

## *Summary*

- **ArcMap 8.3 and the Geodatabase were effective tools in creating the Caribbean surface geology dataset.**
- **Auto-complete polygon and snapping in ArcMap were very efficient in digitizing process.**
- **Geodatabase topology and attributing with domains increased data integrity.**
- **Using the geodatabase also allowed for convenient data storage, distribution, and integration into team's SDE geodatabase.**
- **Saved several weeks worth of time!**
- **I recommend exploring geodatabase capabilities for your projects.**

## *Contacts and Links*

**Christopher French - GIS Specialist - U.S. Geological Survey**

**[chfrench@usgs.gov](mailto:chfrench@usgs.gov)**

**303.236.1655**

**Caribbean Geology website:**

**<http://greenwood.cr.usgs.gov/energy/WorldEnergy/OF97-470K/>**

**World Energy website:**

**<http://energy.cr.usgs.gov/oilgas/wep/index.htm>**