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Geologic Map Database of the Washington DC Area featuring data from three 30 X 60 minute quadrangles: Frederick, Washington West, and Fredericksburg

Version 1.0

By

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ABSTRACT

The Washington DC Area geologic map database (DCDB) offers geologic map information to many types of professionals and to private citizens. Digital, geographically referenced, geologic data is more versatile than traditional hard copy maps, and facilitates the examination of relationships between numerous aspects of the geology and other types of data such as: land-use data, vegetation characteristics, surface water flow and chemistry, and various types of remotely sensed images. The DCDB was created by combining Arc/Info coverages, designing a Microsoft (MS) Access database, and populating this database. Proposed improvements to the DCDB include the addition of geochemical, structural, and hydrologic data.

INTRODUCTION

The Washington DC Area geologic map database (DCDB) is a database of geographically referenced geologic data for the Washington DC area. The goal of this database is to make geologic map information of the Washington DC area more usable for geologists, engineers, environmental professionals, park professionals, and others who have uses for it.

The data in the DCDB is based on geologic mapping done at scales ranging from 1:24,000 to 1:100,000. This primary data was then re-compiled at 1:100,000 in three 30 X 60 minute quadrangles: Frederick, Washington West, and Fredericksburg. This data collection and map compilation work was conducted throughout the 1990s. The source materials for the database are digital files involved in the publication of the Frederick quadrangle (Southworth et al., in press), the Washington West quadrangle (Lyttle et al., in press), and the Fredericksburg quadrangle (Mixon et al., 2000).

The DCDB is a living and breathing database in the sense that it will change with time as new types of data are added and the geographic extent of the database is extended. This document discusses the parts of the DCDB, how to use the DCDB, some of the methods used in its creation, and its future directions.

DCDB CONSTITUENTS

The file "dcdb_eesp.mdb" is a MS Access 2000 database. It contains a collection of tables, queries, and forms that facilitate entry and storage of attribute data for the U.S. Geological Survey geologic maps of the Frederick, Washington West, and Fredericksburg 1:100,000 scale 30 x 60 minute quadrangles. The data in this database can be accessed by running "MS Access" or through ArcView or Arc/Info via Open Database Connectivity (ODBC) drivers. Geographic Information System (GIS) data is linked to the MS Access database by the fields MAP_UNIT, Mapunit, or MapUnit depending on the table. The file "dcdb_dm.mdb" is a version of the MS

Access database that is compliant with version 4.3 of the North American Data Model Standard for geologic map data (NADM). Johnson et al. (1998) describes this data model in detail.

Database Structure

dcdb_eesp.mdb

<u>Tables</u>
[MAP_UNIT] – name and description of the Map Units
[FORMATION] – reference table of formations, groups, and members for each Map Unit
[LITHOLOGY] – primary, secondary, and tertiary lithologies of the Map Units
[CLASTS] – lithologies of clasts and cement composition
[MINERALS] – minerals ranked as primary, secondary, and other
[METAMORPH] – prograde minerals, retrograde minerals, and metamorphic ages
[PLANES] – inventory of the planar features of Map Units (i.e., bedding, schistosity, cleavage, etc.)
[CHARACTER] – numerous unit characteristics
[GEOCHRON] – isotopic ages and methods
[SOURCE] – outside references for data within the database
[provinces] – reference table for Appalachian physiographic provinces. Like the other reference tables in this database, it stores the names associated with the numbers that are stored in the <Province> field of the [CHARACTER] table.
[lin_type] – reference table for linear feature types (i.e., T = thrust fault, SS = strike-slip fault, etc.)
[min_pt] – mineral abundances at specific point locations
[lith_pt] – lithologic characteristics at specific point locations
[gchron_pt] – isotopic ages at specific point locations
[chemistry] – geochemical data for specific point locations
[sink] – sinkhole size and trend information (currently, this information is not stored)
[fossil] – Fossils at specific point locations
[bed_entry] interim table during the data entry process
[rock_class_chg] – reference table for converting the Southern California Mapping Project rock_class codes to those of the Standard data model
[faults] – fault type and length (currently, this information is stored in the Arc/Info .aat file "fault.aat" and the .dbf file that is associated with the ArcView shapefile "fault.dbf"). A reference table for the <type> field in the .aat and .dbf is stored in this database as table [lin_type]
[structure] – structure type and strike and dip measurements (currently, this information is stored in the Arc/Info .pat file and the .dbf file that is associated with the ArcView shapefile)

<u>Queries</u>
---data entry---
[Append_Bedrock] – appends records from table [bed_entry] to table [CHARACTER] for bedrock units
[Append_Clasts] – appends records from table [bed_entry] to table [FORMATION]

[Append_Formation] – appends records from table [bed_entry] to table [CHARACTER] for bedrock units
[Append_Lithology] – appends records from query [lithchange2] to table [LITHOLOGY]
[AppendMapUnit] – appends records from query [lithchange2] to table [LITHOLOGY]
[Append_Metamorph] – appends records from table [bed_entry] to table [METAMORPH]
[Append_Minerals] – appends records from query [minchange] to table [MINERALS]
[Append_Planes] – appends records from query [folchange] to table [PLANES]
[Append_Surficial] – appends records from table [bed_entry] to table [CHARACTER] for surficial units
[clastchange] – takes fields <ClastPrim> and <ClastSec> from the [bed_entry] table and puts their data into fields <CLAST_LITH> and <CLAST_RANK>
[folchange] – takes fields <FoliatDom>, <FoliatSec>, and <FoliatTert> from the [bed_entry] table and puts their data into fields <FOLIATION> and <FOL_RANK>
[lithchange2] – takes fields <LithPrim>, <LithSec>, and <LithTert> from the [bed_entry] table and puts their data into fields <LITHOLOGY> and <LITH_RANK>
[minchange] – takes mineral information from the [bed_entry] table and puts it into fields <MINERAL>, <MIN_RANK>, and <MIN_TYPE>
[name1] – updates fields <Name> and <Name_Rank> of the [bed_entry] table for map units that are members
[name2] – updates fields <Name> and <Name_Rank> of the [bed_entry] table for map units that are formations
---data viewing---
[output5] – presents name, lithology, mineralogy, and physiographic province information about the map units (a very good query for use with ArcView)
[clast_comb] – presents clast information about the map units (a good query for use with ArcView)
[lith_prim] – selects primary lithologies for use by query [output5]
[lith_sec] – selects secondary lithologies for use by query [output5]
[lith_tert] – selects tertiary lithologies for use by query [output5]
[members] – selects map units that are members of formations. It is a supporting query for the query [output5]
[min_prim] – selects primary minerals for use by query [output5]
[min_sec] – selects secondary minerals for use by query [output5]
[min_oth] – selects other minerals for use by query [output5]

Relationships

A diagram that illustrates the joins between tables in dcdb_eesp.mdb is available by selecting "Relationships" from the "Tools" menu in MS Access. In this database, the field <MAP_UNIT> is the one that facilitates many of the joins that exist between the tables.

dcdb_dm.mdb

Tables

[COA] – Map Unit names and descriptions – a data linkage hub in NADM 4.3
[Lithform] – lithological classification reference table for the <lith_form> field in table [RockComposition]. It currently does not contain the right type of values to work with the data in the <lith_form> field.
[Lithology] – lithological terms defined
[Organization] – the organization(s) that are responsible for the data
[Projection] – details about the geographic projection(s) used for the geospatial data
[RockComposition] – contains most of the lithologic data. Data from the field <Origin> of table [CHARACTER] was placed into the field <lith_form> of the [RockComposition] table.
[RockUnit] – rock unit rank (i.e., formation, member, group, supergroup) and thickness
[RockUnitRank] – reference for rock rank information
[StratigraphicAge] – stratigraphic ages of the Map Units
[StratigraphicRank] – ranks the geologic time names
[StratigraphicTime] – look up table for geologic time names
[Structure] – classifies structural data into types
[StructureType] – look up table for types of structural data used in the table [Structure]
---same as dcdb_eesp.mdb---
[MAP_UNIT] – name and description of the Map Units
[CLASTS] – lithologies of clasts and cement composition
[MINERALS] – minerals ranked as primary, secondary, and other
[METAMORPH] – prograde minerals, retrograde minerals, and metamorphic ages
[PLANES] – inventory of the planar features of Map Units (i.e., bedding, schistosity, cleavage, etc.)
[CHARACTER] – numerous Map Unit characteristics
[GEOCHRON] – isotopic ages and methods
[SOURCE] – references for data within the database
[lin_type] – reference table for linear feature types (i.e., T = thrust fault, SS = strike-slip fault, etc.)
[provinces] – look up table for Appalachian physiographic provinces

Queries

Five queries used to put the dcdb_eesp.mdb into dcdb_dm.mdb are stored in dcdb_dm.mdb: [Make_COA], [Make_COADescription], [Make_RockComposition], [Make_Rock_Unit], [Make_StratigraphicAge]

Relationships

A diagram that illustrates the joins between the tables in dcdb_dm.mdb is available by selecting "Relationships" from the "Tools" menu in MS Access. The <coa_id> field is the one that allows the relationships among the data that was put into the NADM format. In order to connect to other data and to ArcView shapefiles the field MAP_UNIT must be used or the <coa_id> fields in the ArcView shapefiles must be populated.

GIS Layers

The GIS data layers that were compiled for this project include:

bedrock – bedrock and coastal plain map units
surficial – surficial materials
faults – faults, fold axes, and thermal aureoles
structure – point structural measurements
sink – sinkholes

These layers are included on the CD as Arc/Info coverages and export files, ArcView shapefiles, and SDTS files. The attribute data for these GIS Layers is stored in the MS Access database mentioned in this document, except in the cases of faults and structure whose attribute data is stored in the Arc/Info attribute tables or .dbf files associated with ArcView shapefiles.

USING THE DATABASE WITH THE GIS LAYERS

Instructions for using the MS Access database (dcdb_eesp.mdb) in concert with the ArcView shapefiles (.shp extensions):

For ArcView 3.1 or 3.2a

1. Open ArcView
2. Continue with the default new project or use the project provided in this open file report by selecting "Open Project" from the "File" menu and navigating to "c:\ofr01227\of01227.apr". If you elected to stay with the new project, then you will need to start a new "View" by clicking on the "Views" tab of the "Project" window, and then clicking on the "New" button. If using a new project you will have to select "Add Theme" from the "View" menu and select the shapefiles that you desire. If you elected to use the project provided ("of01227.apr"), four views have already been created. These views are named Bedrock, Surficial, Fault, and Structure.
3. Select the "Extensions" option from the "File" menu and make sure that the "Database Access" option is checked.
4. Bring the project window to the front. To do this, select the project (e.g.,"of01227.apr" or "untitled") from the "Window" menu to make sure that the project window is active.
5. Select "SQL connect" from the "Project" menu. A dialog box will appear.
6. Select "MS Access Database" from the top pick list, and click the "Connect" button.
7. Then choose dcdb_eesp.mdb or dcdb_dm.mdb from the directory/file dialog box.
8. Double click on the table/query that you want. For example, select query [output5]. By double-clicking, its name will be placed in the "From" text box.

9. Double click on the fields that you want. For example, select "All Columns" and an "*" is placed into the "Select" box. Please see the ArcView Help Menu if more discussion about the "SQL Connect" feature is needed.
10. Once "Query" is clicked another table will appear in your ArcView project - by default it will be called [Table1]. Move the SQL dialogue box to the back or close it.
11. Select a field in this table and a field in an ArcView attribute table (i.e., the table that corresponds to the active theme in a "view") that you wish to join it to. For example, select the field <MapUnit> in "Table1" (the ArcView name for "output5") by clicking on the top of the data column, then select the field <Mapunit> in the attribute table of the "bedrock.shp" theme.
12. Make sure that the ArcView attribute table is active (click on its window) and then click on the join button or select join from the "table" menu. Useful joins include:

MS Access	ArcView
output5	bedrock.shp or surficial.shp
CHARACTER	bedrock.shp
MAP_UNIT	bedrock.shp or surficial.shp
clast_comb	bedrock.shp or surficial.shp
GEOCHRON	bedrock.shp
FORMATION	bedrock.shp or surficial.shp

13. Now the symbolization of the bedrock theme can be altered. For example, with "View1" active, double-click on the "bedrock.shp" theme in the legend bar to the left of the map. From the dialogue box that appears, select "Unique Value" from the "Legend Type" box and choose the field <ROCK_GRP> from the "Values Field" box. Then select "Apply", and a newly classified map is drawn.

DATA ENTRY

To enter geologic information into the MS Access database dcdb_eesp.mdb, open the form “Intro” and you will be presented with forms for inputting your data. The forms are presented in the following order:

1. [Intro]
2. [BEDROCK_GENERAL_A]
3. [BEDROCK_GENERAL_B]
4. [STRUCTURE_POINTS]
5. [LITHOLOGY_POINTS]
6. [MINERAL_POINTS]
7. [SINK_HOLES]
8. [FOSSIL_POINTS]
9. [CHEMISTRY_POINTS]
10. [GEOCHRON_POINTS]

After the forms are filled in, the data must be placed into the appropriate tables for storage. To accomplish this, queries can be run by opening them from the database queries window. Using this approach, they must be run in this order:

1. name1
2. name2
3. Append_Character
4. Append_Lithology
5. Append_Minerals
6. Append_Clasts
7. Append_Metamorph
8. Append_Planes
9. AppendMapUnit
10. Append_Formation

The reference tables [provinces], [lin_type], and [rock_class_chg] must be populated separately and forms have not been created for them. Pick lists should be negotiated for the lithology and rock_class fields. This set of forms does not accommodate data entry for the attribute data associated with faults and folds. These data need to be added to the fault.dbf and fault.aat for the ArcView shapefile and Arc/Info coverage, respectively. To convert the data to an NADM compatible format, queries stored in dcdb_dm.mdb can be used.

METHODS

Creating the DCDB involved piecing together digital datasets of three 30 X 60 minute quadrangles (Frederick, Washington West, Fredericksburg). These data were in the form of multiple Arc/Info coverages.

Several tasks were performed to combine these data into one bedrock coverage, one surficial coverage, one fault and fold axes coverage, one structural measurements coverage, and one sinkhole coverage. The tasks were: Identification and separation of surficial units, Joining of coverages, Edgematching and making Map Unit codes uniform, Database structure design, and Population of the Database.

The surficial geologic units were identified and then separated from the Washington West and Fredericksburg coverages and placed into separate coverages. The result was separate bedrock and surficial coverages.

The surficial, bedrock, fault and fold axes, and structure point coverages of each individual 30 X 60 minute quadrangle were combined with their counterpart in the other quadrangles. For example, the “faults” GIS coverage of the Fredericksburg 30 X 60 minute quadrangle was combined with the "faults" GIS coverage of the Washington West and Frederick 30 X 60 minute quadrangles.

Edgematching along the quadrangle boundaries was necessary to remove "boundary faults". Approximately one half of the contacts that crossed the Frederick/Washington West boundary were modified. Fewer modifications were required for the Washington West/Fredericksburg boundary. Map Unit codes were altered so that the codes were unique identifiers of the Map Units in the combined dataset. For example, "Cl" and "OCl" were both codes for the Lunga Reservoir Formation, and OCl had to be chosen as the correct code.

The database for storing information about the map features was designed based on fields and relationships suggested by field geologists of the Eastern Earth Surface Processes Team of the U.S. Geological Survey. One large spreadsheet style table was split up to allow normalization of lithologic, mineralogic, clast, and planar feature information. "dcdb_eesp.mdb" is the resulting digital database file in MS Access format.

During the database design process, a method for entering data into its format was designed using MS Access "forms" and "queries" (see previous section "Data Entry" for more details). In addition, a method for converting this design to the North American Data Model Standard was created. "dcdb_dm.mdb" is an example of this database.

CONCLUSION

There are many potential uses for the data in the DCDB. Some of these uses include: correlation of vegetation types with rock and surficial material types, comparison of isotopic ages with various tectonic models, and examination of the relationships between structural features and sinkhole development. As the DCDB expands to include geochemical, porosity, and fracture density data our ability to examine the effects of the geology on ecosystems will be greatly enhanced. The geochemical data will also greatly enhance our ability evaluate tectonic models, and the fracture density and porosity estimates will facilitate greater understanding of sinkhole development.

In addition to being a very useful regional database, The DCDB is a prototype for a national database. It will be used to evaluate the effectiveness of the North American Data Model Standard, and will be a building block for a National Geologic Map Database.

REFERENCES

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