

**Data Structure for Arizona
Geological Survey Digital Geologic
Maps**

by

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INTRODUCTION

This document describes the database structure for Arizona Geological Survey digital geologic maps. The database structure was designed using a proposed standard format from the U.S. Geological Survey [USGS, 1995] as a guide. Similarities and differences between our data structure and the proposed standard are described throughout the text. This document is a working document. As new maps are digitized and problems or deficiencies with this system are recognized, modifications will be made. It is anticipated that the most common modification will be the addition of descriptor codes in Tables 2, 3 and 5.

DIGITIZING PROCEDURES

The 1:100000 scale maps have been digitized using PC Arc/Info 3.4.2 and a Calcomp Drawingboard II table digitizer. The source of the line work and structural data was the mylar originals compiled for published 1:100000-scale geologic maps. The map projection of the coverages is Universal Transverse Mercator (UTM), zone 12; map units are meters, with a -3.2×10^6 yshift. Arcs are digitized in the Arcedit module using stream mode with the weed tolerance set at 5.08 meters. Lines are later smoothed with the Arcedit spline command with the grain tolerance set at 40 meters. Ornamented arcs (lines with attached symbols indicating slip, separation, or dip of fault) are digitized such that as the arc is transversed from the start to end node, the ornamentation is on the right side. After the linework is complete, the file is generalized with a 5 meter weed tolerance to reduce the number of vertices in the straighter arcs.

COVERAGES

The following table summarizes the coverages possibly included with each geologic map, and the user-defined features included in each coverage. Field definitions are in parenthesis. I is an integer field, C is a character field, and the number indicates the width.

Table 1. Summary of data tables associated with AZGS geology database.

Coverage	Type	PAT	AAT	Notes
Geology (included for all digital maps)	Poly & Arc	unit (C,6)	Type (I,4), Accuracy (I,1), Descriptor (I,3), Identifier (C,10), LinkTable (I,3)	includes all faults and contacts
Lines (included if applicable)	Arc		Type (I,4), Accuracy (I,1), Descriptor (I,3), Identifier (C,10), LinkTable (I,3)	includes all lines except contacts and faults
Structur (included if applicable)	Point	Type (I,4), Mod1(C,1), Strike (I,3), Dip (I,2), Mod2 (C,2), Loc_ID (C, 6)		includes point structure data with associated numerical measurements to the nearest degree; may include coincident points if several measurements made at same outcrop, linked by Loc_ID
OthrArea (included if applicable)	Poly & Arc	Type (I,4), Identifier (C,10), LinkTable (I,3)	Accuracy (I,1)	includes linework to define areas not based on map units (alteration, metamorphism, geomorphic features)
Location (included if applicable)	Point	Type (I,4), Identifier (C,10), LinkTable (I,3)		points defining locations of sample collection, mines, wells, etc
Label (included if applicable)	Point	Type (I, 4)		point locations of graphical elements for map composition; not linked to actual geographic locations

Geology Coverage

One polygon and arc coverage will include contacts and faults that define the boundaries between map units.

Polygon features

The PAT for this coverage will contain one feature.

- **UNIT:** A character field. Character strings are equivalent to unit labels on maps. See the coverage's metadata, field 5.2.1, for a complete list of unit labels and their explanations.

Arc features

The AAT will contain 5 fields, see Table 2 for a complete list of AAT codes.

- **TYPE:** An integer field with 4 digits.
 - First (leftmost) digit describes the general feature the line represents:
 - 4: Line on the surface of the Earth (e.g. crater outline, lava pond outline, foot of lava flow lobe, landslide scarp, crest line glacial moraine, fluvial terrace scarp, shoreline, top of fault scarp)
 - 5: Line projected to surface of the Earth (e.g. isopachs, structure contours)
 - 6: Line representing intersection of geologic surface with surface of the Earth (contacts, faults, shear zones)
 - 7: Line representing intersection of two geologic surfaces projected to the surface of the Earth. (marker bed cutoff at fault)
 - 8: Line, degenerate area represented by line (dike trace, vein trace)
 - Last 3 digits describe the specific feature. Codes for this come from first minor code described in USGS [1995]. e.g. 6010 is a fault.
- **ACCURACY:** An integer with 1 digit.
 - Digit defines accuracy. Codes are minor codes from USGS [1995], with addition of code for solid (accurate) line.
 - 5: Accurate to line width (.2 mm) at scale of map. Default value
 - 1: Approximately located
 - 2: Inferred
 - 3: Concealed
 - 4: Gradational or mixed
- **DESCRIPTOR:** An integer with 3 digits.
 - Digits are minor codes in USGS [1995]. Additional codes have been added for features not listed in the USGS report. Meaning varies according to TYPE.
- **IDENTIFIER:** A character string used to relate to associated table of additional information (e.g. name of fold or marker bed)
- **LINKTABLE:** An integer with 3 digits used to lookup file name of table containing related data.

Examples of attribute codes for arc features in the *geology* coverage:

approximate normal fault—Type: 6010, Accuracy: 1, Descriptor: 010;

accurate thrust fault—Type: 6010, Accuracy: 5, Descriptor: 020

Lines Coverage

One coverage, named ‘lines’ for all linear features not representing contacts and faults. This coverage includes all linear geologic features that do not bound rock units, including fold hinge-surface traces, degenerate areas like dikes, marker beds, etc.

Arc features

The AAT will contain 5 fields equivalent to the items in the *Geology* coverage. See Table 2 for a complete list of AAT codes.

Table 2. AAT codes currently in use for Geology and Lines coverages:

Type: (I, 4)		Accuracy: (I, 1)	
code	feature	code	feature
6001	Contact	5	Accurate to line width (0.2 mm) at scale of map
6010	Fault	1	Approximately located
6020	Fold Trace	2	Inferred
8001	Dikes & Veins	3	Concealed
8002	Marker Beds	4	Gradational
3333	Border		

Descriptors (I, 3)

Faults (6010)

code	descriptor
010	Unclassified
<i>011</i>	<i>Sub vertical*</i>
<i>012</i>	<i>Normal*</i>
013	Generic high angle w/ separation
014	Reverse
<i>016</i>	<i>Strike slip*</i>
017	Right lateral strike slip
018	Left lateral strike slip
019	Oblique slip
020	Thrust
024	Overtuned thrust
025	Low angle normal

(faults continued)

026	Detachment
027	Generic low angle
028	High angle normal
033	Right normal oblique slip
034	Left normal oblique slip
035	Right reverse oblique slip
036	Left reverse oblique slip
037	Shear zone

**italic numbers and descriptors are no longer used.*

Fold Traces (6020)

code	descriptor
001	Antiform
002	Synform
003	Monocline unspecified
004	(not assigned)
005	Anticline upright
006	Anticline overturned
007	Anticline Inverted
008	(not assigned)
009	(not assigned)
010	Syncline upright
011	Syncline overturned
012	Syncline inverted
013	(not assigned)
014	(not assigned)

Marker Beds (8002)

code	descriptor
001	Ferruginous quartzite
002	Conglomerate

(fold Traces continued)

015	Monocline anticlinal bend
016	Monocline synclinal bend

Dikes & Veins (8001)

code	descriptor
001	mafic
002	intermediate
003	felsic
004	pegmatite
005	old mafic

Structur Coverage

Coverage of point features associated with structural orientation data.

Point features

The PAT will contain six items.

- **TYPE:** An integer with 4 digits. Derived from the USGS OFR major code 600 series. The codes are listed in Table 3.
- **MODIFIER1:** A character, width 1, describing the method or certainty of structural data. The default for this field is 's'. Modifiers listed in Table 4.
- **STRIKE:** An integer with 3 digits for strike or trend, user right-hand rule to define dip direction.
- **DIP:** An integer with 2 digits for dip.
- **MODIFIER2:** A character with 2 digits. Modifier from Table 5; meaning varies according to TYPE. Default value is '1'.
- **LOC_ID:** A character field, width 6. It is a unique identifier for linking data. May be used to link structural data acquired in the same location, e.g. when more than one foliation or lineation is measured in a given outcrop, or for linking measured orientations of faults and contacts with the lines representing the trace of those surfaces. If the first character is a number, reference is to Loc_ID in Structur\pat.dbf; if G, reference is to User_ID in Geology\aat.dbf; if L, reference is to user_ID in lines\aat.dbf. Default value is '0'.

Table 3. AZGS attribute codes for structure data

PLANAR STRUCTURES	
Primary foliations	
<u>Type code (ONNN)</u>	<u>Feature</u>
1	strike and dip of bedding
2	massive igneous rock
3	igneous flow foliation (includes flow banding in lava)
4	eutaxitic foliation in welded tuff
5	cumulate foliation in igneous rocks
6	
7	
8	
9	
Tectonic foliations	
<u>generic</u>	
<u>Type code (ONNN)</u>	<u>Feature</u>
10	generic foliation
11	generic crystalloblastic foliation
12	generic cleavage
13	generic shape (mylonitic) fabric
14	
15	
16	
17	
18	
19	
<u>differentiated foliations</u>	
20	gneissic layering (compositional banding)
21	laminated differentiated foliations
22	layering derived from bedding (transposed)
23	layering derived from bedding w/ tops
24	
<u>mineral alignment foliations</u>	
25	schistosity
26	
27	
28	
29	
<u>disjunct foliations</u>	
30	joints
31	spaced disjunct cleavage/close joints
32	close disjunct cleavage ('fracture cleavage')
33	
34	
<u>mylonite series (TRIG/shape foliations)</u>	
35	weak shape fabric
36	well developed s-tectonite
37	protomylonite
38	mylonite
39	ultramylonite
<u>composite fabrics</u>	
40	cleavage parallel to bedding
41	
42	

43	
44	
<u>geometrical fabrics</u>	
45	continuous crenulation
46	axial surface to fold (no associated foliation)
47	
48	
49	
<u>other discontinuities</u>	
50	<i>faults*</i>
51	vein
52	minor faults
53	
54	

LINEAR STRUCTURES

primary lineations

<u>Type code (ONNN)</u>	<u>Feature</u>
55	generic
56	tool marks
57	flute casts
58	flow feature in igneous flow foliation
59	

tectonic lineations

<u>Type code (ONNN)</u>	<u>Feature</u>
60	generic lineation
61	groove or striae in surface
62	stretch/shape lineation (mylonitic)
63	mineral lineation (mod2 to indicate mineral and generation)
64	intersection lineation; bedding/cleavage
65	intersection lineation; Sn/Sn+1
66	
67	
68	
69	

folds

70	fold hinge orientation, associated with map-scale fold
71	generic minor fold hinge orientation
72	minor fold hinge orientation, antiform
73	minor fold hinge orientation, anticline
74	minor fold hinge orientation, synform
75	minor fold hinge orientation, syncline
76	cascade folds, hinge orientation, no asymmetry
77	asymmetric minor fold hinge orientation
78	
79	
80	

Other

81	apparent dip
90	contact orientation (dip direction & dip)
91	other line feature orientation (i.e. veins & dikes)
92	fault orientation (dip direction & dip)

**italic numbers and descriptors are no longer used.*

Table 4. Modifier 1 codes

code	meaning
s	standard, on-site measurement of planar foliation
a	approximate measurement
I	contorted or irregular orientation, generalized
p	photogeologic determination

Table 5. Modifier 2 codes

Table 5a. Facing direction: use with any primary foliation symbol (1-4):

code	meaning
u	upright
ut	upright, tops indicator seen
o	overturned
ot	overturned, tops indicator seen
d	doubly overturned
dt	doubly overturned, tops indicator seen

Table 5b. Generation: use with any tectonic foliation or lineation: number indicates generation of structural feature--either in given outcrop or regionally

code	meaning
1	Oldest structure recognized
2	Younger than generation 1, older than generation 3
3	Younger than generation 2, older than generation 4
	etc

Table 5c. Veins and mineral lineations (51, 63), code indicates mineral defining the feature.

code	meaning
q(n)	quartz; number in second place indicates generation of vein
h(n)	amphibole; number in second place indicates generation
s(n)	sillimanite; ditto
c(n)	calcite; ditto

Table 5d. Kinematic a-lineation (61 and 62), with sense of shear; code indicates vergence and generation of structure

code	meaning
u(n)	top up plunge; number in second place is generation
d(n)	top down plunge; number in second place is generation

Table 5e. Intersection lineations and asymmetric folds (64, 65, 76); code indicates vergence and generation of structure

code	meaning
d(n)	dextral vergence viewed down plunge; number is generation
s(n)	sinistral vergence viewed down plunge; number is generation

OthrArea Coverage

A polygon coverage for areas not based on map unit contacts, e.g. alteration zones, mylonite zones, metamorphic zones (other area types listed in USGS [1995]).

Polygon features

The PAT for this coverage will contains three user defined fields.

- **TYPE:** An integer with 3 digit minor code in the 690 or 630 series for areas and degenerate areas in USGS [1995]. Codes beginning with 0 were created for situations not covered in the USGS [1995] publication.
- **IDENTIFIER:** A character string used to relate to a separate table with character strings for named areas.
- **LINKTABLE:** An integer with 3 digits used to lookup file name of table containing related data.

Arc features

The AAT will contain 1 field to define the accuracy of the boundaries of the area.

- **ACCURACY:** An integer, width 1, coding identical to ACCURACY field in ‘Geology’ & ‘Lines’ coverages. See Table 2 for a complete list of accuracy codes.

Table 6. Type codes for OthrArea coverages.

code	meaning
320	vent
003	Tertiary mylonitic fabric
020	Mesozoic to early Tertiary metamorphic fabric
3nn	
9nn	

Location Coverage

Location of sample collection, fossil localities, age dates, wells, etc. Also includes degenerate areas as defined in USGS [1995]—mines, breccia pipes etc. Each type of locality is related to a table specified by the LINKTABLE field using IDENTIFIER as the relate field. The table LinkTabs associates integers from the LINKTABLE field with path names for the external tables.

Point features

There will be three items in the PAT.

- **TYPE:** An integer with 4 digits using minor code associated with major code 630 in USGS [1995]. A table will be generated with a list of codes used by the Arizona Geological Survey. Additional codes will be added for geochronological locations, water and oil wells.
- **IDENTIFIER:** A character string used to relate to ID# in separate table (specified by the LINKTABLE field) containing any useful data pertaining to site.

- LINKTABLE: An integer with 3 digits used to lookup file name of table containing related data

Label Coverage

Location of decoration (graphics features) on maps to provide additional information for presentation. The Arizona Geological Survey will not be creating this coverage until generation of paper maps for publication.

Point features

The PAT will contain one item.

- TYPE: An integer with 4 digits. The minor codes associated with major code 611 in USGS [1995]. A table will be generated with a list of codes used by the Arizona Geological Survey.

OTHER TABLES

linktabs

If features in the geology, lines, othrarea, or location coverages contain links to external tables, then a table named 'linktabs' must be present to define the names of the linked tables (full path names) and the 3 digit integer associated with that table in other database files, to be used in the 'LINKTABLE' fields.

The database will contain two items.

- TableID: A unique integer identifier with 3 digits for each external table.
- Table Name: A character field with the full path name string for external table, to allow automatic joining in scripts.

REFERENCES

USGS, 1995, Cartographic and digital standard for geologic map information (Draft): U. S. Geological Survey, Open-File Report 95-525, unpaginated.