Explanation of GIS Attributes used in Geologic Map Geodatabases produced by

Utah Geological Survey Geologic Mapping Program

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Introduction

Geographic information system (GIS) data files of geologic maps produced by the Utah Geological Survey (UGS) are provided in Esri file geodatabase format and comprise four data types: lines, polygons, symbols or point data, and map labels or annotations. There are two types of map labels: (1) names or information that initially are attributes of lines, polygons, or symbols (such as the map unit label, or the dip angle of a strike and dip symbol), and (2) short strings of text placed on the map by the geologist to label, point out, or explain some feature, such as a name of a fault, “breccia zone”, “disturbed area,” etc.

The following lists provide a brief explanation of the various geodatabase feature classes, attribute categories, and primary attributes used on the lines, polygons, and symbols or point data found on UGS geologic maps. This list applies to most geologic maps; no map has every type of attribute. A few maps have additional rarely used attributes not explained below, but which are explained on the explanation plate accompanying such maps. The actual list of all attribute possibilities is very large and combinations of these attributes may be used. Examples taken from various maps published are given for some explanations. See references at end for additional explanations of geologic features and common map symbology.

Discussion on Faults

Faults are a unique type of geologic feature that are one of the more difficult features to handle in GIS databases and thus commonly cause confusion. They can be created and attributed in two basic ways: (1) break all classes of faults into segments where they intersect other lines in the GeologicLines feature class and attribute each segment separately (dotted, dashed, solid, etc.), allowing each fault segment to form the boundary of a polygon as necessary; or (2) convert all faults on the GeologicLines feature class to “contacts” and treat them only as polygon boundaries on that feature class; then duplicate them on a separate feature class where they are attributed by fault type. The UGS requires that the <u>first</u> method be followed. The second method creates too many potential problems with shifted lines and “sliver polygons” formed between duplicated fault segments as edits are made and lines are shifted around slightly during production.

Geodatabase feature classes used by the UGS Mapping Program

<u>Primary feature classes:</u>
GeologicLines
GeologicUnits
GeologicStructureLines
CrossSectionLines
GeologicUnits_leaders
GeologicSymbols
GeologicFeatures_labels

<u>Secondary feature classes:</u>
GeologicUnits_overlays
IsoplethLines
MeasuredSectionLines

Additional feature classes are created as needed.

GeologicLines feature class

Data type: polylines

This feature class represents the major categories of geologic lines shown on most maps. Primary attribute fields (**bold**); select attribute examples shown

Feature – basic classification of geologic lines; a concatenation of the **Type**, **Subtype**, and **Modifier** fields (refer to these for more detailed descriptions). This is the field used for symbolizing geologic lines in the ArcMap table of contents. Select examples shown.

Contact, well located
Contact, approximately located
Contact, concealed
Contact, gradational, approximately located

Crest, arete, well located
Crest, moraine, symmetry unknown
Crest, beach ridge, well located

Bed, coal, concealed
Bed, marker, approximately located

Scarp, landslide, well located
Scarp, terrace, well located
Scarp, tensional, approximately located

Fault, normal, well located
Fault, normal, approximately located
Fault, normal, concealed
Fault, thrust, well located
Fault, thrust, approximately located
Fault, thrust, concealed
Fault, detachment, well located
Fault, detachment, approximately located
Fault, detachment, concealed
Fault, strike-slip, left-lateral, well located
Fault, strike-slip, left-lateral, approximately located
Fault, strike-slip, left-lateral, concealed
Fault, geophysical, gravity
Fault, geophysical, seismic

Dike, igneous, well located
Dike, mafic, concealed

Vein, mineralized, approximately located, queried
Vein, Gilsonite, concealed, queried

Shoreline, Bonneville level, well located
Shoreline, Provo, constructional, well located
Shoreline, Pine Valley, approximately located
Shoreline, Great Salt Lake highstand, well located
Shoreline, Lake Gunnison, concealed

Type – major categories of geologic lines; all **Type** categories are capitalized.

Contact	boundary between mappable geologic units; usually selected at a prominent change in rock type.
Fault	fracture in rock or sediment with discernable offset between opposite sides.
Bed	prominent bed that map author has chosen to show on the map, e.g., coal bed or marker bed.
Crest	linear ridge; generally used for glacial features and beach ridges.
Joint	fracture in rock with no discernable offset between opposite sides.
Lineament	linear feature of known or unknown origin visible on ground, map, or air photos.
Scarp	steep slope or increase in slope of ground surface created by movement on a fault or landslide.

Depression	naturally created small or large basin or low area on ground surface.
Extent	linear extent of a feature, e.g., pit or quarry, glacier ice, sinkhole or collapse feature, etc.
Shoreline	linear feature created by still-stand of a lake; may be erosional or constructional.
Boundary	mapped edge of a feature, e.g., water body, quad boundary or other map boundary, structure contour datum boundary.
Dike	cross-cutting intruded body of rock, commonly igneous magma, but sedimentary dikes also occur in some areas.
Vein	fracture containing mineralized material; may be discordant or concordant; quartz and calcite are common vein materials.

Subtype – primary characteristics or defining features; may apply to one, many, or all of the types listed above. Feature may be shape, type of movement (faults), age, or some other characteristic deemed important by map author.

normal	type of fault that is typically moderate- to high-angle and the hanging wall (upper block) appears to display extensional offset.
reverse	type of fault that is typically moderate- to high-angle and the hanging wall (upper block) appears to display compressional offset.
thrust	type of reverse fault that is typically at a low-angle, and is commonly, but not always parallel or at low angle to bedding planes.
detachment	type of low-angle extensional fault; sometimes referred to as a “gravity fault”.
strike-slip	fault on which movement was parallel to the fault’s strike (opposite side moved left or right in reference to the observer).
attenuation	extensional fault or fault zone that thins strata.
right-lateral	strike-slip fault in which opposite side moved to right (dextral).
left-lateral	strike-slip fault in which opposite side moved to left (sinistral).
scratch	contact or boundary between different map units based on some criteria selected by map author that is not typically used in formation and member contacts; may be a nomenclature change, a boundary across which definitions of map units changes, or a boundary separating units that are lumped together differently; commonly discordant to bedding; may separate a map unit in which members of a formation are combined together from map units of the formation in which members are mapped separately.
moraine	mound or linear ridge of glacial debris, generally till, deposited by a glacier; used as a subtype to a Crest.
gradational	generally a mapped contact that is placed in a broad transitional interval between different formations or lithologies.

geophysical	feature, usually a fault, recognized based on geophysical evidence.
Bonneville	highest of four major named shorelines of Latest Pleistocene Lake Bonneville.
Provo	second highest of four major named shorelines of Latest Pleistocene Lake Bonneville; formed after Bonneville flood.
Stansbury	prominent intermediate named shoreline of Latest Pleistocene Lake Bonneville.
Gilbert	prominent low-level named shoreline of Latest Pleistocene Lake Bonneville.
Gunnison	a major Late Pleistocene lake.
regressive	formed during a lake regression (generally applied to shorelines).
transgressive	formed during a lake transgression (generally applied to shorelines).
intermediate	as applied to shorelines, any local prominent shoreline.
unknown	insufficient geologic data to determine.
Pinedale	major Late Pleistocene ice age peaking about 15,000 to 20,000 years ago.
Bull Lake	major Late Pleistocene ice age peaking about 120,000 years ago.
Pine Valley	local prominent glacial episode in Late Pleistocene.
unknown	sense of movement unknown.

Modifier – additional information that further clarifies the types/features listed above; may be information such as how accurately the feature is located or understood by the map author, the type of data that was used to identify or interpret the feature, etc.

well located	position of contact, fault, or other feature is well constrained by geologic data.
approximately located	position of contact, fault, or other feature is not well constrained by geologic data.
approximately located, queried	feature is not well constrained, existence is questionable.
concealed	contact, fault, or other feature is concealed by overlying deposits or water.
concealed, queried	existence of concealed feature is questionable.
symmetrical	feature shape is the same or similar on either side of axis.
asymmetrical	feature shape is not the same or dissimilar on either side of axis.
intermittent	feature is not always present, but is present seasonally.
perennial	feature is present year-round.

other	many other terms may be added by map author.

FeatureName – proper names associated with mapped features, such as named faults or fault zones.

Examples:
Wasatch fault zone
Hurricane fault

Source – references to geologic sources of mapped features. This can be the author's original mapping or geology sourced from other contributors. This attribution may be done in the form of publication citation.

Notes – any additional comments that the geologist would like to make about mapped features. Brackets [ ] indicate that some defining information is to be entered, such as the geologic age of a feature.

low-angle	shallow dipping surface or lineament.
high-angle	steeply dipping surface or lineament.
steeply dipping	understood.
historic	understood.
prehistoric	understood.

[geol. age]
[strike and dip of plane (such as a fault) - not bedding strike and dip]
[trend and plunge]
[key comment]
[line name - such as name of fault]
[dike vein name]
[marker bed name]
other – many other terms may be added by map author.

Decorated lines, that is, lines with some sort of symbol on one side of the line, such as teeth on thrust faults, require that the lines be digitized in a fixed direction relative to the decorations so the decoration will plot on the side determined by the map author as shown on the source map. For example, teeth on faults are placed on the hanging wall (over-riding or upper plate or block).

GeologicUnits feature class

Data type: polygons

Generally the formation, member or other map unit name, and a shorthand symbol for each. Primary attribute fields (**bold**).

UnitRank – a simple numeric ranking, determined by the author, representing the stratigraphic order of all geologic units that appear on a given map (used for stratigraphic sorting in the ArcMap table of contents).

UnitSymbol – a shorthand plain-text abbreviation of the full map unit age and name. This is unique for every distinct map unit. The capital letter(s) always denote the geologic age (generally at period/system level) of the unit following international guidelines (see age discussion below), however, proper age characters are not used here, rather simple text substitutions, e.g., TR for Triassic or IP for Pennsylvanian age units; proper age characters are used in the UnitLabel field (see below). The small letters denote the name and/or relative age of the unit. The UnitSymbol field is used for preliminary labels on the map, cross sections, and illustrations, and is defined in an explanation accompanying the map.

<u>Examples:</u>

Qa	Tgda	Cop
Qap_3	TRcp	Zmf
QTms	PIPo	Xfhs
Qaf/Qls	IPe	
Qaf/Qls/Ct	SOlf	

UnitLabel – This field contains modified versions of the UnitSymbol attributes that are used to label the geologic units on the map, using the FGDCGeoAge TrueType font (distributed with our map data) created by the U.S. Geological Survey; the UnitLabel field has a dependency on this font and will not label properly without it. This font uses keyboard character replacements that represent proper stratigraphic age characters that have been long-used under international convention in publications. The following keyboard characters (in parentheses) in the FGDCGeoAge font produce these special geologic age symbols: (^) Ꞧ – Triassic, (*) ℙ – Pennsylvanian, (_) Ꞓ – Cambrian. Precambrian subdivisions use Z, Y, X, and W. The following terms and symbols are rarely used, but may appear on a few geologic maps: (*M) ℙM – Carboniferous (Pennsylvanian-Mississippian), ({) Cz – Cenozoic, (}) Mz – Mesozoic, (|) Pz – Paleozoic, (=) pꞒ – Precambrian. A full list of geologic age character substitutions in this font can be found here: https://ngmdb.usgs.gov/fgdc_gds/geolsymstd/fgdc-geolsym-sec32.pdf

UnitName – Unique name for each map unit. Some are formally defined, indicated by upper-case letters. Some are informal terms assigned by the map author, indicated by lower-case letters.

<u>Examples:</u>	<u>(possible matching UnitLabel)</u>
alluvial deposits	Qa
level 3 alluvial pediment-mantle deposit	Qap_3
old mass-movement landslide deposit	QTms
alluvial fan deposits over lacustrine sand	Qaf/Qls
alluvial fan deposits over lacustrine sand over Tintic Quartzite	Qaf/Qls/Ct
Tongue A of Douglas Creek Member of Green River Formation	Tgda
Chinle Formation, Petrified Forest Member	Ꞧcp
Oquirrh Formation	PℙPo
Ely Limestone	ℙPe
Laketown and Fishhaven Dolomites, undivided	SOlf
Ophir Formation	Ꞓop
Mineral Fork Formation	Zmf
Farmington Canyon Complex, hornblende-biotite schist unit	Xfhs

Grouping – a form of unit grouping established by the geologist. The grouping attribute is intended to make the inevitable task of simplifying large-scale data to a smaller-scale easier in the future (examples below).

UnitName:	Grouping:
Spring tufa	surficial deposits
Terrace gravel	surficial deposits
Eolian dune sand	surficial deposits
Temple Cap Formation	San Rafael Group
Navajo Sandstone	Glen Canyon Group
Kayenta Formation	Glen Canyon Group
Wingate Sandstone	Glen Canyon Group

Age_Strat – age or age range of map units as assigned by map author based on standard divisions of geologic time. Generally stated as accurately and precisely as evidence from geologic setting, fossils, or laboratory analyses allow (age designation in unit symbol [for example Q or ℙM] is more generalized than age given here). Some examples are given below, with the letters that would be used in the unit symbol given in parentheses. See most geology textbooks or several web sites such as the U.S. Geological Survey web site at (https://pubs.usgs.gov/fs/2010/3059/pdf/FS10-3059.pdf) or the University of California, Berkeley website at (http://www.ucmp.berkeley.edu/help/timeform.html) for tables showing numeric ranges of geologic age terms.

Examples:
Quaternary (Q)
Quaternary-Tertiary (QT)
Pennsylvanian-Mississippian (ℙM)
Lower Pennsylvanian-Upper Mississippian (ℙM)
Devonian-Cambrian (D€)
Upper Proterozoic (Z)
Middle Proterozoic (Y)
Lower Proterozoic-Upper Archean (XW)
Holocene (Q)
Oligocene-Eocene (T) (for Tertiary)

Occasionally the map author may drop the Q or QT letters to save space – the age is given in the Map Explanation.

Composition – characteristics of the primary lithologies of each unit; the most prominent type should be listed first, followed by other types in ascending order of abundance (examples below).

Examples:
gravel to cobble sized clasts, sand, silt, mud
clay to boulder sized clasts
mudstone, siltstone, gypsiferous silty sandstone
sandstone, conglomerate, siltstone
shale, mudstone, siltstone, claystone

Genesis – genesis refers to the origin of a unit and can be related to various geologic processes and concepts such as; depositional environments and subsurface processes (examples below).

Examples:

eolian sand sheet	debris flows
shallow marine	rockfall
fluvial, slope-wash, creep	braided stream, flood plain
coastal sabkha, tidal flat	flood plain

Description – the full geologic unit description for each unit found on the geologic map plate 1. Essentially, this description should be the same as the one found in the author(s) booklet, or the description found on the map explanation plate 2, if no booklet is produced. If needed, minor changes should be made for clarity so the description can stand on its own without context to other geologic units. The descriptions should contain the formal unit name, best-known age, primary lithology—followed by others in ascending order—and unit thickness. (examples below).

Examples:
Alluvial-fan deposits (Holocene) – Unconsolidated, mostly coarse-grained sand, pebbles, cobbles, and boulders mixed within a silt and clay matrix; poorly sorted but may be locally poorly stratified; deposited by debris flows at decrease in gradient to form fan-shape deposits at the mouths of drainages and as broad coalescing deposits along the base of highlands that have several drainages along their length; less than 50 feet thick.

Smiths Fork till (upper Pleistocene) – Unconsolidated, very poorly sorted boulders and cobbles in a sandy matrix along Dry Fork Canyon; forms low ridge in valley due to armoring effect of boulders; Smiths Fork till was deposited approximately 14 to 32 Ka but cosmogenic 10Be surface-exposure dating reveal that terminal moraines were abandoned by retreating glaciers before 16 Ka (Laabs and Carson, 2005; Laabs and others, 2009; Munroe and Laabs, 2009); less than 35 feet thick.

Dakota Formation (Lower Cretaceous, Albian) – Sandstone interbedded with pebble and gravel conglomerate lenses and separated by carbonaceous shale and local coal beds; sandstone is moderate yellow to yellowish gray on fresh surface but weathers dark yellowish orange to grayish yellow, coarse to medium grained, subangular grains, moderately sorted, thin to very thin bedded, cliff to ledge forming, planar laminated to trough cross-stratified, limonite stained, Liesegang banded, and commonly jointed; conglomerate is comprised of pebble- to gravel-sized clasts in a sandy matrix, angular to subangular, poorly sorted, medium to thin bedded, well to loosely cemented, ledge forming, vuggy and friable where loosely cemented; shale beds are dark gray on fresh surface but weathers light gray, slope forming, contains permineralized wood at base; coal beds are soft, very thin and discontinuous; 115 to 280 feet thick.

Source – references to geologic sources of mapped features. This can be the author's original mapping or geology sourced from other contributors. This attribution my be done in the form of publication citation.

Notes – any additional comments that the geologist would like to make about mapped features. Includes, but not limited to, text that appears on map.

[geologic group to which unit belongs]
[modifications to age of unit made during GIS compilation]

GeologicUnits_overlays feature class

Data type: polygons

Primary attribute fields (**bold**); select attribute examples shown.

Overlay Features – there is a class of polygons that overlie the GeologicUnits feature class, e.g., shear zones, alteration zones, and mineralized zones. For example, if part of the Isom Tuff is silicified, it can be shown on the map as Ti (Tertiary Isom Tuff) with a pattern over the silicified portion (si). The patterned area is placed in a separate polygon feature class which overlies the GeologicUnits feature class in the ArcMap table of contents.
This differs from the way stacked units are handled. Stacked units are map units in which the map author shows a thin mantle of one map unit over another map unit. For example, Qal/Ts indicates a thin mantle of Quaternary alluvial deposits over a Tertiary unit. For GIS purposes, each stacked unit variation is treated as a unique unit with unique attributes in the GeologicUnits polygon feature class.

UnitSymbol – shorthand abbreviation of polygon name that generally appears on map as label.

Examples:
br (breccia zone)
fe (hematitic alteration)
si (silicified zone)
sz (shear zone)
[at discretion of map author, unit symbols may or may not be placed on map - the overlay feature may only be identified on map by a pattern fill]

UnitLabel – this field contains modified versions of the UnitSymbol attributes that are used to label the geologic units on the map (see full description above under the GeologicUnits feature class).

UnitName – full name of overprinted polygon.

Examples:
breccia zone
hematitic alteration
silicified zone
shear zone
etc.

Grouping – a form of unit grouping established by the geologist. The grouping attribute is intended to make the inevitable task of simplifying large-scale data to a smaller-scale easier in the future (optional).

Age_Strat – age or age range of map units as assigned by map author based on standard divisions of geologic time. Generally stated as accurately and precisely as evidence from geologic setting, fossils, or laboratory analyses allow

Composition – characteristics of the primary lithologies of each unit; the most prominent type should be listed first, followed by other types in ascending order of abundance

Genesis – genesis refers to the origin of a unit and can be related to various geologic processes and concepts such as; depositional environments and subsurface processes (optional).

Description – the full geologic unit description for each unit found on the geologic map plate 1. Essentially, this description should be the same as the one found in the author(s) booklet, or the

description found on the map explanation plate 2, if no booklet is produced. If needed, minor changes should be made for clarity so the description can stand on its own without context to other geologic units. The descriptions should contain the formal unit name, best-known age, primary lithology—followed by others in ascending order—and unit thickness.

Source – references to geologic sources of mapped features. This can be the author's original mapping or geology sourced from other contributors. This attribution may be done in the form of publication citation.

Notes
[intensity term]
[source of data]
[age or event]

GeologicStructureLines feature class

Data type: polylines

Structural lines used to depict structural features of the geology. Primary attribute fields (**bold**); select attribute examples shown.

Feature – basic classification of structure lines; a concatenation of the **Type**, **Subtype**, and **Modifier** fields (refer to these for more detailed descriptions). This is the field used for symbolizing geologic lines in the ArcMap table of contents. Select examples shown.

Fold, anticline, upright, well located
Fold, anticline, upright, asymmetrical, well located
Fold, anticline, overturned, approximately located
Fold, anticline, synformal, concealed

Fold, syncline, antiformal, well located
Fold, syncline, upright, approximately located
Fold, syncline, upright, asymmetrical, well located
Fold, syncline, overturned, concealed, queried

Fold, monocline, concealed
Fold, monocline, antiformal bend, well located
Fold, monocline, synformal bend, concealed
Fold, monocline, overturned, approximately located

Fold, recumbent, well located
Fold, recumbent, approximately located
Fold, recumbent, concealed

Fold, S-fold, well located
Fold, S-fold, concealed

Fold, M-fold, well located
Fold, M-fold, approximately located

Fold, Z-fold, well located
Fold, S-fold, concealed

Structure contour, datum 1, projected above ground

Type – major categories of structural lines; all **Type** categories are capitalized.

Fold	a bend or plication in bedding or other planar features in rocks; usually a product of deformation.
Structure contour	a contour (an imaginary horizontal line) drawn on a specified bedding surface to denote a structural surface; generally defined relative to sea level.

Subtype – primary characteristics or defining features.

anticline, upright	a fold, generally convex upward (oldest strata in the core) and the axial surface is approximately vertical.
anticline, upright, asymmetrical	a fold, generally convex upward (oldest strata in the core) and the axial surface is approximately vertical; limbs are dissimilar on either side of axis.
anticline, overturned	a fold, generally convex upward (oldest strata in the core) and the axial surface is tilted beyond vertical.
anticline, synformal	a synformal anticline is an anticline (oldest strata in the core) with an overturned axial surface, so it appears to be a syncline.
syncline, upright	a fold, generally concave upward, (youngest strata in the core), and the axial surface is approximately vertical.
syncline, upright, asymmetrical	a fold, generally concave upward, (youngest strata in the core), and the axial surface is approximately vertical; limbs are dissimilar on either side of axis.
syncline, overturned	a fold, generally concave upward, (youngest strata in the core), and the axial surface is tilted beyond vertical.
syncline, antiformal	an antiformal syncline is a syncline (youngest strata in the core) with an overturned axial surface, so it appears to be an anticline.
monocline	a local steepening in an otherwise uniform dip.
monocline, overturned	a local steepening in an otherwise uniform dip, with one limb that is overturned.
monocline, antiformal bend	an antiformal fold in which the upper limb is gently dipping and the lower limb is steeply dipping; generally the upper of the two folds forming a monocline pair.
monocline, synformal bend	a synformal fold in which the upper limb is steeply dipping and the lower limb is gently dipping; generally the lower of the two folds forming a monocline pair.
recumbent	a fold in which the axial plane is approximately horizontal.
S-fold	S-shaped fold in the limb of a larger fold.
M-fold	M-shaped fold in the hinge zone of a larger fold.
Z-fold	Z-shaped fold in the limb of a larger fold.
unknown	fold form is uncertain and/or relative ages of strata is uncertain.
datum 1	structural contour datum 1
datum 2	structural contour datum 2
datum 3	structural contour datum 3

Modifier – additional information that further clarifies the types/features listed above; may be information such as how accurately the feature is located or understood by the map author, the type of data that was used to identify or interpret the feature, etc.

well located	position of contact, fault, or other feature is well constrained by geologic data.
approximately located	position of contact, fault, or other feature is not well constrained by geologic data.
concealed	contact, fault, or other feature is concealed by overlying deposits or water.
concealed, queried	existence of concealed feature is questionable.
approximately located, queried	feature is not well constrained, existence is questionable.
projected above ground	shown hypothetically how the feature would project or trend through space above the ground surface.

FeatureName – proper names associated with mapped features, such as named anticlines or synclines.

Examples:
North Tintic anticline
Pole Canyon syncline

Elevation – surface elevation of a structural contour above mean sea level.

Datum – structural contour datum; formation or unit the contour is based on.

Source – references to geologic sources of mapped features. This can be the author's original mapping or geology sourced from other contributors. This attribution may be done in the form of publication citation.

Notes – any additional comments that the geologist would like to make about mapped features. Brackets [ ] indicate that some defining information is to be entered.

plunging	fold axis is inclined or plunges into ground.
doubly plunging	fold axis is curved such that both ends are inclined.
isoclinal	in folds, a fold in which limbs are parallel.
recumbent	in folds, a fold in which axial plane is approximately horizontal.
open	in folds, a fold in which limbs form angle greater than 90 degrees.
closed	in folds, a fold in which limbs form angle less than 90 degrees.
[contour interval]	elevation or interval spacing of structural or other contours.
[bearing]	compass bearing.
[plunge]	amount, in degrees, of dip or inclination.
[name of 2nd, 3rd, etc contoured surface]	enter name of surface or feature.
[name of structure]	name of a fold or other structure [e.g., Cane Creek anticline].

IsoplethLines feature class

Data type: polylines

Any type of contoured data, other than structural contour lines. Primary attribute fields (**bold**); select attribute examples shown.

Feature – basic classification of isopleth lines; a concatenation of the **Type, Subtype,** and **Modifier** fields (refer to these for more detailed descriptions). This is the field used for symbolizing geologic lines in the ArcMap table of contents. Select examples shown.

Type – major categories of lines; all **Type** categories are capitalized.

thickness isopleth	thickness of a particular unit [e.g., thickness of a coal bed].
chemical isopleth	chemical composition or content data [e.g., copper oxide content of a particular unit].
depth isopleth	depth below ground surface of a plane.

Subtype – primary characteristics or defining features; may apply to one, many, or all of the types listed above. Subtypes may be combined to more accurately define the features.

<u>Examples of data or features that might be shown with isopleth lines:</u>
coal
tar sand
gypsum
alteration zone
mineralization
chemical variations
[give name of mineral, product, or topic]

Modifier – additional information that further clarifies the types/features listed above; may be information such as how accurately the feature is located or understood by the map author, the type of data that was used to identify or interpret the feature, etc.

well located	see above
approximately located	see above
queried	see above
approximately located, queried	see above
scratch	see above
projected	see above

(can combine terms)

Source – references to geologic sources of mapped features. This can be the author's original mapping or geology sourced from other contributors. This attribution may be done in the form of publication citation.

Notes – any additional comments that the geologist would like to make about mapped features. Brackets [ ] indicate that some defining information is to be entered.

[age]
[datum]
[source of data]
[method]
etc.

MeasuredSectionLines feature class

Data type: polylines

Lines representing locations of measured stratigraphic sections. Primary attribute fields (**bold**); select attribute examples shown.

Feature – basic classification of measured section lines; a concatenation of the **Type, Subtype,** and **Modifier** fields (refer to these for more detailed descriptions). This is the field used for symbolizing geologic lines in the ArcMap table of contents. Select examples shown.

Type – major categories of lines; all **Type** categories are capitalized.

Measured section line	shows location or line of traverse where a section of strata, discussed or mentioned in supporting materials, was measured.

Subtype – primary characteristics or defining features; may apply to one, many, or all of the types listed above. Subtypes may be combined to more accurately define the features.

Modifier – additional information that further clarifies the types/features listed above; may be information such as how accurately the feature is located or understood by the map author, the type of data that was used to identify or interpret the feature, etc.

Source – references to geologic sources of mapped features. This can be the author's original mapping or geology sourced from other contributors. This attribution may be done in the form of publication citation.

Notes – any additional comments that the geologist would like to make about mapped features.
Examples:
section 3a
measured section through Moenkopi Formation

CrossSectionLines feature class

Data type: polylines

Lines representing geologic cross sections. Primary attribute fields (**bold**); select attribute examples shown.

Feature – basic classification of cross section lines; a concatenation of the **Type** and **Modifier** fields (refer to these for more detailed descriptions). This is the field used for symbolizing geologic lines in the ArcMap table of contents. Select examples shown.

Cross section A-A’
Cross section B-B’
Cross section C-C’
Cross section D-D’-D”
etc.

Type – major categories of lines; all **Type** categories are capitalized.

Cross section	line on map showing position of a cross section included elsewhere in supporting materials.

Modifier – additional information that further clarifies the types/features listed above; may be information such as how accurately the feature is located or understood by the map author, the type of data that was used to identify or interpret the feature, etc.

A-A'	cross section A between beginning point (A) and end point (A').
B-B'	cross section B between beginning point (B) and end point (B').
C-C'	cross section C between beginning point (C) and end point (C').
D-D'-D"	cross section D, denoting bend in section between beginning point (D) and end point (D").

Source – references to geologic sources of mapped features. This can be the author's original mapping or geology sourced from other contributors. This attribution may be done in the form of publication citation.

Notes – any additional comments that the geologist would like to make about mapped features.

GeologicUnits_leaders feature class

Data type: polylines

Leader lines used to aid the geologic units map labels and geologic symbols. Primary attribute fields (**bold**); select attribute examples shown.

Feature – basic classification of leader lines; a concatenation of the **Type, Subtype,** and **Modifier** fields (refer to these for more detailed descriptions). This is the field used for symbolizing geologic lines in the ArcMap table of contents. Select examples shown.

Type – major categories of lines; all **Type** categories are capitalized.

Leader line	a short line segment used to lead a map unit label to a polygon that is too small to host a label, or lead a label to a map symbol that is located in a congested area on a map; this enhances map readability.

Subtype – primary characteristics or defining features; may apply to one, many, or all of the types listed above. Subtypes may be combined to more accurately define the features.

Modifier – additional information that further clarifies the types/features listed above; may be information such as how accurately the feature is located or understood by the map author, the type of data that was used to identify or interpret the feature, etc.

Notes – any additional comments that the geologist would like to make about mapped features.

GeologicSymbols feature class

Data type: points

Geologic data that occur at a point, such as bedding and foliation measurements, drill holes, and sample locations, also symbols to show trend, plunge direction, sense of offset on faults, and other features selected by map author. Examples are: strike and dips, arrows, balls and bars on faults, line decorations. Primary attribute fields (**bold**); select attribute examples shown.

Feature – basic classification of geologic symbols; a concatenation of the **Type**, **Subtype**, and **Modifier** fields (refer to these for more detailed descriptions). This is the field used for symbolizing geologic symbols in the ArcMap table of contents. Select examples shown.

Bedding, inclined, field measured
Bedding, inclined, map digitized
Bedding, inclined, photogrammetric (3-point)
Bedding, inclined, approximate, field measured
Bedding, upright, top known
Bedding, overturned, approximate
Bedding, overturned, photogrammetric (3-point)
Bedding, vertical, map digitized, source-B
Cleavage, inclined
Cleavage, vertical
Drill hole
Drill hole, oil well, abandoned
Drill hole, gas well
Drill hole, injection well
Drill hole, oil and gas well, shut-in
Fault, ball and bar
Fault, dip
Fold, minor anticline
Fold, minor syncline, inclined
Fold, minor S
Foliation, inclined, field measured
Lineation, bearing and plunge
Mine or quarry
Joint, vertical
Sample
Volcanic cone, cinder
Adit
Prospect
Shaft
Oil seep

Type – primary classes of point data.

Bedding	attitude of bedding plane – a surface separating layers of stratified rock; generally depicted as a strike and dip symbol but may be shown using structural contours.
Fold	a bend or plication in bedding or other planar features in rocks, too small to map as linear feature.
Foliation	planar textural or structural fabric or features repeated through the rock; generally depicted as a strike and dip.
Joint	planar fracture, crack, or parting in a rock; commonly repeated to form joint sets; generally depicted as a strike and dip; large joints are commonly mapped.
Cleavage	in structural terms, a local planar fabric in a generally fine-grained rock that promotes a tendency to split along planes or parallel surfaces; produced by structural deformation; generally depicted as a strike and dip.
Lineation	small linear geologic feature mapped as a symbol.
Adit	horizontal passage from surface into a mine; a tunnel; commonly includes gently inclined passages.

Shaft	near vertical mine excavation or opening.
Quarry	open excavation for stone or minerals.
Prospect	small exploratory pit or excavation.
Drill hole	hole drilled for exploration or extraction.
Sample	location where a rock or sediment sample is collected for analysis; sample identifier and type generally given in attributes; results of analyses generally explained in accompanying materials, but may be used as attributes.
Spring	location where naturally flowing water emerges from ground.
other	many other types may be used by map author.

Subtype – defines, explains, or augments **Type** data (terms may be combined if needed, some terms are self-evident).

inclined	understood
vertical	understood
upright	understood
horizontal	understood
overturned	understood
anticline	axial symbol placed on anticlines.
syncline	axial symbol placed on synclines.
monocline	axial symbol placed on monoclines.
minor anticline	fold structure too small to map as linear feature.
minor syncline	fold structure too small to map as linear feature.
minor synform	fold structure too small to map as linear feature.
minor antiform	fold structure too small to map as linear feature.
minor S	fold structure too small to map as linear feature.
minor M	fold structure too small to map as linear feature.
minor Z	fold structure too small to map as linear feature.
fossil	understood
dry hole	no oil or gas encountered in bore hole.
oil show	small amount of oil encountered.
gas show	small amount of gas encountered.
water well	bore hole drilled to extract water.
oil well	significant oil encountered in bore hole.
gas well	significant gas encountered in bore hole.
oil and gas well	significant oil and gas encountered in bore hole.
injection well	bore hole drilled to inject water or other liquids.
plunge arrow	triangular arrow symbol showing direction of plunge on fold axes.
minor fold	fold structure too small to map as linear feature.
etc.	

Modifier – additional information that further clarifies the types/features listed above; may be information such as how accurately the feature is located or understood by the map author, the type of data that was used to identify or interpret the feature, etc.

field measured	data determined from field observations and measurements.
map digitized	data digitized from existing source maps.
bearing and plunge	bearing (trend) and plunge (inclination) of small folds and lineation features.
photogrammetric	data determined from photogrammetric means using aerial stereo models.
shut-in	inactive oil or gas well that still has unused capacity.
abandoned	bore hole has been plugged and capped and no longer in use.
etc.	

Rotation – some point data have specific orientations that author should record and symbol should be rotated on map accordingly; expressed as whole numbers in degrees azimuth.

Examples:
23
145
348
Note: map author should verify that symbols are rotated properly.

Strike – strike is the direction of a line made by the intersection of a surface such as strata with the horizontal; expressed as whole numbers in degrees azimuth (can be calculated from Rotation values).

DipDirection – dip direction is perpendicular to strike, and pointing in the direction which the planar surface is dipping down; expressed as whole numbers in degrees azimuth (value is synonymous with Rotation).

DipAngle – dip is the inclination of planar strata or surfaces in the rock in degrees, from horizontal, of a shaft, adit, bore hole, strike-and-dip, or other feature (angle is generally placed on map).

Examples:
5
12
45
68

Feature_ID – attribute that includes but not limited to, text that appears on map.

Examples:

49±0.3 Ma	1989 [date]	43°
sample WA23	50 bbl/day	183°
WA23	0.03% Au	[name]
A	12% Cu	[linked text comment]
B	12 ft	

GPS_ID – attribute for associating map symbols to GPS points collected in the field.

Source – references to geologic sources of mapped features. This can be the author's original mapping or geology sourced from other contributors. This attribution may be done in the form of publication citation.

Notes – any additional comments that the geologist would like to make about mapped features. Examples of other information that might be provided:

geochemical
Isotopic sample
petroleum exploration
mineral exploration
saline water or brine
hot
cold
reclaimed
modified
[type of marker or stand pipe found during mapping]
conodont
palynomorph
vertebrate
etc.

GeologicFeatures_labels feature class

Data type: annotations

Textual labels placed on the map to locate and identify specific features; includes many annotation classes.

Examples of annotation classes:
unit labels
dip angle labels
sample numbers
well numbers
labels for named faults
labels for named fold axes
cross section labels
shoreline labels
structure contour elevation numbers

Examples of text that could be included in this feature class:
Qal
Ꞧm
Wasatch fault
Virgin anticline
Texaco State X²1-12 (well number)
Chesterfield Mine
2,000 feet
5,280
TD -12,460
8 (dip or plunge angle)
WA23-3 (sample number)
[dune field; such as Antelope Valley Dune Field]
[breccia zone]
[disturbed area]
[fault zone]
[silicified in this area]
[name of a broadly defined geomorphic feature]

Additional Descriptions and Explanations of Geologic Features and Map Symbols

Geologic Data Subcommittee of Federal Geographic Data Committee, 2000, Public review draft – digital cartographic standard for geologic map symbolization: U.S. Geological Survey Open-File Report 95-525, variously paginated.

Jackson, J.A., 1997, Glossary of Geology, 4th Edition: Alexandria, Virginia, American Geological Institute, 769 p.