MapUnitPolys (polygon feature class) required

Fields:

MapUnit	*Short plain-text key (identifier) for the map unit. Example values: "Qal", "Tg", "Kit", "water", "Trc3", etc. Foreign key to DescriptionOfMapUnits table. Null values not permitted—a mapped polygon must have an assigned map unit*
IdentityConfidence	*How confidently is this polygon identified as MapUnit? Value is usually "certain", "questionable", or "unspecified". Null values not permitted. Suggest setting default value to "certain". Values must be defined in Glossary.*
Label	*Determined from the appropriate value of the Label in the DescriptionOfMapUnits table and IdentityConfidence: if IdentityConfidence = "questionable", then append "?" to Label value from the DescriptionOfMapUnits table. Allows for subscripts and special characters. Null values permitted*
Symbol	*References an area fill symbol (background color + optional pattern). Area fill symbols must be defined in an accompanying style file. If Esri Cartographic Representations are used to symbolize map units, the value may be null or blank. Null values permitted*
DataSourceID	*Foreign key to DataSources table, to track provenance of each data element. Null values not permitted*
Notes	*Optional field. Free text for additional information specific to this polygon. Null values permitted*
MapUnitPolys_ID	*Primary key.* Example Values = MUP1, MUP2, MUP3, etc. Values must be unique in database. Null values not permitted

Topology rules:

- Polygons must not overlap
- No gaps between polygons
- Boundaries must be overlain by lines in ContactsAndFaults

Note that not all lines in ContactsAndFaults necessarily bound polygons: polygons separated by concealed contacts or faults may have been merged during construction of the database; also some faults, concealed contacts, and concealed faults may dangle (terminate within polygons) and thus not separate polygons. Note also that open water (lakes, double-line rivers), glaciers, and unmapped areas are polygons, and so must have non-null MapUnit values (e.g., water, glacier, unmapped). Water and glacier areas commonly are not labeled (Label=null).

(Leave blank)

ContactsAndFaults (line feature class) required

Fields:

Type	*Specifies the kind of feature represented by the line. Values could be, for example, 'contact', 'fault', 'waterline', 'glacier boundary', 'map boundary'. Values must be defined in Glossary. Null values not permitted*
IsConcealed	*Values = 'N','Y'. This is a flag for contacts and faults covered by an overlying map unit. Null values not permitted*
LocationConfidenceMeters	*Data type = float. Half-width in meters of positional uncertainty envelope; position is relative to other features in database. Null values not permitted. Recommend value of -9 if value is not available. See discussion in "Feature-level metadata", above*
ExistenceConfidence	*Values = 'certain', 'questionable', 'unspecified'. Null values not permitted. Suggest setting default value = 'certain'. Values must be defined in Glossary.*
IdentityConfidence	*Values: 'certain' , 'questionable, 'unspecified''. Null values not permitted. Suggest setting default value = 'certain'. Values must be defined in Glossary.*
Label	*Can be used to store fault name, or human-readable name for a line feature. To group line segments into a specific structure trace, e.g."San Andreas Fault", use optional Extended Attributes table. Typically null*
Symbol	*References a symbol in the accompanying style file. Calculated from Type, LocationConfidenceMeters, ExistenceConfidence, IdentityConfidence, and most appropriate map display scale. Null values permitted*
DataSourceID	*Foreign key to DataSources table, to track provenance of each data element. Null values not permitted*
Notes	*Optional field. Free text for additional information specific to this feature. Null values permitted*
ContactsAndFaults_ID	*Primary key. Example values = CAF1, CAF2, etc. Values must be unique in database*

Topology rules:

- Must not overlap.
- Must not self-overlap.
- Must not self-intersect.
- Must not have dangles, with certain exceptions. Most dangling-line exceptions should be Type='fault' or be Type='contact' and IsConcealed = 'Y'.

Map-unit-bounding fault lines are legitimate elements of this feature class and should not be coincident with contacts.

We recommend using “blank” as the value of Symbol for scratch boundaries (where no line is drawn between adjoining polygons, also known as wash boundaries); scratch boundaries are occasionally used for contacts with exceptionally large values of LocationConfidenceMeters.

Suggested values for Type include:

contact contact,
internal contact,
gradational contact,
unconformable fault
fault, normal
fault, reverse
fault, thrust
scratch boundary
glacier boundary
waterline
map boundary (or, map neatline)

This list is derived from the FGDC standard, sections 1, 2, 30, and 31. Other values certainly are possible (e.g., see FaultType and ContactType vocabularies at *https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/ConceptDefinitionsTG*).

In all cases, note that modifiers such as “approximate”, “certain”, “concealed”, and “queried” are not encoded in Type. These modifiers reflect the convolution of LocationConfidenceMeters, ExistenceConfidence, IdentifyConfidence, and the scale. The description of a contact as “approximate” is not literally preserved in a GeMS database; this information is preserved with the appropriate value of LocationConfidenceMeters. When migrating an existing map into the GeMS schema it is often convenient to store “contact, approximate” in a temporary field (e.g., LTYPE) that is later parsed to calculate values of Type, LocationConfidenceMeters, etc.

DescriptionOfMapUnits (non-spatial table) required

This table captures the content of the Description of Map Units, Explanation, or equivalent List of Map Units (LMU), or legend of the geologic map.

Fields:

MapUnit	*Short plain-text key (identifier) for the map unit. Example values: "Qal", "Tg", "Kit", "water", "Trc3", etc. Values in this field are the link (foreign key) between this table and the MapUnitPolygon table. Null values permitted, and are commonly associated with headings or headnotes. Use of special characters is not recommended in this field*
Name	*Boldface name in traditional DMU, identifies the unit within its hierarchical context. Examples: 'Chinle Formation', 'Shnabkaib Member'. Text in the Name field should have initial capitalization only and no font specification—these are given by ParagraphStyle and Glossary. Formal names should be verified in the U.S. Geologic Names Lexicon (GEOLEX); if your usage does not agree with GEOLEX's, notification should be submitted to the Lexicon website. Place headings in this field and place accompanying headnote text, if any, in the Description field. Null values permitted*
FullName	*Full name of unit, including identification of containing higher rank units, e.g., 'Shnabkaib Member of Moenkopi Formation'. This is the text you would like to see as fly-out when cursor lingers over polygon in an electronic map display. See Lexicon-related note in "Name", above. Null values permitted (e.g., for headings, headnotes, geologic units not shown on map)*
Age	*As shown in traditional DMU (commonly as bold text within parentheses). Use null values for headings and headnotes*
Description	*Free-format text description of map unit. Commonly terse and structured according to one or more accepted traditions (e.g., lithology, thickness, color, weathering and outcrop characteristics, distinguishing features, genesis, age constraints). Allows markup (e.g., HTML) specification of new paragraphs, superscripts and subscripts, and geologic-age font (sans-serif and with special characters). Place headnote text in this field. Null values permitted*
HierarchyKey	*Text string with form nn-nn-nn, nnn-nnn, or similar. Each fragment is numeric, of the same length, left-padded with zeros, and dash-delimited. These strings are useful for resolving queries involving hierarchical relationships, e.g., 'find all members of formation x', 'what is the parent unit of map unit y'. Null values not permitted. Appendix C illustrates the use of HierarchyKey to describe the structure of Description of Map Units for several maps*
ParagraphStyle	*Values are Heading1st, Heading2nd, Heading3rd, …, Headnote, DMU1, DMU2, DMU3, …, or similar. Formatting associated with a paragraph style should be explained with a definition of the style in the glossary. Null values not permitted*

Label	*Text string used to place label in map display; includes graphic elements such as special fonts and formatting for subscripts. For example, Triassic Newark Formation might be "<font=FGDCGeoAge>#n". Null values permitted for units that do not appear on map or are not labeled, e.g., headings, headnotes, water, glacier, some overlay units*
Symbol	*References an area fill symbol in the accompanying style file that is used for symbolizing the unit on the map.*
AreaFillRGB	{*Red, Green, Blue} tuples that specify the suggested color (e.g., '255,255,255', '124,005,255') of area fill for symbolizing this MapUnit. Use of consistent syntax is important to enable computer programs to read this field and display intended color. Each color value is an integer between 0 and 255; values are zero-padded so that there are 3 digits to each R, G, and B value; and color values are separated by commas with no space: NNN,NNN,NNN. Especially important to non-Esri users unable to use the .style file. Null values permitted (e.g., for headings, headnotes)*
AreaFillPatternDescription	*Text description (e.g., 'random small red dashes') provided as a convenience for users who must recreate symbolization. Especially important to non-Esri users unable to use the .style file. Null values permitted (e.g., for headings, headnotes, unpatterned map units)*
DescriptionSourceID	*Foreign key to DataSources. Identifies source of DescriptionOfMapUnits entry. Null values not permitted*
GeoMaterial	*Term to categorize the map unit based on lithologic and genetic character, from NGMDB standard term list (Appendix A); see also discussion in "Extensions to traditional geologic map content", above. Null values permitted for headings and unmapped units*
GeoMaterialConfidence	*Describes appropriateness of GeoMaterial term for describing the map unit (Appendix A). Null values permitted for headings and unmapped units. Preferred terms: high, medium, low. These do not need to be defined in the glossary.*
DescriptionOfMapUnits_ID	*Primary key: DMU1, DMU2, DMU3. Null values not permitted*

Optionally, add AreaFillCMYK field if the map unit colors were defined in CMYK.

DataSources (non-spatial table) required

Fields:

Source	*Terse, plain-text description that identifies the data source. By convention, for DataSources_ID = DAS1, Source = 'This report'. Null values not permitted*
Notes	*Optional field. Notes on source, providing more complete description of processing or data acquisition procedure. Can include a full citation. Null values permitted*
URL	*Optional field. Link, either an online URL or Digital Object Identifier (DOI) to the data source or a full description of the data source. Null values permitted*
DataSources_ID	*Primary key. Example values = DAS1, DAS2, DAS3, … Null values not permitted*

Some example DataSources records:

Source	Notes	DataSources_ID
This report	Field compilation automated by A. Digitdroid, using georeferenced scan of green-line mylar, Esri ArcScan tools, and manual editing	DAS1
This report, interpreted from 6ft lidar DEM	Data acquired winter 2003-2004 by Puget Sound Lidar Consortium	DAS2
This report, Ralph Haugerud field data, 2005		DAS3
USGS Open-file Report 2004-197		DAS4
C. A. Hopson, written communication 2005	Sketch map of lower Chelan creek, used for tonalite phase - gabbro phase contact. University of California-Santa Barbara, written communication 17 July 2005, scale 1:24,000	DAS5
Beta Laboratories, Report 1999-451.	K-Ar dates determined using constants from Dalrymple, 1985.	DAS6
Jackson, J.A., 1997	Cited in Glossary table for sources of term definitions. Jackson, J.A., 1997, Glossary of Geology: Alexandria, VA, American Geologic Institute, 657 p.	DAS7
Modified from DAS4	S. Richard digitized 3 new large landslides based on 2006 air photography.	DAS8

All features and table entries must be associated with a data source. For maps that contain all new information and use a single vocabulary source, this table will be very short. For compilations with data from many sources that have been edited and (or) reinterpreted so that the data source has effectively been changed, this table becomes longer and more useful.

USGS Citation format is preferred.

Glossary (non-spatial table) required

Fields:

Term	*Plain-language word for a concept. Values must be unique within database. Example values: granite, foliation, syncline axis, contact, thrust fault, certain, low, fission track, K-Ar. Null values not permitted*
Definition	*Plain-language definition of Term. Null values not permitted*
DefinitionSourceID	*Foreign key to DataSources. Identifies source of Definition. Null values not permitted*
Glossary_ID	*Primary Key. Example values = GLO1, GLO2, GLO3, … Null values not permitted*

Some example Glossary records:

Term	Definition	DefinitionSourceID	Glossary_ID
contact	Line denoting unfaulted boundary (depositional, intrusive, metamorphic...) between two geologic map units	DAS1	GL001
Biotite isograd	Line marking first appearance, going up-grade, of newly formed biotite in metamorphosed siltstones and shales	DAS1	GL002

Terms that require definition include all values of Type, ExistenceConfidence, IdentityConfidence, ScientificConfidence, ParagraphStyle, and AgeUnits. If there are no intellectual property restrictions, it is permissible and recommended to replicate all or part of an external glossary here. Provide appropriate credit for definitions via the DefinitionSourceID. If such restrictions preclude including a definition in the glossary, the term should still be present, with a note in the definition field to refer the reader to the publication cited in the definition-source record. Values of Term must be unique within the database because they are used in fields in other tables where they function as foreign keys to the Glossary table.

OrientationPoints (point feature class) as-needed

Point structure data (bedding attitudes, foliation attitudes, slip vectors measured at a point, etc.) may be recorded in OrientationPoints, one point per measurement. This table has fields:

Type	*Values must be defined in* Glossary *or by reference to external glossary. Null values not permitted*
Azimuth	*Data type=float. Values limited to range 0-360. Strike or trend, measured in degrees clockwise from geographic North. Use right-hand rule (dip is to right of azimuth direction). Horizontal planar features may have any azimuth. Null values not permitted*
Inclination	*Data type=float. Values limited to range -90 to 90. Dip or plunge, measured in degrees down from horizontal. Negative values allowed when specifying vectors (not axes) that point above the horizon, e.g., paleocurrents. Types defined as horizontal (e.g., horizontal bedding) should have Inclination=0. Null values not permitted*
Symbol	*References a symbol in the accompanying style file. Null values permitted*
Label	*Text to accompany displayed symbol, typically the dip or plunge value for the measured orientation. Null values permitted*
LocationConfidenceMeters	*Data type = float. Radius in meters of positional uncertainty envelope for the observation locale. Null values not permitted. Recommended value is -9 if value is not otherwise available*
IdentityConfidence	*Values = 'certain', 'questionable', 'unspecified'. Specifies confidence that observed structure is of the type specified. Null values not permitted*
OrientationConfidenceDegrees	*Data type=float. Estimated circular error, in degrees. For planar features, error in orientation of pole to plane. Null values not permitted*
PlotAtScale	*Data type = float. At what scale (or larger) should this observation or analysis be plotted? At smaller scales, it should not be plotted. Useful to prevent crowding of display at small scales and to display progressively more data at larger and larger scales. Value is scale denominator. Null values not permitted, default value is 0 (display at all scales)*
StationID	*Foreign key to* Stations *point feature class. If the table represents stations, this field is not required—it would duplicate the Stations_ID primary key field. Null values permitted*
MapUnit	*It is useful to know the map unit to which an analysis or observation pertains. Value obtained by intersection with feature class MapUnitPolys. Foreign key to* DescriptionOfMapUnits*. Null values permitted*
LocationSourceID	*Foreign key to DataSources. Identifies source of location of this point. Null values not permitted*

OrientationSourceID	*Foreign key to DataSources. Identifies source of orientation data at this point. Null values not permitted*
Notes	*Optional field. Free text for additional information specific to this feature. Null values permitted*
OrientationPoints_ID	*Primary Key. Example values = ORP1, ORP2, ORP3, … Null values not permitted*

The Type field identifies the kind of feature for which the orientation was measured, e.g., bedding, overturned bedding, stretching lineation, open joint. Type definitions (in the Glossary table) shall specify the orientation-measurement convention for that Type (strike and dip, trend and plunge, dip direction and dip, etc.). Data creators should ensure that multiple measurements at a single station (e.g., bedding and cleavage) have the same StationID.

GeologicLines (line feature class) as-needed

Dikes, coal seams, ash beds, other kinds of key beds, anticline and syncline hinge-surface traces, and isograds commonly are shown on geologic maps as lines that share three properties:

(a) They do not participate in map-unit topology
(b) They correspond to features that exist within the Earth and may be concealed beneath younger, covering material; and
(c) They are likely to be located with an accuracy that can be estimated.

Fields:

Type	*Values for example could be 'syncline hinge surface trace', 'biotite isograd', … Values must be defined in Glossary or by reference to external glossary. Null values not permitted*
IsConcealed	*Values = 'N','Y'. Identifies lines covered by overlying map unit. Null values not permitted*
LocationConfidenceMeters	*Data type = float. Half width in meters of positional uncertainty envelope. Null values not permitted. Recommend value of -9 if value is not available*
ExistenceConfidence	*Values = 'certain', 'questionable', 'unspecified'. Null values not permitted. Suggest setting default value = 'certain'*
IdentityConfidence	*Values: 'certain', 'questionable', 'unspecified'. Null values not permitted. Suggest setting default value = 'certain'*
Symbol	*References a symbol in the accompanying style file. Determined from Type, IsConcealed, LocationConfidenceMeters, ExistenceConfidence, IdentityConfidence, and expected visualization scale*
Label	*Typically blank, can be used to store name of fold, or other human-readable name for each line feature. To group line segments (e.g., concealed and not-concealed segments) into a specific structure trace, the optional* ExtendedAttributes *table (see documentation for NCGMP09 v1.1) can be used. Null values permitted*
DataSourceID	*Foreign key to* DataSources *table, to track provenance of each data element. Null values not permitted*
Notes	*Optional field. Free text for additional information specific to this feature. Null values permitted*
GeologicLines_ID	*Primary key. Values = GEL1, GEL2, GEL3, … Values must be unique in database as a whole. Null values not permitted*

Topology rules:

- Must not self-overlap.
- Must not self-intersect.

Note that these features could be divided thematically into several feature classes, e.g., into FoldLines, KeyBedLines, DikeLines, and IsogradLines.

CartographicLines (line feature class) as-needed

Some lines on maps (e.g., cross-section lines) have no real-world physical existence, such that LocationConfidenceMeters, ExistenceConfidence, and IdentityConfidence attributes are meaningless. Further, they are never shown as concealed beneath a covering unit, and do not participate in map-unit topology. These lines can be stored in a CartographicLines feature class with fields:

Type	*Term that categorizes what the line represents. Values must be defined in* Glossary *table. Null values not permitted*
Symbol	*References a symbol in the accompanying style file. May be determined from Type*
Label	*Typically blank, can be used to store cross-section designation (e.g., "A-A'"), or their human-readable name for a line feature. Null values permitted*
DataSourceID	*Foreign key to DataSources table, to track provenance of each data element. Null values not permitted*
Notes	*Optional field. Free text for additional information specific to this feature. Null values permitted*
CartographicLines_ID	*Primary key. Values = CAL1, CAL2, CAL3, … Values must be unique in database. Null values not permitted*

DirectionPoints (point feature class) as-needed

This feature class has been created to capture map symbols which indicate a general trend in direction, such as direction of meltwater flow or direction of surface slope, but do not correspond to a specific point location. The symbols are generally dispersed across an area on the map and could be arranged in various ways without changing their meaning. These points represent geologic interpretations of observations and measurements, but these points have no specific real-world physical location; therefore, LocationConfidenceMeters, ExistenceConfidence, and IdentityConfidence attributes are meaningless. They do not participate in map-unit topology.
These features can be stored in a DirectionPoints feature class with fields:

Type	*Term that categorizes what the line represents. Values must be defined in* Glossary *table. Null values not permitted.* *Examples: flow direction, surface slope*
Azimuth	*Data type=float. Values limited to range 0-360. Direction, measured in degrees clockwise from geographic North. Horizontal planar features may have any azimuth. Null values not permitted*
OrientationConfidenceDegrees	*Data type=float. Estimated circular error, in degrees. Null values not permitted*
Symbol	*References a symbol in the accompanying style file. May be determined from Type*
Label	*Text to accompany displayed symbol. Null values permitted*
PlotAtScale	*Data type = float. At what scale (or larger) should this observation or analysis be plotted? At smaller scales, it should not be plotted. Useful to prevent crowding of display at small scales and to display progressively more data at larger and larger scales. Value is scale denominator. Null values not permitted, default value is 0 (display at all scales)*
MapUnit	*It is useful to know the map unit to which an analysis or observation pertains. Value obtained by intersection with feature class MapUnitPolys. Foreign key to DescriptionOfMapUnits. Null values permitted*
DataSourceID	*Foreign key to DataSources table, to track provenance of each data element. Null values not permitted*
Notes	*Optional field. Free text for additional information specific to this feature. Null values permitted*
DirectionPoints_ID	*Primary key. Values = DRP1, DRP2, DRP3, … Values must be unique in database. Null values not permitted*

MiscellaneousMapInformation (non-spatial table) optional

Most paper maps have significant miscellaneous information printed in the collar region around the map graphic. This includes such map properties as the title, authorship, scale, geologic mapping credit, editing credit, cartography credit, date of approval, local magnetic declination, publication series and number, and base map information. These properties are commonly necessary for full comprehension of the information in an associated digital database and can usefully reside in a table in the database.

Information may be harvested from this table to populate formal metadata. A common element of all these properties is that they are single statements that apply to the map as a whole. The details of this information vary from map to map and agency to agency, thus we do not prescribe what properties should be encoded nor what they should be named.

Fields:

MapProperty	*Name of map property. Examples = "Scale", "Authors and affiliations", "Magnetic declination", "Date of Approval", … Null values not permitted*
MapPropertyValue	*Value of map property. Examples = "1:24,000", "G.S. Smith1 and J. Doe2 1-Division of Geology, Some State, 2-Big University", "16.5 degrees", "Approved for publication on 23 September 2017", … Null values not permitted*
MiscellaneousMapInformation_ID	*Primary key. Example values are MMI1, MMI2, … Null values not permitted*

We created this as the template table:

MapProperty	MapPropertyValue	MiscellaneousMapInformation_ID
Report Title		MMI1
Map Title		MMI2
Publication Date		MMI3
Scale		MMI4
Authors		MMI5
Cartography by		MMI6
Publisher		MMI7
Series		MMI8
Series Number		MMI9