

The following was presented at DMT'12 (May 20-23, 2012).

The contents are provisional and will be superseded by a paper in the DMT'12 Proceedings.

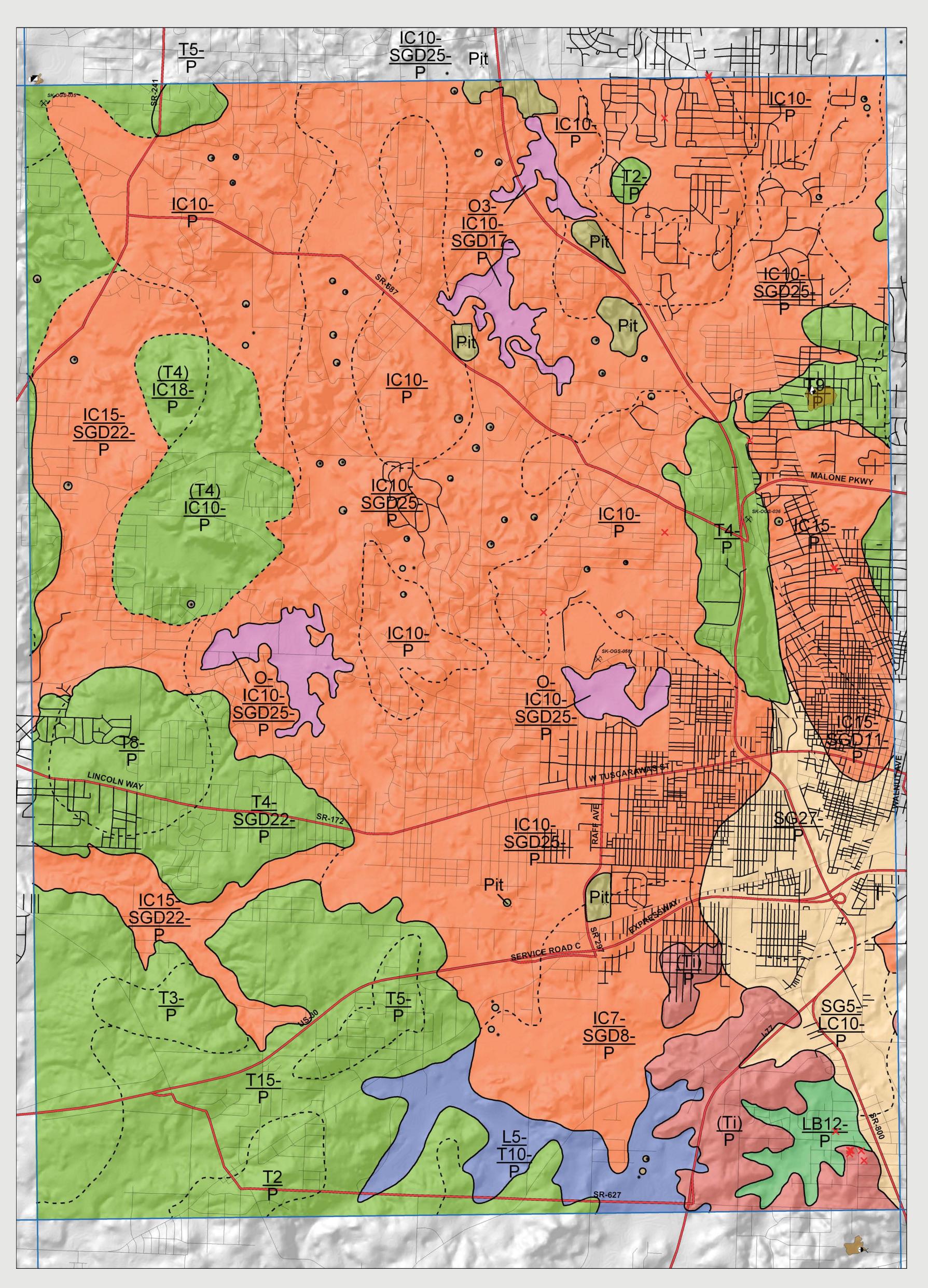
See also earlier Proceedings (1997-2011) http://ngmdb.usgs.gov/info/dmt/

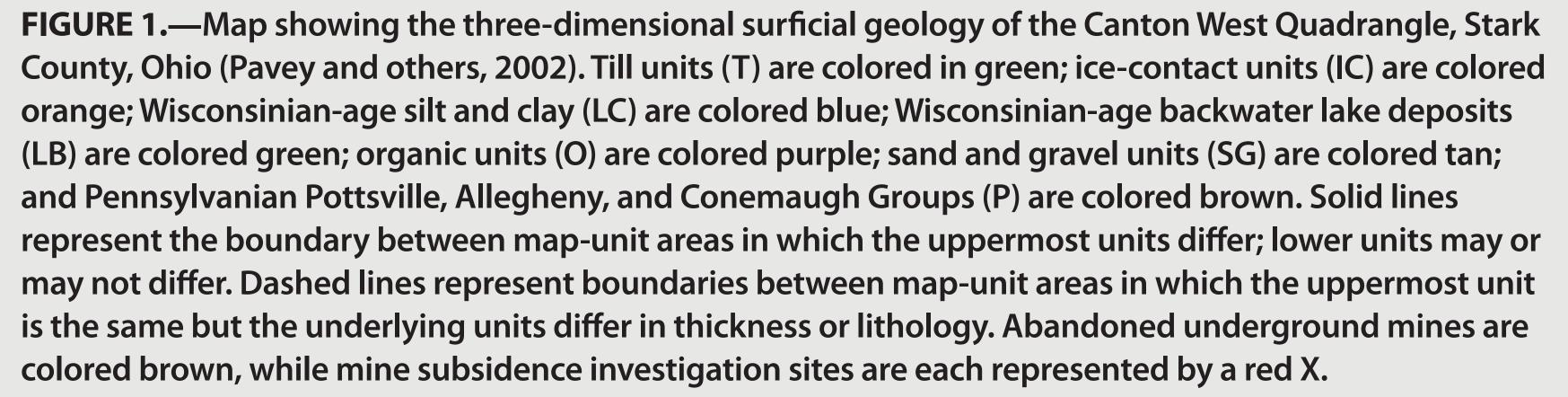


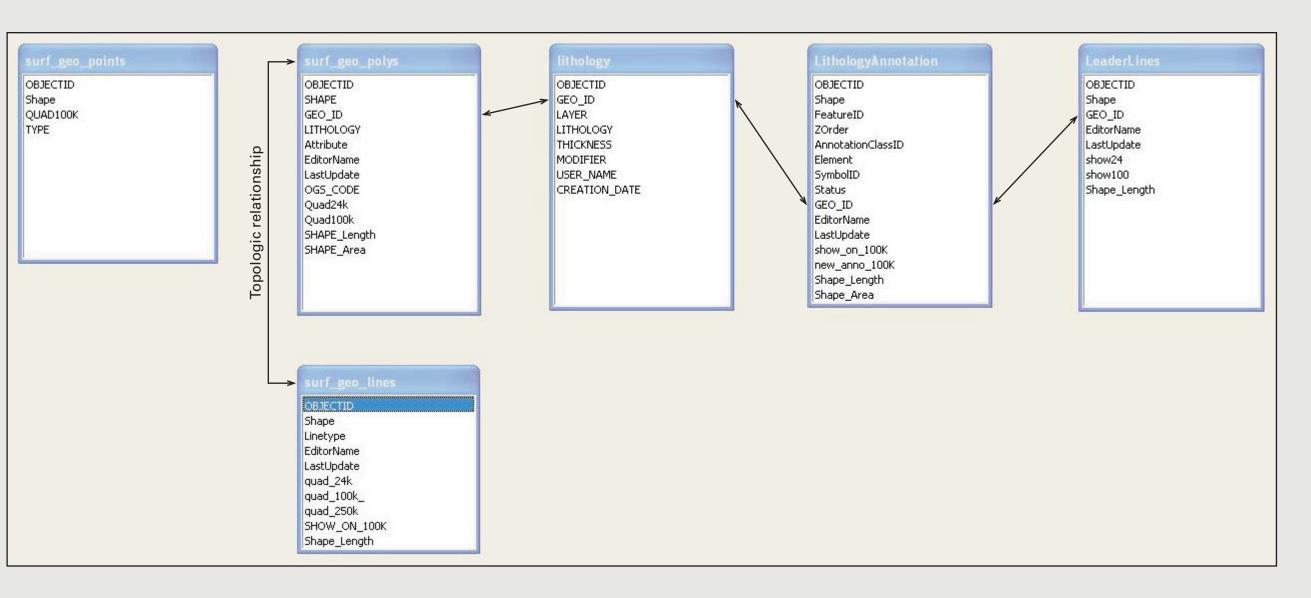
INTRODUCTION

A new standard, funded by the National Cooperative Geologic Mapping Program (NCGMP; USGS National Cooperative Geologic Mapping Program, 2010), has been proposed for the creation of new geologic maps.

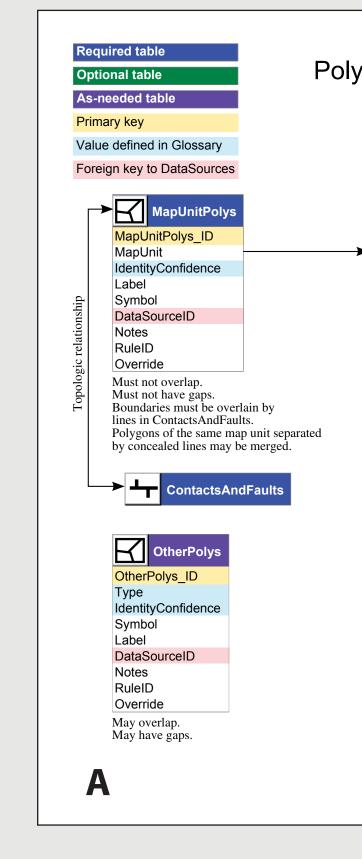
Standard NCGMP09 is designed to focus on the transfer and archiving of map data. The Ohio Department of Natural Resources, Division of Geological Survey (Ohio Geological Survey), has been creating a number of geologic map databases over the last 16 years. Examples include maps for bedrock geology, at 1:500,000-scale and

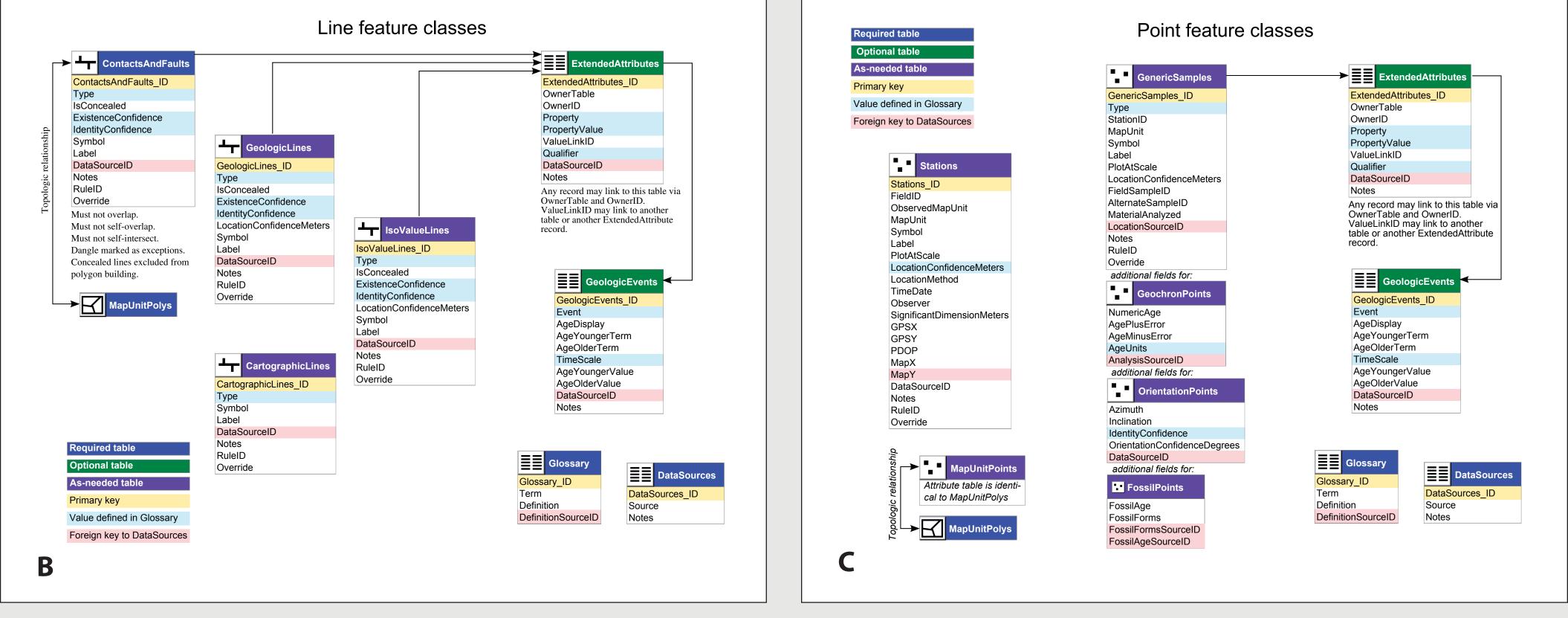






from the surface to the bedrock.





Mapping Program, 2010)

1:24,000-scale; bedrock topography, at 1:50 and 1:24,000-scale; glacial geology, at 1:500, three-dimensional surficial geology, at 1:100 This poster looks at the migration of three-d surficial-geology maps to the NCGMP09 data standard. This dataset was chosen for three

FIGURE 2.—Entity-Relationship diagram for the three-dimensional surficial geology dataset. Note that the surficial-geology polygons have a 1-to-many relationship with the lithology table. Each polygon, while only displaying the unit at the surface, is actually associated with multiple lithologic units

DescriptionOfMapUnits	ExtendedAttributes	GeologicEvents
escriptionOfMapUnits_ID	ExtendedAttributes_ID	GeologicEvents_ID
apUnit	OwnerTable	Event
abel	OwnerID	AgeDisplay
ame	Property	AgeYoungerTerm
ullName	PropertyValue	AgeOlderTerm
ge	ValueLinkID	TimeScale
escription	Qualifier	AgeYoungerValue
eneralLithology	DataSourceID	AgeOlderValue
eneralLithologyConfidence	Notes	DataSourceID
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ymbol	table or another ExtendedAttribu	
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ataSourcePolys_ID		ProportionTerm
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ll parts of map should be		
overed by at least one	Glossary	DataSources
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				Fields	
:500,000-scale	the three-dimensional surficial-geology GIS dataset is for the evaluation	on of geohazard risks, such as a	abandoned-	DescriptionOfMapUnits_ID	Primary key
500,000-scale; and	very different than a traditional geologic map dataset. underground m	ine subsidence claims since a	reas of	MapUnit	is a foreign Short ASC
:100,000-scale.	Second, three-dimensional surficial-geology currently is mining with thin	n glacial drift are more prone t	to collapse	маропп	abbreviatio
e-dimensional	being mapped throughout the state of Ohio as part of the of abandoned u	inderground mines. Including	this dataset		the link (fo
database		Geological Survey automated			headnotes
				Label	Textstring
ree reasons. First,	geology dataset is a critical piece of information needed will assist with g	jeohazards assessments (McD	onald, 2012).		such as sp Triassic Ne
					font>n". Nı
	Surf. Coo. Dolve (polveron footure does)		Surf Caa Lines (line feature class)		labeled, e.g
Fields	Surf_Geo_Polys (polygon feature class)	Fields	Surf_Geo_Lines (line feature class)	Name	Boldface r hierarchica
OBJECTID	ESRI assigned ID for the attribute table		ESRI assigned ID for the attribute table		Member'. T
SHAPE	ERSI field containing the pointer to the geometry	SHAPE	ERSI field containing the pointer to the geometry		Lexicon (G
GEO_ID	Primary key for the polygon	Attribute			OK
LITHOLOGY Attribute	Plain text field containing the map unit abbreviation		Person who attributed the polygon Last edit date	FullName	Full name units, e.g.,
EditorName	Person who attributed the polygon	·	7.5-minute quadrangle name		text you we
LastUpdate	Last edit date		1:100,000-scale quadrangle name		in an elect above. Nul
OGS_CODE	7.5-minute quadrangle code	Quad250k	1:250,000-scale quadrangle name		not shown
Quad24k	7.5-minute quadrangle name		Field used for displaying contact lines on 100K quadrangle maps	Age	As shown i
Quad100k	1:100,000-scale quadrangle name	SHAPE_Length	ESRI calculated polygon perimeter length		headings,
SHAPE_Length SHAPE_Area	ESRI calculated polygon perimeter length ESRI calculated polygon area	C	ContactsandFaults (line feature class)		resolution
		Fields			ages (e.g., d Extended
	MapUnitPolys (polygon feature class)	ContactsAndFaults_ID		Description	Free-forma
Fields			COF1, COF2, Values must be unique in database as a whole		according
MapUnitPolys_ID	Primary key. Example Values = MUP1, MUP2, MUP3, etc. Values must be unique in database as a whole Short plain toxt key (identifier) for the man unit. Example values: Oal To Kit water Trc2 etc. Fore	ian kov to	Specifies the kind of feature represented by the line.		features, g
MapUnit	Short plain-text key (identifier) for the map unit. Example values: Qal, Tg, Kit, water, Trc3, etc. Fore DescriptionOfMapUnits table. Null values not permitted—a mapped polygon must have an assigned map un	Ight key to	Values could be, for example, 'contact', 'fault', 'waterline',		HTML) spe
IdentityConfidence	How confidently is this polygon identified as MapUnit? Value is usually "certain", "questionable", or "unspe	cified". Null	'glacier boundary', 'map boundary'. Values must be defined in Glossary. Null values not permitted		and geolog
	values not permitted. Suggest setting default value to 'certain'	IsConcealed	Values = 'N,"Y'. This is a flag for contacts and faults	HierarchyKey	Has form r
Label	Calculated from MapUnit//Label and IdentityConfidence: if IdentityConfidence = "questionable", then app MapUnit//Label. Allows for subscripts and special characters. Null values OK	Dena ? lo	covered by an overlying map unit. Null values not permitted		zeros, dash
Symbol	References an area fill symbol (background color + optional pattern). Area fill symbols must be defined in an acco		eters Data type = float. Half-width in meters of positional		be the sam These strin
	style file. If cartographic representations are used to symbolize map units, the value may be null or blank. permitted	Null values	uncertainty envelope; position is relative to other		relationshi
RuleID	Data type = integer. If Cartographic Representations are used, this field is required; otherwise it is not included.	in the table	features in database. Null values not permitted. Recommend value of -9 if value is not available		unit of map source no
	(see Symbolization section, below)	ExistanceConfidence	Values='certain', 'questionable', 'unspecified'. Null values		describe th
Override	Data type = blob. If Cartographic Representations are used, this field is required; otherwise it is not included i (see Symbolization section, below)		not permitted. Suggest setting default value='certain'.	ParagraphStyle	Values are DMU1, DN
Notes	Null values OK. Free text for additional information specific to this polygon	IdentityConfidence	Values='certain', 'questionable', 'unspecified'. Null values not permitted. Suggest setting default value='certain'.		paragraph
DataSourceID	Foreign key to DataSources table, to track provenance of each data element. Null values not permitted	Symbol	References a symbol in the accompanying style file.		the glossar
	wine a state Cruef Case. Dely feature class and Manulus't Delys feature class. The fold CEO		Calculated from Type, LocationsConfidenceMeters,	AreaFillRGB	{ <i>Red,</i> Gree
-	arison of the Surf_Geo_Poly feature class and MapUnitPolys feature class. The field GEO into the MapUnitPolys_ID field. In addition, the LITHOLOGY field easily translates into t		ExistanceConfidence,IdentityConfidence,andexpected map display scale. Null values OK		Use of con
	re are issues with using the IdentityConfidence field, since a map polygon can represent		Data type = integer. If Cartographic Representations		to read thi integer bet
surface and subsur	face map unit. All other fields can be used with the Surf_Geo_Polys feature class.		are used, this field is required; otherwise it is not included in the table (see Symbolization section, below)		3 digits to
		Override	Data type = blob. If Cartographic Representations are		commas w ESRI users
			used, this field is required; otherwise it is not included		headnotes
equired table	Point feature classes	Label	<i>in the table (see Symbolization section, below)</i> <i>Can be used to store fault name, or human-readable</i>	AreaFillPatternDescription	Text descr
Dptional table s-needed table ∎	■ GenericSamples ExtendedAttributes	Luber	name for a line feature. To group line segments into		convenien important
rimary key	nericSamples_ID be ationID OwnerTable OwnerID		a specific structure trace, e.g."San Andreas Fault", use Extended Attributes. Typically null		ОК (e.g., he
Ma Syn Lat Stations	IppUnit Property mbol PropertyValue bel ValueLinkID vtAtScale Qualifier	Notes	Free text for additional information specific to this	Symbol	References used for sy
Stations_ID Loc FieldID Field	CationConfidenceMeters DataSourceID IdSampleID Notes ernateSampleID Any record may link to this table via		feature. Null values OK.	DescriptionSourceID	Foreignkey
MapUnit Ma Symbol Loc Label No PlotAtScale Ru	AtterialAnalyzed OwnerTable and OwnerID. CationSourceID ValueLinkID may link to another table or another ExtendedAttribute record.	DataSourceID	Foreign key to DataSources table, to track provenance		entry. Null
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Observer SignificantDimensionMeters Nu	mericAge Event ePlusError AgeDisplay eMinusError AgeYoungerTerm eUnits AgeOlderTerm	-	rison of the Surf_Geo_line feature class and the		character, discussion
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						Fields	
500,000-scale	the three-dimensional surficial-geology GIS dataset is	for the evaluation of geoh	nazard risks, such a	s abandoned-		DescriptionOfMapUnits_ID	Primary ke
00,000-scale; and	very different than a traditional geologic map dataset.	underground mine subsid	dence claims since	areas of		MapUnit	is a foreign Short ASC
00,000-scale.	Second, three-dimensional surficial-geology currently is	mining with thin glacial d	rift are more prone	e to collapse		maporne	abbreviatio
e-dimensional	being mapped throughout the state of Ohio as part of the	of abandoned undergrou	nd mines. Includin	g this dataset			the link (fo
latabase		within the Ohio Geologica		-			headnotes
e reasons. First,		will assist with geohazard	-	••		Label	Textstring
	geology dataset is a critical piece of information needed						such as sp Triassic Ne
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	Surf_Geo_Polys (polygon feature class)			Surf_Geo_Lines (line	e feature class)	Name	labeled, e.g Boldface r
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SHAPE GEO_ID	ERSI field containing the pointer to the geometryPrimary key for the polygon		SHAPE Attribute	ERSI TIEla containing ti	he pointer to the geometry		notification OK
LITHOLOGY	Plain text field containing the map unit abbreviation		EditorName	Person who attributed	I the polygon	FullName	Full name
Attribute			LastUpdate	Last edit date			units, e.g.,
EditorName	Person who attributed the polygon		Quad24k	7.5-minute quadrangl			in an elect
	Last edit date		Quad100k	1:100,000-scale quadr			above. Nul
OGS_CODE Quad24k	7.5-minute quadrangle code 7.5-minute quadrangle name		Quad250k SHOW_ON_100K	1:250,000-scale quadr	g contact lines on 100K quadrangle maps		not shown
Quad100k	1:100,000-scale quadrangle name		SHAPE_Length	ESRI calculated polygo		Age	As shown i may be use
SHAPE_Length	ESRI calculated polygon perimeter length						headings,
SHAPE_Area	ESRI calculated polygon area			ContactsandFaults (li	ne feature class)		resolution ages (e.g., o
	ManUnitDolyc (nolygon foaturo class)		Fields	D Drimary kovy	for database record. Example values -		Extended
Fields	MapUnitPolys (polygon feature class)		ContactsAndFaults_I		for database record. Example values = Values must be unique in database as	Description	Free-forma
MapUnitPolys_ID	Primary key. Example Values = MUP1, MUP2, MUP3, etc. Values must be unique in data	abase as a whole		a whole			color, we
MapUnit	Short plain-text key (identifier) for the map unit. Example values: Qal, Tg, Kit,	- · ·	Туре	_	kind of feature represented by the line. e, for example, 'contact', 'fault', 'waterline',		features, g
IdentityConfidence	DescriptionOfMapUnits table. Null values not permitted—a mapped polygon must ha How confidently is this polygon identified as MapUnit? Value is usually "certain", "qu			'glacier boun	dary', 'map boundary'. Values must be		HTML) spe and geolog
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	permitted			features in o	database. Null values not permitted.		unitofmap
RuleID	Data type = integer. If Cartographic Representations are used, this field is required; othe (see Symbolization section, below)	erwise it is not included in the table	ExistanceConfidence		/alue of -9 if value is not available in', 'questionable', 'unspecified'. Null values		describe th
Override	Data type = blob. If Cartographic Representations are used, this field is required; other	rwise it is not included in the table	ExistanceConnuence		Suggest setting default value='certain'.	ParagraphStyle	Values are
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	roreign key to Datasources table, to track provenance of caen aata clement. Nan vara		Symbol		rom Type, LocationsConfidenceMeters,	AreaFillRGB	{Red, Gree
	arison of the Surf_Geo_Poly feature class and MapUnitPolys feature c				fidence,IdentityConfidence,andexpected		'255,255,25 Use of con
	into the MapUnitPolys_ID field. In addition, the LITHOLOGY field eas re are issues with using the IdentityConfidence field, since a map poly	•	RuleID		cale. Null values OK integer. If Cartographic Representations		to read thi
-	face map unit. All other fields can be used with the Surf_Geo_Polys fe	•		are used, this f	ield is required; otherwise it is not included		<i>integer bet</i> 3 digits to
			Override		ee Symbolization section, below)		commas w
			Overnde		lob. If Cartographic Representations are discrete is required; otherwise it is not included		ESRI users headnotes
					ee Symbolization section, below)	AreaFillPatternDescription	Text descr
ired table onal table eeded table	Point feature classes		Label		to store fault name, or human-readable ne feature. To group line segments into		convenien
e defined in Glossary Type	GenericSamples ExtendedAttributes nericSamples_ID ExtendedAttributes_ID ownerTable OwnerTable			a specific stru	icture trace, e.g."San Andreas Fault", use		important OK (e.g., he
Map Sym	tionID OwnerID Property bUnit PropertyValue PropertyValue A ValueLinkID OwnerID PropertyValue A PropertyValue		Notos		ibutes. Typically null	Symbol	References
—	AtScale ationConfidenceMeters dSampleID ernateSampleID		Notes	feature. Null v	additional information specific to this alues OK.	Description	used for sy
MapUnit Mate Symbol Note	erialAnalyzed ationSourceID es ownerTable and OwnerID. ValueLinkID may link to another table or another ExtendedAttribute record		DataSourceID		DataSources table, to track provenance	DescriptionSourceID	Foreignkey entry. Null
PlotAtScale Rule Over LocationConfidenceMeters add	eID erride ditional fields for: GeologicEvents			of each data e	element. Null values not permitted	GeneralLithology	Term to co
Observer SignificantDimensionMeters GPSX Age	GeochronPoints GeologicEvents_ID mericAge Event ePlusError AgeDisplay		FIGURE 5.—Compa	arison of the Surf_C	Geo_line feature class and the		character, discussion
PDOP Age MapX Ana	AgeYoungerTerm AgeOlderTerm AlysisSourceID ditional fields for: AgeYoungerValue				ne map unit boundaries currently		Null values
DataSourceIDNotesRuleIDOverride	OrientationPoints AgeOlderValue DataSourceID DataSourceID Notes Notes				ciated with the NCGMP09	GeneralLithologyConfidence	Describes a

FIGURE 3 A, B, and C.—Entity-Relationship diagrams for the NCGMP09 database (USGS National Cooperative Geologic

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database standard, as used in the **Type** field. The map unit boundaries will need to be added to NCGMP09 Glossary. The Ohio Geological Survey also will need to assign unique ID numbers to all the Surf_ **Geo_Lines** features.

FIGURE 6.—Description of Map Units table definitions (USGS National Cooperative Geologic Map Program, 2010).



vkev:DMU1,DMU2,DMU3;ExtendedAttributes table OwnerID ign key using this value. Null values not permitted

ASCII string that identifies map unit: Qal, Tec, Qvt. Unit ations must be unique in the database. Values in this field are (foreign key) between this table and the MapUnitPolygon Ill values OK, and are commonly associated with headings or tes. Use of special characters is not recommended in this field ised to place label in map display; includes graphic elements special fonts and formatting for subscripts. For example, Newark Formation might be "<font=FGDCGeoAge>#</ Null values OK for units that do not appear on map or are not e.g., headings, headnotes, water, glacier, some overlay units name in traditional DMU, identifies the unit within i ontext. Examples: 'Chinle Formation', 'Shnabkai names should be verified in the U.S. Geologic Name (GEOLEX); if your usage does not agree with GEO tion should be submitted to the Lexicon website. Null v

ne of unit, including identification of containing higher ran! , 'Shnabkaib Member of Moenkopi Formation'. This i i would like to see as fly-out when cursor lingers over polyg electronic map display. See Lexicon-related note in "Name Null values OK (e.g., for headings, headnotes, geologic units own on map)

wn in bold within parentheses in traditional DMU. Null values e used for map units that inherit Age from a parent unit, or for gs, headnotes, or overlay units. To designate age with more on than permitted by DMU standards, or to record multiple g., deposition and metamorphism) for a unit, create entries in edAttributes and GeologicEvent tables

mat text description of map unit. Commonly structured ng to one or more accepted traditions (e.g., lithology, thickness, weathering and outcrop characteristics, distinguishing s, genesis, age constraints) and terse. Allows markup (e.g., specification of new paragraphs, superscripts and subscripts, ologic-age font (sans-serif and with special characters). Null

m nn-nn-nn, nnn-nnn, or similar. Numeric, left-padded with ash-delimited. Each HierarchyKey fragment of each row MUST same length to allow text-based sorting of the DMU entries. trings are useful for resolving queries involving hierarchical ships, e.g., 'find all members of formation x', 'what is the parent map unit y'. Null values not permitted. Table 1 **Error! Reference** not found., below, illustrates the use of HierarchyKey to e the structure of a complex Description of Map Units

are Heading1st, Heading2nd, Heading3rd, ..., Headnote, DMU2, DMU3, or similar. Formatting associated with a aph style should be explained with a definition of the style in sary. Null values not permitted

Green, Blue} tuples that specify the suggested color (e.g., 5,255', '124,005,255') of area fill for symbolizing this MapUnit. consistent syntax is important to enable computer programs this field and display intended color. Each color value is an between 0 and 255; values are zero-padded so that there are s to each R, G, and B value; and color values are separated by s with no space: NNN,NNN,NNN. Especially important to noners unable to use the .style file. Null values OK (e.g., headings,

escription (e.g., 'random small red dashes') provided as a nience for users who must recreate symbolization. Especially ant to non-ESRI users unable to use the .style file. Null values ., headings, headnotes, unpatterned map units)

ces an area fill symbol in the accompanying style file that is symbolizing the unit on the map.

keytoDataSources.IdentifiessourceofDescriptionOfMapUnits ull values not permitted

categorize the map unit based on lithologic and genetic er, from NGMDB standard term list (Appendix A); see also on in "Extensions to traditional geologic map content", above. ues OK for headings and unmapped units

ropriateness of GeneralLitholoay term for describing the map unit (Appendix A). Null values OK for headings and unmapped

BJECTID	DescriptionOfMapUnits_ID	MapUnit	Label	Name	FullName	Age	Description	GeneralLithology	GeneralLithologyConfidence	HierarchyKe
2	111005	а	а	Alluvium	Alluvium	Holocene	Includes a wide variety of textu	Alluvial sediment	Medium	2
3	111006	0	0	Organic deposit	Organic deposit	Holocene	Muck and peat, formed in undr	Peat and muck	Medium	3
4	112020	C	C	Clay	Clay	Wisconsin	Massive to laminated; may cor	Silt and clay of un	Medium	4
5	112021	10	Ŀ	Silt	Silt	Wisconsin	Massive or laminated, commor	Lacustrine sedime	Medium	5
6	112022	LC	LC	Silt and Clay	Silt and clay	Wisconsin	Laminated to interbedded, may	Lacustrine sedime	Medium	6
7	112023	LS	LS	Silt and sand	Silt and sand	Wisconsin	Laminated to interbeded, may	Lacustrine sedime	Medium	7
8	112024	LB	LB	Backwater lake	Backwater lake	Wisconsin	Mostly lacustrine silt and clay	Lacustrine sedime	Medium	8
9	112026	S	S	Sand	Sand	Wisconsin	Contains minor amounts of dis:	Alluvial sediment,	Medium	9
10	112027	SG	SG	Sand and gravel	Sand and gravel	Wisconsin	Interbedded sand and gravel co	Alluvial sediment,	Medium	10
11	112028	SGi	SGi	Sand and gravel	Sand and gravel	Illinoian	Properties sumilar to unit "SG"	Alluvial sediment,	Medium	11
12	112029	IC	IC	Ice-contact depi	Ice-contact depi	Wisconsin	Highly variable deposits of poor	Ice-contact and ic	Medium	12
13	112031	ICi	ICi	Ice-contact depi	Ice-contact depi	Illinoian	Properties similar to unit "IC" a	Ice-contact and ic	Medium	13
14	112032	SGD	SGD	Sand and gravel	Sand and gravel		Interbedded sand and gravel co	Sand and gravel o	Medium	14
15	112033	CG	CG	Complexly inter	Complexly inter		Complexly interbedded deposit	Clastic sediment	Medium	15
16	112060	Т	Т	Till	Till	Wisconsin	Unsorted mix of clay, silt, sanc	Glacial Till	Medium	16
17	112065	Ti	Ti	Til	Till	Illinoian	Properties similar to unit "T" at	Glacial Till	Medium	17
utoNumber)	\$7 0									

FIGURE 7.—Example of the Description of Map Units table populated with the map units from the Surficial Geology of the Canton 30 x 60 Minute Quadrangle (Pavey and others, 2002). All map units currently appear to translate well into the Description of Map Units table. But the requirement that the glacial map units correspond to Geolex records cannot be obeyed, since the glacial map units correspond to a combination of textural descriptions and processedbased classifications.

SUMMARY

Initial testing of the migration of the three-dimensional surficial geology map data to the NCGMP09 database standard appears to show promise, despite the complexity of mapping geology in three dimensions. The master 1-to-many lithology table and the stacked annotation are critical components to the Ohio Geological Survey surficial-geology maps. The lithology table and the stacked annotation feature class will need to be added to the NCGMP09 database as a non-standard component.

REFERENCES

- McDonald, James, 2012, Evaluating mine subsidence using a GIS software application, in Digital Mapping Techniques '10—Workshop Proceedings, Sacramento, Calif., May 16–18, 2010: U.S. Geological Survey Open File Report, 25 p., <http://ngmdb.usgs.gov/Info/dmt/docs/DMT10_Draft_ McDonald.pdf>.
- Pavey, R.R., Schumacher, G.A., Larsen, G.E., Swinford, E.M., and Vorbau, K.E., 2002, Surficial geology of the Canton 30 x 60 minute quadrangle: Ohio Department of Natural Resources, Division of Geological Survey Digital Map Series SG-2 CAN, 1 map, 1:100,000-scale, <ftp://ftp.dnr.state.oh.us/ Geological_Survey/SurficialPDF_Drafts/Canton_Surficial_v1.pdf>.
- USGS National Cooperative Geologic Mapping Program, 2010, NCGMP09-Draft standard format for digital publication of geologic maps, version 1.1, in Digital Mapping Techniques '09—Workshop Proceedings, Morgantown, W.Va., May 10–13, 2009: U.S. Geological Survey Open File Report 2010-1335, p. 93–146, <http://pubs.usgs.gov/of/2010/1335/pdf/ usgs_of2010-1335_NCGMP09.pdf>.

