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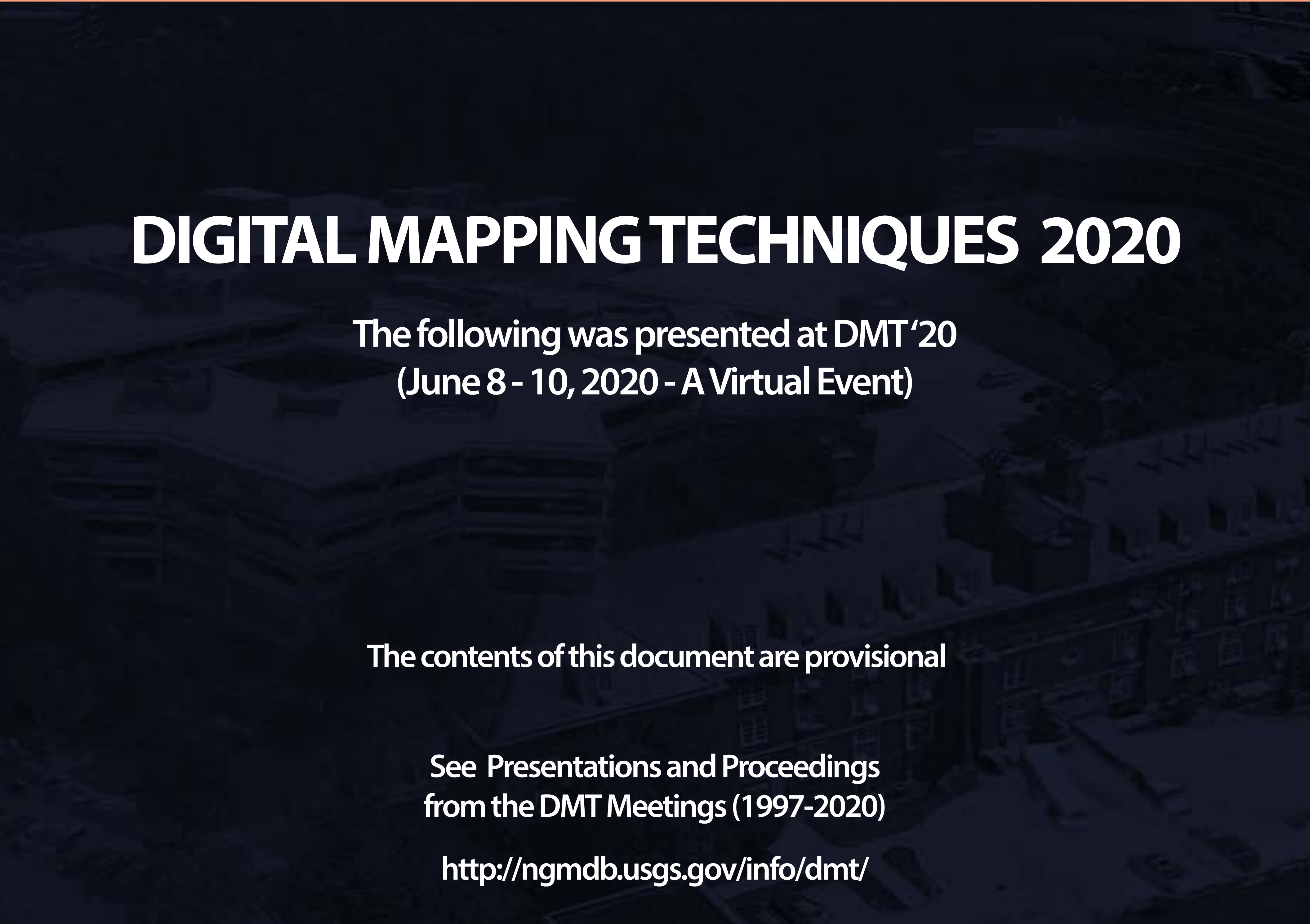
DMT 2020



DIGITAL MAPPING TECHNIQUES 2020

The following was presented at DMT‘20
(June 8 - 10, 2020 - A Virtual Event)

The contents of this document are provisional

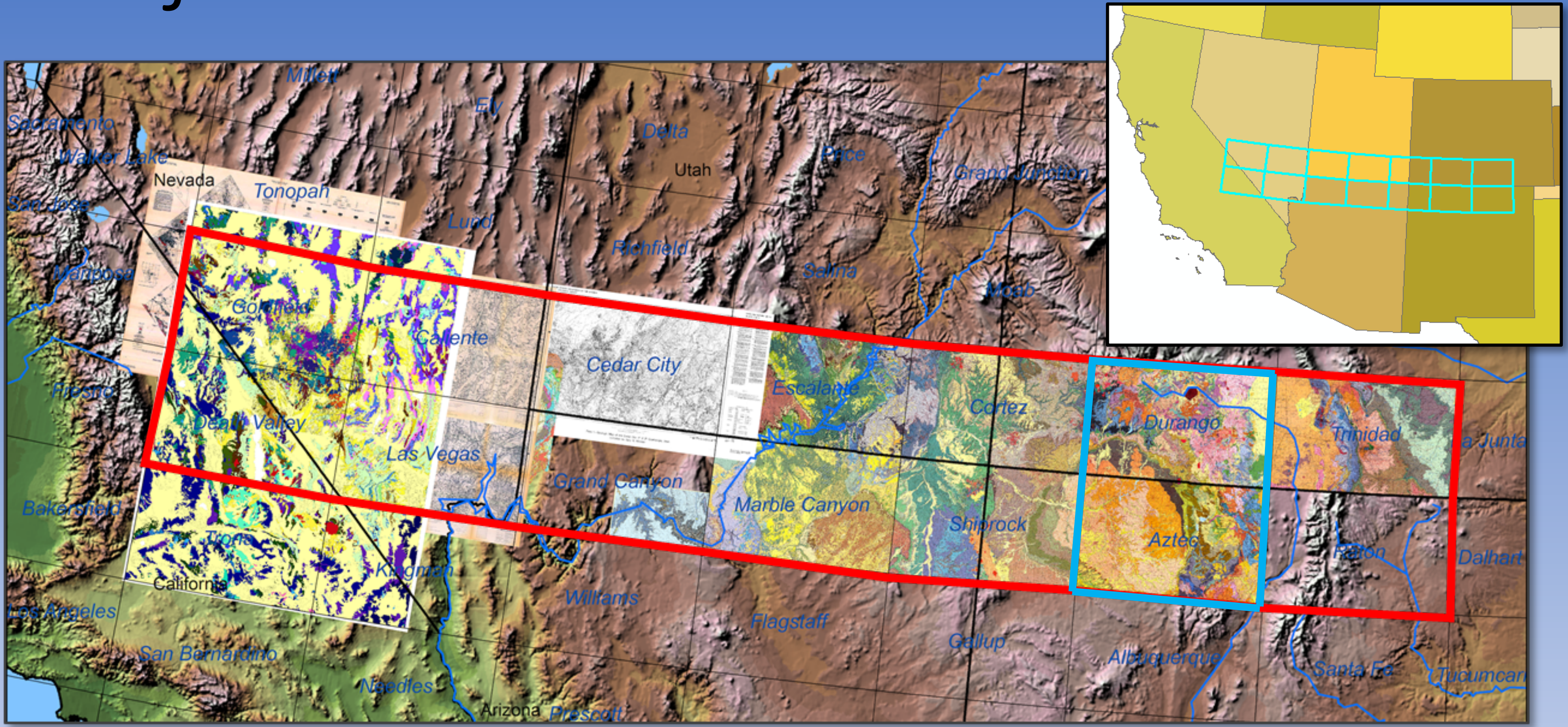
See Presentations and Proceedings
from the DMT Meetings (1997-2020)

http://ngmdb.usgs.gov/info/dmt/

Modifications to Geologic Mapping Schema (GeMS) to support regional compilation: An example from the USGS Geologic Framework of the Intermountain West project

Kenzie J. Turner, Jeremiah B. Workman, Amy K. Gilmer, Samuel A. Johnstone, D. Paco VanSistine, Joseph P. Colgan, Ren A. Thompson, and Donald Sweetkind

Project overview

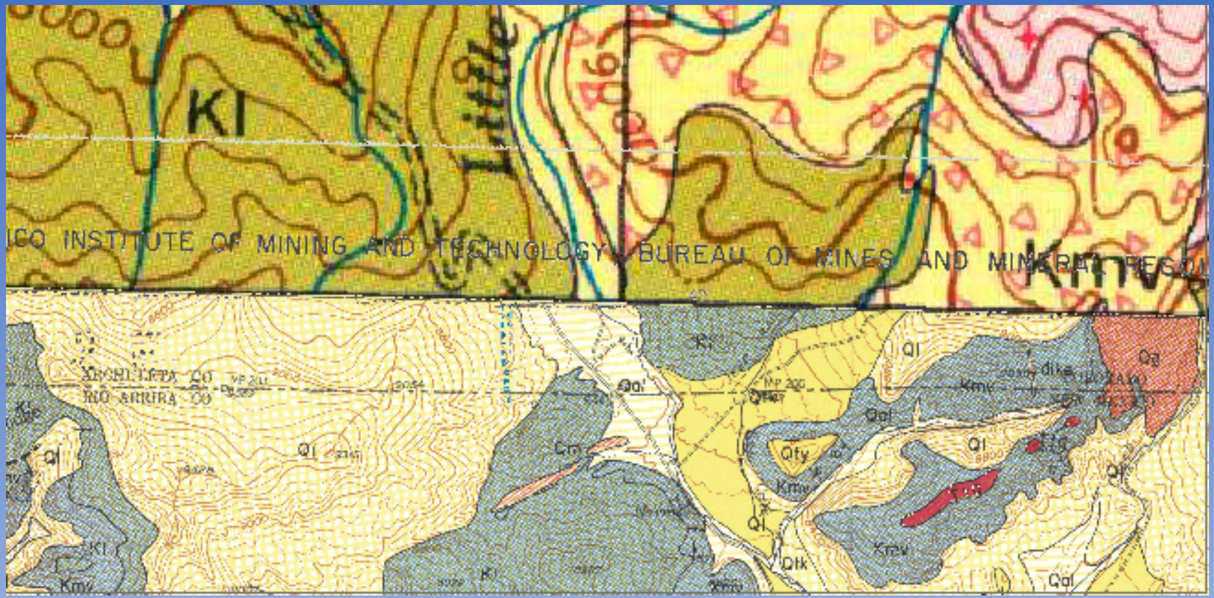


- Transect along 37° (N) from Great Plains to Sierra Nevada
- Equivalent to 14, 1° X 2° (1:250K) quadrangles

- Assemble seamless, integrated geologic map database to support hazard and resource assessment and research objectives
- Provide regional framework for subsurface model interpretation

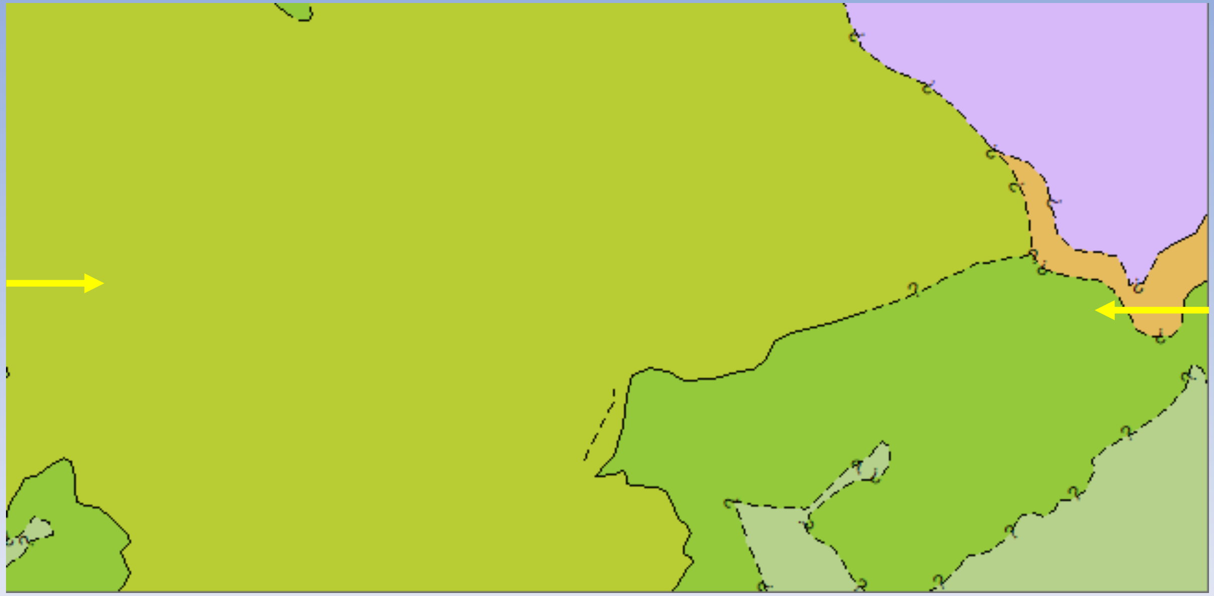
Multi-map, Multi-scale

- Strictly honors original source mapping
- Map units not necessarily integrated across boundaries


From Muehlberger, 1967; Steven and others, 1976

Seamless regional coverage

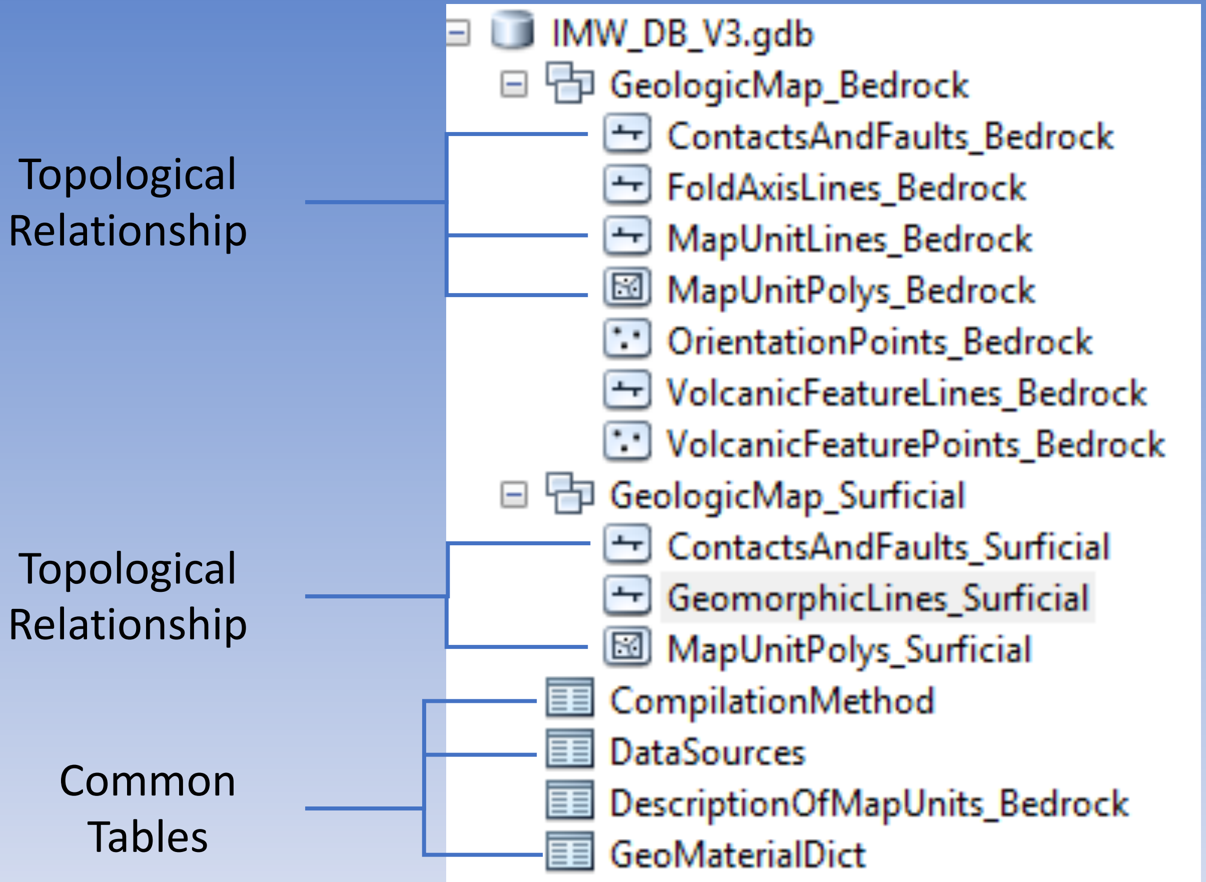
- New interpretive lines are generated from original source maps
- Features are continuous across map and administrative boundaries



Summary of GeMS modifications

- Feature-level documentation of compilation processes and data sources
- Independent surficial and bedrock datasets
- Partition descriptive information into fields
- Method for organizing and maintaining unique map units

Data model

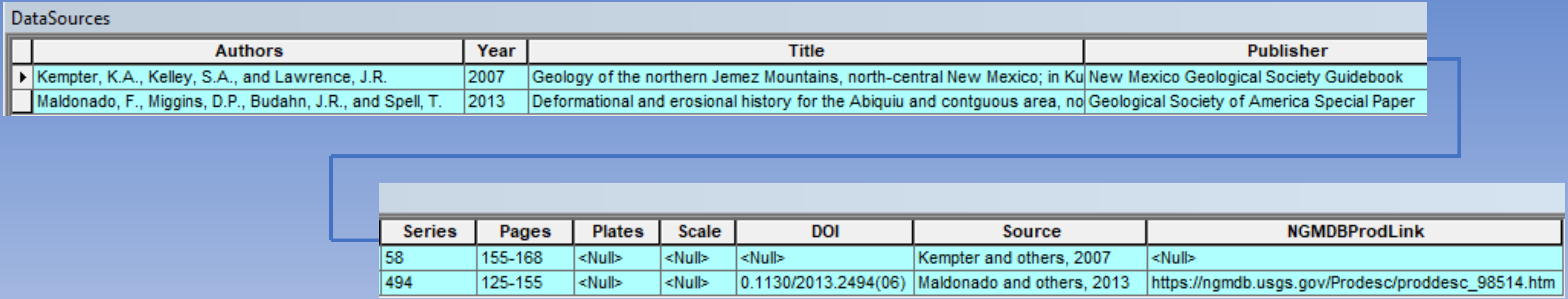


- IMW_DB_V3.gdb
  - GeologicMap_Bedrock
    - ContactsAndFaults_Bedrock
    - FoldAxisLines_Bedrock
    - MapUnitLines_Bedrock
    - MapUnitPolys_Bedrock
    - OrientationPoints_Bedrock
    - VolcanicFeatureLines_Bedrock
    - VolcanicFeaturePoints_Bedrock
  - GeologicMap_Surficial
    - ContactsAndFaults_Surficial
    - GeomorphicLines_Surficial
    - MapUnitPolys_Surficial
  - CompilationMethod
  - DataSources
  - DescriptionOfMapUnits_Bedrock
  - GeoMaterialDict

- ESRI environment—SDE geodatabase (although shown here as a file geodatabase)
- Independent surficial and bedrock data structure—No topologic relationship between them
- MapUnitLines—feature class with both line and map unit attributes
- Drop use of GeologicLines in favor of thematically specific line feature classes

DataSources and CompilationMethod

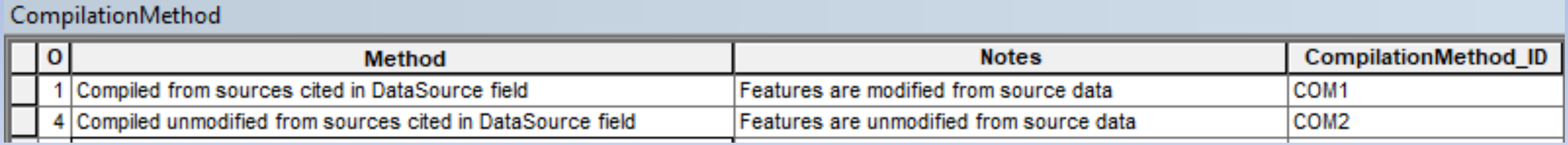
DataSources



DataSources

Authors	Year	Title	Publisher	Series	Pages	Plates	Scale	DOI	Source	NGMDBProdLink
Kempter, K.A., Kelley, S.A., and Lawrence, J.R.	2007	Geology of the northern Jemez Mountains, north-central New Mexico; in Ku	New Mexico Geological Society Guidebook	58	155-168	<Null>	<Null>	<Null>	Kempter and others, 2007	<Null>
Maldonado, F., Miggins, D.P., Budahn, J.R., and Spell, T.	2013	Deformational and erosional history for the Abiquiu and contguous area, no	Geological Society of America Special Paper	494	125-155	<Null>	<Null>	0.1130/2013.2494(06)	Maldonado and others, 2013	https://ngmdb.usgs.gov/Prodesc/proddesc_98514.htm

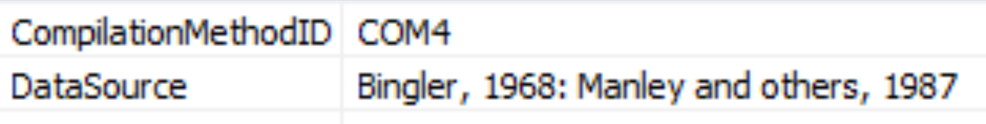
CompilationMethod



CompilationMethod

O	Method	Notes	CompilationMethod_ID
1	Compiled from sources cited in DataSource field	Features are modified from source data	COM1
4	Compiled unmodified from sources cited in DataSource field	Features are unmodified from source data	COM2

Feature-level attribution →



CompilationMethodID	COM4
DataSource	Bingler, 1968: Manley and others, 1987

Partitioning descriptive attributes

- Process and Materials
  - DepositGeneral; DepositMaterial (3 fields); DepositType (3 fields)

- Age
  - ChronoStratAgeMin; ChronoStratAgeMax
  - NumAgeMin; NumAgeMax; NumAgeMethod; NumAgeSource
  - **Seamless database will eventually be integrated with the national geochronologic database

Surficial vs bedrock units

Surficial

- Unconsolidated sediment
- Usually Quaternary (not a requirement)
- Generally undeformed

Surficial vs bedrock units

Surficial

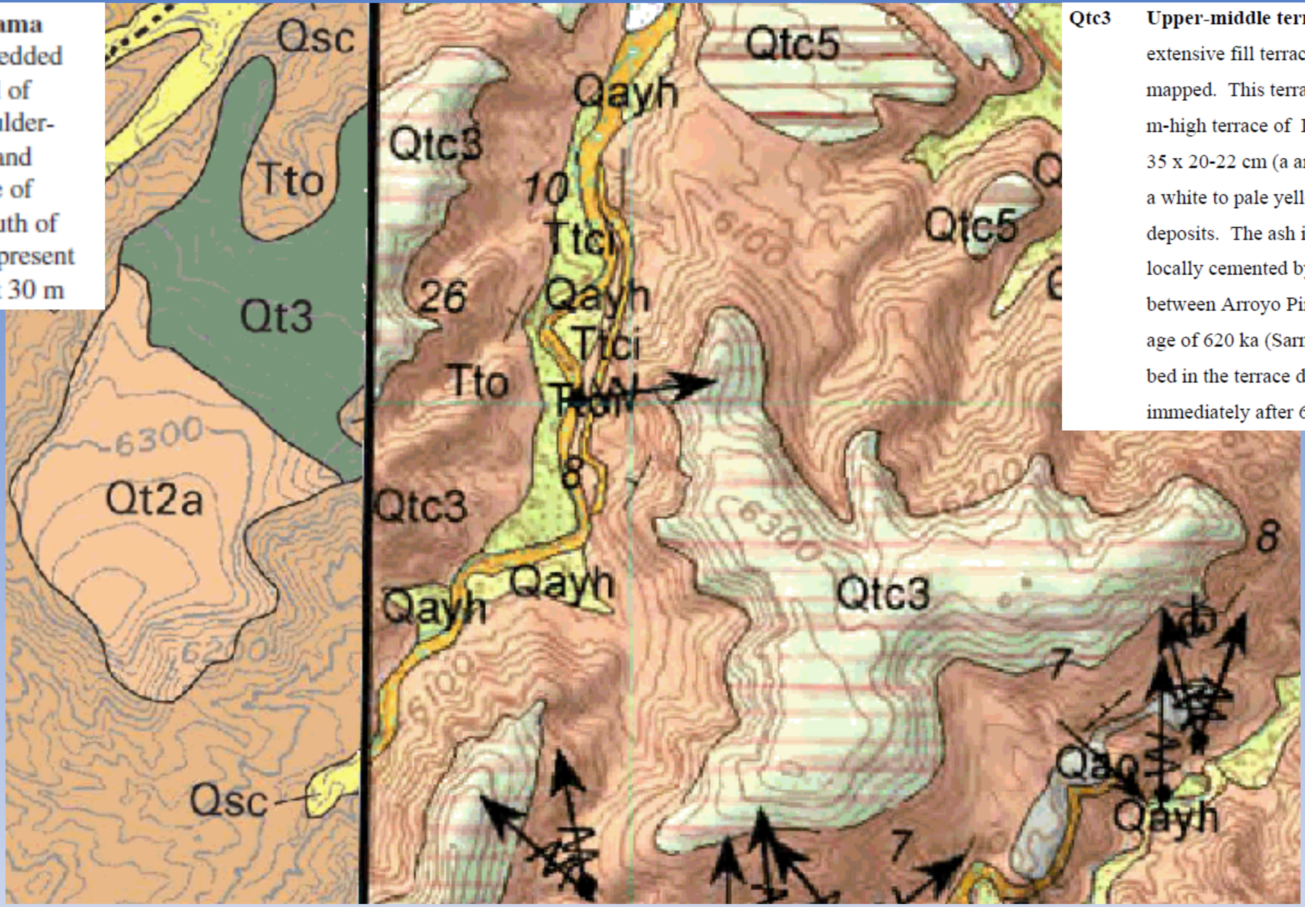
- Unconsolidated sediment
- Usually Quaternary (not a requirement)
- Generally undeformed

Bedrock

- Sedimentary, igneous, metamorphic rocks
- All volcanic rocks (regardless of age) including sedimentary deposits directly associated with volcanic processes

Characterization of surficial deposits

Qt2a **Axial channel deposits of ancestral Rio Chama (Pleistocene)**—Gravels locally interbedded with silt and sand. Gravels composed of subrounded to rounded pebble- to boulder-size quartzite, metamorphic, granite, and intermediate tuffs and lavas with trace of basalt clasts. Inset in Tto and Ttc south of Rio Chama. Found 90–120 m above present Rio Chama channel. Thickness about 30 m



Qtc3 **Upper-middle terrace deposit of the Rio Chama (Middle Pleistocene)** – An extensive fill terrace that contains the Lava Creek B ash, the latter of which was mapped. This terrace deposit is commonly 8-15 m thick and correlates to the 105-117 m-high terrace of Dethier and Reneau (1995, fig. 2). Maximum clast sizes average 29-35 x 20-22 cm (a and b axes of quartzite, in cm). The Lava Creek B ash is generally in a white to pale yellow, single bed 40-70 cm-thick that is associated with floodplain deposits. The ash is generally extensively reworked with silt and very fine sand, and locally cemented by calcium carbonate. The ash seems least reworked and altered between Arroyo Pinavetes and Cañon la Madera. The Lava Creek B ash has an Ar-Ar age of 620 ka (Sarna-Wojcicki et al., 1987), and the restriction of this ash to a single bed in the terrace deposit strongly suggests that it was fluvially reworked and deposited immediately after 620 ka.

Qt3	Axial channel and side-stream channel deposits of ancestral Rio Chama, undivided (Pleistocene)
Qt2a	Axial channel deposits of ancestral Rio Chama (Pleistocene)

From Maldonado, 2008 (Abiquiu, NM: 1:24K)

Qtc3 Upper-middle terrace deposit of the Rio Chama (Middle Pleistocene)

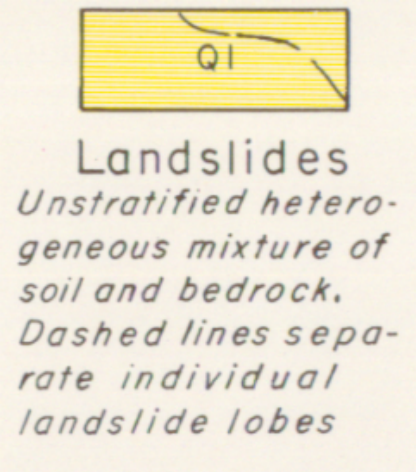
From Koning and others, 2004 (Medanales, NM: 1:24K)

Surficial deposits

Categorize by process: DepositGeneral

- alluvium
- alluvium / colluvium
- glacial deposits
- eolian deposits
- mass wasting deposits
- groundwater / spring discharge deposits
- playa, lake, wetland deposits
- water
- bedrock
- artificial fill

MapUnitPolys_Surficial



Landslides

Unstratified heterogeneous mixture of soil and bedrock. Dashed lines separate individual landslide lobes

Doney, 1968

MASS-WASTING

Conditions in the Cebolla area are ideal for mass-wasting. All the types of slow flowage defined by Sharpe (1938), soil creep, rock creep, talus creep, solifluction, and rock glacier creep, are visible and their effects are conspicuous. The more dramatic slump-and-earthflow topography tends to overshadow the subtler slow-flowage features.

Howe (1909) and Atwood and Mather have described conditions that favor mass-wasting in the San Juan Mountains; similar conditions prevail in the Cebolla area. The Ritito and Los Pinos Formations, which cap the Canjilon escarpment, are for the most part unconsolidated or only partly consolidated. Competent beds resting on incompetent beds furnish stratigraphic conditions that favor mass-wasting. El Rito Formation, a well-cemented conglomerate, overlies incompetent Lewis Shale, and the Mesaverde Group with its massive sandstone overlies incompetent Mancos Shale.

Uplift, tilting, and folding of the beds have placed the competent and incompetent units in positions for severe weathering to promote mass-wasting. Jointing in the upper Mancos limestone and sandstone, in the Mesaverde Group, and in El Rito Formation has made large blocks of material available for mass-wasting. Faulting has uplifted such areas as that along the upper Vallecitos fault and along the Brazos fault.

The climate and topography both favor mass-wasting. In the Cebolla area, where the elevation of the higher ridges is above 10,000 feet, heavy snowfalls are common. The accumulated total precipitation, including snowfall, is more than 100 inches; some of the snow remains on the higher, protected slopes into early June.,

Slow Flowage

Rock creep is more evident and widespread than soil creep. On the flanks of the quartzite hills and ridges, rock creep is especially apparent. The poorly consolidated Cenozoic conglomeratic formations, El Rito, Ritito, and Los Pinos, occupying higher topographic positions, provide a prolific source of material for rock creep. The quadrangle, subjected to glacial and periglacial activity in the past, still is subjected to great frost action. Probably most of the physical weathering in this region comes from frost; as a result, some slopes are almost completely covered by rock debris.

ful streams like the Rio
ulated. These are most

postglacial action have
to form rock streams or
y quartzite, blocks move
uelike basin in Jawbone
ne Mountain, one in the
Vallecitos fault and two
e cone.
crest of the Canjilon
per Vallecitos drainage
to be solifluctionderived
ll receives a high annual
uring the last maximum
time, if they are not still
the Canjilon escarpment

the Cebolla quadrangle
scarpment and northwest
ore than 60 square miles
nbination of slump and
ountains. The surface is
s and depressions. The
pment from which the
, transverse to crescent-
escarpment. The ridges
t with a slight backward
e escarpment. The toe of
ith less definition of the

constituent parts. Bouldery material makes up most of the ridges and is scattered throughout the entire slide area; it is derived mainly from the Ritito and El Rito Formations, which cap the escarpment. Because of the difference in induration of the two formations, slides have carried, unbroken, some large blocks of El Rito, up to 20 feet high, to their present resting place, some of them several miles from the present outcrop. The bulk of the slide material consists of sand, tuff, and gravel from the poorly consolidated units.

cupy the trough areas between the ridges.
area varies from place to place. In some
tree cover, while in others, a dense pine
degrees of cover between these extremes

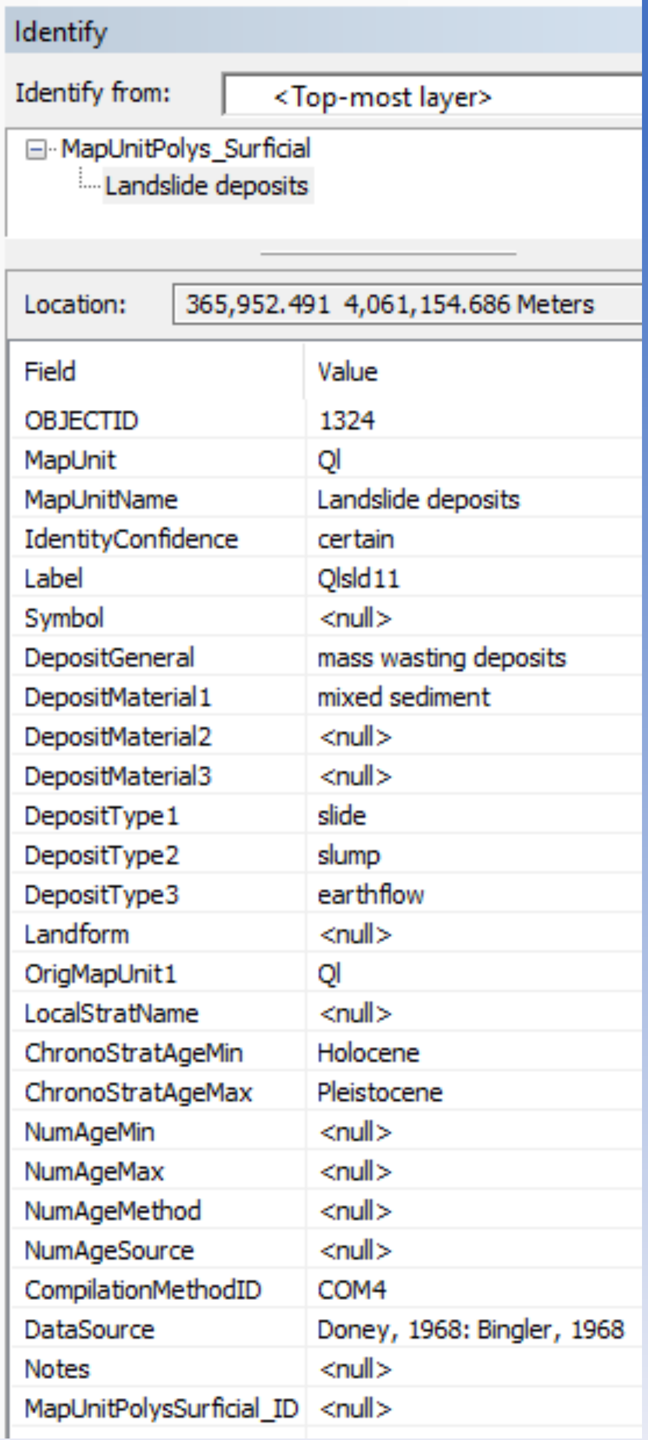
ie the Canjilon escarpment and Penasco
d Mancos shales dipping westward beneath
of the escarpment-capping Cenozoic rocks
by conglomeratic, tuffaceous, and sandy
The porous and permeable Cenozoic beds
water. The downward-percolating water is
-dipping shale, which, when wet, acts as a
water-saturated conglomeratic and tuffa-

summer rain is available in large supply.
ace in numerous springs clustered about the
ead in this quadrangle. The most notable
at the headwaters of El Rito Creek. The
ale. The porous and permeable Ritito and El
the stream, carry the water along the
ntity to maintain the springs throughout the

tain, Red Hill volcano, and cone Qb_5 serve
e major slump and earthflow areas. The
Mountain and Red Hill on the south and
is called the Trout Lakes landslide area; it
he largest of the lakes, about a mile north-
660 feet long; the others range down to
poorly defined lobes and one well-defined
d has been active more recently than those
this area lower than the surrounding slide
outh scarp of this slide supply most of the
trias. The foot of the Trout Lakes lobe is a
istic features of slow earthflow movement.

Some of the transverse ridges stand as much as 40 feet above the lake-, marsh-, and meadow-filled depressions.

Another area of massive slump and earthflow at the headwaters of the Rito de Tierra Amarilla between basalt cone Qb_3 and Penasco Amarillo exhibits three major earthflow lobes between the Canjilon escarpment and the valley of the Rito de Tierra Amarilla. Less distinct earthflow lobes mark the southern slopes of Penasco Amarillo.



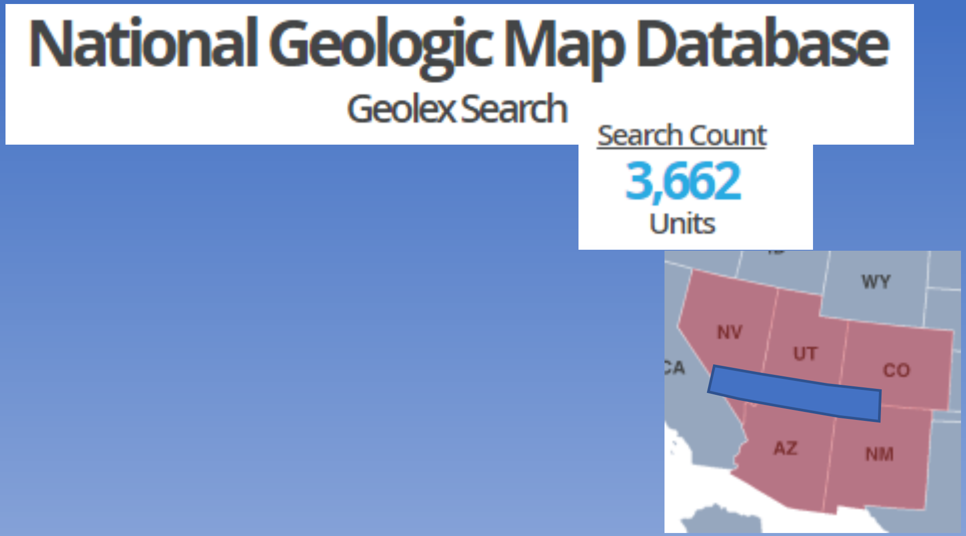
Identify from: <Top-most layer>

MapUnitPolys_Surficial
- Landslide deposits

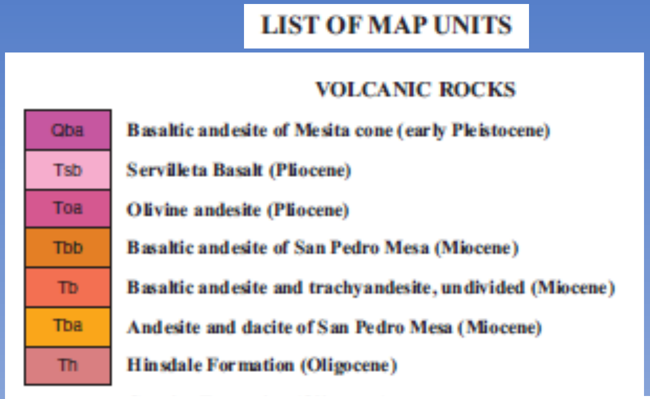
Location: 365,952.491 4,061,154.686 Meters

Field	Value
OBJECTID	1324
MapUnit	Ql
MapUnitName	Landslide deposits
IdentityConfidence	certain
Label	Qlsld11
Symbol	<null>
DepositGeneral	mass wasting deposits
DepositMaterial1	mixed sediment
DepositMaterial2	<null>
DepositMaterial3	<null>
DepositType1	slide
DepositType2	slump
DepositType3	earthflow
Landform	<null>
OrigMapUnit1	Ql
LocalStratName	<null>
ChronoStratAgeMin	Holocene
ChronoStratAgeMax	Pleistocene
NumAgeMin	<null>
NumAgeMax	<null>
NumAgeMethod	<null>
NumAgeSource	<null>
CompilationMethodID	COM4
DataSource	Doney, 1968: Bingler, 1968
Notes	<null>
MapUnitPolysSurficial_ID	<null>

Bedrock units



National Geologic Map Database
Geolex Search
Search Count
3,662
Units

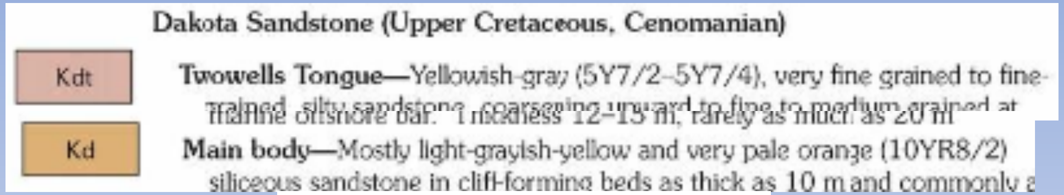


LIST OF MAP UNITS

VOLCANIC ROCKS

Qba	Basaltic andesite of Mesita cone (early Pleistocene)
Tsb	Servilleta Basalt (Pliocene)
Toa	Olivine andesite (Pliocene)
Tbb	Basaltic andesite of San Pedro Mesa (Miocene)
Tb	Basaltic andesite and trachyandesite, undivided (Miocene)
Tba	Andesite and dacite of San Pedro Mesa (Miocene)
Th	Hinsdale Formation (Oligocene)

(Thompson and others, 2015: Alamosa, 100k)



Dakota Sandstone (Upper Cretaceous, Cenomanian)

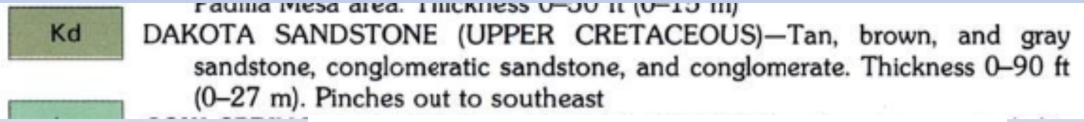
Kdt **Twowells Tongue**—Yellowish-gray (5Y7/2–5Y7/4), very fine grained to fine-

marine offshore bar. Thickness 12–15 m, rarely as much as 20 m

Kd **Main body**—Mostly light-grayish-yellow and very pale orange (10YR8/2) siliceous sandstone in cliff-forming beds as thick as 10 m and commonly

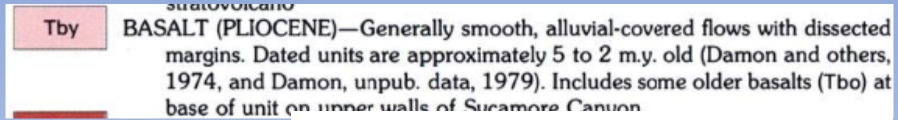
(Robertson, 2006: Pinedale, 1:24k)

VS.



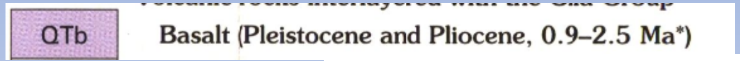
Kd DAKOTA SANDSTONE (UPPER CRETACEOUS)—Tan, brown, and gray sandstone, conglomeratic sandstone, and conglomerate. Thickness 0–90 ft (0–27 m). Pinches out to southeast

(Ulrich and others, 1984: Flagstaff, 1:250K)



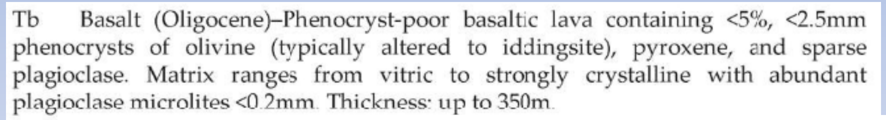
Tby BASALT (PLIOCENE)—Generally smooth, alluvial-covered flows with dissected margins. Dated units are approximately 5 to 2 m.y. old (Damon and others, 1974, and Damon, unpub. data, 1979). Includes some older basalts (Tbo) at base of unit on upper walls of Sycamore Canyon

(Ulrich and others, 1984: Flagstaff, 1:250K)



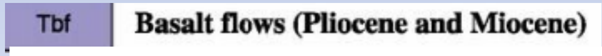
QTb Basalt (Pleistocene and Pliocene, 0.9–2.5 Ma*)

(Ratte, 2001: Tularosa, 1:100k)



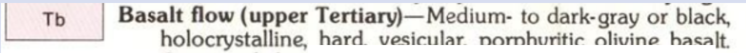
Tb Basalt (Oligocene)–Phenocryst-poor basaltic lava containing <5%, <2.5mm phenocrysts of olivine (typically altered to iddingsite), pyroxene, and sparse plagioclase. Matrix ranges from vitric to strongly crystalline with abundant plagioclase microlites <0.2mm. Thickness: up to 350m.

(Ferguson and Osburn, 2012: Luera Mtns, 1:24k)



Tbf **Basalt flows (Pliocene and Miocene)**

(Wrucke and others, 2004: San Carlos, 1:125k)



Tb **Basalt flow (upper Tertiary)**—Medium- to dark-gray or black, holocrystalline, hard, vesicular, porphyritic olivine basalt. Commonly has

(Scott, 1986: Springer, 1:100k)

Concept of geologic province

Tectonic, magmatic, or stratigraphic associations

Spatial and temporal characteristics

No fixed spatial boundaries

Include 3 GeolProvince fields

Mastin and others, 2014, Modeling ash fall distribution from a Yellowstone supereruption: Geochem., Geophys., Geosys., 15, p. 3459-3475.

Ranked GeolProvince1

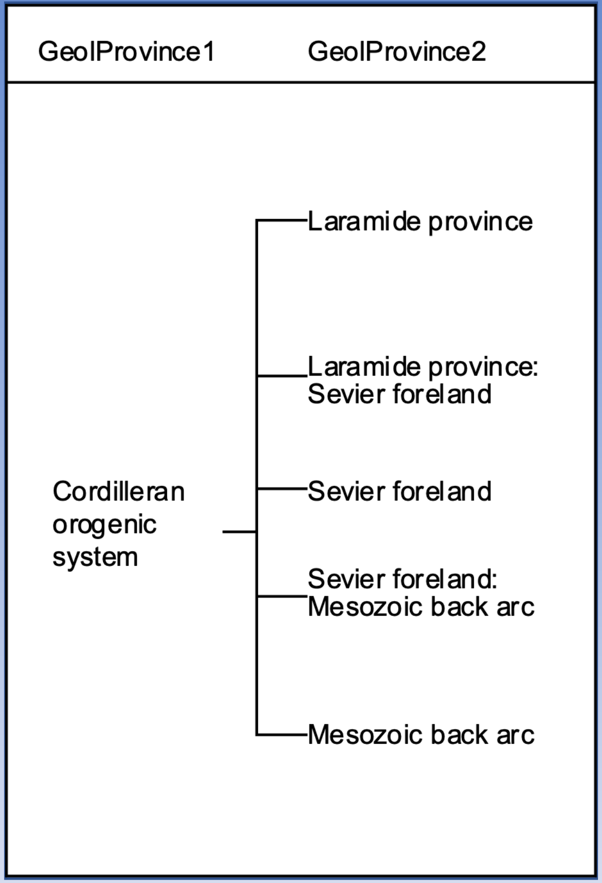
Cenozoic extension

Magmatism of uncertain association

Southern Rocky Mountains volcanic field

Cordilleran orogenic system

Hierarchy of GeolProvince fields



GeolProvince1

GeolProvince2

Cordilleran orogenic system

Laramide province

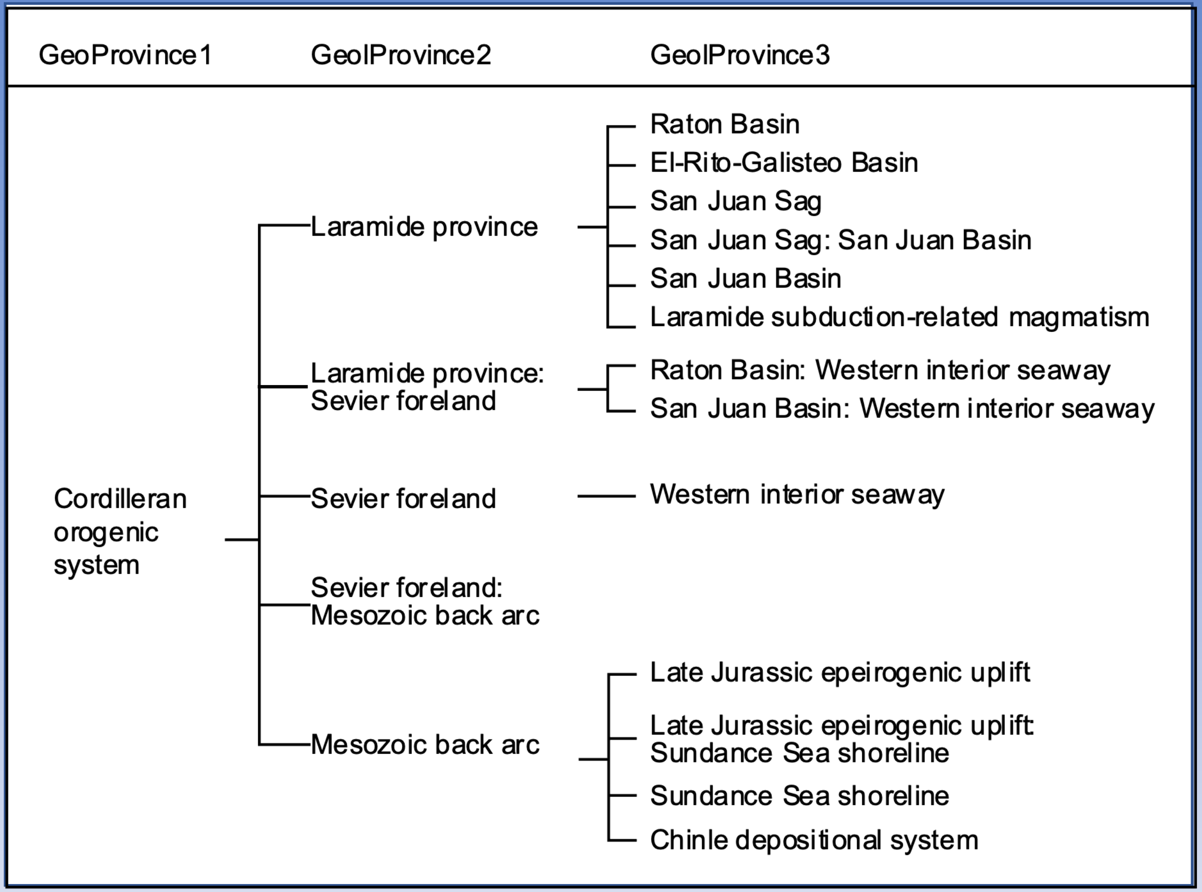
Laramide province: Sevier foreland

Sevier foreland

Sevier foreland: Mesozoic back arc

Mesozoic back arc

Hierarchy of GeolProvince fields



GeoProvince1 | GeolProvince2 | GeolProvince3

- Cordilleran orogenic system
  - Laramide province
    - Raton Basin
    - El-Rito-Galisteo Basin
    - San Juan Sag
    - San Juan Sag: San Juan Basin
    - San Juan Basin
    - Laramide subduction-related magmatism
  - Laramide province: Sevier foreland
    - Raton Basin: Western interior seaway
    - San Juan Basin: Western interior seaway
  - Sevier foreland
    - Western interior seaway
  - Sevier foreland: Mesozoic back arc
  - Mesozoic back arc
    - Late Jurassic epeirogenic uplift
    - Late Jurassic epeirogenic uplift: Sundance Sea shoreline
    - Sundance Sea shoreline
    - Chinle depositional system

Map units and GeolProvince association

- Map unit names only need to be unique within a particular GeolProvince
- An individual map unit can only be associated with a single GeolProvince regardless of location
    - Like the Lava Creek B example

Map units and GeolProvince association

Unit is unique based on combination:

GeolProvince1-GeolProvince2-GeolProvince3-MapUnitName

GeolProvince1	GeolProvince2	GeolProvince3	MapUnitName	MapUnit	DMUID	HierarchyKey
Cenozoic ext.			Bridgetimber Gravel	Tbg	6	001-000-000-001
Cenozoic ext.	Rio Grande rift		Brazos Basalt	Qbl	43	001-001-000-001
Cenozoic ext.	Rio Grande rift		Santa Fe Group	Tsf	678	001-001-000-002
Cenozoic ext.	Rio Grande rift	Jemez vol. field	Bandelier Tuff	Qbt	532	001-001-001-001
Cenozoic ext.	Rio Grande rift	Jemez vol. field	Otowi Mbr. of Bandelier T.	Qbo	45	001-001-001-002
Cenozoic ext.	Rio Grande rift	Jemez vol. field	Tshirege Mbr. of Bandelier T.	Qbt	543	001-001-001-003
Cenozoic ext.	Rio Grande rift	Espanola Basin	Abiquiu Formation	Ta	456	001-001-002-001

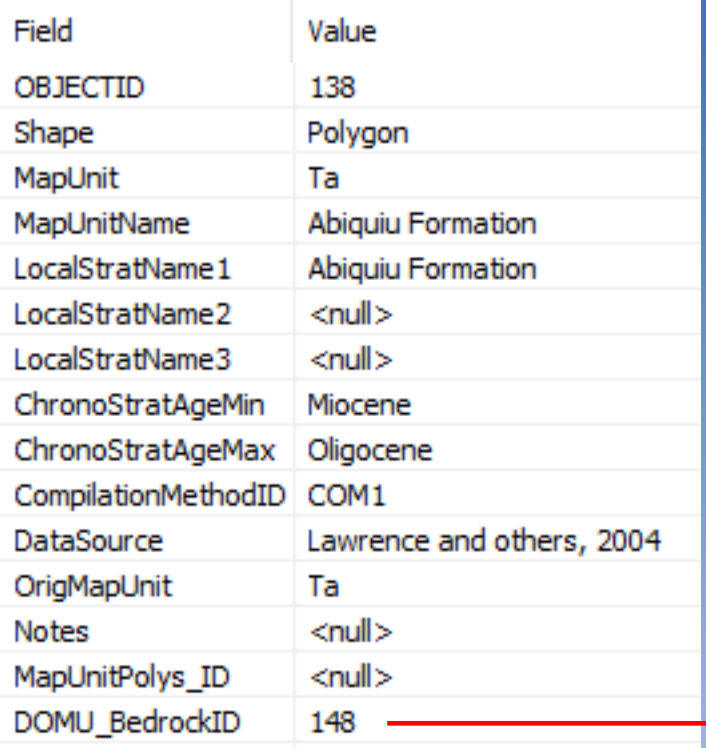
NonUnique MapUnitNames

- Informal unit names referring to lithology, color, or type of deposit (ex. basalt lava flow) can be nonunique within database, BUT must be unique with a GeolProvince
- Using hypothetical example of MapUnitName = basalt lava flow

GeolProvince1	GeolProvince2	GeolProvince3	MapUnitName	MapUnit	DOMUID
Cenozoic extension	Rio Grande rift	Ocate vol. fld.	basalt lava flow	Tbf	9
Cenozoic extension	Rio Grande rift	Taos Plateau vol. fld.	basalt lava flow	Tbf	101
Cenozoic extension	Basin and range		basalt lava flow	Tbf	400
Mogollon/Datil			basalt lava flow	Tbf	304

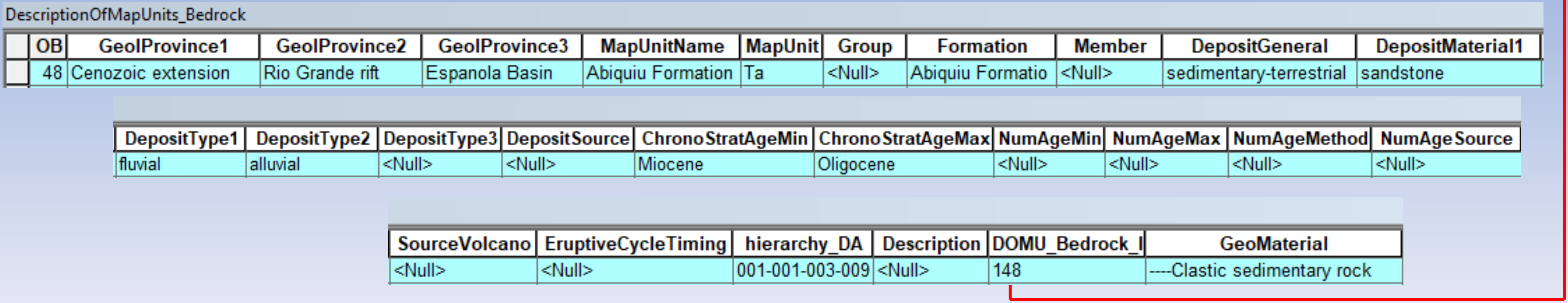
Bedrock attributes

MapUnitPolys_Bedrock



Field	Value
OBJECTID	138
Shape	Polygon
MapUnit	Ta
MapUnitName	Abiquiu Formation
LocalStratName1	Abiquiu Formation
LocalStratName2	<null>
LocalStratName3	<null>
ChronoStratAgeMin	Miocene
ChronoStratAgeMax	Oligocene
CompilationMethodID	COM1
DataSource	Lawrence and others, 2004
OrigMapUnit	Ta
Notes	<null>
MapUnitPolys_ID	<null>
DOMU_BedrockID	148

DescriptionOfMapUnits_Bedrock

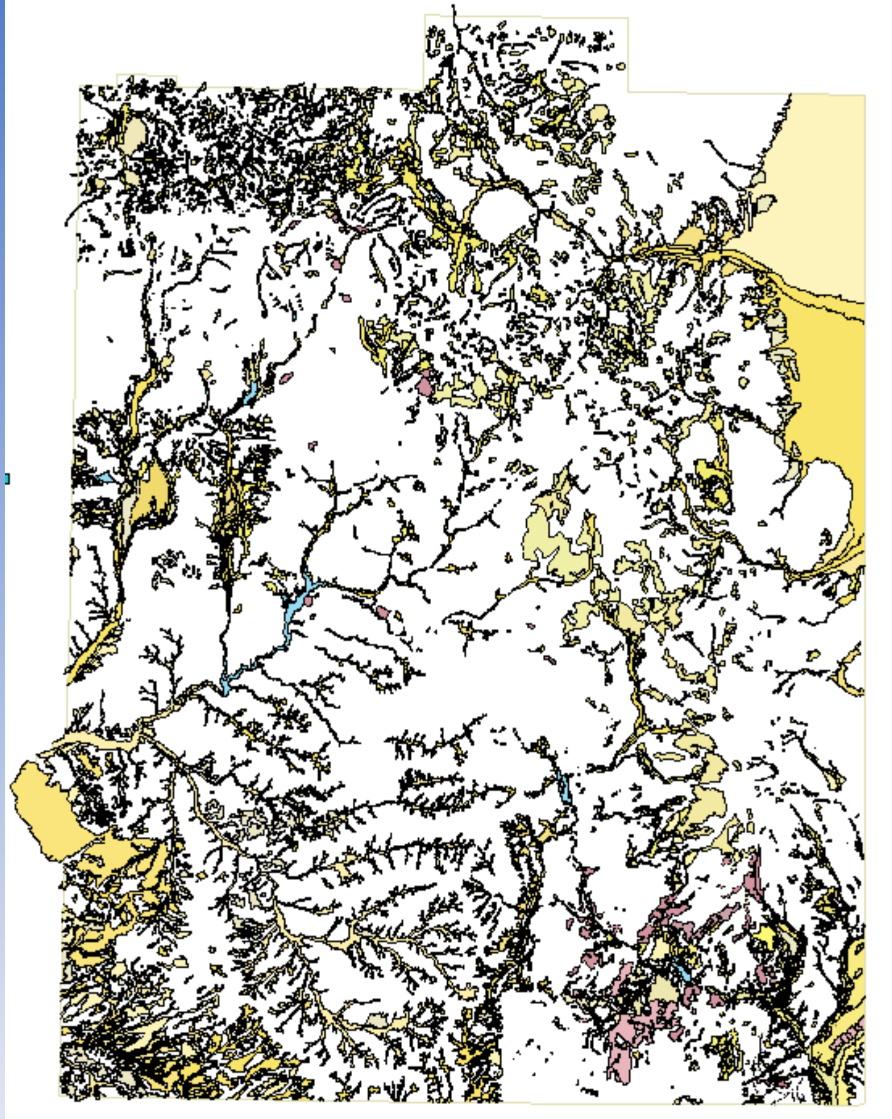
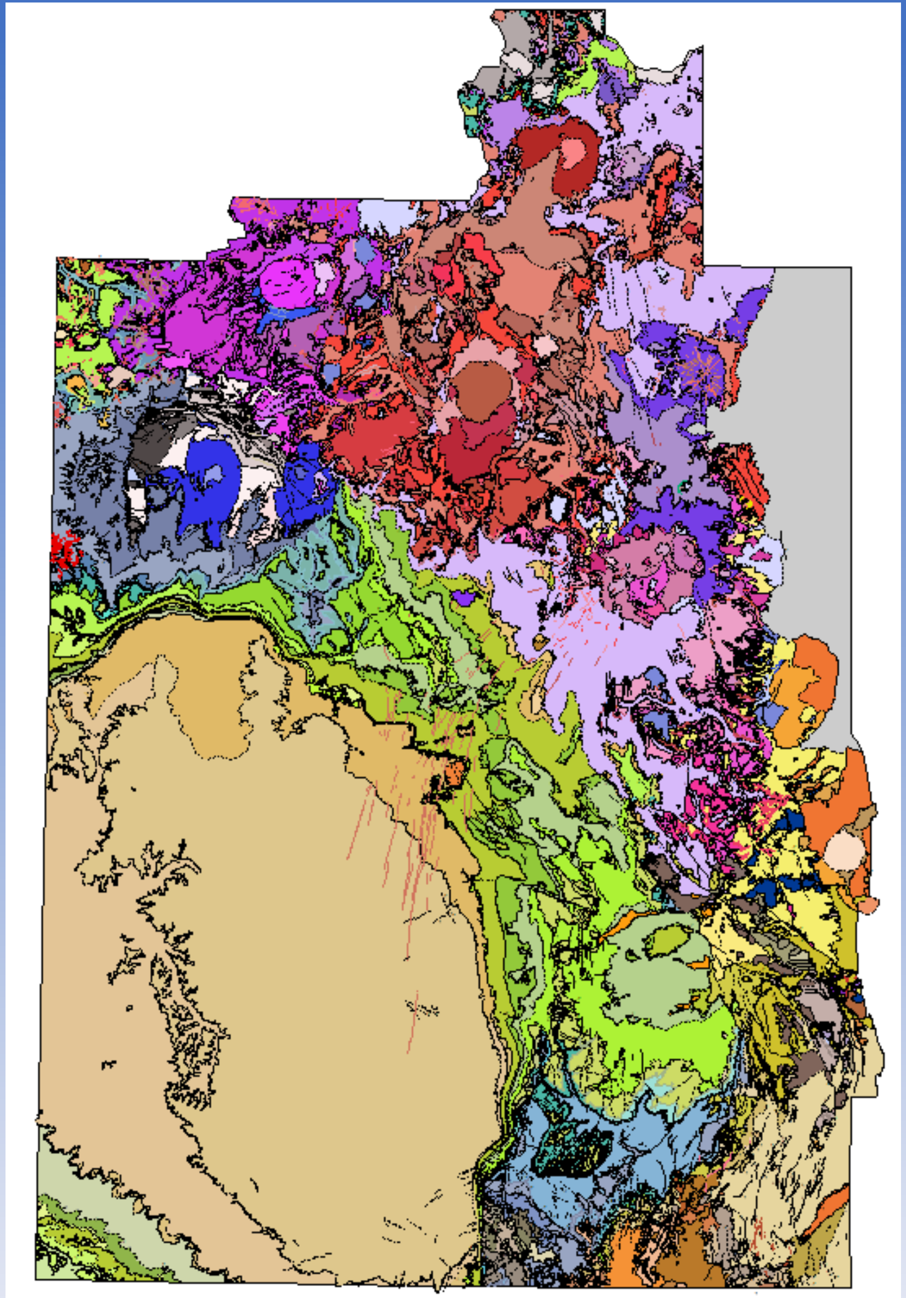


DescriptionOfMapUnits_Bedrock

OB	GeolProvince1	GeolProvince2	GeolProvince3	MapUnitName	MapUnit	Group	Formation	Member	DepositGeneral	DepositMaterial1
48	Cenozoic extension	Rio Grande rift	Espanola Basin	Abiquiu Formation	Ta	<Null>	Abiquiu Formatio	<Null>	sedimentary-terrestrial	sandstone

DepositType1	DepositType2	DepositType3	DepositSource	ChronoStratAgeMin	ChronoStratAgeMax	NumAgeMin	NumAgeMax	NumAgeMethod	NumAgeSource
fluvial	alluvial	<Null>	<Null>	Miocene	Oligocene	<Null>	<Null>	<Null>	<Null>

SourceVolcano	EruptiveCycleTiming	hierarchy_DA	Description	DOMU_Bedrock_I	GeoMaterial
<Null>	<Null>	001-001-003-009	<Null>	148	----Clastic sedimentary rock

Surficial, bedrock, and combined