StateMap Forum

4th Quarterly SM Forum

Topic: Correlation of Map Units

U.S. Department of the Interior
U.S. Geological Survey

Announcements

- Budgets and match
  - Work with your Fiscal or Budget Officers to ensure that they will commit to the match or over-match
  - Your revised budget should be the final budget submitted to the program (Kim Dove)
- Monitoring of StateMap spending accounts
  - Please be proactive
  - Let us know, as early as possible, if you aren't able to spend the entire amount.
- Call for Forum Topics!

USGS

StateMap Forum

CORRELATION OF MAP UNITS

USGS

Today's Agenda

- US Geological Survey – Randy Orndorff
  - Featured on *Secrets of the Earth – "Sinkholes"* also with Jon Arthur (FGS) – (Weather Channel - Season 2, Episode 4, air date 11/10/14)
- Louisiana Geological Survey – Rick McCulloh
- Missouri Geological Survey – Edie Starbuck
- Utah Geological Survey – Grant Willis and Bob Biek

USGS

CMU

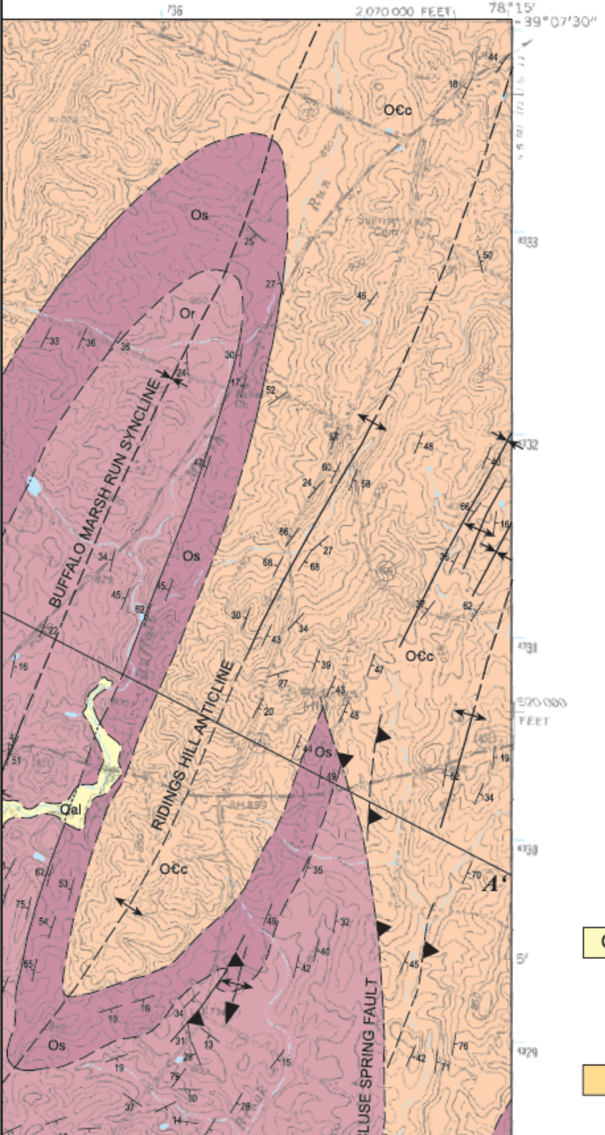
- What is a Correlation of Map Units?
- How is it used?
- What is the history of use at the USGS?
- CMU Standards
- CMU variability – how do they differ and why?

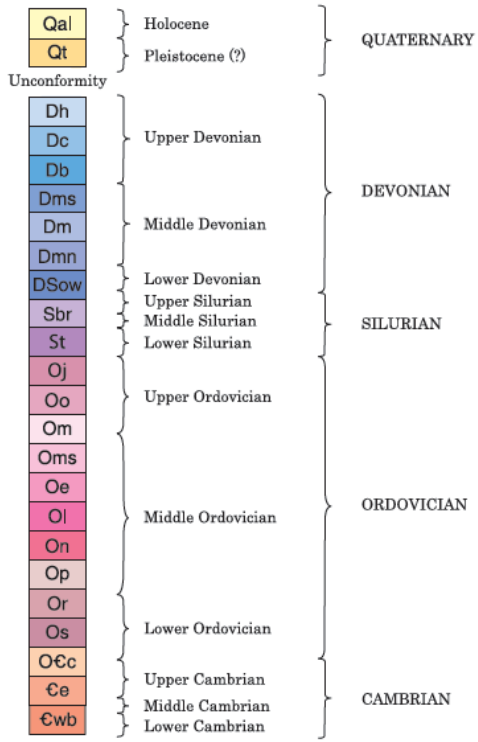
Why and What is a CMU?

- Effective communication
- Only place where units shown in proper sequence
- Author interpretation of position and age of units
- Important to include map symbol
- Does not include any descriptions
- Can show unconformities and other important items for the reader

USGS

Simple CMU from 7-1/2' bedrock map, stacked units





DESCRIPTION OF MAP UNITS

Qal — **Alluvium (Holocene and Pleistocene?)**—Clay, silt, and lesser sand with angular to subrounded clasts, up to boulder size, derived from local bedrock. In area underlain by the Martinsburg Formation, consists of light-olive-gray, yellowish-gray, and pale-yellowish-orange to dark-yellowish-orange, well-bedded to crudely bedded, planar-bedded, clayey silt, with weathered shale fragments as much as an inch long; as much as 20 ft thick along Cedar Creek

Qt — **Terrace deposits (Pleistocene?)**—Deeply weathered, grayish-orange silt matrix containing leached, generally rounded cobbles as much as 8 in. in diameter of reddish-brown and white sandstone, probably derived from rocks of Silurian and Devonian age. Thickness locally as much as 50 ft or more along Cedar Creek. Two terrace levels occur at about 40

Om — **Martinsburg Formation (Upper and Middle Ordovician)**—Interbedded shale and less graywacke-siltstone and graywacke-sandstone. Shale, medium-gray to dark gray ar light-olive-gray, grayish-orange- and dark-yellowish-orange-weathering, commonly silt generally noncalcareous, although calcareous intervals occur in lower part of formatio Sandstone and siltstone (immature, generally lithic graywacke), medium-gra grayish-orange-weathering, very fine to fine-grained, commonly graded (fining upwards lenticular, slightly calcareous to noncalcareous. Many small-scale crossbeds. Graywac is more abundant and more thickly bedded higher in section (approximately 2,000 ft abov base of Martinsburg) where it forms conspicuous ribs in creek beds and may comprise much as 30 percent of some intervals that are several hundred feet thick. Thicker beds a generally graded and display characteristics of complete Bouma cycles, although Boun cycles c-e appear to be most abundant. Contains a few load casts. Thickne approximately 2,600 ft; total regional thickness may be more than 5,000 ft. Best expose in Catlett Run northwest of Virginia Highway 842; top of unit probably not exposed quadrangle

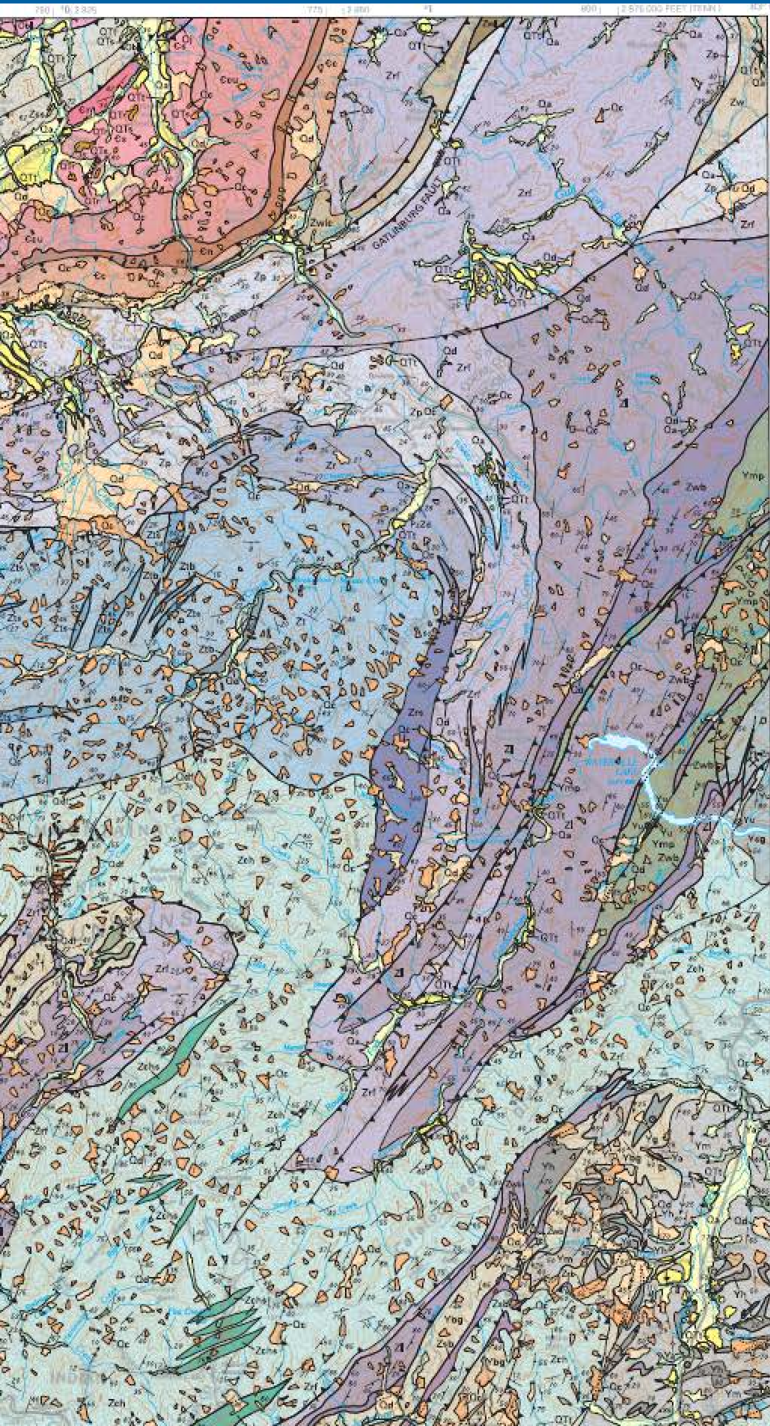
Oms — Stickley Run Member (Middle Ordovician)—Includes all rocks above highe knobby-weathering limestone of the Edinburg Formation (Oe) up to and including rocks containing platy limestones interbedded with shales just below shales of middle pa of Martinsburg Formation (Om). Limestone, medium-gray to grayish-black, olive-gray grayish-orange, and dark-yellowish-orange-weathering, very fine grained, laminated an very thin bedded to thin-bedded, argillaceous, commonly micro-graded. Shal medium-gray to medium-dark-gray, and calcareous. Also includes several thin beds yellowish-brown metabentonite. Contact with the remainder of Martinsburg transitional where limestones become less abundant upwards. A few thin beds graywacke, siltstone and very fine grained sandstone, generally less than 2 in. thick, a found near top. Calcareous shale averages 49 percent carbonate (range is 45 to 53 percen and limestones average 75 percent (range is 65 to 85 percent). Includes rocks previous called Oranda Formation and several hundred feet of rock previously included with lower part of the Martinsburg Formation (Epstein and others, 1995). Thickness may be much as 900 ft. Best exposed at its type locality along southeast side of northbound U. Highway 11 just past bridge over Cedar Creek

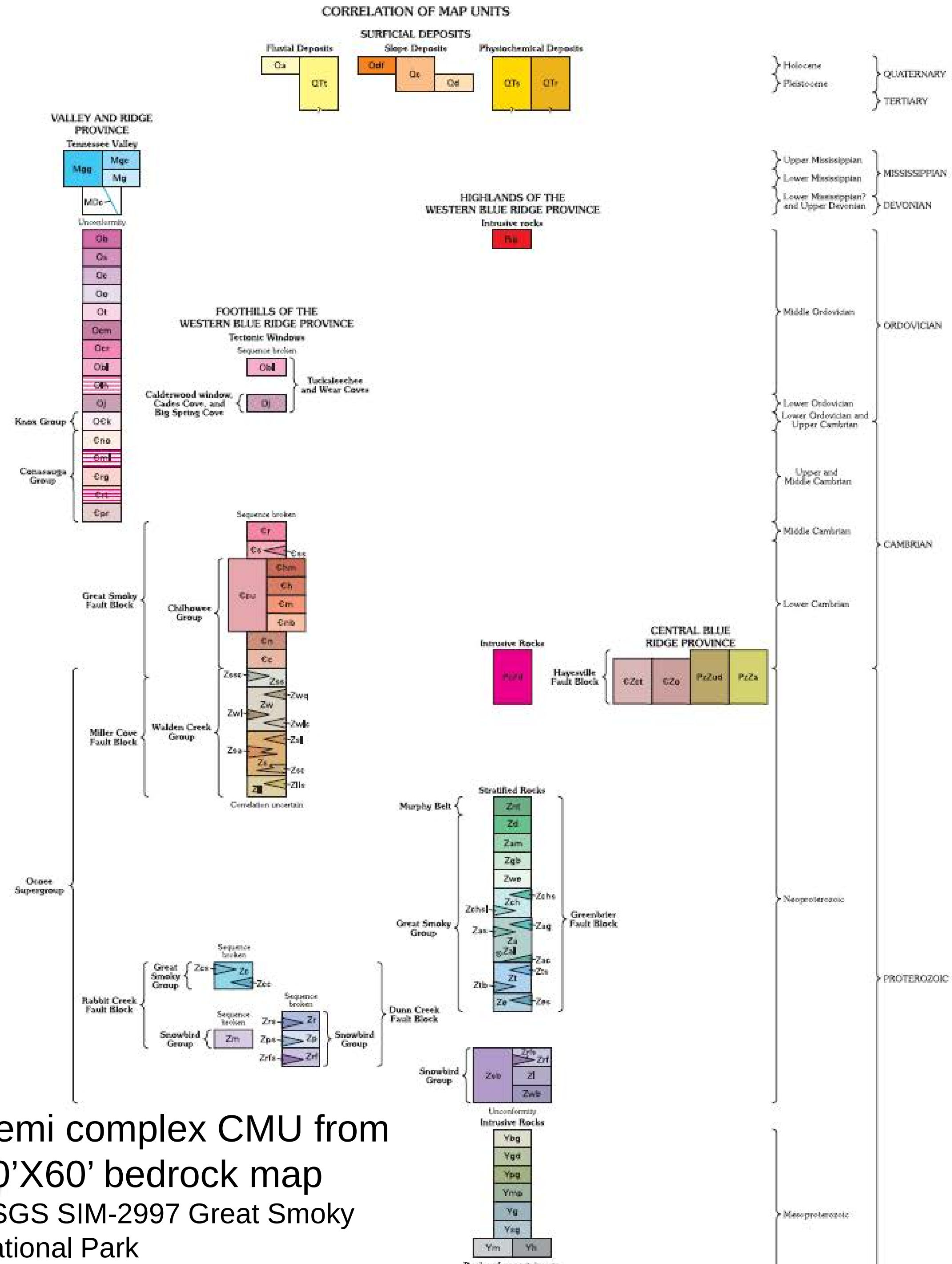
Oe — **Edinburg Formation (Middle Ordovician)**—Interbedded limestone and calcareous shal Limestone, medium- to medium-dark-gray, fine- to medium-grained, thin- thick-bedded, irregularly bedded, knobby weathering. Calcareous shale, medium-dark- very dark gray. Characterized by knobby weathering of fine-grained limestone be interbedded with shale. Contains several thin beds of yellowish-brown metabentonit Lower contact transitional with Lincolnshire Limestone (Ol) and placed at base of fir knobby-weathering, argillaceous limestone; very dark gray, shaly limestone; or calcareo shale. Thickness about 500 ft. Best exposed along entrance ramp to southbound Intersta Highway 81 from U.S. Highway 11

Ol — **Lincolnshire Limestone (Middle Ordovician)**—Limestone, dark-gray to very dark gra medium- to coarse-grained, medium-bedded with bedded black chert nodules; an bioclastic limestone, medium-gray, coarse-grained, thin-bedded. Lower contact placed base of first dark-gray, medium-grained limestone above dove-gray, micritic limestone New Market Limestone (On). Thickness ranges from 75 to 105 ft. Best exposed alon entrance ramp to southbound Interstate Highway 81 from U.S. Highway 11

On — **New Market Limestone (Middle Ordovician)**—Limestone, medium-gray and dove-gra light-gray-weathering, thick-bedded, micritic, fenestral. Lower 10 ft is medium-

USGS GQ-1803, Middletown, VA quad





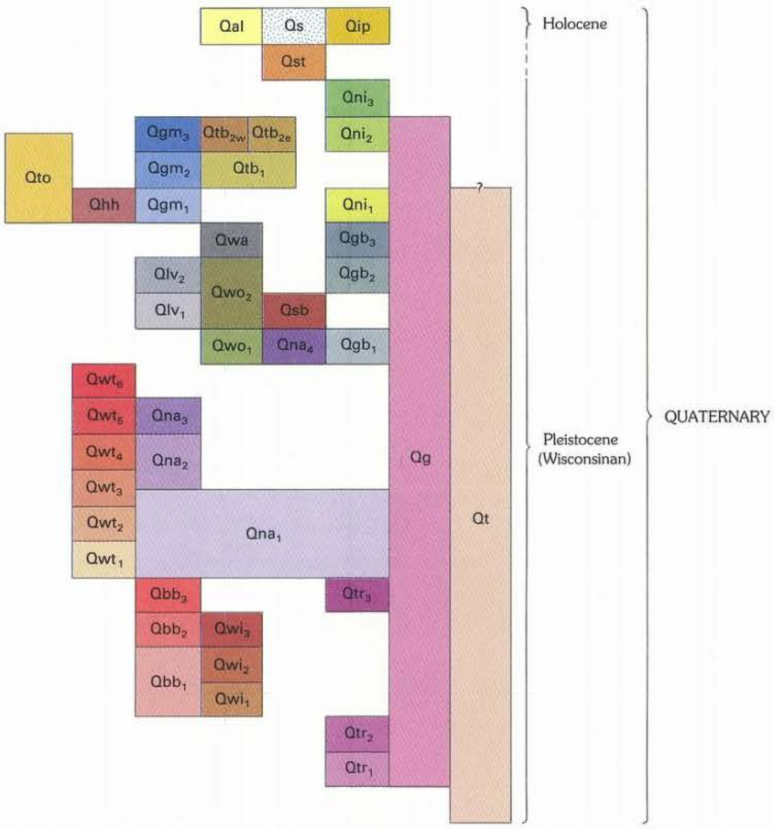
Semi complex CMU from 30’X60’ bedrock map

USGS SIM-2997 Great Smoky National Park

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS
STATE OF NEW HAMPSHIRE
DEPARTMENT OF RESOURCES AND ECONOMIC DEVELOPMENT

CMU from 7-1/2' surficial/glacial map

CORRELATION OF MAP UNITS



Qwt6, Qwt5, Qwt4, Qwt3, Qwt2, Qwt1 — **West Townsend deposits (Pleistocene)**—Sand, gravel, and minor silt deposited in successively lower pond levels between successive stagnant-ice margins and spillways east of Lunenburg Road. Thickness not well known, but ranges from as much as 30 ft (9.1 m) at the northern part to more than 70 ft (21.3 m) at the southern part

Qbb3, Qbb2, Qbb1 — **Bixby Brook deposits (Pleistocene)**—Sand, gravel, and minor silt deposited in a successively lowering lake between successive stagnant-ice margins and spillways to the south and east. Unit Qbb1 as much as 80 ft (24.4 m) thick; unit Qbb2 as much as 70 ft (21.3 m) thick; and unit Qbb3 more than 35 ft (10.7 m) thick

Qwi3, Qwi2, Qwi1 — **Witch Brook deposits (Pleistocene)**—Sand, gravel, and minor silt deposited in a successively lowering lake between successive stagnant-ice margins and spillways, first in the Shirley quadrangle to the south and then east along Turner Road. Thickness not well known, but is at least 50 ft (15.2 m) for units Qwi1 and Qwi3 and as much as 30 ft (9.1 m) for unit Qwi2

Qg — **Uncorrelated meltwater deposits (Pleistocene)**—Sand, gravel, and silt deposited by meltwater streams within or at the margin of stagnant ice. Thickness 20–40 ft (6.1–12.2 m). Deposition was in either a fluvial or lacustrine environment, but chronologic position and(or) base-level controls are not well known

Qt — **Till (Pleistocene)**—Light- to dark-gray, nonsorted to poorly sorted mixture of clay, silt, sand, pebbles, cobbles, and boulders; contains some gravel. Thickness varies but generally is less than 20 ft (6.1 m); may be more than 50 ft (15.2 m) under the crests of drumlins

af — **Artificial fill**—Made land derived chiefly from till, meltwater deposits, and rock waste. Ruled pattern indicates area partly cut and partly filled, where geology is concealed by construction

Bedrock exposures—Individual exposures not shown completely in till areas. Ruled pattern indicates areas of abundant exposures and areas where surficial deposits are less than 10 ft (3 m) thick. Extent of ruled pattern mapped in part from aerial photographs

DESCRIPTION OF MAP UNITS

(A layer of pale-orange windblown fine- to medium-grained sand and silt less than 3 ft (1 m) thick is present over much of the surface of the map area but is not shown. The lower part of this layer is generally mixed with underlying surficial deposits)

Qal — **Alluvium (Holocene)**—Sand, silt, and minor gravel in flood plains along

EXPLANATION OF MAP SYMBOLS

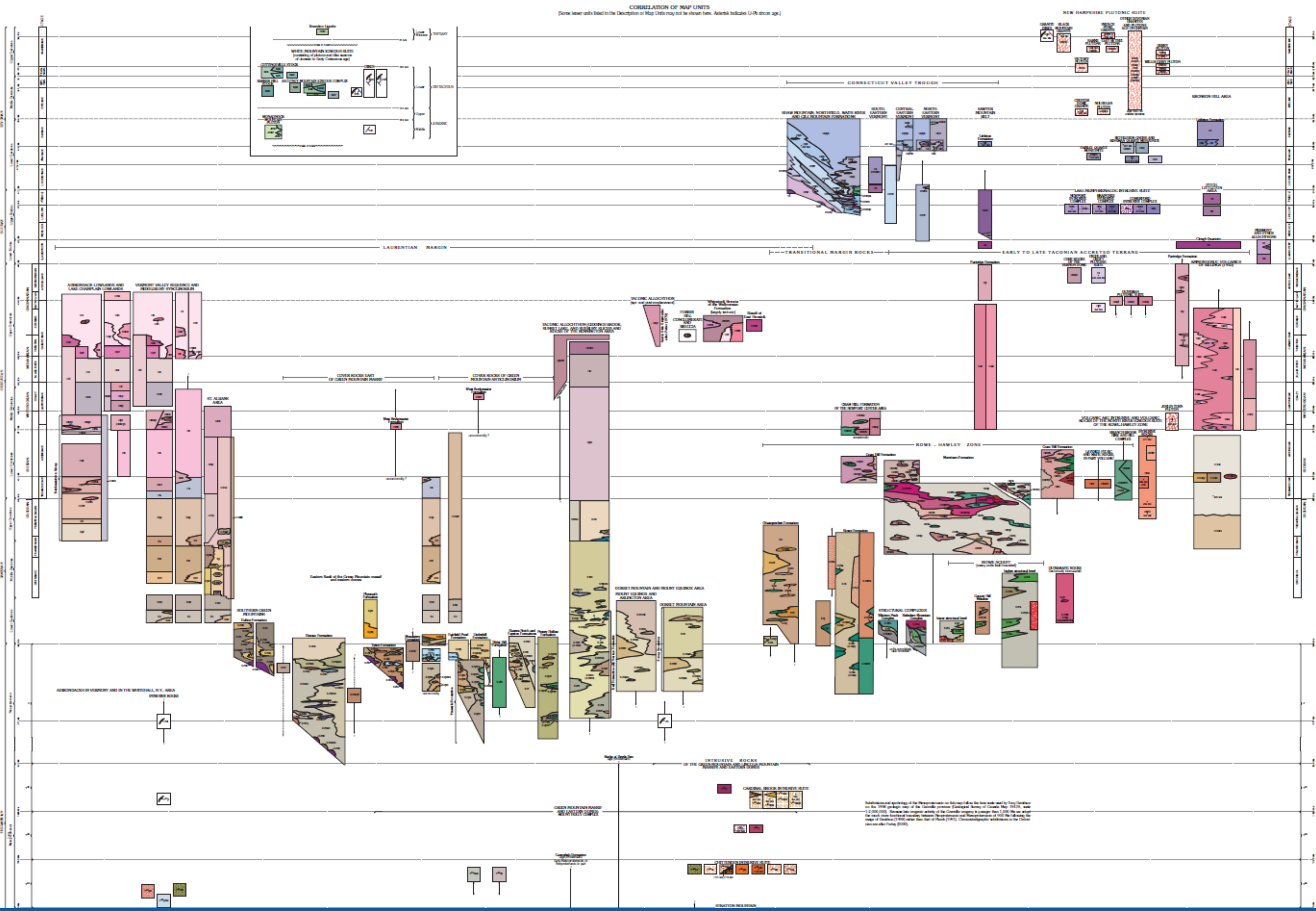
Contact—Dashed where approximately located

—Qgb3—? **Retreatal ice position of stagnant ice front**—Approximate position of ice margin during final stages of deposition of designated map unit. Dashed line indicates intermediate ice retreat position within unit; queried where doubtful

USGS

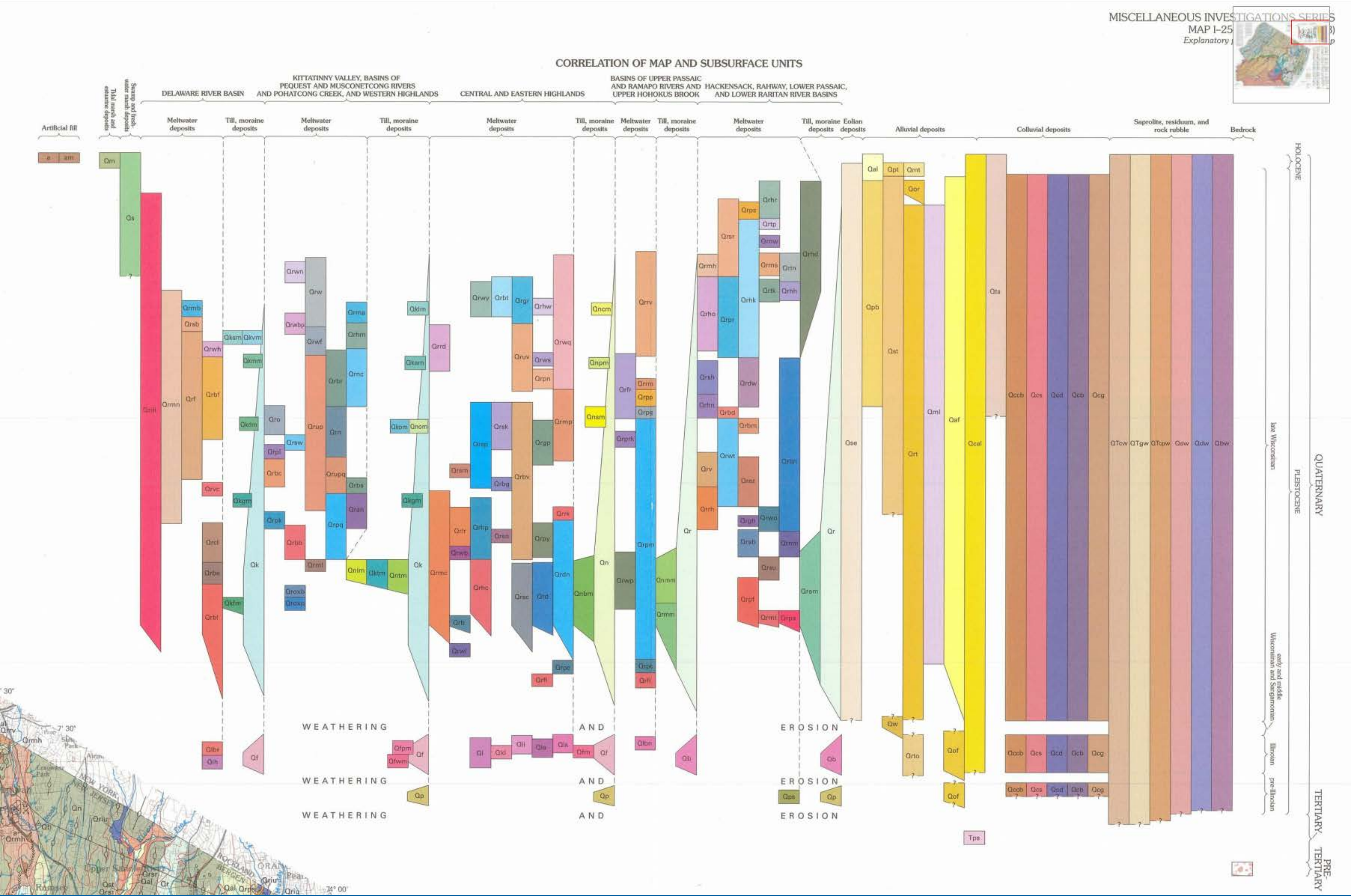
USGS GQ-1677, Townsend, MA & NH quad

Complex CMU from 1:100,000-scale state bedrock map (hundreds of units)



USGS SIM-3184, State geologic map of VT

Complex CMU from 1:100,000-scale state surficial geologic map



USGS I-2540-C, Surficial Geologic Map of NJ

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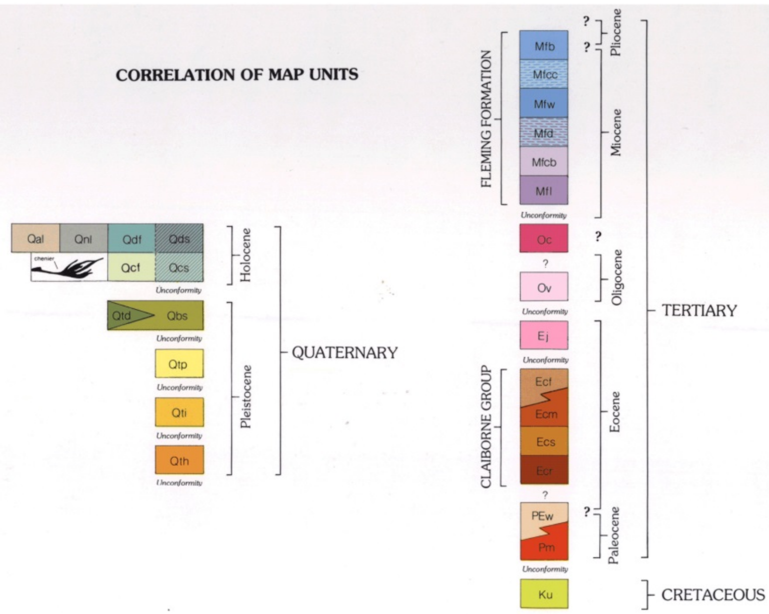
LGS – CMU EXAMPLE

USGS

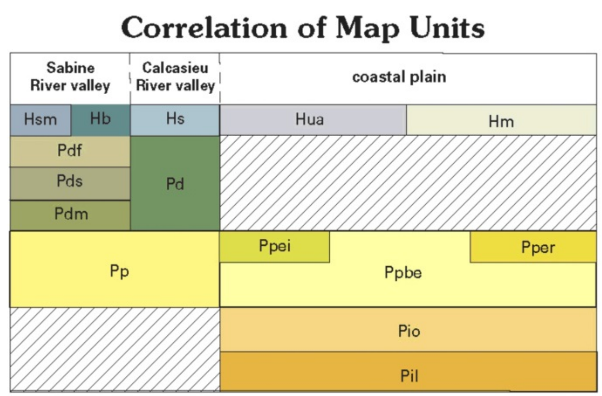
Louisiana Geological Survey

Traditional
(space-economic)



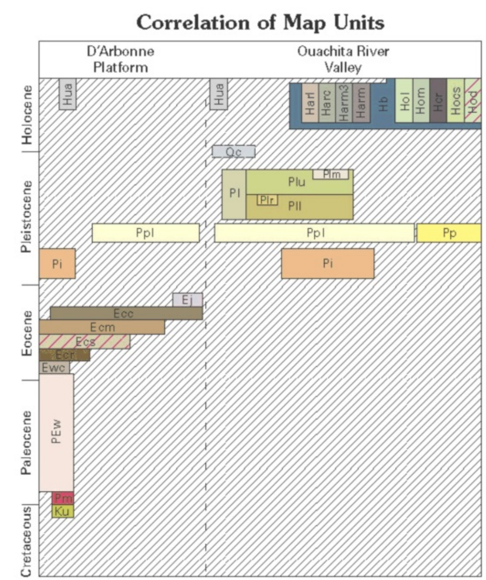
Louisiana state geologic map
(1984)

Intermediate



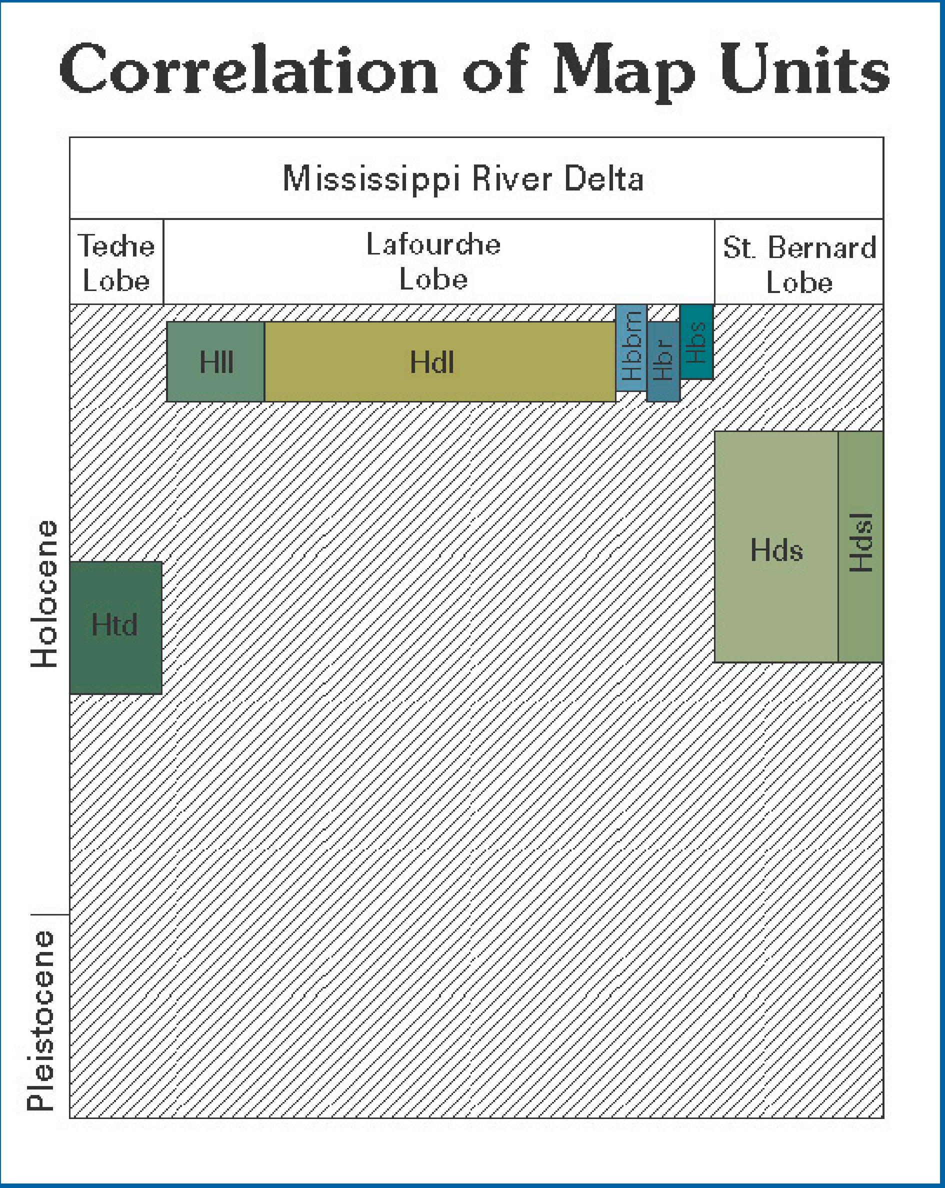
Lake Charles 30 × 60
(2002)

Time-Scaling
(for represented series only)



Monroe South 30 × 60
(2010)

Louisiana Geological Survey



USGS

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MGS – CMU EXAMPLE

Missouri Geological Survey CMU

CORRELATION OF MAP UNITS

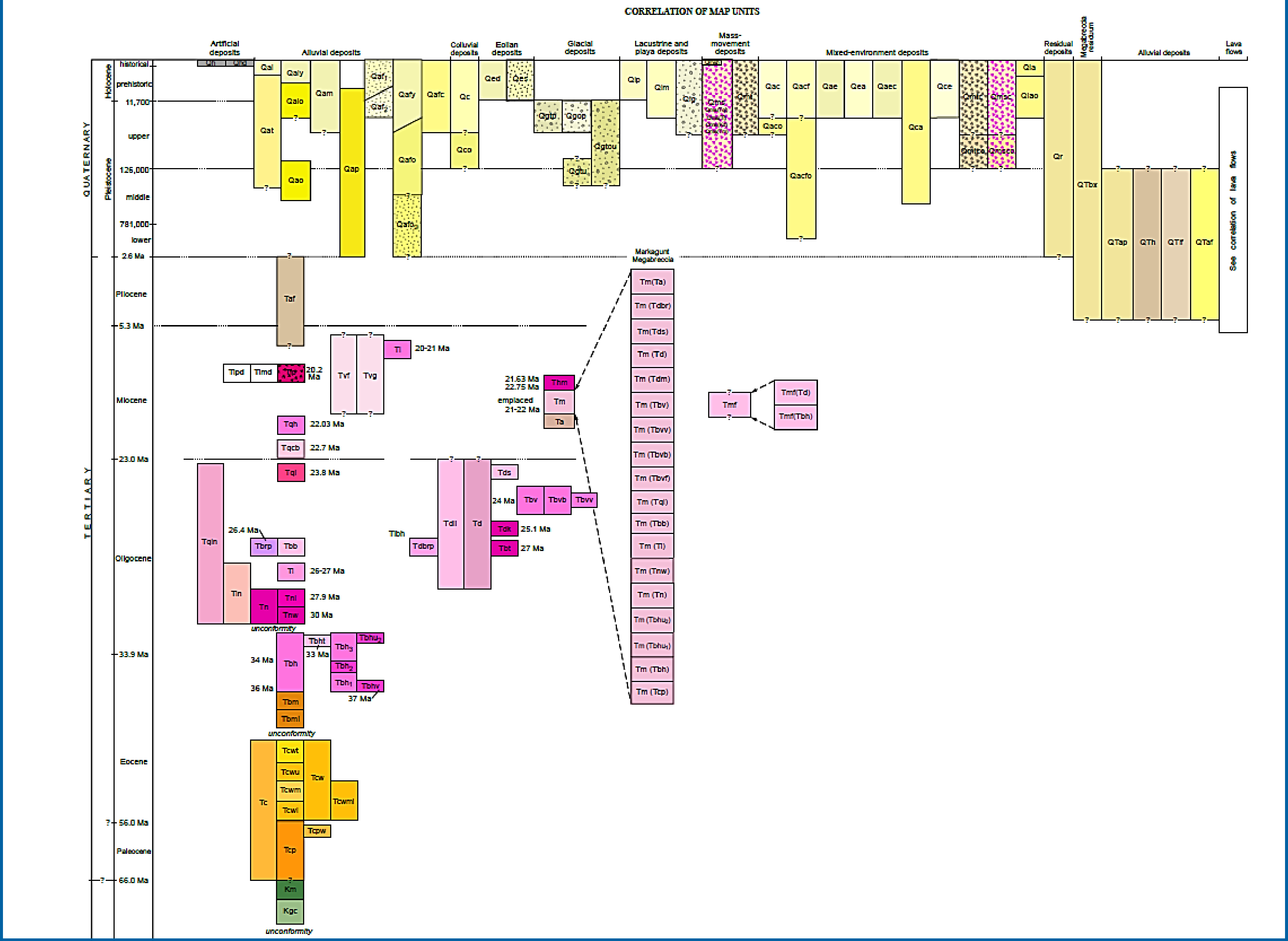
Map Unit Symbol	System *Subsystem*	Series	Map Unit	Thickness (feet)
Pk	Carboniferous *Pennsylvanian*	Desmoinesian	Krebs Subgroup	0 - 40
~~ Unconformity ~~				
Mbk	Carboniferous *Mississippian*	Osagean	Burlington-Keokuk Limestone	0 - 120
Mcfg	Carboniferous *Mississippian*	Osagean and Kinderhookian	Fern Glen Formation and Kinderhookian Series	40 - 50
~~ Unconformity ~~				
Dssg	Devonian	Upper Devonian	Sulphur Springs Group	0 - 25
~~ Unconformity ~~				
Ok	Ordovician	Mohawkian	Kimmswick Limestone	0 - 90
Od	Ordovician	Mohawkian	Decorah Group	15 - 20
Op	Ordovician	Mohawkian	Plattin Group	120 - 130
Oj	Ordovician	Mohawkian	Joachim Dolomite	110 - 120
Osp	Ordovician	Mohawkian	St. Peter Sandstone	100 - 150*

* Complete thickness is not exposed on the Eureka 7.5' quadrangle

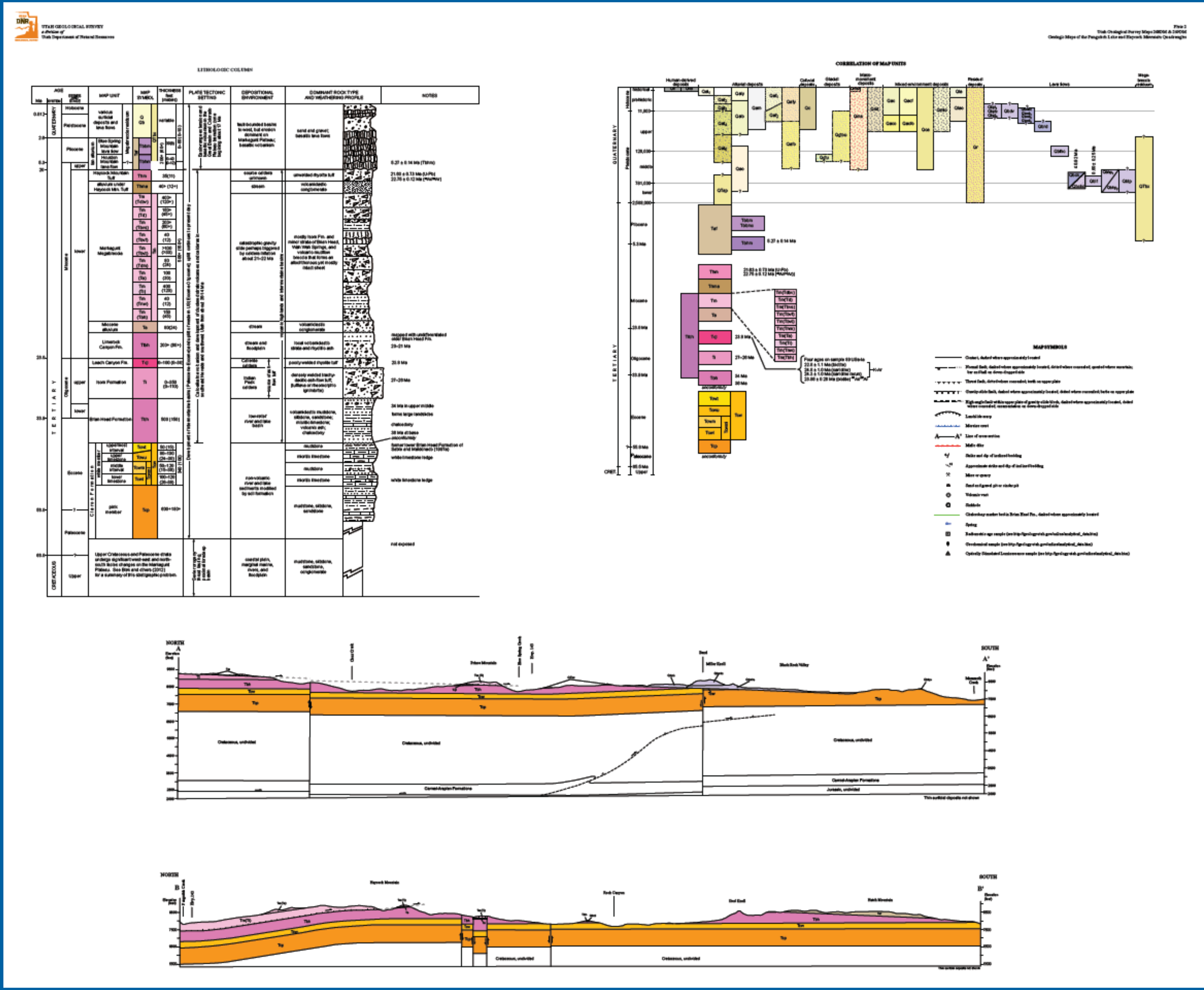
StateMap Forum

UGS – CMU EXAMPLE

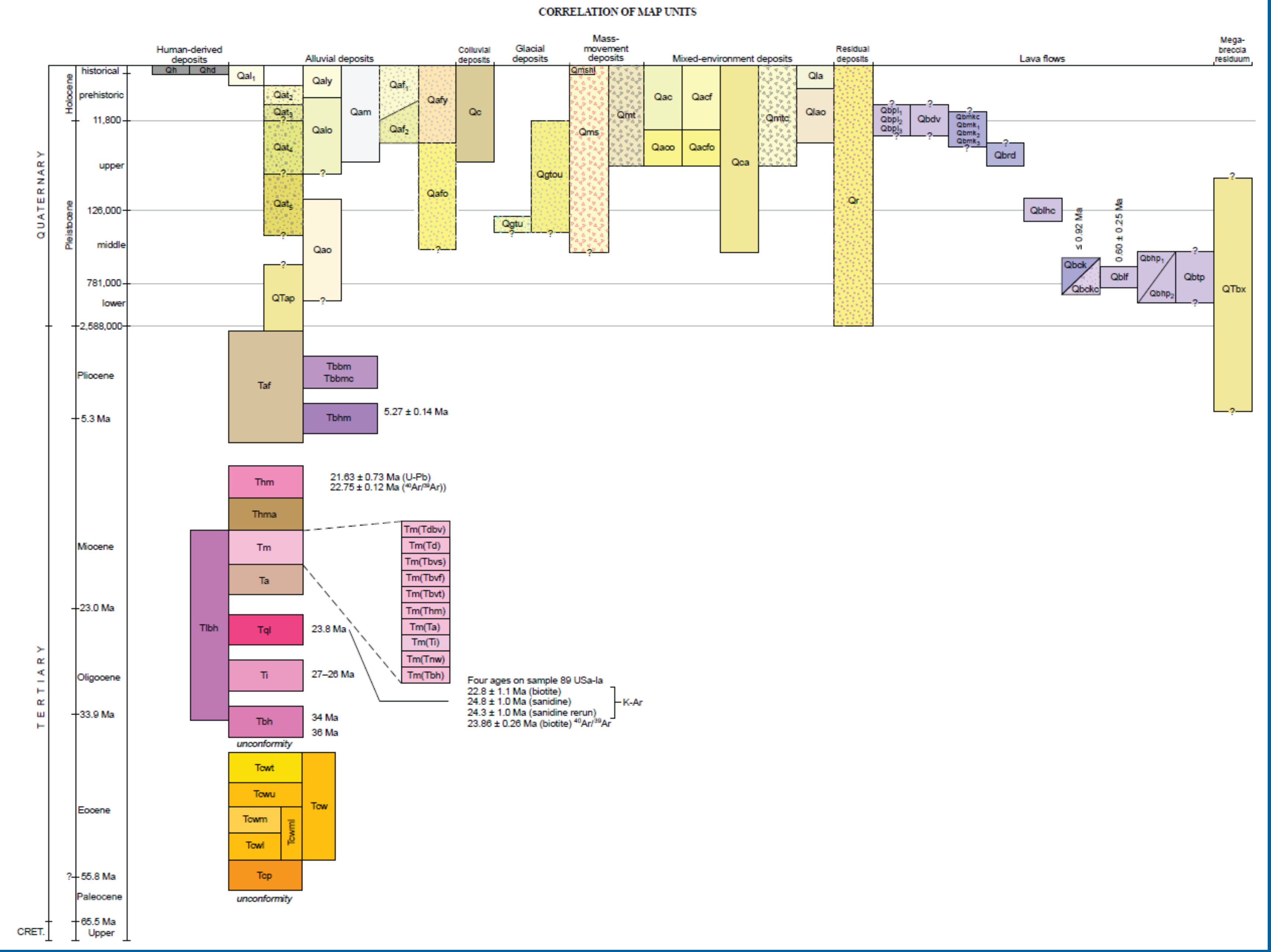
Utah Geological Survey – Panguitch Lake 30'x60' quad



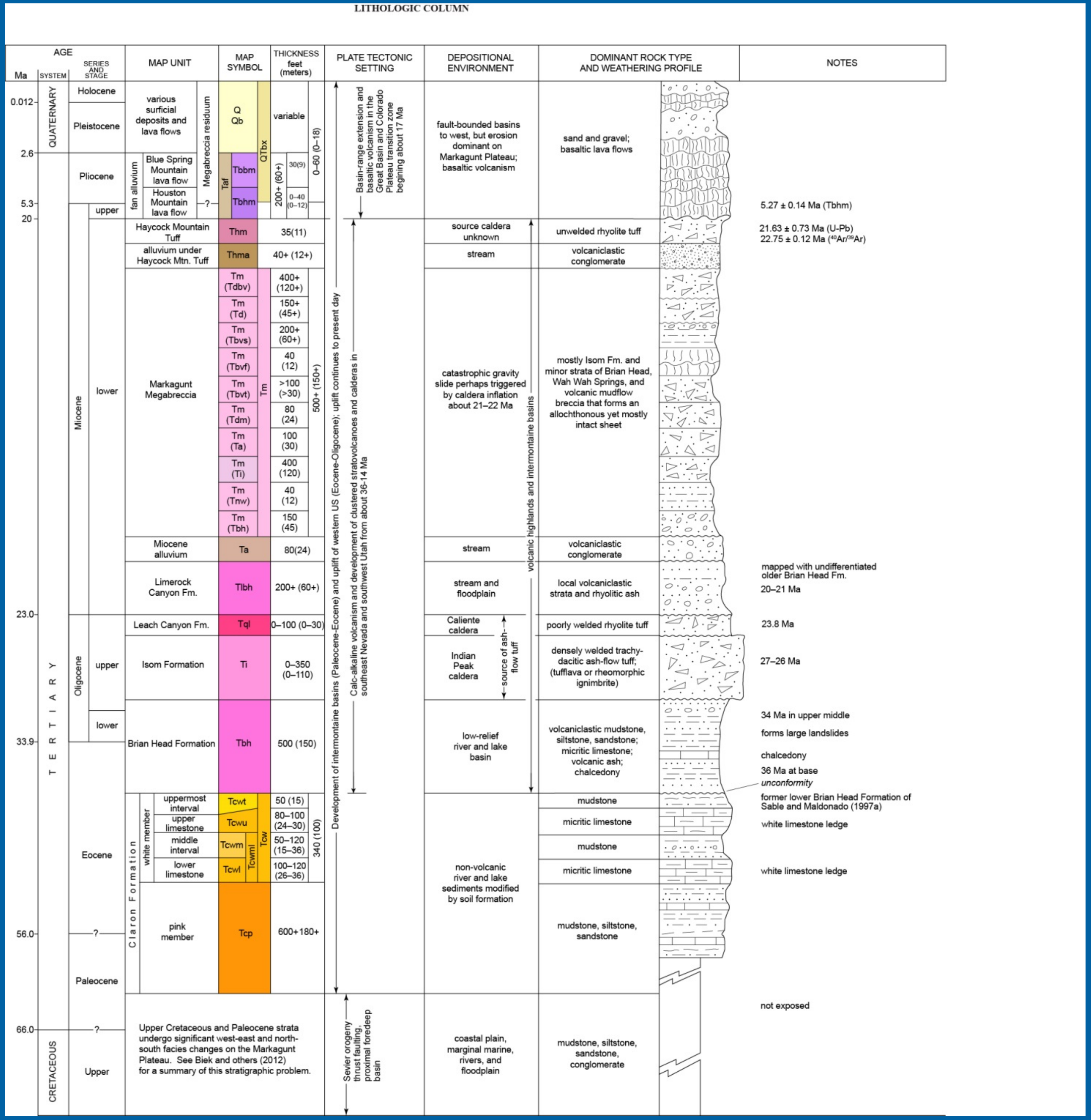
UGS – Panguitch quad – CMU plate placement



Utah Geological Survey – Panguitch Lake 7.5’ quad



UGS – CMU and Strat Column



StateMap Forum

CALIFORNIA GS – CMU EXAMPLES

ABBREVIATED EXPLANATION

Approximate stratigraphic relationships only;
see pamphlet for more detailed information

CENOZOIC — QUATERNARY — Holocene / Pleistocene

- Qhl — Lake deposits
- Ql — Older lake deposits
- Qa — Alluvium
- Qls — Landslide deposits
- Qhp — Playa deposits
- Qp — Older playa deposits
- Qc — Colluvium and alluvium
- Qhs — Sand deposits
- Qlmd — Near-shore and deltaic deposits of Lake Madeline
- Qf — Alluvial fan deposits
- Qpf — Older alluvial fan deposits
- Qta — Talus debris

VOLCANIC UNITS ASSOCIATED WITH FISSURES, CONES, OR UNCERTAIN SOURCES

- Qbb — Basalt of Brockman Flat
- Qbbv — Basaltic agglutinate and flows
- Qbma — Mafic andesite of Black Mountain
- Qscb — Basalt of Stony Creek
- QTmb — Basalt of Merrill Flat
- Qbbo — Older basalt of Brockman Flat
- Qwb — Basalt of Westwood
- Qcla — Hypersthene andesite of Crater Lake Mountain

TERTIARY — Pliocene / Miocene

- Tp — Intrusive plugs, undifferentiated
- Tlrb — Basalt of Lava Rock Reservoir
- Tsra — Mafic andesite of Stone Ranch
- Tsb — Basalt of Squaw Valley
- Tbda — Hypersthene andesite of Big Dry Lake
- Tdrb — Basalt and mafic andesite of Ducasse Reservoir
- Tssb — Basalt and andesite of Summit Spring
- Tcsb — Basalt of Camp Stanford
- Tmma — Hornblende-pyroxene andesite of Merrill Mountain
- Ticb — Basalt of Indian Creek
- Teca — Andesite of East Champs Flat
- Tcha — Andesite of Coyote Hole
- Ttb — High-alumina olivine basalt of Troxel Point
- Tncb — Basalt of North Champs Flat
- Tcra — Basalt and mafic andesite flows of Craemer Reservoir
- Timt — Tuff of Indian Mountain
- Tima — Hypersthene andesite of Indian Mountain
- Tsfb — Basalt and tuff of Silva Flat
- Ttbp — Basalt and andesite flows and pyroclastics of Troxel Point
- Ti — Intrusive basalt or mafic andesite
- Tsrm — Mafic andesite of Shinn Ranch
- Tcla — Mafic andesite of Colman Lake
- Twca — Mafic andesite of West Champs Flat
- Tlha — Mafic andesite of Little Harvey Mountain
- Trca — Mafic andesite of Roney Corral
- Tsst — Tuff of Summit Spring
- Ttlb — Basalt of Twin Lakes
- Tbca — Mafic andesite of Bridge Creek
- Tdvb — Basalt of Dixie Valley
- Tsca — Mafic andesite of Southeast Champs Flat
- Tlla — Mafic andesite of Long Lake
- Tja — Mafic andesite of Jauriga Spring
- Tmr — Rhyolite
- Tgpi — Mafic andesite plugs of Gallatin Peak
- Tjcd — Dacite of Juniper Creek
- Tsft — Tuff of Silva Flat
- Tecf — Hornblende andesite flows of East Champs Flat
- Tbfp — Mafic andesite flows and pyroclastics of Bailey Creek
- Tff — Basalt and andesite flows of Fredonyer Peak
- Thla — Andesitic flows and pyroclastics of Horse Lake Mountain
- Ttmp — Andesitic pyroclastics and flows of Tunnison Mountain
- Tcst — Tuff of Cottonwood Spring
- Tcsf — Basalt and pyroclastics of Cottonwood Spring
- Tasb — Basalt and andesite of Abbott Spring
- Tlob — Basalt of Long Reservoir
- Thrf — Basalt flows of Hagata Reservoir
- Tbha — Andesite and basalt of Bald Hills
- Tdob — Basalt of Dodge Reservoir
- Tlgt — Tuff of Loveland Gulch
- Tswt — Welded tuff of Stratton Spring
- Tstf — Intermediate tuffs and flows of Stratton Spring
- Tha — Andesite of Highway 139
- Tgf — Mafic andesite flows of Gilman Spring
- Tmaf — Mafic andesite flows
- Tasa — Mafic andesite of Al Shinn Canyon
- Tdrt — Dacite and rhyolite tuff
- Tscm — Mafic andesite of Smoke Creek
- Ttma — Mafic andesite of Tunnison Mountain
- Trpt — Tuff of Rye Patch Canyon
- Tsmp — Pyroclastics of Slate Mountain
- Tblb — Basalt of Bullard Lake
- Tbwa — Mafic andesite of Blue Water
- Tfpb — Basalt of Four Pine Spring
- Tseb — Basalt of section eleven
- Tlgb — Basalt of Loveland Gulch
- Tcsa — Mafic andesite
- Tgft — Andesite flows and silicic tuffs of Grasshopper Ridge
- Tas — Mafic andesite and basaltic vent complex
- Tbb — Basalt of Buckhorn Reservoir
- Tbft — Tuff of Bull Flat
- Tmat — Tuff interbeds
- Tvtb — Andesitic or basaltic tuff breccia
- Tamb — Andesite breccia of Antelope Mountain
- Tvg — Siliceous pebble-cobble conglomerate

MESOZOIC — CRETACEOUS

- Kgd — Hornblende-biotite granodiorite
- pKm — Schist, gneiss, and amphibolite

VOLCANIC UNITS ASSOCIATED WITH A SOURCE VOLCANO

(*Source volcano in italics*)

Heavy Mountain Shield Volcano
- Thab — Mafic andesite and basalt of Heavy Mountain
- Theb — Early basalt of Heavy Mountain
- Tjsb — Basalt of Juniper Spring

Antelope-Fox Mountain Stratovolcano
- Tama — Andesite of Antelope Mountain

Secret Valley Shield Volcano
- Tsvb — Basalt of Secret Valley
- Tsvt — Tuff and pumice lapilli tuff
- Tlfb — Basalt of Little Fredonyer Hill
- Tlrt — Tuff of Lava Rock Reservoir

Roop Mountain Shield Volcano
- Trma — Mafic andesite of Roop Mountain

Ashurst Mountain Fissure Flows
- Taob — Olivine basalt of Ashurst Mountain

Susanville Peak Fissure Flows
- Tspa — Mafic andesite of Susanville Peak

Horse Mountain Stratovolcano
- Thfp — Mafic andesite of Horse Mtn.
- Thf — Olivine basalt of Horse Mtn.
- Thlt — Tuff of Horse Lake
- Tpip — Pyroclastic rocks of Pony Mtn.
- Tppf — Mafic andesite of Pony Mtn.

Volcanic Vents of York
- Typa — Mafic andesite flows, vent facies, and intrusions of York Place

Whaleback Mountain Stratovolcano
- Twma — Mafic andesite of Whaleback Mountain

Ambrose Basalt Field
- Tarb — Basalt of Ambrose Reservoir

Hayden Hill Silicic Center
- Tdsd — Dacite of Dago Spring
- Tshd — Dacite of Snyder Hole
- Tdst — Tuff of Dago Spring
- Tart — Tuff of Anderson Ranch
- Thrl — Lahar of Hatfield Reservoir
- Tpct — Tuff of Preston Canyon

McDonald Peak-Three Peaks Stratovolcano Center
- Tmrf — Basalt flows of Mendiboure Reservoir
- Tpsf — Mafic andesite flows of Poulsen Spring
- Ttpf — Basaltic flows and pyroclastics of Three Peaks
- Ttpn — Basalt of Three Peaks North volcano
- Ttpw — Basalt of Three Peaks West volcano
- Ttps — Basalt of Three Peaks South volcano
- Tub — Basalt from small unnamed volcano
- Tomb — Basalt from Olson Mountain volcano
- Tsff — Basalt flows of Skeleton Flat
- Tmst — Tuff of Moran Siding

Cherry Mountain Stratovolcano
- Tmai — Mafic andesite intrusives
- Tcma — Mafic andesite of Cherry Mountain

Lava Peak
- Tlpa — Mafic andesite of Lava Peak

Logan Mountain
- Tlma — Mafic andesite of Logan Mountain

Campbell Mountain Shield Volcano
- Tca — Mafic andesite of Campbell Mountain

Spanish Springs Shield Volcano
- Tsbu — Basalt of Spanish Springs
- Tsbl — Basalt, mafic andesite, and tuff of Spanish Springs

Observation Peak Stratovolcano
- Topa — Andesite of Observation Peak
- Tscb — Basalt of Smoke Creek

Cave Mountain Volcano
- Tcab — Mafic andesite and basalt of Cave Mountain

Dow Butte Volcano
- Tdba — Andesite of Dow Butte

Steel Post Reservoir Volcano
- Tfrf — Mafic andesite and basalt flows of Fredonyer Res.
- Tbrb — Basalt of Branham Reservoir
- Tspv — Andesitic and basaltic pyroclastics, flows, and intrusions of Steel Post Res.

South Madeline Mtn. Stratovolcano
- Tsma — Mafic andesite flows and pyroclastics of South Madeline Mountain

Black Mountain Stratovolcano
- Tbmb — Basalt and mafic andesite of Black Mountain

Cottonwood Mtns. Shield Volcano
- Tcoa — Mafic andesite of Cottonwood Mountains

Whittinger Mountain Stratovolcano
- Twmf — Andesite and basalt flows and pyroclastics of Whittinger Mountain
- Tdva — Mafic andesite of Dry Valley Ridge

Snowstorm Mountain Shield Volcano
- Taf — Andesite flow
- Tsrf — Andesitic flows and pyroclastics
- Tsri — Mafic andesite of Saddle Rock
- Tsu — Mafic andesite of Snowstorm Mountain
- Ttti — Mafic andesite dikes, sills, and plugs of Two Tree
- Tsl — Andesite and mafic andesite flows
- Tafi — Pyroxene andesite
- Tsi — Basalt and mafic andesite dikes and plugs

Juniper-Dill-Twin Buttes
- Ttba — Mafic andesite of Twin Buttes
- Tjrb — Basalt and mafic andesite of Juniper Ridge

- Tt — Tufa deposits

Slate Mountain Fissure Flow
- Tsmf — Andesite of Slate Mountain

South Knob Volcano
- Tskb — Basalt and mafic andesite of South Knob

Anderson Mountain Stratovolcano
- Taaf — Andesite flows and pyroclastics of Anderson Mountain

West Ravendale Mtn.Sheild Volcano
- Twra — Andesite of West Ravendale Mountain
- Tfp — Andesite flows and pyroclastics

Spanish Springs Peak Volcano
- Tssa — Mafic andesite of Spanish Springs Peak

Shinn Mountain Stratovolcano
- Tshv — Vent facies of Shinn
- Tsha — Mafic andesite of Shinn Mountain

Five Springs Mountain Stratovolcano
- Tfsa — Mafic andesite of Five Springs Mountain

Rush Creek Mountain Stratovolcano
- Trua — Mafic andesite of Rush Creek Mountain

Sugarloaf Shield Volcano
- Tsub — Basalt of Sugarloaf

Button Mountain Shield Volcano
- Tbua — Mafic andesite of Button Mountain

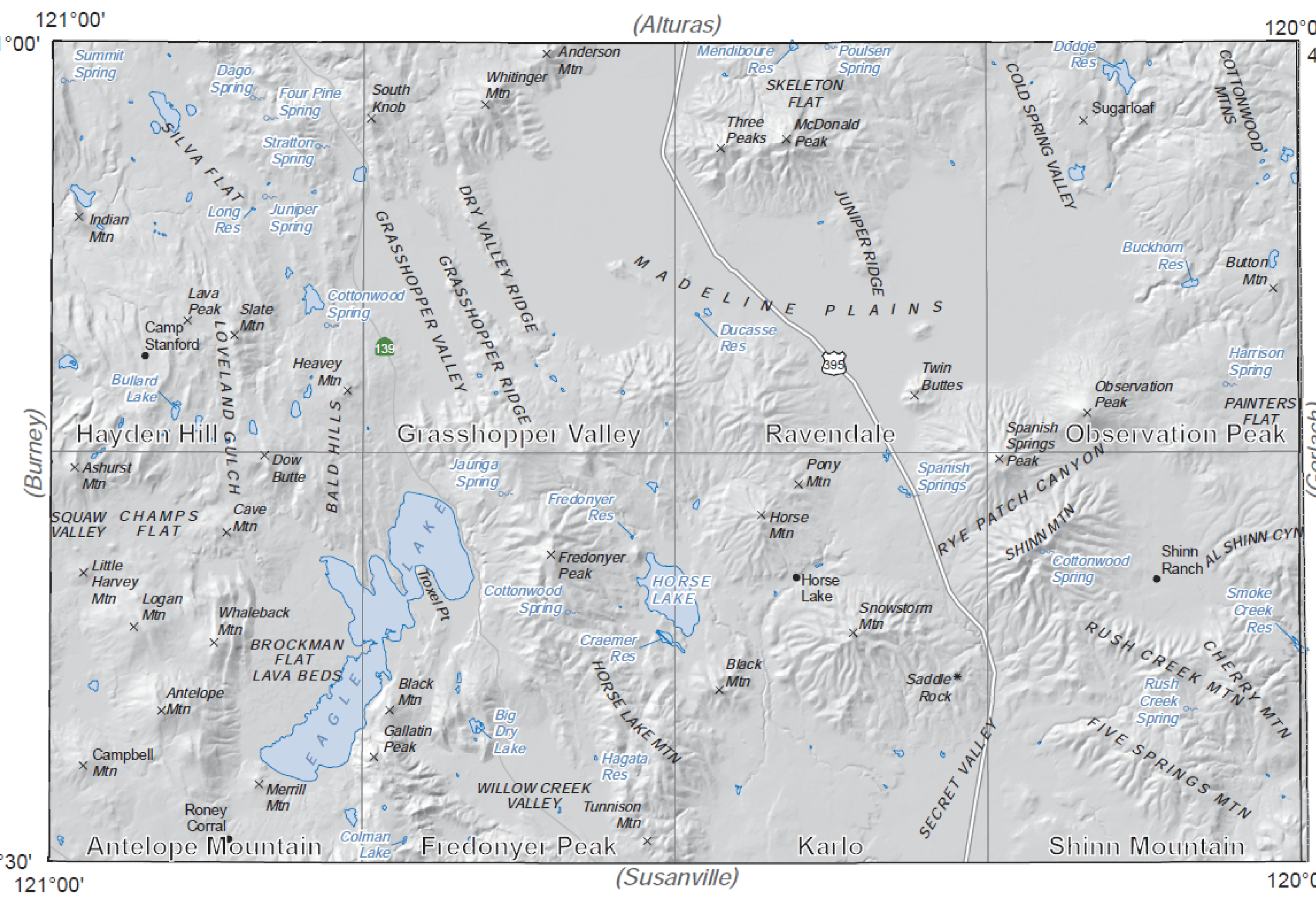
SYMBOL EXPLANATION

- Contact between map units - Solid where accurately located, dashed where approximately located; dotted where concealed; queried where uncertain.
- Fault - Solid where accurately located, dashed where approximately located; short dash where inferred; dotted where concealed; queried where uncertain. Arrow and number indicate dip direction and angle of fault plane. Ball and bar on downthrown side of high-angle fault. Relative horizontal movement shown by arrows parallel to fault.
- Dike - Arrow and number indicate dip direction and angle.

Strike and dip of beds:
- Inclined
- Horizontal

Strike and dip of foliation:
- Inclined

- Arrows on landslides indicate direction of movement.
- Volcanic Center - Vent facies of reddened scoria, cinders, agglutinate, bombs, and agglomerate intruded by co-eruptive dikes and plugs.
- Phreatomagmatic center
- Radiometric Age - Sample location and number. Age presented in pamphlet with unit description.



ABBREVIATED INDEX TO GEOLOGIC SOURCE DATA

See pamphlet for complete list of references

Antelope Mountain 15-Minute Quadrangle
Grose, T.L.T., 1991

Fredonyer Peak 15-Minute Quadrangle
Grose, T.L.T., and Youngkin, M.T., 1991

Grasshopper Valley 15-Minute Quadrangle
Grose, T.L.T., and Abrams, R.H., 1993

Hayden Hill 15-Minute Quadrangle
Grose, T.L.T., Hazlett, D.P., Tuppan, E.J., and Bean, S.M., 1993

Karlo 15-Minute Quadrangle
Grose, T.L.T., and Abrams, R.H., 1991.

Observation Peak 15-Minute Quadrangle
Wagner, D.L., and Saucedo, G.J., 1993

Ravendale 15-Minute Quadrangle
Grose, T.L.T., and Saucedo, G.J., 1993

Shinn Mountain 15-Minute Quadrangle
Wagner, D.L., and Saucedo, G.J., 1991

Preliminary Geologic Map available from:
http://www.conservation.ca.gov/cgs/rghm/rgm/preliminary_geologic_maps.htm

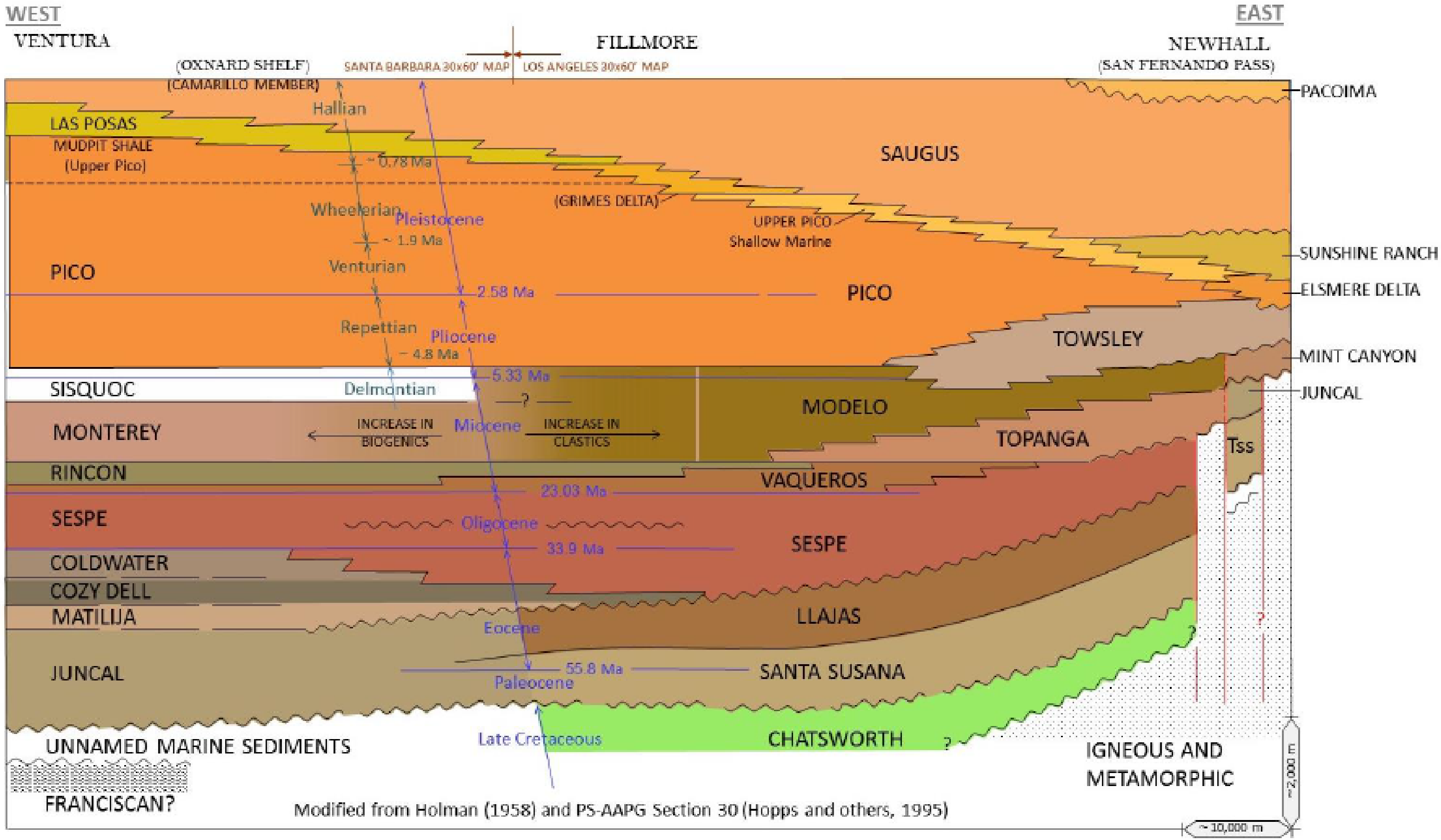


Figure A1. Diagrammatic longitudinal cross-section of the Ventura basin showing general relations of stratigraphic units.

ABBREVIATED EXPLANATION

Approximate stratigraphic relationships only; see pamphlet for more detailed information

CENOZOIC — QUATERNARY — Holocene, Pleistocene

- af — Artificial fill
- Qw — Wash deposits
- Qe — Eolian deposits
- Qa — Alluvium
- Qf — Alluvial fan deposits
- Qb — Beach deposits
- Qls — Landslide deposits *(Only selcted, larger landslides shown)*

Young alluvium
- Qya — Undivided
- Qya_4 — Unit 4
- Qya_3 — Unit 3
- Qya_2 — Unit 2
- Qya_1 — Unit 1

Young alluvial fan deposits
- Qyf — Undivided
- Qyf_5 — Unit 5
- Qyf_3 — Unit 3
- Qyf_2 — Unit 2
- Qyf_1 — Unit 1

Old alluvium
- Qoa — Undivided
- Qoa_3 — Unit 3
- Qoa_2 — Unit 2
- Qoa_1 — Unit 1

Old alluvial fan deposits
- Qof — Undivided
- Qof_4 — Unit 4
- Qof_3 — Unit 3
- Qof_2 — Unit 2
- Qof_1 — Unit 1

- Qoft — Old alluvial fan deposits on wave-cut surface
- Qom — Old Shallow marine deposits on wave-cut surface
- Qoab — Old alluvium and breccia
- Qob — Old breccia

Very old alluvium
- Qvoa — Undivided
- $Qvoa_2$ — Unit 2
- $Qvoa_1$ — Unit 1

Very old alluvial fan deposits
- Qvof — Undivided
- $Qvof_2$ — Unit 2

Ventura Basin

- Qpa — Pacoima Formation

Saugus Formation
- QTs/Qs — Undivided
- QTsu — Upper member
- Qsc — Camarillo member
- Qsv — Volcanic breccia
- QTsg — Conglomerate
- QTsr — Sunshine Ranch Member
- QTsru — upper facies
- QTsrl — lower facies
- QTse — Elsmere Canyon delta plain facies

- Qlp — Las Posas Formation

Pico Formation
- QTp — Undivided
- QTpg — Grimes Canyon deltaic facies
- QTpcu — Coarse-grained upper facies
- QTpms — Mudpit shale member
- QTpc — Sandstone and conglomerate

Los Angeles Basin

- Qsp — San Pedro Formation
- QTi — Ingelwood Formation
- QTms — Sedimentary rocks of the Pacific Palisades area

Fernando Formation
- QTfu — Upper Member
- QTfuc — pebbly sandstone
- QTfuf — fossiliferous
- QTfl — Lower Member
- QTflc — conglomerate

Soledad Basin and San Andreas Fault Zone

Juniper Hills Formation
- QTjh — Undifferentiated
- QTjhc — Clay shale member
- QTjhr — Red arkose member
- QTjhm — Mixed clast member

- Tcs — Castaic Formation, undivided

Punch Bowl Formation
- Tpbc — Clay shale member
- Tpbv — Volcanic clast member

Mint Canyon Formation
- Tmc — Undivided
- Tmcd — Lacustrine deltaic (foreset) facies
- Tmcl — Lacustrine bottomset facies
- Tmcm — Lacustrine and lake-marginal fluvial facies

Tick Canyon Formation
- Ttk — Undivided
- Ttkc — Conglomerate

TERTIARY — Pliocene, Miocene, Oligocene, Eocene, Paleocene

Towsley Formation
- Tw — Undivided
- Tws — Siltstone
- Twc — Conglomerate
- Twhc — Hasley Conglomerate Member

Western Los Angeles Basin-Continental Borderland

Monterey Shale
- Tmt — Undivided
- Tmtd — Deformed

Trancas Formation
- Tr — Undivided
- Tra — Quartz-bearing calcarenites

- Tz — Zuma Volcanics

Modelo Formation
- Tm — Undivided
- Tmsu — Upper sandstone
- Tm_5 — Member 5
- Tm_4 — Member 4
- Tm_3 — Member 3
- Tm_2 — Member 2
- Tm_1 — Member 1
- Tmd — Diatomaceous shale
- Tms — Sandstone
- Tmb — “Burnt shale”

- Tt — Topanga Group, undivided
- Tco — Conejo Volcanics, undivided

Topanga Group
- Tt_4 — Oat Mountain unit 4
- Tt_3 — Oat Mountain unit 3
- Tt_2 — Oat Mountain unit 2
- Tt_1 — Oat Mountain unit 1

Puente Formation
- Tpn — Undivided
- Tpsl — Siltstone
- Tpsh — Siliceous shale
- Tpds — Diatomaceous shale
- Tpss — Sandstone
- Tpnsc — Sycamore Canyon Member
- Tpnscc — conglomerate bed
- Tpny — Yorba Member
- Tpnsq — Soquel Member

Topanga Group *(eastern Santa Monica Mtns.)*
- Ttss — Sandstone
- Ttsl — Siltstone
- Ttcg — Conglomerate
- Ttb — Intrusive and extrusive volcanic rocks

Conejo Volcanics *(along north flank of Santa Monica Mtns.)*
- Tcode — Dacite-bearing epiclastic lenses
- Tcod — Dacite-bearing upper zone
- Tcoa — Andesitic central zone
- Tcoaf — Andesitic flows
- Tcoaa — Andesitic agglomerate
- Tcoab — Andesite breccia
- Tcob — Basaltic lower zone, basalt and andesitic basalt
- Tcobf — Basalt and andesitic basalt, basalt flows
- Tcobb — Basalt and andesitic basalt, basaltic breccia
- Tcop — Basaltic lower zone, pillow basalt
- Tcobz — Basaltic lower zone, basaltic sand

Conejo Volcanics *(upper plate of Malibu Bowl detachment fault)*
- Tcom — Malibu Bowl Tongue
- Tcos — Solstice Canyon Tongue
- Tcor — Ramera Canyon Tongue

Calabasas Formation *(central and western Santa Monica Mtns.)*
- Tcb — Undivided
- Tcbvc — Volcanic conglomerate
- Tcbs — Stokes Canyon Breccia Member

Calabasas Formation *(upper plate of Malibu Bowl detachment fault)*
- Tcbmp — Mesa Peak Breccia Member
- Tcbn — Newell Sandstone Member
- Tcbd — Dry Canyon Sandstone Member
- Tcbl — Latigo Canyon Breccia Member
- Tcbe — Escondido Canyon Shale Member

- Ti — Intrusive rocks, undivided
- Tid — Intrusive rocks, dacite
- Tia — Intrusive rocks, andesitic
- Tib — Intrusive rocks, basaltic
- Tim — Mixed rocks

Topanga Canyon Formation
- Ttc — Undivided
- Ttcb — Big Sycamore Member
- Ttce — Encinal Member
- Ttcc — Cold Creek Member
- Ttcf — Fernwood Member
- Ttcs — Saddle Peak Member

Vasquez Formation *(Soledad basin and San Andreas fault zone)*
- Tvz — Undivided
- Tvza — Andesitic volcanic rocks
- Tvzb — Basaltic volcanic rocks
- Tvzc — Non-marine conglomerate
- Tvzs — Sedimentary rocks

Rincon Formation
- Trn — Marine shale and mudstone

Vaqueros Formation
- Tv — Undivided

Vaqueros Formation *(central and western Santa Monica Mtns.)*
- Tvn — San Nicholas Member
- Tvd — Danielson Member

Sespe Formation
- Tsp — Piuma Member
- Ts — Undivided

(Topatopa Mtns. and eastern Santa Ynez Range)
- Tcw — Coldwater Formation
- Tcz — Cozy Dell Formation

Matilija Formation
- Tma — Undivided
- Tmasl — Siltstone and shale

Llajas Formation
- Tl — Undivided
- Tlc — Conglomerate

Santa Susana Formation
- Tss — Undivided
- Tssl — Limestone

- Tlv — Las Virgenes Formation

Simi Conglomerate
- Tsi — Undivided
- Tsic — Conglomeratic member
- Tsis — Shale member
- Tsia — Sandstone member

San Gabriel Mountains and Eastern Santa Monica Mountains

- Tj — Juncal Formation

MESOZOIC — CRETACEOUS, JURASSIC, TRIASSIC

Tuna Canyon Formation *(central and western Santa Monica Mtns.)*
- Kt — Undivided
- Kte — Informal member 'e'
- Ktd — informal member 'd'
- Ktc — informal member 'c'
- Ktb — informal member 'b'

- Ktr — Trabuco Formation
- Kc — Chatsworth Formation
- Kp — Pelona Schist
- Kgr — Granitic rocks
- Kto — Tonalite
- Kgrd — Granodiorite
- Ktowd — Tonalite (Wilson Diorite of Miller, 1934)
- Kgl — Leucocratic granodiorite
- Ktoqd — Tonalite and quartz diorite
- Kgd — Granodiorite

Santa Monica Slate *(eastern Santa Monica Mtns.)*
- Jsm — Undivided
- Jsms — Spotted slate
- Jsmp — Phyllite

- Jeg — Echo granite

- Mzh — Hornblendite
- Mzm — Mylonite
- Mzdg — Diorite gneiss
- Mzdbh — Biotite-hornblende diorite
- Mzdhb — Hornblende-biotite diorite
- Mzqdb — Biotite-quartz diorite
- Mzmg — Biotite monzogranite
- Mzmgp — Porpyritic biotite monzogranite
- Mzd — Biotite-hornblende quartz diorite, diorite, and gabbro
- Mzhd — Hornblende diorite
- Mza — Alaskite

Mount Lowe Intrusive Suite
- Trlgd — Undivided
- Trlgb — Biotite-orthoclase facies
- Trlgdp — Porphyritic facies
- Trlgdh — Orthoclase-hornblende facies
- Trlgm — Metamorphosed

- Trhdg — Hornblende diorite gabbro

PALEOZOIC

- MzPzsp — Serpentinite
- Pzp — Placerita Formation
- Pzgn — Gneiss complex

PROTEROZOIC

Anorthosite-gabbro complex of Oakeshott (1958)
Unit is composed of sub-units mapped and described by Carter (1980) including:
- Pan — Anorthosite
- Pagb — Anorthosite with gabbro
- Psy — Syenite
- Pfgb — Ferro-gabbro
- Plgb — Leucogabbro
- Pjgb — Jotunitic gabbro
- Pjgba — Jotunite-norite-gabbro-diorite
- Pggn — Gabbroic to anorthositic gneiss
- Pgb — Gabbro
- Phbgb — Hornblende bytownite gabbro
- Pgbia — Anorthosite inclusion-rich gabbro
- Pgn — Gneiss
- Psy+Pmgn — Syenite and Mendenhall Gneiss
- Pmgn — Mendenhall Gneiss

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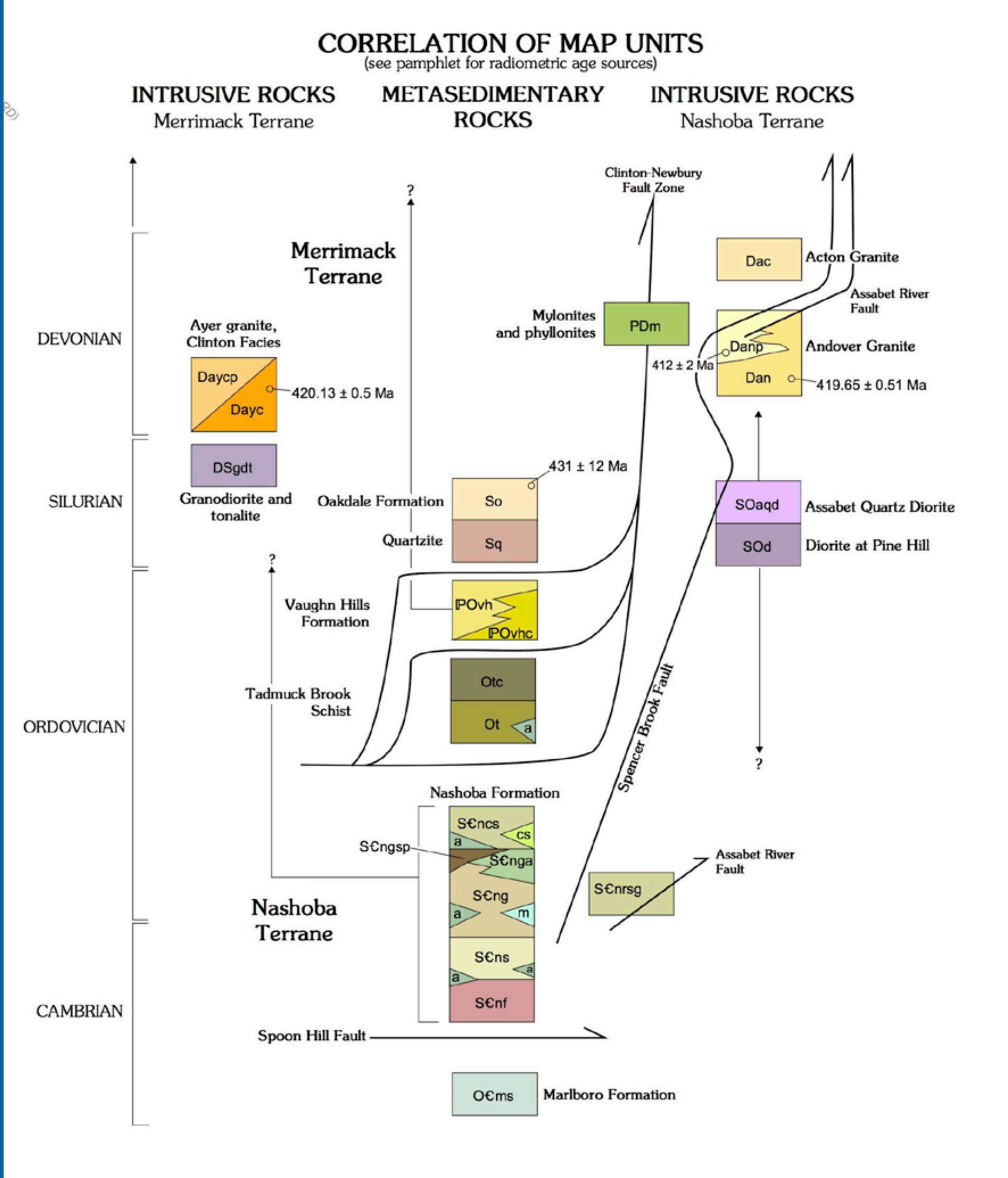
MASSACHUSETTS GS – CMU EXAMPLE

Massachusetts GS – CMU



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ILLINOIS STATE GS – CMU EXAMPLE

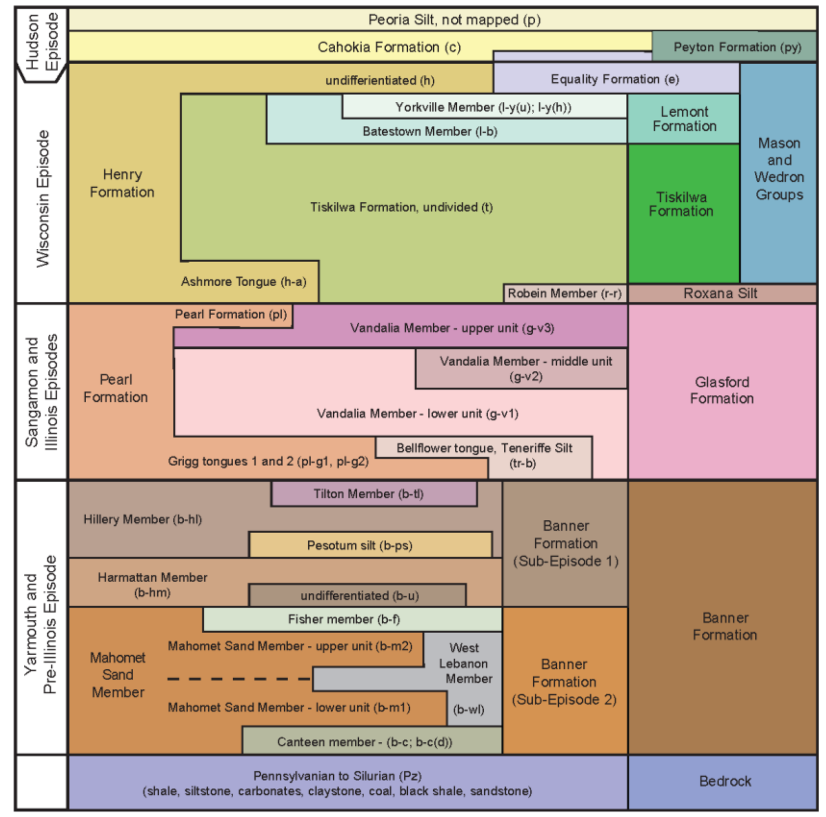
ILLINOIS STATE GEOLOGICAL SURVEY

FROM: SURFICIAL GEOLOGY MAPS OF THE RANTOUL AND GIFFORD 7.5-MINUTE QUADRANGLES

QUATERNARY DEPOSITS

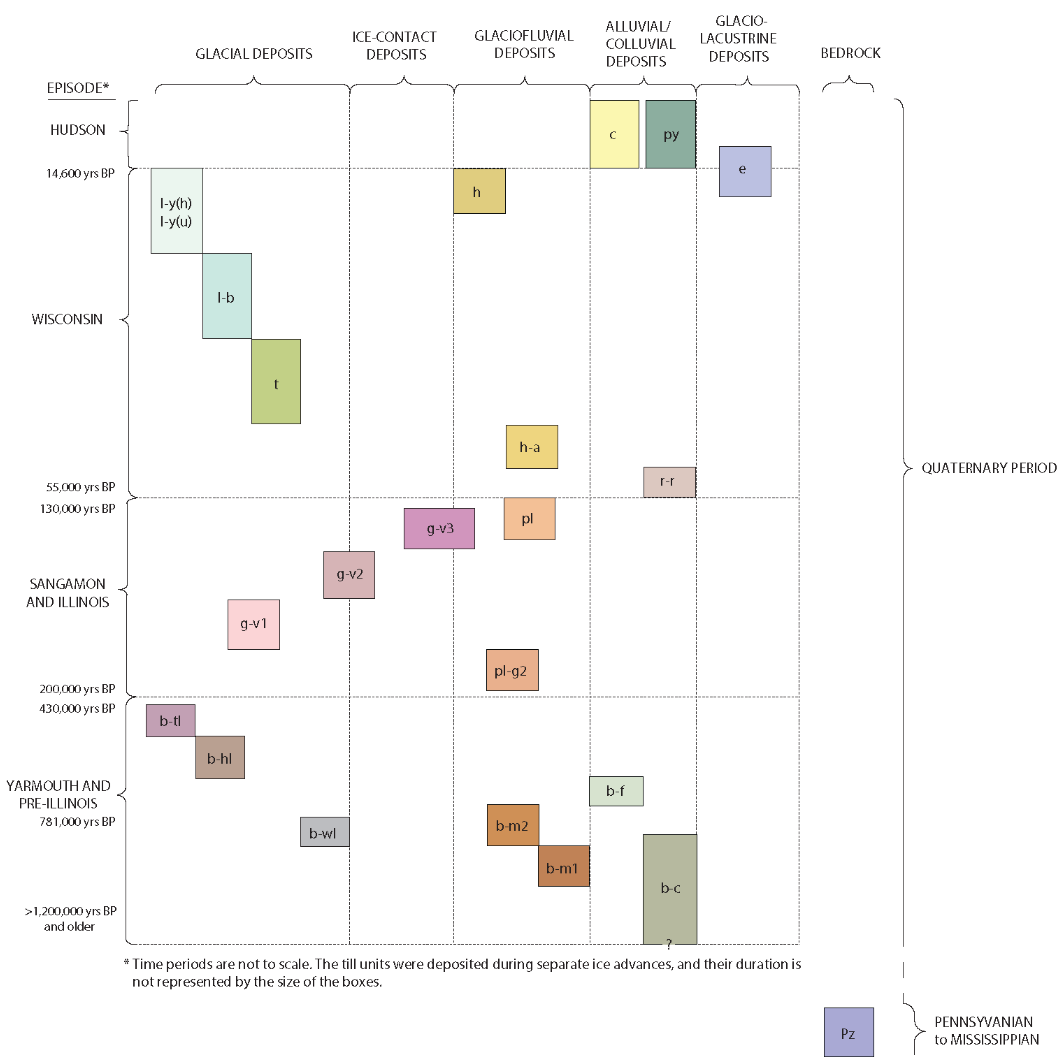
Description	Unit	Interpretation[1]
HUDSON EPISODE (~14,600 years before present (B.P.) to today)[2]		
Areas of disturbed or removed geologic materials; texture ranges from clay to gravel; may include waste or other rubble	Disturbed ground dg	**Deposits disturbed or modified by human activity** in gravel pits, landfills, and other excavations
Sand, silt, clay, and gravel; massive to stratified; locally oxidized; calcareous; poorly sorted; contains beds of organic material; up to 15 feet thick	Cahokia Formation (undivided) c	**Alluvium (stream deposits)** mapped in floodplains along creeks and drainage ditches and in fan-shaped deposits where streams emerge from the moraines onto lower gradient slopes
Diamicton; massive to crudely stratified; sandy loam to silty clay; yellowish brown to gray; calcareous; similar texture and composition to the materials lying upslope; 5 to 20 feet thick	Peyton Formation py	**Post-glacial slopewash and debris flow deposits** lying on nearly flat to moderately inclined slopes along the western edge of the Illiana Morainic System
HUDSON AND WISCONSIN EPISODES (~23,000– ~12,000 years B.P.)[2]		
Silt and clay; stratified to massive; grayish brown; calcare-ous; may contain beds of diamicton, sand, or gravel; 5 to 20 feet thick	Equality Formation e	**Proglacial and postglacial lake deposits** fills depressions or low-lying areas on land surface
WISCONSIN EPISODE (~55,000– ~23,000 years B.P.)[2]		
Sand and gravel; contains some beds of silt; brown to yellowish brown; calcareous; well to poorly sorted; up to 25 feet thick	Henry Formation h	**Glaciofluvial sediment (outwash)** deposited by glacial meltwater in streams and rivers that drained the former ice sheets
Diamicton; silt loam to silty clay texture; stiff to very stiff; calcareous; on steep-sided hillocks and hollows; 10 to 30 feet thick	Yorkville Member, Lemont Formation (hummocky facies) l-y(h)	**Till and ice-contact sediment** derived directly from glacial ice; surface topography is hummocky; formed by uneven downwasting of supraglacial sediment or collapse of ice surface over subglacial drainage channel; present in areas trending from southwest to northeast
Diamicton; silt loam to silty clay; gray to brown; stiff to very stiff; calcareous; contains beds of sand and gravel; found on moderately sloping to rolling terrain; 10 to 30 feet thick	Yorkville Member, Lemont Formation (undulating facies) l-y(u)	**Till and ice-contact sediment** derived directly from glacial ice; surface topography is undulating; present east of the western edge of the Illiana Morainic System
Diamicton or sand, silt and clay; diamicton is sandy loam to silt loam; gray to grayish brown; calcareous; stiff to very stiff; contains beds of sand, silt, and gravel; 25 to 75 feet thick	Batestown Member, Lemont Formation l-b	**Till and ice-marginal sediment** forms end moraines and ice disintegration topography present west beyond the Illiana Morainic System; may include hummocky moraine, deposits in sediment- and ice-dammed lakes, and outwash
Diamicton; loam; grayish brown to reddish gray; calcareous; very stiff; 10 to 50 feet thick	Tiskilwa Formation (cross section only) t	**Till and ice-marginal sediment** derived directly from glacial ice; encountered in the subsurface only, underlying the Batestown Member
Sand and gravel with silt; pebbly and cobbly; brown to grayish brown; calcareous; well to poorly sorted; 10 to 20 feet thick	Ashmore Tongue, Henry Formation (cross section only) h-a	**Glaciofluvial sediment (outwash)** deposited by glacial meltwater in streams and rivers that flowed from an advancing Tiskilwa ice margin; not consistently differentiable from underlying deposits correlated to the Pearl and Glasford Formations
Silt and fine sand; massive to crudely stratified; very dark grayish brown; leached; may contain humus, peat, wood, and/or fossil snails: 5 to 15 feet thick	Robein Member, Roxana Silt (cross section only) r-r	**Proglacial eolian or lacustrine sediment** containing a weakly developed paleosol (Farmdale Geosol) deposited on a former land surface that was well to poorly drained; includes silty slopewash sediment where deposited on or near slopes; originally widespread
SANGAMON AND ILLINOIS EPISODES (~200,000–130,000 years B.P.)		
Fine to coarse sand with gravel; yellowish brown to grayish brown; calcite cemented in places; incised into the Vandalia Member; upper part weathered in profile of Sangamon Geosol; 30 to 150 feet thick	Pearl Formation (cross section only) pl	**Glaciofluvial sediment (outwash)** deposited by glacial meltwater in streams and rivers that flowed from former Vandalia ice margins; contains the Sangamon Geosol in the upper part except where eroded
Diamicton, sand and gravel, and silt and clay; interstratified; includes sediments previously assigned to the Berry Clay, Radnor Member, Toulon Member, or Roby Silt; upper part weathered in profile of Sangamon Geosol; 30 to 90 feet thick	Vandalia Member, Glasford Formation upper unit (cross section only) g-v3	**Proglacial or ice-contact sediment** deposited by glacial meltwater or sediment gravity flows (debris flows) along or in front of former Vandalia ice margins; contains the Sangamon Geosol in the upper part except where eroded
Diamicton, sand and gravel, and silt and clay; interstratified; includes sediments previously assigned to the Radnor Member, Toulon Member, or Roby Silt; 15 to 130 feet thick	Vandalia Member, Glasford Formation middle unit (cross section only) g-v2	**Subglacial or ice-contact sediments** derived directly from glacial ice or deposited by glacial meltwater; deposition is interpreted to have occurred within an area of fast-flowing ice, possibly an ice stream; associated with the deglacial phase of the Illinois Episode glaciation
Diamicton; silt loam to loam; grayish brown; calcareous; contains beds of sand, silt, and gravel; hard; 5 to 70 feet thick	Vandalia Member, Glasford Formation lower unit (cross section only) g-v1	**Till and associated sediment** derived directly from glacial ice; nearly continuous deposit, region-ally
Sand and gravel; pebbly; grayish brown; contains some beds of silt or diamicton; calcareous; well to moderately well sorted; 10 to 50 feet thick	Grigg tongue 2, Pearl Formation (cross section only) pl-g2	**Fluvial and glaciofluvial sediment** deposited in front of advancing Vandalia ice margins, or outflow from lakes ponded behind these ice margins; not consistently differen-tiable from underlying deposits of the Mahomet Sand Member where intervening tills are absent
PRE-ILLINOIS EPISODES (>1,000,000–430,000 years B.P)[3] Sub-Episode 1		
Diamicton; silt loam to loam; grayish brown; calcareous; hard upper part weathered in profile of Yarmouth Geosol; 5 to 15 feet thick	Tilton Member, Banner Formation (cross section only) b-tl	**Till and ice-marginal sediment** derived directly from glacial ice; in a few places may contain evidence of Yarmouth Geosol weathering profile (i.e., oxidation, leaching of primary carbonate minerals, and pedogenic features) in upper 10 feet
Diamicton; loam; reddish brown to grayish brown; calcareous; contains beds of sand, silt, or gravel; hard; may contain material eroded from underlying deposits (e.g., wood and peat); upper part weathered in profile of Yarmouth Geosol; 5 to 90 feet thick	Hillery Member, Banner Formation (cross section only) b-hl	**Till and ice-marginal sediment** derived directly from glacial ice; in a few places contain evidence of Yarmouth Geosol weathering profile (i.e., oxidation, leaching of primary carbonate minerals, and pedogenic features) in upper 10 feet
Sub-Episode 2		
Sand, diamicton, and silt; sandy loam to silty clay loam; black to greenish gray; leached to weakly calcareous; hard; may contain peat, wood, and/or snail shells; 10 to 40 feet thick	Fisher member, Banner Formation (cross section only) b-f	**Fluvial or lacustrine sediment** deposited on a former floodplain of a river flowing in the Mahomet Bedrock Valley; the land surface was poorly drained and occasion-ally covered by overbank deposits or slopewash
Sand and gravel; brown to grayish brown; contains some beds of silt; calcareous; well to moderately well sorted; 10 to 50 feet thick	Mahomet Sand Member, Banner Formation, upper unit (cross section only) b-m1	**Glaciofluvial sediment (outwash)** deposited in the Mahomet Bedrock Valley by streams flowing in front of advancing/retreating ice margins located to the northeast of the map area
Diamicton; sandy loam to clay loam; brown to pinkish gray; calcareous; contains intervals of sand and gravel or silt and clay; hard; 5 to 30 feet thick	West Lebanon Member[4] Banner Formation (cross section only) b-wl	**Till and associated sediment** derived directly from glacial ice flowing into the area from a northern or eastern ice source
Sand and gravel; pebbly to cobbly; brown; locally contains beds of silt or diamicton; calcareous; well to moderately well sorted; 20 to 100 feet thick	Mahomet Sand Member, Banner Formation lower unit (cross section only) b-m2	**Glaciofluvial sediment (outwash)** deposited in the Mahomet Bedrock Valley by streams flowing in front of advancing ice margin located to the northeast of the map area
PRE-ILLINOIS EPISODE AND OLDER		
Diamicton, silt, clay, and sand and gravel; crudely stratified; olive brown; calcareous or leached; contains a higher proportion of fragments of the local bedrock; 10 to 40 feet thick	Canteen member, Banner Formation (cross section only) b-c	**Fluvial and lacustrine sediment, colluvium, or weathered bedrock** that accumulated in the Mahomet Bedrock Valley prior to the latest pre-Illinois Episode glaciation
Shale, siltstone, claystone, and underclay; upper part is soft, fissile, and fractured; locally contains siderite nodules, plant macrofossils, and slickenslides	Pennsylvanian or Mississippian bedrock (cross section only) Pz	**Bedrock;** includes strata having a marine or terrestrial origin that form an irregular surface with valleys and uplands, shaped by multiple cycles of erosion from water and glacial ice

[1] Generally, the Wisconsin Episode sediments mapped at the land surface are overlain by 1 to 5 feet of wind-deposited silt (loess).
[2] The time periods for the Wisconsin Episode and the Hudson Episode are reported as calibrated radiocarbon years and can be directly compared to calendar years before 1950 (Stuiver et al. 2005).
[3] The subdivision of sediments assigned to the pre-Illinois Episode is discussed in Stumpf and Dey (2012).
[4] The West Lebanon "Till" Member was previously only mapped in western Indiana by Bleuer (1976).

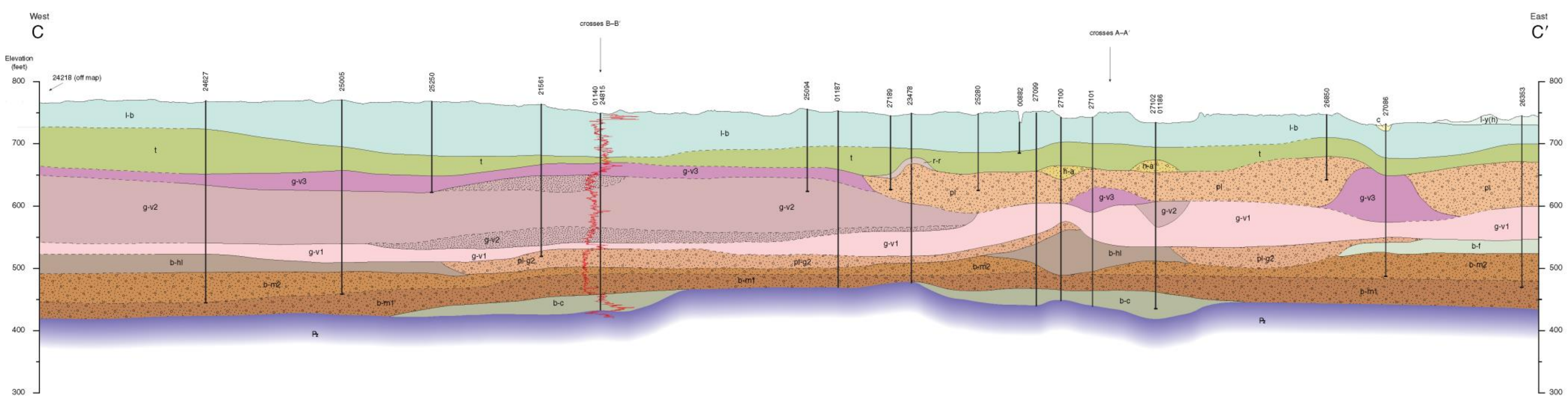


Schematic vertical and intertonguing relationships among the lithostratigraphic units for Quaternary sediments in east-central Illinois.

CORRELATION OF MAPPING UNITS



* Time periods are not to scale. The till units were deposited during separate ice advances, and their duration is not represented by the size of the boxes.



Geologic cross setcion across the Mahomet Bedrock Valley in east-central Illinois.

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QUESTIONS AND DISCUSSION

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