Introduction to the Landers earthquake (“strike-slip”) pre-rupture mapping assignment

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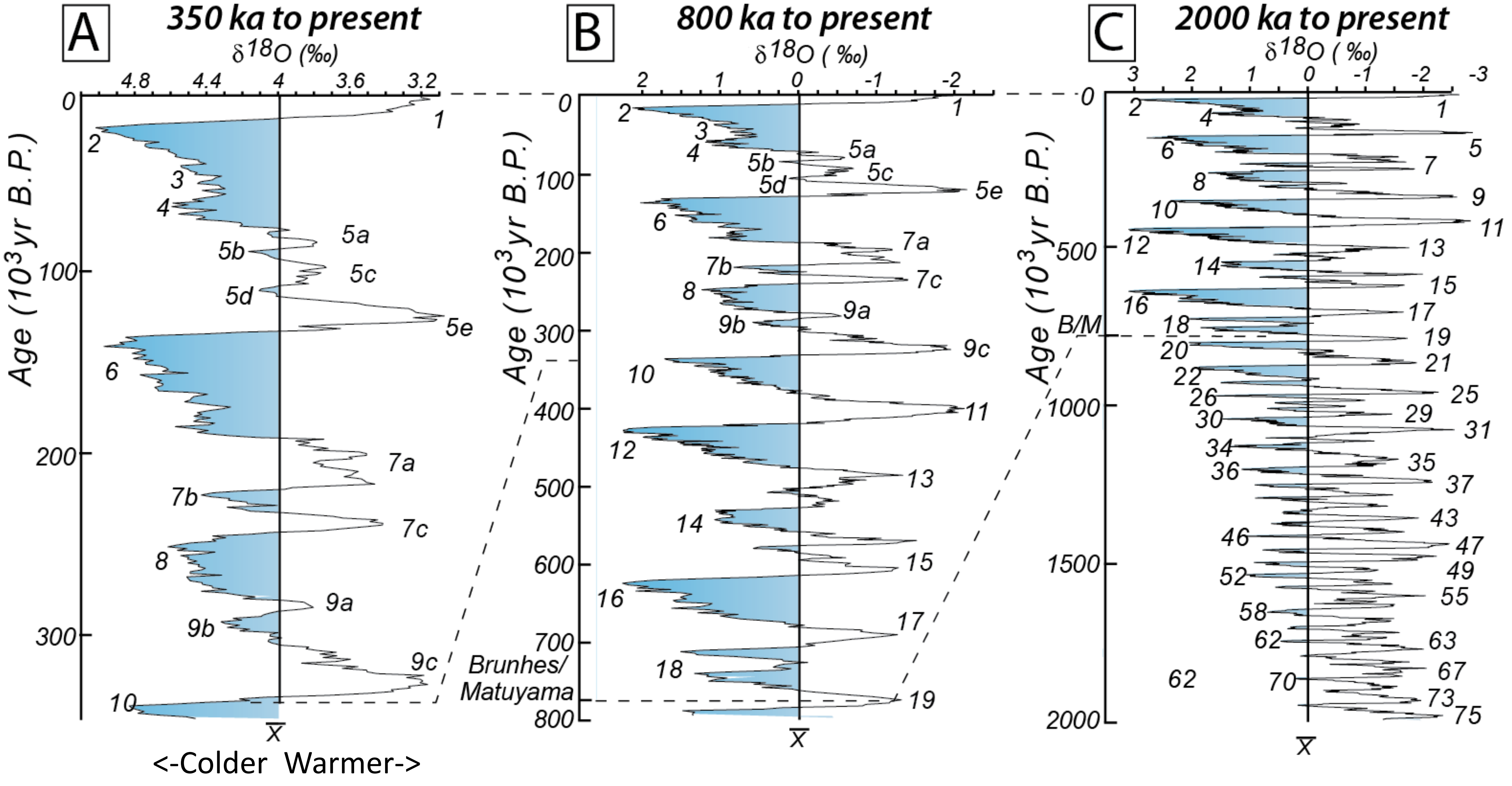
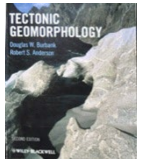
Introduction to surficial geologic mapping 'aka' Quaternary geologic mapping

- Map mostly unconsolidated materials deposited over the Quaternary
- Discriminate by relative elevation, degree of surface modification, soil development, color (desert pavements and presence of carbonate in desert settings)
- Most Tertiary and older, hard rock units are mapped as bedrock
- Likely modulation of surface process by changing climate drives development of the deposits and landforms (sediment supply vs. transport capacity)

Marine Record of Isotopic Change



Isotope stages numbered backward with interglacials odd (current is 1) and the glacials numbered evenly (last is 2). They are subdivided further by letters.



What kind of mapping?

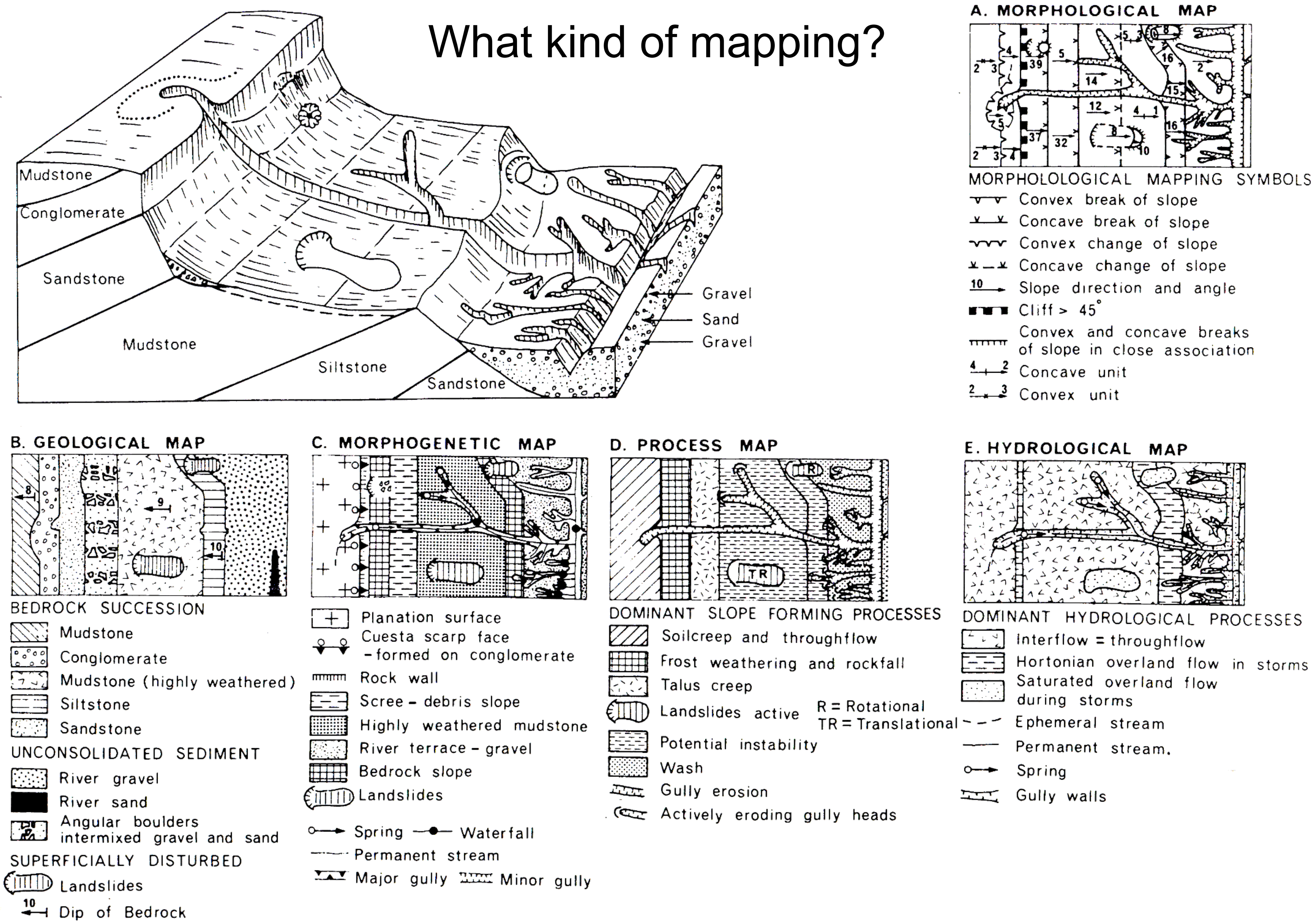
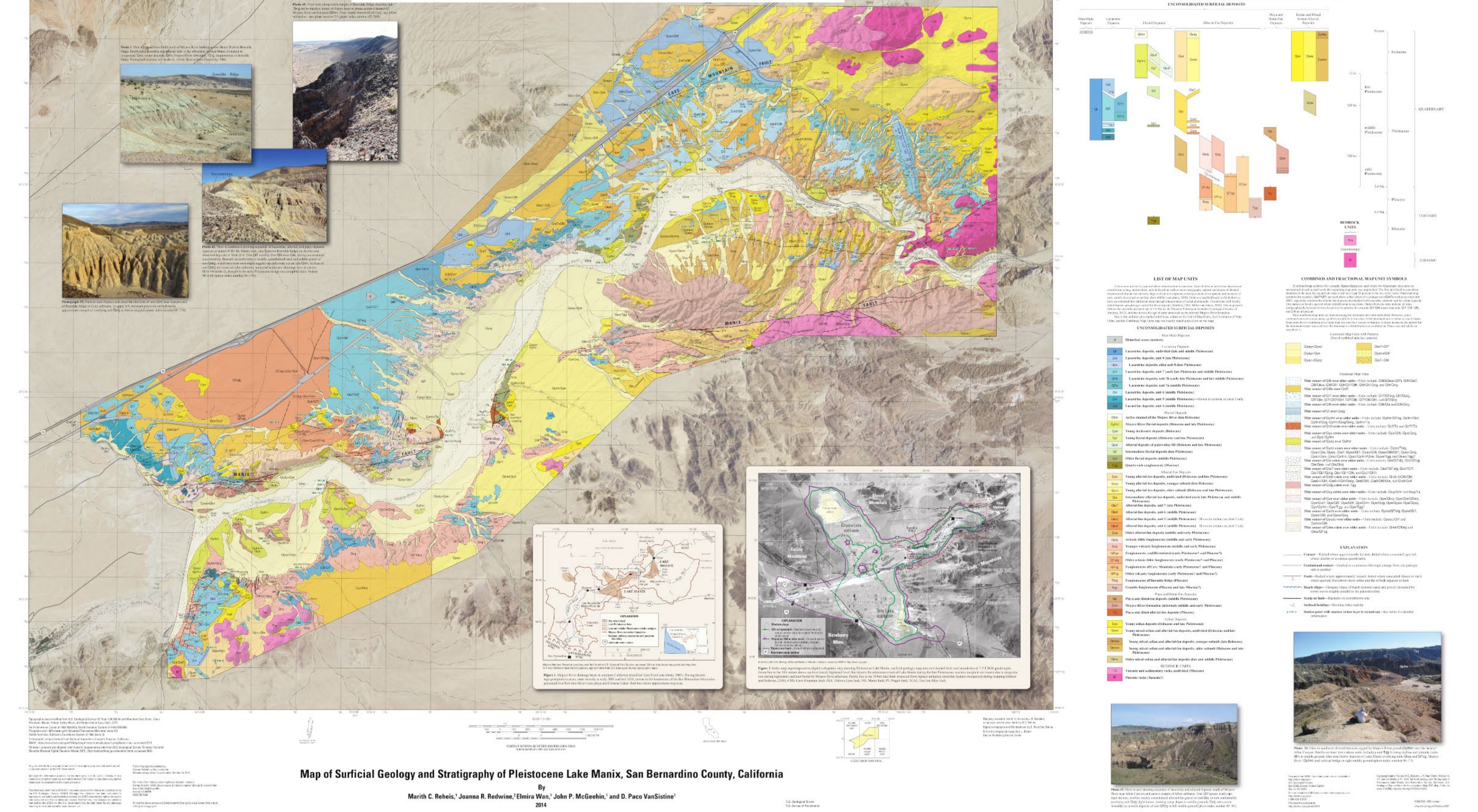


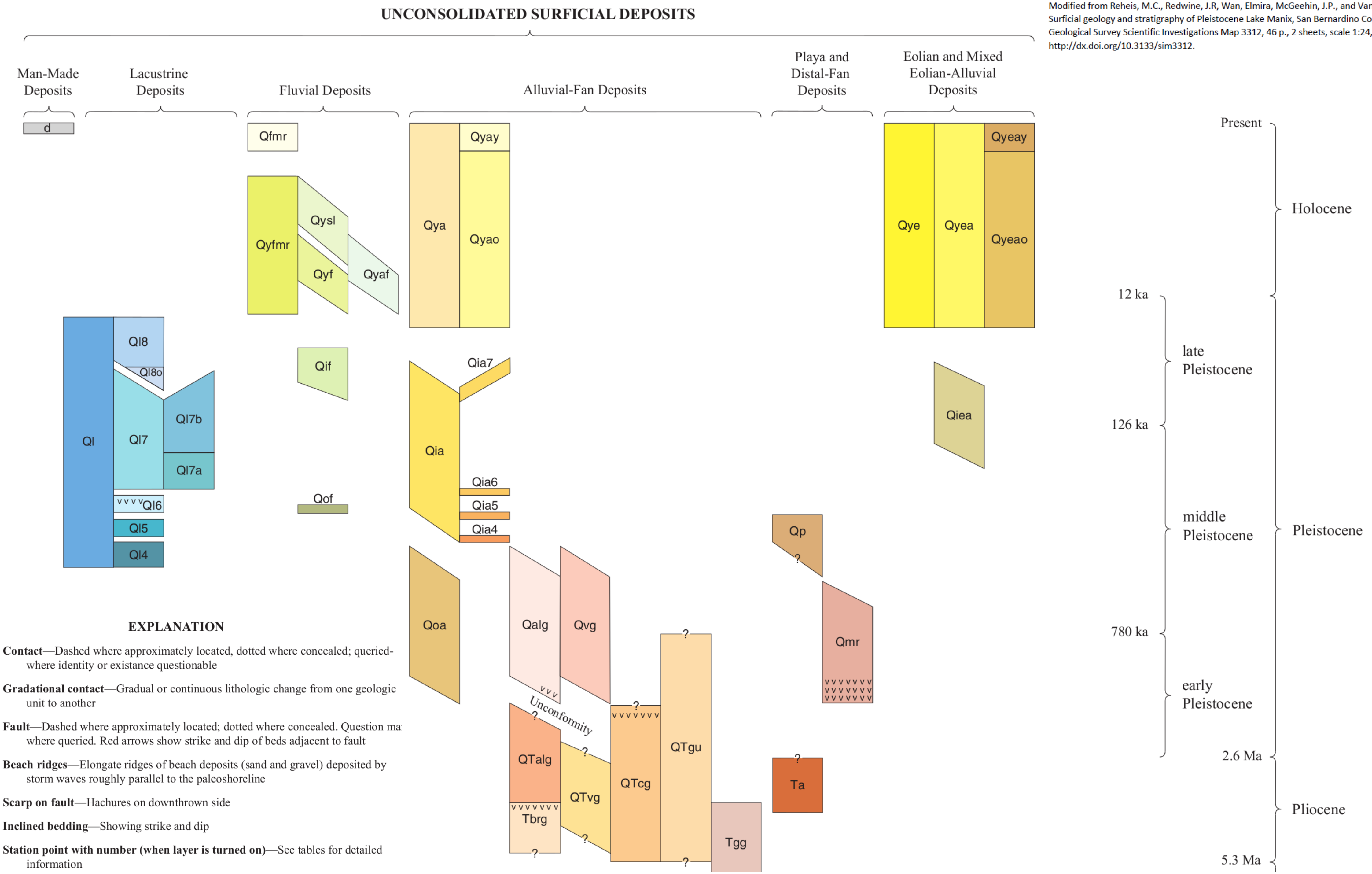
Fig. 10.3. Maps are some of the most common landscape models. These maps show various features and interpretations of one landscape represented in a block diagram. Such maps are very useful for recording field observations. (Modified and extended from Brunsden *et al.* 1975.)

Modified from Reheis, M.C., Redwine, J.R, Wan, Elmira, McGeehin, J.P., and VanSistine, D.P., 2014, Surficial geology and stratigraphy of Pleistocene Lake Manix, San Bernardino County, California: U.S. Geological Survey Scientific Investigations Map 3312, 46 p., 2 sheets, scale 1:24,000, http://dx.doi.org/10.3133/sim3312.

An example



Modified from Reheis, M.C., Redwine, J.R, Wan, Elmira, McGeehin, J.P., and VanSistine, D.P., 2014, Surficial geology and stratigraphy of Pleistocene Lake Manix, San Bernardino County, California: U.S. Geological Survey Scientific Investigations Map 3312, 46 p., 2 sheets, scale 1:24,000, http://dx.doi.org/10.3133/sim3312.



EXPLANATION

Contact—Dashed where approximately located, dotted where concealed; queried—where identity or existance questionable

Gradational contact—Gradual or continuous lithologic change from one geologic unit to another

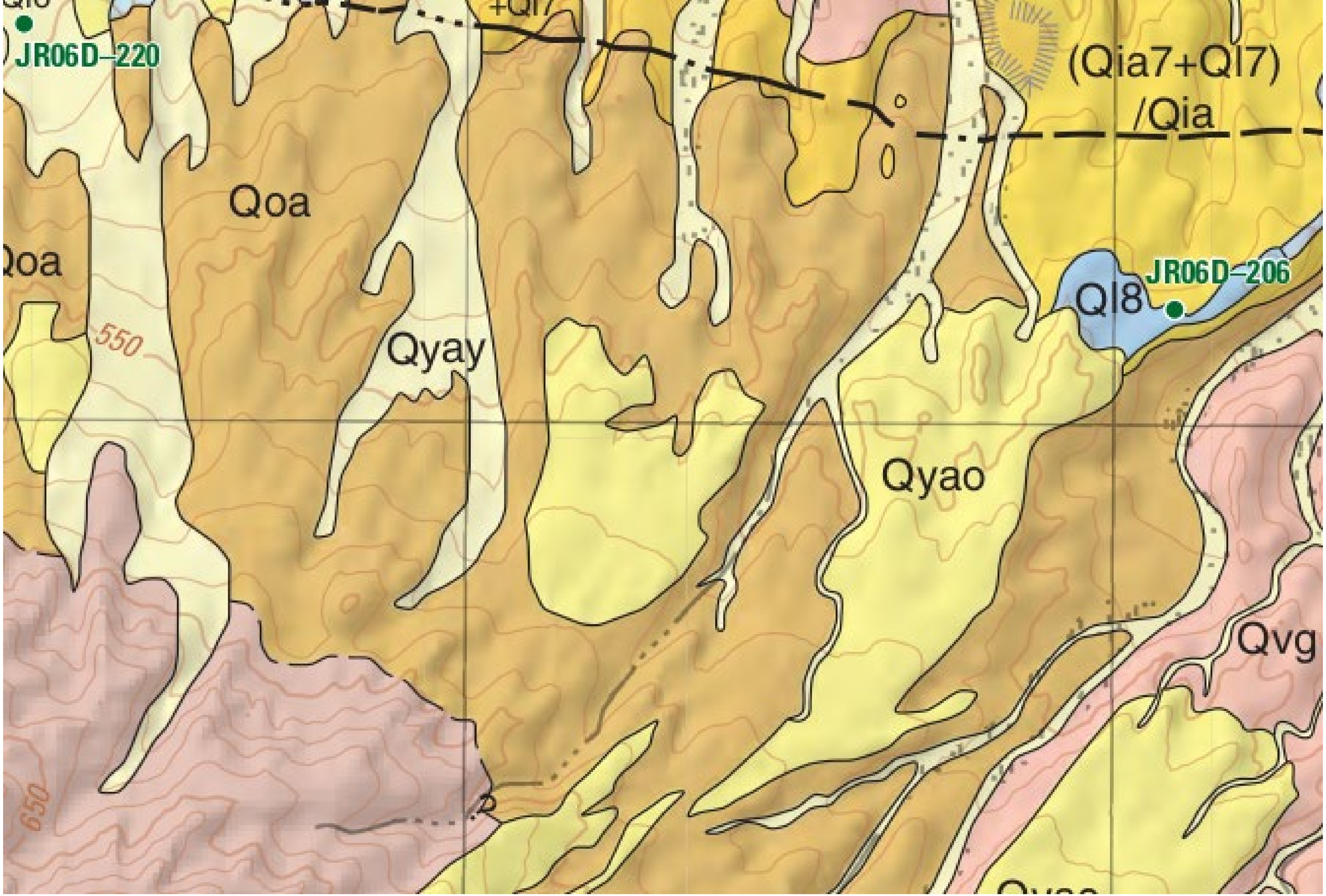
Fault—Dashed where approximately located; dotted where concealed. Question ma where queried. Red arrows show strike and dip of beds adjacent to fault

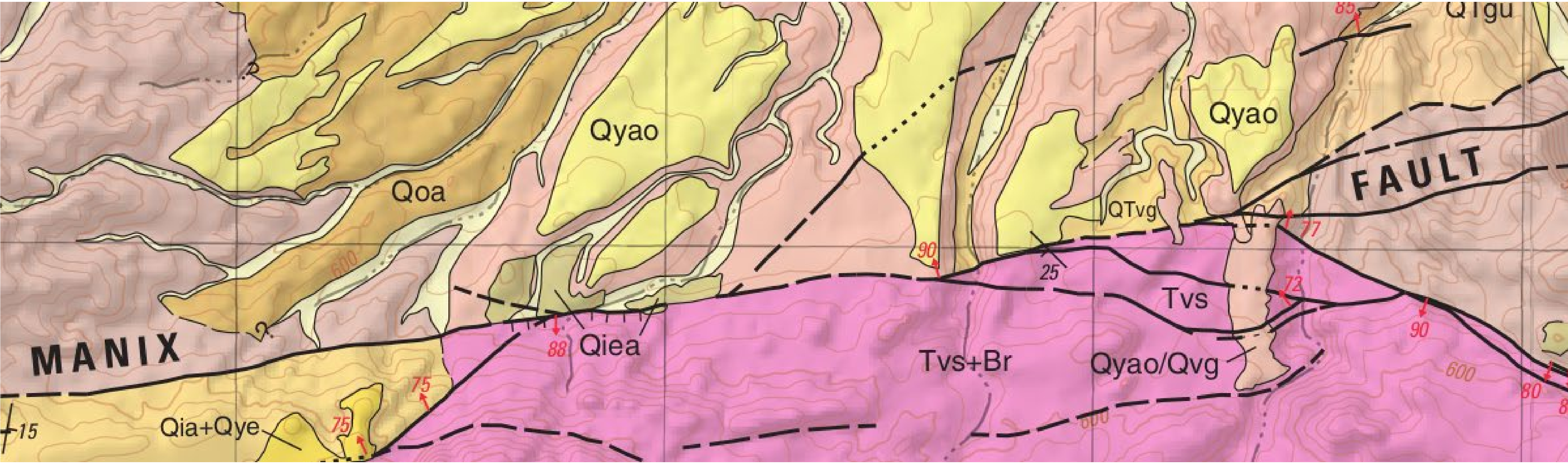
Beach ridges—Elongate ridges of beach deposits (sand and gravel) deposited by storm waves roughly parallel to the paleoshoreline

Scarp on fault—Hachures on downthrown side

Inclined bedding—Showing strike and dip

Station point with number (when layer is turned on)—See tables for detailed information


JR06D–220
(Qia7+Ql7)
/Qia
Qoa
Qoa
JR06D–206
Ql8
550
Qyay
Qyao
Qvg
650


QTgu
85
Qyao
Qyao
Qoa
FAULT
QTvg
77
90
25
72
Tvs
600
MANIX
88
Qiea
Tvs+Br
Qyao/Qvg
90
600
80
75
75
15
Qia+Qye
600


Qoa
Qyao
Qyay
Qoa
Qvg
Qyao
Qyay
Qyay
Qvg
Tgg
Qiea
Qiea
Qyay
Qiea
Qiea
Qiea
Qyay
Tvs+Br
Tvs+Br
QTvg

Man-Made Deposits

d Disturbed areas (modern)—Unconsolidated to loosely compacted rubble composed of silt, sand, and rock. Mapped mainly along the interstate highway and railroad beds. Locally includes bulldozed areas

Fluvial Deposits

Qyf Young fluvial deposits (Holocene and late Pleistocene)—Unconsolidated sand and gravel, undifferentiated by source. Laminated to bedded, with 2–3 cm-thick beds that are locally cross-bedded; well to moderately well sorted sand, silt, and pebble to cobble gravel of mixed lithologies and sources.

Qof Older fluvial deposits (middle Pleistocene)—Mostly well-bedded, clast-supported fluvial gravel and sand; locally includes chaotically bedded deposits.

Alluvial-Fan Deposits

Qya Young alluvial-fan deposits, undivided (Holocene and late Pleistocene)—Alluvial fan and wash deposits. Includes scattered thin mudflow deposits

Qia Intermediate alluvial-fan deposits, undivided (early late Pleistocene and middle Pleistocene)—Fan surfaces with well-developed desert pavement over ~80 percent of surface and well-developed varnish on clasts

Qoa Older alluvial-fan deposits (middle and early Pleistocene)—Alluvial fans with poorly preserved, rounded and eroded surfaces. Locally, thick carbonate soils with stage III or greater morphology are exposed. Moderately developed and degraded desert pavement and varnish. Age is unknown, but based on poor preservation and apparently more developed soils, these deposits are inferred to be older than Qia fans.

QTgu Fanglomerate, undifferentiated (early Pleistocene? and Pliocene?)—Fanglomerate. May include deposits elsewhere mapped as units QTvg, Qoa, and Tertiary

Playa and Distal-Fan Deposits

Qp Playa and distal-fan deposits (middle Pleistocene)—Mud, silt, sand, and lesser fine gravel in massive, poorly sorted, matrix supported beds (photos 34 and 54). Locally includes moderately bedded, poorly sorted alluvial deposits 20–50 cm thick. Deposited by low-gradient streams, playas, and small wetlands

Bedrock Units

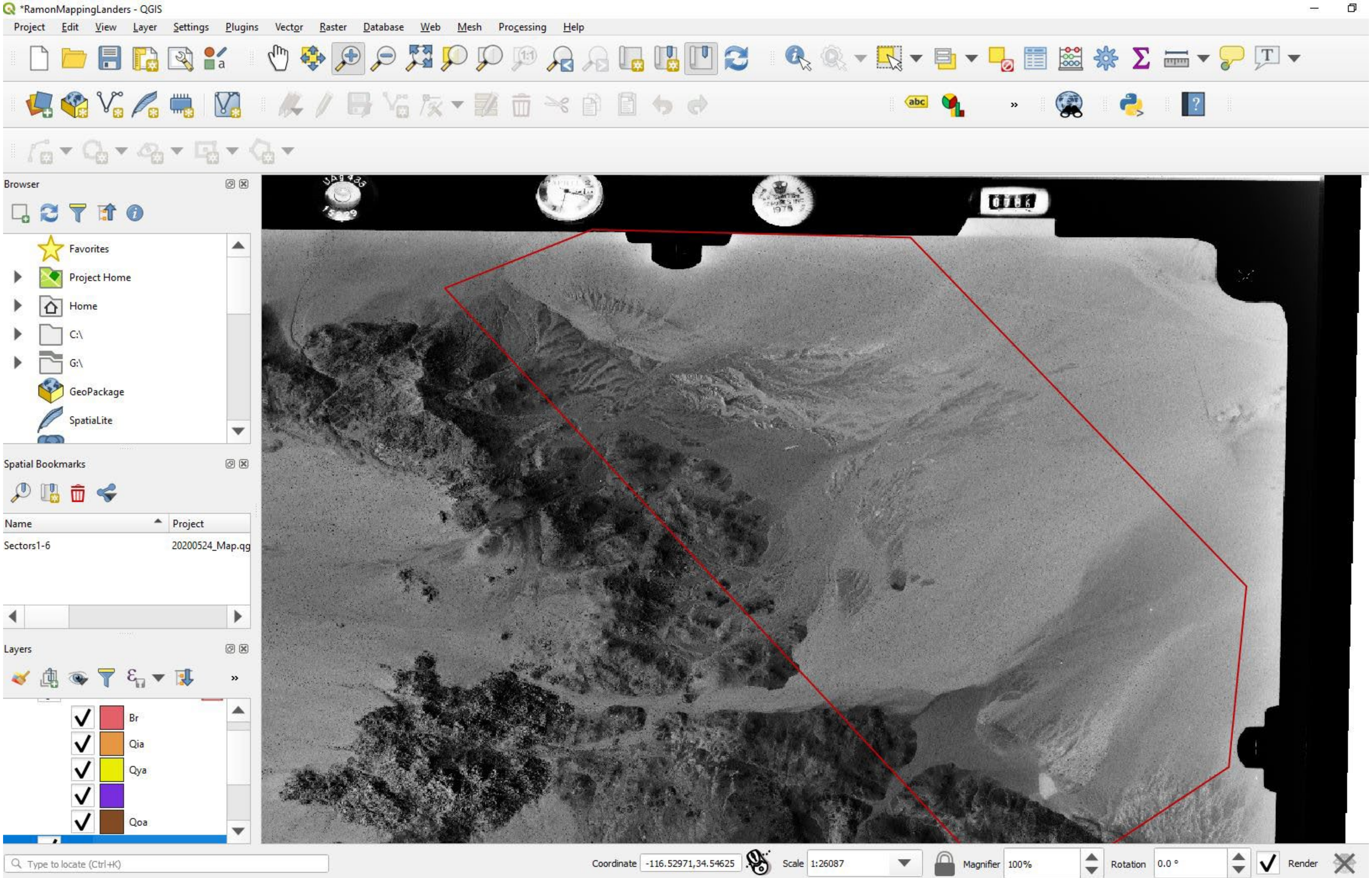
Tvs Volcanic and sedimentary rocks, undivided (Miocene)—Volcanic rocks and volcaniclastic sediments.

Br Extrusive and intrusive igneous, and metamorphic rocks

Modified from Reheis, M.C., Redwine, J.R, Wan, Elmira, McGeehin, J.P., and VanSistine, D.P., 2014, Surficial geology and stratigraphy of Pleistocene Lake Manix, San Bernardino County, California: U.S. Geological Survey Scientific Investigations Map 3312, 46 p., 2 sheets, scale 1:24,000, http://dx.doi.org/10.3133/sim3312.

Pre set basic units in QGIS shape file but you can add more if you want

1) Play with earthexplorer for imagery sources
2) Download Landers pre rupture imagery
3) Map Quaternary units
4) Map geomorphic features/GIR
5) Delineate fault trace and break into 1 km segments and indicate confidence
6) Short report


*RamonMappingLanders - QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help
Browser
Favorites
Project Home
Home
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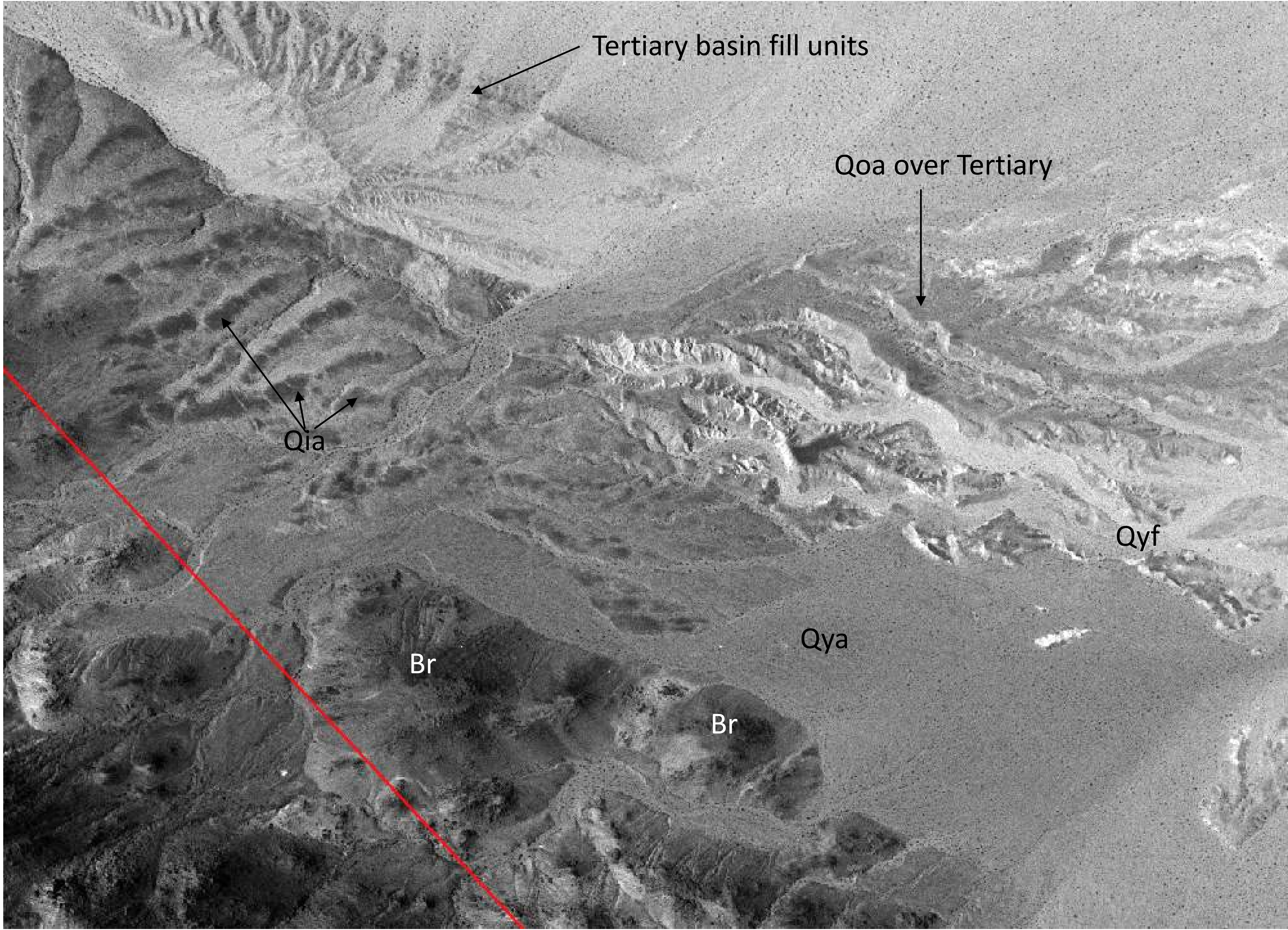
SpatiaLite
Spatial Bookmarks
Name
Project
Sectors1-6
20200524_Map.qg
Layers
Br
Qia
Qya
Qoa
Type to locate (Ctrl+K)
Coordinate
-116.52971,34.54625
Scale
1:26087
Magnifier
100%
Rotation
0.0 °
Render

Mapping and image interpretation

Basic considerations for interpretation

- Shape: general form, configuration, outline of individual objects.
- Size: consider in context of image scale
- Pattern: spatial arrangement of objects (e.g., orchard)
- Tone: relative brightness or color of objects on an image
- Texture: frequency of tonal change (smoothness or coarseness)
- Shadows: gives profile view of object and implies relative heights
- Site: refers to geographic or topographic location; what do you expect to be there?
- Association: occurrence of certain features in relation to others
- Resolution: what is the finest thing you can see?
- Targets: identify main features you want to emphasize on your map

Ramon thoughts

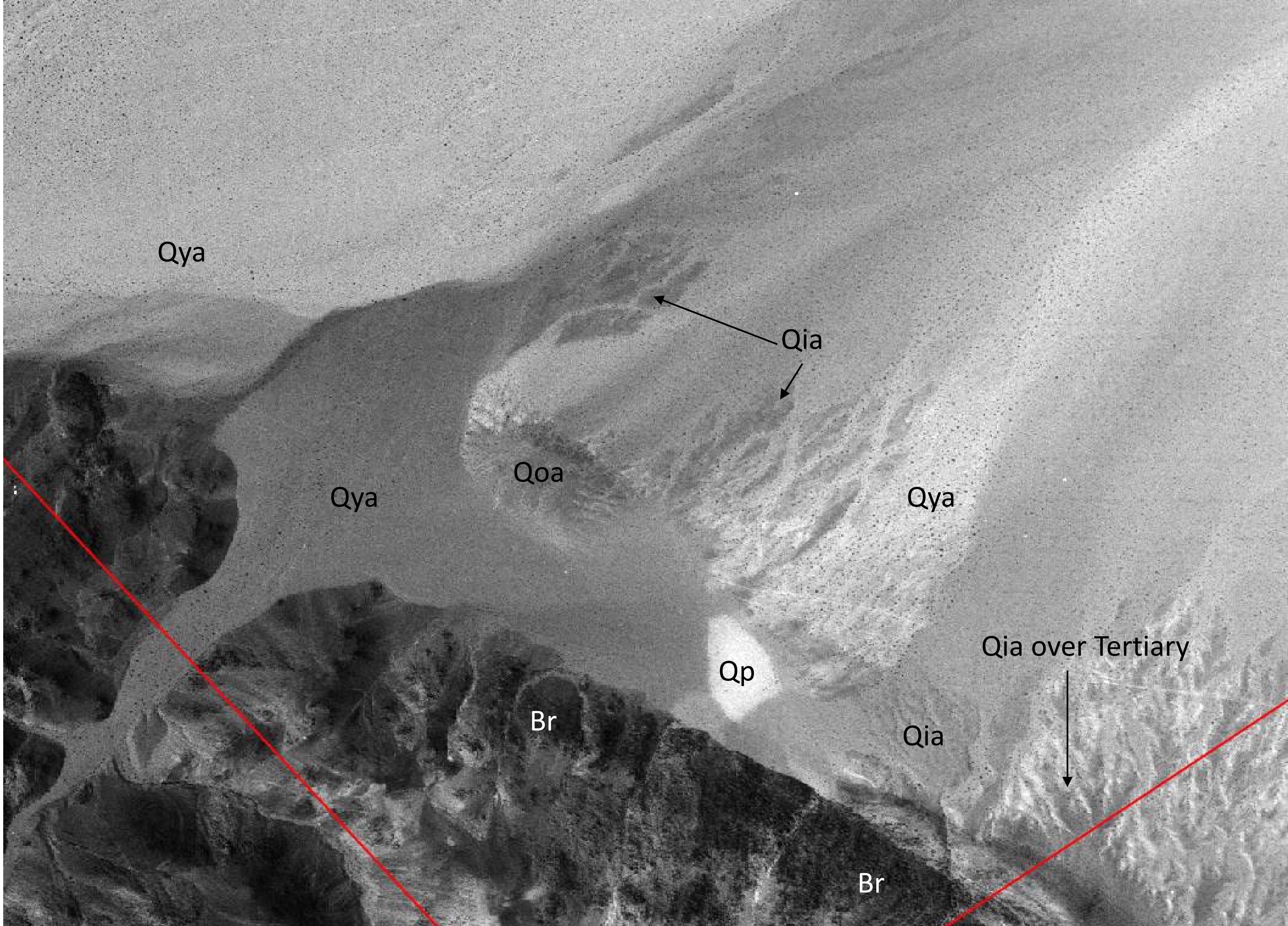


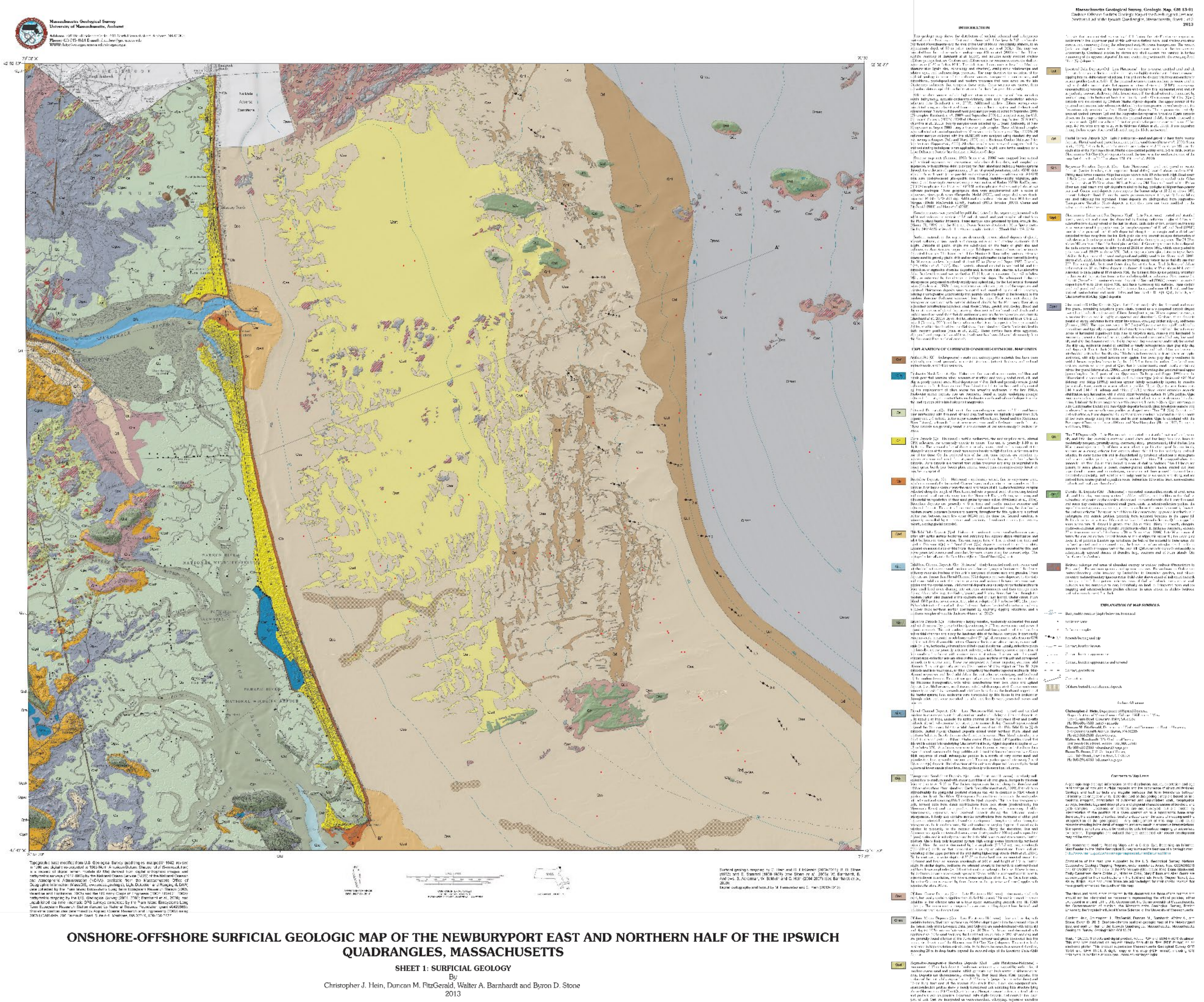
Ramon thoughts

Tonal contrast can come from desert varnish but also can come from different source materials and eolian inputs.

For this assignment, lumping into fewer units is preferred rather than developing new ones unless you have the time to apply it consistently across the area.

See also demo video from Rachel for this area to get started





Does not always have to be in the desert; here is coastal Massachusetts

EXPLANATION OF COMBINED ONSHORE-OFFSHORE MAP UNITS

Qaf

Artificial Fill (Qf Anthropocene) - earth and anthropogenic materials that have been artificially emplaced, primarily in coastal structures (jetties), highway and railroad embankments, and infilled wetlands.

Qm

Freshwater Marsh Deposits (Qm Holocene) - fine-grained organic matter, and fibric and hemic peat that contains minor amounts of stratified and poorly sorted sand, silt, and clay in poorly drained areas. Most deposits are < 3 m thick and generally overlie glacial sediment or bedrock. In west-central Plum Island, this habitat has been artificially created by the emplacement of dikes across the estuarine sediments in the late 1940s. Freshwater marsh deposits also are commonly found at depth, underlying younger saltmarsh deposits; the contact between freshwater marsh and saltmarsh deposits marks the leading edge of the late Holocene transgression.

Qs

Saltmarsh Deposits (Qs Holocene) - fine-grained organic matter, and fibric and hemic peat interbedded with fine sand, silt and clay. Sediments are typically greater than 30% organic and 1-6 m thick. In the major estuaries (Plum Island Sound and the Merrimack River Estuary), saltmarsh deposits overlie estuarine and/or freshwater marsh deposits. These deposits are generally found in environments of low wave energy in backbarrier areas.

Qd

Dune Deposits (Qd Holocene) - mobile, well-sorted, fine and very-fine sand. Internal GPR reflections are commonly chaotic in nature. This unit is generally 1-10 m in thickness. The seaward edge of dunes is usually unvegetated and is mapped at the change in slope of the upper beach face above the storm high-tide line, which marks the toe of the dune. On the landward side of the unit, dune deposits are underlain by inactive estuarine and marsh deposits; on the seaward side they are underlain by beach deposits. Dune deposits are formed from eolian processes and may be vegetated with beach grass, beach pea, beach plum shrubs, coastal pine-oak-maple-cherry forest, or may be unvegetated.

Qb

Beachface Deposits (Qb Holocene) - moderately sorted, fine to very-coarse sand, which is commonly flat-laminated. Coarser layers locally contain some granules and fine pebbles; finer layers contain very-fine sand and traces of silt. Surface beachface samples collected along the length of Plum Island indicate a general trend of increasing textural and mineralogical maturity away from the Merrimack River, reflecting winnowing and differential transportation of finer sand grains by wave action (FitzGerald *et al.*, 1994). Beachface deposits are generally < 5 m thick and overlie inactive estuarine and saltmarsh deposits. This unit is dominated by sediment deposited along the shoreline by modern coastal processes (waves and currents) throughout the tidal cycle and is defined as the area between mean low water (MLW) and the dune toe. Textural variability is generally controlled by the texture and proximity of sediment sources (*i.e.,* estuary mouth, eroding glacial deposits).

Qed

Ebb Tidal Delta Deposits (Qed Holocene) - medium to coarse sand with minor gravel,

The silty clay sediments consist of stratified to nearly homogeneous dark gray silty clay and clayey silt. Thin to thick (< 10 cm to > 1 m) lenses and beds of fine sand occur as interbedded units within the silty clay. Thin beds in these sandy units are planar or ripple-laminated, with silty draped laminae over ripples. The lower gray clay is weathered to reddish brown to yellow brown to depths of 1.5-4 m from the surface. Landward-most sections contain an upper part of Qgsc that is predominantly sand, locally containing minor fine gravel (Stone *et al.*, 2004). Lower (glacier-grounding-line proximal) and upper (grounding-line distal) parts of unit Qgsc units (Belknap and Shipp, 1991) can be differentiated in some offshore seismic profiles. Lower Qgsc (seismic facies unit GM-M of Belknap and Shipp [1991]) sections appear faintly acoustically layered to massive (acoustically transparent) in seismic-reflection profiles; Upper Qgsc (seismic facies units GM-D and GM-P of Belknap and Shipp [1991]) sections reveal extensive acoustic stratification and lamination with a sharp upper bounding surface. In GPR profiles, Qgsc contains very few horizontal, discontinuous internal reflections and is dominated by data noise. Total unit thickness ranges from a thin drape (< 1 m) to > 25 m. Qgsc intertongues with Glaciomarine Deltaic and Fan (Qgdf) deposits beneath distal foreslopes onshore and is observed in seismic-reflection profiles as draped over Thin Till (Qtt) deposits and bedrock offshore. It was deposited during the regional sea-level highstand in environments of low wave energy along the coast and in river estuaries. Qgsc is correlated with the Presumpscot Formation of coastal Maine and New Hampshire (Bloom, 1963; Thompson and Borns, 1985).

Qtt

Thin Till Deposits (Qtt Late Pleistocene) - nonsorted, nonstratified matrix of sand, some silt, and little clay containing scattered gravel clasts and few large boulders; loose to moderately compact, generally sandy, commonly stony; predominantly till of the last (late Wisconsinan) glaciation. In offshore seismic-reflection profiles the top of this unit locally appears as a strong reflector that extends above thin till to the underlying bedrock reflector. In some places this unit is characterized by parabolic reflections in radargrams and seismic profiles, probably produced by scattered boulders. Till is mapped where it is generally less than 3-5 m thick including areas of shallow bedrock. Two till facies are present in some places: a looser, coarser-grained ablation facies, melted out from supraglacial position; and an underlying, more compact, finer-grained lodgement facies deposited subglacially. Both ablation and lodgement facies are sandy and stony, and are derived from coarse-grained crystalline rocks. Subsurface till overlies fresh, nonweathered bedrock and locally weathered rock.

Qtd

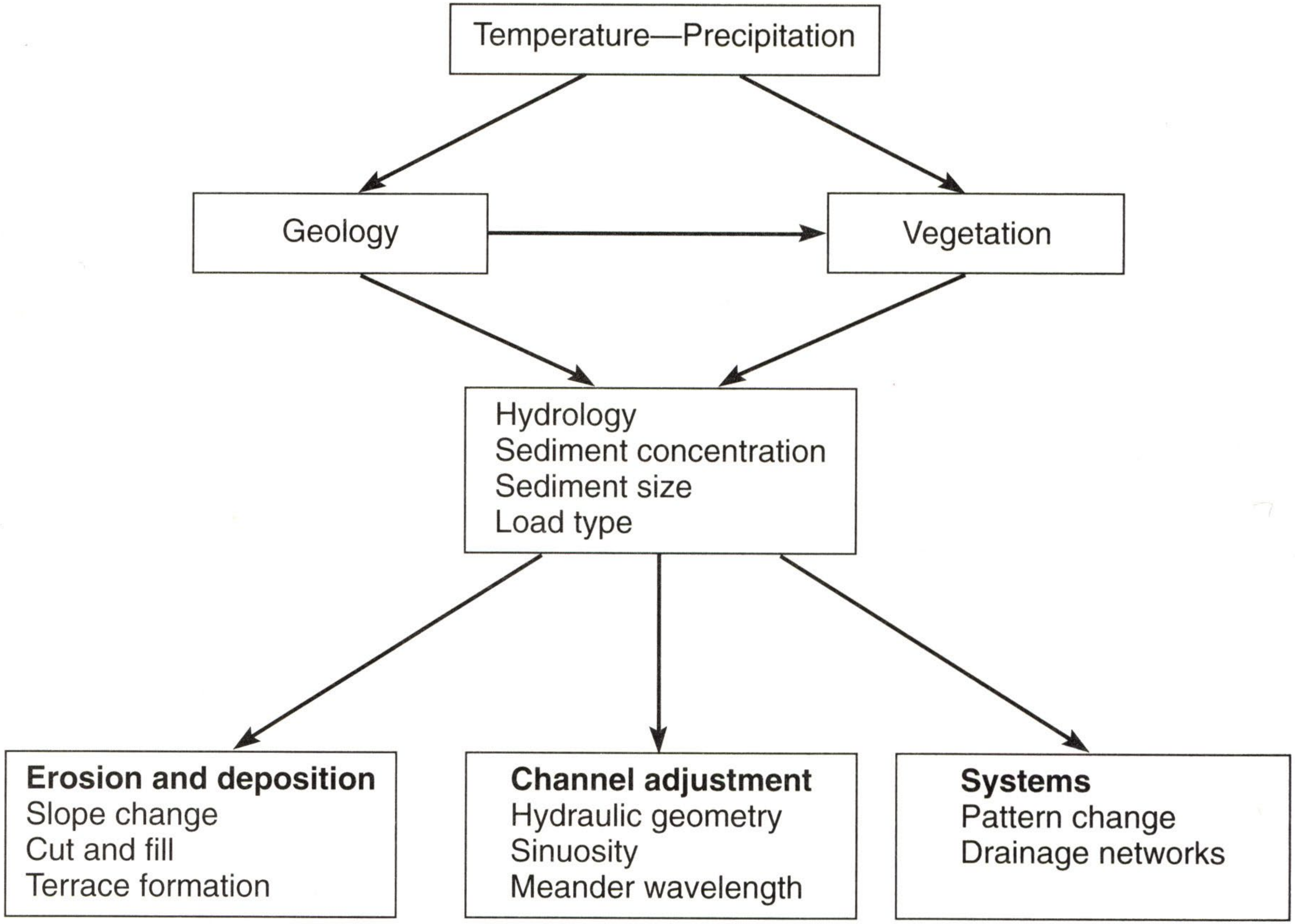
Drumlin Till Deposits (Qtd Pleistocene) - nonsorted, nonstratified matrix of sand, some silt, and little clay containing scattered pebbles, cobbles, and boulders in the shallow subsurface; at greater depths consists of compact, nonsorted matrix of silt, very fine sand, and some clay containing scattered small gravel clasts. In seismic-reflection profiles, the top of this unit appears as a strong, continuous reflector that extends smoothly down to the bedrock reflector. The upper part of this unit is characterized by parabolic reflections in radargrams and seismic profiles, probably from scattered boulders in the upper till. Profiles from deeper sections of this unit are devoid of internal reflectors. Qtd is mapped in areas where total till deposit is greater than 3-5 m thick, chiefly in smooth, elongate, northwest-southeast trending drumlin landforms in which till thickness commonly exceeds 30 m (maximum recorded thickness is 70 m; Stone *et al.*, 2006). Late Wisconsinan till


A
Qtt
Qs
Qaf
Qgsc
Qgdf
Qtd
Qrs
Qe
Qb
Qd
Qsrt
Qm
N E W B U R Y
Pine Island
PINE ISLAND ROAD
PLUMMER LA
Pine Creek
Island Creek
Jericho Creek
Pork Island
Browns Island
PLUM ISLAND
First Burial Ground
Old Town Hill
Newbury Old Town
Old Town Cem
COTTAGE RD
Little River
PARKER RIVER
PARKER RIVER NATIONAL WILDLIFE REFUGE
Newbury Neck Cem
MARSH AVE
Tidal Flat
The Thorofare
Dole Island
Hale Cove
Cape Merrill
PLUM ISLAND SOUND
MUD CREEK
Mud Cr
Creek
ROWLEY
NEWBURY
NORTH POOL
MILL R
Ireland Point
Newbury North Base
Tidal

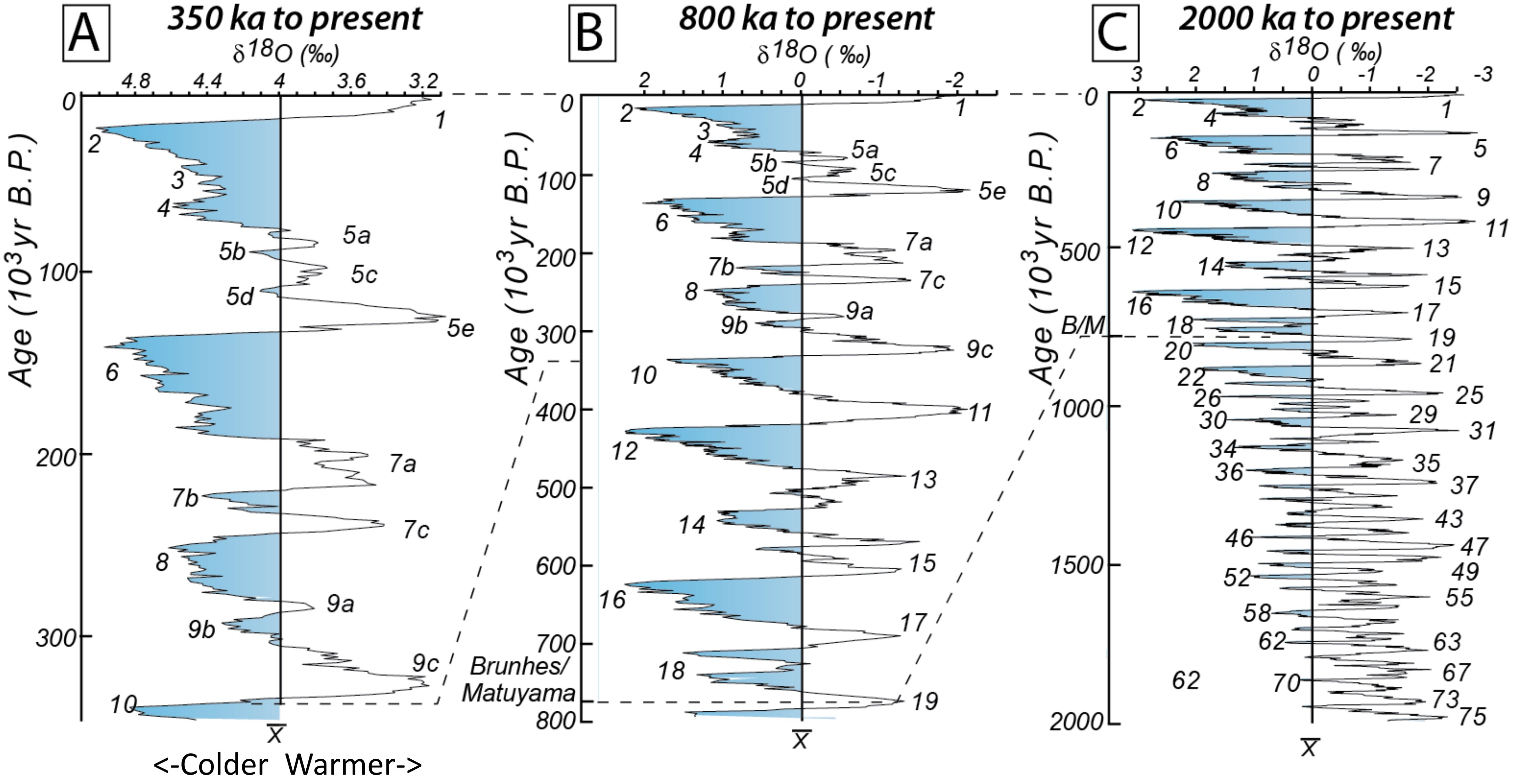
Climate and Climate Change over the Quaternary

Modulates the development of landforms

- Climate: Long term atmospheric and surface conditions that characterize a particular region
- Weather: daily fluctuations in temperature wind speed, and precipitation at a location


Temperature—Precipitation
Geology
Vegetation
Hydrology
Sediment concentration
Sediment size
Load type
Erosion and deposition
Slope change
Cut and fill
Terrace formation
Channel adjustment
Hydraulic geometry
Sinuosity
Meander wavelength
Systems
Pattern change
Drainage networks

Marine Record of Isotopic Change



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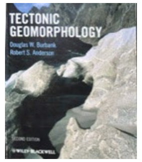
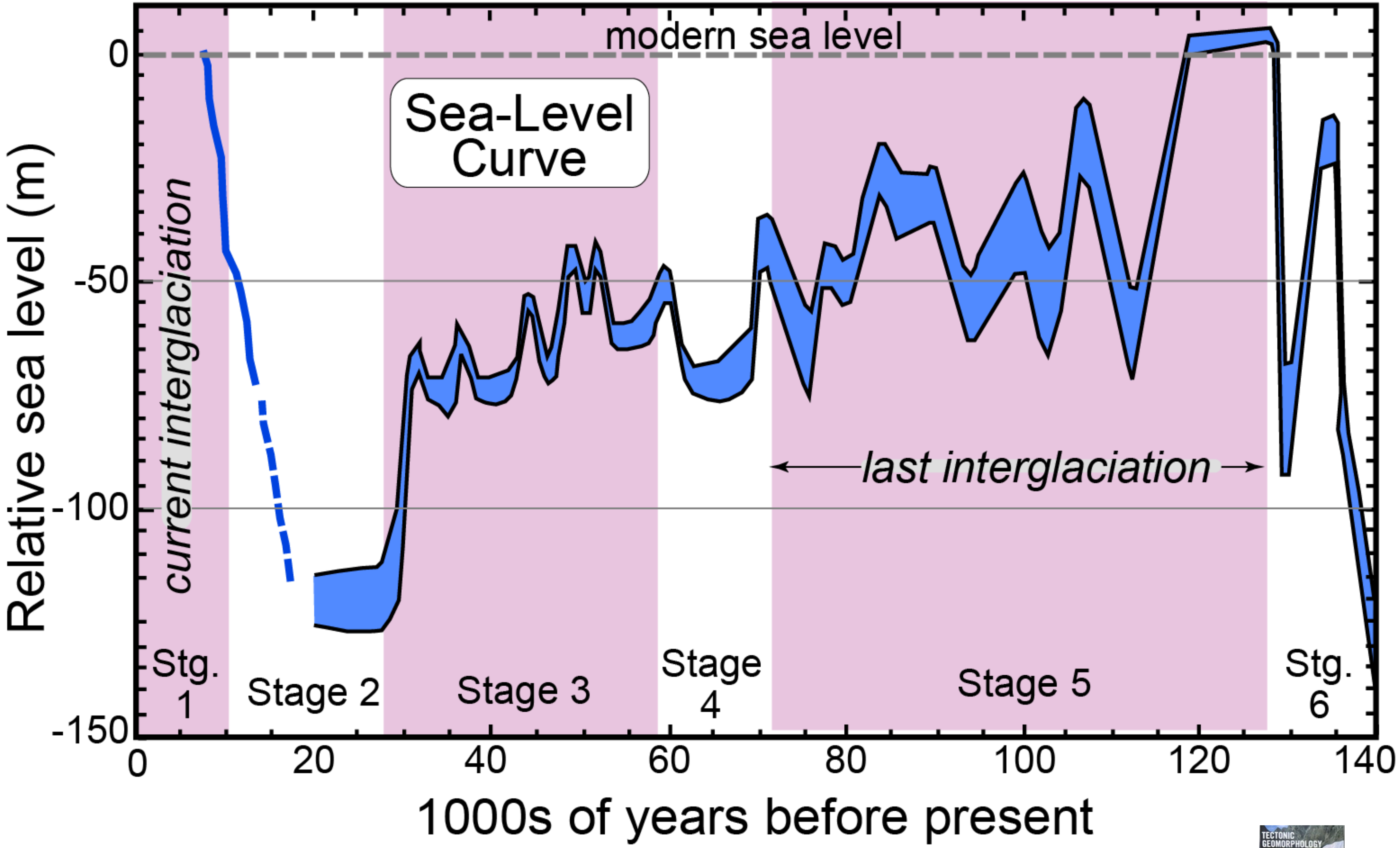
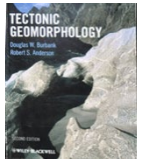



Sea-Level Curve
modern sea level
Relative sea level (m)
0
-50
-100
-150
current interglaciation
last interglaciation
Stg. 1
Stage 2
Stage 3
Stage 4
Stage 5
Stg. 6
0
20
40
60
80
100
120
140
1000s of years before present


TECTONIC GEOMORPHOLOGY