A SPECIAL PLACE !

Outline

-Boundary

-Rocks

-Historical geology

-Processes creating local landforms

- -Mountain building
- -Erosion
- -Rivers

We are in a special place!

THEME

This is a unique location where across very short distances there is evidence of:

- -vast amounts of geologic time
- -multiple geologic processes

How does this happen?

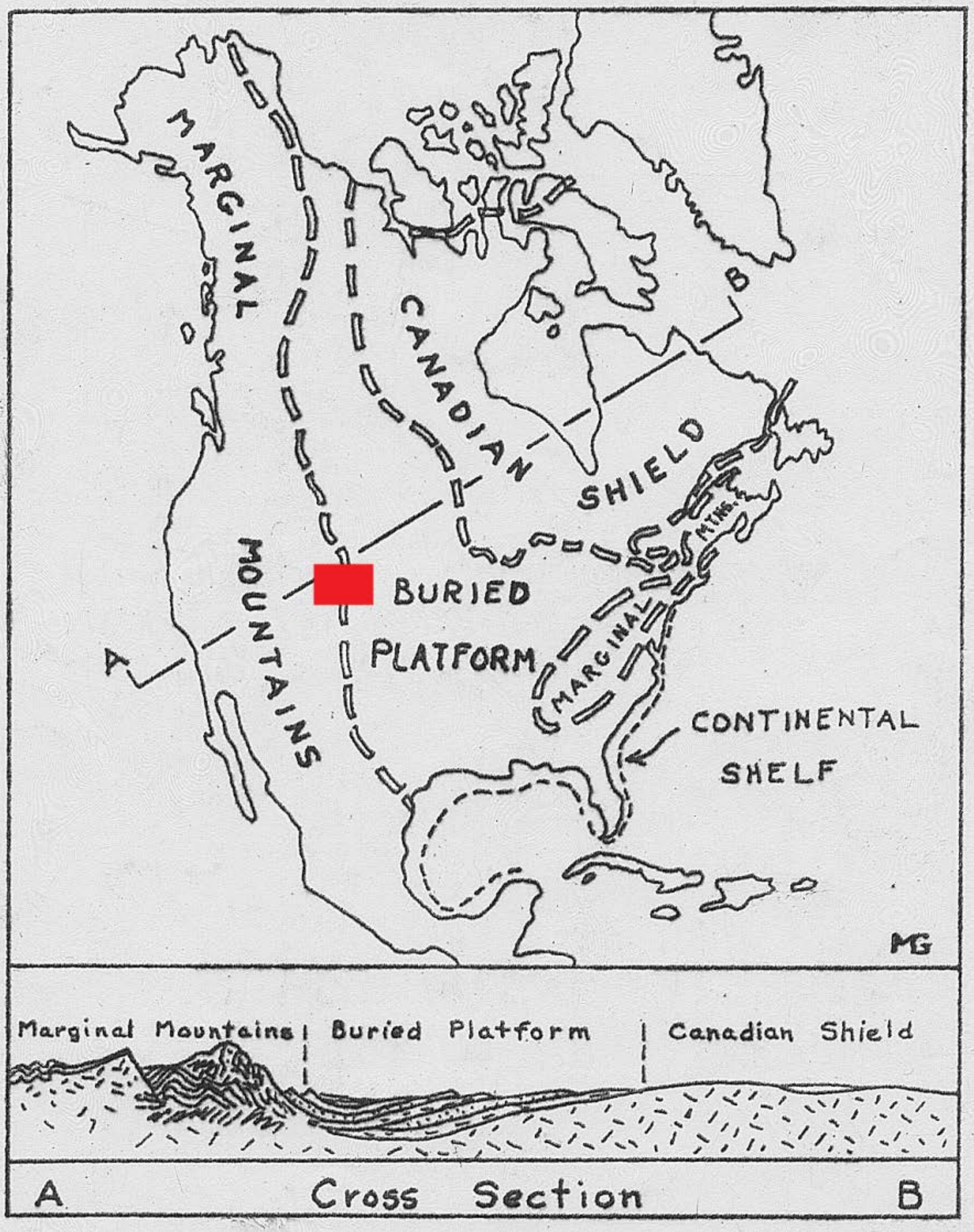
We are at a significant physical

BOUNDARY

—landform types

—rock types

—geological processes



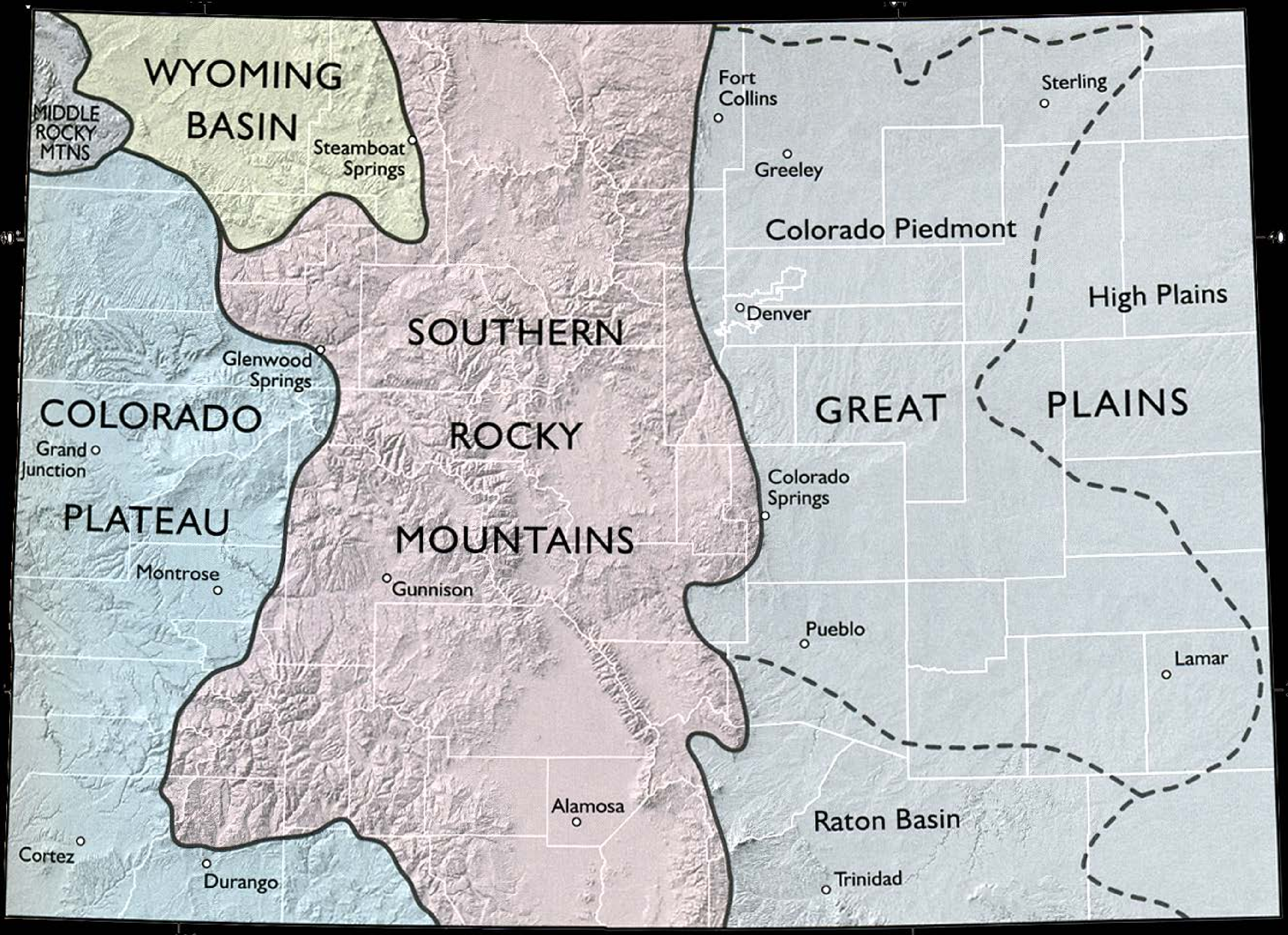
North America

Griffiths & Rubright, *Colorado*

Main Landform Boundary

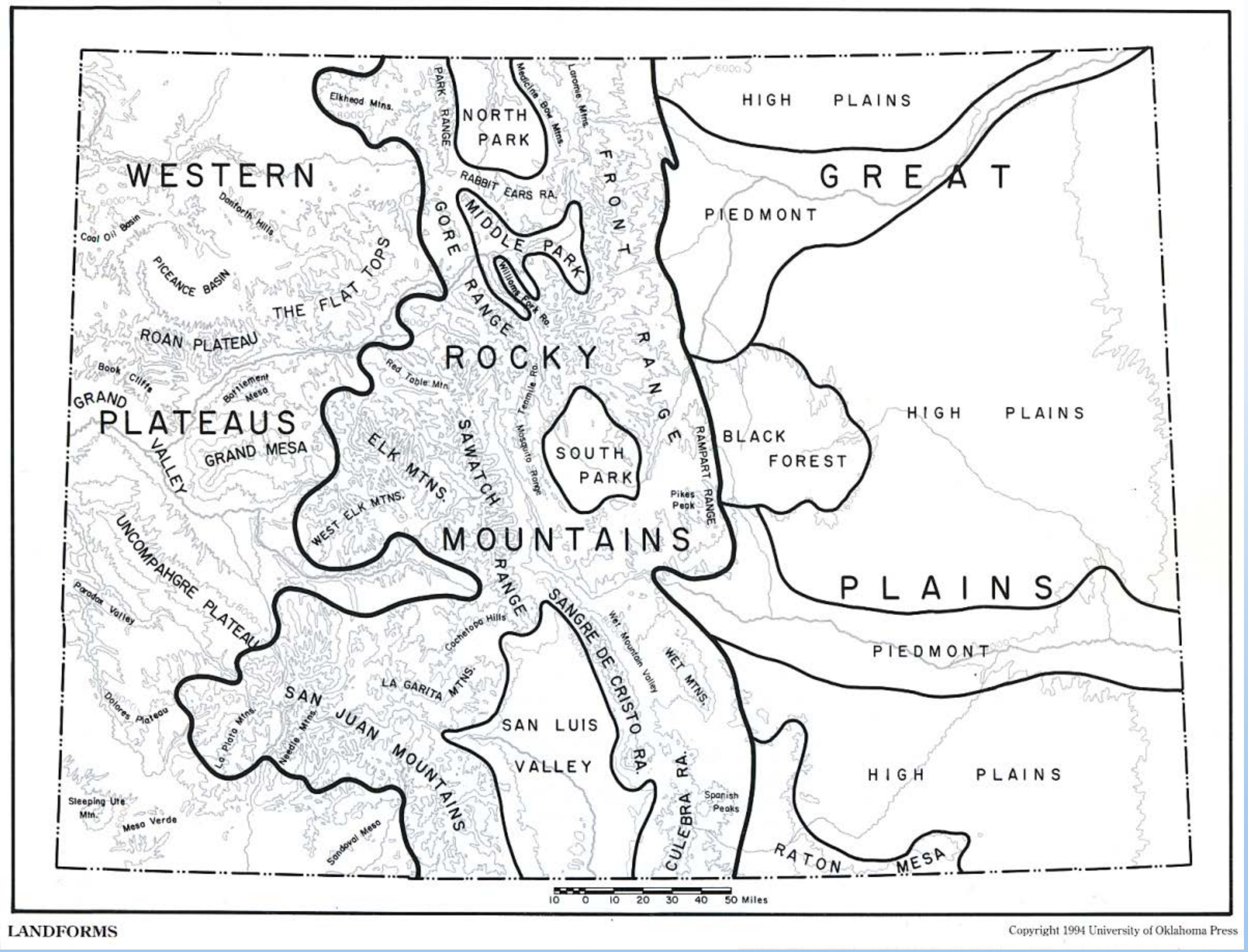
Mountains

Plains



Matthews et al. *Messages in Stone*

Colorado Physiographic Provinces



Noel et al *Historical Atlas of Colorado*

More detail…..

Mountains

Piedmont

Plains

Rock Type Boundaries

Plains rocks (sedimentary)

meet

Mountain rocks (igneous, metamorphic)


N E B R A S K A
SEDGWICK
PHILLIPS
WASHINGTON
KIT CARSON
ALAMOSA
O K L A H O M A

Other boundaries

Biological

— grasslands meet forests

Historical/Cultural

— mining meets farming

— urban meets rural

Natural Areas and boundaries

Mountain side—Gateway

Straddle—Bobcat, Coyote Ridge,

Plains—most

ROCKS

—Mountain rocks

—Plains rocks

Mountain Rock Types

Igneous — molten source

Metamorphic — any rock changed by force

Igneous Rocks

Extrusive

(volcanos)

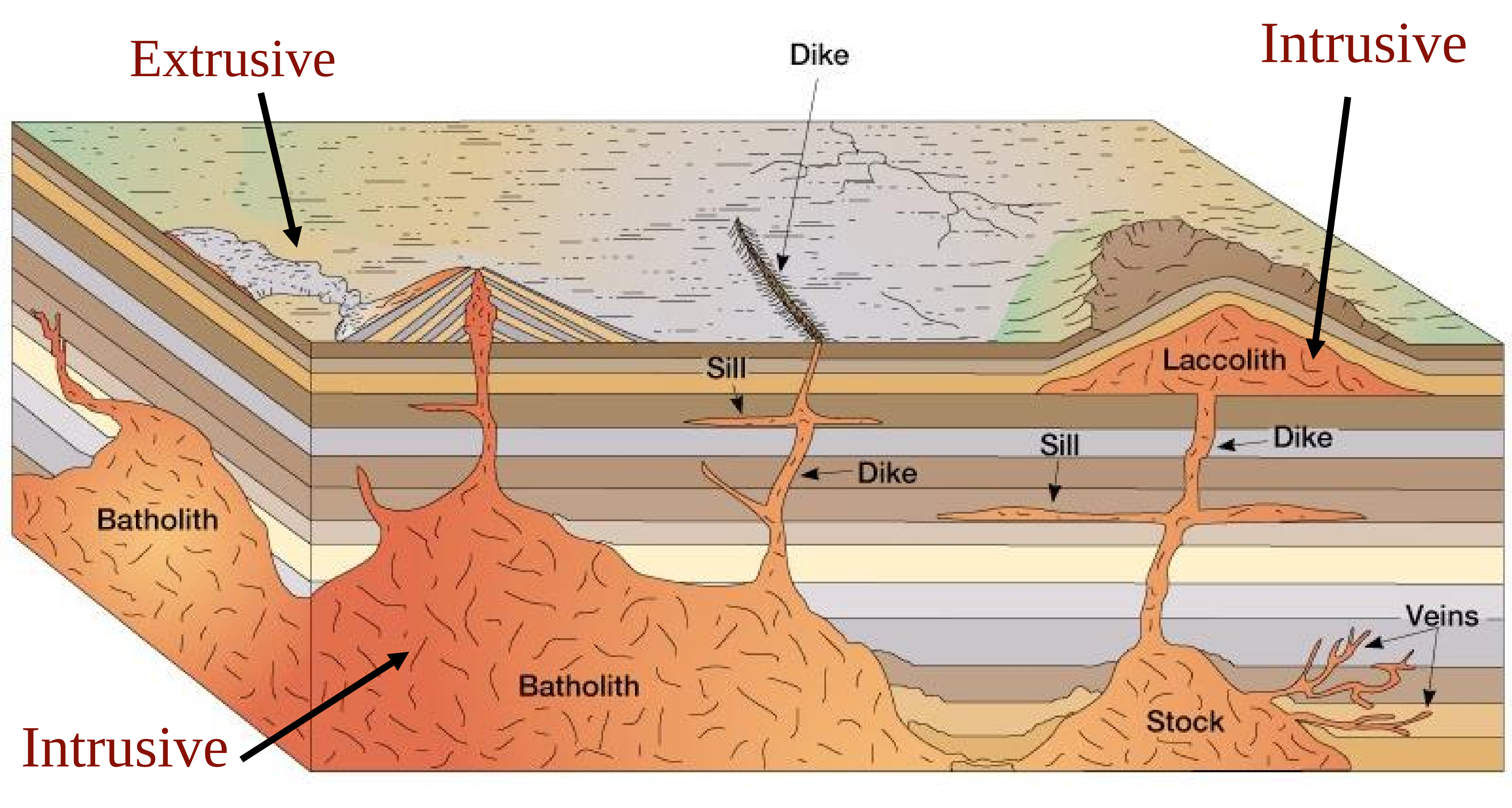
- lava, ash etc.
- surface
- small crystals

Intrusive

(batholiths)

- granite etc.
- underground
- large crystals

Igneous Rocks



McKnight& Hess, *Physical Geography*

Lava

Pahoehoe

Aa

Volcanic ash/pumice

Extrusive Igneous Rocks

Lava

Ash

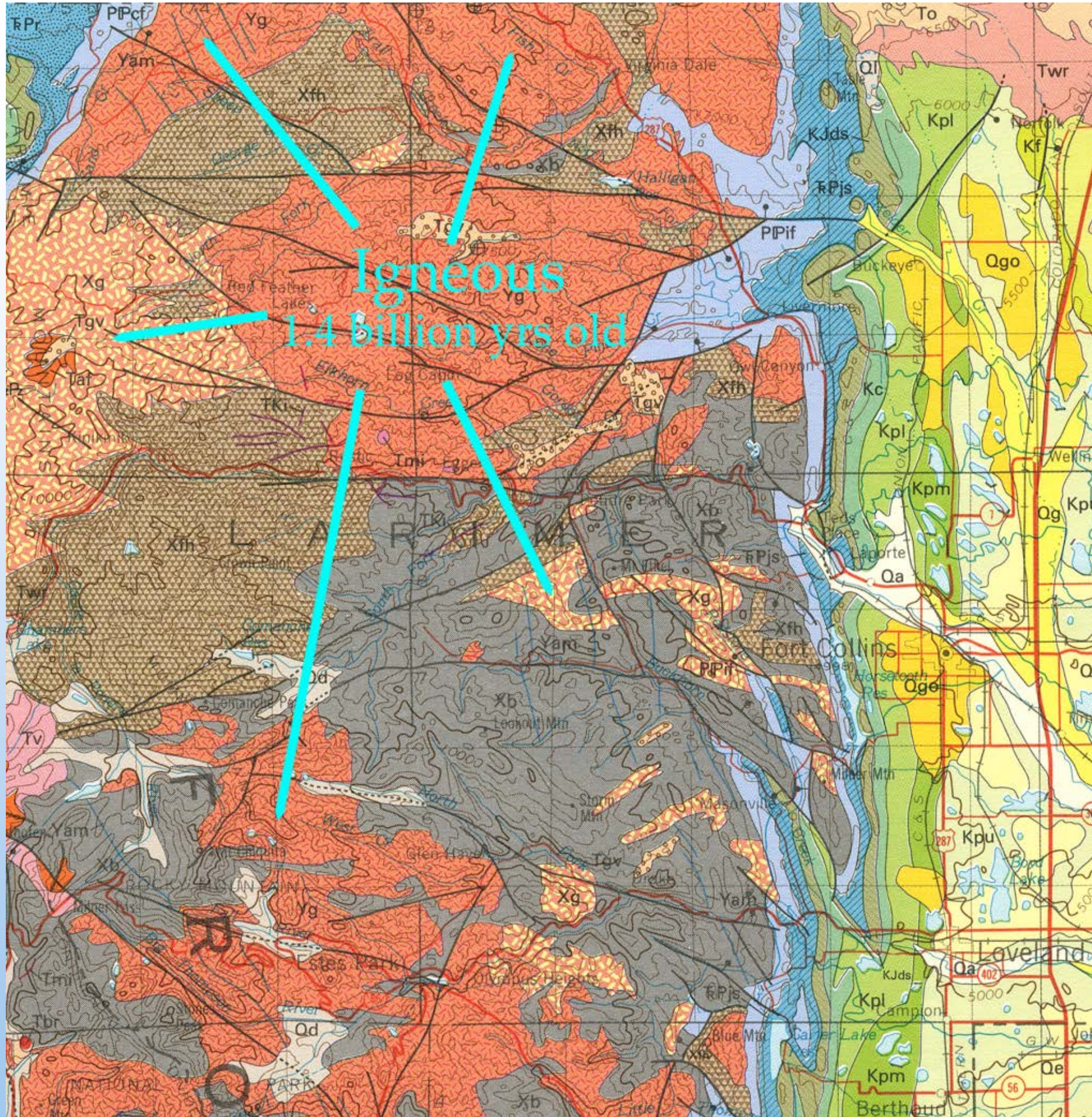
S. Table Mt.

Soapstone

Intrusive Igneous

West of us are huge areas of intrusive igneous (granite)

1.4 billion years old


Igneous
1.4 billion yrs old
L A R I M E R
Fort Collins
Loveland
Estes Park
Berthoud
Laporte
Campion
Virginia Dale
Red Feather Lake
Horsetooth Res
Carter Lake

Granite

cooled slowly underground

fairly uniform

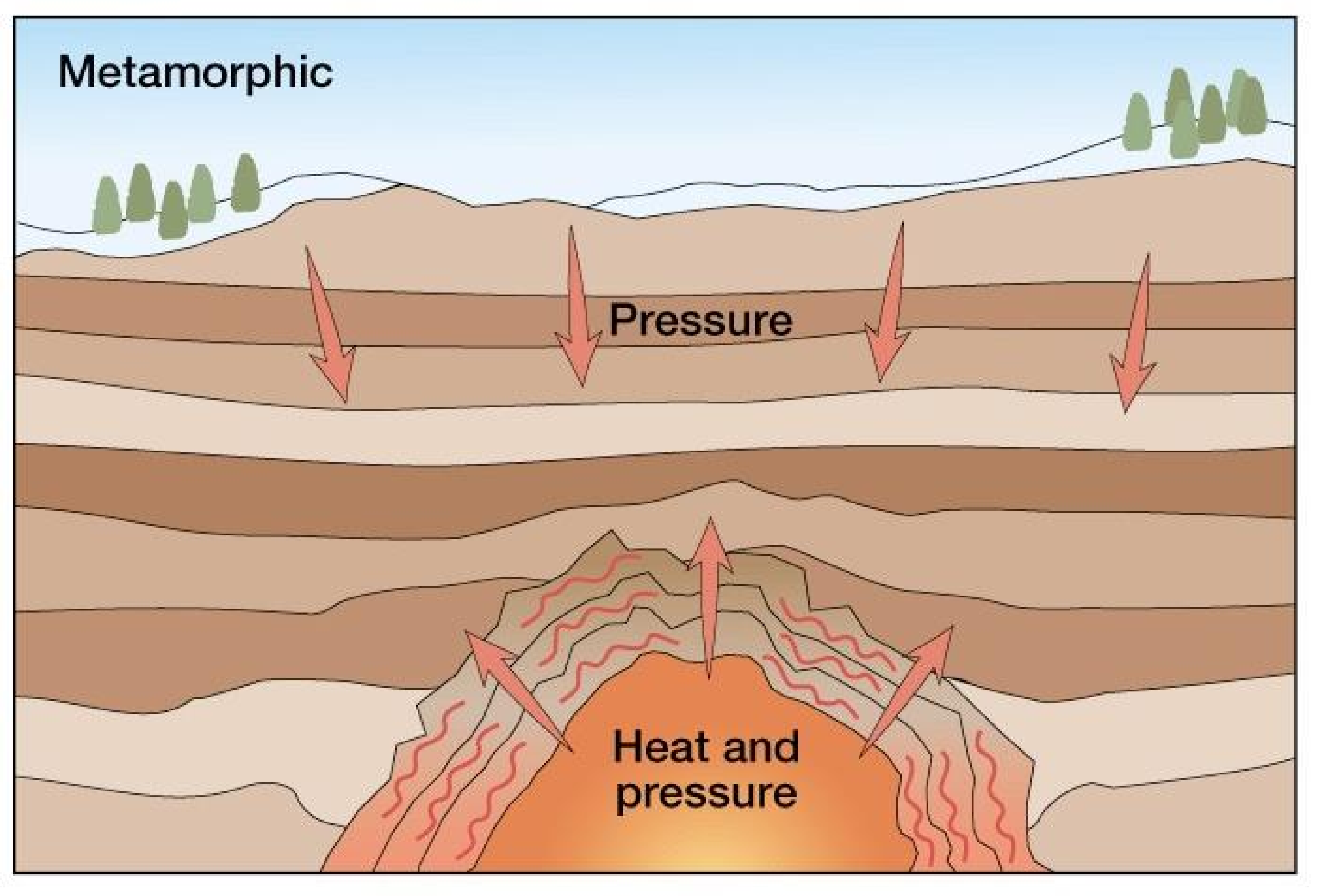
large crystals

Metamorphic Rocks

Metamorphic rocks = any original transformed by heat, pressure, hot fluids

Typical metamorphic = gneiss (granite transformed)

Metamorphic Rocks

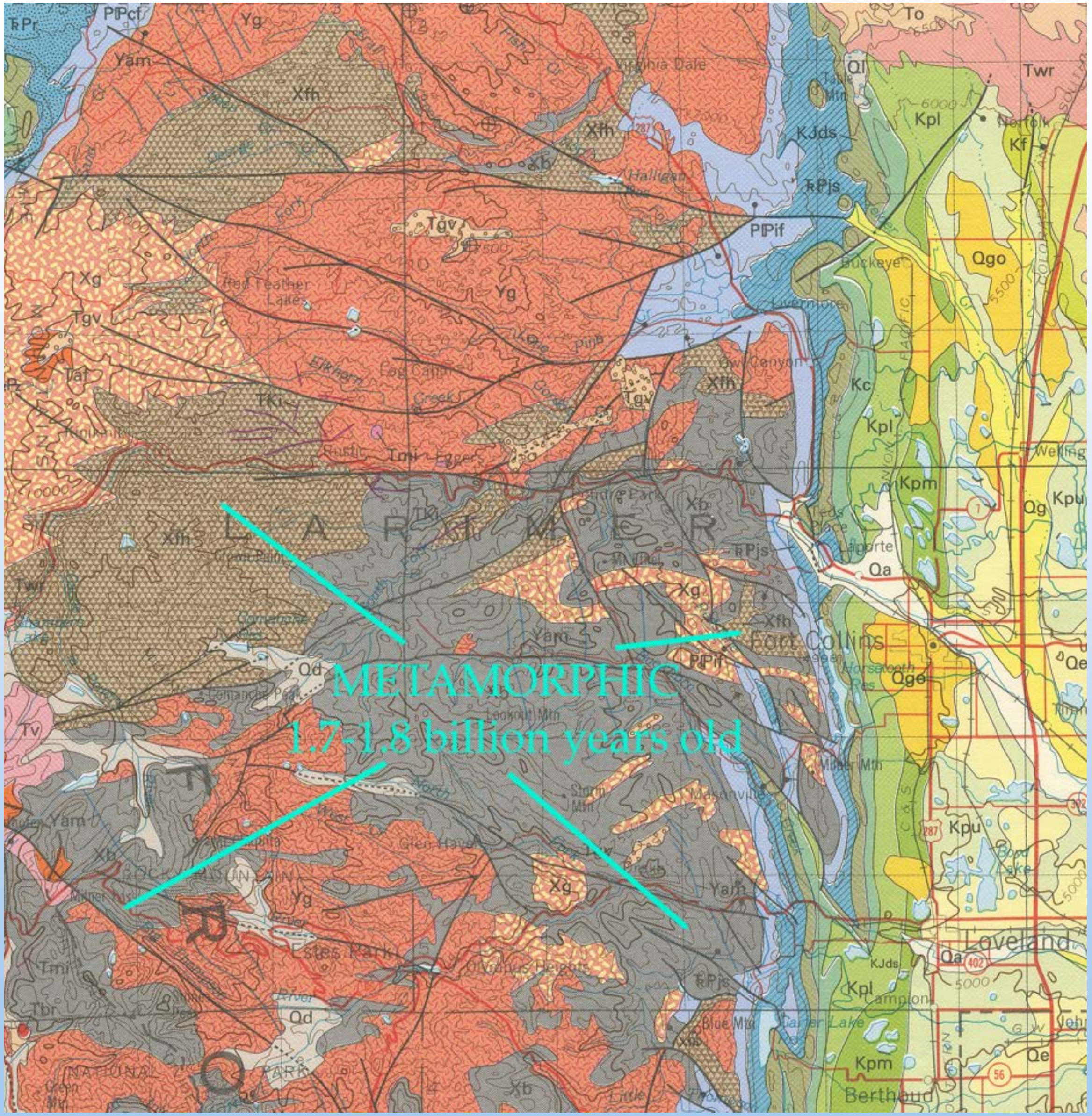


McKnight & Hess, *Physical Geography*

Metamorphic Rocks

closest mountain rocks west of Fort Collins = mostly metamorphic

approx. 1.7 billion years old



METAMORPHIC
1.7-1.8 billion years old
LARIMER
Fort Collins
Loveland
Estes Park
Berthoud

Gneiss at Gateway

-minerals in bands

-bands often wavy

-veins may cut across

Identifying metamorphic Metamorphic Rocks

Can be difficult because:

- often same composition as igneous – they are just altered versions of original rock

Granite

Gneiss

Plains Rock Type

Sedimentary

Sedimentary Rocks

Material:

—worn off somewhere else,

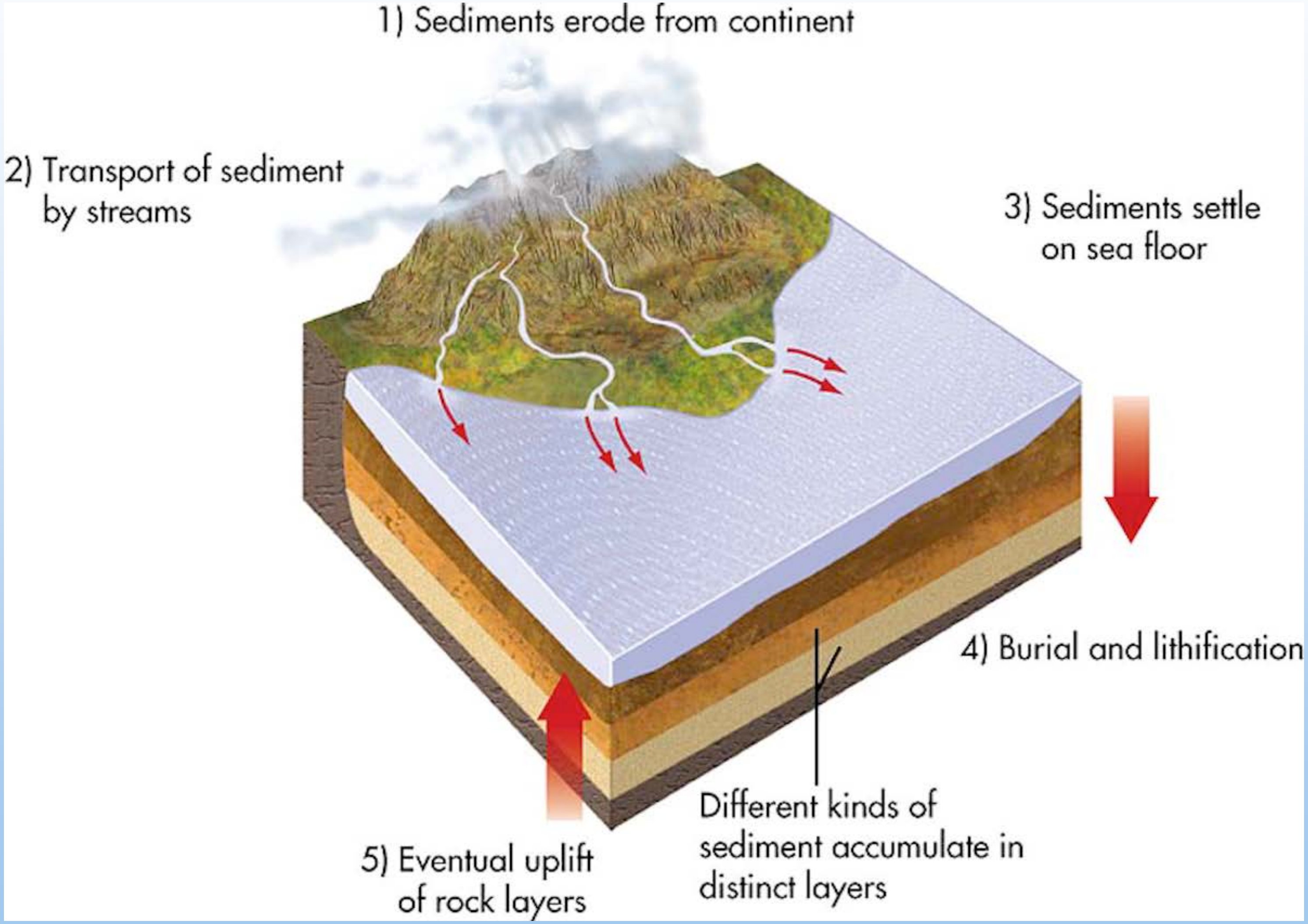
—carried by water and wind,

—settles out in layers (mostly in water)

—later cemented together

Oldest on bottom

Sedimentation



Sedimentary Rocks

Sandstones – sand, in layers

sorted by grain size

Conglomerates – sand and pebbles

mix of several sizes

Shales – layers of mud, layers often thin

very fine particles

Identifying Sedimentary rocks

- —Layers parallel to each other
- —Usually break along these
  "bedding planes" → (flagstones)
- —Often fine grained

Sandstone

Conglomerate

Shale

GEOLOGIC HISTORY

Ancestral Rockies

Rose above sea ca. 300 million ybp about where the current mountains are

One of two large islands

- Frontrangia
- Uncompahgria

Ancestral Rockies

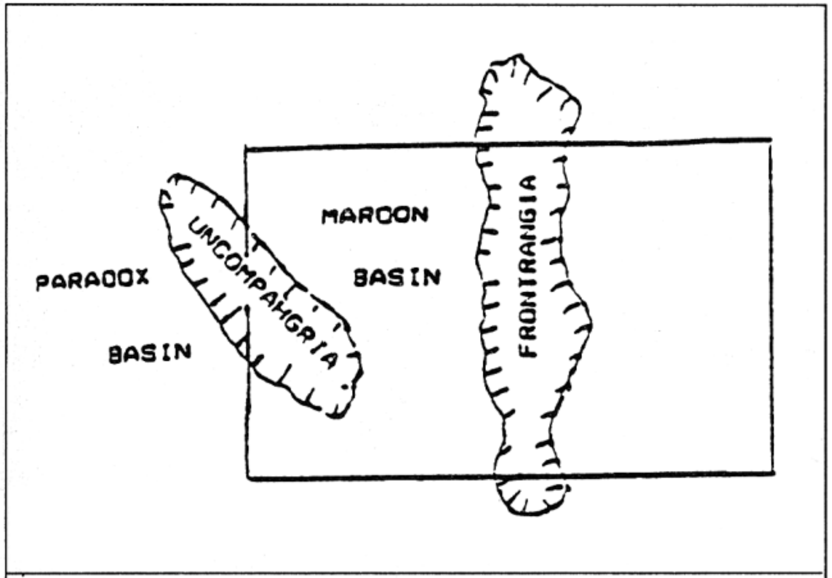


Fig. 32. The approximate location of two islands that bobbed up from the ocean that covered Colorado in Pennsylvanian time.

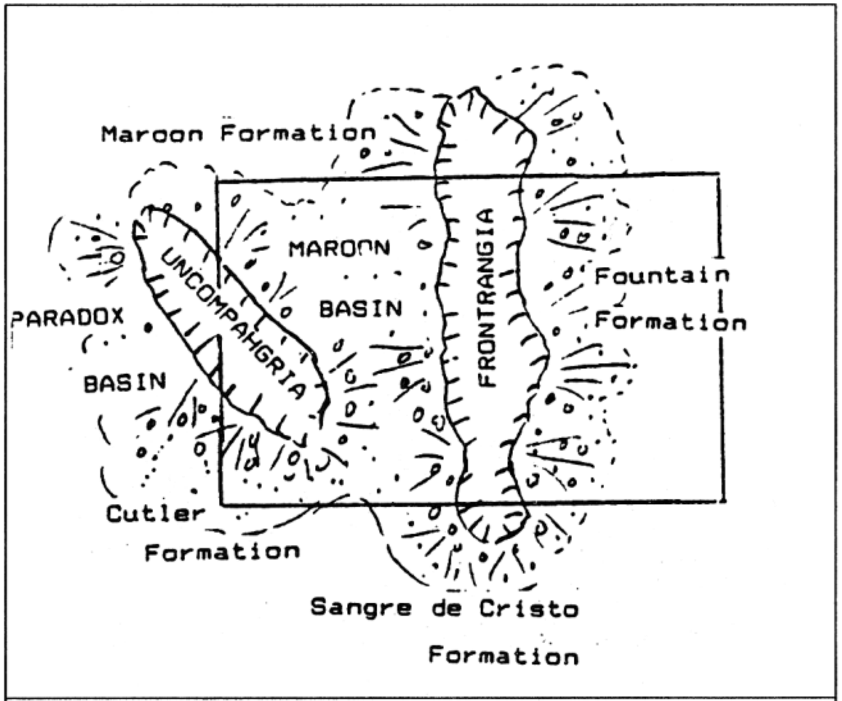


Fig. 33. Coarse, arkosic sediments spread from the two islands to become the Cutler (west), Maroon (center), Fountain (east), and Sangre de Cristo formations (south).

Foutz, Geology of Colorado p. 25

FOUNTAIN FORMATION

280 million ago from Ancestral Rockies

—thick — av. 800 ft

—conglomerate

—varying hardness

—lying on metamorphic rocks
more than 1 billion years older

—purplish, pinkish color

Ancestral Rockies Mountains

Johnson & Raynolds, *Ancient Denvers*

Fountain Conglomerate

Boulder Flatirons

Red Rocks

Fountain Formation
Bobcat Ridge

LYONS FORMATION

—climate very dry (Pangaea)
—sand dunes
—fine grained sandstone,
—well cemented, resistant
—economically important

Lyons Sandstone

260 million
ybp

Johnson & Raynolds, *Ancient Denvers*

Lyons Sandstone

LYKINS FORMATION

—low hills and muddy, slimy, hot salt flats

—limestone and mudstone

—easily eroded (now soil covered)

—first reptiles

—followed by Permian extinction

Lykins Formation

250 million ybp

Johnson & Raynolds, *Ancient Denvers*

MORRISON FORMATION

– age of dinosaurs
– area very flat (mountains gone)
– sediments ca. 400 ft. thick

Morrison Formation

150 million
ybp

Johnson & Raynolds, *Ancient Denvers*

DAKOTA GROUP

—sandy coast of shallow sea

—sediments from mts. in W. Utah
beach sands, thin muds

—plant fossils & dinosaur prints

—very resistant to erosion

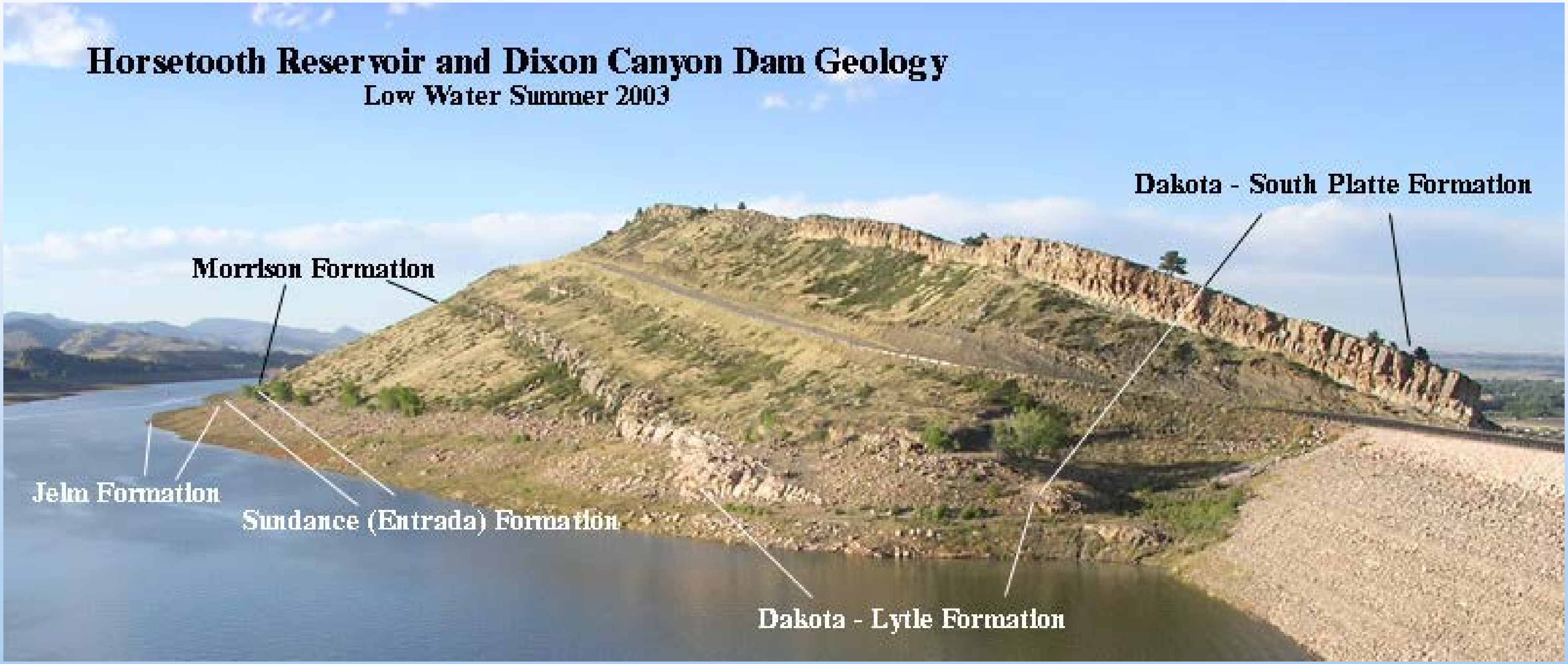
Dakota Group

ca 100 million yrs bp

Johnson & Raynolds, *Ancient Denvers*

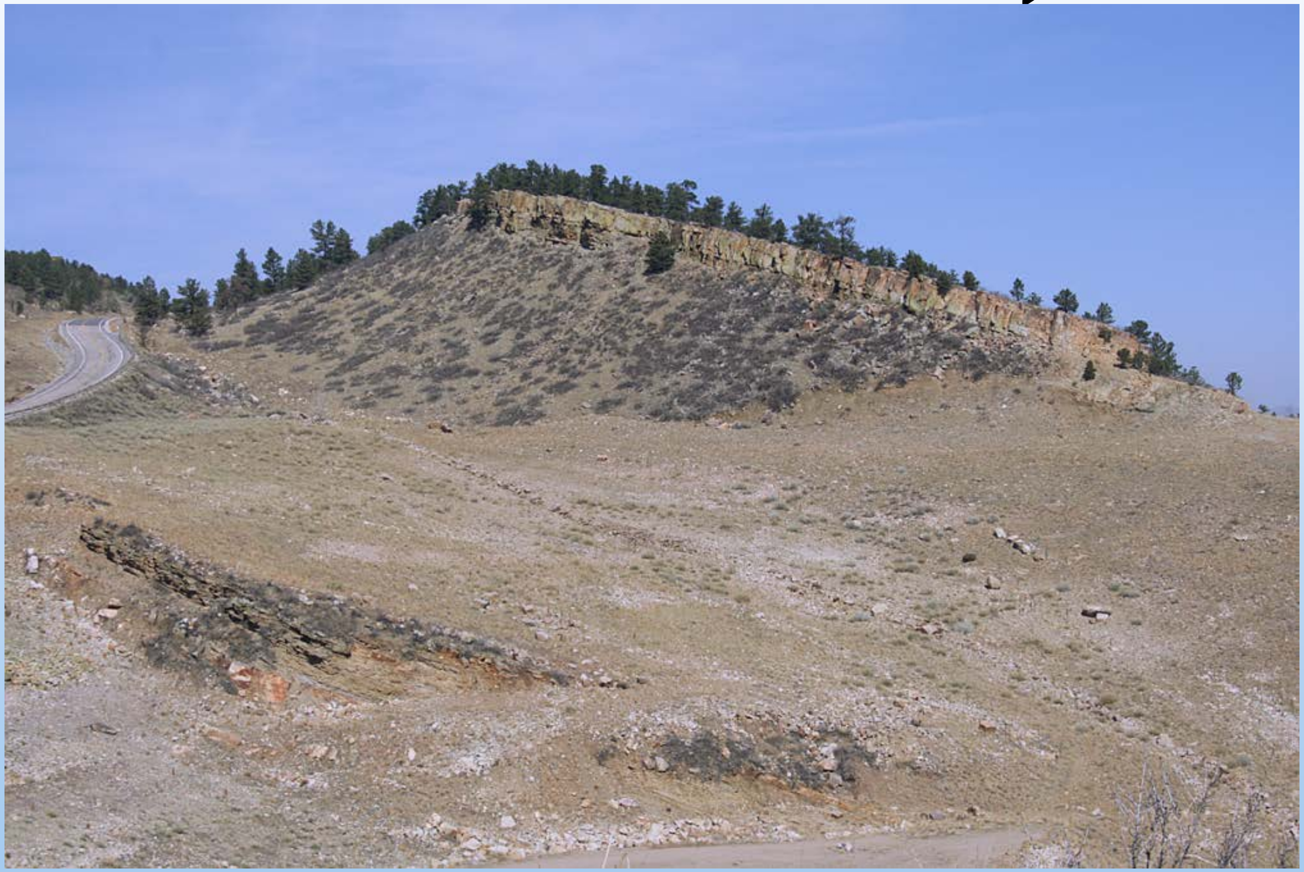
Dakota near Red Rocks

Dakota group



staffweb.psdschools.org
The Horsetooth Quadrangle Virtual Geologic Field Trip

Dakota (South Platte Formation)



Ripples-South Platte

(Dakota)

Dakota (Lytle Formation)

Devil's Backbone

NIOBRARA FORMATION

85 million years ago

—marine origin

—shale and chalk

—abundant small fossils & oil

—endemic plants (Bell's twinpod)

Niobrara

PIERRE FORMATION

—Colorado mostly under water

—muddy sediments more than
1 mile thick

—the rock beneath Fort Collins

—rarely exposed (soil covered)

Pierre

70 million
years bp

Johnson & Raynolds, *Ancient Denvers*

Pierre Shale

Processes creating local landforms

—Mountain building

—Selective erosion

—Rivers

Mountain building

“Laramide Orogeny”

Laramide Orogeny

70 to 40 million ago current Rockies rose in series of pulses (3rd or 4th set of mountains here)

…. probably still rising

Plate push from west

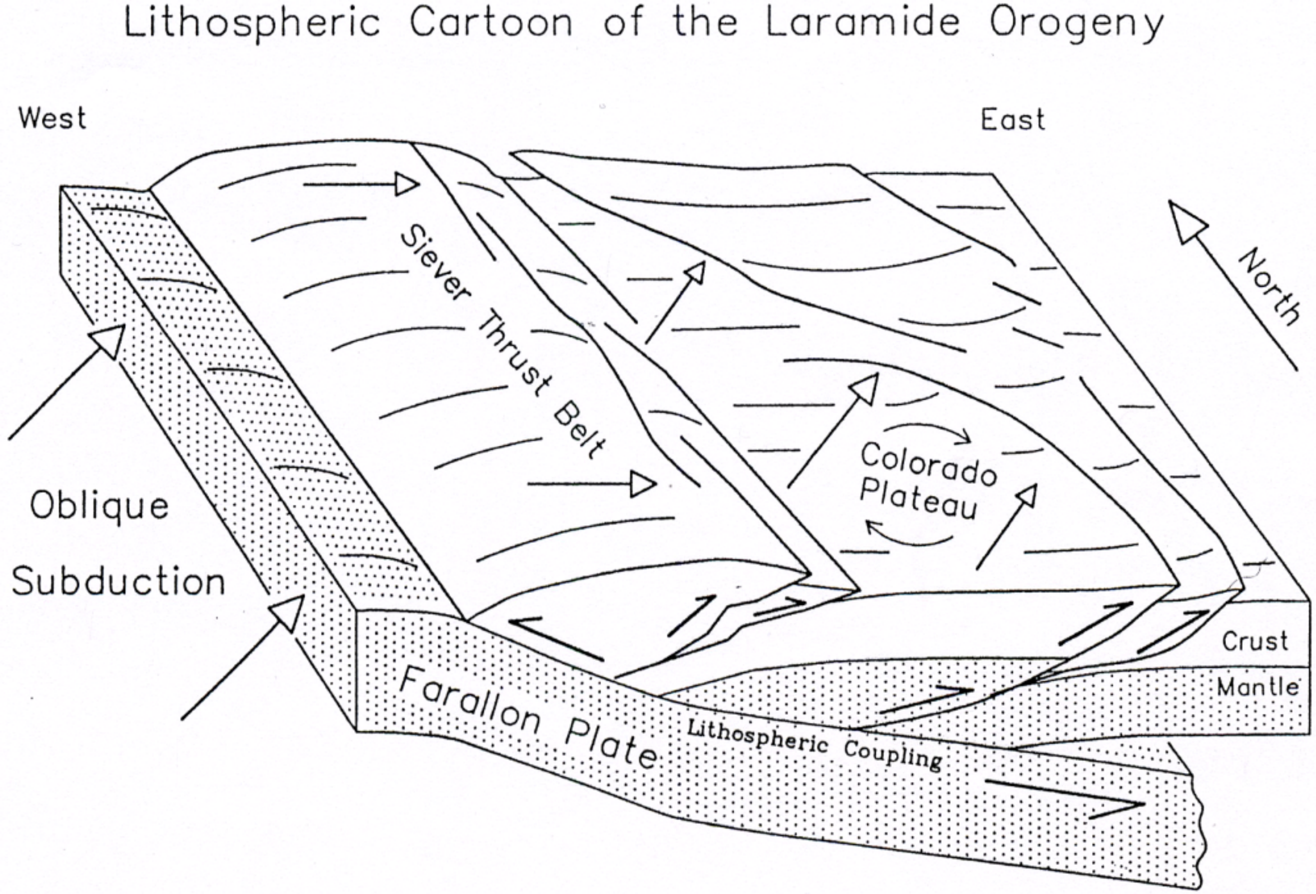


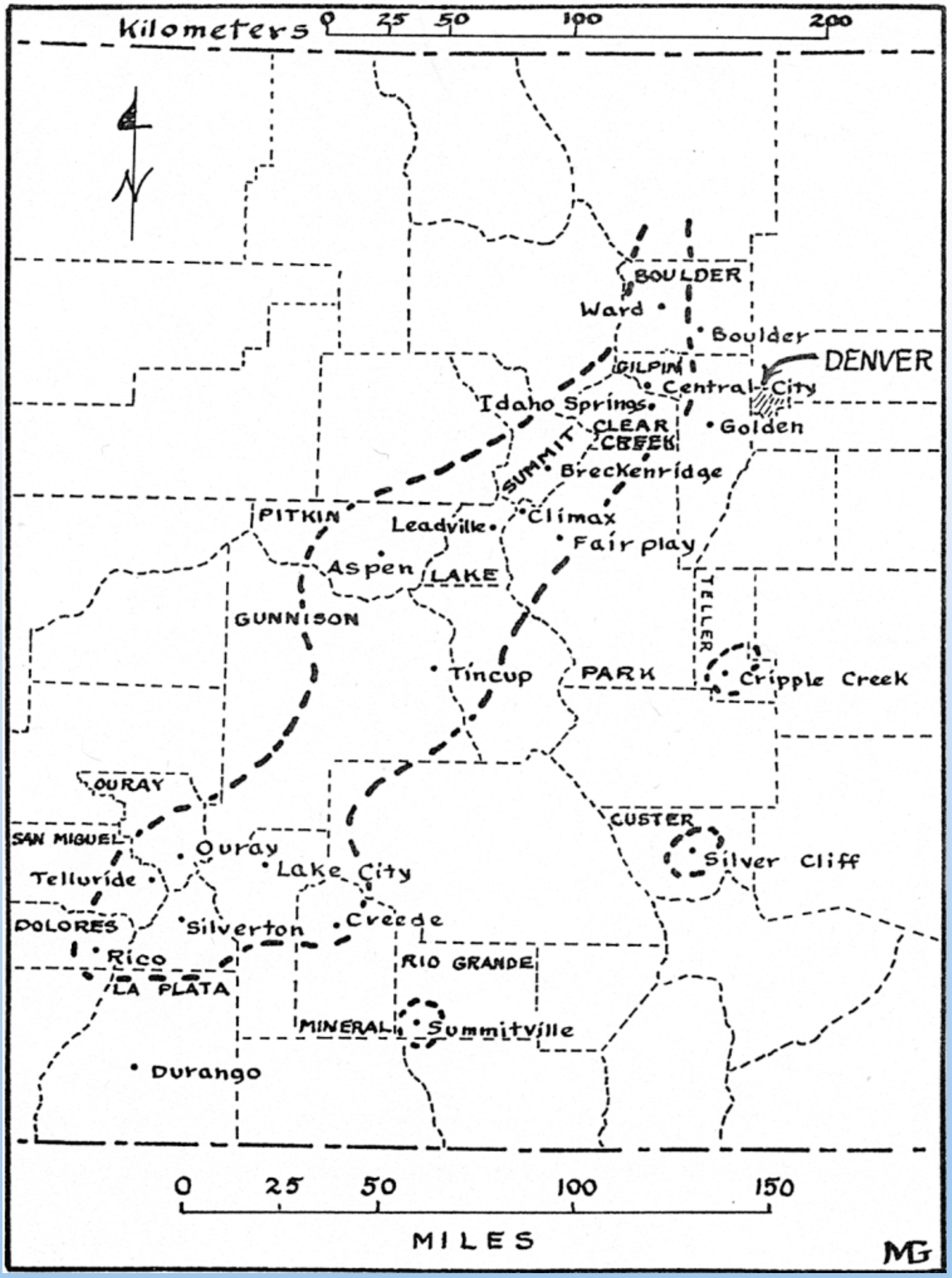
Fig. 1.5. Model for rotation of the Colorado Plateau by northward-increasing slip on a master detachment underlying the plateau (from Erslev, 1993).

Holdaway, MA Thesis 1998

Laramide Orogeny

During and after mountain building:

1. two major periods of volcanic activity
2. magmatic intrusions and metamorphism
3. faulting and folding



Griffiths & Rubright, *Colorado*

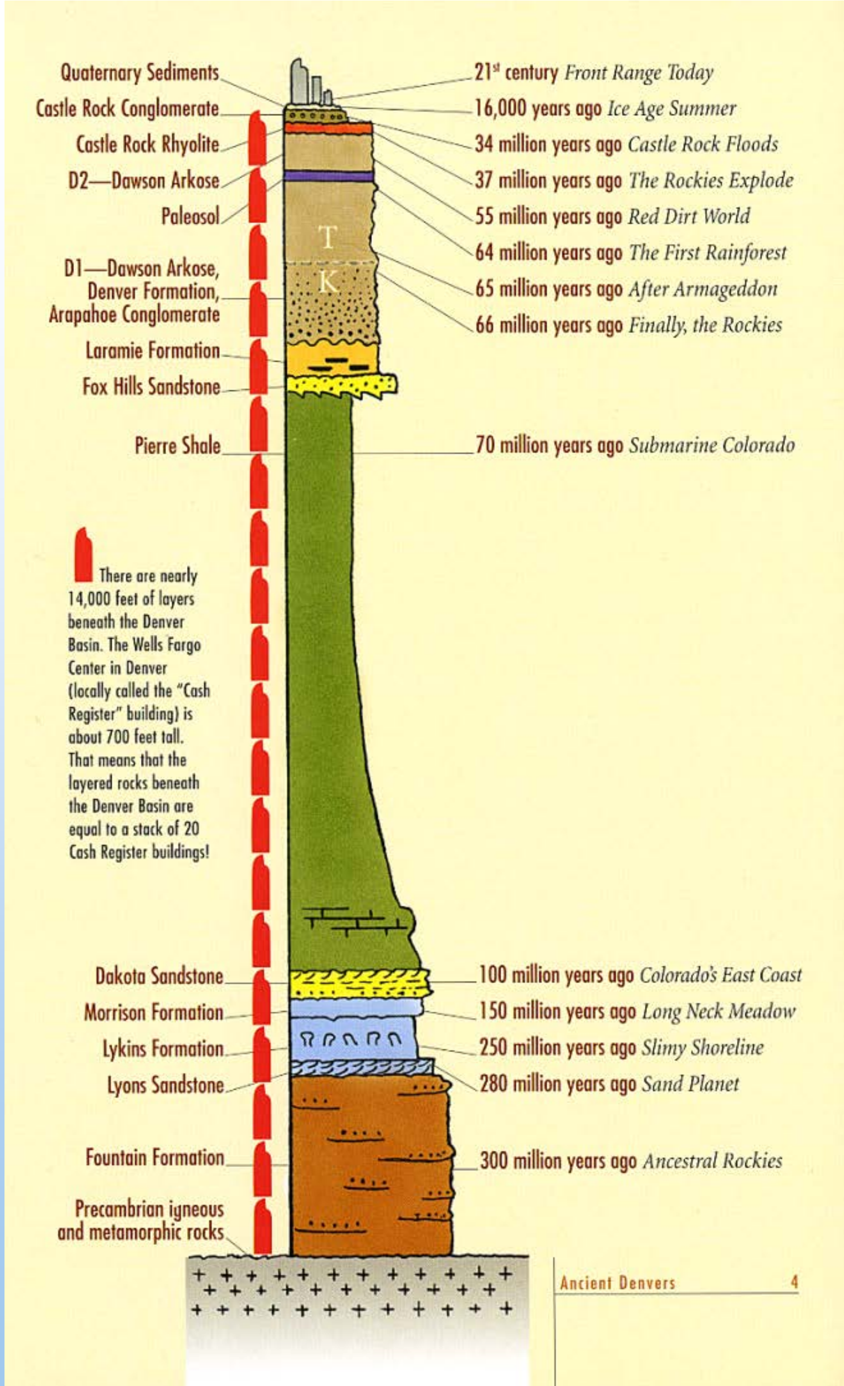
Colorado Mineral Belt

Vein

Mountain erosion

As mountains rose, they were being worn away ⟶ source of huge volume of sediments = sedimentary rocks of Plains

-10,000—15,000 ft. deep



Relative Sediment Depths

(Total = ca 14,000 ft)

Johnson & Raynolds, *Ancient Denvers*

Folding and Faulting

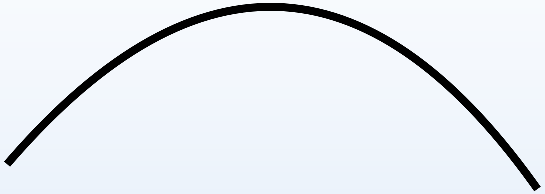
Forces that lifted Rockies caused surrounding sediments to bend and break

Folding

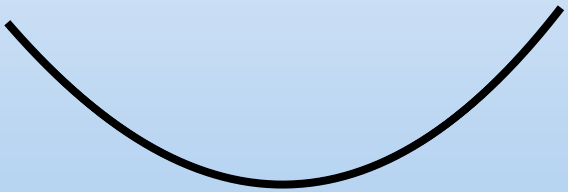
anticlines and synclines

compression

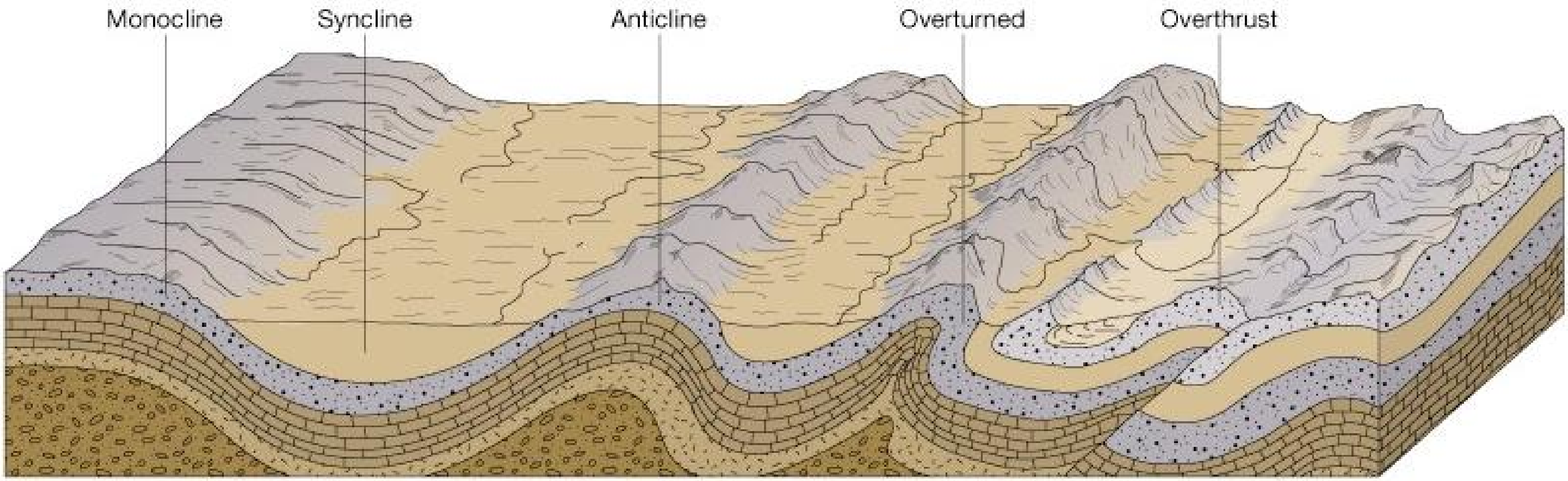
Anticline — up



Syncline — down

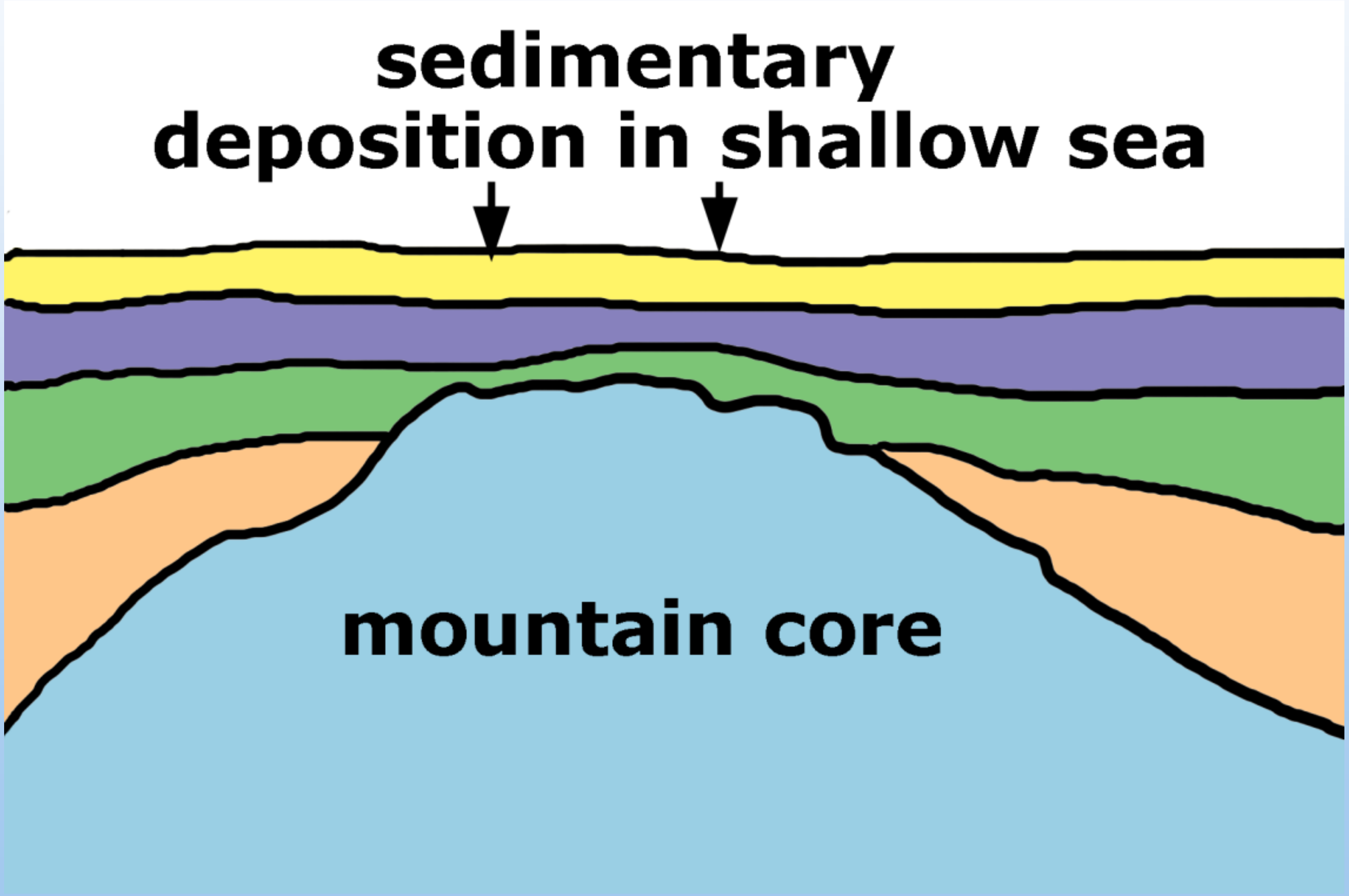


Types of Folds



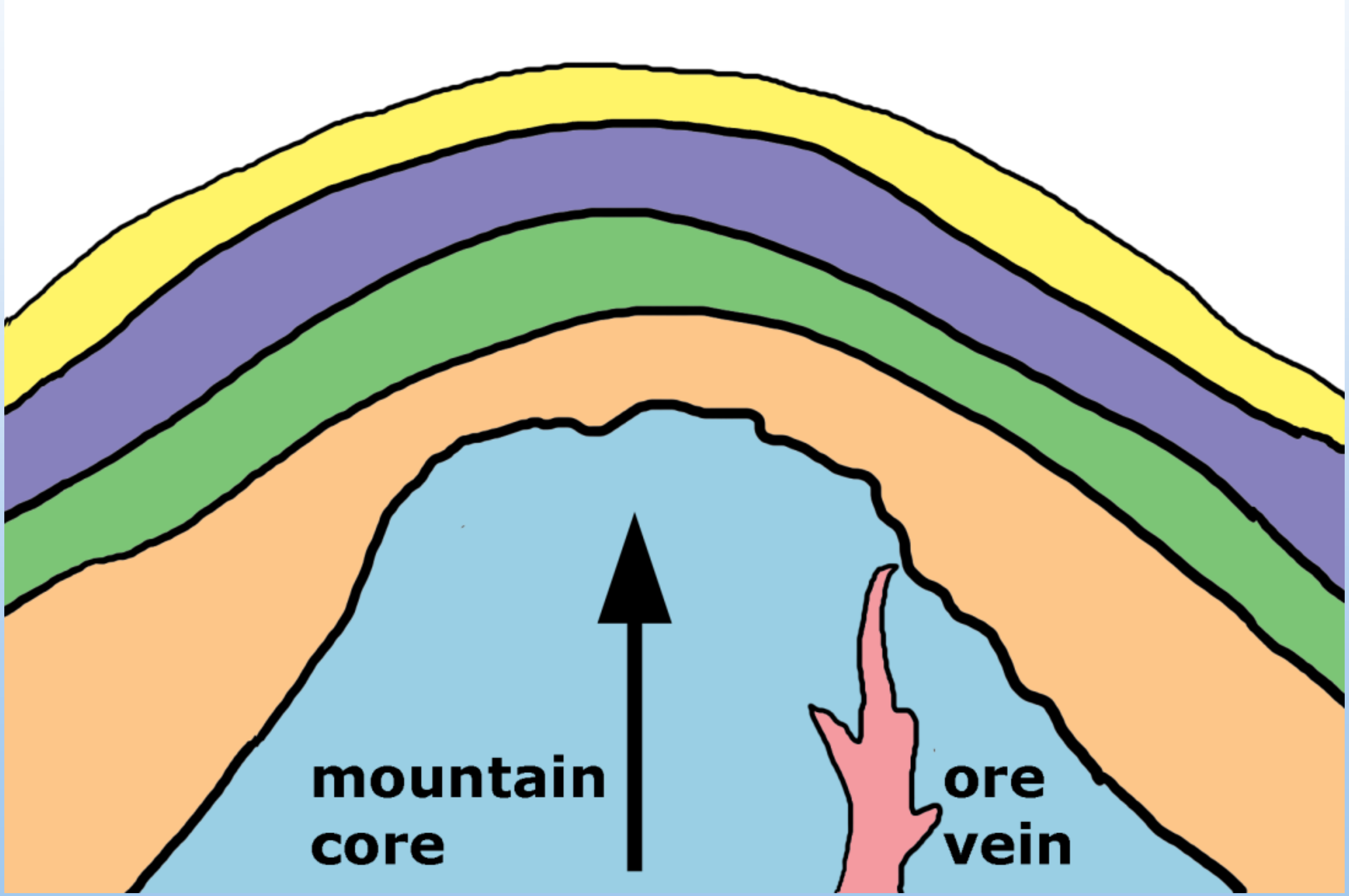
McKnight and Hess, *Physical Geography*

Prior to orogeny



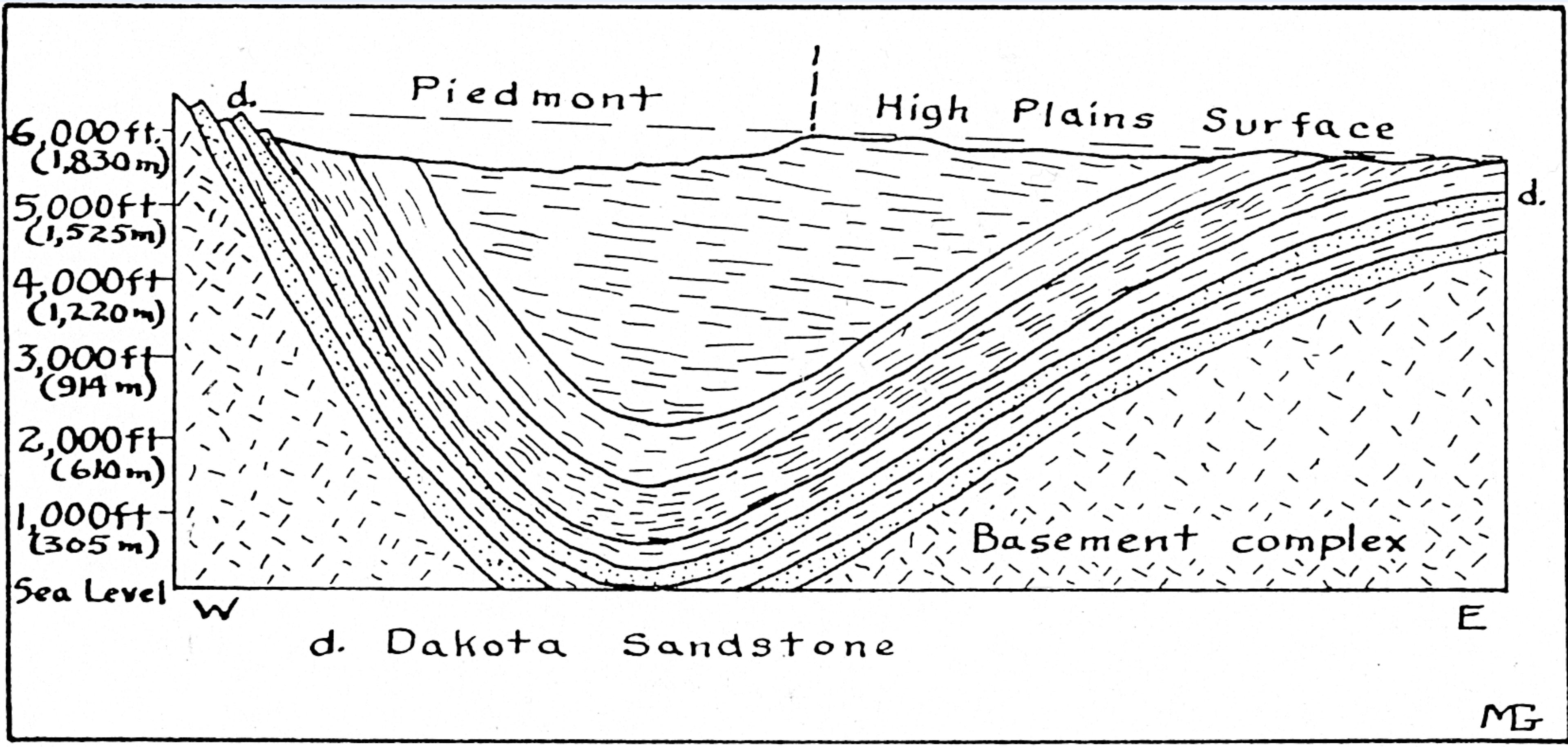
Mountain Uplift

(broadly anticlinal)



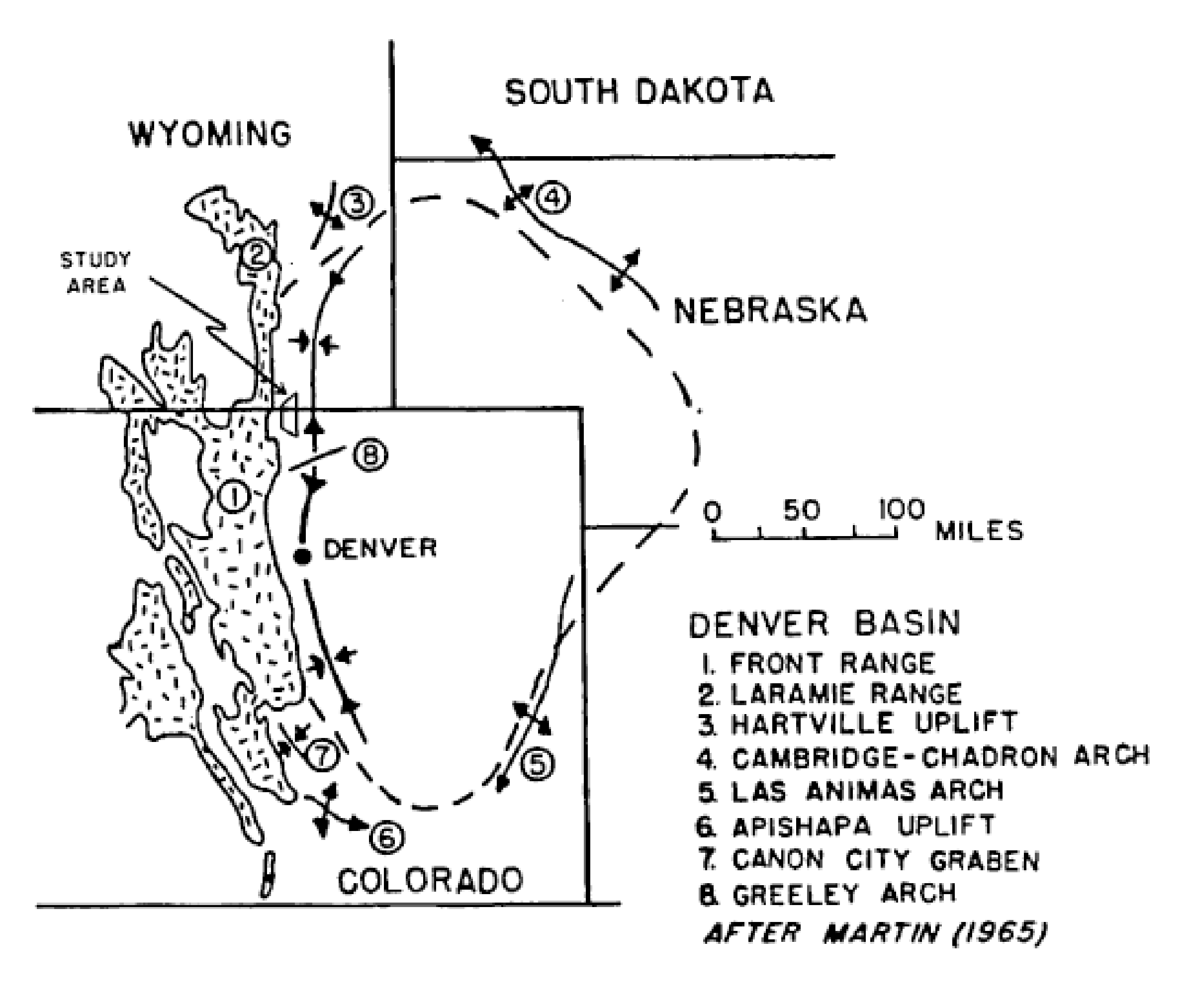
Anticlinal uplift accompanied by synclinal downwarp east of mountains

Synclinal downwarp
Denver Basin



Griffiths & Rubright, *Colorado*

Denver Basin



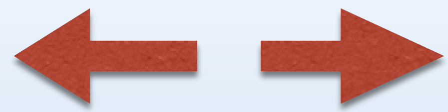
Grube, Dakota Group Stratigraphy,

Faulting

breaking & moving

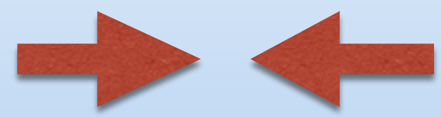
Faults

1. Tension



Normal fault

2. Compression

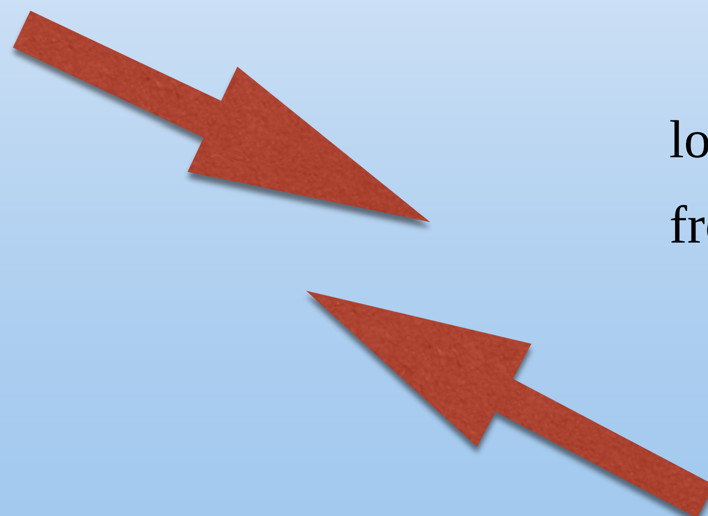


Reverse fault

Faults produced by:

3. Shear

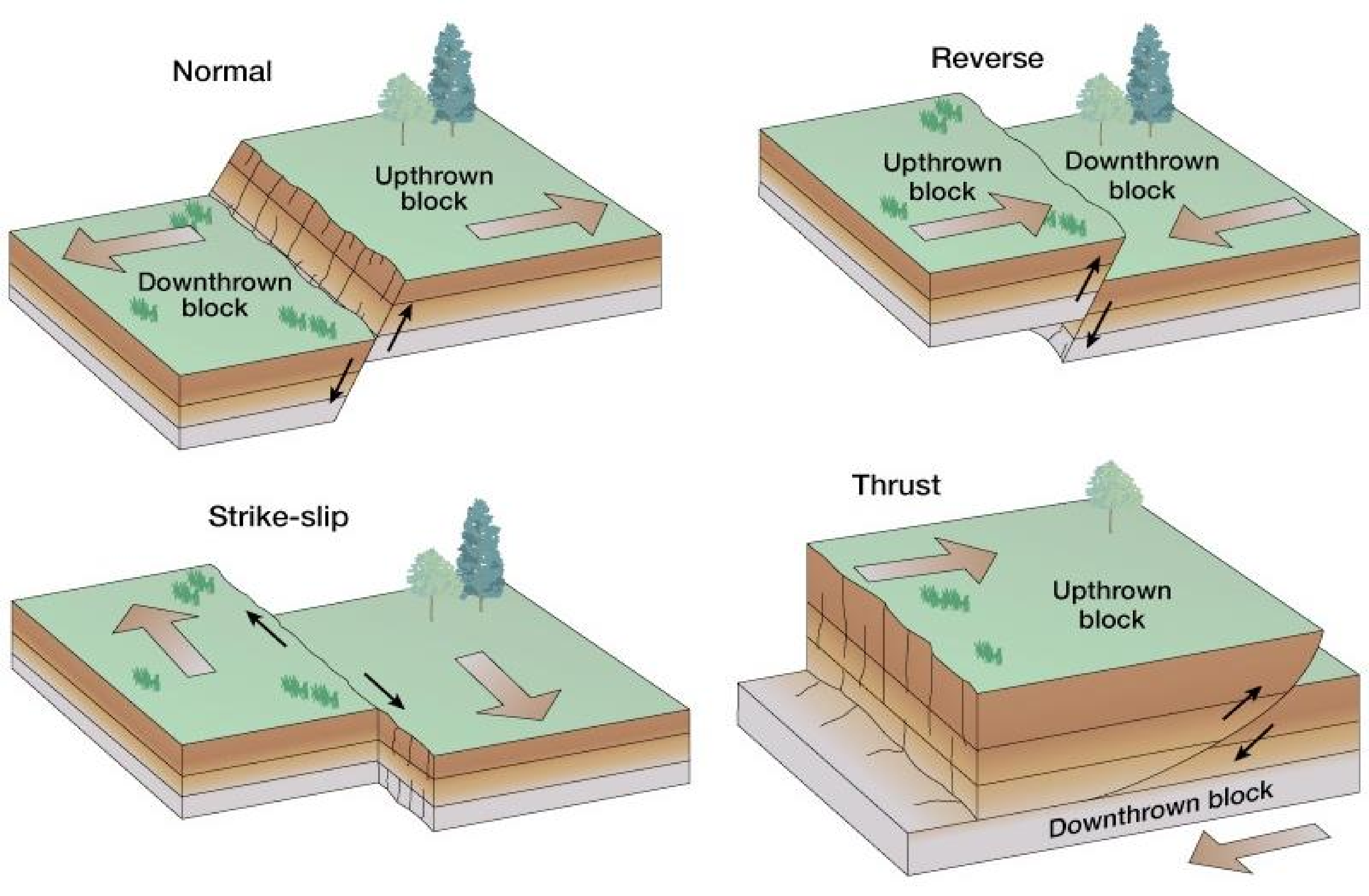
Strike-slip fault



looking down

from above

Fault types



McKnight and Hess, *Physical Geography*

Local Faults

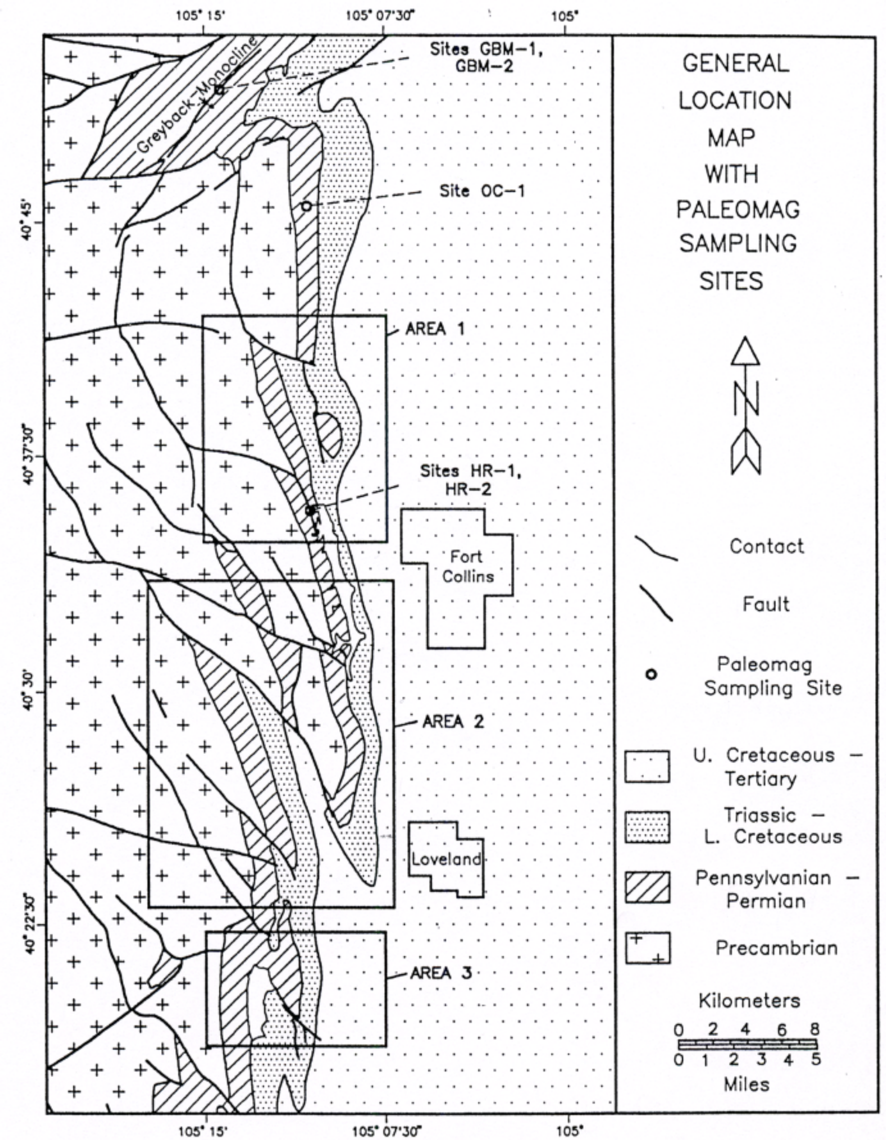


Fig. 4.1. Geologic map of the northeastern margin of the Front Range showing locations of areas 1, 2, and 3, and paleomagnetic study sites.

SELECTIVE EROSION

Demolition

Demolition can be concurrent with landform creation

Demolition — two components:

1. weathering
2. erosion

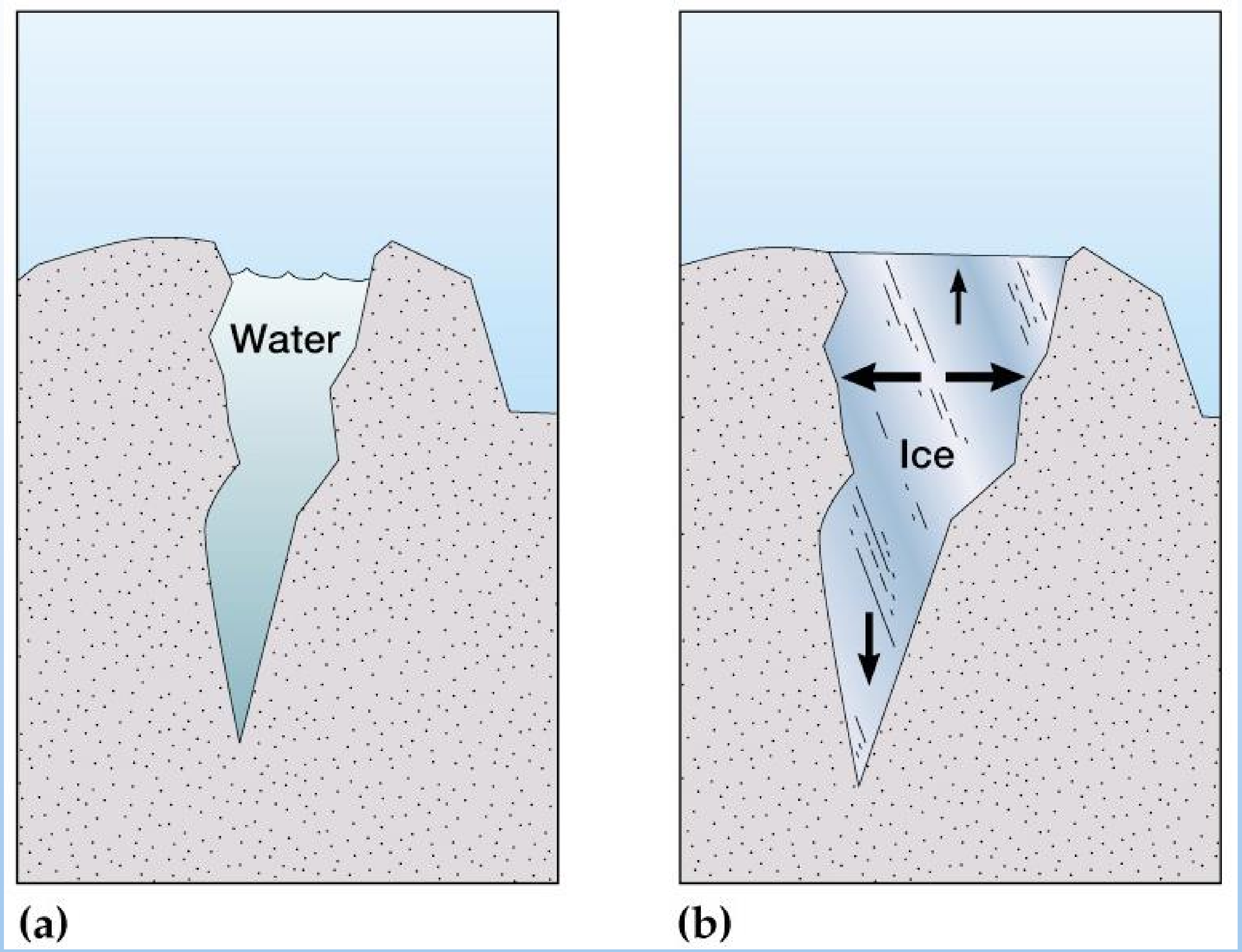
Weathering

breaks up rocks —> moveable

—mechanical

—chemical

Frost ▼ Wedging



McKnight & Hess, *Physical Geography*

Cracks in Granite

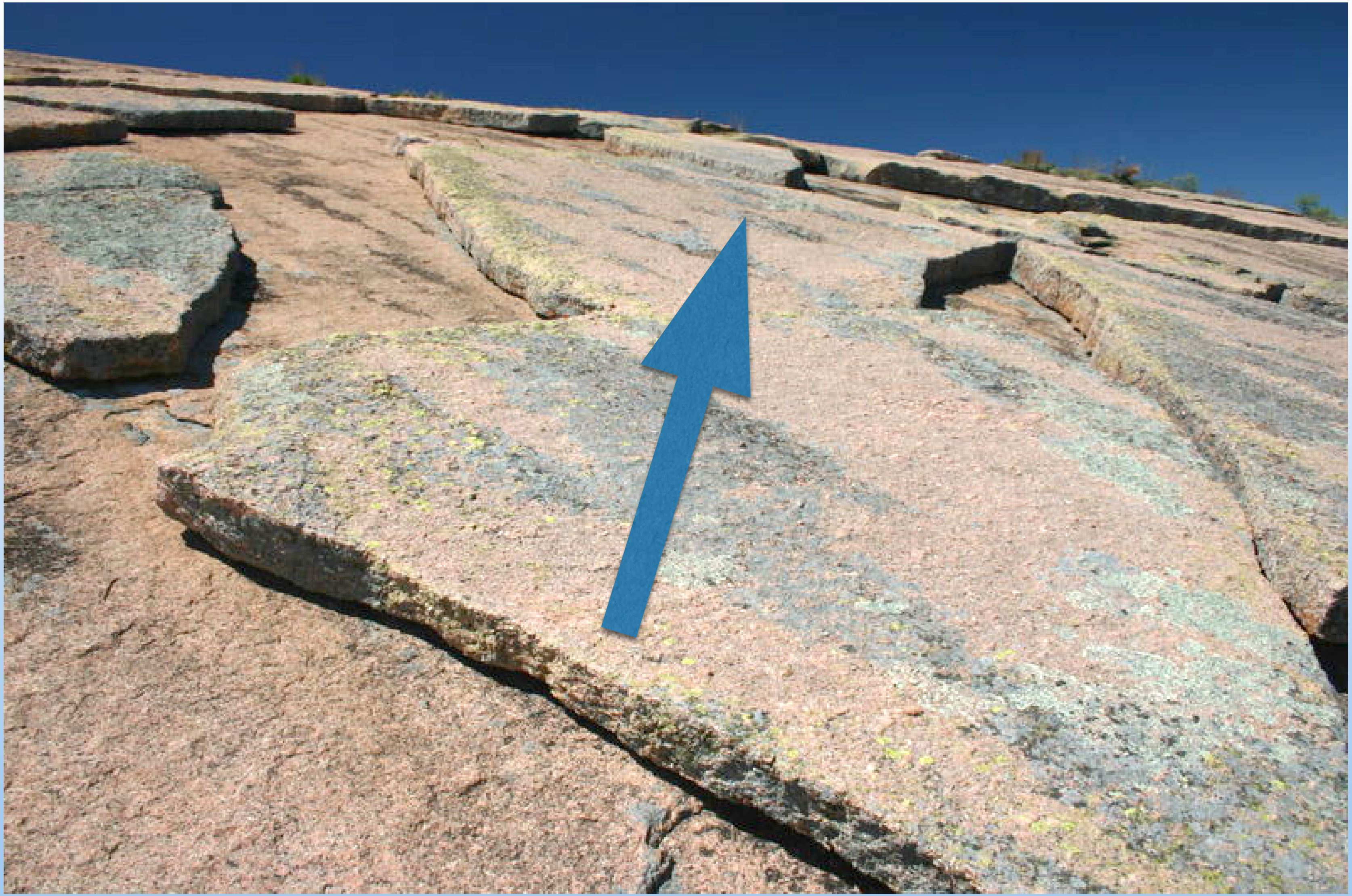
Highly Fractured Granite

Weathering of granite

Gruss

Root wedging

Unloading/Exfoliation



Chemical Weathering

Breaks down minerals within the rock

Spheroidal Weathering

Erosion

Agents of erosion:

1. gravity—-> mass wasting
2. flowing water
3. ice = glaciers
4. wind

Hogbacks

Selective erosion has left “hogbacks”

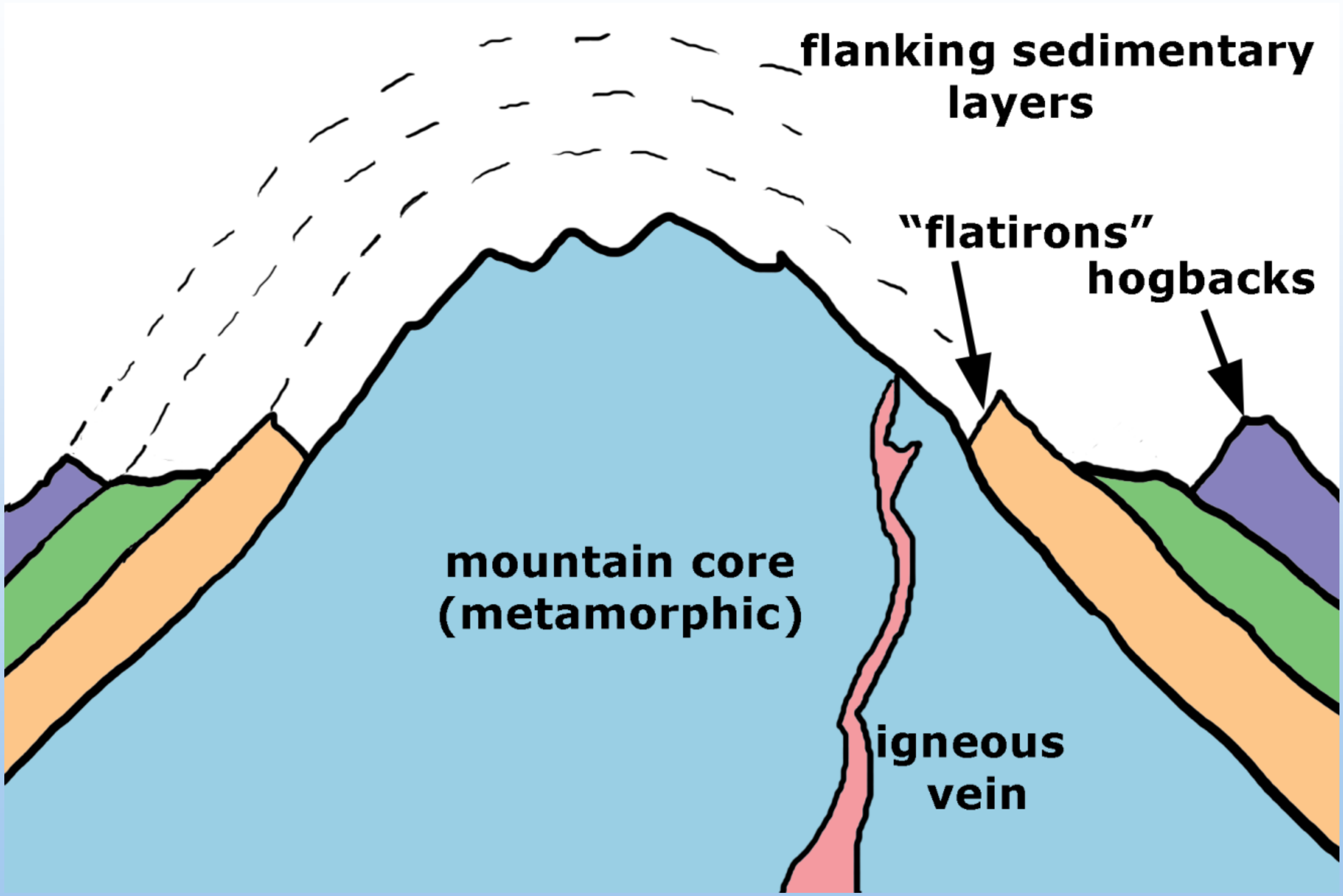
(steeply tilted sedimentary layers)

resistant beds ⟶ hogback ridges

less resistant ⟶ valleys between ridges

These are uncommon features.

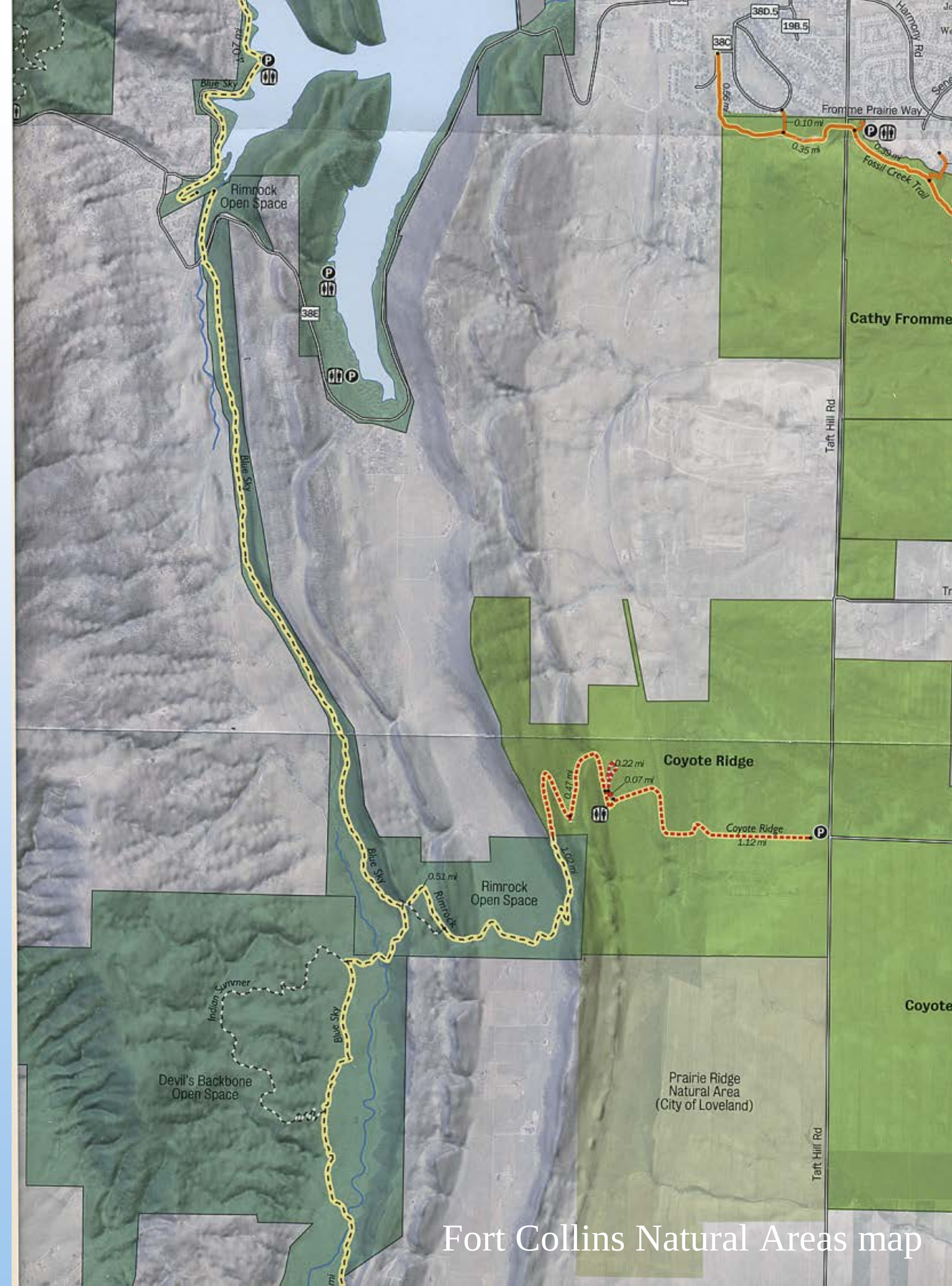
Sediment eroded away



Horsetooth Reservoir Lyons Formation

Hogback - Coyote Ridge

hogbacks



Fort Collins Natural Areas map

Exposing time

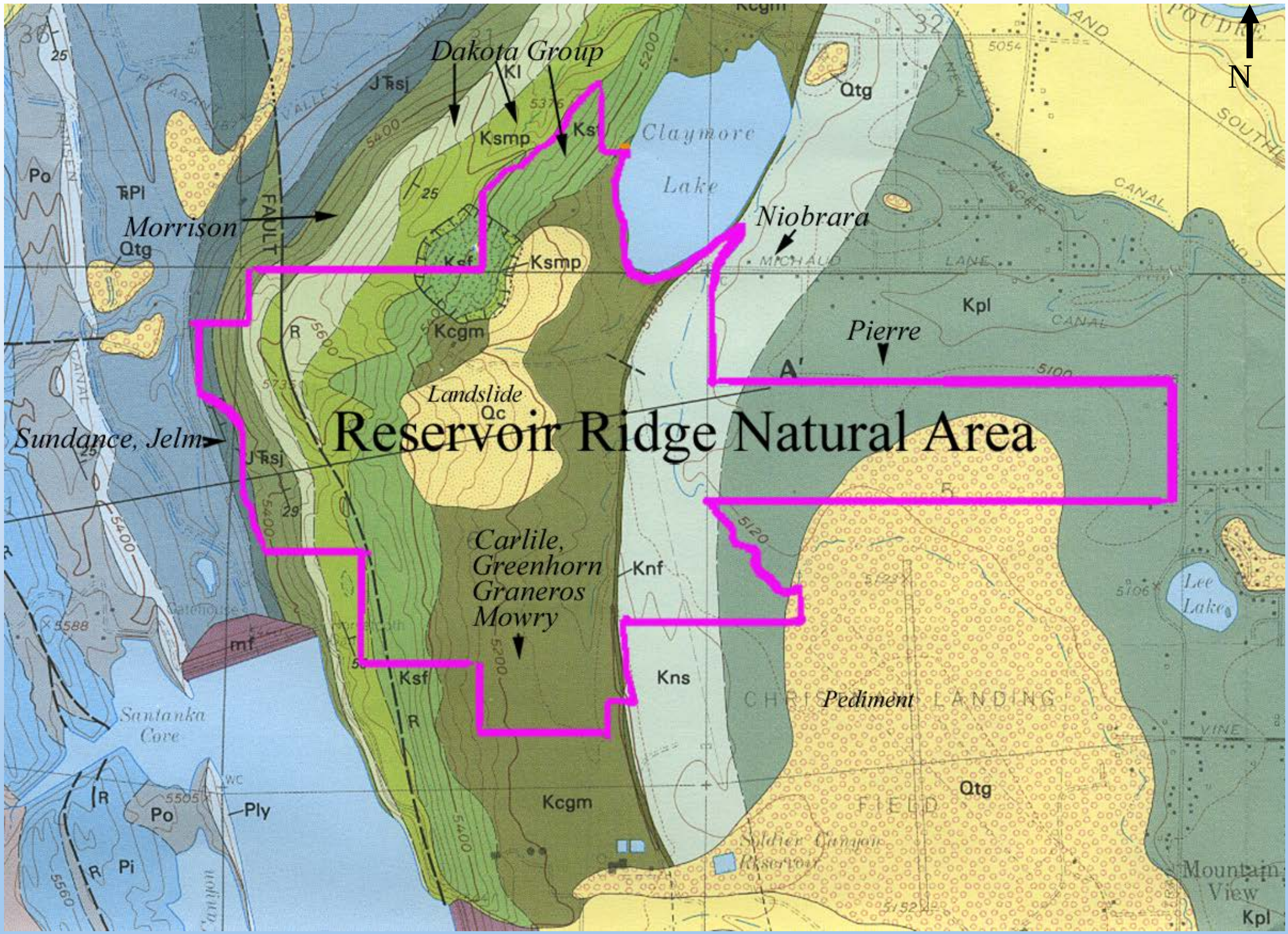
By turning beds up, the surface across them exposes hundreds of millions of years of time in a very short distance

South

Photo by Louis Maher

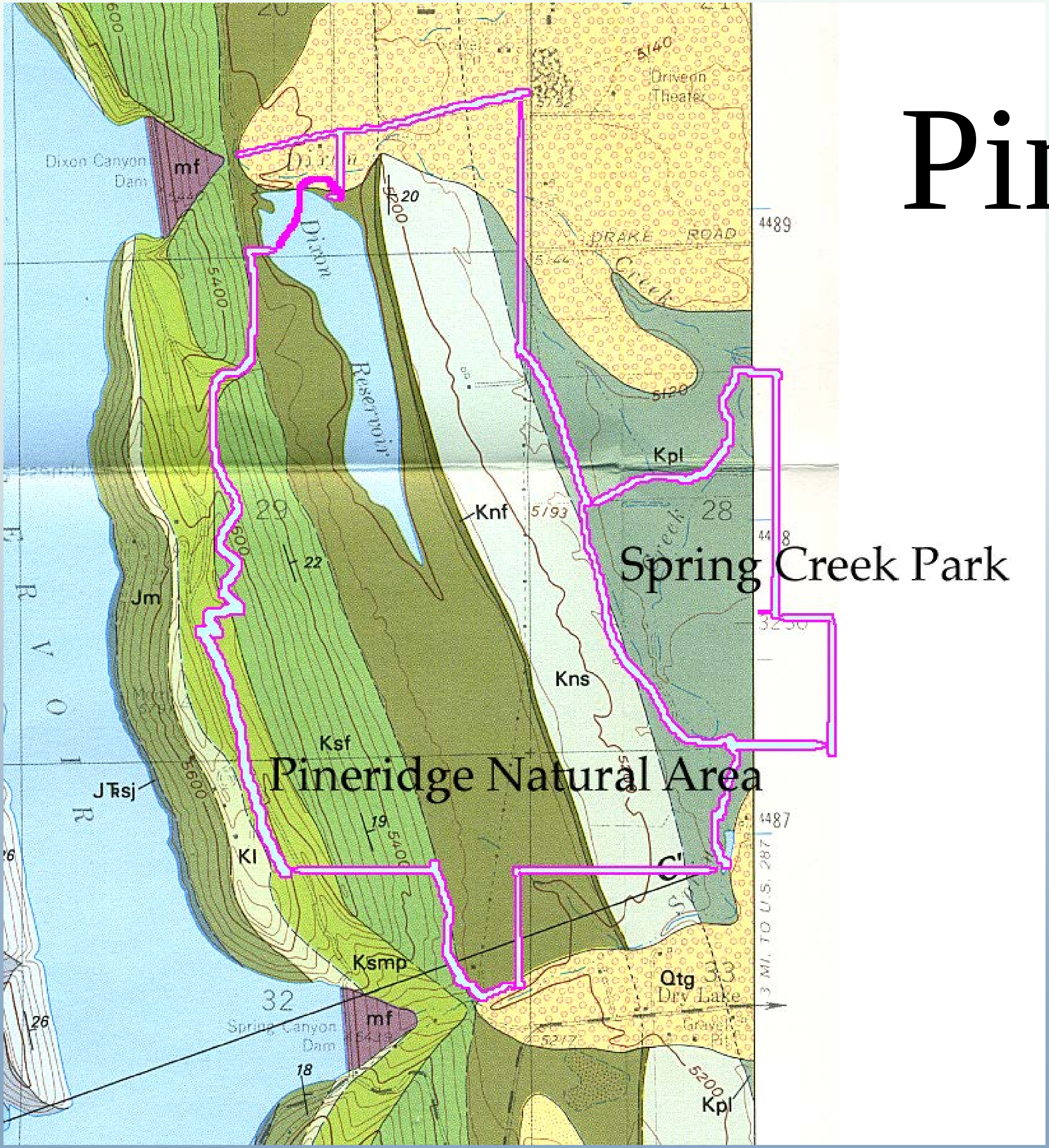
70 million ybp 100 million ybp 200 million ybp 1,700 million ypb

Reservoir Ridge Natural Area



Adapted fromBraddock et. Al Geologic Map of the Horsetooth Quadrangle

Pineridge



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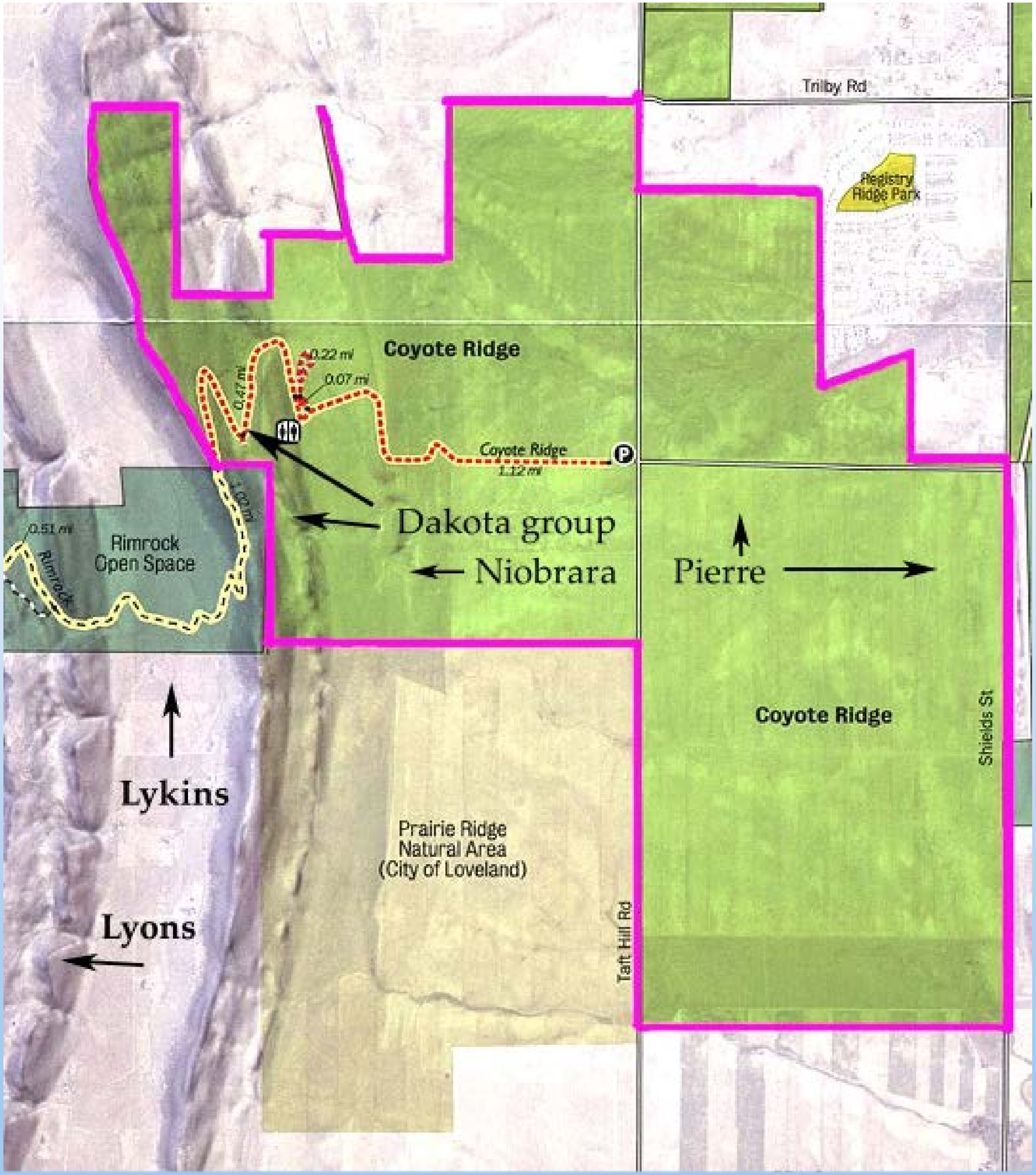
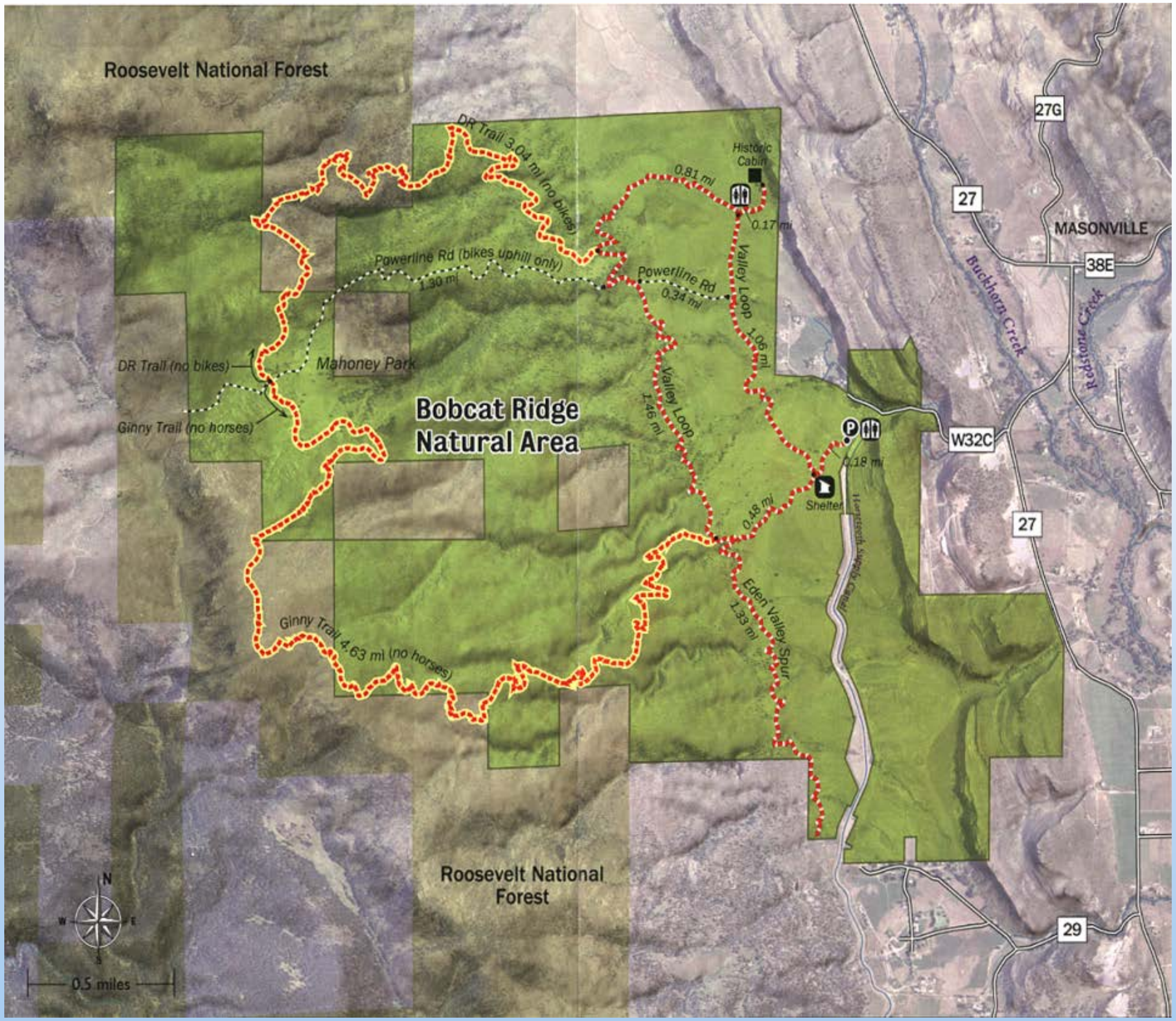
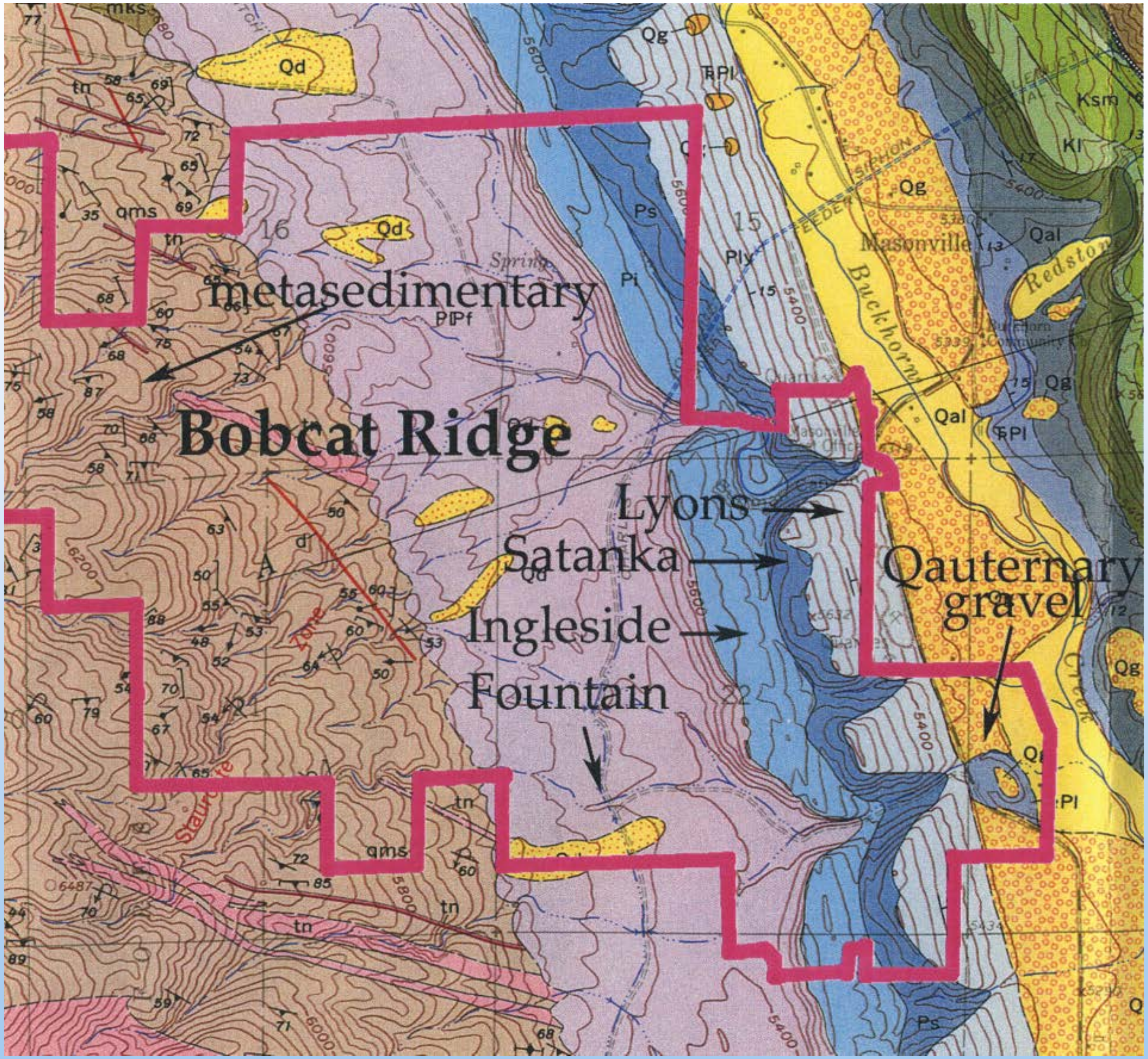


Coyote Ridge

Bobcat Ridge





Bobcat Ridge

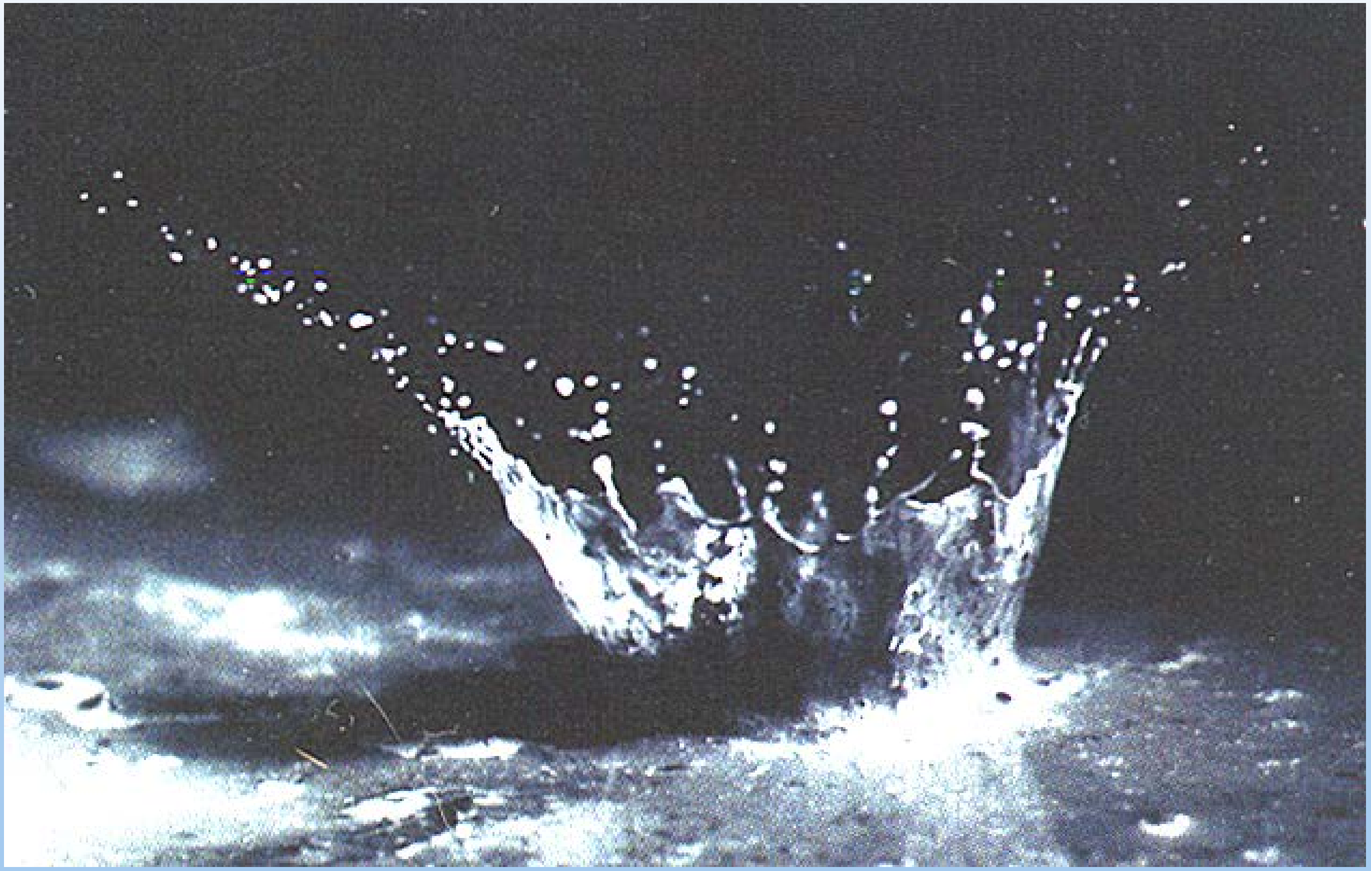
RIVERS

- —Flowing water = greatest landscape remodeler
- —Streams are highly tuned and balanced systems
- —It is all about energy

Flowing water's passion:

—plane landscape off to sea level
—carry everything off to sea

Erosion starts with raindrops



USDA

Raindrop impact

Work of streams

-Ability to remove material depends on:

—Volume (how much water)

—Velocity (how fast it is moving)

-These vary constantly

-Stream constantly adjusts its load to match its energy

Streams both:

—Remove material = Erosion

—Deposit material = Deposition

These occur:

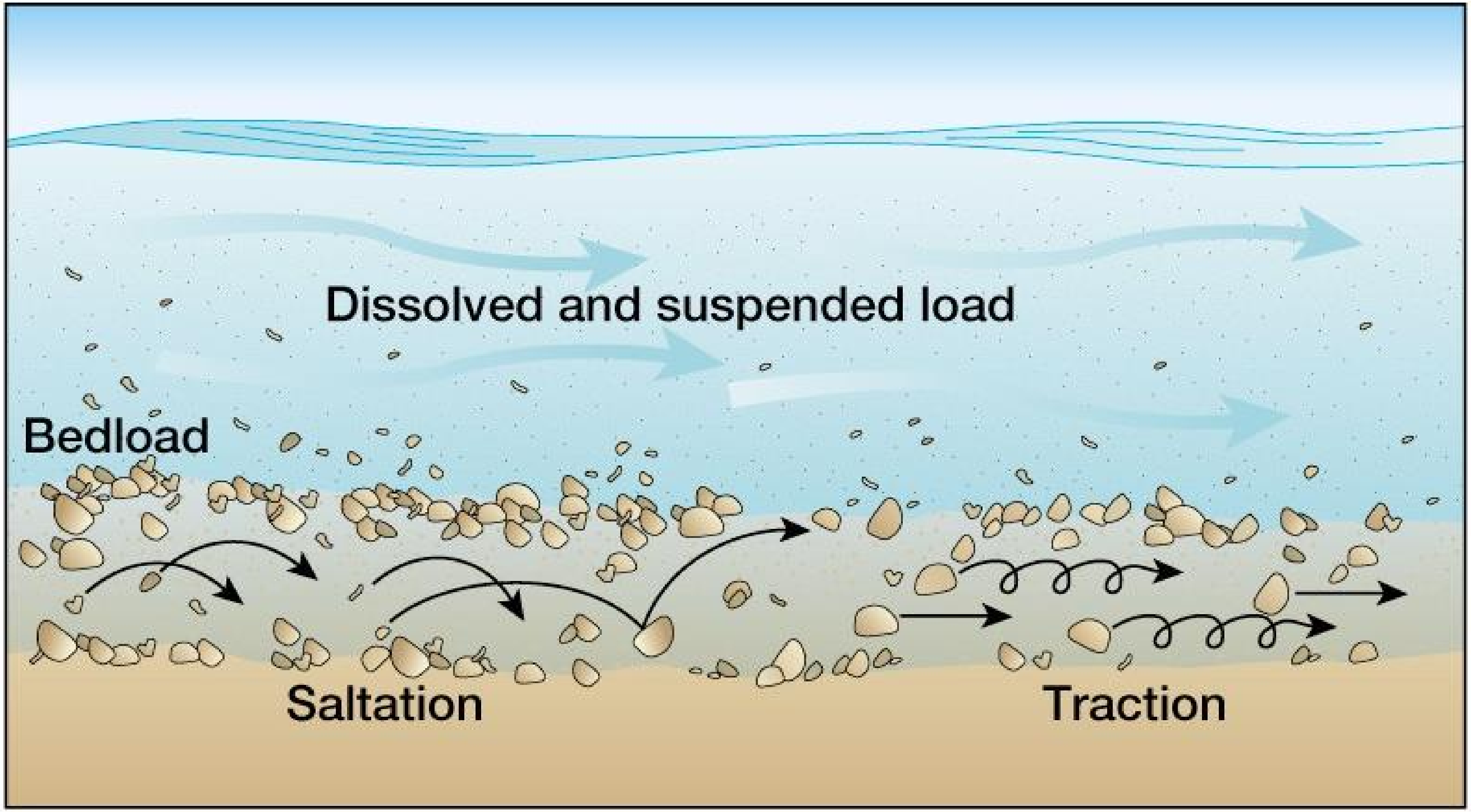
—In different parts of stream

—Same part at different times

Streams work by:

1. Power of current - push, roll
2. Abrasion - rub smooth
3. Corrosion - chemically dissolve

Streams move things

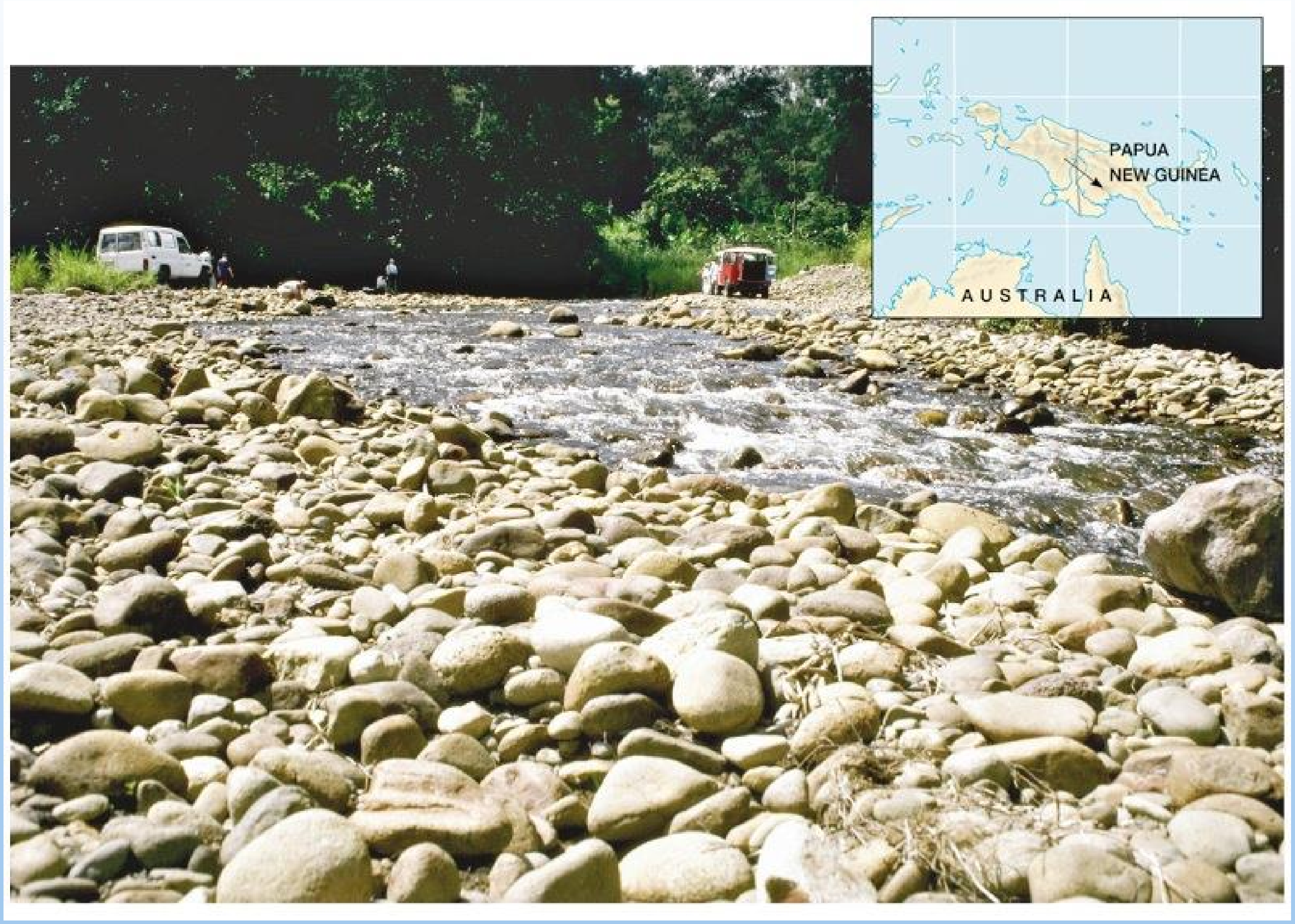


Arbogast, *Discovering Physical Geography*

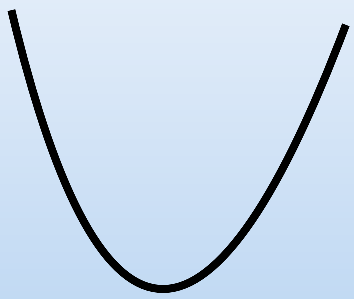
Power of the current

Lawn Lake Flood

Streambed Abrasion



Valley Shape reveals stream energy



down-cutting
(high energy)

depositing
(low energy)

Valley Shape

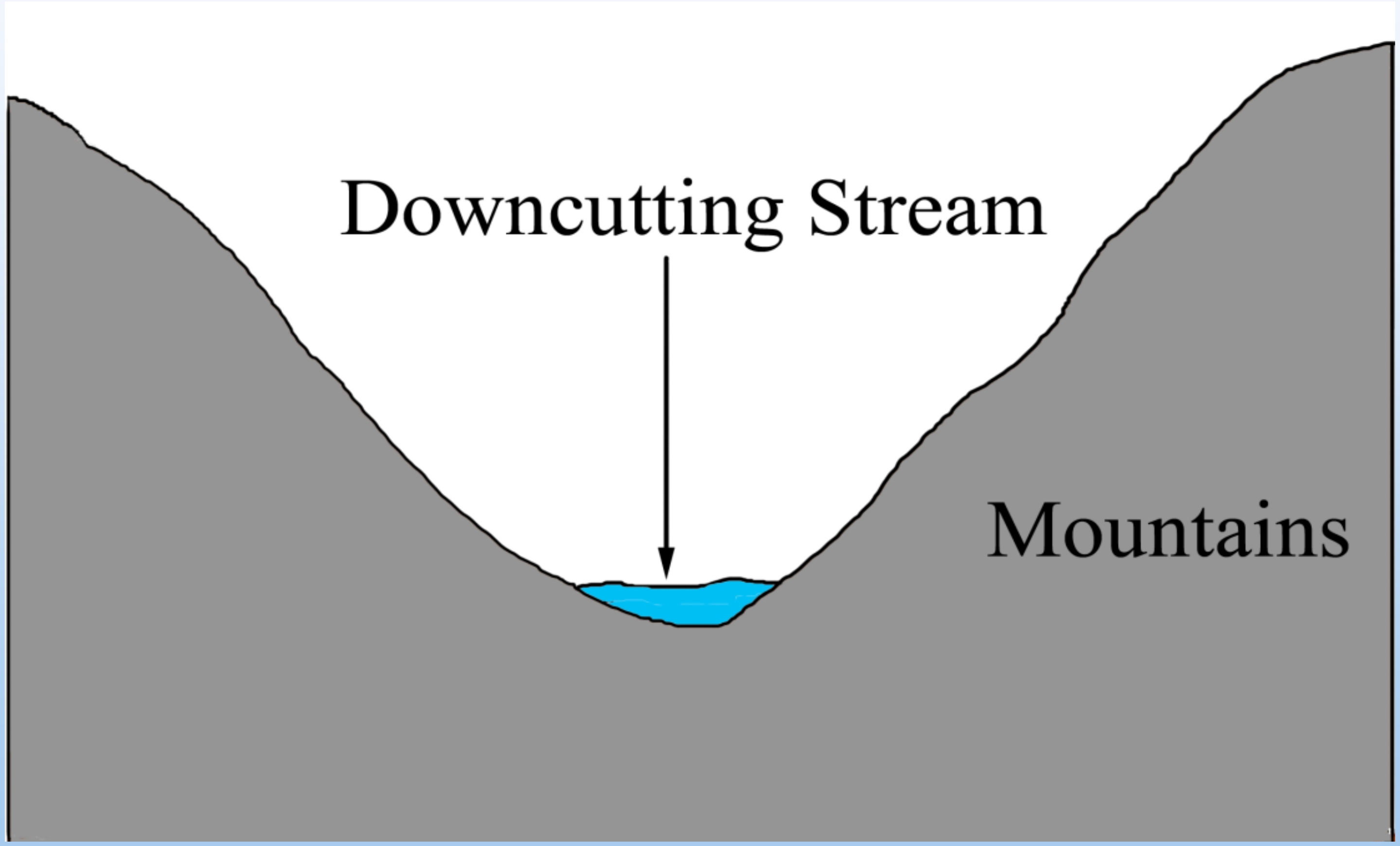
Eroding stream = cutting down

—steep gradient

—“straight” course

—steep valley sides

‘V” shaped valley



Steep Gradient/High Energy

Deposition

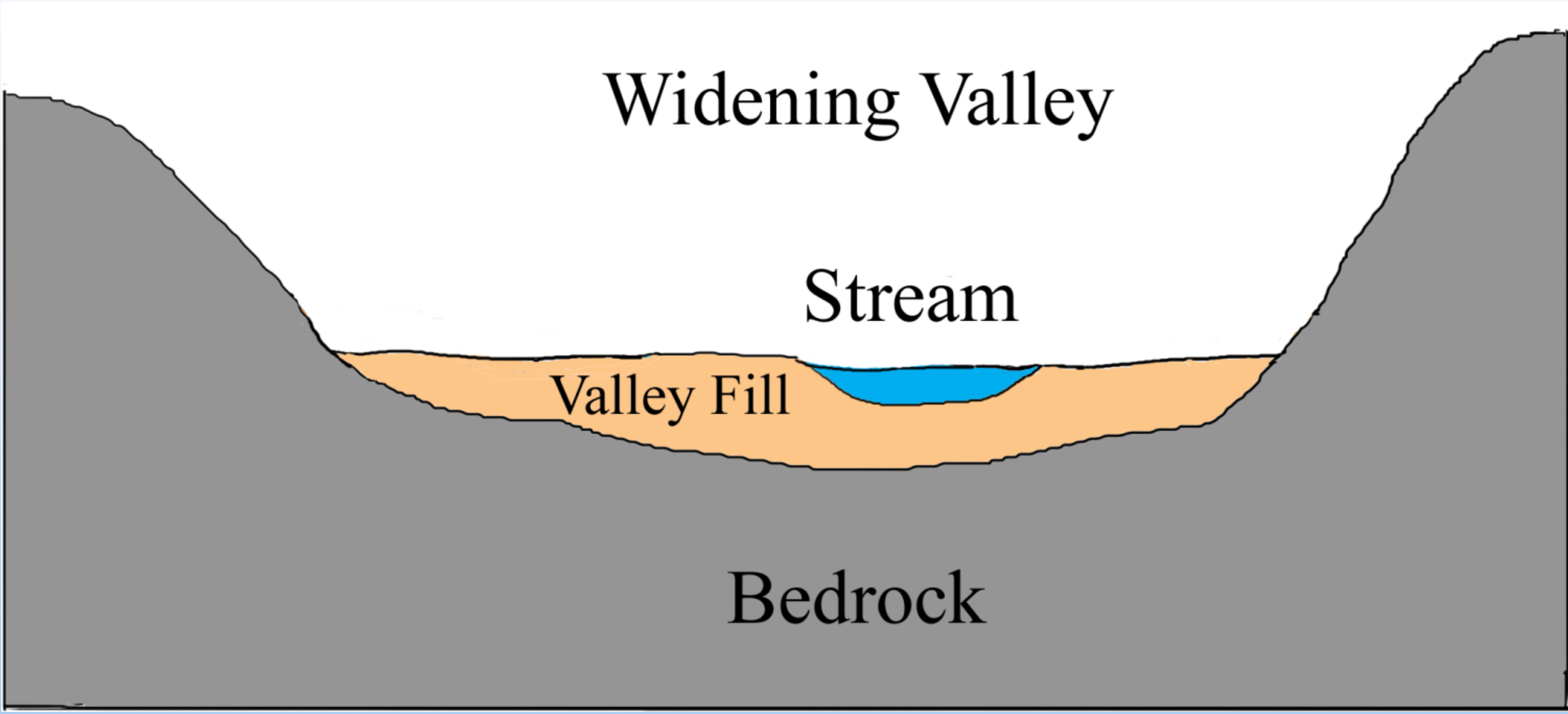
—lower gradient (less energy)

cutting sideways and depositing

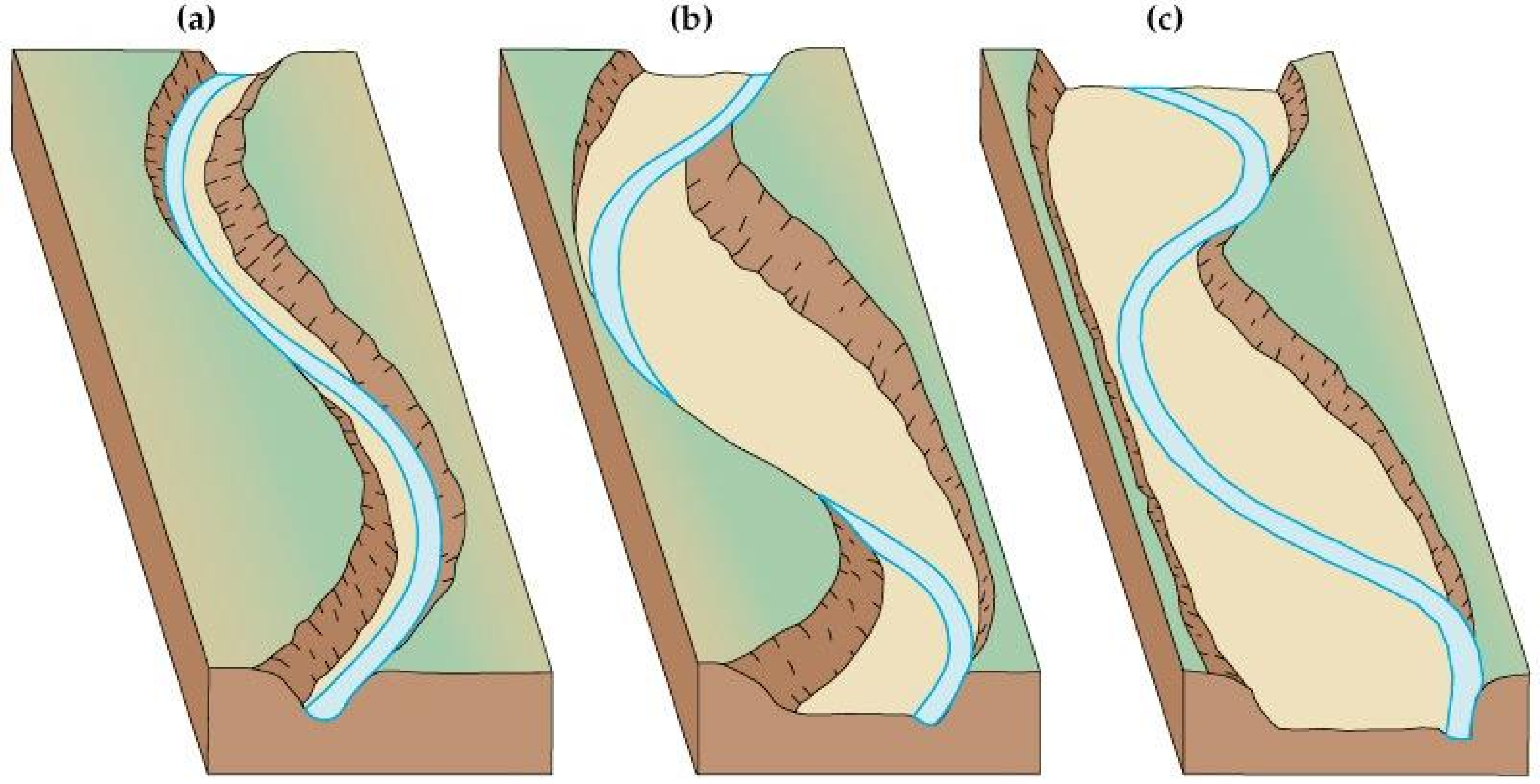
—meandering stream course

—low sides and broad valley

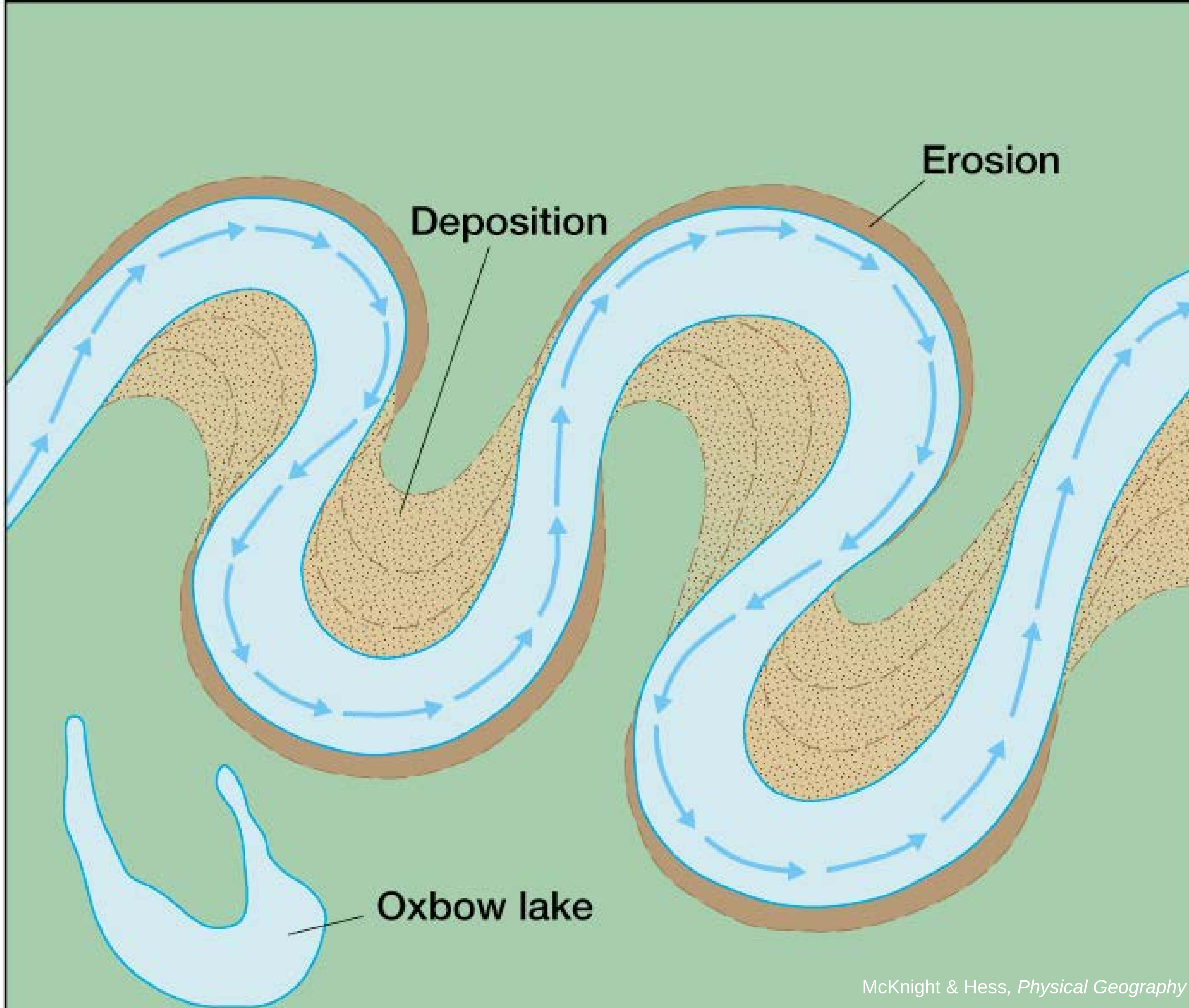
Lower Gradient (less energy)



Valley Widening

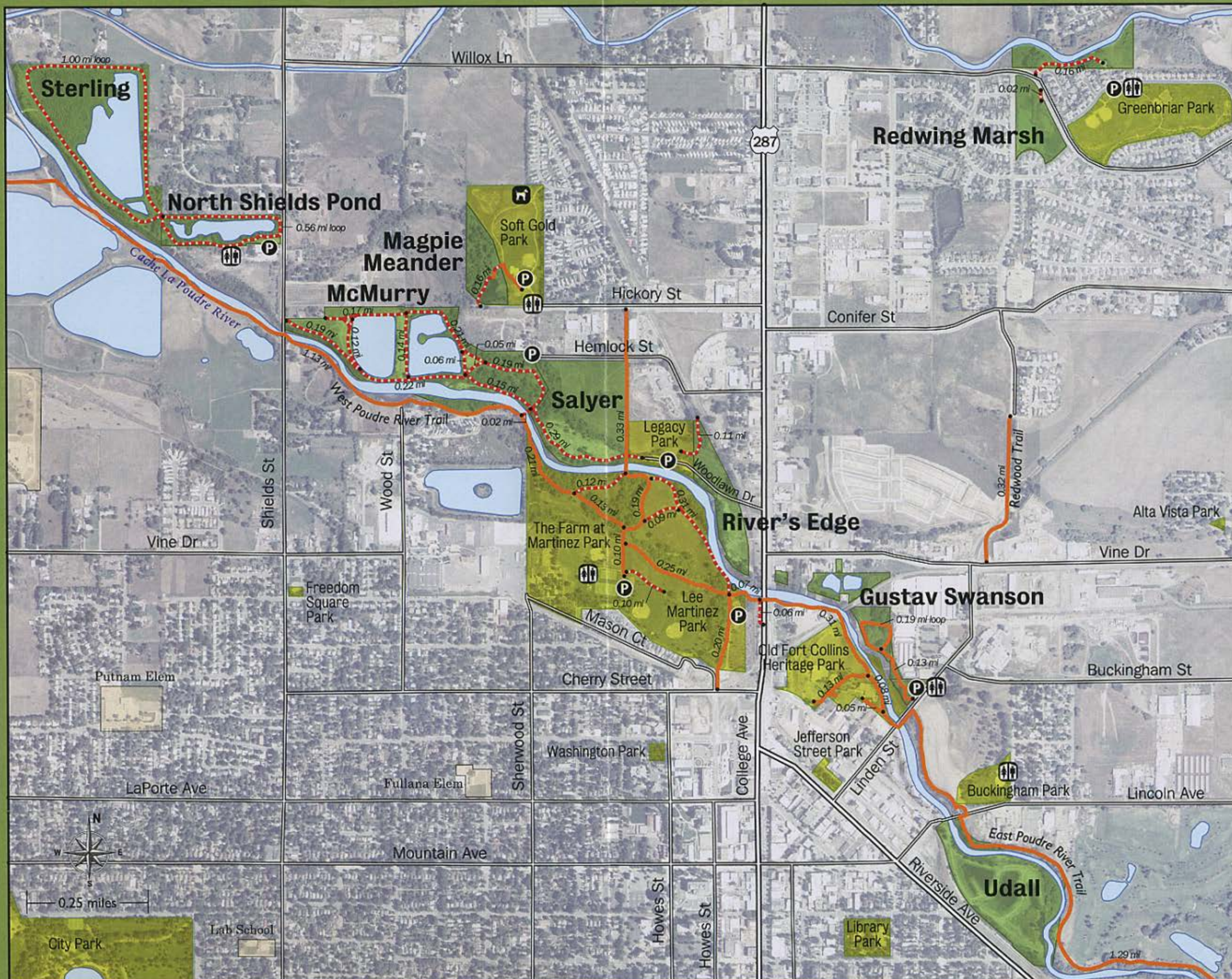


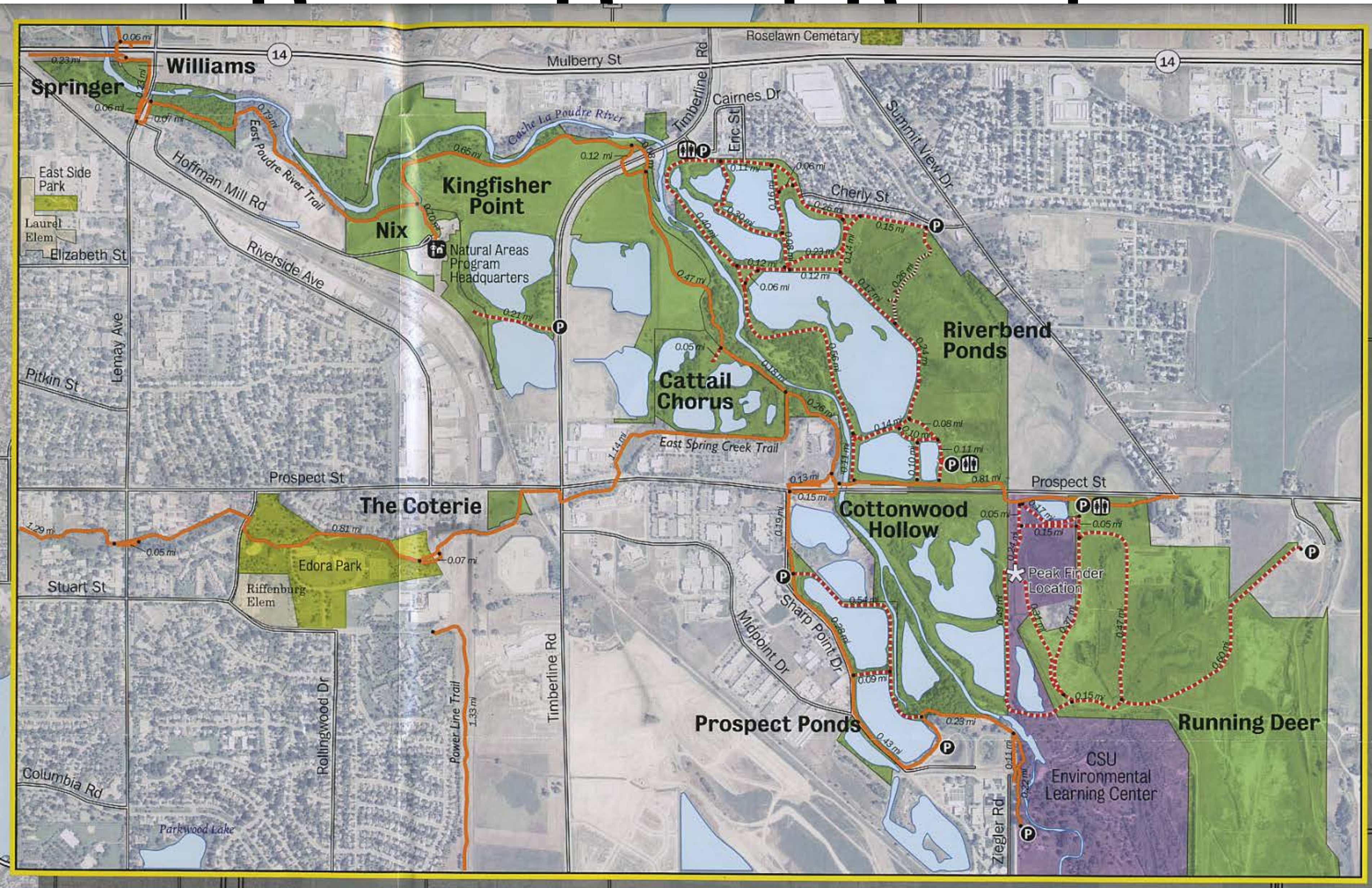
McKnight & Hess, *Physical Geography*



Erosion
Deposition
Oxbow lake
McKnight & Hess, *Physical Geography*

Cache La Poudre River Corridor Natural Areas (north)




Roselawn Cemetary
Mulberry St
Williams
Springer
Cache La Poudre River
East Poudre River Trail
Hoffman Mill Rd
Riverside Ave
East Side Park
Laurel Elem
Elizabeth St
Nix
Kingfisher Point
Natural Areas Program Headquarters
Timberline Rd
Cairnes Dr
Eric St
Summit View Dr
Cherly St
Riverbend Ponds
Cattail Chorus
East Spring Creek Trail
Lemay Ave
Pitkin St
Prospect St
The Coterie
Edora Park
Riffenburg Elem
Stuart St
Cottonwood Hollow
Peak Finder Location
Sharp Point Dr
Midpoint Dr
Rollingwood Dr
Power Line Trail
Prospect Ponds
Running Deer
CSU Environmental Learning Center
Ziegler Rd
Columbia Rd
Parkwood Lake

Poudre Pointbar

Poudre sandbar

Change in Stream Regime

- Streams can go from net eroding to net depositing or vice versa in hours and over millenia

Causes of change

—Season

—Short term precipitation events

—Climate changes precipitation amounts

—Sea levels fall or rise

—Land moves up or down

Stream Rejuvenation

(long term change)

Long pauses in mountain uplift changed streams from downcutting to widening

Renewed uplift changed streams to downcutting again

Stream Rejuvenation

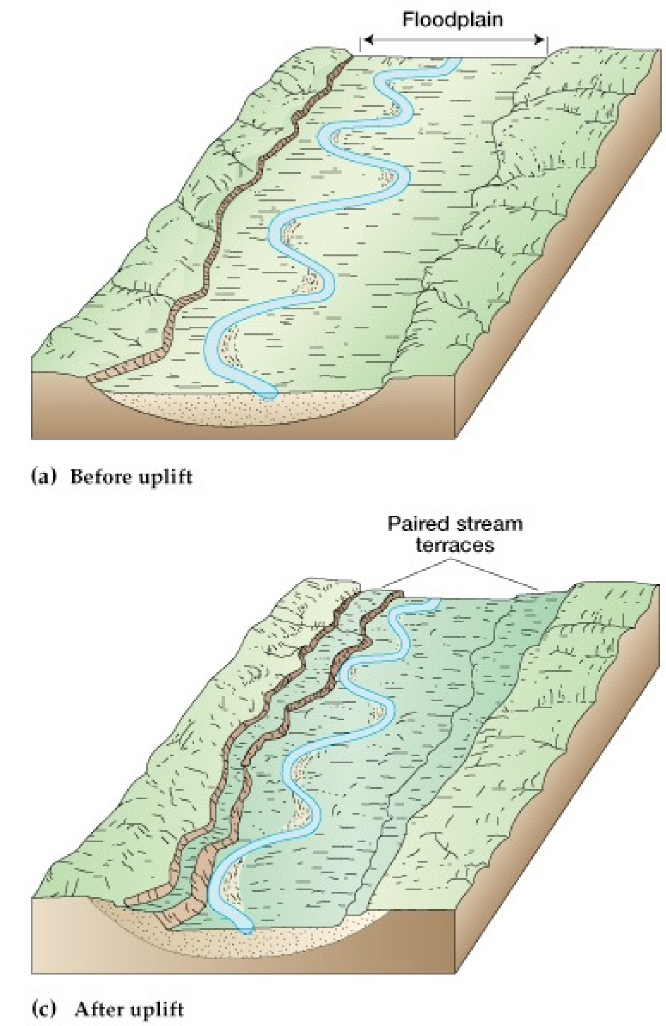
—our streams have been rejuvenated ie. increased their downcutting several times

—rejuvenation often leaves

-terraces

-erosional surfaces

Stream Rejuvenation



Stream Terraces

McKnight & Hess, *Physical Geography*

Stream Terraces Caucasus Mountains

Gregory, The Lie of the Land

Erosional Surfaces

Rejuvenated Big Thompson

Flooding

Floods = natural stream behavior

area flooded = floodplain

Flooding:

—flushes deposits downstream

—brings new soil

—may renew some vegetation

—damages man-made things

Floodplains and floods

Talk about them in intervals

eg. “100 yr floodplain” (made by “100 yr flood”)

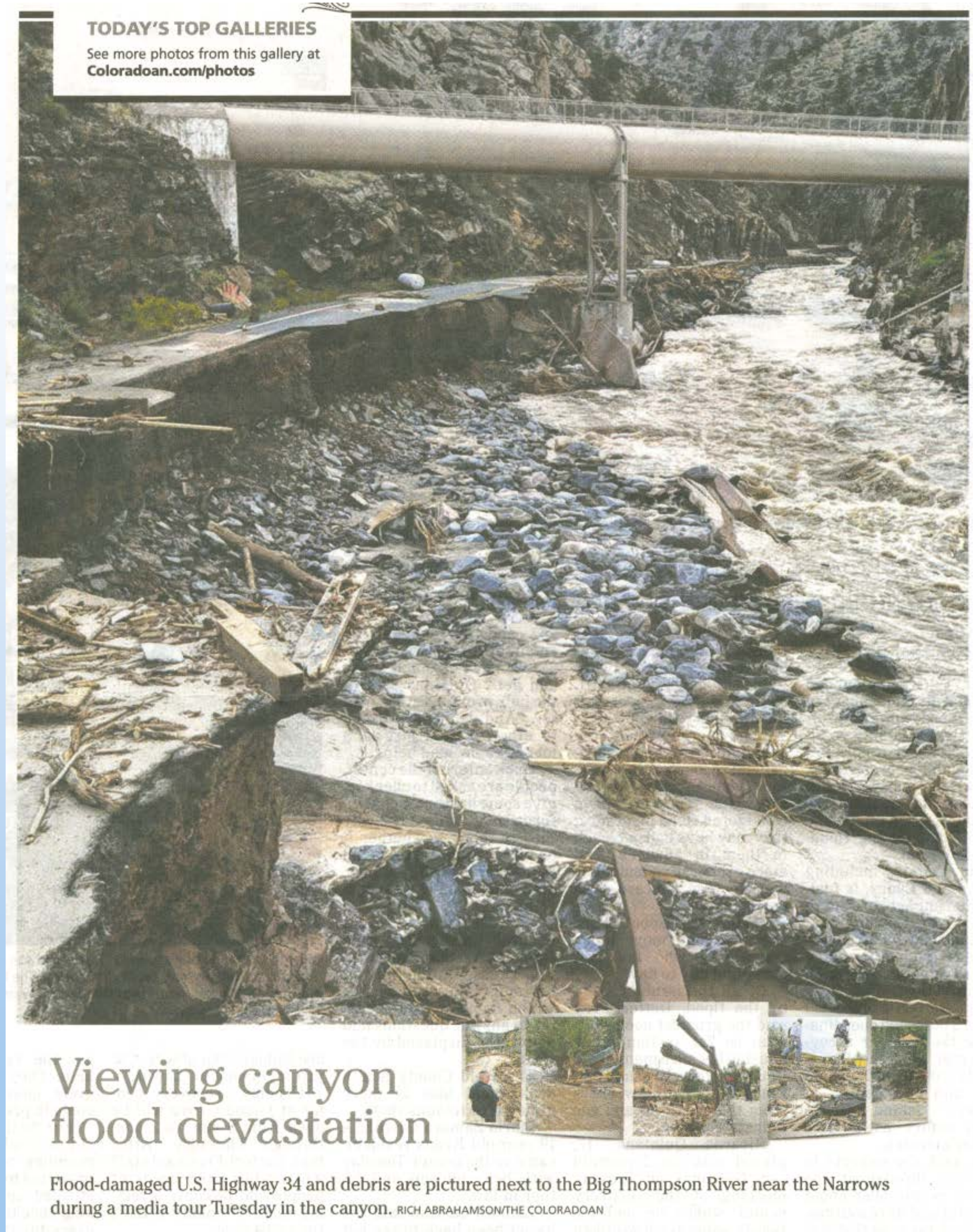
does NOT mean will flood every 100 yrs, but the probability is of a flood of that size once every 100 years

Power

of

water!

ower



TODAY'S TOP GALLERIES

See more photos from this gallery at Coloradoan.com/photos

Viewing canyon flood devastation

Flood-damaged U.S. Highway 34 and debris are pictured next to the Big Thompson River near the Narrows during a media tour Tuesday in the canyon. RICH ABRAHAMSON/THE COLORADOAN


LF

THE ROCK SOLID

END

Contact information

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