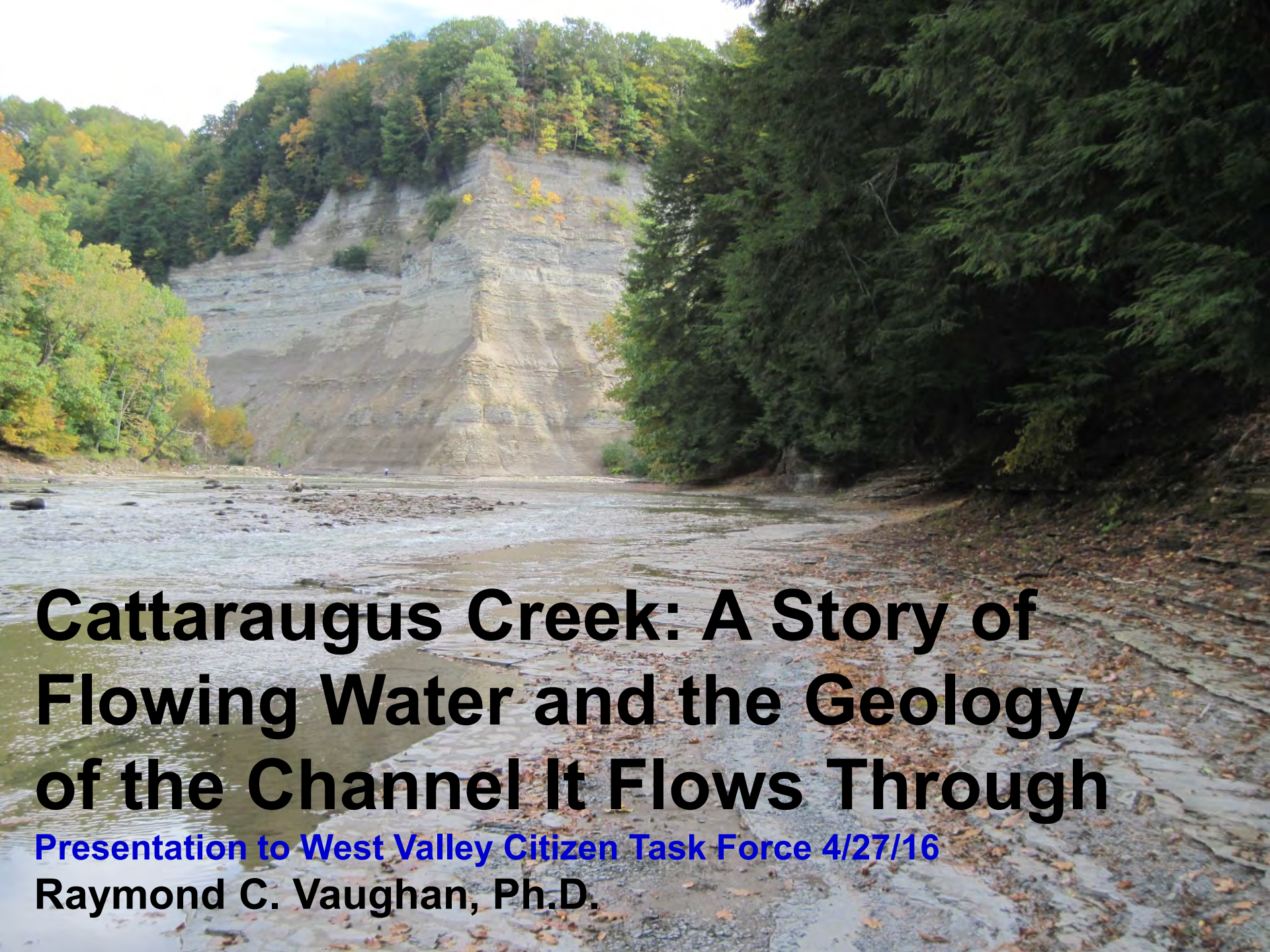


Cattaraugus Creek: A Story of Flowing Water and the Geology of the Channel It Flows Through

Presentation to West Valley Citizen Task Force 4/27/16

Raymond C. Vaughan, Ph.D.

What happens if you drop a grain of sand into Cattaraugus Creek?

- **Does it sink to the bottom?**
- **Does it move downstream?**
- **Does it end up on the bank of the creek?**

The answer depends on how fast the water is flowing

The same question could be asked about:

- **A particle of clay**
- **A grain of sand**
- **A pebble or piece of gravel**
- **A cobble or small slab of rock**
- **A boulder or large slab of rock**

Again, the answer depends on how fast the water is flowing

- **Clay particle:** **Tends to stay in suspension (*suspended sediment*) even in slow-moving water**
- **Sand grain:** **Tends to sink but can be carried downstream by moving water**
- **Pebble/gravel:** **Can bounce along creek bottom & be carried downstream by faster moving water**
- **Cobble or small slab:** **Can bounce along creek bottom & be carried downstream by even faster moving water**
- **Boulder or large slab:** **Can be pushed along creek bottom & be carried short distances downstream by very fast moving water**

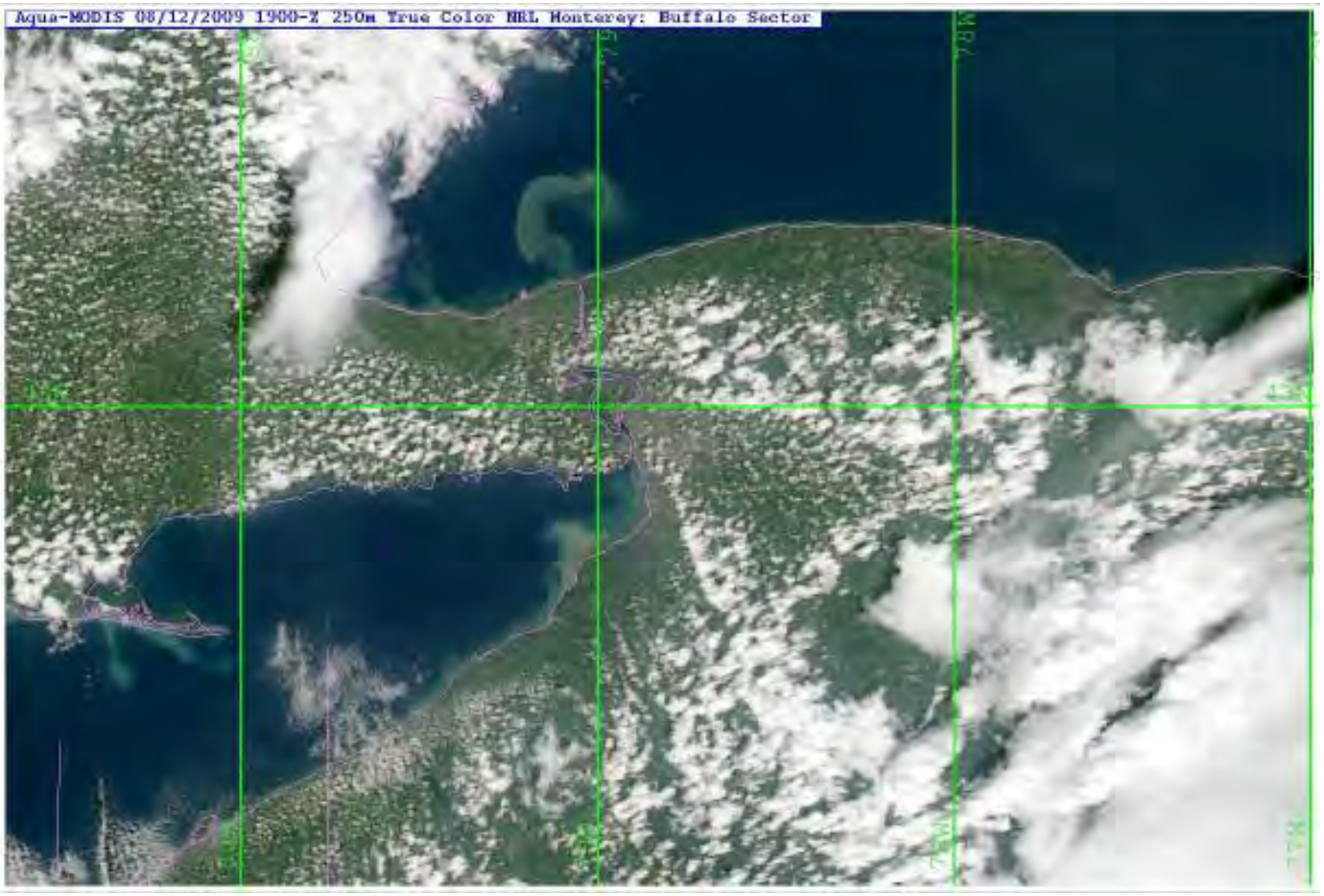
This explains how deltas are formed & how other sediment deposits occur

- **As water slows down, its ability to carry sediment decreases**
- **Larger pieces (coarse sediment) will drop out first as the water slows down**
- **Water flows relatively slowly along the *inside bank* of a creek bend or riverbend, so sediment tends to be deposited there**
- **Even very fine sediment may be deposited at mouth of creek or river, as water slows down upon entering a lake or ocean**

MOUTH OF CATTARAUGUS CREEK

Flash Floods of August 10, 2009, in the Villages of Gowanda and Silver Creek, New York

USGS SIR 2010-5259



The Cattaraugus Creek sediment plume from the August 2009 storm went into Lake Erie, then mostly followed the south shore to Buffalo, then flowed through the Niagara River into Lake Ontario. Cattaraugus Creek sediments are known to be deposited off the mouth of the Niagara River in Lake Ontario.

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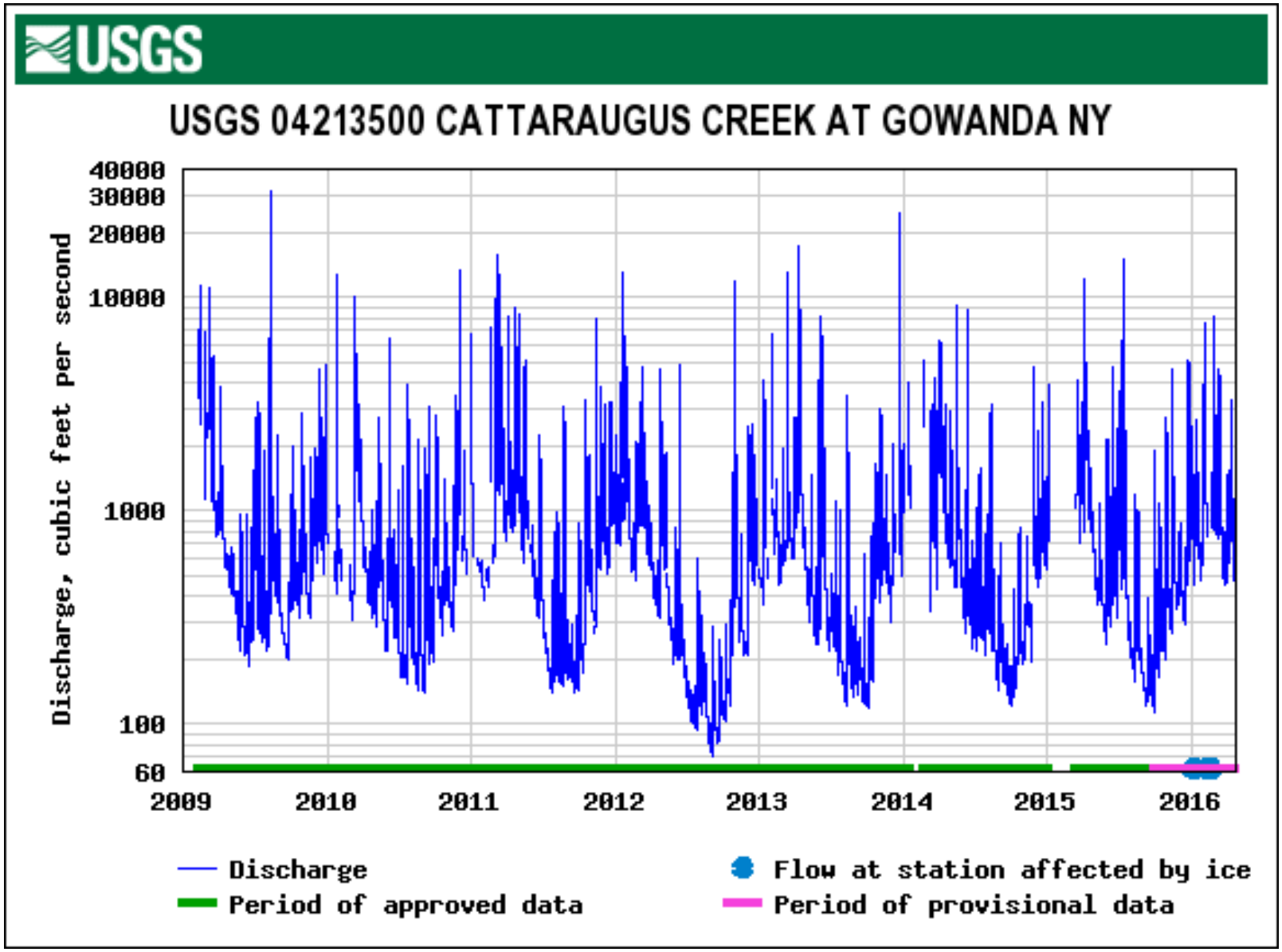
Flow rate

The flow rate of Cattaraugus Creek is extremely variable

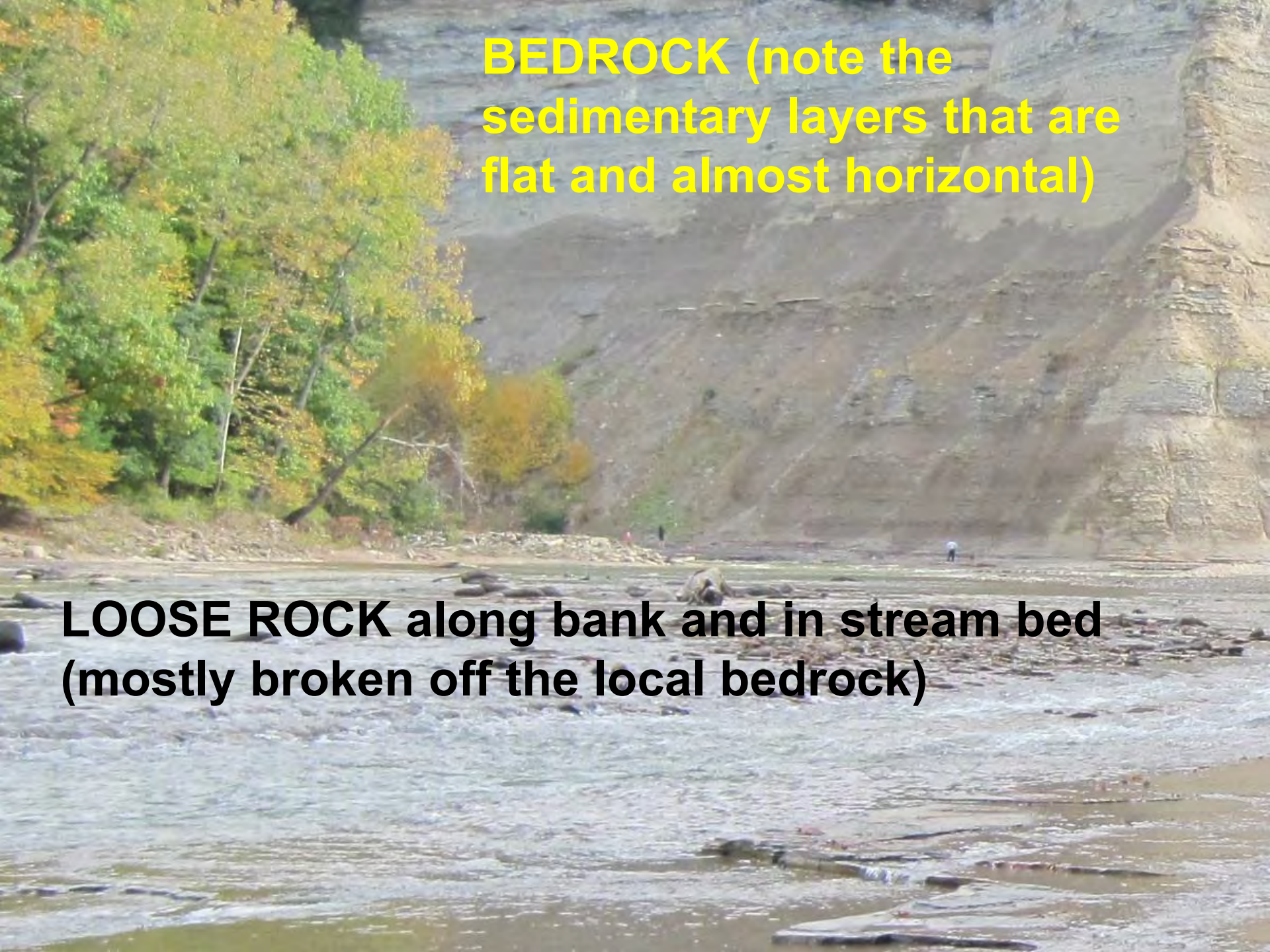
The creek has a very ‘flashy’ response to rainfall & snowmelt

Creek drains quickly because it has a steep gradient (drops more than 500 feet from Buttermilk Creek confluence to Lake Erie)



Lowest flow is about 0.25% of highest flow!

Geology


BEDROCK (note the sedimentary layers that are flat and almost horizontal)
LOOSE ROCK along bank and in stream bed (mostly broken off the local bedrock)


BEDROCK (note the sedimentary layers that are flat and almost horizontal)
LOOSE ROCK along bank (mostly broken off the local bedrock)

WNY BEDROCK

Sedimentary rock, laid down *more than 300 million years ago* as *particles of sediment* (sand, clay, carbonate particles) that were deposited underwater, then *gradually 'cemented' together* by chemical/mineralogical processes into layers of rock such as sandstone, shale, and limestone.

GLACIAL ACTION IN WNY: GLACIERS BREAK UP ROCK

Our soils and the pieces of loose rock we see in WNY are mostly *fragments of local bedrock* (sand, clay, carbonate particles, or larger gravel, cobbles, or slabs) that have been eroded off the bedrock by water and weathering, or by crushing/scraping action of glaciers during the past 1 million years or so.

GLACIAL ACTION IN WNY: GLACIERS HELP CARVE VALLEYS

Glaciers and flowing water (rivers, creeks) have carved the bedrock valleys, some of which are much older than 1 million years

… but Zoar Valley & Cattaraugus Creek appear more recent. As young as 15,000 years?? Postglacial??

CONTINUAL RECYCLING

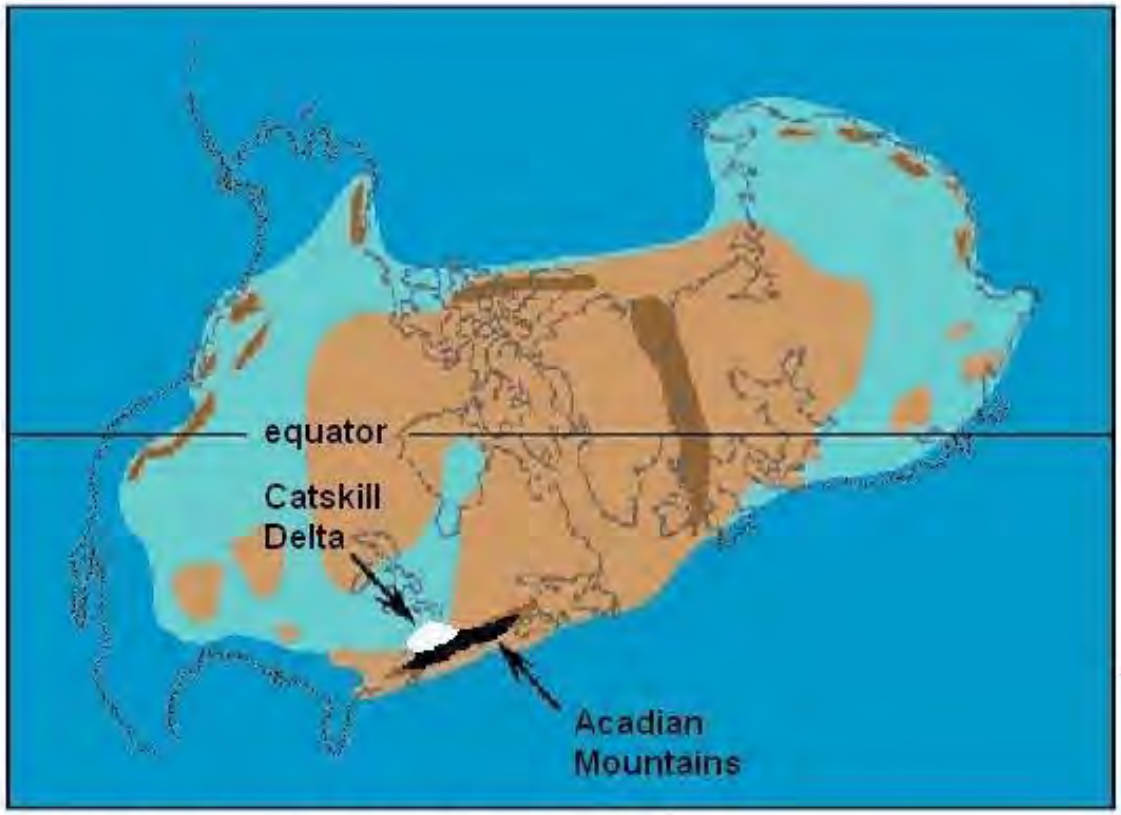
Weathering, erosion, glacial action

Sandstones	**Sand**
Shales	**Clay**
Limestones	**Carbonate particles**

Lithification, cementing together

Geology:
Plate tectonics and how the local bedrock was formed

365 million years ago (Devonian)

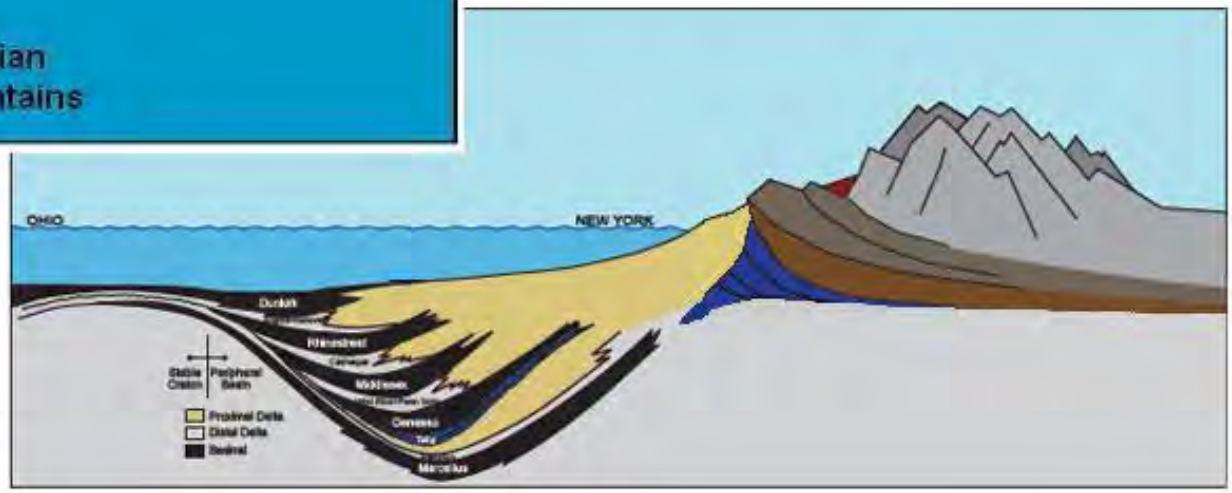


Adapted from Murphy, Devonian Times, www.devoniantimes.org

Our area of Laurentia still south of equator

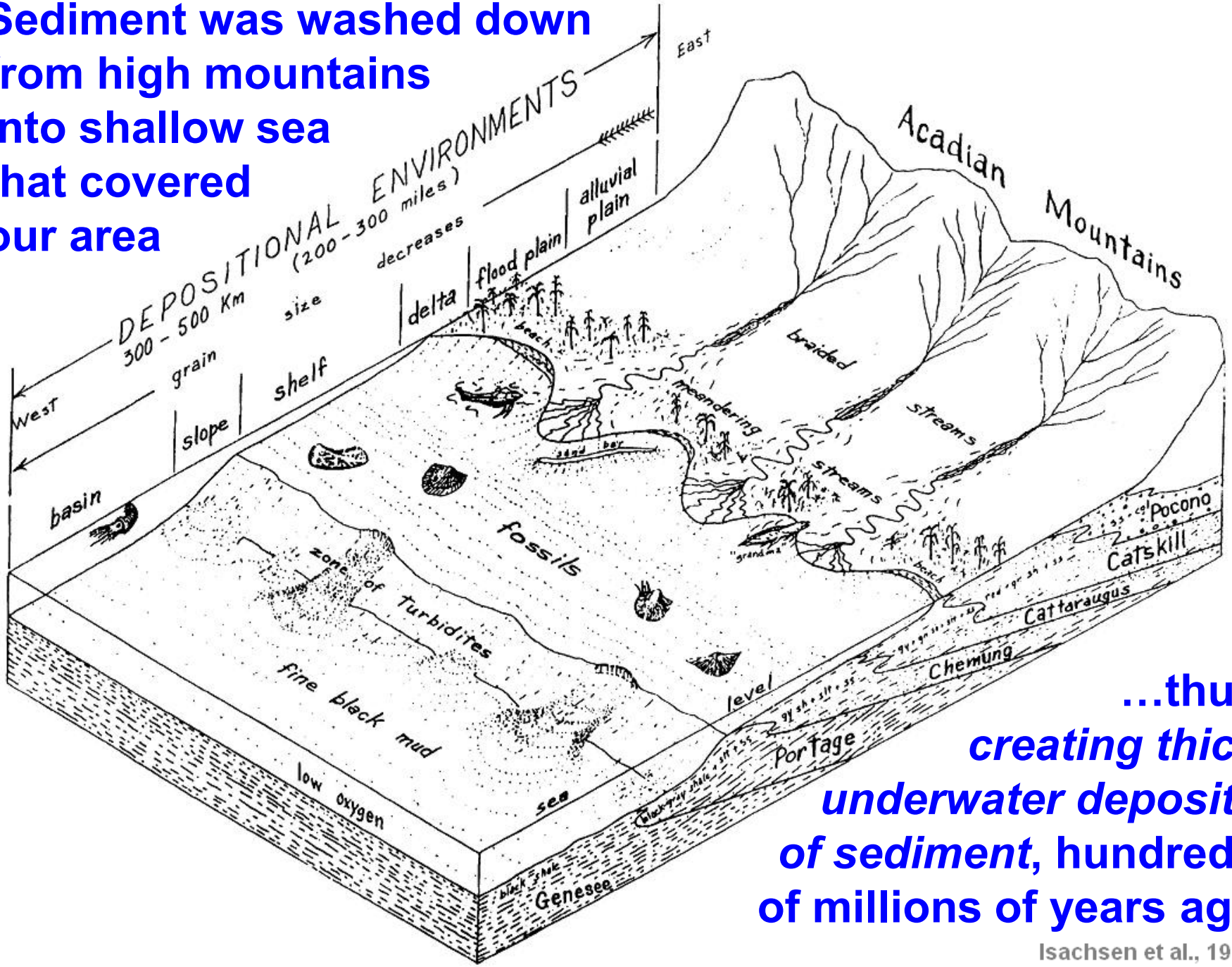
Sediments carried down W-draining streams and rivers from Acadian Mts.

Flowing into inland sea, forming Catskill Delta



Adapted from Smith, Jacobi, Seever, and Loewenstein, www.searchanddiscovery.net/documents/2009/50203smith/images/fig02.htm

Sediment was washed down from high mountains into shallow sea that covered our area



…thus *creating thick underwater deposits of sediment*, hundreds of millions of years ago

Isachsen et al., 1991

The accumulated sediment at the bottom of the ancient inland sea gradually became ‘cemented’ together:

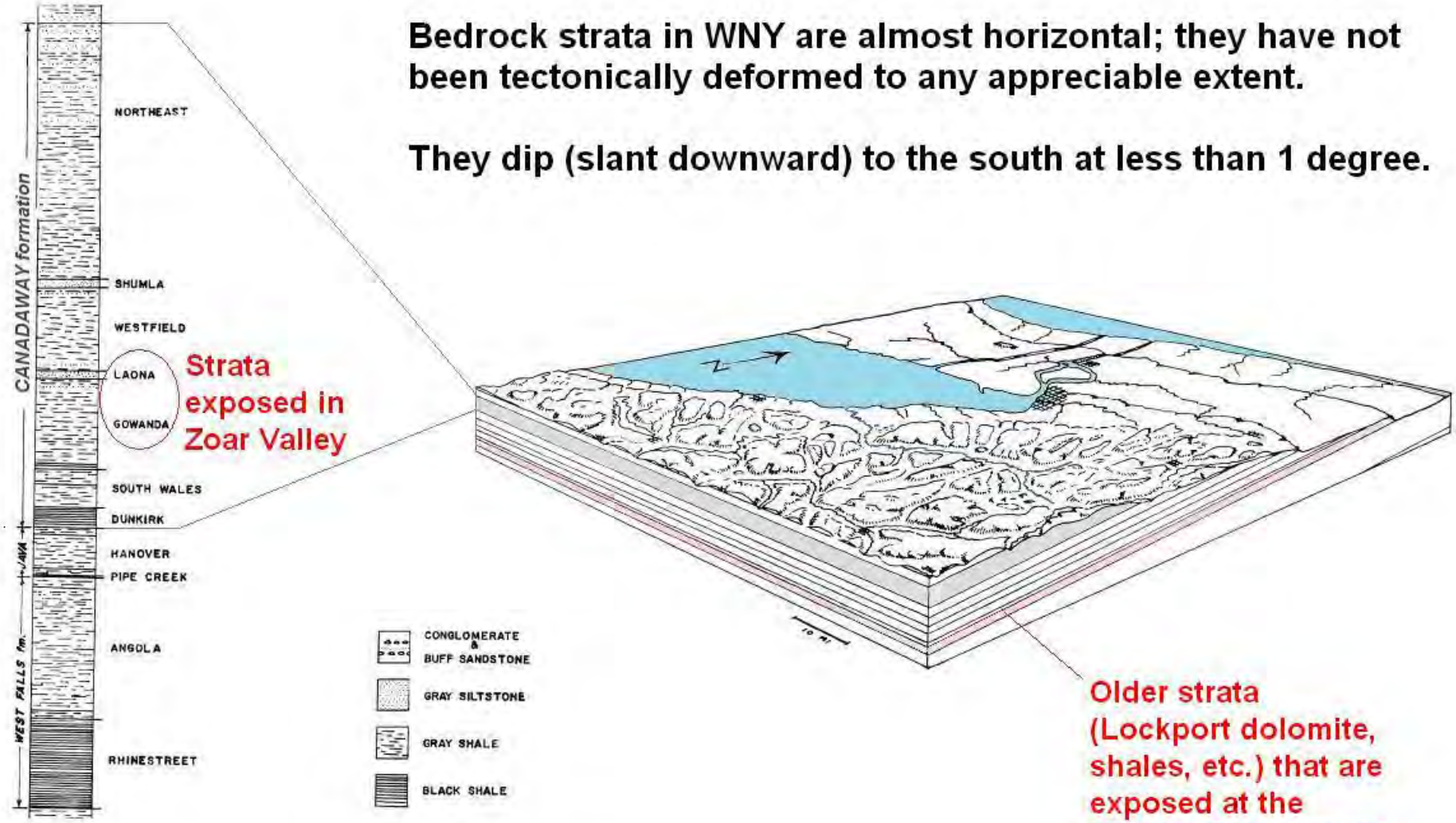
- **Clay particles became shale**
- **Sand grains became sandstone**
- **Etc.**

…and as eastern North America slowly rose above sea level, these beds of sedimentary rock were preserved and are the layers of bedrock we see today

WNY bedrock stratigraphy

Bedrock strata in WNY are almost horizontal; they have not been tectonically deformed to any appreciable extent.

They dip (slant downward) to the south at less than 1 degree.



Adapted from Tesmer & others, NYSGA Guidebook, 1966


How (and when) was the gorge formed?
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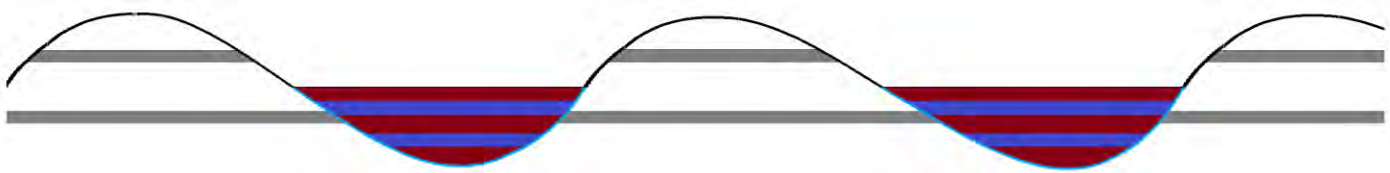
Bedrock valleys in the region

- **Most bedrock valleys in western and central NY are oriented approximately north-south**
- **Examples include the Finger Lakes and the valleys south of Buffalo through which Eighteenmile, Cazenovia, and Buttermilk Creeks flow**



- **Most creeks and other waterways follow these north-south bedrock valleys, carved by glaciers & water, some of which are much older than 1 million years**
- **Cattaraugus Creek is unusual because it runs east to west *and thus crosses several of the bedrock valleys and cuts through the intervening bedrock ridges***

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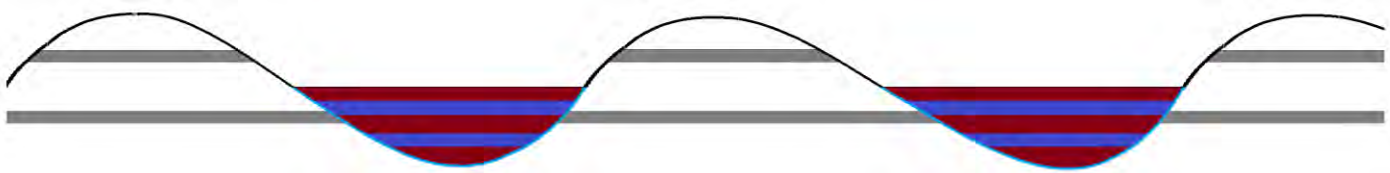

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ZOAR VALLEY GORGE

When was the gorge carved? A lot of rock had to be eroded to form the gorge.

Many geologists consider the gorge to be postglacial. But has there been enough time (and enough flowing water?) since the last glacial retreat ~15,000 years ago to carve the gorge?

The answer is yes for the Niagara gorge, which is roughly the same size – but how about the Zoar Valley gorge? Not clear.

Zoar Valley, main gorge (west of North Otto Rd.)

Length about 6 - 7 miles
Avg. width about 900 feet
Avg. depth about 400 feet
Volume about 10 billion cubic feet
Typical flow about 750 cfs (0.4%)
Peak flow about 30,000 cfs (15%)

Niagara gorge, escarpment to falls

Length about 6 - 7 miles
Avg. width about 1000 feet
Avg. depth about 360 feet
Volume about 10 billion cubic feet
Undiverted flow about 200,000 cfs

WHY ZOAR VALLEY GORGE HISTORY MATTERS

It matters because of the "landscape evolution model" that's being used to predict future erosion (10,000 years into the future) at the West Valley site

The landscape evolution model is being *calibrated* by running from a time 10,000 years ago (a bit after the last glacial retreat) to the present time

One concern with this calibration method is whether it's realistic to assume constant climate (paleoclimate versus today's climate versus future climate)

But also: Did the gorge exist as a drainage pathway?

Erosion Working Group may be able to answer this…

EROSION = MAIN THREAT TO SITE INTEGRITY

- **Long-term erosion (geomorphic downcutting/widening of stream valleys, formation of new ravines) *will cut into buried wastes*, thus exposing and carrying downstream a large portion of any wastes that haven't been removed**
- **This is a recognized problem – *but over what time frame?***
- **DOE and NYSERDA's 1996 Draft EIS predicted about 300,000 mrem/yr dose to a downstream resident in a few hundred years due to uncontrolled erosion!**
- **DOE and NYSERDA replaced their 1996 Draft EIS with a new two-phase decision (2010 and 2020) supported by new EIS documents and a new erosion prediction method (*landscape evolution model*) that predicted very low dose!**
- **How to resolve this difference? DOE and NYSERDA have created an Erosion Working Group whose work may help..**

SUMMARY: CONTAMINATION TRANSPORT DOWN CATTARAUGUS CREEK FROM WV SITE

Relatively high **levels of radioactive contamination flowed down Cattaraugus Creek in late 1960s and early 1970s – some of which may still be deposited in creek sediment and/or flood plain soils**

Some went to Lake Ontario (as identified by Joshi)

Some was behind Springville Dam until released 1996

Relatively low **contamination now flowing down creek**

Future releases into creek will depend on the Phase 2 cleanup decision in year 2020 ***and whether its underlying erosion prediction is accurate***

FUTURE CONTAMINATION TRANSPORT DOWN CREEK FROM WV SITE WILL DEPEND ON 2020 PHASE 2 CLEANUP DECISION & ACCURACY OF ITS UNDERLYING EROSION PREDICTION

	Future erosion rate: HIGH	**Future erosion rate: Low**
Predicted future erosion rate: HIGH **Phase 2 cleanup decision: Dig up & remove tanks & buried waste**	Future radioactive contamination released into creek: **Low**	Future radioactive contamination released into creek: **Low**
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