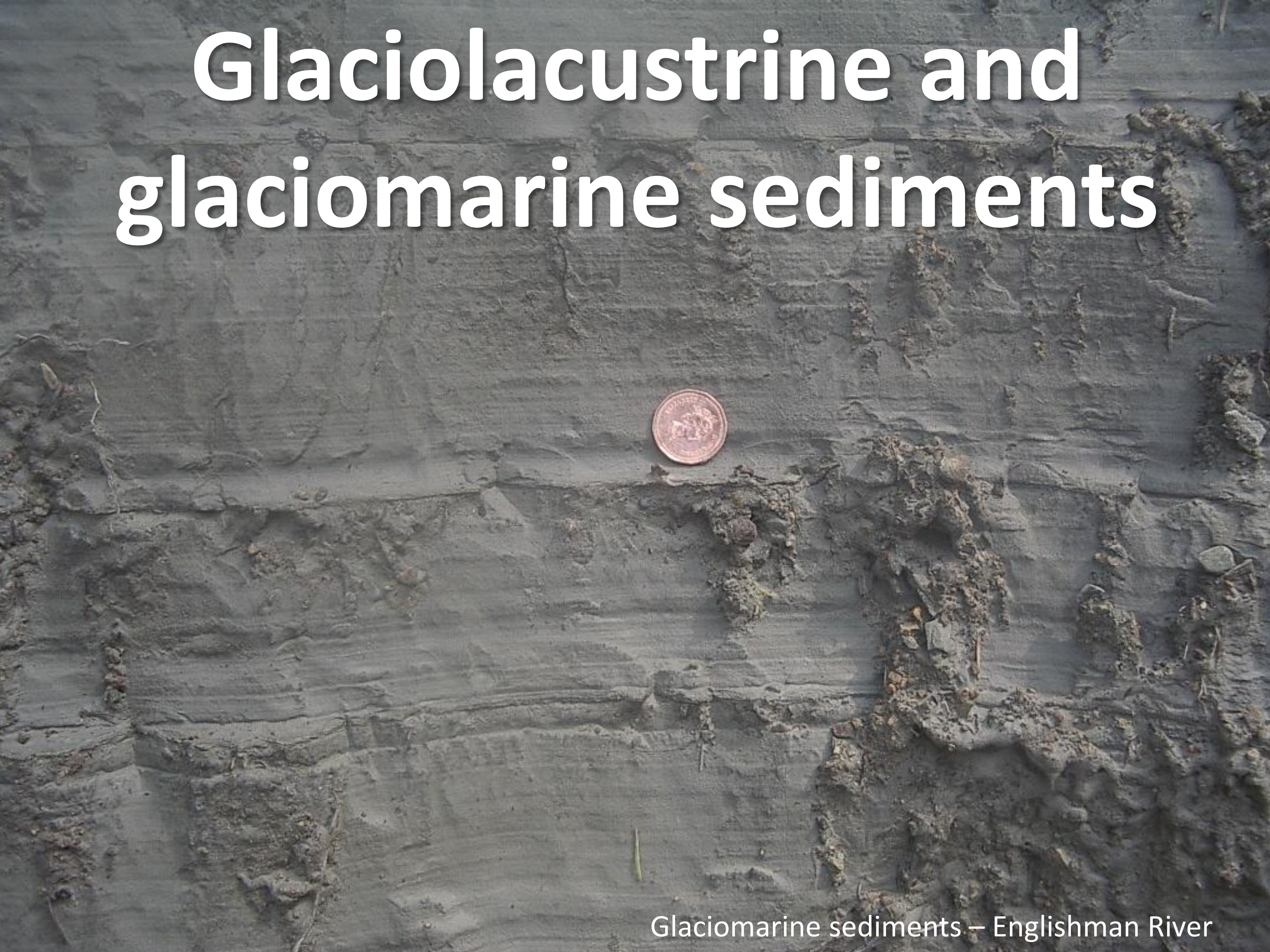
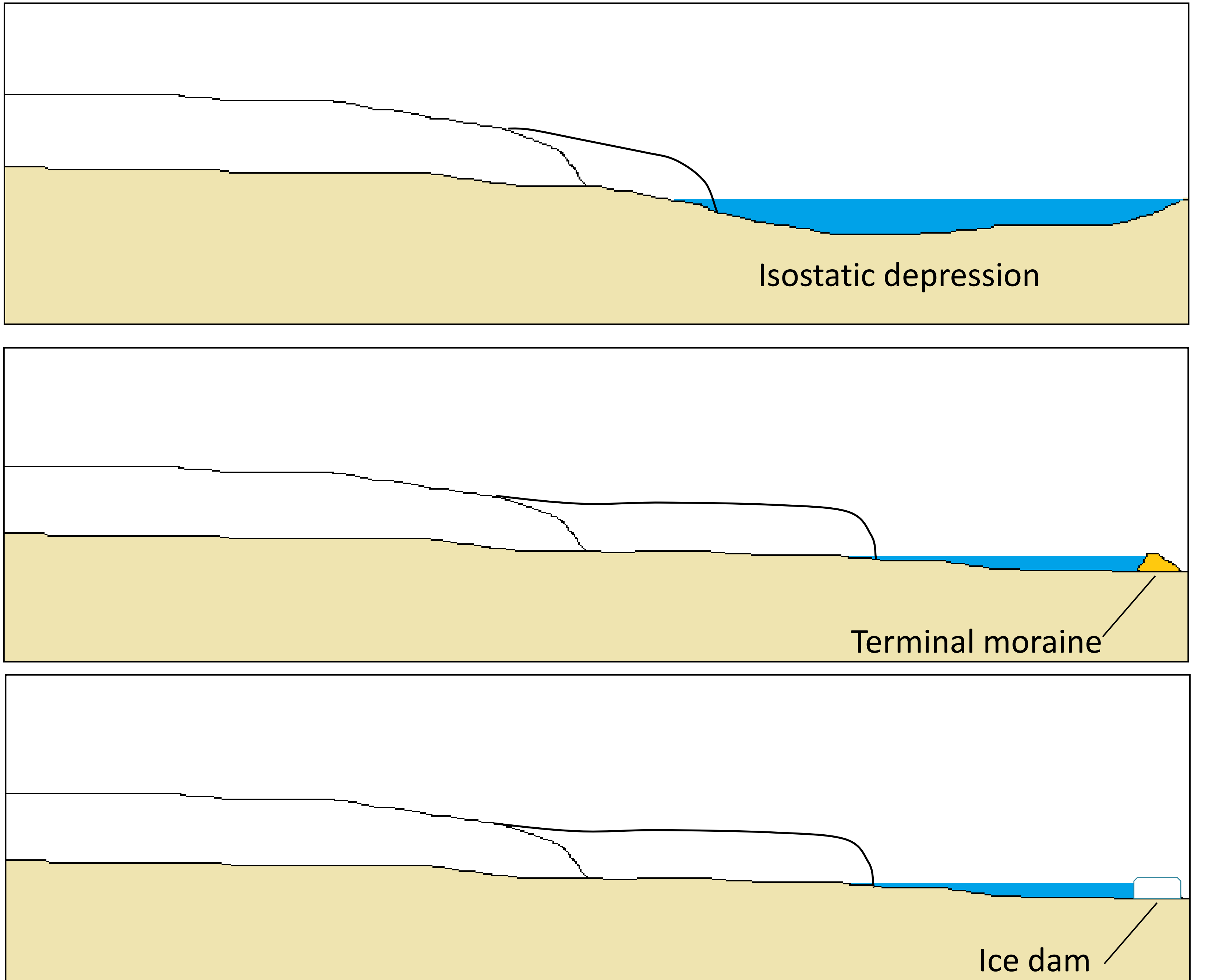
Glaciolacustrine and glaciomarine sediments

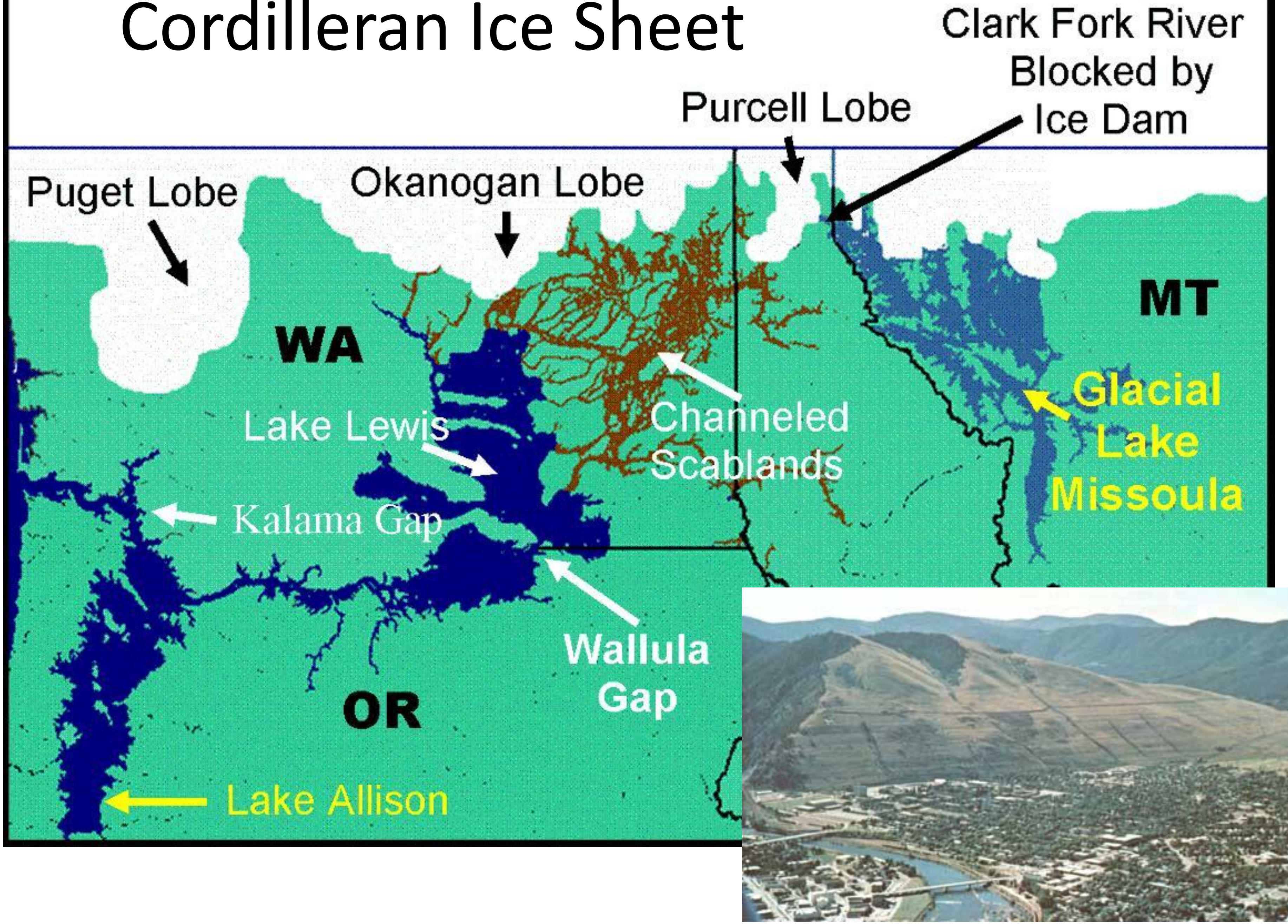


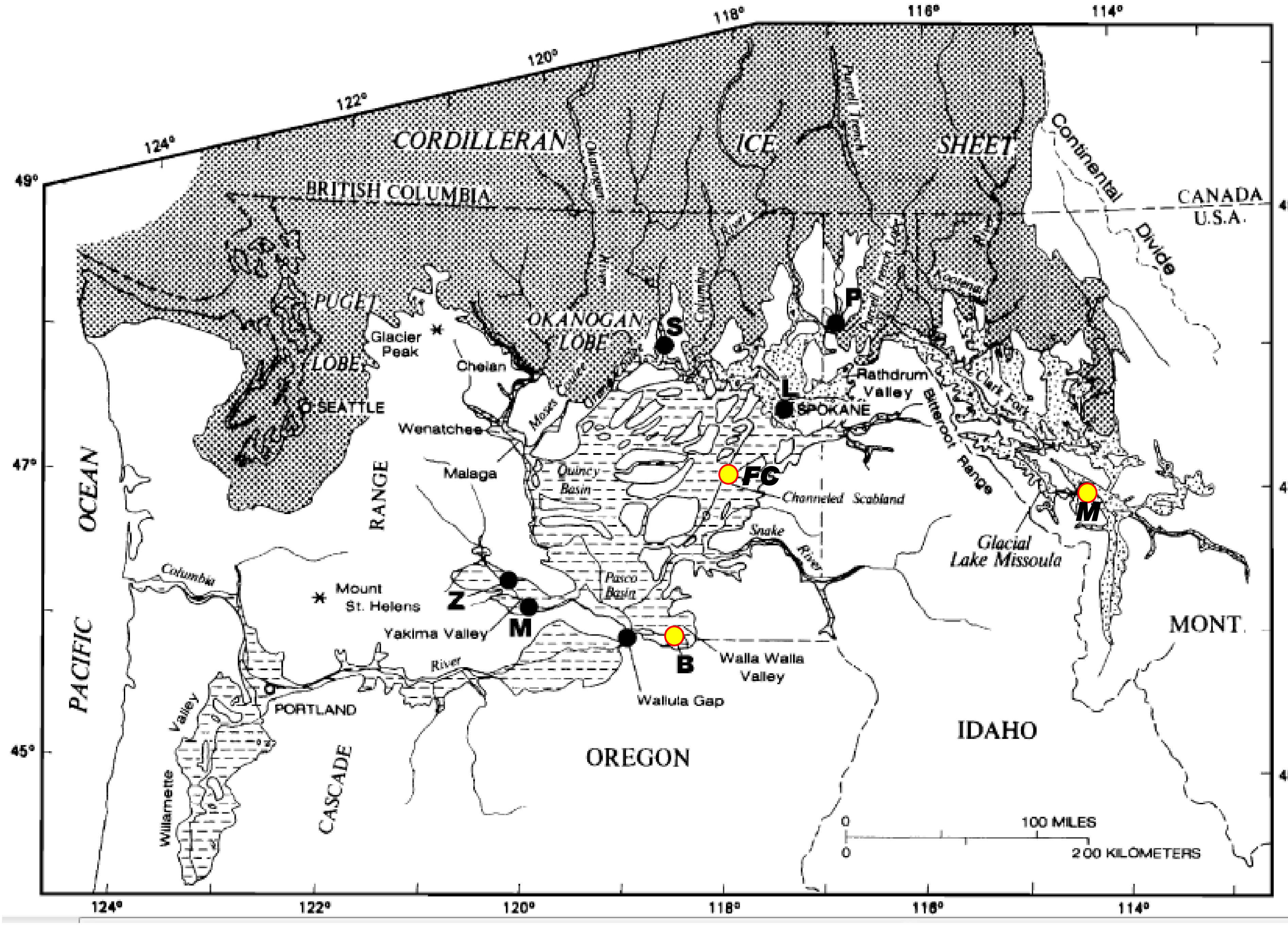
Glaciomarine sediments – Englishman River

Pro-glacial lakes



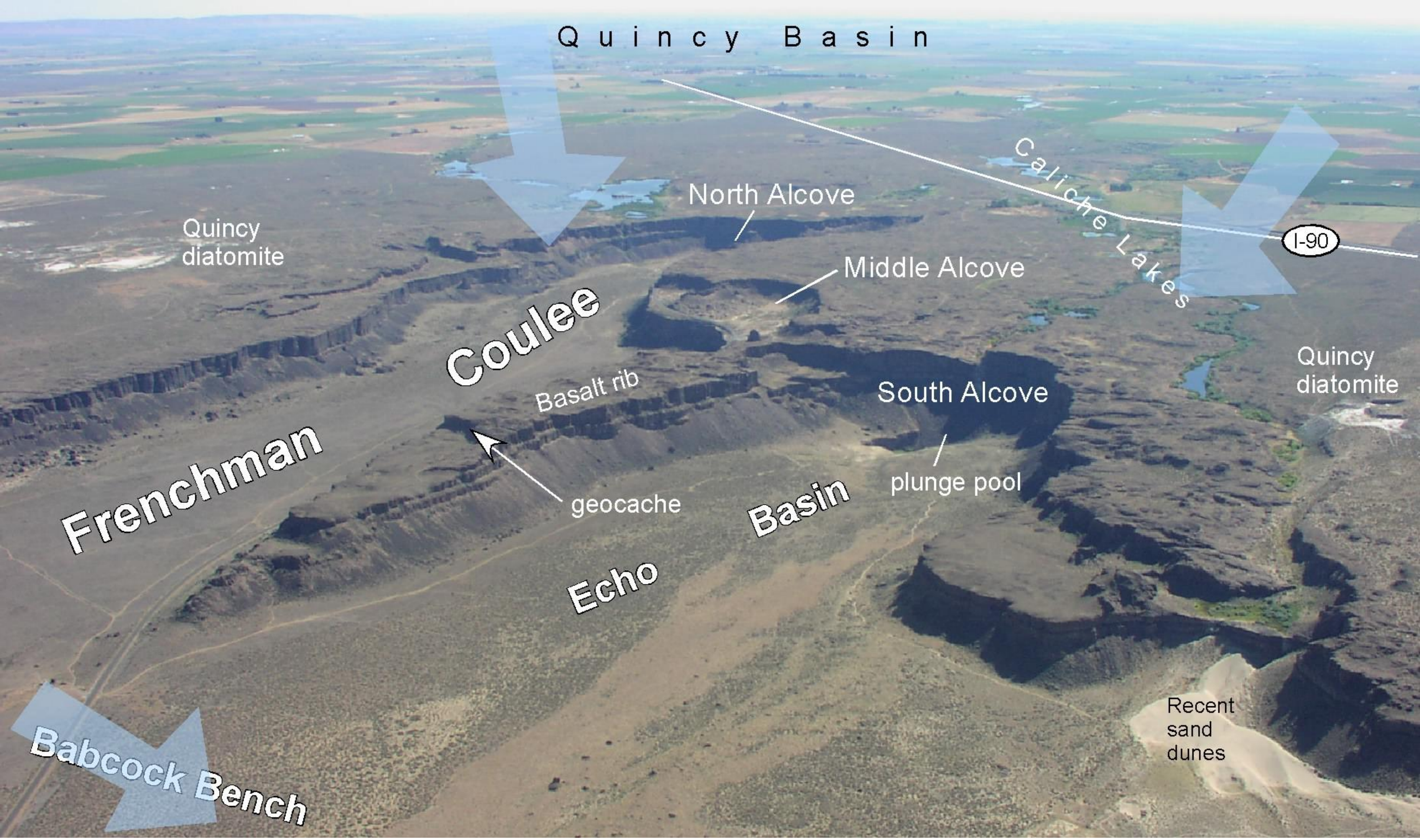
Cordilleran Ice Sheet



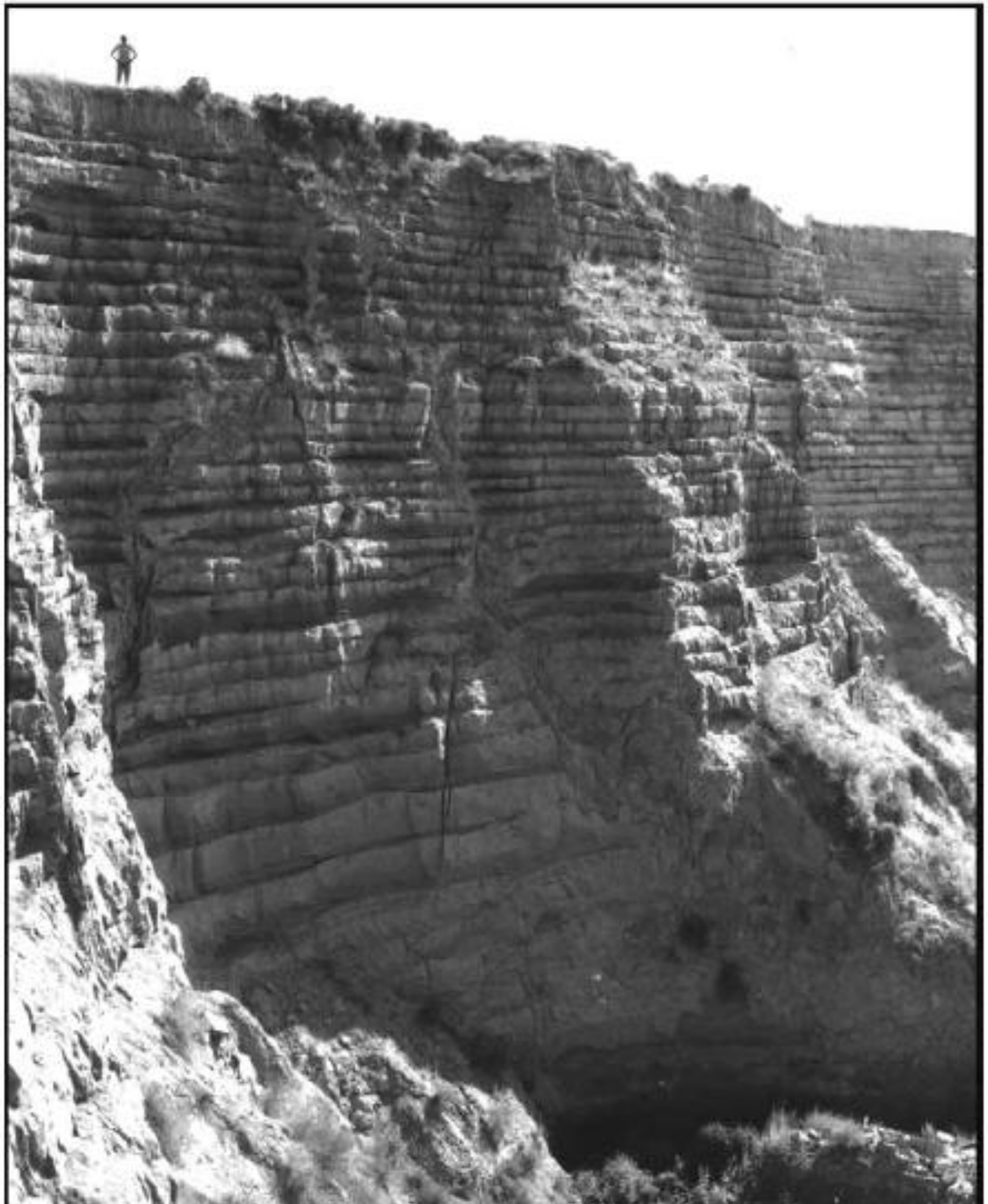


Booth et al., 2003

Part of the Channelled Scablands



http://www.freerepublic.com

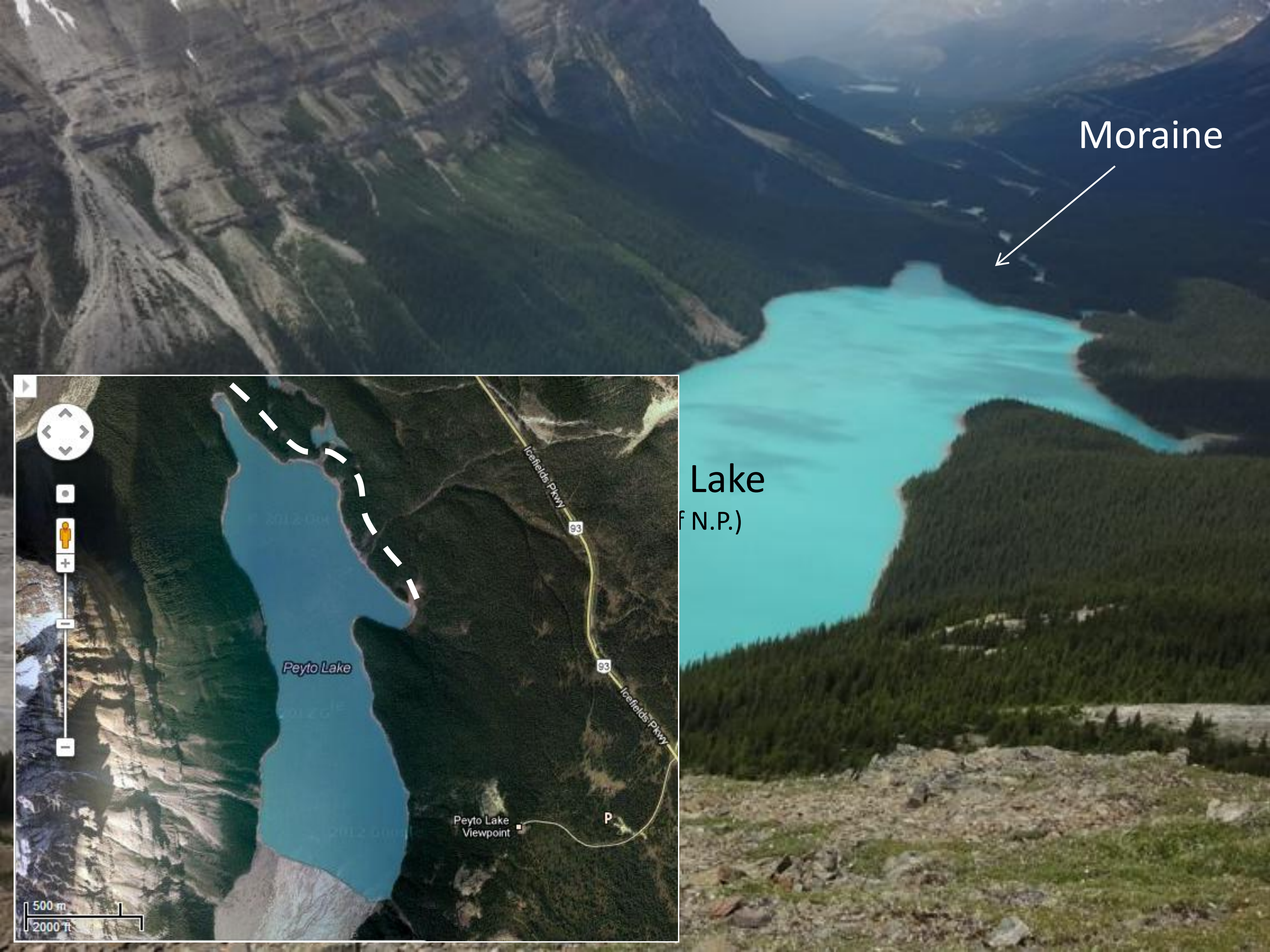


Lake Missoula flood sediments near to Walla Walla Washington

Booth et al., 2003

Lake Agassiz

From Murton et al., Nature 464, 2010

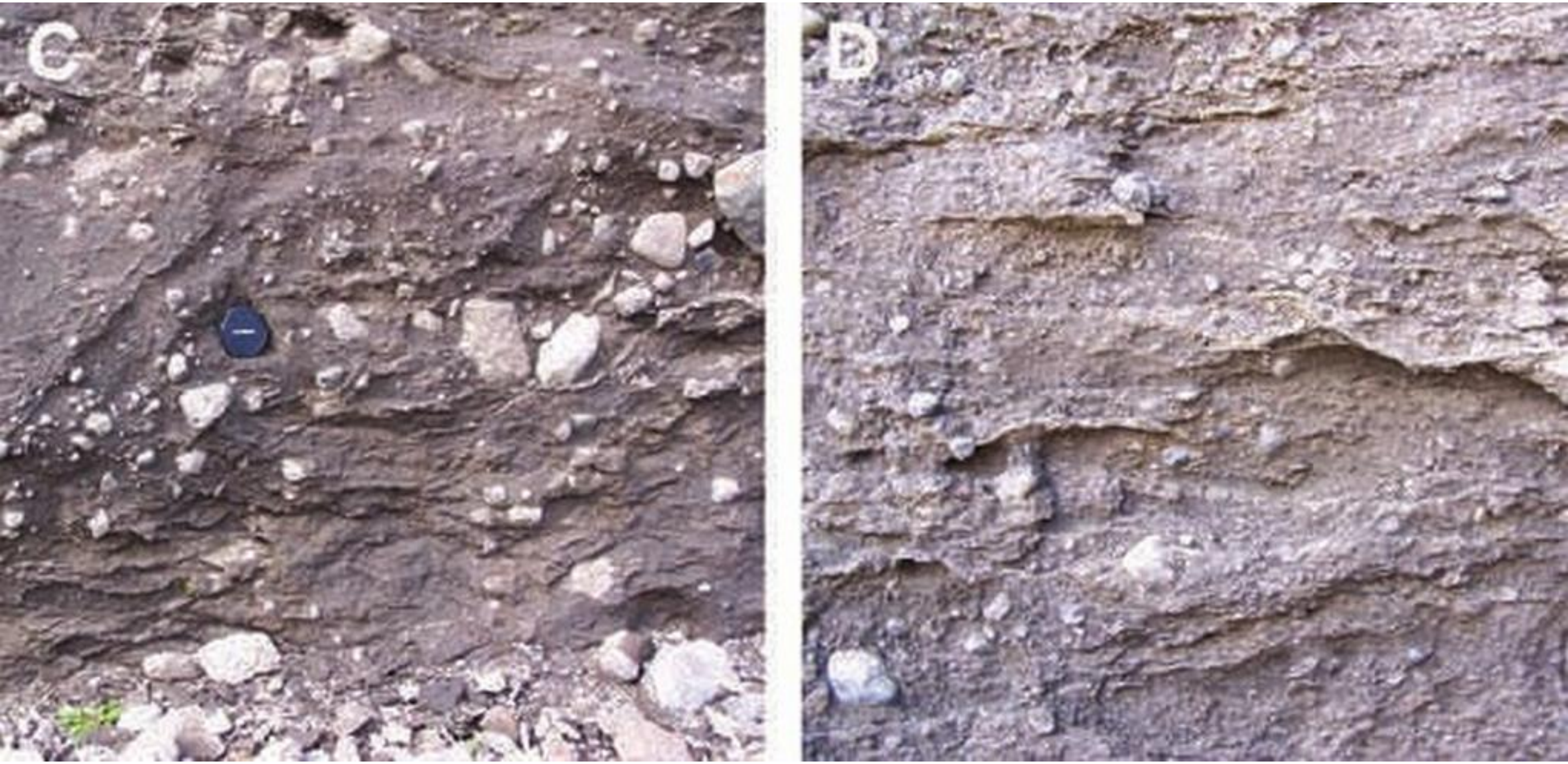

Moraine
Lake
f N.P.)
Icefields Pkwy
93
93
Icefields Pkwy
Peyto Lake
Peyto Lake
Viewpoint
P
500 m
2000 ft

Modes of glaciolacustrine deposition

- Direct deposition from the glacier (waterlain diamict)
- Deposition from meltwater inflows (deltas fans)
- Settling from suspension (varve couplets)
- Rain-out from icebergs (dropstones and diamicts)
- Resedimentation by gravity flows
- Current reworking
- Shoreline sedimentation
- Biological sedimentation

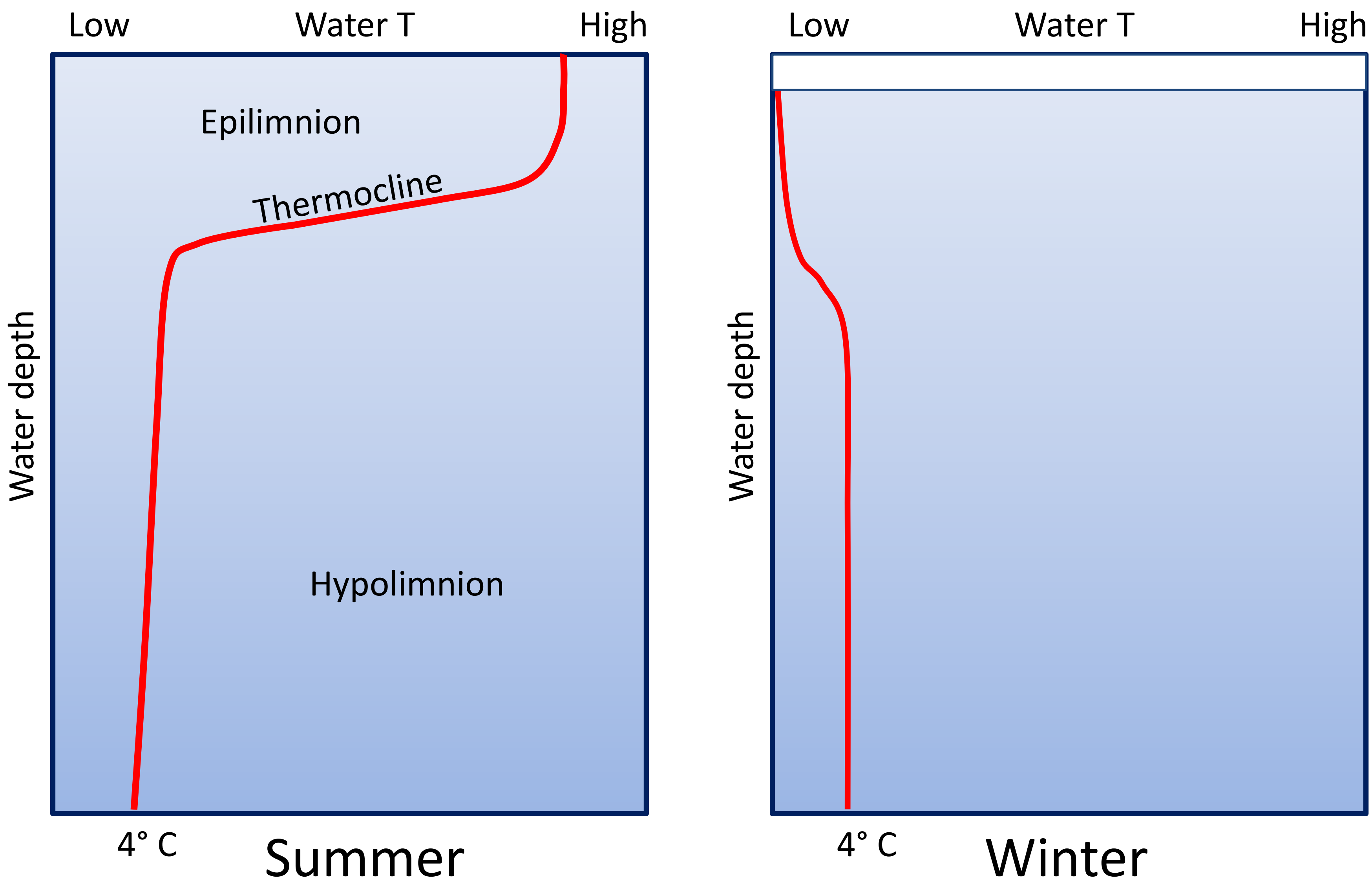
Waterlain diamict

Waterlain diamicts

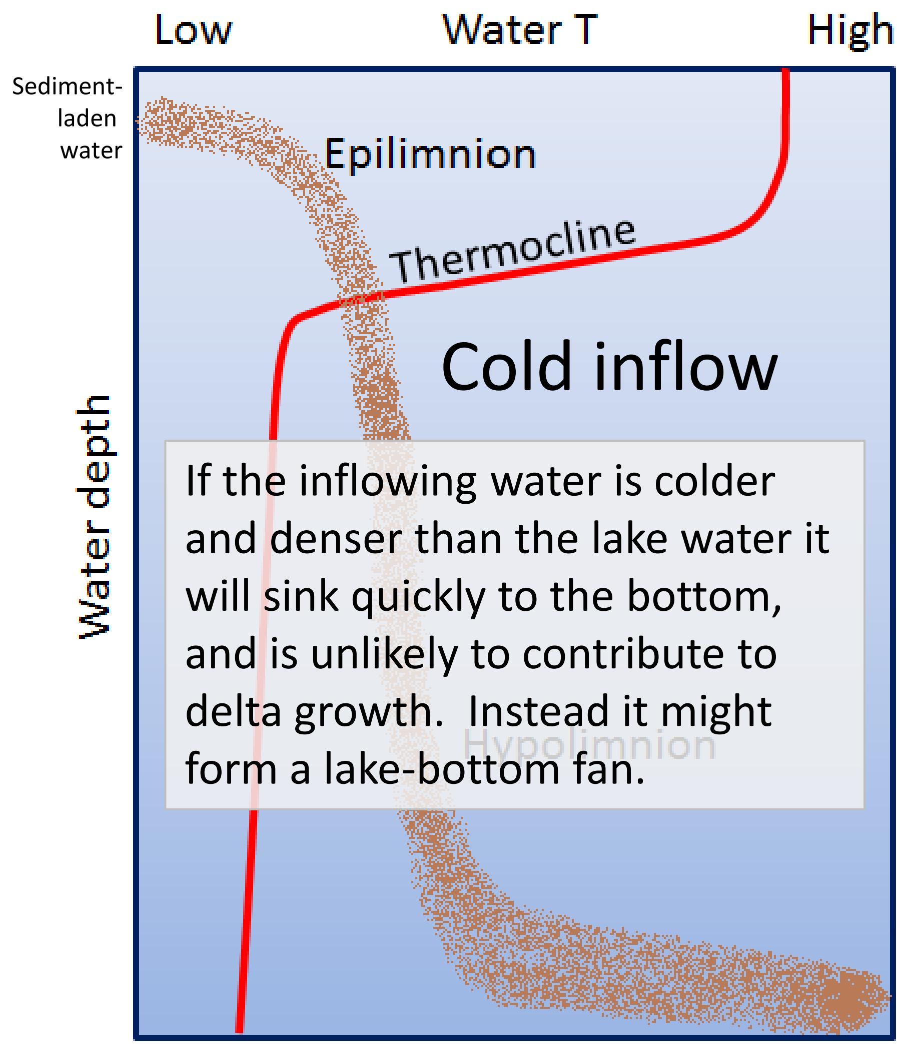


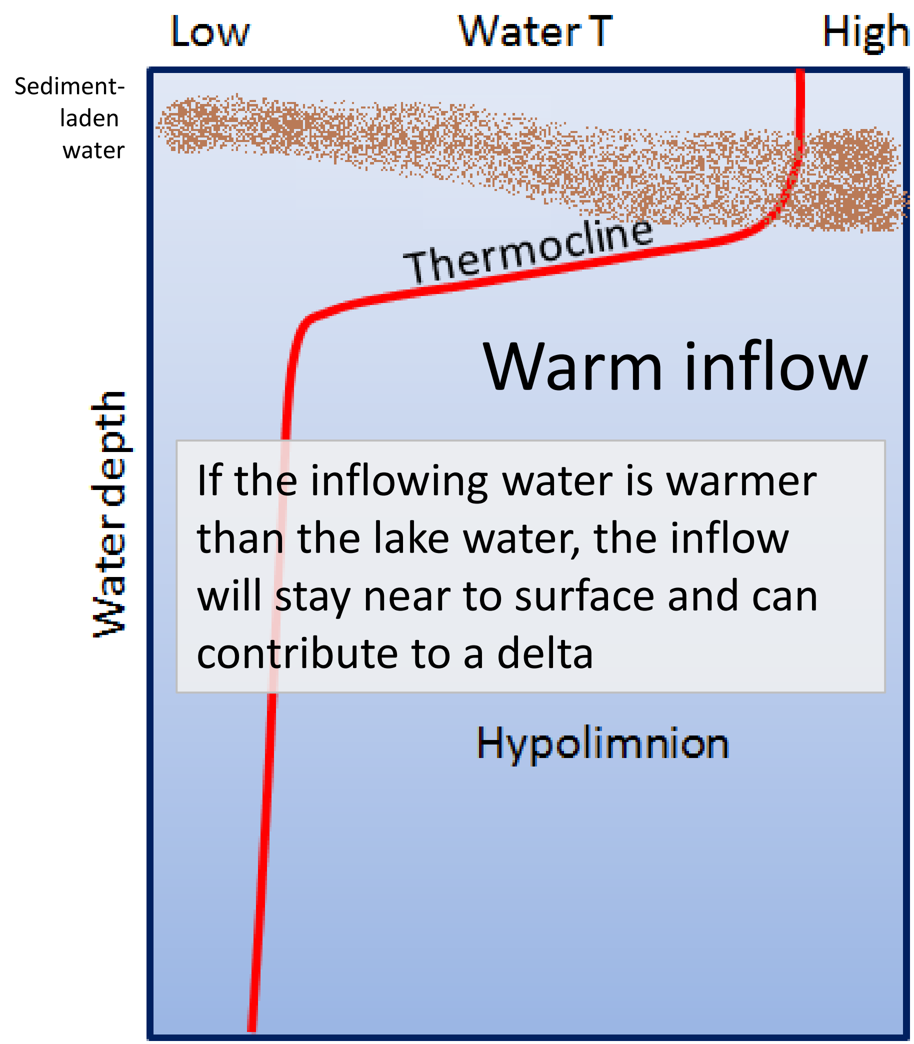
Bennett and Glasser, 2009

Stratification of Lakes in Glacial areas



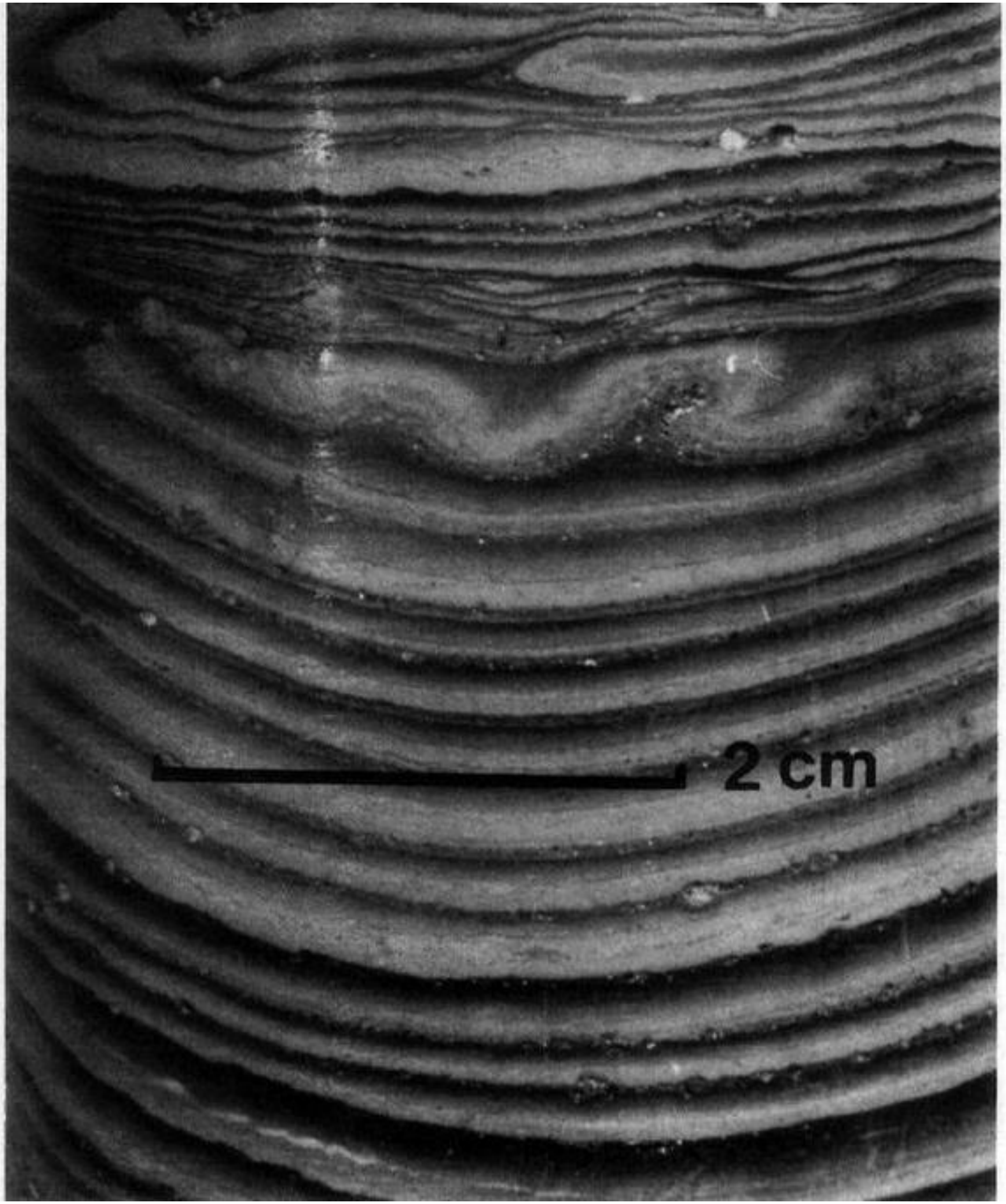
Dispersal of cold and warm inflowing water





Settling from suspension

- Input of water, and therefore sediment, is likely to be highly seasonal (almost none in winter),
- Varve couplets are common in glaciolacustrine sediments (a thin fine layer from settling of clay-sized material in winter, and a thicker coarser layer from silt and sand input during summer)



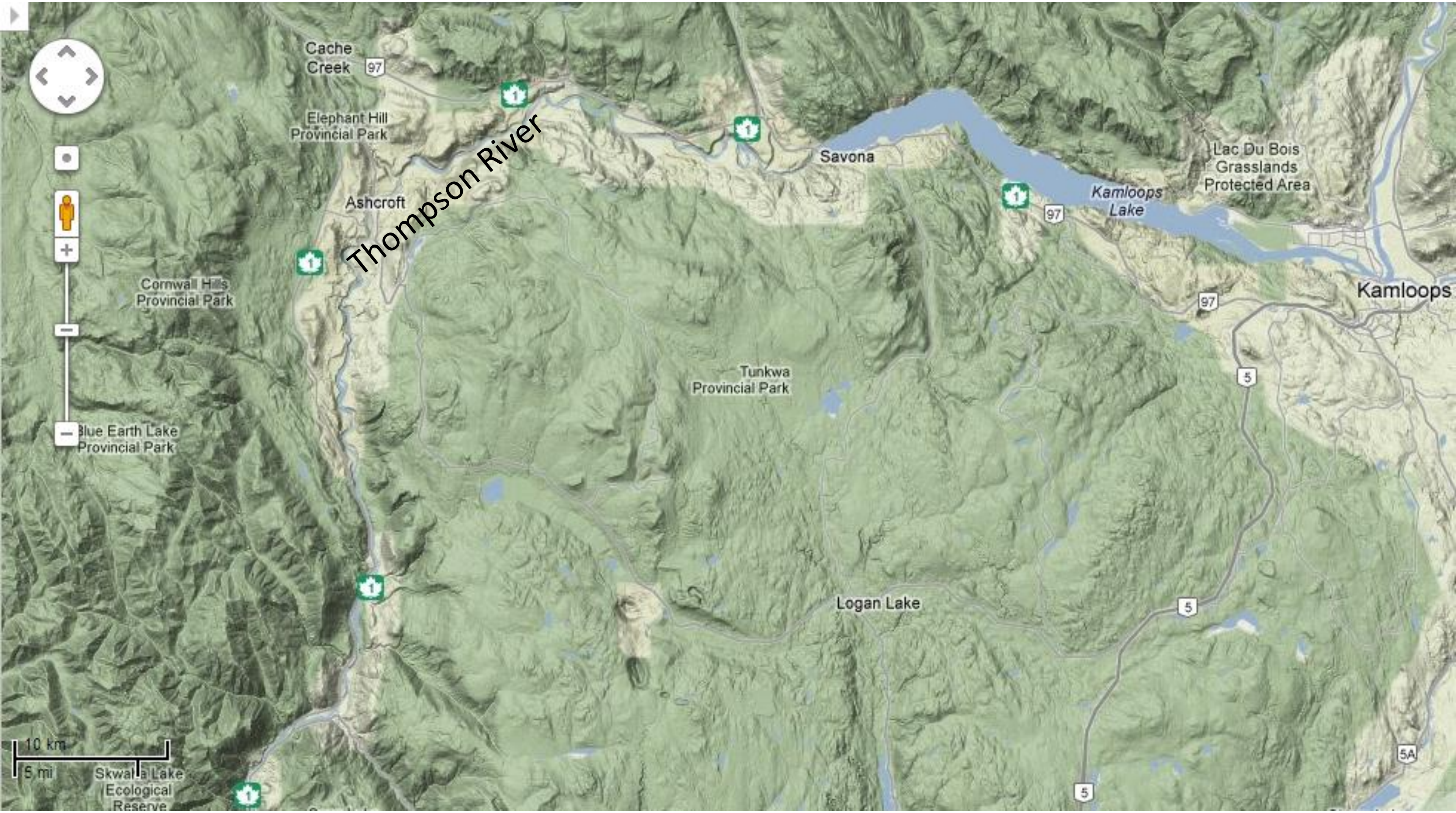
Permo-Carboniferous
Dwyka Formation from
South Africa
Varved couplets with
small dropstones
(Visser et al., 1984, J. Sed. Pet.)

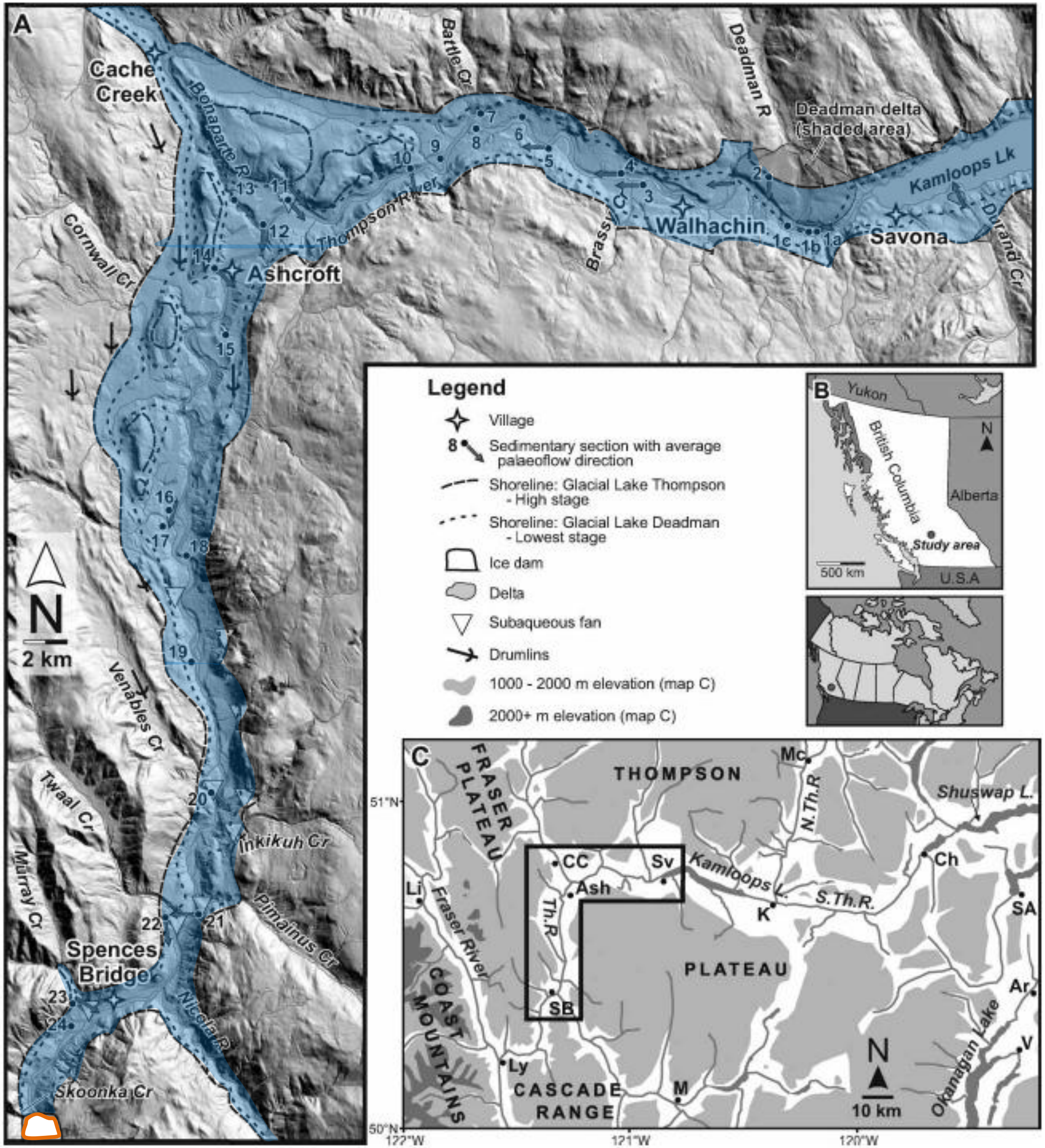
Glacial Lake beach terraces

Lake Superior

Missoula
Montana

Glacial Lake Thompson

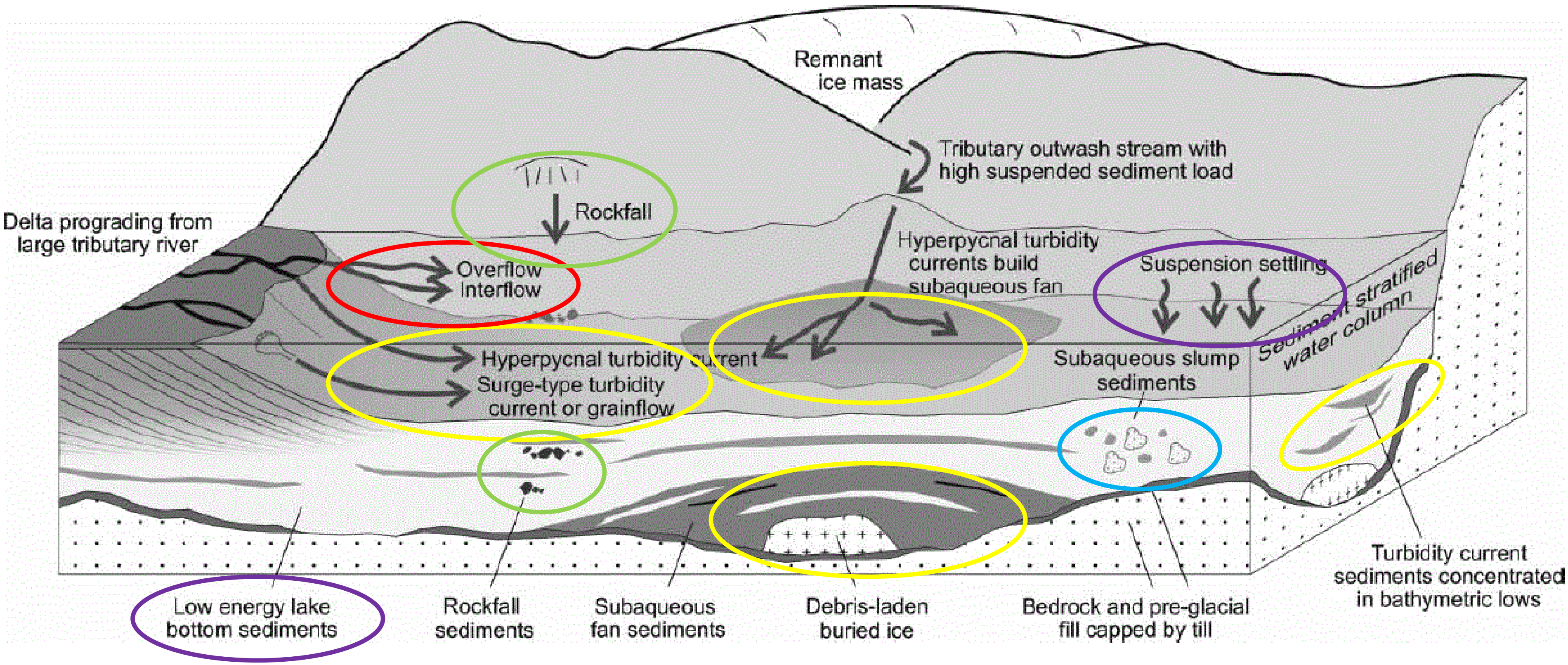




Glacial Lake Thompson during decay of the Fraser Ice sheet

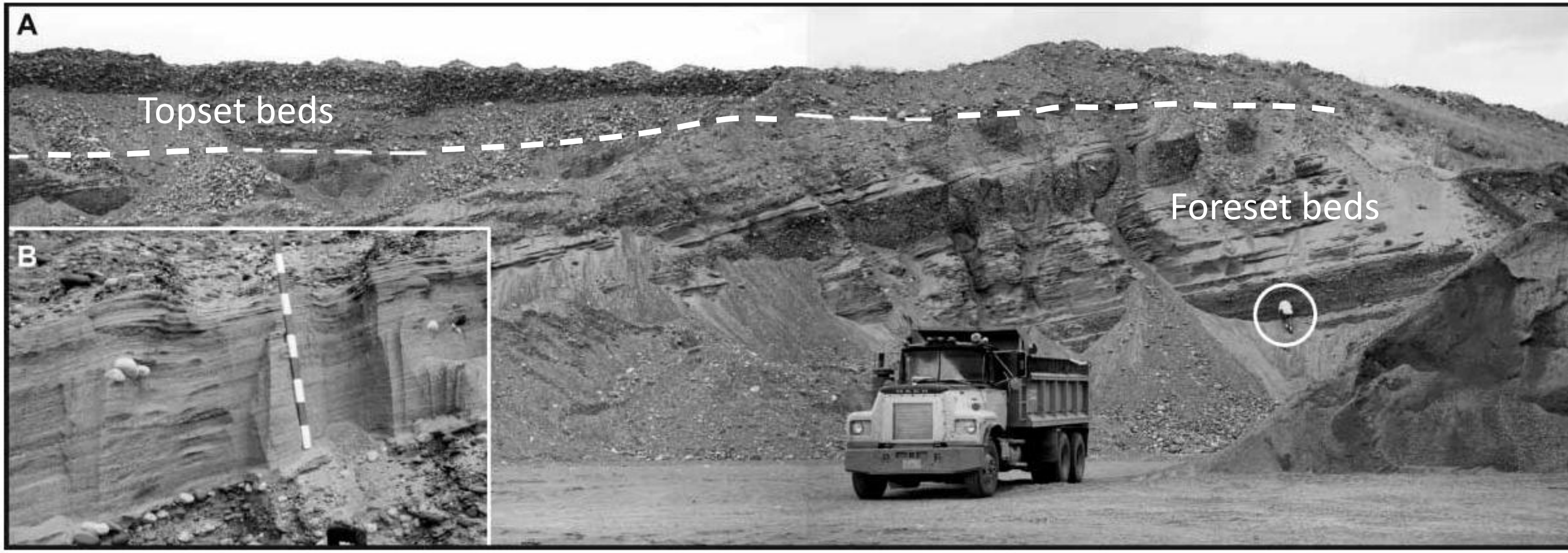
(ca. 13 to 10 ka)

Johnsen, T and Brennand, T, 2006, *The environment in and around ice-dammed lakes in the moderately high relief setting of the southern Canadian Cordillera*, Boreas, V. 35, p. 106

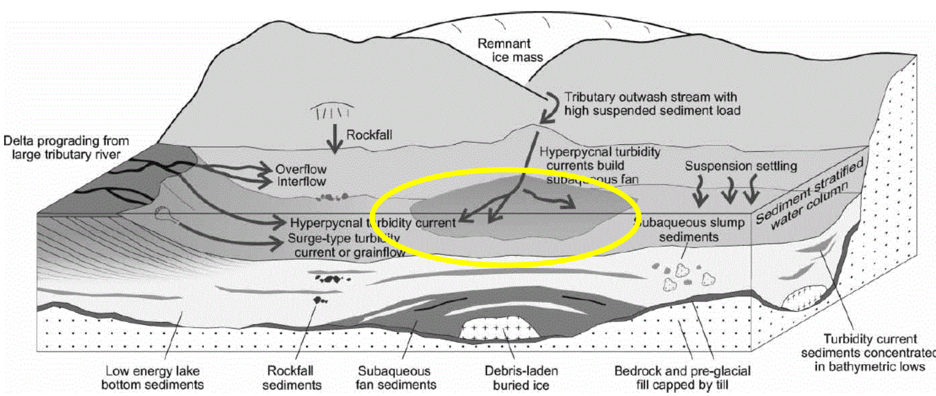


After Johnsen and Brennand, 2006

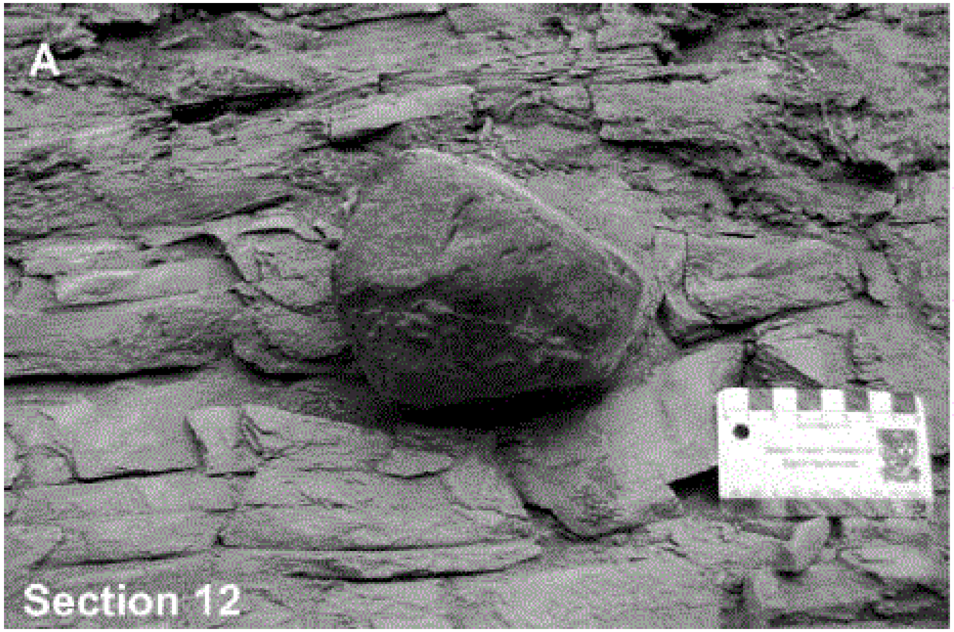
Delta deposits



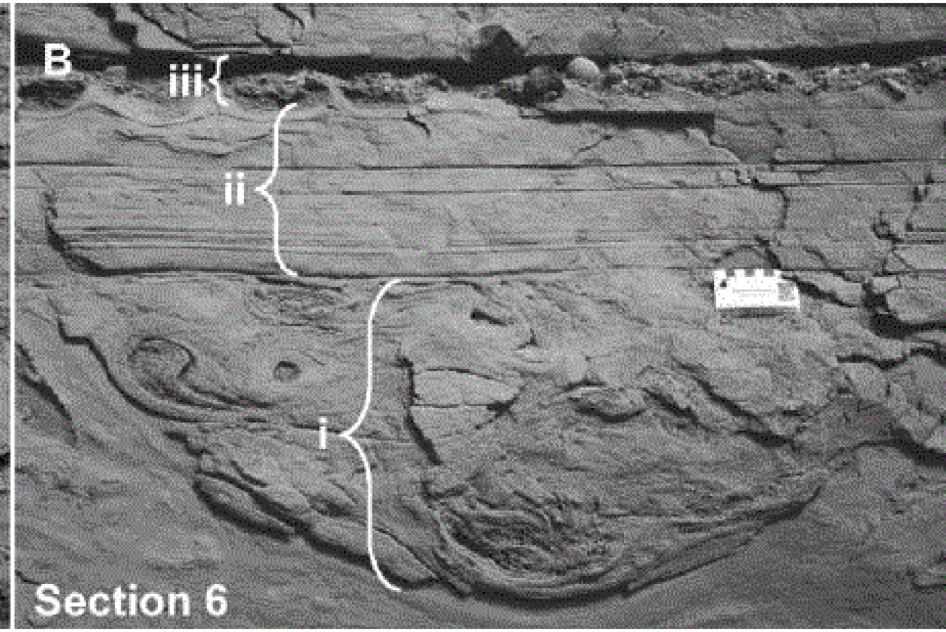
Delta topset and foreset beds. (Topset-foreset contact indicated by dashed line.) B. Close-up of foresets showing inclined, alternating imbricate gravel and plane-bedded sand lithofacies. Person (circle) for scale.



After Johnsen and Brennand, 2006

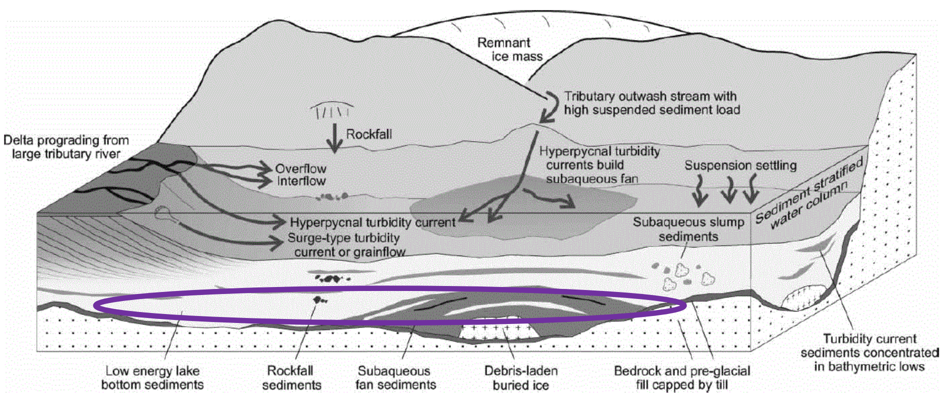


Laminated silt with a dropstone (uncomon in these sediments)



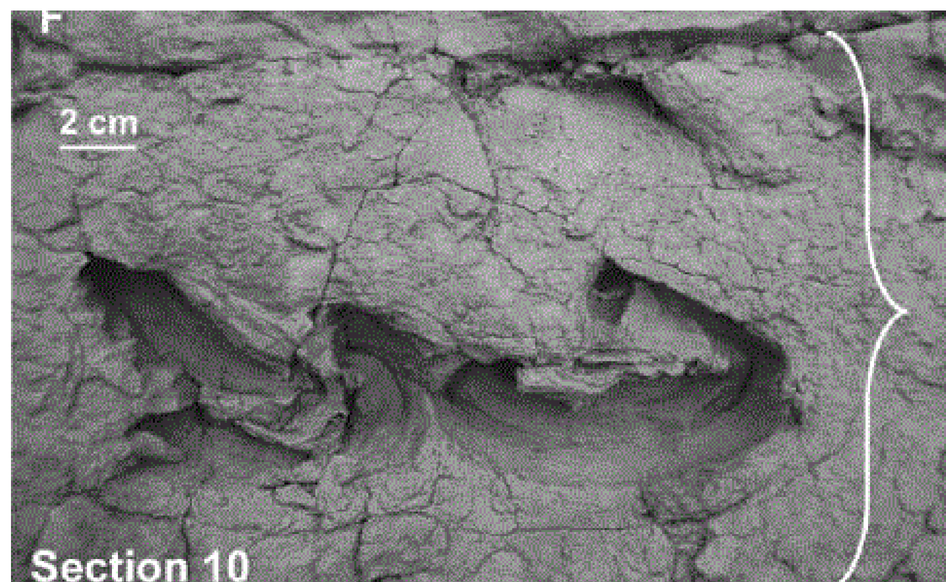
Laminated silt (ii) with convolutions (i) overlain by a layer of silty sandy diamicton (iii)

Low-energy sediments

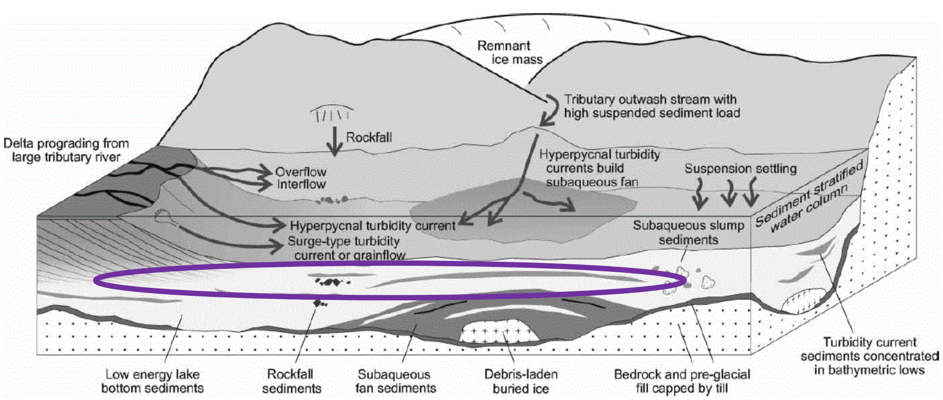


After Johnsen and Brennand, 2006

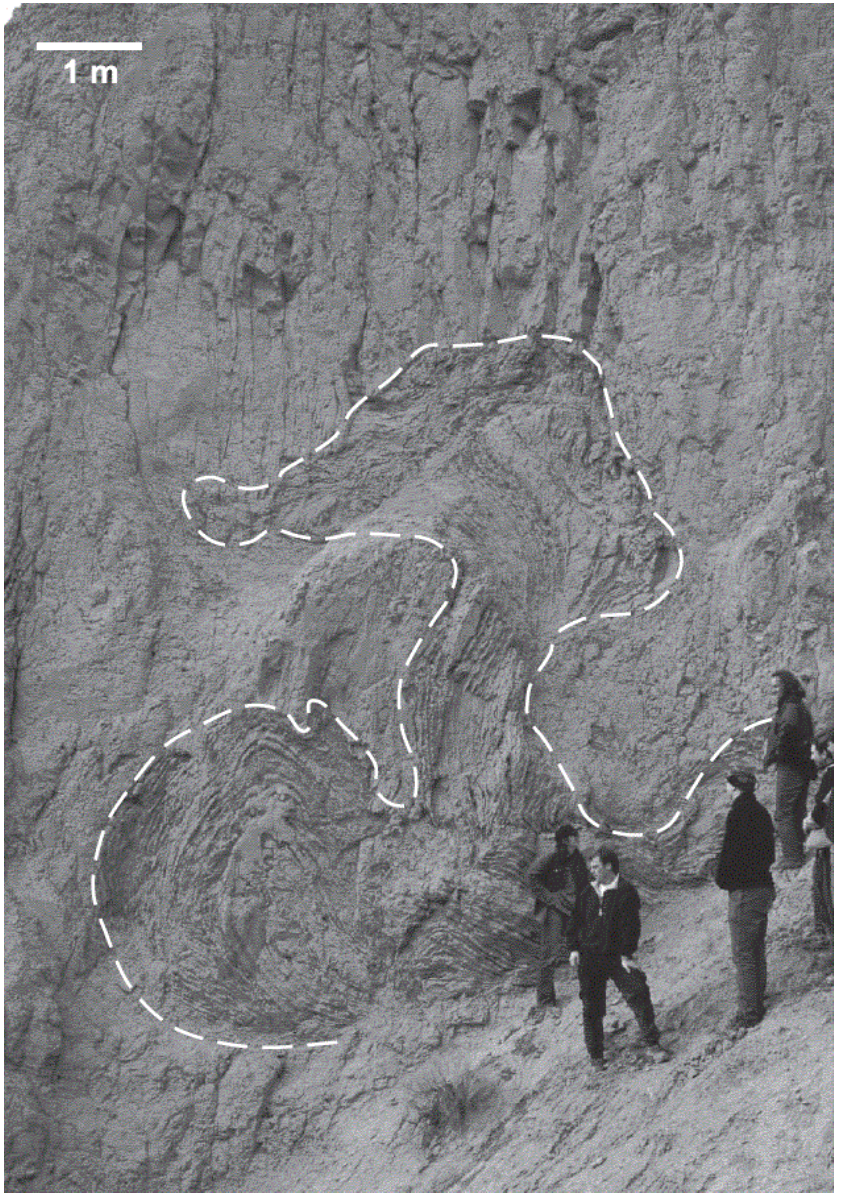
Silt with folded sand inclusions



Low-energy sediments



Silt with folded sand inclusions



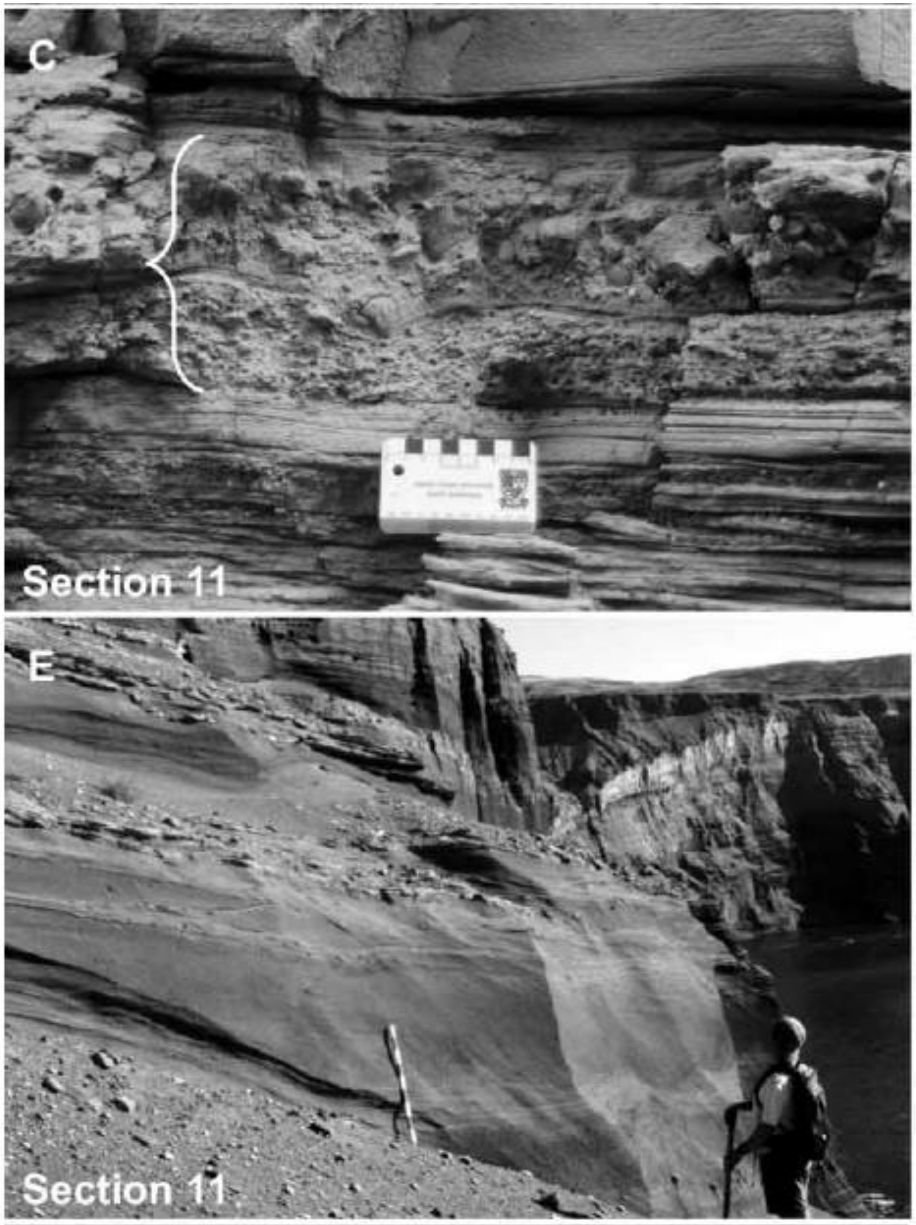
After Johnsen and Brennand, 2006

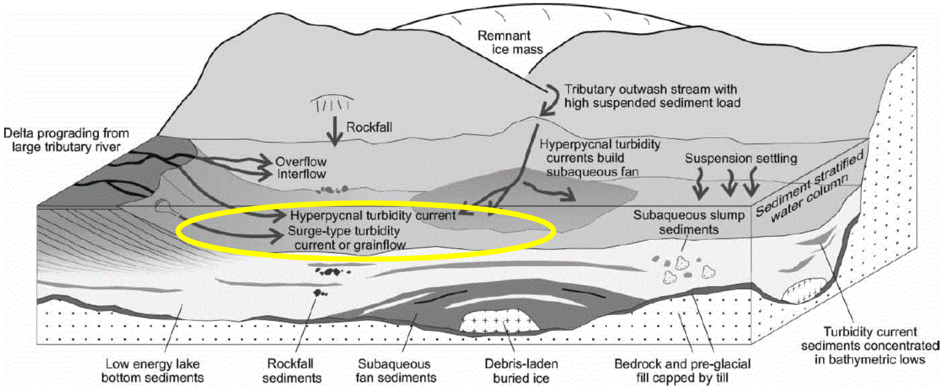

Cyclopsams versus cyclopels?

Low-energy deposits with flow-related layers

Laminated silt with two ~10 cm diamicton flow layers

Massive silt with diamicton layers

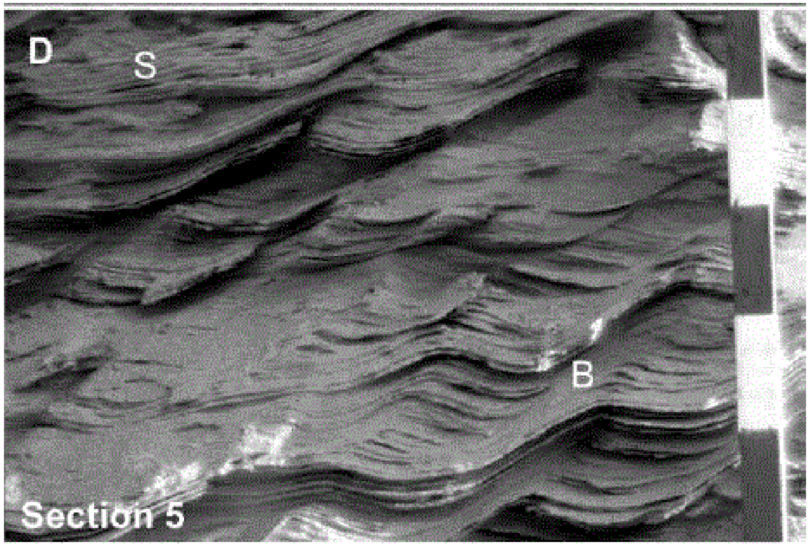


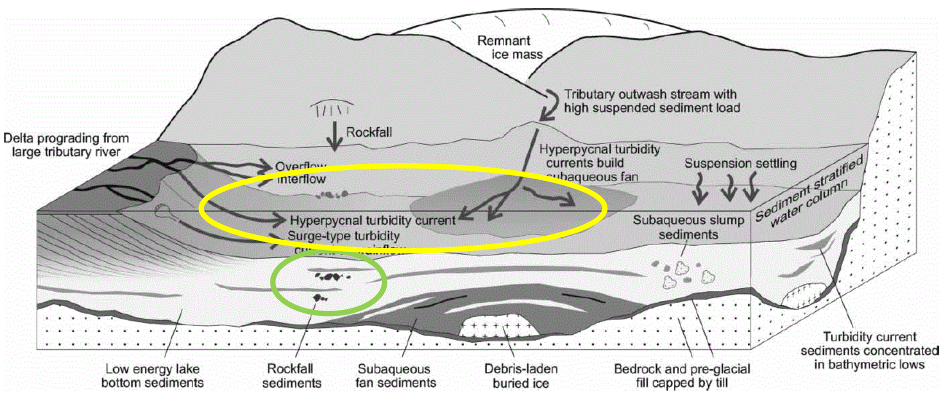


After Johnsen and Brennand, 2006

Flow deposits

Sand with climbing ripples

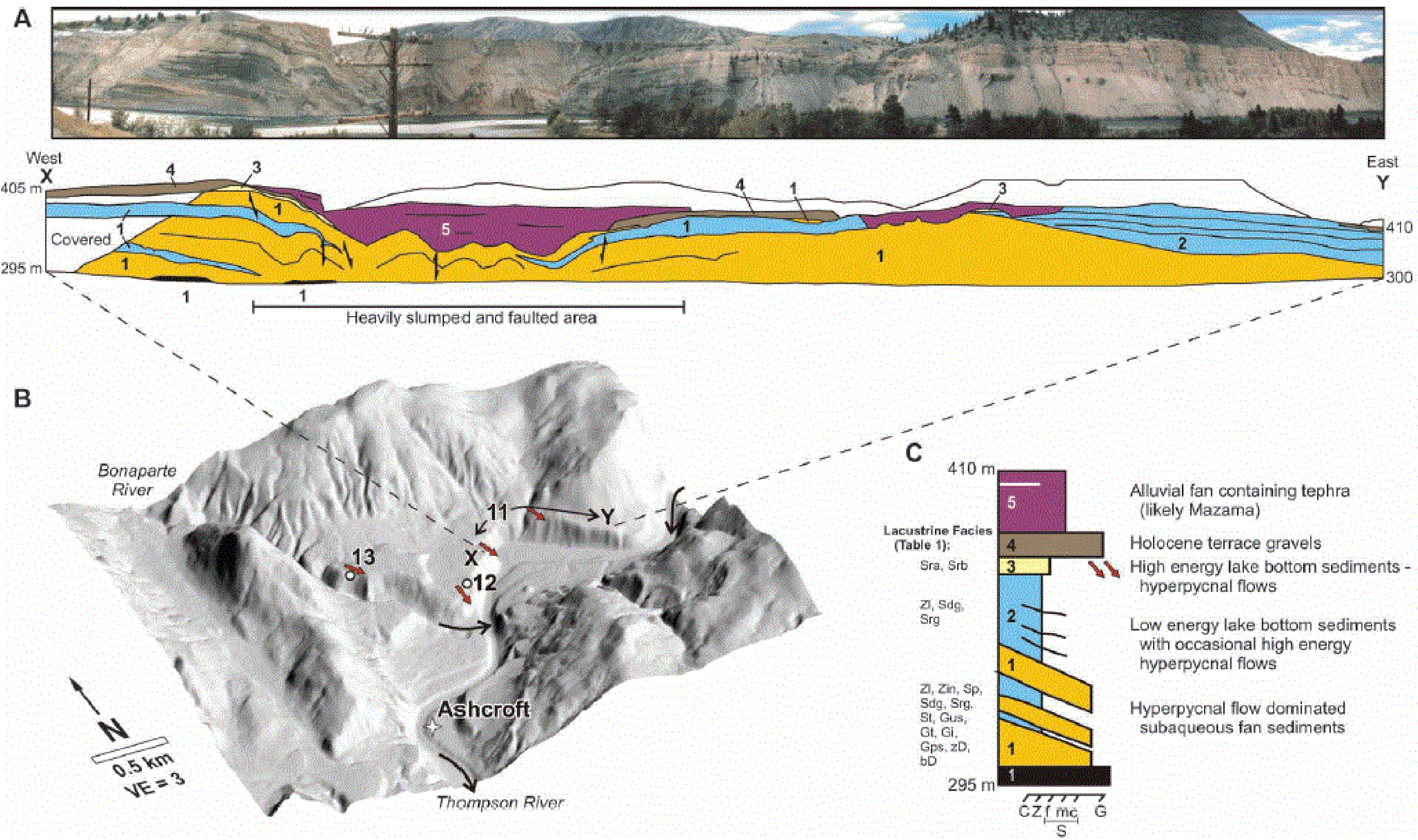




Rockfall deposits

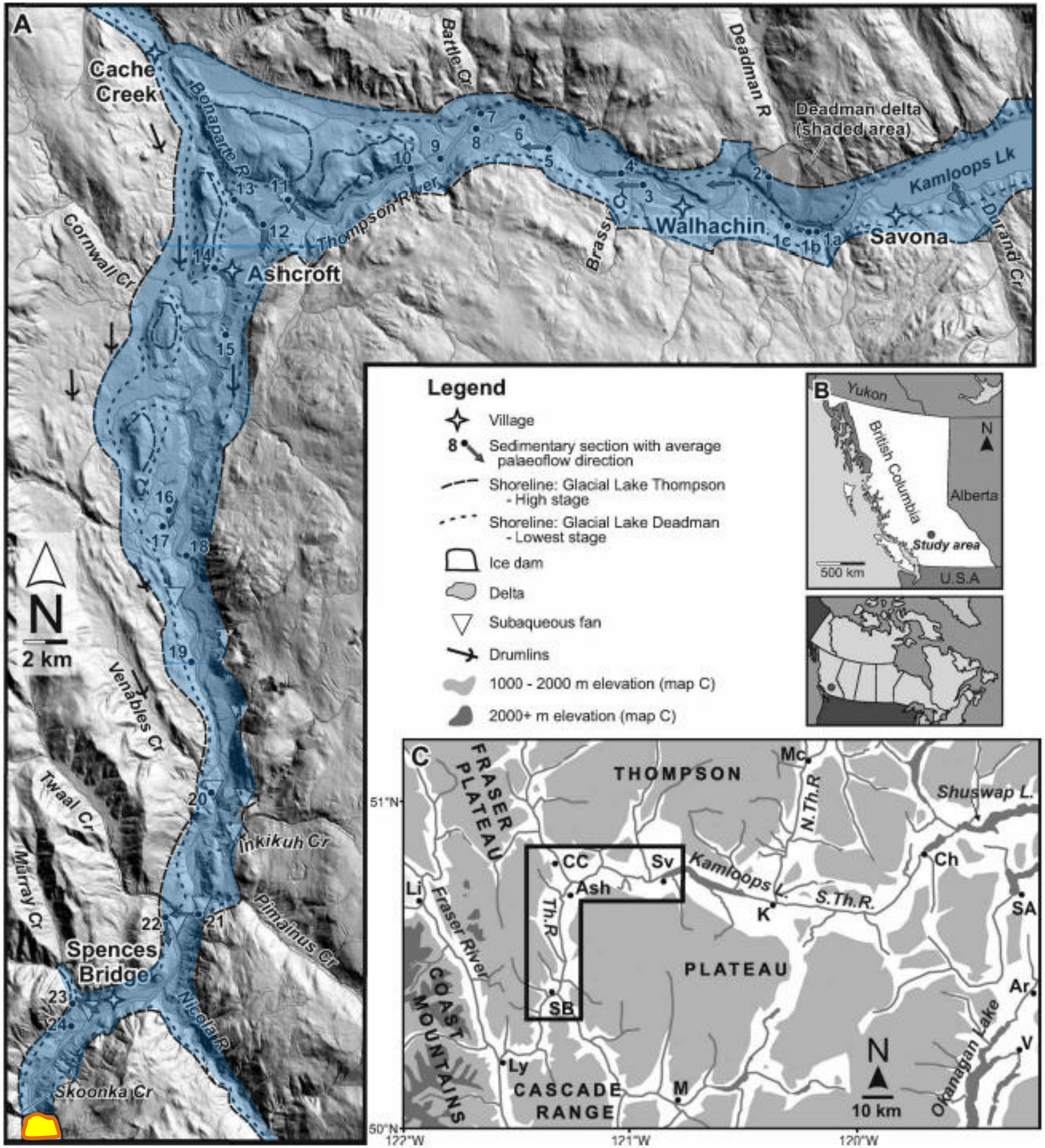
Silt deposit with large angular clasts from a rockfall into the lake

After Johnsen and Brennand, 2006



After Johnsen and Brennand, 2006

Glacial Lake Thompson



After Johnsen and Brennand, 2006

Glaciomarine deposits

Modes of glaciomarine deposition

- Direct deposition from the glacier (waterlain diamict)
- Deposition from meltwater inflows (deltas fans)
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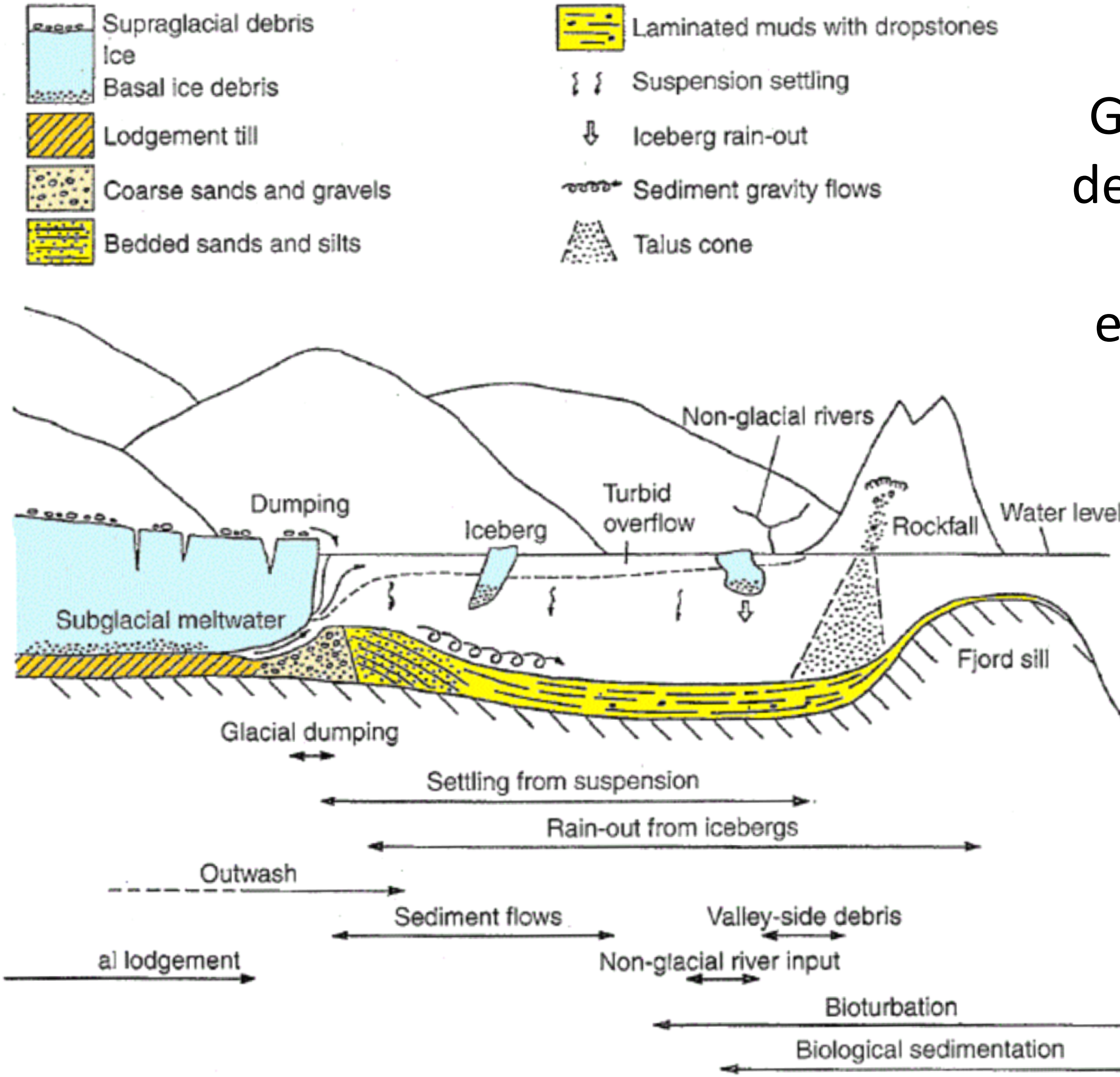
- Rain-out from icebergs (dropstones and diamicts)
- Resedimentation from gravity flows
- Iceberg reworking
- Biological sedimentation and trace fossils

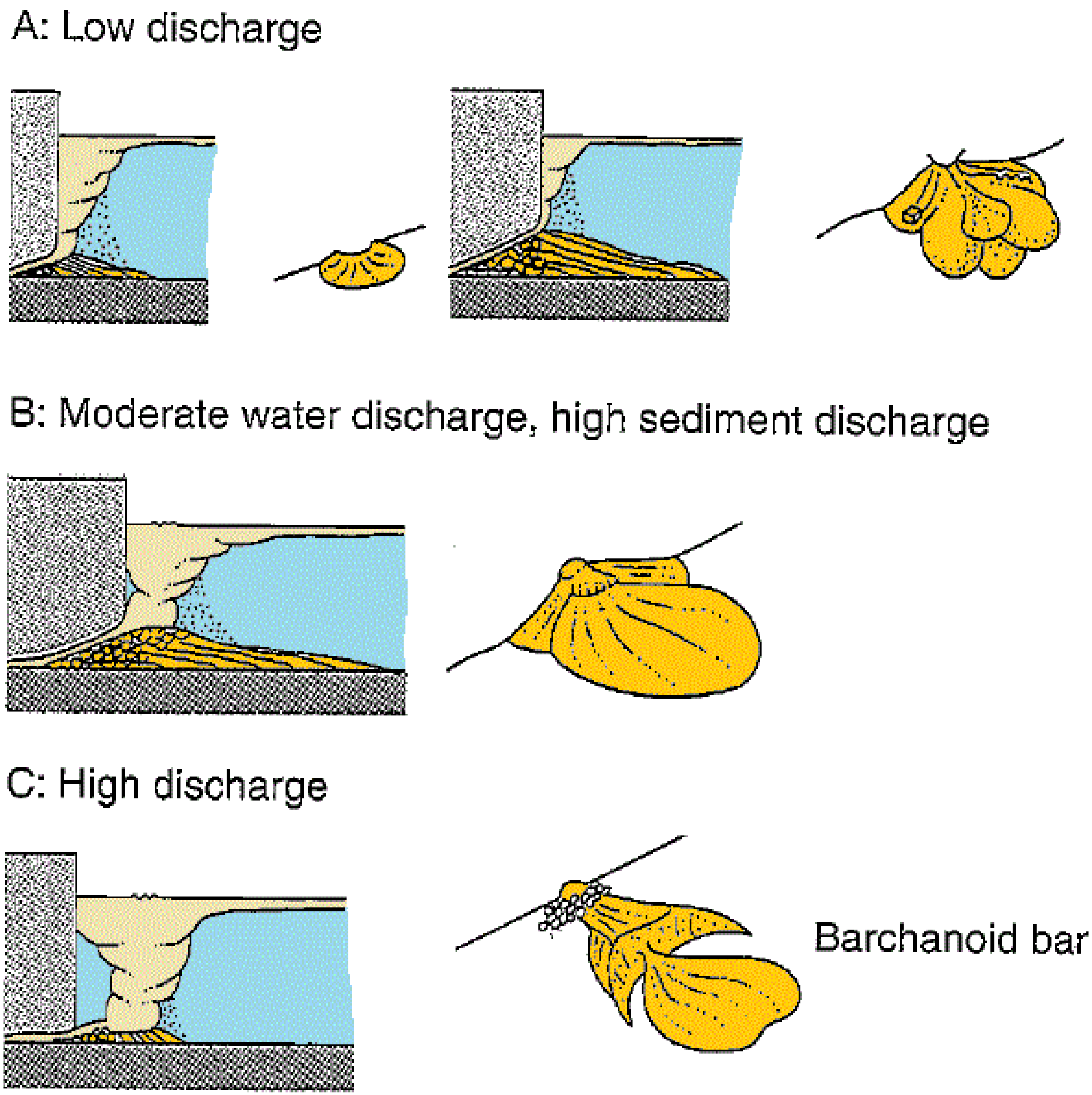
Glaciomarine deposition in a fjord environment



Lodgement till in a glaciomarine setting is commonly much thicker (5-20 m) than in a continental setting (1-5 m) because the glacier over-rides clay-rich sediment.

From Bennett & Glasser, 2009

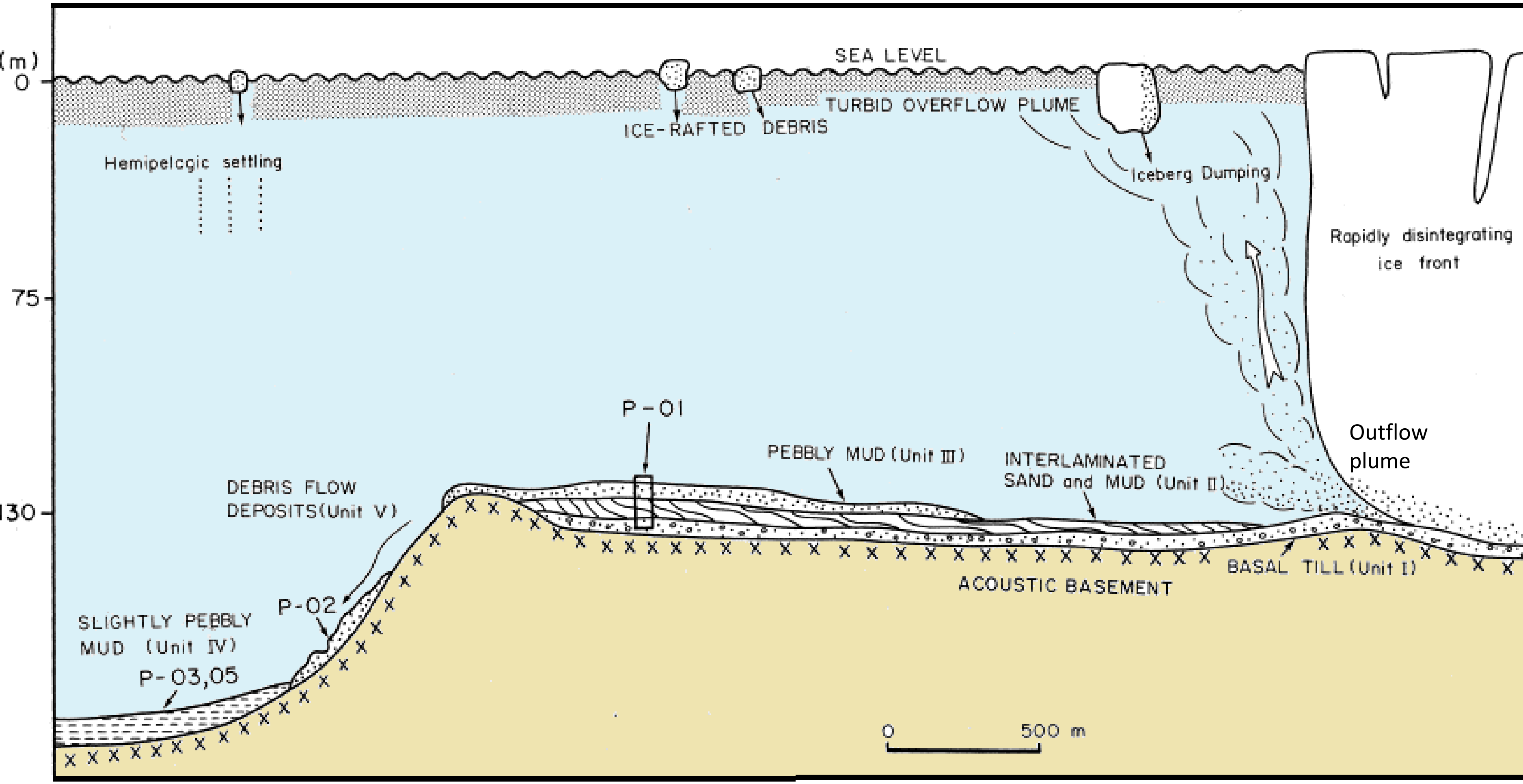
Significance of saltwater density



Typical sea-water has about 0.35% salt and a density of about 1030 g/L. Incoming fresh water is typically much less dense and will rise to the surface taking at least the fine material with it. Incoming water must have at least 30 g of sediment/L in order to be more dense than seawater.

From Bennett & Glasser, 2009

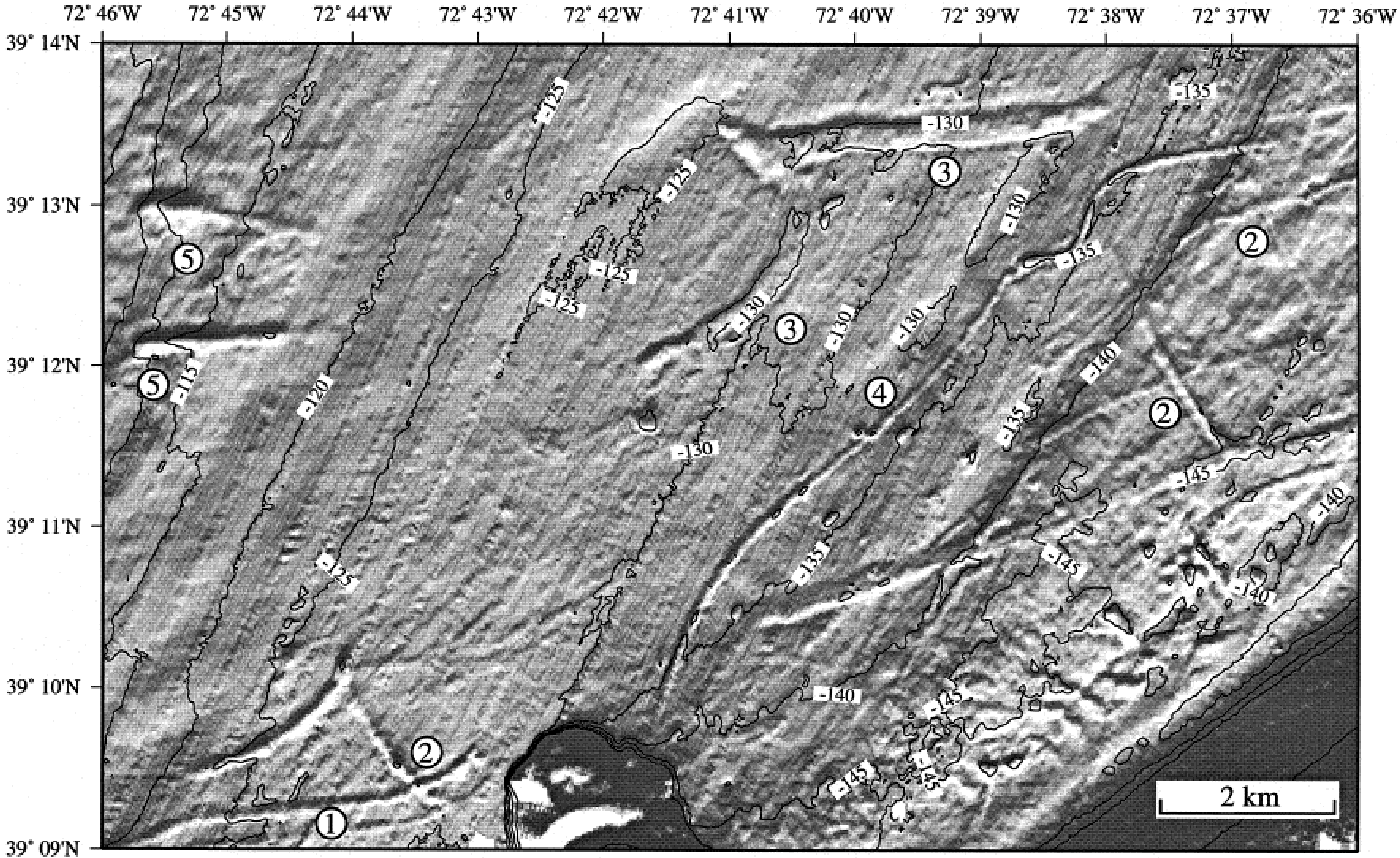
S. Shetland Islands (W. Antarctica)



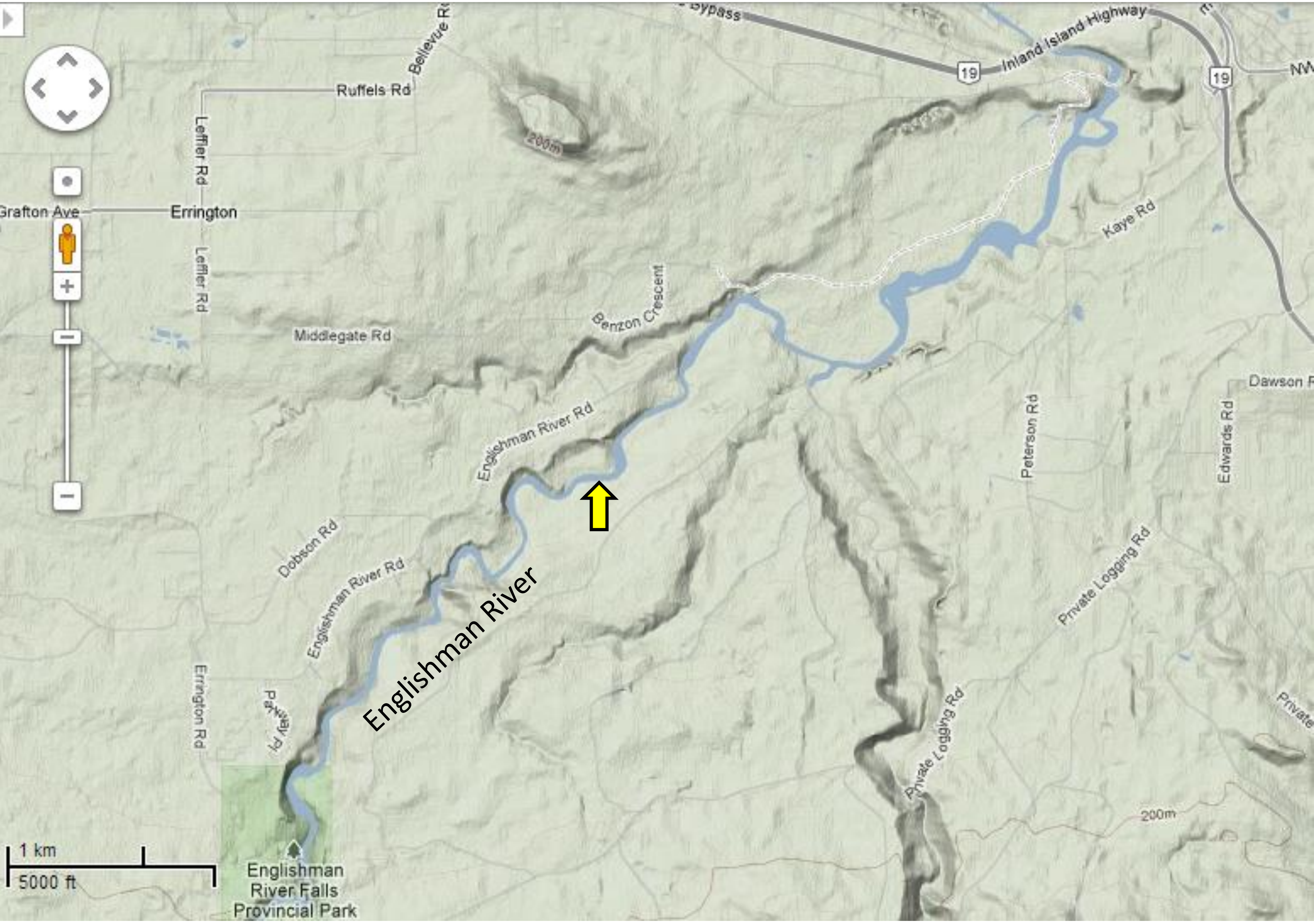
Yoon et al., 1997

Distinguishing glaciomarine diamicts from tills

Iceberg scars off Hudson river, New Jersey (1) parallel scours, which must have been created by a double-keeled object; (2) cross cutting scours where one clearly post-dates the other; (3) wide scours with bermed edges, indicating material pushed to the side during gouging; (4) a long, sinuous scour that starts and stops at almost identical depths, indicating a keel of constant depth; and (5) scours that deepen upslope, indicating a grounded object. (From Goff et al., 1999)



Englishman River glaciomarine sediments




Cyclopsams versus cyclopels?