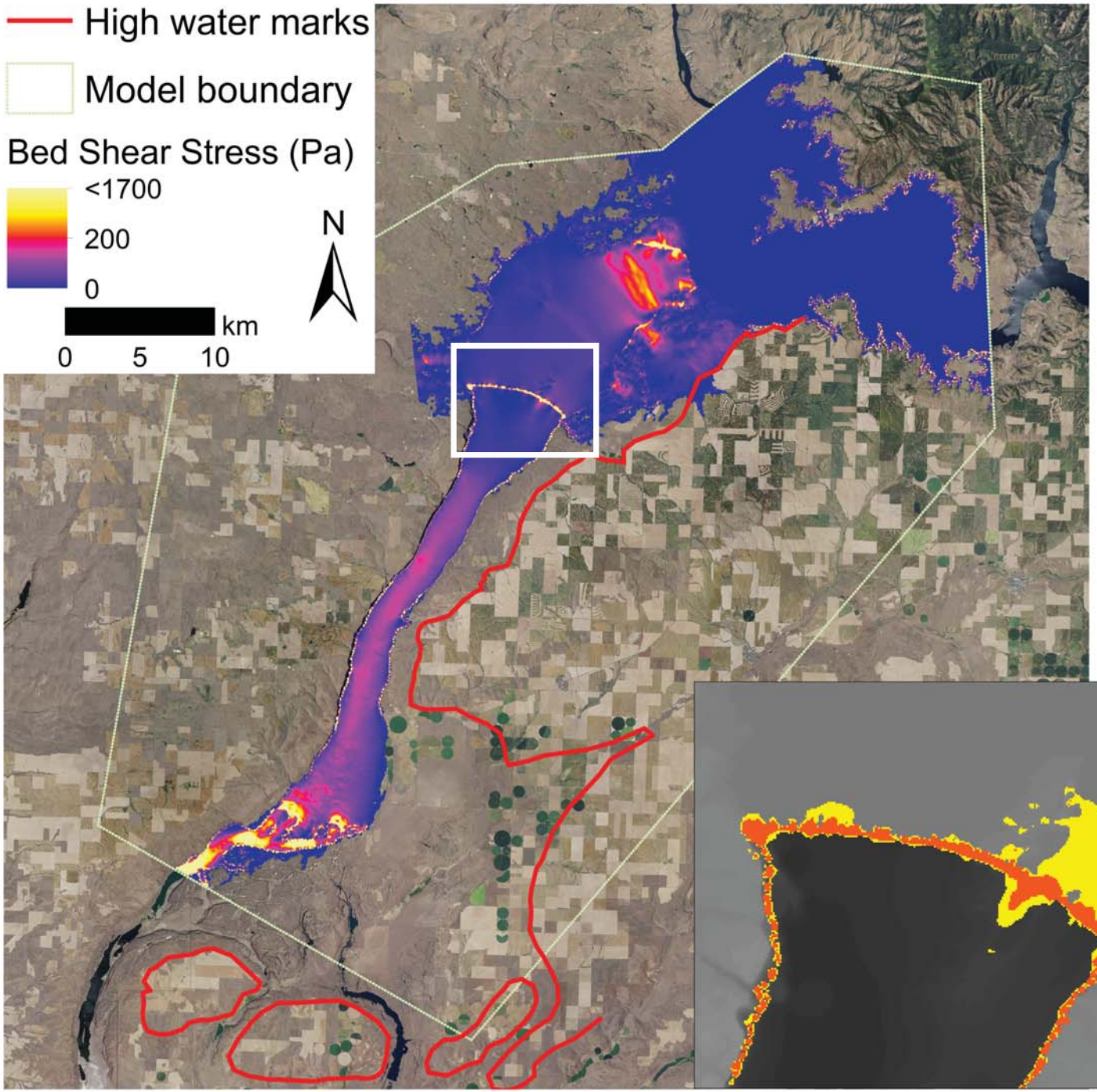
Stop 2.3
Karin Lehnigk
University of Massachusetts

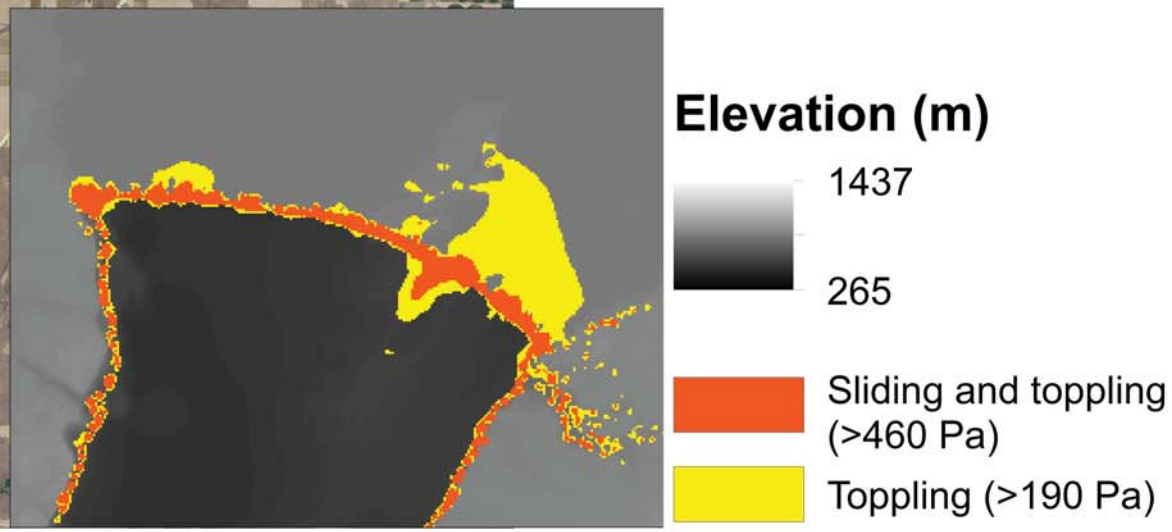
Waterfall Reconstruction (0.7 x 10^6 m^3 s^{-1})



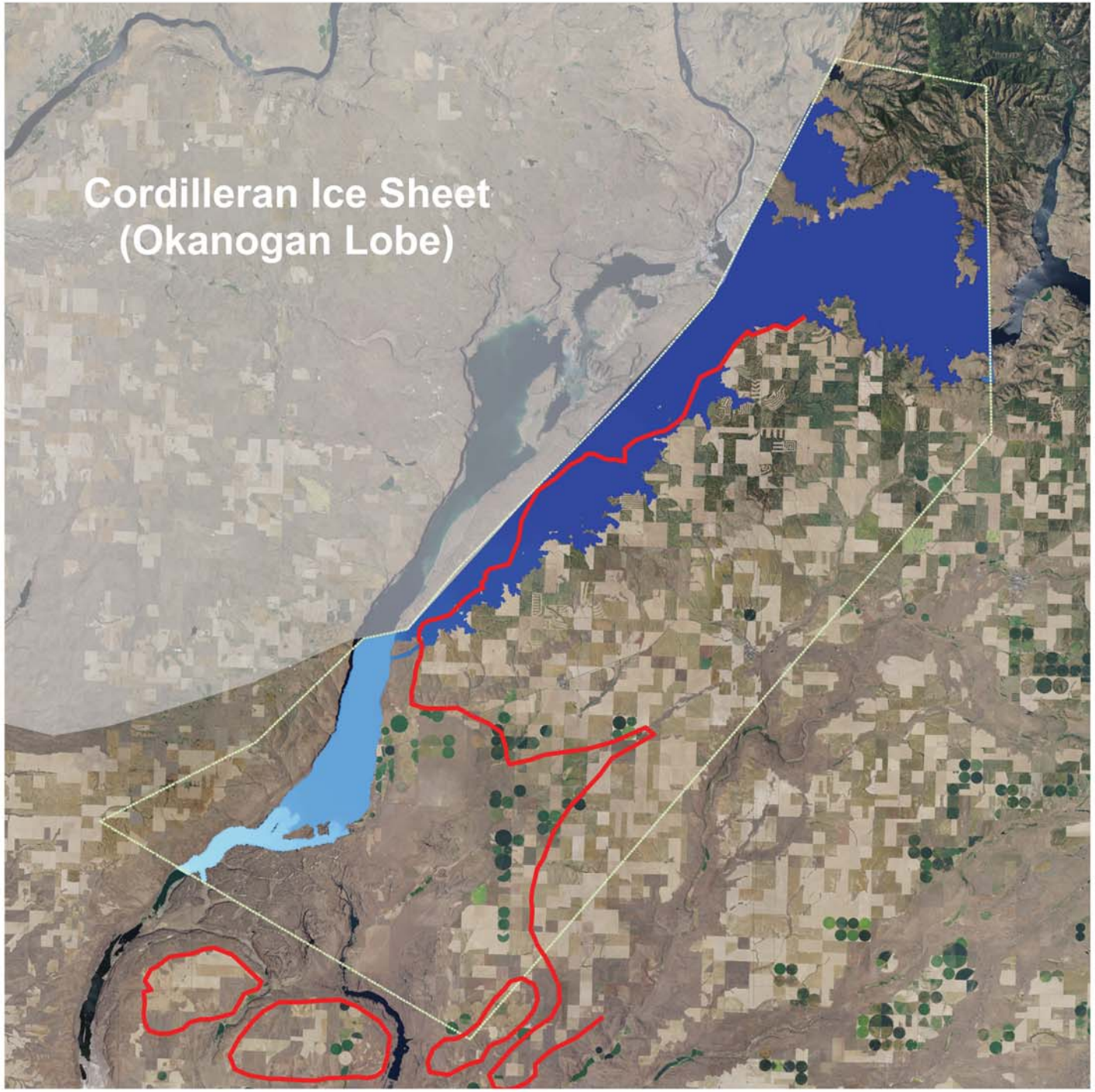
- With the waterfall in place, high water marks are inundated at discharges of 0.7 x 10^6 m^3 s^{-1}

- Shear stresses at the waterfall lip are great enough for plucking via column toppling and sliding

- The discharge responsible for carving Upper Grand Coulee was < 10^6 m^3 s^{-1}



Ice Sheet Reconstruction (0.2 x 10^6 m^3 s^{-1})



- Discharges < 0.2 x 10^6 m^3 s^{-1} exceed high water marks

- Consistent with discharge estimate of 0.13 x 10^6 m^3 s^{-1} from Atwater (1987)

- When the Okanogan Lobe blocked Upper Grand Coulee, discharges out of Glacial Lake Columbia were low

High water marks

Model boundary

Stage (m)

860

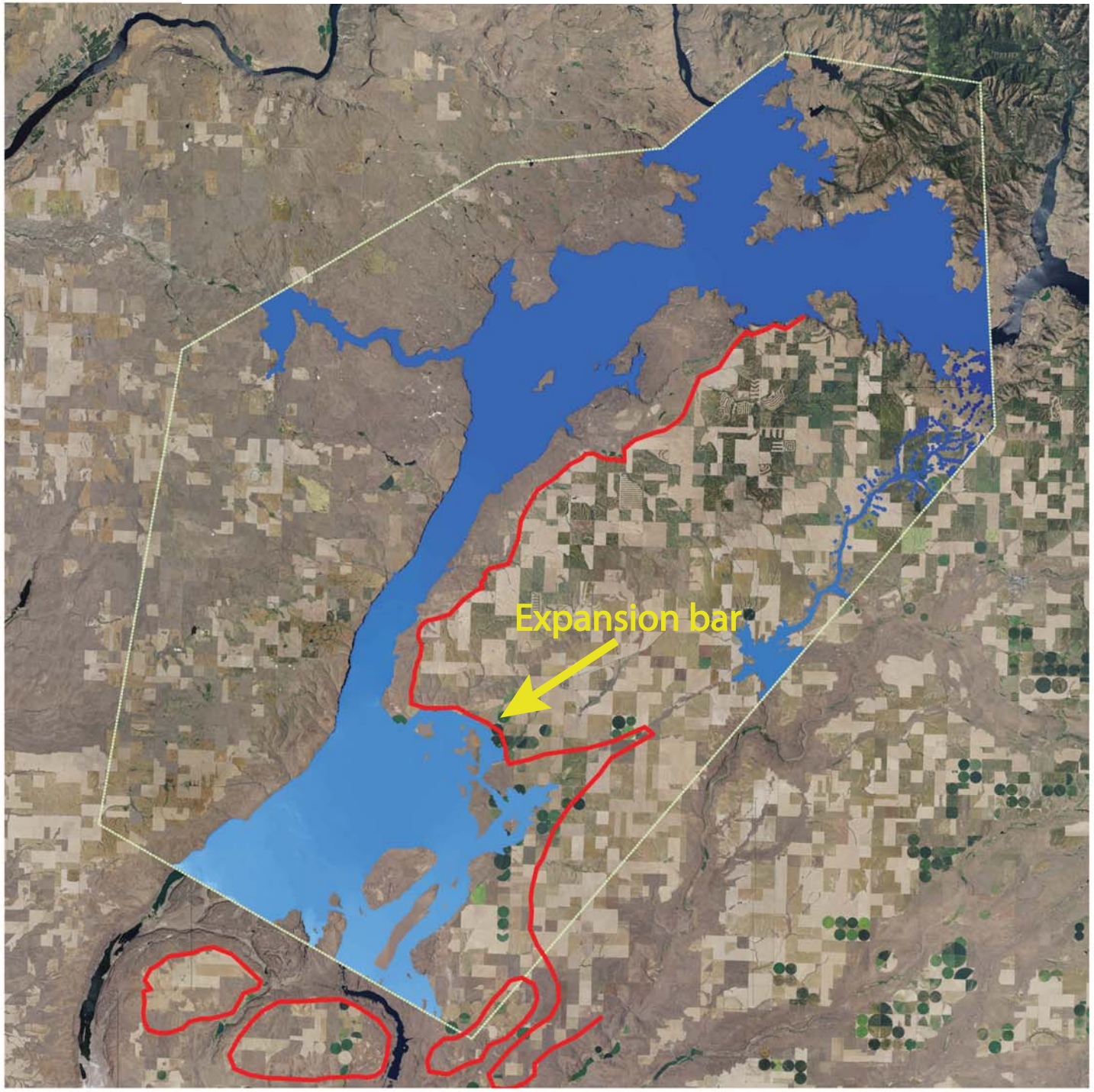
320

km

0 5 10

N

Modern Topography (6 x 10^6 m^3 s^{-1})



- Discharges of 6 x 10^6 m^3 s^{-1} inundate the expansion bar at the mouth of Upper Grand Coulee, but not the eastern rim or Steamboat Rock

- Glacial Lake Columbia drainage under investigation

High water marks

Model boundary

Stage (m)

860

320

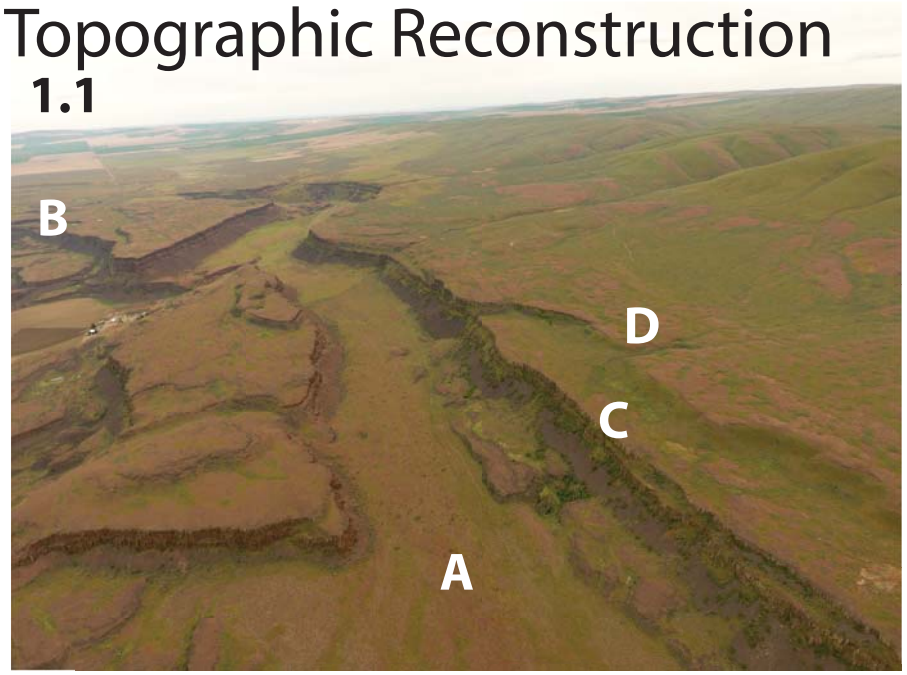
N

km

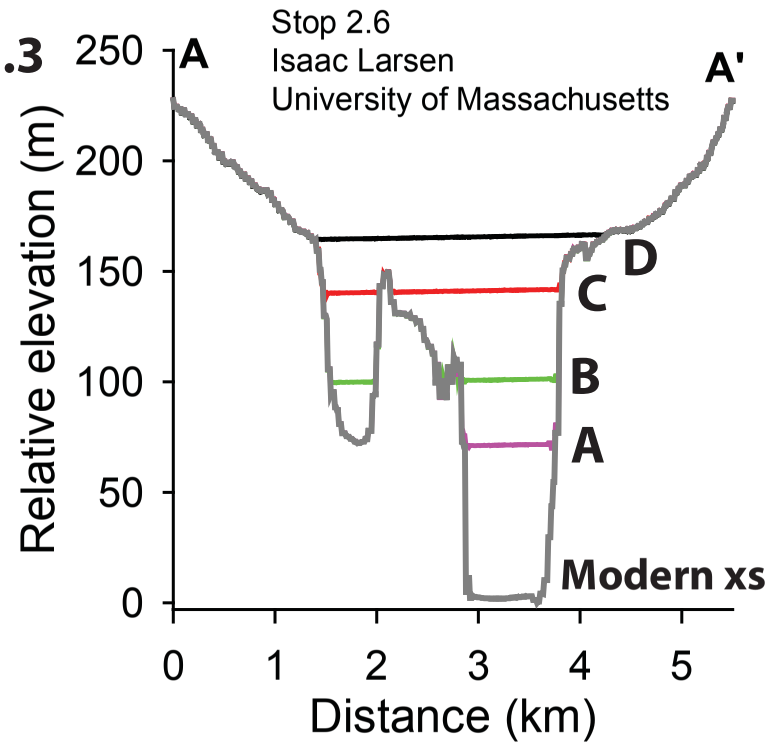
0 5 10

Topographic Reconstruction

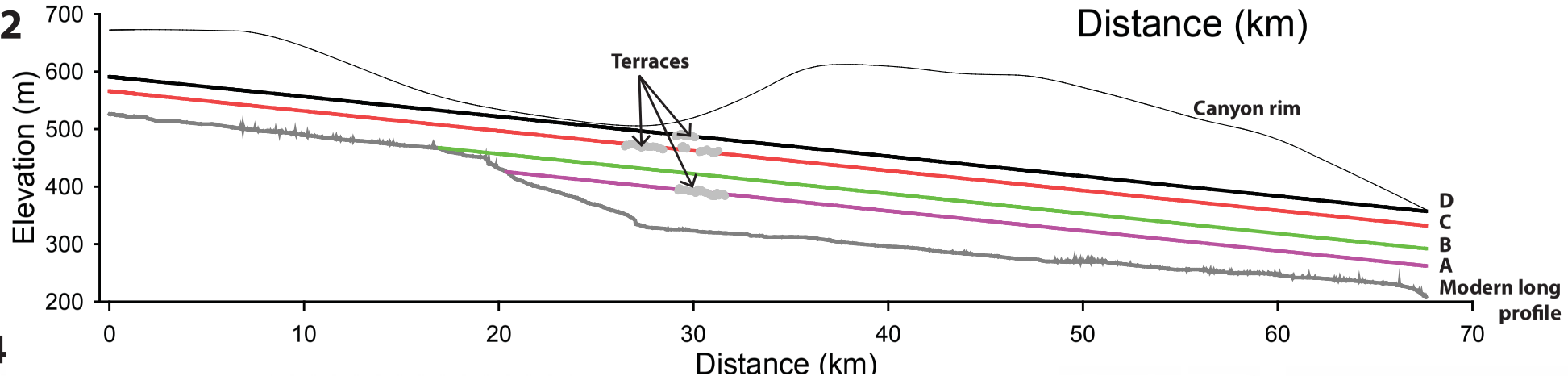
1.1



1.3



1.2



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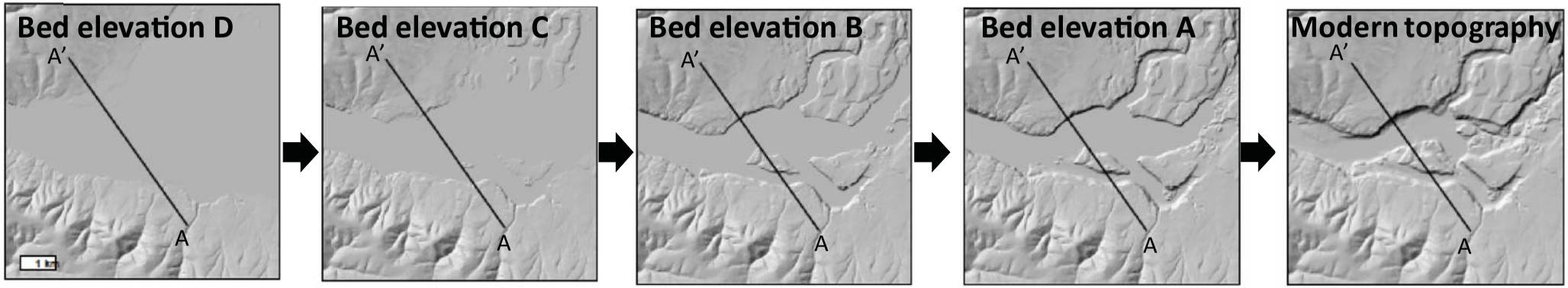
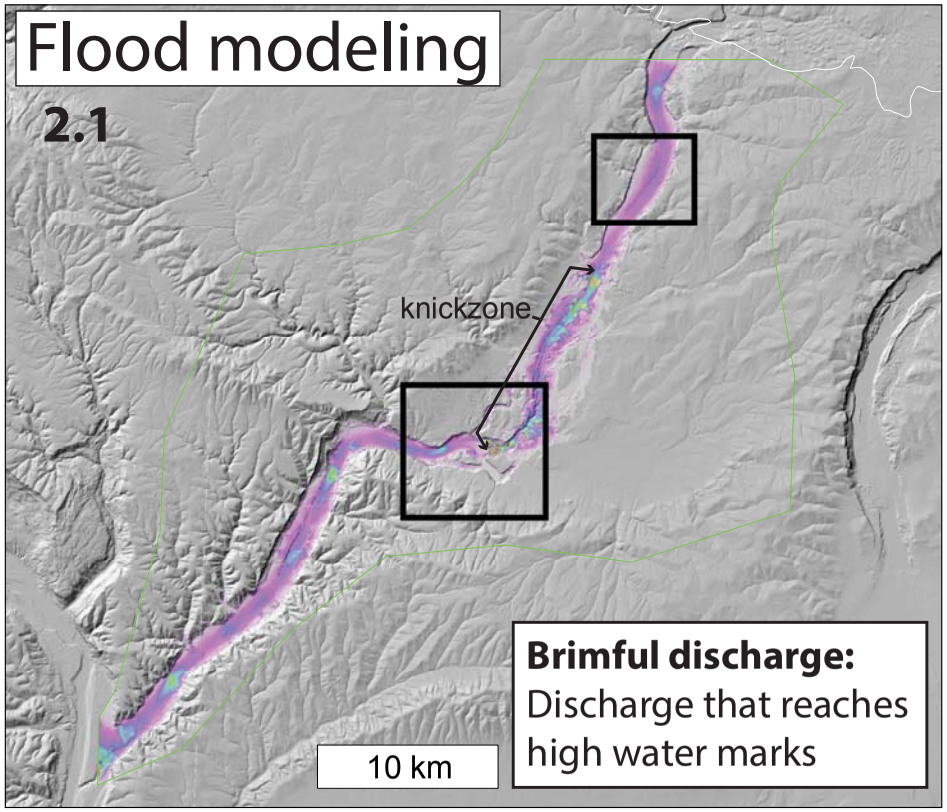
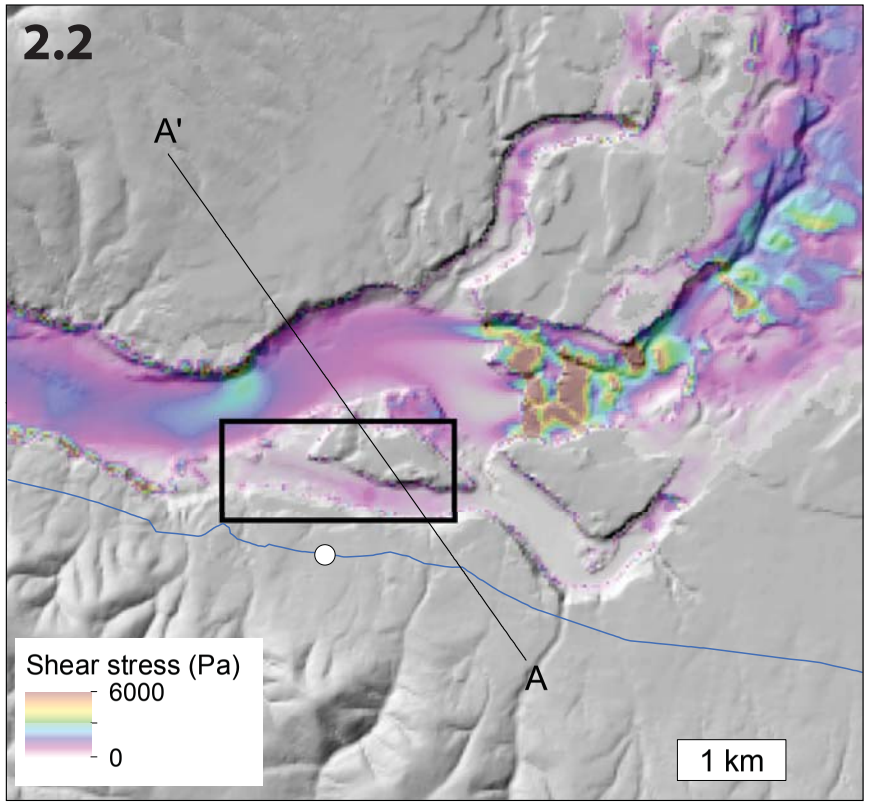


Flood modeling



Brimful discharge:
Discharge that reaches high water marks



Threshold shear stress discharge:

1. Critical Shields number for block sliding from theory (Lamb et al. 2015)

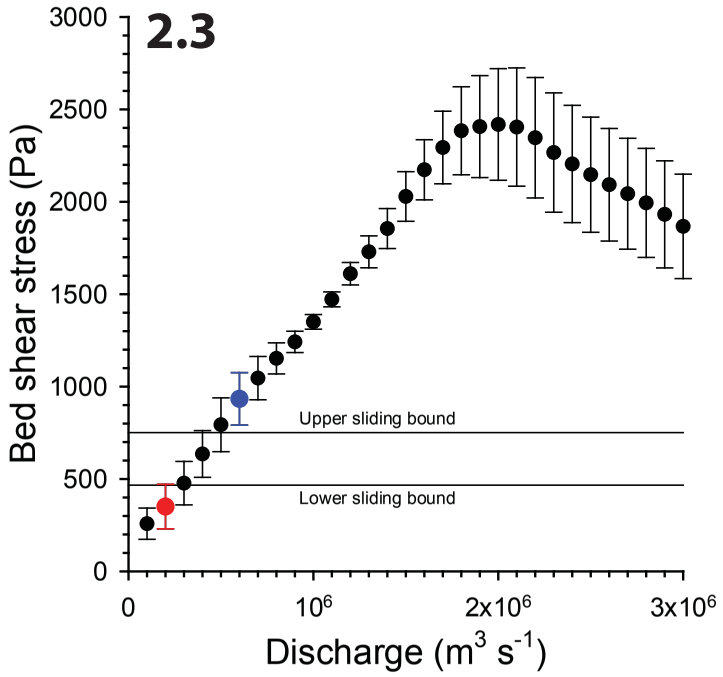
   $\tau^*_c = 0.053$ (lower bound)
   $\tau^*_c = 0.085$ (upper bound)

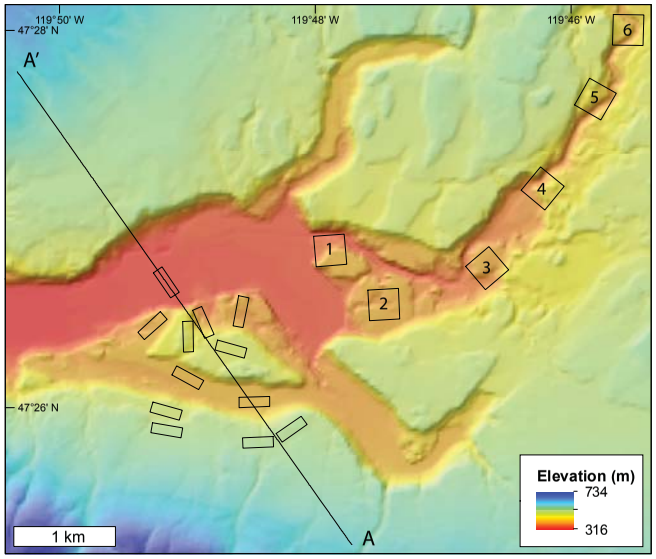
2. Critical shear stress for sliding:

   $\tau_c = \tau^*_c \cdot g(\rho_s - \rho)D$
   where D = 0.5 m

   $\tau_c = 476$ Pa (lower bound)
   $\tau_c = 751$ Pa (upper bound)

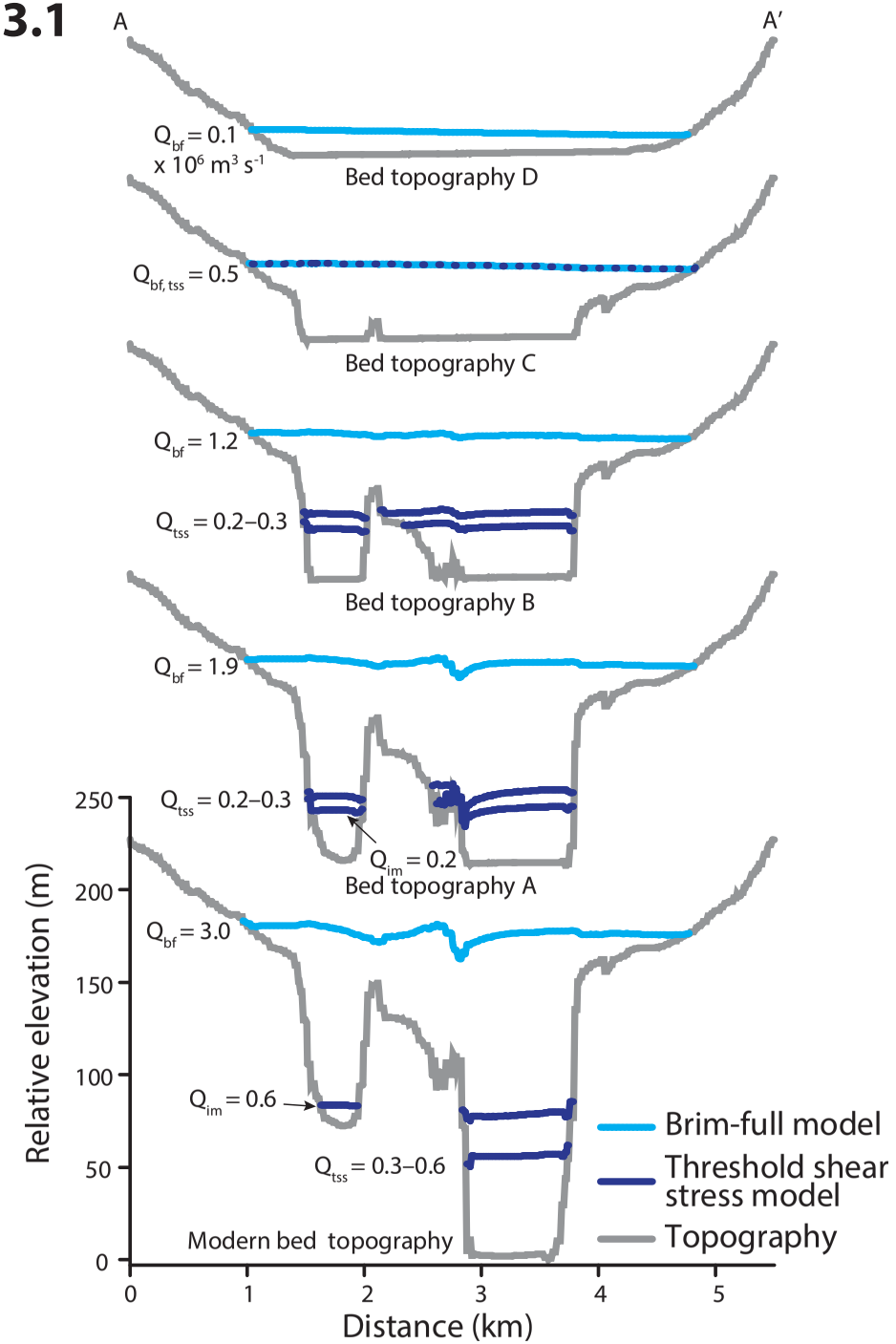
Shear stress thresholds for sliding used to determine discharge values.



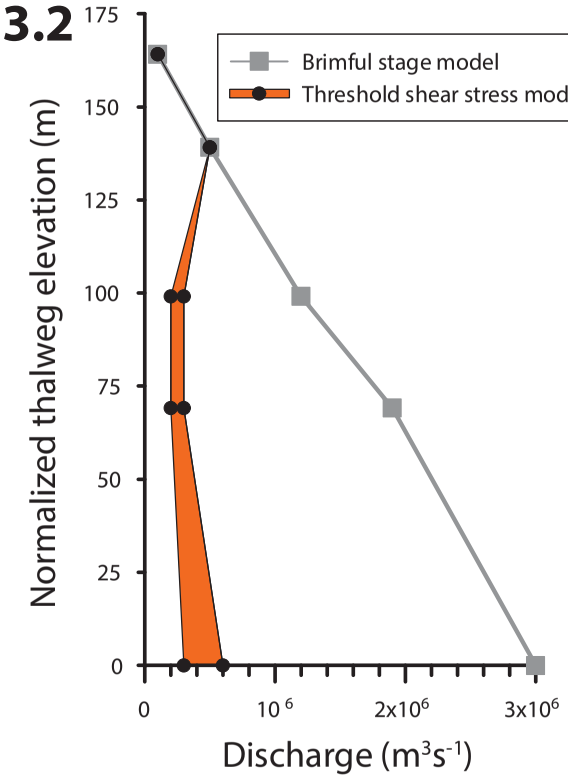


Results

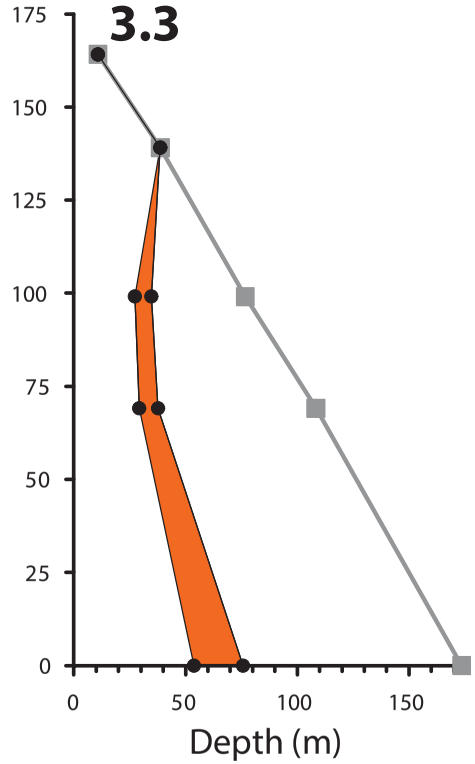
3.1



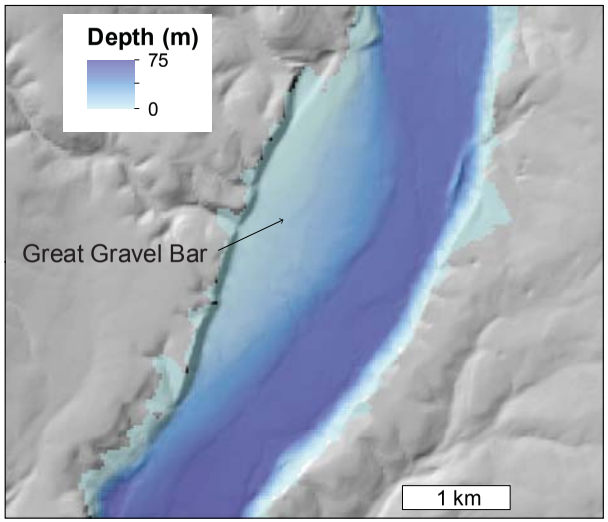
3.2



3.3

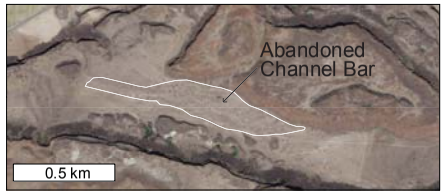


3.4



$Q = 0.6 \times 10^6\ m^3\ s^{-1}$

3.5



3.6

Larsen and Lamb, 2016