The Zanclean flood hypothesis
Searching for independent evidence

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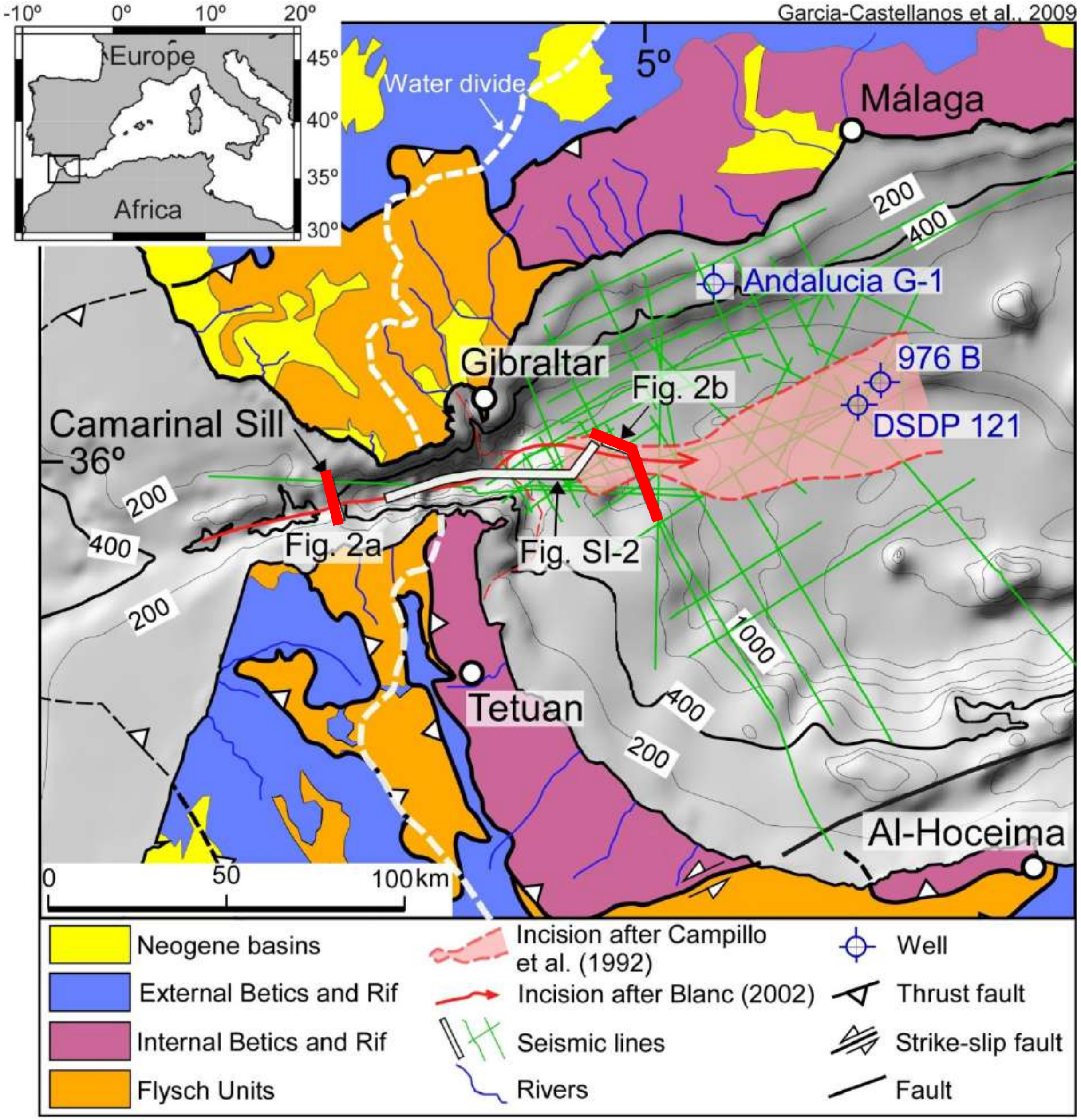
- Widespread erosion of the Mediterranean continental margins suggest the exposure of the seafloor by an evaporative drawdown of kilometric scale during the Messinian Salinity Crisis.

- An erosion trough across the Strait of Gibraltar is the main support for a catastrophic refill of the Mediterranean after the MSC.

- It runs from the Atlantic Ocean to the Mediterranean Sea and it's visible in reflection seismic surveys, under a Plioquaternary sedimentary cover.

- >400km long

- 2-10 km wide

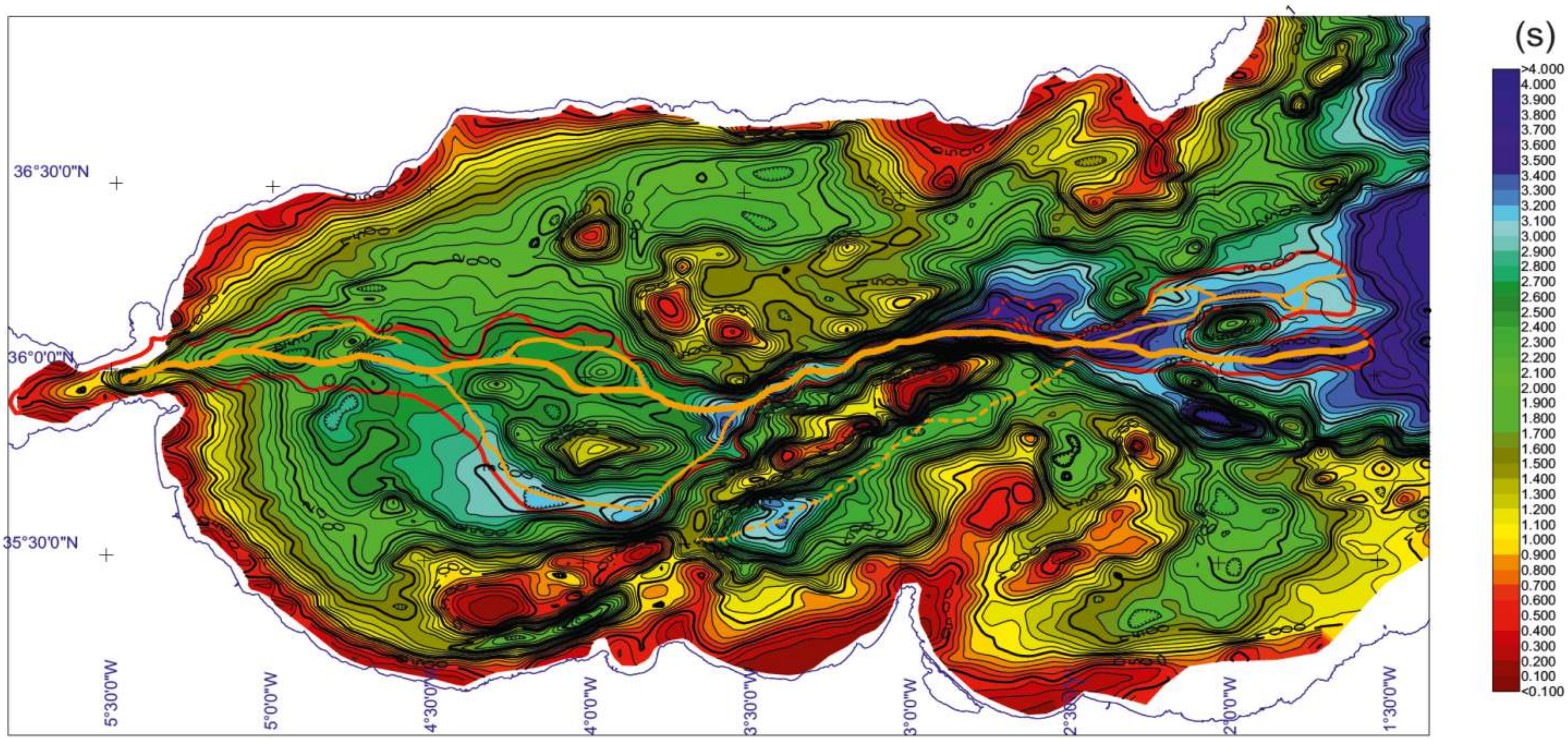


Garcia-Castellanos et al., 2009, Nature

Messinian Erosion Surface map in Alborán (W Mediterranean).

Updated seismic survey + borehole data

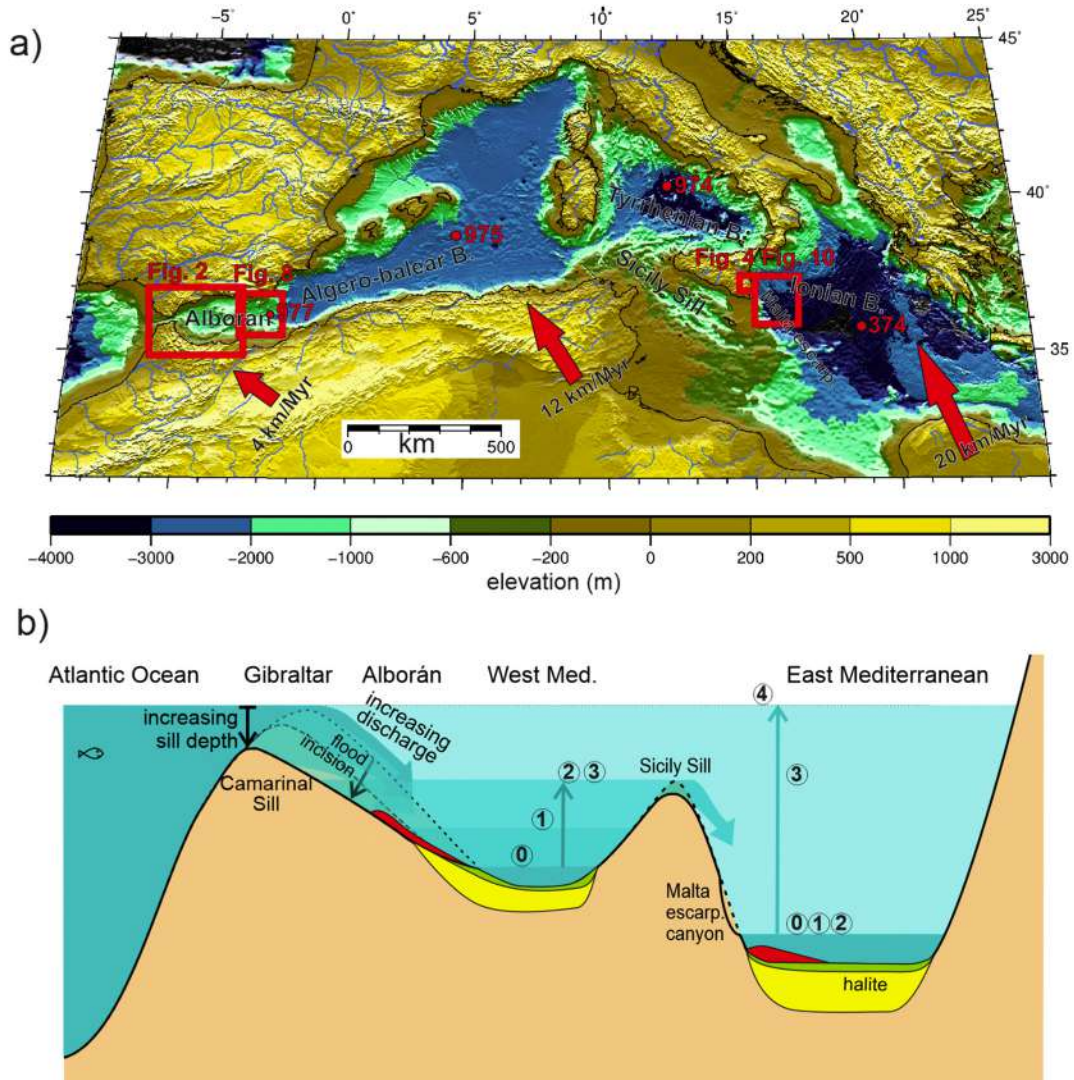
Red lines show the proposed pathway and the channel excavated by the flood.



Two open questions are:

1) Where did that eroded rock (~1000 km^3) go to?

2) Is there an equivalent feature at the threshold where the W Mediterranean should have overtopped into the E Mediterranean?



Attempting at answering those questions, what follows is partly published in this recent article (open Access):

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The Zanclean megaflood of the Mediterranean – Searching for independent evidence

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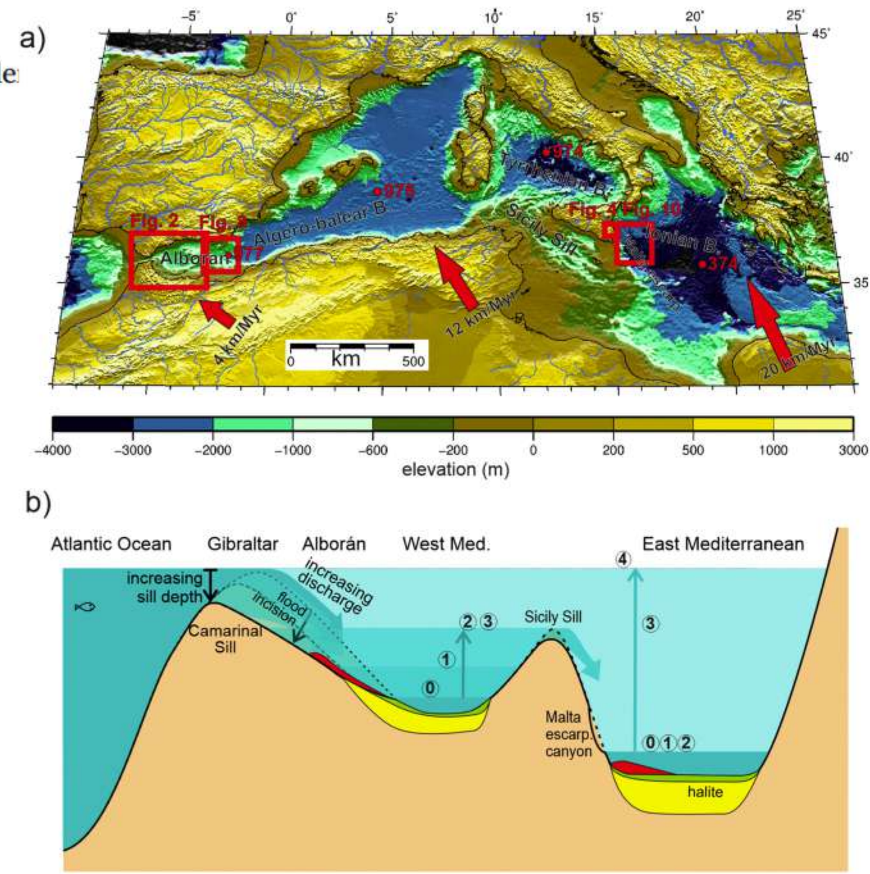
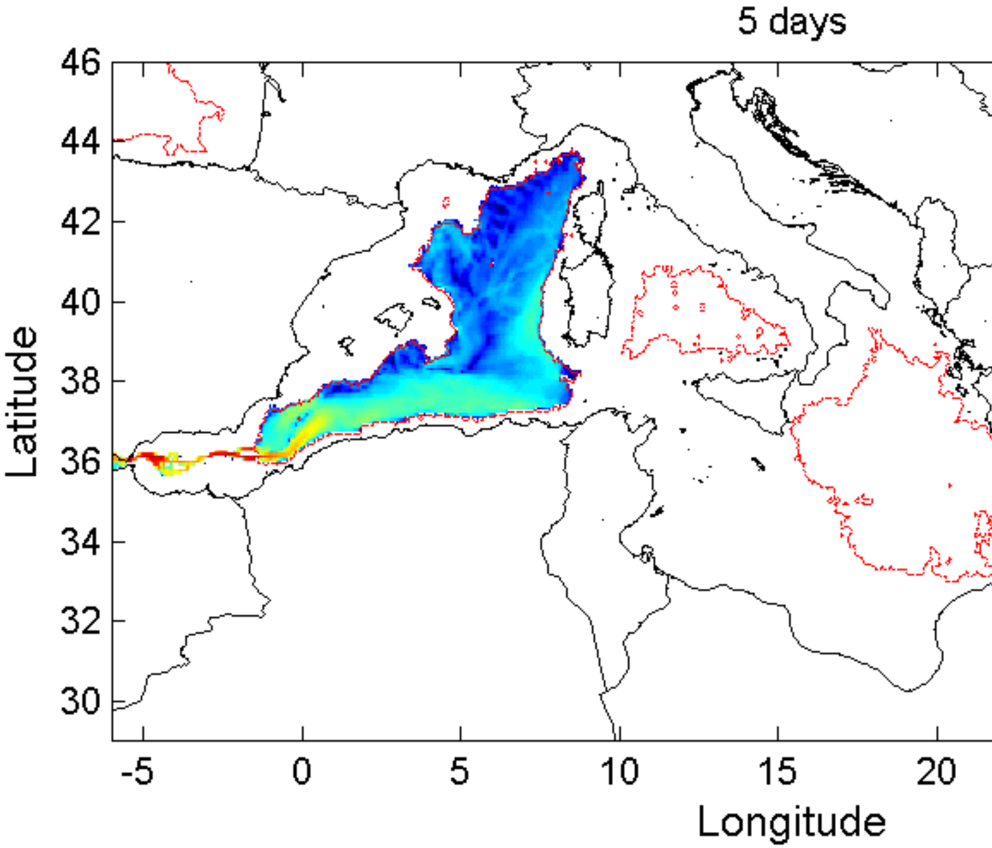
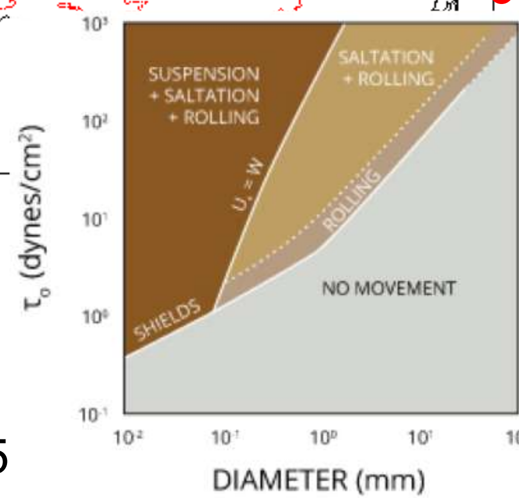


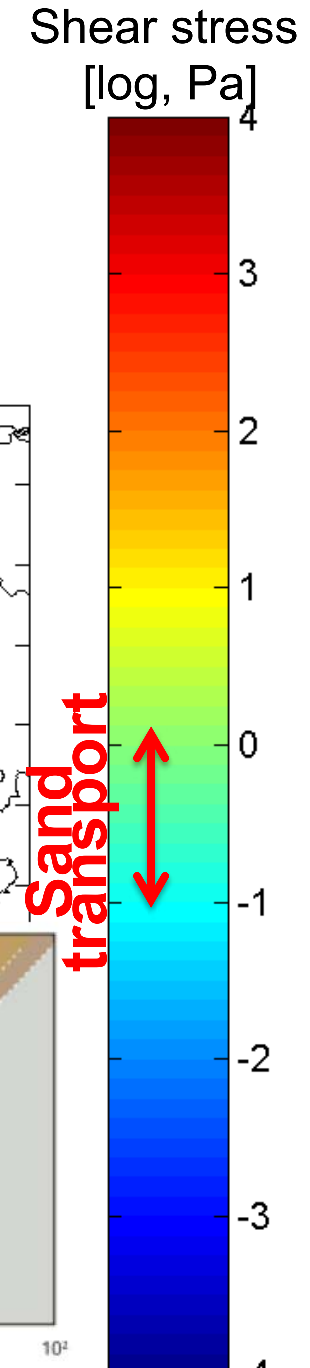
Evidence from

- the Alborán Sea seismic profiles
- Ionian Sea seismic profiles
- Numerical modeling

Where is the erosion/deposition occurring during the flood? Hints from 2D hydrodynamic modeling:



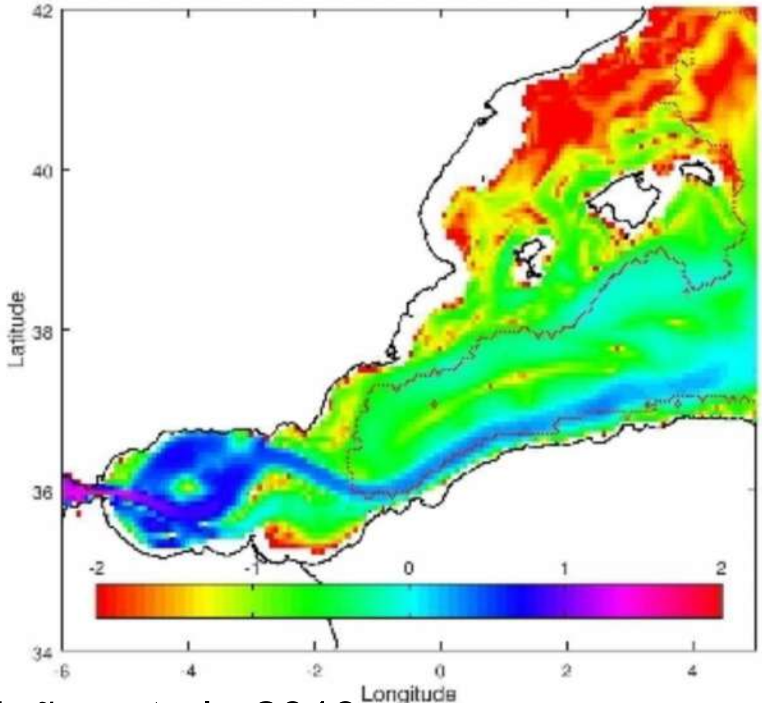




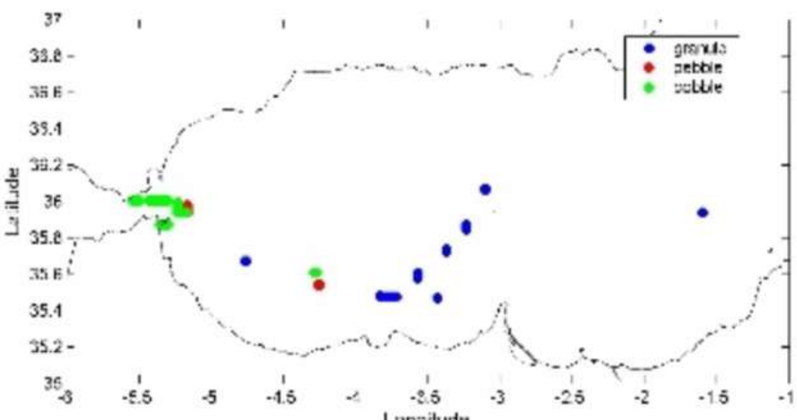
Shear stress [Pa] = rho_w * fric_coeff * vel^2

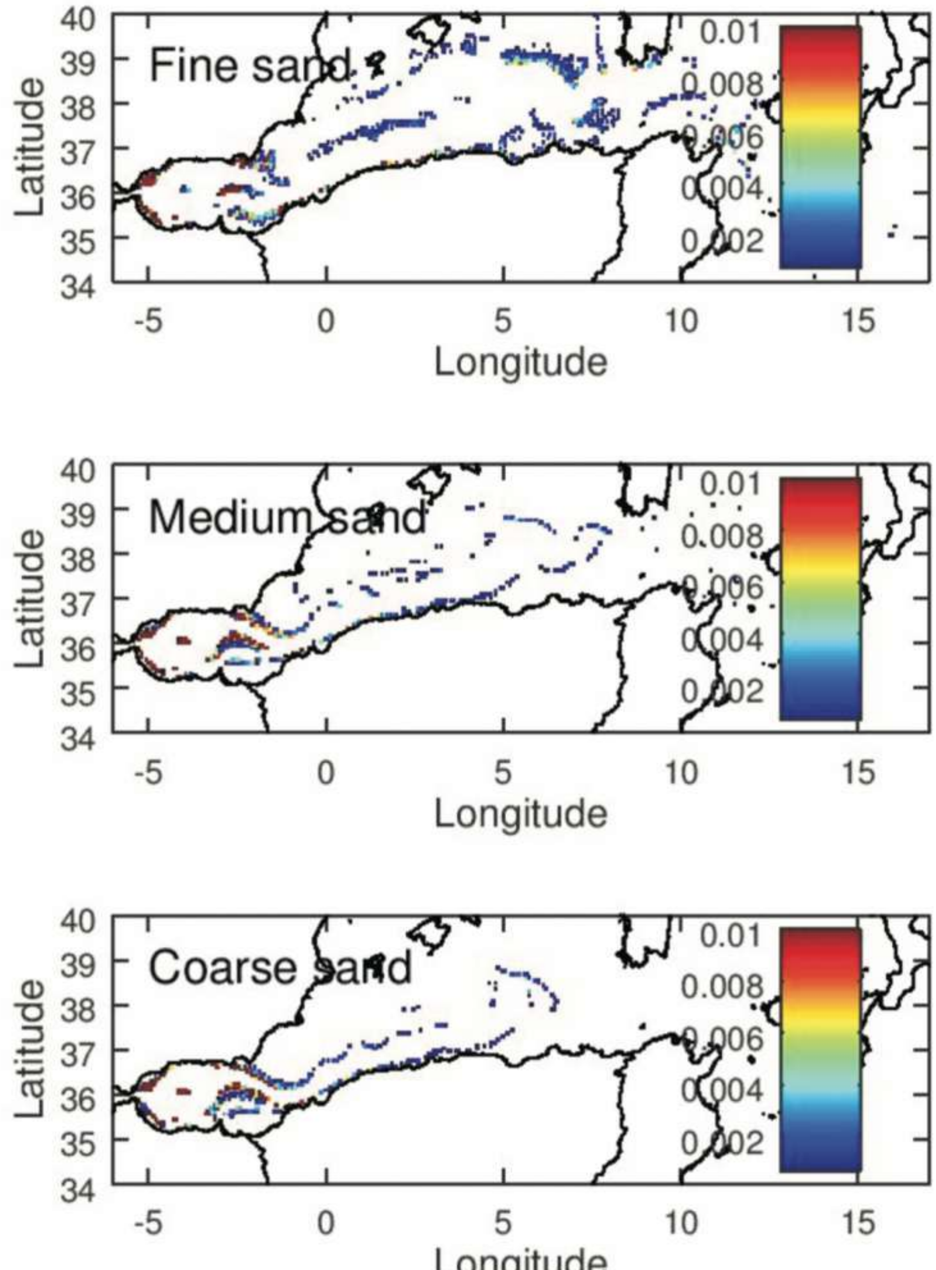
Calculated from the setting by Periañez & Abril, 2015

Peak discharge of the Zanclean Flood (100 Sv)



Periañez et al., 2019





Similar hydrodynamic modeling at the Noto Canyon and the western Ionian Basin (offshore Sicily)

(a) Calculated water flow velocities at rising water levels of the E Med. between -2400 to -1700 m.

(b) Calculated velocity field for a smaller flood event with discharge of 20, 15, 10 and 5 Sv.

The area of unit 2a is shown by a black line.

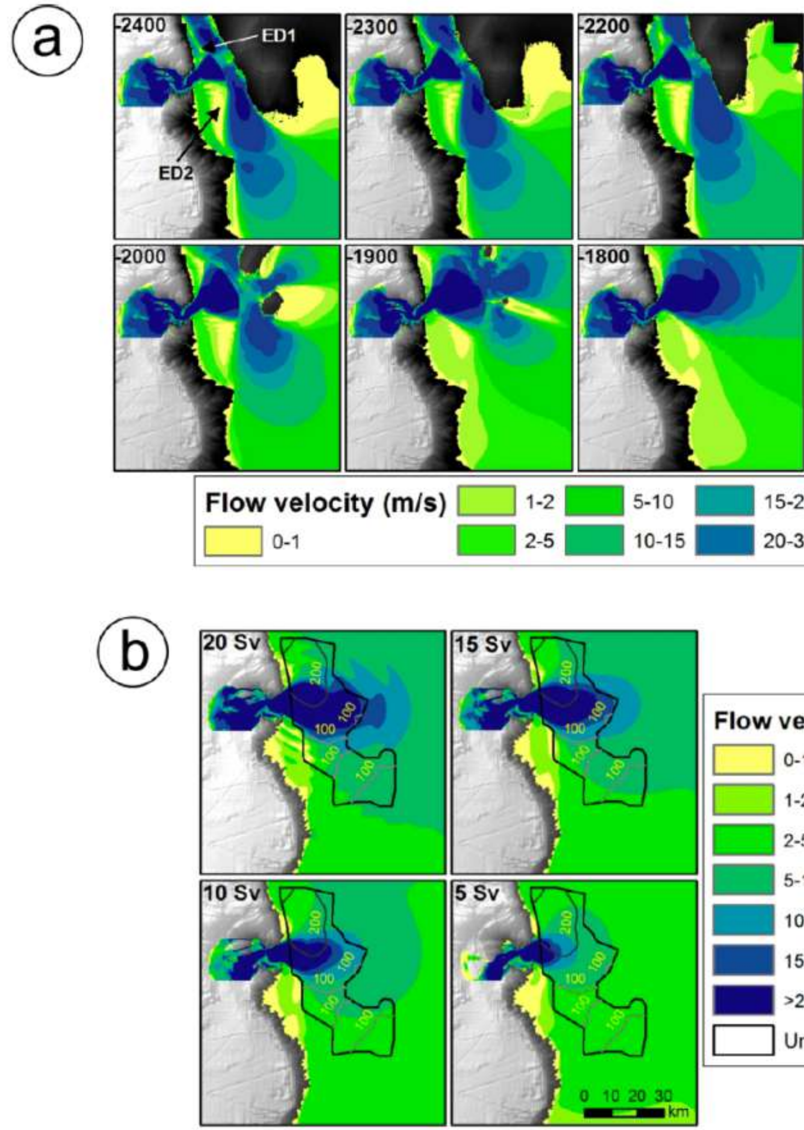
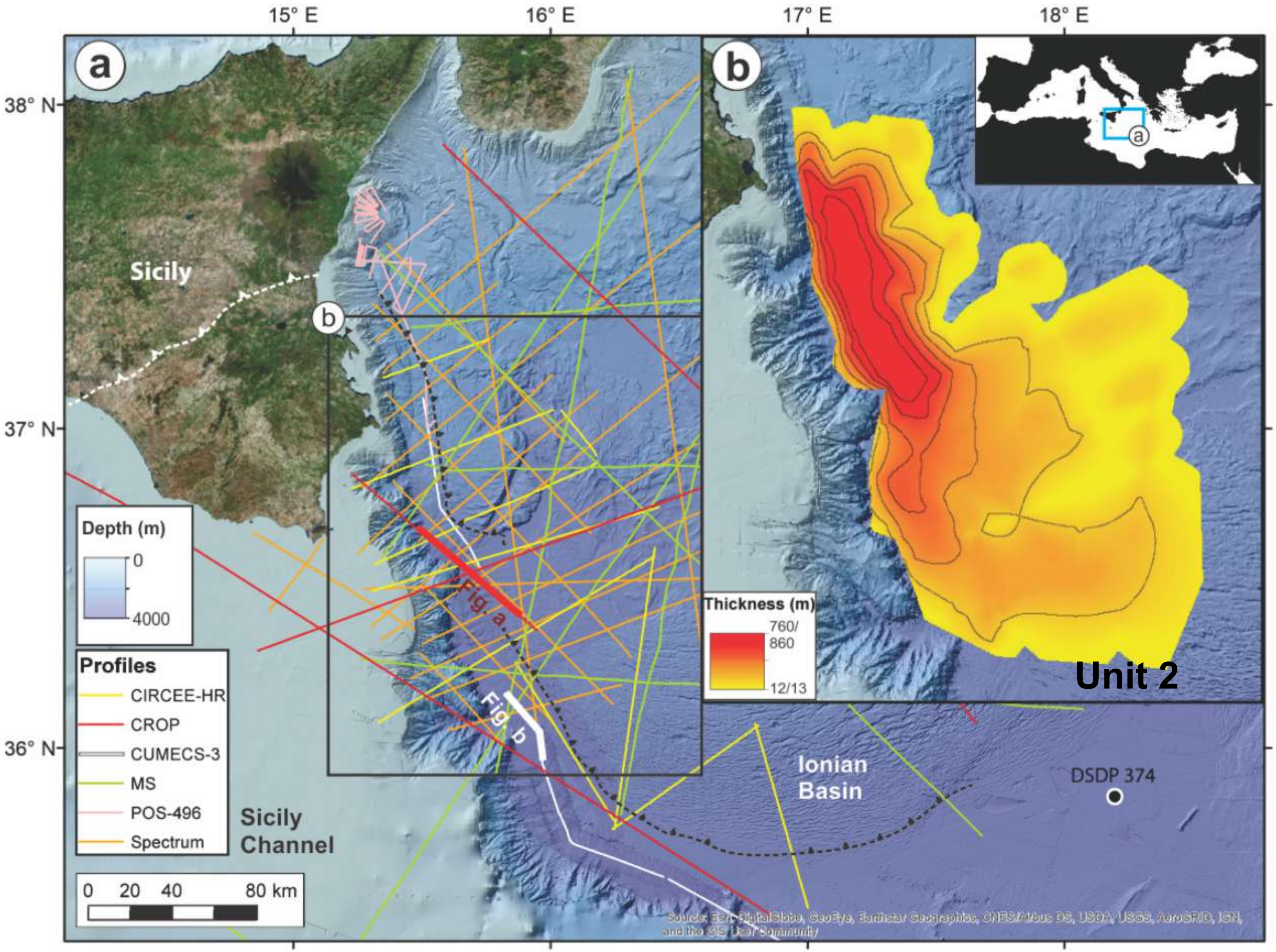


Figure 11: (a) Estimated water flow velocities for water levels between -170
Ionian Basin. (b) Estimated water flow velocities of a theoretically smaller flo
15, 10 and 5 Sv. The area of unit 2a is denoted by a black line. Lo

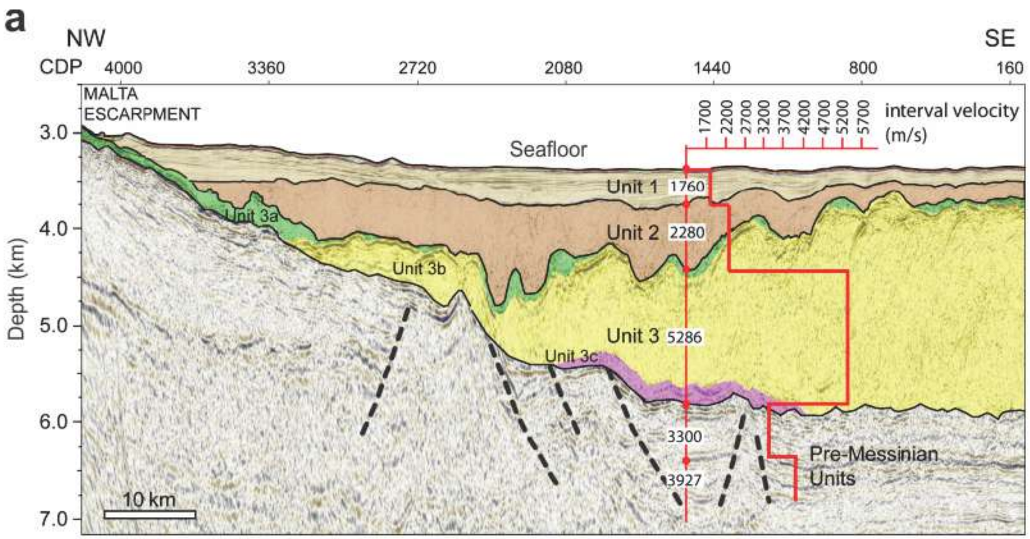
Spatola et al., submitted

2. Seismic stratigraphy of western Ionian Basin



Micallef et al., 2018, Sci. Reports

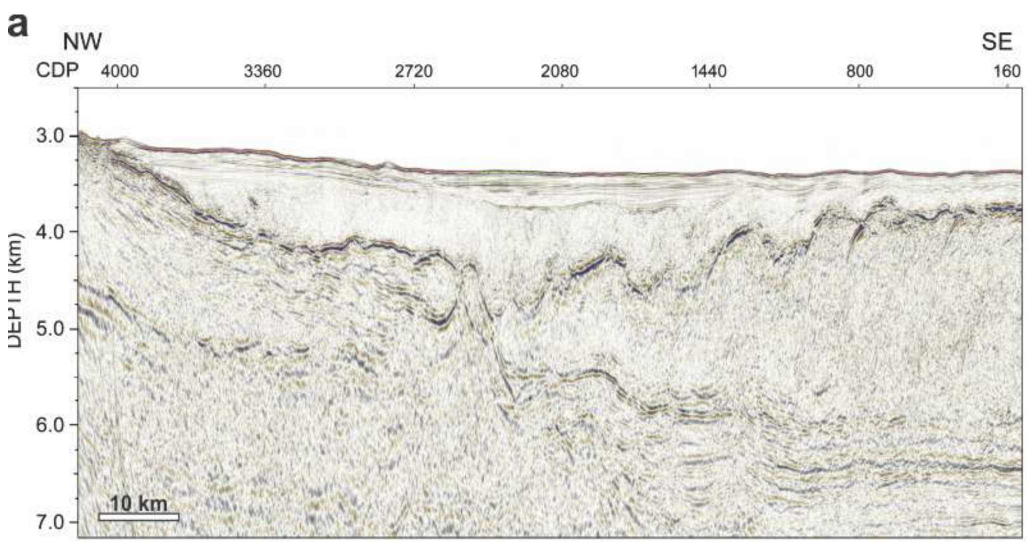
2. Seismic stratigraphy of western Ionian Basin



Unit 2:

- 160 km x 95 km
- Maximum thickness: 760 – 860 m
- Volume: 1430 – 1620 km^3
- Pre-stack depth-migration seismic velocity: **2.3-2.6 km/s**

=>No gypsum

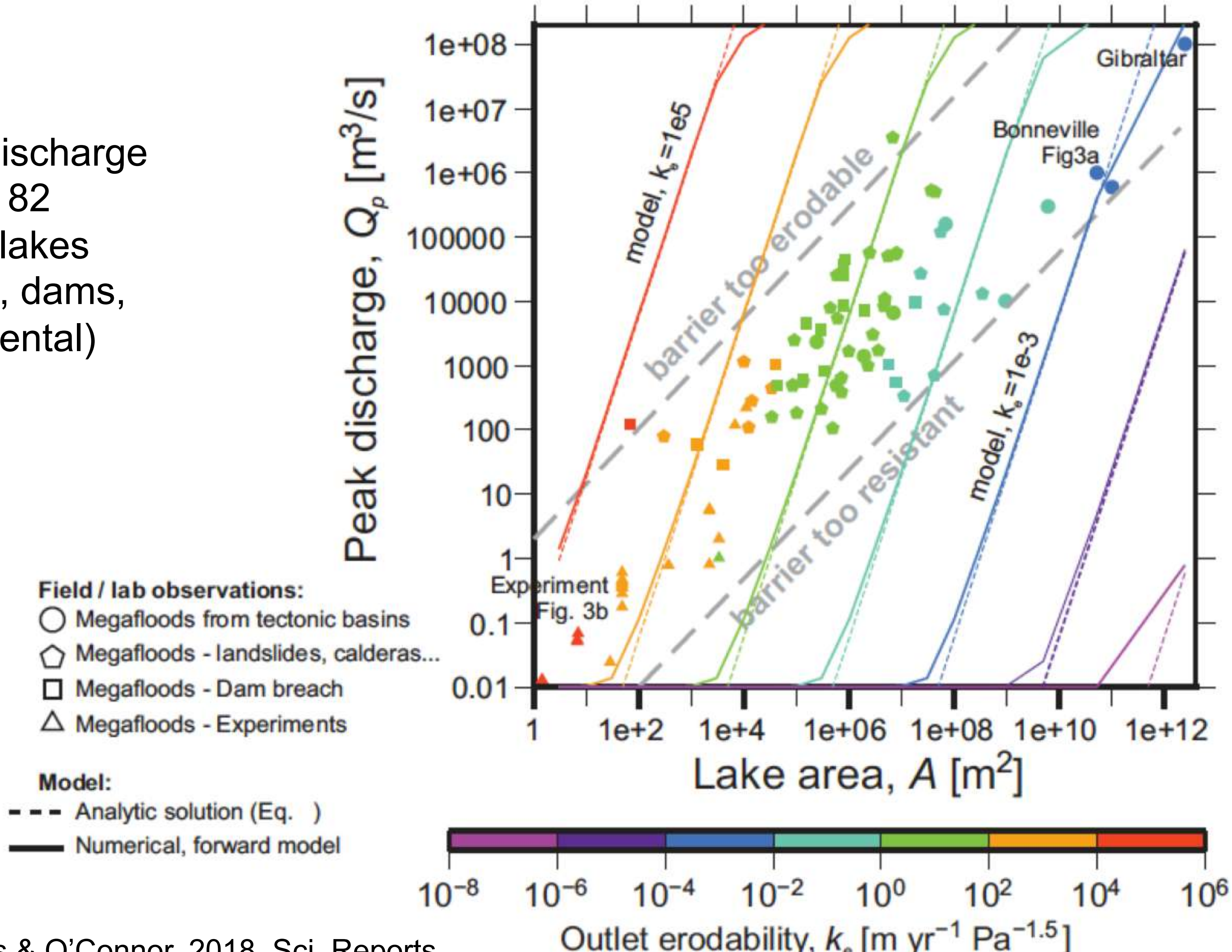


Interpretation:
deposit of material eroded and transported across the Sicily Channel once the western Mediterranean Sea level reached the sill during the **Zanclean megaflood at the end of the MSC**

Micallef et al., 2018, Sci. Reports

Outburst floods from overtopping lakes
Can we predict water discharge from basin size? (we can't)

Peak flood discharge estimated at 82 overtopping lakes (Pleistocene, dams, and experimental)



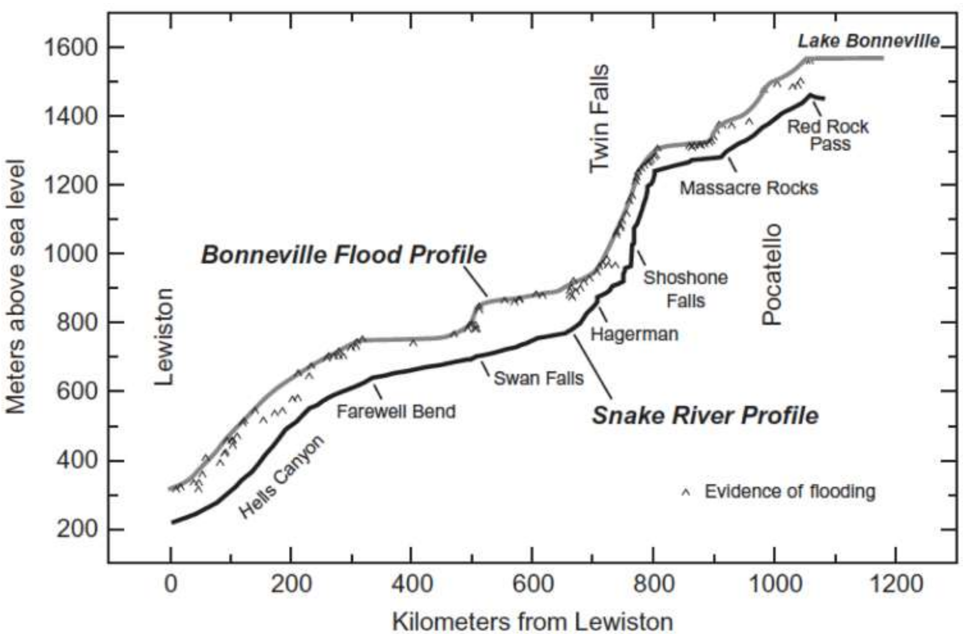
Garcia-Castellanos & O'Connor, 2018, Sci. Reports

A prominent example: Lake Bonneville (today's Salt Lake, Utah, USA)

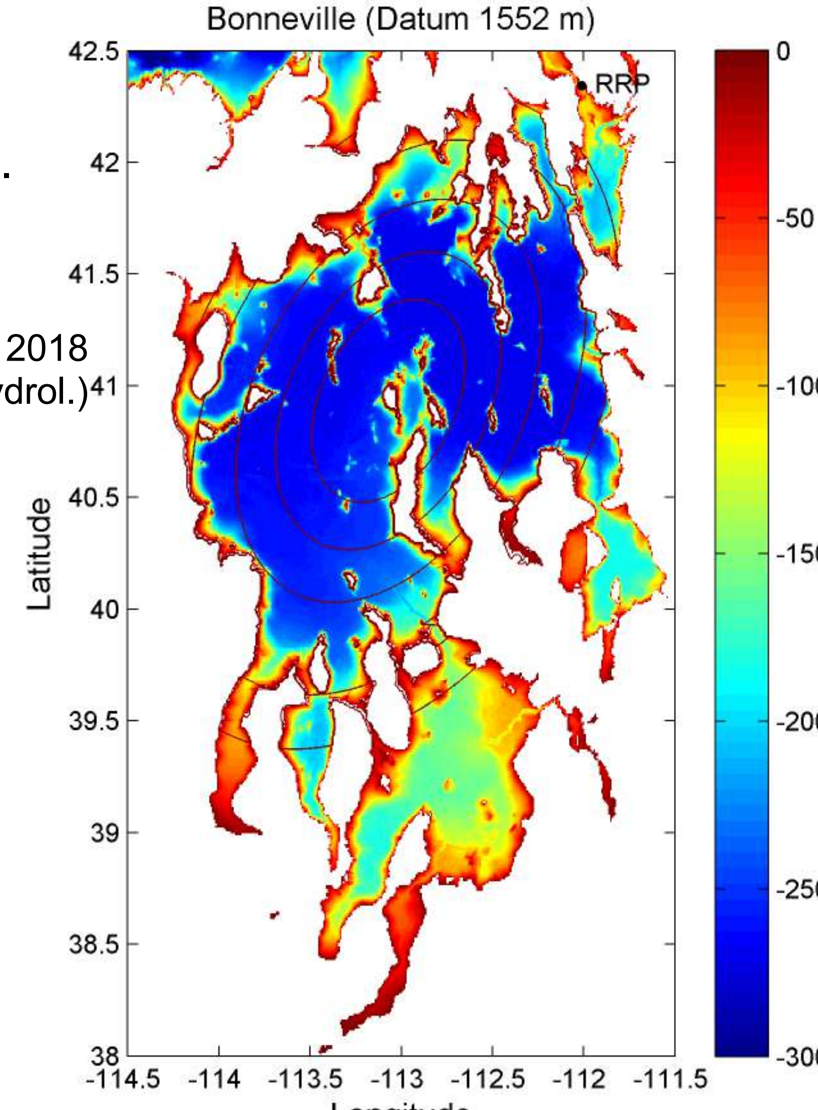
- 17.5 ka, Pleistocene flood.
- Barrier: Consolidated fluvial fan

Constraints:

- Level fall from Bonneville to Provo levels (120 m outlet incision).
- Lake outlet geometry: ~1600x120 m section.
- Estimations of peak discharge: ~10^6 m^3/s

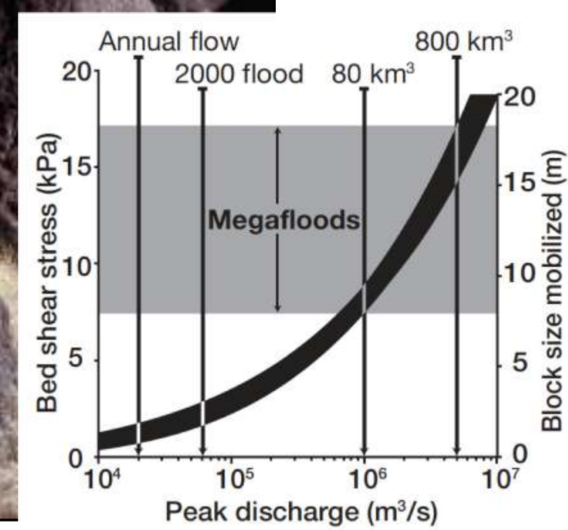


Abril et al., 2018 J Hydrol.)



Other outburst floods from overtopping lakes

Case scenario: Lake Bonneville spillway (Malde, 1968; O'Connor, 1993)
>10m boulders rolled and rounded by megaflood



Missoula floods erosion & transport in the Scablands (Wa, USA)

Transported in suspension??

Dry falls - Amphitheater-headed canyons

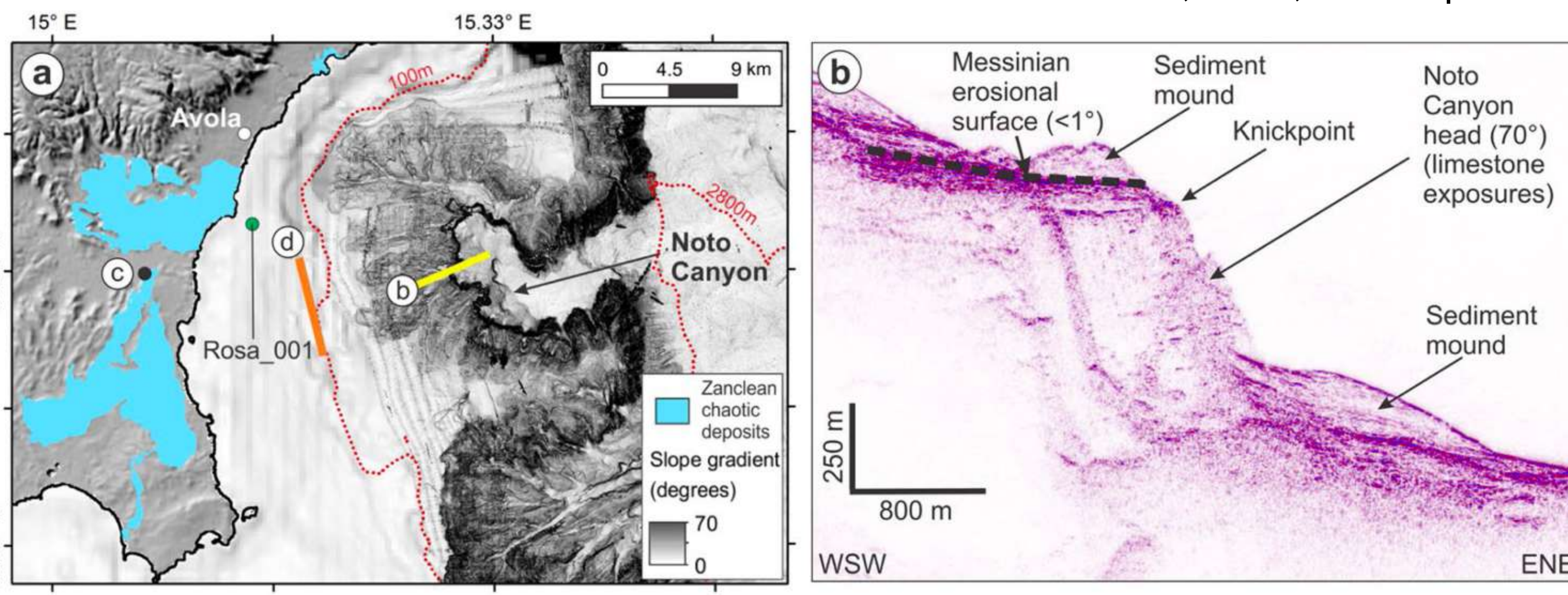
Noto canyon (Sicily): a 2,700-m-deep amphitheater-headed canyon

Horseshoe shape

Base at -2,700 m

< 100 km^3

Micallef et al., 2018, Sci. Reports



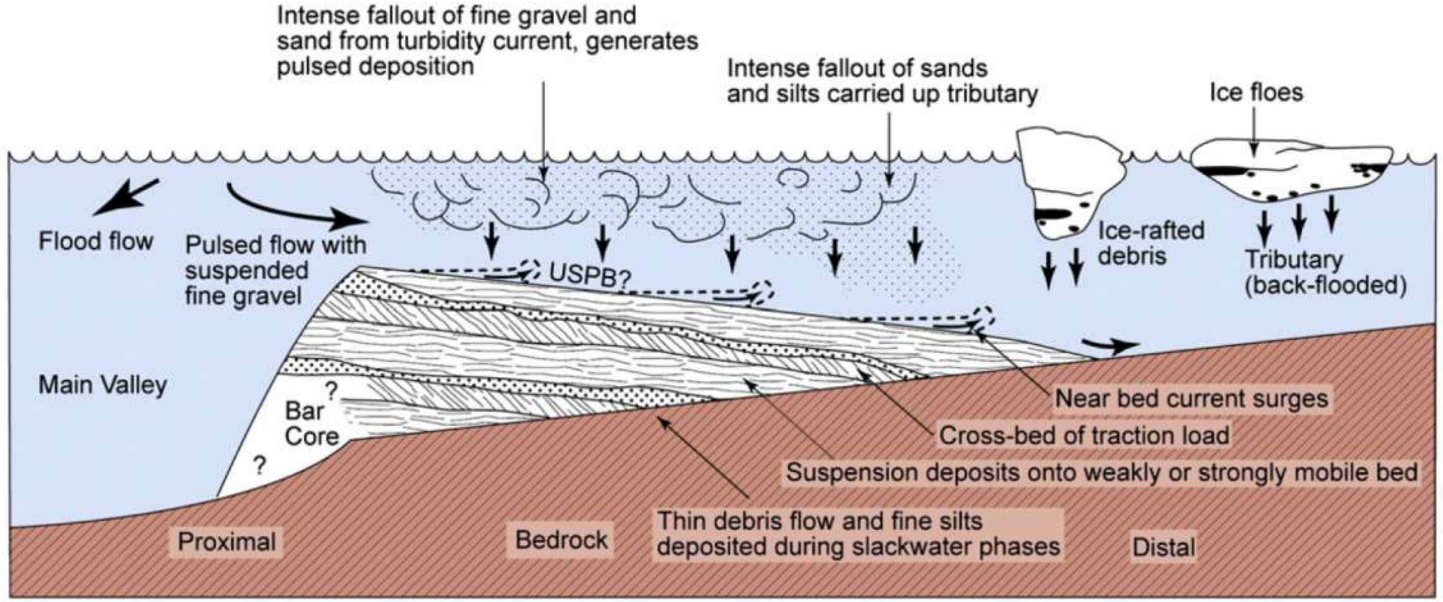
Megaflooding erosion features

Potholes Coulee, WA, USA. Similar to Dry Falls. 10^7 m3/s

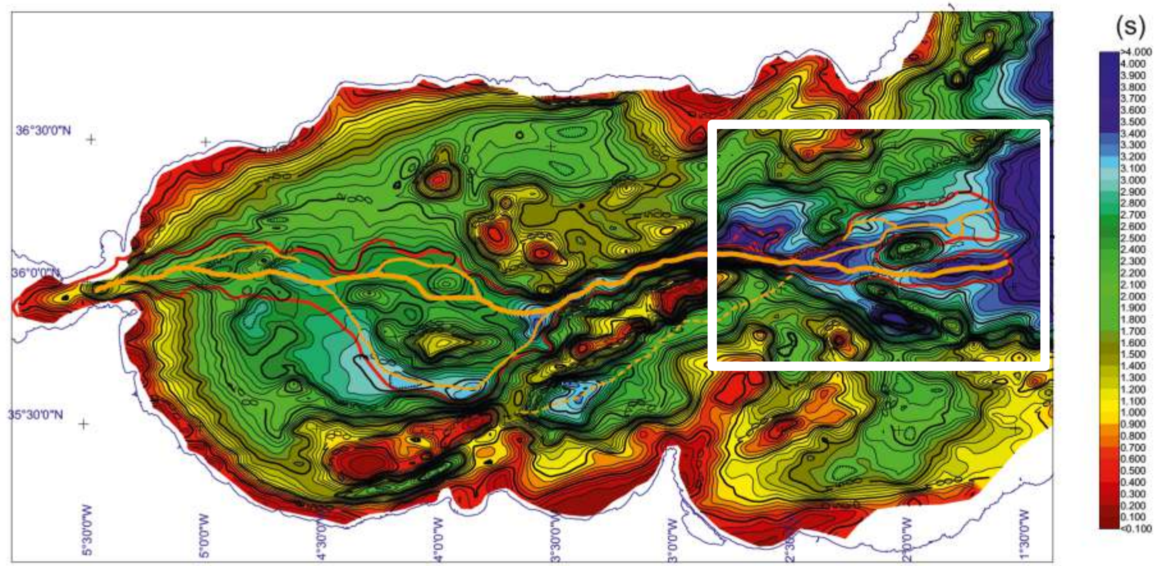
Carling et al., 2009

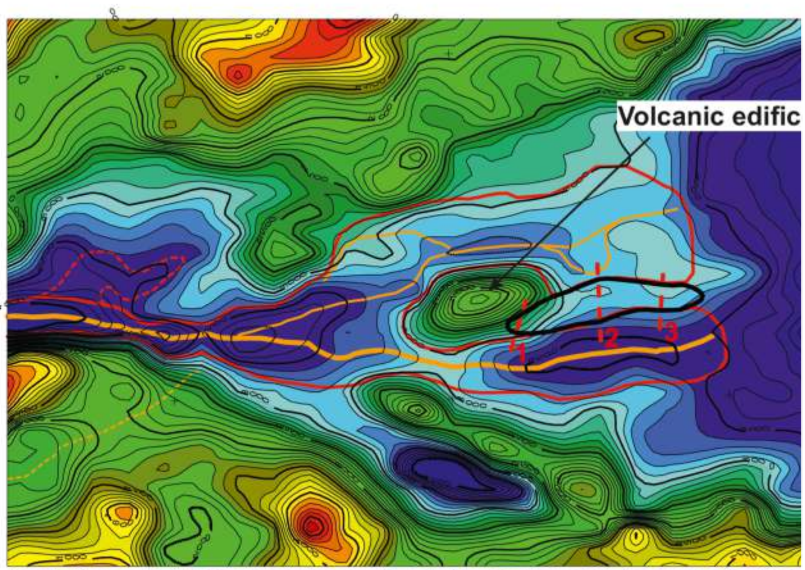
Pleistocene Altay outburst flood:

10^7 m3/s
17 ka

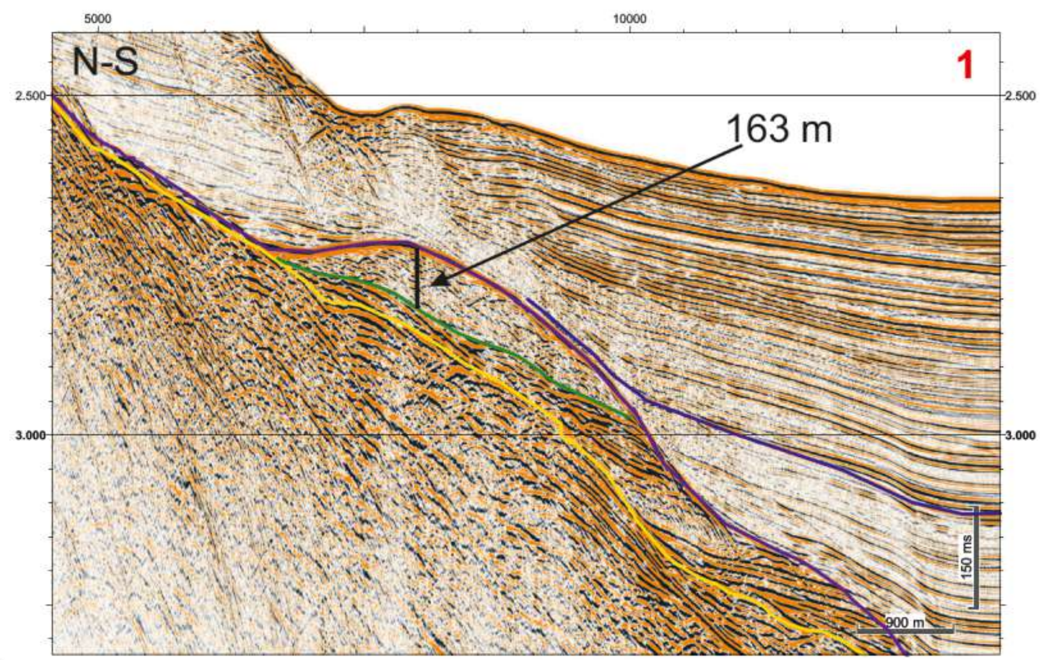


Possible megabar deposits flanking the erosion channel in the Alborán Sea





Isobath map of Pliocene base. Black line represents hypothetical flc
deposits. Contours in miliseconds, color scale bar in seconds.



Take home

- A Mediterranean drawdown implies large erosion rates at sills during the refill between subbasins
  - Faster than tectonics if headloss>10’s m
  - *Catastrophic* if headloss>100’s m

- Catastrophic flooding implies a previous large drawdown in the Mediterranean.

- Flood deposits can validate/refute the flood hypothesis. Two sets of deposits in the Alborán and the Ionian seas are compatible with archetypical megaflood deposits, though independent assessment (drilling) is needed.