

**INGV**

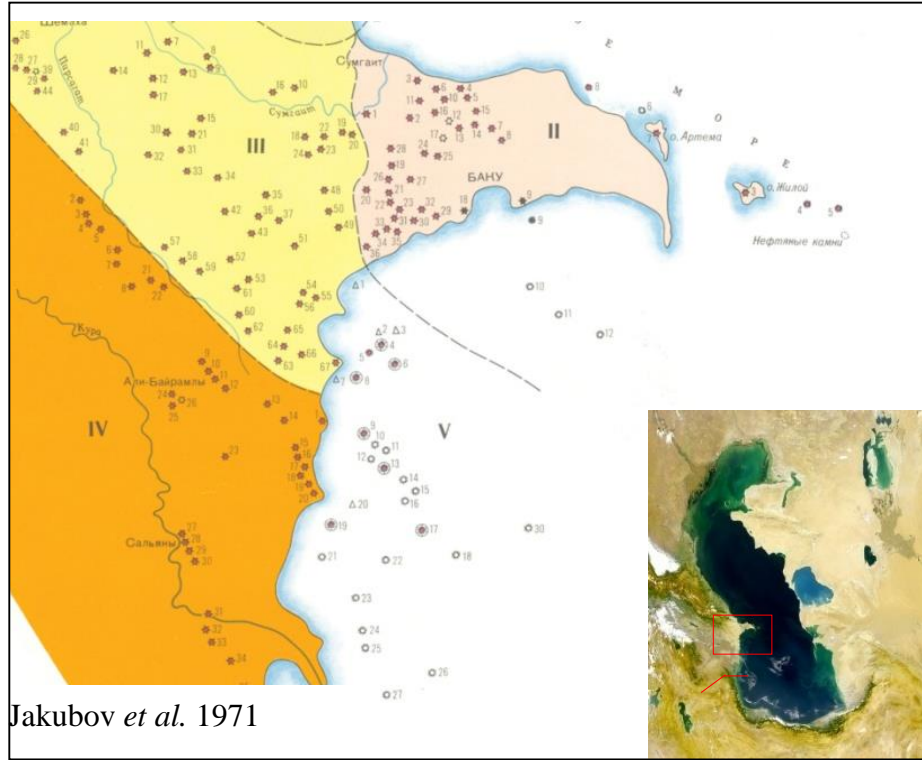


# Explosive mud volcano eruptions and rafting of mud breccia blocks

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# » Mud volcanism in the Caspian: frequent and powerful eruptions



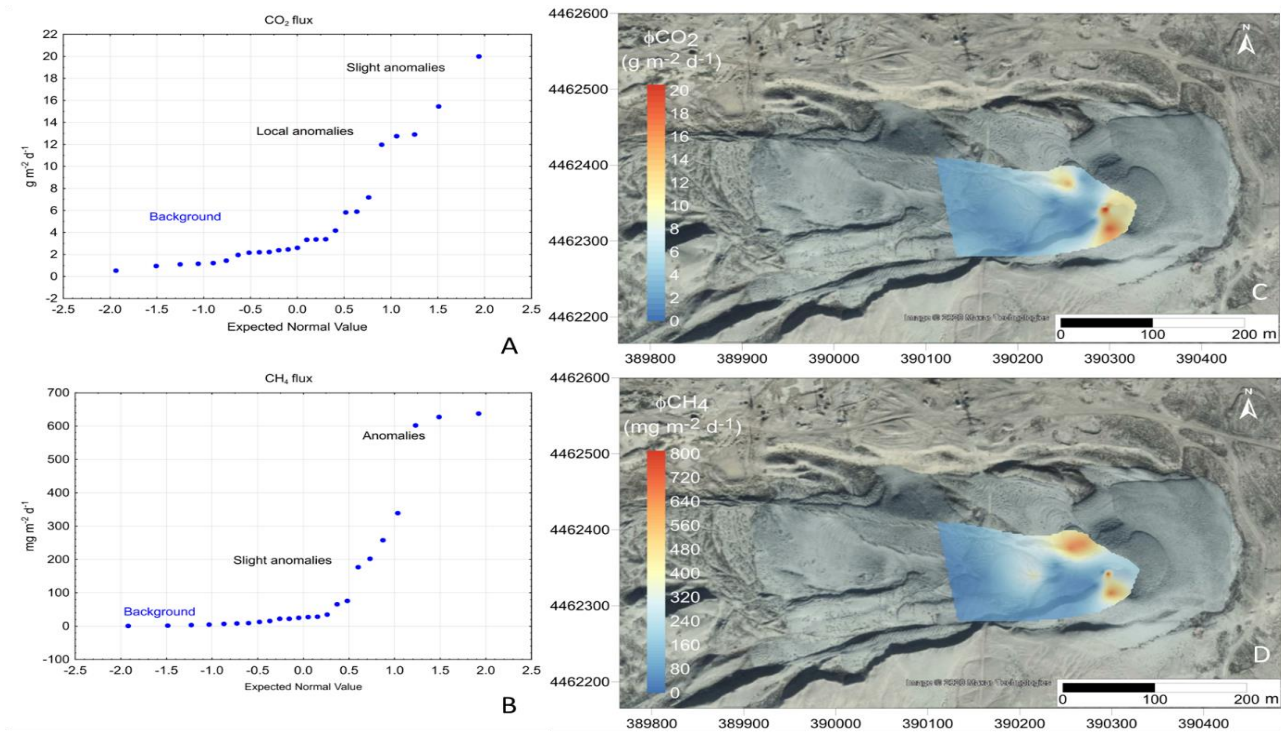
- Highest MV density on Earth concentrated in the Caspian region (Azerbaijan). Hundreds of structures offshore and onshore



- Lokbatan MV: structure with the greatest number of known eruptions displaying spectacular explosive events typically every ~3-5 years.

## What is the reason of these frequent eruptions?

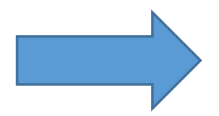
# >> CO<sub>2</sub> and CH<sub>4</sub> flux measurements



- Lokbatan presents a well developed petroleum system
- Very low degassing measured throughout the surface making Lokbatan one of the lowest gas emitters compared to other MV examples worldwide.
- This self-sealing mechanism promotes overpressure build-up in the subsurface and allows a fast recharge resulting in more frequent and powerful explosive episodes



Powerfull and explosive eruptions can breach the mud cone



Copious amount of mud breccia produced.  
Extensive mud breccia flows can transport large blocks



# >> Lokbatan MV: morphology

- ~2 km long mud breccia flow ploughing the western flank. Craters 1 and 2 indicated



- Along the mud flow are present megablocks up to ~50,000 m<sup>3</sup>



What is the origin of these megablocks?



# >> Lokbatan MV: megablocks



- Three large megablocks of layered mud breccia along mud flow.
- “Columnar jointing” internal structures perpendicular to layers observed at megablocks and at crater site
- Megablocks are portions of mud cone transported during mud flows



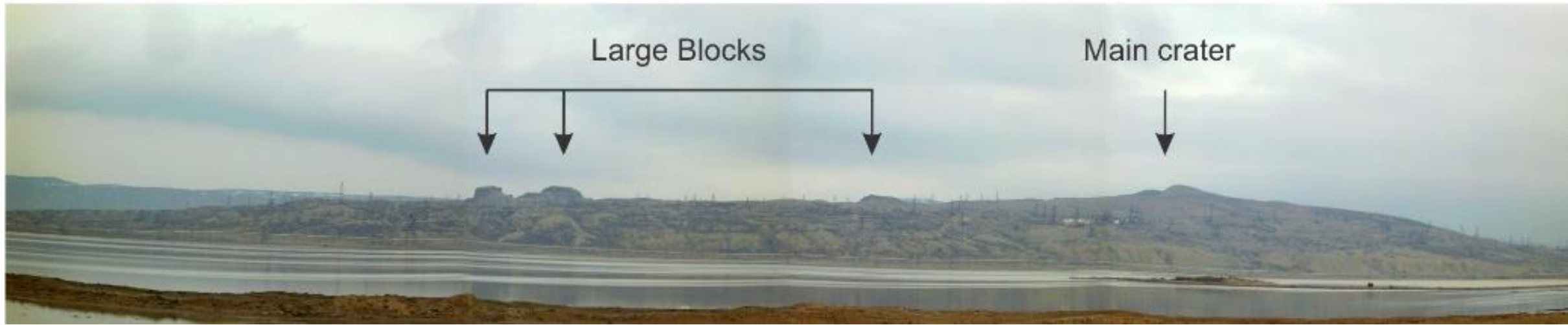
Details megablocks



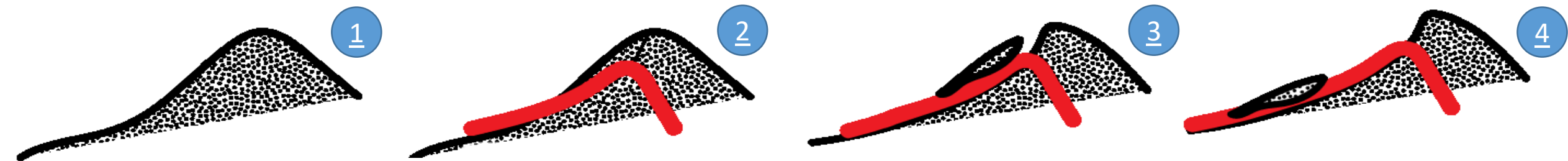
Details crater



# >> Megablock breaching and transport: mud breccia rafting

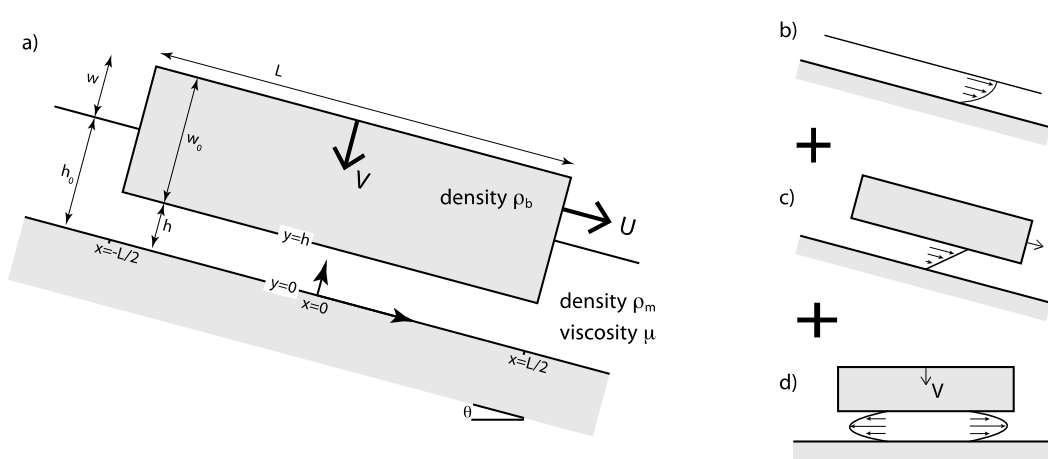


- Megablocks transported along the flanks of the mud flow indicated by arrows

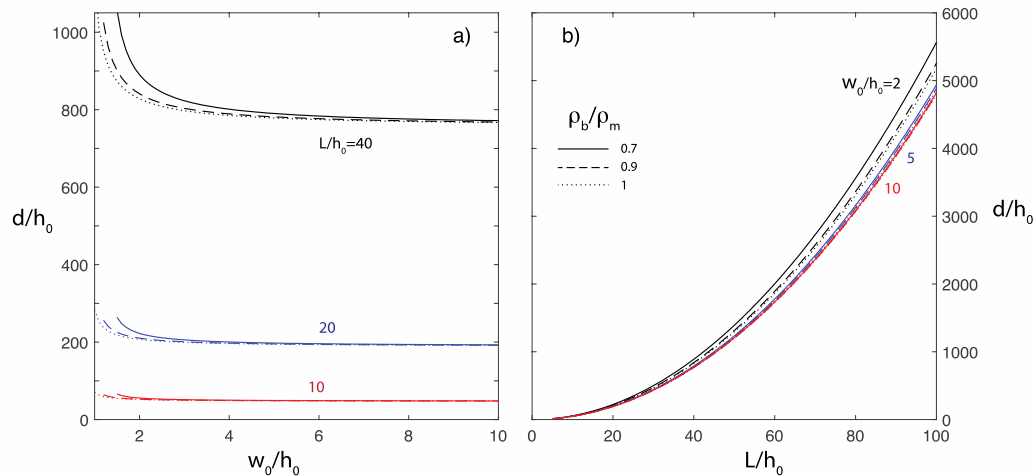


- Schematic model of mud cone breaching and megablocks transport along mud flow during eruptive events

# Testing megablocks transport by lubrication theory



a) Definition of model geometry, length scales and coordinate system. The solution to this problem is obtained by superimposing solutions for the motion of b) a plane layer of fluid, c) the motion of a block over a plane layer, and d) the squeezing flow or lubrication problem



a) Distance  $d$  traveled as a function of block height  $w_0$  for different block lengths  $L$ . b) Distance  $d$  traveled as a function of block length  $L$  for different block heights  $w_0$ . In both panels, all lengths are normalized by initial flow thickness  $h_0$ . Solid, dashed and dotted lines are for  $\rho_b/\rho_m$  of 1, 0.9 and 0.7, respectively.

**For flow thicknesses of 2 m, this implies transport from 100 m to 2 km, consistent with the distances to which blocks have been moved.**





# Conclusions

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- Despite its frequent, large-volume eruptions, Lokbatan mud volcano has minimal degassing when not erupting
- We propose that Lokbatan effectively seals subsurface conduits after eruptions, allowing pressure to recharge rapidly
- This leads to more frequent, more energetic, and larger eruptions
- These powerful eruptions are also able to break apart portions of the crater and transport blocks with the mud breccia flows.
- Using a lubrication theory model, we show that megablocks can be transported over great distances while rafted by mud breccia flows occurring during the eruptions





**Thank you**