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Glacial Geomorphology

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Isostasy / Isostatic Equilibrium

- Isostasy describes the gravitational balance between the Earth's lithosphere and the asthenosphere.
- The Earth's crust floats at an elevation determined by its thickness and density, similar to how an iceberg floats in water.
- Thicker and less dense crust (e.g., continental crust) floats higher and forms mountains, while thinner and denser crust (e.g., oceanic crust) sinks lower, creating ocean basins.
- The lithosphere adjusts vertically when loads on the crust change, such as through glaciation, erosion, or sedimentation.

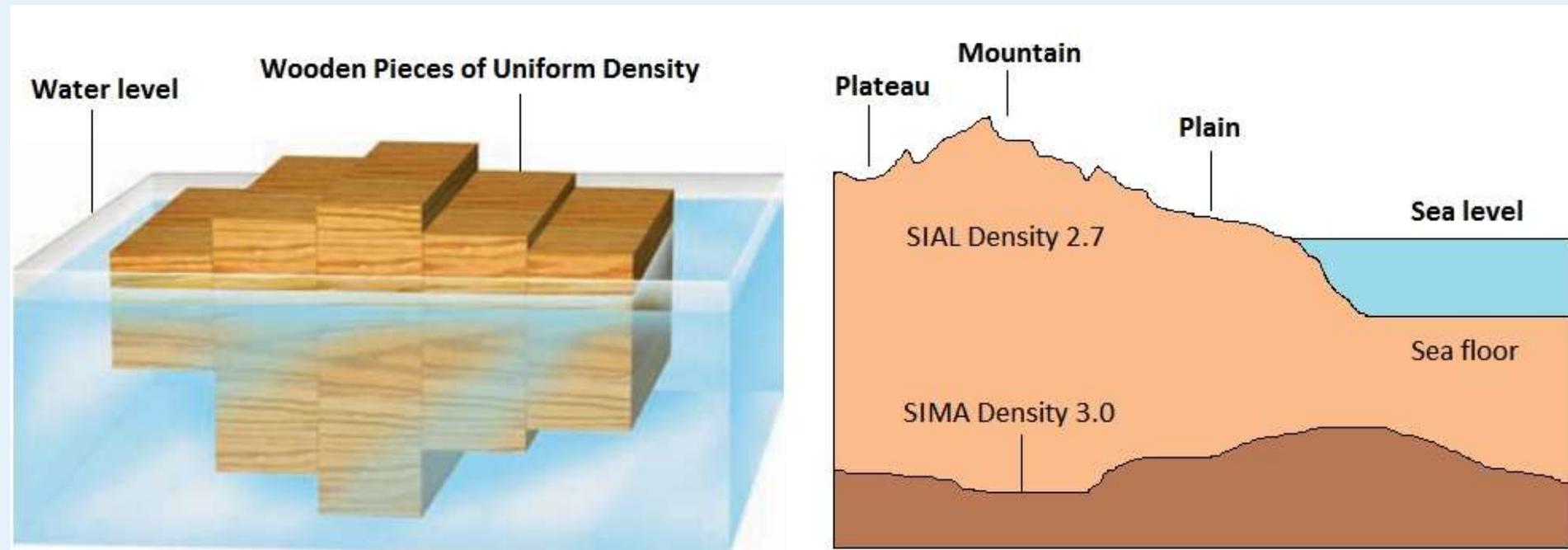
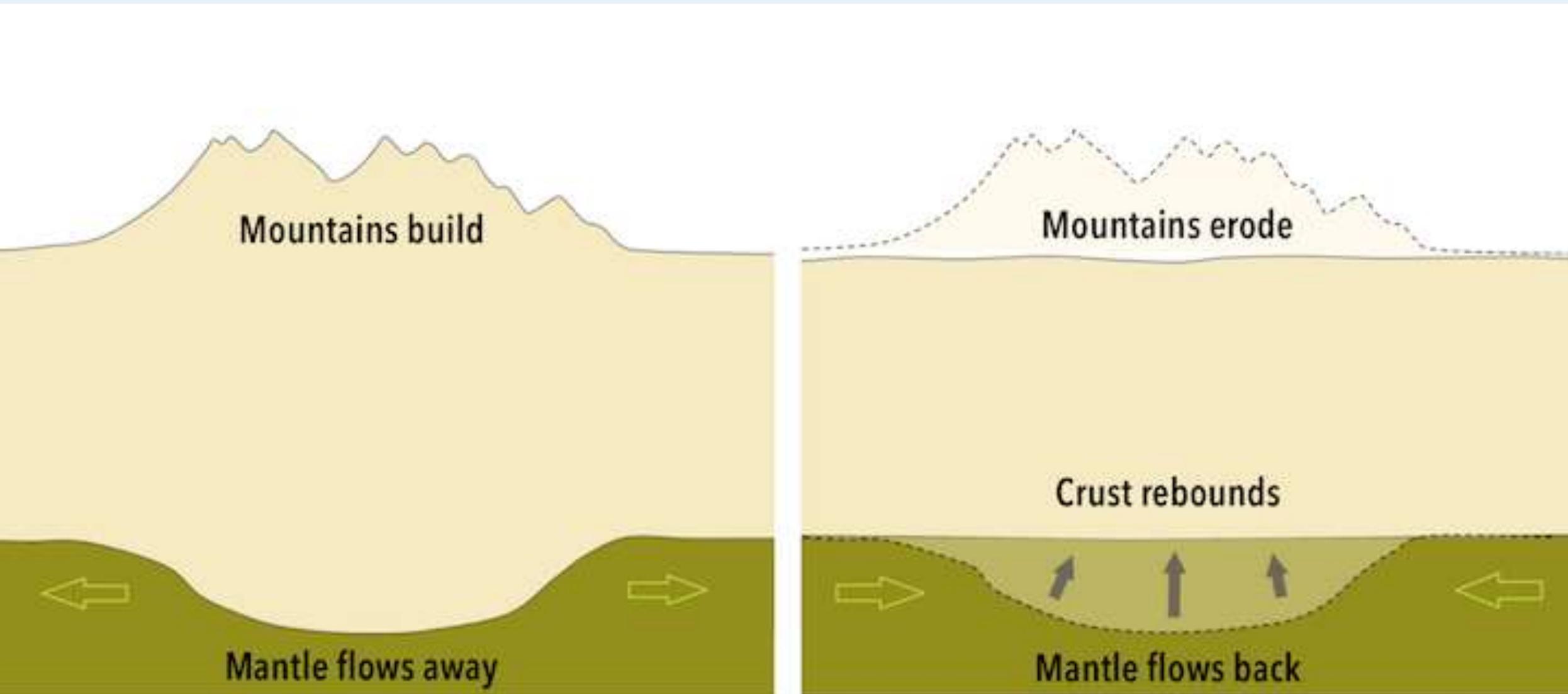


FIGURE: This drawing illustrates how wooden blocks of different thicknesses float in water. In a similar manner, thick sections of crustal material float higher than thinner crustal slabs

<https://www.geofacts.in/2023/10/isostasy-concept-and-theories-of-airy-and-pratt.html>

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<https://www.britannica.com/video/81405/theory-isostasy>



<https://pressbooks.bccampus.ca/geoclone/chapter/3-5-isostasy-3rd/>

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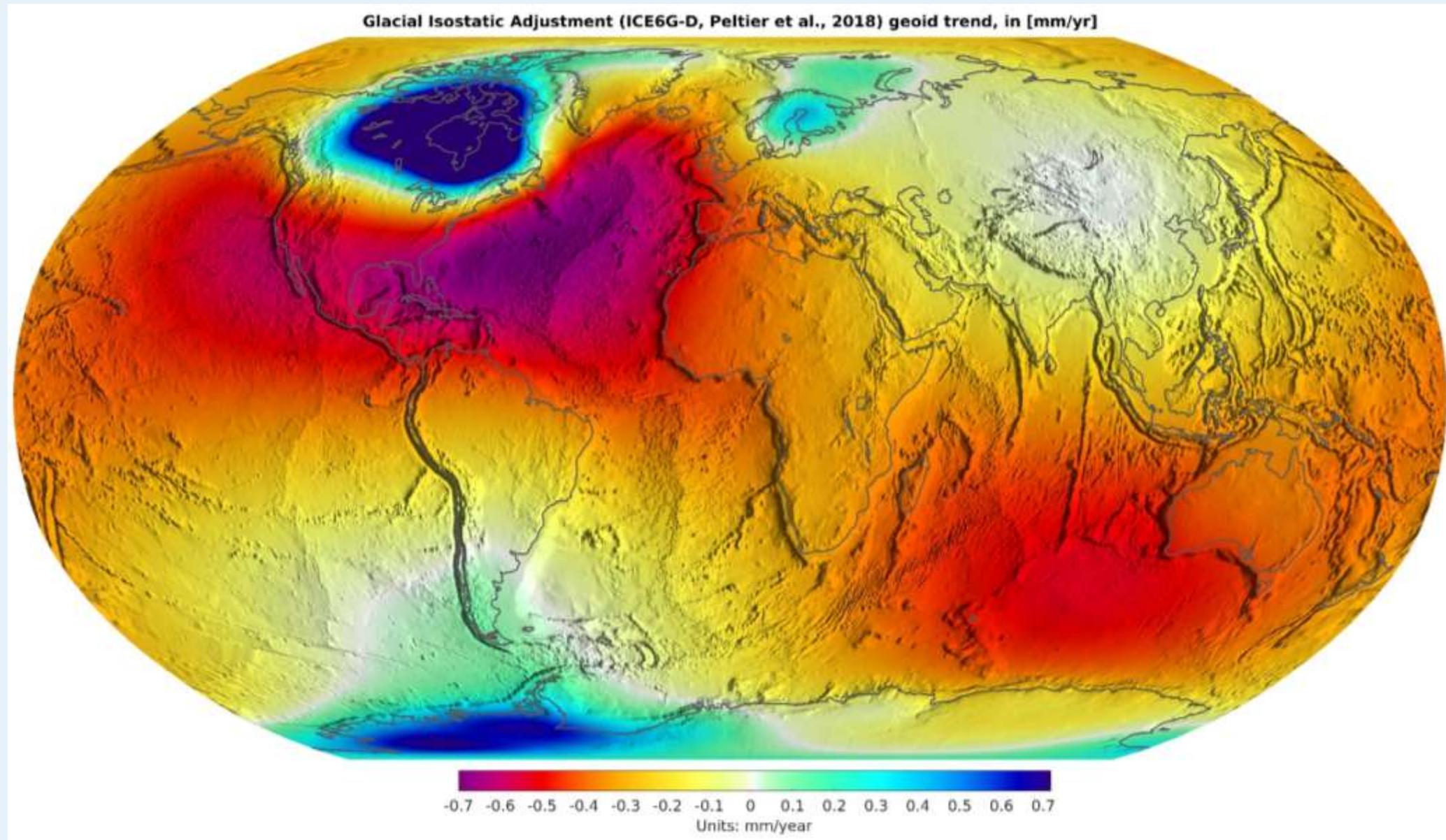
Glacio-isostatic Subsidence and Uplift

Ice sheet formation adds weight, causing the crust to sink; this process is known as glacio-isostatic subsidence. It occurs when the massive weight of an ice sheet forces the lithosphere to sink into the more ductile asthenosphere below. This downward movement leads to a regional lowering of the crust, creating a flexural basin that can extend over vast areas.

When ice sheets melt, the crust rebounds upward, a process known as post-glacial rebound or glacio-isostatic uplift. This occurs as the weight of the ice is removed, allowing the lithosphere to rise back toward its equilibrium position. The process is driven by the slow flow of the viscous asthenosphere beneath the crust, which gradually readjusts over thousands of years. Glacio-isostatic uplift can create features such as raised shorelines, marine terraces, and changes in regional sea level.

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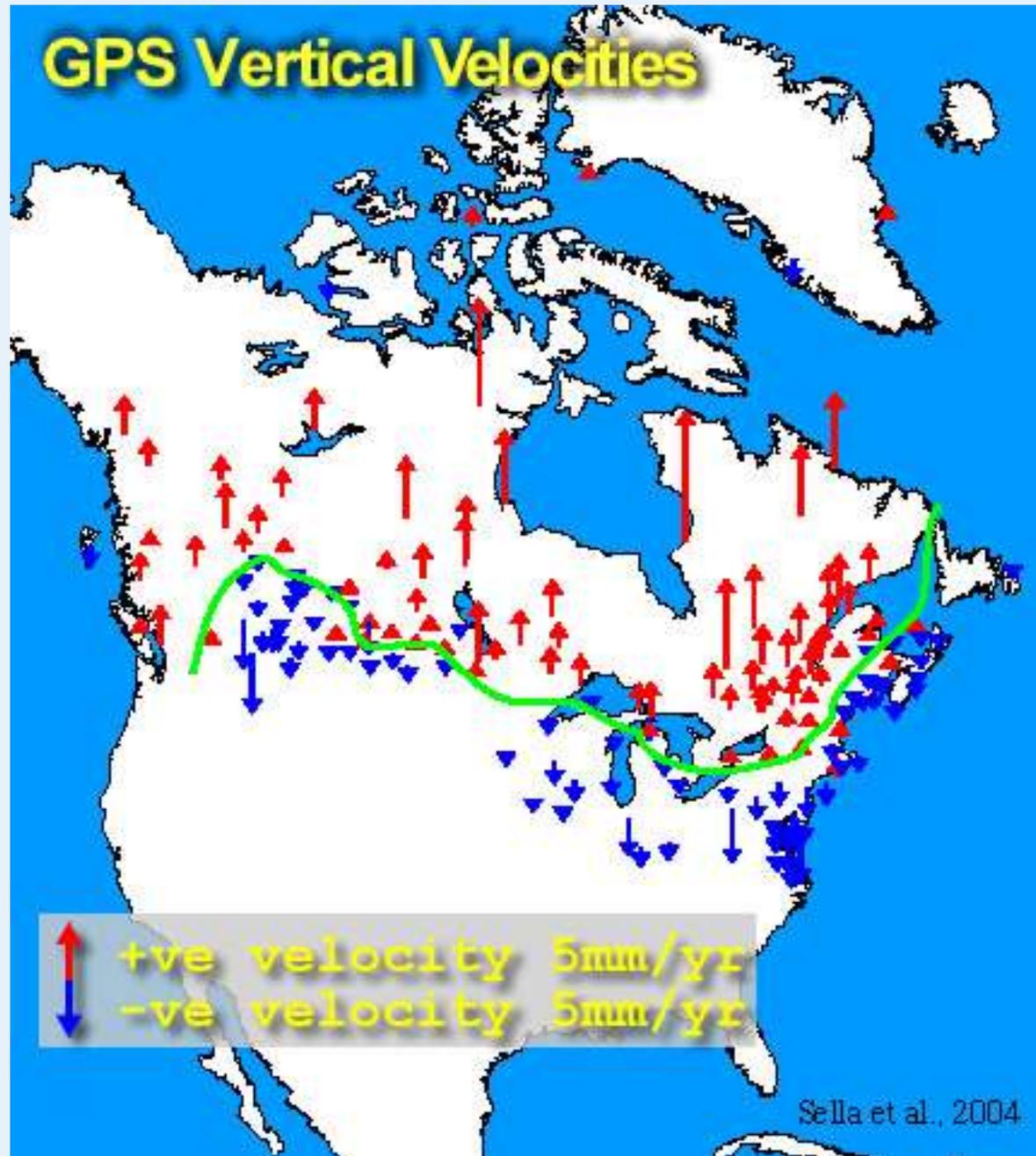


<https://grace.jpl.nasa.gov/data/get-data/gia-trends/>

Peltier, W.R., Argus, D.F. and Drummond, R. (2018) Comment on "An Assessment of the ICE-6G_C (VM5a) Glacial Isostatic Adjustment Model" by Purcell et al. *J. Geophys. Res. Solid Earth*, 123, 2019-2018, doi:10.1002/2016JB013844.

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https://www.unavco.org/highlights/2004/glacial_rebound.html

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Uplift rates (mm/y)

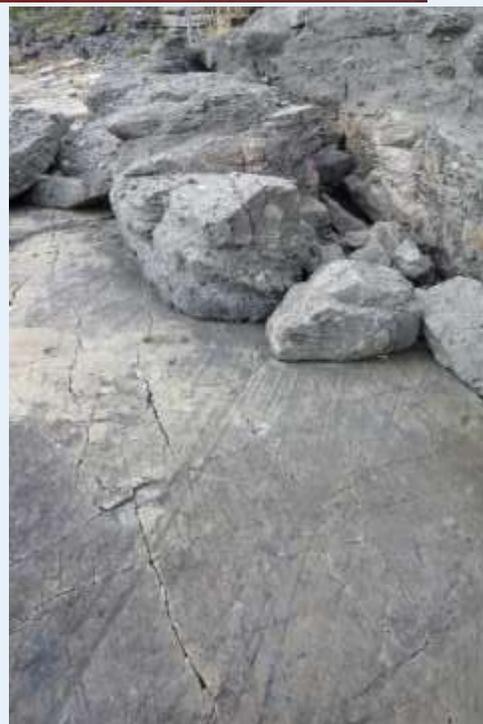


Recent GPS results indicate that the uplift rate in central Scandinavia exceeds 10 mm per year, ranges between 5–10 mm in northern Scandinavia, and is almost negligible beyond the Norwegian coastline. This pattern reflects the thickness of the Scandinavian ice sheet during the Last Glacial Maximum (LGM).

https://link.springer.com/chapter/10.1007/978-3-642-25550-2_8

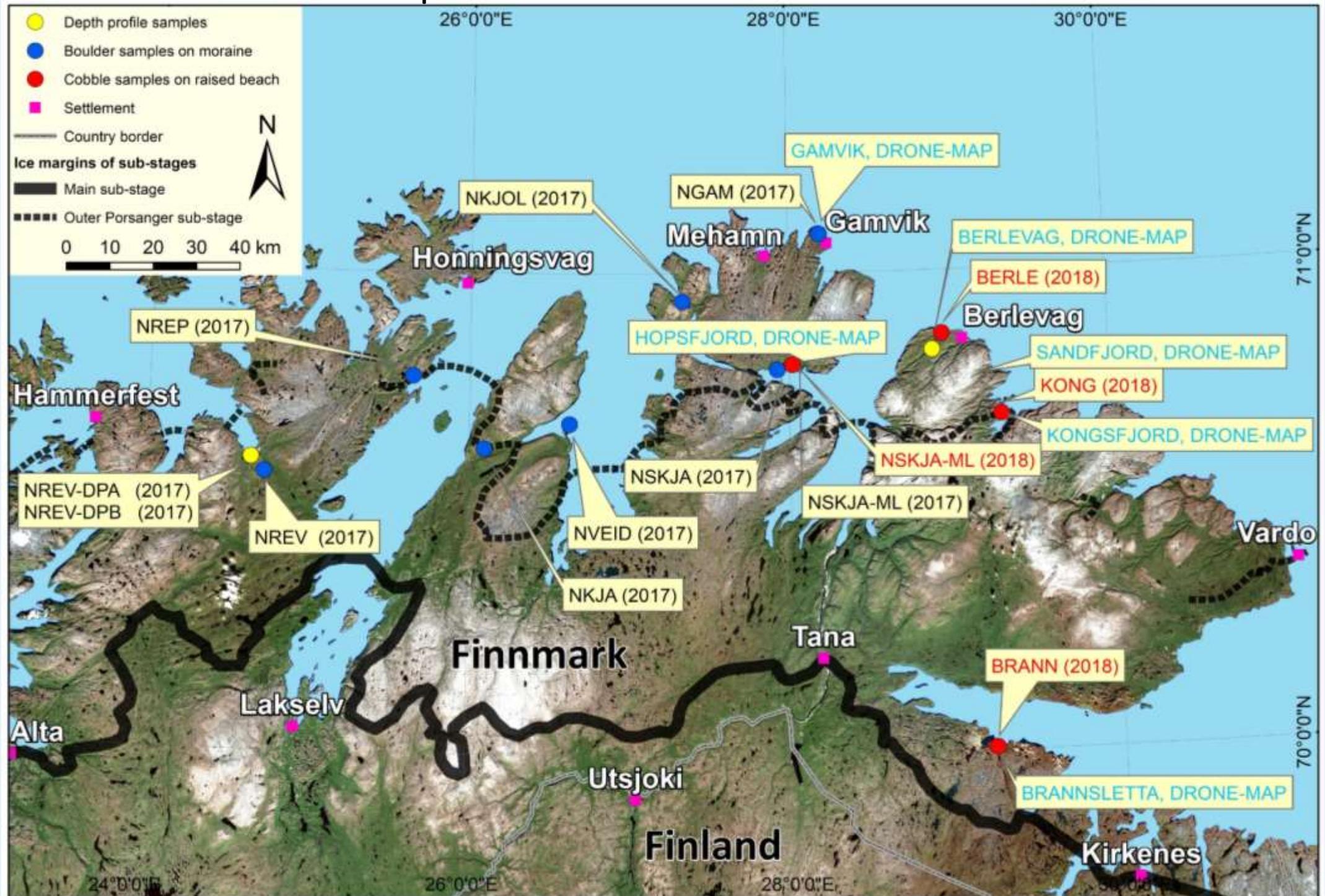
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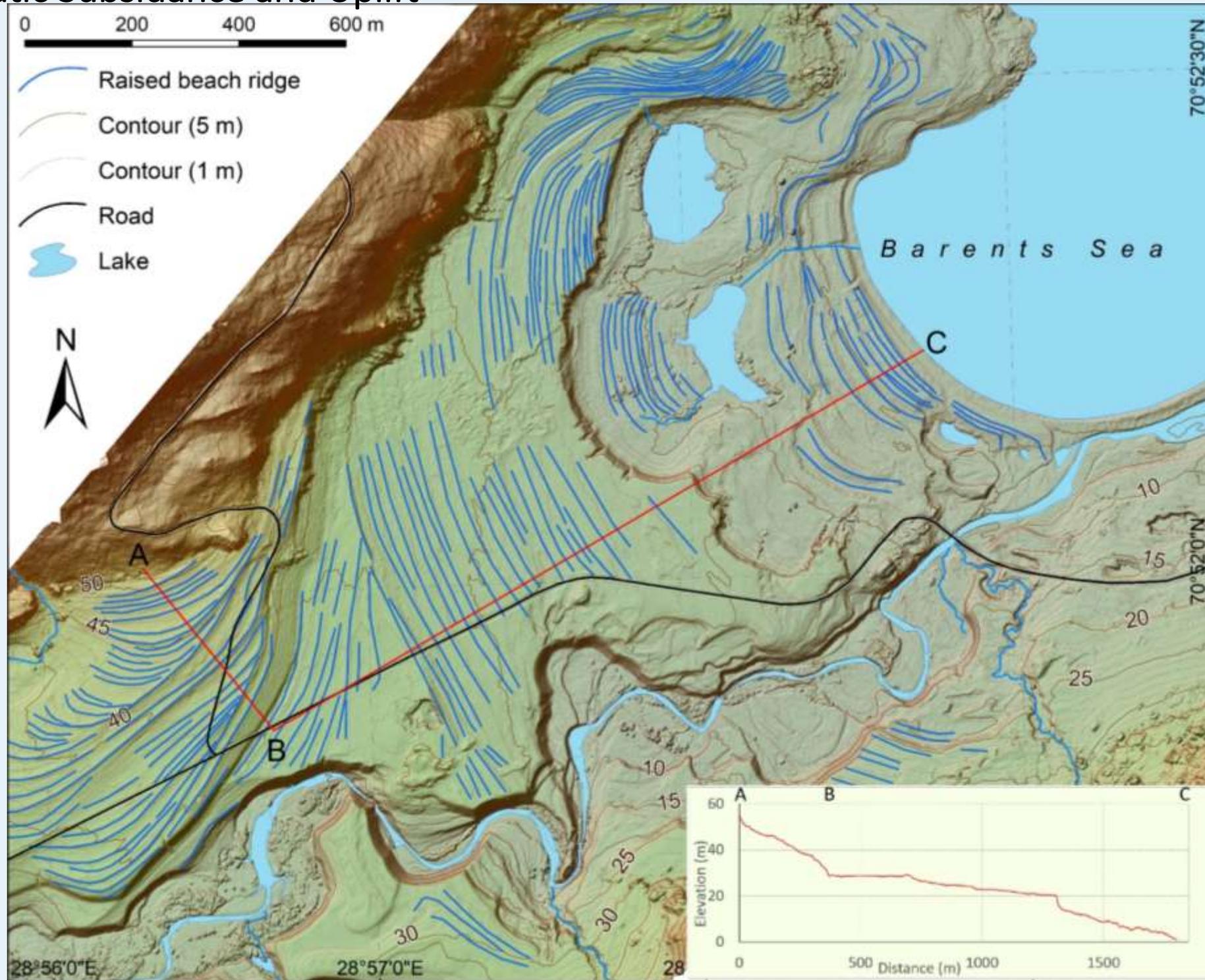
Raised Shorelines

Coasts or shorelines are fundamental geomorphological features that reflect glacio-isostatic uplift. These include **beach ridges, wave-cut marks on bedrock, and the surfaces of marine deltas**, which serve as indicators of paleo sea levels. These features, found at elevations higher than the present-day coastal zones, are referred to as **raised shorelines** and are considered key geomorphological forms for understanding glacio-isostatic uplift.



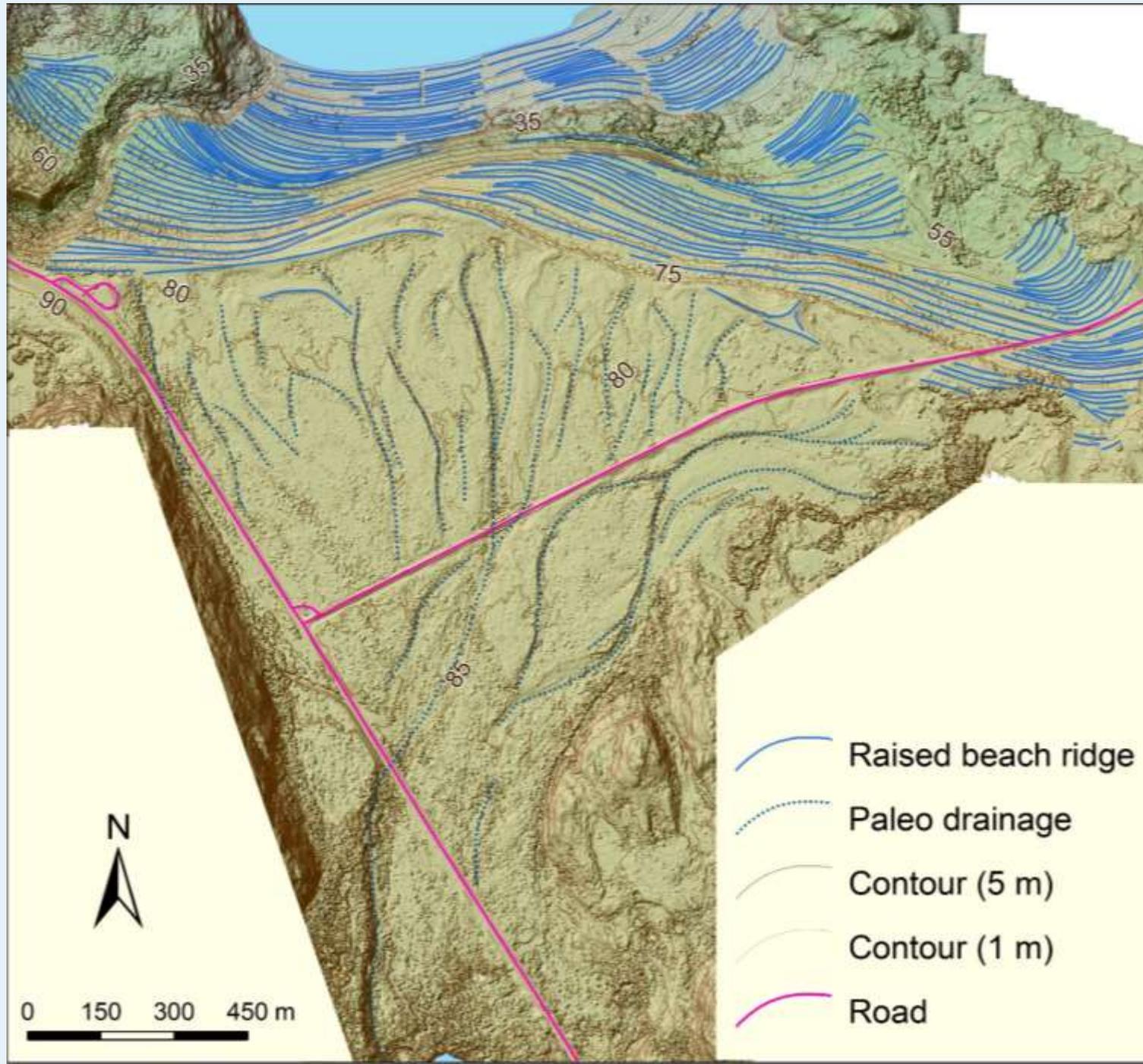
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Raised Shorlines



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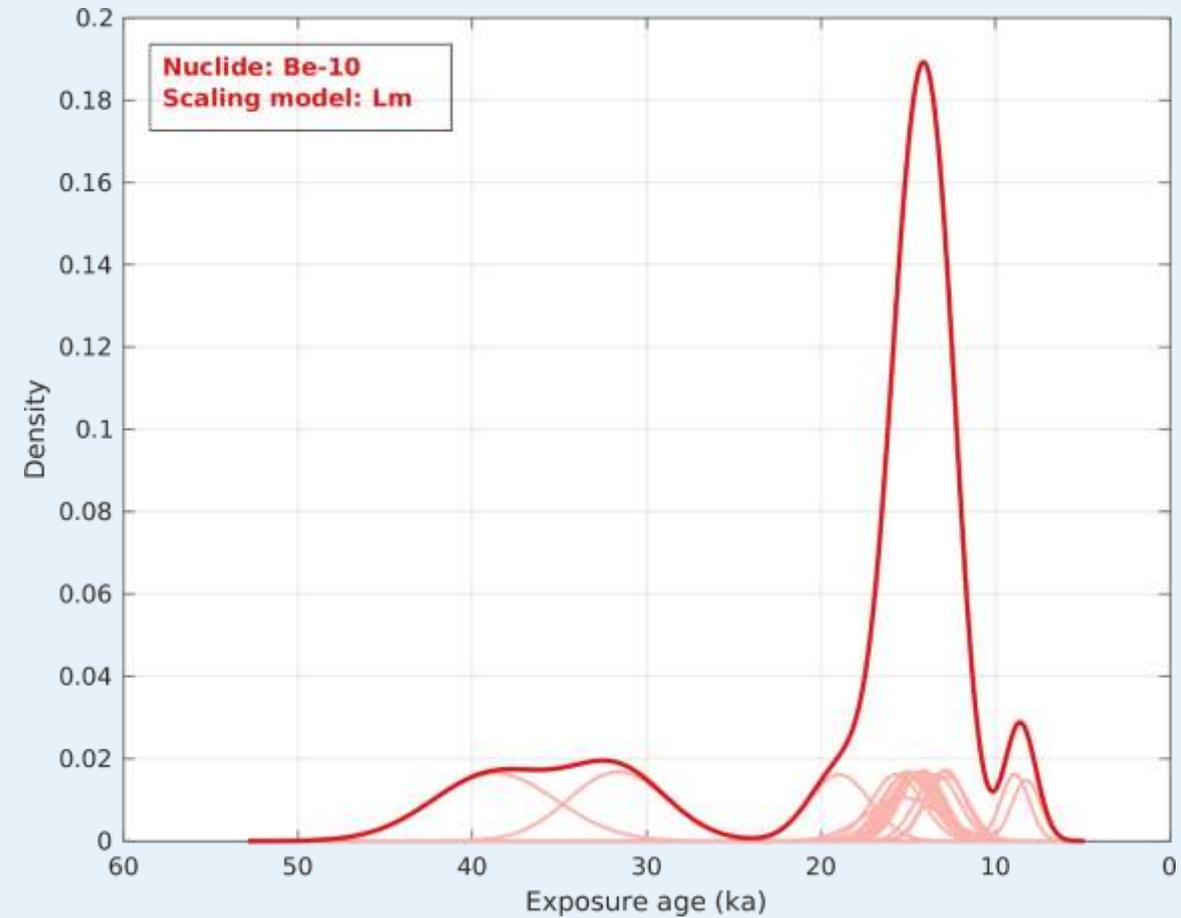


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Raised Shorlines

