Using Erosion Rates to Interpret the Evolution of the Southwestern Norwegian ‘Passive’ Margin

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Is it possible to use erosion rates obtained by cosmogenic nuclide dating in order to help determine why this seemingly ‘passive’ margin in southwestern Norway displays topographic characteristics commonly associated with active rifting?

I. Background and Motivation

The southwestern Norwegian passive margin displays topographic and drainage-pattern asymmetry that is characteristic of landscapes that are experiencing active normal faulting (Hendricks et. al, 2010). However, this margin is said to be in a passive phase which brings up the question of why it displays features more commonly associated with active rifting. This past summer a team went to Norway and observed a valley that had deep river gorges and a fault on one side while on the other side there were no such gorges. Our hypothesis is that the uplift rate is higher on one side which could be the result of uplift on the fault itself and could reveal whether or not active tectonics still play a role in shaping this landscape.

II. Area of Study

Our area of study focuses on southwestern Norway and my specific research targets the Surnadel valley as seen in Figure 2. One of the faults from the Møre-Trøndelag fault complex (MTFC) runs through the Surnadel valley, creating a distinct morphology change across the valley with glacial morphology preserved on the hanging wall while the footwall displays these characteristics at a higher elevation but also shows evidence of post-glacial fluvial incision.

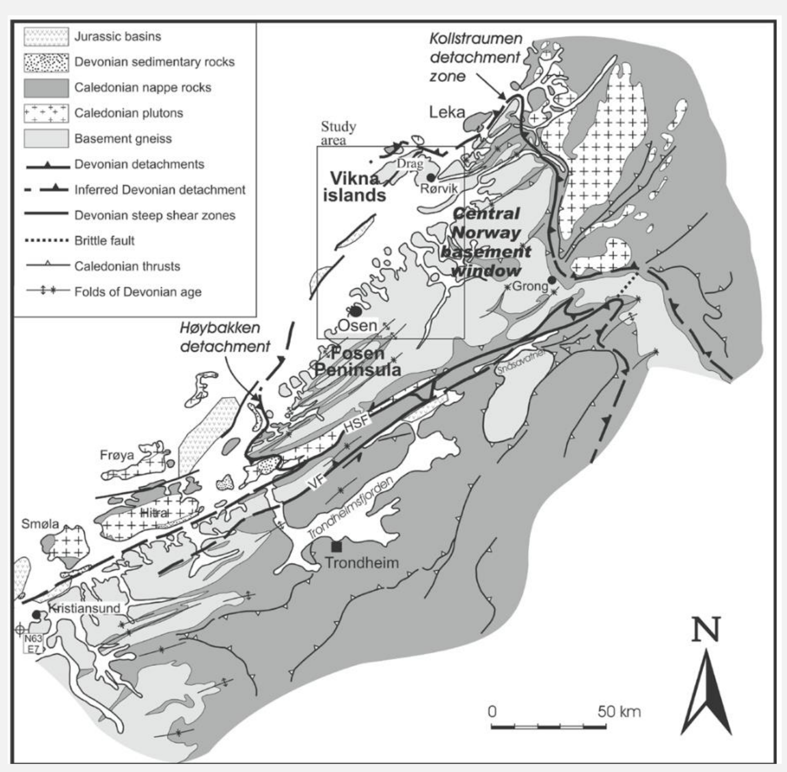


Figure 1: The above image shows the Møre-Trøndelag fault complex (MTFC) in detail. This is the major fault complex that is present within our area of study. Figure from Olsen et. al. (2007).

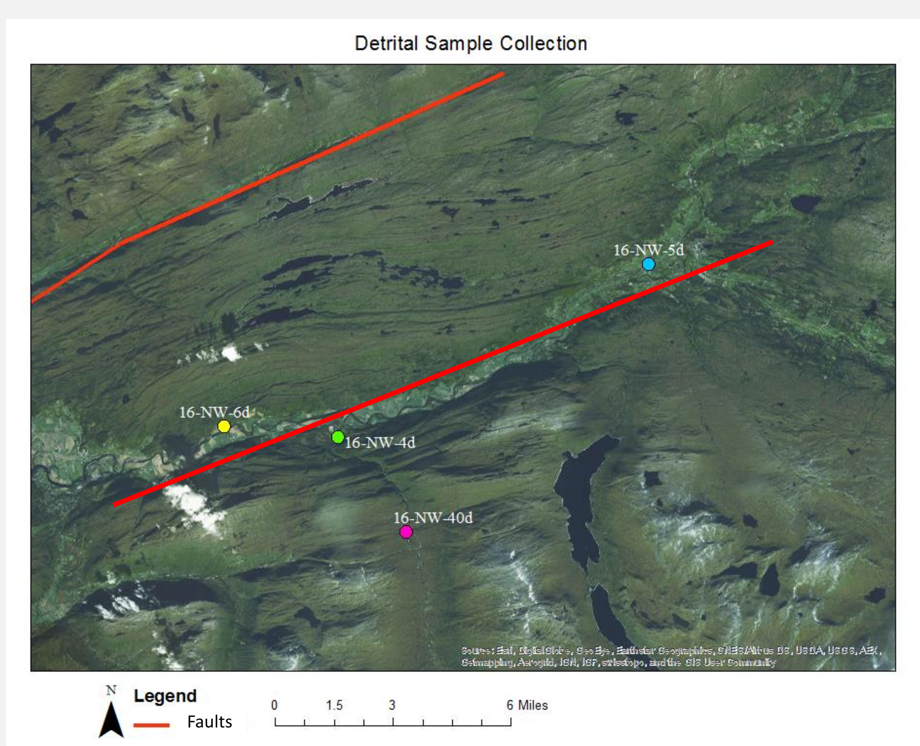


Figure 2: This map created in ArcGIS shows the Surnadal valley along with the locations of where the different detrital samples were taken.

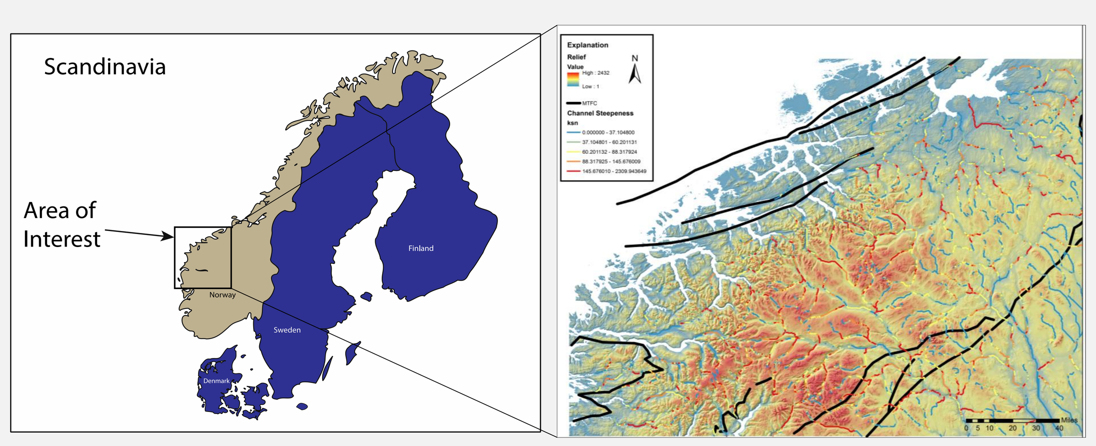
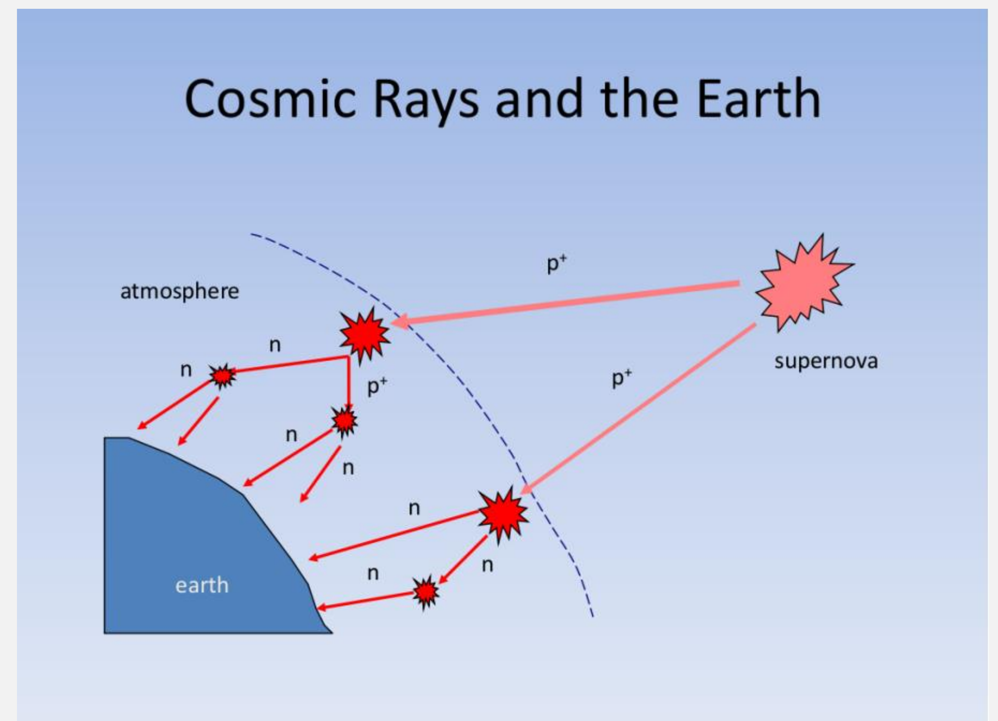


Figure 3: The map on the right side of the figure was created in ArcGIS and displays relief as well as channel steepness in the area surrounding the MTFC. It is connected to the figure on the left in order to show its location relative to the rest of Norway.

III. Cosmogenic Nuclide Dating

My research involves preparing samples for cosmogenic nuclide dating analysis. Primary cosmic rays bombard the Earth’s surface from the sun, bringing high-energy charged particles into the atmosphere and creating cosmogenic nuclides that can be measured in order to reveal how long a rock has been exposed at or near Earth’s surface. We will process samples specifically for the ^{10}Be and ^{26}Al isotopes and then use this data to determine erosion rates.

Figure 4: The model to the right shows how cosmic rays connect in the atmosphere with different nuclei which in turn creates neutrons that come in contact with the earth and create isotopes. Figure from White, W.M. 2013.



IV. Methodology

Multiple detrital samples (sand collected in the river) were taken from various locations across the Surnadel valley. These detrital samples then underwent wet sieving, magnetic separation, and multiple-step density separation. The resulting quartz obtained from the density separation was then sent to Purdue University in order to be further processed for the isotopes ^{10}Be and ^{26}Al. This data will then be used to calculate erosion rates across the valley. We will then compare these erosion rates across the valley and analyze the possible factors for the results.

Figure 5: The picture to the left shows the contrast between the topography that’s characteristic to glaciers near the top of the picture and the deeply incised river valley and gorge below it.

V. Knickpoint Analysis

One part of my research includes using programs such as ArcGIS and Matlab in order to analyze knickpoints or areas that experience a sharp change in channel steepness. The picture in the upper right displays the river profile for the Follda River which is located in the Surnadel Valley. Knickpoints can often be indicators of tectonic activity which gives us another method of determining whether or not there are active tectonics within this region. River profiles generated in Matlab can be used to identify these knickpoints which can than be further analyzed in Google Earth.

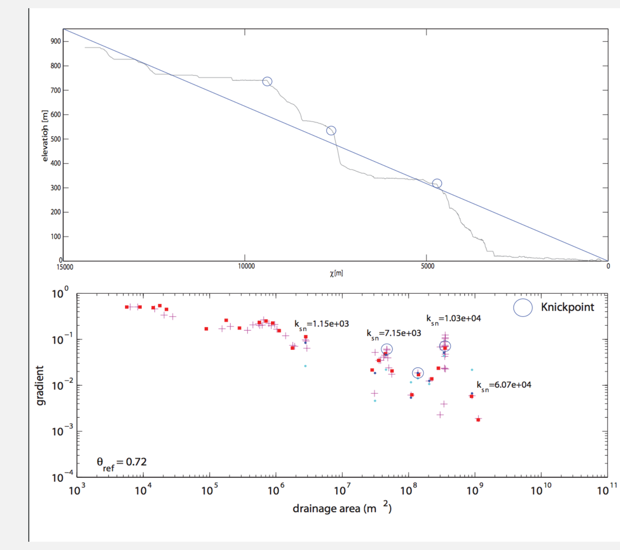


Figure 6: the above figure shows the longitudinal profile of the Follda River with various knickpoints identified.

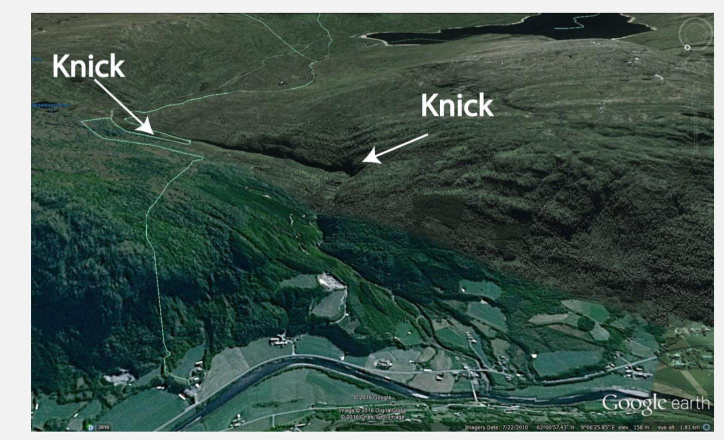


Figure 7: the above image shows a screenshot from Google Earth. The knickpoint identified on the right is indicative of the start of the incised gorge.

VI. Conclusion and Next Steps

Once the detrital samples have been processed, we will be able to use that data to calculate the erosion rates within the valley. This will be able to tell us if one side of the valley does in fact have higher erosion rates which if true would be a good start at establishing that greater uplift is happening. However, this uplift could be either isostatic or tectonic so future work would be needed to determine the cause of the uplift. Our next steps involve the continuation of sample processing as well as an additional field season in Norway.

Acknowledgements and References

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