

**Late- to Post-Cretaceous Inversion of the British Isles**  
*Tectonic Stylolites at Flamborough Head*

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**Introduction**

Late Cretaceous and Tertiary inversion structures play an important role in central Europe, the North Sea and the British Isle (Kley and Voigt, 2008). They are responsible for the uplift of numerous fault blocks, the development of small fault and thrust belts, inversion of basins and creation of structural traps in the North Sea. Inversion seems to be controlled by the northwards push of Africa and later the effects of the Alpine Orogeny on Europe where stresses were transferred relatively far into the forelands. The exact nature of these far field stress transfers and the age of the inversion are not well known.

One of these inverted fold and thrust belts is preserved at Flamborough Head in East Yorkshire (Peacock and Sanders, 1994). The belt contains faults, folds and tectonic stylolites. Recent research on sedimentary and tectonic stylolites has shown, that they can be used to derive directions and magnitudes of the main principle stresses in three-dimension (Koehn et al., 2007; Ebner et al., 2009; 2010). Thus the tectonic stylolites at Flamborough Head offer a unique opportunity to study the Late- to Post-Cretaceous Inversion of the British Isles and the associated tectonic stresses.

**Objectives**

- Map cliff sections at Flamborough Head including faults, folds and stylolites
- Take stylolite samples along cliff to determine stress field
- Measure stylolite amplitude and distance to estimate finite strain during initial compaction and tectonic inversion
- Prepare samples to measure roughness of stylolites in three-dimension.
- Analyze stylolite roughness to determine estimates for tectonic stresses
- Create stress and finite strain maps of fold and thrust belt

**Relevance**

Scientific: The stylolite stress inversion method is very new. Tectonic stresses are not well known, so the data will be new and unique for the British Isles. We do not know much about how far stresses can be transferred across the crust. In addition not much is known about younger inversion events in the UK.

Industrial: A lot of the oil and gas traps in the North Sea are structural and related to young inversion events. It is extremely important to understand these events. In addition stylolites are very important for fluid flow, they can be barriers and conduits at the same time and have a strongly anisotropic permeability.

Therefore the project has a high relevance for science and industry alike.

**What you will learn**

- Advance structural mapping, new structural methods.
- Statistical analysis of roughness data, how to use Matlab, basics of statistical physics.

## References:

- Ebner, M., Koehn, D., Toussaint, R., Renard, F., Schmittbuhl, J., (2009) Scaling of natural stylolites and their use as stress-depth gauges. *Earth and Planetary Science Letters* 277, 394-398.
- Ebner, M., Toussaint, R., Schmittbuhl, J., Koehn, D., Bons, P.D., (2010) Anisotropic scaling of tectonic stylolites: a fossilized signature of the stress field. *Journal of Geophysical Research*.
- Kley, J. & Voigt, T. 2008. Late Cretaceous intraplate thrusting in central Europe: Effect of Africa-Iberia-Europe convergence, not Alpine collision. *Geology* 36(11), 839-842.
- Koehn, D., Renard, F., Toussaint, R., Passchier, C.W. (2007) Growth of stylolite teeth patterns depending on normal stress and finite compaction. *Earth and Planetary Science Letters* 257, 582-595.
- Peacock D.C.P., Sanderson D.J. (1994) Strain and scaling of faults in the chalk at Flamborough Head, U.K. *Journal of Structural Geology* 16, 97-107.

## Application procedure and deadlines

To be considered for PhD studentships to be held in the School of Geographical and Earth Sciences (GES), suitably qualified candidates should apply via the website of the College of Science and Engineering (<http://www.gla.ac.uk/colleges/scienceengineering/graduateschool/prospectivestudents/essentialinformation/>). Closing dates for University and research council funded studentships will be in early in the new year, as stated on the GES studentships page: <http://www.gla.ac.uk/schools/ges/research/postgraduate/>.

Non- English speakers must meet the University's English language requirements. Candidates for NERC studentships should also meet the NERC's requirements for both academic qualifications and residential eligibility. For more information go to <http://www.nerc.ac.uk/funding/application/studentships> and please note that *non-UK European Union citizens will be awarded fees only by NERC.*

For informal enquiries about the research projects please contact the relevant supervisors. Information on the GES graduate school and the application process can be obtained from Mrs Jean McPartland, the assistant to head of the School ([Jean.McPartland@glasgow.ac.uk](mailto:Jean.McPartland@glasgow.ac.uk)).