

*Earth-Science Reviews* Paper Frameworks

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2 Subject: What is the nature of Iceland? Does it contain a continental sliver? Structure, gravity, kinematics. (Leader: Ármann Höskuldsson & Gillian Foulger). 3

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# Subject: General overview (Leader: Gillian Foulger, everyone a co-author).

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8.1 Some clearly wrong but widely repeated concepts: 22

(instead of attempting the impossible job of disproving the plume hypothesis, maybe we should just debunk the large number of wrong assumptions there are, such as LCB=underplating, Faroe-Shetland Basin vertical motions = plume pulses etc)

# Subject: What is the nature of Iceland? Does it contain a continental sliver? Structure, gravity, kinematics. (Leader: Ármann Höskuldsson & Gillian Foulger).

# Draft title: Diachronic breakup and spreading development of the North Atlantic (Leaders: Laurent x 2)

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| --- | --- |
| Breakup, rift propagation & kinematics  Preliminary Title ?:  Diachronic breakup and spreading development of the North Atlantic | PIs |
| Introduction  Why the North Atlantic is so important to understand earth dynamic in general  Why a new paper on the North Atlantic? Problems to solve  Presentation of previous models  Old dataset versus-New data/new observations | LG1, LG2, DF, GF, MS |
| Geodynamic and regional rift setting of the North Atlantic rifted margins |  |
| Main geodynamic events of the North Atlantic- continental rift-oceanic domain  Global plate motion and progressive dislocation of Baltica-Laurentia | LG1 |
| Inheritance (brief summary)-breakup/Wilson cycle – cross-ref with CS/TD chapter | LG1, CS, TD |
| Opening of the North Atlantic- Emplacement of the large igneous province-contrast with the Central Atlantic province | LG1 |
| Introduction presentation of the ‘classic’ breakup’ scenario in the North Atlantic (e.g. Early Eocene ‘instantaneous’ episode) – so-called Main Stage 1 of the global North Atlantic breakup system in the paper  Early interpretation and model | LG1, LG2, DF, GF |
| Terminologies |  |
| Volcanic margins v.s magma-poors – also Nourished ‘fat’ rifted margin | LG1, LG2, DF |
| What is breakup? Basic definition – rupture of the lithosphere (not only the crust)- different models proposed | LG1, LG2, DF |
| Continent-ocean transition zone and continent-ocean "boundaries"- Can we agree on a proper definition? (maybe an oceanic continent % threshold) – complex, certainly not so sharp but we need to define a COB - different models proposed, uncertainties | LG1, LG2, DF |
| Pre-‛Stage 1 breakup’s history-crustal configuration - models |  |
| Main rift/basins organization in the North Atlantic - Rifting phases/rift duration – unclear/unconstrained regions of the NEA (e.g. Rockall, NE- Greenland, JMMC) | LG1, LG2, DF, MS |
| Regional distribution of the LCB  Nature of the pre-breakup deformations. Crustal thickness estimation nature of the continental LCB (Vp>7 km/s) – why are they so important to valid any specific but controversial tectonic scenarios. Continental LCB versus oceanic LCB | LG1, DF, NK, TD |
| Superextension and comparison with Iberian type magma-poor models?  Is the breakup the result of a continuum of lithospheric deformation ?  Different rifted model scenario, controversies, contradicting and/or alternative models | LG1, LG2, DF, TD, NK |
| Pre-volcanic rift development of the distal rifted margin – margin segmentation | LG1, DF |
| Syn-‛Stage 1 breakup’s scenario (s) |  |
| Active versus passive modes of lithospheric deformation – modern development | LG1, LG2 |
| Onset of volcanic passive margin, melt production and plume versus non-plume discussion (just a brief summary) | LG1, LG2, DF, GF |
| Crustal/upper lithospheric plumbing models, asthenospherization of the continental lithosphere and onset of breakup | LG1, LG2, DF, GF |
| Possible influence of the inheritance on the breakup (or not?) – mantle weakening, melt prone (suture, old slab, ect.) | LG1, LG2, DF, GF, CS |
| Timing of the breakup magmatism – state of knowledge -chronostratigraphic chart | LG1, MS, DF |
| Sedimentary response, paleogeography – Regional chart for all segments | LG1, MS, DF |
| First phase of breakup in the North Atlantic |  |
| Seaward dipping reflector<(SDR) volcanostratigraphy - Structural and magmatic development of the magmatic rift – localization of the deformation – SDR mode of emplacement – C-block , other alternative models– comparison with Icelandic SDR | LG1, LG2, DF |
| Role of oblique segment versus SDR development and melt production | LG1, LG2, DF |
| Nature of the crust underneath the SDR: oceanic ?Continental?, exhumed serpentinized mantle ? | LG1, LG2, DF, TD |
| Embryonic crust organization, control and development? (example Form Norway-Greenland and Rockall-SE Greenland | LG1, LG2, DF, TD |
| Spreading propagation, space and time development of the SDR versus embryonic oceanic crust | LG1, LG2, DF, TD |
| Diachronism during the Early Eocene phase of breakup (Main stage 1 of the global North Atlantic breakup system)  C24r, C24A/B evolution – Plate reconstruction at C24 |  |
| Post-‛Stage 1 breakup’ |  |
| Complex spreading system evolution, main spreading system organization – Rift migration/extinction - New magnetic data insights | LG1, DF, LG2 |
| Volcanic margin and microcontinent – JMMC nature and evolution | LG1, LG2, MS, CS |
| The Faeroes-Iceland-Ridge case study – Its real nature – fragment of preserved continental crust/lithosphere?–  The Faeroes-Iceland-Ridge, sub-lithospheric inheritance | LG1, LG2, MS, CS, GF |
| Notion of tectonic buffers and locking zones – evidence of delayed breakup  Late spreading segmentation of the North Atlantic: sub-regional examples  C22 event: initiation of the real Breakup along the Faeroes-Iceland Ridge?  C7-C6: Final Breakup along the Faeroes-Iceland Ridge? (Main stage 2 of the global North Atlantic breakup system)  Plate reconstruction at C22 and C7 | LG1, LG2, DF, MS, CS |
| Discussion: |  |
| Volcanic margin versus magma-poor (Iberian Type) margins: A different rifted margin scenario in the North Atlantic? No continuum of deformation ! | LG1, LG2, DF, MS, TD |
| The breakup: local scale versus North Atlantic scale – evidence of continental/lithospheric ‘buffer’ | LG1, LG2, DF, MS, TD, NK |
| Diachronism of the breakup – a gradual process at the scale of the North Atlantic? | LG1, LG2, DF, MS, TD |
| When happened the real and complete breakup of the North Atlantic ? (Possibly when the JMMC finally formed around 24 Ma. | LG1, LG2, DF, MS, |
| Bibliography |  |

Main PIs of the paper (preliminary draft):

DF: Dieter Franke

LG1: Laurent Gernigon

LG2: Laurent Geoffroy

MS: Martyn Stoker

Other contributions:

CS: Christian Schiffer

GF: Gillian Foulger

NK: Nick Kusznir

TD: Tony Doré

# Draft title: A review of Late Cretaceous-Cenozoic intraplate deformation in the North Atlantic-western Tethys realm (Leader: Randell Stephenson)

Overview

- intraplate deformation excluding deformation related to the incipient/forming plate boundary

- tectonic deformation recorded by fault activity (mainly)

- inversion structures

- structural reactivations

Materials

- map or series of maps (updated Ziegler maps) newly compiled

- Late Cretaceous/Palaeocene/Eocene/Oligocene-Miocene

- base map and common set of paleotectonic/paleogeographic reconstructions

- describe and correlate

Outcomes

- discuss style and timing of tectonic “moments” with plate boundary processes/ reconfigurations

- speculate about cause and effect with global plate tectonics

# Draft title: Mantle potential temperature and the role of pyroxenite and dry and damp peridotite in magmatism in the NAIP (Leader: Malcolm Hole).

Could be whether hot or cold, or extension rate controls volcanic rate. How wet? How fertile? What do we know and what not? Relationship with extension and vertical motions.

Malcolm Hole & James Natland

[It is intended that Jim will provide an overview of mineral geothermometers (Al in olivine, olivine-melt equilibria &c) in a separate paper]

1. Current potential temperature (TP) estimates and models employed
2. Melting of damp peridotite at Iceland in relationship to new experimental data on MORB
3. Effect of oxidation state on TP estimates – XANES Fe3+/ΣFe in Reykjanes Ridge glasses and oxidation state of Icelandic and West Greenland magmas
4. Role of pyroxenite in melting – evidence from olivine chemistry for pyroxenite in the source of NAIP basalts
5. Melt generation rates and crustal thickness estimates
6. Isotopic arguments – evidence for existence of pre-existing continental crust beneath Iceland – primitive mantle He isotopic compositions
7. Proposal of a new damp melting model for Iceland

# Subject: Inheritance. (Leaders: Tony Doré & Christian Schiffer)

Piercing points, mantle reflectors, reactivation of Caledonian, delamination, numerical modelling, dynamic uplift. Could be from earliest known orogeny to present.

Suggestion: Structural heritance in North Atlantic evolution – how important is it, and how does it vary with scale?

1. Introduction (Tony & Christian)
2. Definition and scales of inheritance/reactivation/reworking from lithospheric to grain scale (Bob)
3. Overall North Atlantic structure (Erik/Tony)
4. North Atlantic inheritance at different scales (observations and models/concepts)
   1. Wilson Cycle and modifications/extensions (Christian)
   2. Lithospheric scale reactivation
      1. Rheology, composition and numerical modelling of the lithosphere (Kenni)
      2. thermal history, crustal and lithospheric thickness (Kenni)
      3. development of mantle fabrics (Christian)
      4. post-orogenic collapse (Christian)
      5. Role of transforms (Tony/Erik)
      6. microcontinent formation (Laurent Gernigon)
      7. Lower crustal bodies/High velocity lower crust (Laurent Gernigon)
   3. Basin scale
      1. Overview, including analogue modelling (Tony/Erik)
      2. Norwegian-East Greenland passive margins (Laurent Geoffroy)
      3. West of British Isles, Faroe, Shetland (Johnny Imber)
      4. Labrador Sea-Baffin Bay-West Greenland (Alex Peace)
   4. Sub-basin to grain scale
      1. Overview (Bob)
      2. Reactivated fault styles and observations (Bob)
      3. Fault growth, fault propagation (Ken)
5. Discussion (under construction)
   1. The Wilson Cycle revisited
   2. How important is reactivation for the NA.
   3. Where does it and where does it not work (map)
   4. What are the geological/geodynamic prerequisites
   5. Wider applications (is the NA typical for continental breakup? Can it be used as a template)
   6. Future directions (Imber paper)

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# Subject: Reykjanes Ridge (Leader: Fernando Martinez).

We plan to summarize results from our previous cruises to the Reykjanes Ridge in the context of regional data and the evolution of the flanking North Atlantic basin. Main points include:

* Although the Reykjanes Ridge is thought by some to be the type-example of plume-ridge interaction many of its characteristics can be explained by near-surface plate boundary processes.
* Asymmetric crustal accretion on the ridge, documented through analysis of magnetic profiles, involves a new type of propagating rift phenomenon that takes place within the plate boundary zone.
* The synchronous segmentation of the ridge and subsequent diachronous removal of segmentation involved plate boundary processes causing asymmetric seafloor spreading and ridge segment migration, not changing mantle temperatures.
* The large-scale plate boundary reconfigurations of the Reykjanes Ridge that removed segmentation progressed in a series of rapid steps separated by pauses, indicating a plate boundary control related to removal of segmentation offsets, not progressive mantle thermal effects.
* The transition from orthogonal unsegmented spreading to orthogonal segmented spreading and finally to unsegmented oblique spreading re-established the original geometry of the ridge. The re-establishment of the original linear spreading center geometry indicates a strong plate boundary control, not deep mantle effects.
* Pulsing plume models as explanations for the Reykjanes V-shaped ridges are internally inconsistent as they require a high viscosity dehydrated layer to deflect mantle plume flow and prevent excessive melting. The existence of such a layer at other hotspots would prevent mantle plume melting altogether for plumes not centered beneath spreading centers (i.e., Hawaii).
* V-shaped (chevron) ridges can be explained as a result of propagating buoyant mantle upwelling, driven by large gradients in mantle properties away from the Iceland hotspot. Such migration of propagating instabilities generally occurs at slow spreading ridges in a less pronounced way, driven by small random mantle heterogeneities, forming migrating non-transform discontinuities.
* Excess melting at hotspots can be explained by the effects of buoyant mantle upwelling instabilities acting on unusually fertile and low viscosity (volatile rich) mantle that may have accumulated from prior subduction events or may have been slowly advected from deep in the mantle. Excess hot-spot melting need not result from high mantle plume flux but rather results directly from near-surface vigorous buoyant mantle upwelling instabilities enabled by fertile, low-viscosity mantle.

# Subject: Structure from top to bottom, crust, mantle. (Leaders: Hans Thybo & Irina Artemieva).

# Draft title: The dispersal of the Pangea supercontinent and associated magmatism cannot be explained by ‘hot-spots’ (Leaders: Alex Peace & Dieter Franke)

1. Abstract – AP/GF/DF/CS
2. Introduction – AP
   1. The assembly and breakup of Pangea – DF?/AP
   2. Proposed ‘hot-spots’ in proximity to the disintegrating supercontinent – GF?
3. Opening of the Central Atlantic – DF?
4. The Breakup of East and West Gondwana – DF/JP?
5. The Opening of the South Atlantic – DF?
6. The separation of India and Antarctica – DF/JP?
7. The opening of the Northeast Atlantic, the Labrador Sea and Baffin Bay – AP/GF/CS?
8. Afar – DF?
9. A plate tectonic model for supercontinent dispersal – AP/GF/DF/CS?
10. Conclusions – AP/GF/DF/CS?

# Subject: Comparisons/extensions to other regions (Leader: Nick Kusznir)

Will expand on the following William Smith Meeting abstract:



