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The North Atlantic Igneous Province: Stratigraphy, Tectonic, Volcanic and Magmatic Processes

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REVIEWS

The North Atlantic Igneous Province: Stratigraphy, Tectonic, Volcanic and Magmatic Processes

Edited by D.W. Jolley and B.R. Bell
The Geological Society of London (UK) Special Publication No.197, 344 p. ISBN 1-86239-108-4, Hardback. $142.00 US (list price); $71.00 US (GSL member price); $85.00 US (AAPG member price)

Reviewed by J. Christopher Harrison
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After reading the title and being offered the opportunity to review this volume it was with great interest and anticipation that I accepted the challenge. The North Atlantic Igneous Province is one of the youngest and most accessible of the large igneous provinces that are associated with both the voluminous outpouring of basaltic lavas and the emplacement of giant dyke swarms. Components of the North Atlantic province include: the active subaerial and subglacial volcanism, geothermal areas and seismic activity of Iceland; the ongoing submarine activity of the mid-Atlantic ridge; the submarine volcanic ridges that mark the trace of the Iceland hotspot track during the opening of the North Atlantic since anomaly 24; seaward-dipping reflectors and dyke swarms of the continental margins, and the British Isles; and Paleocene-Eocene flood basalts that are widely exposed onshore from the Faroe Islands through West Greenland and East Greenland to Baffin Island.

This vast region provides a wonderful opportunity to compare modern volcanic and intrusive processes in a wide variety of settings with those preserved in the young geological record. Hydrocarbon exploration, including exploratory wells and related geophysical data, notably 3D reflection seismic data, provides the opportunity to understand the nature and behaviour of sills, dykes and flows, both in three dimensions and through time. The combination of magnetic data from the ocean basins and onland basalt piles upward of 4-km thick, provides a chance to link magnetic reversals to biostratigraphy and absolute ages from the exposed rock record, and to understand in detail the behaviour of the earth's magnetic field during the reversal process. Iceland, itself, is the surface expression of an active plume jet located on an active spreading ridge. There is now convincing evidence to indicate that the arrival of this same plume can be linked to the onset of seafloor spreading in both Labrador Sea-Baffin Bay (at 62 Ma) and in the North Atlantic, north of the Charlie Gibbs Fracture Zone (at 55 Ma). There is evidence that this plume activity could have steered the plate motions of Greenland, to have been part of the driving force for southwestward acceleration of the North Atlantic plate beginning in the Paleocene, and for producing plate convergence and Paleocene-Eocene orogeny across the Canadian Arctic Islands. Both theory and field observation indicate that the arrival of mantle plumes can generate regional uplift over areas of plate, measuring 1000's of kilometres in diameter. These uplift events must have had a profound regional, if not global, effect on our ability to correlate specific unconformities and tectono-eustatic events through the rock record. The poorly understood relationship of plumes to Neogene continental margin uplift is also apparent in the close correlation of extreme topography to flood basalt exposures in both East and West Greenland. Finally, the environmental consequences of accelerated volcanism are well known historically from Iceland, and the related effects were undoubtedly massive during critical periods of flood volcanism in the geological past.

It is clear to me that a book is needed that can examine and highlight the array of links between large igneous provinces and themes as diverse as plate tectonic theory, sequence stratigraphy, geochronology, extreme paleoenvironmental conditions, and hydrocarbon exploration. The North Atlantic Igneous Province could be an obvious focus for such a book. Unfortunately, Geological Society Special Publication No. 197 is not that book. Like most of the special publications of the Geological Society, this volume is no different than a journal special issue that allows researchers with broadly common interests to bring their papers together under one cover. When a book reviewer is confronted with a volume of loosely linked scientific papers, there is an overwhelming urge to try to review the merits of each individual contribution. I have resisted this urge.

The present volume consists of eleven scientific papers and an introductory contribution that places these eleven papers in geological context. Six of the papers deal with either the Faroe Islands or the Faroe-Shetland Basin. There are two papers on West Greenland, one on East Greenland, one on the Norwegian continental margin, and one that re-evaluates magnetic anomalies and the spreading history of the North Atlantic between southeast Greenland and the Rockall Plateau. Many of the contributors are linked to offshore exploration interests and, therefore, the focus is on new data sets that have been obtained to assess hydrocarbon potential. This volume makes useful contributions to a variety of topics deal-

ing with the Paleogene geology of the North Atlantic region. It will be of greatest use to explorationists working in the Faroe- Shetland Basin region. There are several useful papers here for readers wishing to understand some general features of the North Atlantic Igneous Province. However, most papers will only appeal to those with specific interests (for example, dinoflagellates of prevolcanic strata in West Greenland, genesis of Erland Volcano, emplacement of Faroe-Shetland sill complexes, sediment dispersal patterns in Foinaven Sub-basin, etc). Such readers would be better served by requesting reprints from the individual authors.

Deformation Mechanisms, Rheology and Tectonics: Current Status and Future Perspectives

Edited by S. de Meer, M.R. Drury, J.H.P. de Bresser and G.M. Pennock
The Geological Society of London Special Publication No. 200, 2002, 416 p.
ISBN: 1-86239-117-3, Hardcover, £50.00 (GSL member price)

Reviewed by Joe White
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"The motion and deformation of rocks are processes of fundamental importance in shaping the Earth, from the outer crustal layers to the deep mantle." This opening sentence sums up the philosophy behind the collection of papers from this, the 25th anniversary volume of a series of meetings initiated at a seminal meeting in Leiden, the Netherlands. The *Deformation, Rheology and Tectonics* symposia are held in alternate years and serve to bring together researchers working both at a range of scales (atom to mantle) and with a variety of approaches (experimental deformation, numerical and analogue modelling, textural analysis, field studies) in a single forum. In turn, the related conference volumes have become signposts for the state of integrated process-related deformation research.

Publications resulting from DRT symposia are, of necessity, partial records of the meeting, which reflect those attendees who submit their work. Despite this constraint, the editorial group has produced a volume that represents the high quality of presentation and discussion typical of these conferences. The volume is prefaced by an excellent review by the editors on the state of research which incorporates the submitted papers and an extensive bibliography. Twenty-two papers are grouped into four contextual sections - the effect of fluids, microstructures and textures, deformation mechanisms and rheology and tectonics. The groupings are wholly appropriate but one can imagine that there were difficulties in deciding the final organization, as the interdisciplinary nature of the contributions makes different combinations equally feasible; for example, alternative ordering by approach or process would have been feasible, each grouping contains papers comprising experiments, numerical models and field/lab studies of naturally deformed material.

Papers addressing the effects of fluids on deformation emphasize interfacial processes that control dissolution, compaction and creep, including the interaction of porosity, permeability and deformation. Neimeijer and Spiers relate the absence of enhanced pressure solution of phyllosilicate-bearing sandstone, contrary to expectation from natural systems, while Gundersen et al. construct numerical models that examine the same problem. Den Brok et al. develop a method for in situ deformation and observation of stressed interfaces and Zhang et al. examine calcite compaction at varying stress and fluid chemistry conditions. Syndeformational chemical effects on vein formation are described for large strains and locally derived fluids (Le Hebel et al.) and basin-wide fluid flow events (Elburg et al.). The complexity of porosity-permeability relationships inherent in the latter regimes is addressed in compaction studies by Zhu et al.

Microstructural studies are weighted toward the understanding of the dynamic evolution and changes in textures through numerical simulations (Jessell and Bons, Piazolo et al.) or sequential treatment of deformed samples (Heilbronner and Tullis). The importance of textural analysis to interpretation of naturally deformed rocks is reflected in papers by Stipp et al., (quartzites), Liess et al., (amphibolites) and Zucali et al., (glaucophanite). Laboratory methods in this group of papers include image analysis, electron-backscattered diffraction and X-ray and neutron diffraction.

The ultimate aim of understanding deformation processes is to incorporate them into interpretations of earth rheology. Comparison of experimental and theoretical constraints with observed earth behaviour during subduction is examined by Stockhert; and Burg and Vigneresse review non-linear rheological feedback in partially molten deforming systems. Contributions by Renner and Evans, de Bresser et al., question the general applicability of standard steady-state flow laws to natural conditions and the utilization of simple textural models during the accumulation of large strain (Ter Heege et al.). Analoque modeling of continental lithosphere is presented by Brun, while Wiesmayer et al. describe strain accommodation in Bhutan by progressive fault rotation and Handy and Stünitz propose strain localization by reaction weakening as a method of initiating exhumation of subcontinental mantle.

The Special Publication series of the Geological Society has become a common publication vehicle for structural geology collections including several DRT volumes. The usual high quality of presentation is maintained in this volume. Text and both black-and-white and colour figure reproduction is excellent. The latter reflects the editorial care taken to ensure appropriate graphical representation of such a wide range of research. A presumed perk for the editors was creation from microstructure images of the "fun" synoptic subduction zone that comprises the book cover figure.

This volume, or aspects of it, will appeal to researchers in structural geology, tectonics, geodynamics and materials-oriented geoscientists. In addition to the research, graduate students should find the bibliographic components useful in that they exist in the context of the research i.e., references are not simply a down load of title related to key words. The volume is essential for libraries and will be a standard reference for researchers in the field of deformation processes.