BOOK REVIEWS

HERBERT, S. 2005. *Charles Darwin, Geologist*. xxi + 485 pp. Ithaca: Cornell University Press. Price £21.95, US $39.95 (hard covers). ISBN 0 8014 4348 2.

RUDWICK, M. J. S. 2005. *Lyell and Darwin, Geologists. Studies in the Earth Sciences in the Age of Reform*. xvii + 316 pp. Aldershot: Ashgate. Price £60.00 (hard covers). ISBN 0 86078 959 4.
doi:10.1017/S0016756806212615

Everyone knows the outlines of the story of Darwin as the evolutionary theorist, biologist and collector of beetles, but surprisingly the story of Darwin the geologist has not been fully told until now. In some ways this is understandable as Darwin is best known for his evolutionary theory as expounded in *The Origin of Species* in which he went to such lengths to explain why the geological and fossil record was then so unsuitable and unreliable for his purposes. Then there has been the general misunderstanding about Darwin's role on the *Beagle* expedition and the terms under which he was accepted on board by Fitzroy.

However, as Sandra Herbert reminds us in her well researched and eminently readable *Charles Darwin, Geologist*, Darwin's first publications following the *Beagle* voyage were geological and the only 'job' that he ever had was as secretary to the Geological Society of London. In 1838, when just 29, Darwin's autobiographical notes included a self-declaration 'I a geologist' and reflected on his childhood collecting habits which included 'pebbles & minerals'. But privately he was already working in parallel on the species question and had outlined yet another research project on the implications of his evolutionary ideas on mankind.

I suspect that most geologists, especially British ones, have tended to ignore Darwin's geological work because it does not fit into our general concept of what a geologist was like in the latter part of the 19th century. After the *Beagle* voyage Darwin did not do much geological mapping nor field work apart from his flawed investigation of the 'Parallel Roads of Glen Roy'. Nevertheless he made a major contribution to the problem of the formation of coral reefs and atolls which subsequently became more appreciated in America than in Britain. And there was the underlying theme of regional uplift that greatly concerned him and was developed from Lyell's work on the processes involved.

Nevertheless, as Herbert shows, Darwin's geological contemporaries in London saw him as a significant 'up and coming' member of the geological elite – at least until he moved out of London in the 1840s. He remained a member of Council of the Geological Society until 1850 when he effectively distanced himself from the 'inner circle' as he became totally embroiled in his species work. Even so, what is particularly interesting is the role that the Geological Society and its mode of conducting scientific business and debate played in Darwin's development as a very effective communicator of his ideas – at least in print.

A significant part of the groundwork on Darwin as a geologist and Lyell's influence on Darwin has been carried out by Martin Rudwick over the last three decades and more. Another valuable Ashgate Variorum edition collects together ten of Rudwick's essays written over this period. They focus on some of the important developments in the study of geology in the early decades of the 19th century, what he refers to as the 'Age of Reform'. In doing so, Rudwick also concentrates on a few of the central figures in the debates that were largely played out in the 'pit' of the Geological Society of London and the publications of the Society. The essays range from discussions of Lyell's concept of Uniformity, through the making of the *Principles* and its reception to questions of Darwin's role and work as a geologist.

For the geology-based reader of the history of science and Earth Science in particular Rudwick's writing is particularly sympathetic. He is one of just a few historians of science who come from an Earth Science background and has a real feel for the intricacies and interesting problems of the study and pursuit of geology as a science. For instance Rudwick has a real appreciation of the role of illustration and mapping in the business of geology, at least up until the last few decades.

Interestingly, Darwin could not draw at all well and was no great shakes as an illustrator but nevertheless knew the importance of appropriate illustration for all his work. This is particularly well shown in Darwin's work on the Parallel Roads of Glen Roy which he came to regard as 'a great failure'. However, like many a teratological fossil, the growth and development of this particular work reveals a great deal about Darwin's way of working and genesis as a theorist and is the subject of a long and fascinating essay by Rudwick, originally written in 1974.

Perhaps it is about time that geology reclaimed Darwin from the biologists. Both these books make an excellent case for doing so.

Douglas Palmer

SUNAGAWA, I. 2005. *Crystals. Growth, Morphology and Perfection*. xii + 295 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £55.00, US $95.00 (hard covers). ISBN 0 521 84189 5.
doi:10.1017/S0016756806222611

Understanding the processes of crystal growth from solutions and melts is central to many aspects of geology and also to a wide variety of industrial processes. This new book by Professor Sunagawa aims to give a comprehensive and up to date overview of crystal nucleation and growth. The book sets out to explain how crystal form and habit are products of growth history and that the mechanisms of growth are recorded in various ways. The book is a distillation of the author's experience in over half a century's research on crystal growth.

The first part of the book covers the fundamental concepts and contains chapters on crystal growth, factors determining morphology, surface microtopography, perfection and homogeneity, and regular intergrowth of crystals. The second part, entitled 'Application to complicated and complex systems', contains case studies on diamond, quartz, pyrite and calcite, minerals formed by vapour growth, crystals formed by metasomatism and metamorphism, crystals formed through biological activity.

The volume is a detailed and comprehensive, but non-mathematical, treatment of the subject of crystal growth and the book will be of great use to the specialists. Several features of the book however limit its usefulness to the

non-specialist who may want to get an overview of the subject. The book naturally contains a considerable amount of jargon and abbreviations which make it difficult to follow without reading the early chapters of the book in great detail. A two- or three-page glossary of terms and abbreviations at the end or beginning of the book would have made it more accessible. Many of the concepts covered in the book are relatively subtle and perhaps best expressed mathematically or with the aid of graphs and diagrams. Instead the author relies on the text to convey these ideas. Sunagawa has to adopt the German terms *tracht* and *habitus.* The characteristic forms exhibited by different crystal species are called 'crystal habit' in English – this is called *habitus* in German. The term *tracht* is applied to describe the variation of forms due to the combination and degree of development of faces within the same category of *habitus.* Variations seen in *tracht* and *habitus* are determined by the relative normal growth rate of the respective faces.

Overall, while the subject matter is extremely interesting, I must admit I struggled with Professor Sunagawa's writing style and found the text difficult to follow. I was disappointed with the illustrations in the book; many appear to have been taken from papers and other publications rather than especially drawn to illustrate a particular point in the text. I also found myself wishing for additional figures to make some points clearer. The figure captions are regrettably brief, and the accessibility of the subject matter could have been greatly increased by much more detailed figure captions that highlight the essential ideas that are being conveyed. The book is a good companion volume to Heinz Henisch's *Crystals in Gels and Liesegang Rings*, also published by Cambridge University Press.

In summary the book offers much to the specialists, but is perhaps not the best book to make this interesting subject assessible to a wider mineralogical and geological audience.

Allan Pring

GAPAIS, D., BRUN, J.-P. & COBBOLD, P. R. (eds) 2005. *Deformation Mechanisms, Rheology and Tectonics, from Minerals to the Lithosphere*. Geological Society Special Publication no. 243. x + 320 pp. London, Bath: Geological Society of London. Price £90.00 (hard covers). ISBN 1 86239 176 9.
doi:10.1017/S0016756806232618

The Earth's deformation behaviour is governed by the physical response of rocks to stress (rheology). This controls the way the continental crust responds to plate collision, earthquakes and aseismic slip in subduction zones, and mantle convection. Rheology can be investigated directly in laboratory experiments, by observation of large-scale Earth behaviour, by exploration of rock microstructures resulting from deformation and by numerical modelling. This volume is derived from the thirteenth meeting on Deformation Mechanisms, Rheology and Tectonics which was held in St Malo, France, in 2003. These meetings are biennial and indicate the sustained interest in the title topics; the first meeting was held in 1976. The book covers observational, experimental and modelling approaches to understanding rheology. It also includes some papers concerning large-scale tectonic processes as constrained by structural and metamorphic study, in particular the unroofing process whereby rocks buried as deep as 60–100 km are brought to the surface during orogenesis. There is thus a wide range of papers here, representing a 'snapshot' of recent work.

Concerning observations of microstructure, the details of crystal orientation carry key information, because preferred orientation, and the orientation relationships between grains, are influenced by deformation. In the last ten years Electron Backscatter Diffraction (EBSD) has enabled routine mapping of lattice orientations. Reddy & Buchan use this technique to show how calcite microstructures may be used to deduce large-scale aspects of deformation such as shear direction, if it cannot be obtained from other observations. Baratoux *et al.* use EBSD on plagioclase and hornblende to demonstrate contrasting behaviour in rocks deformed at two different temperatures. Grain size in a dynamically recrystallized rock is an important indicator of stress and rheology, and this is deployed in a quartz study by Gueydan *et al.* Renard *et al.* show how the statistics of crack–seal fracture patterns differ from those of other fracture distributions.

On the larger scale, observational studies of brittle and ductile deformation are included. Mirabella and co-workers map out *en echelon* faults in central Italy and show how they grew and interacted with each other. Deeper-level studies are concerned with, for example, decoupling of different parts of the continental crust – in other words the development of high strain zones separating levels or regions of different mechanical behaviours (Handy *et al.*). Other papers concern unroofing of deeply buried rocks in Western Norway (Raimbourg *et al.*), the relationships between deformation and melting (Brown), the dissimilarity between Archaean and younger deformation styles (Blenkinsop and Kisters), and tectonothermal evolution in the Alps (Spalla *et al.*).

Experimental work gives direct data on rock rheology. Austin *et al.* present two papers on dolomite deformation; Zubtsov *et al.* performed indentation experiments on calcite, inducing pressure solution (an important deformation mechanism where stress induces dissolution). Drury gives a useful and well-informed review on experiments on olivine, the rheology of which controls upper mantle deformation.

Last but not least in terms of themes comes numerical modelling. There is activity on all scales, from vein pattern development (Koehn *et al.*) through to numerical models for unroofing during orogenesis in the Alps (Ranalli *et al.*) and for gravity spreading (Delacou *et al.*, also in the Alps) and an analogue model for the Alps (Willingshofer *et al.*).

The book is neatly presented with high-quality illustrations, many in colour. It is a useful compilation of recent work in this broad field. It will provide up to date information for scientists currently working on rock rheology, and gives a representative overview of activity for non-specialists with an interest in how the Earth deforms.

John Wheeler