observation and modelling techniques—they do not follow on smoothly from the previous chapters, but their relevance is obvious. In Chapter 9 we read of cathodoluminescence, scanning electron microscopy, transmission electron microscopy, channelling, and universal stage measurements. The latter two sections are concerned with measuring lattice preferred orientations: it would be useful also to have a section on geological use of forescatter and EBSP—applications which are too new to have been included in this 1996 book, but might find a place in subsequent revisions. The only part I am uncomfortable with is the detailed discussion of how to use a universal stage. Though it could be argued that this is useful, it could equally be argued that instructions on how to use a transmission electron microscope would be useful, and so on. Chapter 10, a short discussion of sampling and section preparation, makes pertinent points about reconstructing 3D geometries from 2D thin sections. Finally, we have a problem section (photomicrographs for the reader to interpret), an extensive glossary, references (I estimate between 800 and 900) and an index.

This book, then, is a wide ranging and up to date introduction to microstructure development, covering the theoretical framework, how to interpret textures in that framework, and different methods of observation. As a result of the breadth of the topic, not all aspects are addressed in the detail that a research-level reader may need (though this is true of any book). Sometimes the depth of treatment is a clear reflection of the authors' own interests: particularly the emphasis on shear zones and how to deduce shear sense. The strengths of the book include the range of issues addressed, the quality and abundance of illustrations, and the number of recent cited papers showing how up to date the discussion is. It would be rather advanced for undergraduates as a standard text, but selected sections could be used in teaching. For postgraduate and further research level work, it provides a good introduction and enough references to allow individual issues to be pursued. In summary, a book well worth having.

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Europe before the Permian

Dallmeyer, R.D., Franke, W. and Weber, K. (editors) 1995. *Pre-Permian Geology of Central and Eastern Europe*. Springer: Berlin, Heidelberg, New York. 604 pp., 233 fig., 30 tables. Price: DM498. ISBN 3-540-55472-6.

The volume is a report of the IGCP Project 233 "Terranes in the Circum-Atlantic Paleozoic Orogens". Eighty-six authors from eight countries have contributed to this overview on topics of the pre-Permian geology of parts of Central and Eastern Europe. Some selection criteria of the chapters are worth mentioning. There are only marginal notes on the left-Rhenish Slate mountains, Brabant massif, Hunsrück, Vosges, Black Forest, Pre-Permian of the South German block, and therefore the title and frontpiece are a little misleading. However, the older pre-Permian rocks are exposed in greater variety in the eastern half of Central Europe, so most of the contributions deal mainly with this part of Europe.

The 11 chapters are subdivided into stratigraphy, structure, igneous activity, metamorphic evolution and metallogenesis. The discussed units are Rhenohercynian foldbelt, Northern Phyllite Zone, Mid-German Crystalline High (with Spessart, Odenwald and Saar-Nahe Basin), Saxothuringian Basin, Western Sudetes, Moldanubian Region, Moravo-Silesian Zone and the North Variscan Foreland. Numerous references and a subject index assist the reader.

In some regards the book deals mostly with the Hercynian processes in Central Europe because their importance in relation to the pre-Hercynian units was underestimated. It has been known for a long time that the eastern half of central Europe is dominated by Cadomian series, processes, granites etc. with differing intensity, masked by Hercynian effects. But it would be an oversimplification to classify more than 2 000 Ma history of the "United Plates of Europe", at least in Central Europe, only as a forerunner of a Devonian development. Nearly all treated structures developed in Cadomian time, such as Avalonia or Armorica. But the accretion of the middle Palaeozoic series with other Proterozoic plates or terranes happened mostly in Palaeozoic time, like that of Avalonia with Baltica in the Ordovician. The authors demonstrate the strong Hercynian overprinting on pre-Hercynian protoliths in many parts of the Bohemian massif. The inner part of the whole Europe is built up from different units which came together in the Palaeozoic.

The parts dealing with the metallogenesis are welcomed, despite the fact that only a few ore mines have survived in Central Europe. Results for different kinds of mineralization are indicative of fluid processes, composition of deeper levels of the crust and of tectonic events and improve the knowledge of the areas. Also, these chapters balance the deficiency in the treatment of the geochemistry of sediments. The relevance of volcanic series for primary mineralization and sources for later hydrothermal leaching are shown. In general the geochemistry is discussed much more in detail for magmatic rocks than for sediments.

The uniform crustal thickness is mentioned and its Upper Palaeozoic to Cenozoic age, caused by extension and magmatism. Therefore, the map of crustal thickness is not a mirror of Hercynian structures.

It is neither difficult nor fair to find "gaps" in books of this type. Here, among other structures, the Cambrian–Lower Carboniferous zone of Doberlug–Delitzsch is not discussed. This is easy to detect because the editors mention a 50 km offset along the Elbe zone, but on p. 161, fig. 5 no offset is to be seen. The final evidence of this problem is the configuration of the synclinal zone of Doberlug–Delitzsch which crosses the Elbe zone. A further minor disadvantage is that there is no treatment of the granite bodies in the eastern Rhenohercynian zone.

Some relations are not clearly proven in the text: it may be that both parts of the "Rheno-" and "Hercynian" differ not only (as the authors believe) by their clastic (Rheno) and pelagic (Hercynian) facies. Furthermore, there is affinity in Silurian and early Devonian sediments in the Rhenohercynian areas with Thuringia and Bohemia, but the Ordovician series in both areas are different.

The basement of the North Variscan Foreland (Chapter IX) is composed of either Gondwana-related Cadomian–Caledonian terranes or of rocks from a Caledonian mountain chain. The platform stage started in Lower Devonian with Old Red formations. The Upper Devonian and Lower Carboniferous series are shelf deposits. During the Upper Carboniferous the area became the marginal basin in front of the Variscides. The external Variscides are thrust upon the Variscan foreland.

The pre-Devonian Rhenohercynian ocean (Chapter III) closed before the onset of the Rhenohercynian rifting which led to the Devonian basin. Pre-Devonian series of the Northern Phyllite Zone hint at a Cadomian basement of this area which later became a part of the southern rim of the Rhenish massif.

The Mid German Crystalline High is an Armorica-derived structure, composed of pre-Devonian and post-Devonian magmatic and metamorphic complexes. According to several seismic profiles and geological data, it is a first order boundary (e.g. north of its eastern part, the characteristic Vendian graywacke (flysch) series are missing). It was a zone of convergence between late Devonian and lower Carboniferous. Up to now, its role in the development in pre-Hercynian time is not completely understood.

The Saxothuringian basin (STB, Chapter V) belongs to Armorica. Its earlier development is Gondwana-related. The Palaeozoic development started with a Cambro–Ordovician rift basin on Cadomian crust. After controversial discussion on large-scale allochthony in the 1920s, the most prominent contribution in the last 10 years has been the assertion of the allochthonous position of large parts, as demonstrated particularily by petrological, seismic and structural data. High-pressure rocks indicate deep subduction conditions during the Hercynian collision. Later thrust tectonics and metamorphism have shaped the crust. The east Saxothuringian zone (Erzgebirge) with rocks of different P,T-conditions at the same level reveals a tectonic stratification. The Hercynian exhumation has caused the development of flat shear zones. Primary Proterozoic sedimentary features are preserved, however. South of the STB the Bohemian is discussed as either a separate basin or as a marginal part of neighbouring units.

The West Sudetes (Chapter VI) have similarities to the Saxothuringian and are characterized as a Hercynian tectonic stack of Cadomian through Hercynian components. Some of the units are described in a comprehensive way, as the Moravo–Silesian Zone, where a discussion of the palaeogeography and sedimentary processes in addition to the Hercynian nappe tectonics is included. This chapter seems to be one of the most informative ones in terms of factual completeness. In other chapters the importance of the Cadomian history seems to be underrated, as in western Bohemia, where the previous geological knowledge regarding age relationship was confirmed by age determinations. This unit is of Cadomian age and it was overprinted in Hercynian times. Most structures in the Moldanubian Zone (Chapter VII) are

related to the Hercynian collision, but the rock masses which collided are dominantly of Upper Proterozoic to Lower Palaeozoic protolith ages.

The last chapter contains a plate tectonics-oriented synopsis of the Palaeozoic by the editors, mostly for the Hercynian stages of the central European crust. The results of many authors, including the editors, are summarized in a mobilistic model for the region which will be a valid source for many years to come. The authors and the editors did a good piece of work. Let us hope that the following period in deciphering crustal features in Europe will be free of the divisions which have burdened earth scientists in the region, in this century.

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Australian times

Young, G.C. and Laurie, J.R. (editors) 1996. *An Australian Phanerozoic Timescale*. Oxford University Press, Melbourne. 279 pp., plus separate folio of 12 stratigraphic charts. ISBN 0-19-553951-6. Price: £110.

This volume compiled by the Australian Geological Survey Organisation (AGSO) presents a new global perspective on the Phanerozoic timescale, correlating extensive Australian and overseas research on biostratigraphy, geochronology and magnetostratigraphy. The book is thus an exceptional contribution to the development and refinement of the Phanerozoic time-scale. As the title suggests, the primary focus of the book is on Australian data. Despite this, rescaling of the geological timescale is presented in a global context, thus ensuring that it will be an essential framework for stratigraphers worldwide.

The book is divided into two sections, with the first providing an overview of each of the Phanerozoic geologic periods, together with summaries of the methods of biochronology, isotope geochronology and magnetostratigraphy. A chapter is also devoted to numerical calibration of the major Phanerozoic boundaries. A set of detailed explanatory notes for the set of biostratigraphic charts of each Phanerozoic period comprises section 2. The separately boxed folio of charts, integrates data on magnetic reversals, sea-level curves, and isotopic data used for age control, and the relationship of Australian biochronological zonation schemes to standard global time-scales presented wherever possible. Formation details are also presented for Australian sedimentary basins for some periods (e.g. for the Permian).

As a petrologist, much of the detail presented in the second part of the text is well beyond the bounds of my field, but nevertheless provides the up to the moment information on the timescale required by most geologists. If your field of interest is stratigraphy, palaeontology or palaeogeography, these explanatory notes provide the necessary detail for your field. From the point of view of an Australian stratigraphic context, this volume is a mandatory requirement.

The first section of the text is of more appeal to the non-stratigrapher/palaeontologist, and will be a valuable teaching aid for both undergraduate and postgraduate courses, with its overview of each of the Phanerozoic geological periods, and discussion of the methods of biochronology, isotope geochronology and magnetostratigraphy and numerical calibration of the major Phanerozoic boundaries. However, some shortcomings are apparent in this section of the book (which, given the scope, is hardly surprising). For example, it is disappointing that while there are 30 pages on magnetostratigraphy, there are only six pages on biochronology, and only four pages on isotopic geochronology. This seems a shame, given the recent advances in geochronological methods, particularly at the research School of Earth Sciences at the Australian National University and AGSO—especially in U–Pb zircon dating. The chapter on numerical calibration is also surprisingly succinct, but does cover the necessary aspects, with relevance of the geochronological data explained in section 2.

Despite this criticism, the collation of such a massive amount of data as presented in this volume represents an enormous amount of work—a project unlikely to be undertaken by anyone other than an organisation such as AGSO. The data are comprehensive and are presented in a standardized, easily followed format. The 79-page bibliography is a testament to the extensive literature review undertaken, and also provides the researcher with further data sources. Overall presentation quality is high, definitions are well explained, indexing is thorough, and the book is presented in an easily followed, logical format. The quality of printing, binding and editing is splendid, and the folio charts are presented in a high quality format. Perhaps one criticism here would be the complete lack of colour diagrams in either the book or the charts; however this is probably a warranted cost-saving measure in an otherwise high quality product.

In summary, this book makes accessible a vast amount of information which is presented in a high quality book and chart format. The editors, their many contributors, the publishers, and the Australian Geological Survey Organisation, should be congratulated on an excellent publication.

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Granites a third time

Brown, M., Candela, P.A., Peck, D.L., Stephens, W.E., Walker, R.J. and Zen, E-an. (editors) 1996. *Third Hutton Symposium. The Origin of Granites and Related Rocks. Transactions of the Royal Society of Edinburgh: Earth Sciences*, **87**. Parts 1 and 2. Royal Society of Edinburgh, U.K. 359 pp. Price £47.00.

This volume of 33 papers represents the proceedings of a symposium held at the University of Maryland at College Park, Baltimore in August 1995. The Hutton Symposium Series has grown out of a meeting organised jointly by the Royal Societies of Edinburgh and London in 1987 to mark the bicentenary of the work of James Hutton. This, the third in the series of Hutton Symposia, published by the Royal Society of Edinburgh is the latest statement from the 'granite community' on the health of their discipline.

It was the final chapter of this volume that caught my attention first, for it seemed that *Clarke's* survey of the 'Status of Granite Science' was a good place to begin this specialist volume. I was hoping for some answers to rather general questions about the achievements and future directions of 'Granite Science'. In response to my enquiry about the current status of granite research I found a carefully honed summary of the 'granite paradigm', although I felt that the discussion on the future of granite research lacked focus. My disappointment was short-lived, however, for this volume contains a number of major review papers which point the way forward for granite geology with great insight.

If a dominant theme can be identified in this collection of papers it is the physics and chemistry of granite melts, with a particular focus on the processes operating in the source regions of granitoid magmas. Three other themes are also significant. These are the mechanisms of granite segregation and ascent, the association between granites and mineral deposits and the relationship between granites and crustal evolution.

Constraining the Source of Granite Magmas

The extent to which granites 'image' their source regions has been the subject of continuing debate amongst granite petrologists over the past two decades. The debate centres on the granite 'source rock model' in which it is argued that granite magmas are probes of the deep crust. Critical to this viewpoint is the extent to which granites are modified during their extraction from the source and ascent to the surface. This subject is debated by *Chappell* and *Collins* for granites from the famous Lachlan Fold Belt in south-eastern Australia. These granites are thought to be divisible into two major groups (the well known S and I-type granites) on the basis of their chemistry. Chappell argues that the observed trace element variations are not modified by fractional crystallisation and that the observed rock chemistry can be related to the unseen source region. In contrast Collins argues that whilst an apparent division between types of source region is evident in the major element chemistry, isotopic studies suggest a continuum of compositions. He presents new Nd and Sr isotopic evidence to show that the Lachlan Fold belt granites derived from three source regions. Similarly, *Krogstad and Walker* show that the Proterozoic Harney Peak Granite in South Dakota, was derived from multiple sources, comprising mixtures