the continuation of Cadomian orogenic events into Cambrian times, and of the post-orogenic plutonism into the Ordovician. Thus some of the post-orogenic intrusives are as young as 480 Ma and are cut by even later, mafic dykes. These findings imply that the tendency of grouping Cadomian and Avalonian events should be reappraised. Another point arising from these radiometric dates is that the at present accepted isotopic and stratigraphic time-scales should be re-examined.

Geologically, the book lays much emphasis on igneous intrusions, although how these are related to the plate tectonic evolution of the Armorican massif is still debated. Some authors in the book propose that the Armorican continental crust originated by progressive Cadomian cratonization, while others (the editors in the Preface) maintain that subduction-related tectono-magmatic activity in the region was analogous to the present-day Andean belt and did not involve continent–continent collision. Considering that in numerous papers in the volume various authors indicate Cadomian back-arcs and arcs, it is clear that the Andean analogy is as yet premature.

The addition of sundry articles dealing with Canadian and European, essentially Avalonian, terranes is useful, but limited by somewhat unsystematic choice. Thus there are four papers on Canadian topics, but only one on the well-investigated Midlands block of England, and while southwestern Iberia has been discussed there is nothing on northwestern Iberia. This indicates that the book is, as already mentioned, a progress report—useful, locally informative, well illustrated and generally well-written, but suffering from the lack of regional balance. All the specialists in late Proterozoic geology and aspects of structure should have it on their shelves; I cannot, however, recommend it too strongly to a general reader who would not find even a comprehensive detailed map of the areas examined.

Nicholas Rast

Lexington, Kentucky, U.S.A.

Structural puzzles in the Columbia province

Reidel, S. P. and Hooper, P. R. (editors) 1990. *Volcanism and Tectonism in the Columbia River Flood-basalt Province.* Geological Society of America Special Paper 239. Geological Society of America, Boulder, Colorado, U.S.A. Price $52.50.

Continental flood-basalt provinces pique the interest of a wide range of geoscientists, lately including those trying to explain major extinctions. The Columbia River province in the Pacific Northwest of the U.S. has been intensely investigated during the past two decades for other reasons: it was being evaluated as both a site for potential nuclear power plants, and as a repository for high-level nuclear wastes. This well-produced and extensively illustrated volume presents some of the results of this research, much of which is buried in technical reports published by various contractors and government agencies. About 75% of the papers deal with the stratigraphy, established largely on the basis of chemical composition, petrologic variation and magnetic reversals, of the up to 4 km-thick sequence of Miocene basalt. The remainder address the structures, structural history and tectonic setting of the province.

Let me quickly sketch some of the features of the Columbia River province. Imagine a roughly circular area upwards of 150,000 km^2, underlain by as much as 175,000 km^3 of basalt that was erupted in areally extensive flows, chiefly between 17 and 15 Ma. The northern third of the province approximates the proverbial featureless plain as far as structures are concerned and is commonly termed the Columbia Plateau. The southeast quadrant is cut by an impressive system of high-angle normal faults belonging to the late Cenozoic extensional Basin and Range province. But the most tantalizing structures constitute the Yakima fold belt in the western third of the area underlain by the Columbia River Basalt Group. Narrow anticlines, standing about 600 km above intervening broad, nearly flat synclines, have a mean spacing of about 20 km and radiate westward from the western edge of the undeformed Columbia Plateau. Some of these anticlinal ridges are 100 km long. Geometry and vergence typically change along the crest of an individual fold, which may be segmented and locally asymmetric or box-shaped. Reverse faults cut one or both flanks. Some workers have pointed out the similarity of these folds to 'wrinkle ridges' on lunar maria and other planetary surfaces.

Why would a general reader of this journal (excepting those for whom continental flood-basalts are a fetish) want to look through or read the six or so papers on the structure of the province? I can recommend them to those of you who are either unfamiliar with the Columbia province, or who like structural puzzles. In spite of the general agreement on matters of geometry and disposition, the origin of these folds is still debated. Why are they localized in the western third? What accounts for their apparently periodic spacing and variable geometry? Are they localized over structures in the basement or do we need more geophysical data to tell? Do they lie above a regional décollement, or are they genetically related to local, spaced faults? What is the role of regional lineaments or transecting structures? The papers in this book will arm you with enough information to begin your own analysis or speculation. Even better, let your students tackle the Yakima fold belt, if you would like to provide them with a neat structural problem in a well-controlled setting. Start by perusing the bedsheet-sized structure map of the province (in the pocket) which portrays faults and the hinges of folds. Then, read Hooper and Conrey, who provide a useful overview of the tectonic setting and large-scale strain. Reidel and others comprehensively review the geometry of the folds and the evidence that they were developing during eruption of the flood basalts. Price and Watkinson analyse the Umtanum fold and its associated thrusts, provide a glimpse of outcrop-scale cataclasis, and present balanced sections. Campbell confronts the sketchy evidence for the geology beneath the flood-basalts and how it might have influenced the structures within them. Watters presents an interesting mechanical model describing the basalts as an elastic multilayer in which early buckling at a dominant wavelength was followed by localized plastic yielding and reverse faulting.

I am not convinced that these papers and the map accompanying the volume definitively answer all of the questions I raised in the paragraph above, but they do provide an excellent overview and lots of food for thought. At the least, they offer a palatable and easily digestible introduction to a part of my local backyard that deserves close scrutiny by a wider group of structural geologists.

Darrel S. Cowan

Seattle, U.S.A.

Micrographs and metamorphism

Augustithis, S. S. 1990. *Atlas of Metamorphic-metasomatic Textures and Processes.* Elsevier, New York. Price $177.25.

This is the second atlas of metamorphic textures produced by the author, and, in common with the first atlas (on transformed and deformed metamorphic rocks), the general purpose and content of this book is obscure. The book contains 85 pages of text followed by 370 black and white micrographs, accompanied by brief captions. The micrographs are generally of good quality, although they are arranged in the order that they are mentioned in the text, with no division into sections, which makes it impossible to use this book as an atlas. The reason for including many of the micrographs is unclear, and may seem very repetitive (for example, 15 micrographs showing myrmekitic intergrowths, and 19 showing symplectites seems excessive).

The text is divided into 17 chapers, and much space is devoted to historical review. To give one example, in the section which aims to give a "historic review of the trend of thinking that emphasizes temperature in metamorphism" the most recent reference mentioned is dated 1889! Throughout the book there is almost no reference to any of the key works published in the last few decades. Considerable space is devoted to disputing statements published at the beginning of the century (Termier, 1903, "dynamic metamorphism deforms but does not transform" is a favourite) which have long been overtaken by subsequent knowledge. The author goes to great length to argue for the idea of polymetamorphism (presenting numerous micrographs of 'crystalloblasts' in support), apparently holding the view that most metamorphic petrologists still believe that every mineral in a metamorphic rock crystallized simultaneously. A statement by Drescher-Kaden (1982) that "for every blastic growth a geotectonic event proceeded" is taken as the most recent significant comment on the role of stress in metamorphism. The author's own work is highly quoted, along with papers from various Theophrastus publications.