

contrast, Carr (Chapter 13) proposes that normal faults are rather planar and need not to be underlain by a regional detachment. Scott's interpretation results in a classical picture of extensional systems as described in many areas of the Basin and Range. Carr's proposition invokes a more complex tectonic history. Planar normal faults formed within a pull-apart volcanic rift, that was the breakaway zone for detachment faulting to the west. Finally the two authors disagree on too many points to be reconciled. Chapter 7 is a kinematic analysis, using an original computer method, of more than 1000 strike-slip and dip-slip faults; it comes to the conclusion that two extensional events, first SE- and second WSW-directed, indicate a progressive clockwise rotation of the extension direction as it is commonly substantiated in the Basin and Range. The authors note the difficulties of presenting their numerous data graphically. Although this does not alter the scientific ground, most diagrams are rather non-aesthetic and illegible.

Chapters by Snow and White (Chapter 21), Stewart and Diamond (Chapter 22) and Marzolf (23) form the second most interesting part of the volume. Chapters 21 and 22 emphasize the relationships between sedimentation and extensional tectonics. Chapter 23 attempts to restore early Mesozoic basins, dismembered by Cenozoic extension. Chapter 21 is a well-exposed field example of sedimentation associated with normal listric faulting and rollover flexure, which can help to understand analogous structures generally observed on seismic profiles. Chapter 22 is a remarkable study of the evolution of a basin pattern and related faulting. Stewart and Diamond argue a two-stage evolution: the first stage involves a major, low-angle detachment responsible for the basin location. The second stage corresponds to high-angle, normal faulting which results in dismemberment of the basin. The authors finally suggest that this changing pattern of extensional tectonics may be related to variations from high to low strain rates through time. Chapter 23 proposes a reconstruction of regional sedimentation patterns (covering all areas concerned with the other chapters of the volume) during the early Mesozoic. This may greatly improve our understanding of basin development during both the Mesozoic and the Cenozoic.

As the volume is a special issue of the Cordilleran section meeting, articles concern mainly regional aspects. But some of them have more general implications. Geographical ordering of chapters is somewhat disappointing for the reader who is not aware of western North American geology and in particular of Nevada and California. Areas covered by most articles are rather small and their general setting is usually insufficiently informative. The reader needs a detailed road map to find his way around. An introductory map presenting the whole area with locations of each case study would have been welcome. As a consequence, the volume seems intended for American geologists and not outsiders involved with extensional tectonics. The Basin and Range province is known to be one of the most appropriate areas for studies of extension. Although the general lack of correlation between adjacent domains does not provide a comprehensive picture of the whole province, this volume provides an excellent insight of geological problems related to extensional tectonics. The average length of articles is more than 20 pages, including numerous illustrations. Out-of-text detailed geological maps and seismic profiles also highlight the considerable work done. The quality of printing is impeccable (only the one line drawing—Fig. 5 of Chapter 7—is inverted with regards to the corresponding photograph). If compilation of such detailed regional studies may appear, at first view, somewhat forbidding, it is a necessary step in progressing with investigations on extensional tectonics. The impressive number of geological data compared with the relatively low price (\$115) makes this volume a very suitable contribution for structural geologists interested in extension.

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The golden age of remote sensing

Beaumont, E. A. and Foster, N. H. (compilers). 1992. *Remote Sensing*. American Association of Petroleum Geologists Treatise of Petroleum Geology Reprint Series, No. 19. The American Association of Petroleum Geologists, Tulsa, Oklahoma, U.S.A. 607 pp. Price \$40 (hardcover); \$32 (softcover).

The relationship between remote sensing and petroleum geology has always been tenuous, lacking the obvious synergy that has led to a

much wider acceptance and appreciation of remote sensing in the minerals industry. Nonetheless, oil companies have been major users of satellite data (if not major publishers of applications or case histories) and it was with great interest that I read the latest volume *Remote Sensing* in the AAPG Petroleum Geology Reprint Series.

To some extent this volume marks a turning point in remote sensing. It looks back at the 'golden age' of remote sensing, describing the early attempts to make sense of a completely new set of data. We are now in the dawn of the next age of remote sensing. New satellites (LANDSAT 6, SPOT 4, ERS-1 and Fuyo-1) all provide us with an abundance of data: in particular satellite-borne radar will image parts of the world that may never have been imaged before. But the real revolution is coming with the ability to carry out desk-top processing and analysis of satellite imagery, moving imagery out of the specialist lab and onto the explorers' desks.

The next remote sensing compilation should be unrecognizable, containing computer applications, visualizations, etc., but moreover much more usage by the exploration geologists and less by the remote sensing expert.

Oil Company management are generally unconvinced about the applicability of remote sensing to oil exploration, often swayed by persuasive technologists. While nobody will question the vital role high quality, ground-registered satellite data plays in field work or surface mapping of any type—especially when used in conjunction with portable satellite navigation equipment—many data are under-interpreted, and used as shiny wallpaper or gifts to important officials!

The remote sensing literature is plagued by esoteric and arcane papers—my favourite is about measuring sheep density—and one arrives at the few excellent and relevant geological papers with a feeling of relief. This volume is a rich collection of such nuggets and contains many of my personal favourites. It is an unenviable task to compile a selection of papers; the editors have done a credible job, though straying on the side of conventionality.

The volume begins with a section on general methods. This includes several chapters from the essential textbooks by Floyd Sabin and James Campbell. These provide much of the necessary background and enable this volume to be used without much prior knowledge of remote sensing.

Sabin's chapter Resource Exploration, reprinted from his textbook, was a genuine landmark in remote sensing; the first clear exposition of the value of remote sensing. It contains all the elements of a good remote sensing study: superb imagery giving regional coverage, detailed understanding of the terrain and surface features, and the combination of application of physics with common sense and a little inspiration.

James Campbell provides some of the necessary nuts and bolts with discussions of image interpretation and details of the orbiting satellites. The latter, published in 1987, is an invaluable reference for those elusive facts about the satellite systems but could have done with an addendum to include the status of the latest satellites.

One paper that was new to me was Jim Taranik and Trautwein's 1977 discussion of integration of techniques. This is a timely reminder to those who are obsessed by technology of the need to make sure that the essentials are well understood. It is salutary to realize, despite the advances in technology, how little we have progressed in 15 years. This paper was one of those relatively unknown gems that this AAPG series tends to unearth from the more obscure publications.

Zeev Berger's analysis of low relief basins is a masterful analysis of subtle surface features as clues to sub-surface features. Rock's paper on geobotanical anomalies associated with petroleum seepage was a careful study that inspired many, though the promise was never really fulfilled, or used predictively.

The thermal imagery section I found the least satisfactory in the book, with only two papers on the subject, and strangely an excellent summary of general remote sensing by Goetz and Rock that seemed out of place in this section. The thermal band is a capability of LANDSAT that has been under-utilized, and geological applications of AVHRR have also not been fully exploited. The two excellent papers on thermal imagery include a typically clear exposition by Sabin dating from 1969, the oldest paper in the book. This is a fascinating topic that has never realized its potential.

The section on radar was particularly interesting with several operational examples. The papers included a variety of studies, mainly from oil companies, largely in tropical regions, that show the value of radar, and the great potential of the new generation of radar satellites to image both areas that are rarely seen through cloud, and sea surface effects. There were some tempting examples of SEASAT data from Koopmans and also Elachi. Wing and Macdonald have two papers showing the use of airborne radar in detecting subtle structures in dense central American jungle.

The highlights of this compilation, for me, were the various case studies in the final section. Bostrom showed the immense value of the SEASAT gravity data in understanding global tectonics, in his classic paper that sparked off much interest in global gravity. The Lang *et al.* (1987) paper on quantitative stratigraphic analysis in Wyoming is one of my personal favourites, and one of those brilliant but simple breakthrough ideas.

A few integration papers at the end of the book were in advance of their time but gave a hint of the developments that were to come. Soil gas anomalies in Nevada, careful correlation of "seepage features" with Landsat data and the general area of what the Russians call "geoindicators" were all included.

This collection marks an important milestone in the history of remote sensing. Early days were dominated by the fascination of wide-

scale synoptic views, with maybe an overpreponderance of unsubstantiated lineament mapping. Then came a 'scientific' phase with much careful measurements of spectral properties and some not overly successful attempts to use the methods predictively. Now we are in the 'integration' phase with remote sensing taking its place alongside all the other datasets available to us; not as a means in itself but an important part of the dataset, and one that should be as much at home on the petroleum explorer's desk as a well log or seismic line.

I strongly recommend this book to all who are interested in the development of remote sensing, and it makes essential reading for any student of the subject.

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