Journal of Structural Geology, Vol. 1, No. 4, 1979, pp. 341 to 343.
Pergamon Press Ltd. 1980. Printed in Great Britain.

BOOK REVIEWS

Progress report on the Arabian–Nubian Shield

Tahoun, S.A. (editor) 1979. *Evolution and Mineralization of the Arabian–Nubian Shield, Vol.* 2. (Institute of Applied Geology, King Abdulaziz University Bulletin No.3.). Pergamon, Oxford. 205 pp., 1 folded map, 114 figs. Price: hardcover US $30.00.

This, the second of four volumes of proceedings of the symposium held in Jeddah in 1978, continues the high standard of editing and production established by the first (see review in Volume 1, Number 3 of this Journal).

The papers are again assigned to groups, though this time there are five sections with the addition of one on metamorphic rocks. The sections are:

1. Structure and evolution (6 papers, 75 pages)
2. Metallogenesis (3 papers, 30 pages)
3. Plutonic rocks (4 papers, 46 pages)
4. Metamorphic rocks (3 papers, 26 pages)
5. Ophiolites (2 papers, 27 pages)

The first contribution in the section on *Structure and evolution* is 'Precambrian tectonics of North-East Africa' by Shackleton who contrasts the nature of the Precambrian crusts in the northern part of the area (Saudi Arabia, eastern Sudan, Egypt and northern Ethiopia) with that of the Mozambique belt to the south. The former area which contains abundant granites, arc-type volcanics and ophiolites, was metamorphosed to greenschist facies, whereas the latter area has few granite plutons, extensive outcrops of reworked Archaean basement and was metamorphosed to a high metamorphic grade. Shackleton envisages four sutures, picked out by ophiolites, possibly extending southwards into the Mozambique belt and thus crossing the supposed contact between the Greenschist Assemblages and the older Mozambique belt. The crust in the north developed by stacking of island arc complexes resulting from east dipping subduction zones and becomes younger towards the east, whereas in the Mozambique belt the eastward younging succession results from a series of collision orogenies.

In contrast with this interpretation, Mohr in 'Lithology and structure of the Precambrian rocks of Eritrea', a study based mainly on reconnaissance surveys and Landsat imagery, describes an ensialic setting with sediments and plutonics similar to those in Arabia but with a series of westwards-younging synformal belts and suture zones. He postulates that there was a Precambrian protocontinent along the site of the present Red Sea.

In three papers: Nawab on 'Geology of the Al-Amar-Idsar region of the Arabian Shield', Schmidt *et al.* on 'Late Proterozoic crustal history of the Arabian Shield, Southern Najd Province, Kingdom of Saudi Arabia' and Delfour on 'Upper Proterozoic Volcanic activity in the Northern Arabian Shield, Kingdom of Saudi Arabia' — a wealth of geochemical, petrographic and geochronological detail from widely separate areas is presented. The authors demonstrate the long continued (1000–500 Ma) development and cratonisation of the crust at a series of subduction zones, west dipping but migrating eastwards with time. The calc-alkaline volcanics, associated plutonics, and shallow water volcanogenic sediments are similar to later ones from other parts of the world. The episode culminated in a major phase of shallow, late- to post-tectonic, alkali granite activity.

The main structural paper in this section is by Moore & Al-Shanti on 'Structure and mineralization in the Najd Fault System, Saudi Arabia'. This is a major NW–SE fault system of late Proterozoic to early Phanerozoic age affecting a belt about 300 km wide and 1100 km long in Saudi Arabia, but if extended into Egypt and the Arabian Sea it may be more than 2000 km long. There has been about 240 km of left-lateral displacement and an unknown amount of vertical movement. The en échelon strike–slip faults and their stress distribution patterns are described, a particular feature of the faults being their end sections where they die out into a series of curved and braided secondary faults. It is these zones which have provided the loci for magma intrusion and the passage of hydrothermal fluids resulting in localised mineralized zones one of which is the Ad-Dawadarni area with its silver–lead–zinc sulphide deposits. The close similarity between the vein and fault pattern associated with the Najd system and those of the mineralized regions of Butte, Montana and Chuquicamata, Chile are pointed out.

In the *Metallogenesis* section Petrascheck on 'Cratonic ore provinces separated by continental drift' discusses the difficulties of correlation of ore provinces after their separation by plate movement. Sabir in 'Precambrian polymetallic sulphide deposits in Saudi Arabia and their metallogenetic significance' recognizes three distinct types based on occurrence, rock association, mineral assemblages and textures. These are: (1) lens-shaped massive sulphides (ZnS, FeS_2, PbS) in felsic pyroclastics; (2) pipe-like cupriferous stockworks with chloritised volcaniclastics; and (3) quartz veins rich in base metal sulphides and high in Au/Ag.

Worl in 'Ore controls at the Mahd Adh Dhahab gold mine, Kingdom of Saudi Arabia' shows that the Au/Ag, telluride and sulphide deposits in quartz vein stockworks in silicified pyroclastics were formed from mineralizing fluids which were of low temperature and salinity, that is they were mainly meteoric waters.

Again in the section on *Plutonic rocks* there is much geochemistry and some geochronology testifying to a long history of development of the crust, and the complexes described are of widely differing types. Marzouki & Fyfe in 'The Al-Hadah igneous complex; product of Pan-African subduction' describe a 600 Ma calc alkaline complex of plutonic rocks and associated dykes with chemistry and assemblages typical of those formed above a subduction zone under a continental crust. However, in the Shield there are associated ophiolites formed under different conditions and the authors postulate a small scale plate oscillation.

A quite different post-tectonic, 500 Ma, complex is described by Radain & Kerrich — 'Peralkaline granite in the western part of the Arabian Shield'. Much chemical data is presented and there seems to be no systematic variation in the major or minor elements in a group of rocks said to be generated by contamination of extremely differentiated granite magma derived by partial melting of the crust and late stage alkali metasomatism. This intrusive complex is regarded as the final episode in the Pan-African event.

Alkali granites are also the youngest rocks among the 'Shallow intrusive granites from Egypt and their relation to mineralization' described by El-Shatoury. This mainly fluid-inclusion study shows differences between the various granite types and in particular points to the high salinity of many post-magmatic fluids.

French & Sindi describe an area of 200 km^2 in the west of the Arabian Shield in 'The Petrology and Geochemistry of the Plutonic Intrusives of the Al-Jibub Area, Kingdom of Saudi Arabia.' The complex comprises layered gabbros cut by anorthosites which are themselves intruded by granite sheets and a related granite–adamellite–granodiorite complex.

Dodge *et al.* in the *Metamorphic Rocks*, 'Geochemistry and $^{87}Sr/^{86}Sr$ ratios of Halaban rocks of the Central Arabian Shield' give the ages of a sequence of metamorphosed basalt and rhyolite lavas as 775–760 Ma. Chemical trends are similar to modern calc-alkaline island arc rocks especially those of the Cascades in the western USA and the magmas are said to have originated by partial melting of oceanic crust at depths in excess of 60 km.

The most interesting result of the work by Abdel-Monem & Hurley — 'U–Pb dating of zircons from psammitic gneisses, Wadi Abu Rosheid–Wadi Sikait area, Egypt' is that the source region supplying the detritus for the psammites contained rocks 1770 Ma old. The regional metamorphism from a Rb–Sr whole rock isochron is 1300–1150 Ma and a period of supposed metasomatic activity dated by Rb–Sr and K–Ar methods gives 600±20 Ma.

Farhat in 'High grade metamorphic complex in the basement at Wadi Araba, Jordan' reports sillimanite–garnet–cordierite assemblages, and from Ca — partitioning between plagioclase and garnet suggests that the conditions of metamorphism were 730°C and 5.8 kb (equivalent to 16–18 km of burial).

In 'The Semail Ophiolite and associated massive sulphide deposits, Sultanate of Oman' Coleman *et al.* claim that the Semail ophiolite with a volume of 30,000 km^3 is the best exposed piece of ancient oceanic

crust. There is an almost complete sequence of rocks, from mélanges, deep water cherts and shallow water limestones to the igneous rocks ranging from serpentinised peridotites, through layered and massive gabbros, and sheeted dykes, to pillow lavas and inter-pillow hyaloclasites. Low grade thermal metamorphism due to hot circulating solutions has resulted in zeolite and greenschist facies rocks and these same fluids have leached out copper from the lavas and dykes and deposited massive Cu sulphides in the pillow lavas. The tectonically repeated complex, which formed at a spreading centre in the Tethyan Sea, is allochthonous, having been driven southwards.

The final paper in the volume 'Chromites from the Al'Ays complex, Saudi Arabia, and the Semail Complex, Oman' by Neary & Brown describes the field occurrence and chemistry of chromites from two almost complete ophiolite sequences. Different trends are recognised, and the origin of the lenses are ascribed to crystallization in mini magma chambers (0.5–1 km) within the main intrusion.

This reviewer would again voice the hope that a good index be provided for the completed four volumes and, as a bonus, would like an authoritative summary of the consensus on the present thinking on the evolution of this part of the crust.

R. Bradshaw

Perimediterranean Tectonics

Lemoine, M. (editor) 1978. *Geological Atlas of Alpine Europe and Adjoining Alpine Areas.* Elsevier, Amsterdam. 584 pp. Price: hardcover US $170.75.

This large, heavy and handsome book costs US $170.75 (about £76 at January 1980 rates) and thus seems destined solely for the outsize shelves of some libraries: few individual geologists could afford it. It appears to be a new type of geology book, being a collection of previously published maps, sections and stratigraphic columns arranged in fourteen chapters each introduced by a brief explanatory text. Excluding the three introductory chapters the average ratio of pages of text to illustrations is 0.15.

Marcel Lemoine, the editor who is also author or coauthor of five chapters, appointed fifteen other geologists, mainly from France, to compile the remaining chapters. When judging the book it is important to understand the editor's thinking. Lemoine states in his preface: "It has been our objective, above all, in this book to achieve two main objectives: (1) to fulfil a need, namely that of providing *information by means of images*, and (2) to remedy the problem of the *wide dispersion of this information*": and " . . . we have limited ourselves to what appeared to be the essentials, the basis of every geological image of a continent, namely its structure and its structural evolution". Thus Lemoine justifies the selection of illustrations which present 'facts' rather than theories. All figure captions are in English and set out in a uniform style. A few figures were specially drawn or redrawn for the book; they are of noticeably better quality than some which have been reproduced with little or no change from the originals.

The geographical scope within Europe is from the west of the Iberian Peninsula to the Caucasus, but the book also embraces the Maghrebides of North Africa and the Alpine chains of Asiatic Turkey. The nappes of the Maghrebides, but not the Atlas ranges of the African block, are included because they link the Betides of Spain with the Calabrian–Sicilian arc. The Pontides and Taurides of Anatolia are included because it is argued that they are the direct continuations of the Alpine–Carpathian and Dinaride–Hellenide belts respectively. Wisely, the editor has also included accounts of Cenozoic structures within the Iberian Meseta, the Corso-Sardinian block, and the Moesic platform. These units which remained relatively stable during the Alpine orogeny are wholly or partially enclosed by Alpine chains, and their Cenozoic tectonic evolution is intimately associated with those chains.

The book commences with fifteen preliminary pages containing among several items two coloured maps at 1:22,000,000 showing the relief and structure of Europe, and a preface in which Lemoine explains the thinking behind the project.

The first chapter by Ellenberger & Lemoine is a perceptive account of the history of European tectonic thought and the influence upon it of political and philosophical ideas. Lemoine is the sole author of Chapter 2, a concise and well-constructed synthesis of the principal components of the Perimediterranean Alpine chains and their relationships to external and internal stable blocks. We are reminded about the original notions of intracrustal subduction as envisaged by Alpine geologists such as Ampferer in 1916, and Amstutz and Kraus in the 1950s. Despite its merits the chapter has a somewhat old-fashioned flavour; there are no references later than 1975, even *Mesozoic–Cenozoic Orogenic Belts* (Geological Society of London: Special Publication No.4) which appeared in 1974 is not cited in this chapter, or in any of the succeeding regional chapters. The content of the explanatory text accompanying Chapter 3 on the Mediterranean Sea is disappointing, and the bibliographic details of some papers which are cited in both this chapter and Chapter 2 are given differently in the two reference lists, a careless slip considering the editor is the author of both chapters.

Rather than catalogue the relative merits of all eleven regional chapters I have selected for comment only a few, and hope that they are representative. Manuel Julivert ably summarises and illustrates in Chapter 4 aspects of Cenozoic tectonics in the 'stable' block of the Iberian Meseta — a province whose 'Alpine' structures are generally neglected because they lie between the orogenic belts of the Pyrenees and Betides. By reproducing Riba, Puigdefabregas and Quirantes' previously unpublished maps and sections of the Ebro Basin the author of this chapter has probably introduced some geologists to one of the best preserved and exposed post-tectonic molasse basins. However, it should be noted that in the legend for the lower map of Fig. 4.8 the ornaments for the Oligocene and the Lower and Middle Miocene appear to have been transposed, if the convincing distribution of these rocks in the upper section of Fig. 4.10 is correct. An account by Durand-Delga & Lemoine of Alpine structures in the Pyrenees and Lower Provence follows in Chapter 5 and gives greater emphasis than is customary in articles on Pyrenean structures to the tectonics of lower Provence. This is a welcome departure probably reflecting the French outlook of the authors.

Although Chapter 8 is the second longest (68 pages) Lemoine was obliged to be especially selective considering the quantity of available material on the Jura and Alps. It must have been a challenge to write yet another brief synopsis of the tectonics of a region which has been so thoroughly investigated and summarised. Literature published after 1973 is not referred to or used as a source of illustrations.

The explanatory text and selection of illustrations compiled by Bergougnan, Brunn, Fourquin, de Graciansky, Gutnic, Marcoux, Monod, & Poisson for their account of the Alpine chains of Anatolia and Cyprus is a feeble outcome for an enterprise undertaken by so many experts. Apart from reproducing Pavoni's (1961) highly speculative map of units displaced by the North Anatolian fault they do not discuss or illustrate the mosaic of semirigid microplates which make up this western extension of Asia. An even more striking omission is a map of Anatolian–Aegean seismicity. Figures 2.12–2.14 in Chapter 2, which show the seismicity of the entire Mediterranean region, only partly offset this deficiency; their small scale does not allow the reader to appreciate the detailed pattern of seismic zones now recognized in the northeastern Mediterranean area.

In summary: the strength of the *Geological Atlas of Alpine Europe* is that for the teacher of tectonics or researcher about to start work in the region it provides a catholic set of references and illustrations within a single, if somewhat unwieldy, book. Its principal weakness, apart from that arising from the uneven quality of different chapters, is that even when originally published it was significantly out-of-date. For an investment of $170.75 most potential purchasers would wish for a product likely to remain a definitive work for a reasonably long period of time.

P. L. Hancock

Metamorphic Rocks of Asia

Sobolev, V. S. (General Coordinator) 1978. *Metamorphic Map of Asia* (at 1:5,000,000). Moscow. Distributed by Pergamon Press, Oxford. Price for 9 sheets: $118.00.

The map, on a scale of 1:5,000,000, and printed on nine sheets including one sheet of titles and one of legend, was compiled at the Institute of Geology and Geophysics of the Siberian Branch of the USSR Academy of Sciences on the instructions of the Subcommission for Cartography of Metamorphic Belts of the World under the Presidency of Professor H.J. Zwart.

As with the previously published map of Europe the various metamorphic facies and their subdivisions are printed in colour and the age of the metamorphism is indicated by symbols. A comparison of the legends of the two maps shows that the one under review is much less detailed, perhaps not surprising in view of the huge area covered, and that there is no uniformity of ornament.

Much of the exposed rock in Asia is of sedimentary or igneous origin, commonly of great thickness, yet this map shows not only the types of metamorphism actually seen but also the types to be expected,