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BOOK REVIEWS

Progress report on the Arabian–Nubian Shield

Al.-Shanti, A. M. S. (editor) 1980. *Evolution and Mineralization of the Arabian–Nubian Shield, Vol.* 3. (Institute of Applied Geology, King Abdulaziz University Bulletin No. 3). Pergamon, Oxford. 164 pp., 1 folded map, 89 figs. Price: hardcover: US $34.0.

Cooray, P. G. & Tahoun, S. A. (editors) 1980. *Evolution and Mineralization of the Arabian–Nubian Shield, Vol.* 4. (Institute of Applied Geology, King Abdulaziz University Bulletin No. 3). Pergamon, Oxford. 168 pp., 5 folded maps, 71 figs. Price: hardcover: US $34.0.

With these two volumes the publication of the proceedings of the 1978 Jeddah symposium is now complete (for reviews of Volumes 1 and 2 see this journal, Vol. 1, Nos 3 and 4).

The two volumes considered in this review contain twenty-seven papers on a range of topics similar to those in the two previously published volumes. Topics discussed range from tectonic syntheses and models covering half the Arabian Shield to X-ray studies of radioactive minerals in a single pegmatite.

Of most general interest are those contributions which provide the reader with a good review of the literature and a succinct account of work in progress, while at the same time proposing models which attempt to explain the development of all, or parts of, the shield. Approximately one third of the papers fall into this category while a further third present an abundance of geochemical, petrographic and structural data from more restricted areas but on which, ultimately, the final synthesis depends. Of particular importance in this regard are detailed maps compiled from field maps originally on a scale of 1:100,000 or greater.

One of the main reasons for this flood of work on the shield was the need to evaluate deposits of economic importance and hence the remaining third of the contributions is concerned firstly with the mineralization of selected areas, and secondly with the mechanisms of mineralization and their tectonic and igneous settings which can be used as a basis for planning further investigations of mineral resources.

This review is concerned primarily with the first category of contributions, that is those which present the reader with tectonomagmatic models of wide applicability. Fleck *et al.* (Vol. 3) give a well illustrated account of the age and evolution of the southern part of the Saudi Arabian Shield south of latitude 22°N, that is south of about the latitude of Jeddah. Their Rb/Sr dates, which they relate to previous geochemical and petrological investigations, show that continental lithosphere developed over a period from 900–680 Ma in an intra-oceanic island-arc environment with the production of andesites and rapidly deposited volcaniclastic sediments containing no 'sialic' detritus. Related plutonics, ranging from early diorites and trondhjemites in the west to later quartz diorites and granodiorites in the east, were probably derived by partial melting of oceanic lithosphere or upper mantle. This complex Hijaz tectonic cycle was located at a margin where two oceanic plates converged and gave rise to a subduction zone inclined to the east. The axis of magmatic and tectonic activity migrated eastwards or northeastwards with time.

A second major episode, the Pan-African event *sensu stricto* dated between 650 and possibly 520 Ma, was the suturing of Arabia to the African plate during a collision event. Associated granodioritic to granitic plutonism occurred widely throughout the shield and no pattern of migration of igneous activity can be discerned.

Fleck and his colleagues detect some similarity between these plate margin processes and intra-plate tectonics, for example, the N–S folds and the NW–SE Najd Fault System, and later events in the Himalayan collision-zone system.

Nasseef & Gass (Vol. 4) give support to this idea of progressive cratonization on east dipping subduction zones based on their geochemical studies of 1000 Ma granites in a 700 km WSW to ENE traverse from Jeddah to the edge of the shield. Only 39 samples were studied, and there are large gaps where granites of appropriate age are not exposed, but a number of factors including $K_2O : K_2O + Na_2O$ ratios suggest that there were four east dipping Proterozoic subduction zones simultaneously active at about 1000 Ma.

The prolonged (960–520 Ma) subduction history marginal to the African continent, which resulted in the formation of new crust rather than reworking of old crust, is confirmed by Brown (Vol. 4) in a study of calc-alkaline magma genesis which is spread over three distinct magmatic cycles. He sees certain, but not too closely defined, similarities between the Pan-African processes and circum-Pacific Cordilleran suites, particularly those in back-arc marginal basins in the SW Pacific.

Stoeser & Elliott (Vol. 4) are concerned with the extensive post-orogenic, that is post island-arc granites dated between 670 and 550 Ma. The earlier bodies are sub-solvus calc-alkaline monzogranites which increase in abundance to the northeast across the shield, whereas the later bodies are commonly peralkaline hypersolvus granites located principally in the east and northeast of the shield. Although there are numerous mineral occurrences (e.g. scheelite, wolframite and molybdenite) and significant geochemical anomalies no deposit of economic significance has been recorded.

A quite different approach to the evolution of the shield is that of Hadley & Schmidt (Vol. 4) who show in a detailed study that the Proterozoic sedimentary history divides into three phases. Rock types, clastic components, textures, thicknesses and distribution point to changing environments of deposition, in N–S trending basins — these environments range from ocean floor basins containing flysch-type sediments to shallow-water marine, with molasse and carbonates, to shallow-water continental/marine. The earliest phase contains only volcanic components, the middle phase shows a volcanic/plutonic provenance and the last phase, deposited in shallow basins, was supplied from rocks of the earlier phases. General trends show increasing textural and compositional maturity, carbonate content, ratio of sediments to volcanics, and detritus containing plutonic K feldspars. A major departure from previous models is that the subduction zones are interpreted as having been inclined to the west.

These regional studies are complemented by a compilation of radiometric ages from the Egyptian part of the shield (Hashad, Vol. 3) and by a tentative correlation of the Saudi Arabian, Sudan and Egyptian shields by Basahel (Vol. 4).

The basis for these regional syntheses is detailed work both in the field and the laboratory. Good examples are given by Akaad & Noweir (Vol. 4) for an area in eastern Egypt and particularly by Skiba (Vol. 3) for an area of 36,000 km^2 around Jeddah. The latter paper discusses only the form and evolution of the late-Precambrian (Hijaz tectonic cycle) plutonic masses but again it is shown that there is a complex two-phase history of plutonism, with several minor stages each possessing its own characteristic tectonic style, mode of emplacement and geochemistry, with separate differentiation trends being recognised in each of the two major phases. In spite of a wealth of chemical data Skiba finds it impossible to be certain of the derivation of the acid magmas — they may have been derived from sialic crust or from the top of the mantle.

The presence of linear belts of ultramafic and basic intrusions with probable ophiolitic affinities plays an important part in many models of shield evolution. Two contributions in Vol. 4 by Al-Rehaili & Warden and Nasseef *et al.* describe such bodies from Saudi Arabia and Egypt respectively. The latter identification is based solely on field and petrographic data with no chemical analyses available, but there does seem to be good evidence for E–W trending ophiolite belts in eastern Egypt adding support to the multiple subduction zone models being suggested for the shield in general.

Other papers in the two volumes present much data on more local occurrences of gneisses, ignimbrites and granites, on mineralization and on palaeomagnetism.

Although the discussions at the symposium are not reported (apart from a few brief comments in Vol. 1) it would seem from the papers presented that some consensus has been arrived at which suggests that before 1100 Ma there was no continental crust in the region and that over an extended Pan-African event of 500 million years duration there was progressive cratonization of material which was being added to the crust from activity at a series of island arcs which are progressively younger eastwards. There is still a difference of opinion about the nature and inclination of the subduction zones.

This Pan-African (*sensu lato*) event had a complex history, with a