

presenting and publishing such unorthodox views which deserve notice. Controversy, even if generated by ideas which are generally held to be incorrect, may lead to a worthwhile reappraisal of the observations. It is hoped that contributions will be made to the discussion publication since Davies has left quite a number of questions unanswered in his paper. I look forward to reading the discussion document.

D. E. Roberts

Using Explosions

Al-Sadi, H. N. 1979. *Seismic Exploration*. Birkhauser, Basel. 220 pp. Price: hard-cover sFr49, DM54, US \$29.50.

Seismic techniques, in particular seismic reflection, have long been the major geophysical methods employed for subsurface structural exploration in the petroleum industry. In recent years the reflection method has become increasingly important in academic studies as new techniques, such as those used by COCORP in the United States, are employed to provide information on the structure of the lower continental crust, hitherto a complete unknown, with many surprising and interesting results.

H. N. Al-Sadi's book is a relatively short (220 pages) and comprehensive account of the techniques used in modern seismology, concentrating on the manipulation and processing of seismic waveforms. The first two chapters deal with the general theory of wave propagation and elastic waves, and are followed by two chapters on the mathematical analysis of waveforms and their manipulation in both time and frequency domains. The techniques of reflection and refraction surveying are then covered and the book concludes with a discussion of digital processing of seismic reflection data.

The coverage is soundly based in mathematics and all techniques are fully presented. Consequently this is not a book for casual reference since full knowledge of preceding chapters is necessary for the understanding of any specific points in later chapters. The book serves as an excellent text for advanced undergraduate and postgraduate students of geophysics. It is, however, a shame that the author does not provide more examples of the use of the techniques he so ably describes.

P. Kearey

Ethiopian-Somalian Geology

Merla, G. et al. 1979. *A Geological Map of Ethiopia and Somalia* (1973) at 1:2 000 000. (plus an explanatory text including 22 black and white illustrations and 37 colour illustrations and a 1:3 000 000 map of major landforms) Consiglio Nazionale delle Ricerche, Italy. Distributed by Pergamon Press, Oxford. 117 pp. Price: US \$60.00, £27.50.

Thirteen and more years ago, the Ethiopian region was a blank on the map to English-speaking geologists, judging from the blank in their literature. The British were occupied in Kenya, notably its classic sector of the African Rift Valley. Americans came lately to Arabia, to the Precambrian basement of southwest Arabia in particular. But the intervening region remained uninvestigated, perhaps because there were no cultural links with British or U.S. universities or geological survey departments. (I except some valiant researches in ex-British Somaliland).

All that has changed utterly. Plate tectonics beckoned two large French-Italian and German enterprises to Afar at the end of the 1960s, and a new-born and terrible beauty was revealed in all its volcanic and tectonic starkness. Articles on Ethiopian-Somalian geology now frequently appear in English-language journals, and several new 1:250 000 and 1:500 000 maps of Afar geology help focus our attention on this active 'triple junction'. Farther south, across the Horn of Africa, petroleum prospects have attracted U.S. oil companies to make deep-crustal surveys of the hugely subsided coastal zone of southern Somalia.

And yet, another and much neglected tide of learning is flowing since the beginning of the century. Meticulous and adventurous researches stemming from Italian university geology departments have been published and argued over down the decades—in Italian journals. This prolific work led, in 1933, to Giuseppe Stefanini's publication of a 1:2 million geological map of the Ethiopia-Somalia region, accompanied by 195 pages of commentary. As a pioneering and now classic work, it was superseded during the travails of World War II (in 1943) by Giotto Dainelli's monumental *Geologia dell'Africa Orientale*, a work of three

volumes (1843 pages) and one volume of maps crowned with a revised 1:2 million geological map. Whatever criticisms might be levelled against Dainelli's work, in particular wearisome duplication of factual detail, it has certainly never received just recognition from the scientific community. Its wartime appearance, and the growth of a monoglot, English literature, effectively muffled it.

Apposite to a century of largely ignored geological research in Ethiopia and Somalia, is the following passage from the work under review (p. 10): "The Italian reader cannot help feeling shocked by the manner in which Italian papers are quoted by foreign authors. An exceedingly faulty orthography, misquotations, erroneous information, and more often sheer neglect are common . . . The importance and priority of Italian contributions to Ethiopian and Somali geology being a well-known fact, a little effort and use of dictionary could be expected". Could be expected? Alas, the English language is a ruthless and disdainful supremacist. This is tacitly acknowledged by Professor Giovanni Merla, a student of Stefanini, in this 'third edition' of the 1:2 million geological map, and accompanying 95-page commentary. The language employed is no longer Italian but English.

The University of Florence team led by Merla had the new map completed and printed in 1973, six years before the commentary with which it is now united. The map shows nearly three times as many lithological subdivisions as did its 1933 and 1943 predecessors, though compared with Dainelli's map, the colourings are of darker shade so that clarity is lost. The text, drastically curtailed by comparison with Dainelli's memoir, is written in very readable English with occasional and charming Italian grammatical style.

Ten chapters commence with an 'Introduction' and 'Summary of the Geological History', both by Merla himself. The first comprises a terse account of previous geological maps and, such is the pace of modern Ethiopian research, there is a necessary section devoted to corrigenda to the 1973 map. The second chapter essentially highlights Merla's abiding interest in processes of regional uplift, and platform and basin subsidence, rather than the neglect of other topics. Thus, the pre-Mesozoic evolution of the region is not mentioned here. The crustal nature of Afar is debated without reference to the crucial seismic profiling made by Berckhemer et al. (1975, in: *Afar Depression of Ethiopia*).

The Precambrian 'basement' is discussed in Chapter 3 (again by Merla) in terms of a two-fold classification into high and low-grade metamorphic rocks. But this lithological discussion is largely superseded by the work of V. Kazmin, both in journal articles and in a geological map of the Ethiopian Empire, published in 1973 by the Geological Survey of Ethiopia. Neither in Kazmin's nor Merla's work will the structural geologist find much of detailed interest, reflecting a wide-open field entered only by the pioneering mapping of the late Dr. W. H. Morton and students of Professor R. M. Shackleton. A brief appendix (by P. Canuti) on the ?Ordovician glacial sediments of northern Ethiopia unnecessarily duplicates a previous discussion (by Merla) in Chapter 1.

The Mesozoic and early Tertiary marine sedimentary sequence (Chapters 4 to 6) forms one of two topics central to this new work. Merla (Ethiopia) and A. Azzarolli and Canuti (Somalia) provide an excellent review of recent changes and present status of formation ascriptions. Also discussed are time-space facies variations that express transgression—regression cycles, superimposed in some areas with continuing basin evolution. Rather crude cross-sections illustrating this vital topic are scattered as Figs. 6 and 14. Complementary sections and isopachyte maps for the Somali region can be found in Barnes (1976—cited in Merla's bibliography).

'The Volcanites' is title to the longest chapter, 7. It relates to the boldest, most ambitious feature of the new map, a detailed subdivision (by E. Abbate & M. Sagri, based on the work of B. Zanettin et al.) of the Tertiary volcanic rocks of the plateaux. The result, which would greatly have interested Dainelli, is not altogether a happy one, although the authors frankly acknowledge the formidable problems they have faced. Despite the plethora of available radiometric ages, conveniently tabulated here in an appendix, correlation both across the Ethiopian rift valley and N-S across the Ethiopian plateau is so difficult that five independent provincial stratigraphies are set up. The corresponding five different sets of colours on the map add a prerequisite of decipherment to discernment.

Within each province, extrapolation of volcanic formations for hundreds of kilometres beyond studied type-areas, on the assumption of a sub-horizontal and continuous stratigraphy, makes no allowance for probable lenticular development of separate, low-angle basaltic shields about observed dike-swarm axes. One glance at the histograms of radiometric ages presented in Fig. 7 (p. 52) is sufficient to show that either the bulk of these ages, or else the adopted stratigraphic scheme, is seriously in error. Out of numerous instances I select only one, the

Simien volcanic shield centred at 14°N 43°E. Mapping there has failed to establish other than a continuous sequence of flood basalts; yet Merla's map is constructed to indicate a succession of three lithologically (and petrologically) distinct formations. The partial failure of Abbate and Sagri's visionary approach is a necessary if painful step forward to elucidating and representing the regional stratigraphy of the Ethiopian volcanics.

The final chapters deal with photointerpretation of southern Somali Plateau geology (8), geomorphology (9), and the equivalent of a single page on tectonics (10). This last offering, in the context of the Ethiopian rift system, is inexcusable. Those fault-lines which are marked on the map are shown in grossly schematic form: whilst this is an advance on Dainelli (who was in no position to even guess the fault pattern), surely a greater degree of accuracy could have been expected? A good, though not comprehensive, reference list is followed at the end of the booklet by thirty-six randomly selected and arranged, yet compellingly beautiful colour photographs of landforms. They are prefaced with a few monochrome plates reproduced from Merla & Minucci's 1938 monograph on the geology of Tigray, evoking a strong nostalgia in this reviewer.

I leave till last the fact, irrelevant to some, important to others, that the commentary is informed with a deep affection for its subject and for those who have built before us. There are tantalising vignettes of the great figures of the past, in particular of Giotto Dainelli and Vittorio Böttego. A strong bond with the land and its peoples is manifested, for example in spontaneous explanations of place-names: Emni Negarit = "drum stone", Garbeharre = "shoulders of earth (i.e. terraces)", Mai Hawariät = "water of the apostles". Dessiè = "my joy". Merla notes, a little despondently and one hundred percent correctly, that the change of medium from Italian to English is a move away from correct pronunciation of Ethiopian place-names. Perhaps this explains the mélange of English and Italian spellings of place-names in his text.

Professor Merla's self-admitted last testament, like that of Dainelli, is one of moving gratitude and simplicity. Whatever the shortcomings of this handsome 'third edition', and in spite of an unworthy financial stigma, a giant step forward is firmly based on the forgotten yet illustrious Italian foundations of Ethiopia-Somalia geological exploration.

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