

Chapter 1 is a general introduction and survey of the sources of data which form the bases of several theories on the formation and evolution of Earth's crust. Plate tectonics is, of course, the assumed foundation of all theories.

Chapter 2 deals with the origin of the Earth–Moon system, and covers the types of evidence and the various models. Homogeneous accretion models are favoured in a partisan manner. The author leans toward the giant impactor model for the origin of the Moon, selectively ignoring the same isotopic difficulties he cites as evidence against capture models.

Chapter 3, on the structure, composition and evolution of the mantle and core, deals with mantle heterogeneities, mantle convection and the causes of seismic discontinuities. It is soundly commented that progress in discovering the sizes, shapes and distribution of different mantle reservoirs will come through advances in seismic imaging (an opinion guaranteed to annoy some geochemists).

In Chapter 4 comes the 'nitty-gritty' of the book—the crust. The various types of crust are introduced and their geophysical properties quantified. There is an over-simplistic section on metamorphism. The composition of the crust and its subdivision into provinces are discussed. There is much here with which the opinionated reader may take umbrage.

Plate tectonics is introduced in Chapter 5, and its geomagnetic and seismic bases are examined. There are sections on the kinds of plate boundaries, relative plate motions and their consequences, and on sundry other topics. Expression is occasionally clumsy but the substance cannot be faulted, within the ambit of the theory.

Tectonic settings are carefully dealt with in Chapter 6, each setting being discussed according to its characteristic lithological associations, metamorphic style and mineral and energy deposits. All readers (and especially terrane accretionists) should heed the author's admonition to great caution in correlating ancient lithological associations with present-day tectonic settings. This chapter contains numerous diagrams, culled from Scholl *et al.* (*Geology* 8, 564–568, 1980), which I did not find instructive.

Chapter 7, on magma associations and mantle sources, covers the kinds of magmas produced in each of the major tectonic settings, and clearly demonstrates that the seed sown by Australian workers (over the past 15 years) has fallen mostly on stony ground. The sections of mafic rocks are competent summaries of current opinion. Granitoid rocks are dealt with perfunctorily, perpetuating the common but false impressions that 'S-type' granitoids are syncollisional muscovite leucogranites, and that 'I-types' are formed through fractional crystallization of mantle-derived mafic magmas. The intraplate associations of several different types of granitoid suites are virtually ignored.

Chapters 8 and 9 cover Phanerozoic orogenic systems and Precambrian crustal provinces, respectively. Differing styles of crustal evolution are soundly discussed, with reference to various case studies, within the established plate tectonic framework. In Chapter 8 the author resists the temptation to extend the North American terrane accretion model to all other continents. In many minds, this model remains 'suspect' and has completely failed to produce any advance in understanding the evolution of some regions (e.g. SE Australia). The problem may lie in the existence (and non-recognition) of fundamental differences in the palaeogeographic positions, of SE Australia and western North America, relative to the other continents. Models for the formation of the Archaean crust are reviewed in Chapter 9. The tectonic context of this ancient crust is assessed (the warning in Chapter 6 notwithstanding) and it is concluded that plate tectonics has operated since the early Archaean. In this chapter there is also an uncritical regurgitation of the largely discredited CO₂-flushing theory for the origin of granulite terranes.

In the final two chapters, the book turns again to discussion of Earth as an integrated system. Chapter 10 is on the origin and evolution of the crust and mantle. It takes up where Chapter 2 ends and actually deals with the origin, evolution, composition and growth rates of the continental crust, and the origin of plate tectonics. Here the author finally succumbs to accretionary temptation. On page 346 he states that "It would appear that collision of arcs and microcontinents is the most important mechanism by which continents have grown". This occurs in the same paragraph where the processes of over- and underplating are accorded brief mention as possible growth mechanisms. Would it be nit-picking to point out that no new crust is created in accretion—only redistributed? Perhaps we should distinguish between mere areal expansion of a chosen continent and true growth in total continental volume. This chapter also contains an interesting section on the comparative evolution of the known terrestrial planets. However, it does not really deal with what is probably the main reason for the unique development of a stable continental crust on Earth ("No

water, no granites—no oceans, no continents.": Campbell & Taylor, *Geophys. Res. Lett.* 10, 1061–1064, 1983).

Chapter 11 (exogenic Earth systems) deals with the atmosphere, hydrosphere and biosphere, and their interactions with each other, the crust and the mantle. The chemical evolution and structure of Earth's atmosphere and oceans are compared with the situations on Venus and Mars. Climate and sea-level changes are treated, and there is a section on the origin of life. Evolution and plate tectonics are discussed, stressing the effects of plate movements on the creation and destruction of ecological niches. The causes and immediate mechanisms of extinction are discussed; as causes, cometary impact is favoured and volcanism dismissed.

To summarize, this is a worthwhile compilation of current collective wisdom (and lack thereof). There is something here for everyone in the Earth sciences, and every institutional geological library should possess at least one reference copy. Many specialists will want a personal copy. As for the student market, I fear that undergraduates may not buy it, postgraduate students in the U.K. might purchase a copy if they feel wealthy, while their opposite numbers in the U.S.A. may be financially more able to cope with the expenditure. In any case, all should take a look at this book, to see where their bit of research might fit into (and perhaps alter) the global picture.

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Maps divide and rule

Maling, D. H. 1989. *Measurements From Maps—Principles and Methods of Cartometry*. Pergamon Press, Oxford. 577 pp. Price £45, \$80 (hardback); £20, \$36 (softback).

This book is concerned with cartometry—"the measurement and calculation of numerical values from maps". We all use maps at some time or other and as structural geologists are often interested in making measurements from them. From this point of view I approached the book, first turning to the cover. "Maps and Measurement" it says on the front, over a grey/white image of the eastern Mediterranean. On the back it is suggested that cartometry can be extended to satellite images, air photographs and photomicrographs; it all sounds wonderful. The definition of maritime boundaries as established by the UN Convention on the Law of the Sea, frankly, was not a big selling point with me, but this was offset somewhat by a further sentence implying the inclusion of stereological methods. Well I knew this was just the publishers sales pitch, better read the book and find out what it's all about.

On page 1 we find that the basic techniques of cartometry involve the measurement of distance, area and direction, together with the counting of objects on a map. Well I have used a ruler and can count to 10 on a good day, and direction measurement sounds particularly relevant to structural geology. Unfortunately, the latter is covered in little detail and mainly from the point of view of navigation and the Mercator projection.

Next, a little on maps themselves. "The scale of a map is its most important mathematical property"; profound as this may be I was tempted to add the word "discuss" to produce a typical high-school exam question in geography. Then it is on to measuring distance and area. Here we are told how to use a ruler and dividers, and that one can estimate the area of some feature on a map by cutting it out and weighing it. Given the price of maps today, and the level of recurrent grant to university departments, I would not recommend proposing this for first year practicals to your department head! Right at the end of the chapter on area measurement, there is a brief mention of image analysis; I remember the "Quantimet" and even when it was state of the art. By now I was realizing that modern (dare I say computerized) digital methods are not featured too highly in this book. But on we go, with chapters on measurement errors, statistical sampling and accuracy, which contain many interesting points, although little to stimulate the reader. I particularly liked the idea that "personal errors include mistakes . . . in manipulating the dividers"; in the right (or wrong) hands a pair of dividers could indeed be stimulating!

Now the title of Chapter 10, "Deformations of the Medium", is

more in my line. Map projections are interesting non-affine transformations and the chapter includes strain maps of the stretch of paper resulting from varying humidity. After this interlude, it is back to the length of the coastline, and a concise discussion of measurement applied to aerial photographs and satellite imagery.

The length of the coastline figures prominently in various parts of the book. I am sure it will come as no surprise to you to know that the measured length of a line increases as the length of the measuring step decreases (those dividers again). What you probably do not know, and I certainly did not, is just how much work has gone into investigating this phenomenon. Some of it is most ingenious, including that by a Russian lady Chernyaeva who did some interesting work with bent wires. Mandelbrot, fractals and self-similarity get a little over one page, sandwiched between more traditional investigations by workers in western Europe and Russia. I liked the conclusion that self-similarity has limited applicability to the natural landscape or maps—a clear warning to stay off that band-wagon!

There then follow interesting chapters on probabilistic methods of distance measurement and geometrical area measurement. These techniques have major application in modern scanning and digitizing devices, but almost nothing is made of these recent technologies. Instead it is back to planimeters (I had often wondered how they worked!) and area measurement by point-counting and line scanning.

In the section on point counting, crude electronic counters are described, but no mention yet of modern digitizers and computers.

At last we arrive at Chapter 21, "Cartometry and the Digital Computer". Digitizing on both vector and raster modes is discussed, together with limitations based on the errors and accuracy of digitizing devices. There is even an oblique reference to digital terrain models, together with a brief discussion of the use of Landsat MSS imagery, and the BBC Domesday project is cited as an example of a GIS (geographical information system). Hang on, there are two more chapters to go and things are beginning to hot up on the technology front. Alas, in Chapter 22 it is back to the Mercator projection and the final climax: those maritime boundaries and the UN Convention on the Law of the Sea, mentioned on the cover.

Clearly, in spite of my initial optimism, this book has little to offer the structural geologist. I enjoyed reading many parts of it and learnt many things about maps and, more particularly, the mechanical devices used to measure them. One gets the feeling that the author has a vast experience in map measurement, but the failure to include computer methods and many relevant aspects of stereology suggest that the book will have limited appeal, even to devoted students of cartometry, be they geographers or geodesists.

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