Fractals in Biology and Medicine, Volume II. G. A. Losa, D. Merlini, T. F. Nonnenmacher and E. R. Weibel (eds). Birkhäuser Verlag AG, PO Box 133, CH-4010, Basel, Switzerland. 369 pp. Price: DM 118/Fr 98.

Fractals were first introduced by Mandelbrot[1] while trying to find a solution to the seemingly simple problem of determining the length of the British coastline. He found that Euclidean concepts fail in these and other situations and that fractals were better suited for these purposes. Fractals typically (though not always) have a non-integer dimension and their fractal dimensions[2] are always greater than their topological dimensions. Further, fractals typically exhibit statistical self-similarity[2] over a range of length scales. Fractals can be used not only to describe objects but also to analyse time series data[3].

Fractals became very popular once their connection with chaos[4] was discovered in dissipative systems. It was found that attractors in chaotic dissipative systems are typically fractal in nature[4]. This led to many new methods of characterizing fractal dimensions[5]. Further, concepts like multifractals[5] became popular.

Fractals have now found applications in many areas of science and engineering other than chaotic dynamics[6–8]. Image compression techniques using fractals are quite common[6]. They have been used extensively in geophysics[9]. Recently, many applications have emerged in biology and medicine[10–14]. The book under review is an attempt to consolidate various new results in this exciting field of research. It contains papers presented at the Second International Symposium on Fractals in Biology and Medicine, held in Switzerland in 1996.

The first article in the book was presumably included to serve as an introduction to the field. It gives a brief overview of classical and stochastic dynamical systems from a mathematical viewpoint. Some remarks on applications of fractals in biology are thrown in (more as an afterthought). This article is too brief to be of much use to a reader new to the field. A more comprehensive introductory article would have made the book more self-contained. The rest of the articles can be classified into two broad types. Majority of them deal with the application of existing fractal techniques to classify and distinguish various types of cells. In particular, the use of fractal dimension to distinguish between malignant and benign cells is promising and could develop into an useful diagnostic tool to aid the pathologist. The other class of articles deals with application of dynamical systems and fractal theory to other biological subsystems. There is a sprinkling of articles on refinement of techniques, new fractal models, etc. There is even a highly speculative article proposing a binary theory of everything (taking a cue from string theorists) which claims to describe how complex structures of our Universe are generated!

I highlight below some of the interesting results from the first class of articles: In one article, using the spectral fractal dimension, the chromatin appearance (which is an important criterion used by pathologists in making a cancer diagnosis) is shown to be statistically self-affine. More importantly, the spectral fractal dimension is shown to differ significantly between benign and malignant cases leading to a correct diagnosis in 16 out of the 19 cases studied. In another paper, by measuring epithelial volume fraction of both fibrous mastopathy and mammarian cancer, significant differences are found using standard methods from dynamical systems theory. In a different article, fractal dimension using box counting method is shown to be effective in quantifying nuclear changes in MCF-7 human breast cancer cells when treated with steroid harmones. The same method is used in yet another article to analyse grey scale images of cells, but this time to distinguish between morphologically closely related malignant cells. Using local fractal dimension analysis, another paper characterizes tumour profile geometry quantitatively and further demonstrates that this approach gives a more accurate diagnosis as compared to human observers.

In the second class of articles, there is an interesting one which performs a dynamical analysis of the heart beat interval time series after cardiac transplantation. It is shown that the point correlation dimension drops to 1 after transplantation but increases with time to reach the normal value of around 5.4. A similar analysis is performed in a different article on the open and close time series of a large conductance Ca-activated K-channel. A non-integer point correlation dimension is obtained suggesting the presence of low-dimensional chaos. Another article demonstrates that arterial vasomotion patterns exhibit characteristics of nonlinear dynamical systems and show large-scale sensitivity to external perturbations. In another article, the fractal dimension is found to decrease immediately after a fracture (in sheep) and then increase to normal values as healing progresses.

To summarize, the book under review is an useful collection of articles on applications of fractals to biology and medicine. It, however, lacks a good introductory article which would have made the book more self-contained.

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11. Nonnenmacher, T. F., Losa, G. A. and Weibel, E. R. (eds), *Fractals in Biology and Medicine*, Birkhauser, Basel, 1994.
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13. Prusinkiewicz, P. and Hanan, J. S., *Lecture Notes in Biomathematics: Lindenmayer Systems, Fractals and Plants*, Springer-Verlag, New York, 1989.

14. Prusinkiewicz, P., Lindenmayer, A., Hanan, J. S., Fracchia, F. D., Fowler, D. R., de Boer, M. J. M. and Mercer, L., *The Algorithmic Beauty of Plants*, Springer-Verlag, New York, 1990.

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Atlas of Carbonate Microfacies from the Reservoirs of Bombay Offshore Basin, India. K. Satyanarayana, R. R. Sharma, D . K. Dasgupta and K. K. Das. Regional Geology Laboratory, Exploration Business Group, Oil & Natural Gas Corporation Ltd., Mumbai, India. 1999. ISBN 81-7525-086-0. Price: US $290.

Oil exploration and exploitation are a technology- and money-intensive game that demand thorough in-depth analysis of all available geological and geophysical information. The game becomes more intricate while exploring a carbonate reservoir rock because of its mercurial susceptibility to diagenetic changes. These changes make it difficult to read correctly the depositional environment so essential in oil exploration and exploitation. Sedimentary environment controls the size, shape, composition, internal organization, position in a basin and bounding lithologies – be it either a carbonate or terrigenous sand bodies. Further, since diagenetic changes in carbonate rock occur at different stages of its evolution, the timing of such changes is important with respect to its structural changes and hydrocarbon migration.

Microfacies analysis of carbonate rock is essential in order to fully comprehend the composition, internal organization, post-depositional changes and evolution of porosity. The present book under review highlights these intricate microfacies changes in carbonate rocks of Bombay Offshore Basin in response to shift in depositional environment. The Oil & Natural Gas Corporation Limited (ONGC) has done a commendable service to the scientific community in publishing this atlas which will certainly help students and researchers engaged in the study of carbonate rock. Notwithstanding the fact that such an atlas is not new in the book market[1–2], what is new, however, is that (i) all illustrations are drawn from Indian sources, and (ii) ONGC has for the first time endeavoured to publish data that so long remained confined in their files. The price is, however, prohibitively high for anybody to procure a personal copy.

The atlas documents various microfacies and resultant porosity variations in carbonate reservoir rocks of various producing horizons of Bombay offshore oil basin. The illustrations are excellent. The authors have presented microfacies illustrations separately for various hydrocarbon bearing structures, e.g. Bombay High field, Deep continental shelf, Panna field, Bassein field, Mukta block, Neelam field, Heera field and Ratnagiri block. Illustrations of each field are preceded by a brief description of the salient geological features of the field, accompanied by generalized stratigraphic column and a map showing locations of wells drilled into the structure. It would have been instructive for the students if various log responses and structure contour and isopach maps had been presented for each field.

While providing a brief geological history of the Bombay Offshore Basin, the authors describe the basin as formed due to extensional tectonics. It is difficult to explain reverse fault in a pericratonic extensional basin (see p. 2). There are no evidences of it in the accompanying illustrations. It is also not clear how some homoclines and periclines are incorporated as 'basement structural elements' in the map.

The authors have thoughtfully included glossary of terms used in microfacies description and analysis. However, terminologies are not exhaustive and descriptions of those that are presented are very brief, casual and some are not correct. The term 'micrite' (acronym of microcrystalline calcite ooze) does not refer only to lithified carbonate mud (1–4 μm), but is used also as a synonym for modern carbonate mud. Further, in the glossary of 'micrite' and 'sparite' it should have been clearly mentioned that while the former can form a rock by itself with or without any association of allochems, it does not in case of sparite that forms cement in the pore spaces of allochems only. Sparite (if not neomorphic) does not exist independently. Authors have entered separate glossary for 'sparite' and 'sparry calcite'. What is the difference between the two? Why not simply define 'sparite' as a mosaic of crystals larger than those in micrite, formed either as cement or as neomorphic spar[3].

Again, since pellets cannot always be established as of fecal origin, it is better and safer to use a non-genetic term 'pelloid'. Keeping this in view, pelmicrite/pelsparite should be defined as a limestone composed of pelloids (allochem) in a matrix of micrite or sparry cement respectively.

The definitions of 'oomicrosparite', 'pelmicrudite' and 'pelsparrudite' in the glossary are misleading. Oomicrosparite means ooids set in a groundmass of homogeneous neomorphic spars, characterized by crystal sizes varying between 4 and 10 microns; it is not as given in the glossary. 'Oosparmicrite' may be a transitional type between oosparite and oomicrite where micrite from oomicrite may have been partially washed out with the resultant void spaces filled-in by calcite spar. In such cases, one has to be sure that calcite spars are not products of neomorphism. Again, since the size of the allochems is considered in determining the grain size name[4], it is not clear how pelloids can belong to rudite class (>1 mm).

The definition of 'packstone' has been defined casually as 'a limestone containing lime mud and particle supported'. It would have been better to define it as 'a grain-supported allochemical rock with carbonate mud matrix in the interstices'. The definition of 'pellet lime mud' is misleading and not clear. How could lime mud be 'shaped into sand-sized pellets'?

A mold, as defined in the glossary, cannot be natural impression but a pore formed by complete or selective removal by solution of a former individual constituent (allochem).

Coming to the illustrations in the atlas, none of them are numbered which is essential for reference and discussion purposes.

In legends of many of the illustrations, the word 'sparitization' has been interchangeably used both for neomorphic spars (microspars and pseudospars) and void-filling cements (see top and