Oceanography from space

John R. Apel

Spaceborne Synthetic Aperture Radar for Oceanography. Edited by Robert C. Beal, Pat S. DeLeonibus and Isadore Katz. Pp.216. ISBN 0-8018-2668-3. (The Johns Hopkins University Press: 1981.) $29.25, £17.

THE US spacecraft Seasat, launched in June 1978, carried among its instrument complement a synthetic aperture imaging radar, SAR, operating at a radar wavelength of approximately 21 cm. During the satellite's short, three-month life, this instrument provided about 1.5 million km of imagery, mapped in a 100-km-wide swath at a resolution in excess of 40 m. The high resolution imagery represents a new and important vantage point for viewing phenomena occurring near the surface of the sea. This volume, stemming from a symposium held at The Johns Hopkins University Applied Physics Laboratory in the spring of 1980, presents the first broad, coherent publication of results and understanding of radar imagery of the ocean surface.

The SAR has provided images of the sea that often exhibit puzzling and varied features which must be interpreted in terms of changes in the small-scale roughness (near 30 cm length) of the surface. The original function of the Seasat SAR was to provide imagery of long-length surface gravity waves, from which one might derive a badly needed quantity, namely two-dimensional surface wave spectra, via Fourier transform techniques. The ocean surface as seen through the radar's eye has proved to be marvellously more complicated than anticipated, however, with such additional features as internal waves, current boundaries, eddies, wind stress variations, rainfall, oil slicks and shallow bottom topographic features appearing in the radar image. While surface waves with lengths greater than perhaps 100 m can often be seen in SAR images as periodic modulations, the functional relationship between the power spectral density obtained from the film and the surface wave psd is essentially unknown. Indeed, there is much discussion in the book of the basic hydrodynamic mechanisms that allow long waves to be imaged via variations in 30 cm wave energy. It follows that the theory of the imaging process for the ocean surface is in a relatively rudimentary state.

The book opens with generalized discussions of surface wave characteristics by Phillips and Kitaigorodskii, followed by a theoretical exposition on SAR imaging mechanisms by Harger and a review of the state of our understanding of oceanic winds by Pierson. A number of more detailed research results are presented next, classified according to winds, waves and circulation. These are punctuated by dramatic examples of SAR images, most of which are of regions off the US east coast (thereby revealing the geographical orientation of the contributors to the book). The clear emphasis of the research papers is on geophysics, not radar technology. Then follow reproductions of some 21 full-swath SAR images of the western North Atlantic, New England and the central Atlantic states, prepared by the symposium organizer Robert Beal; these illustrate the myriad of land and ocean features that characterize Seasat radar images.

This volume represents the first organized exposition of the oceanic results from SAR and, as such, should be available to anyone interested in this phase of the subject. Beyond this audience, however, there should be considerable interest on the part of oceanographers, marine meteorologists, and forward-looking civilian and military users of the sea. The results presented here are so unusual and compelling that the future will almost of necessity see additional imaging radars in space; however, a great deal of research work remains to be done before maximum use can be made of such instruments.

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Explosion in palaeobotany

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Paleobotany, Paleoecology, and Evolution. Edited by Karl J. Niklas. Vol.1, pp.297, ISBN 0-03-059136-8; Vol.2, pp.279, ISBN 0-03-056656-8. (Praeger: 1981.) Vol.1 $37.50, £31.25; Vol.2 $36, £27.

PALAEOBIOLOGY has, in its own jargon, undergone a recent evolutionary explosion. Twenty years ago the study of fossil plants consisted largely of investigating their structure, and where possible reconstructing the whole plant from its variously preserved fragments. In the past two decades, however, the science has linked up with a number of bordering disciplines to encompass the development, reproductive biology, biogeography, biochemistry and a range of other aspects of past plant life. These two volumes contain a collection of papers by workers in the United States, which illustrate this diversity of new approaches. They were presented at a symposium held in Cornell University to honour Professor Harlan P. Banks on his retirement. The theme is very fitting, since over some 35 years of research and lecturing Banks has contributed uniquely to giving fossil botany an image not only of a challenging and rigorous science, but of an exciting one for students to enter.

The volumes comprise 14 articles dealing with topics ranging from Pre-Cambrian microfossils (E. S. Barghoorn) and palaeoecology (A. H. Knoll), through Devonian plant structures (C. B. Beck) and Carboniferous swamp ecology (T. L. Phillips and W. A. DiMichele) to various aspects of gymnosperm (T. N. Taylor) and flowering plant evolution (G. Retallack and D. L. Dilcher; J. A. Wolfe and W. L. Crepet). Two chapters deal largely with extant plants in the context of their evolutionary history — T. Swain and G. Cooper-Driver with biochemical strategy of primitive land plants, and R. M. Schuster with liverwort evolution. Three deal with a broader perspective of evolutionary processes, B. H. Tiffney reviewing changing diversity through the history of land plants, T. J. M. Schopf the process of genomic change, and A. M. Ziegler and others the biogeography of plants through the Palaeozoic.

Evidence for the interaction of plants and past environments is a recurrent theme. The study of microfossils is still very young, and the prospect of unravelling their ecology, novel. But Knoll is able to demonstrate convincingly the correlation between environment of deposition and various aspects (species diversity, association) of Precambrian microfossils. The occurrence of this "horizontal" variation between different assemblages, in addition to the well-documented "vertical" changes, is important for two aspects of Precambrian work: if such microfossils are to be used in dating rocks, the environmental control of assemblages must be understood; equally, if we are to interpret this early phase of plant history, it is important not to confuse migration in response to environmental change with evolutionary innovation. A different aspect of palaeoecology is reviewed by Phillips and DiMichele in a quantitative review of the vegetation of the Carboniferous coal swamps, preserved in a three-dimensional state in coal balls of the American Mid-West. These give quantitative data on biomass, species diversity and succession. Remarkably few genera constitute the dominant plants in the assemblages, in contrast to present-day humid tropical forest. Little evidence of directional succession emerges, and abiotic factors (water level, salinity) were evidently