Finding Quasars

Proceedings of a Workshop on Optical Surveys for Quasars. (Tucson, AZ, Jan. 1988.) PATRICK S. OSMER, ALAIN C. PORTER, RICHARD F. GREEN, and CRAIG B. FOLTZ, Eds. Astronomical Society of the Pacific, San Francisco, 1988 (distributor, Brigham Young University Press, Provo, UT). xvi, 378 pp., illus. $32. Astronomical Society of the Pacific Conference Series, vol. 2.

Imagine a gaseous sphere with a diameter less than 1/10,000 that of our Milky Way galaxy. Then imagine packing this astronomically minuscule chunk of gas with luminous energy equal to the brightness of 100 to 1000 galaxies. Viewed from Earth across a distance so vast that its light has taken billions of years to reach us, this object called a quasar appears as a brilliant point in the center of an otherwise ordinary galaxy. Currently, many believe that the actual source of energy in a quasar is a monstrous black hole. For this reason alone, large numbers of astronomers have been studying quasars since their discovery nearly a quarter century ago. But of equal interest are the insights quasars suggest into the infancy of the universe.

Proceedings of a Workshop on Optical Surveys for Quasars is a collection of 46 reviews and poster presentations that demonstrates immense progress in one narrow but important area of quasar research, the production of large samples of quasars. Sponsored by the National Optical Astronomy Observatories, the workshop gathered participants from almost every group active in the field. The papers are highly technical, but the optical survey data are of wide astronomical interest. The compendium of 20 surveys alone makes this book a unique resource.

Some of the key questions to be answered by such large samples of quasars include:

1) When did quasars first form? The strategy is to establish the time when the numbers of quasars appear to increase rapidly. If found, that epoch may also be a clue to when the surrounding galaxies first formed.

2) What are the relative numbers of *intrinsically* brighter and fainter objects? Time evolution of these distributions directly reflects the statistical ensemble of quasar births, evolution in brightness, and perhaps final demise. Quasars may also show the effects of optical distortions (such as multiple imaging, brightening, or variability) due to the lensing or bending of light from the gravity of intervening objects, luminous or otherwise. Thus quasars provide a probe of the "dark matter" most astronomers believe to permeate space.

3) Are quasars clustered? If so, changes in any clustering with time may be used to track the competition between the pull of gravity and the expansion of the universe. We can take advantage of Einstein's theory of general relativity to relate the inferred matter density to the geometry of the universe. At distances beyond which gravity has had time to rearrange matter, clustering provides a fossilized imprint of the fluctuations in the universe during the first moments of the big bang.

4) What are the correlations among the observable properties of quasars? These properties include luminosity, spectral features, time scales of variability (related to the size of the quasar emitting region), the presence of neighboring quasars and galaxies, and distance. Such correlations constrain quasar models and cosmologies.

Only five years ago, sufficient data to address these questions were practically nonexistent. Three new technologies, however, have revolutionized the speed and accuracy of quasar searches: faster computers for automated data reduction and simulation of errors and selection biases, charge-coupled devices (CCDs) as detectors with near-perfect efficiencies, and multiple-object spectroscopy using optical fibers.

The most impressive evidence of recent progress is the survey by B. Boyle and his colleagues. They have detected, identified, and obtained distances to 420 quasars that are 100 times fainter than the largest previous survey of 114 quasars completed by M. Schmidt and R. Green in 1983. Contrary to the widespread belief that quasars were once much more plentiful in the early universe, these new faint surveys suggest that, on average, quasars were actually about the same in number but 100 times brighter.

Progress has also been made in surveys for quasars more distant than those studied by Boyle. Three teams led by S. Warren, C. Hazard, and M. Schmidt have broken the record for finding the most distant quasar several times in the last two years. (The previous record stood for nine years.) As the searches continue, the teams are finding dozens of quasars that do not break records but are very distant. Whether their data show an increase of quasars with time, and thus detection of the epoch of quasar creation, remains controversial.

Within the next few years, these three surveys and several other extensive ones described in the book will be finished. And as promised, all the key questions identified above will be answered at some level. But the history of astronomy warns us that new information, improved statistics, fainter limits, and more sophisticated questions will undoubtedly arise and keep these quasar surveyors busy for years to come.

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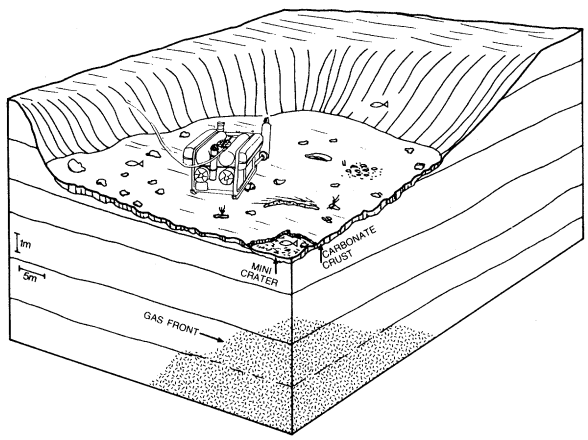
Seafloor Discoveries

Seabed Pockmarks and Seepages. Impact on Geology, Biology and the Marine Environment. M. HOVLAND and A. G. JUDD. Graham and Trotman, London, 1988 (U.S. distributor, Kluwer, Norwell, MA). xii, 293 pp., illus. $117.

Webster's Collegiate Dictionary defines "pockmark" as a mark or pit due to smallpox. But the present book obviously does not deal with an oozing medical problem; rather, it is concerned with geological features for which the medical term seems appropriate: concave, crater-like depressions that occur on the seafloor. Before 1970, pockmarks were not included in geological jargon, and only in the latest edition of the American Geological Institute's *Glossary of Geology* (1987) does the term make its appearance. But since 1970, when seabed pockmarks were first observed with the aid of the then-new side-scan sonar on the continental shelf off Nova Scotia, they have been reported to be present on the seafloor in many parts of the world.

This book does an outstanding job of summarizing the occurrences of seabed pockmarks worldwide, with particular attention (two chapters) given to the North Sea, an area of significant petroleum development. Not only are the morphological, mineralogical, and biological aspects of pockmarks considered in detail, the processes that may form them are discussed at length. Although pockmarks are defined in the AGI *Glossary* on the basis of morphology, this book implies a genetic element in the definition by emphasizing the role of fluid escape



"Artist's impression of a carbonate-cement-paved pockmark. Completely paved pockmarks have to date only been observed on the plateau in Norwegian blocks 25/7 and 24/9 of the North Sea. Note ROV [remotely operated vehicle] inside pockmark." [From *Seabed Pockmarks and Seepages*]

in their formation; the authors clearly favor gas, particularly methane, as the most important fluid in the process. Besides pockmarks, the book considers a wide variety of seafloor features, all of which have the common element of being associated with some kind of seafloor seepage. Examples include mud volcanoes, hot springs, cold springs, hydrothermal vents, and volcanic emanations.

The enthusiasm of the authors for their subject comes across clearly. They are eager to have seabed pockmarks recognized as significant and to stimulate an awareness of the importance of various kinds of seabed seepages. Each of the ten chapters starts with an interesting quotation and a brief description of what's ahead. The text is generously illustrated, although a few of the acoustical records seem to have lost definition during printing and sometimes it is not possible to find locations on maps of areas discussed in the text. A reader unfamiliar with marine geochemistry and marine surveying techniques would do well to begin by examining appendixes 1 and 2. Appendix 1 discusses methane and emphasizes the complications inherent in the carbon isotopic record, although it would have been better to stress the utility of this record instead. Appendix 2 describes marine surveying techniques. A third appendix presents a series of seabed relief maps summarizing locations of pockmarks and seepages worldwide; a large line drawing might have been more effective here. A good glossary and index aid the reading population, which should include anyone interested in the science and technology of the seafloor. The book has implications for the development of offshore petroleum and mining industries and for marine pollution, radioactive waste disposal, and balancing of the global carbon cycle.

In their epilogue, the authors conclude with the following plea: "How long will we accept the strange fact that we now know more about the far side of the Moon and the surface of Mars than we know about our own dynamic planet's vitally important water-hidden surface?" Their book may help revise priorities with regard to the direction of future research.

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Metalloenzymes

The Bioinorganic Chemistry of Nickel. JACK R. LANCASTER, JR., Ed. VCH, New York, 1988. xviii, 337 pp., illus. $85.

Evidence that nickel is an essential trace element in biology has been steadily accumulating over the past 20 years. However, the diversity of its specific biological roles is only now beginning to emerge.

This is the first book devoted exclusively to the bioinorganic chemistry of nickel, and the editor has assembled a series of 14 well-written, concise papers by some of the leading experts in this extremely active area of research. The collection shows how the combination of biochemical, bioanalytical, and biophysical techniques has established the presence of nickel at the active sites of four distinct types of enzyme: urease, hydrogenase, CO dehydrogenase, and methyl coenzyme-M reductase. The authors review relevant aspects of nickel coordination chemistry, biological utilization and transport of nickel, biochemistry and enzymology of individual nickel metalloenzymes, and spectroscopic methods for investigating biological nickel centers.

How and why nature utilizes nickel to catalyze such widely different reactions as the hydrolysis of urea, the oxidation of hydrogen, the reductive desulfurization of methyl thioether, and the carbonylation of a methyl group are fascinating questions. The accounts in this book make it obvious that definitive answers are still to come. Clearly x-ray crystallographic studies of these enzymes will be essential for obtaining them. At present, information concerning the nickel centers has been pieced together through a variety of sophisticated biophysical techniques—EPR, electron spin echo, NMR, x-ray absorption, and MCD spectroscopy. Unfortunately, with the notable exception of x-ray absorption, we lack spectroscopic probes for biological Ni(II) centers. In particular, they cannot be detected by EPR, irrespective of the spin state in low-symmetry biological environments, and this presents a major impediment for detailed biophysical characterization. Techniques by which the chemically informative electronic and magnetic properties of Ni(II) centers embedded in protein matrix can be investigated will clearly be essential for further advances. What is apparent from the studies presented in this book is that the nickel coordination environment is very different in each of the known nickel metalloenzymes: octahedral coordination by O or N in urease, a mixture of S and O or N coordination in hydrogenases, and porphynoid coordination with unknown axial ligands for the F_{430} cofactor of methyl coenzyme-M reductase. The nickel environment in CO dehydrogenase is the least well characterized, but promises to be the most interesting, since the current evidence suggests some form of bimetallic FeNi active site.

This book is an extremely useful compendium of information concerning structure-function relationships in nickel metalloenzymes. As such it should be on the bookshelf of any researcher interested in bioinorganic chemistry and will surely attract the interest of a broader audience of inorganic chemists and biochemists. This book should be viewed as a progress report on a rapidly advancing field. Indeed, several significant advances are about to be reported or have occurred since the book went to press. These developments include the finding of a new biological Ni(II) porphynoid, tunichlorin, which suggests a metabolic role for nickel in marine tunicates, as well as further spectroscopic and magnetic characterization of the nickel centers in ureases, methyl coenzyme-M reductase and hydrogenases. In addition the interested reader should be referred to two excellent review articles on the microbiological and biochemical aspects of nickel enzymes that appeared in 1987 but are not cited in this book: R. P. Hausinger, *Microbiol. Rev.* **51**, 22-42, and C. T. Walsh and W. H. Orme-Johnson, *Biochemistry* **26**, 4901-4906.

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