Ambiguities in the Scientific Revolution

Occult and Scientific Mentalities in the Renaissance. BRIAN VICKERS, Ed. Cambridge University Press, New York, 1984. xiv, 408 pp., illus. $39.50. From a symposium, Zurich, June 1982.

The scientific revolution of the 16th and 17th centuries seemed to be a fairly clear-cut phenomenon to 19th- and early 20th-century historians of science. It involved a rational rejection of "superstitions" such as witchcraft, alchemy, astrology, and magic, as well as a rejection of an outworn Aristotelian philosophy that dealt with words more than things. Those unsatisfactory systems were replaced by modern science: a revived mechanical philosophy and a methodology based on mathematics, reason, and experimentation. Cracks began to appear in the structure of that historical interpretation, however, in the form of disconcerting facts about early scientific heroes: some of Francis Bacon's ideas on induction and empiricism perhaps came from the tradition of natural magic; Johannes Kepler attempted to reform astrology as part of his Copernican reform of astronomy; Isaac Newton left in manuscript some 1,200,000 words from his private study of alchemy. When it also became apparent that general interest in the so-called occult sciences peaked in the Renaissance and early modern period just as the supposedly rational revolution should have been effecting a diminution in the appeal of such subjects, problems with the old interpretation became intense, and a number of historians in recent years have argued that the occult must actually have contributed to the scientific revolution. That thesis in its turn has been criticized as overstated if not totally misconceived. The volume under review, in 13 essays of varying length, presents new evidence and new arguments that bear upon these issues, especially upon the question whether "occult" and "scientific" mentalities can be adequately distinguished in Renaissance and early modern Europe.

The reader who expects the answer to that question to be an obvious affirmative may be surprised. Brian Vickers, who not only edited the book but has contributed an introduction and a long essay of his own, argues that they can. Vickers is a relative newcomer to this area of scholarship and brings to the question his skills in linguistic and rhetorical analysis. Two principal points divide the occultists from other thinkers of the period, Vickers says: their sense of words as "real" (opposed to the recognition that words are "signs" that point to something else) and their tendency to treat analogy as identity (rather than seeing that analogous items have differences as well as similarities). The realist view of language and the conflation of analogy with identity constitute patterns of thought that make possible the occultist worldview of correspondences (between metals and planets, for example), magical manipulations with words (as in incantation), and so forth. This is a convincing argument, and one that almost divides the personalities involved along expected lines. Ficino, Reuchlin, Agrippa, Paracelsus, and the alchemists appear among the occultists, and Kepler, Galileo, Bacon, Hobbes, Locke, and Boyle have the different perceptions of language that characterize the emergent new sciences. Yet the analysis is not perfect, for it seems to put J. B. van Helmont among the scientists. Van Helmont has been more often described as a Paracelsian, an alchemist, or a hermeticist; Lotte Mulligan's essay in this volume even cites him as an "extreme example" of "irrationalism" (p. 376).

Other problems arise, as with John Dee. Dee operated a sort of academy for English explorers in the 16th century, teaching them the mathematics useful for navigation. He also wrote a preface to the first English edition of Euclid in which he urged the application of mathematics in all sorts of practical activities. Yet one activity for which he recommended mathematics was "Archemastrie." Nicholas Clulee, in an essay marked by some exciting detective work in tracking down Dee's references, has discovered that "Archemastrie" included a form of divination in which knowledge of past, present, and future might be had by gathering celestial rays in mirrors or other reflecting surfaces, and wisely concludes (p. 65), "The effort to find a dividing line between magic and genuine science—a crossroads where magic either transforms itself into science or is left behind and true science taken up—is, in regard to Dee, mistaken because it pushes a later conceptual distinction between magic and science, involving a narrowed definition of legitimate science, back onto Dee, for whom it is inappropriate."

Conversely, persons wholly committed to a study of influences we might see as occult have had rather a scientific approach. In his provocative essay "The scientific status of demonology," Stuart Clark points out that in the period of concern the action of the devil was not considered supernatural in our sense at all, since (for theological reasons having to do with the power of God) he had to work within the natural order of things. He might of course understand and be able to manipulate the natural order better than human beings can, or as the Great Deceiver he might be able to create illusions of things that were really impossible, such as metamorphoses of humans into animal forms. Serious epistemological problems exist in distinguishing what might be the work of the devil from natural magic (not dependent upon demonic agency but having hidden causes unknown to man), or from natural monsters and prodigies such as Bacon recommended for study (and the early Royal Society studied extensively) as being more illuminating than the ordinary course of nature. In attempting to settle the epistemological questions bound up in these distinctions and others Clark sees most demonologists as contributing to scientific discourse—"a debate about the grounds for ordered knowledge of nature and natural causation" (p. 368).

Three essays offer welcome new insights into the perennially fascinating Kepler, two concentrating on the Kepler-Fludd controversy, examined in the 1950's by Wolfgang Pauli. Fludd was the arch-occultist of the early 17th century, and Kepler's modernity seems strained as one realizes that he and Fludd shared many presuppositions in this famous quarrel. But their differences were important, too, and further illuminate the general differences between occult and scientific mentalities. Robert Westman observes in his chapter that Fludd had a "visual epistemology" in which "the world of images mediates between the world of the senses and the world of the intellect" (p. 203). Kepler said Fludd produced "pictures forged from air," but Kepler made pictures too—witness his nesting polyhedra that represent God's archetypal Ideas for the creation of the world. The crucial difference comes from the fact that, while Fludd and Kepler both assigned metaphysical meaning to their visions, Kepler also assigned physical and mathematical

meaning to his. In an interesting addendum to the early modern material, Westman suggests that Pauli's work on these pictorial archetypes may have been stimulated in part by the visualization crisis in modern physics.

Fludd thought Kepler was a numerologist, albeit a mistaken one, and since Fludd was one himself he attempted to straighten Kepler out on the matter. Judith Field finds in her essay, however that Kepler knew he was not in that tradition. Kepler had opted for *numeri numerati* (counted numbers) over *numeri numerantes* (counting numbers), thus for geometry over arithmetic in music, astrology, and astronomy. He saw himself as heir to Plato, Euclid, Ptolemy, and Proclus rather than Pythagoras, Boethius, Iamblicus, and Porphyry. Since many historians have also seen Kepler as something of a numerologist in his search for "the music of the spheres," Field's work is a significant clarification.

A number of the essays mention epistemology, and, although no author quite makes the point explicit, as a whole the collection presents considerable evidence for an epistemological crisis during the 16th and 17th centuries. What can one know, and how can one know it? Through what human faculties is knowledge to be obtained? Or, since both the senses and the intellect are subject to error, should one rely solely on divine illumination? Mulligan in " 'Reason,' 'right reason,' and 'revelation' in mid-seventeenth-century England" has found that these questions cut across all fields—religion and politics as well as the study of nature. Almost everyone called for the use of "right reason," by which each one meant his own idiosyncratic mix of "reason" and "revelation," with none to decide which "right reason" was really "right." No one knew, and one must be very sensitive to that point in any search for "occult and scientific mentalities" in the Renaissance and early modern period. As Richard Westfall notes in his essay on Newton's alchemy, "A different standard of rationality in the seventeenth century may have encouraged Newton to open himself to the influence of a tradition that appears to us almost as the antithesis of reason" (p. 332). No single factor seems to divide the principal actors in the drama as we would wish, and it may be that we have not yet asked quite the right questions on any of these issues regarding the origins of modern science.

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Fluvial Sedimentology

Modern and Ancient Fluvial Systems. J. D. COLLINSON AND J. LEWIN, Eds. Blackwell Scientific, Palo Alto, Calif., 1983. viii, 575 pp., illus. Paper, $56. International Association of Sedimentologists Special Publication no. 6. From a conference, Keele, England, Sept. 1981.

This book incorporates 44 of the papers presented at the second international conference on fluvial sedimentology. The editors have endeavored to select papers representative of the overall balance of the meeting and have organized them into four sections that reflect the interdisciplinary range of topics discussed—hydrodynamics and bedforms, present-day channel processes, facies models, and economic aspects.

In the first group, M. R. Leeder and J. R. L. Allen present two thoughtful syntheses of flow dynamics, lag and bedform genesis. Two additional papers summarize new experimental data. Papers concerning modern channels provide numerous largely descriptive views of erosional and depositional processes and products. The focus of study has shifted from the well-known meandering channel to examples of very coarse-grained and very fine grained fluvial systems. Channel segments located in proglacial or glacially influenced terranes receive the most attention. However, the sedimentary dynamics of large, humid-climate, and tropical streams remain little described. Perhaps of greatest general interest is a paper by D. G. Smith on anastomosed fluvial deposits. Anastomosed systems have been popularized by sedimentologists only in the past few years, though their basic features were discussed nearly 20 years ago by S. A. Schumm. The greatest number of papers focuses on the analysis of ancient alluvial sequences. Most of these papers are primarily descriptive but do illustrate the ways in which paleoflow and bedform dynamics can be inferred from preserved sedimentary structures and other features. A few papers, notably that of P. F. Friend, discuss broader concepts of the stratigraphy of fluvial deposits. The remaining papers provide good examples of the way interpretation and mapping of ancient fluvial deposits aid the understanding and prediction of mineral resources, including gold, uranium, coal, and petroleum.

Modern and Ancient Fluvial Systems is an overview of current research directions for the nonspecialist and contains many papers that will be of interest to the specialist in terrestrial depositional environments. However, in comparing this book with its predecessor (Canadian Society of Petroleum Geologists Memoir 5, 1977), which resulted from the first fluvial conference, I find myself somewhat let down. Whereas the first volume teemed with thought-provoking concepts and attempts at synthesis and generalization, this volume seems to reflect a period of retrenchment and of return to the relatively safe task of description, preferably at a highly localized and detailed level, with little attempt to integrate the observations into the larger context of the fluvial system or basin studied. Thus assessment of the significance of the models and concepts presented is left to the reader. It may well be that, as Collinson and Lewin propose in their introduction, "many case histories will be a better basis for interpretation of new examples." However, my expectation is that the third volume, when it is published, will contain citations of more papers in the first volume than in this one.

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The Erosion of Shorelines

CRC Handbook of Coastal Processes and Erosion. PAUL D. KOMAR, Ed. CRC Press, Boca Raton, Fla., 1983. xii, 305 pp., illus. $70. CRC Series in Marine Science.

The objective of this book is "to provide a state-of-the-art presentation of the science of coastal erosion processes," apparently for an audience of coastal geologists and geomorphologists. Judged against this stated objective the book is a success.

There are 14 chapters, including four by Komar. The 14 authors include a representative cross-section of American coastal geologists and geomorphologists, as well as a coastal engineer, a meteorologist, and two overseas authors with American experience. The introductory chapter, by Komar, qualitatively summarizes what has been described mathematically about coastal processes. Following chapters cover topics that range from edge waves (Holman) to barrier islands (Nummedal) to erosion statistics (Dolan, Hayden, and May). For the reader desiring to follow up a topic, there are bibliographies, many of them excellent, at the ends of the chapters.

Sea level rises so slowly on ocean beaches that a research career is not long