Rubbing of one of four human figures engraved on a basaltic boulder, designated Monument 12, from Chalchupa, El Salvador. "The general style and several specific motifs seen in these figures . . . has produced a consensus . . . that Monument 12 represents Olmec inspriation." The monument thus "represents the most distant example from the Gulf coast of Olmec-style sculpture." [From R. J. Sharer's paper in *Regional Perspectives on the Olmec*, after D. Anderson, 1978]

under the category of Olmec. Through these examinations, the volume offers conclusive evidence of the cultural complexity of Formative-period Mesoamerica. The examinations also demonstrate that much of Formative period cultural development occurred independent of the Olmec heartland. In fact, much of what we currently label Olmec may well be the product of the interaction of the Gulf Coast heartland with other areas in the region.

Concluding chapters by Arthur A. Demarest and Paul J. Tolstoy divide Mesoamerica into eastern and western regions and examine the influence of Olmec on both. Tolstoy concludes that Olmec iconography, wherever it is found, is a "unitary phenomenon" and suggests that the solution to the Olmec problem will require a compromise between those scholars who view Olmec as an origin culture and those who see it as a product of "equal partners." In contrast, Demarest appears to lean toward a view of parallel Formative period development while recognizing that the heartland Olmec may have been the chief actor in that development. Demarest also notes that many of the Mesoamerican regions that until now have been thought of only as transmitters of Olmec culture were in fact its primary shapers and developers.

Regional Perspectives on the Olmec is the latest and most up-to-date compilation of information concerning the development of Mesoamerican Formative period culture in particular and Mesoamerican civilization in general. It will be the fundamental reference on this topic for many years and will continue to be a source of information not only for Mesoamericanists but for all those who are interested in the development of primal civilizations wherever they occur.

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Hardware from Prehistory

Time, Energy and Stone Tools. ROBIN TORRENCE, Ed. Cambridge University Press, New York, 1989. viii, 124 pp., illus. $44.50. New Directions in Archaeology. Based on a meeting, Minneapolis, MN, 1982.

As the most durable (and often the most abundant) traces of ancient human activities, stone tools are of particular interest to archeologists, for an understanding of how and why they were manufactured, maintained, used, and discarded, could provide more general insights into the behaviors and strategies of the people who produced them. Most such research within the last few decades has focused on methodological issues, including the development of techniques for identifying raw material sources and trading networks, reconstructing manufacturing techniques, and determining the functions or uses of individual tools. Only recently have analysts attempted to address more general issues of human behavior and technological organization. Such issues are the focus of this volume.

Most of the 11 chapters are revisions of papers that were first presented at the 1982 meeting of the Society for American Archaeology. At least five of the contributors have subsequently completed Ph.D. dissertations on their topics. These works have been repeatedly cited and form the nucleus of a rapidly growing body of literature, so it is good to see them in print at last.

Several themes link the papers. With one exception, all the contributors are studying prehistoric hunting and gathering societies, and most of them employ theoretical concepts derived from the study of present-day foraging peoples. One such concept, ultimately based on principles of evolutionary ecology, asserts that humans (and other organisms) strive to optimize their foraging behavior so as to maximize their intake of energy or nutrients while minimizing their expenditure of energy or time and minimizing risk. As Torrence notes in the introductory chapter, most of the contributions begin with the assumption that "tool-using, as for many other forms of behavior, was carried out in such a way as to optimize the expenditure of time and energy" (p. 2). For example, a particular technique of tool manufacture or resharpening may require more effort than another but at the same time may conserve raw material by extending the useful life of the tool. Increased time and energy devoted to tool manufacture must be balanced against decreased time and energy spent in acquiring raw material; the technique used will be the one that minimizes total energy expenditure. Such propositions may provide insights into such phenomena as changes from chipped stone to ground stone to metal technologies (Hayden, Boydston) and the use of tools with standardized shapes (Jeske, Myers).

A thoughtful evaluation of these applications is provided in the concluding chapter by Michael Jochim (one of the first archeologists to apply optimal foraging models to prehistoric hunter-gatherers). He points out that there are a number of unresolved problems. For example, optimization models require a measurable "currency." Energy intake can be measured in calories, but it is not clear that raw-material acquisition can be measured in a similarly straightforward way. Not only the amount of stone but also the relative quality, abundance, and accessibility of different types of stone are significant factors. Despite the limitations, he finds the studies exciting for "linking technology to the overall organization of behavior within a framework of economics and evolutionary ecology" (p. 111). I would agree.

A second theme is the application of a series of concepts derived from Lewis Binford's studies of technological organization among contemporary Nunamiut foragers in Alaska. Concepts such as curated and expedient technologies (Torrence), embedded procurement strategies (Morrow and Jeffries), logistical mobility patterns (Jeske, Lurie), and personal gear and site-specific facilities (Camilli) permeate the work. Binford has observed a number of interesting relationships between the organization of technology and mobility, settlement, and other behaviors. Several contributors seek to apply Binford's models to prehistoric technologies in order to infer the underlying mobility and exchange patterns, with intriguing results.

In general, the papers in this volume are innovative and stimulating. The specific results are sometimes inconclusive or weakly supported, as several cases involve very small samples or questionable statistics. Most of the papers are fairly technical and assume some familiarity with stone tool typologies and North American culture histories (the majority deal with North America, although Peru and Europe are also represented).

Overall, however, the volume serves as a good example of the current status of stone tool analysis and its exciting potential for the reconstruction of past human behavior.

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Processes within the Mantle

Seismic Tomography and Mantle Circulation. R. K. O'NIONS AND B. PARSONS, Eds. Royal Society, London, 1989. viii, 152 pp., illus. £37.50. Reprinted from *Philosophical Transactions of the Royal Society* A, vol. 328 (1989). From a meeting, London, U.K., April 1988.

The gradual motions of the uppermost parts of the earth, "plate tectonics," have become increasingly well understood in the last 25 years. It is generally agreed that the process is a complicated form of thermal convection. Hot material rises beneath mid-oceanic ridges, moves horizontally and cools within oceanic plates, and returns to the interior as subducted slabs beneath island arcs. The upper mantle of the earth, down to the 670-kilometer depth of the deepest earthquakes (in slabs), is clearly involved in the circulation. However, there has been much speculation and little agreement about what happens below that depth. The key question is, Does a chemical discontinuity that is a barrier to vertical flow exist between the upper mantle and the lower mantle?

The organizers of the Royal Society meeting on which this book is based highlighted the field of seismic tomography in the title because this method has recently provided direct information about the lower mantle, thus simulating research in other fields in the earth sciences. The method is basically similar to medical tomography but more difficult in practice. The mathematical analysis of seismic tomography is more complicated. The origin time and location of earthquakes are unknown and are determined along with the velocity structure of the earth. Velocity variations are sufficiently large in the earth that the ray paths are not known in advance. In addition, much of the earth's interior, especially the upper mantle beneath ocean basins, is not traversed by ray paths. For these reasons, tomography is used in conjunction with other seismic methods, such as the study of very-long-wavelength seismic waves (free oscillations), which more evenly sample the mantle.

The book contains contributions from workers in seismology, mantle convection, gravity, geomagnetism, high-pressure mineral physics, and geochemistry. The involvement of the latter four fields warrants some comment. Pressure variations associated with mantle convection cause dynamic topography on the core-mantle boundary and on the free surface. Gravity anomalies are modeled by calculating the mass of the dynamic topography, varying the viscosity structure and chemical discontinuities, and including density structure obtained from seismic studies together with the knowledge that slabs exist beneath island arcs. Dynamic topography of the core-mantle boundary affects short-term variations in the earth's magnetic field and the coupling of the solid mantle and the liquid core during slight variations in the earth's rotation. High-pressure mineralogists have studied the phase change to a more dense silicate structure that occurs between the upper and lower mantle. It is necessary to account for this phase change when examining seismic data for evidence of a chemical discontinuity. Their studies are also relevant to physical properties in the mantle and to the temperature of the liquid core of the earth, as well as the basal temperature of the mantle. Geochemical studies provide evidence for the long-term persistence of chemical heterogeneities within the mantle as well as direct constraints on the amount of radioactive heat generation in the Earth.

Overall, *Seismic Tomography and Mantle Circulation*, consisting of 10 papers (and one abstract) by 16 authors working in the United States and Germany, as well as in Britain, succeeds in describing the approaches of the various fields and the areas of agreement and disagreement. Continued interaction of these fields will lead to further progress.

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Cell Adhesion

Leukocyte Adhesion Molecules. T. A. SPRINGER, D. C. ANDERSON, A. S. ROSENTHAL, AND R. ROTHLEIN, Eds. Springer-Verlag, New York, 1990. xvi, 287 pp., illus. $84. From a conference, Titisee, F.R.G., Sept.–Oct. 1988.

Cell adhesion binds the microscopic cells into the macroscopic tissues of the multicellular organism. In addition, it is an essential determinant in a variety of dynamic processes such as the directed cell motility of embryonic morphogenesis, tumor invasion, and wound repair and several of the processes performed by blood cells, such as hemostasis, inflammation, phagocytosis, and target cell killing. Recent advances in the identification and characterization of the molecules involved in cell adhesion have made it possible to address questions about molecular regulation of directed cell motility and adhesive cell recognition. Nowhere has the problem of adhesive recognition been more important than in the understanding of cellular processes in immunity and inflammation. Adhesive recognition, as displayed by nucleated blood cells, includes the discrimination of self from non-self and the selective adhesion to and phagocytosis of non-self particles. Recognition is also important in the margination and diapedesis of neutrophil leukocytes and monocytes at sites of inflammation. The circulating inflammatory effector cells adhere selectively to capillary and venular endothelium adjacent to sites of inflammation and largely ignore the endothelium of vessels servicing healthy tissue. Finally, the elaborate patterns of lymphocyte recirculation present exquisite examples of selective adhesive recognition.

Leukocyte Adhesion Molecules contains much useful information on the identification and characterization of the adhesion systems involved in leukocyte function. The review by Kishimoto *et al.* of the leukocyte integrins, also known as the CD11/CD18 complex, is timely and authoritative. Different members of this class of adhesion receptors contribute to the adhesion of leukocytes and lymphocytes to each other and to a variety of other cell types and to the attachment of complement-coated particles during phagocytosis. Investigation of the CD11/CD18 complex has been facilitated by the discovery that the fatal congenital condition leukocyte adhesion deficiency syndrome is a result of genetic defects in one of the key peptides of this complex.

In contrast to the thorough presentation of recent studies of the CD11/CD18 adhesion molecules, the important and well-investigated system of lymphocyte homing receptors, which mediate the elaborate patterns of lymphocyte recirculation across specialized portions of the endothelium, is under-represented in this volume. The sole chapter on this subject, by Jutila *et al.*, is altogether too brief and specialized to do justice to this fascinating problem and is more useful to the well-informed reader than to the novice in search of an introduction to the subject. A detailed series of reviews of the lymphocyte homing receptors and their complementary ligands on the endothelium would have been a welcome complement to the excellent coverage of the CD11/CD18 adhesion molecules.

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