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SEDIMENTARY ORGANIC MOLECULES: ORIGINS AND INFORMATION CONTENT

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Improved knowledge of ancient redox levels and of CO₂ abundances is crucial to correct reconstruction of earth's environmental history. Much relevant information must be encoded in the sedimentary record of organic carbon. The presence of organic material in sediments is commonly considered in terms of "preservation," in the sense that some organic debris has escaped recycling. That ultimately immobilized in sedimentary rocks, however, is the product of an ecosystem devoted to utilization - *not* preservation - of organic material. Although it is interesting to think in terms of the fraction of primary organic carbon that winds up in sedimentary rocks, use of the primary production as the reference point directs attention away from most of the action. Nearly all carbon-carbon bonds established in primary production are broken as plant products and utilized within the food chain. Organic geochemistry, sometimes described as "molecular paleontology," deals with the complex mixture of products deriving from these processes. Each organic compound represents only a tiny part of the parent organism. Extending the analogy, we must acknowledge that the fossils have been disarticulated and scrambled.

To progress, we must dissect the processes controlling the composition of sedimentary organic matter. Structurally, this has proven difficult. Individual "biomarkers" can often be recognized, but their contribution to total organic matter is small, and their presence does not imply that their biochemical cell mates have survived. We are finding, however, that a combination of structural *and* isotopic lines of evidence provides new information. A starting point is provided by the isotopic compositions of primary products (degradation products of chlorophylls, alkenones derived from coccoliths). We find strong evidence that the isotopic difference between primary carbonate and algal organic material can be interpreted in terms of the concentration of dissolved CO₂. Moreover, the isotopic difference between primary and total organic carbon can be interpreted in terms of characteristic isotopic shifts imposed by secondary processes (responsive, for example, to O₂ levels in the depositional environment). In favorable cases, isotopic compositions of a variety of secondary products can be interpreted in terms of flows of carbon, and, therefore, in terms of specific processes and environmental conditions within the depositional environment.