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EDITORIAL

Archaeological Chemistry

Through chemical analysis of the material evidence recovered from archaeological sites, the chemist has become a partner with the archaeologist. This partnership has existed for more than a hundred years, but only recently has it included organic and biological materials as well as inorganic artifacts. This special issue of *Accounts of Chemical Research* illustrates the full range of artifactual materials that the chemist is examining today. More importantly, the papers explore the questions that the chemist can help the archaeologist answer through application of a wide range of analytical tools.

How were artifacts made? Humans truly became chemists when they started altering the chemical makeup of the raw materials, aside from food, that they worked with. They converted clay to pottery, sand to glass, ores to metal, and various organic and inorganic materials to dyes and pigments. Today the chemist can explore how these discoveries were made and detail the technology that was developed millennia ago. In the first paper in this issue, Tite and co-workers examine the earliest aspects of the conversion of silica (sand) and other raw materials into glassy products. In the next paper, Henderson focuses on the emergence of early Islamic glasses, a process that had to address a major shift in the availability of desirable raw materials. Then Bishop and Blackman examine the composition of ceramic materials. Their study provides information not only on the technology of production but also on what types of raw materials were used, which leads to the next question.

Where did the raw materials of the artifacts come from? The chemist has had a long association with the question of provenance, or raw material source. Although the major elemental components of an artifact may determine its bulk properties, the trace inorganic elements often reflect the geochemical source of the raw materials. Obsidian has been one of the real success stories in this field. Glascock examines the subject in the context of New World artifacts, and Tykot in the context of Mediterranean artifacts. Once provenance is established, the chemist moves on to try to describe trade routes. Lambert and Poinar examine organic artifacts composed of fossilized resins. For these materials, it is the carbon functionalities rather than the inorganic traces that provide the fingerprint for provenance determination.

How old are the artifacts? Archaeological chemistry came of age when Libby developed ^{14}C dating. The ability of science to provide absolute chronologies to supplement relative chronologies of stratigraphy and style transformed the field of archaeology. Schwarcz describes the full range of chemical dating methods, including not only methods based on radioactive decay but also those based on trapped electrons and on the racemization of amino acids.

How do archaeological materials decompose during burial? Wilson and Pollard address the question of diagenesis, or how materials change after initial deposition. Such processes must be understood to permit chemical analysis to answer any of the questions already posed, but also to decide how materials should be treated after excavation.

How are ancient materials conserved? Once the materials are in the hands of the archaeologist or art historian, a wide range of questions arise, both practical and ethical, about future treatment. This field belongs to the art conservationist, who can obtain useful information from the chemist, as described by Spoto.

What information do buried remains of humans and other animals provide? The final three papers in this issue address this subject respectively from organic, inorganic, and biochemical perspectives. Evershed and co-workers examine archaeological fats, which may come from food residues on pottery or from actual human burials, such as mummies. The specific structures of the fats provide a

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variety of information. Aufderheide, Rapp, and co-workers look at skeletal remains for the information that traces of lead can provide. They relate skeletal lead to social and economic status and to possible health effects in ancient populations such as the Romans. Poinar traces the genetic history of biological samples through the analysis of residual DNA. These experiments represent today's ultimate analytical challenge, because of the considerable problems of contamination and degradation.

Twenty years ago this list of questions would have been much shorter. As new analytical techniques continue to be developed and existing ones improve, the archaeological chemist hopes that during the next 20 years the list of chemically relevant questions will expand further and that the information supplied to the archaeologist will prove useful in understanding ancient human cultures.

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