that in general the work stands as an otherwise pleasing whole. I think that when comparison is made with the available books on this subject I would concur with such a judgment.

M. S. Tite has included such advances as the Ar^{40}/Ar^{39} stepwise heating method of age determination. He was apparently unaware of the even more recent work on use of amino-acid ratios and amino-acid racemization in dating fossil bones. These methods appeared in print in 1971 and 1972, so that the oversight can be excused. The amino-acid racemization technique has proven to be not only important in establishing ages of fossil bones beyong the 40 000 year limit of radiocarbon, but also for drawing climatic inferences for the time of deposition (for younger age deposits with the help of radiocarbon dating).

The use of the uranium decay series in travertine cave deposits and other dense inorganic calcium-carbonate precipitation sites is also not mentioned although this method of dating may be second in importance to the amino-acid racemization method for dating the early history of Man.

Although an adequate discussion of ancient metallurgy is presented, the discussion of the problem of sources of material is not as useful. This may be due to the scarceness of reliable information in this area. It may also be the proper domain of a more geologically oriented book.

The references at the end of each chapter provide a good starting point for reading in any of the areas discussed. The author has primarily devoted his energies in archaeology to the use of physical methods in site locations; consequently this chapter is the most authoritative and most thoroughly referenced one.

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The Raman Effect, Vol. 2: Applications

A. Anderson, ed.
629 pp. Marcel Dekker, New York, 1973. $45.00

The objective of *The Raman Effect* was to provide a basic coverage of the theoretical and experimental principles of Raman spectroscopy and discussions of some of its important applications in physics and chemistry. The first volume, reviewed in the December 1972 issue of PHYSICS TODAY, was devoted primarily to the theoretical aspects. This second volume contains discussions of selected applications by active research physicists and chemists at universities in Europe and the United States.

R. Stuart Tobias (Purdue) gives a detailed and concise review of a large number of applications to inorganic chemistry, including discussions of experimental procedures, interpretation of Raman spectra of inorganic compounds, equilibria and structures in aqueous and nonaqueous solutions, and cation–anion interactions and reactions in molten salts. It is predicted that in the future the primary use of laser Raman spectrophotometers will continue to be in the determination of molecular symmetries. Probably most specimens will be studied in the solid state because of the ease of excitation of the spectra with lasers. Studies of single crystals will be useful.

One of the most interesting challenges will be the description of the nature of the wide variety of chemical bonds found in inorganic compounds. Raman intensities are certain to be investigated more and more, especially for the measurement of molecular polarizability changes as the scatterer vibrates. Studies of equilibria in solutions should yield a better understanding of the structures present. Raman spectroscopy will be used for studies of systems under extremes of temperature and pressure, and will be an ideal method for the study of the structure and reactions of species in such solvents as liquid ammonia. For the inorganic chemist, laser Raman spectroscopy is probably the most exciting new tool developed during the last ten years.

Electronic Raman transitions are treated by J. A. Koningstein (Carleton) and O. S. Mortensen (Copenhagen). They discuss the symmetry of the scattering tensor, the transformation properties of the scattering tensor (especially the antisymmetric components), absolute intensities and depolarization ratios, experimental matters, selection rules and experimental results of the electronic Raman effect of the ytterbium ion in yttrium–gallium garnet and assignment of the electronic Raman transitions.

The longest article in the book is the one by Alfons Weber (Fordham) on high resolution Raman studies of gases. This contains detailed discussions of the theory of rotational Raman scattering, experimental techniques, observed Raman spectra, determination of molecular structures, dynamical aspects of structure determinations, and intensities, line widths and related problems. The presentations are lucid and comprehensive and should be required reading for students and researchers in this field.

High-resolution Raman spectroscopy consists of the study of the resolved pure rotational and vibrational–rota-

tional Raman bands of gases and vapors at low pressures. It is complementary to the infrared and microwave spectroscopy in providing accurate values of the moments of inertia, rotational distortion constants, Coriolis coupling coefficients and anharmonicity constants for the vibrational states of a polyatomic molecule. Recent research has involved molecular structure study, including the determination of the polarizability invariants, the study of intermolecular forces, and studies of special effects such as the resonant Raman effect. The full potential of the laser source in Raman spectroscopy remains to be realized. Primarily this is a problem in the resolving power of instruments and in the photographic or photoelectric collection of the detailed information obtainable from the weak light scattered by a gas of low density.

Rodrigue Savoie (Laval) presents a concise discussion with illustrative examples of the Raman spectra of molecular crystals, including experimental techniques, vibrations in solids, potential energy expressions and force constants, apparent anomalies in the Raman spectra. Small molecules are analyzed because they best illustrate the way in which Raman spectroscopy can be used to gain information on the structure and vibrational energy levels of molecular solids.

The use of powerful lasers may make possible the study of chemical species isolated in solid matrices. Laser sources will also stimulate polarization studies, which will facilitate the making of band assignments. Continued accumulation of experimental results will aid the development of the theory upon which the interpretation of the experimental data is finally based.

The Raman spectra of ionic, covalent and metallic crystals are discussed by G. R. Wilkinson (London). Themes included are the theory of vibrational spectra of solids, experimental determination of the components of the Raman polarizability tensor, experimental Raman studies of crystals of different symmetry, Raman scattering in mixed crystals and crystals containing impurities, and other types of Raman scattering (resonance, polariton, hyper, electron, Landau, plasmon, and magnon).

Laser Raman spectroscopy gives the vibrational frequencies of a wide variety of crystals. The symmetry of the normal modes can be reliably determined after a careful measurement of the anisotropy of the polarizability tensor. For quantitative measurements, single crystals of good optical quality are required. The use of such crystals greatly facilitates the interpretation of the spectra.

These two volumes give a modern and comprehensive treatment of the Raman effect that will be useful to students and researchers. Such a treatment has long been needed.

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Treatise on Materials Science and Technology, Vol. 3: Ultrasonic Investigation of Mechanical Properties

R. E. Green, Jr
166 pp. Academic, New York, 1973.
$14.50

The editor of this *Treatise*, Herbert Herman of the State University of New York at Stony Brook, states in his forward to Volume 3 that "... ultrasonics has been employed both as an important tool in the research laboratory and routinely as a device for nondestructive testing in engineering ... The newer, more sophisticated, ultrasonic testing devices greatly depend on solid state physics concepts and techniques which are now evolving in the research laboratory." The author of this volume, Robert E. Green, Jr, of the Johns Hopkins University, has attempted to provide an introduction to these concepts and techniques "in such a form that it will be of ready use to the experimenter." Within the limitations imposed by the size of the monograph, he has succeeded very well.

The book is divided into two nearly equal parts covering linear and nonlinear elastic-wave propagation. Among the highlights of the first part is an argument, illustrated with a series of figures, for the convenience of using stereographic projections to summarize elastic wave propagation in crystals. A rather lengthy section, which makes liberal use of direct quotations from the literature, describes research on the texture of polycrystalline aggregates. In the half of the book on nonlinear elastic waves, attention is given to the propagation of finite amplitude waves and of infinitesimal waves in the presence of a superimposed stress. Isotropic solids and cubic crystals are treated in detail throughout the book.

In a monograph of this size, many compromises must be made. Each reader will notice favorite topics that have been treated sparingly or omitted entirely. For example, the effect of boundaries, waveguide effects and mode conversion are mentioned only very briefly at the end of the text. Another such compromise has apparently been the decision to sacrifice the logical presentation order on occasion in