interests and specialization is supplied by the biographee, himself, he might come away with a slightly erroneous impression about the capabilities of a given individual, because of the differences in the degree of objectivity which each of us applies to an evaluation of our respective interests and the differences in the ways in which we describe our fields of specialization. However, I don't know any practical way of improving this particular item, and as it stands, it provides very useful information, particularly for the reader who realizes the inherent limitations.

Louis G. Stang, Jr., is Editor of **Nuclear Applications**, *a journal of the American Nuclear Society. Additional factual and unbiased information about him can be obtained from* American Men of Science, *8th, 9th, 10th, and 11th editions.*

SOURCE BOOK FOR SEPARATION CHEMISTS

Title The Solvent Extraction of Metal Chelates

Author Jiri Stary

Publisher MacMillan, 1964

Pages xiv + 240

Price $8.50

Reviewer L. Newman

This book deals with one major aspect of solvent extraction, namely, the field of metal chelates and its importance in analytical, inorganic, and nuclear technology. The subject matter is well organized—starting with a chapter on the composition and stability of the metal chelates. The author gives a brief, but quite adequate and complete, description of the more recent methods for analyzing data. This is followed by a chapter on the theory of solvent extraction, which is a generalized treatment of the various experimental parameters.

It quickly becomes obvious that the author's main purpose in writing this book is incorporated in the chapter on systems, where a section on each of the following reagents and their derivatives is included: beta-diketones; tropolone; 8-hydroxyquinoline; oximes; nitrosophenols; nitrosoarylhydroxylamines; hydroxamic acids; 1-(2-pyridylazo)-2-naphthol; 8-mercaptoquinoline; dithiocarbamates; xanthates; dialkyl- and diaryl-dithiophosphoric acids; dithiols; and, finally, miscellaneous reagents. Each section begins with a brief description of the physical properties of the reagent, sometimes followed by a statement of a means for purifying the reagent, its partition coefficient, and its general utility. The most significant aspects of this chapter are the detailed tables in which the optimum conditions for the extraction of a given element with a given system are listed. In many cases, the wavelength at which the metal chelate absorbs is included. These tables should certainly prove to be a main source of information for practicing chemists who are developing new separation and analytical procedures. The inclusion of some extraction curves for a number of elements in the more popular chelate systems should also prove to be quite valuable.

In the final chapter, the author presents what he considers the most selective procedures for the isolation of each of 48 metals in the form of their chelates. Generally, only one method is given for each element, but it is in sufficient detail for utilization without resorting to the original literature. This chapter will prove most useful for people who wish to use solvent extraction for the separation of an element from a relatively simple system.

The author has wisely omitted subjects such as the techniques of solvent extraction that are adequately covered in other texts. He has done a thorough job in surveying the literature and has included numerous references that have not been readily accessible to the western world. This book will prove to be most valuable as a source book for chemists who are concerned with separation problems.

If one were to find fault with this text, it would be the limitation of material to the field of metal chelates with no discussion of the broad field of ion association systems. How much more complete a source book this could have been, had the author seen fit to include this field! Perhaps he should make this a subject of a future text.

Leonard Newman, Leader of the Analytical Chemistry Group of the Hot Laboratory Division of Brookhaven National Laboratory, will be remembered by readers of **Nuclear Applications** *for a somewhat different kind of book review that he wrote for our June 1965 issue (pp 274-275).*

CONCISE TREATMENT OF A COMPLEX SUBJECT

Title Guide to Activation Analysis

Editor William S. Lyon, Jr.

Publisher D. Van Nostrand Co., Inc., 1964

Pages xix + 186

Price $5.95

Reviewer James L. Brownlee, Jr.

Since its introduction in 1936, the radioactivation method has grown from a highly specialized, seldom-used technique to one that has taken its place among the other highly sensitive methods for trace-element analysis.

Until relatively recently, information on the basic theory, applications, and problems associated with activation analysis was to be found only in journal articles and reviews, or in volumes covering other, more general, areas of science. The first book devoted entirely to the activation method, *Radioactivation Analysis* by H. J. M. Bowens and D. Gibbons, appeared in Britain in 1963 and brought together much of the basic theory and information concerning the method. This was followed shortly by two additional books on the subject (*Neutron Irradiation and Activation Analysis* by D. Taylor and *L'Analyse par Radioactivation* by Ph. Albert, both in 1964). *Guide to Activation Analysis* represents the first American effort dealing specifically with the activation method. It is largely the effort of the group at the Oak Ridge National Laboratory and represents a significant contribution to the field of activation analysis, for which the various contributors are to be commended.

As mentioned in the foreword, the book is designed "to help the uninitiated get started (using the activation technique) with limited personal assistance from those knowledgable in the technique and to provide the newcomer with most of the knowledge he needs to plan and undertake operation". As a starting point toward this objective, H. Ross discusses, in Chapter 1, the influence of basic nuclear properties on activation determinations. This material is handled in a very general manner, serving, to a certain extent, as an introduction to the material to be examined in greater detail in later chapters. Chapter 1 touches briefly upon such topics as nuclear reactions and radioactive decay, decay schemes, interactions of radiation and matter, and radiation detection. Qualitative analysis by characterization of emitted radiation and half-life determination is mentioned briefly. It is unfortunate that this very important topic is given so brief a treatment, since a qualitative knowledge of the composition of a sample is often paramount to a successful activation determination. Ross also discusses quantitative analysis, presenting the basic relations among the various parameters affecting an activation determination, in addition to brief discussions of absolute determinations, errors, and use of daughter activities. Several examples of sensitivity calculations are presented.

F. Dyer treats the subject of reactor neutrons in Chapter 2 in a fairly thorough, yet brief presentation. In the first of three categories covered in this chapter, Dyer describes the characteristics of nuclear reactors, the several types of reactors, discussing the characteristics of reactor neutron energy spectra, and flux stability and variation with distance; thermal flux variation with distance in a graphite reactor and in the pneumatic tube facility of a typical research reactor is shown graphically. Dyer also discusses neutron flux monitoring, and presents tabular data on a number of thermal, resonance, and fast-flux monitors. In a short second section, sample preparation, reactor irradiation facilities, and pulsable reactors are considered. The final sections of Chapter 2 deal with useful nuclear reactions using reactor neutrons. The most important reactions involving the use of thermal, resonance, and fast neutrons are discussed, and several examples of the various reaction types are tabulated. In addition, secondary and excitation reactions are mentioned, as are interfering reactions, with practical examples of each. The chapter presents a broad spectrum of information concerning reactor irradiations and is well written and well referenced.

In order to present a complete picture of neutron sources for activation analysis, J. Strain considers nonreactor neutron sources in Chapter 3. In the brief span of 22 pages, Strain discusses accelerator and isotopic neutron sources in a clear, concise manner. In discussing accelerators, Strain examines some of the characteristics of the three major types of accelerators, covering such pertinent points as neutron-producing reactions and reaction thresholds, neutron yields and energies, and stability and spatial distribution of neutron flux. The latter topics lead into a brief discussion of flux-monitoring techniques, with some data on useful short-lived flux-monitor materials presented in tabular form. In addition, the question of shielding for accelerators is considered, with attention to accelerators used primarily for activation analysis. Several typical installations are shown, as are two types of small pneumatic sample-transfer systems. To complete the accelerator picture, some practical applications are cited, and some cost estimates are made for a complete activation system using an accelerator as a neutron generator.

Strain, who is certainly quite knowledgable on the subject, next discusses isotopic neutron sources. He mentions various materials serving as targets or radiation sources, for photoneutron- and alpha-initiated neutron sources, in addition to the newer spontaneous fission sources. These various sources are discussed from the viewpoint of neutron output, radiation shielding, installation, and cost. Several practical applications of these sources are mentioned. Addresses and ordering and licensing procedures are also indicated.

Because radiochemical separations are often necessary as a means of achieving the highest possible sensitivity in activation analysis, a short chapter on this subject by H. Ross has been included. Since this book is intended as a *guide* to the activation method rather than an encyclopedic work, no specific separations are presented here. However, Ross sets forth the basic principles to be considered in the choice of a separation procedure, where it is deemed necessary. Quite significantly, he points out the considerable advantages of postirradiation as opposed to preirradiation chemical separation, and he goes on to discuss, in general terms, the various methods of chemical separation that can be applied. In addition, he discusses separation efficiencies and several methods of chemical yield determination. References are limited, for the most part, to texts covering particular separation methods, rather than to those containing specific procedures.

In Chapter 5, R. Hahn treats gas-filled and the newer semiconductor radiation detectors, as well as those aspects of statistics that are most applicable to the over-all activation method. In his treatment of radiation detectors, Hahn discusses ionization chambers and proportional and Geiger-Mueller counters, outlining in a very brief fashion the mechanism for operation. In addition, he also discusses dead time and dead-time cor-

rections for gas-filled detectors, as well as their use in radioactivity assay. Hahn presents a brief, but comprehensive and well-referenced, survey on the newer and more interesting semiconductor detectors, though only from the standpoint of *particle* detection. However, no mention is made of high-resolution gamma spectrometry by means of Ge(Li) detectors.

Purely from the standpoint of continuity of material, it would seem that the coverage of counting statistics would have been handled advantageously in a separate chapter, while combining *all* methods for the detection and analysis of radiation into a single, more comprehensive chapter. In addition, some attention could well be paid to decay corrections.

The subject of scintillation counting techniques, including pulse-height analysis and data reduction, is considered in some detail by J. Eldridge in Chapter 6. Eldridge considers the scintillation process, in general, and the three modes of gamma interaction, in particular. Organic and inorganic scintillators and their use in gross counting and pulse-height-analysis systems are discussed. Single-and multi-channel pulse-height analyzers are discussed in some detail, with major emphasis placed on the latter. Much emphasis is placed on the interpretation and use of gamma spectrometry, with such topics as photoelectric and escape peaks, Compton scatter, pair production, and shielding effects being considered in some detail. Some attention is given to the choice of a multichannel pulse-height system, with consideration of the number of channels, memory capacity and subgrouping, the analog-to-digital converter (with some emphasis on differential and integral linearity), live display of spectral data, readout, and other accessory equipment. Some recommendations are made, and approximate costs are given for commercially available systems. In addition, some consideration is given absolute gamma measurements, including half-life determinations, energy measurements, and isotope identification. Finally the topic of computer applications is raised. Mention is made of gain shift phenomena, though base line shift in the analog-to-digital converter is ignored; however, ample treatment of these phenomena is found among the well-chosen references. Some indication of the procedure for making dead-time corrections, especially in the spectrometry of short-lived isotopes, would have added significantly to the material presented.

In Chapter 7, the editor of the volume, W. S. Lyon, Jr., examines some of the nonradioactivation analytical techniques making use of some of the nuclear properties of matter. He discusses, albeit briefly, charged-particle and photon activation, capture-gamma measurements, and neutron scattering. It is unfortunate that Lyons' treatment of these topics is so brief, since they do show great promise. As an example, by the judicious choice of particle or photon energy, one can utilize nuclear reactions that avoid some of the interferences found among neutron-induced reactions for a particular sample matrix. In addition, capture-gamma measurements show promise for the analysis of elements not amenable to ordinary neutron-activation methods.

After bringing together the wealth of material contained in the first six chapters, it would have been a shame not to include several practical examples of typical activation determinations. E. Ricci does this quite well in Chapter 8, with examples, which appear to have been carefully chosen to point out the various problems that can be encountered in making radioactivation determinations. Ricci's examples include considerations of self-shielding by the sample; detector dead-time corrections; chemical separations; thermal, resonance, and fast-neutron activation in a reactor; interfering nuclear reactions; flux monitoring; and single- and multichannel pulse-height analysis. All of his examples are discussed, are well referenced, and contain numerical data, which are reduced in a clear manner to a final result. The only criticism of this material, which seems justified, is the treatment, by inference, of dead-time corrections on the data obtained with a multi-channel analyzer. While not completely ignored (live-time counting is indicated in one of the examples), the treatment can be misleading and is generally not as simple as inferred.

As with many books, the appendices in *Guide to Activation Analysis* provide a considerable treasure of practical information. Appendix A, compiled by Lyon, indicates in three very well-referenced tables, calculated sensitivities for a sizable number of elements for neutron-activation applications to metallurgy, biochemistry and medicine, and geoscience, respectively. Recognizing that *calculated* sensitivities are often misleading, Lyon has also indicated *actual* concentrations of the elements determined in various types of matrices. It is this material that saves Appendix A from being just one more compendium of theoretically obtainable sensitivities. Appendix B, by O. Bizzell and J. Hitch, outlines general guidelines for radiation safety and licensing procedures. This is a very short general treatment and is intended only to introduce some of the safety material discussed more extensively in the various references.

As can be inferred from the title and the relatively short length, *Guide to Activation Analysis* is just what its title implies—a guide for those uninitiated in the activation method. As such, it is to be expected that the authors cannot delve into individual topics in detail but can discuss only the major points, leaving the details to be obtained from the wealth of reference material presented. In general, the authors have done a good job of condensing the voluminous material into a short, fairly concise treatment of a complex subject. Their efforts have resulted in a book that is well worth the consideration of those entering the field of activation analysis, as well as those who expect to use it only for a few specific applications.

James L. Brownlee, Jr., has been a member of the faculties of chemistry and nuclear engineering of the University of Illinois since receiving his PhD degree in 1961 in physical analytical chemistry from the University of Michigan. His doctoral work was in the field of activation analysis with emphasis on the use of short-lived isotopes and the development of rapid radiochemical separation techniques. He holds a BSc degree (1953) from the University of California at Los Angeles and a MSc degree (1959) from the University of Michigan.