Data Section

AN ISOTOPE CATALOGUE
FOR INSTRUMENTAL ACTIVATION ANALYSIS,* I

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Introduction

The development of instrumental activation analysis has been assisted by the introduction and use of Ge(Li) γ-ray detectors. Their greater resolving power has encouraged the solution of spectra using the photopeaks alone. In such a scheme, progress has been governed not only by the quality of spectra but also by the accuracy of the relevant published data. For that purpose, among others, γ-ray compilations with an appreciable fraction of better known energies have now appeared.

The following isotope catalogue has been assembled for use with computer programmes for the analysis of γ-ray spectra from neutron activated samples. The principal function of the catalogue is to provide coefficients for isotope activities in a set of linear simultaneous equations. The known quantities are photopeak integrals and the coefficients which are the γ-ray relative intensities for each isotope. The equations are solved for the unknown isotope activities.1

The catalogue has been prepared from the sources given2–11 in conjunction with data from individual papers. Although most of the review was completed by April, 1970, literature has not been disregarded after any particular date. In addition, the values have been taken with a view to consistency between the various sources mentioned rather than giving infinite weight to the most recent figures.

The catalogue is stored on a computer magnetic tape file and programmes are available to list the isotopes in order of Z and A or the γ-rays in order of energy. The isotope version is used by the analysis programmes which to some extent have determined its format. The γ-energy form is a useful supplement when results from the normal computer method are examined.

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Description of the isotope catalogue

Half-lives appear in days, corresponding in form to the tape file, and with some rounding error in other units. In the few cases where only an upper or lower limit for half-life is available the limit has been used without comment. Cross-sections are those for \((n, \gamma)\) thermal production from the target isotope shown with the given isotope abundance. Where ground state decays are fed by short-lived isomers the cross-sections have been increased to allow for production by isomeric decay and in these cases the percentage of the isomer which decays by isomeric transition is given. The cross-sections have not been increased where ground state decays are fed by longer lived isomers or where the error in the ground state cross-section is much greater than the cross-section for isomer production. The decay modes of the isotopes are indicated and the corresponding Q values are given in keV. A limited description of daughter decays is included and is used in programmes to ensure that daughters are not overlooked. In this context a daughter includes the active ground state formed from an isomer. Thus, the direction of chain decays may be ascertained. For similar reasons some isotopes not formed from \((n, \gamma)\) reactions have the decay modes of their parents included.

The energy format extends to the third decimal place in keV although few energies have been measured to this precision. The corresponding intensities have been calculated from decay schemes using experimental data on conversion where possible. Intensities from 1 to 99999 are allowed corresponding to the range of intensities which might be observed from any isotope in a single detector \(\gamma\)-ray spectrum. The number of \(\gamma\)-rays at some energy emitted per 1000 disintegrations of the parent may be obtained by multiplying by the appropriate intensity factor.

Energy ordered version: The intensities are given per 1000 parent decays and where this quantity is less than one a zero appears. The cross-sections and abundances refer to the same isotopes as before.

Discussion

The catalogued decay scheme parameters have been used for \(\gamma\)-radioassay. Correct radioassay and error calculation necessitate the inclusion and use of errors in the catalogued \(\gamma\)-ray intensities. Similarly, the attribution of spectral \(\gamma\)-rays to catalogued isotopes would be more certain if the energy errors were included.

Improvements in the catalogue for instrumental activation analysis will follow improved isotope production data. This includes cross-sections for reactions other than \((n, \gamma)\), resonance integrals and fission yields where appropriate. All of these can alter with experimental conditions unlike the figures presented here.

It has not been possible in this catalogue to describe completely the ways in which chain decays may proceed. Whilst the decay mode indicators and the half-lives are adequate to calculate the majority of the growth and decay curves, pro-