1945,[1] receiver pockets have occasionally been located at positions where collection of product material might provide evidence of the natural existence of previously undetected isotopes. But regardless of whether or not new isotopes are "discovered," the mass distribution data for any collected material can be used to assign more positive upper limits to the existence of particular isotopes.

During recent electromagnetic collections of erbium and ytterbium isotopes at Oak Ridge National Laboratory, collector pockets were inserted at the "Er^{172}" and "Yb^{167}" positions to check for the possible natural existence of those isotopes. Mass spectrometric analyses of the purified product, performed at Knolls Atomic Power Laboratory,[2] showed new limits of < 0.000008 and < 0.00001 atom %, respectively (*1*, *2*). Assuming, conservatively, at least a tenfold enrichment of the isotopes during the separation, the limits of natural abundance would be <0.0000008 and < 0.000001 atom % for Er^{172} and Yb^{167}, respectively.

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[1] Operated for the U. S. Atomic Energy Commission by Union Carbide Nuclear Company.

[2] Operated for the U. S. Atomic Energy Commission by General Electric Company.

Precision Measurements of the Slow Neutron Absorption Cross Sections of Normal Boron Standards

The thermal neutron cross section of natural boron is widely used as a standard for measurement of other cross sections and in boron loading specifications for reactors and in reactor physics calculations. Mass spectrometer measurements have indicated that the ratio of the two isotopes B^{10} and B^{11} in natural boron may have as much as a 3% geographic variation (*1*). In the past, the uncertainty due to such variations have been circumvented by mixing a large batch of a boron compound and using this material as a standard. Increasing demands for samples of these standards have, in instances, either exhausted the available supply or required laboratories to have their own standard batch of natural boron. Recent improvements in the reliability of mass spectrometric determinations of the boron isotopic abundance and the high degree of precision that has been obtained for neutron transmission measurements in the thermal region now make possible a precise intercomparison of the thermal neutron cross sections and the isotopic abundance for different samples of natural boron which are available for neutron standardization.

TABLE I

The Neutron Absorption Cross Sections and the Isotopic Purity of the Natural Boron Samples

Sample	Atomic % B^{10}	σ_a (2200 m/sec) barns	$E^{+\frac{1}{2}}\sigma_a$ (barns-ev$^{\frac{1}{2}}$)
Argonne–Brookhaven standard boron	19.8 ± 0.2%	764 ± 3	121.5 ± 0.5
New Argonne standard boron	19.7 ± 0.17%	761 ± 3	121.0 ± 0.5
Westinghouse Bettis sample of normal boron	19.7 ± 0.15%	764 ± 3	121.6 ± 0.5
Am. Chem. Soc. reagent grade H_3BO_3	No measurement	762 ± 3	121.2 ± 0.5

In the present experiment the total neutron cross section for four different samples of normal boron has been measured at neutron energies between 0.00291 ev and 0.1 ev with the Columbia University Crystal Spectrometer. The absorption cross section was obtained by subtracting the relatively small known scattering cross section. In addition, the B^{10} content has been measured for three of the four samples with a mass spectrometer.[1] The samples which are compared are Argonne-Brookhaven standard boron, a new Argonne Laboratory standard boron, a sample of natural boron from Westinghouse Bettis Atomic Power Laboratory, and a sample of A.C.S. Reagent grade H_3BO_3.

For the neutron cross-section measurements, each of the four samples was converted to $NaBO_2$ dissolved in D_2O and was contained in a quartz cell of known thickness. A separate cell of identical thickness contained Na_2SO_4 in D_2O solution. This cell was used to determine the effective transmission of elements other than boron in the cell containing the $NaBO_2$. The concentrations of the $NaBO_2$ and Na_2SO_4 were adjusted such that a BO_2^- ion is compared with $\frac{1}{2}SO_4^{--}$ and the number of Na^+ ions per cc was the same for the two cells. When the ratio of the transmissions of the two cells is taken, the effects of Na^+ cancel, as do the effects of the D_2O except for a small D_2O off-balance, for which a small measured correction of 2% was made for the slightly different volume occupied by the BO_2^- and the $\frac{1}{2}SO_4^{--}$ ions in solution. Another small correction of 1% has been made for the effective cross sections of BO_2^- and $\frac{1}{2}SO_4^{--}$ ions including interference effects in the coherent scattering cross sections of these ions. Spectrochemical analysis showed chemical impurities were small, giving rise to 0.1% correction. The details of the sample preparation (*2*) and of the neutron crystal spectrometer and associated techniques (*3*) have been described previously in the literature.

The results are summarized in Table I. The values of $E^{\frac{1}{2}}\sigma_a$ were obtained from a weighted-least-squares fit to a straight line for thirteen measured points between 0.00291 and 0.1 ev for each sample. The errors quoted are

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one standard deviation and include uncertainties due to counting statistics and variations in sample thickness. It is seen from Table I that the measured absorption cross sections of the four samples are identical to within the quoted errors of 0.5% and that the isotopic compositions of the first three samples are identical to within the 1% quoted errors.

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