$Mg^{25}(d,p)Mg^{26}$ reaction by Holt and Marsham[9] have shown that the second, third, and fourth excited states are spin 2 or 3, even parity, and the first excited state may have a spin between 0 and 5, with even parity. These data are in good agreement with the first scheme of the preceding paragraph if the following spin and parity assignments are made: 0, 1, 2, 2, 3, all even parity.

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[9] J. R. Holt and T. N. Marsham, Technical Report ONRL-121-52, Office of Naval Research, London (unpublished).

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A Search for Si^{32} in Natural Silicon

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Two samples of quartz that had been exposed to an intense neutron flux have been examined radiochemically for the presence of 25-day P^{33}. Only P^{32}, formed presumably from impurities, has been found. Using the limits of detectability and analysis conditions and assuming 0.05 barn for the neutron capture cross section of Si^{32}, an upper limit of 4×10^{-6} percent results for the abundance of Si^{32} in natural silicon.

NUCLEAR systematics[1] indicate that Si^{32} might be a beta-stable nuclide and occur in natural silicon in small, as yet undetected, amounts. The upper limit to its abundance from mass-spectrographic analysis[2] is one part in 50 000. A much lower limit can be inferred from some negative results of neutron activation experiments that are reported here.

Two different samples of quartz that had been exposed to a rather intense neutron flux were examined radiochemically for P^{33}. This nuclide has a half-life of 25 days and a beta-energy of 0.26 Mev. If there is any Si^{32} in natural silicon, exposure to neutrons should produce Si^{33} by the (n,γ) reaction. Since Si^{33} is expected to be short lived, the presence of Si^{32} in natural silicon should be reflected by the presence of 25-day P^{33} in neutron irradiated silicon.

Phosphorus was isolated radiochemically from about 30 g of each sample of quartz by evaporating away SiF_4 in the presence of phosphorus carrier, and then alternating ammonia phosphomolybdate and magnesium ammonium phosphate precipitations. The final precipitate showed a small amount of radioactivity that was proven by chemical recycling to be phosphorus and by absorption and decay curves to be P^{32}. This, presumably, was the product of the interaction of neutrons on sulfur or phosphorus impurities in the quartz. It is estimated that if the beta-radioactivity isolated had contained as much as 10 percent P^{33} it would have been detected in either decay or absorption curves.

This limit of detectability and the irradiation and analysis conditions, yield a limit for the product of the natural abundance of Si^{32} multiplied by the activation cross section of Si^{32} to form Si^{33}. The limits from the two samples are listed in Table I.

Table I. Results of search for P^{33} in neutron-activated silicon.

Sample	1	2
Upper limit to cross section in barns×abundance	3.2×10^{-9}	1.6×10^{-9}
Upper limit to abundance of Si^{32} (assuming a cross section of 0.05 barn for Si^{32})	6.4×10^{-8}	3.2×10^{-8}

Sample 1 exposed in the thimble of the Argonne Heavy Water Pile for about 12 hours

Sample 2 exposed in the "goat hole" of the Argonne Heavy Water Pile for about 5 days

An upper limit of 2×10^{-9} for the product of the abundance of Si^{32} in natural silicon multiplied by the cross section of Si^{32} in barns, results from this work. Although thermal neutron absorption cross sections do not follow too regular a pattern anywhere in the Periodic Table, we estimate the cross section of Si^{32} to be 5×10^{-2} barn with an uncertainty of a factor of 10 by comparison with other light even-even nuclei. The abundance of Si^{32} in natural silicon can then be calculated to be less than 4×10^{-6} percent.

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[1] This has been emphasized, for example, by H. Suess in private discussions at the University of Chicago.

[2] Edward P. Ney and John H. McQueen, Phys. Rev. **69**, 41 (1946).