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VARIATIONS IN THE URANIUM-235 CONTENT OF FIFTEEN ORES

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A B S T R A C T

The uranium isotope compositions of samples from fifteen ores have been compared to a standard. Variations of about one tenth per cent of the uranium-235 content were observed.

VARIATIONS IN THE URANIUM-235 CONTENT OF FIFTEEN ORES

The uranium-235 concentrations of samples prepared from thirteen United States ores and two others have been compared to the Works Laboratory standard of natural isotopic composition. The domestic ores differ from each other by as much as 0.1 per cent of the U^{235} content. Such differences are large enough to be of concern in the procurement and accountability of uranium.

The domestic ore samples were supplied by the Source Materials Procurement Division of the United States Atomic Energy Commission (3); the Uranium Measurements Department prepared uranium hexafluoride from them. The uranium was removed from one to two kilograms of ore by leaching several times with 8 N nitric acid. The solutions were combined, filtered, and evaporated to dryness. The residue was dissolved in 2 N nitric acid, ammonium nitrate was added as a salting agent, and the uranium was extracted into diethyl ether. The uranium was recovered from the ether phase by washing with distilled water and evaporating to dryness. The uranyl nitrate was converted to urano-uranic oxide which was fluorinated to uranium hexafluoride by the high-pressure method (1) in batches of less than two grams.

In order to prevent contamination, each ore sample was processed completely in new vessels which had never contained uranium before; the oxides were fluorinated in new reaction containers.

Each of the hexafluoride samples was compared to two or more samples of the normal standard, obtained from ore (mainly from Belgian Congo) processed by Harshaw and used here since 1947. Each ratio tabulated below includes measurements made on two or three relative, dual-collector, Nier-type mass spectrometers of six-inch radius; no significant difference was detected between results from different instruments. The sample and standard positions were periodically reversed on the sample inlet systems to cancel the effect of possible atmospheric leakage, and leak fractionation effects were avoided by passing both materials through the same leak. The bias from the memory effect on the ratios is less than 0.00004.

The reproducibility of the preparation and analytical procedures was verified a month later by preparing new uranium hexafluoride samples from other portions of eight of the ore samples and analyzing them. These later results are indicated by parentheses in the table.

Sample No.	Mineral	Mine Location	95 Per Cent Confidence	
			Ratio*	Limits
542	Autunite in granite or quartz monzonite	Marysvale, Utah	1.0002	± 0.0004
640-651	Arsenical in sandstone	Camp Bird mine, Temple Mountain, Utah	0.9999 (0.9997	± 0.0002 ± 0.0002)
1235	Uraninite-fluorite-tyuyamunite in Todilto limestone	Haystack Mountain, McKinley Co., N. Mex.	0.9993 (0.9994	± 0.0002 ± 0.0003)
1487	Uraninite in sandstone	Big Indian Wash, Utah	1.0001 (1.0000	± 0.0001 ± 0.0002)
1740	Low-vanadium oxide ore from sandstone, Petrified Forest, Chinle formation	Ramco No. 17 mine, Cameron, Arizona	0.9997	± 0.0002
1757	Uraninite-copper-vanadium in sandstone, Shinarump, Chinle formation	C-3 mine, Monument Valley, Utah-Arizona	0.9994 (0.9995	± 0.0002 ± 0.0002)
1762	Partly oxidized coffinite in sandstone, Brushy Basin, Morrison formation	Jackpile mine, Valencia County, New Mexico	0.9993 (0.9993	± 0.0002 ± 0.0002)
2294	Arsenical uraninite-coffinite in volcanic rocks	White King mine, Lakeview, Oregon	1.0002	± 0.0002
3033	Uraninite-copper in sandstone	White Canyon, Utah	0.9995 (0.9992	± 0.0002 ± 0.0002)
3034	Uraninite in sandstone, Upper Wind River formation	Aljob Claims, Natrona County, Wyoming	0.9996	± 0.0003
3035	Uranium-vanadium in Salt Wash sandstone, Morrison formation	Paradox D mine, Montrose Co., Colorado	0.9998	± 0.0003
3036	Uraninite (some coffinite) in metamorphic rocks	Schwartzwalder and Mena mines, Denver, Colorado	1.0001 (0.9999	± 0.0002 ± 0.0002)
3039	Schroëckerite in mudstone, Lost Creek deposit	Sweetwater County, Wyoming	0.9995 (0.9995	± 0.0002 ± 0.0002)
Lot 19	Orange oxide	Belgian Congo	1.0000	± 0.0001
Lot 305	Orange oxide	Port Hope, Canada	0.9998	± 0.0001

*Of the $U^{235}/(1-U^{235})$ ratio of the sample to the $U^{235}/(1-U^{235})$ ratio of the standard.

Our value of 0.9993 ± 0.0002 , for sample 1762 of coffinite from the Jackpile Mine, is in good agreement with values obtained by W. R. Shields (5). He obtained a ratio of 0.9990 ± 0.0002 on carnotite ore from the same mine, and 0.9993 ± 0.0002 on coffinite from New Mexico. His value for uraninite, 0.9993 ± 0.0002 , overlaps our values for samples 1235, 1757, 3033 and 3034, but not our values for other samples also containing some uraninite. Senftle et al. (4) have reported variations of 0.13 per cent in the U^{235} abundance in domestic ores, based on Y-12 analyses of ten samples. Although Hamer and Robbins (2) have reported the maximum deviation from a standard to be 0.05 per cent for twelve ore samples from several continents, the maximum deviation among the twelve samples is about 0.09 per cent.

Mr. William B. Kenna and Mr. Richard T. Phillipponne of the U.S.A.E.C. kindly supplied the domestic ore samples, Mr. George Petit directed the preparation of uranium hexafluoride from them and Mr. O. C. Smitherman supervised the spectrometer comparisons.

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