



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

129

FEB 5 1982

MEMORANDUM FOR: John G. Davis, Director  
Office of Nuclear Material Safety  
and Safeguards

FROM: Robert B. Minogue, Director  
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER # 129 THORIUM IN HUMAN TISSUES

SUMMARY

The content of the naturally-occurring alpha-emitting isotopes of thorium (Th-228, Th-230, and Th-232) was measured in 22 sets of human tissues obtained at autopsy from Grand Junction, Colorado and in 10 sets from Washington, DC. For all three isotopes and in both populations, the highest concentration was found in the pulmonary lymph nodes (2.6 to 11.0 pCi/kg). For Th-230 and Th-232, the next highest levels were in the lung (0.32 to 0.80 pCi/kg), whereas for Th-228 the second highest concentration was found in the bone (0.54 to 0.66 pCi/kg). Kidney and liver levels were lower and similar to each other (0.03 to 0.29 pCi/kg). These results indicate that inhalation is the primary pathway of intake for Th-230 and Th-232 and that Th-228 occurs as a result of the ingrowth from ingested Ra-228. Elevated concentrations of thorium-230 were found in the tissues of two individuals who had been employed as miners. Residents of Grand Junction did not have statistically greater thorium-230 concentrations in their lungs compared to residents of Washington, when the values were adjusted for age.

INTRODUCTION

The objectives of the study were to determine the distribution of the naturally-occurring isotopes of thorium in the human body and to see whether individuals who lived in a town having uranium mill tailings had levels of Th-230 in their tissues greater than the levels in the tissues of non-exposed individuals.

Although thorium is a widely distributed element in the environment, its distribution in the human body has not been adequately studied. Thorium is considered for licensing purposes 1) as source material in industrial applications and 2) as a contaminant of interest in uranium mill tailings. In addition, its chemical properties make the study of thorium useful for inferring information about the biological behavior of plutonium.

This memorandum transmits the results of the project entitled, "Thorium in Human Tissues." The study was conducted by Drs. MacDonald E. Wrenn and Norman Cohen of the Institute of Environmental Medicine of New York University under the direction of the Health Effects Branch. Begun in FY 1977, the work required four years for development of analytical techniques and acquisition and analysis of tissues.

METHODOLOGY

Twenty-two sets of tissues were obtained at autopsy from persons in Grand Junction, Colorado, a town in the western United States with a uranium mill tailings pile, and ten sets were collected in Washington, DC where no elevated source of thorium is known to exist. The samples taken were generally from accident victims, and the subjects were generally long-time residents of the area. No subject had a chronic debilitating disease or a disease known to affect liver or skeleton metabolism. From each case, the following organs were collected by a pathologist: the right lung (plus lymph nodes), a kidney, approximately one-half of the liver, and approximately 200 grams of bone from the vertebra. The tissue samples were placed in individual plastic bags, frozen, and shipped to New York University.

A simple accurate analytical technique was developed for the determination of environmental levels of alpha-emitting isotopes of thorium using Th-229 as an internal tracer. The method consisted of tissue digestion, separation of thorium from other elements by solvent extraction, electrodeposition, and solid-state alpha-spectrometric measurements using Si(Li) surface barrier detectors.

RESULTS AND DISCUSSION

The following table gives the median values of the concentrations of the three thorium isotopes in the five organs analyzed in the two populations:

Median Concentration of Thorium Isotopes (pCi/kg)

	<u>Th-228</u>	<u>Th-230</u>	<u>Th-232</u>
<u>Grand Junction</u>			
Lymph Nodes	5.1	11.0	7.8
Lung	0.28	0.80	0.58
Bone	0.54	0.92	0.16
Kidney	0.07	0.29	0.07
Liver	0.07	0.15	0.03
<u>Washington</u>			
Lymph Nodes	2.6	4.6	2.8
Lung	0.24	0.36	0.32
Bone	0.66	0.32	0.10
Kidney	0.09	0.17	0.03
Liver	0.09	0.11	0.05

For all three isotopes and in both populations, the highest concentration was found in the pulmonary lymph nodes. For Th-228, the second highest concentration was found in the bone, whereas for Th-230 and Th-232 the second highest concentration was found in the lung. Since the gastrointestinal absorption of soluble thorium is very low and the isotopic ratio found in the lymph nodes is similar to that found in air and soil, these results suggest that inhalation is the primary pathway for intake of Th-230 and Th-232. If inhalation were the only route of thorium uptake, the ratio of Th-228/Th-232 in tissue should be similar to that in air. This fact, coupled with the higher concentration of Th-228 in bone, suggests that some of the Th-228 originated from the decay of Ra-228 which is readily absorbed through the gut and translocates to bone.

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Two of the cases from the western location showed clearly elevated Th-230 concentrations in all tissues, compared to the rest of the subjects. The first was a hard-rock miner whose thorium concentration was an order of magnitude higher than the median of the location, and the second was a uranium miner whose thorium concentration was more than two orders of magnitude higher. These two cases were not included in the calculation of the median concentrations because their exposures were clearly of an occupational origin.

The median concentrations for Th-230 and Th-232 in Grand Junction tissues exceeded those from Washington, DC. Two statistical test were performed to test the hypothesis that the concentrations were significantly different. The results confirmed that the Th-230 and Th-232 concentrations in the lung, lymph nodes, kidney, and bone of Grand Junction subjects exceeded those of the Washington, DC area. However, because the age distribution of the two groups was different (67 years median for Grand Junction and 33 years median for Washington, DC), an adjustment was made and the results of the reanalysis showed no statistically significant differences between the two locations. This suggests there is no enhanced uptake resulting from inhalation of thorium-containing mill tailings material.

#### CONCLUSIONS AND RECOMMENDATIONS

The results reported in NUREG/CR-1227 represent the only sufficiently detailed study in man to date which allows assessment of the distribution of thorium isotopes among organs. Using reference weights for organs in men and women, it was found that the highest total accumulation of thorium is in the skeleton. For Th-230 and Th-232, about 11-29% of the body content is in the lung; for Th-228, only 5% is in the lung. The organ distribution pattern of thorium found in this study is in good agreement with that recently adopted in ICRP No. 30. This study suggests that environmental thorium is probably retained with half-times of a year or greater. We, therefore, recommend that your staff adopt the ICRP 30 methodology for internally deposited thorium.

The whole subject area of the naturally-occurring radionuclides requires additional health-related research. We plan to sponsor other studies that will provide needed information on actinide radiobiology. For further information, please contact Dr. Judith Foulke, Health Effects Branch (427-4563).

  
Robert B. Minogue, Director  
Office of Nuclear Regulatory Research

cc: Dr. M. E. Wrenn

## SUMMARY

The content of the naturally-occurring alpha-emitting isotopes of thorium (Th-228, Th-230, and Th-232) was measured in 22 sets of human tissues obtained at autopsy from Grand Junction, Colorado and in 10 sets from Washington, DC. For all three isotopes and in both populations, the highest concentration was found in the pulmonary lymph nodes (2.6 to 11.0 pCi/kg). For Th-230 and Th-232, the next highest levels were in the lung (0.32 to 0.80 pCi/kg), whereas for Th-228 the second highest concentration was found in the bone (0.54 to 0.66 pCi/kg). Kidney and liver levels were lower and similar to each other (0.03 to 0.29 pCi/kg). These results indicate that inhalation is the primary pathway of intake for Th-230 and Th-232 and that Th-228 occurs as a result of the ingrowth from ingested Ra-228. Elevated concentrations of thorium-230 were found in the tissues of two individuals who had been employed as miners. Residents of Grand Junction did not have statistically greater thorium-230 concentrations in their lungs compared to residents of Washington, when the values were adjusted for age.

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Original signed by:  
ROBERT B. MINOGUE

Robert B. Minogue, Director  
Office of Nuclear Regulatory Research

cc: Dr. M. E. Wrenn

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August 4, 1982

Mr. Robert B. Minogue, Director  
Office of Nuclear Regulatory Research  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Mr. Minogue:

This is a request for a single copy of Research Information Letter (RIL) Number 129 which discusses thorium in human tissues. This RIL was discussed in the May-June, 1982, issue of "Nuclear Safety."

This agency is charged with the stabilization and closure of the Maxey Flats Nuclear Waste Burial Facility in Kentucky, and these types of documents would be quite useful to us as we carry out this task. If we could receive the appropriate forms for obtaining these RIL's, it would be most appreciated.

Thank you,

A handwritten signature in cursive script, appearing to read "Doyle Mills".

Doyle Mills  
Environmental Control Manager  
Office of Special Projects

DM:kp

*file RIL # 129*

*Pat  
Please send by  
mail 5/6*