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Hair Tissue Mineral Analysis

- Uranium -

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Uranium (U) is a naturally occurring element in the earth and is present in most soils, rock and water. Its concentration in the earth's crust is about 3 parts per million, which is a higher concentration than for silver, tin, cadmium and mercury, and similar to the concentrations of arsenic and molybdenum. Higher concentrations of uranium can be found in granite formations. Natural uranium is found in three isotopes U-234, U-235 and U-238. Over ninety-nine percent of this mixture is U-238. Although radioactive, the alpha emissions from naturally occurring uranium is not considered a health hazard compared to enriched uranium in the form of a higher percentage or concentration of U-235. Enriched uranium is produced for use in nuclear energy and contains approximately three percent U-235, while further enrichment for weapons contains over ninety-seven percent. Both are highly radioactive, and exposure to these forms presents a serious health hazard. Depleted uranium contains less U-235 and is not as radioactive.

Sources of uranium

Although naturally present in the earth's crust, uranium can be found in much higher concentrations in different areas of the country, primarily in those regions with granite deposits. Increased concentrations may also be found in or near uranium mining and milling operations as well as industrial manufacturing that use depleted uranium for production of aircraft parts, plating, munitions, etc. Ore used for the production of phosphate fertilizer may also be a source of uranium.

The main source of uranium intake or exposure, other than in those working with or living near mining operations is through ingestion of water and foods containing uranium. Foods grown in soils high in uranium may contain higher than normal concentrations, particularly root vegetables. The average water concentration of uranium is 1.2 ug/L but varies widely throughout the U.S. The U.S. EPA has established a maximum contaminate level for uranium in drinking water at 0.03 mg/L.

Health effects of uranium

Even though naturally occurring uranium has radioactivity, this is not the main issue with exposure. The most common finding with prolonged exposure is related to abnormal renal function. Inhalation can cause irritation to the lungs and skin exposure to soluble uranium can produce dermal irritation. Uranium accumulates largely in bone, but is also distributed and deposited in the liver and kidneys.

Biological tests for uranium

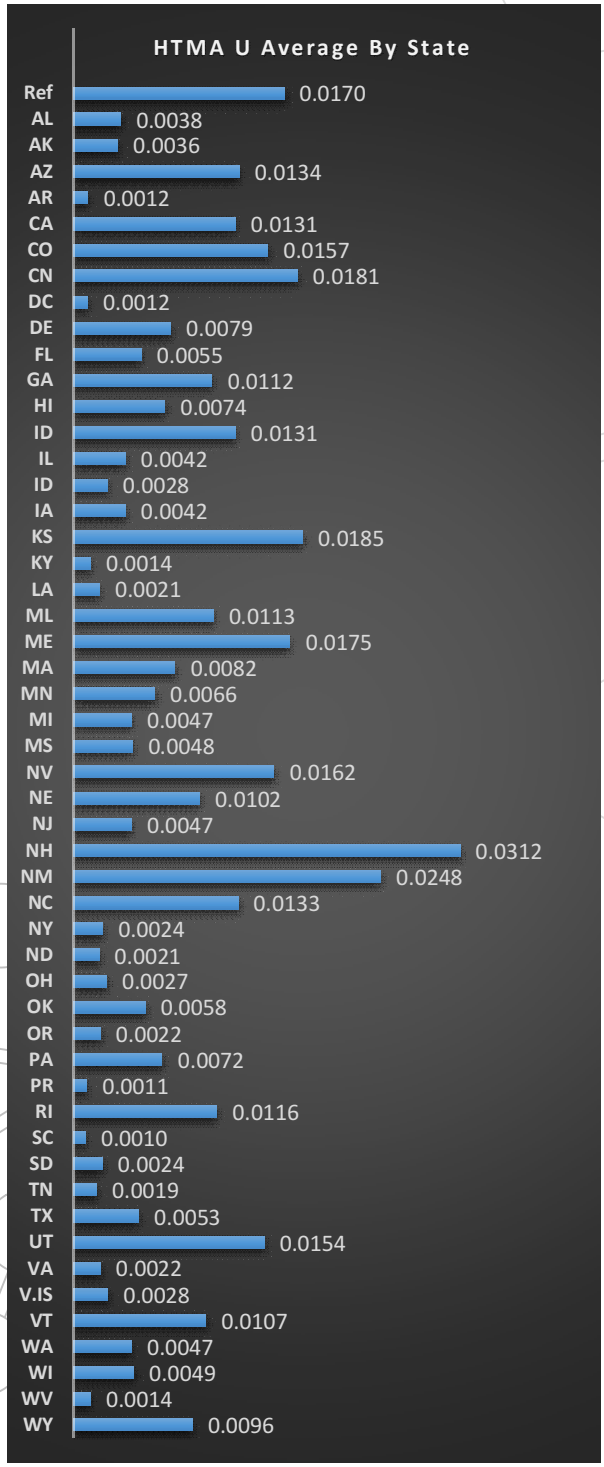
Uranium can be analyzed in hair, blood, urine and tissues. Total body radiation detection can also be used to assess uranium exposure. Urine is the most common specimen used to test for uranium. However, since ingested uranium that is not deposited in body tissues is excreted in the urine within a few days the test can only detect an exposure from approximately a week prior and does not provide information about body retention. As with other heavy metals, uranium may be cleared from the circulation and sequestered into tissues after exposure has ceased.

Hair analysis as an indicator of uranium exposure

Urine testing for environmental and occupational exposure to uranium is commonly used. However, some problems exist with this method. According to Karpas (Karpas Z. 2001), urinalysis reflects recent exposure (within a few days) or chronic on-going exposure. Also, due to the normal diurnal fluctuations, the use of "spot samples" makes it difficult to estimate the amount of internal dose received. Further, he states that if urine samples are not collected in a short time following exposure, internal dosimetry calculations may be misleading. These drawbacks may be overcome with the use of hair and nail sample analysis, and may show better insights for internal dosimetry of uranium exposure.

Other researchers have also found that hair uranium analysis is useful and that uranium levels correlate with uranium intake. (Karpas, Z, et al. 2005) Testing of groups exposed to high uranium intake from drinking water found that the hair content of uranium could be traced to the water source and that hair tests can serve as an excellent indicator of occupational or environmental exposure, and provide information about the source of uranium as well

(Karpas, Z, et al. 2005). Muikku, and colleagues reported that the uranium content of hair samples can be used for occupational exposure and studies also reveal that variation of uranium concentrations in water sources are shown by the variations in hair uranium content. (Muikku, M, et al. 2007, Muikku, M, et al. 2009). Zunic, et al. found that the heavy metal content found in human hair may serve as a good indicator of dietary, environmental and occupational exposures to uranium (Zunic, ZS, et al. 2012).



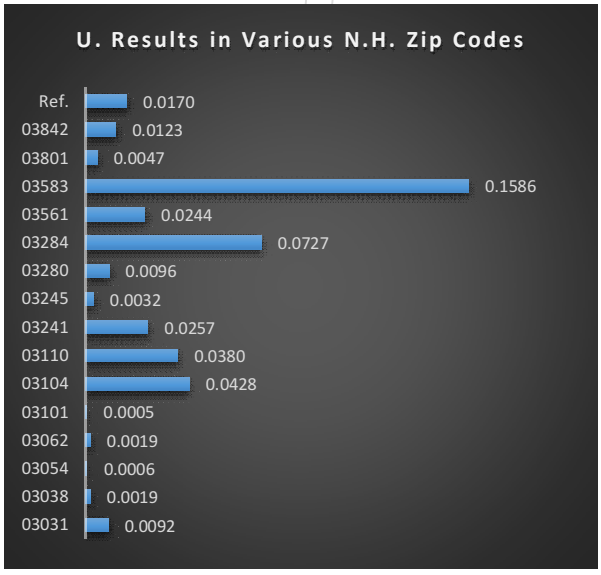
HTMA and U.S. geographic uranium findings

At Trace Elements, we have often found high levels of uranium in individuals in various geographic pockets throughout the US. Levels greater than 0.300 mg% often correspond to high uranium levels in the water supply. The most common geographical areas where uranium is abundant are those with high granite rock and soil. In those areas uranium is naturally occurring along with radon. High uranium in water supplies is also found in agricultural areas where the water is exposed to fertilizer runoffs. However, agricultural sources of uranium are not typically associated with radon. It should be stressed again that uranium is a naturally occurring element and therefore will be found in all humans to some extent. However, HTMA has proven to be an effective screening tool in determining excess exposure in individuals and families which otherwise would not have been detected.

The previous chart shows the average HTMA result for uranium levels found in over one hundred fifty thousand individuals living within the United States and US territories. Average uranium levels of individuals tested within each state, territory are shown in the legend. We can readily see the highest averages are found in New Hampshire (NH) followed by New Mexico, (NM). Although these average uranium levels found in individuals tested should not be construed to represent the entire state, but may only represent areas within the state of individuals who were exposed to excessive levels of uranium, and can be determined by result of samples submitted from regional zip codes.

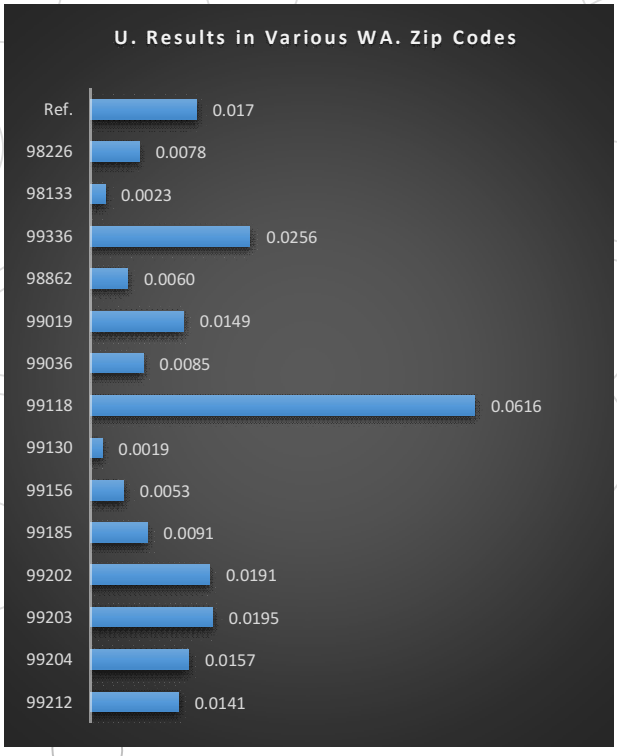
New Hampshire uranium average by zip code

The second chart depicts the average uranium found in individuals tested in various counties or zip codes in New Hampshire. Although a high average may be seen in a particular area, it could be isolated due to contaminated wells being used by a small number of individuals who were tested.



Washington state uranium average by zip codes

Also, states that have a low total average of uranium in individuals tested may have areas of high concentrations based upon samples from various zip codes. For example, the following chart for Washington State shows a significant variance in individual test levels submitted from different zip codes. This shows that uranium levels cannot be assumed to be either low or high in certain U.S. states, but is dependent upon local individualized exposure.



Hair testing for uranium at TEI

Uranium is analyzed at Trace Elements (TEI), using ICP-MS. In our method, mass 238.050 atomic mass units is monitored using 19 sweeps per reading. This mass is read for 50.0 ms each sweep for a total of 950 ms per sample. We use both the AutoLens system and Dual Detector system of Perkin Elmer Elan models to take advantage of the ion detector's full dynamic range. Internal standardization on Lutetium mass 174.941 is used to stabilize the U reading. No correction factors are necessary to read U-238. No interference acts on this mass. Uranium is quantified by the Elan software using a calibration curve of three standards and a calibration blank. The concentrations of calibration standards are 0.05, 0.08 and 0.8 parts per million. Internal standardization occurs throughout the run with the in-line addition of Lu-175 standard which stabilizes the uranium signal. Detection limits and liner reporting ranges are verified every six months per CLIA regulations. The calibration limit for U is 0.0005 milligrams percent (mg%). The linear reporting rage is 0.0005 to 0.4000 mg%. Rechecks are performed on samples with uranium values of 0.0590 mg% or higher. Accuracy for the laboratory ICP-MS technique, methodology/procedures in use at TEI is based upon NIST (National Institute of Standards and Technology) traceable standard reference material. We have found hair uranium analysis to be highly accurate and reproducible. (Dutrizac, L. 2006).

Discussion

We have seen many cases of individuals being unknowingly exposed to high uranium levels in their environment. In most cases these have been found to be water sources that were discovered to be excessive after HTMA tests of individuals and their families. Since radon gas is typically found where uranium concentrations are high we also instruct individuals to have their environment tested for the presence of radon gas, which has proved to be excessive by EPA standards in many past cases.

Studies at TEI have shown that HTMA is an excellent tool for the assessment of individuals and groups to the possible exposure of excessive metals that may be in their environment. These studies support findings of other researchers who have reached similar conclusions. After completing a study involving over one-hundred different households where drinking water was supplied from private wells in southern Finland Karpas stated; "These results conclusively demonstrated that the uranium found in the bioassays can be traced to the drinking water, thus providing a direct link to the source of exposure. Hair may serve as an excellent indicator of occupational or environmental exposure to uranium and provide information regarding its source. Bioassay of hair is attractive as it is an effective bio-concentrator, samples can be easily stored and the concentration reflects an integrated value. (Karpas, et al. 2005)

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