Elevated Uranium and Lead in wells on the Crow Reservation, Big Horn County - a potential problem

Anita L. Moore-Nall, Margaret J. Eggers, Anne K. Camper and David R. Lageson, Montana State University, Bozeman, Montana

2012 GSA Annual Meeting, November 4-7, Charlotte, North Carolina

Bighorn Reservoir near the confluence of Black Canyon and the Bighorn River. Mississippian aged Mission Canyon Formation with solution breccia and red staining from the Pennsylvanian aged Amsden Formation above, forms the canyon walls. This is the formation that hosts the mineralized uranium/vanadium deposits upriver in the two abandoned mining districts. The Bighorn River was declared a 303d impaired waterway once it passes through the Crow Reservation due to elevated lead (Pb) and mercury (Hg) in 1996. As of 2010 it remains on the list.

ABSTRACT:

NURE (National Uranium Resource Evaluation) data show several wells with elevated U (uranium) and Pb (lead) in Big Horn County, Montana. Wells with elevated U and Pb might pose health risks if the designated use is for drinking water. The EPA national primary drinking water standards are 30 µg/L for uranium and 15 µg/L for lead. Values of uranium in the NURE data base exceed the standard in several wells in the county, with the highest value reaching 404 µg/L. Lead data in the NURE data base is questionable due to instrumentation problems at the time the data were analyzed. The GWIC (Ground Water Information Center) data from the Montana Bureau of Mines and Geology also shows some elevated uranium and lead values in Big Horn County. The GWIC data for Big Horn includes 600 sites which were tested for lead and 169 for uranium. The GWIC data base shows 102 wells that exceed the 15 µg/L value for lead, with 55 wells exceeding 80 µg/L, and the highest value being 585 µg/L. Most of these wells are monitoring wells that are proximal to the Decker mining area and may be related to the coal, especially the Tongue River member of the Fort Union Formation. Many of the high uranium values in the wells on a GIS (Geographic Information System) generated map of NURE data are in the Quaternary terrace deposits. Many wells on the Reservation are in these shallow Pleistocene deposits; most were not tested for uranium at the time the Indian Health Service had the wells drilled. These data prompted the Crow Water Quality Project at Little Big Horn College (LBHC) to include uranium as a parameter in its home well water testing. In the 94 wells LBHC has tested to date for uranium, 2/3 were positive for uranium and 8% exceeded the EPA primary standard. These latter wells pose health risks if the water is used for drinking or cooking; further testing is implicated.

Sampling a tributary of the Little Bighorn River for metals and measuring flow, part of the Crow Water Quality Project

Members of the Crow Environmental Health Steering Committee and Crow Water Quality Project staff

What are the health risks from uranium exposure?

Uranium occurs naturally in the geologic formations of the Crow Reservation. Radium is a decay product, so the occurrence of uranium in groundwater indicates that radium is likely to be present as well. Alpha particles are the primary form of radiation emitted by both elements. Although our bodies eliminate most of the uranium and daughter products consumed in drinking and cooking water, small amounts are absorbed from the digestive tract and enter the bloodstream. Uranium in the bloodstream is filtered by the kidneys, potentially damaging the kidney cells in the process. Both uranium and radium are deposited primarily in our bones, resulting in small increases in the risks of breast, liver and bone cancer. These health risks are based on consumption of contaminated water over many years. Children, infants, pregnant and nursing women, and women of childbearing age are at greater risk, because growing infants and children absorb more of these radioactive elements. Uranium and radium can cause irreversible damage during critical periods of human development. Well water contaminated with uranium can still be used for bathing, washing clothes and other non-consumptive uses, as absorption through skin is too minimal to be a health risk (Georgia Department of Natural Resources; US EPA 2012).

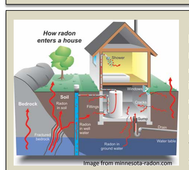
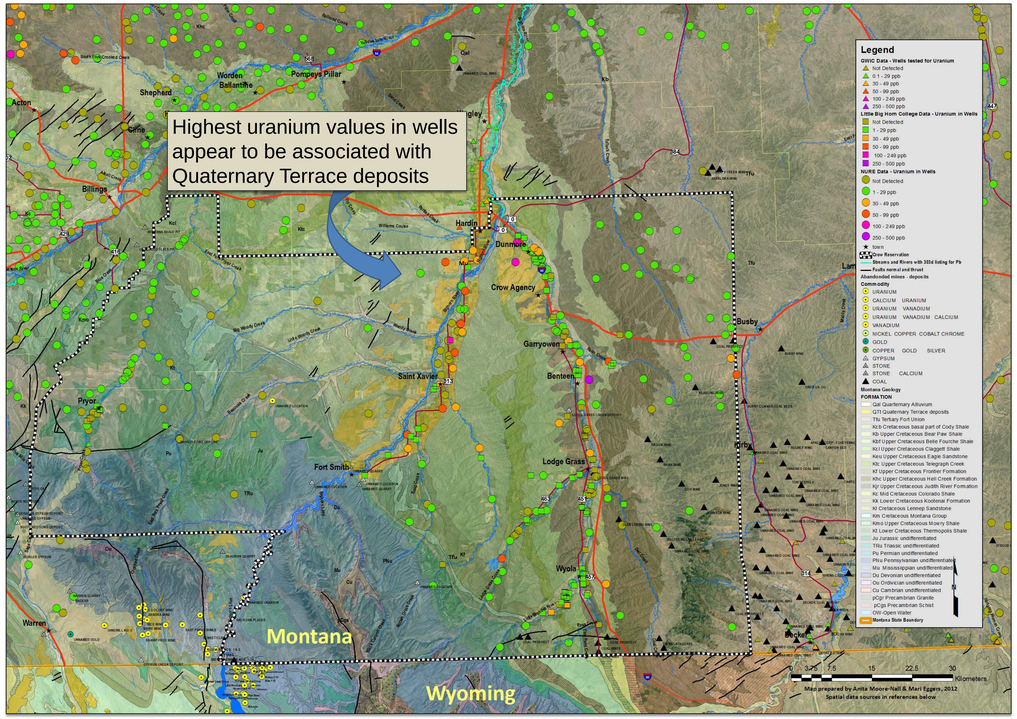
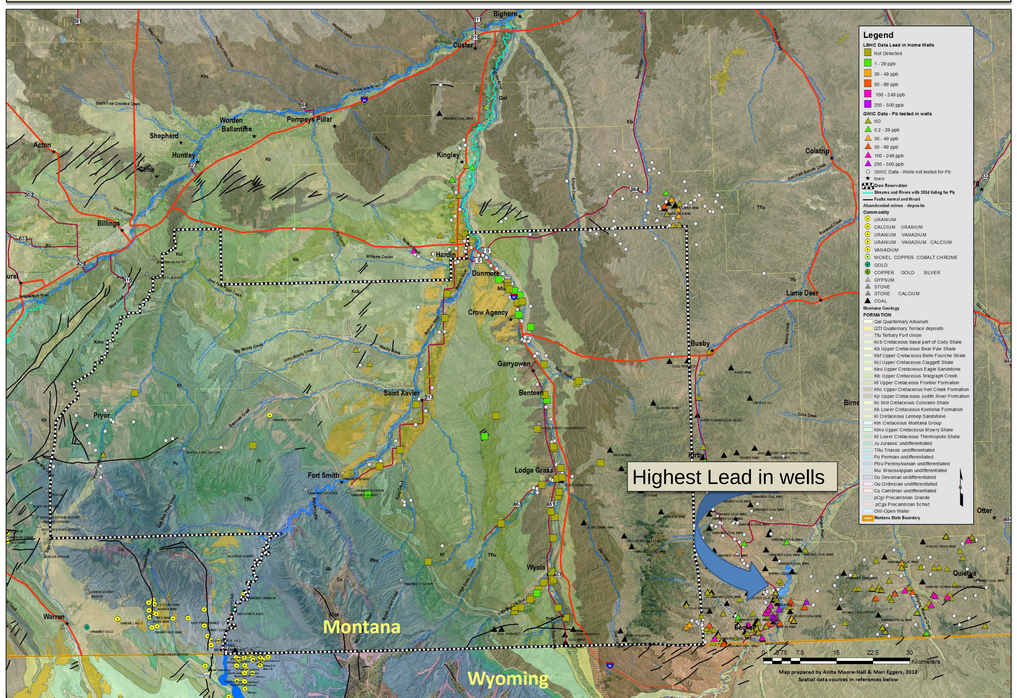


Image from minnesota-radon.com

Radon? Radon, also a decay product of uranium, is another health risk. The primary routes of potential human exposure to radon are inhalation and ingestion. Radon in the ground, groundwater, or building materials enters working and living spaces and disintegrates into its decay products. Although high concentrations of radon in groundwater may contribute to radon exposure through ingestion, the inhalation of radon released from water is usually more important. As it further breaks down, radon emits atomic particles. These particles are in the air we breathe. Once inhaled, they can be deposited in our lungs. The energy associated with these particles can alter cell DNA, thus increasing the risk of lung cancer. Homeowners with higher U values in their wells may be at more risk for radon in their homes. There is insufficient radon data for Big Horn County although radon data for adjoining counties shows 32 to 38 % of homes tested at or above 4 pCi/L, requiring mitigation (Air Chek, Inc., 2009).



GIS generated maps with geologic formations and well data from three data bases: the USGS NURE-HSSR data base; the Montana Bureau of Mines and Geology GWIC data base and the Little Big Horn College data base showing uranium concentration in wells (top map) and lead concentration in the bottom map. The lead map does not include NURE data due to instrumentation problems with the analysis of lead.



CROW WATER QUALITY PROJECT:

On learning from Moore-Nall about the NURE data for the Crow Reservation and the occurrence of uranium in the geologic formations in the Pryor Mountains adjacent to the reservation, the Crow Water Quality Project decided to include uranium testing in its home well water testing. Residents from throughout the Reservation volunteered to have their well water tested for mineral and microbial contaminants, including uranium. Energy Laboratories, an EPA certified lab in Billings, Montana, has conducted these tests. An explanation of test results and of the health risks of elevated uranium are being provided to participating homeowners both in print and in person. Our project is a community-based participatory research initiative of Little Big Horn College (the Tribal College for the Reservation), the Crow Tribe, the Apsaalooke [Crow] Water and Wastewater Authority, the local Indian Health Service Hospital and other local stakeholders, with support from academic partners at MSU Bozeman and the University of New England.

Methods:

- Geographic Information System (GIS) analysis: Initially data from the USGS National Uranium Resource Evaluation and Hydrogeochemical and Stream Sediment Reconnaissance Program database (NURE-HSSR)* was examined to look at the distribution of lead and uranium in wells in Bighorn County, Montana. These data were compared with GWIC data for the county.
- Water Sampling: Based on the findings from the GIS study additional testing of water from home wells was implemented on the Crow Reservation to include U.
- Data from the water sampling was added to the GIS analysis to produce the maps to the left

*From 1973 to 1980, the Federal Government systematically evaluated the uranium resources of the conterminous States and Alaska. The National Uranium Resource Evaluation (NURE) program included hydrogeochemical and stream sediment sampling, one of nine components of the program. Los Alamos Scientific Laboratory (LASL), New Mexico, was assigned the Rocky Mountain States including Montana. The Department of Energy (DOE) administered the NURE program from 1977 until 1984 when funding disappeared and the program effectively ended. The sample archive, including original maps, field notes and data tapes was transferred to the United States Geological Survey (USGS) in 1985. The USGS compiled and reformatted the databases from all the DOE laboratories, and reports from contractors to enhance the usefulness of the National Geochemical Database. This database is publically available on-line and in CD-ROM format at : http://pubs.usgs.gov/of/1997/ofr-97-0492/ .

The Crow Water Quality Project tests home well water quality

Outreach: Pretty Eagle students and project staff provide home well water testing for community members.

Stock well near southern edge of Crow Reservation

Old hand water pump on Crow Reservation

Results and Discussion:

- Most of the home wells tested to date do not have elevated lead (Pb); the elevated lead in the data bases is mainly in the monitoring wells associated with coal mines in the south eastern part of Big Horn County.
- More than 2/3 of the local wells sampled by the Crow Water Quality Project have tested positive for uranium, and about 8% of wells tested exceeded EPA's Maximum Contaminant Level of 30 µg/L. While EPA's MCL reflects both health and economic considerations, EPA's Maximum Contaminant Limit Goal (MCLG) is 0 µg/L – meaning that ideally, you don't want any uranium in your drinking water. In Canada, the "Maximum Acceptable Concentration" is 20 µg/L (Health Canada 2010). The World Health Organization has recommended a guideline value of 15 µg/L (WHO 2004). In short, at least 8% of wells tested present a health risk to the residents, and this percentage would increase if one of the more conservative standards for uranium was used.
- For homeowners whose well water exceeds 30 µg/L uranium, the recommendation is to haul water for drinking and cooking, or to treat well water with point of use reverse osmosis or distillation technology.
- Additionally, the Little Big Horn River and its tributaries – the water source for Crow Agency's municipal water supply – have been found to have low level uranium (up to 1.5 µg/L); the Big Horn River at Hardin – also a municipal water supply source – is averaging about 4 µg/L uranium. Such low levels of uranium are common in drinking water nationwide. An EPA survey of nearly 1000 sites in the U.S. found an average concentration of 2.55 µg/L uranium. Hence residents using these local municipal water supplies are negligibly at risk from uranium exposure, and are no more at risk than the average American.

Conclusion and Future Work:

The occurrence of uranium in home well water is widespread on the Crow Reservation, with at least 8% of homes at risk of serious chronic health problems from long term consumption of their well water. As uranium in water cannot be detected by taste, smell or sight, we encourage homeowners to have their well water tested for this contaminant. Certified labs in Montana can provide this service for $10 - $25. Local residents using surface water municipal water supplies are not at risk of uranium exposure from their drinking water. Continued risk communication and risk mitigation with residents of the Crow Reservation are warranted.

ACKNOWLEDGEMENTS:

Alfred P. Sloan Graduate Scholarship Programs – Minority PhD Component/Sloan Indigenous Graduate Partnership; Montana State University – Dennis and Phyllis Washington Foundation Native American Graduate Fellow; HOPA Mountain National Science Foundation Fellow; Zero Emissions Research and Technology Grant; TRGS Tobacco Root Geological Society scholarship; AGI The American Geologic Institute; Center for Native Health Partnerships' Grant #P20MD002317 from National Institute of Minority Health & Health Disparities; NIH Grant #P20 RR-16455-04 from the INBRE Program of National Institute of General Medical Science National Institutes of Health; Award #RD83370601-0 from the Environmental Protection Agency; EPA STAR Fellowship Research Assistance Agreement #FP91674401. **NOTE:** The content is solely the responsibility of the authors; it has not been formally reviewed by any of the funders and does not necessarily represent the official views of the National Institutes of Health or of the Environmental Protection Agency. The EPA does not endorse any of the products mentioned.

REFERENCES: Air Chek, Inc., 2009, The Radon Information Center, http://www.radon.com/radon/radon_map.html; EPA, Uranium, downloaded from http://www.epa.gov/rpdweb00/radionuclides/uranium.html on 9/25/12; Georgia Department of Human Resources, Radium and Uranium in Public Drinking Water Systems, downloaded from www.gaepd.org/Documents/radwater.html in 2011; GWIC Data downloaded from the Montana Bureau of Mines and Geology http://mbmggwic.mtech.edu/ in 2011; Health Canada, Water talk – Uranium in drinking water, downloaded from http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/uranium-eng.php on 9/25/12; Kurttio, P., Auvinen, A., Salonen, L., Saha, H., Pekkanen, J., Makelainen, I, Vaisanen, S.B., Penttila, I.M., Komulainen, H. , 2002, Renal Effects of Uranium in Drinking Water, Environmental Health Perspectives, 110(4), pp. 337-342; Peterson, D.A., and Boughton, G.K., 1998, Organic compounds and trace elements in fish tissue and bed sediment from streams in the Yellowstone River Basin, Montana and Wyoming, U.S. Geologic Survey Water-Resources Investigations Report 00-4190, 46p.; Peterson, D.A., and Zelt, R.B., 1999, Element concentrations in bed sediment of the Yellowstone River Basin, Montana, North Dakota, and Wyoming - A retrospective analysis; **Spatial data from**: Montana Natural Resources Information System (NRIS): http://nris.mt.gov; Smith, S.M., 2006, National Geochemical Database, On-line Manual for USGS Reformatted NURE HSSR Data Files Open-File Report OFR 97-492 Version 1.40 http://pubs.usgs.gov/of/1997/ofr-97-0492/; NURE Spatial Data for water: http://tin.er.usgs.gov/nure/water/; Wyoming Geographic Information Center: http://wyatt.wygisc.org/wygeoinfo; University of Nebraska Lincoln, 2008, Drinking water: Uranium, Downloaded from http://www.ianrpubs.unl.edu/live/g1569/build/g1569.pdf on 9/25/12; World Health Organization, 2004, Uranium in drinking water: Background document for development of WHO Guidelines for drinking-water quality, downloaded from http://www.who.int/water_sanitation_health/dwq/chemicals/en/uranium.pdf on 9/25/12.