RADIONUCLIDES IN NORTH DAKOTA SOILS

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Mankind has known of the biological hazards of radiation since the first case of sunburn and has taken precautions to avoid overexposure from that day on.

With Roentgen's discovery of x-rays and Becquerel's discovery of radioactivity, man has begun to realize more fully the hazards of the more penetrating forms of radiation.

Since the 1940's and the development of atomic warfare, atomic and hydrogen bombs, bomb testing programs and other research into nuclear devices, man has unleashed quantities of radioactive materials referred to as fallout into the atmosphere. This fallout has in turn fostered additional attention on the potential biological hazards of radiation to the world population.

Further information on these biological hazards has been uncovered through the medical use of x-rays. The medical profession now realizes the need to weigh the calculated risk of x-ray or diagnostic and therapeutic use of radioisotopes against the benefit to be gained from such use. During this time and utilizing all available information, groups of competent scientists throughout the world have devoted much careful thought to the establishment of safe limits of exposure.

Some scientists have objected to these standard limits in the past decade without offering any concrete basis for their objections or proposing more plausible standards. These same individuals have made many unproved statements and accusations in areas in which they have little if any background knowledge. This has naturally caused considerable public fear and unrest. This is not to say that genuine concern is unnecessary, since it is well known that certain life processes are known to concentrate radioactive materials. Plants grown on radioactively contaminated soil, for example, may pick up the radioactivity, concentrate it and then introduce it to man through his diet.

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Simply knowing the safe limits of exposure and being capable of sound scientific reason are not enough. Someone must look at radiation levels as they have been and what they presently are. With this point in mind, the Department of Pharmaceutical Chemistry and Bionucleonics at North Dakota State University set out to establish the quantities of materials present in North Dakota soils.

This information could be of considerable interest if, due to the world food demands, land not presently tilled in North Dakota were irrigated and farmed. Too high a level of radioactive isotopes in the soil might be a hazard to the health and well-being of the public. Fertilization of forage crops might easily induce radioactivity transmission to man through milk. This second example is well guarded against already through the United States Public Health Service surveillance of milksheds throughout the nation, but it serves to illustrate the type of problems which might be encountered if adequate information is not at hand.

It must be realized, however, that man himself, as well as his earthly environment, is naturally radioactive to begin with. All of the carbon, hydrogen and potassium in nature, for example, contains a percentage of radioactive carbon-14, hydrogen-3, and potassium-40, and thus man's body, through food, contains radioactive materials. The oxygen one breathes contains radioactive materials, radon-222, and thus so does man's body so long as he lives. While science knows that the average man's body contains an equilibrum concentration of (1) 6,363 picocuries of radium isotopes, (2) 68,000 picocuries of carbon-14, and (3) 172,000 picocuries of potassium-40, this is of no real concern since these levels are and have been with us since the time of Adam. Soil, too, has a natural radioactive content. Particularly, in North Dakota we find normal concentrations of such soil radioactive materials as potassium-40 and high concentrations of such natural materials as uranium and thorium.

The first problem faced by the NDSU research team was how to establish the normal soil radioactivity prior to the 1940 bombs and later atomic weapons tests. First, our research team selected locations for sampling in the state so as to procure samples of soil from as many points as possible.

Then sites were researched which could be documented to have existed prior to atomic explosions and before these explosions upon which buildings had been placed over normal soil. A second handicap involved removing usable samples which would fit our needs from under the structures. We then took second samples some distance away from the structure to provide a contaminated soil sample. By subtracting the radioactivity of the protected sample from the contaminated sample, we were able to determine the amount of contamination due to fallout. This was accomplished through cooperation of the county agricultural agents under the direction of the NDSU Cooperative Extension Service.

Soil samples were taken to a depth of six inches, since fallout is known not to penetrate beyond this depth in soil. All samples were dried to remove moisture and ground in a mill to reduce them to uniform particle size. All samples were then placed in lined cardboard containers with a bottom well to accommodate our multichannel analyzer detector for counting the radioactivity. These containers were then sealed for counting.

All counting in this work was performed on a Nuclear Data 512-Channel analyzer with a 3"x3" sodium iodide crystal mounted inside a lead lined safe especially constructed for this purpose by the research team. Counting determines the number of radioactive atoms present within a given energy level. Different energy levels of the various radioactive materials identify which radioactive materials are present, and comparing this value with the standard for the material reveals the concentration present in the soil sample. All necessary calculations were accomplished utilizing the facilities of the NDSU Computer Center Model 360 IBM computer.

Radioactive materials which the soil samples were examined for were potassium-40, cesium-137, barium-133, antimony-125, uranium, cadmium-109, thorium-232, cerium-144, and cerium-141. These are the most likely to be found either in nature or in the fallout from atomic weapons testing.

Since potassium-40, uranium, and thorium-232 occur naturally and vary in no way through bomb testing, we will not be concerned in this paper with their content in soil. The soil content of the other radioactive materials, which come from fallout, are listed in Table 1 by county sites surveyed.

Table 1. Radioactive Fallout Products Determined In North Dakota Soil Samples.

	Radioactive Material[2]					
County[1]	Cerium - 144	Cerium - 141	Antimony - 125	Cesium - 137	Cadmium - 109	Barium - 133
Barnes	19,500	799	1,041			
Benson	T[3]	T	T	T		
Bottineau	6,650	T	201	306	90	T
Burke	27,370	797	814			
Burleigh			T			
Cass	18,480	317	466			
Dunn				T	174	166
Foster	24,650	578	1,214			
Gr. Fks.	7,210	T	243			
Grant	29,080	668	870			
Griggs	6,500	253				
Hettinger	17,200	438	272			
Kidder						
LaMoure	6,140					
Logan	12,830		300			
McHenry	5,140	263	227			
McKenzie	26,910	T	815	1,450	316	655
Morton					168	
Pembina	11,110		362			
Ramsey	19,700	547	640			
Ransom	8,120		266			
Renville	4,100			443	112	
Rolette	20,630	272	640			
Sargent	11,900		450			
Sheridan	14,010	254	284			
Sioux	8,460		269			
Slope	4,800					
Stark	31,110	556	663			
Stutsman	12,530		297			
Traill	12,020	296	327			
Walsh	25,570	578	632			
Ward	30,910	757	776			
Wells	28,720	1,068	1,388			
Williams	29,090	1,066	1,721			

[1]Survey sites were not located in all counties in the state.
[2]Activities cited are in picocuries/kilogram of soil.
[3]T equals unmeasurable trace.

What, then, do the data in Table 1 tell us? If we take the worst situation existing in terms of fallout at one of the survey sites and compare it with the naturally occurring potassium-40 radioactivity in the soil, we find the fallout to be one-fifth that of the potassium-40 that has been with us since day one. If we consider the other naturally occuring radioactive materials found in soil, such as thorium, uranium and radon, along with the potassium-40, and compare the natural fallout to these, we find that fallout in the worst possible site surveyed is less than one-tenth the value of the natural radioactivity all of the population has been exposed to for a lifetime. While this then seems insignificant for the moment, it certainly will bear watching in the future in order to guarantee freedom from excessive radiation dosage to the overall general population in the state.