HIGH RADIOACTIVITY IN DRINKING WATER AND GROUND WATER IN SOUTH TEXAS

by

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Abstract

Radioactivity measurements in South Texas made by the Texas State Department of Health have demonstrated that high gross alpha, gross beta and radium 226 levels exist in natural ground waters. Levels of radium 226 over 50 times recommended drinking water limits have been found. Data on some water wells sampled are presented, and correlation of radioactivity versus water quality and well depth is attempted. Body burden estimates are presented for some individuals.

Introduction

Uranium and its radioactive daughter products in the earth are responsible for part of the natural background exposure of people through several mechanisms. These include:

a. Contributions to the gamma-ray dose from the earth;
b. Release of Radon 222 into the atmosphere with the resulting alpha, beta, and gamma exposure;
c. Uptake in plants and animals and introduction into the food chain; and
d. Solution of radioactive minerals in drinking water.

This paper will treat the last of these as it occurs in South Texas.

Uranium was discovered in South Texas in 1954 along a 300 mile belt paralleling the Gulf Coast about fifty miles inland. The trend has been adequately described by others.[1] Economically recoverable deposits were discovered in Karnes and Live Oak Counties, and by 1971 numerous open-pit mines had been stripped, mined, and deserted.

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Investigation of a complaint about water discharged from a Live Oak County mine in 1971 led to the discovery that ground water, seeping into mines which were dug below the level of the water table, contained concentrations of radium 226 as high as 192 pCi/l, well in excess of maximum permissible concentrations allowable for discharges.[2,3] The State Health Department had conducted sampling of ground waters in Karnes County in the 1960's and had found levels of radium 226 to be less than six picocuries per liter (pCi/l).

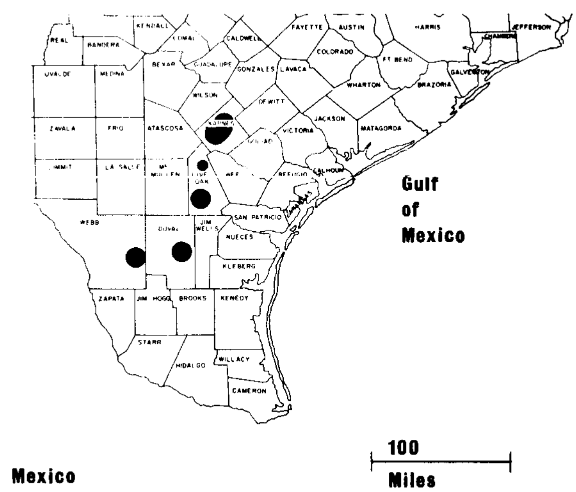

Figure 1 - Map of South Texas Showing County Boundaries and Areas of Commerical Uranium Deposits

Alpha activities in excess of 3,000 pCi/l were found in a uranium exploration well drilled into an ore zone. Radium accounted for 5.6 pCi/l of this, the remainder being uranium.

A sampling of less than twenty wells showed that, with the exception of two exploration wells, none contained water exceeding 9 pCi/l gross alpha activity. Also, none contained concentrations of radium 226 greater than 3 pCi/l, the recommended public drinking water limit.[4] Due to the small number of wells sampled until 1971, the 1971 sampling was our first indication of high levels of radium occurring in local ground waters.

Description of Sampling

Samples to determine radioactivity content of water supplies, both public and private, have been collected from wells and distribution systems in the uranium mining area over the past ten years, although most samples have been collected within the past three years. Most of the supplies have wells as their source(s) but a few municipal supplies use water from surface reservoirs. That data is included in this work where appropriate. Initial sampling of wells in the area consisted of selecting the wells closest to a uranium mill in Karnes County to determine if the mill was contributing to the radioactivity in the wells. More recent sampling has been conducted within five miles of known uranium deposits containing ore with more than 0.15% U_3O_8, municipal supplies in the region, and in areas where uranium mineralization is likely. In one area, seven miles in diameter, all fifty-six known water wells were sampled.

The data examined in this work is not considered as being representative of all well water in South Texas, but as being representative of well water within the vicinity of the significant uranium deposits. The breakdown of number of supplies sampled by county is presented in Table I., and is indicative of this deliberate bias. No other known bias in the data is present.

Table I.
Number of Supplies Sampled by County

Atascosa	2
Bee	2
Brooks	1
Cameron	1
Duval	5
Gonzales	2
Harris	1
Jim Hogg	3
Jim Wells	2
Live Oak	66
Karnes	44
Nueces	1
Webb	4
Uncertain	3

Analysis of the Data

The individual data for all 137 supplies sampled containing the county, total dissolved solids, sulfate, bicarbonate, gross alpha, gross beta, and radium 226 concentrations, when known, is too lengthy to be presented here, but is available from the authors upon request.

Radioactivity data was obtained from two sources: gross alpha and beta and some of the radium data are from the Texas State Department of Health Laboratory Section, other radium 226 data are from the Environmental Protection Agency and Public Health Service. Texas radium data is total radium as determined by precipitation with a barium carrier and counting in an internal proportional counter. Data from the Federal laboratories were deviewed using the radon emanation technique. Gross alpha and gross beta results are obtained by evaporating up to 150 milliliters of the sample (depending upon total dissolved solids content) on a planchet and counting in internal proportional and low-beta anti-coincidence counters. Radium 226 and strontium 90 sources are used as standards. The results were corrected for sample self-absorption.

The data, which covers almost ten years of sporadic sampling on a few supplies, has shown no discernable trend with time on the more frequently sampled supplies, although there is not enough older data to completely refute this possibility in all supplies. Most supplies have been sampled only once.

The data for those supplies with highest alpha activities (over twenty picocuries per liter) is presented here in Table II. All of these supplies are wells. In Figure 2, Distribution of Gross Alpha Values, the number of supplies having a gross alpha value within the range indicated on the abscissa is plotted against gross alpha activity.

Table II.
Radioactivity of Wells with Highest Alpha Activity

Well	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	County
1	43	50	Live Oak
23	23	33	Live Oak
26	31	68	Live Oak
45	320	580	Live Oak
59	35	57	Karnes
61	33	60	Gonzales
64	42	82	Live Oak
67	68	135	Gonzales
86	21	56	Karnes
90	23	71	Karnes
95	603	3000	Unknown
96	3111	1572	Unknown
97	144	146	Karnes
100	111	115	Live Oak
102	54	121	Karnes
107	22	29	Karnes

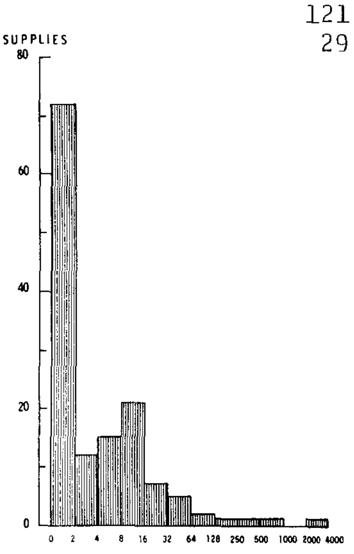

Figure 2 - Distribution of Gross Alpha Values

A modified geometrical progession was used in Figure 2 because of the range in values of the data. Figure 3, Distribution of Gross Beta Values, is also presented in this manner. Neither plot indicates the data came from a single statistical population.

The theory of the uranium deposition in the area requires several factors to be present for uranium to concentrate in the earth. One of these is a change in soil chemistry such as occurs due to oxidation of the surface layers.[1] The boundary between oxidized layers on the surface of the earth and lower reduced layers of the ground in this part of the State occurs typically between 50 and 200 feet. This fact may be a significant factor in increasing the radioactivity of the water. An evaluation of this possibility is beyond the scope of this investigation, but should be pursued by other investigators.

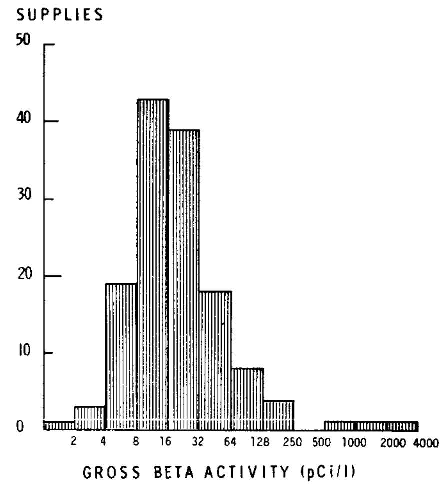

Figure 3 - Distribution of Gross Beta Values

Of 133 wells, the depth was known for 29, partial chemical water quality data for 28, and radium 226 (or total radium) for 15. Plots of radium 226 concentration, gross alpha and gross beta activities of water supplies versus several parameters were examined. There was no correlation detected for activity (alpha, beta, or radium) versus total dissolved solids, sulfates, or bicarbonate. These plots, available upon request, are not presented here. There was, however, a trend noted between gross alpha and a similar, though less distinct trend for gross beta versus depth. No well deeper than 400 feet had a gross alpha activity greater than 3 pCi/l, and the percentage of wells with gross alpha values greater than 3 pCi/l decreases with increasing well depth (see Figure 4).

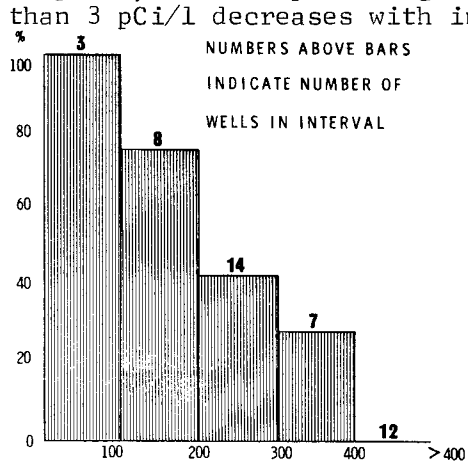

Figure 4 - Percent of Wells with Gross Alpha Activity Greater Than 3 pCi/l Versus Well Depth.

Radium 226 data on wells which are used for human consumption are presented in Table III. Included in this table are estimated body burdens of adults who have been consuming the water from these wells for extended periods.

The Federal Radiation Council estimations in their Report No. 2, namely that the body burden of people exposed to constant levels of radium 226 is at most fifty times their daily consumption, have been used to calculate these body burdens.

Table III.
Radium 226 Data for Wells Used for Human Consumption

Well No.	^{226}Ra (pCi/l)	Estimated Body Burden (pCi)	% of RPG	County
1	110	12100	404	Live Oak
3	0.8	88	3	Live Oak
27	0.2	22	1	Live Oak
32	4	440	15	Live Oak
45	5	550	18	Live Oak
50	0.5	55	2	Live Oak
78	2.4	264	9	Live Oak
85	0.4	44	1	Karnes
87	2.1	231	8	Karnes
100	153	16800	560	Live Oak

Two wells produce water with radium concentrations resulting in individuals exceeding the Radiation Protection Guide (RPG). The owners of these wells have been notified of this situation and have been advised to quit consuming the water.

Summary and Conclusions

High radium 226 concentrations in well waters in South Texas were discovered in 1971 and a considerable amount of data on the ground waters in the vicinity of the uranium deposits has been collected. In most wells, alpha and beta radioactivity is low, however in 25 wells shallower than 300 feet, 15 had alpha concentrations in excess of 3 pCi/l.

In two wells, used for drinking water supplies for humans high levels of radium 226 were found. These high concentrations, well above those allowable in licensed industrial discharges, and very much in excess of recommended drinking water standards have resulted in individual exposures probably exceeding the RPG and raise concern for other users of ground water in the area. While less than two percent of the supplies have radium concentrations in excess of occupational exposure limits, it is our opinion that no one should use water of this character routinely. Attempts are being made to screen supplies in the area most likely to contain elevated radioactivity. Work in progress in the area includes sampling every source of public water supplies and selected private wells used as the principle source of drinking water for humans.

Uranium is known to occur in other parts of Texas and in many other regions of the world, with a potential impact on human exposure to radiation. Uranium producing areas should be evaluated by the responsible health agency in sufficient detail to exclude the possibility of radiation exposures beyond acceptable standards.

Acknowledgements

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