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SOIL ACTIVATION DOWNSTREAM OF THE MESON AREA FRONT END HALL

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The first major construction project of the 1978-79 Mesopause was the extension of the Front End Hall through to the 300' Area. This report concerns levels of activation found in the soil during excavation.

The top of the berm was removed by bulldozer and no radiation levels above background were found. (Background was 2,000 counts per minute (cpm) as read with a Victoreen Thyac sodium iodide type detector). The first contaminated soil was seen around the marker pipe coming up from the Front End Hall, the pipe having provided a neutron conduit. The soil read 11,000 cpm six feet above the roof level. In contrast, away from the pipe soil activity was only 3,000 cpm next to the concrete roof itself.

Activation levels were higher in the forward direction. The exterior of the north wall showed levels (at a depth 5' below the roof and 7' above the beam lines) ranging from 7,000 cpm at the northwest corner to 20,000 cpm above the beam lines. Samples taken from soil on top of the Front End Hall had Na-22 levels of approximately 10 pCi/gm while levels on the front side were just below 100 pCi/gm. Concrete chips from inside the 18" thick walls had levels of 325 pCi/gm.

Radiation levels for the rest of the excavation are indicated in the longitudinal section from the Front End Hall to the 300' Area and in a transverse (east-west) section halfway between the Front End Hall and 300' Area ($Z \simeq 320'$). Levels were highest near the walls and the beam pipes. The vertical assymetry is probably an artifact, a result of hotter soil near the beam lines falling into lower excavation levels.

The soil was "protected" by concrete sheaths around the beam pipes. The pipe itself was considerably more radioactive than the soil. There were two hot area where beam had been lost: about two-thirds of the way down the M2 line at $Z \simeq 345'$ and about one-third of the way down on the M1 line ($Z \simeq 295'$). The maximum level was about 80 mr/hr on contact. Most of the pipe was between one and two mr/hr.

High levels around the M2 pipe were a result of dumping the M2 beam directly into the soil. If one assumes a beam of 10^{10} particles per pulse was dumped one-tenth of the time with a rep rate of 10 seconds and a duty factor of 5,000 hours per year, then 2×10^{15} protons were dumped during the eight months of these running conditions (January-August, 1978). A sample of the compacted clay taken from the longitudinal section where the activity was 20,000 cpm had a Na-22 content of 0.49 ± 0.45 pCi/g. If this level of half a picocurie per gram per 20,000 cpm is extrapolated for the entire downstream activation area with higher levels, an estimate of 0.7 mCi total activity is obtained. There is, of course, a great deal of uncertainly in this number.

Without doing a CASIM Monte Carlo simulation, one can get an approximate value for the total number of stars produced by summing areas under the curves found in Van Ginneken (1). This method produces a value of 155 stars per incident proton. If 0.02 Na-22 atoms are produced per star (2) 2×10^{15} protons produce 4×10^{13} atoms of Na-22. This corresponds to an activity of 2 mCi.

These levels of sodium do not lead to an off-site water contamination problem. If one assumes water will percolate 65 feet down to the aquifer at a rate of three feet per year (3) with 15% leachability, and that the activity is diluted into 40 gallons at an off-site well, the present EPA limit of 0.2 pCi/ml restricts original production to 8.7×10^{3} mCi/yr. Three orders of magnitude provide a large margin of safety.

The ratio of total Na-22 activity produced to leachable tritium activity produced is calculated as follows:

$$\frac{A_{t, \text{Na-22}}}{A_{l, \text{H-3}}} = \frac{(0.02 \text{ atoms/star})(\lambda_{\text{Na-22}})}{(0.075 \text{ atoms/star})(\lambda_{\text{H-3}})}$$

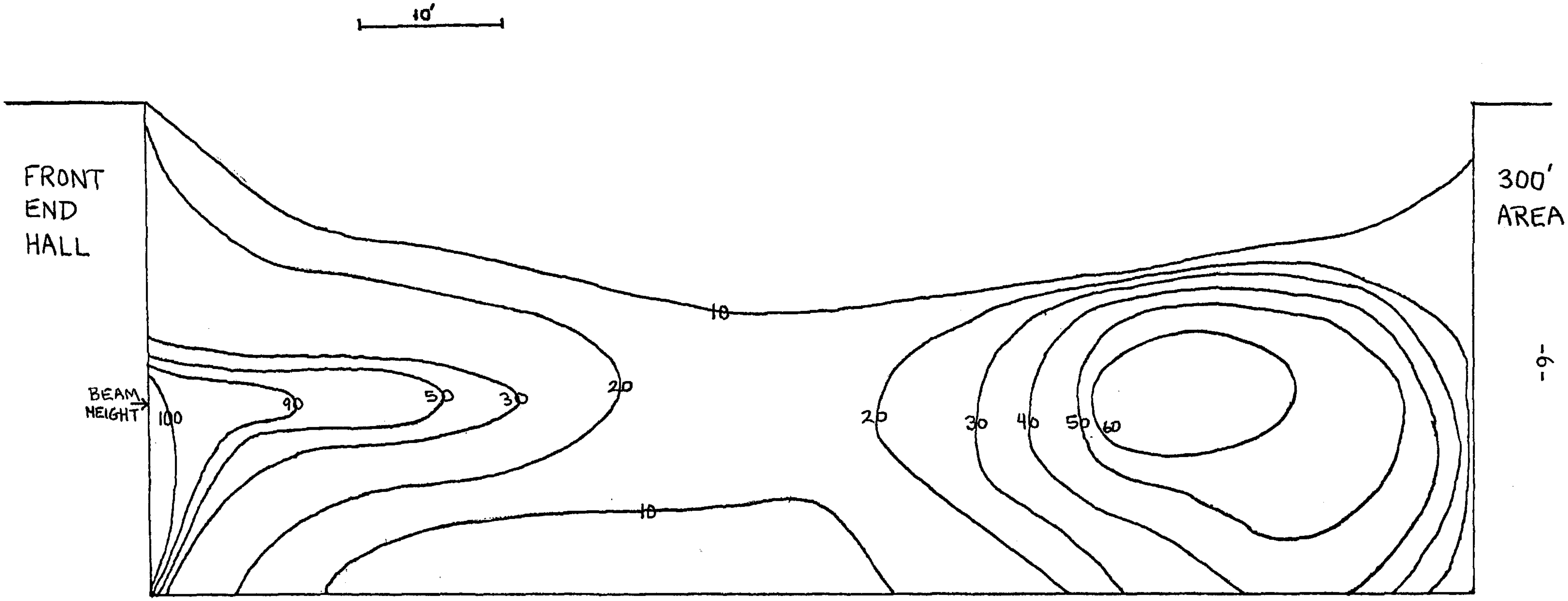
where λ is the inverse of the half life. This ratio, 1.26, indicates tritium production of 0.5 mCi (or 1.7 mCi from the Van Ginneken method). The EPA limit for tritium in drinking water of 20 pCi/ml, coupled with the "standard" migration-dilution model mentioned above, puts the yearly leachable tritium production limit at 2.7 mCi.

These data indicate that dumping beam into the soil on a routine basis is acceptable at low and moderate intensities (less than 10^{10} particles per pulse) with a minimum of shielding. Also of interest is the agreement within an order of magnitude between approximations based on CASIM and estimates from field measurements.

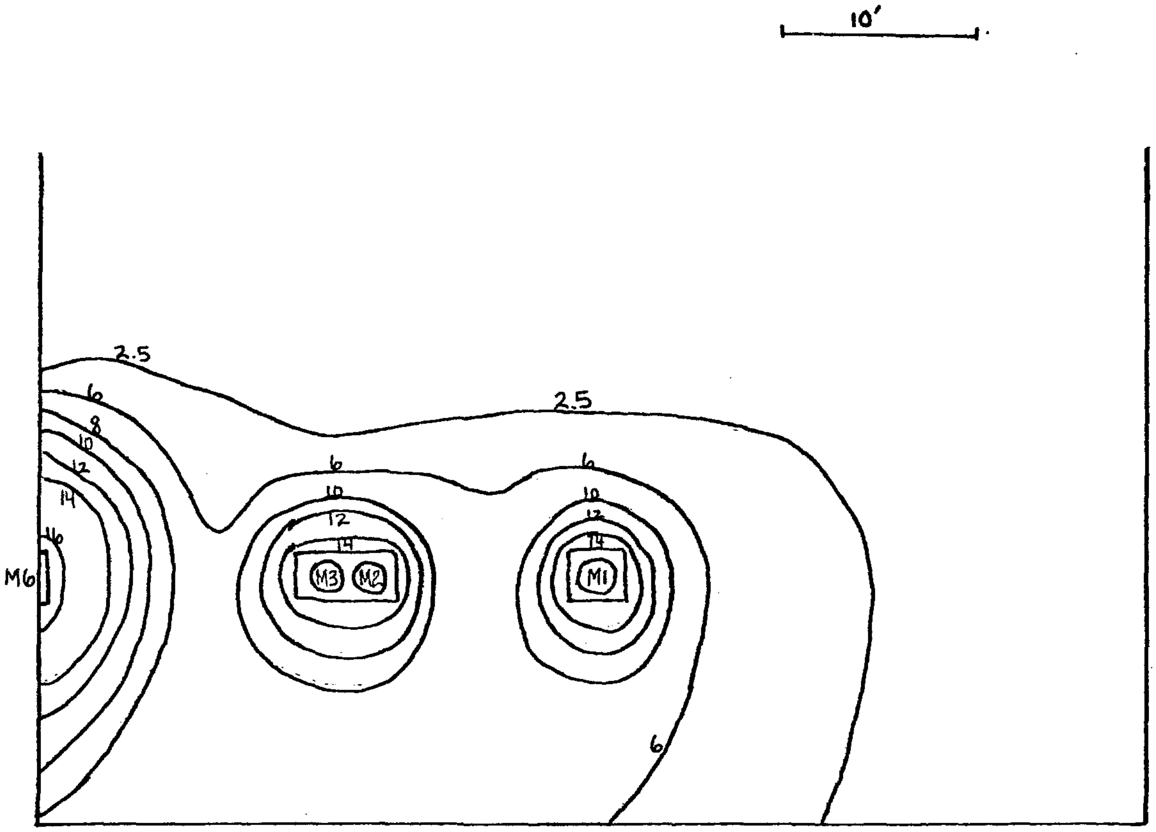
1. A. Van Ginneken, High Energy Particle Interactions Targets, Vol. 1, p. 85

2. P. Gollon, TM-816 (1978)

3. S. Baker, Environmental Monitoring Report FNAL, 1977.



LONGITUDINAL SECTION from the Front End Hall to the 300' Area, between M6 and M2/M3. Numbers refer to activity levels in thousand counts per minute. Background is 2000 counts/minute.



TRANSVERSE SECTION at z = 320'