LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : File

DATE: July 10, 1978

FROM : Willy Abeele, H-12

SUBJECT : PROGRESS REPORT

SYMBOL : H12-78-213

0728 Report

1. In the second half of May, a project was initiated to monitor the emanation of tritiated water due to soil aeration. The goal of this project is to see if any correlation can be found between atmospheric and boundary-layer conditions on the one hand and total evaporation versus aeration of tritium out of its deposit site on the other. The experiment is being performed by placing a sieve of known diameter and filled with silica gel on a particular spot located on top of Pit P1. The sieve is covered by a heavy aluminum plate, leaving only a small gap open so that soil aeration can take place. To eliminate the influences of an excessive surface temperature gradient, caused by the shadow of the sieve on the ground, the experiment was run at night only, or on a rare cloudy day. The amount of total water and tritiated water evaporated was accurately measured. Soil moisture measurements, both with the neutron probe and oven drying of soil samples were taken at regular intervals.

   The results of this experiment showed that there was surprisingly little correlation between the moisture content in the upper 0.05 m of the soil and the release of tritiated water. This is more than likely due to the fact that the heaviest precipitation in the area during that period amounted to 1.27 mm, which was surely not enough to clog up the pores and prevent the evaporation of tritiated water moving up from greater depths. The correlation coefficient between moisture content and the proportion between tritiated and natural water is only -0.3504 while the correlation coefficients between moisture content and tritiated water aeration is -0.3666. Both correlation coefficients are not significant at the 5% level of confidence.

   By incorporating the soil vapor pressure at 0.10 m as an additional independent variable a slight improvement is obtained in the regression between moisture content, soil temperature and tritiated water aeration. The multiple correlation coefficient climbs to 0.3980, but is still too low to be significant at the 5% level of confidence.

   If the soil vapor pressure at 0.4 m is used as an independent variable together with the moisture ratio by volume at 0.4 m, measured with the neutron probe, a correlation coefficient of 0.7947 was obtained with

7954

tritiated water vapor aeration as the dependent variable. This coefficient of correlation is significant at the 1% level of confidence. Whether this highly significant coefficient of correlation is an indication of cause and effect relationship is somewhat arguable, since temperature gradient for example could be the one and only reason for the existence of a vapor pressure gradient. However, the relationship between temperature, moisture ratio by volume and tritiated water aeration was not as good as the one between vapor pressure, moisture ratio by volume and tritiated water aeration. The multiple correlation coefficient was in this case 0.7128. The difference is due to the non-linear relationship between temperature and saturated vapor pressure, but the lower values obtained using temperature as an independent variable do not exclude the fact that temperature itself is a cause for higher tritiated water vapor aeration. However, the higher correlation coefficients obtained using measurements taken at greater depths seem to indicate to me that liquid water flow is more important a factor in tritium aeration than vapor flow. This conclusion was reached since moisture content was increasing significantly with depth over the range considered and that it is a known fact that liquid flow becomes more and more prevalent as the moisture content increases.

The addition of the atmospheric vapor pressure as an independent variable did not improve the multiple correlation coefficient. This is due to the very nature of the experiment, since the silica gel created a vapor pressure that was essentially zero in all cases at the soil-atmosphere interface. The loss of moisture in the upper meter (the moisture content was found to be maximum at 1 m) was found to be, after correction for precipitation, 9.95 mm between the 1st and the 12th of June. This was measured using the neutron probe.

Based on the discontinuous nightly measurements that were made using the silica gel filled sieve, and through interpolation, a total of 10.69 mm was predicted. The two above values seem to agree fairly well. The difference could be due to instrumental error, or higher evaporation rates at night, or higher evaporation induced to the presence of silica gel, or all of the above.

In order to evaluate the flux of tritiated water through the soil (at a certain fixed depth), the formula

$$F_D = F_S + C_T \cdot \Delta_M$$

was applied where

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

F_D = ^3H_2O flux through the soil

F_S = ^3H_2O flux at the soil surface

C_T = concentration of ^3H in evaporated water

Δ_M = change in soil moisture storage

when the flux of tritiated water through the soil was calculated the chronological results obtained showed consecutive values of (on 10^{-15} mm day^{-1}) 104.500; 13.550; 9.620; 8.033; 2.700, and 2.446. The continuously declining trend can only be an indication that, at least during the month of June, the upward loss of residual water is declining as the month progresses.

WA:tj
cc: Dan Wilson
Merlin Wheeler
Margaret Anne Rogers
Tony Gallegos