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Reviewed by E. M. Bramlitt Date 4/29/97

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REPOSITORY P.N.N.L.
COLLECTION Marshall Islands
BOX No. 5685
FOLDER Enewetak 1976

Mr. E. M. Bramlitt
Defense Nuclear Agency
Field Command
Kirtland Air Force Base, NM 87115

Dear Ed:

Enclosed are the $^{239-240}Pu$ in soil contours Dr. Pam Doctor and I obtained using the data you sent us that were collected at random soil locations on the island of Enjebi (Janet) Enewetak Atoll in 1972.

The enclosure labeled "A" gives estimated contours in units of pCi/gram; in addition, the location of data points are indicated by a cross. Three contour levels in $\log_e$ scale are indicated; 2.08, 2.71 and 3.56. These are rounded from actual contour levels of 2.079442, 2.70805, and 3.555348, which when antilogs are taken, correspond to 8, 15, and 35 pCi/gram, respectively. The contours on the plot are in $\log_e$ units since the contours were obtained on the logarithms of the data. The coordinates around the plot correspond to the North and East coordinate system you supplied with the data.

Enclosure "B" gives the same contour lines as "A" and in addition plots the value of the $^{239-240}Pu$ soil concentrations (pCi/gram) at collection locations. These are the data used to estimate the contours. Enclosure "C" is identical to "B" except that Pam has roughed in the shoreline of Enjebi and colored the four bands of estimated concentrations (<8, 8-15, 15-35, >35 pCi/gram). The contour lines extending off the island should be ignored.

The estimated contours were obtained using a nearest-neighbor estimation routine on the SURFACE II Graphics System developed by the Kansas Geological Survey. This system is described in "The SURFACE II Graphics System" by R. J. Sampson, pp. 244-266 in Display and Analysis of Spatial Data (J. C. Davis and M. J. McCullogh, eds.), John Wiley and Sons, 1975. The specific subroutines used were GRID and NEAR. The basic idea is to estimate $^{239-240}Pu$ concentrations at equally spaced grid points over the island. The grid size used here was 100 feet. The estimate at each grid point was obtained as a weighted average of the eight nearest data points, where the data nearest

to the grid point are assigned the highest weights. As mentioned above, the data were transformed to logarithms before any calculations were made. Once the grid estimates are obtained the desired contour lines are drawn automatically by linear interpolation between grid estimates. We did not iterate on the residuals to produce the enclosed contours. Iteration does not seem to be required for these data, i.e. the contours obtained after iterating would, in my judgement, be about the same as those given here.

The $^{239-240}Pu$ data collected at 0-5 cm and 0-10 cm increments were adjusted to correspond more closely to the 0-15 cm increments used at most sample locations. This was done by dividing the 0-5 cm and 0-10 cm data by 1.88 and 1.26, respectively. The factor 1.88 is the median of the ratios of 0-5 cm to 0-15 cm concentrations obtained from the profile samples on Enjebi. Similarly, 1.26 is the median ratio of the 0-10 cm to 0-15 cm concentrations. The 0-5, 0-10, and 0-15 cm concentrations were weighted averages of concentrations obtained at 0-2, 2-5, 5-10, and 10-15 cm, the weights being 2/15, 3/15, 5/15, and 5/15 respectively. This is the same weighting procedure you have been using.

I have enclosed the revised list of soil Pu concentrations dated September 1976 which you sent Pam Doctor in your letter of October 8, 1976. These are the data we used except for the circled data which are for the 0-5 or 0-10 cm samples. The data used for these values are indicated next to the circled concentration. Please note that the North coordinate for sample location 120 appears to be in error since this N-E location is off the island. Using Figure B.8.1.f as a guide I replaced N144480 with N144880 which puts the sample in about the right position according to the figure. Also we have switched the Pu concentrations for samples 89 and 90 and for 27 and 28 since the Am/Pu ratios then fall into line. Since samples 89 and 90 are spacially adjacent and 27 and 28 fairly near to each other I don't think the contours would change much if we hadn't switched those samples.

Now concerning the interpretation of the contour maps: It appears that the computer contouring has done a reasonably good job of automatically estimating and drawing contours around the "hot spots". A major drawback, however, is the lack of confidence statements associated with the contours. As I have noted in our phone conversations, the method of contouring we have used does not provide for estimating these confidence intervals. This is most unfortunate since we are left with a pretty map with little to guide us concerning its accuracy. We should recall, also that these contours were drawn without knowledge of the locations of detonation points, wind patterns at time of detonation, and other "subjective" data that might possibly be useful in drawing contours. I think we need to seriously face the question of whether

our automatic contouring result are an improvement over someone setting down and drawing contours by hand. What is needed are estimates of variability on the contour lines. One can get a feel for the relative accuracy of some of the contours in certain parts of the island by noting whether any data points are in the vicinity of the contour lines. In general, other things being constant, the more dense the data points, the more confident we can be of the placement of the contour lines.

We have talked some about Kriging and how this technique can give estimates of confidence limits on contours if the data are adequate. I understand you have a copy of Dr. Delfiner's report on his attempts to use Kriging to answer the question "Which hectares on Janet exceed an average Pu concentration of 40 pCi/g"? His overall conclusion was that "this question cannot be answered on the basis of the present data". He indicated that denser sampling was required in order to identify the "structure" (trends around the GZ's or across the island) of the data for spacings less than 50 meters. This structure must be identified before Kriging can be applied to the above question. Dr. Delfiner suggested that "the best that can be done is to calculate an undifferentiated global mean.

This raises the question of whether more samples could be collected around the GZ areas and/or hot spots suggested by the present data before the cleanup crew gets underway next year. These samples might allow the structure to be estimated so that Kriging could be applied. Of course, the use of In Situ devices for measuring ^{241}Am on the island is another approach for obtaining data for estimating the structure. If the In Situ devices are used, however, it is imperative that the resulting In Situ ^{241}Am data be calibrated with Pu concentrations in soil by taking a large number of soil samples close to each other and in the area "read" by the detector. This would need to be repeated at several locations on the island. This should be done before the In Situ device is used to make cleanup decisions.

Hope these comments and the enclosed plots are helpful. I'm sending copies to Tom McCall at ERDA and Bruce Church at NVO, also.

Best regards,

Pamela G. Doctor
for
Richard O. Gilbert
Senior Research Scientist
Statistics Section
Systems Department

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Copies with enclosures to

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