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**Geostatistics Project of the
National Uranium Resource Evaluation Program**

October—December 1977

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**GEOSTATISTICS PROJECT OF THE NATIONAL
URANIUM RESOURCE EVALUATION PROGRAM
October - December 1977**

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by

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ABSTRACT

Additional work has been done to display radio-metric data from the Lubbock quadrangle in pseudocolor maps. A digitized topographic map of the quadrangle was obtained from the U.S. Geological Survey and this is being incorporated into the study of the radio-metric data.

Single-record data from the Lake Mead calibration range and from the Slayton test line have been obtained from GeoMetrics, Inc. and analysis of this data has begun.

Principal component analyses have been used to investigate the relationship of geological formation to the location of points in a (Tl, Bi, K) coordinate system.

LASL personnel attended a workshop in Grand Junction, Colorado, where some of the problems of calibrating aerial gamma-ray spectrometers were addressed.

I. INTRODUCTION

This report outlines the activities and progress of the Los Alamos Scientific Laboratory (LASL) on the Geostatistics project during the October - December 1977 quarter. The Geostatistics project is part of the National Uranium Resource Evaluation (NURE) program sponsored by the US Department of Energy's (DOE) Grand Junction, Colorado, office. The NURE program is designed to assess the potential uranium resources throughout the conterminous United States and Alaska. The Geostatistics project at LASL, in close cooperation with the Grand Junction Office of DOE, will apply statistical methods to the analysis

of data collected by airborne instrumentation. In addition to this study, a close statistical consulting relationship will be maintained with the DOE Grand Junction Office to handle a broad range of problems.

The capability of LASL to produce pseudocolor maps of the aerial radiometric data has been improved. Some new computer codes have been developed and existing ones have been modified to run easier and more efficiently. A digitized topographic map of the Lubbock quadrangle¹ was obtained from the U.S. Geological Survey and an effort is under way to integrate this with the aerial radiometric data.

Single-record data from the Lake Mead calibration range and from the Slayton² test line have been obtained from GeoMetrics, Inc. This data set is being used in an investigation of the relationship of filtering techniques to signal enhancement under various signal-to-noise ratio conditions.

Principal component analyses have been used to investigate the relationship of geological formation to the location of data points in a (Tl, Bi, K) coordinate system. Some observations concerning the use of ratios such as Bi/Tl in radiometric data analysis have been made.

LASL personnel attended a workshop in Grand Junction, Colorado, where some of the problems of calibrating airborne gamma-ray detection equipment were considered. LASL personnel are also participating on the American Society for Testing and Materials (ASTM) subcommittee E10.10.38, where the calibration of airborne gamma-ray spectrometers will eventually be considered.

II. RATIOS IN RADIOMETRIC DATA ANALYSIS

The use of various ratios of Bi, Tl, and K intensities in the search for radiometric anomalies is quite common. One reason for the use of such ratios is that although the observed Bi, Tl, and K signals might be expected to change considerably within a homogeneous geological formation, the ratios should remain fairly stable. Anomalies in the ratios could therefore, in some cases, be expected to correspond to radiometric anomalies. The condition that a ratio (say Bi/Tl) remain fairly constant within a set of data is equivalent to all the points in the data set falling close to a straight line through the origin when they are plotted on the (Bi, Tl) coordinate system. If the line does not go through the origin, then the ratio will not be constant.

A preliminary study of data from the Lubbock quadrangle indicates that in some cases, points from within a given geological formation do not cluster about a straight line through the origin. It is not clear at this time whether this phenomenon is caused by lack of homogeneity in the formations studied or by some other condition or conditions. Some details of this study will now be presented.

Principal component analysis³ is a method of decomposing the variation in a multivariate data set into independent components. For example, in a set of (Bi, Tl, K) data the first principal component defines the direction of maximum point spread in the three-dimensional coordinate system. The second principal component defines the direction of maximum variation with the constraint that it must be orthogonal to the first principal component, and so on.

If data from a geological formation tend to cluster about a line in the (Bi, Tl, K) space then an estimate of the location of that line can be obtained from the first principal component.

Data from the first two map lines in the Lubbock quadrangle were analyzed in order to obtain an indication of the usefulness of the ideas mentioned above. Records from geological formations TRD, PB, and TO¹ were used. The parametric representation of the line defined by the first principal component of the TRD data is

$$Tl = 57.65 + .232 t$$

$$Bi = 99.81 + .883 t$$

$$K = 175.14 + .408 t.$$

For the PB data the line is

$$Tl = 60.60 + .222 t$$

$$Bi = 89.58 + .205 t$$

$$K = 222.88 + .953 t.$$

For the TO data the line is

$$Tl = 45.47 - .017 t$$

$$Bi = 83.16 - .999 t$$

$$K = 160.90 + .009 t.$$

None of these lines come close to the origin. This might be due to heterogeneity in the geological formations or noise in the data. However, the lines have an interesting property that they all come very close to the point $Tl = 47.33$, $Bi = 72.85$, and $K = 161.94$. Table I presents the sample means and standard abbreviations for Bi, Tl, and K in each of the three formations sampled, along with the number of records used in the calculations and the distances of the respective lines from the origin and from the point mentioned above. The apparent tendency of the three lines to go through a point other than the origin could affect the interpretation of ratio data. It may be that if an adjustment is applied to the data before taking ratios, the variability of the ratios can be reduced and anomalies can be enhanced. Work in this area is continuing.

TABLE I

RELATIONSHIP OF TRD, TO, AND PS LINES

Formation	Number of Records	Distance from Origin	Distance from Point ^a	T1		B1		K	
				Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
TRD	731	118.50	3.15	57.65	12.95	99.81	35.51	175.14	71.36
TO	355	41.35	2.32	45.47	8.53	83.16	42.20	160.90	24.44
PB	901	167.55	3.72	60.61	13.91	89.58	22.67	222.88	51.35

^aThe point is T1 = 47.73, B1 = 72.85, K = 161.94.

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3. T. W. Anderson, An Introduction to Multivariate Statistical Analysis, (John Wiley and Sons, New York, 1958).