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Hydrogeology • Mineral Resources Waste Management • Geological Engineering • Mine Hydrology

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Mr. Jeff Pohle
Division of Waste Management
Mail Stop 623-SS
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: NTS

Dear Jeff:

A copy of the review of the following document is enclosed.

1. Nimick, F.B., and Williams, R.L., 1984, A Three-Dimensional Geologic Model of Yucca Mountain, Southern Nevada. Sandia National Laboratories, Albuquerque, NM and Livermore, CA, SAND83-2593.

Please contact me if you have any questions concerning this review.

Sincerely,

James L. Osiensky

JLO:sl

WMGT DOCUMENT REVIEW SHEET

FILE #:

DOCUMENT #: SAND83-2593

DOCUMENT: Nimick, F.B., and Williams, R.L., 1984, A Three-Dimensional Geologic Model of Yucca Mountain, Southern Nevada. Sandia National Laboratories, Albuquerque, NM and Livermore, CA, SAND83-2593.

REVIEWER: Williams & Associates, Inc., James L Osiensky

DATE REVIEW COMPLETED: November 2, 1987

ABSTRACT OF REVIEW: APPROVED BY: Roy E Williams

The report under review describes an initial version of a three-dimensional trend surface generation model for the geology of Yucca Mountain. The trend surface model was designed for use with sparse and irregularly distributed input data. The purpose of the trend surface analysis is to provide a quantitative method for the interpolation and extrapolation of data between data points (drill holes). The main limitation of the model for use in the vicinity of Yucca Mountain is the lack of a comprehensive three-dimensional field data based description of faults that occur in this area. It is anticipated that trend surface analysis of this type will become more significant as additional data become available during site characterization.

BRIEF SUMMARY OF DOCUMENT:

The report under review describes the development of a three-dimensional geometric framework of the geology of Yucca Mountain using trend surface analysis. The framework was developed to aid in the interpolation and extrapolation of known geologic features that occur in the vicinity of Yucca Mountain. The report describes the initial version of a 3-D geologic framework model of Yucca Mountain. In addition, the report describes the modeling method and configuration, the input data used, and an analysis of the interpolative and extrapolative ability of the model.

The geometric framework model consists of a collection of three-dimensional trend surface representations; the base of each stratigraphic zone is defined as one trend surface. Information concerning the nature and distribution of rock units and geologic structures at Yucca Mountain is limited to maps of surface outcrops, and drill hole logs. Because these data are very sparse and irregularly distributed, Sandia National Laboratories (SNL) developed an estimation technique to handle sparse and irregularly spaced data. This technique is called trend modulation by multi-kernel summation (Williams and Nimick, 1984). The method generates a single, continuous analytical surface equation (trend surface equation) from a collection of three-dimensional coordinates. The interpolation technique used to generate trend surfaces is discussed in Appendix A of the report. According to the report, the interpolation method is the core of the implementation of the trend surface analysis. Data such as fault location, orientation, and offset are used to transform coordinates for the base of a unit to the coordinates of the unit prior to faulting. The data are manipulated by the mathematical estimation technique to generate a set of analytical equations; each equation represents the surface at the base of a single defined unit. According to the report, the assumption has been made that the actual geologic surfaces were smooth and continuous when the layers of pyroclastic materials originally were deposited.

Data for the model are input on three-dimensional coordinates, x, y, z. For Yucca Mountain, x and y coordinates are the east and north locations in state plane coordinates; the z coordinate is the absolute elevation above mean sea level.

Data used in the model include drill hole locations, lithologic logs, and gyroscopic surveys. The x, y, z coordinates for a given lithologic unit are based on drill hole data. The effect of faults which occur between data points (drill holes) must be removed prior to calculation of the geologic surfaces. According to the report, only vertical (z) offsets on faults were accommodated. All fault offsets were accounted for relative to a structural block containing drill holes USW G-3, USW GU-3, USW H-3, and USW G-1. This structural block was presumed not to have moved due to faulting.

Lithologic units that were found to be missing in certain drill holes were assumed (for the purpose of the model) to reach zero thickness at the location of the drill holes where they are missing. According to the report, the model can be adjusted as more information becomes available. Tables 3 through 11 of the report summarize the input data for the individual drill holes used for the model.

The model was evaluated using two types of analyses. In the first analysis, the accuracy of the generated surface was evaluated by comparing the model surfaces with data measured for drill holes not included in the model. The second type of analysis consisted of generating a number of cross sections from the model. Predicted data were compared to real field data from drill holes USW G-4, UE-25B#1, USW H-1, USW H-3, and USW H-5. The results of the comparisons for drill hole USW G-4 are presented in tables 15 and 16 of the report. The results for the comparison of predicted and actual elevations and thicknesses at drill hole USW H-1 is presented in table 17 of the report. The authors of the report suggest the comparisons for drill hole

USW G-4 are reasonable on average but can be imprecise in detail. This statement basically is true for the other drill holes.

Figures 5, 6, 7, and 8 of the report present cross sections which illustrate the predictive capability of the model. According to the report, the cross sections should be viewed as representative of the information available as a result of calculating the surfaces described in the report and as a result of inserting fault offsets manually via the graphics system. The authors of the report suggest that the cross sections are consistent with various publications of the USGS.

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

The report under review presents a method for the interpolation and extrapolation of geologic data in the vicinity of Yucca Mountain. The trend surface generation model is capable of yielding a three-dimensional trend surface of the geologic stratigraphy at Yucca Mountain. The model is capable of generating cross sections along any chosen path; in addition, the model can be used to produce maps of the elevation or thickness of selected generated trend surfaces (stratigraphic units). The primary significance of the model is its ability to extrapolate data in the form of trend surfaces to areas in which no geologic data are available.

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT:

The primary limitation of the model under review is the lack of available input data, especially for faults that occur within the area. As would be expected, the ability to ascertain the accuracy of the generated trend surfaces is severely limited by the data available for input.

SUGGESTED FOLLOW-UP ACTIVITIES

No follow-up activities are suggested at the present time. However, it is anticipated that this type of model will become more significant as additional data become available during site characterization. It is very likely that model representations of the type presented in the report will be standard application materials to be evaluated by the NRC during licensing of a repository.

REFERENCES CITED:

Williams, R.L., and Nimick, F.B., 1984, A Technique for the Geometric Modeling of Underground Surfaces. Sandia National Laboratories, Albuquerque, NM, SAND84-0307.

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