Released in 1997 (LA-UR-00-2057)

Title:
Revised Site-Wide Geologic Model for Los Alamos National Laboratory (FY97)

Author(s):
G. Cole, D. Broxton, S. Reneau, and D. Vaniman

Abstract:

A revised digital geologic model has been developed for Los Alamos National Laboratory. This model was developed through an analysis of the FY96 preliminary geologic model (and supporting data), incorporation of additional data in the northwest and southwest quadrants of the region, and a preliminary attempt at modeling fault structures in the western portion of the study area. Digital grids representing the basal contacts of each geologic unit were generated for both the preliminary and revised models. These models are available at the Facility for Information Management, Analysis, and Display (FIMAD) archives.

Summary:

The main product for FY97 was development of a self-consistent, 3-D geologic/stratigraphic model for the Laboratory, building upon the FY96 efforts and database. The approach for FY96 provided equal treatment for all data meeting the minimum quality standards as described in Vaniman et al. (1996). The approach for FY97 concentrated on evaluation by geologic experts of subsets of data, i.e., all data for a particular unit. Many of the irregularities in the initial model were caused by variation in the quality of the data, principally as a result of differences in the scale of mapping and differences in the quality of the topographic control. The geologic experts identified which data were to be utilized in the new model, and had the option of weighting and manually contouring portions of the data to provide new control points.

New data were obtained for the northwest and southwest portions of the study area, regions which were poorly constrained in the preliminary model. Faults were also added to the model, allowing stepwise offsets of stratigraphic units in regions where the linear interpolations of the preliminary model had failed badly. Additional efforts were in application of the commercial software modeling tools used to generate the grid surfaces.

The underlying theme in creation of Version 2 of the site-wide model incorporates the following:

- Evaluation of the data by "expert" geologists to identify the appropriate contact control points or contact surface location,
- Best-guess estimations of the contact surface in regions of sparse data, based on the precept that expert guesses are better than uneducated guesses,

- Maintenance of self-consistency of the whole model, based on knowledge of process (i.e. units should not intersect; paleodrainages and ancient volcanoes have a predictable morphology), and

- Incorporation of structural offsets within the unit surfaces.

Details of Revised 3-D Model:

The basal contact of each stratigraphic unit was determined through examination of the FY96 model, utilization of isopach maps, which were computer-generated from the FY96 model, and incorporation of new contacts and existing structural data. All units of the preliminary model were maintained in the revised model with the exception of Qbt3nw, which was included in Qbt3. The final model for a given unit surface can selectively incorporate original data from different sources, for different geographical areas, as well as processed (smoothed/contoured/filtered) data for other portions of the map. For example, more poorly-constrained data from Griggs (1964) had been used in the northeast portions where data coverage is sparse; more-recent, better quality data were used in the south; and extrapolated data were used along the faults to the west. Descriptions of the data support for the revised model will be available in the 3-D database.

Structural offsets for contact surfaces were obtained by placing closely spaced control points (200-foot intervals) along structural breaks (@100-foot offset from features). Contact surface elevations for each of these control points were interpolated from the available control information provided by geologists. The closely spaced control points allowed the Triangulated Irregular Network (TIN) generation process to properly model the structural breaks.

Details for the generation of the individual gridded contact surfaces are provided below. Data references are defined/described in the FY96 report (Vaniman, et al., 1996). The geologists who defined the data set for the current model are identified where appropriate. All computer processing/analysis was done by G. Cole.

Qbt5:

As no new data were available for this unit, and the original data set included only data from a single source (Rogers, 1995), the spatial extent and placement of this unit remain the same as for the previous version of the model. The data control points were input into a TIN model and then gridded.

Qbt4-Qbt1v:

S. Reneau analyzed the distributions of the basal contacts for Tshirege units Qbt4, Qbt3 (including Qbt3nw), Qbt2, and Qbt1v. Minor irregularities due to the disparate data sources were removed, and limits for interpolation were restricted at some peripheral areas. The final data set was a sequence of hand-contoured maps for these units. The contours were digitized, converted to a TIN model, and then gridded.

Qbt1g:

The Qbt1g basal surface is located above the thin (20-100 cm) Tsankawi Pumice Bed (unit Qbtt). The preliminary model for this surface was generated from a limited number of observations. The more recognizable base of Qbtt has much better spatial control. As a consequence, the base of the Qbtt commonly appeared as intersecting the base of Qbt1g in the preliminary model. To remove this artifact induced by the differing data support for the two contacts, an isopach surface for the Tsankawi Pumice Bed (from Self et al., 1995) was added to the base of the Tsankawi, in order to provide the base of Qbt1g. The isopach surface for Qbtt was contoured by D. Vaniman and gridded, and then added to the grid model for Qbtt, to obtain the Qbt1g basal surface.

Qbtt:

Data for the Qbtt surface were compiled by S. Reneau. Within the Laboratory boundary, the data set consists primarily of contact points from Broxton and Reneau (1996), and drill hole data compiled by Vaniman et al. (1996); with data from Rogers (1995) added for the area northeast of the Los Alamos sewage treatment plant in Pueblo Canyon. North and west of the Laboratory boundary, data from Griggs (1964) were utilized. New fieldwork by S. Reneau provides contact information in the northwest (Rendija Canyon), southwest (Frijoles Canyon) and south (Water, Ancho, and other canyons). Fault offsets in the western portion of the map were estimated by S. Reneau. The set of data control points was used to develop a TIN model, which was then gridded.

Qct:

Accuracy of the basal surface of the Cerro Toledo unit in the preliminary model suffered from the same constraints as the Tsankawi Pumice unit. This contact was therefore obtained by subtracting an isopach surface (grid) for Qct (contoured by S. Reneau) from the surface (grid) for Qbtt.

Qbof:

Generation of the surface representing the top of the Qbog/base of Qbof encounters problems similar to that of the Tsankawi and Cerro Toledo units, due to the limited data on and variable thickness of the Guaje Pumice Bed (Qbog). An isopach surface for the Guaje Pumice Bed (from Self et al., 1995) was added to the base of the Otowi, in order to provide the base of Qbof. The isopach surface was contoured by D. Vaniman and gridded, and then added to the grid model for Qbog.

Qbog:

D. Broxton compiled data for the Qbog basal surface. Within the southern half of the Laboratory boundary, the data set consists primarily of contact points from Broxton and Reneau (1996), and drill hole data from Vaniman et al. (1996). In the north half of the Laboratory, these data are supplemented with data from Rogers (1995). Northeast of the Laboratory boundary, data from Griggs (1964) were utilized. New fieldwork by S. Reneau provides contact information in the northwest (Rendija Canyon), and southwest (Frijoles Canyon). Outcrops of the Tschicoma Formation (TT) in the northwest are considered by D. Broxton to approximate the base of Qbog. Therefore the topography was used to represent the base of Qbog in selected areas. Several lines of control points were added in this northwest region to augment the outcrop data. S. Reneau estimated fault offsets in the western portion of the map. This set of data control points was used to develop a TIN model, which was then gridded. The elevations along the outline of the Tschicoma outcrops were used to constrain the TIN model. The same outlines were then used to identify areas for which the gridded TIN model was replaced by gridded topographic data.

Tpf:

Data for the Tpf basal surface were compiled by D. Vaniman. Data for the central region are solely from drill hole contacts. Data from Griggs (1964) are used in the northeast region. To the east and southeast, several contact locations are provided by Dethier (1997) and Reneau (1995) for White Rock Canyon. In the west, surface elevations along the faults were estimated by D. Vaniman assuming: (1) a steady rise in the Tpf base to the west, and (2) growth fault behavior along the north-south trending structures. The set of data control points was used to develop a TIN model, which was then gridded.

Tpt:

There are few contact control points for the base of Tpt. D. Vaniman modeled the Totavi deposits as being of uniform average thickness of about 65 feet except for a southwest-trending trough in White Rock Canyon [control points from Reneau et al. (1995) and Dethier (1997)]. Random isopach points were generated in the region outside of the trough and a TIN was generated from these points and the three trough points. The gridded TIN was then subtracted from the Tpf grid to provide the Tpt basal surface.

Tsfuv:

The location of the base of the Tsfuv unit is poorly constrained. Data for the Tsfuv surface were compiled by D. Vaniman. Due to the importance of the upper volcaniclastic, undifferentiated, Santa Fe Group as an aquifer, D. Vaniman incorporated the available data within a speculative spatial model based on his geologic analysis. Deep well data suggest a north-northeast trending trough. Two wells provide minimal constraint for the eastern margin of the trough; the western margin is largely speculative. The margins of the trough were used to limit the extent of this unit. A TIN was generated using the Tsfuv contact point elevations within the trough and the elevations of the base of the Tpt along the trough margins. This TIN was then gridded.

References:

Broxton, D.E., and Reneau, S.L., 1996, Buried early Pleistocene landscapes beneath the Pajarito Plateau, New Mexico. In New Mexico Geol. Soc. Guidebook 47 (F. Goff, B. Kues, M.A. Rogers, L. McFadden, and J. Gardner, eds.), 325-334.

Dethier, D., 1997, Geologic map of the White Rock quadrangle, Los Alamos and Santa Fe Counties, New Mexico. New Mexico Bureau of Mines and Mineral Resources map 73.

Griggs, R.L., 1964, Geology and groundwater resources of the Los Alamos area, New Mexico. Geological Survey Water-Supply Paper 1753. 107 pages with plate providing geologic map and sections.

Reneau, S.L., 1995, Geomorphic studies at DP Mesa and vicinity, Los Alamos National Laboratory, Los Alamos, LA-12934-MS, p. 65-92.

Reneau, S. L., Dethier, D. P., and Carney, J. S., 1995, Landslides and other mass movements near Technical Area 33, Los Alamos National Laboratory: Los Alamos National Laboratory Report LA-12955-MS, Los Alamos, New Mexico, 48 p.

Rogers, M.A., 1995, Geologic Map of the Los Alamos National Laboratory Reservation, 25 sheets (scale 1"=400'). State of New Mexico Environment Department

Self, S., Heiken, G., Sykes, M.L., Wohletz, K., Fisher, R., and Dethier, D.P., 1995, Field excursions to the Jemez Mountains, New Mexico. Bulletin 134, New Mexico Bureau of Mines and Mineral Resources

Vaniman, D.T., Cole, G., Gardner, J., Conoway, J., Broxton, D., Reneau, S., Rice, M., WoldeGabriel, G., Blossom, J., and Goff, F., 1996, Development of a site-wide geologic model for Los Alamos National Laboratory, LA-UR-00-2059.