WHC-MR-0291

# Suprabasalt Geology of Soil Column Disposal Candidate Site Number 1: A Preliminary Evaluation of the Uniformity of the Site Geology and Recommendations for Number of Boreholes

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930



Approved for Public Release

WHC-MR-0291

# Suprabasalt Geology of Soil Column Disposal Candidate Site Number 1: A Preliminary Evaluation of the Uniformity of the Site Geology and Recommendations for Number of Boreholes

K. A. Lindsey
S. P. Reidel

Date Published
January 1992

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company
P.O. Box 1970
Richland, Washington 99352

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Approved for Public Release

# CONTENTS



FIGURES:

# INTRODUCTION

A large number of boreholes, including several Basalt Waste Isolation Project (BWIP) boreholes have been drilled in and around the 200 West Area of the Hanford Site, Washington. Data acquired from these boreholes form the basis for stratigraphic interpretations of the 200 West Area (Tallman et al. 1979; Bjornstad 1984; DOE 1988; Delaney et al. 1991; Lindsey 1991).

The data collected from the boreholes in the 200 West Area and vicinity indicate that the stratigraphy is relatively uniform in this area. Stratigraphic trends in and around the 200 West Area are fairly simple as compared to the rest of the Hanford Site. This report describes the degree of uniformity and the variation in stratigraphic units in that area and provides a preliminary evaluation of using only one borehole to characterize soil column disposal candidate site 1 (SCDS1) (Koegler and Reidel 1991).

# GENERAL GEOLOGY OF THE 200 WEST AREA

The suprabasalt stratigraphic section in the 200 West Area is divided, from bottom to top, into the following units: (1) Ringold Formation, (2) Plio-Pleistocene unit, (3) early "Palouse" soil, and (4) Hanford formation. The physical characteristics and distribution of these units are summarized in the following sections.

## RINGOLD FORMATION

The Ringold Formation in and around the 200 West Area is subdivided into four main stratigraphic sequences. These sequences, originally defined by Lindsey (1991), are similar to those that have been defined historically for the Ringold Formation in the 200 West Area (Myers et al. 1979; Tallman et al. 1981; Bjornstad 1984; DOE 1988). From bottom to top, the four Ringold sequences are: (1) gravel unit A, (2) the lower mud sequence, (3) gravel unit E, and (4) the upper Ringold unit (Figures 1 and 2).

Gravel units A and E are very similar, consisting dominantly of clast-supported, pebble to cobble gravel with a fine- to coarse-grained quartzo-feldspathic sand matrix. Variable but generally small (<5%) amounts of silt are found in these gravels. These gravels also contain localized interbeds of sand and mud no more than 10 m thick. In the 200 West Area, unit A is 0 to 45 m thick and unit E is up to 90 m thick and they usually are separated by the muds of the lower mud sequence. Where the lower mud sequence is absent, in the northern part of the 200 West Area, it is difficult if not impossible to differentiate the two units. Both units generally thin to the north onto the Gable Mountain anticline and thicken to the south into the Cold Creek syncline. Unit A corresponds to the lower part of the basal unit and unit E corresponds to the middle unit as defined by (DOE 1988).

The lower mud sequence, if present in the area of SCDS1, consists of a lower silty interval dominated by paleosols and an upper clayey interval

dominated by massive to laminated clay and lesser silt. The lower mud sequence can be up 10 m thick in the area of SCDS1 while it thickens to the south into the Cold Creek syncline and pinches out in the northern part of the area. The paleosols correspond to the upper part of the basal unit and the massive to laminated deposits to the lower Ringold unit as described by DOE (1988).

The upper Ringold unit in the 200 West Area consists of sand, silty sand, and sandy silt that form laterally discontinuous lenses throughout much of the 200 West Area. The upper unit is 0 to 12 m thick and pinches out near the borders of the 200 West Area.

## PLIO-PLEISTOCENE UNIT AND EARLY "PALOUSE" SOIL

The Plio-Pleistocene unit and early Palouse soil are two laterally discontinuous units that are found throughout much of the 200 West Area while they are absent elsewhere beneath the Hanford Site. The Plio-Pleistocene unit is up to 10 m thick in the area of SCDS1, disconformably overlies the Ringold Formation, and consists of variably developed pedogenic carbonate cemented silt, sand, and basaltic gravel and less cemented silt and silty sand. At many locations, the unit consists of several carbonate-rich horizons alternating with carbonate-poor horizons. The carbonate-rich horizons consist of massive to highly fractured pedogenic carbonate, usually Stage III and IV. Individual layers generally range from 0.5 to 1 m in thickness while massive carbonate rarely exceeds 0.5 m in thickness. In the northern part of the area, carbonate cement generally is better developed.

The early Palouse soil consists of 2 to 3 m of brown to dark tan silt, clayey silt, and sandy silt in the area of SCDS1. Calcium carbonate is common in the unit although carbonate cement is not observed. The silts that dominate the unit occasionally contain floating grains of basalt, and muscovite is common in the unit. On natural gamma logs, the unit can be recognized by a high natural gamma response.

## HANFORD FORMATION

The Hanford formation is divided into three main lithologic packages: (1) coarse gravels, (2) laminated sands, and (3) graded rhythmites (DOE 1988; Delaney et al. 1991). The thickest occurrences of the Hanford formation are found in the 200 West Area where it is up to 65 m thick. At and near SCDS1, the Hanford formation is approximately 10 to 25 m thick. Gravelly lithologies consist of coarse-grained sand and granule to boulder gravel that display massive bedding, plane to low-angle bedding, and large-scale cross-bedding in outcrop. Matrix commonly is lacking from the gravels, giving them an open-framework appearance. The laminated sands consist of fine- to coarse-grained sand and granules that display plane lamination and bedding and less commonly plane and trough cross-bedding in outcrop. Small pebbles and pebbly interbeds (<20 cm thick) may be encountered. The silt content of these sands is variable. However, where silt content is low, an open-framework texture may occur. Graded rhythmite deposits consist of silt and fine- to coarse-grained sand forming normally graded rhythmites. Plane lamination and ripple cross-lamination is common in outcrop.

## HOLOCENE SURFICIAL DEPOSITS

Holocene surficial deposits consisting of silt, sand, and gravel form a thin (<5 m) veneer across much of the Hanford Site. In the 200 West Area, these deposits consist dominantly of laterally discontinuous sheets of wind-blown silt and fine-grained sand.

## SPECIFIC STRATIGRAPHIC TRENDS NEAR SCDS1

The structural grain of the area trends roughly east-west parallel to the major structures bounding SCDS1, the Gable Butte segment of the Umtanum Ridge anticline to the north and the Cold Creek syncline to the south. As a result of this structure, the Ringold Formation and underlying Columbia River Basalt Group gently dip to the south off the Umtanum Ridge anticline into the Cold Creek syncline. Major stratigraphic variations tend to occur in a north-south direction parallel to this dip direction. Based on geologic trends seen in the 200 West Area and surrounding area, the geology of SCDS1 is relatively easy to predict.

Gravels of unit E and possibly unit A dominate the Ringold Formation in the area of SCDS1 (Figures 1 and 2). The Ringold Formation thins to the north beneath SCDS1 while it shows little east-west variation. The Hanford formation shows little lithologic variation in the area of SCDS1 (Figures 1 and 2), consisting dominantly of open-framework gravels. Near SCDS1, the Hanford formation is thinnest along the northern edge of the 200 West Area while it thickens to both the north and south. The only significant stratigraphic variations seen in the area of SCDS1 center on the lateral extent of the Ringold lower mud sequence, the Ringold upper unit, and the Plio-Pleistocene unit.

Coming up-dip and north, out of the Cold Creek syncline, Ringold strata thin or pinchout. In the area of SCDS1, one of the most notable pinchouts is that of the lower mud sequence (Figure 2). Although the actual position of the pinchout is not known, it is must occur between borehole 699-51-75 (where the lower mud does not occur) and borehole 299-W6-1 (where the lower mud is found). Where the lower mud sequence is absent, unit E directly overlies unit A and the two units are hydrologically connected.

Erosional remnants of the upper Ringold unit are found along the north-central boundary of the 200 West Area (Figures 1 and 2). These strata pinch out to the north and south. However, because of the lack of boreholes in the area of SCDS1, it is unclear how far to the north these strata extend. A similar situation is encountered when trying to access the extent of the Plio-Pleistocene unit north of the 200 West Area. Both units are found in borehole 299-W6-1 and both are absent in the next borehole to the north (699-51-75). Examination of Figure 1 reveals the probable reason these units do not extend to the north.

Borehole 699-51-75 is situated within one of the major cataclysmic flood channelways incised across the Pasco Basin. Significant flood erosion in the channelway lead to the removal the Plio-Pleistocene unit, upper Ringold unit, and a good part of Ringold unit A. Erosion was followed by deposition of a

thick sequence of flood gravel. The area around borehole 299-W6-1 is not situated in a channelway and, as a result, the strata removed from the area to the north are preserved. The exact position of the erosive channelway edge is not known because no boreholes penetrate deep enough in the area between 699-51-75 and 299-W6-1 to encounter it.

## CONCLUSIONS

The SCDS1 is located in an area of relatively uniform geologic stratigraphy. There are sufficient boreholes in the area to provide a level of confidence in suggesting that one borehole may be all that is necessary to characterize the SCDS1. The BWIP boreholes provide a continuous record of the stratigraphy in the vicinity of the SCDS1 that can be used to obtain physical properties on the stratigraphic units and verify the uniformity.

A single borehole extending to basalt at SCDS1 should verify suspected stratigraphic trends and establish the position of the unknown stratigraphic pinchouts relative to SCDS1. If the Plio-Pleistocene unit does not occur beneath the SCDS1, the structural dip of these strata and their position above the regional water table may lead to effluent migrating south in and across these relatively less permeable strata before finally moving through them into the underlying Ringold gravels. If the erosional pinchout is located south of SCDS1, then Hanford gravels will rest directly on the gravels of Ringold unit E, placing the two formations in direct hydrologic communication. As outlined above, a similar question about the position of the Ringold lower mud sequence pinchout also exists and needs to be resolved if the extent of vertical hydrologic intercommunication within the Ringold Formation is to be addressed.

It is therefore concluded that a single borehole at SCDS1 may be all that is necessary to adequately characterize the site. However, a final decision as to the number of boreholes necessary to characterize the SCDS1 cannot be made until the first characterization borehole has been drilled and the data from it interpreted.

## REFERENCES

Bjornstad, B. N., 1984, *Suprabasalt Stratigraphy Within and Adjacent to the Reference Repository Location*, SD-BWI-DP-039, Rockwell Hanford Operations, Richland, Washington.

Delaney, C. D., K. A. Lindsey, and S. P. Reidel, 1991, *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, WHC-SD-ER-TI-003, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE, 1988, *Consultation, Draft, Site Characterization Plan, Reference Repository Location, Hanford Site, Washington*, DOE/RW-0164, 9 Vol., U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, D.C.

Koegler, K. J., and S. P. Reidel, 1991, *Characterization Work Plan, C018H Soil Column Disposal Site Evaluation*, WHC-SD-EN-AP-041, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K. A., 1991, *Revised Stratigraphy for the Ringold Formation, Hanford Site, South-Central Washington*, WHC-SD-EN-EE-004, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K. A., and D. R. Gaylord, 1989, *Sedimentology and Stratigraphy of the Miocene-Pliocene Ringold Formation, Hanford Site, South-Central Washington*, WHC-SA-0740-FP, Westinghouse Hanford Company, Richland, Washington.

Myers, C. W., S. M. Price, J. A. Caggiano, M. P. Cochran, W. J. Czimr, N. J. Davidson, R. C. Edwards, K. R. Fecht, G. E. Holmes, M. G. Jones, J. R. Kunk, R. D. Landon, R. K. Ledgerwood, J. T. Lillie, P. E. Long, T. H. Mitchell, E. H. Price, S. P. Reidel, and A. M. Tallman, 1979, *Geologic Studies of the Columbia Plateau, A Status Report*, RHO-BWI-ST-4, Rockwell Hanford Operations, Richland, Washington.

Tallman, A. M., K. R. Fecht, M. C. Marratt, and G. V. Last, 1979, *Geology of the Separations Areas, Hanford Site, South-Central Washington*, RHO-ST-23, Rockwell Hanford Operations, Richland, Washington.

Tallman, A. M., J. T. Lillie, K. R. Fecht, 1981, "Suprabasalt Sediments of the Cold Creek Syncline Area" in *Subsurface Geology of the Cold Creek Syncline*, RHO-BWI-ST-14, Rockwell Hanford Operations, Richland, Washington.

Figure 1a. Topography and Principal Features of Candidate Sites 1 and 3 and Locations of Geologic Cross-Sections.

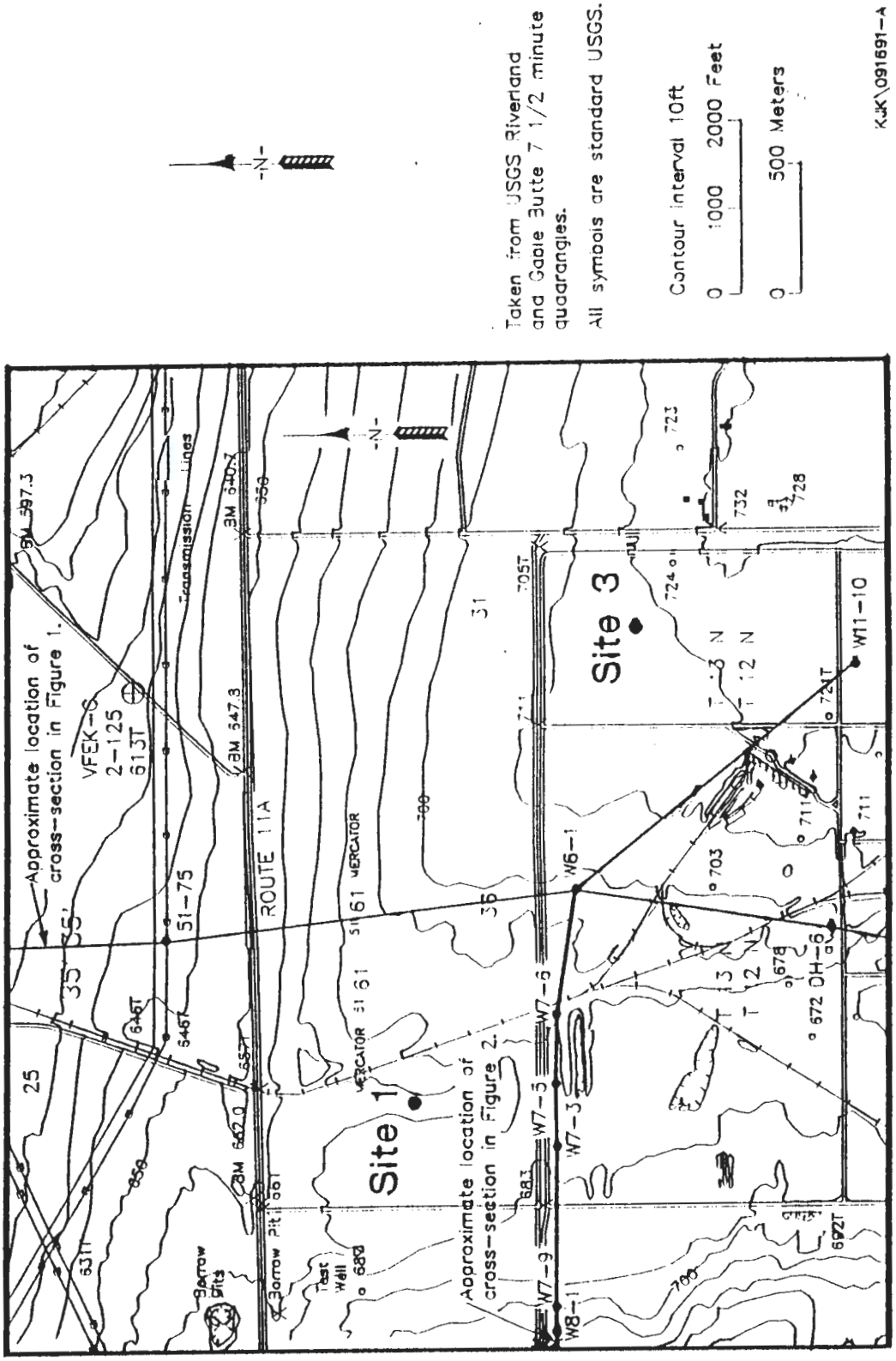
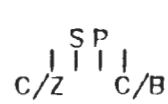


Figure 1b. Explanation for Cross-Sections.

Grain Size Scale – Horizontal Relief of Section Indicates Grain Size of Dominant Particals in Bed.




C/Z Clay and silt
S Sands (fine-grained to granular)
P Pebble Gravel
C/B Cobble to Boulder Gravel

Other Lithologies

 Cobbly/bouldery

 Pebbly

 Sandy

 Silt rich

 Clay rich

 Paleosol

 Carbonate-rich

 Ashy

 Basalt

Other Symbols

—— Formation major unit contacts

Facies contact

 Cementation/Compaction

Abbreviations

PM – pre-Missoula gravels
EP – early "Palouse" soil
PP – Plio-Pleistocene unit
UR – Upper unit, Ringold Formation
E – Uppermost gravel-dominated sequence, Ringold Formation
A – Lowermost gravel-dominated sequence, Ringold Formation
B,C,D – Discontinuous gravel-dominated sequences below unit E and above unit A, Ringold Formation
LM – Lower mud (fine-grained) sequence, Ringold Formation

KJK\091791-A

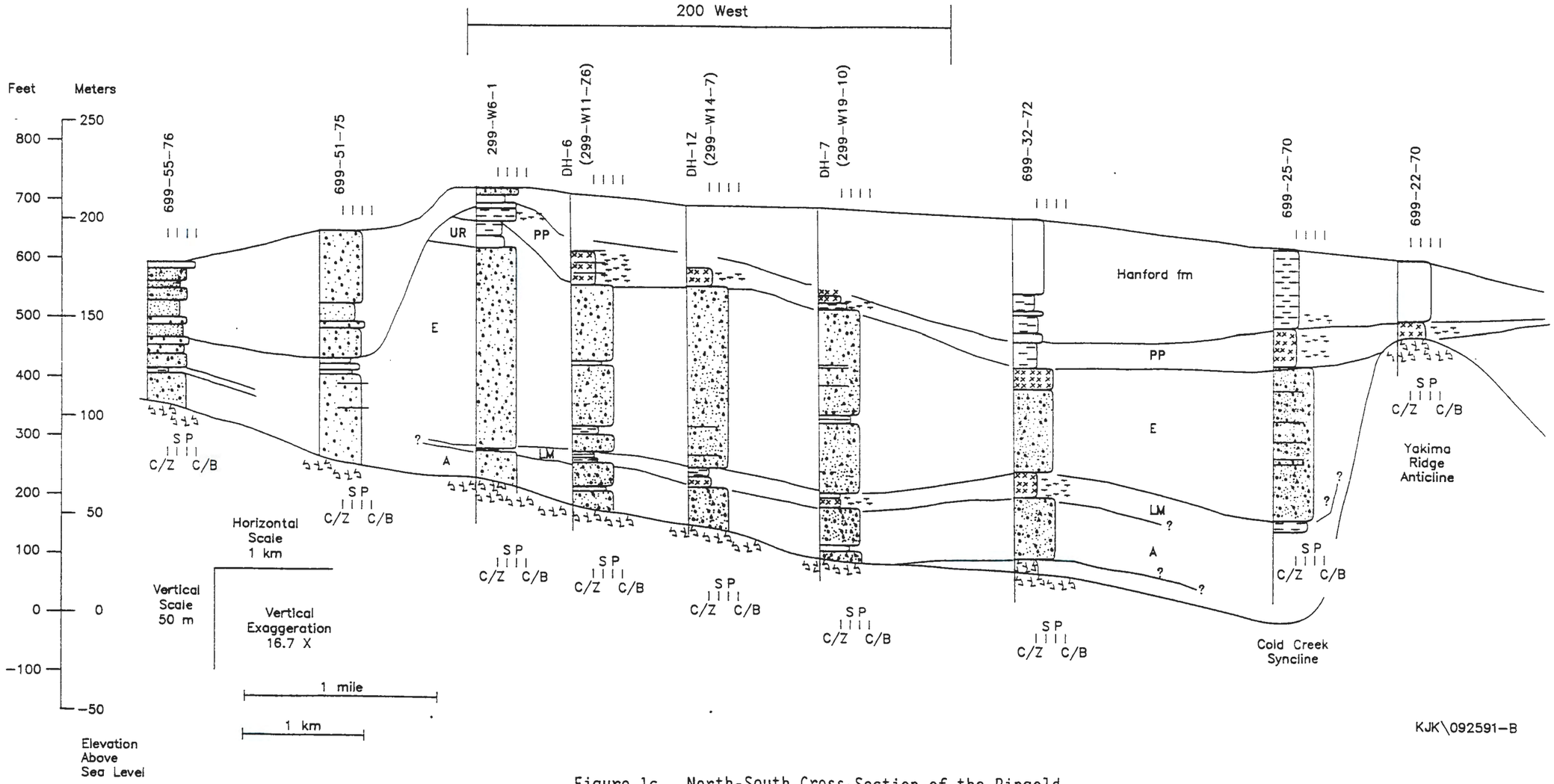



Figure 1c. North-South Cross-Section of the Ringold Formation in the 200 West Area.

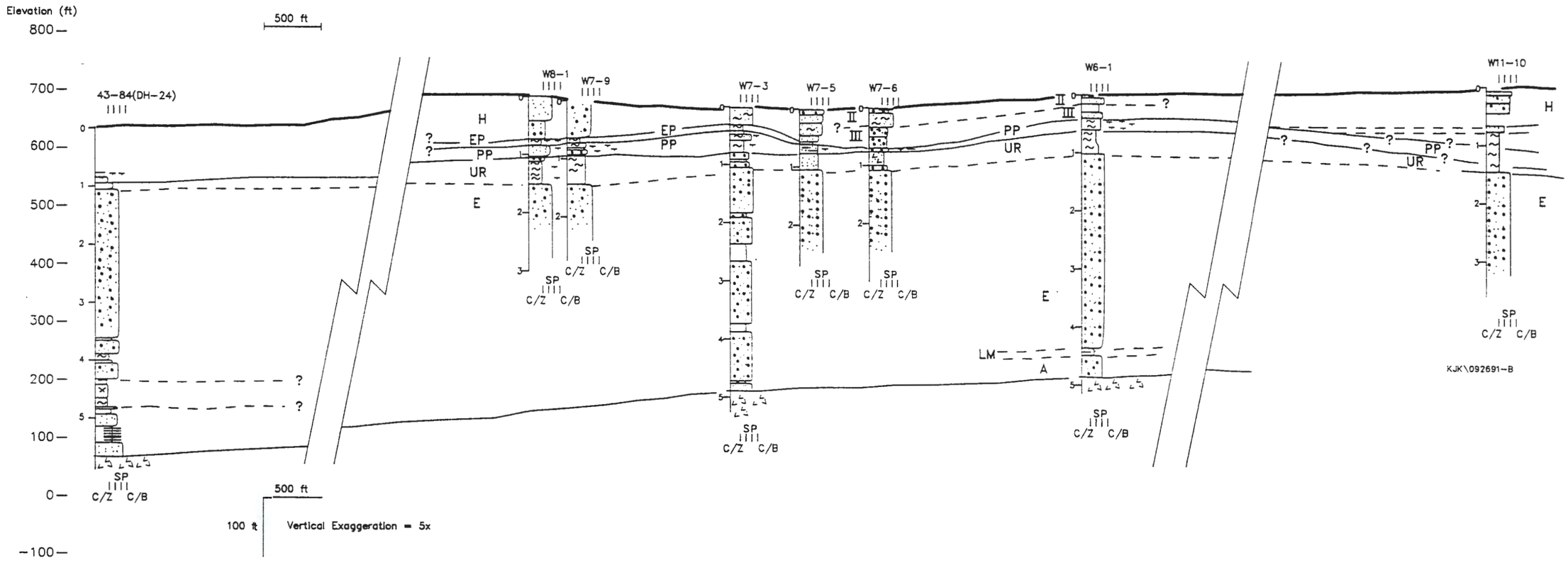



Figure 2. East-West Cross-Section of the Ringold Formation in the 200 West Area.