

ANNUAL PROJECT SUMMARY
Project period October 1, 1999-September 30, 2000

Title: The Quaternary Geologic Framework for the City of Seattle and the Seattle-Tacoma Urban Corridor: Collaborative Research with the University of Washington and the U.S. Geological Survey

External Grant Award Number: 99HQGR0034

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INVESTIGATIONS UNDERTAKEN

Background

This report covers the second year of an anticipated six-year project. Our investigations in this year represent the initiation of certain tasks, and the continuation of others, that will continue throughout that period, and which have a variety of milestones and products during that time.

The project plan focuses on the Quaternary framework of the Seattle area, because most of the central Puget Lowland has a recent sedimentary cover one hundred to over one thousand meters thick. We recognize five major components to develop this framework and to disseminate the resulting information:

1. Develop the regional stratigraphy and chronology for the central Puget Lowland;
2. Create a subsurface geologic database for the City;
3. Prepare new surficial geologic maps of the City;
4. Develop the geologic model (3-D map and database) of the City; and
5. Provide education and technical outreach.

The surficial and 3-D geologic mapping in the four quadrants of the City of Seattle (Figure 1) provides the framework for the overall project. Their anticipated completion dates are as follows:

Map Quadrant	Surficial Geologic Map	3-D Geologic Map
Seattle SW	2000	2001
Seattle NW	2001	2002
Seattle SE	2002	2003
Seattle NE	2003	2004



Figure 1. Map quadrangles for the City of Seattle

Component 1—Regional Stratigraphy and Chronology

We plan to produce a chronological and lithologic composite section of glacial and nonglacial deposits in the central Puget Lowland that can be used to evaluate the distribution, correlation, and deformation of individual geologic units across the region. This component was not included in this grant, in recognition of our reduced award, but we acknowledge it here because of its importance to the present proposal. No geologic study of a limited area, such as the City, can possibly succeed without also developing an adequate regional context. We have made significant progress on this component in 2000 using resources from other sources.

Component 2—Subsurface Geologic Database for the City of Seattle

We are building a comprehensive subsurface geologic database for the City. For this year of the overall project, the database had been fully designed and its population is well under way. At present, about 11,000 geotechnical records from the City's Department of Design, Construction, and Land Use office (DCLU), primarily submitted from private geotechnical consultants in support of building permit applications, have been indexed in an MS Access database and displayed on an ArcView GIS platform.

Component 3—Surficial Geologic Maps of the City of Seattle

We are preparing new geologic map coverage for the City, based on a combination of field investigations (coastal and river-valley bluffs, excavations, landslide scars) and near-surface borehole data. We are targeting first the areas of greatest interest for seismic-hazard evaluation (*e.g.*, West Seattle and the area of the Seattle fault, coastal landsliding, liquefaction-prone areas) and most readily available data. Both field work and acquisition of City-held data is complete for the Seattle SW quadrant.

Component 4—Three-Dimensional Geologic Model of the City of Seattle

This component of the project represents the integration of all previous stages. We envision a graphically supported database, where geologic materials are located in space and are characterized in terms of both their material properties and their stratigraphic assignment. Each stratigraphic unit will have a lateral and vertical definition. This component has been delayed by budgetary reductions in both project years to date, but we continue to explore available methods of cataloging and displaying subsurface geologic data.

Component 5—Education and Technical Outreach

This is an ongoing effort, anticipated to continue throughout the duration of the project. Activities are listed in the next section of this report.

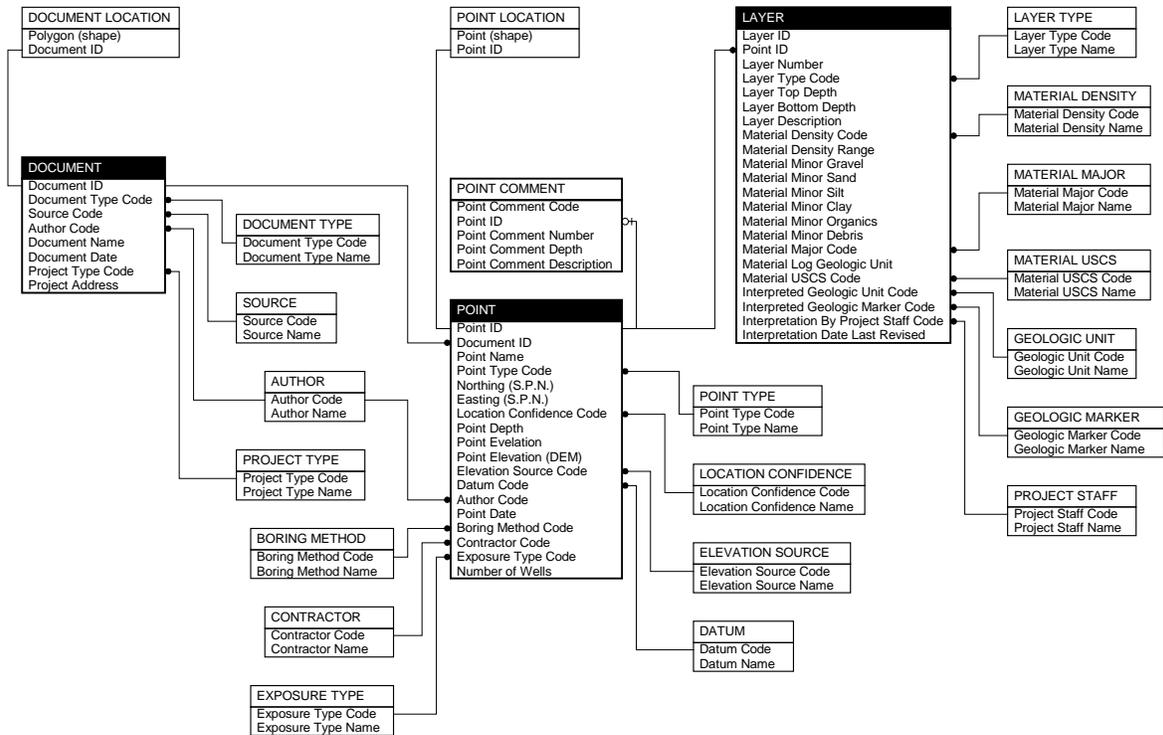
RESULTS

Component 1—Regional Stratigraphy and Chronology

Over the last several years, support from NCGMP (USGS) has enabled us to produce six (completed) 7.5-minute maps at 1:24,000 in the Seattle-Tacoma area and to bring two additional quadrangles to within a few months of completion. Although not part of our NEHRP-funded project, this effort is critical to the geologic mapping and hazard evaluation of the City of Seattle, and we intend to continue this effort. We anticipate full remapped coverage over the next several years of the Seattle-Tacoma urban corridor and adjacent developing areas to the west.

Component 2—Subsurface Geologic Database for the City of Seattle

We have developed, and are now populating, a database of existing subsurface geologic and geotechnical data that covers the City of Seattle. This database accommodates both spatial and nonspatial data by following a GIS-based approach. The design facilitates spatial analyses, visualization, and other representations of the data. The basic architecture of the database is diagrammed below:



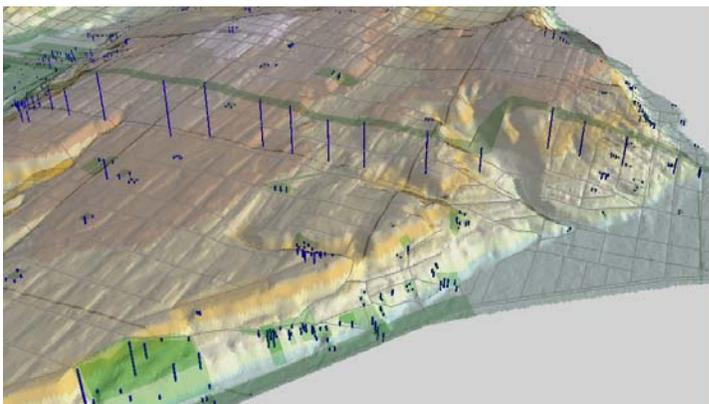
Our progress to date in populating the main tables of the database is as follows:

	Total area— to date	Seattle SW quad only—to date	Total area — anticipated
DOCUMENTS	3500	350	≈ 6000
POINTS	11,000	1100	≈ 25,000
LAYERS	4000	3400	≈ 100,000

Component 3—Surficial Geologic Maps of the City of Seattle (figures on following page)

Component 4—Three-Dimensional Geologic Model of the City of Seattle

We are currently using GIS software (ESRI’s ArcView and ArcInfo) for the development and creation of the surficial geologic maps. This software allows us to integrate multiple layers of processed data (from a variety of sources) to assist in the identification and the drawing of geologic contacts and features. It provides an easy and efficient method to enter, process, and review new data as it becomes available and to make adjustments and revisions to our interpretations (figure below).



Example of a 3-D perspective display of topography, exploration borings, and subsurface project sites in the northwest part of the Seattle SW quadrangle (view to southeast across Alki Point).

Component 5—Education and Technical Outreach

Specific activities for this component to date are summarized in the following table:

ACTIVITY	DATE	AUDIENCE
SHORT COURSES		
Quaternary Geology of the Central and Southern Puget Lowland (3 days including a 1-day field trip)	April 1999 and Sept 2000	Consultants, Agency Staff, Public
Quaternary Geology of the Central and Southern Puget Lowland	Jan 2000	Nelson Couvrette Associates
Quaternary Geology of the Central and Southern Puget Lowland (2 days including field trip)	May 2000	Landau Associates
FIELD TRIPS		
Geology of Seattle	June 1999 and Aug 2000	City of Seattle Staff
Geology of Seattle	Sept 2000	UW Department of Geology and Geophysics
Geology of the Seattle Southwest Quad	July 2000	Technical Advisory Group Members
Quaternary Geology of the Central and Southern Puget Lowland (2-day)	June 2000	Association of Engineering Geologists
Prehistoric Earthquake and Tsunami in the Puget Sound area	Sept 2000	WSSPC attendees: state geologists and emergency managers
TECHNICAL MEETINGS		
Project Updates	Quarterly	City of Seattle depts.
Technical Advisory Group Meetings	Quarterly	TAG Members
CONFERENCES		
Evening Forum on the Quaternary Geology of the Puget Lowland	August 1998; October 2000	2 nd and 3 rd Symposia on the Hydrogeology of Washington State
Convened a 1.5 -day symposium on the Quaternary Geology of the Puget Lowland	April 2000	GSA attendees
Many individual presentations, see CV's and Section 4.2 of this proposal for partial listing	1999 and 2000	Professionals and research community
PUBLIC MEETINGS		
Project Impact Disaster Saturdays Display of "The Geology of Seattle" complete w/geologic samples and stratigraphic models	All	Public

NON-TECHNICAL SUMMARY

Many engineering applications in urban and urbanizing areas depend on the spatial distribution of geologic materials and the sequence and history of their deposition. Yet, curiously, the Seattle region is served by one of the most incomplete and unorganized sets of geologic information of any major population center. This project is developing a detailed understanding and representation of the three-dimensional distribution of geologic materials beneath Seattle. To date, we have begun to organize the

vast amount of existing geologic information into a form that can be used, and to begin preparing the geologic maps that will ultimately display this information.

REPORTS PUBLISHED

Reports:

Borden, R. K., and Troost, K. G., 2000 (in press), Late Pleistocene Stratigraphy in the south-central Puget Lowland, West-Central Pierce County, Washington: Olympia, Washington State Department of Natural Resources, Report of Investigation.

Abstracts:

Booth, D. B., Troost, K. G., Hagstrum, J. T., Blakely, R. J., and Thorson, R. M., 2000, Geologic Evaluation of Tectonic Deformation in the Central Puget Lowland, Washington State: Abstracts with Programs, 96th Annual Meeting Cordilleran Section, Vancouver, British Columbia, April 27-29, 2000.

Hagstrum, J. T., Booth, D. B., and Troost, K. G., 2000, Magnetostratigraphy and Paleomagnetic Correlation of Pleistocene Deposits in the Central Puget Lowland, Washington: Abstracts with Programs, 96th Annual Meeting Cordilleran Section, Vancouver, British Columbia, April 27-29, 2000.

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