Hydrogeologic Framework Investigation of the Spokane Valley–Rathdrum Prairie Aquifer

By **Sue Kahle**, U.S. Geological Survey (USGS) and **John Covert**, Washington State Department of Ecology (WDOE)

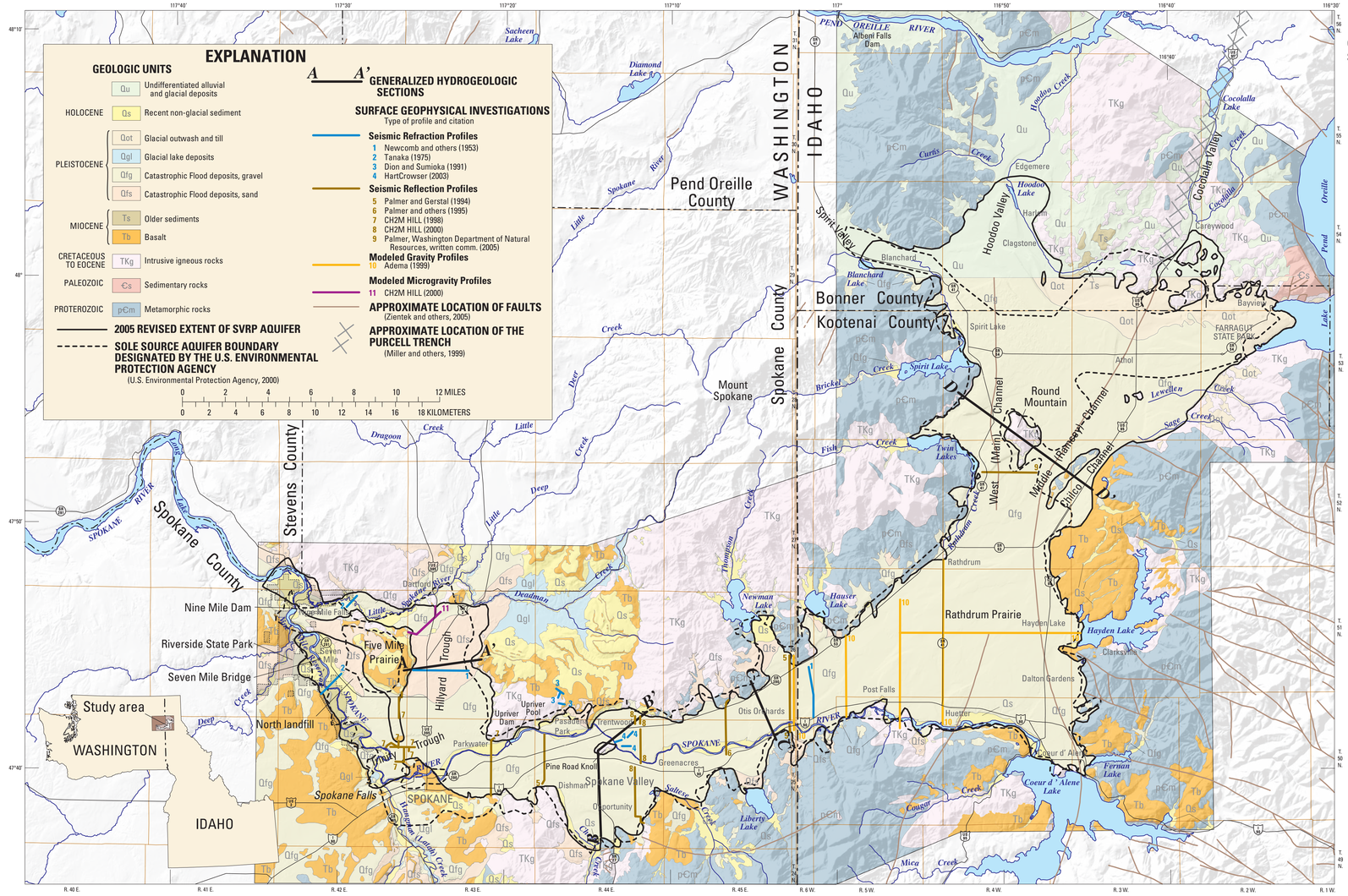
BACKGROUND

The Spokane Valley – Rathdrum Prairie (SVRP) aquifer is the sole source of drinking water for more than 400,000 residents in Spokane County, Washington, and Kootenai County, Idaho. The area includes the rapidly growing cities of Spokane, Spokane Valley, and Liberty Lake, Washington, and Coeur d'Alene and Post Falls, Idaho. Recent and projected urban, suburban, and industrial/commercial growth has raised concerns about potential future impacts on water availability and water quality in the SVRP aquifer, and the Spokane and Little Spokane Rivers. The Washington Department of Ecology, Idaho Department of Water Resources, and U.S. Geological Survey are conducting a joint investigation of the Spokane Valley – Rathdrum Prairie aquifer to collect and compile comprehensive geologic and hydrologic data sets that will provide an improved scientific basis for ground- and surface-water management.

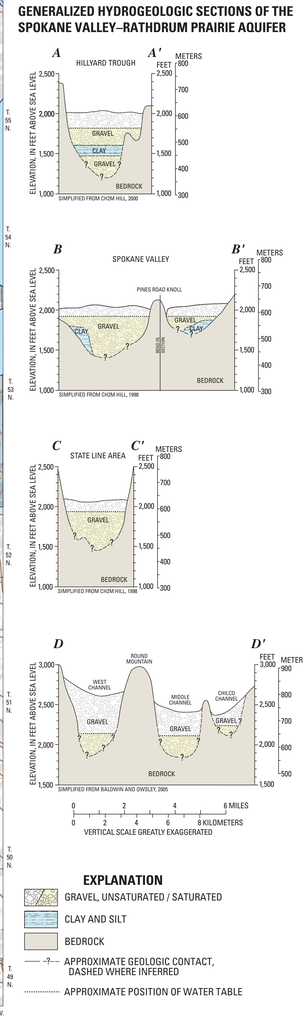
The aquifer is highly productive, consisting primarily of thick layers of coarse-grained sediments – gravels, cobbles, and boulders – deposited during a series of outburst floods resulting from repeated collapses of the ice dam that impounded ancient glacial Lake Missoula. A subtask of the overall joint investigation is to update our knowledge of the hydrogeologic framework in order to provide a more accurate and complete representation of the aquifer's areal extent, thickness, and hydrologic properties. The hydrogeologic data will be used to aid in the construction of a numerical ground-water flow model that will support the conjunctive management of ground- and surface-water resources.

OBJECTIVES

The purpose of this subtask is to gain a better understanding of the hydrogeologic framework of the SVRP aquifer using existing and newly collected data. Drilling and surface geophysical methods are proposed that would augment existing subsurface geologic information. Using existing and new data, hydrogeologic cross sections and maps will be constructed in order to illustrate the thickness and extent of the aquifer, as well as identify major lithologic variations within the aquifer. The locations of existing geophysical transects and selected hydrogeologic cross sections for the Hillyard Trough (*A*–*A*′), Spokane Valley (*B*–*B*′), Stateline area (*C*–*C*′), and the West, Middle, and Chilco Channel areas (D– D′) are shown at the right.



MAP SHOWING SIMPLIFIED SURFICIAL GEOLOGY, GENERALIZED HYDROGEOLOGIC SECTIONS, AND SURFACE GEOPHYSICAL INVESTIGATIONS



AQUIFER EXTENT

The areal extent of the SVRP aquifer has been designated somewhat differently between investigators and over time. This 2005 revised aquifer extent covers about 370 square miles and is slightly larger than the original Spokane Valley-Rathdrum Prairie Sole Source aquifer boundary that was designated by the U.S. Environmental Protection Agency in 1978 (see map).

In some areas, the revised extent includes unconsolidated coarse-grained deposits located outside the original Sole Source aquifer boundary that are in direct hydraulic connection with the main body of the aquifer. An example of this is in the Chilco Channel area in Idaho where ground water flows into the Rathdrum Prairie portion of the Sole Source aquifer from an area in hydraulic connection with the aquifer but outside the sole source aquifer boundary. Near the headwaters of the aquifer, adjustments were made by moving the boundaries of the aquifer within Hoodoo and Spirit Valleys and near Careywood to ground-water divides that have been mapped during previous investigations.

In Washington, near the aquifer's outlet northwest of Spokane, recent analysis of ground-water level data, Nine Mile Reservoir elevation data, bedrock outcrops, and historical streamflow data has resulted in redrawing the western arm of the aquifer boundary as ending near Nine Mile Dam rather than being continuous through that area as shown in previous aquifer boundaries. A bedrock ridge extending northwest from Five Mile Prairie down to Nine Mile Dam forms the northern boundary of the western arm of the aquifer. As such, the aquifer ends south of Nine Mile Dam and the water moving through this arm of the aquifer re-emerges into the Spokane River (Nine Mile Reservoir) before the dam.

AQUIFER THICKNESS

The thickness of the SVRP aquifer is generally unknown except along its margins where wells have been drilled through its entire thickness. Since many wells completed in the SVRP aquifer are extremely productive, very few wells extend more than 100 feet into the saturated zone. In Washington, the greatest known thickness was recorded in the Hillyard Trough where a 780-foot well didn't penetrate the full thickness of the aquifer deposits (glacial lake flood deposits). Near the Idaho-Washington State line, the thickness of the aquifer is about 500 feet (CH2M Hill, 1998). In Idaho, the greatest known thickness is near Spirit Lake where a 700-foot well was drilled without penetrating the entire thickness of the aquifer.

VARIABILITY OF AQUIFER MATERIAL

Although most of the aquifer has long been assumed to be coarse grained throughout, recent investigators have identified a thick layer of clay, silt, and sand located in the Hillyard Trough (CH2M Hill, 2000 section A–A'). The areal extent of this unit, however, is poorly defined, as are other possible occurrences of thick fine-grained layers elsewhere within the aquifer. Basic hydrogeologic data is needed in order to identify major areas of lithologic variability within the aquifer.

In the Hillyard Trough, which is near the hydrologically 'lower end' and discharge area of the SVRP aquifer, it is particularly important to learn more about the geometry of the fine-grained layer. The layer appears to separate the upper aquifer from a deeper confined system that may play a role in discharge from the SVRP aquifer by way of the deeper system.

REFERENCES

Adema, G.W., 1999, Bedrock depth and morphology of the Rathdrum Prairie, Idaho: Moscow, University of Idaho, M.S. thesis, 67 p.

Baldwin, J., and Owsley, D., 2005, The Ramsey Channel of the Spokane Valley-Rathdrum Prairie Aquifer: Idaho Department of Environmental Quality Technical Ground Water Report No. 26, 23 p.

CH2M HILL, 1998, City of Spokane wellhead protection program phase I-Technical assessment: CH2M Hill report for the City of Spokane Wellhead Protection Program, 2 vols., variously paged, 12 appendixes.

CH2M HILL, 2000, Spokane aquifer joint board wellhead protection program, management plan and report appendix: CH2M Hill report for the Spokane Aquifer Joint Board, 3 vols., variously paged, 24 appendixes.

Dion, N.P., and Sumioka, S.S., 1991, Extent and source of organic solvents in ground water in the Argonne Road area near Spokane, Washington: U.S. Geological Survey Water-Resources Investigations Report 89-4121, 39 p.

HartCrowser, 2003, Draft groundwater remedial investigation/feasibility study, Kaiser Trentwood Facility, Spokane, Washington, v. 1: Prepared for Kaiser Aluminum and Chemical Corporation, variously paginated.

Kahle, S.C., Caldwell, R.R., and Bartolino, J.R., 2005, Compilation of geologic, hydrologic, and ground-water flow modeling information for the Spokane Valley – Rathdrum Prairie Aquifer, Spokane County, Washington and Bonner and Kootenai Counties, Idaho: U.S. Geological Survey Scientific Investigations Report 2005-5227.

Miller, F.K., Burmester, R.F., Powell, R.E., Miller, D.M., and Derkey, P.D., 1999, Digital geologic map of the Sandpoint 1- by 2-degree quadrangle, Washington, Idaho, and Montana (ver. 1.0): U.S. Geological Survey Open-File Report 99-144, 11 p., and 1 digital plate (scale 1:250,000), accessed January 13, 2004, at *http://wrgis.wr.usgs.gov/open-file/of99-144/.*

Newcomb, R.C., and others, 1953, Seismic cross sections across the Spokane River Valley and the Hillyard trough, Idaho and Washington: U.S. Geological Survey Open-File Report 53-199, 16 p., 18 pls.

Palmer, S.P., and Gerstel, W.J., 1994, Preliminary report on seismic reflection profiling of the Spokane Valley, Spokane County, Washington: Olympia, Washington Department of Natural Resources, Division of Geology and Earth Resources, 12 p.

Palmer, S.P., King, Michael, Gruenenfelder, C.R., Miller, S.A., and Hendron, L.H., 1995, Application of reflection seismology to the hydrogeology of the Spokane aquifer: Washington Geology, v. 23, no. 2, p. 27-30.

Tanaka, H.H., 1975, Seismic profile lines in the Spokane area [abs.]: U.S. Geological Survey Professional Paper 975, p. 115.

U.S. Environmental Protection Agency, 2000, Sole source aquifer protection program overview: U.S. Environmental Protection Agency, data available on the web, accessed June 6, 2001, at *http://www.epa.gov/ogwdw/swp/ssa.html.*

Zientek, M.L., Derkey, P.D., Miller, R.J., Causey, J.D., Bookstrom, A.A., Carlson, M.H., Green, G.N., Frost, T.P., Boleneus, D.E., Evans, K.V., Van Gosen, B.S., Wilson, A.B., Larsen, J.C., Kayser, H.Z., Kelley, W.N., and Assmus, K.C., 2005, Spatial databases for the geology of the Northern Rocky Mountains–Idaho, Montana, and Washington (ver.1.0): U.S. Geological Survey Open-File Report 2005-1235, 201 p., accessed June 2005, at *http://pubs.usgs.gov/of/2005/1235/.*

Spokane Valley–Rathdrum Prairie Hydrologic Study
For additional information:
http://www.idwr.state.id.us/hydrologic/projects/svrp
http://wa.water.usgs.gov/projects/svrp