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Department of Water Resources
Eastern Region

December 31, 2009

Idaho Department of Water Resources
Attn: Gary Spackman, Administrator
322 E Front Street
PO Box 83720
Boise, ID 83720

COPY

Re: City of Newdale Transfer of Water Rights 22-2217 and 22-7269

Dear Mr. Spackman,

This letter was prepared as a follow-up to the Newdale ground water issues. As you are aware, we prepared an Application for Transfer of Water Rights to move a portion of the existing water rights mentioned above into a new well due to well contamination. The processing of the transfer application necessitated the employment of the ESPA Spreadsheet tool of which the IDWR state office so graciously participated in devising a specific spreadsheet tool for this particular analysis. Using the provided tool revealed depletive affects to the South Fork River, especially the Heise reach of the South Fork of the Snake River. As a result, we have conducted a limited geologic analysis of the Rexburg Bench environs to help determine the validity of underlying assumptions built into the aquifer model.

This brief report demonstrates that the geology and hydrology of the Rexburg Bench does not support the ESPA Spreadsheet Analysis reflecting potential depletive affects on the South Fork reach of the Snake River.

This report was prepared in collaboration with Dr. Glenn F. Embree, PhD, Principal geologist of Geologic Exploration & Consulting. Dr. Embree has been studying the geology of the Rexburg area since 1974. He has worked with the United States Geological Survey for many years on projects throughout Eastern Idaho and is considered an expert relative to the geology of this particular area. Dr. Embree compiled published and unpublished data from his research along with the research of fellow scientists to prepare the enclosed report.

Regards,

A handwritten signature in blue ink that appears to read "Roger".

W. Roger Warner

Enclosures: Newdale Report, including Figures 1 and 3 attached;
Vicinity Map;
Map of the General Geology;
Map of the Known Geothermal Wells;
Glenn F Embree Resume

Newdale Report

Introduction:

The objective of this brief report is to provide an overview of the most recent available geologic data, which will increase our understanding of the subsurface structure and stratigraphy, and their impact on groundwater flow in the Rexburg Bench/Heise area. We have examined 1:24,000 scale geologic maps produced by Doherty, D.J., Embree, G.F., Hoggan, R.D., and Prostka, H.J. who worked in the area between 1970 and 2008. The U.S. Geological Survey, Idaho Geological Survey, BYU-Idaho, Idaho State University, and the INL and its contractors funded most of this mapping. Some of this mapping was published as a U.S.G.S Open-File Report 78-1009 but more recent mapping has not yet been published. Subsurface data was obtained from Haskett (1972), Schneider (1980), and Welhan (2009). We have also incorporated data from geothermal exploration wells drilled in 1978 through 1980 (Embree, et al, 1978; Stoker et al, 1980; Energy Services Inc., 1981).

Two structure sections (Figure 1) were constructed from the data described above in order to help predict the direction of ground water flow on the Rexburg Bench. Due to the scarcity of deep wells and the absence of deep exposures on the southern portion of the bench, the structure within the Paleozoic/Mesozoic package has been stylized, based on projection of structural trends from exposures to the south. The package of volcanic rocks that makes up the Heise Volcanic Field is also quite complex due to the mixture of regionally extensive ignimbrite sheets and local rhyolite lava flows and tephra deposits, as well as the effect of paleotopography on the distribution of those units. The dips of major Heise ignimbrites, the Huckleberry Ridge tuff and basalt units, on the other hand are relatively well constrained and are consistent with our understanding of the regional distribution of major units. Stylized bedding planes within the Trh (Rhyolites of the Heise Volcanic Field) unit reflect the typical onlap relationship seen within this package (Figure 2 and 3). Older units generally dip slightly more steeply and extend up-slope to higher elevations than the overlying units. Each ignimbrite sheet pinches out against the unit below. This suggests that each successive sheet lapped onto a dipslope of the previous unit. The time intervals between these major, regionally distributed units is on the order of one to two million years, leaving time for a few degrees of tectonic tilt to develop on each unit prior to the deposition of the next sheet.

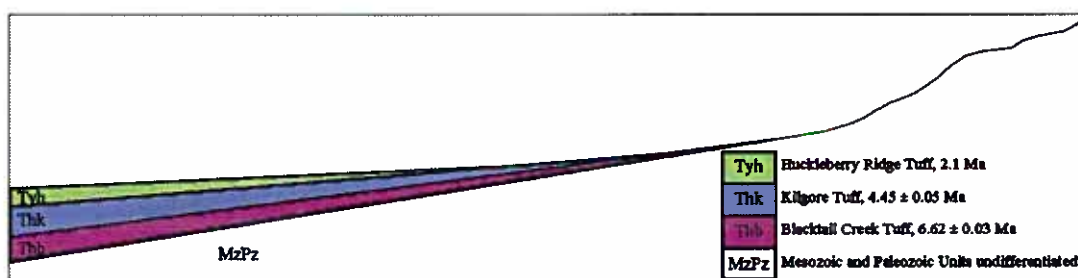


Figure 2. Stylized bedding planes that reflect the typical onlap relationship.

Interpretation:

Surface geology and geomorphology along with the well data are represented in structure sections A-A' and B-B'. All of this data indicate that there is little likelihood that ground water from the Newdale area is a significant contributor to the South Fork of the Snake River. We believe that the proposed well in the SW ¼ of the NWE ¼ of Section 7, T 6 N, R 42 E, will have no adverse effect on the South Fork of the Snake River, for the following reasons:

1. The existence of several steeply dipping thrust faults and intense folding within the Mesozoic and Paleozoic rocks should inhibit ground water flow through that structural-stratigraphic package between Newdale and the South Fork. Steep east dipping fold limbs and the presence of numerous shale units within the Mesozoic strata produce significant barriers.
2. The dips within the Heise Volcanic units range from ~5° to ~20° to the northeast or north, promoting flow to that direction, away from the South Fork.
3. The dips in the post Heise units are more gentle, but both sections A-A' and B-B' indicate that they dip about 2° to 5° to the north or northwest. This is consistent with the findings of Haskett (1972) reporting a dip of 1° to 2° to the northwest.
4. The onlap relationships of the Heise Volcanic units cause them to pinch out to the southwest, further inhibiting southwestward flow (Figure 2).
5. A northwest trending volcanic rift zone lies approximately eight miles south-southwest of the proposed drill site. This rift zone appears to be a continuation of the Grand Valley Fault that forms the northeast margin of the Swan Valley Graben. On the Rexburg Bench there are at least 10 basaltic vents located along this rift zone. It is expected that this rift will behave similarly to the major northwest trending rift zones which cross the Snake River Plain. On the plain, the elevated water table on the northeast side of these rifts suggests that their feeder dikes act as dams, slowing the southwestward flow of groundwater down the plain. In the case of the rift on the Rexburg Bench, the dike system would most likely behave in a similar manner, inhibiting groundwater flow to the southwest, and directing it to the northwest toward Sugar City.
6. The fact that the South Fork tends to hug the Heise side of the graben, along with the sloping topography of Antelope Flat and Ririe Reservoir area suggest that displacement on the Heise fault is greater than that of the faults on the southwest side of the valley. This indicates that the northeast side of the graben is dropping faster than the southwest side. Thus, the graben floor with its sediment and basalt fill dip gently to the northeast. This suggests that the majority of groundwater in addition to the surface water inflow into the South Fork is from the southwest.
7. The presence of several warm springs (including Heise Hot Springs) along the northwest striking Heise Fault suggests that the groundwater flow in that area is dominated by water moving up along the fault and not flow from the Rexburg Bench. In most geothermal

systems in this type of setting, water percolates down through the hanging wall block of a graben, is heated at depth and then moves up along the boundary fault. If a significant volume of groundwater was flowing from the Newdale area on the Bench toward the South Fork, we would expect that it would mask or significantly dilute the hot water before it reached the surface. One of the biggest challenges to geothermal exploration in the northern Rexburg bench and Sugar City areas has been the presence of the cold surface aquifer, which masks geothermal targets beneath. This is not the case along the Heise Cliffs, indicating that the prolific shallow aquifer on the bench does not extend through the Heise Volcanic rocks or the Paleozoic/Mesozoic rocks in the Kelly Mountain area.

Water Budget:

Haskett (1972) reported that the natural recharge of the Rexburg Bench was previously estimated to be about 35,000 acre feet per year while ground water pumpage was calculated to be about 40,000 acre feet per year without any apparent decline of the water table. Haskett stated that the fact that the water table was not in decline indicates that there must be some other source of inflow into the aquifer underlying the Rexburg Bench in addition to natural recharge. It was suggested by Haskett, based upon his analysis of water table contours, that the additional inflow may be from three possible sources including the South Fork of the Snake River.

Based upon evidence provided herein, it appears unlikely that significant recharge from the South Fork passes through the multitude of deep thrust faults and stratigraphic barriers, including the steeply dipping Mesozoic and Paleozoic rocks, to recharge the Rexburg Bench aquifer.

References:

Christiansen, R.L., 2001, The Quaternary and Pliocene Yellowstone Plateau Volcanic Field of Wyoming, Idaho, and Montana: U.S. Geological Survey Professional Paper 729-G.

Doherty, D.J. Unpublished Geologic Maps of the Heise, Hawley Gulch, Heise SE, and Poplar 7 ½ minute quadrangles, Idaho.

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Embree, G.F., Lovell, M.D., Doherty, D.J., 1978, Drilling data from Sugar City exploration well, Madison County, Idaho: U.S. Geological Survey Open File Report 78-1095.

Energy Services Inc, 1981, Madison County geothermal project preliminary well drilling report: Unpublished, limited distribution report by Energy Services Inc., Idaho Falls, ID, 40 p.

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Hoggan, R.D., Unpublished geologic maps of the Paleozoic and Mesozoic rocks in the Heise, Hawley Gulch, Heise SE, and Poplar 7 ½ minute quadrangles, Idaho.

Mitchell, V.E. and Bennett, E.H., 1979, Geologic map of the Driggs Quadrangle, Idaho: Idaho Bureau of Mines and Geology, Geologic Map Series, Driggs 2 ° Quadrangle.

Morgan, L.A., McIntosh, W.C., 2005, Timing and development of the Heise volcanic field, Snake River Plain, Idaho, Western USA: Geological Society of America Bulletin, v. 117, no. 314; p. 288-306.

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Prostka, H.J., and Hackman, 1974, Preliminary geologic map of the NW ¼ Driggs 1 ° by 2 ° quadrangle, southeastern Idaho: USGS Open-File Report 74-105.

Schneider, J., 1980, Correlation of well data in the Rexburg area, southeastern Idaho: Unpublished student project, Geology Department, Ricks College, Rexburg, Idaho, 15 p.

Stoker, R.C., Kunze, J.F., 1980, Evaluation of the geothermal potential around Rexburg, Idaho: Contract DE-FC07-79ET27028, U.S. Department of Energy, Geothermal Energy; Report Prepared by Energy Services Inc., Idaho Falls, ID, 154p.

Welhan, J., 2009, Personal communication.

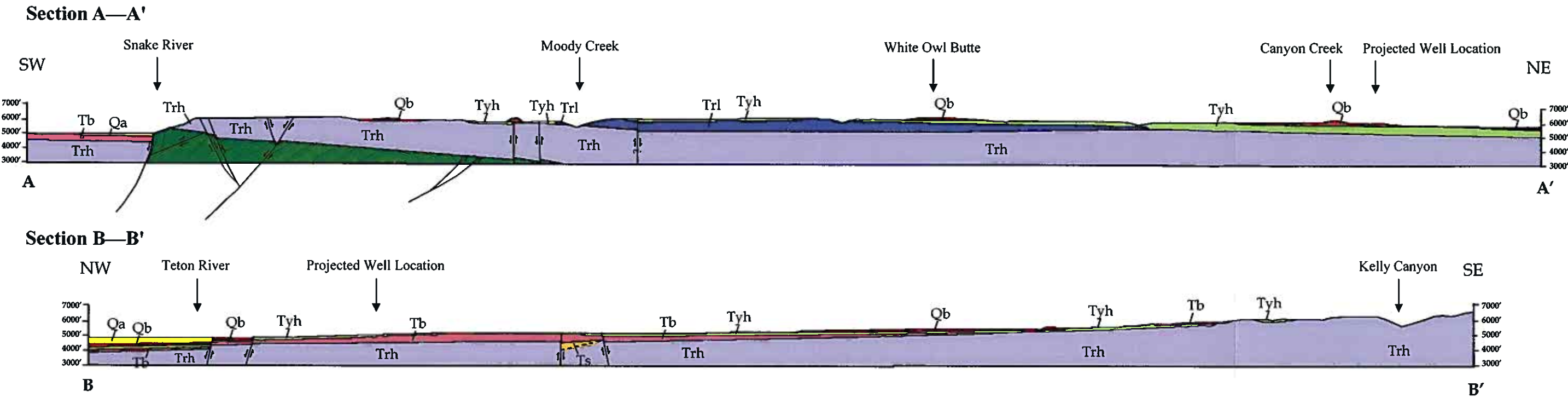
Map References:

Johnson, Bruce R., and Raines, Gary L, 1995, Digital map of major bedrock lithologic units for the Pacific Northwest: a contribution to the Interior Columbia River Basin Ecosystem Management Project: U.S. Geological Survey Open File Report 95-680.

The following data were obtained from the Idaho Department of Water Resources GIS Database (http://www.idwr.idaho.gov/gisdata/gis_data.htm):

- Geothermal Resources
- Faults
- Major Rivers
- Cities
- Major Lithologic Units (Johnson, 1995)
- Idaho Shaded Relief

Figure 1 Geologic Cross Sections



Section Unit	Map Equivalent	Unit Description
Qa	Qa, Qpg	ALLUVIUM OF MODERN FLOOD PLAINS (HOLOCENE) - Unconsolidated fluvial clayey silt, silty sand, and gravel, may contain some basalt flows
Qb	part of Qpmb and within some areas shown as Qplf	BASALT FLOWS AND TEPHRA (PLEISTOCENE)- Vesicular basalt, scoria, and cinders with some interbedded sediments
Tyh	part of Qplf	HUCKLEBERRY RIDGE TUFF (PLIOCENE)- Compound cooling unit of crystal-rich welded rhyolitic ash-flow tuff (2.06 Ma)
Tb	part of Qpmb	PRE-HUCKLEBERRY RIDGE TUFF BASALTS (PLIOCENE)- Vesicular to scoriaceous basalt flows
Ts		TERTIARY SEDIMENTS (PLIOCENE) - Unconsolidated Lacustrine and alluvial sediments (Haskett, G, 1972)
Trl	part of Qplf	RHYOLITE OF LONG HOLLOW (PLIOCENE)- Perlitic and vitrophyric rhyolite lava flow, part of the Heise Volcanic field
Trh	Tpf	RHYOLITES OF THE HEISE VOLCANIC FIELD (MIOCENE TO PLIOCENE)- Rhyolite welded tuffs, lava flows, air fall tephra, and tuffaceous sediments, ranging in age from 4.45+/-0.05 to ~8 Ma
MzPz	C, O, D, Ms, PPnc, TR, J, Ku, KI	MESOZOIC AND PALEOZOIC ROCKS UNDIFFERENTIATED- Carbonate and clastic sedimentary rocks ranging in age from Cambrian to Cretaceous

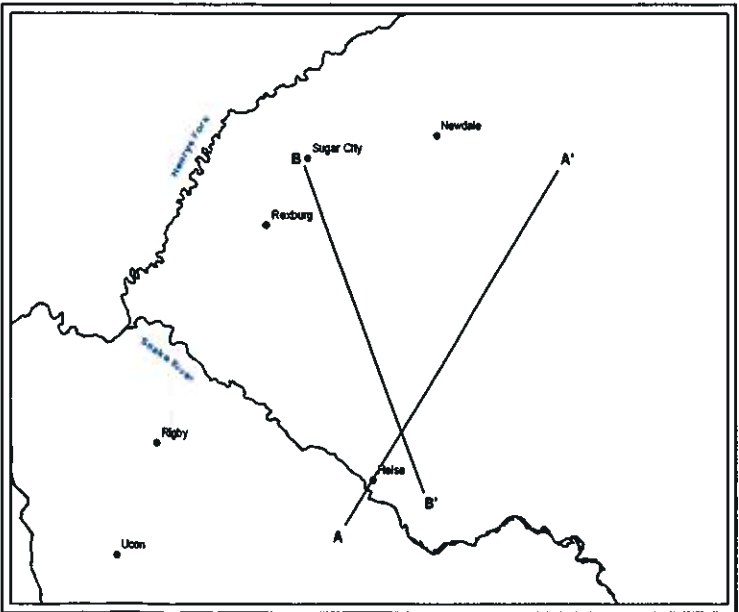
0 2000 4000 6000 8000
Feet

----- Approximate contact
----- Projected folded bedding

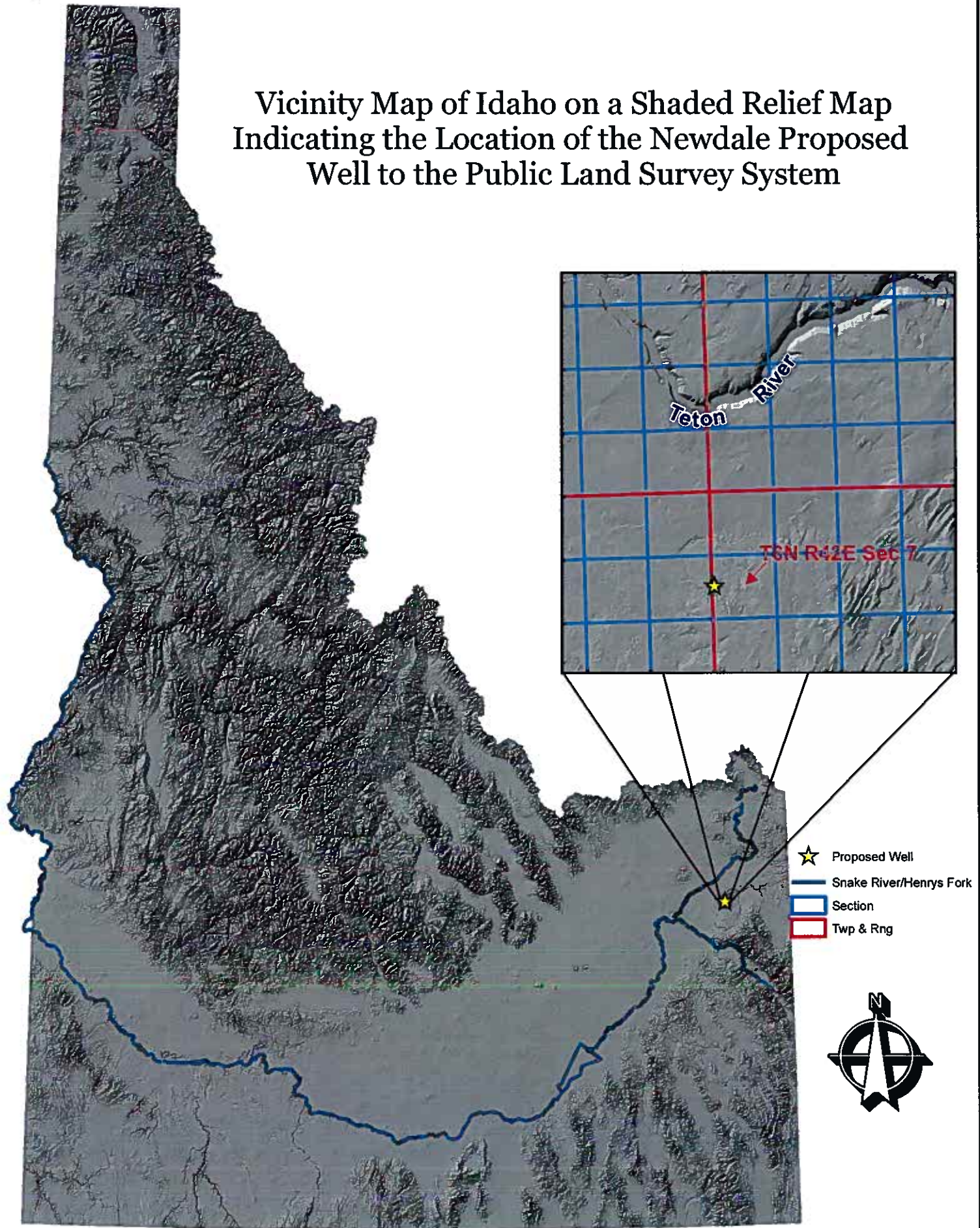
This data was collected and depicted in cross section by Glenn F. Embree, PhD in February 2009, with graphic assistance by K. Moore at Rocky Mountain Environmental Associates, Inc. Section was drawn from unpublished geologic maps.

References for data used herein can be found in the Newdale Report.

Location of Section Lines

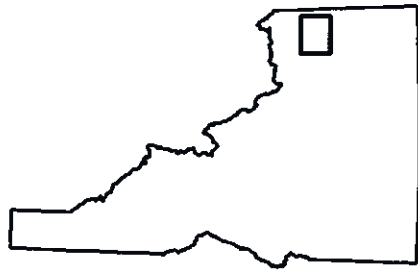


Vicinity Map of Idaho on a Shaded Relief Map Indicating the Location of the Newdale Proposed Well to the Public Land Survey System



*Index map only. Sections not drawn with these units.

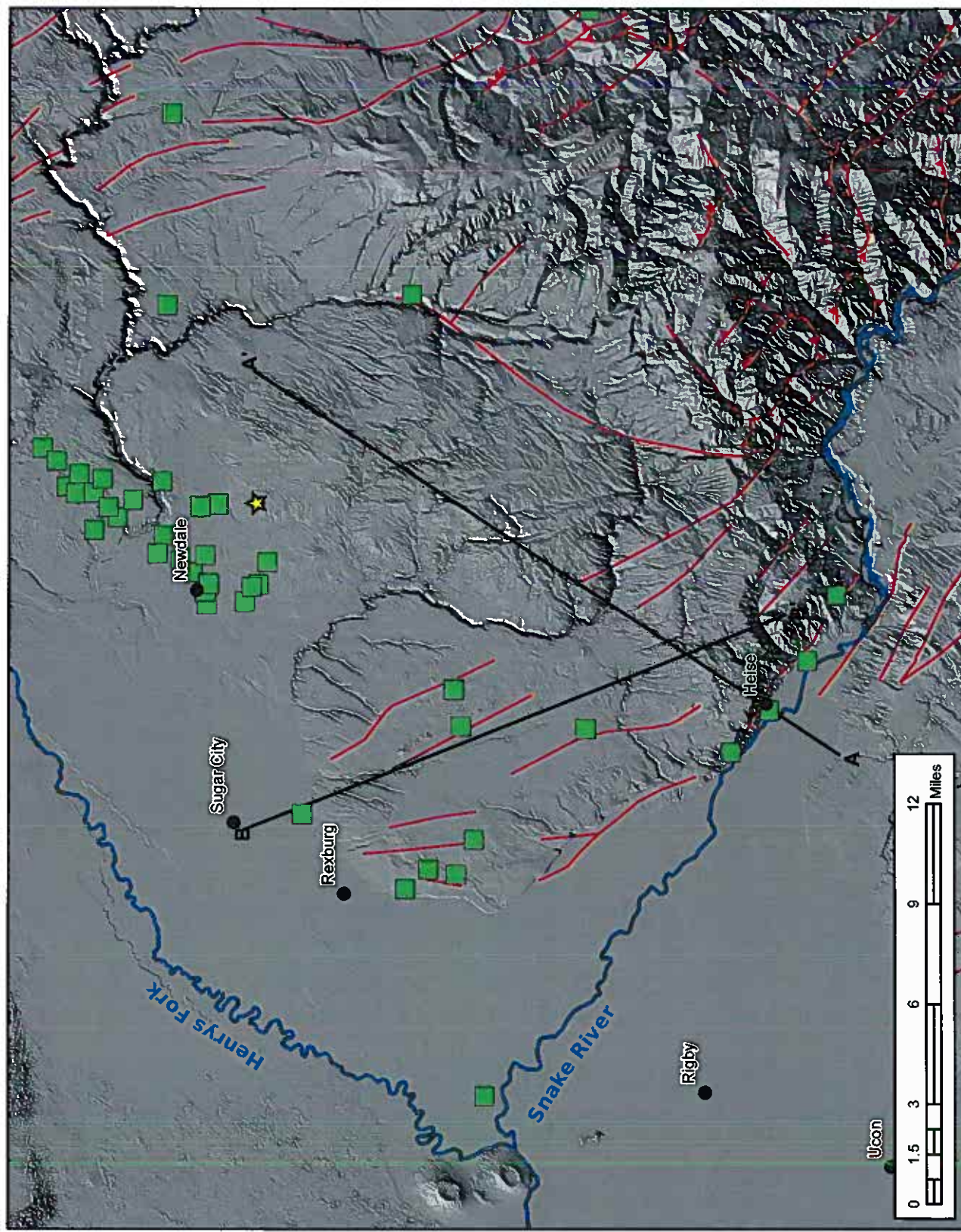




Legend

- ★ Proposed Well
- City
- Geothermal Wells
- River
- Fault**
 - - - Caldera
 - Normal
 - Thrust

Map of the Known Geothermal Wells in Relation to Trending Faults Near Newdale



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Rexburg, Idaho 83460-0505
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EDUCATION

B.S. (Geology) San Diego State University, San Diego, Ca., 1967

M.S.(Geology) Brigham Young University, Provo, Utah, 1969 Thesis title: Lateral and vertical variations in a Quaternary basalt flow, Petrography and chemistry of the Gunlock Flow, Southwestern Utah.

Ph. D.(Geology) University of Idaho, Moscow, Idaho, 1976, Dissertation title: Structural analysis of the Precambrian rocks, Green Lake Basin, Teton Range, Wyoming.

EXPERIENCE

1989-Present, Consulting: Work with the United States Geological Survey, Idaho Geological Survey, United States Department of Energy, government contractors, and universities on regional geologic mapping, and seismic and volcanic hazard studies.

1969-2007, BYU-Idaho, Rexburg, Idaho. Responsibilities: Teaching Geology, Physical Geology, Historical Geology, Environmental Geology, Mineralogy, Petrology, and Field Methods. Served as Geology Department Chair and Dean of the College of Physical Sciences and Engineering.

1981-1989 Consulting Geologist. Responsibilities: Mining, petroleum, and geothermal exploration and evaluation of properties in Idaho, Montana, Utah, California, Arizona, Texas, Ohio, and Mexico. Seismic and volcanic hazard evaluation.

1974-1981(Summers and full time May 1978-August 1979) United States Geological Survey, Branch of Central Environmental Geology, Denver, Colorado. Responsibilities: Geologic Mapping, Eastern Snake River Plain, project chief, supervising mapping and study of silicic volcanic rocks of Eastern Snake River Plain, Geothermal resource evaluation.

1968, 1970, 1971, 1983-85(Summers) Brigham Young University, Provo, Utah. Responsibility: Instructor at Geology Summer Field Camp.

1967(Summer) Atlantic Richfield Corp., Long Beach, California. Responsibility: Evaluate subsurface geology of the San Gabriel Basin.

SOCIETY MEMBERSHIPS AND CERTIFICATION

Registered Professional Geologist - State of Idaho
Geological Society of America

PUBLICATIONS

Embree, G. F., 1970, Lateral and vertical variations in a Quaternary basalt flow: Petrology and chemistry of the Gunlock flow, Southwestern Utah: Brigham Young University Geology Studies, v. 17, p. 17-115.

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Williams, E.J., and Embree, G.F., 1980, Pleistocene movement on Rexburg Fault, Eastern Idaho (abs.): Geol. Soc. America Abstracts, Rocky Mtn. Section, 33rd Ann. Meetings.

Schuster, R.L. and Embree, G.F., 1980, Landslides caused by rapid draining of Teton Reservoir, Idaho: in Proceedings of 17th Ann. Symposium on Engineering Geol. and Soils Engineering, Boise, Idaho, p. 1-14.

McBroome, Lisa A., Doherty, David J. and Embree, Glenn F., 1982, Correlation of Major Pliocene and Miocene ash-flow sheets, Eastern Snake River Plain, Idaho, Montana Geol. Soc. 1981 Field Conf. and Symposium, Southwest Montana, p. 323-330.

Embree, G.F., McBroome, L.A., Doherty D.J., 1982, Preliminary stratigraphic framework of the Pliocene and Miocene rhyolites on the Eastern Snake River Plain, Idaho, in Bill Bonnicksen and R. M. Breckenridge, editors Cenozoic Geology of Idaho: Idaho Bureau of Mines and Geology Bulletin 26, p. 333-343.

Embree, G.F., Hoggan, R.D., and Williams, E.J., 1983, Preliminary reconnaissance geologic map of the Copper Mountain Quadrangle, Lemhi County, Idaho: U.S. Geological Survey Open File Report 83-599.

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Leeman, W. P., Manzies, M. A., Matty, D. J., Embree, G. F., 1985, Strontium, neodymium and lead isotopic compositions of deep crustal xenoliths from the Snake River Plain: evidence for Archean basement: Earth and Planetary Science Letters.

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Chung, D.H., Carpenter, D.W., Crowe, B.M., Embree, G.F., Hackett, W.R., Jackson, S.M., Kuntz, M.A., Leeman, W.P., McKague, H.L., Smith, R.P., 1990, Assessment of Potential Volcanic Hazards for New Production Reactor Site at the Idaho National Engineering Laboratory, Lawrence Livermore National Laboratory, 98 p.

Kuntz, M.A., Skipp, B., Lanphere, M.A., Scott, W.E., Pierce, K.L., Dalrymple, G.B., Morgan, L.A., Champion, D.E., Embree, G.F., Smith, R.P., Hackett, W.R., Rodgers, D.W., and Page, W.R., 1990, Revised geologic map of the Idaho National Engineering Laboratory and adjoining areas, Eastern Idaho: U.S. Geol. Sur. Open-File Rept. 90-333, P. 1-35.

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Price, K.B., Embree, G., Hoggan, R., and Hansen, S., 1999, Field guide along the northern edge of the eastern Snake River Plain, and the Lemhi and Beaverhead mountain ranges bordering Birch Creek Valley, Idaho, in Hughes, S.S., and Thackray, G.D., eds., Guidebook to the Geology of Eastern Idaho: Pocatello, Idaho Museum of Natural History, p. 335-342.

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Jordan, B, Embree, G, Moore, D, 2008, Lava Dams and the Formation of Pillow Lavas near the mouth of Teton Canyon, Idaho, USA (abs.): International Association of Volcanology and Chemistry of the Earth's Interior 2008 - General Assembly - Reykjavík - Iceland

SELECTED UNPUBLISHED REPORTS

Neogene Fault Activity in the southern Beaverhead Range adjacent to the Eastern Snake River Plain and Birch Creek Valley, Idaho: 1989 report for EG & G Idaho: G.Embree

Sections on Geologic setting, seismic activity, and volcanism in the E.I.S. for the Special Isotope Separation Project: U.S. Department of Energy: 1988. G.Embree and R.Hoggan

Geologic mapping of eight 7.5 minute quadrangles, located between Rexburg and the Teton Range. In 2008, mapping of the Rexburg and Ririe Quadrangles were completed and submitted to the Idaho Geological Survey for review and publication.

Figure 3. Cross section from Prostka (1978).

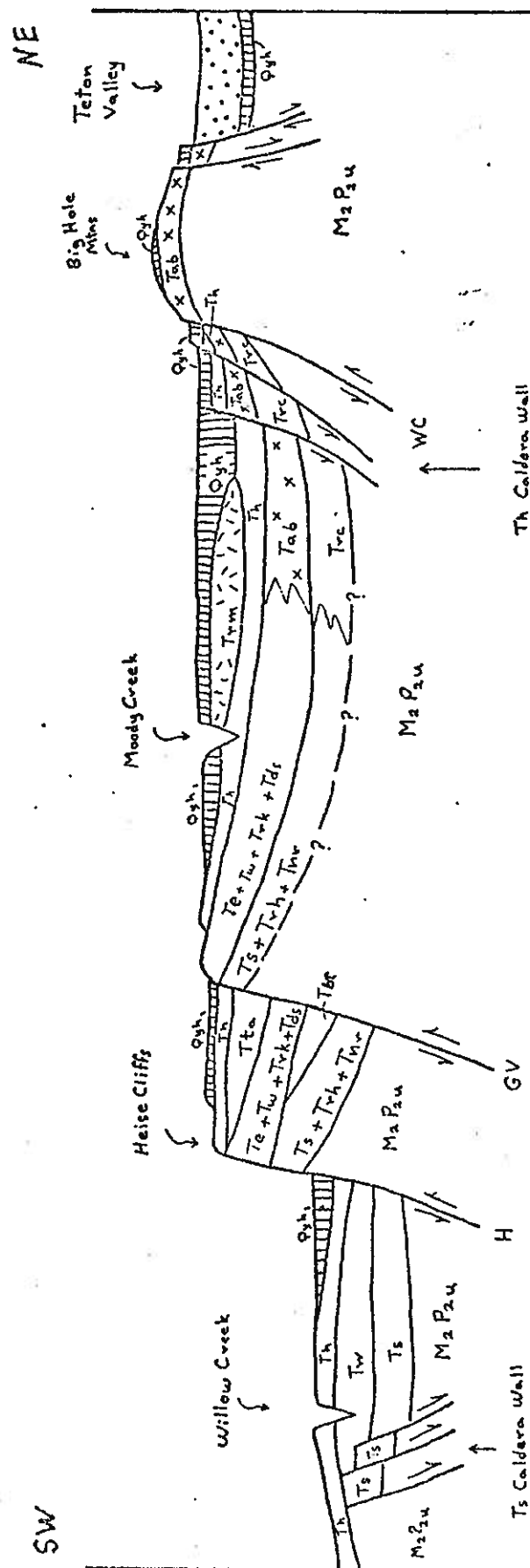


Figure 3.--Highly idealized cross section showing the general structural and stratigraphic relations across the best exposed portion of the Rexburg caldera complex.