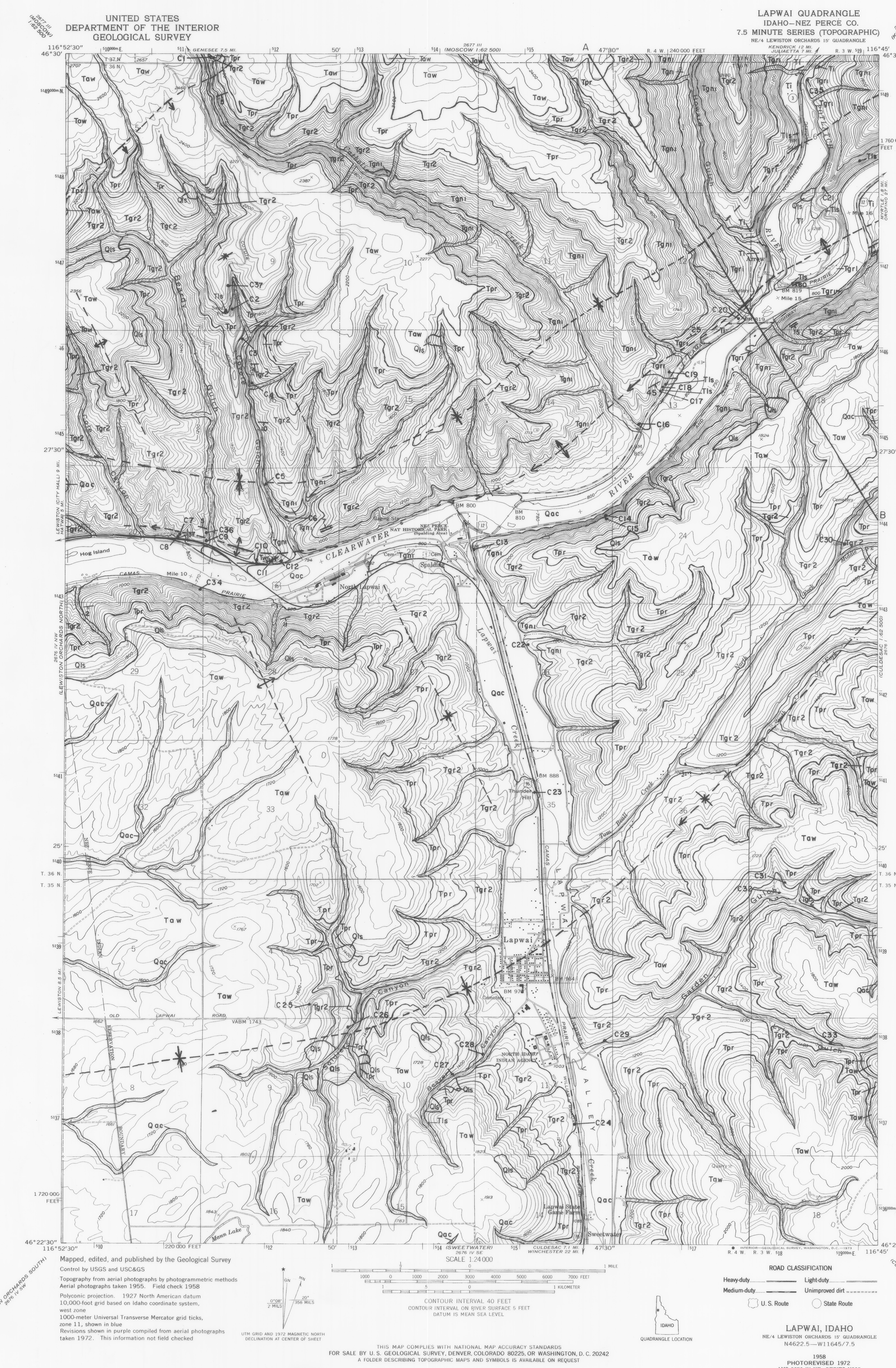
BEDROCK GEOLOGIC MAP OF THE LAPWAI QUADRANGLE, NEZ PERCE COUNTY, IDAHO

John H. Bush and Dean L. Garwood

2001

Idaho Geological Survey
Technical Report 01-1
Bush and Garwood
2001



INTRODUCTION

The bedrock geologic map of the Lapwai quadrangle represents a compilation of previous research and additional field work. Distribution of the loess of the Palouse Formation and post basalt gravel units are not illustrated in keeping with the emphasis on bedrock geology. However, alluvium and colluvium associated with the major streams are illustrated because their map patterns help interpret bedrock structures. Landslide deposits, modified from mapping by Othberg and others (in preparation), are included because of their relation to bedrock contacts. Continuous outcrops are not common and the contact lines are interpretive. Regional maps by Bond (1963), Newcomb (1970), Rember and Bennett (1979), Swanson and others (1979a ,1980), and Hooper and others (1985) were used in the compilation. In addition, a map of the Lewiston structure by Hollenbaugh (1959) was used for some details. The basalt chemistry was analyzed by the GeoAnalytical Laboratory at Washington State University (Table 1). Magnetic polarities were determined using a field fluxgate magnetometer and in places field readings were verified in the paleomagnetic laboratory of the Idaho Geological Survey.

Structural interpretations illustrated differ in places from most previous regional maps. The major syncline that forms part of the Lewiston basin trends across the southern portion of the map and has been recognized by all researchers since Bond (1963). This syncline is paralleled on the north by an east-west trending anticline-syncline pair traceable across most of the quadrangle. These folds, first noted in part by Newcomb (1970), are asymmetrical with steeper southern limbs. The anticline of this pair can best be delineated in the northeast part of the of the map where the Potlatch and Clearwater rivers join. In that area, basalt units change across the axial trace from a steep southerly dip (>40 degrees) to a gentle northerly dip (<15 degrees) over a distance of less than 300 feet. Plunge directions change along the strike of the axial trace. Overall, fold geometry is further complicated by deformation that began during extrusion, and older flows commonly have steeper dips than younger flows. Axial traces were located by detailed mapping, sampling, and tracing of the outcrops as well as sketching from a distance. In addition to the major folds illustrated, there are low-amplitude, long-wavelength folds that trend north-northwest. These folds are most evident along the Clearwater River, west of Lapwai Creek.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance of the many ranchers and landowners who generously permitted access to their property during the course of this study. John Bond provided well data in addition to insights to specific areas. Steve Reidel reviewed our work in the field and our interpretations of chemistry. Discussions with both Bond and Reidel were especially important and useful. Special thanks to the Idaho Geological Survey who provided funding, moral support, and geological assistance. In particular, we would like to thank Dan Weisz who assisted with the paleomagnetic research and numerous other projects. The authors would also like to thank John Kauffman for his critical review of the map descriptions.

DESCRIPTION OF MAP UNITS

The stratigraphic nomenclature for the Columbia River Basalt Group is based on that presented by Swanson and others (1979b). The group is divided into four formations: from base upward, these are the Imnaha, Grande Ronde, Wanapum, and Saddle Mountains. The Grande Ronde can be subdivided into four magnetostratigraphic units (Swanson and others, 1979b). The three oldest, the R_1, N_1, and R_2 units, have been mapped in the Lapwai quadrangle using stratigraphic position, lateral tracing, chemistry, and magnetic polarity. The use of chemistry for subdivision of the Grande Ronde relied on criteria outlined by Reidel and others (1989).

Several of the basalt units are separated by sediments that belong to the Latah Formation. In places, these sediments are laterally continuous but overall are too thin or too discontinuous to trace across the entire quadrangle. The sediments change thickness and composition over short distances. They tend to thicken in synclinal areas and are generally absent in anticlinal areas. Rare exposures occur in recent roadcuts and quarries. Exposures of Latah sediments are noted on the map, but they are not depicted as separate, continuous units.

SURFICIAL DEPOSITS

Qac

Alluvium and colluvium (Holocene) -- Stream, slope-wash, and debris-flow deposits. In the plateau areas, the composition commonly consists of reworked loess or mixtures of loess and basalt. Downstream from the plateau edges, basalt comprises most of the deposits until the drainages reach lower elevations where the deposits include incorporated parts of post-basalt sediments. Compositions are highly variable at lower elevations because of the influence of several different types of river, slope-wash, and catastrophic flood sediments common to the Lewiston basin. Locally, composition is also influenced by erosion of nearby Latah and post-basalt Tertiary sediments. Though dominated by basalt, the Potlatch and Clearwater rivers contain gravel and sand deposits with a high percentage of pre-basalt lithologies, reflecting headwater erosion through and beyond the eastern edge of the basalt sequence.

Qls

Landslide deposits (Holocene-Pleistocene) -- Highly variable rock and soil masses ranging from slumped coherent blocks to earth flows. The map pattern of this unit was modified from Othberg and others, (in preparation). Slump blocks consist primarily of intact and broken sections of basalt and interbed sediments. Earth flows consist mainly of unstratified, unsorted gravel rubble in a clayey matrix derived from liquified Sweetwater Creek interbed sediments (Othberg and others, in preparation). Location of landslides is controlled by stratigraphic position of sedimentary interbeds and the hydrogeologic regime. The largest landslides occur where valley incision has cut through the Saddle Mountains Basalt sequence exposing sedimentary interbeds to steep topography. The landslides are not considered to be relic features that are stable today (Othberg and others, in preparation). The landslide debris can be highly unstable when modified, either because of natural changes in precipitation or artificial modifications such as cuts, fills, and changes in surface drainage and ground-water infiltration.

LATAH FORMATION

Tls

Latah Formation sedimentary interbeds (Miocene) -- Clay, silt, sand, and gravel deposits that in places separate basalt flows. The most notable Latah unit is the Sweetwater Creek interbed of Bond (1963). The Sweetwater overlies the uppermost Priest Rapids flow throughout the quadrangle. It ranges from 0 to at least 60 feet in thickness on this quadrangle and consists of intercalated sand, silt, clay, and ash-rich strata with local gravel stringers. The best exposure occurs in a sand pit along Coyote grade road in the northwestern part of the quadrangle. At that locality, basal gravel grades upward into cross-bedded sand units that total sixty feet in thickness. These sand units are overlain by thin silt and clay layers beneath overlying Saddle Mountains Basalt. Basalt pebbles and fragments are rare in the gravel and sand, suggesting that deposition occurred in a developing low area with little erosion. Gaylord and others (1989) describe the Sweetwater Creek interbed for the Lewiston basin and conclude that deposition resulted primarily from fluvial and mixed fluvial-lacustrine sedimentation.

COLUMBIA RIVER BASALT GROUP: SADDLE MOUNTAINS FORMATION

Twr

Weissenfels Ridge Member (Miocene) -- Medium to coarse-grained basalt with microphenocrysts of plagioclase and olivine in an intergranular groundmass with minor glass (Hooper and others, 1985). This basalt occurs in a roadcut along Highway 12 (11T 512082 mE, 5143454 mN) between exposures of the R_2 unit of the Grande Ronde. The basalt is very weathered with a deep rusty brown coating. The chemistry (C11) is similar to the basalt of Lewiston Orchards as reported by Hooper and others (1985). Although the exposure does not permit three dimensional visualization, it is interpreted as a dike. Flows of this member appear to have normal magnetic polarity (Hooper and others, 1985).

Taw

Asotin and Wilbur Creek Members (Miocene) -- Consists of fine- to coarse-grained basalt that is sparsely plagioclase-phyric and has normal magnetic polarity. Although not consistent, the basalt of the Asotin Member tends to be denser than that of the Wilbur Creek. The lowermost basalt, generally the Wilbur Creek, overlies the Sweetwater Creek interbed of Bond (1963). No feeder dikes have been identified (Schuster and others, 1997).

Reidel and Fecht (1987) have shown that flows from these two members locally mixed at the surface to form the Huntzinger flow in the Pasco basin, indicating nearly simultaneous eruption. In the Lewiston basin, the Asotin overlies the Wilbur Creek, which in turn contains an upper subunit called the basalt of Lapwai (Reidel and Fecht, 1987). Most researchers have attempted to delineate between the Asotin and Wilbur Creek Members and correlate between outcrops (Swanson and others, 1979a; Swanson and others, 1980; and Hooper and others, 1985). Chemically, the two members can be distinguished (Camp and others, 1984). Where there are good outcrops the flows can be distinguished using stratigraphic and chemical data. However, the basalts in these members were emplaced as valley-filling flows over irregular surfaces and our research shows that they cannot be correlated from locality to locality as laterally continuous units over long distances and therefore are illustrated as one unit.

COLUMBIA RIVER BASALT GROUP: WANAPUM FORMATION

Tpr

Priest Rapids Member (Miocene) – Medium- to coarse-grained basalt with microphenocrysts of plagioclase and olivine in a groundmass of intergranular pyroxene, ilmenite blades, and minor devitrified glass. Distinguished from overlying Saddle Mountains Basalt flows by its reverse polarity and distinctive chemistry (Table 1). In addition to its distinctive chemistry, Priest Rapids can generally be distinguished from the underlying Grande Ronde in the field by its coarse-grained nature and visible olivine. Previously identified and described by Wright and others (1973) and Swanson and others (1979a and 1980). This unit is equivalent to the Lolo flow of Bond (1963).

COLUMBIA RIVER BASALT GROUP: GRANDE RONDE FORMATION

Tgr_2

R_2 magnetostratigraphic unit (Miocene) -- Two to three fine-grained to very fine-grained reverse magnetic-polarity flows of Grande Ronde chemical type (Wright and others, 1973; Swanson and others, 1979a; Reidel and others, 1989). Locally in the western part of the quadrangle, the uppermost basalt is abundantly plagioclase-microphyric . Chemically, the uppermost unit is similar to the Meyer Ridge unit and the lowermost flows are similar to the Wapshilla Ridge units of Reidel and others (1989). The entire sequence is as much as 600 feet in thickness at the western edge of the quadrangle but gradually begins to thin towards the east. Locally, individual flows thin and separate into several flow units. Several of these thin flow units are exposed in a roadcut along the northern side of the Clearwater River on the western edge of the quadrangle where the road crosses the westerly plunging axis of an anticline. This thinning and separation of flows is interpreted to have occurred across the rising anticline during extrusion. Red flow tops are common in this member and thick flow-top breccias are present locally. The unit entirely pinches out to the northeast on the Juliaetta and Texas Ridge quadrangles (Garwood and others, 1999).

Based on eighteen samples (Table 1), the basalt has intermediate to very low MgO (3.04-4.50 wt%) and high to very high TiO_2 (1.76-2.54 wt%) compared to other Grande Ronde units. In the Lapwai quadrangle, N_2 flows are missing and the R_2 flows form the uppermost surface of the Grande Ronde Basalt, which is deeply weathered to a saprolite at some locations. Locally, Latah Formation sediments separate the lowermost Priest Rapids flow from the top of the Grande Ronde.

Tgn_1

N_1 magnetostratigraphic unit (Miocene) -- Several fine-grained, aphyric, normal magnetic-polarity flows of Grande Ronde chemical type (Wright and others, 1973; Swanson and others, 1979a; Reidel and others, 1989). The unit ranges from 500 to 600 feet in thickness. The sequence is dominated by the intermediate to high MgO and relatively low TiO_2 flows described by Reidel and others (1989) and may correlate to their China Creek unit. Stratigraphically, these flows are correlated to N_1 units of the Texas Ridge and Juliaetta quadrangles to the east, but chemically minor differences are apparent (Bush and others, 1999; Garwood and others, 1999).

Tgr_1

R_1 magnetostratigraphic unit (Miocene) -- Several fine-grained generally aphyric, predominately reverse magnetic-polarity flows of Grande Ronde chemical type (Wright and others, 1973; Swanson and others, 1979a; Reidel and others, 1989). The sequence is approximately 400 feet in thickness. The lowermost flow has transitional or weak magnetic polarity and is, in places, sparsely plagioclase phyric. Locally, flows are separated by sediments of the Latah Formation.

Stratigraphically, these R_1 flows can be correlated to R_1 units mapped along the Potlatch River on the Juliaetta and Texas Ridge quadrangles to the northeast. However, the R_1 on those quadrangles differ in that they do not contain Latah interbeds, and individual flows or flow units with scoriaceous zones are rare (Garwood and others, 1999; Bush and others, 1999).

COLUMBIA RIVER BASALT GROUP: IMNAHA FORMATION

Ti

Imnaha Basalt (Miocene) -- One flow in the Lapwai quadrangle that is typically plagioclase phyric and has transitional magnetic polarity. Locally, the basalt is highly weathered. It is separated from the overlying Grande Ronde Formation by sediments of the Latah Formation. In the northeastern part of the quadrangle, the Imnaha is highly fractured with extensive calcite veining and forms the core of an anticline.

SYMBOLS

Anticline axial trace

Syncline axial trace

Monocline axial trace

Contact

Dike

12 Strike and dip

19 Inferred strike and dip

C25 Chemistry sample location

Tls Latah sediment exposure

REFERENCES CITED

Bond, J.G., 1963, Geology of the Clearwater Embayment, Idaho: Bureau of Mines and Geology, Pamphlet 128, 83 p.

Bush, J.H., D.L. Garwood, and G.N. Potter, 1999, Bedrock geologic map of the Texas Ridge quadrangle, Latah and Nez Perce Counties, Idaho: Idaho Geologic Survey, Technical Report T-99-5, scale 1:24,000, 3 sheets.

Camp, V.E., P.R. Hooper, D.A. Swanson, and T.L Wright, 1984, Columbia River Basalt in Idaho: Physical and chemical characteristics, flow distribution, and tectonic implications, *in* Bill Bonnichsen and R.M. Breckenridge, eds., Cenozoic Geology of Idaho: Idaho Bureau of Mines and Geology Bulletin 26, p. 55-75.

Garwood, D.L., J.H. Bush., and G.N. Potter, 1999, Bedrock geologic map of the Juliaetta Quadrangle, Latah and Nez Perce Counties, Idaho: Idaho Geologic Survey, Technical Report T-99-4, scale 1:24,000, 3 sheets.

Gaylord, D.R., J.H. Lundquist, and G.D. Webster, 1989, Stratigraphy and sedimentology of the Sweetwater Creek interbed, Lewiston basin, Idaho and Washington, *in* S.P. Reidel and P.R. Hooper, eds., Volcanism and Tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 199-208.

Hooper, P.R., G.D. Webster, and V.E. Camp, 1985, Geologic map of the Clarkston 15-minute quadrangle, Washington and Idaho: Washington Division of Geology and Earth Resources, Geologic Map GM-31, 11 p., 1 pl., scale 1:48,000.

Hollenbaugh, K.M., 1959, Geology of Lewiston and vicinity, Nez Perce County, Idaho: University of Idaho M.S. thesis, 52 p.

Newcomb, R.C., 1970, Tectonic structure of the main part of the basalt of the Columbia River Group, Washington, Oregon, and Idaho: U.S. Geological Survey, Miscellaneous Geological Investigations Map 587, 1 sheet.

Othberg, K.L., R.M. Breckenridge, and D.W. Weisz, in preparation, Surfcial geologic map of the Lapwai Quadrangle, Nez Perce County, Idaho: Idaho Geological Survey Surficial Geologic Map Series, scale 1:24,000.

Reidel, S.P. and K.R. Fecht, 1987, The Huntzinger flow; Evidence of surface mixing of the Columbia River basalts and its petrogenetic implications: Geological Society of America Bulletin, v. 98, p. 942-978.

Reidel, S.P., T.L. Tolan, P.R. Hooper, M.H. Beeson, K.R. Fecht, R.D. Bentley, and J.L. Anderson, 1989, The Grande Ronde Basalt, Columbia River Basalt Group: Stratigraphic descriptions and correlations in Washington, Oregon, and Idaho, *in* S.P. Reidel and P.R. Hooper, eds., Volcanism and Tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 21-54.

Rember, W.C., and E.H. Bennett, 1979, Geologic map of the Pullman quadrangle, Idaho: Idaho Bureau of Mines and Geology, scale 1:250,000.

Schuster, J.E., C.W. Gulick, S.P. Reidel, K.R. Fecht, and S. Zurenxo, 1997, Geologic map of Washington- southeast quadrant: Washington Division of Geology and Earth Resources, Geologic Map GM-45, 2pl., scale 1:250,000.

Swanson, D.A., J.L. Anderson, R.D. Bentley, G.R. Byerley, V.E. Camp, J.N. Gardner, and T.L. Wright, 1979a, Reconnaissance geologic map of the Columbia River Basalt Group in eastern Washington and northern Idaho: U.S. Geological Survey Open File Report 79-1363, scale 1:250,000.

Swanson, D.A., T.L. Wright, P.R. Hooper, and R.D. Bentley, 1979b, Revisions in stratigraphic nomenclature of the Columbia River Basalt Group: U.S. Geological Survey Bulletin 1457-G, 59 p.

Swanson, D.A., T.L. Wright, V.E. Camp, R.T. Helz, S.A. Price, and M.E. Ross, 1980, Reconnaissance geologic map of the Columbia River Basalt Group, Pullman and Walla Walla quadrangles, southeast Washington and adjacent Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-1139, scale 1:250,000.

Wright, T.L., M.J. Grolier, and D.A. Swanson, 1973, Chemical variation related to the stratigraphy of the Columbia River basalt: Geological Society of America Bulletin, v. 84, no. 2, p. 371-385.

Table 1. Major chemical elements* of sampled basalt units

Map #	Unit	Smpl. #	SiO_2	Al_2O_3	TiO_2	FeO**	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5
C1	Tgr2	L200	56.71	13.71	2.395	11.65	0.183	6.60	3.04	2.13	3.12	0.459
C2	Tpr	L211	49.97	13.54	3.317	13.87	0.240	9.27	5.08	1.31	2.60	0.801
C3	Tgr_2	L210	56.12	13.75	2.462	11.70	0.194	6.84	3.13	2.02	3.32	0.466
C4	Tgr_2	L209	55.22	13.91	2.125	11.70	0.211	7.76	3.98	1.38	3.36	0.347
C5	Tgn_1	L111	54.62	14.38	1.854	11.41	0.213	8.56	4.30	1.15	3.18	0.320
C6	Tgn_1	L112	55.08	13.98	1.953	11.63	0.206	7.77	4.09	1.53	3.39	0.369
C7	Tgr_2	L108	55.52	14.38	2.082	10.38	0.204	8.20	4.20	1.28	3.36	0.398
C8	Tgr_2	L109	54.89	14.01	2.015	11.47	0.201	8.08	4.26	1.51	3.19	0.369
C9	Tgr_2	L110	54.76	13.72	2.206	12.27	0.213	7.64	3.82	1.69	3.27	0.413
C10	Tgr_2	L105	55.79	14.28	1.776	10.68	0.184	8.02	4.25	1.49	3.27	0.244
C11	Twr	L106	48.84	15.15	2.187	11.61	0.175	11.46	7.28	0.49	2.31	0.508
C12	Tgr_2	L107	56.32	13.99	2.107	10.37	0.187	7.79	3.91	1.66	3.36	0.303
C13	Tgn_1	L115	55.83	13.82	2.007	11.59	0.194	7.50	3.76	1.75	3.25	0.299
C14	Tgn_1	L122	55.07	14.29	1.905	10.93	0.195	8.12	4.32	1.47	3.34	0.359
C15	Tgr_2	L121	54.64	14.41	1.719	11.01	0.183	8.75	4.74	1.19	3.09	0.266
C16	Tgn_1	L103	57.16	13.58	2.237	11.44	0.187	6.65	2.96	2.13	3.33	0.325
C17	Tgn_1	L102	54.52	13.61	2.439	12.24	0.202	7.65	3.92	1.65	3.37	0.403
C18	Tgn_1	L101	53.33	14.50	1.874	11.12	0.194	9.33	5.15	1.14	3.07	0.285
C19	Tgr_1	L100	54.31	13.72	2.633	12.44	0.199	7.62	3.76	1.70	3.21	0.409
C20	Ti	L127	49.57	15.67	2.406	12.25	0.184	9.66	6.33	0.69	2.94	0.302
C21	Tgr_1	L128	54.41	13.94	2.269	11.85	0.190	8.00	4.21	1.61	3.16	0.360
C22	Tgn_1	L116	55.20	13.90	1.948	11.80	0.207	7.79	4.07	1.59	3.15	0.355
C23	Tgr_2	L114	55.29	14.63	1.757	9.98	0.183	8.82	4.50	1.32	3.24	0.275
C24	Tgr_2	L130	54.43	14.02	1.846	12.00	0.197	8.23	4.49	1.21	3.27	0.316
C25	Taw	L123	53.70	14.75	1.865	10.86	0.163	9.04	4.95	1.61	2.59	0.475
C26	Tpr	L124	49.74	13.40	3.335	14.25	0.235	9.23	5.21	1.16	2.65	0.810
C27	Tpr	L125	50.28	13.76	3.276	13.56	0.218	9.43	4.88	1.06	2.76	0.768
C28	Tgr_2	L126	55.57	13.67	2.447	12.28	0.194	6.89	3.30	1.93	3.26	0.462
C29	Tgr_2	L117	53.86	14.27	2.081	12.85	0.219	8.08	4.08	1.01	3.16	0.398
C30	Tgr_2	L113	54.67	13.75	2.536	12.22	0.198	7.33	3.55	2.03	3.24	0.472
C31	Tpr	L120	50.20	13.54	3.243	13.76	0.224	9.19	5.16	1.09	2.79	0.797
C32	Tgr_2	L119	55.60	13.58	2.418	12.33	0.190	6.78	3.15	1.99	3.50	0.465
C33	Tgr_2	L118	53.46	14.46	2.076	12.47	0.191	8.51	4.41	0.87	3.23	0.319
C34	Tgr_2	L129	55.16	13.68	2.208	12.46	0.188	7.32	3.74	1.53	3.30	0.409
C35	Tgr_1	L104	53.27	14.63	1.872	10.94	0.184	9.37	5.32	1.08	3.06	0.280
C36	Tgr_2	L135	56.27	14.33	1.948	9.38	0.197	8.41	4.45	1.48	3.18	0.350
C37	Taw	L136	50.44	16.61	1.428	7.68	0.227	13.42	7.22	0.55	2.25	0.176

* Weight-percent analysis at Washington State University's GeoAnalytical laboratory by X-ray fluorescence under the direction of P.R. Hooper. Analyses are normalized on a volatile-free basis.

** Total Fe is expressed as FeO.