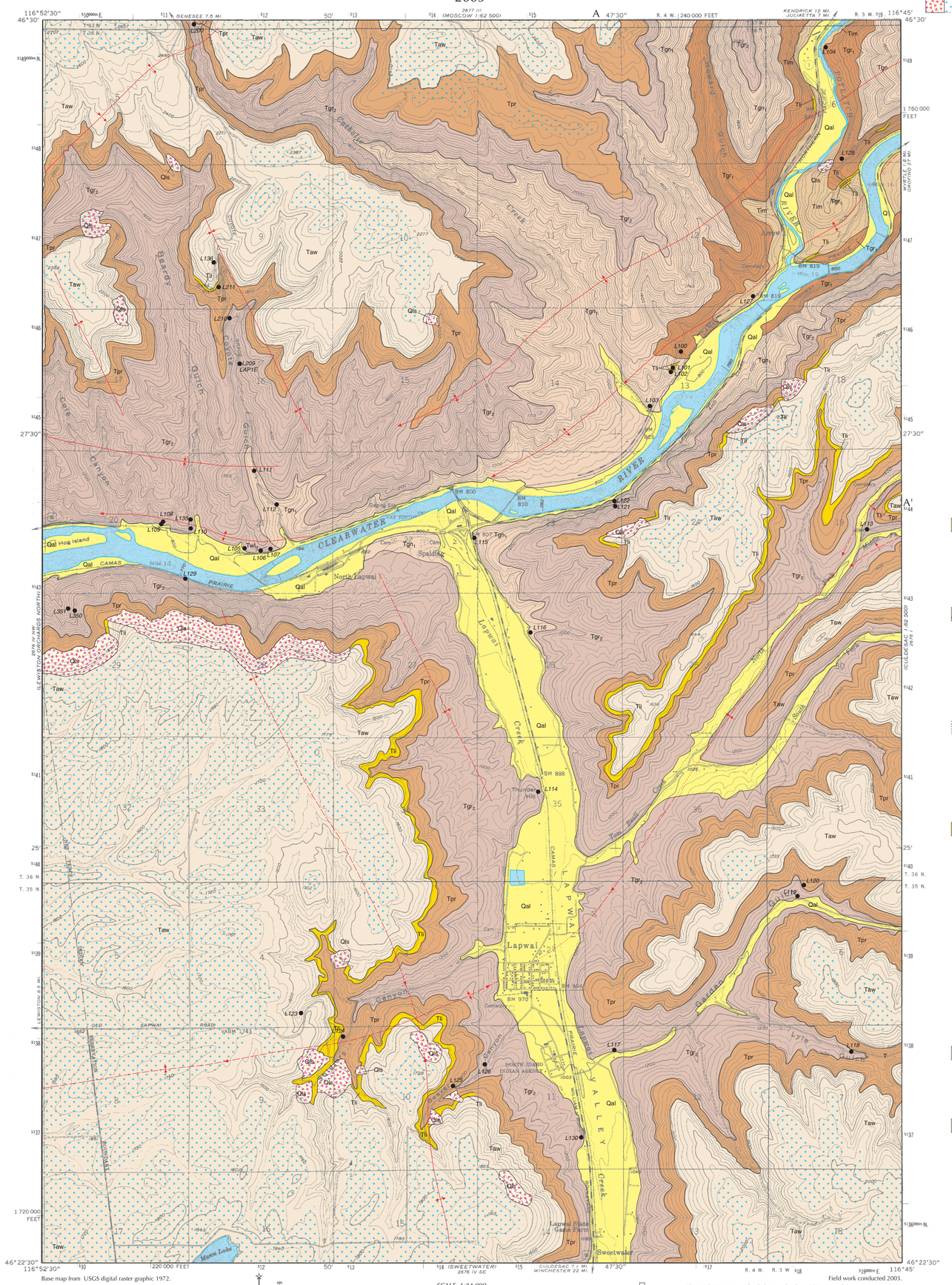
Geologic Map of the Lapwai Quadrangle, Nez Perce County, Idaho

John H. Bush, Dean L. Garwood, and John D. Kauffman

2005

Disclaimer: This Digital Web Map is an informal report and may be revised and formally published at a later time. Its content and format may not conform to agency standards.



Base map from USGS digital raster graphic 1972.
Topography by photogrammetric methods from aerial photographs taken 1955. Field checked 1958.
Polyconic projection. 1927 North American Datum.
10,000-foot grid ticks based on Idaho coordinate system, west zone.
1000-meter Universal Transverse Mercator grid ticks, zone 11.

UTM Grid and 1971 Magnetic North Declination at Center of Map

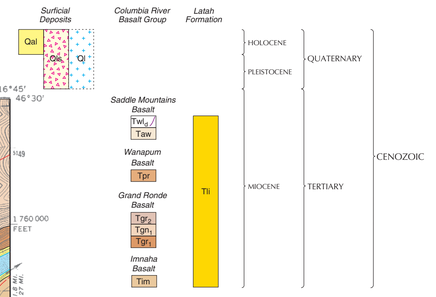
SCALE 1:24,000

QUADRANGLE LOCATION

Field work conducted 2003.

This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program.
Digital cartography by Jesse S. Bird and Jane S. Freed at the Idaho Geological Survey's Digital Mapping Lab.
Map version 8-4-2005.

CORRELATION OF MAP UNITS



INTRODUCTION

The bedrock geologic map of the Lapwai quadrangle represents a compilation of previous research and additional field work. Distribution of loess of the Palouse Formation and postbasalt gravel units are not illustrated in keeping with the emphasis on bedrock geology. However, alluvium associated with the major streams is illustrated because the map patterns help interpret bedrock structures. Landslide deposits, modified from mapping by Othberg and others (2003), 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 (Table 1) was analyzed at the GeoAnalytical Laboratory at Washington State University. 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.

STRUCTURE

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 subtle folds are most evident along the Clearwater River, west of Lapwai Creek. Because these cross-folds are small features on an overall westward-plunging fold set, in places both limbs dip west.

DESCRIPTION OF MAP UNITS

QUATERNARY DEPOSITS

Qal — **Alluvium (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 postbasalt sediments. Composition is 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 postbasalt Tertiary sediments. Though dominated by basalt, the Potlatch and Clearwater rivers contain gravel and sand deposits with a high percentage of prebasalt 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 (2003). 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, 2003). 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, 2003). 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.

Ql — **Loess deposits (Holocene and Pleistocene)**—Silty and clayey loess of the Palouse Formation. Remnants of the Palouse hills occur in the north part of the quadrangle. The map pattern of this unit was taken from Othberg and others (2003).

TERTIARY SEDIMENTS

Latah Formation

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 thin or absent in anticlinal areas. Rare exposures occur in recent roadcuts and quarries.

Tli — **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 interbed overlies the uppermost Priest Rapids flow throughout most of the quadrangle, although it is mapped only where it is exposed or where pebbles or sand in the soil indicate its presence. 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

The stratigraphic nomenclature of the Columbia River Basalt Group is based on that presented by Swanson and others (1979b). In Idaho, 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).

Saddle Mountains Basalt

Twl_5 — **Basalt of Lewiston Orchards, Weissenfels Ridge Member, dike (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 (L-106) 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 Member and Wilbur Creek Member, undivided (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. Thickness ranges from about 300 feet in the southwestern part of the quadrangle to about 100 feet near the north edge of the map. 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 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.

Wanapum Basalt

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. Thickness is about 200 feet over most of the quadrangle, but the unit thins eastward to about 100 feet along the east-central edge of the map. 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 character and visible olivine. Previously identified and described by Wright and others (1973) and Swanson and others (1979a and 1980). All of the samples analyzed were the Lolo chemical type of Wright and others (1973).

Grande Ronde Basalt

Tgr_2 — **Grande Ronde Basalt, 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).

In the Lapwai quadrangle, N_1 flows are missing and the R_1 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 — **Grande Ronde Basalt, 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 — **Grande Ronde Basalt, 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 Formation interbeds, and individual flows or flow units with scoriaceous zones are rare (Garwood and others, 1999; Bush and others, 1999).

Tim — **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 Basalt 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.

Table 1. Major oxide and trace element chemistry of basalt samples collected in the Lapwai quadrangle.

Sample number	Latitude	Longitude	Unit name	Map unit	Major elements in weight percent										Trace elements in parts per million																
					SiO_2	TiO_2	Al_2O_3	FeO*	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Ni	Cr	Sc	V	Ba	Rb	Sr	Zr	Y	Nb	Ga	Cu	Zn	Pb	La	Th
L-106	46.44655	-116.84321	basalt of Lewiston Orchards	Twl_5	48.84	15.15	2.187	11.61	0.175	11.46	7.28	0.49	2.31	0.508	73	269	40	286	305	8	243	161	36	18.2	16	58	100	6	23	59	2
VC78-034	46.44655	-116.84604	basalt of Lewiston Orchards	Twl_5	50.76	15.73	2.27	10.41	0.16	11.53	5.77	0.44	2.26	0.48																	
L-136	46.47544	-116.85014	Asotin	Taw	50.44	16.61	1.428	7.68	0.227	13.42	7.22	0.55	2.25	0.176	141	293	24	232	303	9	258	102	26	8.3	15	87	86	0	9	42	1
VC78-267	46.40081	-116.8341	basalt of Lapwai	Taw	52.97	15.57	1.70	10.78	0.17	9.12	5.34	1.42	2.37	0.36																	
L-123	46.40012	-116.83714	Wilbur Creek	Taw	53.70	14.75	1.865	10.86	0.163	9.04	4.95	1.61	2.59	0.475	46	77	30	254	727	36	277	225	42	16.3	22	37	117	11	35	76	4
VC78-266	46.39885	-116.83728	Wilbur Creek	Taw	53.78	14.81	1.82	11.28	0.18	8.52	4.69	1.84	2.41	0.47																	
L-120	46.41293	-116.76425	Priest Rapids	Tpr	50.20	13.54	3.243	13.76	0.224	9.19	5.16	1.09	2.79	0.797	44	102	40	363	475	25	284	188	45	16.5	22	38	143	3	26	66	3
L-124	46.39763	-116.83148	Priest Rapids	Tpr	49.74	13.40	3.335	14.25	0.235	9.23	5.21	1.16	2.65	0.810	42	101	36	364	469	28	287	190	48	16.0	24	44	146	7	25	38	4
L-125	46.39289	-116.81515	Priest Rapids	Tpr	50.28	13.76	3.276	13.56	0.218	9.43	4.88	1.06	2.76	0.768	46	109	37	362	459	23	298	184	45	15.6	23	42	139	2	29	56	0
L-211	46.47295	-116.84958	Priest Rapids	Tpr	49.97	13.54	3.317	13.87	0.240	9.27	5.08	1.31	2.60	0.801	26	105	40	383	618	29	292	183	46	16.9	24	29	144	6	8	56	6
L-101	46.46508	-116.78306	Grande Ronde N_1	Tgn_1	53.33	14.50	1.874	11.12	0.194	9.33	5.15	1.14	3.07	0.285	25	94	35	330	432	24	344	149	31	12.2	17	76	101	6	15	41	5
L-102	46.46464	-116.78355	Grande Ronde N_1	Tgn_1	54.52	13.61	2.439	12.24	0.202	7.65	3.92	1.65	3.37	0.403	9	40	31	371	639	41	304	205	43	16.5	21	86	126	6	26	34	7
L-103	46.46102	-116.7868	Grande Ronde N_1	Tgn_1	57.16	13.58	2.237	11.44	0.187	6.65	2.96	2.13	3.33	0.325	0	22	30	344	738	55	311	196	38	14.4	24	8	128	10	21	46	7
L-111	46.45457	-116.84413	Grande Ronde N_1	Tgn_1	54.62	14.38	1.854	11.41	0.213	8.56	4.30	1.15	3.18	0.320	8	36	31	343	492	44	323	156	34	12.0	17	38	115	6	7	36	2
L-112	46.4512	-116.84081	Grande Ronde N_1	Tgn_1	55.08	13.98	1.953	11.63	0.206	7.77	4.09	1.53	3.39	0.369	5	32	42	384	551	36	319	174	39	12.7	21	39	122	8	19	36	0
L-115	46.44802	-116.81232	Grande Ronde N_1	Tgn_1	55.83	13.82	2.007	11.59	0.194	7.50	3.76	1.75	3.25	0.299	6	22	34	347	536	44	305	184	36	12.8	19	24	114	9	8	36	1
L-116	46.438	-116.80384	Grande Ronde N_1	Tgn_1	55.20	13.90	1.948	11.80	0.207	7.79	4.07	1.59	3.15	0.355	4	33	35	385	541	35	313	166	37	13.1	20	40	119	7	15	45	5
L-122	46.45149	-116.79182	Grande Ronde N_1	Tgn_1	55.07	14.29	1.905	10.93	0.195	8.12	4.32	1.47	3.34	0.359	5	31	42	365	566	33	320	158	35	12.0	23	39	118	8	14	39	7
VC78-033	46.44866	-116.85445	Grande Ronde N_1	Tgn_1	53.47	14.40	2.16	12.89	0.23	7.93	3.66	1.71	2.90	0.46																	
L-100	46.46664	-116.78185	Grande Ronde R_1	Tgr_1	54.31	13.72	2.633	12.44	0.199	7.62	3.76	1.70	3.21	0.409	0	22	31	371	627	42	343	211	40	18.5	26	13	130	9	17	46	6
L-104	46.49718	-116.761	Grande Ronde R_1	Tgr_1	53.27	14.63	1.872	10.94	0.184	9.37	5.32	1.08	3.06	0.280	24	99	33	328	424	25	351	147	30	11.2	22	78	102	5	16	22	5
L-128	46.48595	-116.75853	Grande Ronde R_1	Tgr_1	54.41	13.94	2.269	11.85	0.190	8.00	4.21	1.61	3.16	0.360	16	44	35	341	513	42	330	197	39	14.1	18	70	121	7	2	45	2
L-105	46.4468	-116.8459	Grande Ronde R_1	Tgr_1	55.79	14.28	1.776	10.68	0.184	8.02	4.25	1.49	3.27	0.244	2	27	39	329	496	38	321	154	31	12.3	23	19	105	6	19	49	9
L-107	46.44651	-116.8418	Grande Ronde R_1	Tgr_1	56.32	13.99	2.107	10.37	0.187	7.79	3.91	1.66	3.36	0.303	11	23	36	339	593	46	319	177	35	13.9	20	38	116	9	20	43	12
L-108	46.44939	-116.85771	Grande Ronde R_1	Tgr_1	55.52	14.38	2.082	10.38	0.204	8.20	4.20	1.28	3.36	0.398	6	32	43	386	681	30	344	167	41	12.6	22	52	131	3	4	40	12
L-109	46.44919	-116.85806	Grande Ronde R_1	Tgr_1	54.89	14.01	2.015	11.47	0.201	8.08	4.26	1.51	3.19	0.369	4	32	39	353	509	36	310	157	35	10.7	22	31	117	8	9	43	2
L-110	46.44866	-116.85361	Grande Ronde R_1	Tgr_1	54.76	13.72	2.206	12.27	0.213	7.64	3.82	1.69	3.27	0.413	9	36	35	389	544	43	305	162	34	11.8	21	23	122	9	26	41	9
L-113	46.44875	-116.75492	Grande Ronde R_1	Tgr_1	54.67	13.75	2.536	12.22	0.198	7.33	3.55	2.03	3.24	0.472	10	33	33	393	676	46	317	198	41	14.8	21	22	132	10	18	53	0
L-114	46.42241	-116.80278	Grande Ronde R_1	Tgr_1	55.29	14.63	1.757	9.98	0.183	8.82	4.50	1.32	3.24	0.275	8	34	37	331	473	31	329	150	32	11.3	21	31	105	6	17	28	2
L-117	46.39631	-116.79175	Grande Ronde R_1	Tgr_1	53.86	14.27	2.081	12.85	0.219	8.08	4.08	1.01	3.16	0.398	8	31	37	397	548	26	329	169	39	12.8	23	47	137	9	11	57	7
L-118	46.39621	-116.75733	Grande Ronde R_1	Tgr_1	53.46	14.46	2.076	12.47	0.191	8.51	4.41	0.87	3.23	0.319	5	35	39	374	513	20	333	163	34	12.2	22	22	118	9	22	33	0
L-119	46.4119	-116.7651	Grande Ronde R_1	Tgr_1	55.60	13.58	2.418	12.33	0.190	6.78	3.15	1.99	3.50	0.465	6	25	36	352	701	53	310	212	40	14.6	24	22	126	8	30	59	0
L-121	46.45125	-116.79182	Grande Ronde R_1	Tgr_1	54.64	14.41	1.719	11.01	0.183	8.75	4.74	1.19	3.09	0.266	6	38	41	322	467	29	325	141	29	10.7	21	33	106	7	0	26	11
L-126	46.39499	-116.81063	Grande Ronde R_1	Tgr_1	55.57	13.67	2.447	12.28	0.194	6.89	3.30	1.93	3.26	0.462	8	26	35	356	734	52	320	205	42	14.0	22	23	131	10	25	48	4
L-129	46.44372	-116.85417	Grande Ronde R_1	Tgr_1	55.16	13.68	2.208	12.46	0.188	7.32	3.74	1.53	3.30	0.409	10	35	32	388	560	42	308	167	35	12.4	20	22	122	7	8	26	6
L-130	46.38766	-116.79649	Grande Ronde R_1	Tgr_1	54.43	14.02	1.846	12.00	0.197	8.23	4.49	1.21	3.27	0.316	7	30	33	340	490	28	310	153	36	10.1	20	45	116	6	12	59	5
L-135	46.44949	-116.85354	Grande Ronde R_2	Tgr_2	56.27	14.33	1.948	9.38	0.197	8.41	4.45	1.48	3.18	0.350	6	29	35	333	539	34	323	151	35	10.1	23	29	119	4	8	47	4
L-200	46.49958	-116.85269	Grande Ronde R_2	Tgr_2	56.71	13.71	2.395	11.65	0.183	6.60	3.04	2.13	3.12	0.459	0	11	34	345	776	58	316	204	42	16.1	23	7	131	7	22	66	9
L-209	46.46508	-116.84661	Grande Ronde R_2	Tgr_2	55.22	13.91	2.125	11.70	0.211	7.76	3.98	1.38	3.36	0.347	2	32	36	351	677	31	319	160	34	13.3	24	8	119	7	31	47	7
L-210	46.47011	-116.84753	Grande Ronde R_2	Tgr_2	56.12	13.75	2.462	11.70	0.194	6.84	3.13	2.02	3.32	0.466	0	24	30	355	846	55	325	203	41	16.0	24	14	133	11	28	65	6
L-350	46.44035	-116.87029	Grande Ronde R_2	Tgr_2	54.33	13.66	2.547	12.92	0.203	7.26	3.65	1.74	3.23	0.455	12	27	36	410	682	44	312	192	41	14.5	22	30	129	9	23	67	5
L-351	46.44093	-116.87149	Grande Ronde R_2	Tgr_2	54.64	13.75	2.196	12.25	0.206	7.94	4.10	1.44	3.10	0.378	6	31	42	380	558	33	322	164	38	11.9	23	26	121	8	29	44	2
LAP1E	46.46278	-116.84556	Grande Ronde R_2	Tgr_2	55.61	13.83	2.110	11.47	0.198	7.78	3.93	1.39	3.34	0.351	0	29	32	381	567	29	316	160	35	10.8	21	12	121	7	24	44	5
L-127	46.47241	-116.77125	Imnaha	Tim	49.57	15.67	2.406	12.25	0.184	9.66	6.33	0.69	2.94	0.302	101	115	32	322	221	15	363	162	35	11.7	20	132	112	5	12	48	1

* Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO.
** Samples collected by V. Camp in 1978. Analytical results used with permission (Camp, written commun., 2002).
All analyses performed at Washington State University GeoAnalytical Laboratory, Pullman, Washington.

SYMBOLS

- Contact: approximately located.
- Axial trace of fold with plunge direction; dotted where concealed.
- Anticline.
- Syncline.
- Monocline: arrow on dipping limb.
- Monocline, anticlinal bend: shorter arrow on limb with steeper dip.
- 25 Strike and dip of basalt flows.
- 4 Inferred strike and dip of basalt flows.
- L117 Sample location and number.

REFERENCES

Bond, J.G., 1963, Geology of the Clearwater embayment, Idaho: 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 Geological 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, 2003, Surficial geologic map of the Lapwai quadrangle, Nez Perce County, Idaho: Idaho Geological Survey Digital Web Map DWM-12, 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. Zurenko, 1997, Geologic map of Washington - southeast quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-45, 2 pl., 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,