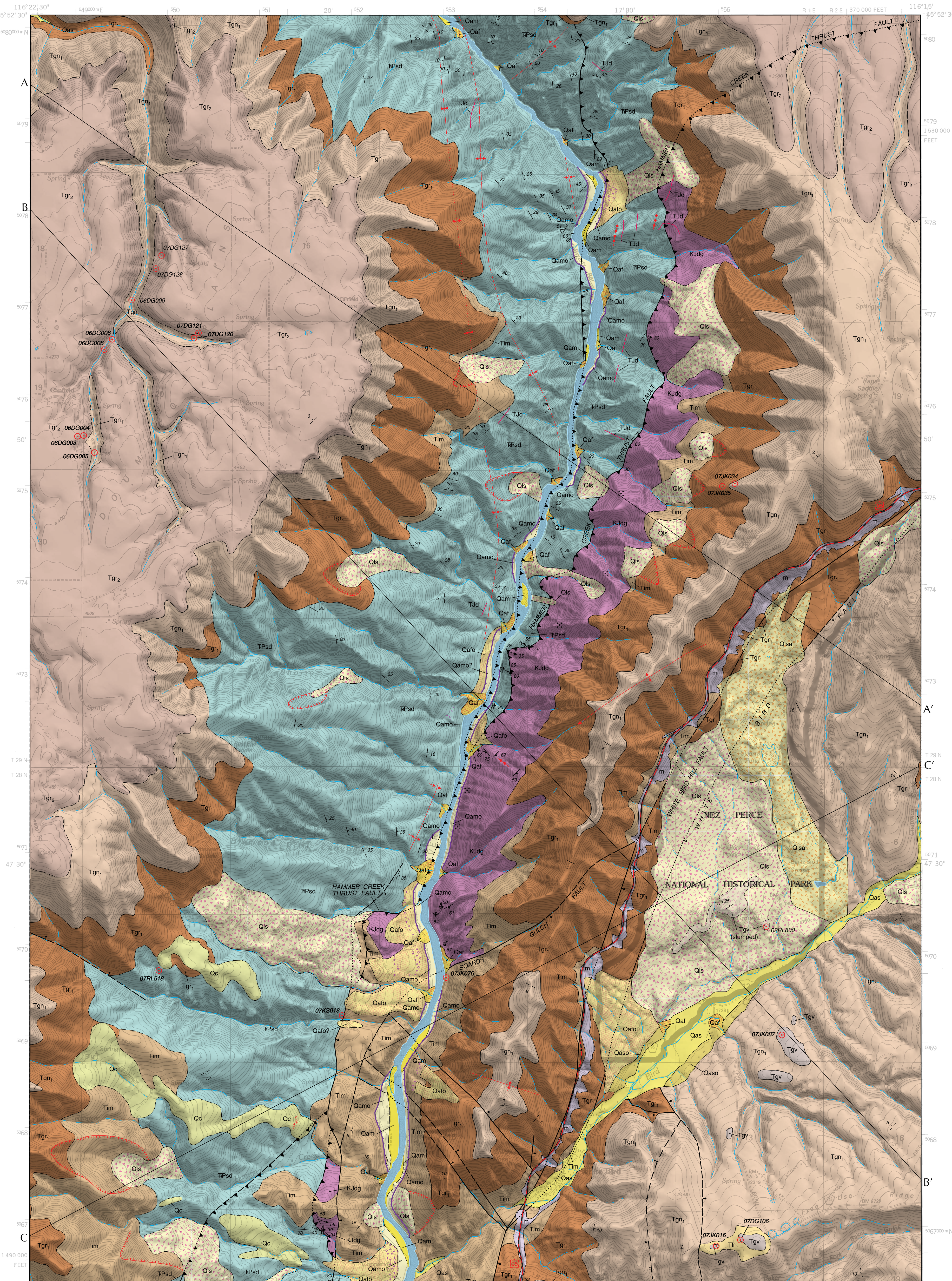
Geologic Map of the White Bird Quadrangle, Idaho County, Idaho

Dean L. Garwood, Keegan L. Schmidt, John D. Kauffman, David E. Stewart,
Reed S. Lewis, Kurt L. Othberg, and Peter J. Wampler

2007



Base map scanned from USGS film positive, 1995.

Topography by photogrammetric methods from aerial photographs taken 1961. Partial field check by U.S. Forest Service 1995.

Polyconic projection. 1927 North American Datum.

10,000-food grid ticks based on Idaho coordinate system, west zone.

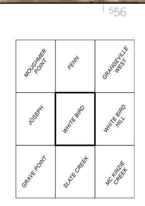
1000-meter Universal Transverse Mercator grid ticks, zone 11.

UTM Grid and 1971 Magnetic North Declination at Center of Map

SCALE 1:24,000

Contour interval 40 feet

QUADRANGLE LOCATION



ADJOINING QUADRANGLES

Field work conducted 2003.

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Digital cartography by Theresa A. Taylor and Jane S. Freed at the Idaho Geological Survey's Digital Mapping Lab.

Note on printing: The map is reproduced at a high resolution of 600 dots per inch. The inks are resistant to run and fading but will deteriorate with long-term exposure to light.

Map version 12-10-2007.

PDF (Acrobat Reader) map may be viewed online at www.idahogeology.org.

CORRELATION OF MAP UNITS

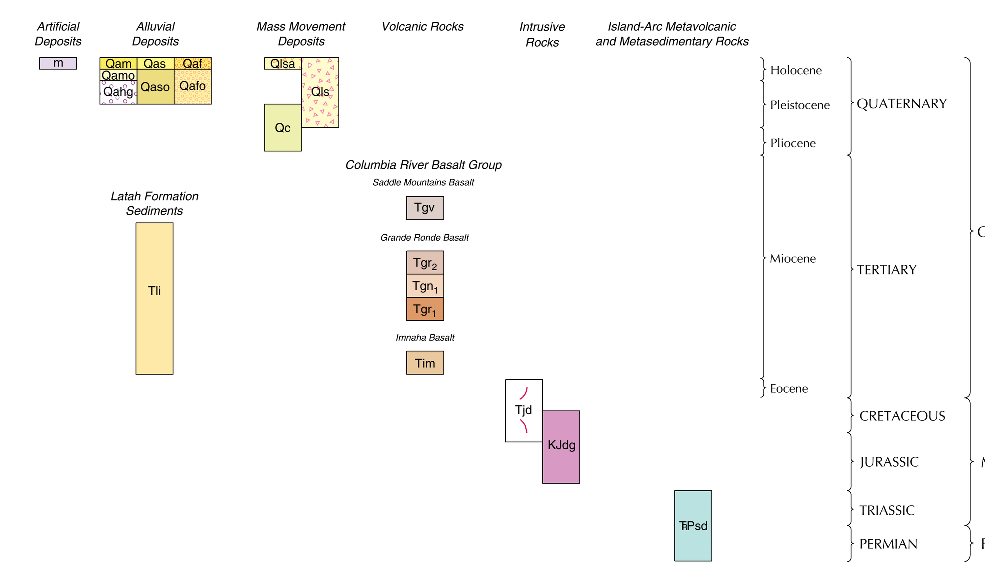

Table 1. Major oxide and trace element chemistry of samples collected in the White Bird quadrangle.

Sample number	Latitude	Longitude	Unit name	Map unit	SiO_2	TiO_2	Al_2O_3	FeO*	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5
02RL800	45.78555	-116.27168	Basalt of Grangeville	Tgv	52.20	1.276	15.36	8.90	0.159	7.53	11.30	2.38	0.74	0.161
06DG003	45.83366	-116.36833	Grande Ronde R_2	Tgr_2	56.51	2.284	14.12	11.31	0.185	3.15	6.79	3.37	1.84	0.444
06DG004	45.83374	-116.36745	Grande Ronde R_2	Tgr_2	56.52	2.297	14.64	12.12	0.140	2.44	6.33	3.50	1.57	0.441
06DG005	45.83207	-116.36594	Grande Ronde N_1	Tgn_1	55.68	2.217	14.10	11.93	0.187	3.28	7.00	3.57	1.59	0.438
06DG006	45.84318	-116.36347	Grande Ronde R_2	Tgr_2	54.15	2.296	13.80	13.02	0.211	3.93	7.71	3.08	1.38	0.426
06DG008	45.84217	-116.36459	Grande Ronde R_2	Tgr_2	54.12	2.295	13.76	13.01	0.245	3.68	7.77	3.12	1.56	0.448
06DG009	45.84703	-116.36073	Grande Ronde N_1	Tgn_1	54.02	2.315	13.70	12.79	0.227	3.99	7.79	3.20	1.53	0.452
07DG106	45.75481	-116.27532	Basalt of Grangeville	Tgv	52.46	1.299	15.52	9.07	0.161	7.32	10.99	2.34	0.68	0.171
07DG120	45.84329	-116.35197	Grande Ronde N_1	Tgn_1	55.60	2.159	13.73	12.48	0.211	3.41	6.92	3.49	1.57	0.421
07DG121	45.84381	-116.35135	Grande Ronde R_2	Tgr_2	55.54	2.162	13.72	12.52	0.198	3.38	6.93	3.52	1.60	0.427
07DG127	45.85137	-116.35651	Grande Ronde R_2	Tgr_2	54.98	2.284	13.78	11.80	0.215	3.96	7.77	3.15	1.66	0.409
07DG128	45.85009	-116.35731	Grande Ronde R_2	Tgr_2	54.09	2.336	13.75	12.72	0.225	3.93	7.87	3.01	1.61	0.462
07JK016	45.75423	-116.27872	Basalt of Grangeville	Tgv	53.16	1.349	15.24	9.01	0.174	6.57	11.12	2.42	0.79	0.165
07JK034	45.82903	-116.27606	Grande Ronde N_1	Tgn_1	55.23	2.065	13.94	11.96	0.199	3.90	7.70	3.08	1.56	0.349
07JK035	45.82876	-116.27782	Grande Ronde R_1	Tgr_1	56.01	2.068	14.25	10.81	0.191	3.97	7.58	3.07	1.74	0.316
07JK076	45.78057	-116.31659	Imnaha	Tim	51.81	3.053	13.60	13.82	0.234	4.33	8.58	3.23	0.89	0.444
07JK087	45.77493	-116.26951	Basalt of Grangeville	Tgv	52.66	1.290	15.25	10.19	0.285	6.22	10.84	2.39	0.72	0.161
07KS018	45.77685	-116.33117	Seven Devils Volcanics lithic tuff	ŦPsd	73.08	0.427	13.87	4.18	0.300	0.66	0.61	6.34	0.44	0.105
07RL518	45.78125	-116.35686	Seven Devils Volcanics basaltic andesite	ŦPsd	52.65	1.460	16.30	11.38	0.191	4.76	8.49	3.34	1.24	0.195

Major elements in weight percent (columns SiO_2 to P_2O_5); trace elements in parts per million (columns Ni to Nd below).

Sample number	Ni	Cr	Sc	V	Ba	Rb	Sr	Zr	Y	Nb	Ga	Cu	Zn	Pb	La	Ce	Th	Nd
02RL800	57	223	25	219	267	14	245	112	23	11.7	20	67	74	3	20	31	4	
06DG003	5	10	30	326	759	47	360	189	36	11.5	21	12	139	10	29	60	6	32
06DG004	8	11	33	341	775	39	336	196	55	11.5	22	23	150	8	28	48	6	30
06DG005	11	10	34	359	764	38	323	190	42	11.2	21	16	135	7	26	52	4	34
06DG006	11	18	35	367	620	38	334	167	38	10.0	22	22	128	6	21	44	4	28
06DG008	11	18	36	371	593	40	330	168	38	10.1	21	22	128	7	21	43	4	28
06DG009	14	20	35	374	602	35	332	165	37	10.9	20	22	130	6	22	45	4	26
07DG106	62	225	33	231	280	14	240	117	24	10.3	16	67	80	1	19	38	2	20
07DG120	12	11	33	357	688	39	310	187	42	11.4	20	19	132	5	21	48	5	29
07DG121	12	10	33	359	697	40	309	189	41	11.1	21	17	130	6	24	58	5	30
07DG127	11	10	36	380	671	38	330	173	40	11.1	20	19	132	5	21	46	5	26
07DG128	14	18	36	377	584	36	335	167	39	9.7	19	23	130	5	21	49	6	27
07JK016	44	145	33	233	295	16	244	127	24	12.1	17	54	80	3	19	36	4	18
07JK034	12	10	34	359	594	38	318	179	38	10.4	20	38	123	6	20	46	5	25
07JK035	11	12	32	347	667	47	358	188	35	10.2	20	35	117	7	18	50	6	28
07JK076	21	22	38	394	415	35	265	246	48	16.8	20	85	138	3	25	54	4	32
07JK087	47	145	34	232	490	15	247	121	23	11.6	16	64	79	2	19	35	4	19
07KS018	0	4	14	66	178	6	109	90	33	1.5	15	7	100	4	2	14	3	10
07RL518	18	32	42	407	257	25	233	100	39	1.6	18	12	101	0	10	18	1	15

* Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO.
All analyses performed at Washington State University GeoAnalytical Laboratory, Pullman, Washington.

INTRODUCTION

The geologic map of the White Bird quadrangle depicts rock units exposed at the surface or underlying thin surficial cover of soil and colluvium. Thicker surficial alluvial, colluvial, and landslide deposits are also shown where they mask or modify the underlying rock units or form significant mappable units. The plateau soils include loess parent material (Barker, 1982), but because loess deposits are thin, they are not included on this map. In addition to present channel deposits, the Salmon River alluvial deposits form terrace remnants of at least two older regimes of the river. The map is the result of our field work in 2006 and 2007 and the compilation of previous research, including that of Bond (1963) and reconnaissance mapping from 1978 to 1980 by Camp (1981) and Swanson and others (1981).

Much of the quadrangle is underlain by Miocene basalt flows of the Columbia River Basalt Group. Exposures of prebasalt rocks are restricted to the Salmon River canyon in the central part of the quadrangle and consist of Permian to Triassic island-arc rocks of the Seven Devils Group, which include metamorphosed volcanic flows and sediments, and Jurassic to Cretaceous intrusive rocks.The island-arc rocks were accreted to the North American continent during the Jurassic to Cretaceous. Folds and faults in these rocks are likely related to the accretion process. Intrusive rocks were emplaced later, probably in the late Jurassic or Cretaceous.

DESCRIPTION OF MAP UNITS

In the following unit descriptions and later discussion of structure, we use the metric system for sizes of mineral or clast constituents of rock units. We use the English system for thickness and distance measurements to conform to those on the base map.

ARTIFICIAL DEPOSITS

m **Made ground (Holocene)**-Artificial fills composed of excavated, transported, and emplaced construction materials of highly varying composition, but typically derived from local sources. Mostly fill along the U.S. 95 White Bird grade.

SEDIMENTARY AND MASS MOVEMENT DEPOSITS

Alluvial Deposits

Qam **Alluvium of the Salmon River (late Holocene)**—Channel and flood-plain deposits that are part of the present river system. Two grain-size suites are typically present: coarse sand in thin shoreline deposits, and well-sorted and rounded pebble to boulder gravel in river bars and islands. Gravel includes clasts of basaltic, granitic, and metamorphic rocks. Low-terrace deposits occur as much as 20 feet above the river channel and were inundated during flood discharge as recently as 1974 (Davis, 2001). The low terraces were disrupted almost beyond recognition by hydraulic placer mining in the nineteenth century (see Symbols).

Qamo **Older alluvium of the Salmon River (early Holocene)**—Primarily stratified sand and well-rounded pebble to boulder gravel of point-bar and terrace remnants above modern levels of the Salmon River. Gravel clast lithology similar to *Qam*. May be capped by thin loess and eolian sand. Height above present mean water level is about 40 feet (see Symbols for height measurements). Interfingers with colluvium and alluvial-fan deposits at toe of canyon slope. Davis (2001) and Davis and others (2002) describe the alluvial deposits and eolian caps seen in pits dug for the research. Deposits of Mazama ash and radiocarbon dating suggest an early Holocene age.

Qahg **Gravel of high terraces in the Salmon River canyon (late Pleistocene)**—Stratified sand and well-rounded pebble to boulder gravel that form terrace remnants from 100 feet to 250 feet above present mean water level (see Symbols for height measurements). Gravel clast lithology similar to *Qam*. Commonly capped by local colluvium, alluvial-fan deposits, or thin loess. Shown on map as pattern only.

Qas **Channel and flood-plain deposits of Salmon River tributaries (Holocene)**—Primarily stratified and rounded pebble to boulder gravel in White Bird Creek. Gravel clasts predominantly basalt.

Qaso **Older channel and flood-plain deposits of tributary streams (early Holocene to late Pleistocene)**—Stratified and rounded pebble to boulder gravel in terrace remnants in the White Bird Creek valley. May be graded to older alluvium of the Salmon River (*Qamo*).

Qaf **Alluvial-fan deposits (Holocene)**—Crudely bedded, poorly sorted brown muddy gravel derived from basalt colluvium on steep canyon slopes. Gravel is composed of subangular and angular pebbles, cobbles, and boulders of basalt in a matrix of granules, sand, silt, and clay. May include beds of silt and sand reworked from loess and Mazama ash.

Qafo **Older alluvial-fan deposits (late Pleistocene to early Holocene)**—Poorly sorted gravel deposits of incised alluvial fan remnants. Texture and lithology similar to *Qaf*.

Mass Movement Deposits

Qc **Colluvial deposits, undifferentiated (Pleistocene-Pliocene)**—Poorly sorted and poorly stratified angular basalt cobbles and boulders mixed with silt and clay. Deposited by gravity movements of various sources, including ancient alluvial-fans and landslides. Surface weathered forming high clay content within a few feet in depth.

Qlsa **Deposits of active landslides (Holocene)**—Slumps, slides, and debris flows of Miocene Latah Formation sediments in the White Bird basin, active as recently as the 1970s and potentially still active.

Qls **Landslide deposits (Holocene and Pleistocene)**—Poorly sorted and poorly stratified angular basalt cobbles and boulders mixed with silt and clay. Deposited by slumps, slides, and debris flows. In addition, the unit may include the landslide scarp and the headwall (steep area adjacent to and below the landslide scarp) from which material broke away (see Symbols). Location of landslide deposits in steep canyons is typically controlled by the presence of sedimentary interbeds and the interface between basalt units and underlying basement rocks. In the White Bird basin, landslides older than *Qlsa* above are also associated with the Latah Formation sediments. In other areas, landslides range in age from ancient movements that are relatively stable features to those that are more recent and potentially less stable.

Latah Formation Sediments

Sediments of the Latah Formation are stratigraphically equivalent to the Ellensburg Formation in Washington (Swanson and others, 1979).

Tli **Sediments interbedded with basalt flows (Miocene)**—Mostly silty sediments. Locally sand with pebble layers or lenses. A silty interbed occurs near the top of the White Bird grade within the Grande Ronde N_1, not far above the N_1-R_1 contact. Sand and pebble deposits mostly occur beneath the basalt of Grangeville, as do the fossiliferous lake sediments in the White Bird basin.

VOLCANIC ROCKS

Columbia River Basalt Group

The stratigraphic nomenclature for the Columbia River Basalt Group follows that of Swanson and others (1979) and Camp (1981). In Idaho, the group is divided into four formations. From oldest to youngest, these are Imnaha Basalt, Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Imnaha Basalt is exposed on the slopes of the Salmon River canyon and along White Bird grade. Grande Ronde Basalt, from oldest to youngest, has been subdivided into the informal R_1, N_1, R_2, and N_2 magnetostratigraphic units (Swanson and others, 1979). Of these units,flows of the R_1, N_1, and R_2 are exposed in the quadrangle. No Wanapum Basalt occurs in the quadrangle. A single flow of Saddle Mountains Basalt, the basalt of Grangeville, occurs as thin remnants within the White Bird basin, resting either on the Grande Ronde Basalt, or on the slumped lake sediments and associated sand and pebbles. Basalt units were identified using hand sample characteristics, paleomagnetic signatures, geochemical signatures, and compilation of previous data. Representative samples of most basalt units were collected for chemical analysis. Sample locations are identified on the map, and analytical results are listed in Table 1. Samples were analyzed at Washington State University's GeoAnalytical Laboratory.

Saddle Mountains Basalt

Tgv **Basalt of Grangeville (Miocene)**—Medium to dark gray, fine- to medium-grained basalt with common plagioclase phenocrysts 1-4 mm in length and scarce to common olivine phenocrysts generally <1 mm in diameter that tend to weather pinkish or orangish. Reverse magnetic polarity as determined in the field and the laboratory. Consists of one flow ranging from 20-80 feet in thickness. Forms the capping unit on slumped lake sediments in the National Historical Park and also occurs as thin, isolated remnants along the lower segment of Free Use Road. Probably flowed into the basin from the south, capping local stream sediments and at least part of the lake sediments. Equivalent to the Grangeville Member of Camp (1981) and the Amphitheater flow of Bard (1978).

Grande Ronde Basalt

Tgr_2 **Grande Ronde R_2 magnetostratigraphic unit (Miocene)**—Medium to dark gray, fine-grained basalt, commonly with a sugary texture. Uncommon to common plagioclase phenocrysts 1-2 mm long. Reverse magnetic polarity, although field magnetometer readings commonly give weak normal or conflicting results, particularly near the top of the R_2 section. Unit consists of one to three or possibly four flows and thins from north to south. It likely pinched out against the developing Mt. Idaho structure. Maximum thickness is about 300 feet at the northwest edge of the quadrangle above Center Creek.

Tgn_1 **Grande Ronde N_1 magnetostratigraphic unit (Miocene)**—Dark gray, fine-grained generally aphyric to plagioclase microphyric basalt. Normal magnetic polarity. Consists of four to six flows (possibly some with multiple flow units) with a total thickness of about 600 feet. Well exposed in the Salmon River canyon and along White Bird grade. Individual flows range from 50 to 150 feet in thickness. Flows near the top of the sequence are commonly 50-70 feet thick and typically sugary textured with scarce small plagioclase phenocrysts 1-3 mm long. Flows lower in the sequence are typically thicker, generally 100-200 feet. The thick entablature flow at or near the base of Grande Ronde N_1 is probably equivalent to the Johns Creek flow of Bond (1963).

Tgr_1 **Grande Ronde R_1 magnetostratigraphic unit (Miocene)**—Mostly dark gray, fine-grained aphyric to microphyric basalt. Very rare plagioclase phenocrysts 2-4 mm long in one or more flows. Reverse magnetic polarity, although flows near the R_1-N_1 boundary commonly have inconsistent and weak field magnetometer polarity readings; therefore, themapped contact is poorly constrained. In general, the contact occurs between the Johns Creek and Center Creek flows of Bond (1963), both of which have thick, tiered entablatures and are commonly separated by oneor two thin flows. Outcrop characteristics of flows are similar to those in the Grande Ronde N_1 unit. Consists of about five to seven flows with a maximum thickness of 800-900 feet.

Tim **Imnaha Basalt**

Imnaha Basalt (Miocene)—Medium- to coarse-grained, sparsely to abundantly plagioclase-phyric basalt; olivine common; plagioclase phenocrysts generally 0.5-2 cm long but some as large as 3 cm. Normal magnetic polarity. Weathers to a sooty brown granular detritus. Commonly has well-developed fanning or irregular columns 1-2 feet in diameter. Maximum exposed thickness is about 600 feet on the ridge north of the confluence of the Salmon River and White Bird Creek.

INTRUSIVE ROCKS

TJd **Dacite dikes (Jurassic to Tertiary)**—Aplitic and porphyritic dikes that intrude the diorite complex and the Seven Devils Group rocks. The porphyritic dikes are light to medium gray with conspicuous phenocrysts of white plagioclase laths as large as 4 mm set in a fine-grained groundmass. Biotite is present and locally pseudohexagonal. The dikes are resistant to weathering and form light-colored talus.

KJdg **Diorite complex (Jurassic to Cretaceous)**—This composite intrusive body consists primarily of textural variations of diorite, but also includes small bodies of gabbro, quartz diorite, and felsic aplite dikes not shown on the map. The diorite is dark gray with light-colored plagioclase 1-3 mm long and black hornblende 2-5 mm long, giving the rock a mottled appearance. Samples typically contain a few percent quartz. Texture ranges from mostly medium grained to very fine grained in places, and the rock is locally mylonitized adjacent to the Hammer Creek thrust. The diorite weathers readily to a fine, dark brown soil. At several localities, including the area along the east side of the lower Salmon River between Soards Gulch and Owens Gulch, this complex contains notable migmatite textures in rocks that vary in composition from diorite to biotite-hornblende quartz diorite, biotite tonalite, and trondhjemite. The migmatite is strongly banded at millimeter to centimeter scale and typically contains very weak solid-state fabric or no fabric.

ISLAND-ARC METASEDIMENTARY AND METAVOLCANIC ROCKS

Seven Devils Group

ŦPsd **Seven Devils Group, undivided (Permian to Triassic)**—Red to gray volcaniclastic, volcanic flow, and sedimentary rocks locally metamorphosed to greenschist facies. Composition ranges from basaltic andesite to rhyolite with as much as 15 percent quartz phenocrysts. The original nature of these rocks can be difficult to determine in the field. We suspect that the section exposed along the lower Salmon River between Hammer Creek and Pine Bar (north of the quadrangle) consists of two distinct packages of rocks: a lower package of porphyritic to phyric volcanic flow and intrusive (mostly sill) rocks and uncommon volcaniclastic rocks with clast size ranging from 2 to 10 mm. Compositions range from basaltic to andesitic. This sequence is commonly strongly metamorphosed to chlorite-rich greenstone. The lower package occurs in the northern part of the map near Shorts Bar and farther downstream, and it is lithologically similar to parts of the Triassic Wild Sheep Creek Formation of Vallier (1977).

The upper package is considerably less metamorphosed, well-bedded, and contains the following lithologies: (1) Red to gray weathering, thickly bedded plagioclase ± amphibole ± quartz lithic tuffs and lava flow rocks of rhyolitic to basaltic andesite composition. At some localities, these rocks contain flattened pumice that clearly indicates a pyroclastic flow origin. Most outcrops of lithic volcanics, however, do not show clear textures indicating that clasts were pumice. Either these textures have been destroyed by diagenesis and mild metamorphism, or the volcanic part of the section is mostly lava flow in origin. (2) Medium- to thick-bedded volcanic breccias and very immature epiclastic conglomerates with subangular to subrounded clasts, and graywackes, siltstones, and argillites with uncommon interbedded thin recrystallized limestone layers. One limestone was fossiliferous. Epiclastic conglomerates are mostly matrix supported and uncommonly clast supported. The clasts contain a mix of mostly porphyritic rock of volcanic or shallow intrusive origin that reach sizes of about 50 cm and coarse sand-size plagioclase and quartz crystals in a mud- to fine sand-sized matrix. Most of the exposures of the *ŦPsd* unit in the quadrangle belong to this upper package. The quartz-bearing volcanics and epiclastic rocks of the upper stratigraphic package are similar in lithology to parts of the Permian Windy Ridge or Hunsaker Creek formations, or possibly to the Triassic Doyle Creek Formation of Vallier (1977). Some or all of the rocks may not fit the described stratigraphy of the Wallowa Terrane in Hells Canyon and the Wallowa Mountains west of the White Bird quadrangle. South of the White Bird quadrangle, on the Slate Creek and Graves Point quadrangles, other lithologies appear in the section, including black argillites, conglomerates, and sandstones.

STRUCTURE

The structural history of this area is complex and long-lived. Rocks of the Seven Devils Group and associated intrusive units were modified by folding, faulting, and erosion before the eruption of the Miocene Columbia River Basalt Group. Postbasalt and synbasalt modification of all units by folding, faulting, and erosion adds to the complexity of the area.

PRE-MIOCENE STRUCTURES

The main prebasalt structure is a north-northeast-trending zone of thrust faulting, which we name the Hammer Creek thrust, that extends across the quadrangle from southwest to northeast. Along the trace of the thrust, deeper and partially migmatized rocks of the diorite basement complex (*KJdg*) have been thrust west-northwest over footwall rocks of the Seven Devils Group. The upper package of the Seven Devils Group in the footwall has been deformed into open, shallowly south-southeast-plunging folds with amplitudes of hundreds of meters. Splays of the Hammer Creek thrust occur in rocks of the footwall both north and south of Hammer Creek Bar. Near Shorts Bar, this fault thrusts the lower package of Seven Devils Group rocks westward over rocks of the upper package. The Hammer Creek thrust appears to be part of a major thrust fault system that continues southwest of the map to Pittsburg Landing, where it is mapped as the Klopton Creek thrust (White and Vallier, 1994), which places the Cougar Creek basement intrusive complex northwestward over rocks assigned to the Jurassic Coon Hollow Formation. To the northeast near Grangeville, this structure is interpreted to merge with the Mt. Idaho fault zone, a mylonite shear zone that shows evidence for dextral-reverse oblique kinematics (Schmidt and others, 2007). North and south of the White Bird quadrangle, the Hammer Creek thrust splays disappear beneath tilted but unfaulted Columbia River Basalt Group units.

MIOCENE AND LATER STRUCTURES

Synbasalt and postbasalt structures include tilting, folding, and faulting. Much of the tilting and folding are related to formation of the White Bird basin and to uplift of the Mt. Idaho structure northeast of the quadrangle (Schmidt and others, 2007). Major faults in the area may be in part related to reactivation along the Hammer Creek thrust system that started during the Miocene and likely continues to the present. Minor faults are interpreted as localized adjustments related to the major faults.

The main fault that offsets basalt units is the White Bird fault, although it is buried beneath landslide deposits for much of its length in the quadrangle. It extends from the head of Magpie Gulch on the northeast to the roadcut south of White Bird on Banner Ridge. Vertical displacement on the fault is estimated to be as much as 1,000 feet in White Bird basin; the relative sense of displacement is down-to-the-east. To the northeast, on the White Bird Hill quadrangle, the fault continues through Poe Saddle, bends to the northeast, and can be traced along the west slope of Chapman Creek and across White Bird Hill where the amount of displacement decreases and the relative sense of displacement changes. Farther northeast, the fault can be traced to the Grangeville area and is mapped as the Mt. Idaho fault (Schmidt and others, 2007). Preliminary reconnaissance indicates the White Bird fault probably continues to the south in the Slate Creek quadrangle.

Subsidiary to but closely associated with the White Bird fault is the White Bird Hill fault, which is aligned along the highway grade and exposed as sheared, brecciated basalt in several roadcuts. The White Bird Hill fault is likely a splay off the White Bird fault, beginning at about Poe Saddle on the north (just east of the quadrangle boundary) and probably merging with it again just south of the town of White Bird. Displacement on the White Bird Hill fault is also down-to-the-east, although the amount of vertical displacement is probably less than 300 feet.

We also propose an unnamed fault approximately parallel to and west of the Salmon River on the basis of the elevation of Grande Ronde-Imnaha contact east of the river and on the ridge west of the river in the south part of the quadrangle. East of the river near Giants Nose, the contact is at approximately 2,000 feet elevation, whereas on the ridge west of the river it is at approximately 3,800 feet elevation. To the north, this offset diminishes, and the elevation of the contact is about the same.

Other faults displacing the basalts are the northeast-trending Soards Gulch fault, three northwest-trending faults near Giants Nose on the ridge west of White Bird, and some minor faults east of White Bird. The Soards Gulch fault has approximately 300 feet of offset with down-to-the-southeast displacement. The three faults near Giants Nose have down-to-the-northeast displacement; maximum offset is about 100 feet. Soards Gulch fault appears to merge with either the unnamed fault described above or the Hammer Creek thrust. The Giants Nose faults appear to terminate against the Soards Gulch fault.

DISCUSSION

At least three stages of deformation have occurred in the area. In stage 1 deformation reverse movement on the Hammer Creek thrust and associated folding occurred in the Mesozoic before the eruption of the Columbia River Basalt Group. During this stage, rocks of the diorite basement complex (*KJdg*) were thrust west-northwest over footwall rocks of the Seven Devils Group. Stage 2 deformation involved north-south compression that included folding and faulting of the Imnaha and Grande Ronde formations. This stage marks the onset of the Mt. Idaho uplift to the east and downwarping of the White Bird basin. The White Bird and White Bird Hill faults probably formed as oblique or strike-slip faults associated with the compressional activity during this period. These faults probably accommodated reverse movement on the Mt. Idaho structure to the east. After this stage, the White Bird Basin had started to form and began to fill with Latah Formation sediments. The basalt of Grangeville then flowed into the basin, capping local stream sediments and at least part of the lake sediments. In stage three deformation, east-west oriented extension was accommodated by north-south striking normal faults. These structures are part of the Neogene Basin and Range extensional province that continues well to the south into southeastern Oregon and Nevada. The White Bird and White Bird Hill faults were reactivated during this stage of deformation as normal faults rather than oblique or strike-slip faults.

High-angle fractures on the White Bird Hill fault record left lateral strike-slip, whereas intermediate angle fractures record oblique normal and reverse slip (Jones, 2003). We interpret the strike-slip and reverse movement to be part of stage 2 deformation and the normal movement to be part of stage 3. Normal faults that cross into the footwall of the thrust fault in the map terminate rapidly to the north. Most of the normal deformation is restricted to the hanging wall of the Hammer Creek thrust. These relationships appear to indicate that the Hammer Creek thrust fault has been reactivated at depth during Neogene time and serves as a major detachment surface for extensional deformation to the south.

SYMBOLS

Contact: dashed where approximately located.

Fault: bar and ball on downthrown side; dashed where approximately located; dotted where concealed.

Thrust fault: dashed were approximately located; dotted where concealed; teeth on upper plate.

Strike and dip of volcanic flows.

Estimated strike and dip of volcanic flows.

Fold axis.

Anticline.

Syncline.

Monocline; synclinal flexure; shorter arrow on steeper limb.

Historic hydraulic placer mining: Low-terrace placers of the Salmon River were extensively mined in the late 19th century using hydraulic methods. The line symbol is the upper limit of a mining disturbance zone that extends to the river shore. Although mostly removed, remnants of terraces mined are present as a subtle break in slope between the valley wall and the modern flood plain.

Strike and dip of foliation.

Strike and dip of mylonitic foliation.

Strike and dip of cleavage.

Bearing and plunge of lineation, type unknown.

Bearing and plunge of mylonitic lineation.

Quartz vein.

Headwall scarp of landslide or small slope failure.

Sample location and number.

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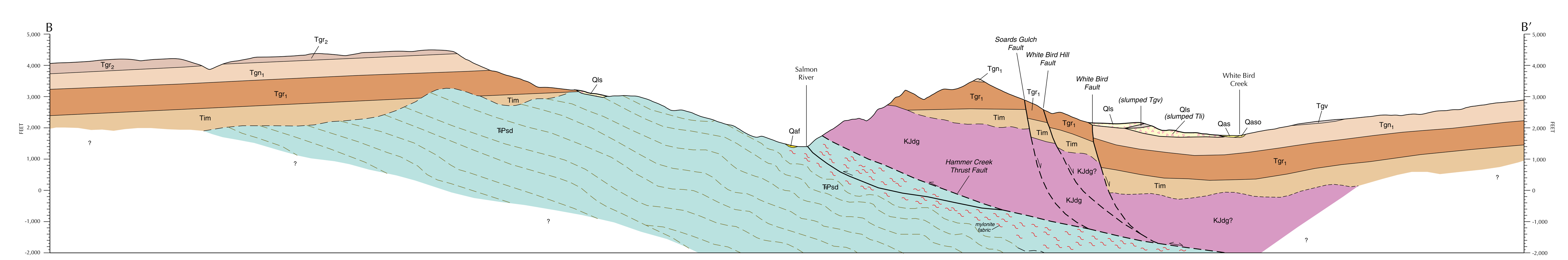

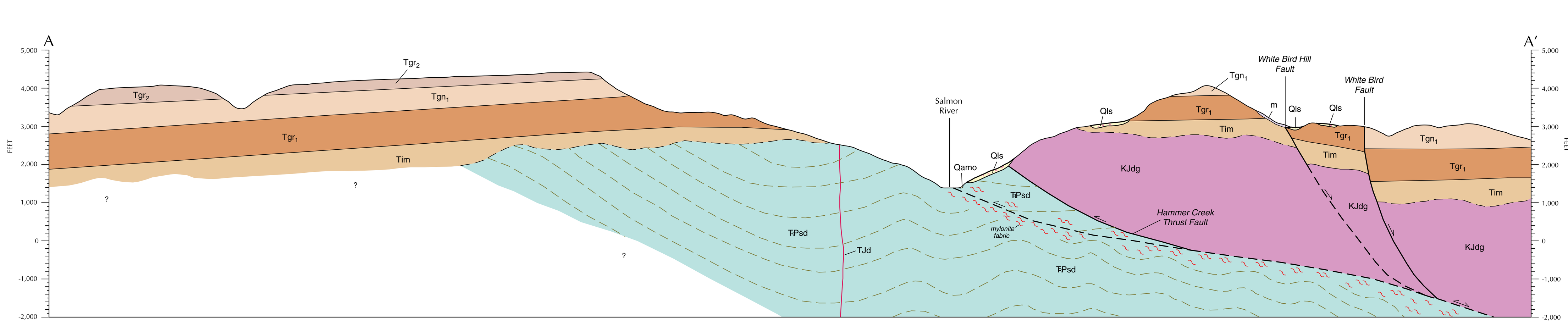

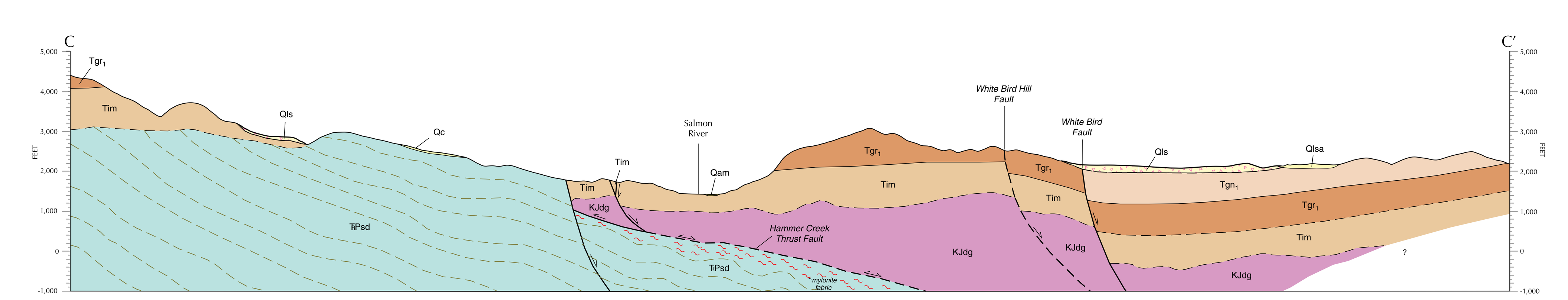

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