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DIGITAL WEB MAP 215
GEOLOGIC MAP SERIES 132
FEENEY AND OTHERS

GEOLOGIC MAP OF THE PAYETTE QUADRANGLE, PAYETTE COUNTY, IDAHO, AND MALHEUR COUNTY, OREGON

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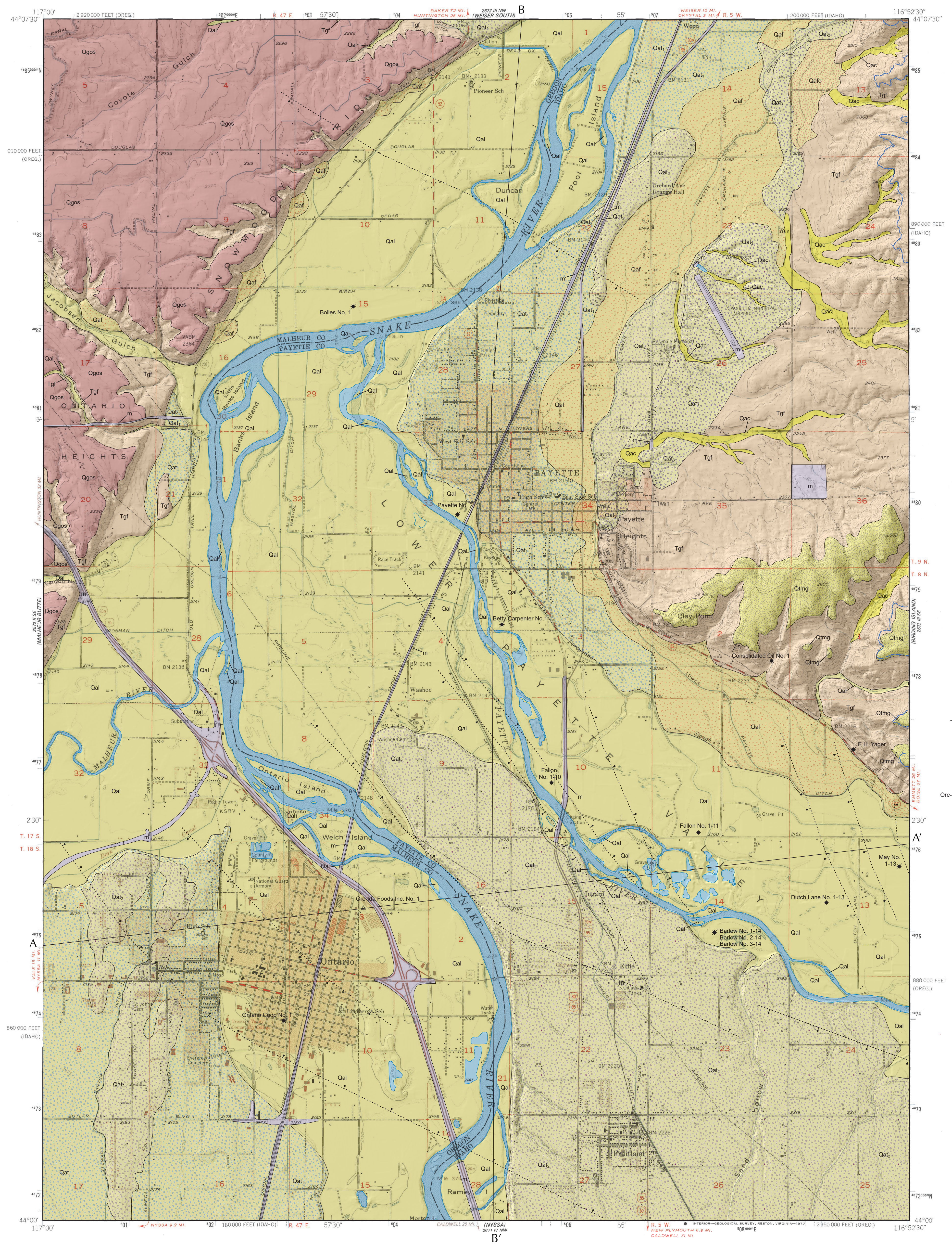
2023



Base Map Credit

Topographic base modified from digitally scanned 1:24,000-scale USGS paper map, compiled from aerial photographs taken in 1946 and 1950.

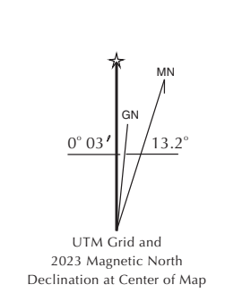
Transverse Mercator projection. 1927 North American Datum.

10,000-foot grid ticks: State Plane Coordinate System, Idaho West Zone and Oregon South Zone.

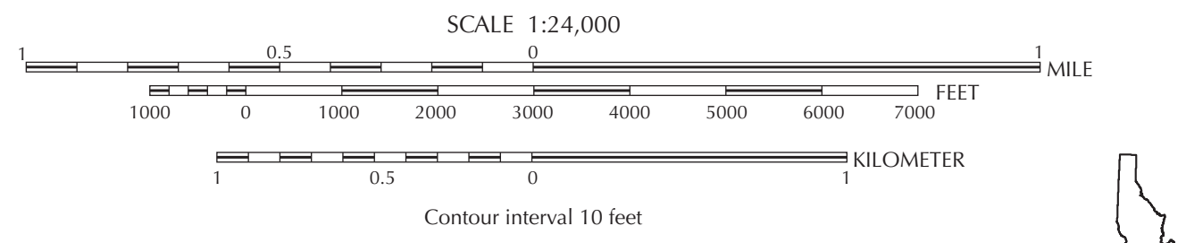
1000-meter grid ticks: Universal Transverse Mercator, zone 11.

Shaded relief from 10 m DEM.

Declination from NOAA National Geophysical Data Center.

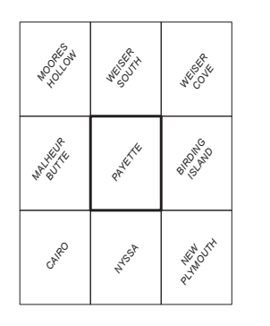


UTM Grid and 2023 Magnetic North Declination at Center of Map



Contour interval 10 feet

QUADRANGLE LOCATION



ADJOINING QUADRANGLES

Field work conducted in 2022.

This geologic map was supported by the U. S. Geological Survey, National Cooperative Geologic Mapping Program, under assistance Award No. G22AC00357. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

Digital cartography by Jonathan Sandquist, Linda Tedrow, David Vohra, and Nathan Hopkins at the Idaho Geological Survey's Digital Mapping Lab.

Technical review by Russ Di Fiori and Claudio Berti.

Map version 12-28-2023.

This map can be downloaded in PDF format from
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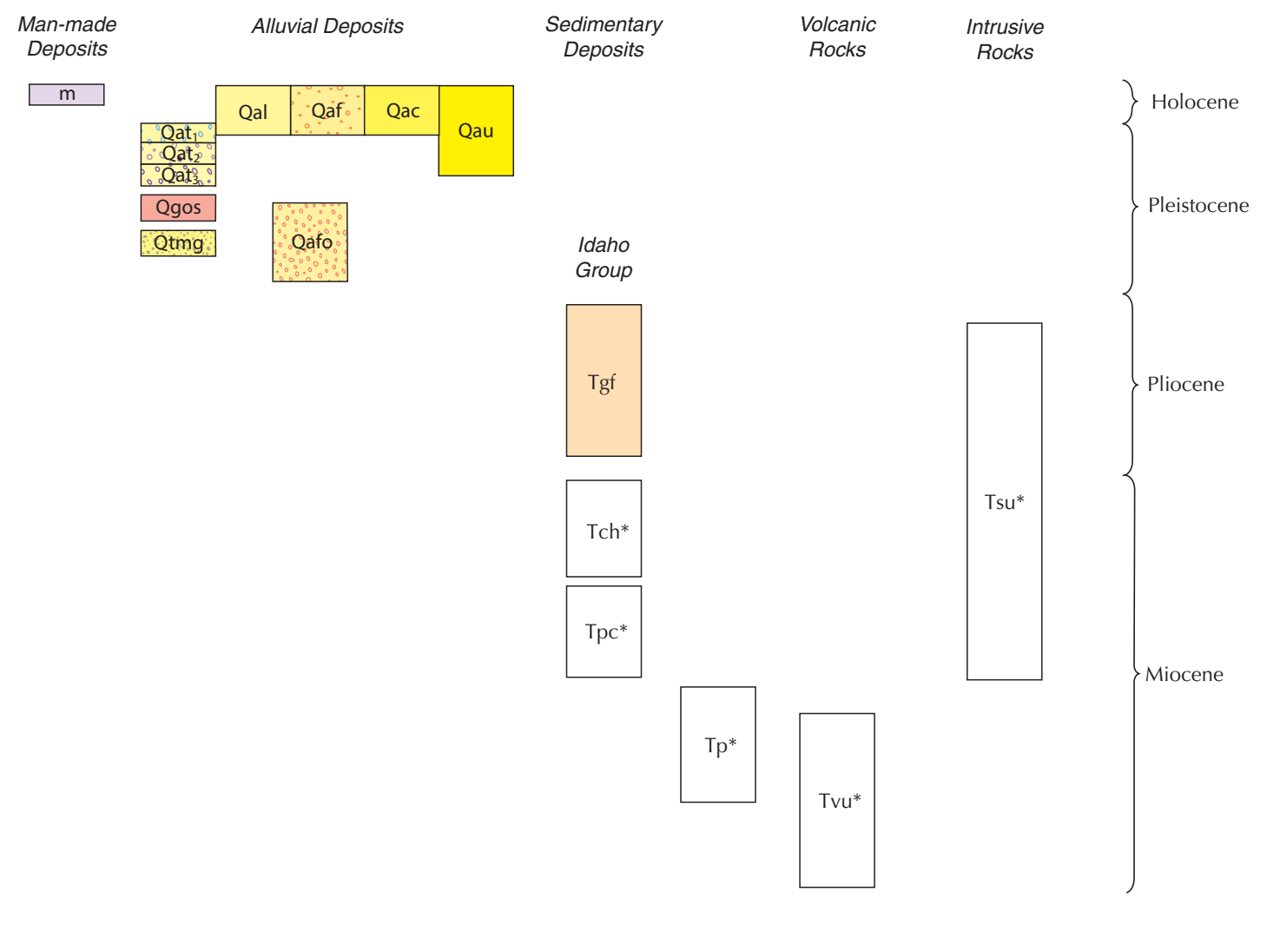
CORRELATION OF MAP UNITS



*appears in cross section only

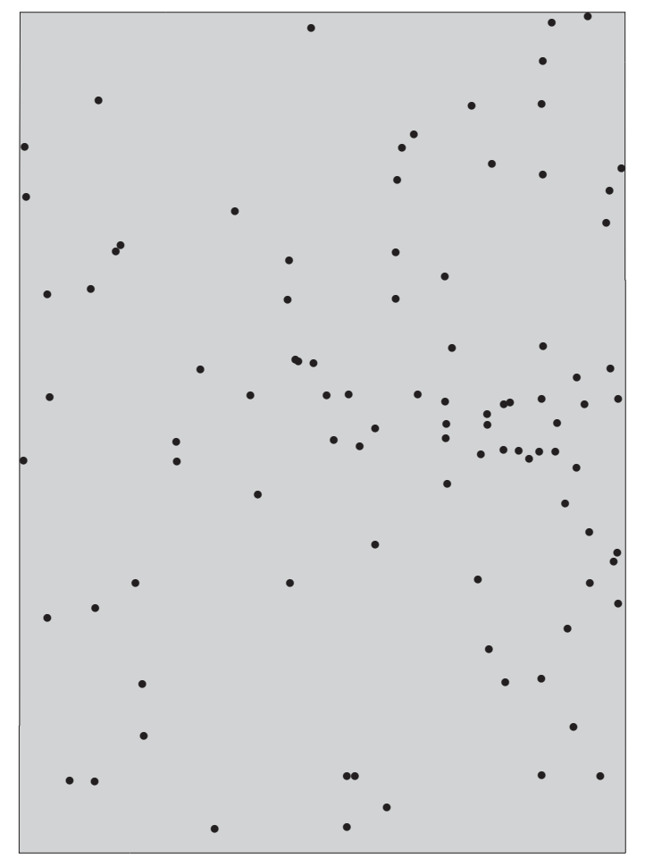
INTRODUCTION

The geologic map of the Payette 7.5' quadrangle depicts rock units exposed at the surface or underlying a thin cover of soil or colluvium; alluvial and man-made deposits are depicted where they form significant mappable units. This map is the result of field work performed in the summer and autumn of 2022 by Feeney and McClaughry and from unpublished mapping in the state of Oregon conducted by Mark L. Ferns. This map was produced concurrently with the geologic map of the Weiser South 7.5' quadrangle (Feeney and others, 2023b). Previously published work in the area includes Kirkham (1931; Idaho side), Savage (1961; Idaho side), Brooks and others (1976; Oregon side) and Fitzgerald (1981; Idaho side). Water well data (IDWR, 2022; OWRD, 2022), Oil and Gas logs (IGS, 2022; DOGAMI, 2022), and 2-D seismic lines were used to support subsurface interpretations. Soils information was accessed via the USDA Natural Resources Conservation Service Web Soil Survey (Soil Survey Staff, 2023).

The Payette 7.5' quadrangle is underlain by the Pliocene to Miocene sedimentary rocks of ancient Lake Idaho. Geothermal and petroleum well information and geophysical data indicate Tertiary igneous intrusions and volcanic rocks are interbedded with and underlie the Lake Idaho sedimentary rocks at depth (Wood, 2019). In the northwest and eastern part of the map area the Lake Idaho sedimentary deposits are overlain by Early to Middle Pleistocene gravels. The Snake River Plain is the path of the Late Pleistocene Bonneville Flood, and the quadrangle includes remnants of Bonneville Flood slack-water deposits. Quaternary alluvial deposits related to the modern Snake, Payette, and Malheur rivers are prominent features, as well as alluvial fans and man-made deposits.

LOCATION OF FIELD OBSERVATIONS

Payette Quadrangle



▨ Extent of LiDAR coverage as of 10/2023

SYMBOLS

	Contact: Solid where certain; dashed where approximately located.
	Normal fault: ball and bar on downthrown side; dotted where concealed.
74	Strike and dip of bedding.
Fallon No. 1-11	Oil and gas well, shut in or producing.
Payette No. 2	Oil and gas well, abandoned.
Ore-Ida Foods Inc. No. 1 △	Geothermal well.
	Approximate extent of the Bonneville Flood slack-water at maximum stage, 760 m (2,493 ft) elevation (O'Connor, 1993); hachures point towards lower elevations.

DESCRIPTION OF MAP UNITS

Grain-size classification of unconsolidated sediment and consolidated sedimentary rocks employs the Wentworth scale (Lane, 1947), and bedding thickness is after McKee and Weir (1953). Where possible grain sizes are listed in order of decreasing abundance, otherwise listed in decreasing grain size. Time scale is from the Geological Society of America (Walker and Geissman, 2022) integrated with the global chronostratigraphical correlation table for the last 2.7 million years (Cohen and Gilbert, 2016). Measurements are given in abbreviation of metric units (e.g., dm=decimeter). Unit thicknesses, distances, and elevations are in both metric and English units.

MAN-MADE DEPOSITS

m **Made ground (late Holocene)—**Riprap, gravel, sand, silt, clay, and concrete emplaced by anthropogenic activities. Natural materials are locally derived. Includes fills for road base for Interstate 84, Highway 95, bridge abutments, and railroad base where they extend beyond more than 2 m (7 ft) above the surrounding landscape. To emphasize the underlying geology, municipal and rural infrastructures (roads, buildings, canals, foundations, bridges, or small-scale modified ground) were not mapped.

ALLUVIAL DEPOSITS

Qal **Stream alluvium (Holocene to Late Pleistocene)—**Unconsolidated, well- to moderately-sorted, compositionally diverse, sand, silt, gravel, cobbles, and clay deposited in channels, levees, and flood plains by rivers, tributary streams, and ephemeral streams. Thickness up to 15 m (50 ft) along the Snake River, up to 9 m (30 ft) on the Malheur and Payette rivers, and up to 5 m (16 ft) in tributary streams. The surface of floodplain deposits of the Snake, Malheur, and Payette rivers have been heavily modified by agricultural practices.

Qaf **Alluvial-fan deposits (Holocene to Late Pleistocene)—**Crudely stratified sand, silt, and clayey gravel in lightly dissected to undissected fans emerging from streams and ephemeral drainages from local highlands onto alluvial plains. Thickness ranges from 2 to 20 m (6 to 65 ft).

Qac **Alluvium and colluvium (Holocene to Late Pleistocene)—**Sand and clayey-silt in the form of debris aprons, wedges, small alluvial fans. No sorting or bedding with exception to the minor ephemeral stream alluvium component. Unit is derived from sand beds of the Glenns Ferry Formation. Thickness varies but no more than 6 m (20 ft).

Qafo **Older alluvial fan deposits (Pleistocene)—**Sand, clayey-silt, and rare gravel in a fan shaped deposit perched high above younger active fans. May include poorly defined alluvial terraces. Highly dissection by streams.

Qau **Stream alluvium, terraces, and man-made deposits, undivided (Quaternary)—**Appears in cross section only; individual units of modern stream alluvium and gravels are too thin to subdivide in the cross section at this scale.

BONNEVILLE FLOOD SLACK-WATER DEPOSITS

Around 17.4 ka (Janecke and Oaks, 2011), Utah's Lake Bonneville overflowed and incised its banks at Red Rock Pass in southeast Idaho. The subsequent draining of the lake lead to a cataclysmic flood along the Snake River Plain (Malde, 1968). After tearing through southern Idaho, the Bonneville Flood waters were constricted and temporarily impinged at Farewell Bend 30 km (19 mi) to the northwest of the quadrangle, where the wide and shallow Snake River Plain meets the narrow and deep Hells Canyon. From this point the voluminous and raging flood waters were backed-up and transformed into an enormous slack-water pond, impeding the flows of Snake, Weiser, Payette, Boise, Malheur rivers, and numerous other minor drainages. Slack-waters of the Bonneville Flood inundated these drainages to a minimum elevation of 742 m (2,435 ft) and a maximum of 760 m (2,493 ft) (O'Connor, 1993) resulting in the deposition of up to 6 m (19 ft) of brown to dark-brown clay, silt, and sand. The sediments are massive to finely laminated and bury older soils developed in the underlying deposits. Locations below 760 m (2,493 ft) elevation in the map area may contain remnant Bonneville Flood slack-water deposits, which have not been eroded by younger fluvial systems. To maximize the utility of the map, we show units underlying the Bonneville Flood deposits and denote with a line on the map the upper limit of the Bonneville Flood slack-water (see symbols).

ALLUVIAL TERRACE DEPOSITS

Pleistocene to Holocene alluvial terraces are composed of moderately sorted gravely sand, silt, and clay. Gravel clasts are rounded to sub-rounded pebbles, cobbles, and some boulders. Clast lithologies are diverse: mostly composed of granitic rocks, felsic volcanic rocks, quartzites, and mafic volcanic rocks. The terrace sequence records long-term episodic incision of the western Snake River Plain, which was largely driven by glacial climate fluctuations during the Pleistocene, and potentially minor influences from local tectonics.

Qat₁ **First alluvial terrace deposits (Holocene to Late Pleistocene)—**Lightly dissected and continuous surface 2 to 6 m (6 to 20 ft) above the Payette and Weiser rivers. Owyhee and Nyssaton silt loam soils series are present (Soil staff survey, 2023). Unit varies in thickness from 3 to 8 m (10 to 26 ft). Surface highly modified by agricultural practices.

Qat₂ **Second alluvial terrace deposits (Late Pleistocene)—**Light to moderate dissection, mostly continuous surface 8 to 27 m (26 to 89 ft) above the Payette and Weiser rivers. Unit has a slight surficial gradient (1 to 3 degrees) down towards the river for the deposits found on Dead Ox Flats and south of Weiser River. Nyssaton silt, Owyhee silt loam, Greenleaf series soils (Soil staff survey, 2023) are present. Thickness up to 16 m (52 ft). Surface highly modified by agricultural practices.

Qat₃ **Third alluvial terrace deposits (Late Pleistocene)—**Moderately dissected, continuous surface found in the northeast corner of the map. Surface is 17 to 21 m (56 to 69 ft) above the Snake River. Greenleaf, McLoughlin, Lolaliota sandy loam, Owyhee silt loam soils series are present (Soil staff survey, 2023). Thickness as much as 10 m (32 ft). Surface highly modified by agricultural practices.

Qgos **Gravel of the Oregon Slope (Middle To Late Pleistocene)—**Gravel, sand, and silt forming the planar Oregon Slope and Ontario Heights. The Oregon Slope and Ontario Heights dip shallowly to the east. The gravels are equivalent to the Intermediate terrace deposits on the Malheur Butte quadrangle (Madin and Ferns, 1997). Cobble- and pebble-size clasts are granite, Tertiary porphyritic felsic intrusive rock, quartzite, black chert and aphyric basalt. Since there are not proximal chert bearing formations in Idaho, the chert is likely derived from the Elkhorn Ridge Formation in the Blue Mountains of Oregon to the northwest. The headwaters and tributary drainages of the Burnt River pass through large segments of the Elkhorn Ridge Formation (Gilluly, 1937; Brooks and others, 1976), however the mouth of the river is located 40 km (25 mi) northwest of the Oregon Slope. The mouth of the Malheur River divides the gravel of the Oregon Slope in two, but neither the headwaters nor any tributary streams of the Malheur access any significant chert bearing deposits. Therefore, gravel of the Oregon Slope may represent an older stage of the Burnt River or it may record a time when the Malheur River was capturing more northerly drainages which would access the Elkhorn Ridge Formation. The porphyritic felsic volcanic clasts are unique in provenance to Idaho. The gravel of Oregon Slope deposit reflects the mixing of multiple drainage systems; the Snake River of Idaho and possibly either, or both, an early stage of the Burnt River and/or the Malheur River of Oregon. Thickness varies but is generally less than 15 m (50 ft) as measured from water well data (OWRD, 2022).

Qtmg **Tenmile Gravel (Early Pleistocene)—**Subrounded to rounded cobbles, pebbles, and small boulders as much as 40 cm long of Tertiary porphyritic felsic intrusive rocks, granite, quartzite, and rare mafic volcanic rocks within a matrix of unconsolidated coarse sand. Covered by 1 to 2 m (3 to 6 ft) of loess. Soils in loess on the gravel are well-developed duripans (Elijah and Chilcott series; Soil Survey Staff, 2023). The base of the soil includes a caliche layer (Bkk horizon) as much as 8 cm thick above the gravel. Unit is tentatively correlated to the Tenmile Gravel in the Boise Valley (Savage, 1958; Othberg and Stanford, 1992). Gravel represents ancestral Payette River progradational gravel which was deposited following the draining of ancient Lake Idaho, but prior to Pleistocene stream incision in the western Snake River Plain (Othberg, 1994; Othberg and others, 1996; Wood and Clemens, 2002). Unit is probably older than 1.5 Ma but younger than 1.67 Ma Glenns Ferry deposits at Marsing (Repenning and others, 1995; Othberg and others, 1996). Thickness approximately 3 to 5 m (10 to 15 ft).

SEDIMENTARY DEPOSITS

Idaho Group

Tgf **Glenns Ferry Formation (Pliocene)—**Coarse- to fine-grained arkosic sandstone, siltstone, claystone, rare pebble to cobble conglomerate, and silicic ash tuffs. Lightly consolidated and poorly to well indurated. Generally flat lying to dipping less than 5 degrees. Exposure in the quadrangle is poor, the best exposures are found east of the town of Payette in road cuts around Clay Point and at the Clay Peak recreational area (southeast of the town of Payette). Exposures show buff to tan, medium-to fine-grained sand and lesser silt with orange to burnt-orange Liesegang banding throughout. Bedding in sand is massive and shows meter-scale cross bedding. The sandy cliffs of Glenns Ferry Formation in Idaho are considered the sand-fronts of progradational deltas (Wood, 1994). Well logs and high-resolution seismic reflection data indicate the sandy cliffs overlie progradational clinoform beds of clay, silt, and fine sand. The underlying fine-grained progradational delta beds do not appear at the surface of this map. Additionally, the fine-grained nature of these deltas would be largely indistinguishable at outcrop scale from the underlying deep-water lacustrine clays of the Chalk Hills Formation. An alternative contact between the Glenns Ferry Formation and Chalk Hills is included in the cross sections. Water well data from the state of Oregon indicate much of this formation is brown clay to silt with rare sand beds (OWRD, 2022). In aerial imagery the Glenns Ferry Formation appears as a banded unit with alternating 3 to 5 meter (10 to 16 ft) horizons of light-tan and faint maroon. In Oregon, 19 km (12 mi) northwest of the quadrangle along state highway 201 on a bend in the Snake River a landslide created a 70 m (230 ft) exposure of fine-grained lacustrine Glenns Ferry Formation, with multiple thin ash beds, conglomerates, and sand. Dates from two of the ten ashes present revealed zircon fission track ages of 3.3 ± 1.0 Ma (middle) and 5.5 ± 0.4 Ma (base) (Thompson, 1991). At the Hagerman Fossil beds, near the type locality of the Glenns Ferry Formation ash beds are dated from 4.2 to 3.2 Ma ($^{40}Ar/^{39}Ar$ on ash Hart and Brueseke, 1999; Link and others, 2002). The youngest Glenns Ferry Formation is the Fromans Ferry marsh deposit found 35 km (22 mi) to the south, near Marsing, Idaho. Based on fossil assemblage the Fromans Ferry deposit is bracketed from 1.5 to 1.67 Ma (Repenning and others, 1995). From the ash dates of Thompson (1991) and the type of deposits seen we interpret the Glenns Ferry Formation present in this quadrangle to be Pliocene in age. Unit thickness as mapped is up to 137 m (450 ft). If the lower fine-grained progradational delta beds interpreted from geophysical data were to be included in the unit would be as much as 595 m (1,950 ft).

Tch **Chalk Hills Formation (late Miocene)—**Interpreted from oil and gas wells and regional mapping (Feeney and others, 2023a, b). Appears in cross section only.

Tpc **Poison Creek Formation (late Miocene)—**Interpreted from oil and gas wells and regional mapping (Feeney and others, 2023a, b). Appears in cross section only.

Tp **Payette Formation (late to middle Miocene)—**Interpreted from oil and gas wells and regional mapping (Feeney and others, 2023a, b). Appears in cross section only.

VOLCANIC ROCKS

Tvu **Volcanic rocks, undifferentiated (Miocene)—**Interpreted from oil and gas wells. Appears in cross section only.

INTRUSIVE ROCKS

Tsu **Sill rocks, undifferentiated (Pliocene? to Miocene)—**Interpreted from 2-D seismic data. Appears in cross section only.

STRUCTURE

Only concealed normal faults are present in the Payette Quadrangle. They are all interpreted from two 2-D seismic lines running perpendicular to each other (north-south and east-west). The northernmost fault in the map is the southwestern half of a northwest-trending horst (Feeney and others, 2023b). In the south part of the map a series of northwest-trending horsts and grabens are formed by numerous normal faults. The northwest-trend of the faults in this map is interpreted from the shallow dip of the fault in seismic data and following trends seen in regional structures (Fitzgerald, 1982).

HYDROCARBON RESOURCES

The Payette quadrangle is at the heart of the southwest Idaho oil and gas play which produced Idaho's first commercial hydrocarbon resources in 2014. As of 2023, Payette, Birding Island, and New Plymouth are the only 7.5' quadrangles in the state of Idaho to have commercial hydrocarbon production. Hydrocarbon reservoirs are found in three sand zones (Figure 1); listed stratigraphically from lowest to highest, the Willow sands, the Harmon sands, and Hamilton sands. The Willow sands are producing wet gas (ethane, propane, and butane) and light oil, the Harmon field is producing wet gas, and the Hamilton sands are producing lean gas (methane). The reservoirs appear to be a combination of stratigraphic and structural traps. The source is presumed to be organic rich zones within the Payette Formation.

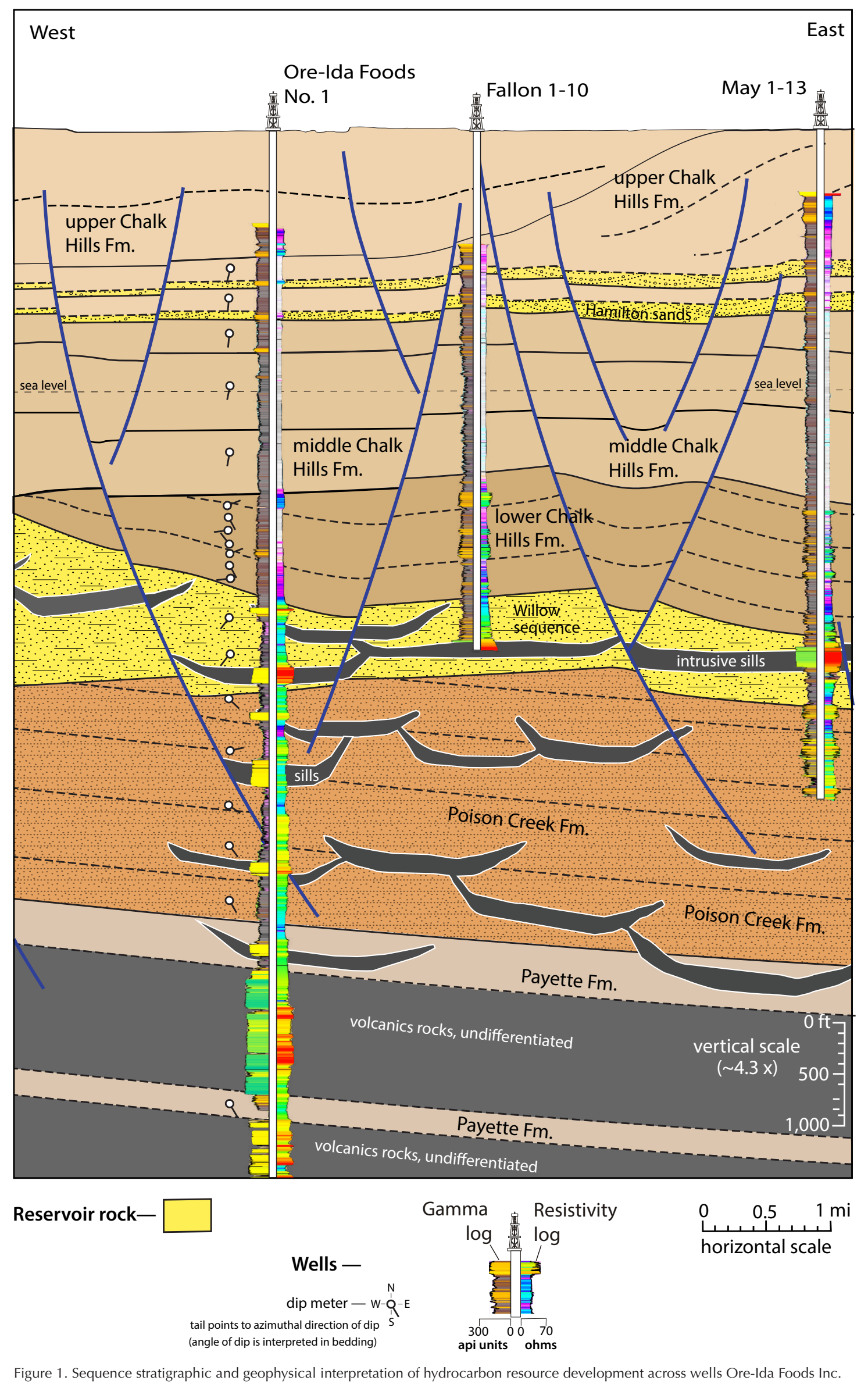


Figure 1. Sequence stratigraphic and geophysical interpretation of hydrocarbon resource development across wells Ore-Ida Foods Inc. No.1, Fallon 1-10, and May 1-13, neighboring part of cross section A-A'. Resistivity: Low resistivity is represented in hues of indigo and blues progressing through the color spectrum to high resistivity capping out in the color red.

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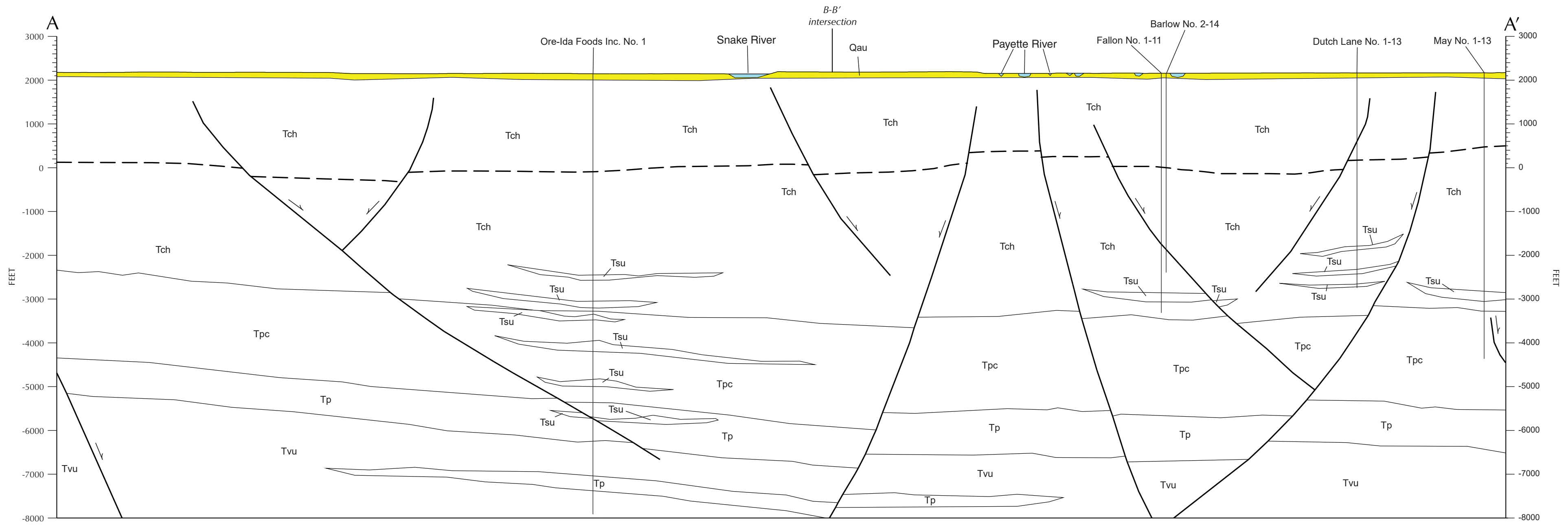
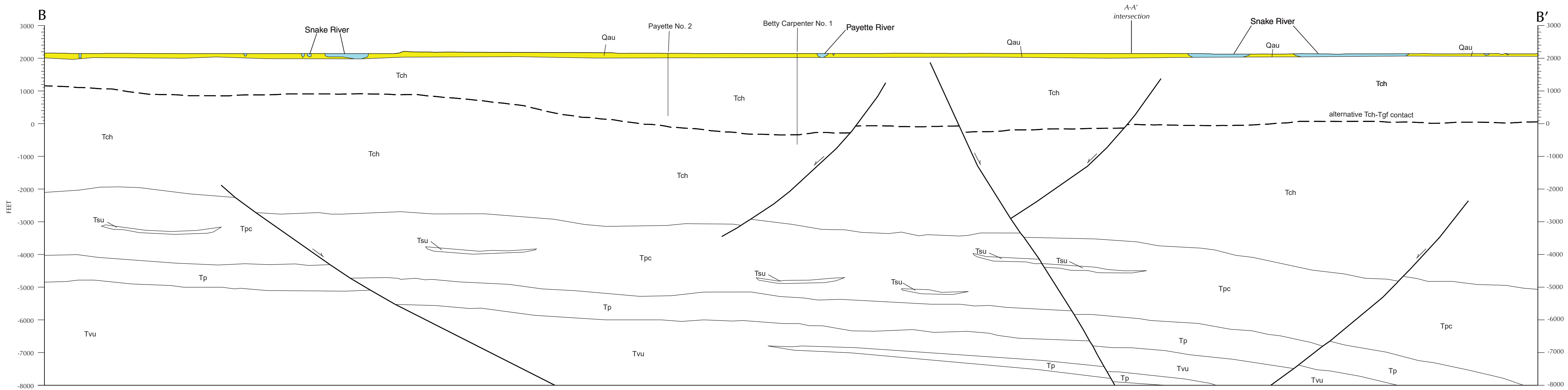


No vertical exaggeration. Indicators of fault motion in cross section: arrow depicts relative motion.



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University of Idaho, Moscow, Idaho 83844-3014 and by
the Oregon Department of Geology and Mineral Industries, Portland, Oregon 97232