Plate 1, Michalek, M., 2009, M.S. Thesis, Idaho State University

Geological Map of Parts of the Lake Hills and Carey Quadrangles, Blaine County, Idaho

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2010

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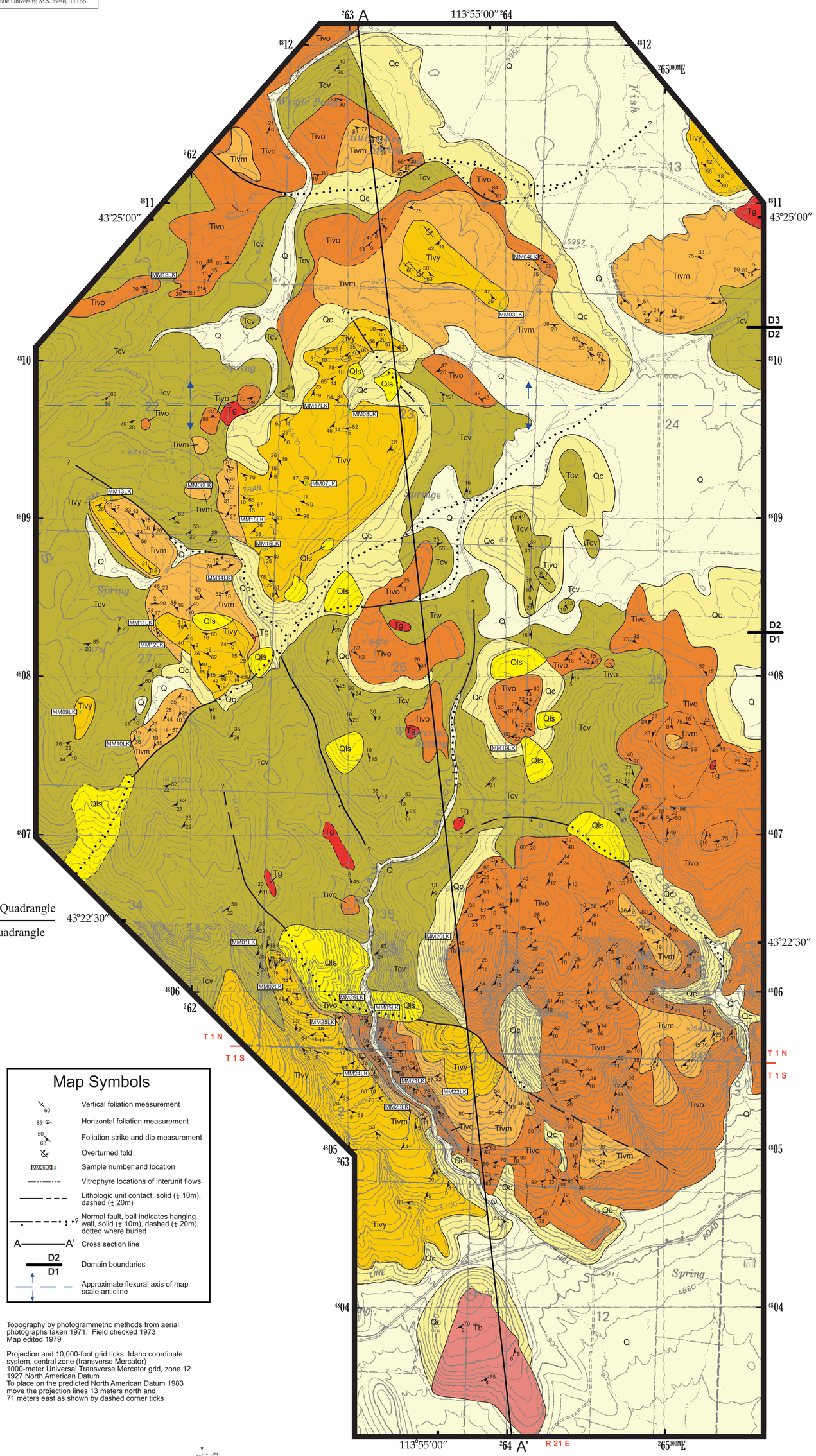
Michalek, M., 2009, Age and amount of crustal flexure in the Lake Hills, south-central Idaho, and implications for the subsidence of the Eastern Snake River Plain: Idaho State University, M.S. thesis, 111pp.



Correlation of Map Units

- Quaternary
  - Q, Qc, Qls
  - unconformity
  - QTb
  - unconformity
- Tertiary
  - Miocene
    - Tg / Tivy — 8.76±0.38 Ma
    - Tg / Tivm — 8.39±0.54 Ma
    - Tg / Tivo — 9.21±0.18 Ma, 9.16±0.20 Ma
  - unconformity
  - Eocene: Tcv

Description of Units

Quaternary

Q — **Modern alluvial deposits** (Quaternary)- Intermittent stream channel, floodplain and terrace deposits. Clasts are angular to rounded, mud to boulder in size. Minimum thickness of 1 m.

Qc — **Colluvium** (Quaternary)- Unconsolidated, poorly to moderately sorted, angular to subangular deposits of silt to boulders, derived from the Idavada and Challis Volcanic Groups.

Qls — **Landslide Deposits** (Quaternary)- Rotated blocks and hummocky topography, most commonly in the Idavada and Challis Volcanic Groups. Deposits are commonly located in close proximity to faults and many contain localized springs in the scarps.

Quaternary/Tertiary

QTb — **Basalt** (Neogene)-Basalt, black to light gray, plagioclase phenocryst-rich lava flow with a blocky, partially vegetated and irregular surface with numerous folds. Unconformably overlies the Idavada Volcanic Group. Unit is a single lava flow, 1-2 m thick in the north and 4-5 m thick in the south.

Miocene

Tivy — **Idavada Volcanic Group youngest** (upper Miocene)-Rhyolite ash-flow tuff. This unit consists of three partially to densely welded tuffs that are indistinguishable in hand sample and thin section. The three flows have a similar sequence of vitrophyre, lithophysal zones and vapor phase zones. The basal contact for each flow is characterized by a thin, slope-forming, black, phenocryst-poor vitrophyre that grades upward into a slightly devitrified 1.5 m thick black, vitric, cliff-forming zone within which feldspar phenocrysts can be seen in hand sample. Jointing and a weathered rounded appearance is typical in the cliff-forming zone. Commonly the devitrified zone grades upward into a 1-3 m thick, welded, banded, ashy, upper vitric zone. Vitric glass chips and small pumice lithics are present within the upper vitrophyre. Next in succession is a cliff-forming, massive, jointed lithophysal zone 2-5 m thick. Lithophysal cavities are elongated and up to 30 cm wide. The lithophysal zone is pinkish tan in color and weathers into granule gravel. Abruptly overlying this is a densely-welded, platy, pastel colored vapor phase zone. The vapor phase zone is lithophysae-free, angular, and contains completely flattened pumice or vesicles. In hand sample, feldspar phenocrysts can be seen. Further up-section, numerous alterations between lithophysal and vapor phase zones are common. In thin section, total percentage of phenocrysts ranges from 14-25%. Major (= 10%) phenocrysts are large feldspars, minor (3-10%) phenocrysts are pigeonite and magnetite and trace phenocrysts are zircon, apatite, orthopyroxene, ilmenite, quartz and augite. The uppermost flow has limited exposure in Road Canyon and a thickness of about 12 m. Thickness for the middle flow ranges from 6-79 m and the lower flow ranges from 22-121 m. Exposed unit thickness is 40 m in the south to 200 m in the north. The unit overlies Tivm or Tcv. Sample MM01LK was dated at 8.76±0.38 Ma (^{40}Ar-^{39}Ar, Sanidine).

Tivm — **Idavada Volcanic Group middle** (upper Miocene)- Rhyolite ash-flow tuff. The basal unit is thin (< .5m) slope-forming vitrophyre with slightly devitrified zones with rare feldspar phenocrysts up to 2-3 mm in size that weather into angular fragments. Up-section the vitrophyre changes into a thin, banded, light gray zone with lithic fragments and abundant glassy chips. The overlying massive lithophysal zone is thin with smaller more rounded pastel pink, purple or blue lithophysae. The vapor phase zone abruptly overlies the lithophysal zone and weathers into angular plates 1-4 cm thick. Outcrops exhibit a pastel pink, purple or blue color with rare color banding. The lithophysal and vapor phase zones alternate upwards through the unit. In thin section, total percentage of phenocrysts ranges from 6-22%. Major (= 10%) phenocrysts are small feldspars, minor (3-10%) phenocrysts are pigeonite and magnetite and trace percentages were found of zircon, apatite, orthopyroxene, ilmenite, quartz and augite. Total unit thickness is 40-60 m. The unit overlies Tivo or Tcv. Sample MM22LK was dated at 8.39±0.54 Ma (^{40}Ar-^{39}Ar, Sanidine).

Tivo — **Idavada Volcanic Group oldest** (upper Miocene)-Rhyolite ash-flow tuff. This unit consists of two indistinguishable tuffs. The vitrophyre, lithophysal and vapor phase zones of the upper tuff closely resembles the lower tuff in thickness, phenocryst abundance, color and appearance. The basal unit of the lower flow is thin, black, glassy, phenocryst-free, slope-forming vitrophyre. The vitrophyre gradationally grades into a slightly devitrified zone 1.5 m thick, resistant, and phenocryst-rich zone. Typically overlying this is a light gray, ashy, banded spherulitic zone with glassy spheroids with a gradational contact with the devitrified zone and an abrupt contact with the overlying lithophysal zone. Pinkish tan and up to 4 m thick, the lithophysal zone is overlain by a vapor phase zone that is pastel pink, contains feldspar phenocrysts and weathers into 3-4 cm thick angular plates in which flattened pumice or vesicles are visible. Lithophysal and vapor phase zones alternate in the upper portions of the flows, with the lithophysal zones becoming thinner and containing smaller lithophysae cavities up-section. In thin section, total percentage of phenocrysts ranges from 10-28%. Major (= 10%) phenocrysts are large feldspars, minor (3-10%) phenocrysts are pigeonite and magnetite and trace percentages were found of zircon, apatite, orthopyroxene, ilmenite, quartz and augite. In the south, upper flow thickness is about 40 m and the exposed lower flow thickness is about 60 m. East of Philips Canyon, the unit thickens to 200 m (lower flow, 180 m; upper flow, 40 m) but this is nonrepresentative of the unit within the rest of the field area. Maximum exposed thickness in the south is 100 m and total thickness in the north is 100m. Sample MM21LK was dated at 9.16±0.20 Ma and sample MM20LK was dated at 9.21±0.18 Ma (^{40}Ar-^{39}Ar, Sanidine).

Tg — **Gravels** (Miocene)-Unconsolidated, moderately sorted, subrounded to rounded cobbles 5 cm to 25 cm in size. Cobbles are predominantly derived from the Challis Volcanic Group and the Wood River Formation. Typically overlies the Challis Volcanic Group with rare deposits between the Idavada Volcanic Group ignimbrites. Maximum thickness for each bed is 0.5 m.

Eocene

Tcv — **Challis Volcanic Group** (Eocene)- Andesite to Rhyolite flows and tuffs. Biotite-rich, light pink to reddish brown lithic-rich ash-flow and ash-fall tuffs. Biotite-rich tuff breccia including vitrophyre, light gray greenish banded ash-fall tuffs and interbedded volcaniclastic sedimentary rocks. Cliff-forming dacite lava flows with abundant biotite phenocrysts and distinctly bright green epidote alteration. Exposed unit thickness is about 1500 m (4920 ft). Unit dated at 45.6-49.5 Ma immediately to the north of this study area (Sanford and Snee, 2005).

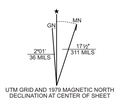
Map Symbols

- Vertical foliation measurement
- Horizontal foliation measurement
- Foliation strike and dip measurement
- Overturned fold
- Sample number and location
- Vitrophyre locations of interunit flows
- Lithologic unit contact; solid (± 10m), dashed (± 20m)
- Normal fault, ball indicates hanging wall, solid (± 10m), dashed (± 20m), dotted where buried
- Cross section line
- Domain boundaries
- Approximate flexural axis of map scale anticline

Topography by photogrammetric methods from aerial photographs taken 1971. Field checked 1973
Map edited 1979

Projection and 10,000-foot grid ticks: Idaho coordinate system, central zone (transverse Mercator)
1000-meter Universal Transverse Mercator grid, zone 12
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection lines 13 meters north and 71 meters east as shown by dashed corner ticks

QUADRANGLE LOCATION



UTM GRID AND 1979 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:12 000

.5 .25 0 1
Miles
2000 1000 0 1000 2000 3000 4000 5000
Feet
1 .5 0 Kilometers 1
1000 0 Meters 1000

CONTOUR INTERVAL 40 FEET NORTH OF LATITUDE 43°22′30″ AND 20 FEET SOUTH OF 43°22′30″
NATIONAL GEODETIC VERTICAL DATUM 1929

[1]Idaho State University, Department of Geosciences, Pocatello, Idaho 83209
Field work conducted 2006 and 2007

Digital cartography by Milana Michalek and Diana Boyack at
Idaho State University, Department of Geoscience, Digital Mapping Laboratory

Funded by NASA EPSCoR Grant #01412359, GSRSC Grant #FO6-104 and NSF GK-12

Geologic History

Eocene

The oldest rocks exposed within the field area are the Challis Volcanic Group (Tcv). Part of the southwestern Challis Volcanic Field, Challis rocks in the Lake Hills were most likely erupted from fissures and eruptive centers located west-southwest of Mackay, Idaho (Snider, 1995) or west of the Little Wood River (Sanford and Snee, 2005). The lowermost rocks are andesite and dacite lava flows and tuff breccias (Sanford and Snee, 2005). These are overlain by volcaniclastic and ash-fall tuffs. Dacite to rhyolite ash-flow tuffs are found at the top of the sequence (Kuntz et al, 2007; Sanford and Snee, 2005). For the purpose of this study the Challis Volcanic Group has remained undifferentiated.

Miocene

Thin and discontinuous gravels (Tg) were deposited in numerous locations in the field area. Emplacement of the first Idavada Group unit, Tivo, occurred around 9.16 Ma. The oldest rhyolite ash-flow tuffs were emplaced unconformably over Challis and Gravel units and at least partially filled topographic depressions. After tuff emplacement, the Lake Hills experienced a brief volcanic hiatus, during which the lower unit was locally eroded and tilted. The next ash-flow tuff unit, Tivm, was unconformably deposited over Challis, Gravel or lower tuff units at 8.39±0.54 Ma. The final ash-flow tuff unit, Tivy, was emplaced over Tivm at 8.76±0.38 Ma. All three Tiv units are interpreted to have originated from the Twin Falls volcanic field, which stretched across the Eastern Snake River Plain (ESRP) from south of the eastern Bennett Hills to east of Twin Falls, Idaho (Pierce and Morgan, 1992).

During the Miocene, the study area also experienced NE-SW extension along NNW striking normal faults, as well as crustal flexure associated with subsidence of the ESRP. Crustal flexure created three distinct domains across the field area. In Domain 1, to the south, Challis and Idavada units tilt progressively to the southeast, towards the ESRP as much as 41°. In Domain 2, Challis and Idavada units are subhorizontal. The northernmost, Domain 3, Challis and Idavada units tilt to the north as much as 33°. These domains define an east-trending antiform that is interpreted to be a flexural hinge associated with ESRP subsidence.

Two Miocene normal fault sets are located in the study area. Set one strikes NE, dips NW and individual faults have a maximum displacement of 150 m. An example is located in the middle of the mapping area, striking through T1N and R21E, sections 23, 24, 26, 27 and 34. Set two strikes NW, predominantly dips SW. Individual faults have a maximum displacement of about 120 m. A prime example of fault set two is crossed by the Road Canyon road in T1N and R21E and section 35. Both fault sets displace the uppermost Idavada unit. Set two displaces set one in one location (T1N and R21E, section 26). Both faults sets are interpreted to reflect post 8 Ma Basin and Range extension.

Quaternary/Tertiary

A phase of volcanic quiescence after the emplacement of Tivy was terminated after the emplacement of a small volume basaltic lava flow in the southernmost portion of the map area during the early Pleistocene or Pliocene (Kuntz et al., 2007). The location of source vents is unknown. Crustal flexure continued after the emplacement of the basalt, as shown by its current southern tilt of 5-6°.

Quaternary

After the emplacement of the Neogene basalt, no new volcanic units were emplaced in the Lake Hills area. Sediment produced by weathering and erosion is present beneath modern creek and river beds. Though water rarely flows in these drainages today, the volume of sediment and amount of stream incision provides evidence for much larger flows in the Pleistocene. Landslides are also present and active in the study area, particularly in close proximity to faults.

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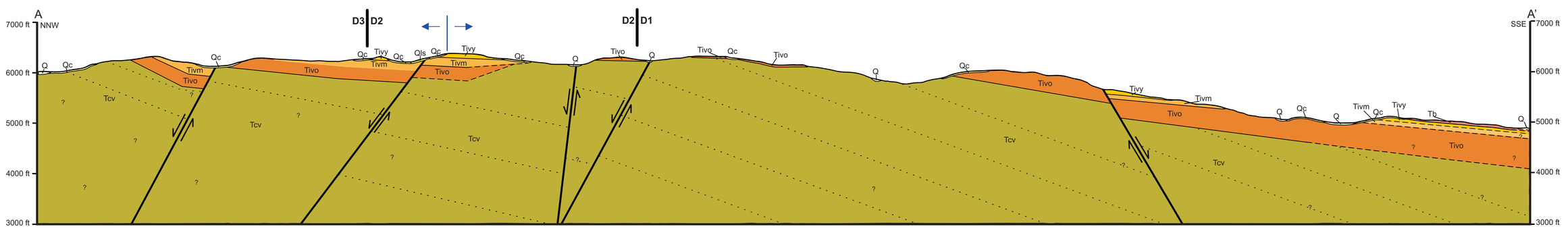

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University of Idaho, Moscow, Idaho 83844-3014