Text and references accompanying Nevada Bureau of Mines and Geology Map 185

Geologic Map of the Bateman Spring Quadrangle, Lander County, Nevada

by

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INTRODUCTION

The Bateman Spring quadrangle, located just southeast of Battle Mountain, Lander County, Nevada, covers about 15 km^2 of the west side of the northern Shoshone Range and about 130 km^2 of the northeastern part of Reese River Valley. The Shoshone Range is a long (>100 km), generally north-northeast-trending mountain range. Mount Lewis (at 2950 m, the highest point in the Shoshone Range) is one of the highest peaks in north-central Nevada. However, unlike some of the other high ranges in the region, the Shoshone Range does not maintain a high elevation over much of its length. The Reese River, an ephemeral tributary of the Humboldt River, originates more than 200 km to the south in the southern Toiyabe Range. The quadrangle is part of an area previously mapped by Stewart (1969). For this study, Quaternary geology of the quadrangle was mapped by A.R. Ramelli and P.K. House over a period of several years, with most work done 2000–2003, and bedrock geology was mapped by C.T. Wrucke, with most work done in 1997–2002. Adjacent areas to the north and east were previously mapped by House et al. (2001), Ramelli et al. (2001), and John and Wrucke (2003).

GEOLOGY

The Bateman Spring quadrangle includes lower Paleozoic sedimentary rocks and Miocene intrusive dikes in the Shoshone Range, alluvial-fan deposits flanking the Shoshone Range, alluvial-flat deposits adjacent to the Reese River, and floodplain deposits of the Reese and Humboldt Rivers. Structural features resulting from two deformational periods are exposed in the Bateman Spring quadrangle: the Roberts Mountain thrust and Cenozoic extensional faults.

The eastern edge of the quadrangle exposes siliciclastic sedimentary rocks of the Roberts Mountain allochthon (Stewart and McKee, 1977; John and Wrucke, 2003). The Roberts Mountain thrust, which formed during the Late Devonian to Early Mississippian Antler orogeny (cf., Gilluly and Gates, 1965), placed Ordovician and Cambrian rocks of the Valmy Formation (O€vu, O€va) over Devonian rocks of the Slaven Chert (Dss, Dssc, Dsg, Dsc), a thrust relation exposed extensively in the Shoshone Range in the eastern part of the quadrangle. Devonian sections are also duplicated by thrusting, but this relation is not exposed in the quadrangle and is shown only in cross section.

The quadrangle is located just west of the north-northwest-trending northern Nevada rift, a middle Miocene zone of continental extension and associated volcanic flows and dikes (Zoback et al., 1994). To the north and east of the quadrangle, the Paleozoic rocks are capped by Miocene volcanic rocks (Ramelli et al., 2001; John and Wrucke, 2002; John and Wrucke, 2003), but the only exposed Miocene rocks in the quadrangle are basaltic andesite dikes (Tbi). Miocene volcanic rocks (Tob?) are inferred to underlie the basin and are thus shown in cross section, but the thickness and western extent of these rocks are unknown.

Most of the quadrangle spans the piedmont of the northern Shoshone Range, with medium- to coarse-grained alluvial-fan deposits grading to nearly flat-lying, fine-grained distal-fan deposits. At the confluence of the Reese and Humboldt Rivers, in the northwest part of the quadrangle, the valley floor has an extremely low gradient (averaging about 0.1%). At an elevation of about 1380 m, this area was above the high stands of late Pleistocene Lake Lahontan. However, the area was inundated by at least one higher, older lake stand (Reheis, 1999), so buried deposits likely contain at least minor lake deposits interbedded with older riverine and alluvial-flat deposits.

Middle to late Holocene alluvial deposits are offset by north- to northeast-striking extensional faults, including a prominent frontal fault that bounds the west side of the Shoshone Range along the eastern edge of the

quadrangle, and secondary faults distributed across the valley floor to the west of the frontal fault. Holocene scarps along the frontal fault are preserved in only a few locations at narrow canyon mouths. The secondary faults merge to the north, forming a horsetail splay from the frontal fault. Based on their structural association, we infer that the secondary faults ruptured during the main frontal-fault events, although this would be difficult to prove and the secondary faults may not all rupture during any given event.

Wallace (1979) inferred that a frontal fault earthquake took place <2000 yr bp, based on fault scarp morphology. A paleoseismic trench south of the quadrangle exposed offset 7 ka Mazama tephra (Wesnousky et al., 2005), and mapping of Humboldt River deposits just north of the quadrangle indicate the course of the river shifted in response to faulting about 2,400 yr bp (House et al., 2001; Ramelli et al., 2001).

Evidence of an earlier (pre-Holocene) surface-rupturing event was found in a few locations along the frontal fault during this study. This event probably occurred at least a few tens of thousands of years ago, based on soil development in bracketing deposits. Pleistocene deposits with strongly developed soils (possibly >100 ka old) are offset only by the Holocene and late Pleistocene events, suggesting a long recurrence interval (i.e., at least several tens of thousands of years).

GEOLOGIC UNITS

Alluvial-Fan Deposits

Medium- to coarse-grained alluvial-fan deposits originating from the Shoshone Range in the east and south parts of the quadrangle. Dominantly composed of pebble gravel and sand, with lesser percentages of cobbles and boulders. Gravel deposits are typically angular to subrounded, poorly to moderately sorted, and poorly to moderately stratified. Clast lithologies are predominantly Paleozoic carbonate rocks.

Qa Deposits of recently active alluvial-fans (modern) Gravel and sand deposits within and adjacent to recently active washes. Surfaces characterized by mostly unmodified to slightly subdued bar-and-swale morphology, and sparse to no vegetation. Minimal or no soil development. Subject to frequent or intermittent flooding.

Qay Young alluvial-fan deposits, undivided (late Holocene to late Pleistocene) Gravel and sand deposits of the piedmont on the west flank of the Shoshone Range. Mapped as undivided where Qay_1 and Qay_2 form anastomosing surfaces with limited topographic separation.

Qay_1 Young alluvial-fan deposits (late to middle Holocene) Gravel and sand deposits forming fan-terrace remnants characterized by subdued to fully smoothed bar-and-swale surface morphology. Inset below adjacent older surfaces at fan heads along major drainages, but have minimal topographic separation along minor drainages and distal locations. Surface clasts have weak to incipient rock varnish. Soils are typically A-C profiles with 0- to 5-cm-thick Av horizon (vesicular A) and 30- to 50-cm-thick Bk horizon (Stage I $CaCO_3$); may have a weak Bw horizon.

Qay_2 Young alluvial-fan deposits (early Holocene to late Pleistocene) Gravel and sand deposits forming fully smoothed fan-terrace remnants generally preserved only near fan heads. Surface clasts have moderate to dark rock varnish. Soils typically consist of 5- to 10-cm-thick Av (vesicular A) horizon, 10- to 20-cm-thick Bw (cambic) horizon, and 50- to 100-cm-thick Bk horizon (Stage I to II $CaCO_3$ with continuous coatings up to 1 mm thick).

Qai Intermediate-aged alluvial-fan deposits (late Pleistocene) Gravel and sand deposits forming fully smoothed and generally small fan terrace remnants preserved only along the piedmont/mountain range interface. Surface dominated by fine-grained eolian material. Surface clasts have dark rock varnish. Soils typically consist of 10- to 20-cm-thick Av (vesicular A) horizon, 15- to 30-cm-thick unstructured A horizon (eolian cap), 20- to 40-cm thick Bt (argillic) horizon, which is typically overprinted with Stage I $CaCO_3$ (Btk), and 30- to 60-cm-thick Stage II+ to Stage III $CaCO_3$ horizon (Bk or Bkm); upper soil horizons are locally stripped.

Qao Older alluvial-fan deposits (Pleistocene) Gravel and sand deposits forming fully smoothed, deeply dissected, and broadly rounded fan-terrace remnants exposed only in upthrown sides of Cenozoic faults. Surface expression similar to Qai, with dominant fine-grained eolian cover, and small, localized areas of desert pavement (pavettes). Surface clasts have dark rock varnish. Soils typically consist of 10- to 20-cm-thick vesicular A horizon (Av), 15- to 30-cm-thick unstructured eolian silt cap (A), 20- to 40-cm-thick argillic horizon overprinted with Stage I $CaCO_3$ (Btk), and 50- to 100-cm-thick Stage III-IV $CaCO_3$ horizon (Bkm); upper soil horizons are typically stripped.

Alluvial-Flat Deposits

Medium- to fine-grained alluvial deposits forming very low-gradient surfaces at the distal end of the Shoshone Range piedmont. Deposits are mostly moderately to well-sorted fine sand and silt, and some pebble gravel. Clast lithologies are predominantly Paleozoic carbonate rocks.

Qaf_1 Deposits of recently active washes (modern) Deposits within and adjacent to recently active washes. Dominantly fine sand and silt, but include coarse sand and pebble gravel within channels. Surfaces characterized by sparse to no vegetation. No soil development. Subject to frequent flooding.

Qaf_2 Young basin fill (late Holocene) Dominantly fine-grained deposits forming terraces set slightly above recently active washes. Surfaces are partially to fully smoothed. Minimal soil development. Subject to intermittent flooding.

Qaf_3 Young basin fill (late to middle Holocene) Dominantly fine-grained deposits forming terraces with minimal separation from Qaf_2 surfaces. Surfaces are generally fully smoothed. Soil horizons include a thin (up to 5 cm) eolian silt cap and variable Bk horizon (Stage I $CaCO_3$).

Qaf_4 Young basin fill (early Holocene to late Pleistocene) Dominantly fine sand and silt deposits exhumed due to uplift along a fault trace trending through Bateman Spring. Surfaces are generally fully smoothed. Upper soil horizons typically stripped, with variable Bk horizon preserved.

Riverine Deposits

Deposits of the Humboldt and Reese Rivers in the northern part of the quadrangle. Age ranges are from correlative units on the Battle Mountain and Stony Point quadrangles to the north (House et al., 2001; Ramelli et al., 2001).

Qm Meander-belt deposits of the Humboldt River (about 2000 to 5600 cal yr BP) Deposits of a recently abandoned meander belt of the Humboldt River. Composed mainly of lateral accretion deposits of predominantly pebble gravel and sand. Surface has highly irregular topography associated with complex assemblage of meander scrolls, abandoned channels, oxbow lakes, and isolated floodplain remnants. Equivalent to Qm_2 of House et al., 2001 and Ramelli et al., 2001.

Qf_1 Young floodplain deposits (about 2000 to 3500 cal yr BP) Deposits of infrequently inundated floodplain and overflow channels of the Humboldt River. Dominantly composed of vertical accretion deposits consisting of fine sand and organic-rich silt and clay. Located adjacent to recently abandoned meander belt (Qm). Includes minor networks of distributary channels in overflow areas between more extensive floodplains separated by older or higher units. Equivalent to Qf_{2a} of House et al., 2001 and Ramelli et al., 2001.

Qf_2 Young floodplain (about 3500 to 5600 cal yr BP) Deposits of a flat and generally featureless, infrequently inundated floodplain surface. Composed dominantly of silt to silty clay overlain locally by a thin (generally 10 to 25 cm) mantle of eolian silt. About 1 m higher than Qf_1. Equivalent to Qf_{2b} of House et al., 2001 and Ramelli et al., 2001.

Qf_3 Floodplain deposits of the Humboldt and Reese Rivers (late Pleistocene) Deposits of relatively high, inactive floodplain surfaces of the Humboldt River (north part of the quadrangle) and Reese River (northwest part of the quadrangle). Dominantly composed of fine sand, silt, and clay. Locally mantled by as much as 1 m of eolian silt. Equivalent to Qf_4 of House et al., 2001 and Ramelli et al., 2001.

Eolian Deposits

Qe Eolian deposits (Holocene) Fine-grained eolian deposits (predominantly fine sand), locally forming dunes. Mapped only where thick enough to be obvious on imagery. Up to 2 m or more thick at distal parts of alluvial fans.

Buried Deposits

QTa Buried alluvial deposits, undivided (Pleistocene to Miocene) Interfingering alluvial fan, alluvial flat, and riverine deposits with a wide range of characteristics. Shown only in cross section. Up to 2000 m thick, based on gravity data by Ponce and Morin, 2000.

Bedrock Units

Tob? Olivine basalt (Miocene) Olivine basalt flows. Shown only in cross section and inferred from the adjoining Mule Canyon and Stony Point quadrangles (John and Wrucke, 2003; Ramelli et al., 1999). Age about 14.7 Ma (John and Wrucke, 2003). Thickness unknown, but inferred to be about 100 m based on exposures on adjoining quadrangles.

Tbi Intrusive basaltic andesite (Miocene) Basaltic andesite dikes 2 to about 10 m wide in northeastern part of quadrangle. May be feeders to flows exposed to east in adjacent Mule Canyon quadrangle where labeled Tbi (John and Wrucke, 2003) and elsewhere on east flank of Shoshone Range. Specimens from basaltic andesite dikes in Argenta and Mule Canyon quadrangles yielded, respectively, whole rock $^{40}Ar/^{39}Ar$ ages of 16.13±0.9 Ma and 16.4±0.4 Ma (R.J. Fleck, oral commun., 2001).

Table 1. Biostratigraphic information for the Bateman Spring quadrangle.

LOCALITY NUMBER	FIELD NO.	STRATIGRAPHIC UNIT	FAUNA	AGE	SOURCE
F1	SHO-00-C6	Slaven Chert (Dsc)	Conodonts: *Icriodus* sp. *Pandorinellina exigua exigua*	Early Devonian	S.A. Leslie[1]
F2	SHO-00-C4	Slaven Chert (Dsc)	Conodonts: *Icriodus* sp. *Pandorinellina exigua exigua*	Early Devonian	S.A. Leslie[1]
F3	SHO-99-R36	Slaven Chert (Dsc)	Conodonts: *Trilonche* sp. *Stigmophaerostylus* spp.	early Late Devonian or Younger	P. J. Noble[2]
F4	SHO-99-C34	Slaven Chert (Dsc)	Conodonts: *Icrodus nevadensis* *Icrodus claudiae* *Pandorinellina* (*Ozarkodina*?) *steinhornensis*	middle Early Devonian (middle Pragian)	S.A. Leslie[1]
F5	SHO-00-R3	Slaven Chert (Dsc)	Conodonts: *entactinids* with bladed spines *Ceratoikiscum* sp. *Helenifore laticlavium*	late Early Devonian to Late Devonian	P.J Noble[2]
F6	SHO-98-06	Slaven Chert (Dsc)	Conodonts: *Polygnathus linguiformis linguiformus* *Polygnathus costatus patulus*	early Middle Devonian (Eifelian)	P.J. Noble [2] and M.T. Kurka[2]
F7	SHO-98-05	Slaven Chert (Dsc)	Conodont: *Polygnathus linguiformis alveolus*?	early Middle Devonian (Eifelian)	P.J. Noble[2] and M.T. Kurka[2]
F8	SHO-98-03	Slaven Chert (Dsc)	Conodonts: *Polygnathus linguiformis linguiformis*	early Middle Devonian (Eifelian)	M.T. Kurka[2] and P.J. Noble[2]
F9	SHO-98-01	Slaven Chert (Dsc)	Conodonts: *Polygnathus* spp. Some identifiable to *linguiformis* stock	Early to early Middle Devonian (Eifelian)	M.T. Kurka[2] and P.J. Noble[2]
F10	SHO-00-C7	Slaven Chert (Dsc)	Conodonts: *Pandorinellina exigua exigua*	Early Devonian	S.A. Leslie[1]
F11	SHO-99-31	Slaven Chert (Dsc)	Conodonts: *Icriodus nevadensis* *Pandorinellina exigua exigua* *Polygnathus dehiscens*	middle Early to late Early Devonian (middle Pragian to middle Emsian)	S.A. Leslie[1]
F12	SHO-99-16	Valmy Formation, undivided (O€v)	Graptolite: *Didymograptus similus*?	late Early Ordovician	S.C. Finney[3]
F13	SHO-99-07 & BS468	Elder Sandstone[4]	Graptolites: *?Pristiograptus* sp. monograptid *Pristiograptus* sp.	Middle Silurian (Wenlockian)	S.C. Finney[3]

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[4]Unit too small to show. Consists of thin sequence of argillite and sandstone structurally beneath quartzite in small area mapped Valmy Formation O€v.

Slaven Chert

Dsc Chert (Early, Middle and Late? Devonian) Dominantly medium-gray to black chert in two thrust sheets, one in northeast part of quadrangle and a structurally higher one in southeast part. Thrust sheet of Valmy Formation separates Devonian sheets. Slaven in northeast thrust sheet contains numerous conspicuous bold sequences of black to medium-gray sandstone and quartzite, commonly 3- to 7-m-thick, separated by sequences of chert commonly 10 m or more thick. Sandstone and quartzite consist of fine- and medium-size quartz grains and sparse grains of black chert; bedding commonly not evident. Interlayered chert contains subordinate amounts of dark-gray to dark-greenish-gray argillite. Slaven in southeast thrust sheet consists mainly of chert and argillite as in northeast thrust sheet. Chert in both thrust sheets commonly in beds 1- to 15-cm-thick, forming ribbon chert. Chert and much of argillite altered medium-light gray to light grayish-green and locally stained brown and yellow-brown from iron oxides. Locally contains black, medium-gray weathering, laminated limestone in lenses 1- to 5-m-long. Sequences of thin-bedded, brown-weathering sandstone a few meters to possibly 10 m thick present locally. Barite in beds 1- to 30-cm-thick in sections as thick as about 5 m containing interlayered chert exposed at barite mines and prospects near southeast corner of quadrangle. Upper and lower contacts thrust faults. Thickness in northeast thrust sheet about 500 m, and about 150 m in southeast sheet. Age in lower thrust sheet Early, Middle, and Late Devonian based on fossils at fossil localities F1–F11 (table 1). Age in upper thrust sheet probably Early to Late Devonian based on lithologic correlation with Slaven Chert widely exposed elsewhere in Shoshone Range (Gilluly and Gates, 1965).

Dsg Greenstone (Middle or Late? Devonian) Dark greenish-gray to brownish-gray in subhorizontal body exposed on opposite sides of hill east of Slaven Canyon, near southeast corner of quadrangle. Poorly exposed. Maximum thickness 18 m. Internal structure of original flow or flows not evident. Locally silicified in dull dark-greenish-black masses as large as 0.5 m wide. Similar greenstone in Slaven Chert to south in Tenabo quadrangle originated as submarine basalt flows (C.T. Wrucke, unpublished information). Devonian age based on inferred correlation with black chert of Slaven Chert at Tenabo.

Dssc Sandstone and chert breccia (Early or Middle Devonian) Medium-gray, medium-grained sandstone commonly containing a few percent of sand and grit-size fragments of black chert. Sandstone locally dominant but commonly interlayered with and locally dominated by chert breccia consisting of pebble-size black to medium-gray fragments of chert, angular to subangular clasts also commonly present. Abundance of chert clasts highly variable from a few percent to about 80 percent; clast supported where clasts abundant. Locally contains thin limestone lenses. Thickness as much as 50 m. Age Early or Middle Devonian based on fossils in Mule Canyon quadrangle to east (John and Wrucke, 2003).

Dss Sandstone (Early? Devonian) Black fine-grained sandstone and siltstone that commonly weathers light- to medium-gray and red-brown. Commonly laminated. Exposed in southeast corner of quadrangle. Consists mostly of very fine- to medium-grained feldspathic sandstone composed of angular quartz, 20 to 30 percent angular plagioclase, <1 percent potassium feldspar, and accessory white mica. Sandstone typically bimodal from 5 to 40 percent well-rounded, medium-grained quartz. Weathers mostly red-brown. Thickness about 30 m. Early Devonian age based on presence of fine-grained sandstone interbedded with chert of that age in northeast part of quadrangle and from similarities with dated sandstone and siltstone in Tenabo quadrangle (C.T. Wrucke, unpublished information) and Battle Mountain quadrangle (House et al., 2001).

Valmy Formation

O€v Valmy Formation, undivided (Ordovician and Cambrian) Interbedded quartzite and argillite and minor amounts of limestone. Quartzite dominant near southeast corner of quadrangle. In northeast part of quadrangle, quartzite occurs locally as large high-standing conspicuous outcrops 5 m or more thick, but abundant quartzite also present in thinner, less conspicuous bodies interlayered with argillite. Base of lowest conspicuous quartzite shown as thrust fault within areas mapped as Valmy Formation, undivided. Ratio of quartzite to argillite highly variable throughout unit. Quartzite commonly bimodal, consisting mostly of a tight mosaic of very fine to fine, angular to subrounded grains and 5 to 10 percent randomly distributed well-rounded, fine- to medium-size grains, but grain size from smallest to largest is seriate. Argillite dark-gray to black and fissile, locally abundant in sections 10 m or more thick. Maximum thickness of unit about 350 m. Graptolites from fossil locality F12 and localities in coextensive rocks in adjacent Mule Canyon quadrangle (John and Wrucke, 2003) yielded Late Ordovician age, but wide range in Ordovician possible from correlation with similar rocks widely exposed in the Shoshone Range (Gilluly and Gates, 1965). Cambrian age based on determination by Anita G. Harris (written communication) of very late Late Cambrian conodont elements from limestone in Valmy Formation in Stony Point quadrangle 1 km north-northwest of northwest corner of quadrangle (Ramelli et al., 2001). Probably some argillite in unit of same age as argillite unit (O€va).

O€va Argillite (Early? or Middle? Ordovician) Black to medium-gray argillite in thrust sheet at base of Ordovician rocks in east-central part of quadrangle.

Thickness 5 to 40 m. Uncertain Early? or Middle? Ordovician age based on a single poorly preserved graptolite fragment collected in adjacent Mule Canyon quadrangle (John and Wrucke, 2003).

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