FIRST DAY: MIDDLE TRIASSIC STRATIGRAPHY AND AMMONITE BIOSTRATIGRAPHY IN WESTERN NEVADA: FOSSIL HILL TO FAVRET CANYON

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Assembly Point: Exit 119 on Interstate 80, east of Reno.
Departure Time: 8 AM
Distance: 141.7
Stops: 3 (one optional)

SUMMARY

Today’s trip traverses an essentially west-to-east transect from Fossil Hill in the southern Humboldt Range through the southern end of the Tobin Range to Favret Canyon in the Augusta Mountains (Fig. 1.3). All stops are in Middle Triassic strata that yield ammonite and halobiid bivalve assemblages critical to Anisian-Ladinian biostratigraphy. These are basinal strata of the Fossil Hill Member of the Prida Formation (to the west) and Favret Formation (to the east) that record a paleogeographically complicated pattern of syndepositional subsidence (Nichols and Silberling, 1977) attributable to back-arc extension. The strata are silty shales and dark lime mudstones deposited below wave base in an euxinic paleoenvironment. Fossil content is mostly of planktonic and nektonic organisms, especially ichthyosaurs, radiolarians, conodonts, halobiid bivalves and cephalopods. The stops focus on the megafossil biostratigraphy, particularly of the cephalopods.

The Prida and Favret formations are part of the Star Peak Group, which is composed mainly of carbonate rocks ranging from late Spathian through the Carnian in age (Fig. 1.4). Beneath the Star Peak Group are mid-Spathian and older Lower Triassic, and possibly uppermost Permian, volcanic rocks of the Koipato Group. Strata above the Star Peak group are mainly fine-grained, terrigenous-clastic rocks —sometimes referred to as the Auld Lang Syne Group, but more commonly as the “mud pile”—of a large Norian to Lower Jurassic deltaic complex and its thick offshore equivalents. All of the rocks of the Star Peak Group to be visited on Days 1 and 2, together with the underlying and overlying lower Mesozoic rocks, characterize the lower Mesozoic cover of the so-called Golconda terrane. Although not among the scheduled field-trip stops, the basal, offshore strata of the Auld Lang Syne Group occur just west of the Golconda terrane, which is characterized by upper Paleozoic rocks of the Golconda allochthon (Fig. 1.1). Because these strata everywhere are evidently structurally juxtaposed with the lower Mesozoic rocks of the Golconda terrane, they are regarded as a distinct allochthonous tectonic block, the Jungo terrane (Silberling, 1991), which will enter into the discussion on Day 2. All of the lower Mesozoic rocks in northwest Nevada, except the easternmost exposures of those belonging to the cover on the Golconda terrane, lie seaward of the initial-strontium 0.706 isopleth, which is generally interpreted to be the oceanward limit of continental crust.

Mileage | Comments
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0.0 | Traveling east on U.S. Interstate 80, **leave highway on exit 119** (to Oreana). **0.1**
0.1 | Stop sign; turn right. **0.4**
0.5 | Road forks; **continue straight** (towards Rochester). **0.2**
0.7 | Road forks; **go straight**, Humboldt Range ahead. The Humboldt Range is named after German geologist (among other things) Baron Friedrich Heinrich Alexander von Humboldt (1769-1859). John Charles Frémont conferred the name during his explorations of 1845-1846. The higher parts of the southern Humboldt Range expose Upper Permian (?) and Lower Triassic volcanic rocks (principally andesite, rhyolite tuffs and flows) of the Koipato Group (Wallace et al., 1969). The overlying Triassic carbonate rocks of the Star Peak Group crop out primarily along the western and eastern margins of the range. The southern part of the Humboldt Range thus describes a broad, south-plunging, antiform.
We are now driving up Limerick Canyon on the west limb of this antiform. Enter Spring Valley, named after its natural springs. A group of prospectors, in the 1860s, named the canyon in which they struck “pay dirt” Rochester, after their native city in New York state. The first major production from the Rochester district was during World War I and the years shortly thereafter. Development of the district by open-pit mining during recent decades is primarily for gold, although production of silver as a by-product makes the district one of the major producers of silver in North America. To the right is the ghost town of Fitting, which has an interesting history of placer gold mining. First located by American prospectors, during the last part of the 19th Century, it came to be operated by Chinese miners, thousands of whom in the 1860’s had been imported into this country as laborers on the Central Pacific Railroad, the western segment of the first transcontinental railroad. Early (in American terms) mining districts in the west were self regulated. Hence, this placer gold district was divided into individual claims measuring only 20 x 20 ft in area. A shaft was hand dug through the semi-consolidated gravels to depths of 10 or more meters on each claim, and the higher grade gravel directly above the bed rock was then excavated and processed. Waste rock was dumped into an adjoining abandoned shaft. All in all, a very dangerous business. Cave-ins were not uncommon, and the remains of a number of Chinese miners are no doubt still buried here.

Unionville, a silver mining camp founded in the early 1860’s, and now known as a “ghost town that refused to die,” is located in a beautiful, narrow valley in the Humboldt Range about 15 miles to the north of here. Road forks; go straight. 0.7 Road curves to right to proceed south. Note alkali playa to left in valley floor and Stillwater Mountains ahead on the skyline. The name of the mountains is from the Stillwater Slough, a large and deep slough about 40 miles south of here named for its sluggish (“still”) water. Road forks; go right. Granite Mountain is high peak at 9:30. 2.0 Turn left on two-track road. 1.0 Road forks; go right. Stop where road begins steep ascent. STOP 1. Fossil Hill to right. Fossil Hill is one of the first known and most extensively studied Triassic ammonite localities in Nevada (Figs. 1.5-1.6). The first descriptions of Triassic fossils from this area were published by Gabb (1864) and Meek (1877). Middle Triassic ammonites from here and other localities in the Humboldt Range figured in Hyatt and Smith’s (1905) classic monograph on the Triassic cephalopod genera of North America. The name “Fossil Hill” subsequently appeared in J.C. Merriam’s (1908) monograph on Triassic ichthyosaurs, many of which came from nearby “Saurian Hill.” Ammonites from Fossil Hill became the basis of James
Perrin Smith's (1914) monographic treatment of the Middle Triassic ammonites (and other marine invertebrates) from North America; this monograph listed 110 species of ammonites from Fossil Hill. Subsequent commercial fossil collecting at Fossil Hill brought ammonites to the British Museum that figured in the now classic monographs of Spath (1934, 1951).
The 1905 expedition to Saurian and Fossil hills, on which both Smith and Merriam were participants, was organized and financed by Miss Annie Alexander, heiress to the C & H Sugar fortune and an avid amateur naturalist. Her field notes from this expedition were published by Zullo (1969), and a full account of this remarkable lady is given by Stein (2001).

Smith (1914) was aware that the section at Fossil Hill crossed the Anisian-Ladinian boundary, but most of his collections from Fossil Hill were attributed to his all-inclusive "*Daonella dubia* zone." Reevaluation of the fauna based on closely spaced, bed-rock collections (Silberling, 1962; Silberling and Nichols 1982) resulted in the recognition of 12 successive, faunally distinct "beds" distributed through three upper Anisian zones: the Rotelliformis, Meeki, and Occidentalis zones.

Bucher (1989, 1992; Monnet and Bucher, 2005a, b) established the current biostratigraphic framework (Figs. 1.6-1.7). The oldest assemblage here is the *Gymonotoceras mimetus* Zone of Monnet and Bucher (2005a). The base of the late Anisian, which is defined by the *G. weitschati* Zone in the Augusta Mountains, has not been documented in the southern Humboldt Range. Documentation of new and more detailed biostratigraphy across the Anisian-Ladinian boundary at Fossil Hill is now in preparation. The section has been sampled for magnetostratigraphy but is remagnetized. There is no published $\delta^{13}C$ record.

Currently, the Anisian of the Prida and Favret formations in Nevada can be resolved into 31 biochronologic units based on ammonoids, the most highly resolved Triassic succession in the entire world (Fig. 1.7). U-Pb age calibration of the Anisian (Ovtcharova et al., 2006) indicates, by correlation with south China, a $246.9 \pm 0.4$ Ma age for the early middle Anisian Hyatti Zone and a $244.6 \pm 0.5$ Ma age for the late middle Anisian Shoshonensis Zone. These ages fit well within interpolations for the isotopic ages of the
upper and lower limits of the Anisian of, respectively, ~240 Ma and ~247 Ma (Mundil et al., 1996; Lehrmann et al., 2006; Galfetti et al., in press). Thus, the gross average duration of each biochronologic unit is ~0.23 my, without taking the intervals of separation (gaps) into account.

Ammonoids show a protracted recovery during the early Anisian, having a peak in diversity during the *Unionvillites hadleyi* Subzone (late Hyatti Zone). Large fluctuations (up to 50%) in ammonoid diversity took place during the late middle and late Anisian, without a first-order trend and with comparatively lower turnover. The Hadleyi peak resulted from limited exchanges between the low and high paleolatitude faunas (typical high-latitude genera such as *Amphipopoanoceras, Arctohungarites* and *Tetsaoceras* occur in the Hadleyi subzone, but are represented by a few individuals only).

**After the stop, retrace route back to the north-south road at the valley edge.**

1.4 Road intersection; **go straight.**

1.4 Turn right on main road. **2.0**

2.2 Road intersection; **turn right** to proceed southward. **2.2**

2.4 Road forks; **continue straight.** Note that Middle and Upper Norian as well as Lower Jurassic ammonoids occur in the low hills of the Pershing district at the extreme southern end of the Humboldt Range. **13.3**

Intersection with paved road; **turn left.** Ahead, to the south, before the turn are the Buena Vista Hills, from which a large tonnage of magmatic iron ore was shipped during the 1940’s and 50’s from a gabbroic complex of Jurassic age. Road now heads across the Antelope Valley to McKinney Pass. The Antelope Valley, of course, takes its name from the pronghorn antelope, denizens of the valley floors in this part of Nevada. **2.1**

Pavement ends. **19.0**

Crest of McKinney Pass, which divides the East Range to the north from the Stillwater Range to the south. The Augusta Mountains (Cain Mountain is the high peak) are ahead and expose a full section of the calcareous Star Peak Group. Favret Canyon is the v-shaped valley north of Cain Mountain. Pleasant Valley is in the foreground. Slope wash of limestone here at McKinney Pass is of late Early Norian age, and from a relatively thin limestone unit within the thick section of dominantly fine-grained clastic rocks of the Auld Lang Syne Group, which overlies the Star Peak Group.

The name East Range is shortened from “East
FIGURE 1.7. Correlation of Anisian ammonoid zonations of Nevada, British Columbia and the Sverdrup basin (from Monnet and Bucher, 2005b).
Humboldt Range,” used on some old maps but now reserved for a mountain range in eastern Nevada. The Augusta Mountains were named by one of the geologists of the Fortieth Parallel Survey, Arnold Hague. Cain Mountain commemorates Hiram Cain, an early settler in the 1800s. Favret Canyon was named for Joe Favret, the Basque caretaker during the late 1930’s at the “Jenkins” ranch about 12 miles northwest of Cain Mountain.

McKinney Pass is in the southwestern part of the old “Sonoma Range” quadrangle, covering one degree of latitude and longitude. The geologic framework of this huge area was established by Henry G. “Fergie” Ferguson (1882-1966), S.W. Muller (see above), and Ralph J. Roberts (1911-present!) immediately before and after World War II. Ferguson and Roberts were geologists with the U.S. Geological Survey (USGS) and were mainly responsible for the Paleozoic rocks, Cenozoic volcanics, structure, and ore deposits of the quadrangle. Muller, whose research was supported by the USGS, concentrated on the Triassic rocks and the structures involving them. Their findings, published in the early 1950’s as four 1:125,000 scale geologic maps of the Sonoma Range quadrangle, are of enduring utility despite having been accomplished before the interpretation of sedimentary environments or the analysis of structural strain were well understood, and before isotope dating techniques and plate tectonics theory were established. Furthermore, Triassic ammonite zonation then still mainly followed that of Mojsisovics, and Triassic conodonts had not yet been discovered (for better or worse). All the more remarkable is that starting in the late 1920’s, Ferguson and Muller, at first working independently and then as a team, also established the basic geology of the old “Hawthorne” and “Tonopah” one-degree quadrangles (Muller and Ferguson, 1939; Ferguson and Muller, 1949) farther south in northwestern Nevada, where we will be visiting on Field Trip Day 3.

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Road forks; go right. Road to left leads to Winnemucca. The Tobin Range is ahead, and the Pleasant Valley is in the foreground. A conspicuous normal-fault scarp having as much as 5 m of displacement along the western edge of the Tobin Range resulted from the Pleasant Valley earthquake of October 2, 1915. 2.7

Road enters from left; curve hard right into Pleasant Valley. 4.2

Road forks; take the left fork (go straight). 2.0

Crest of small burm; note Cain Mountain and Favret Canyon ahead. 0.6

Road intersection; go left under power lines. 2.1

Crest of hill. STOP 2 (optional). Here, we can examine Favret Formation (Fossil Hill Member) ammonoid-bearing strata in low hills to left. After stop, drive to south to McCoy Springs. 1.8

Just before homestead and spring turn left at the fork in the road. Dixie Valley to south. Numerous hot springs are present in Dixie Valley and the southern end of Jersey Valley. The 60 megawatt Dixie Valley Geothermal power plant, located about 20 miles to the southwest along the Stillwater Range, is the state’s largest geothermal plant. 0.5

Hard left; note Cain Mountain (Fig. 1.8). Dixie Valley Formation red beds are below Favret Formation. 2.0

Road intersects cross roads; turn right. 0.4

Turn left on two-track road. 1.8

End of road.

STOP 3. Favret Canyon (Figs. 1.9-1.10). During this stop we will take a rather steep hike up the north side of the canyon to the more gently sloped plateau at the top and once there, we’ll begin our traverse on top of the massive Lower member of the Favret Formation and gradually walk up through much of the Middle Anisian portion of the Fossil Hill member (Hyatti Zone and type area of the Taylori Zone). The Shoshonensis Zone is also represented on this side of the canyon, but not nearly as well as on the south side. Looking across to the steep south side of the canyon, you will have an excellent view of the entire Fossil Hill member which ranges up to the Occidentalis Zone, as well as the overlying Augusta Mountain Fm. Also obvious will be a major fault that runs along the range
In the Favret Canyon area, the lower part of the Hyatti Zone is condensed and although fossils of the *Intornites mctaggarti* subzone are locally abundant, they are strongly re-crystallized (Bucher, 1992). Interestingly, ammonoids are usually outnumbered by coiled nautiloids in these beds. The intermediate *Constrictus* and *Americanus* subzones, with type areas in the Prida Formation of the northern Humboldt Range, have not as yet been reported from the Favret Formation (Bucher, 1992). Ammonoid faunas belonging to the uppermost *Unionvillites hadleyi* subzone consistently occur in calcareous, nodular sandstone a few meters above the base of the Fossil Hill member. These beds are laterally transported sandy sediments with obvious sorting of ammonoids (Bucher, 1992).

Four intervals of closely spaced limestone beds provide excellent lithostratigraphic markers within the middle Anisian part of the Fossil Hill member throughout the Augusta Range and the southern Tobin Range as well. The base of the lowest marker coincides with the base of the Taylori Zone (Nicholsi subzone) and its top with the Spivaki subzone of the same zone. Ammonoid faunas of the Escheri subzone are found in the next “main cliff”. Ascending, the first “upper small cliff” coincides with the base of the Shoshonensis Zone, whose type area is in the McCoy Mine area, one of tomorrow’s stops. Its middle part yields the Riebei subzone fauna and the Ransomei subzone fauna is found at its top. The top of the second “upper small cliff” yields the Wallacei subzone fauna. Ammonoids of the overlying Fergusoni subzone, whose type area is also in the McCoy Mine area, have only recently been reported from the Augusta Range,
in the Oliver Gulch area, about 1.5 km south of Favret Canyon. Faunas of the topmost Mojsvari subzone, whose type area is also south of Favret Canyon, occurs a couple of meters below two closely spaced thin bedded sand sheets, which in turn, are ~ 10 m above the top of the “upper small cliff”. This isolated pair of turbidites locally contains accumulations of fragmentary reptile bones (e.g. thalattosaurids). The oldest late Anisian fauna of the Gymnotoceras weitschati Zone, together with the oldest representative of Daonella occurs 6 to 10 meters above the pair of thin sandstone layers. The remaining 100-120 m of the upper part of the Fossil Hill Member contains the same late Anisian succession as that of the type locality of Fossil Hill.

The type areas for the Gymnotoceras weitschati and mimetus Zones are also located in the small canyons and gulches to the south of Favret Canyon, where the faunas are better developed and the outcrops for these particular intervals of the stratigraphic column are usually better. Ammonoids representative of only the Cordeyi subzone of the Weitschati zone have been found in Favret Canyon.

For the most part, ammonoid preservation is better in some respects in this area than at Fossil Hill, where the beds have been subjected to considerable “heating” from nearby intrusive rocks. This generally holds true for the other sites (south end of the Tobin Range, McCoy Mine area) on the eastern side of the Fossil Hill basin as well. The examination of suture lines on specimens from Fossil Hill can be difficult, whereas it is relatively
FIGURE 1.10. Distribution of Anisian ammonoid taxa in the Oliver Gulch section (from Monnet and Bucher, 2005a).
easy for ammonoids from this area

After stop, retrace route back down the valley to the main north-south road. 1.7

86.8 Intersection with main north-south road; **turn right. 0.5**

87.3 Road to left: **go straight** to continue north up the Jersey Valley. The Jersey Valley took its name from the now defunct town of Jersey City (1876-1877). 6.6

93.9 Intersection with main road. **Go right (straight).** Fish Creek Mountains to right (east), Tobin Range to left (west). The Fish Creek Mountains take their name from Fish Creek, a stream on the east side of the range. The Tobin Range was named for the family of that name, who lived in Winnemucca.

The “Desert Hot Tub” located near some hot springs along our route, is something of an engineering marvel that includes an elaborate system of PVC pipes and “tennis ball valves” for filling and draining. It was built from local rock and cement several years ago by an enterprising soul and his wife who camped at the site in their motor home for a couple of weeks. Apparently, they had nothing better to do. 10.6

104.5 Cattleguard; conical hill to left is Squaw Tit. 0.7

105.2 At Jersey Summit, road forks; **bear right.** Enter Buffalo Valley. 1.5

106.7 Lander County line (leave Pershing County); Mount Tobin at 9:00. Created in 1862, Lander County honors Frederick W. Lander, chief engineer for the Central Overland Route (a wagon route). In particular, Lander negotiated a truce with the Paiute Indians, for which he was honored. Lander died a Brigadier General in 1862 from wounds received at a battle in Virginia during the American Civil War.

Pershing County, established in 1919, was named after General John Joseph Pershing of World War I fame. 3.1

109.8 Road enters from right; **continue straight. 3.3**

113.1 Road to Buffalo Valley Ranch enters from left; **continue straight.** The high Tobin Range to the left is underlain by highly deformed upper Paleozoic deep-water sedimentary rocks (e.g., radiolarian cherts) forming the upper plate of the Golconda thrust fault, which is generally held to be late Permian(?) or earliest Triassic in age. Unfortunately, an obvious direct overlap of this fault by Triassic strata, such as those of the Koipato Group, is nowhere exposed, so its age is inferred from various structural arguments. To the right of the road, Cenozoic volcanic rocks cover most of the Fish Creek Mountains. 5.9

Pass under power lines. China Mountain, capped by nearly horizontal Triassic rocks of the Star Peak Group, at 9:30 on skyline. Battle Mountain straight ahead on skyline. Battle Mountain exposes rocks of the Golconda allochthon emplaced by the Golconda thrust on lower-plate upper Paleozoic sedimentary rocks, which in turn rest unconformably on Paleozoic strata of the still older Roberts Mountains thrust allochthon. 4.2

Cattleguard; Copper Canyon Mine at 10:30 at base of Battle Mountain. 2.9

Road intersection at tailings pond; **go straight.** Reese River Valley to right; Shoshone Range on eastern skyline. The Reese River was named for John Reese, a guide and settler of the mid-1800s. The Shoshone Range takes its name from the Shoshone Indians. 4.4

Intersection with paved State Highway 305. Turn left and drive up Reese River Valley. Shoshone Range to right, Battle Mountain to left. Battle Mountain takes its name from a skirmish with Shoshone Indians in 1857. 11.3

Cross I-80 overpass and enter Battle Mountain. Wagon trains bound for California traversed this valley in the 1840’s and 50’s. Battle Mountain was born in 1869 when the Central Pacific Railroad pushed through here on its way to the historic meeting with the Union Pacific RR at Promontory Point, Utah. A post office was established in 1870. Today, this little town is affectionately known as the “armpit of America.”

**End of first-day road log.**