Text and references accompanying Nevada Bureau of Mines and Geology Map 182

# Geologic Map of the Minden Quadrangle, Douglas County, Nevada and Alpine County, California

*by*

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## INTRODUCTION

The Minden quadrangle covers about 40 km$^2$ of the east side of the southern Carson Range and about 100 km$^2$ of the west-central part of Carson Valley in Douglas County, Nevada and Alpine County, California, about 30 km south of Carson City. The Carson Range is a 75-km-long, north-trending spur of the Sierra Nevada. Due to its high elevation and alpine climate, the Carson Range commonly is described as being part of the Sierra Nevada, although basin and range faulting actually extends to the Lake Tahoe basin on the west side of the range. Bedrock geology of the Minden quadrangle was mapped by D.A. John in 1978–1980 as part of the Freel Peak 15-minute quadrangle (Armin and John, 1983), with more detailed mapping by L.J. Garside and D.A. John in 1993–94 and 2002–03. Quaternary geology was mapped by A.R. Ramelli and J.C. Yount over a period of several years, with most work done 2000–03. The area immediately to the north was mapped by Pease (1980) and Stewart (1999).

## GEOLOGY

The Minden quadrangle includes Cretaceous plutonic rocks and metamorphic pendant rocks of the Carson Range, a small outcrop of Tertiary andesite in the southeast corner of the quadrangle, deposits of the East and West Forks of the Carson River, alluvial fan deposits flanking the Carson Range, and distal alluvial fan deposits of the Pine Nut Mountains. The Mesozoic metavolcanic rocks, which are the southernmost extent of pendant rocks that cover about 30 km$^2$ of the Carson Range, were intruded by Cretaceous plutonic rocks that were part of the Sierra Nevada batholith prior to late Tertiary basin and range faulting. The Tertiary volcanic rocks are undated, but are presumably associated with regionally extensive Miocene volcanic rocks. The East and West Forks of the Carson River join on the quadrangle and form a broad, flat floodplain that covers most of the eastern part of the quadrangle. The Carson Range piedmont consists of small alluvial fans that are progressively buried by river deposits as they are downfaulted by the prominent range-front fault (Genoa fault).

## UNIT DESCRIPTIONS

### Alluvial deposits of the Carson River

#### DEPOSITS OF THE EAST FORK OF THE CARSON RIVER

**Qrea – Deposits of recently active meander-belts (modern to late Holocene) –** Light gray to light brown sandy gravel and coarse sand with thin interbeds of clay. Soils typically limited to a thin mollic (A) horizon. Generally no more than a few meters thick.

**$Qre_1$ – Young East Fork meander-belt deposits**

> **$Qre_{1a}$ – (late Holocene) –** Light gray to light brown sand and clay. Soils typically consist of a 10–20 cm mollic (A) horizon. Generally no more than a few meters thick.
>
> **$Qre_{1b}$ – (late Holocene) –** Light gray to light brown sandy gravel, sand and clay. Soils typically have a 20–30 cm mollic (A) horizon and a 10–20 cm weak cambic (Bw) or oxidized horizon. A few to several meters thick.

**$Qre_{1c}$ – (late to middle Holocene) –** Light gray to light brown sandy gravel and clay. Soils typically have a 5–10 cm clayey A horizon, a 20–30 cm cambic (Bw) horizon, and locally has a strongly silica-cemented (Bqm) hard pan that may be an older, buried soil horizon. Generally a few meters thick.

**$Qre_2$ – Intermediate age East Fork meander-belt deposits (early Holocene to latest Pleistocene) –** Light gray to light brown sandy gravels with thin interbeds of clay. Moderately developed soils typically have a 30–50 cm mollic (A) horizon and distinctly reddened cambic (Bw) horizon. Distribution limited to eastern part of river system. Generally no more than a few meters thick.

**Qreo – Older East Fork Carson River deposits (Pleistocene to Pliocene) –** Shown only in cross section. From well logs, inferred to be similar to younger, overlying river deposits.

### DEPOSITS OF THE WEST FORK OF THE CARSON RIVER

**$Qrw_1$ – Young West Fork meander-belt deposits**

**$Qrw_{1a}$ – (late Holocene) –** Light gray to light brown sandy gravel with interbeds of clay. Soils typically consist of a 10–20 cm thick mollic (A) horizon. Generally no more than a few meters thick.

**$Qrw_{1b}$ – (late Holocene) –** Light gray to light brown sandy gravel with interbeds of clay. Soils typically have a 20–30 cm mollic (A) horizon and a 10–20 cm weak cambic (Bw) horizon. Generally no more than a few meters thick.

**$Qrw_{1c}$ – (late to middle Holocene) –** Light gray to light brown coarse sand and sandy gravel with interbeds of clay. Soils typically have a 20–30 cm mollic (A) horizon and a 10–20 cm cambic (Bw) horizon. Generally no more than a few meters thick.

**$Qrw_2$ – Intermediate age West Fork meander-belt deposits (early Holocene to latest Pleistocene) –** Light gray to light brown sandy gravels with interbeds of clay and cobble to boulder gravels. Soils typically have a 30–50 cm mollic (A) horizon and distinctly reddened cambic (Bw) horizon. Generally a few to several meters thick.

**Qrwo – Older West Fork Carson River deposits (Pleistocene to Pliocene) –** Shown only in cross section. From well logs, inferred to be similar to younger, overlying river deposits.

### UNDIVIDED DEPOSITS OF THE CARSON RIVER

**Qri – Intermediate-age deposits of the Carson River (late to middle Pleistocene) –** Light to dark brown cobble gravel and gravelly sand; well-developed soils typically have 20–30 cm thick sandy A horizon, and a 50–80 cm thick argillic horizon (Bt). Forms prominent terrace south of Gardnerville that is 15–20 m higher than valley floor; along southern edge of terrace, covered by and interfingers with alluvial fan deposits derived from adjacent volcanic outcrops. Several meters to tens of meters thick.

### FLOODPLAIN DEPOSITS OF THE CARSON RIVER

**$Qf_1$ – Young floodplain deposits**

**$Qf_{1a}$ – (late Holocene) –** Very light gray to dark gray clay and sand. Soils typically limited to a 10–20 cm mollic (A) horizon. Based on location relative to meander belts, inferred to be correlative with $Qre_{1a}$ and $Qrw_{1a}$. Typically less than 1 meter thick.

**$Qf_{1b}$ – (late Holocene) –** Very light gray to dark gray clay and sand. Soils typically limited to a 10–30 cm mollic (A) horizon. Based on location relative to meander belts, inferred to be correlative with $Qre_{1b}$ and $Qrw_{1b}$. Typically less than 1 m thick.

**$Qf_2$ – Intermediate age floodplain deposits (late Pleistocene) –** Light gray to brown clay and coarse sand; moderately developed soils typically have 5–10 cm thick mollic horizon (A), 20–40 cm thick Bt horizon, and 1 m or more thick weakly silica-cemented horizon (Bq). Form surface remnant on which most of Minden developed area is located; a few meters higher than adjacent younger surfaces. Relatively fine-grained floodplain deposits are generally less than a meter thick and overlie on older river deposits.

## Alluvial fan deposits

**Qa – Deposits of recently active washes (modern to late Holocene) –** Light brown sand and gravel; dominantly reworked decomposed granite (grus). Minimal to no soil development. Generally no more than a few meters thick.

**Qay – Young alluvial fan deposits (Holocene to Latest Pleistocene)**

**$Qay_1$ – (late to middle Holocene) –** Light brown sand and gravel; dominantly reworked decomposed granite (grus). Soils typically have a 10–20 cm thick mollic (A) horizon and cambic (bw) horizon. A few to several meters thick.

**$Qay_2$ – (early Holocene to late Pleistocene) –** Light brown sand and gravel; dominantly reworked decomposed granite (grus). Soils typically have a 20–30 cm thick mollic (A) horizon and moderately to strongly reddened cambic (Bw) horizon. A few to several meters thick.

**Qai – Intermediate age alluvial fan deposits (late Pleistocene) –** Light gray to light brown sand and gravel with abundant boulders; dominantly reworked decomposed granite (grus). Soils typically have a 30–50 cm thick mollic (A) horizon and 20–40 cm thick Bt horizon. A few to tens of meters thick.

**Qapi – Intermediate age distal fan deposits of the Pine Nut Mountains (late Pleistocene) –** Light to dark brown sand and clay. Soils typically have a 10–20 cm clayey A horizon, 20–40 cm Bt horizon, and 1 m or more weakly silica-cemented (Bq) horizon. Interfingers with and includes older deposits of the East Fork of the Carson River, but boundary indistinct due to cultivation. Forms smooth, gently sloped surfaces. A few to several meters thick.

**Qao – Older alluvial fan deposits (late to middle Pleistocene) –** Light brown to light gray sand and gravel with abundant boulders, although surface boulders are commonly completely weathered. Soils are typically stripped, and thus similar to Qai. Generally several to tens of meters thick.

**Qo – Older alluvial fan deposits (Pleistocene to Pliocene) –** Shown only in cross section. Similar to younger, overlying alluvial fan deposits.

## Other alluvial deposits

**Qb – Basin fill (Holocene) –** Dark brown to dark gray clay, fine sand, and peat. Soils typically consist of a 20–40 cm thick mollic (A) horizon. Generally less than 1 m thick.

**Qs – Spring deposits (Holocene to late Pleistocene) –** Dark brown to dark gray clay and fine sand; commonly peats. Soils typically consist of mollic (A) horizons of variable thickness. Thickness variable, but generally no more than a few meters.

## TERTIARY UNITS

Descriptions of plutonic rocks are modified slightly from Armin and John (1983), rock age data are from Evernden and Kistler (1970), Armin and John (1983), and Robinson and Kistler (1986). Mineral modes and rock chemical data are from Armin and John (1983).

**Ta – Hornblende andesite flows (Tertiary) –** Light greenish gray, massive, coarsely jointed, locally flow banded andesite flows. The rock consists of phenocrysts (~10%) of glassy plagioclase (7%, 2–5 mm), oxidized hornblende (3%, 1–7 mm long), and rare biotite in a fine grained groundmass. Occurs only near southeast corner of map.

## MESOZOIC UNITS

**Ka – Aplite (Upper Cretaceous) –** White and very light gray aplite. Black tourmaline is a sparse constituent.

**Kbm – Bryan Meadow Granodiorite (Upper Cretaceous) –** Light gray medium-grained hypidiomorphic-granular granodiorite typically containing about 5% subhedral and euhedral hornblende crystals as long as 1 cm and similar amounts of pseudohexagonal books of biotite in a groundmass of feldspar and quartz. Subhedral plagioclase crystals are commonly rimmed with myrmekite, and poikilitic phenocrysts of weakly microperthitic microcline occur locally. Euhedral sphene crystals as long as 2 mm are ubiquitous. Discoid mafic enclaves are locally common. Relatively small areas of leucocratic rock are common, particularly near margins of the pluton. Age probably ~90 Ma (table 1).

**Kkg – Granodiorite of Kingsbury Grade (Upper Cretaceous) –** Medium-grained hornblende-biotite granodiorite characteristically containing 5–10% coarse (7–10 mm) anhedral biotite flakes. The hypidiomorphic-granular granodiorite contains plagioclase laths, perthitic microcline occurring as poikilitic patches as much as 15 mm in diameter and as small interstitial grains, quartz, and 2–5 mm-long hornblende laths. This pluton is strongly foliated along its northern contact, where a fine-grained chilled margin indicates that it intruded Kdp.

**Kdp – Granodiorite of Daggett Pass (Cretaceous) –** Medium- to coarse-grained, well foliated hornblende-biotite granodiorite that grades into a mafic quartz monzodiorite near the west quadrangle boundary about 1 km east of Daggett Pass (in the adjacent South Lake Tahoe quadrangle). The mafic outer(?) margin of this pluton consists of 50–60% plagioclase, 7–10% interstitial microcline perthite, 8–20% quartz, 10–15% biotite flakes (as long as 1 cm), and 8–15% hornblende prisms, which commonly have relict clinopyroxene cores. Myrmekite commonly is present as late rims of plagioclase crystals and as small interstitial patches. A strong protoclastic foliation is present in the monzodiorite. The more leucocratic inner(?) granodioritic phase of this pluton consists of 40–50% plagioclase, 15–20% interstitial potassium feldspar, 12–24% quartz, 8–15% biotite flakes, and 5–10% hornblende prisms. Hornblende crystals define

a strong protoclastic foliation. The unit is intruded both by Kkg and Kbm. Age probably ~92 Ma (table 1).

**Kfp, Kfpp Freel Peak Granodiorite (Upper Cretaceous) –** Light-gray medium-grained biotite granodiorite that weathers yellowish gray. Abundant ovoid aggregates of quartz, small potassium feldspar phenocrysts, and ragged biotite flakes are distinctive. Subhedral microperthitic microcline crystals average 3 mm long; crystals commonly as long as 1.5 cm give the rock a weakly porphyritic texture. Plagioclase crystals are locally antiperthitic. Oblate, spheroidal, and iscoidal mafic enclaves are abundant; they commonly define local foliation, but no regional foliation pattern is apparent. Friable, deeply weathered outcrops have shed thick grus over much of the area underlain by this pluton. Named for Freel Peak, located a few kilometers southwest of the quadrangle (Armin and John, 1983). A conspicuously porphyritic granodiorite body, regarded as a porphyritic variant (**Kfpp**), makes up most of the unit in the Minden quadrangle. This medium- to coarse-grained unit is light pinkish orange to pale gray, and weathers pale orangish gray to ivory. Weakly microperthitic, subhedral to euhedral microcline phenocrysts, as long as 3 cm, form as much as 10% of the rock. Intrudes Kjc, and is intruded by Kbm (Armin and John, 1983). A whole-rock Rb/Sr isochron age of 93.5 Ma agrees well with a 93.2 Ma K/-Ar age on hornblende and suggests that a somewhat younger biotite K/-Ar age (table 1) may be too young, possibly due to Ar loss.

**Kjc – Quartz diorite of Jobs Canyon (Cretaceous) –** Fine- to medium-grained, equigranular, locally strongly foliated, hornblende-biotite quartz diorite cropping out in the southwest corner of the quadrangle, and named for outcrops just to the south in Jobs Canyon. Consists of 60–70% plagioclase, 3–5% perthitic potassium feldspar, 5–10% quartz, 15–20% biotite, and 5–10% hornblende. The quartz diorite of Jobs Canyon is intruded by Kbm.

**Kqdp – Quartz monzodiorite north of Daggett Pass (Cretaceous?) –** Dark-blue-gray, medium-grained, equigranular, locally strongly foliated hornblende-biotite quartz diorite; exposed north of Daggett Pass (South Lake Tahoe quadrangle) in the northwestern part of the quadrangle. Consists of 45–60% oscillatory zoned plagioclase (An45–An35), 2–5% potassium feldspar, 5–10% interstitial quartz, and 30–40% anhedral biotite and hornblende in about equal amounts. Equivalent to the mafic granodiorite unit of Bonham and Burnett (1976) to the west in the adjoining South Lake Tahoe quadrangle.

**Kqd – Quartz diorite and diorite (Cretaceous?) –** Small body of medium-gray, very fine grained to locally coarse-grained rock consisting dominantly of subhedral plagioclase, hornblende, subordinate subhedral biotite, and interstitial quartz. Comb structure occurs in the relatively rare coarse-grained diorite.

**Mzmv – Metavolcanic rocks (Mesozoic) –** Mostly metamorphosed dacite and andesite flows(?), with smaller volumes of pyroclastic and volcaniclastic rocks. Predominantly dark greenish-gray rocks that commonly are moderately to strongly foliated. Rocks range from dark spotted hornfels to lighter gray flaser semi-schists. Relict phenocrysts of albitized plagioclase and altered mafic minerals locally are present. Rare, thin units of lighter-colored rock represent probable rhyolitic pyroclastic rocks and stretched-pebble volcanic conglomerate (elongation of 2:1 to 3:1). Relict bedding in dark intermediate-composition volcaniclastic rocks commonly is subparallel to foliation. The penetrative foliation locally develops into a slaty cleavage; poorly expressed lineation rakes 90º. Metavolcanic rocks north of Kingsbury Grade are part of a larger pendant covering about 30 square km that extends northward to Genoa Peak and near Spooner Summit (Pease, 1980; Grose, 1985). This pendant was briefly described by Moore (1969) who assigned it a Triassic and Jurassic age. More recent work suggests that these volcanic units may correlate with other Middle Jurassic(?) metavolcanic units of western Nevada (Stewart, 1997; Garside, 1998). Most rocks of the unit are metamorphosed to the greenschist facies, and locally to amphibolite-facies assemblages near contacts with the granodiorite of Daggett Pass (Kdp). Common metamorphic assemblages include: (1) plagioclase + epidote + actinolite + chlorite + quartz, (2) plagioclase + chlorite + quartz + biotite + sericite ± epidote, (3) plagioclase + quartz + biotite ± sericite, (4) plagioclase + epidote + chlorite + quartz + muscovite, and (5) plagioclase + hornblende (blue green) + quartz + biotite (all assemblages + opaque minerals and sphene).

## STRUCTURE

The steep eastern front of the Carson Range is bounded by a major normal fault system. The southern part of the frontal fault system (Genoa fault) is one of the most active faults in the Basin and Range province. The main part of the Genoa fault, extending approximately from Jobs Canyon near the south edge of the quadrangle north to Jacks Valley, about 10 km north of the quadrangle, has ruptured with multiple large displacements (≥5 m/event) during the late Holocene (Ramelli et al., 1999). Based on exploratory trenches, two of which were located within the quadrangle, Ramelli et al. (1999) interpreted that the most recent earthquake occurred between 500 and 600 years ago, with an event prior to that at about 2,000 years ago. However, subsequent work, including trenching at Fay Canyon just south of the quadrangle (Rood et al., 2011), indicates slightly younger ages for these events (about 300, and 1,700 years, respectively).

Near the south edge of the Minden quadrangle, the Genoa fault steps left almost 2 km. This step is located at the intersection with the Jobs Canyon fault, a continuation of the Waterhouse Peak fault that bounds the west side of

Hope Valley to the southwest of the quadrangle. The step in the range front indicates a major discontinuity in the Genoa fault. However, the presence of bedrock at shallow depths below the Jobs Creek alluvial fan indicates that much of the vertical throw occurs along one or more piedmont faults that likely provide a more direct link between the central and southern sections of the fault.

## Possible influence of faulting on the Carson River

The Carson River is one of the three largest river systems in the region (along with the Truckee and Walker Rivers). The two main forks of the Carson River (East and West Forks) join on the Minden quadrangle. Both forks drain formerly glaciated areas within the Sierra Nevada. The East Fork is the larger of the two and drains the east side of the Sierra Nevada as far south as Sonora Peak, located 60 km south of the quadrangle. Relatively high flow along the East Fork is indicated by larger meander scrolls and more widespread deposition. The West Fork drains Hope Valley, and being closer to its source area, generally has coarser deposits. Boulder-dominated deposits along the West Fork just south of the quadrangle are interpreted as glacial outwash.

Upon entering Carson Valley, the East Fork of the Carson River makes an abrupt westward bend and flows along the western part of the valley before flowing back to the east and exiting the valley to the northeast. This anomalous pattern has long led to speculation that the river is responding to recent faulting along the Genoa fault that downdropped the western side of the valley. The distribution of meander belts along the East Fork support this interpretation. Older meander belts ($Qre_{1c}$ and $Qre_2$) are limited to the eastern side of the river system, as would be expected. In contrast, the next youngest meander belt ($Qre_{1b}$) bends sharply to the west, spreads laterally, and overwhelms the West Fork deposits. West Fork deposits, ($Qrw_{1b}$) inferred to correlate with $Qre_{1b}$, similarly spread laterally to the west and abut the alluvial fans flanking the Carson Range. The youngest meander belt ($Qre_{1a}$) separates the older belts, suggesting an as yet incomplete shift back to the east. Peakall (1998) attempted to date meander belts just north of the Minden quadrangle to test this theory. Most of the ages that he obtained are similar to the interpreted timing of faulting along the Genoa fault (Ramelli et al., 1999), but the dating resolution was insufficient to demonstrate a rapid shift to the west and subsequent, more gradual return to the east.

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**Table 1. K/Ar and Rb/Sr ages for the Minden quadrangle and vicinity**

| Unit | Symbol | Sample no. | N. Lat. | W. Long. | Age (Ma)[1] | ±1s | Mineral | Method | Reference |
|---|---|---|---|---|---|---|---|---|---|
| Bryan Meadow Granodiorite | Kbm | KA1518 | 38°47'07" | 119°52'50" | 89.3 | 2.0 | biotite | K-Ar | Evernden and Kistler, 1970 |
| Bryan Meadow Granodiorite | Kbm | KA1518-R | 38°47'07" | 119°52'50" | 89.6 | 2 | biotite | K-Ar | Evernden and Kistler, 1970 |
| Bryan Meadow Granodiorite | Kbm | FP-78-104 | 38°54'16" | 119°57'57" | 84.1 | 0.5 | biotite | K-Ar | Robinson and Kistler, 1986 |
| Bryan Meadow Granodiorite | Kbm | FP-78-104 | 38°54'16" | 119°57'57" | 78.1 | 0.6 | hornblende | K-Ar | Robinson and Kistler, 1986 |
| Bryan Meadow Granodiorite | Kbm | FP-78-106 | 38°48'19" | 119°58'20" | 87.5 | 0.5 | biotite | K-Ar | Robinson and Kistler, 1986 |
| Bryan Meadow Granodiorite | Kbm | FP-78-106 | 38°48'19" | 119°58'20" | 82.6 | 0.6 | hornblende | K-Ar | Robinson and Kistler, 1986 |
| Bryan Meadow Granodiorite | Kbm | FP-78-106 | 38°48'19" | 119°58'20" | 83.9 | 0.6 | hornblende | K-Ar | Robinson and Kistler, 1986 |
| Bryan Meadow Granodiorite | Kbm | FP-78-108 | 38°46'33" | 119°54'00" | 89.6 | 2 | biotite | K-Ar | Robinson and Kistler, 1986 |
| Granodiorite of Daggett Pass | Kdp | KA1516-HBD | 38°58'37" | 119°53'15" | 92.1 | 2 | hornblende | K-Ar | Evernden and Kistler, 1970 |
| Granodiorite of Daggett Pass | Kdp | KA1516 | 38°58'37" | 119°53'15" | 88.3 | 2 | biotite | K-Ar | Evernden and Kistler, 1970 |
| Granodiorite of Daggett Pass | Kdp | KA1517 | 38°57'52" | 119°51'00" | 85.6 | 2 | biotite | K-Ar | Evernden and Kistler, 1970 |
| Freel Peak Granodiorite | Kfp | FP-78-105 | 38°49'56" | 119°54'56" | 93.2 | 3 | hornblende | K-Ar | Armin and John, 1983 |
| Freel Peak Granodiorite | Kfp | FP-78-105 | 38°49'56" | 119°54'56" | 82.9 | 1.5 | biotite | K-Ar | Armin and John, 1983 |
| Freel Peak Granodiorite | Kfp | FP-78-105 | 38°49'56" | 119°54'56" | 85.4 | 0.5 | biotite | K-Ar | Robinson and Kistler, 1986 |
| Freel Peak Granodiorite | Kfp | FP-78-105 | 38°49'56" | 119°54'56" | 84.4 | 0.6 | hornblende | K-Ar | Robinson and Kistler, 1986 |
| Freel Peak Granodiorite | Kfp | | | | 93.5 | 2.8 | whole rock | Rb-Sr | A.C. Robinson, written commun., 1994 |

1. K-Ar ages of Evernden and Kistler (1970) converted to the constants of Steiger and Jager (1977)

**Table 2. Mineral modes (volume percent) for plutonic rocks of the Minden quadrangle**

| Unit | Symbol | no. | Plagioclase | Pl %An | K feldspar | Quartz | Biotite | Hornblende | Opaques | Sphene | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bryan Meadow Granodiorite | Kbm | 28 | 32–61 (46.1) | 38–24 | 5–27 (18.5) | 6–38 (22.1) | 2–15 (6.6) | 0–14 (4.8) | 0.3–2.2 (1.0) | 0.1–1.6 (0.8) | ap, z |
| Granodiorite of Kingsbury Grade | Kkg | 17 | 40–52 (45.6) | 45–22 | 11–30 (19.0) | 15–36 (20.2) | 3–14 (8.7) | 2–13 (6.0) | 0.4–1.1 (0.8) | 0.1–0.8 (0.4) | al, ap, tour, z |
| Granodiorite of Daggett Pass | Kdp | 18 | 37–60 (47.4) | 45–20 | 7–20 (13.8) | 8–21 (16.2) | 8–15 (11.6) | 7–15 (8.9) | 0.7–1.6 (1.0) | tr–1.0 (0.4) | ap, cpx, tour, z |
| Freel Peak Granodiorite, equigranular | Kfp | 14 | 41–57 (49.4) | 32–22 | 11–25 (15.7) | 19–32 (23.4) | 4–11 (7.7) | 0–4 (1.8) | 0.2–1.9 (1.1) | 0–0.7 (0.3) | al, ap. Z |
| Freel Peak Granodiorite, porphyritic | Kfp | 8 | 32–50 (42.6) | 33–12 | 19–39 (28.8) | 17–26 (22.6) | 4–7 (5.7) | 0 (0) | 0.4–1.3 (0.9) | tr–0.8 (0.3) | al, ap, z |
| Quartz monzodiorite north of Daggett Pass | Kqdp | 4 | 44–53 (49.1) | 52–33 | 3–20 (11.2) | 6–12 (8.8) | 8–20 (14.3) | 7–18 (12.7) | 0.4–2.9 (1.3) | 0–0.3 (0.1`) | ap, cpx, z |

From Armin and John (1983). Numbers give the range and (mean) values for all samples. Pl %An, typical anorthite content of plagioclase. Abbreviations: tr, trace; al, allanite; ap, apatite; cpx, clinopyroxene; tour, tourmaline; z, zircon

**Table 3. Chemical data for granitic units of the Minden quadrangle. From Armin and John (1983). Values are not normalized to 100%.**

| Unit | Kbm | Kbm | Kbm | Kfp | Kqdp |
|---|---|---|---|---|---|
| Sample Number | FP-78-104 | FP-78-106 | FP-78-108 | FP-78-105 | 79WM33 |
| $SiO_2$ | 65.4 | 64.7 | 68.5 | 68.3 | 61.2 |
| $Al_2O_3$ | 14.8 | 15.1 | 14.2 | 14.2 | 16.0 |
| $Fe_2O_3$ | 2.3 | 2.5 | 1.8 | 2.0 | 1.9 |
| FeO | 2.0 | 2.2 | 1.6 | 1.8 | 4.6 |
| MgO | 1.7 | 1.8 | 1.2 | 1.0 | 4.1 |
| CaO | 4.1 | 4.4 | 3.1 | 2.6 | 6.1 |
| $Na_2O$ | 3.9 | 3.8 | 3.7 | 4.4 | 3.2 |
| $K_2O$ | 2.9 | 3.0 | 3.4 | 3.2 | 2.5 |
| $H_2O^+$ | 0.56 | 0.43 | 0.36 | 0.41 | 0.77 |
| $H_2O^-$ | 0.23 | 0.16 | 0.15 | 0.25 | 0.05 |
| $TiO_2$ | 0.63 | 0.61 | 0.44 | 0.40 | 0.76 |
| $P_2O_5$ | 0.16 | 0.18 | 0.15 | 0.13 | 0.16 |
| MnO | 0.11 | 0.12 | 0.09 | 0.13 | 0.09 |
| $CO_2$ | 0.04 | 0.05 | 0.03 | 0.03 | 0.03 |
| F | 0.04 | 0.04 | 0.04 | 0.05 | |
| Total | 99.87 | 99.09 | 98.76 | 98.90 | 101.46 |