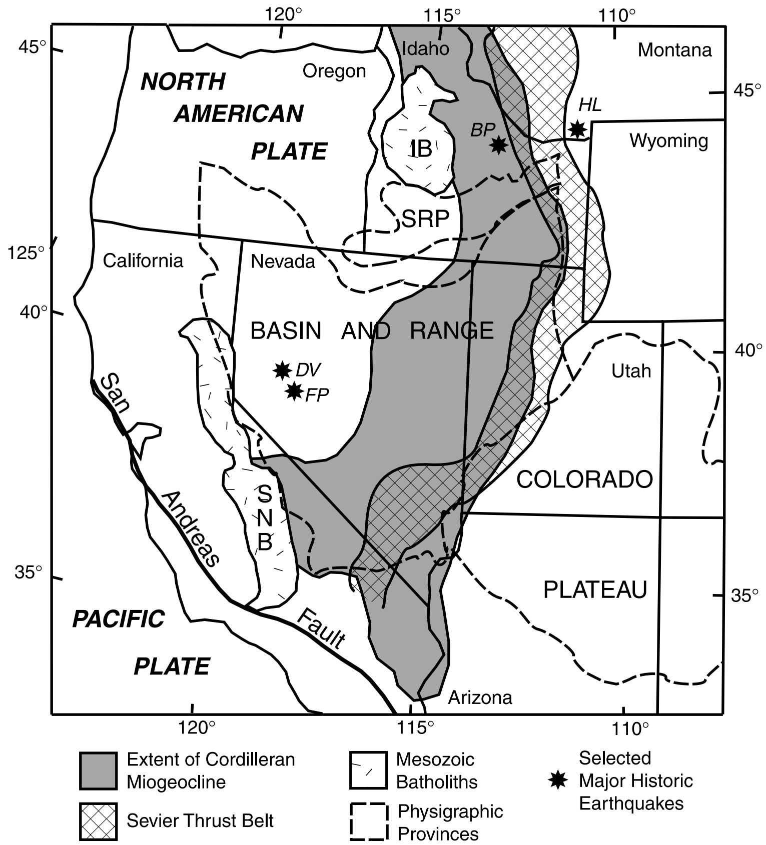

Figure 2.1. Map of the western United States showing major tectonic, geologic, and physiographic features discussed in the text. IB, Idaho Batholith; SNB, Sierra Nevada Batholith. Major earthquakes discussed in the text: BP, Borah Peak; DV, Dixie Valley; FP, Fairview Peak; HL, Hebgen Lake.

more than 1000 km wide, which includes the Basin and Range province (Fig. 2.2; e.g., Bennett et al., 1999).

Within the Basin and Range, faults with Quaternary ($<$ 1.6 Ma) slip rates of order 0.1–1.0 mm/yr are developed over a broad region, but historical seismicity is clustered on only a few of them. For example, the northern Basin and Range region contains several hundred fault segments with significant late Quaternary ($<$ 130 ka) slip, yet contemporary seismicity and large ($M \geq 6.5$) historical earthquakes are concentrated in two north-trending belts along or near the margins of the province, including the Eastern California seismic belt and Central Nevada seismic belt on the west, and the Intermountain seismic belt on the east (Fig. 2.2; Wallace, 1984; Smith and Sbar,

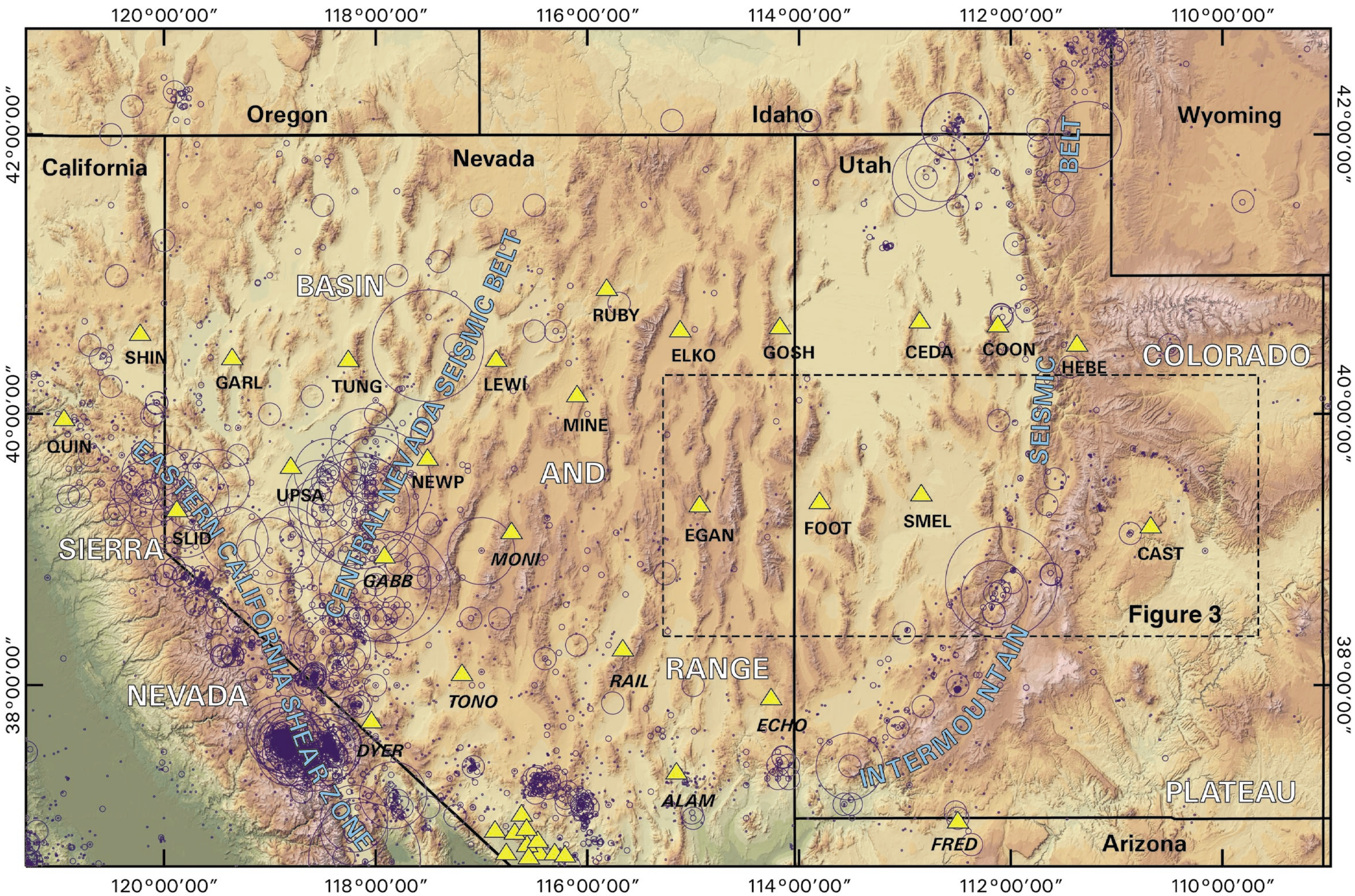

Figure 2.2. Shaded digital elevation model of the western United States showing the major seismic belts, and earthquakes greater than magnitude 3.0 in blue circles. Yellow triangles are GPS sites of the BARGEN network; sites labeled in bold text are part of the initial BARGEN network, and have been operational since 1997; sites labeled in italicized text are part of the expanded BARGEN network, and have been operational since 1999. Site density near Yucca Mountain and the Nevada Test Site (~116°W at the bottom edge of the figure) precluded site labels. Location of Figure 2.3 is shown with a dashed box.

distance of the province (Figs. 2.3 and 2.4; Allmendinger et al., 1983, 1987). We use maximum vertical fault slip rates and subsurface fault geometries to map the average late Quaternary horizontal velocity field of the seismogenic crust, and then compare the geologic velocity field with the geodetic velocity field, to evaluate whether strain accumulation is localized within the Intermountain seismic belt (Dixon et al., 1995, 2000; Martinez et al., 1998; Thatcher et al., 1999), or distributed more evenly so as to include the broad region of late Quaternary faults to the west (Bennett et al., 1999).

The transect includes the very low-angle Sevier Desert detachment, expressed as a band of prominent multi-cyclic reflections, dipping $\sim$10–12° W underneath the Sevier Desert from the surface to a depth of 12–15 km (Allmendinger et al., 1983; Planke and Smith, 1991). Some geologists have suggested the reflection band is an unconformity in its shallow reaches and a Mesozoic thrust fault at depth (Anders and Christie-Blick, 1995), casting doubt on whether the structure has ever had normal slip. Therefore, our analysis also bears on the question of whether significant strain in extensional regions can be accommodated along low-angle (0–30°) normal faults.

2.2 Tectonic Setting

The baseline CAST–SMEL lies astride the Intermountain seismic belt (Figs. 2.2 and 2.3), which coincides with three other major elements of the Cordilleran orogen, collectively known as the Wasatch line or Wasatch zone. These elements have defined the eastern margin of the orogen throughout most of its history, and include the hinge zone of west- thickening shallow marine sediments of Proterozoic and Paleozoic age (Cordilleran miogeocline), the east limit of east-directed decollement thrust faulting and folding of Mesozoic age (Sevier thrust belt), and the eastern limit of Cenozoic crustal extension in the Basin and Range province (Fig. 2.1). West of the Wasatch zone, sites SMEL, FOOT , EGAN and MINE lie within the miogeocline, which has been variably shortened by thrust faulting in the Late Paleozoic and Mesozoic, and extended by normal faulting in the Late Mesozoic and Cenozoic. These events have

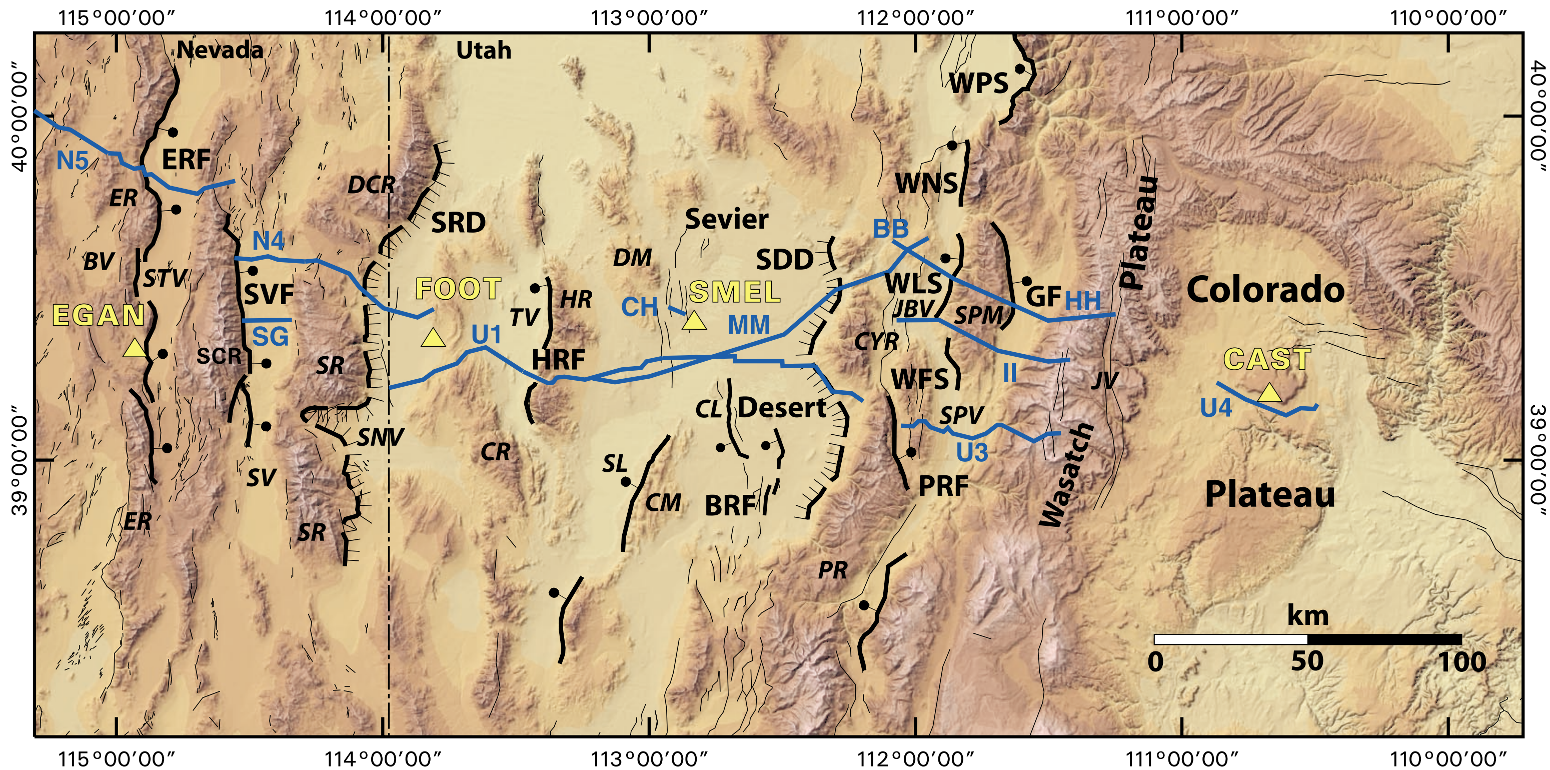

Figure 2.3. Shaded relief map of the area of study showing GPS sites (yellow triangles), seismic reflection profiles (green lines), and surface traces of high-angle (bold line with ball-and-bar symbol on hanging wall) and low-angle (hachures on hanging wall) normal faults. Abbreviations: Faults: BRF, Black Rock fault zone; ERF, Egan Range fault; GF, Gunnison fault; HRF, House Range fault; PRF, Pavant Range fault; SDD, Sevier Desert detachment; SRD, Snake Range detachment; SVF, Spring Valley fault; WFS, Wasatch fault, Fayetteville segment; WLS, Wasatch fault, Levan segment; WNS, Wasatch fault, Nephi segment; WPS, Wasatch fault, Provo segment. Lakes: CL, Clear Lake; SL, Sevier Lake. Mountain Ranges: CM, Cricket Mountains, CR, Confusion Range; CYR, Canyon Range; DCR, Deer Creek Range; DM, Drum Mountains; ER, Egan Range; HR, House Range; PR, Pavant Range; SCR, Schell Creek Range; SPM, San Pitch Mountains; SR, Snake Range. Valleys: BV, Butte Valley; JBV, Juab Valley; JV, Joes Valley; SNV, Snake Valley; SPV, San Pete Valley; STV, Steptoe Valley; SV, Spring Valley; TV, Tule Valley. Reflection profiles: CH, Drum Mountains scarps (Crone and Harding 1984); N4 and N5, COCORP Nevada lines 4 and 5 (Hauser et al., 1987); SG, Spring Valley (Gans et al., 1985), MM, BB, HH, II, seismic lines MM′ , BB′ , HH′ , and II′ of Smith and Bruhn (1984); U1, U3, and U4, COCORP Utah lines 1, 3, and 4 (Allmendinger et al., 1987).

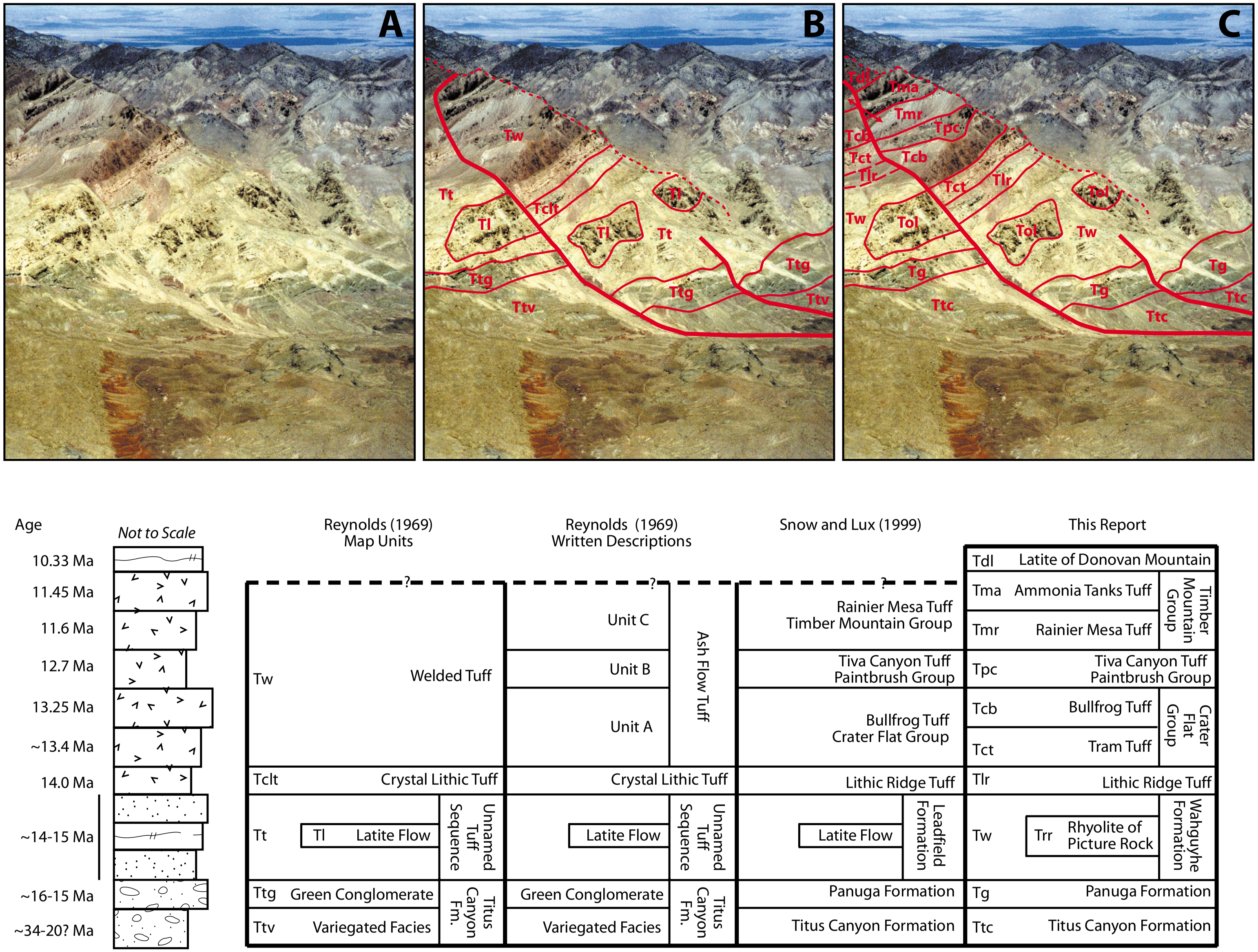

Figure 5.5. Photographs and chart showing changes in Tertiary stratigraphy of the Grapevine Mountains suggested by this report. A) Photograph looking north into Titus Canyon, which shows a fairly complete Oligocene through middle Miocene stratigraphic sequence. B) Overlain on the photograph is the Tertiary stratigraphy mapped by Reynolds (1969). C) Overlain on the photograph is the Tertiary stratigraphy recognized in this report. The chart underneath the photographs shows evolution of changes to Oligocene and Miocene stratigraphy in the Grapevine Mountains.

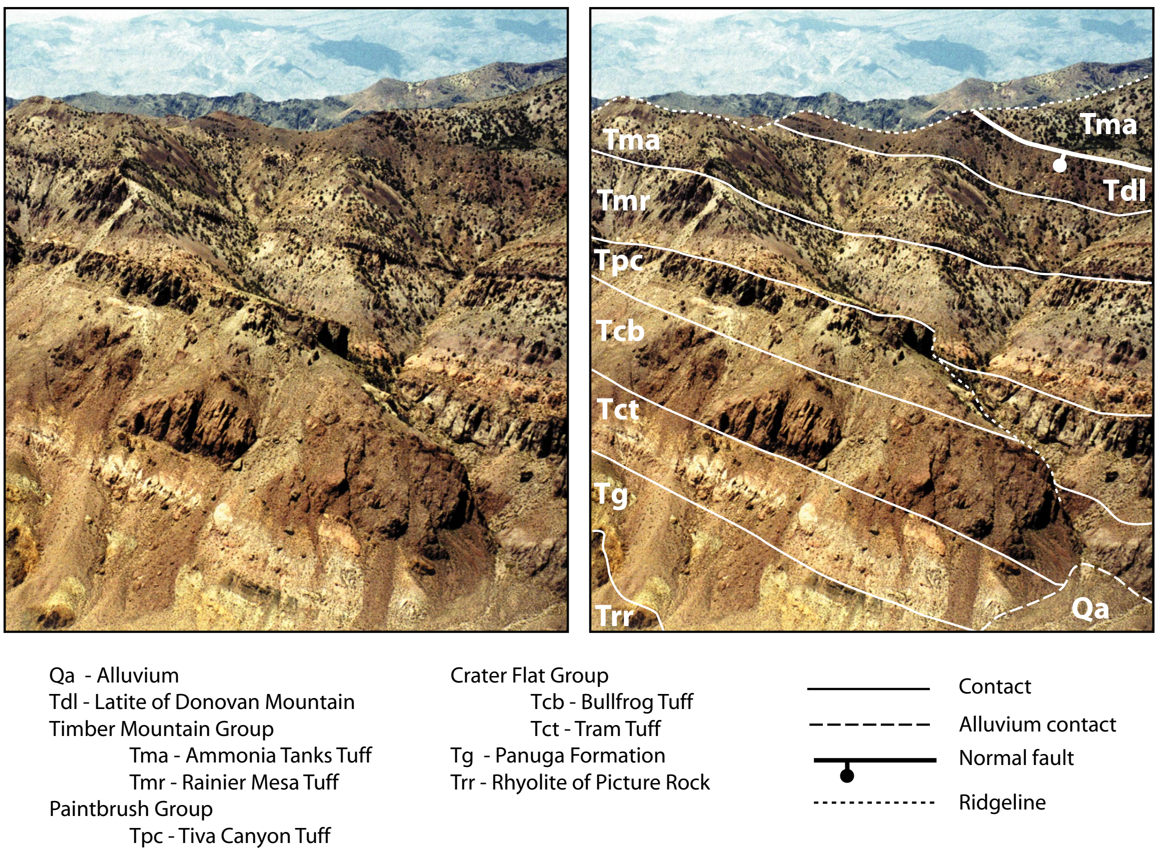

Figure 5.6. A) Photograph of ash flow tuffs of the southwest Nevada volcanic field exposed on the western wall of Titus Canyon. B) Contacts between ash flow tuff units recognized in this study, overlain on the same photograph. Short dashed lines are ridge lines. Strata beyond upper ridge line are Paleozoic miogeoline.

Figure 5.8. Photograph looking north along the western range front of the Grapevine Mountains, ~1 mile north of Fall Canyon. Yellow and orange colored beds on the left side of the photo are deposits of the Red Wall Basin sequence. Person in left center of photo for scale.

the upper sequence (for zircon (U-Th)/He). Results of (U-Th)/He zircon analyses yield ages of 3.09 ± 0.19 Ma (Table 5.1), while geochronologic results from the basalts are still in progress. Field evidence suggests a tentative correlation of the tuff within the upper sequence with the ~3.2 Ma Tuff of Mesquite Spring (Snow, 1990; Snow and Lux, 1999), a correlation strengthened by the (U-Th)/He geochronology. If this correlation is correct, then the Red Wall Basin deposits are early- to mid-Pliocene in age, and would be correlative with the Nova Formation found on the western side of Death Valley (Snow and Lux, 1999).

5.4.4 Quaternary

Quaternary Gravels

Outcrops of poorly to moderately consolidated conglomerates located within the Grapevine Mountains are mapped as Quaternary gravels. These gravels weather grayish-brown to reddish-brown, and contain clasts of locally derived Paleozoic car-

Table 5.1. (U-Th)/He Geochronology of Zircons from Eastern Death Valley

Sample[a]	F_t	U (ppm)	Th (ppm)	^{4}He (ncc/mg)	Raw Age (Ma)	Corrected Age[b] (Ma)
NAN-MST-RWBa	0.74	561.73	312.74	187.66	2.43±0.03	3.26±0.04
NAN-MST-RWBc	0.79	331.18	211.37	112.68	2.43±0.03	3.06±0.03
NAN-MST-RWBd	0.82	239.01	193.14	80.49	2.23±0.03	2.84±0.03
NAN-MST-RWBe	0.72	396.20	221.60	125.60	2.30±0.03	3.19±0.04
						3.09±0.19

[a] Sample locality at 36°53′01″ N, 117°13′28″ W (~3 km NNW of the mouth of Red Wall Canyon, Grapevine Peak 7.5′ quadrangle). Ages determined on single zircon crystals. Single crystals were hand-picked from a zircon separate created from crushate using standard density and magnetic techniques.

[b] Ages corrected for alpha-ejection after Farley (in prep.)