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## FISSION TRACK AGES FROM VOLCANIC ROCKS IN SOUTHWESTERN UTAH AND SOUTHEASTERN NEVADA

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Fission track ages on Oligocene and Miocene rocks in the Indian Peak volcanic field (Best and others, in press) and other parts of Great Basin (Best and others, 1989) are reported (fig. 1). Minerals were extracted from the samples by conventional magnetic and heavy liquid techniques and then dated using the external detector method along with either: (a) a neutron flux determined by comparing the fission track density in glass SRM-962 with the track density in two other samples of the same glass irradiated in the NBS RT-3 and RT-4 sites with a copper foil detector (Carpenter and Reimer, 1974) and a decay constant of  $7.03 \times 10^{-17}/\text{yr}$ , or (b) a zeta calibration factor of  $310 \pm 4$  determined from several irradiations of SRM-962 glass and Fish Canyon zircon. Irradiations were done at either the USGS Triga Reactor in Denver, or at the Oregon State University Triga Reactor. Errors given are two standard errors of the mean using the method described by Green (1981).

### SAMPLE DESCRIPTIONS

1. Y227 *DES-1C* Fission Track Rhyolite tuff ( $37^{\circ}38'08''\text{N}$ ,  $113^{\circ}16'16''\text{W}$ ; Desert Mound 7.5' quad., Iron Co., UT). *Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $4.71 \times 10^8$  tracks/cm<sup>2</sup> (1254 tracks), induced track density (track counts) =  $5.48 \times 10^8$  tracks/cm<sup>2</sup> (1459 tracks), mica detector track density (track counts) = 182,121 tracks/cm<sup>2</sup> (3555 tracks), zeta =  $310 \pm 4$ . *Comments:* Devitrified part of Leach Canyon Formation (Williams, 1967) collected in roadcut in Leach Canyon. See also sample 13.

zircon  $24.2 \pm 2.0$  Ma

2. Y226 *BADGER-IA* Fission Track Dacite lava flow ( $38^{\circ}54'00''\text{N}$ ,  $115^{\circ}11'00''\text{W}$ ; Badger Hole Spring 7.5' quad., White Pine Co., NV).

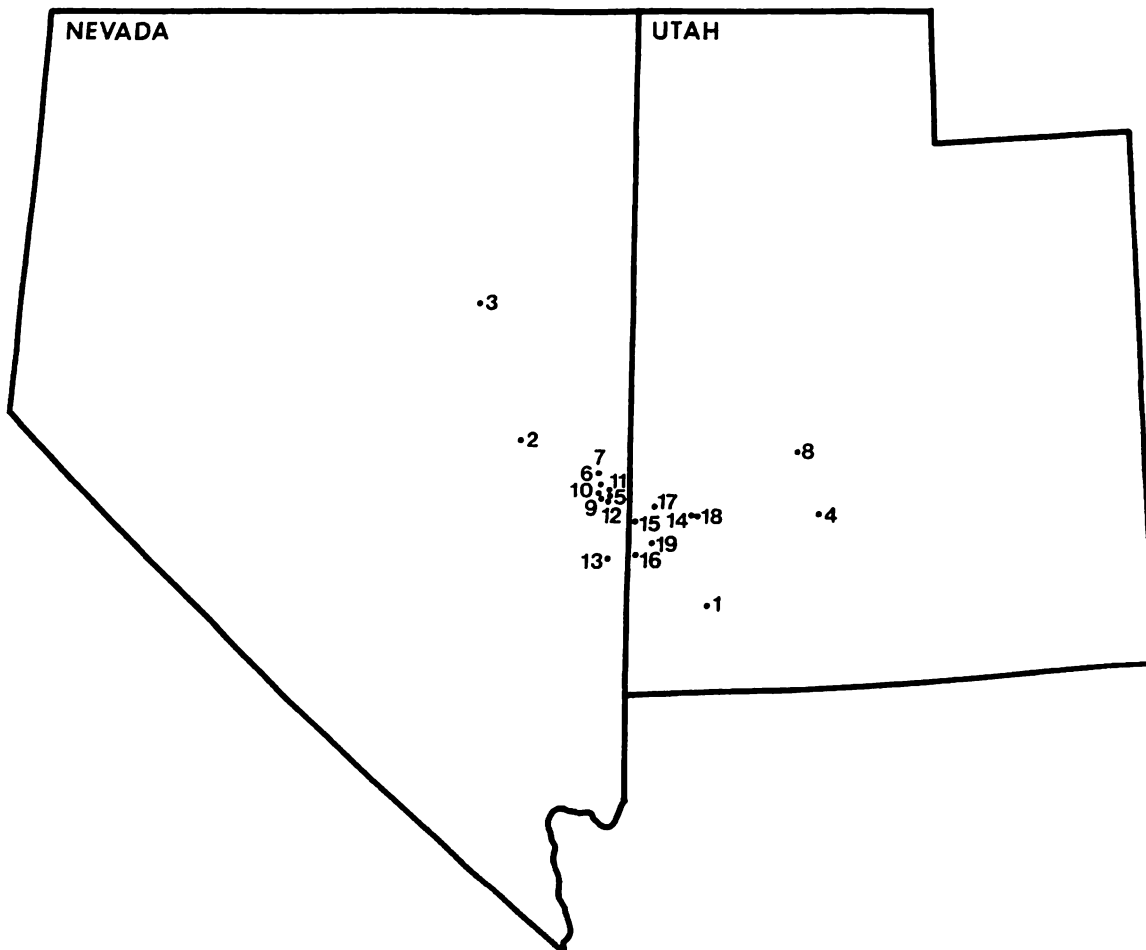


FIGURE 1. Index map of dated samples in Utah and Nevada. Numbers on map correlate to numbers in text.

*Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $5.03 \times 10^6$  tracks/cm<sup>2</sup> (737 tracks), induced track density (track counts) =  $3.75 \times 10^6$  tracks/cm<sup>2</sup> (548 tracks), mica detector track density (track counts) = 182,121 tracks/cm<sup>2</sup> (3555 tracks), zeta =  $310 \pm 4$ . *Comments:* Vitrophyre collected in roadcut along Highway 6 near base of thick lava flow containing phenocrysts of pl-px-hrb; flow underlies Windous Butte Formation.

**zircon 37.9 ± 4.4 Ma**

3. Y266 COLD CR-2

Fission Track Granite (39°56'47"N, 115°33'38"W; Cold Creek Ranch 15' quad., White Pine, NV). *Analytical data:* (zircon - 4 grains) Fossil track density (track counts) =  $10.21 \times 10^6$  tracks/cm<sup>2</sup> (1665 tracks), induced track density (track counts) =  $1.91 \times 10^6$  tracks/cm<sup>2</sup> (298 tracks), mica detector track density (track counts) = 182,121 tracks/cm<sup>2</sup> (3555 tracks), zeta =  $310 \pm 4$ . *Comments:* Coarse-grained. Induced track counts are quite low, giving the sample a large uncertainty. It should have been irradiated for a longer period of time.

**zircon 156 ± 20 Ma**

4. Y264 PIUTE-2

Fission Track Latitic rock (38°20'10"N, 112°14'52"W; Piute Reservoir 7.5' quad., Piute Co., UT). *Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $6.39 \times 10^6$  tracks/cm<sup>2</sup> (1202 tracks), induced track density (track counts) =  $6.03 \times 10^6$  tracks/cm<sup>2</sup> (1134 tracks), mica detector track density (track counts) = 182,121 tracks/cm<sup>2</sup> (3555 tracks), zeta =  $310 \pm 4$ . *Comments:* Altered clast in volcanic debris flow in lower member of Bullion Canyon Volcanics; directly overlies Jurassic Arapien Formation. Age is minimum time of inception of volcanism in this part of Marysvale volcanic field (Cunningham and others, 1983).

**zircon 29.9 ± 2.6 Ma**

5. Y228 ATL-1-70-5

Fission Track Rhyolite lava flow or shallow intrusion (38°27'30"N, 114°20'34"W; Atlanta 7.5' quad., Lincoln Co., NV). *Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $6.85 \times 10^6$  tracks/cm<sup>2</sup> (1350 tracks), induced track density (track counts) =  $5.90 \times 10^6$  tracks/cm<sup>2</sup> (1162 tracks), mica detector track density (track counts) = 182,121 tracks/cm<sup>2</sup> (3555 tracks), zeta =  $310 \pm 4$ . *Comments:* Rock from the Atlanta-Silver Park mining district (Cox, 1981; Best and others, 1989). Designated as Ryan Spring Formation on Willis and others (1987) but this age determination shows it to be much older and part of Escalante Desert Formation. Rock is variably hydrothermally altered and lies along margin of Indian Peak caldera complex.

**zircon 32.7 ± 2.8 Ma**

6. Y225 GOUGE-1-485-7

Fission Track Rhyolite lava flow (38°35'46"N, 114°28'11"W; The Gouge Eye 7.5' quad., Lincoln Co., NV). *Analytical data:* (zircon - 8 grains) Fossil track density (track counts) =  $5.51 \times 10^6$  tracks/cm<sup>2</sup> (1610 tracks), induced track density (track counts) =  $4.83 \times 10^6$  tracks/cm<sup>2</sup> (1411 tracks), mica detector track density (track counts) = 182,121 tracks/cm<sup>2</sup> (3555 tracks), zeta =  $310 \pm 4$ . *Comments:* This sample has two distinct grain populations. The younger group (22.8, 26.9, and 26.8 Ma) give an age of  $25.3 \pm 3.2$

Ma, while the older group (45.2, 33.6, 35.8, 37.3, and 38.3 Ma) give an age of  $37.1 \pm 3.6$  Ma. *Comments:* Member of the formation of The Gouge Eye (Loucks and others, 1989); see also sample 7.

**zircon 32.1 ± 2.6 Ma**

7. Y224 INSDP-3

Fission Track Rhyolite ash-flow tuff (38°38'37"N, 114°29'02"W; Indian Springs Knolls 7.5' quad., Lincoln Co., NV). *Analytical data:* (zircon - 4 grains) Fossil track density (track counts) =  $3.04 \times 10^6$  tracks/cm<sup>2</sup> (1424 tracks), induced track density (track counts) =  $2.78 \times 10^6$  tracks/cm<sup>2</sup> (1299 tracks), mica detector track density (track counts) = 182,121 tracks/cm<sup>2</sup> (3555 tracks), zeta =  $310 \pm 4$ . *Comments:* Basal ash-flow in B member of the formation of The Gouge Eye (Loucks and others, 1989; compare sample 60 in Armstrong, 1970); see also sample 6.

**zircon 30.9 ± 2.6 Ma**

8. Y265 RED-IA

Fission Track Latitic lava flow (38°41'46"N, 112°25'03"W; Red Ridge 7.5' quad., Millard Co., UT). *Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $4.72 \times 10^6$  tracks/cm<sup>2</sup> (1651 tracks), induced track density (track counts) =  $3.96 \times 10^6$  tracks/cm<sup>2</sup> (1385 tracks), mica detector track density (track counts) = 182,121 tracks/cm<sup>2</sup> (3555 tracks), zeta =  $310 \pm 4$ . *Comments:* Near base of volcanic rocks of Dog Valley (Cunningham and others, 1983); age is minimum time of inception of volcanism in northern Marysvale volcanic field.

**zircon 33.6 ± 2.6 Ma**

9. Y209 HOR-1-70-4

Fission Track Low-silica rhyolite lava flow (38°28'27"N, 114°23'40"W; Horse Corral Pass 7.5' quad., Lincoln Co., NV). *Analytical data:* (zircon - 7 grains) Fossil track density (track counts) =  $4.79 \times 10^6$  tracks/cm<sup>2</sup> (1361 tracks), induced track density (track counts) =  $3.41 \times 10^6$  tracks/cm<sup>2</sup> (968 tracks), neutron fluence (track counts) =  $8.49 \times 10^{14}$  neutrons/cm<sup>2</sup> (3139 tracks). *Comments:* Designated as Ryan Spring Formation on Willis and others (1987) but this age determination shows it to be much older and part of Escalante Desert Formation. Rock is variably hydrothermally altered and probably lies just outside margin of Indian Peak caldera complex; see also sample 11.

**zircon 35.6 ± 3.2 Ma**

10. Y208 HOR-1-69-4

Fission Track Dacite ash-flow tuff (38°27'47"N, 114°23'34"W; Horse Corral Pass 7.5' quad., Lincoln Co., NV). *Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $6.70 \times 10^6$  tracks/cm<sup>2</sup> (1802 tracks), induced track density (track counts) =  $5.66 \times 10^6$  tracks/cm<sup>2</sup> (1523 tracks), neutron fluence (track counts) =  $8.49 \times 10^{14}$  neutrons/cm<sup>2</sup> (3139 tracks). *Comments:* Propylitically altered sample from probably the intracaldera member of the Wah Wah Springs Formation; collected at margin of Indian Peak caldera complex (Willis and others, 1987).

**zircon 30.0 ± 2.4 Ma**

11. Y207 ATL-1-70-3

Fission Track Low-silica rhyolite lava flow (38°28'20"N, 114°21'28"W; Atlanta 7.5' quad., Lincoln Co., NV). *Analytical data:* (zircon - 7 grains) Fossil track density (track counts) =  $3.86 \times 10^6$  tracks/cm<sup>2</sup> (1274

tracks), induced track density (track counts) =  $2.81 \times 10^6$  tracks/cm<sup>2</sup> (927 tracks), neutron fluence (track counts) =  $8.49 \times 10^{14}$  neutrons/cm<sup>2</sup> (3139 tracks). *Comments:* Designated as Ryan Spring Formation on Willis and others (1987) but this age determination shows it to be much older and part of Escalante Desert Formation. Rock is variably hydrothermally altered and probably lies just outside margin of Indian Peak caldera complex; see also sample 9.

**zircon 34.8 ± 3.2 Ma**

12. *Y206 ATL-1-68-3* Fission Track  
Dacite lava flow (38°25'07"N, 114°20'56"W; Atlanta 7.5' quad., Lincoln Co., NV). *Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $7.87 \times 10^6$  tracks/cm<sup>2</sup> (1275 tracks), induced track density (track counts) =  $6.77 \times 10^6$  tracks/cm<sup>2</sup> (1097 tracks), neutron fluence (track counts) =  $8.49 \times 10^{14}$  neutrons/cm<sup>2</sup> (3139 tracks). *Comments:* Member of Lund Formation probably extruded along ring fracture of White Rock caldera (Willis and others, 1987; Best and others, in press) that was the source of the ash-flow deposits that make up most of formation.

**zircon 29.5 ± 2.6 Ma**

13. *Y217 CND-1PV* Fission Track  
Rhyolite ash-flow tuff (37°51'23"N, 114°19'53"W; Condor Canyon 7.5' quad., Lincoln Co., NV). *Analytical data:* (zircon - 6 grains) Fossil track density (track counts) =  $5.38 \times 10^6$  tracks/cm<sup>2</sup> (1066 tracks), induced track density (track counts) =  $6.32 \times 10^6$  tracks/cm<sup>2</sup> (1251 tracks), neutron fluence (track counts) =  $8.49 \times 10^{14}$  neutrons/cm<sup>2</sup> (3139 tracks). *Comments:* Basal vitrophyre in Leach Canyon Formation (Williams, 1967); see also sample 1 which more accurately represents age of unit.

**zircon 21.6 ± 2.0 Ma**

14. *USGS 4501 & 4505 LAM-9-70-1* Fission Track  
Dacite ash-flow tuff (38°21'32"N, 113°31'40"W; Lamerdorf Peak 7.5' quad., Beaver Co., UT). *Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $4.53 \times 10^6$  tracks/cm<sup>2</sup> (743 tracks), induced track density (track counts) =  $3.98 \times 10^6$  tracks/cm<sup>2</sup> (652 tracks), neutron fluence (track counts) =  $8.72 \times 10^{14}$  neutrons/cm<sup>2</sup> (3314 tracks). *Comments:* Basal vitrophyre of tuff member of Lund Formation (Abbott and others, 1983; Best and others, in press). Biotite separate from this sample yielded a K-Ar age of  $27.9 \pm 1.0$  (2 $\sigma$ ; Best and Grant, 1987).

**zircon 29.8 ± 3.4 Ma**

**sphene 30.6 ± 4.6 Ma**

15. *Y123 WRP-7-70-1A* Fission Track  
Flow-layered dacite vitrophyre (38°14'08"N, 114°02'10"W; White Rock Peak 7.5' quad., Beaver Co., UT). *Analytical data:* (zircon - 6 grains) Fossil track density (track counts) =  $4.04 \times 10^6$  tracks/cm<sup>2</sup> (1247 tracks), induced track density (track counts) =  $3.47 \times 10^6$  tracks/cm<sup>2</sup> (1072 tracks), neutron fluence (track counts) =  $7.94 \times 10^{14}$  neutrons/cm<sup>2</sup> (2937 tracks). *Comments:* Member of Lund Formation probably extruded along ring fracture of White Rock caldera (Best and others, in press; Best, Kowallis, and others, 1989) that was the source of the ash-flow deposits that make up most of formation.

**zircon 27.6 ± 2.5 Ma**

16. *Y137 MOD-1-6-1* Fission Track  
Rhyolite lava flow (37°51'05"N, 113°57'26"W; Modena 7.5' quad., Iron Co., UT). *Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $13.85 \times 10^6$  tracks/cm<sup>2</sup> (914 tracks), induced track density (track counts) =  $11.15 \times 10^6$  tracks/cm<sup>2</sup> (736 tracks), neutron fluence (track counts) =  $2.58 \times 10^{14}$  neutrons/cm<sup>2</sup> (2614 tracks). *Comments:* Member of Steamboat Mountain Formation (Best, 1987); age is younger than most of formation which is chiefly about 12 Ma (Best, Mehnert and others, 1987).

**zircon 9.6 ± 1.0 Ma**

17. *USGS 4503 SWT-1* Fission Track  
Rhyolite ash-flow tuff (38°25'38"N, 113°51'13"W; Sawtooth Peak 7.5' quad., Beaver Co., UT). *Analytical data:* (zircon - 9 grains) Fossil track density (track counts) =  $3.56 \times 10^6$  tracks/cm<sup>2</sup> (857 tracks), induced track density (track counts) =  $2.75 \times 10^6$  tracks/cm<sup>2</sup> (663 tracks), neutron fluence (track counts) =  $8.72 \times 10^{14}$  neutrons/cm<sup>2</sup> (3314 tracks). *Comments:* Basal vitrophyre of the Sawtooth Peak Formation. A biotite separate from this sample yielded a K-Ar age of  $33.5 \pm 1.2$  Ma (Best and Grant, 1987).

**zircon 33.6 ± 3.7 Ma**

18. *USGS 4502 LAM-9-70-3* Fission Track  
Dacite ash-flow tuff (38°21'50"N, 113°30'20"W; Lamerdorf Peak 7.5' quad., Beaver Co., UT). *Analytical data:* (zircon - 7 grains) Fossil track density (track counts) =  $4.27 \times 10^6$  tracks/cm<sup>2</sup> (1234 tracks), induced track density (track counts) =  $4.44 \times 10^6$  tracks/cm<sup>2</sup> (1282 tracks), neutron fluence (track counts) =  $8.72 \times 10^{14}$  neutrons/cm<sup>2</sup> (3314 tracks). *Comments:* Top of Three Creeks Tuff Member of Bullion Canyon Volcanics (Abbott and others, 1983; Best and Grant, 1987).

**zircon 25.1 ± 2.2 Ma**

19. *Y14 STM-8-171-2* Fission Track  
Low-silica rhyolite lava flow (38°05'26"N, 113°47'27"W; Steamboat Mountain 7.5' quad., Iron Co., UT). *Analytical data:* (zircon - 5 grains) Fossil track density (track counts) =  $7.51 \times 10^6$  tracks/cm<sup>2</sup> (1164 tracks), induced track density (track counts) =  $8.05 \times 10^6$  tracks/cm<sup>2</sup> (1247 tracks), neutron fluence (track counts) =  $1.02 \times 10^{15}$  neutrons/cm<sup>2</sup> (3915 tracks). *Comments:* Member of Ryan Spring Formation (Best and Grant, 1987; Best, Grant, and others, 1987). Sample from 194-204 foot interval of core.

**zircon 28.4 ± 2.5 Ma**

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