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Fission-track dating of the Climax and Gold Meadows stocks, Nye County, Nevada

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Abstract:

Fission-track ages indicate an age of 101 m.y. for the Climax stock and a minimum age of 93.6 m.y. for the Gold Meadows stock, both at the Nevada Test Site, Nye County, Nevada. Younger fission-track ages for apatite concentrates suggest that the stocks have been within 4 km of the surface since Late Paleocene time.

Results and Interpretation:

The Climax stock, Nye County, Nevada (Maldonado, 1977), has been sampled in five locations for fission-track dating. Apatite from five of the samples was dated, zircon from two, and sphene from one. A sample of the Gold Meadows stock, Nye County, Nevada, was also dated using apatite and sphene. The purpose of this study was to determine the thermal history of the respective stocks. Because apatite records the rock's most recent cooling regime (Naeser and Forbes, 1976), it is a very useful indicator of tectonic history.

Four of the five samples collected from the Climax stock (Maldonado, 1977) are outcrop samples (fig. 1; table 1, nos. 2-5; appendix). The fifth sample (fig. 1; table 1, no. 1) is a drill core from a depth of 536 m in drill hole U15bGZ. Apatite from the four surface samples gave concordant fission-track ages, with an average age of 101 ± 3.2 m.y. ($\pm$one standard error of the mean). This is in excellent agreement with the stock's sphene and zircon ages, which give an average age of 101 ± 1.2 m.y. However, the apatite from the drill core gave a discordant age, 78.6 ± 3.4 m.y.

The concordance of the fission-track ages of the surface samples means that the rock now exposed at the surface has never been above 100°C in the last 100 m.y.; these concordant ages also indicate the probable time of emplacement of the stock. Assuming that the geothermal gradient for this area was the same during the Late Cretaceous as it presently is, about 25°C/km (Roy and others, 1968), we can state that this stock was intruded at a depth of less than 4 km. The discordant ages of the drill-core apatite points to a somewhat different thermal history for the buried parts of the stock. There are two possible interpretations: First, the stock was emplaced at a depth in the crust so that the 100°C isotherm was between the rock presently at the surface and the rock at a depth of 500 m. This would permit the cooling of the "surface" samples to less than 100°C while the lower samples would remain above 100°C for an extended time. Second, at some time after intrusion, the accumulation of sedimentary or volcanic materials buried the stock to such a depth that partial annealing of the apatite took place. It is not possible to distinguish between these two possibilities using the present data. If it is assumed that sample 1 (core) cooled through the 100°C isotherm 79 m.y. ago, an average uplift rate of 0.05 mm/yr can be calculated. Most of that uplift would have taken place prior to the deposition of the Belted Range Tuff on the Climax stock 13 m.y. ago.

The Gold Meadows stock, Nye County, Nevada (Snyder, 1977) was sampled at one surface site (fig. 2; table 1, no. 6; appendix). The apatite and zircon from this sample have discordant fission-track ages, 55.6$\pm$2.8 m.y. ($\pm\sigma$) and 93.6$\pm$4.3 m.y. ($\pm\sigma$), respectively. These ages suggest a slightly more complex history for this stock than for the Climax stock. Apparently the Gold Meadows stock either was emplaced at a deeper level in the crust or was, at some later time, buried to a deeper level. It has a calculated uplift rate of about 0.07 mm/yr for the last 56 m.y. The zircon from the Gold Meadows stock is apparently younger than the sphene and zircon from the Climax stock. This younger age could be the result of a deeper level of intrusion and/or later burial of the Gold Meadows stock, or of the emplacement of the stock about 7 m.y. after the emplacement of the Climax stock.

Other Ages:

Marvin and others (1970) reported six biotite K-Ar ages from the Climax stock and one from the Gold Meadows stock. The six biotite ages from the Climax stock range from 89 to 97 m.y. Using the IUSG constants for 40K, we recalculated the ages, obtaining 91 to 100 m.y. The oldest age is very close to the average fission-track age for the Climax stock. The 91.8-m.y. K-Ar biotite age for the Gold Meadows stock recalculates to 94.3 m.y., which is in very good agreement with the zircon age of 93.6 m.y.

Analytical Methods:

The apatites were dated by the population method (Naeser, 1976); they were etched in 7% HNO_3 for 25 seconds at room temperature. The zircon and sphene were dated by the external-detector method (Naeser, 1976). The zircon was etched in a KOH-NaOH eutectic melt (Gleadow and others, 1976) and the sphene, in 50M NaOH at 140°C (Naeser, 1976).

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Table 1. Fission track data--Climax and Gold Meadows stocks, Nye County, Nevada

Sample	Mineral	ρ_s x10^6 (t/cm^2)	ρ_i x10^6 (t/cm^2)	Ø x10^{15} (n/cm^2)	T x10^6 yr	±2σ x10^6 yr	U (ppm)
Climax stock							
1 DF-1637	apatite	0.287 (1195)1/	0.243 (1013)1/	1.12	78.6	6.7	6.3
1 DF-1638	sphene	19.79 (733)	43.84 (812)	3.87	104	11	330
1 DF-1639	zircon	10.99 (1628)	7.21 (534)	1.12	101	6.4	190
2 DF-1640	apatite	0.431 (1794)	0.307 (1280)	1.12	93.3	6.8	7.9
3 DF-1641	apatite	0.327 (1362)	0.203 (845)	1.11	106	9	5.3
4 DF-1642	apatite	0.372 (1552)	0.248 (1032)	1.10	98.3	7.9	6.5
5 DF-1645	apatite	0.349 (1454)	0.212 (885)	1.10	107	9	5.6
5 DF-1644	zircon	17.36 (1366)	11.44 (450)	1.11	100	6.4	300
Gold Meadows stock							
6 DF-1646	apatite	0.163 (681)	0.193 (803)	1.10	55.6	5.6	5.0
6 DF-1647	zircon	13.71 (1904)	9.58 (665)	1.10	93.6	8.5	250

$\lambda_F = 7.03\text{x}10^{-17}\text{yr}^{-1}$

1/ Fission-tracks counted.

Appendix: Sample Locality

1. Climax stock Granodiorite: From drill hole U15bGZ at 536 m below collar; 37° 14' 46" N; 116° 03' 27" W; Oak Spring quadrangle, Nye County, Nevada.
2. Climax stock Granodiorite: Surface outcrop; 37° 14' 04" N; 116° 03' 16" W; Oak Spring quadrangle, Nye County, Nevada.
3. Climax stock Granodiorite: Surface outcrop; 37° 14' 23" N; 116° 03' 50" W; Oak Spring quadrangle, Nye County, Nevada.
4. Climax stock Granodiorite: Surface outcrop; 37° 14' 18" N; 116° 3' 54" W; Oak Spring quadrangle, Nye County, Nevada.
5. Climax stock Quartz monzonite: Surface outcrop; 37° 13' 32" N; 116° 03' 40" W; Oak Spring quadrangle, Nye County, Nevada.
6. Gold Meadows stock Quartz monzonite: 37° 13' 52" N; 116° 12' 28" W; Rainier Mesa quadrangle, Nye County, Nevada.

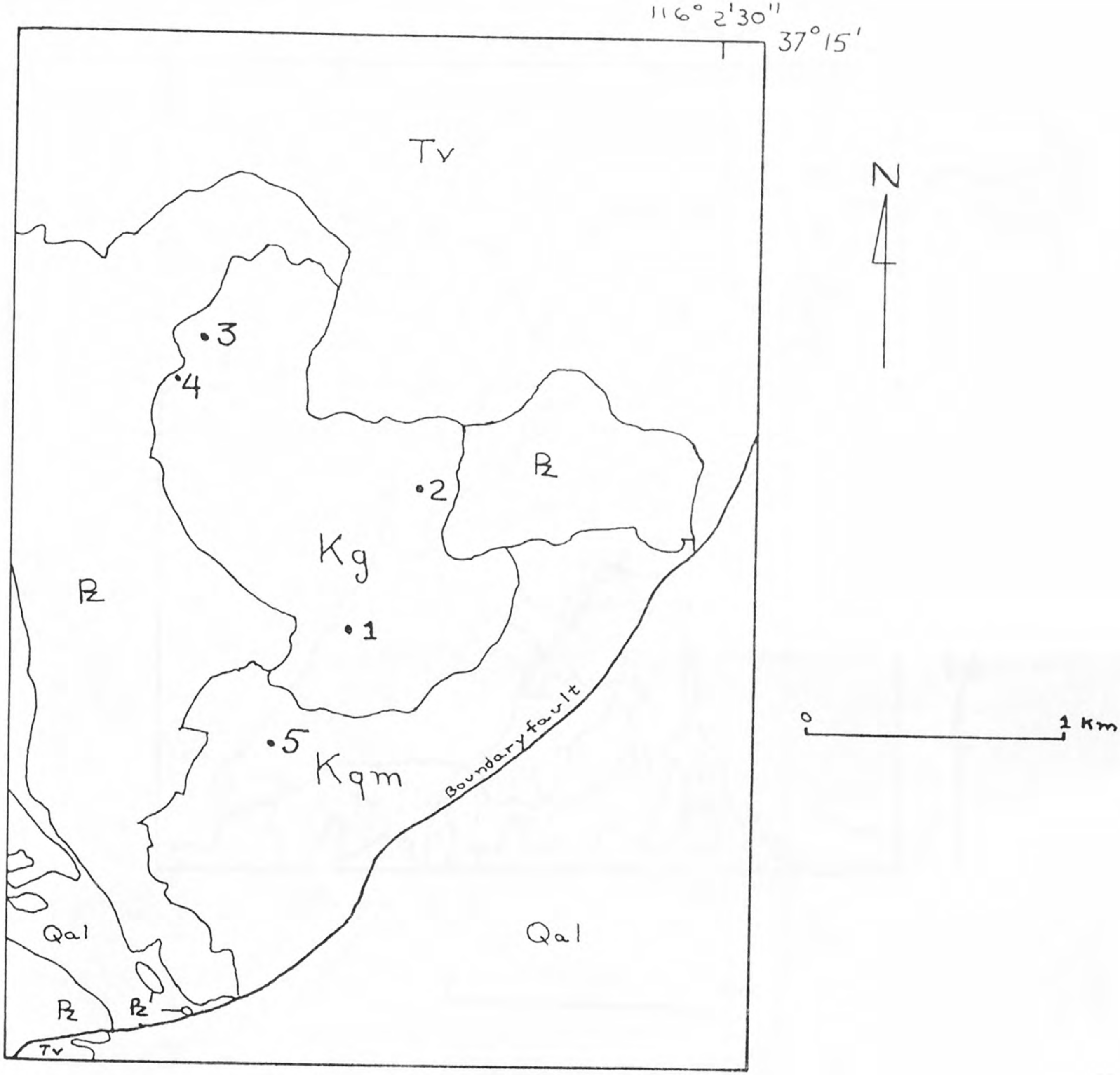

Figure 1.--Generalized geology of the Climax stock, Nye County, Nevada. Modified from Barnes and others, 1963. Qal, Quaternary alluvium; Tv, Tertiary volcanics; Kg, Cretaceous granodiorite; Kqm, Cretaceous quartz monzonite; Pz, Paleozoic and Precambrian sedimentary rocks. Numbers indicate sample localities for nos. 1-5. See Appendix for description of sample localities.

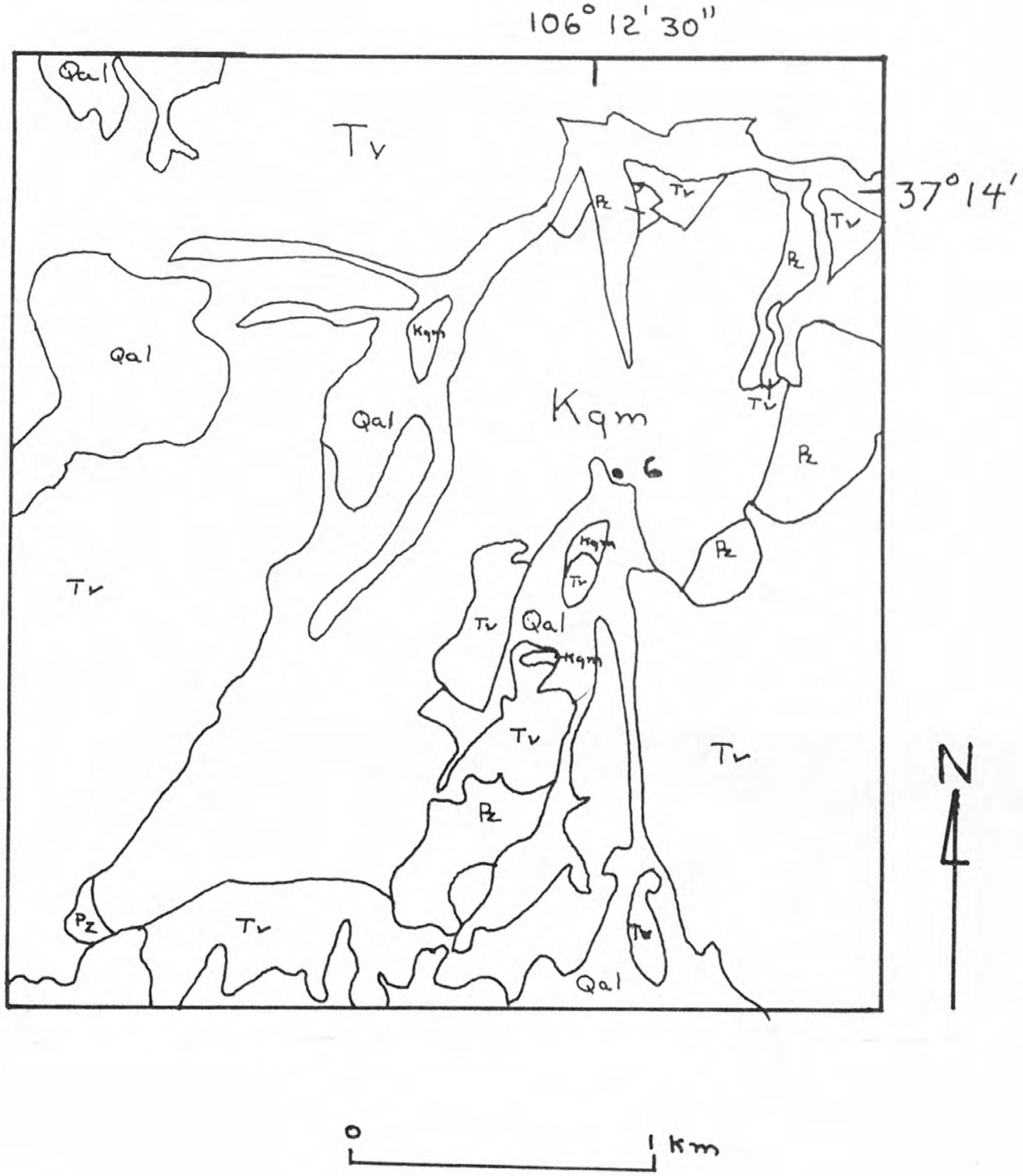

Figure 2.--Generalized geology of the Gold Meadows stock, Nye County, Nevada. Modified from Gibbons and others, 1963. Qal, Quaternary alluvium; Tv, Tertiary volcanics; Kg, Cretaceous granodiorite; Kqm, Cretaceous quartz monzonite; Pz, Paleozoic and Precambrian sedimentary rocks. 6 is sample locality for sample 6. See Appendix for description of sample locality.