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## K-AR AGE OF THE SAN MARCOS GABBRO AND RELATED GABBROIC ROCKS OF THE SOUTHERN CALIFORNIA BATHOLITH

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The San Marcos Gabbro (Miller, 1937) and similar late Mesozoic gabbroic rocks in southern California (Larsen and others, 1951) are thought to be the earliest in the sequence of plutonic rocks that form the Southern California batholith (Miller, 1946; Larsen, 1948; Larsen and others, 1951). These gabbros intrude prebatholithic metamorphic and volcanic rocks and are intruded by the more silicic rocks of the batholith. At numerous localities, the gabbro ("black granite") is quarried for decorative building stone and dimension stone (Hoppin and Norman, 1950).

K-Ar ages on rocks of the Southern California batholith (Morton, 1969; Evernden and Kistler, 1970; Armstrong and Suppee, 1973) range from about 75 to 110 m.y. The present results are consistent with these earlier measurements and indicate that the K-Ar age of the San Marcos Gabbro is about 105 to 110 m.y. Banks and Silver (1966) measured U-Pb zircon ages ranging from 106 to 119 m.y. on seven units from the batholith. They suggested that their Mount Rubidoux Granite, which is one of the latest in the intrusive sequence, is about 120 m.y. old. These data suggest that the K-Ar ages reported here may reflect the time of cooling rather than the time of emplacement.

Argon measurements were made by isotope dilution using techniques and equipment described by Dalrymple and Lanphere (1969). Potassium was measured by flame photometer using lithium metaborate fusion (Ingamells, 1970). Analytical uncertainties are the estimated standard deviation of precision (Cox and Dalrymple, 1967). Constants used in the calculations are  $\lambda_{\epsilon} = 0.585 \times 10^{-10} \text{ yr}^{-1}$ ,  $\lambda_{\beta} = 4.72 \times 10^{-10} \text{ yr}^{-1}$ , and  $K^{40}/K_{\text{total}} = 1.19 \times 10^{-4}$  mole/mole. L. B. Schlocker, W. A. Davis, and B. M. Myers assisted with the laboratory analyses.

### SAMPLE DESCRIPTIONS

1. 73G013 K-Ar (biotite) 105.9±3.2 m.y.  
(hornblende) 102.9±3.1 m.y.

San Marcos Gabbro, medium-grained quartz-biotite-hornblende gabbro (33°13'46"N, 117°11'03"W; small abandoned quarry in the South Fork of Gopher Canyon, San Marcos Mountains; SW¼ sec. 10, T 11 S, R 3 W; San Marcos 7½' quad., San Diego Co., CA). Analytical data: (biotite) K<sub>2</sub>O = 9.22%, 9.27%, \*Ar<sup>40</sup> = 1.487 x 10<sup>-9</sup> moles/gm, \*Ar<sup>40</sup>/ΣAr<sup>40</sup> = 91.9%; (hornblende) K<sub>2</sub>O = 0.716%, 0.725%, \*Ar<sup>40</sup> = 1.125 x 10<sup>-10</sup> moles/gm, \*Ar<sup>40</sup>/ΣAr<sup>40</sup> = 80.9%; collected by: G. B. Dalrymple, C. S. Grommé, and L. T. Silver. Comment: This sample is from the large norite body that forms the main mass of the San Marcos Mountains, from which the name "San Marcos Gabbro" was derived (Miller, 1937). The sample dated by Evernden and Kistler (1970) at 91.1 m.y. (biotite) and 101.1 m.y. (hornblende) is from a small quarry 350 m 342° from this locality.

2. 7L681-H1 K-Ar (hornblende) 111.1±4.4 m.y.

San Marcos Gabbro, medium-grained hornblende gabbro (33°12'01"N, 117°11'29"W; in quarry in the S end of the San Marcos Mountains, 350 m N of SW corner, sec. 22, T 11 S, R 3 W; San Marcos 7½' quad., San Diego Co., CA). Analytical data: K<sub>2</sub>O = 0.233%, 0.235%, \*Ar<sup>40</sup> = 3.96 x 10<sup>-11</sup> mole/gm, \*Ar<sup>40</sup>/ΣAr<sup>40</sup> = 29.6%; collected by: G. B. Dalrymple and C. S. Grommé. Comment: From the same intrusive body as 73G013. See comments for no. 1 (above).

3. 7G012 K-Ar (hornblende) 106.0±2.3 m.y.

San Marcos Gabbro, medium-grained hornblende gabbro (33°06'02"N, 117°07'38"W; in quarry of Raymond Granite Co.; sec. 30, T 12 S, R 2 W; Rancho Santa Fe 7½' quad., San Diego Co., CA). Analytical data: K<sub>2</sub>O = 0.318%, 0.319%, \*Ar<sup>40</sup> = 5.08 x 10<sup>-11</sup> moles/gm, 5.17 x 10<sup>-11</sup> moles/gm, \*Ar<sup>40</sup>/ΣAr<sup>40</sup> = 58.1%, 66.0%; collected by: G. B. Dalrymple, C. S. Grommé, and L. T. Silver. Comment: The sample is from a small gabbro body that is not shown on the map of Larsen (1948), but the rock is petrographically similar to other nearby exposures of the San Marcos Gabbro.

4. 7L661-H1 K-Ar (biotite)  $104.8 \pm 3.1$  m.y.  
 San Marcos Gabbro, medium-grained quartz-biotite norite ( $33^{\circ}03'33''N$ ,  $117^{\circ}04'20''W$ ; in roadcut of old highway on N shore of Lake Hodges about 300 m W of Highway 395, Escondido  $7\frac{1}{2}'$  quad., San Diego Co., CA). Analytical data:  $K_2O = 9.32\%$ ,  $9.37\%$ ,  $*Ar^{40} = 1.487 \times 10^{-9}$  moles/gm,  $*Ar^{40}/\Sigma Ar^{40} = 85.7\%$ ; collected by: G. B. Dalrymple and C. S. Grommé. Comment: The sample was collected from an outcrop not shown on the map of Larsen (1948), but the rock is petrographically similar to other nearby exposures of the San Marcos Gabbro.
5. 7L601-H1 K-Ar (biotite)  $106.2 \pm 3.2$  m.y.  
 (hornblende)  $104.3 \pm 3.1$  m.y.  
 Medium-grained quartz-biotite-hornblende gabbro ( $32^{\circ}49'49''N$ ,  $116^{\circ}57'29''W$ , in abandoned quarry at 500-foot elev., about 1 km ESE of Santee, El Cajon  $7\frac{1}{2}'$  quad., San Diego Co., CA). Analytical data: (biotite)  $K_2O = 9.01\%$ ,  $9.05\%$ ;  $*Ar^{40} = 1.457 \times 10^{-9}$  moles/gm,  $*Ar^{40}/\Sigma Ar^{40} = 83.0\%$ ; (hornblende)  $K_2O = 0.809\%$ ,  $0.816\%$ ,  $*Ar^{40} = 1.287 \times 10^{-10}$  moles/gm,  $*Ar^{40}/\Sigma Ar^{40} = 82.3\%$ ; collected by: G. B. Dalrymple and C. S. Grommé. Comment: The sample locality is south of the part of the Southern California batholith mapped by Larsen (1948). It is approximately 20 km west of the Cuyamaca Peak  $30'$  quadrangles (Larsen and others, 1951) where similar gabbros, which have been correlated with the San Marcos Gabbro, are named the Cuyamaca Gabbro. At this locality, the gabbro is intruded by numerous dikes of quartz diorite, and the sample site is about 15 m southeast of the contact of the gabbro with a later quartz-diorite intrusive body.

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