Summary of recent Rb-Sr age determinations from Precambrian rocks of north-central New Mexico

Douglas G. Brookins, 1974, pp. 119-121

in:

Ghost Ranch, Siemers, C. T.; Woodward, L. A.; Callender, J. F.; [eds.], New Mexico Geological Society 25th Annual Fall Field Conference Guidebook, 404 p.

This page is intentionally left blank to maintain order of facing pages.

SUMMARY OF RECENT Rb-Sr AGE DETERMINATIONS FROM PRECAMBRIAN ROCKS OF NORTH-CENTRAL NEW MEXICO

by

DOUGLAS G. BROOKINS
Department of Geology
University of New Mexico
Albuquerque, New Mexico

INTRODUCTION

Since the compilation by Wetherill and others (1965) of geochronologic data for North America, many more data have been obtained. Dr. L. T. Silver (personal commun.) has determined the radiometric ages of many samples from New Mexico by the U, Th-Pb methods; these will be reported on separately at a later date. In addition, several investigators have determined Rb-Sr ages from north-central New Mexico. It is the purpose of this brief report to summarize these data and to comment on their significance.

All Rb-Sr ages are based on a half life of ^{87}Rb of 50 b.y. (billion years), and the reader is referred to specific references for the analytical details. The errors reported by the various authors are given as presented in their respective reports; no attempt will be made here to assess errors based on one fixed method.

For the interested reader, early dates on the Precambrian basement rocks are given in Wetherill and others (1965). Thirteen K-Ar and Rb-Sr dates on minerals from the Harding mine range from 920 m.y. to 1372 m.y. A ^{207}Pb/^{206}Pb date on monazite near Las Vegas and samarskite from the Petaca district are given as 1340 ± 200 m.y. and 875 ± 30 m.y. respectively. Wasserburg and others (1965) reported on Rb-Sr results from central New Mexico; the northernmost two areas studied are the Lucky Star claim, Sangre de Cristo Mountains and from Tijeras Canyon, Sandia Mountains. Rb-Sr mineral dates of 1380 and 1390 m.y. were reported from the former. Many dates have been reported from the Sandias; Brookins (1973a; and in press) has summarized the available data and places an age of formation of 1500 ± 80 m.y. for the Sandia granite. Newer data will be reported on later in this report.

RECENT INVESTIGATIONS

The recent radiometric age determinations by the Rb-Sr whole rock method for Precambrian basement rocks from north-central New Mexico are presented in Table 1. Brief comments on each age (or range of ages) listed in Table 1 are given below in order to clarify the status of our knowledge of Precambrian basement rock geochronology.

La Madera Quadrangle

Whole rocks and separated muscovite from one locality of a metarhyolite suspected to have undergone metasomatism yields an isochron age of 1425 ± 25 m.y. with initial ^{87}Sr/^{86}Sr = 0.7198 ± 0.0016 (Long, 1972); if one assumes the initial ratio to be 0.707 (a value not unrealistic for a non-metasomatized system) this age can be recalculated to 1600 m.y. or possibly higher. From a second locality an apparent isochron age of 1425 ± 15 m.y. with initial ^{87}Sr/^{86}Sr = 0.7159 ± 0.0007 is obtained. If the data from both localities are lumped together and an initial ratio of 0.72 assumed, then one calculates an age of 1400 ± 50 m.y. Pegmatitic muscovite from the area yields ages of 1452 m.y. as well. Long (1972) assumes that metasomatism has occurred and that the model proposed by Gresens (1967) is correct (i.e., hydrogen ion metasomatism of rhyolite to yield muscovite-quartz rich schist and/or pegmatites). The Gresens model, however, has not been verified by any experimental data. Regardless of this factor, however, Long (1972) is correct in suspecting lack of systemal closure for the metarhyolite in that the initial ^{87}Sr/^{86}Sr ratios are higher than those for many similar rhyolites. He further proposes that the original rhyolitic rocks may have been 1600 to possibly 1800 m.y. old and metasomatized concomitant with pegmatite formation at about 1425 m.y. ago. This, in turn, implies that the pegmatites formed by metasomatism. It is also interesting to note that pegmatites from this area are used as classic examples of products of crystallization from a melt (R. H. Jahns, personal commun.; Jahns and Burnham, 1969).

Table I. Summary of recent Rb-Sr age determinations from Precambrian basement rocks of north-central New Mexico.

	Formation or Rock Unit	Age	Reference
A.	Pegmatites, La Madera quad.	1425 ± 25 m.y.	Long (1972)
	Metarhyolite, La Madera quad.	1.6 (?) b.y.	Long (1972)
B.	Embudo Granite, Sangre de Cristo Mts.	1673 ± 41 m.y.	Fullagar and Shiver (1973)
C.	Brazos Peak	1700 my.	Barker (1973)
D.	Cibola Gneiss, Sandia and Manzanitas Mountains	1600 ± 60 my.	Taggart and Brookins (unpublished data)
E.	Sandia Granite	1504 ± 15 my.	Brookins (1973a) Taggart and Brookins (unpublished data)
F.	Meta-quartz latite, north end of Nacimiento uplift	1800 ± 50 my.	Brookins and McLelland (unpublished data)
G.	Gneissic leuco-granodiorite north end of Nacimento uplift		1840 ± 170 m.y. Brookins and McLelland (unpublished data)
H.	Granitic rocks and associated amphibolite from LASL Drill Hole One, Barley Canyon Site	1870 ± 130 m.y.	Brookins (1973b)

Embudo Granite

Fullagar and Shiver (1973) suggested that the most likely age of formation for the Embudo Granite was 1673 ± 41 m.y. with initial ^{87}Sr/^{86}Sr = 0.7012 ± 0.0013; this date does not include two samples which fall off a 1656 ± 27 m.y. isochron or data for two aplites of 1642 m.y. age. They argue for derivation of the magma for the granite from the mantle with little or no crustal contamination; no supportive evidence for such a deep source of the magma is presented, although the low initial ratio does argue for (a) a deep source and (b) lack of contamination. Mineral whole rock isochron ages are 1212 ± 63 m.y. with initial ratios of 0.7062 ± 0.0007 and 0.7188 ± 0.0035 respectively. These "1200" m.y. ages argue for a thermal event affecting the rock at about this time. Long (1974) has pointed out that Fullagar and Shiver (1973) actually sampled four distinct bodies of granitic rocks which may not be temporally related. Based on field evidence Long (1974) argues that the youngest of the granitic bodies (Periasco Granite) may be as young as 1400 m.y.; this granite is definitely younger than the other three granitic bodies which, with the Pehasco Granite, have collectively been lumped together as the Embudo Granite of Fullagar and Shiver (1973). This example again merely points to the need for careful field control in attempting a geochronologic investigation.

Brazos Peak

Barker and others (1973) reported an age of approximately 1700 m.y. with an initial ratio of 0.7015 (errors in age and initial ratio not given in abstract) for trondhjemitic rocks from Brazos Peak, New Mexico. They argue for a crustal source for the magma with little if any crustal contamination. They consider the rocks to have formed in a quartzite-rhyolite-tholeiite province.

Cibola Gneiss, Southern Sandia and Northern Manzanita Mountains

Six samples of the Cibola Gneiss (nomenclature suggested by V. C. Kelley, personal commun.; formerly called Tijeras Gneiss), which consists predominantly of granitic gneisses derived from arkosic material with interbedded quartzites, yield a preliminary whole rock isochron age of 1600 ± 60 m.y. with an initial ratio of 0.7075 ± 0.0012 (unpublished data by Taggart and Brookins). This date will no doubt be revised when additional samples are run (e.g., samples which are much more radiogenic than those run to date have yet to be analyzed).

Sandia Granite

Many samples of the Sandia granite have been analyzed by numerous investigators using all major methods of age determination. These data are summarized by Brookins (1973a; and in press) and indicate a minimum age of formation of 1470 ± 20 m.y. by the $^{207}Pb/^{206}Pb$ method and an age of 1480 ± 15 m.y. for muscovite from an aplite. K-Ar dates are slightly lower at 1350 m.y. Rb-Sr whole rocks reported on by Wasserburg and others (1965) yield 1410 m.y. but with large uncertainty. Most of the samples studied have come from aliquots of one 5 kg sample of the Sandia Granite taken from a roadcut in Tijeras Canyon. Taggart and Brookins (unpublished data) have examined granite samples from the north end of the Sandias and at several points farther south. Their preliminary results yield 1507 ± 30 m.y. with an initial ratio of 0.7027 ± 0.0006; if these data are combined with the lowest apatite value reported by Wasserburg and others (1965) this age becomes 1504 ± 15 m.y. with an initial ratio of 0.7033 ± 0.0002. The low initial ratio and good age agreement between the U-Pb and Rb-Sr ages suggests little crustal contamination; yet Wasserburg and others (1965) present evidence for some type of incipient event (presumably weak metamorphism), as demonstrated by Sr isotopic disequilibrium, which has affected the Sandia Granite. This metamorphic(?) event is difficult to tie down in time; sphene fission track dates of 1400 m.y. and K-Ar biotite dates of 1350 m.y. suggest the possibility of an event approximately 100-150 m.y. after granite formation; a fission track date on apatite of 50 m.y. is due, presumably, to Laramide uplift which in turn may have been accompanied by enough heat to reset the sphene and biotite and perturb the Rb-Sr systematics of some samples. The problem is by no means resolved.

Meta-Quartz Latite, North End Of Nacimiento Uplift

Six samples of meta-quartz latite have been analyzed by the Rb-Sr method. The preliminary age is 1800 ± 50 m.y. with an initial ratio of 0.7015 ± 0.0015; this age is subject to revision but is not expected to vary significantly. More detail on this rock unit is found in a dissertation by McLelland (unpub. Ph.D. dissert., Univ. New Mexico, in progress). The meta-quartz latite has been intruded by tonalite which caused metasomatism near the contacts (D. McLelland, written commun.). The samples were selected in the field removed from areas of suspected metasomatism and, to our best estimate, we have succeeded in that the age is in agreement with those farther north (Barker and others, 1973) and the initial ratio is low. We therefore suspect very little contamination of the original igneous rock.

Gneissic Leuco-Granodiorite, North End Of Nacimiento Uplift

The meta-quartz latite mentioned above is intruded by tonalite over much of the area mapped by McLelland (unpub. Ph.D. dissert., Univ. New Mexico). A small body of leuco-granodiorite with gneissic appearance is intruded into the tonalite and our preliminary data are for this body, which lies in the southeastern part of the Regina quadrangle. Only four whole rocks have been analyzed to date; the preliminary result is 1840 ± 170 m.y. with an initial ratio of 0.7017 ± 0.0015. This date cannot be resolved from that of the meta-quartz latite, yet the old age and low initial ratio suggest, again, little if any crustal contamination.

Granitic Rocks and Amphibolite, Barley Canyon

Six samples of granodiorite (four samples) and coeval amphibolite (two samples) from the LASL Geothermal Project Test Drill Hole # One have been studied in conjunction with geochemical studies being carried out on the basement rocks in the drill site area. Permission to cite these data has been kindly granted by the U.S. Atomic Energy Commission. The six samples were selected from core taken between 2437 and 2550 foot depth. The petrography of these samples has been reported on by Perkins (1972). The preliminary whole rock isochron yields an age of 1840 ± 130 m.y. with an initial ratio of 0.7020 ± 0.0011. This age must be considered very preliminary in that samples were selected based on available chemical and petrographic information and do not in all cases meet criteria for whole rock study (i.e., maximum dimension of largest constituent mineral less than one tenth minimum dimension of whole rock; this criterion is difficult to meet for core samples). However, the points are colinear (Brookins, 1973b) and the initial ratio low; consequently the age is presumed to be accurate to the error limits stated.

DISCUSSION

It is apparent that there are many problems to be resolved concerning the radiometric dating of the Precambrian basement rocks in north-central New Mexico. A few of these are: 1) the age of formation of the granitic rocks found in the cores of uplifts and by drilling; 2) the ages of the pregranitic metaigneous and metasedimentary rocks intruded by the granitic rocks; 3) the regional pattern of both ages of formation of Precambrian basement rocks and of subsequent events (or one main event?) affecting the rocks; 4) the use of the various data to correlate rocks and events in north-central New Mexico, including work with rocks which have possibly been subjected to allochemical changes as well as isochemical regional metamorphic-induced changes; 5) testing of various petrogenetic theories by combined geochronologic-chemical methods in conjunction with field control.

From the preliminary data (Table 1), it is apparent that many of the Precambrian granitic rocks fall in the age bracket of 1600 to 1800 m.y., and may possibly be older in some cases. The rocks intruded by the granites are at least 1.8 b.y. old in at least one instance (meta-quartz latite in northern Nacimiento uplift); no data are yet available on the metasedimentary rocks. Arguments for a possible fossil subduction zone in northern New Mexico—southern Colorado (Barker and others, 1973) cannot be demonstrated by the geochronologic data presented here and are beyond the scope of this note.

The northernmost rocks (e.g., Brazos Peak, Nacimiento uplift, etc.) appear to be significantly older than those from the central part of the State (e.g., Sandia Granite), but where to draw the "boundary" between two possible age provinces is speculative at this time. More work is needed on the rocks of the Petaca district not only to address the problems of petrogenesis in the area but to determine the age province of these rocks. Similarly, the age(s) of metamorphism(s) affecting the rocks is clearly in the 1200 to 1400 m.y. range for rocks from north-central New Mexico, although younger events of a more local nature will undoubtedly be recognized.

There is one very important point to be made from these preliminary data: the Rb-Sr whole rock method does allow one to accurately date Precambrian basement rocks provided careful field and other control go hand in hand with the study. This is reflected in the resolution of the age of the Cibola Gneiss from that of the Sandia Granite, for example. We feel that as work progresses, a much clearer picture of the geologic history of north-central New Mexico will be revealed, which will help not only in geologic interpretation but also will guide subsequent geochronologic investigations as well.

REFERENCES

Barker, F., Arth, J. G., and Peterman, Z. E., 1973, Geochemistry of Precambrian trondhjemites of Colorado and northern New Mexico: EOS, Trans. Amer. Geophys. Un., v.54, p. 1220-1221.

Brookins, D. G., 1973a, Summary and interpretation of radiometric age determinations from the Sandia Mountains, north-central New Mexico: Geol. Soc. Amer. Abs. with Progr., v. 5, p. 467.

Brookins, D. G., 1973b, Preliminary report to Los Alamos Scientific Laboratory on the Rb-Sr geochronology of six samples from Granite Test Hole One—Barley Canyon Site: Unpublished report to Los Alamos Scientific Laboratory, 5 p.

Brookins, D. G., 1973c, Radiometric age determinations from the Sandia Granite, New Mexico: summary and interpretation: Isochron/West, no. 8, Dec. 1973 (in press).

Fullagar, P. D., and Shiver, W. S., 1973, Geochronology and petrochemistry of the Embudo Granite, New Mexico: Geol. Soc. Amer. Bull., v. 84, p.2705-2712.

Gresens, R. L., 1967, Tectonic-hydrothermal pegmatites II. An example: Contr. Min. Petrol., v. 16, p. 1-28.

Jahns, R. H., and Burnham, C. W., 1969, Experimental studies of pegmatite genesis, I. A model for the derivation and crystallization of granitic pegmatites: Econ. Geol., v. 64, p. 843-864.

Long, L. E„ 1972, Rb-Sr chronology of Precambrian schist and pegmatite, La Madera quadrangle, northern New Mexico: Geol. Soc. Amer. Bull., v. 83, p. 3425-3432.

Long, P. E., 1974, Precambrian granitic rocks of the Dixon-Penasco Area, northern New Mexico: Geol. Soc. Amer. Prog. with Abs., v. 6, p.453.

Perkins, P. C., 1972, Petrography of some rock types of the Precambrian basement near the Los Alamos Laboratory Geothermal Test Site, Jemez Mountains, N.M.: Draft report, Los Alamos Scientific Laboratory, CM B-13.

Wasserburg, G. J., Towell, D. L., Steiger, R. H., 1965, A study of Rb-Sr systematics in some Precambrian granites of New Mexico: Amer. Geophys. Union Trans., V. 46, p. 173-174.

Wetherill, G. W., and others, 1965, Geochronology of North America: NAS-N RC Pub. 1276, 315 p. (See pages 153-154 for N. M. dates).