A new database of Precambrian isotopic ages in New Mexico

Paul W. Bauer

New Mexico Geology, v. 15, n. 2 pp. 40-42, Print ISSN: 0196-948X, Online ISSN: 2837-6420.
https://doi.org/10.58799/NMG-v15n2.40

Download from: https://geoinfo.nmt.edu/publications/periodicals/nmg/backissues/home.cfml?volume=15&number=2

New Mexico Geology (NMG) publishes peer-reviewed geoscience papers focusing on New Mexico and the surrounding region. We aslo welcome submissions to the Gallery of Geology, which presents images of geologic interest (landscape images, maps, specimen photos, etc.) accompanied by a short description.

Published quarterly since 1979, NMG transitioned to an online format in 2015, and is currently being issued twice a year. NMG papers are available for download at no charge from our website. You can also subscribe to receive email notifications when new issues are published.

New Mexico Bureau of Geology & Mineral Resources
New Mexico Institute of Mining & Technology
801 Leroy Place
Socorro, NM 87801-4796

https://geoinfo.nmt.edu

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

A new database of Precambrian isotopic ages in New Mexico

by *Paul W. Bauer*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801

The New Mexico Bureau of Mines and Mineral Resources has recently released *Compilation of Precambrian isotopic ages in New Mexico* as Open-File Report 389. This 130-page report, by Paul W. Bauer and Terry R. Pollock, contains information on 350 published and unpublished radiometric ages for Precambrian rocks of New Mexico. All data were collected from original references, entered into a REFLEX database, and sorted according to several criteria. Based on author's descriptions, samples were located as precisely as possible on 7.5′ topographic quadrangle maps, which are on file at the New Mexico Bureau of Mines and Mineral Resources.

In the compilation, data are sorted in several ways. Part I lists all ages chronologically according to isotopic method. Part II contains all of the data collected for each of the 350 age determinations. Parts III, IV, V, and VI are specialized cross indices that can be useful for certain kinds of searches, such as by mountain range, rock unit name, and county. The table of contents includes:

Part I. List of isotopic age determinations by isotopic method.
- a. U–Pb ages
- b. Pb–Pb model ages
- c. Rb–Sr ages
- d. K–Ar ages
- e. Ar–Ar ages
- f. Sm–Nd, Fission-track, Pb–alpha, and determinations of uncertain geochronologic significance

Part II. Comprehensive list of all isotopic age determinations with complete data listing.
Part III. List of isotopic age determinations by mountain range.
Part IV. List of isotopic age determinations by rock unit.
Part V. List of isotopic age determinations by county.
Part VI. References
Appendix 1. List of area designations by county.
Figure 1. Map of New Mexico showing exposures of Precambrian rocks, and mountains and physiographic provinces used in database.
Figure 2. Histograms of isotopic ages.
Figure 3. Graph of igneous rocks that have U–Pb zircon plus Rb–Sr, K–Ar, or $^{40}Ar/^{39}Ar$ age determinations.
Table A. Geochronology laboratories listed in database, with number of age determinations.
Table B. Constants used for age recalculations.

In Part I, ages are listed chronologically according to isotopic method. Part Ia contains 69 U–Pb ages, almost exclusively from zircon (zircon = 66; sphene = 1; apatite = 1; monazite = 1). Part Ib contains 37 Pb–Pb model ages (zircon = 28; sphene = 4; epidote = 3; galena = 2). Part Ic contains 185 Rb–Sr data, including both isochron and model ages. Part Id contains 42 K–Ar ages, from both whole-rock samples and mineral separates. Part Id contains 17 new and potentially controversial data based on the ^{40}Ar–^{39}Ar method. Part Ie contains a miscellaneous list of Sm–Nd data and age determinations that are of uncertain geological significance. These include fission-track, Pb–alpha, invalid Rb–Sr isochron ages, single point model ages, and K–Ar determinations plagued by excess Ar. These uncertain data are not included in any of the other indices. Information on each date in Part I is displayed in the format shown in Table 1.

For many users, this format is more useful than a single chronologic list that mixes all isotopic methods, because of the typically large differences in isotopic age of a single sample between the various isotopic systems. For example, White (1978) calculated an Rb–Sr age of 1274 Ma for the Magdalena granite, whereas Bowring et al. (1983) determined a U–Pb zircon age of 1654 Ma for the same pluton. Such discrepancies are characteristic of the Precambrian of New Mexico, and it is generally agreed that in medium-grade metamorphic terrains, U–Pb zircon ages typically record the time of crystallization of igneous rocks, whereas the Rb–Sr, K–Ar, and Ar–Ar systematics were wholly or partially reset by subsequent thermal/metamorphic events. This is illustrated in Figures 1 and 2 (reproduced from Figures 2 and 3 of the compilation). Figure 1 contains histograms of ages according to isotopic system. In general, U–Pb ages are older than all other isotopic systems. Figure 2 is a graph showing age determinations of ten rocks that have U–Pb zircon ages and at least one other isotopic-system age (Rb–Sr, K–Ar, Ar–Ar). It clearly illustrates that Rb–Sr, K–Ar, and Ar–Ar ages are typically younger than the crystallization age (U–Pb zircon age).

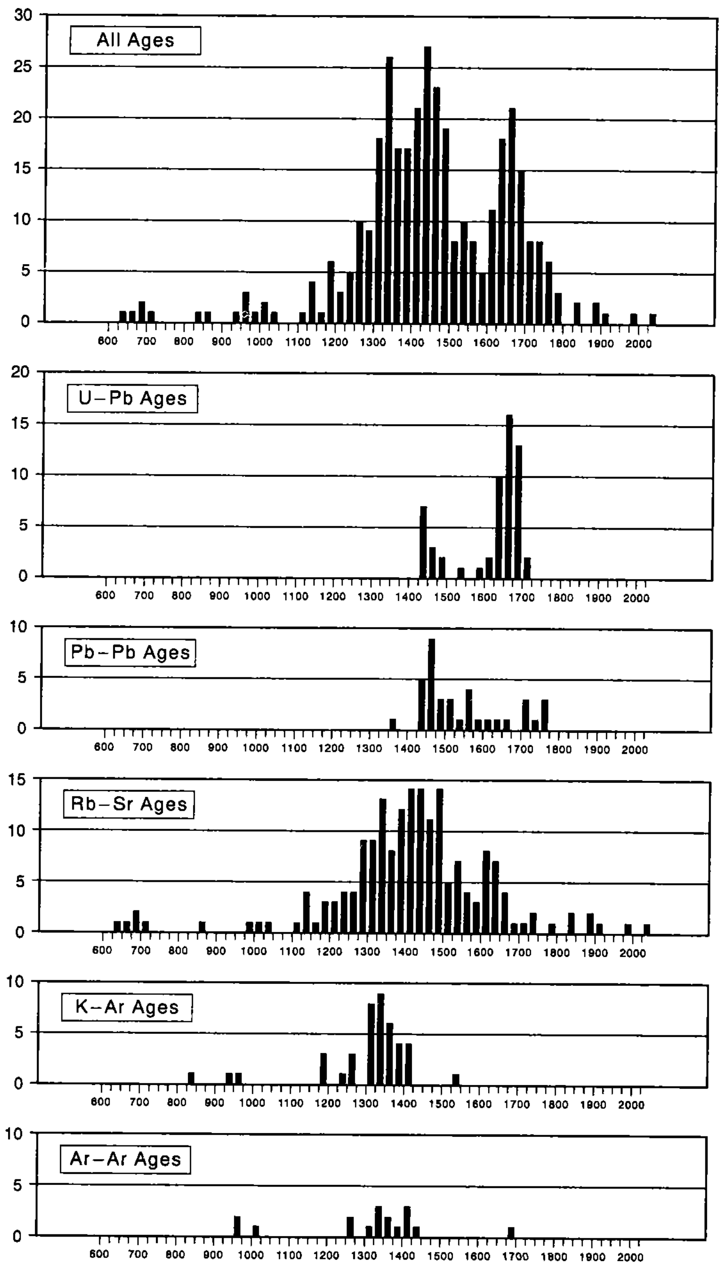

Figure 1—Histograms of isotopic ages. Data for all graphs have been averaged over 25 million year intervals. Vertical axes represent the number of age determinations. Horizontal axes represent age in million years.

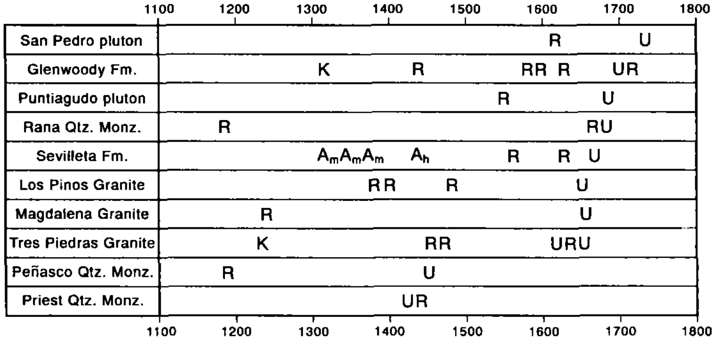

Figure 2—Graph showing isotopic ages from ten igneous rocks that have U–Pb zircon ages as well as Rb–Sr, K–Ar, and/or ^{40}Ar–^{39}Ar age determinations. U–Pb zircon ages (interpreted as crystallization ages) are typically older than ages from the other systems, indicating that the Rb–Sr, K–Ar, and ^{40}Ar–^{39}Ar systematics have been at least partially reset by post- crystallization thermal/tectonic events. U = U–Pb zircon, R = Rb–Sr, K = K–Ar, A_m = ^{40}Ar–^{39}Ar muscovite, A_h = ^{40}Ar–^{39}Ar hornblende.

Part II is a comprehensive list of all the information gathered for each age entry. It is organized from youngest to oldest and contains data on location, unit name, type of age (isochron, model, plateau, etc.), isotopic method, rock type, metamorphism and deformation, material dated, decay constant, lab used, references, and comments on the geologic or geographic setting and the significance of the date. Each entry is denoted with a record number (from 1 to 350) that is referenced in the cross indices in Parts I, III, IV, V. The detailed information in Part II can be used to check an age found in any of the cross indices. A double asterisk (**) following the isotopic age indicates that, in the opinion of the authors, the significance or validity of the age is uncertain. In many cases, this indicates that the rock has undergone a complex thermal/metamorphic history, and the reported isotopic age may not necessarily represent a time of crystallization or metamorphism. Many of these indeterminate ages are included for completeness only, and should not be cited as representative of times of crystallization, accumulation, or peak metamorphism.

All ages for which analytical data are available, or which were published prior to 1976, have been recalculated using the current decay constants of Steiger and Jäger (1977). Old K–Ar ages were recalculated using the conversion tables of Dalrymple (1979). Rb–Sr data were recalculated according to the formula $t_2 = t_1 \cdot \lambda_1/\lambda_2$ where t_2 = recalculated age, t_1 = old age, λ_1 = old decay constant, and λ_2 = new decay constant. Old U–Pb and Pb–Pb ages were reduced to approximate new decay constants. Information in the Part II comprehensive list is displayed in the format shown in Table 2.

Part III is a cross index that arranges dates according to location within a mountain range. The range with the most listings is the Picuris Range, with 80 determinations. Each entry includes isotopic age, isotopic method, material dated, name of unit, rock type, and record number. Most geographic names are from USGS maps, however data points from drillholes were assigned names based on geologic settings (e.g. Las Vegas basin or Pecos slope). The Sangre de Cristo Mountains are divided into several ranges: the southern Sangre de Cristo Mountains, the Rincon Range, the Cimarron Mountains, the Picuris Mountains, and the Taos Range. Areas within mountain ranges are loosely based on the nearest geographic feature labelled on the 7.5′ quadrangle map. Areas include towns, mountains, canyons, rivers, etc. Appendix 1 lists all of the area designations by county. The information in Part III is organized as shown in Table 3.

Part IV arranges ages alphabetically according to the name of the rock unit. This includes formal names of groups, formations, complexes, and igneous units (e.g. Vadito Group, Pecos Complex, Sandia Granite), as well as informally named and previously unnamed units. The list also contains the isotopic age, isotopic method, material dated, mountain range, and rock type. Units with published names such as the "Granite of Old Mike Peak" were inverted (e.g. Old Mike Peak Granite) for the purpose of organizing the data alphabetically. Units without formal names were assigned informal rock-unit names based on nearby geographic features (e.g. Kilbourne Hole xenolith). In all cases, informal names are listed in lowercase letters, whereas formal names are in uppercase. Rocks from drillholes are named according to the name of the drillhole (e.g. Sun No. 1 Bingham State granite). With only minor exceptions,the rock-type designations (e.g. granite, metarhyolite, amphibolite) are listed as given in the original references. Information in Part IV is organized as shown in Table 4.

Part V is a cross index by county. Of the 33 counties in New Mexico, 25 contain dated Proterozoic rocks. This index also lists the isotopic age, isotopic method, material dated, mountain range, rock unit, and record number. Taos County has the most listings, with 104. The information in Part V is organized as shown in Table 5.

Part VI is a complete list of references cited in the compilation. Also included are publications that summarize Precambrian geochronological data and that reworked earlier data. In researching this compilation, the authors have attempted to locate every published and unpublished isotopic age for the Precambrian of New Mexico. The database is designed to be periodically updated. If you know of Precambrian isotopic ages that are not included in the report, please send the information to the attention of Paul Bauer, NM Bureau of Mines and Mineral Resources, Socorro, NM 87801. Phone: (505) 835–5106. FAX: (505) 835–6333. email: bauer@jupiter.nmt.edu.

Open–File Report 389 is available for $15 from Publications, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801, (505) 835–5410.

ACKNOWLEDGMENTS—Lynne Hemenway of the New Mexico Bureau of Mines performed most of the data entry for the compilation. Gretchen Hoffman of the New Mexico Bureau of Mines ☞

TABLE 1—Format of fields displayed in Part 1 (List of isotopic age determination by isotopic method), and sample data for a selected age.

Fields		
AGE AND UNCERTAINTY (**) MOUNTAIN RANGE NAME OF UNIT COMMENTS:	MATERIAL DATED ROCK TYPE REFERENCE	RECORD # AREA 7.5′ QUAD
For example:		
1654 ± 1 Magdalena Mountains Magdalena Granite	zircon granite Bowring et al., 1983	#285 Jordan Canyon area Magdalena Quad
COMMENTS: Granite and fine-grained facies are undeformed; country rock (ca. 1664 Ma) is highly deformed.		

TABLE 2—Format of fields displayed in Part II (Comprehensive list of all isotopic age determinations), and sample data for a selected age.

Fields				
AGE & UNCERTAINTY (**)	ISOTOPIC METHOD	COUNTY	QUADRANGLE	RECORD #
MOUNTAIN RANGE	TYPE OF AGE	LAT-LONG	LAB USED	METAMOR. DEFORMED
NAME OF UNIT	MATERIAL DATED	T-R-SECTION	REPORTED AGE	RECALCULATED AGE
ROCK TYPE	100,000 SHEET	UTM COORDS	DECAY CONSTANT(S)	
AREA	2° SHEET	TYPE OF REF	OUTCROP (✓) *or* DRILLHOLE NAME	
REFERENCE 1				
REFERENCE 2	REFERENCE 3			
COMMENTS:				
For example:				
1678 ±	U-Pb	Taos	Cerro quad	#304
Taos Range	concordia	36°49.75′ 105°31.95′	U. of Kansas	
Jaracito Canyon granodiorite	zircon	30 N 13E 15	1678 ±	Yes Yes
granodiorite	Wheeler Peak	4075850 452500		
Urraca Ranch area	Raton	abstract	✓	
Bowring et al., 1984				
Reed, 1984		Lipman and Reed, 1989		
COMMENTS: Along Latir Creek, 1.4 km E of gaging station. Uncertainty <10 Ma.				

TABLE 3—Format of fields displayed in Part III (List of isotopic age determinations by mountain range), and sample data for a selected mountain range.

Fields						
MOUNTAIN RANGE						
AGE	(**)	METHOD	MATERIAL	UNIT NAME	ROCK TYPE	RECORD #
For example:						
Magdalena Mountains						
1247 ± 62	**	Rb-Sr	whole-rock	Magdalena Granite	granite	#35
1327 ± 136	**	Rb-Sr	whole-rock	Magdalena Granite	granite	#75
1420 ± 117	**	Rb-Sr	whole-rock	Magdalena Granite	granite	#147
1485 ± 234	**	Rb-Sr	whole-rock	Garcia Canyon metagabbro	amphibolite	#210
1654 ± 1		U-Pb	zircon	Magdalena Granite	granite	#285
1664 ± 3		U-Pb	zircon	North Baldy metarhyolite	metarhyolite	#298
1664 ± 3		U-Pb	zircon	Shakespeare metarhyolite	felsic schist	#299

TABLE 4—Format of fields displayed in Part IV (List of isotopic age determinations by rock units), and sample data for a selected rock unit.

ROCK UNIT						
AGE	(**)	METHOD	MATERIAL	MOUNTAIN RANGE	ROCK TYPE	RECORD #
For example:						
Tres Piedras Granite						
1234 ± 19	**	K-Ar	biotite	Tusas Mountains	granitic gneiss	#32
1462 ± 21	**	Rb-Sr	whole-rock	Tusas Mountains	quartz monzonite gneiss	#191
1469 ± 43	**	Rb-Sr	whole-rock	Tusas Mountains	quartz monzonite gneiss	#197
1621 ± 15	**	U-Pb	zircon	Tusas Mountains	granite	#262
1626 ± 17	**	Rb-Sr	whole rock	Tusas Mountains	quartz monzonite gneiss	#265
1650 ±	**	U-Pb	zircon	Tusas Mountains	granite	#281

TABLE 5—Format of fields displayed in Part V (List of isotopic age determinations by county), and sample data for a selected county.

COUNTY						
AGE	(**)	METHOD	MATERIAL	MOUNTAIN RANGE	ROCK UNIT	RECORD #
For example:						
Sierra County						
1304	**	Rb-Sr	whole-rock	Caballo Mountains	Caballo Granite	#56
1325	**	Rb-Sr	whole-rock	San Andres Mountains	Capitol Peak Pluton	#72
1408	**	K-Ar	biotite	San Andres Mountains	Rhodes Canyon granodiorite	#140
1430	**	Rb-Sr	whole-rock	San Andres Mountains	White Mine gneiss	#157
1608	**	Pb-Pb	zircon	Black Range	Pickett Springs granite	#256
1647	**	Pb-Pb	zircon	Black Range	Pickett Springs granite	#276
1655	**	U-Pb	zircon	Black Range	Pickett Springs granite	#287

(*Continues on p. 47*)

New Mexico Bureau of Mines and Mineral Resources staff notes

The Bureau filled three positions: **Matthew Heizler**, Geochronologist; **Terry Telles**, Secretary–Receptionist; and **Sandra Swartz**, Chemical Technician. Anniversaries of our staff with five or more years of service from March through May were: **Judy Vaiza**, 19; **Marshall Reiter**, **Norma Meeks**, 18; **John Hawley**, 16; **Ruben Archuleta**, 14; **Gretchen Hoffman** and **Richard Chamberlin**, 13; **Debbie Goering**, 7 with New Mexico Tech.

George Austin, **Jim Barker**, **Gretchen Hoffman**, **Virginia McLemore**, and **Abe Gundiler** attended the annual meeting of the Society of Mining Engineers in Reno, Nevada. **Abe's** talk was "Thiosulfate leaching of gold from copper-bearing ores" (SME Preprint No. 93–281). **George**, **Jim**, **Ginger**, and **Abe** also attended several SME committee meetings. **Orin Anderson** attended the southwest section of American Association of Petroleum Geologists meeting in Fort Worth, Texas, and was a coauthor with Spencer Lucas of a paper in the proceedings volume on Triassic Dockum Formation of west-Texas. The annual meeting of AAPG in New Orleans, Louisiana was attended by **Frank Kottlowski**, **Orin Anderson**, and **Ron Broadhead** (**Ron** also attended House of Delegates and Affiliated Society Presidents meetings). **Richard Chamberlin** and **Steve Haase** were general cochairpersons for the 1993 New Mexico Geological Society spring meeting in Macey Center; **Steven Ralser** was registration chairman; **Judy Vaiza** handled on-site registration with **Theresa Lopez**; **Norma Meeks** oversaw our exhibit; and **Lynne Hemenway** did the wordprocessing. New NMGS officers are President **Ron Broadhead**, Vice-President Robert Newcomer, Jr., Treasurer **Richard Chamberlin**, and Secretary David Schoderbek. **Ron Broadhead** was stratigraphy, sedimentology and geochronology session moderator and **Jim Barker** served as economic geology session moderator; talks were by **Charles Chapin**, **Orin Anderson**, **Gretchen Hoffman**, **George Austin**, **Jim Barker**, **Marshall Reiter**, **Shirley Wade**, **David Sivils**, **John Hawley**, and **Tanya Baker**. Also attending the NMGS meeting were **Nelia Dunbar**, **Glen Jones**, **Frank Kottlowski**, **Dave Love**, and **Neil Whitehead**. **George Austin** and **Jim Barker** gave a talk at the forum on the geology of industrial minerals titled "Geology and marketing of western perlite", **Frank Kottlowski** and **Gus Armstrong** were coauthors of a poster "Limestone of New Mexico and adjoining areas suitable for sulfur removal in coal-fired powerplants." **Jim Barker** and **Gretchen Hoffman** attended the Four Corners Geological Society meeting in Durango, Colorado; **Gretchen** presented a paper "Coal quality characteristics of the Fruitland and Menefee Formations in the San Juan Basin, northwest New Mexico." **Paul Bauer** gave an invited talk at UTEP (technical seminar series) titled "Proterozoic orogenesis in New Mexico"; **Steve Cather's** invited talk at SMU was titled "Neogene tectonics and sedimentation in the Rio Grande rift." **Charles Chapin** attended several meetings: USGS NAWQUA meeting in Albuquerque; American Association of State Geologists, Liaison Committee in Washington, DC; New Mexico Geochronology Research Laboratory Quaternary Dating field conference, Zuni–Bandera volcanic field (also with **Nelia Dunbar**, **Dave Love** and **Bill McIntosh**); gave a paper titled "Element mobility in a Rio Grande Rift Basin" at the National Western Mining Conference in Denver, Colorado. **Fang Luo** presented a talk titled "Vertical permeability determination from single-well test: Phase I—constant flow rate test" at the SPE 1993 Production Operation Symposium in Oklahoma City, Oklahoma. A poster session presented by **Ginger McLemore** at the Society of Economic Geologists meeting in Denver, Colorado was titled "Alteration and epithermal mineralization in the Steeple Rock mining district, Grant County, New Mexico and Greenlee County, Arizona".

Other meetings attended by NMBMMR staff members include Tucson Gem and Mineral Show and Albuquerque Gem and Mineral Show (**Bob Eveleth**); State GISAC meeting (**Glen Jones**); New Mexico Mining Association Environmental Committee meeting (**Frank Kottlowski**); subcommittee on New Mexico groundwater protection plan (**Lynn Brandvold**); Microsoft windows for workgroups (**Fang Luo**); New Mexico Mining Association Board of Directors meeting (**Frank Kottlowski**); Four Corners Regional Science Fair judges (**Ginger McLemore**, **Dave Love**, and **Chris McKee**); Water Quality Control Commission meeting (**Lynn Brandvold**); Weapons waste treatment technology support group (TTGS) meeting at Sandia National Laboratories (**Abe Gundiler**); BLM Rio Puerco project meetings (**Dave Love**).

Bauer

(Continued from p. 42)

and Mineral Resources produced the fine histograms from REFLEX and QUATTRO PRO. Open–File Report 389 was inspired by the recent publication of the Arizona Bureau of Geology and Mineral Technology's *Compilation of Radiometric Age Determinations in Arizona* by Reynolds, et al. (1986, Bulletin 197, 258 pp.).

References

Bauer, P. W. and Pollock, T. R., 1993, Compilation of Precambrian isotopic ages in New Mexico: New Mexico Bureau of Mines and Mineral Resources, Open–File Report 389, 130 pp.

Bowring, S. A., Kent, S. C., and Sumner, W., 1983, Geology and U–Pb geochronology of Proterozoic rocks in the vicinity of Socorro, New Mexico: New Mexico Geological Society, Guidebook 34, pp. 137–142.

Bowring, S. A., Reed, J. C., Jr. and Condie, K. C., 1984, U–Pb geochronology of Proterozoic volcanic and plutonic rocks, Sangre de Cristo Mountains, New Mexico: Geological Society of America, Abstracts with Programs, v. 16, no. 4, p. 216.

Dalrymple, G. B., 1979, Critical tables for conversion of K–Ar ages from old to new constants: Geology, v. 7, pp. 558–560.

Lipman, P. W. and Reed, J. C., Jr., 1989, Geologic map of the Latir volcanic field and adjacent areas, northern New Mexico: U.S. Geological Survey, Miscellaneous Investigations Map I–1907, scale1:48,000.

Reed, J. C. Jr., 1984, Proterozoic rocks of the Taos Range, Sangre de Cristo Mountains, New Mexico: New Mexico Geological Society, Guidebook 35, pp. 179–185.

Steiger, R. H. and Jäger, E., 1977, Subcommission on geochronology: convention on the use of decay constants in geo- and cosmochronology: Earth and Planetary Science Letters, 39, pp. 359–362.

White, D. L., 1978, Rb–Sr isochron ages of some Precambrian plutons in south-central New Mexico: Isochron/West, no. 21, pp.8–14. □