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New ages for intrusive rocks
in the Colorado mineral belt

By

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This report is preliminary and has not been
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The Colorado mineral belt is defined by a series of Tertiary and uppermost Cretaceous igneous intrusive bodies and associated hydrothermal ore deposits that trends northeastward across Colorado from the Four-Corners area. The belt has produced at least \$4 billion in metals, principally molybdenum, gold, silver, zinc, and lead. It has been studied intensively, and studies continue as new concepts and techniques develop.

New and improved methods of fission-track and K-Ar age dating have proved to be powerful tools in the classification of the various intrusive rocks and, hence, of mineral deposits that are or may be associated with particular rock bodies. The age data reported here (table 1) thus have economic as well as tectonic and petrogenetic application. The data indicate that in some areas the intrusive and hydrothermal activity are of different ages and significance than has been assumed in the past.

SAMPLE LOCATIONS

East Lake Creek stock

E. Lake Ck.-1: 39°28'36" N., 106°33'20" W., Mount Jackson quadrangle, Eagle County, Colorado. Collected by Ogden Tweto.

West Cross Creek stock

W. Cross Ck.-1: 39°25'40" N., 106°32'15" W., in unsurveyed sec. 21, T. 7 S., R. 82 W., Mount Jackson quadrangle, Eagle County, Colorado. Collected by Ogden Tweto.

West Tennessee Creek stock

W. Tenn.-1: 39°20'48" N., 106°25'25" W., 0.5 km SE of the Homestake mine, Homestake Reservoir quadrangle, Pitkin County, Colorado.

Fulford stock

Fulford-1: 39°31'36" N., 106°39'24" W., sec. 14, T. 6 N., R. 83 W., roadcut 0.8 km E. of Triangle Res., Fulford quadrangle, Eagle County, Colorado.

I-22: 39°31'40" N., 106°39'28" W., in sec. 14, T. 6 S., R. 83 W., Fulford quadrangle, Eagle County, Colorado. Collected by Ogden Tweto.

Ute Mountains

Ute-1: 37°14'25" N., 108°46'35" W., sec. 36, T. 35 N., R. 18 W., roadcut alongside Cottonwood Creek, Sentinel Peak NE quadrangle, Montezuma County, Colorado.

Ute-2: 37°16'47" N., 108°46'51" W., sec. 24, T. 35 N., R. 18 W., SW side of Ute Peak, Moqui SE quadrangle, Montezuma County, Colorado.

Ute-3: 37°15'52" N., 108°48'41" W., sec. 27, T. 35 N., R. 18 W., small roadcut, Moqui quadrangle, Montezuma County, Colorado.

La Plata Mountains

La Plata-2: 37°24'15" N., 108°5'26" W., 0.3 km SW of Allard mine, La Plata quadrangle, Montezuma County, Colorado.

La Plata-3: 37°23'45" N., 108°04'32" W., at first switchback on road up Bedrock Creek on west side of La Plata River, La Plata quadrangle, La Plata County, Colorado.

La Plata-4: 37°26'13" N., 108°0'55" W., 0.4 km SW of Snowstorm Peak, La Plata quadrangle, Montezuma County, Colorado.

La Plata Mountains--Continued

La Plata-5: 37°25'28" N., 108°02'38" W., roadcut at road fork between Darby Creek and Basin Creek on west side of La Plata River, La Plata quadrangle, La Plata County, Colorado.

Rico

Rico-1: 37°41'40" N., 108°31'37" W., 0.4 km NW of the Expectation mine, Rico quadrangle, Dolores County, Colorado.

Rico-2: 37°38'23" N., 108°3'22" W., roadcut 0.4 km ENE of Montelores Bridge, Rico quadrangle, Dolores County, Colorado.

Ouray

Ouray-1: 37°59'5" N., 107°42'38" W., roadcut in switchback to the south on the road to the Camp Bird mine, near Senator Gulch, Ironton quadrangle, Ouray County, Colorado.

Ouray-2: 37°59'40" N., 107°42'14" W., elevation 9,320 ft on Weehawken pack trail, Ironton quadrangle, Ouray County, Colorado.

Mount Sopris stock

Sopris-1: 39°16'13" N., 107°8'43" W., sec. 18, T. 9 S., R. 87 W., by Thomas Lakes, Mount Sopris quadrangle, Pitkin County, Colorado.

Tincup

Tincup-1: 38°40'39" N., 106°30'34" W., sec. 15, T. 51 N., R. 4 E., 0.2 km W. of the summit of Green Mountain, Fairview Peak quadrangle, Gunnison County, Colorado.

Round Mountain stock

Rnd. Mtn.-1: 38°46'26" N., 106°51'32" W., about halfway up Round Mountain, Cement Mountain quadrangle, Gunnison County, Colorado.

Porphyry Creek stock

Porp. Ck.-1: 38°28'22" N., 106°24'14" W., sec. 27, T. 49 N., R. 5 E., Sargent quadrangle, Gunnison County, Colorado.

Eldora stock

Eldora-1: 39°57'06" N., 105°35'16" W., west edge of the town of Eldora, Nederland quadrangle, Boulder County, Colorado.

Apex stock

Apex-1: 39°52'3" N., 105°33'18" W., exposure in trench, Central City quadrangle, Gilpin County, Colorado.

Apex-2: 39°52'3" N., 105°33'18" W., same location as Apex-1, Central City quadrangle, Gilpin County, Colorado.

Empire stock

Empire-1: 39°45'48" N., 105°43'20" W., roadcut along U.S. 40, 3.4 km west of Empire, Empire quadrangle, Clear Creek County, Colorado.

Chicago Basin stock

Chi. Bas. 217: 37°36'13" N., 107°36'30" W., south of Needle Creek, Needle Mountains quadrangle, La Plata County, Colorado.

Chi. Bas. 137: 37°36'9" N., 107°36'43" W., south of Needle Creek, Needle Mountains quadrangle, La Plata County, Colorado.

Jamestown

JS-1: 40°07' N., 105°24' W., sec. 25, T. 2 N., R. 72 W., Gold Hill quadrangle, Boulder County, Colorado.

JS-2: 40°07'12" N., 105°23'15" W., sec. 19, T. 2 N., R. 71 W., drill core, Raymond quadrangle, Boulder County, Colorado.

Montezuma stock

H1200: 39°32'02" N., 105°49'33" W., 0.6 km NE of Webster Pass, Montezuma quadrangle, Summit County, Colorado. Collected by George Neuerburg.

Quartz Creek stock

BMG-1QC: 37°23'40" N., 106°45'02" W., drill core from Quartz Creek, Wolf Creek quadrangle, Mineral County, Colorado. Collected by George Neuerburg.

Leadville

Leadville-1: 39°15'3" N., 106°14'45" W., dump of the Big Six mine, Eureka pipe, Climax quadrangle, Lake County, Colorado. Collected by Ogden Tweto.

Leadville-2: 39°15'18" N., 106°14'28" W., White Cloud mine, Climax quadrangle, Lake County, Colorado. Collected by Ogden Tweto.

Table 1.--Fission-track and K-Ar analytical data

[Numbers in parentheses are number of tracks counted. Values for constants used in calculating ages are as follows: λ_P , $7.03 \times 10^{-17} \text{ yr}^{-1}$, $^{40}\text{K}_e$, $0.501 \times 10^{-10} \text{ yr}^{-1}$, λ_e , $4.962 \times 10^{-10} \text{ yr}^{-1}$, ^{40}K , 1.167×10^{-4} . Leaders (---) indicate no data.]

Sample loc.	Lab. No.	Mineral	M_{hs}	M_{pl}	$M_{\text{t}} \times 10^{15}$	U (ppm)	K_2O (wt. percent)	^{39}Ar (10^{10} mol/g)	^{40}Ar (percent)	Age, m.y. $\pm 2\sigma$
East Lake Creek stock										
E. Lake Ck.-1	DF-848	sphene	10.30 (2564)	5.50 (687)	0.587	300	---	---	---	65.3 \pm 5.5
	DF-849	zircon	9.87 (777)	8.77 (345)	0.887	320	---	---	---	59.5 \pm 7.5
West Cross Creek stock										
W. Cross Ck.-1	DF-850	zircon	4.36 (1130)	3.89 (504)	0.887	140	---	---	---	59.3 \pm 6.2
	D2499B	biotite	---	---	---	---	8.45 8.51	7.668	95	61.8 \pm 1.4
West Tennessee Creek stock										
W. Tenn.-1	DF-1164	apatite	0.069 (143)	0.100 (209)	1.14	2.8	---	---	---	46.4 \pm 9.8
	D2566B	biotite	---	---	---	---	8.55 8.54	8.319	87	66.4 \pm 2.2
Fulford stock										
Fulford-1	DF-1161	zircon	6.21 (1329)	6.08 (675)	1.07	180	---	---	---	65.3 \pm 6.0
I-22	D2498B	biotite	---	---	---	---	8.39 8.38	7.635	94	62.2 \pm 1.5
Ute Mountains										
Ute-1	DF-1073	zircon	10.3 (2377)	8.26 (956)	0.867	300	---	---	---	64.2 \pm 4.8
Ute-2	DF-1076	--do--	6.18 (1258)	4.49 (456)	0.862	170	---	---	---	70.7 \pm 7.5
	DF-1075	apatite	1.96 (490)	7.19 (899)	4.12	50	---	---	---	66.9 \pm 7.5
Ute-3	DF-1077	zircon	7.60 (1232)	5.34 (433)	0.852	200	---	---	---	72.1 \pm 7.9
	D2548B	biotite	---	---	---	---	8.41 8.41	8.898	76	72.0 \pm 1.7
La Plata Mountains										
La Plata-2	DF-993	zircon	12.90 (2508)	12.2 (1188)	1.09	360	---	---	---	68.7 \pm 4.7
La Plata-3	DF-994	--do--	8.81 (1916)	8.57 (932)	1.09	250	---	---	---	66.9 \pm 5.2
	DF-995	apatite	1.58 (1466)	1.36 (1240)	1.05	41	---	---	---	72.8 \pm 5.5
	D2541B	biotite	---	---	---	---	8.94 8.98	8.915	92	67.8 \pm 1.6
La Plata-4	DF-996	zircon	6.52 (1238)	7.08 (672)	1.09	210	---	---	---	60.0 \pm 5.6
	DF-997	apatite	0.139 (129)	0.110 (102)	1.05	3.3	---	---	---	79.1 \pm 20.4
La Plata-5	DF-998	zircon	18.70 (1040)	17.50 (487)	1.09	510	---	---	---	69.6 \pm 7.4
	DF-999	apatite	1.06 (978)	1.31 (1217)	1.05	40	---	---	---	50.3 \pm 4.2
	D2542B	biotite	---	---	---	---	8.79 8.76	8.682	94	67.5 \pm 1.6

Table 1.--Fission-track and K-Ar-analytical data--Continued

Sample Loc.	Lab. No.	Mineral	U, μs	Th, μs	$^{238}\text{U} \times 10^{15}$	U (ppm)	K ₂ O (wt. percent)	^{39}Ar (10 ¹⁰ mol/g)	^{40}Ar (percent)	Age, m.y. ±2σ
Rico										
Rico-1	DF-1166	zircon	4.78 (1174)	4.86 (596)	1.04	150	---	---	---	61.4±6.0
	DF-1168	apatite	0.016 (34)	0.169 (353)	1.14	4.8	---	---	---	6.6±2.3
	DF-1167	sphene	8.46 (1645)	12.15 (1181)	1.89	210	---	---	---	78.4±5.8
	D2573PY	pyroxene	---	---	---	---	0.118 0.116	0.1917	68	51.1±2
Rico-2	DF-1146	zircon	9.89 (2151)	9.72 (1058)	1.07	290	---	---	---	64.9±4.7
	DF-1145	apatite	0.017 (36)	0.038 (121)	1.14	1.6	---	---	---	20.2±7.4
Ouray										
Ouray-1	DF-1149	zircon	3.25 (346)	5.05 (269)	1.06	150	---	---	---	40.7±6.5
	DF-1148	apatite	0.011 (22)	0.093 (93)	1.14	2.6	---	---	---	7.7±3.4
Ouray-2	DF-1116	zircon	8.06 (1865)	9.81 (1135)	1.10	280	---	---	---	54.1±4.0
	DF-1117	apatite	0.017 (35)	0.060 (125)	0.89	2.1	---	---	---	15.0±5.6
Mount Sopris stock										
Sopris-1	DF-1104	zircon	3.34 (664)	6.50 (647)	1.12	190	---	---	---	34.2±3.7
	D2552B	biotite	---	---	---	---	8.30 8.25	4.108	87	34.2±0.8
Tincup										
Tincup-1	DF-1150	zircon	5.67 (1208)	10.44 (1112)	1.06	310	---	---	---	34.5±2.8
	DF-1151	epidote	0.708 (177)	3.91 (489)	3.46	36	---	---	---	37.3±6.4
Round Mountain stock										
Rnd. Mtn-1	DF-1160	zircon	2.16 (489)	11.74 (1332)	1.05	360	---	---	---	11.5±1.2
	DF-1147	apatite	0.025 (52)	0.173 (361)	1.14	4.9	---	---	---	9.7±2.8
	D2567B	biotite	---	---	---	---	8.66 8.62	1.736	62	13.9±0.3
Porphyry Creek stock										
Porp. Ck.-1	DF-1152	zircon	4.19 (911)	7.45 (810)	1.05	230	---	---	---	35.3±3.3
	D2569B	biotite	---	---	---	---	8.92 8.86	4.961	84	38.4±0.9
Eldora stock										
Eldora-1	DF-934	zircon	7.49 (1560)	8.50 (885)	1.27	210	---	---	---	66.8±5.5
	DF-1000	do--	9.31 (1293)	10.67 (741)	1.19	290	---	---	---	61.8±5.5
	DF-942	apatite	0.168 (311)	0.200 (370)	1.17	5.5	---	---	---	58.5±8.8

Table 1.--Fission-track and K-Ar analytical data--Continued

Sample Loc.	Lab. No.	Mineral	U_s	$2p_i$	$3\phi \times 10^{15}$	U (ppm)	K ₂ O (wt. percent)	4^{40}Ar (10^{10} mol/g)	^{40}Ar (percent)	Age, m.y. $\pm 2\sigma$
Apex stock										
Apex-1	DF-1188	zircon	7.10 (1414)	7.20 (717)	1.05	220	---	---	---	61.7 \pm 5.5
	DF-1189	apatite	0.428 (99)	0.700 (162)	1.96	11.4	---	---	---	71.1 \pm 17.7
Apex-2	DF-1190	zircon	8.00 (1926)	8.47 (1020)	1.04	260	---	---	---	58.8 \pm 4.4
	DF-1191	apatite	0.285 (594)	0.498 (1037)	1.96	8.1	---	---	---	66.7 \pm 6.7
Empire stock										
Empire-1	DF-932	sphene	11.2 (1872)	11.4 (950)	1.16	315	---	---	---	67.9 \pm 5.3
	DF-941	apatite	0.847 (1765)	1.568 (3266)	1.16	43	---	---	---	37.3 \pm 2.2
Chicago Basin stock										
Chi. Bas. 217	DF-908	zircon	1.46 (494)	9.01 (1522)	1.07	270	---	---	---	10.4 \pm 1.1
Chi. Bas. 137	DF-907	--do--	1.87 (480)	13.30 (1688)	1.08	390	---	---	---	9.2 \pm 0.9
Jamestown										
JS-1	D2419B	biotite	---	---	---	---	8.55 8.64	7.390	88	58.8 \pm 2.0
JS-2	41FT.	zircon	8.92 (661)	13.06 (484)	1.10	750	---	---	---	44.9 \pm 2.7
	3361FT.	--do--	7.32 (351)	10.56 (253)	1.09	400	---	---	---	45.1 \pm 3.8
Montezuma stock										
H1200	DF-674	--do--	1.85 (1235)	16.76 (1319)	1.25	430	---	---	---	35.0 \pm 2.7
Quartz Creek stock										
BMG-1QC	DF-1118	--do--	2.88 (614)	7.78 (828)	1.09	230	---	---	---	24.2 \pm 2.5
Leadville										
Leadville-1	D2642S	sanidine	---	---	---	---	11.34	6.360	91	38.5 \pm 0.6
Leadville-2	DF-1445	zircon	13.8 (1343)	20.2 (984)	1.15	510	---	---	---	47.0 \pm 3.9

1_{ps} = tracks/cm² fossil, $\times 10^6$
 2_{pi} = tracks/cm² induced, $\times 10^6$
 3_{ϕ} = neutrons/cm²

4^{40}Ar = radiogenic argon
 5_{K-Ar} age is too old