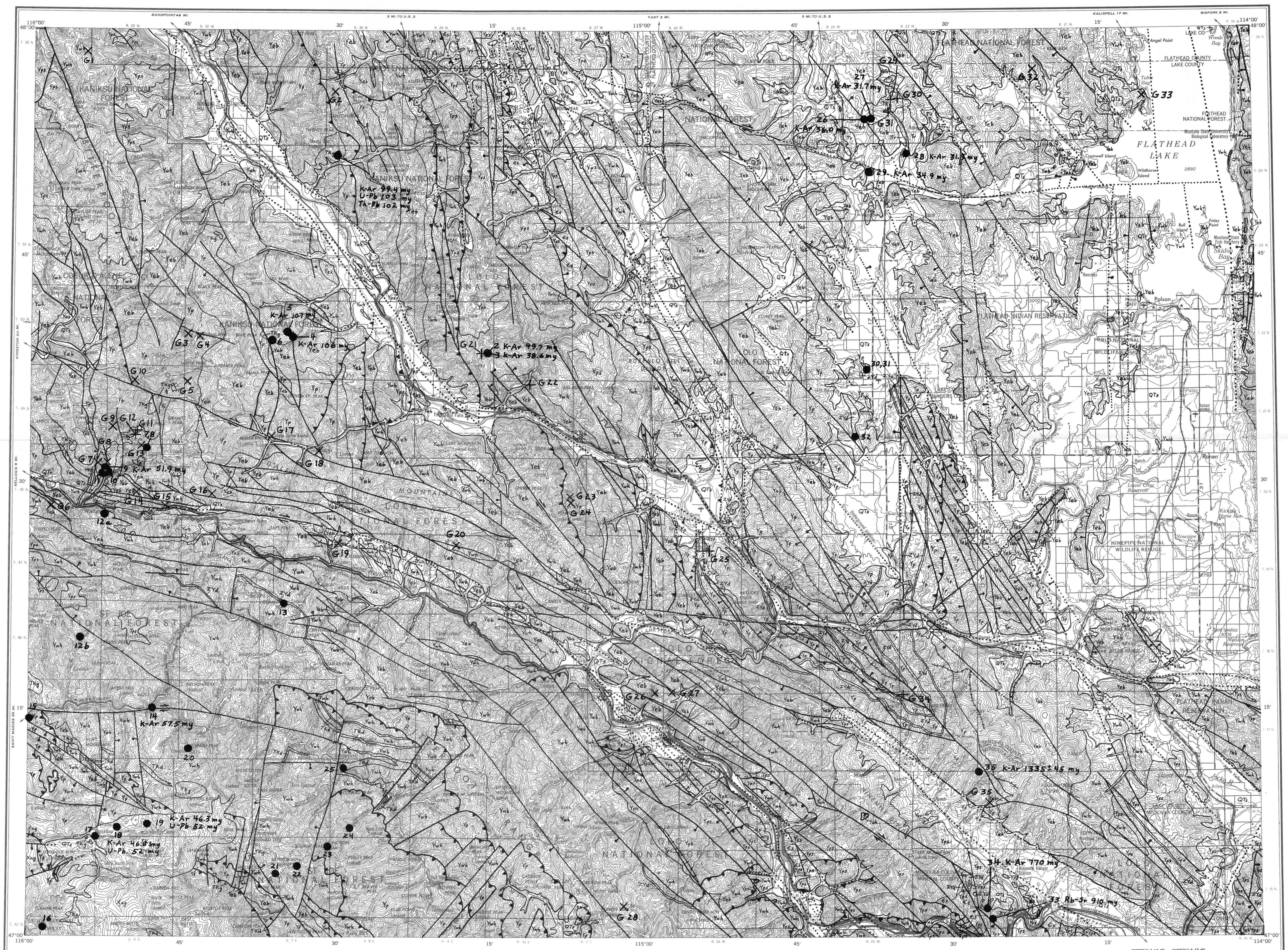
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1354-G

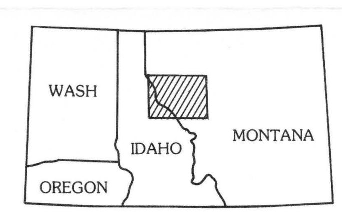
This map is part of a folio of maps of the Wallace $1^{o} \times 2^{o}$ quadrangle, Montana-Idaho, prepared under the Conterminous United States Mineral Assessment Program (CUSMAP).



Base from U.S. Geological Survey, 1956

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

Geology by J. E. Harrison, A. B. Griggs, and J. D. Wells, 1970-1980. Assisted by H. R. Covington (1972), Joseph Boggs (1973), and J. P. Harrison (1970-1980)



INDEX MAP

CORRELATION OF MAP UNITS

QTs } QUATERNARY AND TERTIARY
Tv } TERTIARY
TKg TKd } TERTIARY AND CRETACEOUS

Unconformity

€s } CAMBRIAN

Unconformity

ZYd } PROTEROZOIC Z AND Y
Yps, Ywh, Yeb, Yp } PROTEROZOIC Y

Unconformity

Xag } PROTEROZOIC X

DESCRIPTION OF MAP UNITS

QTs VALLEY FILL DEPOSITS (QUATERNARY AND TERTIARY)--Alluvium, glacial deposits, an semiconsolidated to consolidated conglomerate interlayered in places with shale, coal, and volcanic ash; shown only in major valleys and basins or along main stream courses

Tv VOLCANIC ROCKS (TERTIARY)--Largely andesitic to dacitic welded tuff

TKg GRANITIC INTRUSIVE ROCKS (TERTIARY AND CRETACEOUS)

TKd DIORITIC INTRUSIVE ROCKS (TERTIARY AND CRETACEOUS)

€s SEDIMENTARY ROCKS (CAMBRIAN)--Includes Red Lion Formation, Hasmark Dolomite, Silver Hill Formation, Flathead Quartzite, and equivalent rocks

ZYd DIORITIC TO GABBROIC SILLS AND DIKES (PROTEROZOIC Z and Y)

Yps MISSOULA GROUP (PROTEROZOIC Y)--Includes Pilcher, Libby, Garnet Range, and McNamara Formations, Bonner Quartzite, and Striped Peak, Mount Shields, Shepard, and Snowslip Formations

Ywh WALLACE AND HELENA FORMATIONS (PROTEROZOIC Y)

Yeb RAVALLI GROUP (PROTEROZOIC Y)--Includes Empire, St. Regis, Spokane, Revett, and Burke Formations

Yp PRICHARD FORMATION (PROTEROZOIC Y)

Xag ANORTHOSITE, SCHIST, AND GNEISS (PROTEROZOIC X)

EXPLANATION

● K-Ar B46.8m.y U-Pb Z52 m.y. SAMPLE LOCALITY AND NUMBER, METHOD OF ANALYSIS, MINERAL, AND RADIOMETRIC DATE--Only 20 most reliable dates shown on map; see tables 1,2,3, and text for additional information. Minerals dated: B=biotite, M=muscovite, H=hornblende, Z=zircon, Mz=monazite, WR=whole rock

SAMPLE LOCALITY AND NUMBER FOR GALENA OCCURRENCE--Lead isotope ratios indicate age of mineralization; see table 4

G30 + Cenozoic or Mesozoic mineralization

G4 × Precambrian mineralization

INTRODUCTION

Most of the bedrock in the Wallace quadrangle belongs to the Belt Supergroup, a thick (about 18,000 m) sequence of generally fine-grained clastic and carbonate rocks of Middle Proterozoic age. Regional metamorphism prior to Cambrian time prograded the Belt rocks to greenschist facies, and some metal-bearing veins were emplaced in fractures. The Belt rocks were intruded in Late Proterozoic time by basic dikes and sills.

Basic to felsic dikes and plutons were intruded during the Cretaceous (about 100 m.y. ago) and Tertiary (about 50 m.y. ago), and a small volcanic field formed 35-30 m.y. ago in the northeast corner of the quadrangle. A variety of metal-bearing veins or stockwork systems formed in association with the intrusions. Belt rocks were prograded to amphibolite facies in contact zones around the intrusions. A wide metamorphic aureole that reaches into the southwestern part of the quadrangle was formed by the Idaho batholith, whose northern edge is about 40 km south of the quadrangle.

Fifty radiometric dates have been determined for rocks and minerals from the quadrangle. These dates are listed in table 1; the 20 most reliable dates are shown on the map. Analytical data for new dates presented in this paper are given in tables 2 and 3. All known dates are listed even though many serve only to constrain geologic interpretations or to illustrate problems in interpreting hybrid ages. (A hybrid age does not date a definite geologic event but is given by an isotopic system that has lost a variable amount of radiogenic isotopes due to thermal or chemical conditions external to the isotopic system.) Hybrid K-Ar ages are quite common in the study area because Mesozoic-Tertiary thermal events have partially modified the argon, and possibly the potassium, isotopic system of the dated material. Hybrid U-Th-Pb zircon ages are common for Phanerozoic intrusives in this region because the zircons commonly have cores that were inherited from Precambrian source-rocks of the magmas.

Sample locations for galena are shown on the map, and unpublished lead isotopic ratios are given in table 4. As interpreted by Zartman and Stacey (1971), the lead isotopic ratios fall into two broad groups--one group indicates a Precambrian affinity, the other group a Mesozoic-Tertiary affinity.

DISCUSSION

The emplacement ages for the granodiorite east of Trout Creek, Mont., and for the granodiorite near the southwest corner of the quadrangle were determined from a concordia diagram (figure 1) of the isotopic U-Pb data obtained by analyses of various size-fractions of zircon. The colinear patterns of data points on the diagram were derived from 4 size-fractions of zircon from a hornblende granodiorite (sample 1) and 2 size-fractions each from two occurrences of a biotite granodiorite (samples 18 and 19). The array of data points are best explained as mixing lines between inherited and newly crystallizing components of zircon. According to such an interpretation, the upper concordia intercept (not shown in figure 1, but calculated as Early Proterozoic or Late Archean) reflects the age of the source rock from which the magma was derived, and the lower concordia intercept yields the emplacement age of the pluton. For the hornblende granodiorite (sample 1), the determined emplacement age of 102 ± 8 m.y. is in excellent agreement with an essentially concordant U-Th-Pb monazite analysis of 102-106 m.y. The biotite granodiorite (samples 18 and 19) is shown to be distinctly younger and has an emplacement age of 52 ± 7 m.y. Complementary K-Ar mineral ages for both plutons further strengthen these assignments and attest to the validity of the interpretation.

For sample 2 (LP-4), from the pluton that lies buried beneath Liver Peak, the zircon concentrate was sufficient for only one analysis, and only one point could be plotted. A dotted line is drawn through that point (figure 1), parallel to the line determined for samples 18 (W-98-4) and 19 (W-98-5). The ages, thus extrapolated, of 42 m.y. is based on the untested assumption that additional U-Pb analyses from this pluton would plot parallel to the line for samples W-98-4 and W-98-5. Agreement between the extrapolated U-Pb age and the biotite K-Ar age is not very satisfactory. Also, the K-feldspar date for sample 2 is too young when compared to the date for coexisting biotite. Some K-feldspars allow the gradual escape of radiogenic argon formed during the radiometric decay of 40-potassium; thus, the calculated date, in such cases, will be spurious (too young).

As previously stated, the dates for 15 sample localities shown on the map are probably primary ages. The remaining dates (listed in table 1) cannot be taken at face value; the following discussion explains why some dates are questionable. Dates given by samples 6, 9 (hornblende), 22, and 25 are considerably older than the dates for comparable samples and minerals. For example, two of the dates given by the hornblende from sample 9 are decidedly older than the date given by coexisting biotite. The older hornblende dates are probably the result of argon being incorporated by the hornblende as it crystallized. The presence of extra or excess argon is especially deleterious to determining a valid age for a rock when a constituent mineral of low potassium content such as an amphibole or plagioclase is dated.

The date given by the hornblende from sample 6 is older than the biotite dates for samples 4 and 5, all from the Haines Point pluton. This pluton is a syenite complex that shows fenitized (K-enriched) phases. The age of fenitization (about 107 m.y.) is probably reflected by samples 4 and 5, whereas the older age (171 m.y.) for hornblende may reflect either the primary age of the syenite complex or excess argon in the hornblende.

Excess argon appears to be the cause of the old dates given by samples 22 and 25. A pre-Belt date was given by sample 22, but the dated rock is part of the Wallace Formation of the Belt Supergroup. Plagioclase of sample 25 gave a date older than the calculated age of the earth.

Dates given by samples 7, 8, 10, 11, 12a-b, 13, 15, 16, 17, 30, 31, and 32 are questionable. The primary mineralization in the Hercules mine is apparently Precambrian, on the basis of the isotopic lead ratios for galenas. But biotite from samples 7 and 8, biotite believed to have formed during mineralization, gave Cretaceous dates. These dates may indicate a remobilization of ores during intrusion of the nearby Gem stocks or a modification of the argon isotopic system in the biotites by the thermal event accompanying the intrusion of the Gem stocks. The K-Ar and Pb-alpha dates from samples 10 and 11, respectively, for the Gem stocks are Cretaceous (possibly Late Jurassic) but agreement between the dates is poor and they seem to be anomalously older than the regional Cretaceous dates (about 100 m.y.) for other plutons in the area. The Rb-Sr isochron date for samples 12a-b is clearly anomalous for the Belt age of the Wallace Formation. The Rb-Sr isochron date for sample 15 may be the actual age of the pegmatite but, again, the date is at variance with other dated Tertiary or Cretaceous plutonic bodies in this region. The U-Pb zircon dates for sample 16, a high-grade pelitic schist, suggest that the schist is pre-Belt. As the schist does not match any of the Belt stratigraphic sections, this inference is probably correct. The dates obtained from two hornblendes and a margarite concentrate from samples 30, 32, and 31, respectively, may be very close to the actual age of intrusion. The dates are similar to the 740-850 m.y. ages commonly obtained from similar diorite dikes and sills in other areas of Belt terrain. However, until corroborating dates are obtained by the Rb-Sr or U-Pb age method for these dikes and sills, some doubt remains as to their actual age.

Hybrid dates were obtained for samples 20, 21, 23 and 24. The radiometric dates listed in table 1 for these samples do not denote the age of some geologic event, but rather show the effect of thermal heating from the emplacement of the Late Cretaceous Idaho batholith. The heat from the batholith caused the loss of varying amounts of argon from the minerals of the schist; so that the apparent ages now determined vary from 194-1045 m.y. The calculated date is thus not a true age, but instead bears some complex relationship to the maximum temperature to which the schist was heated and to the length of time it remained at that temperature.

Table 1.--Geochronometric data

Map location number	Rock type	Material analyzed	Type of analysis	Age[1] (m.y.)	Reference
1	hornblende granodiorite.	hornblende-------	K-Ar	99.4±3.4	This paper
		zircon-----------	U-Pb	103 ±8	Do.
		monazite---------	U-Th-Pb	104 ±2	Do.
		Liver Peak pluton			
2	quartz monzonite (drill core).	biotite----------	K-Ar	49.7±1.7	Do.
		K-feldspar-------	K-Ar	40.0±1.4	Do.
		zircon-----------	U-Pb	≈42	Do.
3	selvage around mineralized veinlet (drill core).	biotite----------	K-Ar	38.6±1.1	Do.
		Haines Point pluton			
4	muscovite syenite-----	muscovite--------	K-Ar	106 ±3	Do.
5	biotite syenite ------	biotite----------	K-Ar	107 ±4	Do.
6	hornblende-biotite syenite.	hornblende-------	K-Ar	171 ±14	Do.
7	vein, Hercules Mine	biotite----------	K-Ar	122 ±6	Armstrong, 1975
8	---do----------------	--do-------------	K-Ar	104 ±5	Do.
		Gem stocks			
9	lamprophyre dike in stock.	biotite----------	K-Ar	51.9±1.5	McDowell, 1971
		hornblende-------	K-Ar	68.8±2.0	Do.
		--do-------------	K-Ar	60.8±1.8	Do.
		--do-------------	K-Ar	52.5±1.5	Do.
		--do-------------	K-Ar	50.8±1.5	Do.
10	quartz monzonite------	hornblende-------	K-Ar	131 ±4	Do.
		--do-------------	K-Ar	137 ±4	Do.
11	granodiorite----------	zircon-----------	Pb-α	94 ±10	Larson and others, 1958
		--do-------------	Pb-α	116 ±10	
12a-b	argillite(?) (Wallace Fm).	isochron of 5 whole-rocks	Rb-Sr	860 ±150	Armstrong, 1976
13	diorite (Wishards sill).	whole-rock-------	K-Ar	575 ±4	Do.
14	lamprophyre dike------	hornblende-------	K-Ar	57.5±2.0	Marvin and Dobson, 1979
15	pegmatite------------	muscovite-plagioclase isochron.	Rb-Sr	68.8±1.2	Armstrong, 1975
16	pelitic schist--------	zircon----	207Pb-206Pb	1665	Reid and others, 1973
			238U-206Pb	1404	
			235U-207Pb	1530	
		Roundtop pluton			
17	biotite granodiorite	biotite----------	K-Ar	[2]41.1±1.8	Reid and others, 1968.
18	--do-----------------	biotite----------	K-Ar	46.8±1.7	This paper
		zircon-----------	U-Pb	52 ±7	Do.
19	--do-----------------	biotite----------	K-Ar	46.3±1.7	Do.
		zircon-----------	U-Pb	52 ±7	Do.
		Wallace Formation			
20	schist---------------	whole-rock-------	K-Ar	335 ±4	Armstrong, 1976
21	--do-----------------	--do-------------	K-Ar	520 ±6	Do.
22	--do-----------------	biotite----------	K-Ar	1780 ±50	Hietanen, 1969
		Prichard Formation			
23	schist---------------	whole-rock-------	K-Ar	194 ±2	Armstrong, 1976
24	--do-----------------	--do-------------	K-Ar	1045 ±12	Do.
25	gabbro dike----------	plagioclase------	K-Ar	5190 ±940	Marvin and Dobson, 1979
		Hog Heaven Volcanics[3]			
26	andesite porphyry-----	biotite----------	K-Ar	35.5±0.8	This paper
			K-Ar	36.0±0.8	Do.
27	latite---------------	--do-------------	K-Ar	31.7±2.4	Daniel and Berg, 1981
28	andesitic tuff-------	--do-------------	K-Ar	31.3±0.6	This paper
29	--do-----------------	--do-------------	K-Ar	34.9±0.6	Do.
30	diorite sill---------	hornblende-------	K-Ar	803 ±16	Do.
31	hornfels-------------	margarite--------	K-Ar	775 ±16	Do.
32	diorite sill---------	hornblende-------	K-Ar	854 ±20	Do.
		Garnet Range Formation and Pilcher Quartzite			
33	argillite------------	isochron of 10 whole rocks.	Rb-Sr	910	Obradovich and Peterman, 1968
34	diorite sill---------	biotite----------	K-Ar	770±50	Do.
		Prichard Formation			
35	hornfels-------------	biotite----------	K-Ar	1335±45	Do.

[1] Previously published ages have been recalculated if they were not calculated with the decay constants recommended by the IUGS Subcommission on Geochronology (Steiger and Jager, 1977).
[2] This age has not been recalculated; no analytical data available.
[3] Of Johns, W. M., Smith, A. G., and others, 1963.

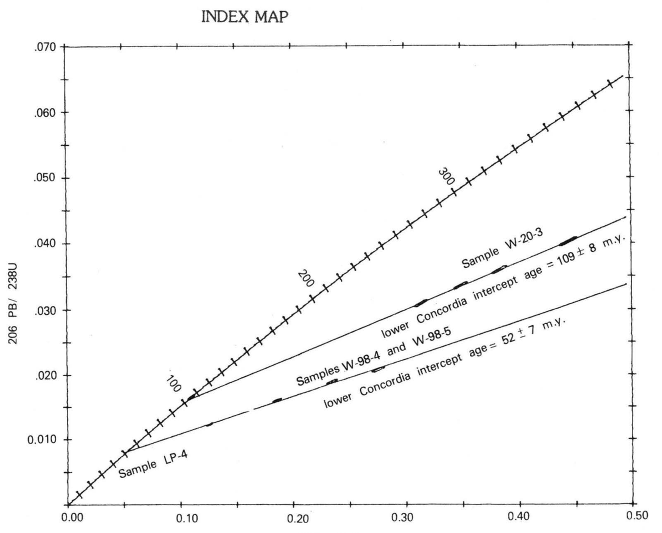


Figure 1.--Concordia plot showing lower concordia intercept ages as determined by U-Pb ratios for zircon separates.

Table 2.--Analytical data for new K-Ar ages

[Ar^{40} values given as percentage of total argon. Constants: $K^{40}\lambda e = 0.581 \times 10^{-10}/yr$ $\lambda_{\beta} = 4.962 \times 10^{-10}/yr$; $K^{40} = 1.167 \times 10^{-4}$. Argon mass spectrometry by Harald H. Mehnert; flame photometry analyses of samples 1-2, 4-6, 18-19 for potassium by V. M. Merritt, D. R. Norton, or E. L. Brandt; isotope dilution analyses of samples 3, 26, 28-32 by Kiyoto Futa.]

Map location number	Sample No. Mineral dated	K_2O%	$^{*}Ar^{40}$ (10^{-10}mol/g)	$^{*}Ar^{40}$%	Age (m.y.) ±2σ
1	W-20-3 hornblende------	1.41, 1.41	2.059	85	99.4±3.4
2	LP-4 biotite---------	8.00, 8.03	5.818	86	49.7±1.7
	K-feldspar------	6.40, 6.36	3.714	79	40.0±1.4
3	LP-2 biotite---------	6.406	3.655	81	38.6±1.1
4	W-36-1 muscovite-------	10.98, 10.94	17.24	86	106 ±3
5	W-36-2 biotite---------	9.14, 9.12	14.52	94	107 ±4
6	W-36-3 hornblende------	0.24, 0.25	0.6862	78	171 ±14
18	W-36-4 biotite---------	8.88, 8.89	6.060	87	46.8±1.7
19	W-98-5 biotite---------	7.56, 7.49	5.076	82	46.3±1.7
26	W-11-4 biotite---------	8.19	4.226	85	35.5±0.8
			4.292	83	36.0±0.8
28	AD-1 biotite---------	8.31	3.778	85	31.3±0.6
29	AD-2 biotite---------	7.42	3.764	73	34.9±0.6
30	AD-4 hornblende------	0.392	5.698	98	803 ±16
31	AD-3 margarite-------	0.507	7.060	96	775 ±16
32	W-59-15 hornblende------	0.396	6.230	92	854 ±20

Table 3.--Analytical data for U-Th-Pb ages for zircon concentrates and one monazite concentrate

[Decay constants: $^{238}U = 1.55125 \times 10^{-10}yr^{-1}$; $^{235}U = 9.8485 \times 10^{-10}yr^{-1}$; $^{232}Th = 4.9475 \times 10^{-11}yr^{-1}$; $^{238}U/^{235}U = 137.88$. Isotopic composition of common lead assumed to be $^{204}Pb:^{206}Pb:^{207}Pb:^{208}Pb$ = 1:18.7:15.6:38.6. See graphical representation of these data on fig. 1. Analytical work done by Loretta Kwak]

Mesh size	Concentration (ppm) U	Th	Pb	Isotopic composition of lead (atom percent) ^{204}Pb	^{206}Pb	^{207}Pb	^{208}Pb	Age, in millions of years $^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{208}Pb/^{232}Th$
1. Hornblende granodiorite [W-20-3]											
- 50+100	367.7	200.9	16.44	0.0383	77.87	6.781	15.31	253	372	1201	256
-150+200	469.6	279.4	18.67	0.0222	78.07	6.359	15.55	227	329	1132	222
-250+324	522.7	355.5	19.43	0.0184	77.93	6.141	15.91	213	304	1081	188
-400	558.9	413.0	19.26	0.0241	77.45	6.058	16.47	196	277	1035	164
monazite	5207	27680	205.4	0.0112	36.35	1.919	61.72	106	106	112	103
2. Quartz monzonite [LP-4]											
-100+200	1139.4	458.9	8.66	0.0571	80.77	5.566	13.61	45	56	560	49
18. Biotite granodiorite [W-98-4]											
-100+200	694.6	103.6	14.81	0.0234	84.19	8.435	7.356	132	247	1554	209
-200+400	691.4	96.5	13.61	0.0544	83.26	8.284	8.403	120	214	1434	201
19. Biotite granodiorite [W-98-5]											
-100+200	565.8	96.0	9.40	0.0517	83.83	7.782	8.337	102	173	1296	141
-200+400	680.7	127.7	8.85	0.0672	82.24	7.083	10.61	78	120	1054	126

REFERENCES

Armstrong, R. L., 1975, The geochronometry of Idaho: Isochron/West, no. 14, p. 1-50.
_____ 1976, The geochronometry of Idaho: Isochron/West, no. 15, p. 1-31.
Cannon, R. S., Jr., Pierce, A. P., Antweiler, J. G., and Buck, K. L., 1962, Lead-isotope studies in the northern Rockies, U.S.A. in Petrologic studies--a volume in honor of A. F. Buddington: Geological Society of America, p. 115-131.
Daniel, F., and Berg, R. B., 1981, Radiometric dates of rocks in Montana: Montana Bureau of Mines and Geology Bulletin 114, 118 p.
Harrison, J. E., Griggs, A. B., and Wells, J. D., 1981, Generalized geologic map of the Wallace $1^{o} \times 2^{o}$ quadrangle, Montana and Idaho: U.S. Geological Survey Miscellaneous Field Investigaions Map MF-1354-A.
Hietanen, A., 1969, Distribution of Fe and Mg between garnet, staurolite, and biotite in aluminum-rich schist in various metamorphic zones north of the Idaho batholith: American Journal of Science, v. 267, p. 422-456.
Hunt, G., 1962, Time of Purcell eruption in southeastern British Columbia and southwestern Alberta: Journal of Alberta Society of Petroleum Geologists, v. 10, p. 438-442.
Johns, W. M., Smith, A. G., and others, 1963, Geologic investigations in the Kootenai-Flathead Area, northwest Montana, western Flathead County, and part of Lincoln County: Montana Bureau of Mines and Geology Bulletin 366 (Progress Report 5), 32 p.
Kleinkopf, M. D., Harrison, J. E., and Zartman, R. E., 1972, Aeromagnetic and geologic map of northwestern Montana and northern Idaho: U.S. Geological Survey Geophysical Investigations Map GP-830.
Larsen, E. S., Jr., Gottfried, D., Jaffe, H. W., and Waring, C. L., 1958, Lead-alpha ages of the Mesozoic batholiths of western North America: U.S. Geological Survey Bulletin 1070-B, p. 35-62.
Long, A., Silverman, A. J., and Kulp, J. L., 1960, Isotopic composition of lead and Precambrian mineralization of the Coeur D'Alene district, Idaho: Economic Geology, v. 55, p. 645-648.
Marvin, R. F., and Dodson, S. W., 1979, Radiometric ages--Compilation B, U.S. Geological Survey: Isochron/West, no. 26, p. 3-32.
McDowell, R. W., 1971, K-Ar ages of igneous rocks from the western United States: Isochron/West, no. 2, p. 1-16.
Obradovich, J. D., and Peterman, Z. E., 1968, Geochronology of the Belt Series, Montana: Canadian Journal of Earth Sciences, v. 5, p. 737-747.
Reid, R. R., and Greenwood, W. R., 1968, Multiple deformation and associated progressive polymetamorphism in the Beltian rocks north of the Idaho batholith, Idaho, U.S.A.: International Geological Congress, 23rd, Prague, 1968, Proceedings, v. 4, p. 75-87.
Reid, R. R., Morrison, D. A., and Greenwood, W. R., 1973, The Clearwater orogenic zone--A relict of Proterozoic orogeny in central and northern Idaho in Belt symposium: Moscow, Idaho, University of Idaho, Department of Geology, p. 10-56.
Steiger, R. H., and Jager, E., 1977, Subcommission on Geochronology: Convention on the use of decay constants in geo- and cosmochronology: Earth and Planetary Science Letters, v. 36, p. 359-362.
Zartman, R. E., and Stacey, J. S., 1971, Lead isotopes and mineralization ages in Belt Supergroup rocks, northwestern Montana and northern Idaho: Economic Geology, v. 66, p. 849-860.

Table 4--Published sources for isotopic lead ratios determined for galenas from within the Wallace $1^{o} \times 2^{o}$ quadrangle

Map location number	Mine or location	Reference
G1	Holiday mine----------------	Zartman and Stacey, 1971
G2	Silver Butte (King) mine----	Do.
G3	Jack Waite mine (Idaho)-----	Cannon and others, 1962
G4	Jack Waite mine (Montana)---	Zartman and Stacey, 1971
G5	Ione mine------------------	Cannon and others, 1962
G6	Galena mine----------------	Long and others, 1960; Zartman and Stacey, 1971
G7	Prospect in south Gem Stock.	Zartman and Stacey, 1971
G8	Success (Granite) mine------	Long and others, 1960; Cannon and others, 1962
G9	Mountain Goat mine----------	Long and others, 1960
G10	Edith Murray (Pontiac) mine.	Do.
G11	Sunrise prospect in north Gem Stock.	Cannon and others, 1962
G12	St. James Prospect in north Gem Stock.	Do.
G13	Hercules mine---------------	Long and others, 1960; Cannon and others, 1962
G14	Star mine------------------	Long and others, 1960; Cannon and others, 1962
G15	Luck Friday mine-----------	Long and others, 1960; Cannon and others, 1962; Zartman and others, 1971
G16	Prospect, Idaho-Montana Silver, Inc.	Cannon and others, 1962
G17	Jim Fiske mine-------------	Zartman and others, 1971
G18	Montana Standard mine-------	Do.
G19	Hemlock mine---------------	Do.
G20	Rock Island mine-----------	Do.
G21[1]	Liver Peak prospect (drill cores).	This paper.
G22	Silver King (Belle Stowe) mine.	Zartman and Stacey, 1971
G23	Russell Group claims (Morning Star Extension).	Do.
G24	Russell Group claims (Blue Bird mine).	Do.
G25	Letterman mine-------------	Do.
G26	Little Pittsburg mine------	Do.
G27	Nancy Lee mine-------------	Do.
G28	Iron Mountain mine---------	Cannon and others, 1962
G29	Gildersleeve mine----------	Zartman and Stacey, 1971
G30	West Flathead mine---------	Do.
G31	Flathead mine--------------	Do.
G32	Battle Butte mine----------	Do.
G33	Jumbo mine-----------------	Do.
G34	Roadcut on westside of Flathead Lake (approximate location)	Cannon and others, 1962
G35	Lucky Lode mine------------	Zartman and Stacey, 1971
G36	Lost Cabin mine------------	Do.

[1] For data on Cenozoic mineralization see table 5.

Table 5.--Analytical ratios for galena samples and a K-feldspar concentrate from the Liver Peak prospect

[These isotopic lead ratios indicate that mineralization occurred during the Cenozoic; analyzed minerals were obtained from drill cores. Analyzed K-feldspar concentrate had 46 ppm Pb, 0.37 ppm U, and 0.21 ppm Th. Analytical work done by Loretta Kwak]

Core No.	Pb^{206}/Pb^{204}	Pb^{207}/Pb^{204}	Pb^{208}/Pb^{204}	Geologic relationships
DDH LP-2, 270m (Wallace Fm)	16.540	15.240	36.518	Galena associated with stockwork of molybdeum-tungsten mineraliation.
DDH LP-1a, 860m (Burke Fm)	16.697	15.274	36.757	Do.
DDH LP-4, 1085m (quartz monzonite stock).	16.557	15.244	36.546	Do.
DDH LP-4, 824m (quartz monzonite stock).	16.647	15.259	36.561	K-feldspar from unaltered quartz monzonite.

GEOCHRONOMETRIC AND LEAD ISOTOPE DATA ON SAMPLES FROM THE WALLACE 1° X 2° QUADRANGLE, MONTANA AND IDAHO

By

R.F. Marvin, R.E. Zartman, J.D. Obradovich and J.E. Harrison

1984

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1984
For sale by Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225