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The Chemistry of Seven Igneous Biotites from Eastern Nevada and Western Utah

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.

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INTRODUCTION

In previous studies we have referred to unpublished analyses of biotites recovered from selected plutons in eastern Nevada and western Utah. The purpose of this report is to present those chemical data and to place them in the context of other information available on the rocks from which the analyzed biotites were recovered. Sample locations (fig. 1), minerals coexisting with the analyzed biotites, and selected references are listed in table 1.

The biotites were prepared for analysis by methods described by Lee and Van Loenen (1970). Final purification was by centrifuging in adjusted mixtures of methylene iodide and bromoform and by repeated passes through the Frantz isodynamic separator. Major elements (table 2) were determined by chemical methods described by Peck (1964) and calculated on the basis of 24 (O, OH, F, Cl) to the general mica formula $X_2Y_{4-6}Z_8O_{20}$ (OH, F, Cl)$_4$, using the computer program described by Jackson, Stevens, and Bowen (1967). Quantitative barium, rubidium, and strontium values were obtained by means of X-ray fluorescence methods described by Lee and Doering (1974, 1980). Semiquantitative spectrographic results are based on their identity with geometric brackets whose boundaries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12 percent, and so forth; and the results are reported arbitrarily as midpoints of these brackets, 1.0, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1 percent, respectively. The precision of a reported value is approximately one bracket at 68-percent or two brackets at 95-percent confidence.

BIOTITE ANALYSES

All of the biotite analyses (table 2) were plotted on a ternary diagram (Lee, Kistler, Friedman, and Van Loenen, 1981, fig. 2) illustrating the chemical differences between these biotites and those recovered from various two-mica granites of northeastern Nevada. Biotites from the two-mica granites typically have MgO contents of about 6 percent, whereas the biotites in table 2 and those from various other muscovite-free granitoids of the eastern Great Basin have MgO contents greater than 9 percent. Biotites from the two-mica granites of northeastern Nevada also contain more Al_2O_3 than do those from the muscovite-free granitoids of the area (Lee and Van Loenen, 1970; Lee, Kistler, Friedman, and Van Loenen, 1981).

Samples 177-MW-60 and 371-DL-66 are from the Osceola stock of Jurassic age. Based on oxygen and strontium isotope data, Lee and Christiansen (in press) suggest that this intrusion originated in the lower crust and that it was contaminated as it passed through a thick Precambrian-Cambrian sequence of quartzite-dominated clastic rocks.

Samples 293 (a xenolith) and 294 are from the intrusion of the Deep Creek Range. Major and minor element data have been presented (Lee, in press) for two samples (GR91 and GR92) of this pluton. Both of these samples contain normative corundum, and sample GR91 has a $\delta^{18}O$ value of 9.6 permil (Lee, Friedman, and Gleason, 1981).

Sample 298 is from the Jurassic intrusion of the House Range. Major and minor element data have been listed (Lee, in press) for two samples (GR3 and GR4) of this pluton. Both these samples contain normative corundum, and sample GR3 has a $\delta^{18}O$ value of 9.3 permil.

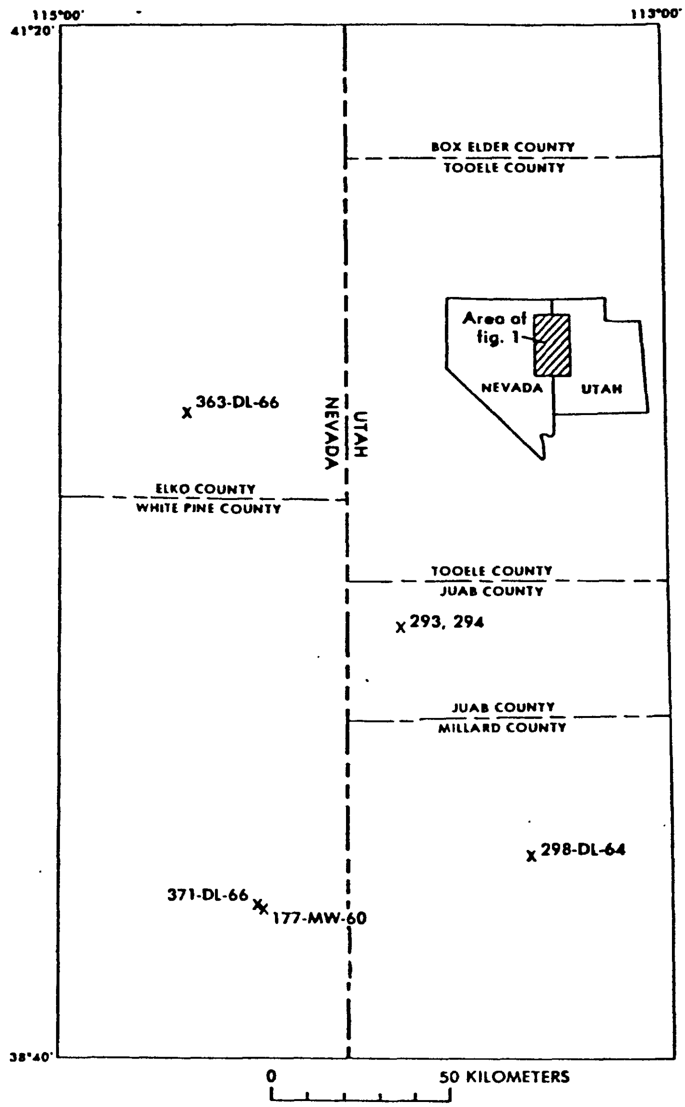

Figure 1.--Northeastern Nevada and northwestern Utah, showing locations of samples included in this study. Sample site 493 is about 88 km east of the southeast corner of the map area. Exact coordinates of all samples listed in table 1.

Table 1.--Data for rocks from which analyzed biotites were recovered

Sample No.	Location Lat N ° ′ ″	Location Long W ° ′ ″	Minerals coexisting with biotite (+ quartz and feldspar)	Selected references
177-MW-60	39 03 49	114 18 27	Magnetite, sphene, epidote, zircon, allanite, and apatite.	Biotite K-Ar age 76 m.y. (Lee and others, 1970); zircon U-Pb age is Jurassic;[1] whole rock Rb-Sr work gave an initial $^{87}Sr/^{86}Sr$ value of 0.7075 at an age of 145 m.y.[2]
371-DL-66	39 04 11	114 18 44	----do----------------------	----do------------------------------
293 (Xenolith)	39 47 16	113 52 30	Amphibole; minor sphene, apatite, and zircon.	
294	39 47 16	113 52 30	Zircon; much apatite and allanite; minor sphene, ilmenite, garnet, and epidote.	
298-DL-64	39 11 14	113 25 04	Minor amphibole; magnetite, zircon, sphene, allanite, and apatite; minor fluorite.	Zircon U-Pb age 169±3 m.y.[1]
363-DL-66	40 20 55	114 34 00	Amphibole, pyroxene, magnetite, apatite, sphene, zircon.	Chemical analysis of apatite (Lee and others, 1973).
493	38 35 15	112 04 12	Pyroxene, magnetite, apatite, zircon.	

[1]Data by D. E. Lee, J. S. Stacey, and L. Fischer will be included in a forthcoming U.S. Geological Survey Professional Paper on isotope research, under the probable title: "Muscovite-phenocrystic two-mica granites of northeastern Nevada are Late Cretaceous in age."

[2]Data by D. E. Lee, R. W. Kistler, and A. C. Robinson will be included in a forthcoming U.S. Geological Survey Professional Paper on isotope research, under the probable title: "The strontium isotope composition of granitoid rocks from the southern Snake Range, Nevada."

Table 2.--Analytical data for selected igneous biotites from eastern Nevada and western Utah

[Methods of analysis given in text. ---, not determined]

Sample No.--	177-MW-60	371-DL-66	293	294	298-DL-64	363-DL-66	493
			Specific Gravity				
Average-----	3.04	3.04	2.99	3.04	3.04	3.06	3.00
Range-------	3.01-3.09	3.01-3.09	2.97-3.01	3.02-3.06	3.02-3.06	3.04-3.08	2.97-3.03
			2V and Index of Refraction (β)				
2V(-)-------	4^{o}-15^{o}	<1^{o}	9^{o}	4^{o}	3^{o}	9^{o}	23^{o}
β Index-----	1.628	1.634	1.616	1.632	1.630	1.644	1.616
		Chemical Analyses (Weight Percent) - Elaine L. Munson Brandt, Analyst					
SiO_2--------	37.02	37.15	39.08	37.78	37.72	37.84	40.79
Al_2O_3-------	16.02	16.16	14.95	15.95	13.76	13.33	11.61
Fe_2O_3-------	4.02	3.86	1.44	2.84	3.16	2.42	1.75
FeO---------	14.83	14.31	13.15	15.22	13.37	13.82	9.61
MgO---------	11.73	11.99	14.75	11.05	14.39	14.42	17.71
CaO---------	.35	.38	.17	.16	.16	.22	1.28
Na_2O--------	.18	.18	.39	.37	.42	.37	.72
K_2O---------	9.29	9.43	9.68	9.38	9.29	9.22	8.64
$H_2O(+)$------	3.58	3.44	2.49	2.80	2.63	2.14	.96
$H_2O(-)$------	.16	.14	.11	.08	.07	.08	.12
TiO_2--------	1.62	1.73	1.71	2.27	2.94	4.38	3.76
P_2O_5-------	.10	.11	.09	.09	.07	.03	.16
MnO---------	.40	.35	.42	.62	.65	.20	.10
Cl----------	.01	.01	.01	.01	.04	.27	.27
F-----------	.53	.49	1.93	1.75	1.40	1.13	3.60
Subtotal----	99.84	99.73	100.37	100.37	100.07	99.87	101.08
Less O------	.22	.21	.81	.74	.60	.54	1.58
Total-------	99.62	99.52	99.56	99.63	99.47	99.33	99.50
		Quantitative Ba, Rb, Sr (Weight Percent) - W. P. Doering, Analyst					
Ba----------	---	0.2179	0.0714	0.1312	0.1059	0.3011	---
Rb----------	---	.0652	.1378	.1343	.1299	.0845	---
Sr----------	---	.0021	.00068	.00087	.00179	.00252	---

Number of Ions on Basis of 24 (O, OH, F, Cl)

		177-MW-60		371-DL-66		293		294		298-DL-64		363-DL-66		493	
Z	P^{5+}------	.01		.01		.01		.01		.01				.02	
	Si-------	5.59	8.00	5.60	8.00	5.84	8.00	5.70	8.00	5.70	8.00	5.76	8.00	6.07	8.00
	Al^{IV}-----	2.40		2.39		2.15		2.29		2.29		2.24		1.91	
Y	Al^{VI}-----	.45		.49		.49		.55		.17		.16		.13	
	Fe^{3+}-----	.46		.44		.16		.32		.36		.28		.20	
	Ti-------	.18	5.65	.20	5.68	.19	5.83	.26	5.62	.33	5.87	.50	6.00	.42	5.89
	Mg-------	2.64		2.70		3.29		2.49		3.24		3.27		3.93	
	Fe^{2+}-----	1.87		1.80		1.65		1.92		1.69		1.76		1.20	
	Mn-------	.05		.05		.05		.08		.08		.03		.01	
X	Ca-------	.06		.06		.03		.03		.03		.04		.20	
	Na-------	.05		.05		.11		.11		.12		.11		.21	
	K--------	1.79	1.90	1.82	1.95	1.85	2.02	1.81	1.97	1.79	1.96	1.79	1.97	1.64	2.05
	Ba-------	---		.01		.01		.01		.01		.02		---	
	Rb-------	---		.01		.02		.01		.01		.01		---	
	OH-------	3.60		3.46		2.48		2.82		2.65		2.17		.95	
	F--------	.25	3.85	.23	3.69	.91	3.39	.84	3.66	.67	3.33	.54	2.78	1.69	2.71
	Cl-------	.00		.00		.00		.00		.01		.07		.07	

Semiquantitative Spectrographic Analyses (Weight Percent) - Leon A. Bradley, Analyst

	177-MW-60	371-DL-66	293	294	298-DL-64	363-DL-66	493
Be----------	0	0.0001	0	0	0.0001	0	0
Co----------	.005	.005	.007	.005	.01	.015	.007
Cr----------	.015	.015	.1	.01	.007	.015	.003
Cu----------	.002	.003	.007	.001	.0007	.007	.003
Ga----------	.005	.005	.007	.01	.01	.01	.005
Li----------	.015	.02	.05	.05	.07	.015	.01
Mo----------	.0005	.0005	0	0	0	0	.0007
Nb----------	0	0	.001	.005	.007	.015	.002
Ni----------	.005	.01	.05	.01	.01	.03	.015
Pb----------	.0015	.001	0	.002	.002	0	.002
Sc----------	.0015	.001	.002	.007	.007	.0007	.0015
Sn----------	0	0	0	.0015	0	0	0
V-----------	.03	.05	.03	.03	.03	.07	.003
Y-----------	0	0	0	0	0	0	.002
Yb----------	.0002	.0002	0	0	0	0	.0002
Zn----------	0	0	0	.05	0	0	0
Zr----------	.007	.005	0	.01	.003	0	.005

Sample 363-DL-66 is from the pluton of the Dolly Varden area. Major and minor element data have been presented (Lee, in press) for two samples (GR125 and GR126) of this pluton. Sample GR125 contains 0.44 percent normative wollastonite, and sample GR126 contains 0.46 percent normative corundum. Sample GR125 has a $\delta^{18}O$ value of 9.1 permil.

Sample 493 is from the stock in Monroe Canyon, Sevier County, Utah. Both the stock and the volcanic rocks it intrudes probably are Miocene in age (Callaghan and Parker, 1961).

R. W. Kistler of the U.S. Geological Survey is engaged in a study of the strontium isotope compositions of all of the rocks mentioned in this report as well as of more than 200 other granitoid rocks collected from throughout the Basin and Range province. When this strontium isotope work is complete, some of the data in tables 1 and 2 may take on added significance.

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