GSA Data Repository Item # 8525

Title of article Petrologic Evidence for Jurassic, Island-Arc-Like Basement Rocks in the Southwestern Transverse Ranges and California Continental Borderland

Author(s) Sorena Sorensen

see Bulletin v. 96, p. 997 - 1006

Contents 16 pages

Appendix I & II; Tables 1 through 5

APPENDIX I:

X-ray Fluorescence (XRF) and Instrumental Neutron Activation Analysis (INAA)

Whole-rock samples for XRF were broken into chips and powdered in a tungsten carbide disc mill. Rock chips used for INAA were abraded with silicon carbide paper, washed with spectroscopic grade acetone, and pulverized to flour in a stainless steel percussion mortar.

Splits of powders for XRF were fused with $Li_2B_4O_7$ at ~ 1050°C for 20 minutes, using the method of Welday and others (1963), then reground in pica (ball) mills and pressed into pellets with a cellulose backing. Standards were fused, reground, and pressed along with samples.

The elements Si, K, Ca, Ti, and Fe were determined using an energy dispersive system (EDAX); Na, Mg, and Al were counted using a crystal spectrometer with a gas proportional counter. Both types of equipment were used at Pomona College, Claremont, California. The background-correcte data were reduced using a working curve method of standard counts versus standard concentrations. Almost all unknown counts were well within the calibration range, but exceptions are noted in the tables. Analyses are believed to be $\pm$ 2 percent for Ca, Fe, Mg, Na, and Al, and $\pm$ 5 percent for Si, Ti, and K.

One hundred milligrams of rock flour were weighed into polyvials for INAA. These were irradiated at the U.C.L.A. Engineering Nuclear Reactor, which has a neutron flux of 2×10^{12} neutrons cm^{-2} sec^{-1}. Three detectors were used. Two are Ge (Li) gamma-ray detectors; one has < 1.85 keV resolution at 1.33 MeV, with 17 percent efficiency, and the other has < 1.75 keV resolution at 1.33 MeV, with 21 percent efficiency. The third is a 31 percent efficiency, high-purity germanium detector with < 1.70 resolution at 1.33 MeV. Mixed element standards were made from known concentration solutions evaporated on high purity MgO or SiO_2 powders. Four different counts of sample activity were made, beginning a few hours after irradiation and ending after four weeks. The data were reduced using a version of the SPECTRA gamma-ray analysis program of Baedecker (1976). Sample concentrations of most elements are $\pm$ 5-10 percent.

APPENDIX II

Electron Probe Microanalysis and Calculation of Mineral Formulae

Mineral analyses were made using U.C.L.A. ARL-EMX microprobe with automated crystal spectrometers. Accelerating voltage was 15 kV, and sample currents were 150 nAmps for plagioclase and micas, and 180 nAmps for all other minerals. A minimum spot was always used. The standards are a variety of analyzed minerals as well as synthetic silicate glasses. Control samples were analyzed at least once every two hours.

The analyses were corrected for background and time. Interelement and matrix effects were corrected using the method and alpha factors of Albee and Ray (1970). Major element analyses are reproducible to within 2 percent. This microprobe analytical procedure is identical to that used and described by Jacobson (1980).

Analyses of plagioclase, garnet, white mica, amphibole, biotite, and staurolite were calculated into formulae using the method outlined in Deer et al. (1966), with some additional considerations described below. All iron is assumed to be ferric iron in plagioclase; cation proportions are calculated on the basis of 8 oxygens. All iron is estimated as ferrous in garnet and the formula is calculated on the basis of 12 oxygens. White mica formulae are based on 11 oxygens, and all iron is assumed to be ferrous.

Amphiboles were normalized to 23 oxygens, and ferric iron estimates were made using the method of Papike et al. (1974), which solves the charge balance of $(Na + K)^{A} + Al^{VI} + Fe^{+3VI} + 2\ Ti^{+4Vi} = Al^{IV} + NaM^{4}$. The site occupancies are as follows: tetrahedral = Si and Al; M(1)-M(3) = Al, Fe^{+3}, Ti^{+4}, Mg, Fe^{+2}, and Mn; M_4 = Mg, Fe^{+2}, Mn, Ca, and Na; A = Na and K.

Biotite is calculated on the basis of 11 oxygens, all iron ferrous, and staurolite on the bais of 46 oxygens, all iron ferrous.

Table 1: Whole-rock, Major-element Analyses of Santa Cruz Island Schist, Santa Monica Formation, Willows Plutonic Complex, Saussurite Gabbro, Los Angeles Basin-KSB 20 Amphibolite, and Puente Hills Greenschist Samples.

Puente Hills (PH) and Santa Cruz Island (SCR) Schists							
	PH	SCR	SCR	SCR	SCR	SCR	SCR
Sample	SPA-3	826SC3	827SC2	Y411A	826SC5	826801	828808
number of analyses	2	2	2	2	2	2	2
(weight %)							
SiO2	51.0	53.9	55.1	56.4	57.7	60.0	74.2
TiO2	1.3	0.6	0.8	0.7	1.7	0.4	0.4
Al2O3	15.2	16.7	16.0	16.0	15.0	15.9	12.8
FeO	7.3	6.9	7.8	9.4	9.9	4.8	3.9
MgO	5.8	5.9	6.2	5.0	3.4	2.4	nd
CaO	11.3	4.6	6.8	2.1	5.0	3.5	0.3
Na2O	3.8	2.9	5.4	6.0	6.6	7.4	5.1
K2O	0.3	4.0	0.2	0.2	0.2	0.5	1.7
Total	96.1	95.6	96.6	96.0	99.6	95.0	98.4

	Santa Monica Formation				Willows Plutonic Complex		
Sample	N167B	N854A	N166	AVSMS	827807	Y411B	827808
number of analyses	2	2	2	6	2	2	2
weight %							
SiO2	57.3	64.6	65.0	63.9	48.4	55.4	53.1
TiO2	0.9	0.8	0.8	0.7	0.6	0.6	0.3
Al2O3	18.6	16.9	17.5	17.6	20.9	16.6	15.8
FeO	6.5	6.5	6.5	5.6	9.3	9.1	8.6
MgO	4.2	1.9	2.2	2.4	4.5	4.2	7.4
CaO	6.8	0.8	0.8	0.8	9.7	8.6	10.0
Na2O	2.9	1.4	1.1	1.4	3.9	3.7	3.4
K2O	1.3	3.0	3.2	2.9	0.3	0.5	0.3
Total	98.5	95.9	97.1	95.3	97.7	98.6	99.0

Table 1 (Continued): Whole-rock, Major-Element Analyses of Santa Cruz Island Schist, Santa Monica Formation, Willows Plutonic Complex, Saussurite Gabbro, Los Angeles Basin-KSB 20 Amphibolites, and Puente Hills Greenschist Samples.

	WPC PxGabb	Saussurite Gabbros				
Sample	Y411D	826803	828809	KSB 23B	CAT-SG2	SA-49A
number of analyses	2	2	2	2	2	2
weight %						
SiO2	47.9	45.4	47.0	53.0	48.1	46.4
TiO2	0.2	tr	tr	0.9	0.1	nd
Al2O3	15.9	19.3	20.9	16.7	16.2	24.8
FeO	6.7	6.9	3.5	8.5	5.7	2.5
MgO	8.9	16.3	15.0	8.0	17.0	15.8
CaO	16.0	12.6	15.0	5.9	14.7	14.0
Na2O	1.3	1.0	1.8	4.5	1.5	
K2O	0.2	0.3	0.2	1.3	0.2	
Total	97.2	101.9	103.5	99.0	103.6	106.3

	Amphibolites		
Sample	KSB 20D	HSSG-1	U-19-1
number of analyses	2	2	2
weight %			
SiO2	53.7	55.7	51.1
TiO2	0.8	0.9	0.5
Al2O3	16.0	16.7	13.7
FeO	7.3	8.3	8.2
MgO	7.7	3.4	11.6
CaO	7.2	8.3	11.3
Na2O	4.8	4.8	2.6
K2O	0.6	0.3	0.4
Total	98.2	98.5	99.5

Table 1 (Continued): Whole-rock Analyses of Trace Elements in Basement Rocks

	Santa Cruz Island (SCR) and Puente Hills (PH) Schists					
	SCR	SCR	SCR	SCR	SCR	PH
Sample	826SC3	Y411A	826SC5	826801	828808	SPA-3
(µg/g)						
Sc	33.0	28.5	29.1	19.4	13.4	28.4
Cr	85.7	15.8	7.0	13.2	5.9	42.9
Co	32.3	28.4	26.7	17.9	4.5	28.0
Zn	73.2	301	76.1	41.0	41.4	70.2
Ga	22.9					18.6
Rb	52.6				23.3	
Sr		1.1	72.3	148		480
Zr	177	46	161	237	114	53.2
Sb	0.3	0.1	0.3	0.2	0.1	0.9
Cs	0.4			0.1	0.3	
Ba	719	33	35	103	323	66.9
La	3.0	6.5	5.0	8.9	2.9	5.4
Ce	8.3	13.4	12.3	18.1	6.3	14.1
Nd	6.3	8.6	12.7	10.0	5.0	12.7
Sm	2.3	2.4	3.1	2.3	0.7	2.9
Eu	0.7	0.9	1.2	0.8	0.3	1.1
Gd	4.5		7.1			5.4
Tb	0.5	0.5	0.8	0.4	0.2	0.7
Dy	3.4	5.2		3.3	3.7	6.9
Ho	0.5	0.7		0.7	0.2	0.7
Yb	1.8	1.8	2.6	1.7	1.3	2.0
Lu	0.3	0.3	0.5	0.3	0.3	0.4
Hf	1.8	2.1	2.4	3.3	4.0	2.4
Ta	0.2	0.1	0.2	0.3	0.3	0.3

Table 1(Continued): Whole-rock Analyses of Trace Elements in Basement Rocks

	Willows Plutonic Complex				
				Altered	Gabbros
Sample	827807	827808	Y411D	826SC3	828809
(µg/g)					
Sc	36.8	40.1	59.4	21.0	25.7
Cr	13.2	142	136	39.9	888
Co	23.6	35.4	46.9	64.1	27.7
Ni			137	83.6	204
Sr	503	244	315	182	131
Zr			218		
Sb		0.067		0.086	0.151
Cs	0.2				
Ba	62.3				
La	4.1	3.0	0.4	0.3	0.7
Ce	9.4	6.8	2.3	0.7	1.3
Nd	6.9	4.5			1.3
Sm	2.7	1.1	0.5	0.1	0.5
Eu	0.9	0.4	0.3	0.1	0.2
Gd		1.4			1.1
Tb	0.5	0.2	0.2	0.1	0.1
Dy	3.8	1.4	1.7		0.6
Tm	0.7	0.7		0.4	0.4
Yb	1.6	0.7	0.5	0.1	0.5
Lu	0.24	0.11	0.09	0.03	0.08
Hf	0.8	1.1	1.33		0.09
Th	0.2	0.8			
U		0.1			

Table 1 (Continued): Whole-rock Analyses of Trace Elements in Basement Rocks

	Saussurite Gabbros			Amphibolites			
Sample	KSB-23B	CAT-SG2	SA-49A	U-19-1	KSB-20D	HSSG-1	CI
(µg/g)							
Sc	20.6	41.5	1.5	54.3	29.4	29.0	5.76
Cr	68.2	604	58.1	438	235	15.2	2640
Co	30.1	41.0	26.1	41.7	35	29	502
Ni	82.9	190	258		118		11000
Rb			5.4	9.1	8.8		2.29
Sr	939	214	239	161	644	249	7.9
Zr						209	3.7
Sb	0.52		0.136	0.9	0.1	0.2	0.162
Cs	1.1	0.4	0.3	0.6	2.0		0.187
Ba	194	37	121	130	113	49	2.27
La	15.8	0.6	0.2	1.0	13.3	8.6	0.236
Ce	28.9	1.4	0.5	3.5	1.9	17.8	0.616
Nd	18.7	1.9		3.0	9.2	10.6	0.457
Sm	3.5	0.6	0.08	1.3	2.0	3.1	0.149
Eu	1.3	0.4	0.3	0.6	0.7	1.2	0.056
Gd	3.4	1.6		2.2	2.1	2.7	0.197
Tb	0.5	0.2		0.3	0.4	0.5	0.036
Dy	2.8	1.2		1.4	5.1	3.8	0.245
Tm	0.6		0.3	0.7	0.6	0.7	0.01
Yb	1.4	0.6	0.1	1.2	1.5	1.7	0.159
Lu	0.23	0.1	0.01	0.2	0.3	0.3	0.024
Hf	1.7			0.7	1.5	2.1	0.119
Ta	0.1				0.1	0.2	0.016
Th	1.7			0.1	2.2	1.1	0.029
U	0.8			0.2	0.2	1.7	0.008

Table 2: Analyses of Plagioclase from Basement Rocks

	Willows Plutonic Complex						
	Gabbros		Hornblende Gabbros				Saus Gabb
Sample	Y411D	T302	827807	827808	Y411B	Y411E	828809
number of analyses	11	5	3	2	3	8	2
(weight %)							
SiO2	45.5	49.7	53.8	53.0	54.8	49.7	68.8
Al2O3	34.4	32.5	29.7	28.8	29.1	32.4	18.9
Fe2O3	0.3	0.2	0.2	0.2	0.4	0.1	0.0
CaO	18.2	14.6	11.2	11.7	10.8	15.5	0.4
Na2O	1.0	3.4	5.3	4.9	5.6	2.8	11.5
K2O	(0.02)	(0.01)	0.0	0.1	0.1	(0.06)	0.09
Total	99.42	100.41	100.2	98.9	100.5	100.66	100.59
	Cations on the basis of an 8 oxygen formula						
Si	2.11	2.26	2.42	2.43	2.46	2.26	2.99
Al IV	1.88	1.74	1.58	1.55	1.54	1.73	1.01
Fe3	0.01	0.0	0.0	0.02	0.0	0.0	0.0
Ca	0.90	0.71	0.54	0.57	0.52	0.75	0.02
Na	0.09	0.30	0.46	0.43	0.48	0.25	0.97
K	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.99	1.01	1.00	1.00	1.00	1.00	0.99
an	91	70	54	56	51	75	02
ab	09	30	46	43	48	25	98
or	00	00	00	00	00	00	00

	Santa Cruz Island and Puente Hills Greenschist						
Sample	826SC3	827SC1	828808	826SC4	826807	8278010	SPA6-2
number of analyses	4	7	7	4	5	4	3
(weight %)							
SiO2	67.5	68.9	67.1	69.3	67.6	68.8	67.4
Al2O3	19.6	19.9	19.6	20.2	19.9	19.7	19.9
Fe2O3	0.1	(0.03)	(0.02)	(0.06)	0.0	(0.04)	0.3
CaO	0.1	0.3	0.2	0.2	0.0	0.4	0.1
Na2O	11.5	10.9	11.5	12.4	11.6	11.9	11.3
K2O	0.1	0.1	(0.05)	(0.01)	0.1	(0.05)	0.0
Total	99.3	100.1	98.57	101.97	99.6	100.59	99.2
	Cations on the basis of an 8 oxygen formula						
Si	2.99	3.00	2.98	2.97	2.97	2.99	2.97
Al IV	1.02	1.02	1.02	1.02	1.03	1.01	1.03
Fe3	0.0	0.0	0.0	0.0	0.0	0.0	0.01
Ca	0.0	0.01	0.01	0.0	0.02	0.0	0.01
Na	0.98	0.92	0.99	1.03	0.98	1.00	0.97
K	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.98	0.93	1.00	1.03	1.00	1.00	0.98
an	00	01	01	00	02	00	01
ab	100	99	99	100	98	100	99
or	00	00	00	00	00	00	00

Table 2 (Continued): Analyses of Plagioclase

Santa Monica Formation

Sample	N854A	N525	N176	N184A	N188	Metagraywackes N198A	N167
number of analyses	4	5	6	6	5	3	6
(weight %)							
SiO2	60.3	62.1	59.6	60.6	65.0	51.6	56.0
Al2O3	24.0	22.1	24.6	23.9	21.0	28.3	26.4
Fe2O3	0.3	0.1	0.1	0.3	0.0	0.1	0.1
CaO	6.0	3.7	6.4	5.4	1.9	11.0	9.0
Na2O	8.7	9.5	8.2	8.8	10.3	4.6	6.6
K2O	0.1	0.2	0.1	0.2	0.1	0.1	
Total	99.4	97.7	99.1	99.1	98.4	95.7	98.2
Cations on the basis of an 8 oxygen formula							
Si	2.71	2.81	2.68	2.72	2.90	2.43	2.56
Al IV	1.27	1.18	1.31	1.26	1.10	1.57	1.42
Fe3	0.01	0.0	0.0	0.01	0.0	0.0	0.0
Ca	0.29	0.18	0.31	0.26	0.09	0.55	0.44
Na	0.75	0.83	0.72	0.77	0.89	0.42	0.58
K	0.0	0.01	0.01	0.0	0.01	0.0	0.0
Total	1.04	1.02	1.04	1.03	0.99	0.97	1.02
an	27	18	30	25	09	56	43
ab	72	81	69	74	90	43	57
or	01	01	01	01	01	01	01

Metasediments from Los Angeles Basin Wells

Sample	SeabPk-1	CSP-1	HSSG-1	ShBart1-1	ShBart1-1	HSSG-1amphib
number of analyses	4	6	5	2rims	2cores	4
(weight %)						
SiO2	62.6	61.8	59.9	66.8	66.1	64.2
Al2O3	22.4	23.2	24.9	20.3	20.7	23.1
Fe2O3	0.1	0.1	0.2	0.1	0.2	0.1
CaO	3.9	5.3	6.8	1.5	1.1	3.7
Na2O	9.2	8.8	8.2	10.8	9.7	9.6
K2O	0.1	0.1	0.2	0.1	2.2	0.1
Total	98.3	99.3	100.2	99.6	100.0	100.8
Cations on the basis of an 8 oxygen formula						
Si	2.81	2.76	2.67	2.94	2.92	2.81
Al IV	1.42	1.22	1.31	1.05	1.08	1.19
Fe3	0.0	0.0	0.01	0.0	0.01	0.0
Ca	0.19	0.25	0.32	0.07	0.05	0.17
Na	0.80	0.76	0.71	0.92	0.83	0.82
K	0.0	0.0	0.01	0.0	0.12	0.0
Total	0.99	1.01	1.04	0.99	1.00	0.99
an	19	25	31	07	05	17
ab	80	74	68	92	83	83
or	01	01	01	01	12	00

Table 3: Analyses of Amphibole from Basement Rocks

	Willows	Plutonic			Complex
	Px Gabbro	Hornblende Gabbros			
Sample	Y411D	827807	827808	Y411B	Y411E
number of analyses	14	9	12	14	8
(weight %)					
SiO2	44.2	47.3	51.5	46.8	49.9
TiO2	1.6	1.4	0.3	1.3	0.4
Al2O3	11.6	8.0	4.1	8.0	7.1
FeO	10.2	14.8	12.6	15.9	12.2
MgO	15.3	14.4	16.4	13.3	16.0
MnO	0.1	0.4	0.2	0.4	0.3
CaO	12.1	10.4	12.0	10.7	11.6
Na2O	2.1	1.0	0.4	1.3	1.0
K2O	0.3	0.2	0.1	0.2	0.2
Total	97.5	97.9	97.6	97.9	98.7
Cations on the basis of a 23 oxygen amphibole formula					
Si	6.41	6.88	7.39	6.87	7.11
Al IV	1.59	1.12	0.61	1.13	0.89
Al VI	0.39	0.25	0.08	0.26	0.30
Ti	0.17	0.15	0.03	0.14	0.04
Fe3 est	0.21	0.24	0.34	0.17	0.19
Mg	3.31	3.12	3.51	2.91	3.40
Fe2	1.03	1.56	1.17	1.78	1.26
Mn	0.01	0.05	0.02	0.05	0.04
Total VI	5.12	5.40	5.16	5.32	5.23
Excess VI	0.12	0.40	0.16	0.32	0.23
Ca	1.88	1.62	1.84	1.68	1.77
NaM4	0.0	0.0	0.0	0.0	0.0
NaA	0.59	0.28	0.11	0.37	0.28
K	0.06	0.04	0.02	0.04	0.04
A Total	0.65	0.32	0.13	0.41	0.32
Mg/(Mg+F2)	0.76	0.67	0.75	0.62	0.73

11 07 16

Table 3 (Continued): Analyses of Amphibole from Basement Rocks

Saussurite Gabbros

Sample	828809	826803	826803	CAT-SG2	SA-49A	SA-49A	KSB-23B
number of analyses	15	10	2	1	16	9	12
(weight %)							
SiO2	53.9	53.4	45.4	58.7	55.8	50.1	51.0
TiO2	0.2	0.1	0.1	0.0	(0.02)	0.2	0.7
Al2O3	4.2	3.2	14.0	0.5	2.3	8.9	5.1
FeO	5.0	8.9	9.0	3.3	4.0	5.7	11.6
MgO	20.3	19.2	16.8	23.6	21.9	18.6	16.8
MnO	0.1	0.2	0.1	0.06	0.07	0.08	0.3
CaO	12.9	11.9	11.8	13.0	12.6	12.6	12.2
Na2O	0.6	0.4	2.2	0.09	0.6	2.0	0.5
K2O	0.2	(0.06)	0.3	0.0	(0.07)	0.2	0.2
Total	97.4	97.4	99.7	99.3	97.4	98.4	98.4
Cations on the basis of a 23 oxygen amphibole formula							
Si	7.53	7.54	6.35	7.92	7.74	7.01	7.24
Al IV	0.47	0.46	1.65	0.08	0.26	0.99	0.76
Al VI	0.22	0.07	0.66	0.0	0.11	0.48	0.10
Ti	0.02	0.01	0.01	0.0	0.0	0.02	0.07
Fe3 est	0.0	0.24	0.32	0.06	0.0	0.0	0.33
Mg	4.23	4.04	3.50	4.74	4.53	3.88	3.56
Fe2	0.58	0.81	0.73	0.32	0.46	0.67	1.04
Mn	0.01	0.02	0.01	0.01	0.01	0.01	0.04
Total VI	5.07	5.20	5.23	5.12	5.11	5.06	5.14
Excess VI	0.07	0.20	0.23	0.12	0.11	0.06	0.14
Ca	1.93	1.80	1.77	1.88	1.87	1.89	1.86
NaM4	0.0	0.0	0.0	0.0	0.01	0.06	0.0
NaA	0.16	0.11	0.60	0.02	0.15	0.49	0.14
K	0.04	0.01	0.05	0.0	0.01	0.04	0.04
A Total	0.20	0.12	0.65	0.02	0.16	0.53	0.18
Mg/(Mg+F2)	0.88	0.83	0.83	0.94	0.91	0.85	0.00

Table 3 (Continued): Analyses of Amphiboles from Basement Rocks

	Northern Margin/KSB-20 Amphibolite					Sta Monica Metagraywacke	
Sample	U-19-1	U-19-1	HSSG-1	HSSG-1	KSB-20D	N167B	N167B
number of analyses	1	1	15	3	22	1C	1R
(weight %)							
SiO2	47.6	53.2	44.8	49.3	45.6	49.8	50.3
TiO2	0.3	(0.07)	0.4	0.4	0.7	1.3	0.4
Al2O3	9.9	3.4	10.8	6.1	11.5	6.1	6.5
FeO	13.9	8.7	17.5	14.8	12.9	16.1	14.6
MgO	13.1	18.0	10.8	13.7	13.4	14.2	14.5
MnO	0.1	0.1	0.3	0.4	0.2	0.3	0.3
CaO	11.4	12.2	11.0	11.1	11.4	11.0	10.9
Na2O	1.7	0.7	1.8	1.1	1.3	0.5	0.6
K2O	0.1	(0.03)	0.2	(0.05)	0.1	0.2	0.1
Total	98.2	96.43	97.6	97.05	97.1	99.5	98.2
Cations on the basis of a 23 oxygen amphibole formula							
Si	6.91	7.62	6.68	7.26	6.65	7.14	7.25
Al IV	1.09	0.38	1.32	0.74	1.35	0.86	0.75
Al VI	0.61	0.20	0.58	0.32	0.63	0.17	0.36
Ti	0.03	0.01	0.05	0.04	0.08	0.14	0.04
Fe3 est	0.0	0.0	0.09	0.0	0.18	0.24	0.12
Mg	2.84	3.84	2.40	3.01	2.91	3.03	3.12
Fe2	1.69	1.04	2.09	1.82	1.40	1.69	1.65
Mn	0.02	0.02	0.04	0.05	0.03	0.04	0.04
Total VI	5.18	5.11	5.24	5.25	5.22	5.31	5.32
Excess VI	0.18	0.11	0.24	0.25	0.22	0.31	0.32
Ca	1.77	1.87	1.76	1.75	1.78	1.69	1.68
NaM4	0.04	0.02	0.0	0.0	0.0	0.0	0.0
NaA	0.44	0.18	0.52	0.31	0.37	0.14	0.17
K	0.02	0.01	0.04	0.01	0.02	0.04	0.02
A Total	0.46	0.19	0.56	0.32	0.39	0.18	0.19
Mg/(Mg+F2)	0.63	0.79	0.53	0.62	0.68	0.64	0.00

Table 3 (Continued): Analyses of Amphibole from Basement Rocks

	Santa Cruz Island Schist						
	core	rim	core	rim			
Sample	826801	826801	826807	826807	8278010	828805	826SC5
number of analyses	6	6	3	3	7	13	8
(weight %)							
SiO2	46.7	54.2	48.7	54.8	52.6	52.1	53.7
TiO2	1.6	(0.02)	1.4	(0.02)	(0.02)	(0.04)	0.02
Al2O3	5.8	1.1	6.5	1.1	2.0	2.7	1.3
FeO	13.8	11.2	14.6	14.5	16.8	14.5	12.2
MgO	14.7	16.8	14.3	15.3	13.2	14.4	16.3
MnO	0.2	0.3	0.3	0.3	0.3	0.6	0.2
CaO	11.0	11.9	10.7	11.5	11.4	10.1	11.7
Na2O	1.5	0.5	1.6	0.6	1.0	1.2	0.4
K2O	0.1	(0.05)	0.1	0.1	0.1	0.1	(0.05)
Total	95.5	96.17	98.2	98.2	97.6	95.74	95.97
Cations on the basis of a 23 oxygen amphibole formula							
Si	6.99	7.87	7.10	7.89	7.74	7.72	7.85
Al IV	1.01	0.13	0.90	0.11	0.26	0.28	0.15
Al VI	0.02	0.06	0.21	0.08	0.09	0.19	0.07
Ti	0.18	0.0	0.15	0.0	0.02	0.0	0.0
Fe3 est	0.16	0.0	0.0	0.0	0.0	0.0	0.0
Mg	3.28	3.64	3.11	3.28	2.90	3.18	3.55
Fe2	1.57	1.36	1.78	1.75	2.07	1.80	1.49
Mn	0.03	0.04	0.04	0.04	0.04	0.08	0.02
Total VI	5.24	5.10	5.29	5.15	5.11	5.25	5.14
Excess VI	0.24	0.10	0.29	0.15	0.11	0.25	0.14
Ca	1.77	1.85	1.67	1.77	1.80	1.60	1.83
NaM4	0.0	0.05	0.04	0.08	0.09	0.14	0.03
NaA	0.44	0.09	0.41	0.09	0.20	0.20	0.09
K	0.03	0.01	0.02	0.02	0.02	0.02	0.01
A Total	0.47	0.10	0.43	0.11	0.22	0.22	0.10
Mg/(Mg+F2)	0.68	0.73	0.64	0.65	0.58	0.64	0.00

Table 4 : Analyses of White Micas from Basement Rocks

	Santa Monica Formation						
Sample	N525	N176	N166	N184A	N854A	N188	N188
number of analyses	5	2	3	3	3	4	1
(weight %)							
SiO2	47.7	47.1	48.3	46.0	47.3	45.6	44.4
TiO2	0.4	0.0	0.5	0.5	0.4	0.0	0.6
Al2O3	37.5	34.4	38.0	36.6	36.2	35.8	34.9
FeO	1.0	2.3	1.0	1.2	1.5	0.8	1.3
MgO	0.6	2.4	0.6	0.6	0.8	0.7	4.0
Na2O	0.4	0.4	0.8	0.6	0.8	0.4	0.1
K2O	10.3	9.4	9.7	10.0	9.0	9.8	9.4
Total	97.9	96.0	98.9	95.5	96.0	93.1	94.9
	Cations on the basis of an 11 oxygen formula						
Si	3.07	3.10	3.07	3.04	3.09	3.08	2.97
Al IV	0.93	0.90	0.93	0.96	0.91	0.92	1.03
Al VI	1.91	1.77	1.91	1.89	1.88	1.93	1.73
Ti	0.02	0.0	0.02	0.02	0.02	0.0	0.03
Mg	0.06	0.23	0.06	0.06	0.08	0.07	0.40
Fe2	0.05	0.13	0.05	0.07	0.08	0.05	0.07
Total VI	2.04	2.13	2.04	2.04	2.06	2.05	2.24
Na	0.05	0.05	0.10	0.08	0.10	0.05	0.01
K	0.85	0.79	0.78	0.84	0.75	0.84	0.80
Total	0.90	0.84	0.88	0.92	0.85	0.89	0.81

	Sta Monica Fm			Sta Cr	Isl	Sch
Sample	HSSG-1	CSP-1	SeabCH-5	826SC3	828808	
number of analyses	6	2	5	5	5	
(weight %)						
SiO2	47.0	47.5	45.4	50.2	48.1	
TiO2	0.5	0.0	0.4	0.1	0.2	
Al2O3	35.8	36.3	35.8	25.4	25.3	
FeO	1.0	0.7	1.0	5.8	7.2	
MgO	0.8	0.6	0.5	3.6	2.8	
Na2O	1.1	0.7	1.1	0.1	0.1	
K2O	7.9	9.3	8.5	10.3	9.0	
Total	94.1	95.3	92.7	95.5	92.7	
	Cations on the basis of an 11 oxygen formula					
Si	3.11	3.12	3.07	3.40	3.36	
Al IV	0.89	0.88	0.93	0.60	0.64	
Al VI	1.90	1.93	1.92	1.43	1.45	
Ti	0.02	0.0	0.02	0.0	0.01	
Mg	0.08	0.06	0.05	0.36	0.29	
Fe2	0.06	0.04	0.06	0.33	0.42	
Total VI	2.06	2.03	2.05	2.12	2.17	
Na	0.14	0.09	0.14	0.01	0.01	
K	0.67	0.78	0.73	0.89	0.80	
Total	0.81	0.87	0.87	0.90	0.81	

Table 5 : Analyses of Biotite, Garnet, and Staurolite from the Santa Monica Formation

Sample	Biotite N198A	Biotite N525	Biotite N176	Biotite N166	Biotite N184	Biotite N854	Biotite SeabPk1
number of analyses	3	9	6	4	5	4	5
(weight %)							
SiO2	34.3	35.6	34.4	36.1	35.5	35.7	33.8
TiO2	3.0	2.9	3.7	2.7	2.7	1.5	1.5
Al2O3	19.4	21.2	19.0	20.6	20.0	20.5	21.5
FeO	22.6	20.0	18.1	20.7	18.4	19.4	19.8
MgO	7.8	8.3	9.8	9.5	9.0	10.3	9.6
MnO	0.3	0.1	0.2	0.2	0.1	0.1	0.2
Na2O	0.2	0.1	0.2	0.2	0.2	0.2	0.4
K2O	8.1	7.7	8.7	9.1	8.9	7.4	7.1
Total	96.0	96.0	94.1	99.1	94.8	95.1	94.0
Cations on the basis of an 11 oxygen biotite formula							
Si	2.63	2.66	2.63	2.64	2.69	2.68	2.59
Al IV	1.37	1.34	1.37	1.36	1.31	1.32	1.41
Al VI	0.38	0.52	0.34	0.42	0.48	0.49	0.53
Ti	0.17	0.16	0.22	0.15	0.16	0.09	0.09
Mg	0.89	0.93	1.12	1.03	1.01	1.15	1.09
Fe2	1.45	1.25	1.16	1.27	1.17	1.22	1.26
Mn	0.02	0.01	0.02	0.01	0.01	0.01	0.01
Total VI	2.91	2.87	2.86	2.88	2.83	2.96	2.98
Na	0.02	0.02	0.03	0.02	0.03	0.03	0.05
K	0.79	0.74	0.87	0.85	0.86	0.71	0.69
Total	0.81	0.76	0.90	0.87	0.89	0.74	0.74

16 of 16

Table 5 (Continued): Analyses of Biotite, Garnet and Staurolite from the Santa Monica Formation

	Biotite	Garnet core	Garnet rim	Staurolite rim	Staurolite core
Sample	HSSG-1	HSSG-1	HSSG-1	HSSG-1	HSSG-1
number of analyses	2	3	3	4	4
(weight %)					
SiO2	34.5	37.5	38.0	28.5	28.5
TiO2	1.0	0.1	0.1	0.7	0.6
Al2O3	19.7	21.5	21.9	52.4	53.0
FeO	17.4	31.7	34.0	12.6	12.6
MgO	11.3	3.3	3.2	1.3	1.6
MnO	0.0	6.1	3.5	0.2	0.2
CaO	0.0	1.8	2.5	0.0	0.0
ZnO	0.0	0.0	0.0	0.5	0.4
Na2O	0.3	0.0	0.0	0.0	0.0
K2O	8.5	0.0	0.0	0.0	0.0
Total	92.7	102.0	103.2	97.3	96.8
Cations on the basis of an 11 oxygen formula for biotite Cations on the basis of a 12 oxygen formula for garnet Cations onthe basis of a 46 oxygen formula for staurolite					
Si	2.67	2.97	2.97	7.91	7.95
Al IV	1.33	0.03	0.03	0.09	0.05
Al VI	0.50	1.98	1.98	17.45	17.32
Ti	0.06	0.0	0.0	0.14	0.13
Mg	1.30	0.39	0.37	0.55	0.64
Fe2	1.13	2.10	2.22	2.92	2.93
Mn	0.0	0.41	0.24	0.04	0.03
Ca	0.0	0.15	0.21	0.0	0.0
Zn	0.0	0.0	0.0	0.10	0.08
Na	0.04	0.0	0.0	0.0	0.0
K	0.83	0.0	0.0	0.0	0.0
Total	0.89	8.05	8.04		