DATA REPOSITORY ITEM DR-1, U-Pb SHRIMP-RG ANALYTICAL PROCEDURES

U-Pb analyses were performed at the Stanford - U.S.G.S. Micro Analytical Center (SUMAC). Zircon grains were prepared at Stanford University using standard mineral separation techniques, including, Frantz magnetic and heavy liquid separations. Separated zircons were handpicked under a binocular microscope to ensure purity and freedom from cracks, inclusions, or obvious alteration. The selected grains were mounted in epoxy with the laboratory standard R33 (419 Ma) and polished with diamond compound to expose the mid-points of the crystals. Polished grain mounts were imaged in reflected light with an optical microscope, gold-coated, and imaged in cathodoluminescence (CL) mode with a JEOL 5600 scanning electron microscope (SEM).

The SHRIMP-RG ion microprobe at SUMAC was operated with an O_2^- primary ion beam varying from 4 to 6 nA, which produced a spot with a diameter of ~20–30 µm and a depth of 1–2 µm on the target zircons. Eleven peaks were measured sequentially for 10 min with an ETP electron multiplier (Zr_2O, ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{238}U, ThO, UO, ErO, YbO, and HfO). Data was reduced following the methods described by Ireland and Williams (2003), using the SQUID and IsoPlot programs of Ludwig (2001, 2003).

References

Ireland, T.R. and Williams, I.S., 2003, Considerations in zircon geochronology by SIMS: Reviews in Mineralogy and Geochemistry, v. 53, p. 215-241.

Ludwig, K.R., 2001, Eliminating mass-fractionation effects on U-Pb isochron ages without double spiking: Geochimica et Cosmochimica Acta, v. 65, n. 18, p. 3139-3145.

Ludwig, K.R., 2003, Isoplot 3.00: Special Publication 4, Berkeley Geochronology Center, Berkeley, California.

TABLE DR1: TABULATED ZIRCON U/Pb AGE DATA FROM VOLCANIC AND INTRUSIVE SAMPLES

Sample grain	% Common	^{206}Pb	ppm U	ppm Th	232Th/238 U	^{207}Pb$_{corr}$ 206/238 Age (Ma)	err (1σ)	Total 238/206	err (%)	Total 207/206	err (%)	^{204}Pb$_{corr}$ 207/235	err (%)	^{204}Pb$_{corr}$ 206/238	err (%)
07-72 gabbro															
72-1.1	2.62	347	299	0.89		**16.6**	**0.3**	378.8	1.9	0.0671	9.9			0.0025	3.6
72-2.1	0.35	824	989	1.24		**16.9**	**0.2**	380.5	1.4	0.0491	5.0	0.0112	24.6	0.0026	1.6
72-3.1	1.85	259	198	0.79		**16.8**	**0.4**	376.0	2.2	0.0610	8.2	0.0179	18.6	0.0026	2.4
72-4.1	0.48	468	487	1.07		**16.4**	**0.3**	390.7	1.7	0.0502	6.6	0.0130	19.5	0.0025	1.9
72-5.1	1.00	866	1093	1.30		**17.1**	**0.2**	372.8	1.4	0.0543	4.7	0.0149	17.8	0.0026	1.6
72-6.1	0.40	948	1255	1.37		**16.7**	**0.2**	383.5	1.3	0.0495	4.7	0.0162	8.6	0.0026	1.4
72-7.1	0.92	644	708	1.14		**16.5**	**0.3**	386.9	1.6	0.0536	5.7	0.0111	32.7	0.0025	2.0
72-8.1	-0.06	985	975	1.02		**17.1**	**0.2**	375.6	1.3	0.0459	4.7	0.0125	18.0	0.0026	1.5
72-9.1	1.38	908	1106	1.26		**17.3**	**0.2**	367.9	1.3	0.0573	4.4	0.0172	11.8	0.0027	1.5
72-10.1	0.65	1041	1404	1.39		**16.8**	**0.2**	379.9	1.3	0.0515	4.3	0.0130	19.9	0.0026	1.5
09-217 volcanic ash															
217-1.1*	1.45	164	99	0.62		**106.4**	**1.4**	59.2	1.3	0.0597	3.7	0.0844	22.8	0.0164	1.6
217-2.1	-0.05	373	265	0.73		**98.8**	**1.1**	64.8	1.1	0.0476	2.8	0.0927	5.2	0.0154	1.1
217-3.1*	0.06	371	240	0.67		**95.5**	**1.0**	67.0	1.1	0.0484	2.7	0.0915	6.3	0.0149	1.1
217-4.1*	9.14	203	166	0.84		**95.9**	**1.7**	60.6	1.3	0.1205	7.2	0.0553	81.3	0.0147	2.7
217-5.1	0.36	385	247	0.66		**102.6**	**1.1**	62.1	1.1	0.0510	2.5	0.1015	5.7	0.0160	1.1
217-6.1	0.13	163	63	0.40		**99.3**	**1.3**	64.3	1.3	0.0490	4.0	0.0866	11.3	0.0154	1.4
217-7.1	2.16	144	69	0.50		**101.0**	**1.4**	62.0	1.4	0.0652	3.7	0.1205	9.8	0.0159	1.5
217-8.1*	0.45	216	80	0.38		**97.4**	**1.2**	65.4	1.2	0.0515	3.5	0.1086	3.7	0.0153	1.2
217-9.1	6.92	312	237	0.79		**101.0**	**1.6**	58.9	1.1	0.1030	8.7	0.0633	95.9	0.0155	3.4
217-10.1	-0.04	333	191	0.59		**100.5**	**1.1**	63.7	1.1	0.0477	2.8	0.1003	3.6	0.0157	1.1
217-11.1*	0.07	1437	185	0.13		**142.9**	**1.3**	44.6	0.9	0.0495	1.1	0.1502	1.6	0.0224	0.9
217-12.1	0.07	348	243	0.72		**101.9**	**1.1**	62.7	1.1	0.0486	2.7	0.0966	5.5	0.0159	1.1
09-206 dacite															
206-1.1	1.06	398	520	1.35		**19.9**	**0.3**	320.6	1.6	0.0548	5.7	0.0084	68.6	0.0030	2.3
206-2.1	2.67	81	75	0.95		**20.0**	**0.7**	312.8	3.3	0.0675	12.2			0.0026	10.0
206-3.1	6.99	37	32	0.90		**21.7**	**1.1**	275.3	4.6	0.1017	14.1			0.0023	24.7
206-4.1	20.10	39	29	0.76		**18.5**	**1.1**	278.2	4.5	0.2053	11.5			0.0020	32.4
206-5.1	5.56	79	44	0.58		**19.2**	**0.7**	316.2	3.3	0.0903	10.6			0.0028	7.6
206-6.1	3.26	63	37	0.60		**19.4**	**0.7**	321.3	3.7	0.0722	13.1			0.0025	12.0
206-7.1	1.74	91	61	0.69		**19.8**	**0.6**	319.9	3.1	0.0602	12.4			0.0028	8.5
206-8.1	6.07	51	37	0.75		**19.3**	**0.8**	313.7	4.0	0.0944	12.7	0.0415	13.3	0.0032	4.0
206-9.1	5.87	60	39	0.66		**19.5**	**0.8**	311.2	3.7	0.0928	13.9			0.0030	5.3
206-10.1	3.86	40	26	0.68		**20.1**	**1.0**	307.9	4.6	0.0770	18.6	0.0861	28.6	0.0037	7.9
09-209 gabbro															
209-1.1	2.18	74	32	0.44		**21.8**	**0.8**	288.4	3.5	0.0637	13.3			0.0025	15.7
209-2.1	1.34	275	113	0.42		**20.4**	**0.4**	311.5	1.9	0.0570	7.3			0.0029	3.7
209-3.1	1.04	192	79	0.43		**20.1**	**0.5**	317.6	2.3	0.0546	9.1	0.0165	29.5	0.0031	2.6
209-4.1	1.92	63	32	0.52		**20.6**	**0.8**	306.4	3.6	0.0616	14.3			0.0024	15.2
209-5.1	3.78	64	30	0.49		**19.7**	**0.8**	313.6	3.6	0.0763	12.8	0.0336	13.3	0.0032	3.6
209-6.1*	1.41	352	156	0.46		**26.5**	**0.7**	239.0	2.5	0.0577	7.3	0.0193	33.7	0.0041	2.8
209-7.1	0.18	97	44	0.47		**22.4**	**0.7**	286.7	2.9	0.0479	12.4			0.0028	10.7
209-8.1	1.18	456	109	0.25		**20.5**	**0.3**	310.8	1.5	0.0558	8.3	0.0085	74.3	0.0031	2.3
209-9.1	-0.24	80	39	0.50		**20.0**	**0.7**	322.6	3.3	0.0446	15.2			0.0026	9.9
209-10.1	2.08	70	38	0.57		**20.8**	**0.8**	302.4	3.5	0.0629	12.9			0.0029	9.6
209-11.1	3.22	76	41	0.55		**21.6**	**0.8**	287.7	3.3	0.0719	12			0.0028	11.88
209-12.1	-0.15	78	42	0.56		**21.0**	**0.7**	306.9	3.3	0.0452	14.6			0.0025	11.86
09-235A volcanic ash															
235A-1.1	2.17	79	39	0.51		**18.5**	**0.6**	340.9	3.3	0.0635	12.5	0.0257	13.0	0.0029	3.3
235A-2.1	0.46	120	73	0.62		**17.7**	**0.5**	361.1	2.9	0.0500	11.9			0.0026	4.5
235A-3.1	2.82	86	34	0.41		**17.6**	**0.7**	355.9	3.3	0.0687	28.5			0.0025	7.2
235A-4.1*	0.98	258	65	0.26		**461.2**	**4.8**	13.4	1.1	0.0642	1.6	0.6466	2.2	0.0748	1.1
235A-5.1	4.96	52	22	0.44		**17.2**	**0.9**	355.8	4.3	0.0856	22.3			0.0025	8.1
235A-6.1	4.65	77	38	0.51		**17.8**	**0.7**	344.6	3.6	0.0831	11.8	0.0333	12.3	0.0029	3.6
235A-7.1	1.07	190	133	0.72		**18.5**	**0.4**	343.6	2.3	0.0548	9.1			0.0028	3.3
235A-8.1	1.70	243	242	1.03		**18.5**	**0.4**	342.3	2.1	0.0599	7.9	0.0157	35.3	0.0029	2.6
235A-9.1	5.37	101	66	0.67		**17.5**	**0.6**	347.6	3.3	0.0888	11.1			0.0024	9.6
235A-10.1	4.41	83	42	0.52		**18.1**	**0.7**	339.6	3.6	0.0813	12.0			0.0024	9.9
235A-11.1*	12.15	81	53	0.68		**15.7**	**0.7**	361.2	3.7	0.1424	9.98	0.0249	59	0.0025	6.14
235A-12.1	3.40	116	57	0.51		**18.2**	**0.6**	342.4	3.0	0.0733	10.7	0.0118	70.6	0.0028	3.863
235A-13.1	5.15	55	40	0.76		**18.7**	**0.8**	325.9	4.2	0.0871	13.8	0.0159	87	0.0029	5.769
09-237A volcanic ash															
237A-1.1	0.83	195	93	0.49		**21.9**	**0.5**	291.2	2.1	0.0530	8.6	0.0251	8.9	0.0034	2.1
237A-2.1	0.04	395	257	0.67		**21.5**	**0.3**	299.8	1.6	0.0468	6.4			0.0032	2.5
237A-3.1	-0.04	302	180	0.62		**21.3**	**0.4**	301.8	1.8	0.0461	7.4	0.0211	7.6	0.0033	1.8
237A-4.1	0.83	253	107	0.44		**21.6**	**0.4**	295.4	1.9	0.0530	7.1	0.0145	36.0	0.0033	2.3
237A-5.1	0.55	254	103	0.42		**22.4**	**0.4**	286.1	1.9	0.0508	7.8	0.0134	42.5	0.0034	2.4
237A-6.1	-0.17	327	169	0.53		**22.0**	**0.4**	293.4	1.7	0.0452	7.0	0.0212	7.2	0.0034	1.7
237A-8.1	0.60	868	1092	1.30		**21.8**	**0.3**	293.5	1.2	0.0512	4.2	0.0240	4.3	0.0034	1.2
237A-9.1	0.10	296	151	0.53		**22.0**	**0.4**	291.6	1.8	0.0472	7.4	0.0151	25.5	0.0034	2.0
237A-10.1	-0.35	312	151	0.50		**21.5**	**0.4**	300.2	1.7	0.0437	7.4	0.0077	76.7	0.0032	2.3
237A-11.1	0.07	347	186	0.55		**21.5**	**0.4**	299.4	1.7	0.0470	7.2			0.0032	2.7

TABLE DR2: TABULATED ZIRCON U/Pb AGE DATA FROM VOLCANIC AND INTRUSIVE SAMPLES

Sample grain	% Common ^{206}Pb	ppm U	ppm Th	232Th/238 U	$^{207}Pb_{corr}/^{206}Pb/^{238}U$ Age (Ma)	err (1σ)	Total 238/206	err (%)	Total 207/206	err (%)	$^{204}Pb_{corr}$ 207/235	err (%)	$^{204}Pb_{corr}$ 206/238	err (%)
07-72 gabbro														
72-1.1	2.62	347	299	0.89	**16.6**	**0.3**	378.8	1.9	0.0671	9.9			0.0025	3.6
72-2.1	0.35	824	989	1.24	**16.9**	**0.2**	380.5	1.4	0.0491	5.0	0.0112	24.6	0.0026	1.6
72-3.1	1.85	259	198	0.79	**16.8**	**0.4**	376.0	2.2	0.0610	8.2	0.0179	18.6	0.0026	2.4
72-4.1	0.48	468	487	1.07	**16.4**	**0.3**	390.7	1.7	0.0502	6.6	0.0130	19.5	0.0025	1.9
72-5.1	1.00	866	1093	1.30	**17.1**	**0.2**	372.8	1.4	0.0543	4.7	0.0149	17.8	0.0026	1.6
72-6.1	0.40	948	1255	1.37	**16.7**	**0.2**	383.5	1.3	0.0495	4.7	0.0162	8.6	0.0026	1.4
72-7.1	0.92	644	708	1.14	**16.5**	**0.3**	386.9	1.6	0.0536	5.7	0.0111	32.7	0.0025	2.0
72-8.1	-0.06	985	975	1.02	**17.1**	**0.2**	375.6	1.3	0.0459	4.7	0.0125	18.0	0.0026	1.5
72-9.1	1.38	908	1106	1.26	**17.3**	**0.2**	367.9	1.3	0.0573	4.4	0.0172	11.8	0.0027	1.5
72-10.1	0.65	1041	1404	1.39	**16.8**	**0.2**	379.9	1.3	0.0515	4.3	0.0130	19.9	0.0026	1.5
09-217 volcanic ash														
217-1.1*	1.45	164	99	0.62	**106.4**	**1.4**	59.2	1.3	0.0597	3.7	0.0844	22.8	0.0164	1.6
217-2.1	-0.05	373	265	0.73	**98.8**	**1.1**	64.8	1.1	0.0476	2.8	0.0927	5.2	0.0154	1.1
217-3.1*	0.06	371	240	0.67	**95.5**	**1.0**	67.0	1.1	0.0484	2.7	0.0915	6.3	0.0149	1.1
217-4.1*	9.14	203	166	0.84	**95.9**	**1.7**	60.6	1.3	0.1205	7.2	0.0553	81.3	0.0147	2.7
217-5.1	0.36	385	247	0.66	**102.6**	**1.1**	62.1	1.1	0.0510	2.5	0.1015	5.7	0.0160	1.1
217-6.1	0.13	163	63	0.40	**99.3**	**1.3**	64.3	1.3	0.0490	4.0	0.0866	11.3	0.0154	1.4
217-7.1	2.16	144	69	0.50	**101.0**	**1.4**	62.0	1.4	0.0652	3.7	0.1205	9.8	0.0159	1.5
217-8.1*	0.45	216	80	0.38	**97.4**	**1.2**	65.4	1.2	0.0515	3.5	0.1086	3.7	0.0153	1.2
217-9.1	6.92	312	237	0.79	**101.0**	**1.6**	58.9	1.1	0.1030	8.7	0.0633	95.9	0.0155	3.4
217-10.1	-0.04	333	191	0.59	**100.5**	**1.1**	63.7	1.1	0.0477	2.8	0.1003	3.6	0.0157	1.1
217-11.1*	0.07	1437	185	0.13	**142.9**	**1.3**	44.6	0.9	0.0495	1.1	0.1502	1.6	0.0224	0.9
217-12.1	0.07	348	243	0.72	**101.9**	**1.1**	62.7	1.1	0.0486	2.7	0.0966	5.5	0.0159	1.1
09-206 dacite														
206-1.1	1.06	398	520	1.35	**19.9**	**0.3**	320.6	1.6	0.0548	5.7	0.0084	68.6	0.0030	2.3
206-2.1	2.67	81	75	0.95	**20.0**	**0.7**	312.8	3.3	0.0675	12.2			0.0026	10.0
206-3.1	6.99	37	32	0.90	**21.7**	**1.1**	275.3	4.6	0.1017	14.1			0.0023	24.7
206-4.1	20.10	39	29	0.76	**18.5**	**1.1**	278.2	4.5	0.2053	11.5			0.0020	32.4
206-5.1	5.56	79	44	0.58	**19.2**	**0.7**	316.2	3.3	0.0903	10.6			0.0028	7.6
206-6.1	3.26	63	37	0.60	**19.4**	**0.7**	321.3	3.7	0.0722	13.1			0.0025	12.0
206-7.1	1.74	91	61	0.69	**19.8**	**0.6**	319.9	3.1	0.0602	12.4			0.0028	8.5
206-8.1	6.07	51	37	0.75	**19.3**	**0.8**	313.7	4.0	0.0944	12.7	0.0415	13.3	0.0032	4.0
206-9.1	5.87	60	39	0.66	**19.5**	**0.8**	311.2	3.7	0.0928	13.9			0.0030	5.3
206-10.1	3.86	40	26	0.68	**20.1**	**1.0**	307.9	4.6	0.0770	18.6	0.0861	28.6	0.0037	7.9
09-209 gabbro														
209-1.1	2.18	74	32	0.44	**21.8**	**0.8**	288.4	3.5	0.0637	13.3			0.0025	15.7
209-2.1	1.34	275	113	0.42	**20.4**	**0.4**	311.5	1.9	0.0570	7.3			0.0029	3.7
209-3.1	1.04	192	79	0.43	**20.1**	**0.5**	317.6	2.3	0.0546	9.1	0.0165	29.5	0.0031	2.6
209-4.1	1.92	63	32	0.52	**20.6**	**0.8**	306.4	3.6	0.0616	14.3			0.0024	15.2
209-5.1	3.78	64	30	0.49	**19.7**	**0.8**	313.6	3.6	0.0763	12.8	0.0336	13.3	0.0032	3.6
209-6.1*	1.41	352	156	0.46	**26.5**	**0.7**	239.0	2.5	0.0577	7.3	0.0193	33.7	0.0041	2.8
209-7.1	0.18	97	44	0.47	**22.4**	**0.7**	286.7	2.9	0.0479	12.4			0.0028	10.7
209-8.1	1.18	456	109	0.25	**20.5**	**0.3**	310.8	1.5	0.0558	8.3	0.0085	74.3	0.0031	2.3
209-9.1	-0.24	80	39	0.50	**20.0**	**0.7**	322.6	3.3	0.0446	15.2			0.0026	9.9
209-10.1	2.08	70	38	0.57	**20.8**	**0.8**	302.4	3.5	0.0629	12.9			0.0029	9.6
209-11.1	3.22	76	41	0.55	**21.6**	**0.8**	287.7	3.3	0.0719	12			0.0028	11.88
209-12.1	-0.15	78	42	0.56	**21.0**	**0.7**	306.9	3.3	0.0452	14.6			0.0025	11.86
09-235A volcanic ash														
235A-1.1	2.17	79	39	0.51	**18.5**	**0.6**	340.9	3.3	0.0635	12.5	0.0257	13.0	0.0029	3.3
235A-2.1	0.46	120	73	0.62	**17.7**	**0.5**	361.1	2.9	0.0500	11.9			0.0026	4.5
235A-3.1	2.82	86	34	0.41	**17.6**	**0.7**	355.9	3.3	0.0687	28.5			0.0025	7.2
235A-4.1*	0.98	258	65	0.26	**461.2**	**4.8**	13.4	1.1	0.0642	1.6	0.6466	2.2	0.0748	1.1
235A-5.1	4.96	52	22	0.44	**17.2**	**0.9**	355.8	4.3	0.0856	22.3			0.0025	8.1
235A-6.1	4.65	77	38	0.51	**17.8**	**0.7**	344.6	3.6	0.0831	11.8	0.0333	12.3	0.0029	3.6
235A-7.1	1.07	190	133	0.72	**18.5**	**0.4**	343.6	2.3	0.0548	9.1			0.0028	3.3
235A-8.1	1.70	243	242	1.03	**18.5**	**0.4**	342.3	2.1	0.0599	7.9	0.0157	35.3	0.0029	2.6
235A-9.1	5.37	101	66	0.67	**17.5**	**0.6**	347.6	3.3	0.0888	11.1			0.0024	9.6
235A-10.1	4.41	83	42	0.52	**18.1**	**0.7**	339.6	3.6	0.0813	12.0			0.0024	9.9
235A-11.1*	12.15	81	53	0.68	**15.7**	**0.7**	361.2	3.7	0.1424	9.98	0.0249	59	0.0025	6.14
235A-12.1	3.40	116	57	0.51	**18.2**	**0.6**	342.4	3.0	0.0733	10.7	0.0118	70.6	0.0028	3.863
235A-13.1	5.15	55	40	0.76	**18.7**	**0.8**	325.9	4.2	0.0871	13.8	0.0159	87	0.0029	5.769
09-237A volcanic ash														
237A-1.1	0.83	195	93	0.49	**21.9**	**0.5**	291.2	2.1	0.0530	8.6	0.0251	8.9	0.0034	2.1
237A-2.1	0.04	395	257	0.67	**21.5**	**0.3**	299.8	1.6	0.0468	6.4			0.0032	2.5
237A-3.1	-0.04	302	180	0.62	**21.3**	**0.4**	301.8	1.8	0.0461	7.4	0.0211	7.6	0.0033	1.8
237A-4.1	0.83	253	107	0.44	**21.6**	**0.4**	295.4	1.9	0.0530	7.1	0.0145	36.0	0.0033	2.3
237A-5.1	0.55	254	103	0.42	**22.4**	**0.4**	286.1	1.9	0.0508	7.8	0.0134	42.5	0.0034	2.4
237A-6.1	-0.17	327	169	0.53	**22.0**	**0.4**	293.4	1.7	0.0452	7.0	0.0212	7.2	0.0034	1.7
237A-8.1	0.60	868	1092	1.30	**21.8**	**0.3**	293.5	1.2	0.0512	4.2	0.0240	4.3	0.0034	1.2
237A-9.1	0.10	296	151	0.53	**22.0**	**0.4**	291.6	1.8	0.0472	7.4	0.0151	25.5	0.0034	2.0
237A-10.1	-0.35	312	151	0.50	**21.5**	**0.4**	300.2	1.7	0.0437	7.4	0.0077	76.7	0.0032	2.3
237A-11.1	0.07	347	186	0.55	**21.5**	**0.4**	299.4	1.7	0.0470	7.2			0.0032	2.7