Geochemistry and geology of spatially and temporally associated calc-alkaline (I-type) and K-rich (A-type) magmatism in a Carboniferous continental arc setting, Pataz gold mining district, northern Peru

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SUPPLEMENTARY PAPERS

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* Appendix and Tables A1 and A2 [indicated in the text and listed at the end of the paper] are Supplementary Papers; copies may be obtained from the Geological Society of Australia's website (www.gsa.org.au) or from the National Library of Australia's Pandora archive (<http://nla.gov.au/nla.arc-25194>).

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APPENDIX

Whole-rock analytical methods

Samples were submitted for whole-rock geochemical analysis in two batches. The first batch comprising mainly samples from the Pataz batholith, was submitted to Actlabs, Canada, after preparation in the Actlabs laboratories in Lima, Peru, in 2008. The second batch of samples, comprising samples from Misquichilca, the Esperanza subvolcanic complex, and the Vijus and Atahualpa Formations (i.e. Pataz batholith country rock), were submitted to ALS Laboratories, Lima, Peru, in 2009.

The first analytical batch comprised 37 whole-rock samples (Table A1) that were collected from diamond core, underground exposures and surface outcrops between Vijus and Ariabamba (Figure 2). Although most samples came from the Pataz batholith, one sedimentary rock sample from the Contaya Formation was analysed to assess the role of local country rock assimilation on the chemistry of the batholith magmas. Major elements and Ag, Ba, Be, Bi, Cd, Co, Cr, Cu, Mo, Ni, Pb, S, Sr, V, Y, Zn and Zr were analysed by ICP-MS, following crushing, pulverisation and lithium metaborate/tetraborate fusion. All other trace elements, including rare earth elements, were analysed by INAA. Full analytical results are shown in Table A2. The quality of analytical results was monitored using a range of International Standards, including DNC-1, BIR-1, SY-3, NIST-1633b and JSD-3. Accuracy is better than 5% relative for major elements, and better than 10% relative for most trace elements, including the REE. Duplicate analyses indicate precision better than 5%.

The second batch comprised 20 samples (Table A1), all collected from surface outcrop. Igneous rocks investigated in this batch of analyses are the Lavasen Volcanics, Esperanza subvolcanic complex, the Vijus Formation and the Atahualpa Formation. The relatively small number of whole-rock geochemical samples from the Lavasen Volcanics is a consequence of the remoteness of much of the study area and widespread hydrothermal alteration and weathering (silicification, argillic alteration) observed in these rocks. Major elements were analysed by XRF following crushing, pulverising and lithium tetraborate/metaborate fusion. All trace elements, including rare earth elements, were analysed by ICP-MS. Full analytical results are shown in Table A2. The quality of analytical results was monitored using International Standards UTS-1, SARM-39, SY-4 and NCSDC79003. Accuracy is better than 5% relative for major elements and most trace elements, including REE, and better than 10% relative for Cu, Hf, Nb, Ni, Ta, W, Zn and Zr. Duplicate analyses indicate precision better than 5%.

Table A1 Whole-rock geochemical samples, location and description.

Sample no.	Location	WGS84 East	WGS84 North	Drill core	Description
WWG1	La Lima	208877	9148719		Tonalite
WWG2	Papagayo	210167	9146878		Metapyroxenite
WWG3	Papagayo	210200	9146781		Diorite porphyry
WWG4	Papagayo	209981	9146626		Diorite
WWG5	Karola	210978	9145854		Diorite
WWG6	Karola	211206	9145183		Monzogranite
WWG7*	Karola	210309	9144554		Tonalite porphyry
WWG8**	Karola	210309	9144554		Microdiorite
WWG9**	Karola	209879	9144415		Diorite
WWG10**	Estrella	209757	9145317		Quartz diorite
WWG11	Estrella	208130	9145129		Monzonite porphyry
WWG12	La Lima	210234	9147416		Andesite dyke
WWG13	Papagayo	210250	9147500		Granodiorite
WWG14	Papagayo	209950	9147900		Granodiorite
WWG15	Cedro	210558	9143937		Quartz diorite
WWG16	Cedro	211486	9142420		Granodiorite
WWG17	Pataz	214219	9139997		Quartz diorite
WWG18	Consuelo	211250	9142200		Diorite
WWG19	Chagual	207008	9138292		Basalt
WWG20	Papagayo	210466	9147085	38X08-450, 58.7–59.2 m	Monzogranite
WWG21*	Papagayo	210466	9147085	38X08-450, 88.1–88.9 m	Granodiorite
WWG22*	Papagayo	210466	9147085	SJX08-22, 0.0–1.1 m	Granodiorite
WWG23*	Papagayo	210466	9147085	SJX08-22, 47.4–48.5 m	Monzogranite
WWG24*	Suyubamba	218208	9133535		Microdiorite
WWG25**	Antipita	214387	9134489		Mafic volcanoclastic
WWG26	Pataz	214266	9139651		Tonalite
WWG27**	Shicun	205729	9149098		Tonalite
WWG28**	Suyubamba	216115	9131175		Mafic volcanoclastic
WWG29	Suyubamba	217114	9132692		Microdiorite
WWG30	Piaz	219336	9128706		Granodiorite
WWG31	Ariabamba	222747	9126649		Tonalite
WWG32**	Ariabamba	221649	9126574		Monzogranite
WWG33	Ariabamba	221277	9126111		Monzogranite
WWG34	Piaz	219293	9128810		Granodiorite
WWG35	Cedro	211467	9141448		Shale
WWG36*	Papagayo	210466	9147085	15X08-123; 104.2–104.8 m	Granodiorite
WWG37*	Papagayo	210466	9147085	15X08-123; 141.4–142.0 m	Granodiorite

* Weak alteration (5–20% of primary ferromagnesian minerals replaced by chlorite)

** Moderate to strong alteration (20–80% of primary ferromagnesian minerals replaced by chlorite)

Table A1 Locations of whole-rock geochemical samples (continued).

Sample no.	Location	WGS84 East	WGS84 North	Description
195022*	Esperanza	213340	9149437	Latite porphyry
195023	Esperanza	213530	9149566	Latite porphyry
195024*	Esperanza	213688	9149576	Latite porphyry
195025*	Esperanza	213550	9149639	Latite porphyry
195026*	Esperanza	213681	9149934	Latite porphyry
195027	Esperanza	213631	9150071	Dolerite
195028	Esperanza	213549	9150209	Quartz latite porphyry
195029	Esperanza	212949	9150248	Dolerite
195030*	Esperanza	213660	9150305	Quartz latite porphyry
195031**	Santa Catalina	212560	9152153	Pyroclastic breccia
206475	Santa Clara	214821	9153391	Pyroclastic breccia
206477***	Santa Clara	214931	9153204	Lapilli-tuff
206597 ^l	Revolcadoro	207891	9146624	Volcaniclastic sandstone (V)
206598***	Revolcadoro	207877	9146550	Volcaniclastic sandstone (V)
206599	Revolcadoro	207999	9146405	Volcaniclastic sandstone (V)
206600	C-Z road	211497	9141239	Volcaniclastic sandstone (A)
206601	C-Z road	211488	9141268	Volcaniclastic sandstone (A)
206602	C-Z road	211644	9141127	Volcaniclastic sandstone (A)
206773 ^l	Misquichilca	217217	9161658	Ignimbritic breccia
206774***	Misquichilca	217342	9161401	Ignimbritic breccia

* Weak alteration (5–20% of primary ferromagnesian minerals replaced by chlorite)

** Moderate to strong alteration (20–80% of primary ferromagnesian minerals replaced by chlorite)

* Weak to intense sericitisation of feldspars, patchy chloritisation (after biotite?) of ferromagnesian minerals, or chloritisation of biotite

** Minor secondary carbonate and secondary Fe oxides

*** Moderate to strong argillic alteration of feldspar and vitric clasts

^l Minor silicification, patchy to widespread argillic alteration

Weak to moderate silicification and argillic alteration

Descriptions: (A) Atahualpa Formation; (V) Vijus Formation

Table A2 Complete whole rock analyses, Pataz district

Sample_id	Location	Stratigraphic unit	Classification	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃ (T)	MnO
WWG1	La Lima	Pataz batholith	tonalite	54.11	15.55	8.85	0.162
WWG2	Papagayo	Pataz batholith	metapyroxenite	47.94	11.24	10.90	0.182
WWG3	Papagayo	Pataz batholith	diorite porphyry	53.62	16.19	9.35	0.116
WWG4	Papagayo	Pataz batholith	diorite	55.44	15.45	8.44	0.163
WWG5	Karola	Pataz batholith	diorite	52.66	16.29	9.81	0.156
WWG6	Karola	Pataz batholith	monzogranite	75.12	13.78	2.26	0.025
WWG7	Karola	Pataz batholith	tonalite porphyry	61.96	15.32	6.91	0.120
WWG8	Karola	Pataz batholith	microdiorite	47.90	13.81	12.81	0.295
WWG9	Karola	Pataz batholith	diorite	50.12	14.46	10.73	0.238
WWG10	Estrella	Pataz batholith	quartz diorite	52.00	16.36	10.44	0.254
WWG11	Estrella	Unassigned	monzonite porphyry	72.71	11.99	2.21	0.036
WWG12	La Lima	Pataz batholith	andesite dyke	55.73	16.78	8.29	0.122
WWG13	Papagayo	Pataz batholith	granodiorite	68.71	15.41	4.08	0.074
WWG14	Papagayo	Pataz batholith	granodiorite	67.94	15.53	4.03	0.077
WWG15	Cedro	Pataz batholith	quartz diorite	54.97	15.60	9.14	0.157
WWG16	Cedro	Pataz batholith	granodiorite	69.12	14.05	3.66	0.070
WWG17	Pataz	Pataz batholith	quartz diorite	52.79	18.51	7.47	0.120
WWG18	Consuelo	Pataz batholith	diorite	50.44	17.06	7.62	0.124
WWG19	Chagual	Ambo Group	basalt	51.05	18.61	10.03	0.178
WWG20	Papagayo	Pataz batholith	monzogranite	74.28	13.80	2.33	0.058
WWG21	Papagayo	Pataz batholith	granodiorite	70.31	14.74	3.33	0.096
WWG22	Papagayo	Pataz batholith	granodiorite	66.91	15.29	4.15	0.076
WWG23	Papagayo	Pataz batholith	monzogranite	71.64	13.92	2.83	0.052
WWG24	Suyubamba	Pataz batholith	microdiorite	46.76	14.34	13.79	0.219
WWG25	Antipita	Vista Florida Group	mafic volcanoclastic	45.00	13.10	12.97	0.174
WWG26	Pataz	Pataz batholith	tonalite	62.26	15.12	8.74	0.139
WWG27	Shicun	Pataz batholith	tonalite	63.62	15.54	6.45	0.129
WWG28	Suyubamba	Vista Florida Group	mafic volcanoclastic	47.70	15.33	12.36	0.210
WWG29	Suyubamba	Pataz batholith	microdiorite	47.54	14.72	12.77	0.194
WWG30	Piaz	Pataz batholith	granodiorite	68.36	15.56	4.09	0.072
WWG31	Ariabamba	Pataz batholith	tonalite	64.84	16.40	5.46	0.088
WWG32	Ariabamba	Pataz batholith	monzogranite	71.46	14.14	2.82	0.058
WWG33	Ariabamba	Pataz batholith	monzogranite	76.42	12.18	1.46	0.027
WWG34	Piaz	Pataz batholith	granodiorite	71.76	14.46	3.07	0.062
WWG35	Cedro	Contoya Formation	shale	60.86	13.14	10.81	0.121
WWG36	Papagayo	Pataz batholith	granodiorite	69.79	15.14	4.01	0.079
WWG37	Papagayo	Pataz batholith	granodiorite	69.11	15.72	4.18	0.075
195022	P-SC road	ESC	Latite porphyry	71.80	14.35	3.04	0.050
195023	P-SC road	ESC	Latite porphyry	75.30	13.00	2.12	0.040
195024	P-SC road	ESC	Latite porphyry	76.10	13.00	1.84	0.035
195025	P-SC road	ESC	Latite porphyry	76.10	13.00	1.86	0.034
195026	P-SC road	ESC	Latite porphyry	68.10	14.75	4.76	0.110
195027	P-SC road	ESC	Dolerite	49.60	14.85	15.10	0.198
195028	P-SC road	ESC	Quartz latite porphyry	74.70	12.90	1.52	0.021
195029	P-SC road	ESC	Dolerite	47.90	13.50	14.85	0.230
195030	P-SC road	ESC	Quartz latite porphyry	72.80	13.10	1.76	0.028
195031	Santa Catalina	Lavasen Volcanics	Resed. pyrocl. brx	77.20	12.45	2.07	0.047
206475	Santa Clara	Lavasen Volcanics	Resed. pyrocl. brx	73.70	13.55	2.05	0.041
206477	Santa Clara	Lavasen Volcanics	Pyroclastic lapilli-tuff	76.80	12.75	1.92	0.069
206597	Revolcadoro	Vijus Formation	Felsic volc sst	67.90	15.05	3.76	0.105
206598	Revolcadoro	Vijus Formation	Felsic volc sst	68.80	15.80	4.81	0.114
206599	Revolcadoro	Vijus Formation	Felsic volc sst	70.50	15.35	3.75	0.060
206600	C-Z road	Atahualpa Formation	Felsic volc sst	69.70	13.55	5.13	0.097
206601	C-Z road	Atahualpa Formation	Felsic volc sst	69.00	13.60	5.54	0.085
206602	C-Z road	Atahualpa Formation	Felsic volc sst	65.80	14.10	7.16	0.098
206773	Misquichilca	Lavasen Volcanics	Pyrocl.(ignimbritic) brx	82.70	10.05	0.82	0.017
206774	Misquichilca	Lavasen Volcanics	Ignimbritic brx	77.40	12.25	2.02	0.025

Abbreviations: P-SC road (Paraiso - Santa Catalina road); C-Z road (Cedro - Zaramilla road); ESC (Esperanza Subvolcanic Complex); Felsic volc sst (Felsic volcanoclastic sandstone); Resed. (Resedimented); pyrocl. (pyroclast-rich); WWG1 to WWG37: Samples analysed at Actlabs, Canada.

Major elements were analysed by ICP-MS following crushing, pulverising and lithium tetraborate/metaborate fusion; Ba, Cr, Cu, Ni, Pb, Sr, V, Y, Zn and Zr were analysed by ICP-MS; all other trace elements including rare earth elements were analysed by INAA.

The quality of analytical results was monitored using a range of International Standards, including DNC-1, BIR-1, SY-3, NIST-1633b and JSD-3.

Accuracy is better than 5% relative for major elements, better than 10% relative for most trace elements, including the rare earth elements (La, Ce, Nd, Sm, Eu, Tb, Yb, Lu) and better than 25% for uranium.

Table A2 Complete whole rock analyses, Patatz district

Sample_id	MgO	CaO	Na ₂ O	K ₂ O	TiO ₂	Ti	P ₂ O ₅	LOI	Total	Ba	Cu	Ga	Nb	Ni
WWG1	6.24	8.55	1.53	1.16	0.71	0.42	0.10	2.27	99.22	316	27	na	na	25
WWG2	16.76	6.27	1.23	0.94	0.76	0.45	0.18	3.35	99.74	236	41	na	na	336
WWG3	4.99	7.38	3.26	1.24	1.16	0.69	0.24	2.07	99.63	457	64	na	na	85
WWG4	5.41	7.25	2.29	1.92	0.98	0.59	0.09	2.50	99.95	445	41	na	na	27
WWG5	4.53	8.09	2.07	1.81	1.61	0.97	0.19	2.20	99.43	252	31	na	na	10
WWG6	1.02	0.35	6.21	0.70	0.24	0.15	0.07	1.21	101.00	82	8	na	na	8
WWG7	3.14	5.97	2.22	1.96	0.78	0.47	0.17	2.05	100.60	607	10	na	na	13
WWG8	6.33	11.93	2.45	0.62	1.75	1.05	0.19	1.59	99.69	256	215	na	na	95
WWG9	7.63	5.63	2.66	1.38	0.62	0.37	0.09	6.82	100.40	380	7	na	na	21
WWG10	5.73	5.90	2.30	1.95	1.23	0.74	0.27	4.55	101.00	532	14	na	na	26
WWG11	0.36	0.23	1.67	6.75	0.54	0.32	0.12	1.75	98.38	1797	20	na	na	9
WWG12	3.13	7.32	3.17	1.14	1.15	0.69	0.52	3.03	100.40	297	7	na	na	22
WWG13	0.91	3.39	4.18	2.33	0.47	0.28	0.13	1.06	100.80	771	8	na	na	6
WWG14	0.88	3.25	4.23	2.65	0.48	0.29	0.13	1.17	100.40	1016	10	na	na	6
WWG15	4.47	7.55	1.80	1.41	1.26	0.75	0.31	2.43	99.10	392	20	na	na	15
WWG16	1.18	2.76	3.10	3.55	0.42	0.25	0.10	1.42	99.43	964	16	na	na	9
WWG17	4.42	8.16	3.20	1.38	0.82	0.49	0.16	2.97	99.99	381	31	na	na	49
WWG18	3.87	10.71	2.67	0.99	0.83	0.50	0.13	4.86	99.29	301	71	na	na	12
WWG19	4.96	9.61	2.35	0.92	1.10	0.66	0.22	1.05	100.10	323	22	na	na	12
WWG20	0.42	1.83	3.53	3.51	0.24	0.15	0.06	0.91	101.00	551	9	na	na	8
WWG21	0.75	3.01	3.82	2.25	0.40	0.24	0.10	0.86	99.66	457	2	na	na	8
WWG22	0.91	2.99	3.82	2.52	0.48	0.29	0.13	2.20	99.49	987	3	na	na	5
WWG23	0.55	1.97	3.52	3.40	0.29	0.17	0.08	1.07	99.31	830	3	na	na	8
WWG24	6.89	12.66	2.21	0.24	1.48	0.89	0.12	0.85	99.55	72	155	na	na	82
WWG25	5.84	11.05	2.05	0.20	2.66	1.59	0.28	6.58	99.90	56	177	na	na	82
WWG26	2.51	2.56	3.56	2.09	1.28	0.77	0.34	1.24	99.84	524	19	na	na	21
WWG27	2.03	4.67	2.37	2.65	0.75	0.45	0.22	1.92	100.30	890	11	na	na	14
WWG28	8.60	10.39	2.87	0.13	1.16	0.70	0.10	1.70	100.60	152	151	na	na	81
WWG29	7.97	12.14	2.00	0.22	1.25	0.75	0.10	1.06	99.95	73	149	na	na	80
WWG30	0.99	3.69	3.28	2.59	0.49	0.29	0.13	1.14	100.40	677	6	na	na	10
WWG31	1.32	4.26	3.38	2.74	0.68	0.41	0.20	0.63	100.00	912	5	na	na	8
WWG32	0.70	2.40	3.23	3.31	0.32	0.19	0.10	2.29	100.80	689	5	na	na	9
WWG33	0.08	0.91	3.30	4.29	0.07	0.04	0.02	1.17	99.93	272	3	na	na	9
WWG34	0.68	2.44	3.22	3.19	0.35	0.21	0.10	1.12	99.88	684	2	na	na	8
WWG35	4.16	4.72	2.32	1.73	1.43	0.86	0.19	1.06	100.60	293	73	na	na	57
WWG36	0.87	3.30	3.71	2.35	0.48	0.29	0.14	0.73	100.60	1056	5	na	na	9
WWG37	0.91	3.43	3.87	2.52	0.50	0.30	0.14	0.50	101.00	1019	3	na	na	8
195022	0.46	2.62	3.13	3.58	0.34	0.20	0.06	0.81	100.38	978	<5	16	11.6	2
195023	0.06	0.66	3.83	4.21	0.15	0.09	0.02	0.52	100.05	878	9	17	15.5	1
195024	0.04	0.68	3.78	4.02	0.13	0.08	0.05	0.30	100.09	918	6	17.0	15.5	1
195025	0.03	0.64	3.76	4.11	0.14	0.08	0.01	0.42	100.22	1005	5	17	14.9	2
195026	0.72	2.91	3.83	3.02	0.56	0.34	0.16	0.86	99.93	654	7	20	14.1	1
195027	5.07	8.85	3.82	0.46	2.88	1.73	0.30	0.36	101.59	79.2	82	21	20.7	34
195028	0.11	0.74	3.82	4.32	0.12	0.07	0.01	0.52	98.95	1025	89	16	15.7	1
195029	6.00	10.60	2.52	0.84	2.28	1.37	0.24	0.77	99.85	72.5	166	20	10.9	90
195030	0.08	0.90	3.85	4.53	0.15	0.09	0.02	0.68	98.14	1065	23	15	14.6	2
195031	<0.01	0.07	3.32	4.25	0.11	0.07	0.01	1.02	100.72	925	6	17	14.1	2
206475	0.05	1.10	3.20	4.48	0.14	0.08	0.01	1.76	100.42	598	<5	21	15.9	1
206477	0.02	0.57	1.45	4.72	0.11	0.07	0.01	1.62	100.23	569	<5	17	14.0	1
206597	0.49	1.54	3.28	4.35	0.45	0.27	0.12	1.11	98.56	1990	29	19.0	13.8	3
206598	0.87	2.21	3.33	2.47	0.47	0.28	0.13	1.27	100.47	1690	10	19	13.1	2
206599	0.57	1.63	2.42	3.22	0.46	0.28	0.12	1.72	99.99	1030	27	19	13.1	2
206600	0.82	1.68	3.24	4.20	1.10	0.66	0.29	0.44	100.38	1015	18	17	20.1	8
206601	1.04	1.59	3.30	4.05	1.09	0.65	0.29	0.72	100.44	995	24	17	20.0	13
206602	1.88	2.04	3.24	3.59	1.16	0.70	0.30	1.05	100.51	518	20	20	21.7	13
206773	0.20	0.04	1.11	2.33	0.07	0.04	0.01	1.77	99.32	1540	18	12	11.3	9
206774	0.06	0.23	0.83	5.75	0.08	0.05	0.01	1.37	100.21	1100	<5	13	12.1	6

All other samples were analysed at SGS Laboratories in Lima, Peru.

Major elements were analysed by XRF following crushing, pulverising and lithium tetraborate/metaborate fusion; all trace elements, including rare earth elements, were analysed by ICP-MS.

The quality of analytical results was monitored using International Standard UTS-1, SARM-11, SARM-39, SY-4 and NCSDC79003

Accuracy is better than 5% for major elements and most trace elements (including rare earth elements) and better than 10% relative for Cu, Hf, Nb, Ni, Ta, W, Zn and Zr

Table A2 Complete whole rock analyses, Patatz district

Sample_id	Pb	Sr	Zr	Cr	Rb	Sb	Th	U	V	Y	Zn	La	Ce	Pr
WWG1	12	182	101	292	60	0.7	5.2	1.5	na	na	90	16.3	31	na
WWG2	< 5	97	129	1240	70	1.0	3.4	0.6	na	na	77	12.3	25	na
WWG3	15	367	185	207	60	1.0	8.4	2.3	na	na	81	33.1	61	na
WWG4	< 5	235	103	216	100	1.8	6.2	1.8	na	na	82	18.9	38	na
WWG5	12	243	93	128	80	0.5	7.3	2.2	na	na	86	17.9	34	na
WWG6	< 5	46	166	266	< 10	0.4	9.8	2.3	na	na	22	29.6	54	na
WWG7	< 5	181	200	158	80	0.7	9.2	2.5	na	na	70	32.6	57	na
WWG8	14	252	101	264	30	1.7	0.7	< 0.1	na	na	89	7.88	19	na
WWG9	19	110	81	272	50	1.1	3.7	1.1	na	na	105	13.8	26	na
WWG10	6	126	101	204	100	1.3	4.9	1.4	na	na	92	18.7	35	na
WWG11	16	50	382	197	210	3.1	20.3	4.9	na	na	211	57.7	107	na
WWG12	9	821	170	148	40	1.3	5.5	1.4	na	na	81	42.8	75	na
WWG13	11	190	276	173	120	0.6	13.0	3.6	na	na	65	57.8	99	na
WWG14	12	208	324	200	90	0.6	11.6	2.1	na	na	67	64	103	na
WWG15	7	155	96	194	60	0.8	6.5	0.8	na	na	93	25.7	49	na
WWG16	22	138	258	180	110	1.0	14.2	2.4	na	na	61	44.6	77	na
WWG17	9	383	151	168	50	1.3	4.1	1.0	na	na	64	25.7	46	na
WWG18	< 5	163	96	96.6	50	1.2	3.6	1.0	na	na	72	16.9	35	na
WWG19	5	269	131	106	40	0.8	2.7	0.3	na	na	90	20.4	45	na
WWG20	17	102	168	255	120	0.3	10.2	3.1	na	na	33	27.8	46	na
WWG21	14	161	219	230	110	0.4	14.4	5.4	na	na	51	39.3	64	na
WWG22	9	198	292	133	70	0.3	14.0	4.4	na	na	43	54	86	na
WWG23	10	131	192	212	110	0.3	11.8	5.4	na	na	33	36.3	59	na
WWG24	10	240	86	285	< 10	2.1	0.2	< 0.1	na	na	85	2.89	8	na
WWG25	< 5	369	165	211	< 10	0.7	1.3	< 0.1	na	na	87	15	31	na
WWG26	18	186	383	112	90	0.3	14.0	3.2	na	na	101	47.1	85	na
WWG27	11	178	232	189	110	0.4	9.5	2.3	na	na	71	31.5	55	na
WWG28	12	236	70	336	< 10	1.0	0.3	< 0.1	na	na	65	2.68	8	na
WWG29	7	163	69	371	< 10	0.8	< 0.1	< 0.1	na	na	70	2.51	8	na
WWG30	13	199	244	160	80	1.0	11.2	2.3	na	na	89	42.1	67	na
WWG31	12	196	371	159	100	0.7	14.0	2.0	na	na	68	75.5	134	na
WWG32	11	141	184	196	120	0.8	13.2	2.6	na	na	41	32.6	61	na
WWG33	6	35	118	281	200	0.7	17.7	6.1	na	na	12	21.9	50	na
WWG34	16	146	196	203	110	1.0	13.4	2.3	na	na	40	39.3	74	na
WWG35	9	99	216	282	80	1.4	6.0	1.7	na	na	98	24.1	48	na
WWG36	16	194	302	199	110	0.7	11.7	1.6	na	na	81	53.5	97	na
WWG37	8	198	291	206	110	0.7	14.0	2.9	na	na	51	56	101	na
195022	26	126	263	20	146	1.0	14.5	3.1	43	34.7	51	44.5	93	10.4
195023	20	52.2	173	10	170	0.2	16.2	3.7	8	45.3	62	48.4	101	12.5
195024	18	45.6	166	20	140	0.5	16.9	3.8	5	45.7	88	47.2	98.1	11.8
195025	17	49.4	170	10	155	0.2	16.5	3.6	5	47.6	47	59.6	98.8	14.1
195026	16	188	234	10	104	0.4	12.3	3.3	25	48.0	110	35.5	75.7	9.57
195027	10	208	192	40	27.1	0.4	3.1	0.7	375	30.2	171	21	49.1	6.57
195028	7	62.5	155	30	134	0.2	16.1	3.2	5	39.8	25	43	91.8	11
195029	7	210	138	160	58.9	0.7	1.2	0.4	474	40.6	182	10.7	25.4	3.74
195030	11	60.8	167	10	119	0.2	17.0	3.3	8	37.8	34	48.4	101	12
195031	<1	16.2	169	10	107	0.2	15.0	3.6	5	50.7	42	35.7	76	9.41
206475	4	32.9	202	<10	185	0.2	17.8	3.3	<5	45.9	38	42.8	92.3	9.33
206477	1	16.1	142	10	180	0.2	15.9	3.5	<5	42.5	33	37.8	80.3	9.97
206597	35	144.5	305	10	164	0.4	14.0	3.4	56	37.3	2270	40.7	86	10.4
206598	26	201	307	10	116	0.2	13.5	2.9	54	38.8	660	43.5	90.1	10.5
206599	13	108	290	10	129	0.3	13.3	2.8	56	38.7	41	45.4	94.3	11.1
206600	13	143	309	30	120	0.3	14.0	3.0	96	50.3	103	47	101	12
206601	18	132.5	320	30	107	0.2	14.1	3.0	96	50.0	84	44.9	95.9	11.7
206602	17	175	340	30	164	0.3	15.1	3.2	99	54.8	104	42.4	93.5	11.6
206773	11	60	78	<10	127	0.7	12.4	2.5	5	35.3	37	18.7	46.1	4.96
206774	16	14.8	87	<10	213	1.7	14.2	1.8	5	43.3	24	26.8	51.8	7.61

Table A2 Complete whole rock analyses, Patatz district

Sample_id	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
WWG1	16	3.36	0.99	na	0.5	na	na	na	na	1.90	0.31
WWG2	13	2.91	1.07	na	0.5	na	na	na	na	1.41	0.23
WWG3	31	6.26	1.68	na	0.9	na	na	na	na	2.87	0.46
WWG4	17	3.7	1.08	na	0.5	na	na	na	na	2.27	0.38
WWG5	18	3.4	1.1	na	0.6	na	na	na	na	1.77	0.28
WWG6	24	4.58	0.86	na	0.6	na	na	na	na	1.64	0.28
WWG7	30	5.8	1.36	na	0.6	na	na	na	na	2.87	0.45
WWG8	13	3.96	1.46	na	0.8	na	na	na	na	3.07	0.49
WWG9	12	3.03	1.33	na	0.5	na	na	na	na	1.79	0.30
WWG10	17	3.87	1.23	na	0.5	na	na	na	na	1.88	0.31
WWG11	52	10.7	1.83	na	1.3	na	na	na	na	5.89	0.96
WWG12	30	6.28	1.86	na	0.5	na	na	na	na	1.71	0.26
WWG13	45	8.38	1.75	na	1.2	na	na	na	na	5.75	0.91
WWG14	39	7.26	1.86	na	0.9	na	na	na	na	2.86	0.44
WWG15	22	5.11	1.42	na	0.8	na	na	na	na	2.72	0.42
WWG16	31	6.4	1.4	na	0.9	na	na	na	na	3.48	0.53
WWG17	21	4.61	1.36	na	0.6	na	na	na	na	2.63	0.40
WWG18	18	4.59	1.31	na	0.7	na	na	na	na	2.81	0.41
WWG19	25	6.41	1.85	na	1	na	na	na	na	3.75	0.58
WWG20	16	3.68	0.8	na	0.8	na	na	na	na	2.25	0.34
WWG21	22	6.72	1.03	na	1.6	na	na	na	na	5.10	0.75
WWG22	30	7.44	1.39	na	1.4	na	na	na	na	4.41	0.67
WWG23	21	5.35	1.03	na	1.1	na	na	na	na	4.53	0.66
WWG24	7	2.99	1.06	na	1.1	na	na	na	na	3.27	0.48
WWG25	18	5.2	1.67	na	0.9	na	na	na	na	2.20	0.31
WWG26	37	9.57	1.98	na	1.7	na	na	na	na	5.67	0.83
WWG27	27	5.35	1.26	na	1	na	na	na	na	2.99	0.45
WWG28	6	2.26	0.89	na	0.7	na	na	na	na	2.61	0.40
WWG29	7	2.49	0.9	na	0.6	na	na	na	na	3.11	0.45
WWG30	28	5.5	1.31	na	0.8	na	na	na	na	2.82	0.42
WWG31	45	9.79	1.99	na	1.4	na	na	na	na	3.76	0.51
WWG32	25	5.02	1.1	na	0.8	na	na	na	na	3.08	0.45
WWG33	28	7.1	0.67	na	1.7	na	na	na	na	5.95	0.79
WWG34	25	5.67	1.36	na	1.1	na	na	na	na	3.08	0.44
WWG35	23	5.34	1.69	na	1.1	na	na	na	na	3.41	0.47
WWG36	33	6.77	1.81	na	1	na	na	na	na	2.79	0.38
WWG37	35	7.87	1.84	na	1.4	na	na	na	na	3.82	0.51
195022	36	7.19	1.33	6.64	1.08	6.31	1.29	3.78	0.55	3.62	0.54
195023	47.8	9.73	1.37	8.82	1.37	8.09	1.58	4.97	0.68	4.64	0.70
195024	44.6	9.16	1.26	8.75	1.35	8.11	1.63	5.08	0.72	4.80	0.73
195025	51.2	10.6	1.33	10.00	1.52	8.81	1.70	5.18	0.71	4.77	0.69
195026	35.4	8.5	1.74	8.33	1.42	8.68	1.71	5.18	0.74	4.83	0.75
195027	26.0	6.57	2.01	6.81	1.06	6.30	1.12	3.23	0.43	2.76	0.37
195028	34.5	7.49	1.11	7.51	1.22	7.16	1.43	4.44	0.60	4.05	0.59
195029	16.7	5.24	1.73	5.75	1.12	7.28	1.56	4.60	0.65	4.47	0.66
195030	41.9	9.15	1.33	8.06	1.26	6.95	1.38	4.28	0.57	3.76	0.59
195031	33.9	8.07	1.12	7.87	1.43	8.60	1.83	5.49	0.79	5.51	0.84
206475	33.1	7.02	1.03	7.71	1.27	7.91	1.55	4.87	0.69	4.66	0.70
206477	36.7	7.73	1.27	7.52	1.21	7.29	1.45	4.43	0.62	4.17	0.60
206597	40.6	8.45	1.40	7.87	1.20	7.12	1.40	4.24	0.60	3.95	0.59
206598	39.7	8.42	1.52	8.17	1.24	7.36	1.41	4.34	0.61	4.06	0.58
206599	37.0	7.80	1.48	7.93	1.21	7.23	1.40	4.33	0.60	4.02	0.56
206600	39.4	8.70	1.95	9.68	1.56	9.42	1.83	5.61	0.75	5.15	0.75
206601	39.5	8.64	1.85	9.31	1.51	9.07	1.86	5.59	0.77	5.11	0.74
206602	46.4	10.4	2.09	10.45	1.68	10.00	1.96	5.98	0.81	5.45	0.79
206773	19.0	4.81	0.72	4.84	0.89	5.89	1.22	3.83	0.52	3.48	0.49
206774	33.9	9.22	1.32	9.98	1.40	7.55	1.38	4.16	0.51	3.82	0.52