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LATE NEOGENE VOLCANISM IN THE CERRO BLANCO REGION OF THE PUNA AUSTRAL, ARGENTINA (~26.5°S, ~67.5°W)

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The Cerro Blanco Caldera near the southern edge of the Puna plateau has been of recent interest due to satellite radar interferograms that show the center is actively deflating (Pritchard and Simmons, 2002). The purpose of this abstract is to present K/Ar ages (Table 1) and chemical analyses (Table 2 and comparative ranges from our regional data set) of latest Miocene to Pleistocene volcanic rocks that put the Cerro Blanco region into an evolutionary tectono-magmatic context. These volcanic rocks reflect the eastward migration of the arc front from the Maricunga Belt at ~ 7 Ma to the modern CVZ front at ~ 1. 5 Ma. Their chemical trends show similarities to those of southern Puna lavas that have been linked to Pliocene delamination of lower crust and mantle lithosphere (Kay et al., 1994). Five general magmatic stages can be recognized in the Cerro Blanco region.

Table 1. K/Ar ages (analyses preformed at the SERNAGEOMIN, Chile)

Sample	Age	Type	K	Ar/rad nl/g	%atm	latitude	longitude	Description
SAF60	8.1±0.5	biotite	6.893	2.168	63	26°33.81'	67°44.41'	Dacitic ignimbrita Rosada
SAF62	7.3±0.5	whole rock	2.361	0.671	70	26°40.26	67°45.90	Dome north of Cerro Blanco caldera.
CO108	6.4±0.3	whole rock	3.151	0.786	64	26°31.61'	68º05.79'	Dacite south of Laguna El Peinado.
CO77	4.7±0.2	whole rock	2.623	0.52	46	26°55.74'		Dacite flow near Las Grutas
CO88	4.4±0.5	whole rock	2.070	0.353	84	26°43.66'	68º09.51'	Deeply eroded mafic andesite.
CO80	4.0±0.5	biotite	6.514	1.07	79	26°38.77'	68º09.27'	Laguna Amarga rhyolitic ignimbrite.
CO85	3.8±0.7	biotite	6.468	0.966	88	26°40.88	68º09.11'	Laguna Amarga rhyolitic ignimbrite.
CO81	3.7±0.7	biotite	7.045	1.002	79	26°38.96'	68º08.96'	Laguna Amarga rhyolitic ignimbrite.
CO76	2.3±0.3	whole rock	2.066	0.185	84	26°55.69'	68º03.07'	Course gray andesite in dome.
CO78	2.1±0.4	whole rock	1.521	0.126	87	26°54.74'	68º08.12'	Andesite west of Las Grutas.
CO90	1.5±0.6	biotite	7.210	0.414	94	26°45.37'	68º10.65'	Coarse andesitic.
CO91	1.5±0.4	biotite	7.392	0.479	90	26°49.20'	68º11.7'	Coarse dacite - reddish unit.
CO92	1.1±0.4	whole rock	2.464	0.109	94	26°48.38'	68º10.29'	Coarse andesite.
SAF63	1.3±0.4	whole rock	2.030	0.101	93	26°40.63'	67°45.1'	Dome north of Cerro Blanco caldera.

The first stage coincides with widespread ~ 8 to 4.4 Ma volcanism that extends from the Maricunga Belt to east of the modern CVZ arc (Mpodozis et al., 1996). The Rosada Ignimbrite erupted in the Cerro Blanco region at this time. Kraemer et al. (1999) report an age of 6.3±0.2 Ma. New K/Ar ages of 8.1±0.5 Ma for a red ignimbrite level (68.8% SiO_2) and of 7.3±0.5 Ma for a dome (63.8% SiO_2) north of the Cerro Blanco crater are in Table 1. Some trace element ratios for these dacites are La/Ta=24-43, Ba/La=17-18, La/Yb=24-35 and Sm/Yb=3-4.5. Nearby dacites and andesites have K/Ar ages of 6.4±0.3, 4.7±0.2 and 4.4±0.5 Ma (Table 1) and ratios of La/Ta=29-57, Ba/La=15-25 and La/Yb=19-28. La/Yb and arc-like Ba/La (>20) and La/Ta (>25) ratios like these are common in 8 to 4.4 Ma volcanic rocks to the west (Mpodozis et al., 1996). The second stage is marked by the Pliocene eruption of the Laguna Amarga/Laguna Verde ignimbrites near the Chile-Argentine border. Their K/Ar ages range from 4.0 to 3.7 Ma (Table 1; Mpodozis et al., 1996; Kraemer et al., 1999). Unlike the Cerro Blanco region ignimbrites, they are rhyolites (71-77% SiO_2) with La/Ta=17-20, Ba/La=18-27, La/Yb=17-24, large Eu anomalies (0.31-0.61) and high Th (25-50 ppm). The third stage is marked by the emplacement of an E-NE trending chain of andesitic domes along faults in the Cordillera de San Buenaventura. This chain terminates near Cerro Blanco where an andesite (58.4% SiO_2) has a K/Ar age of 1.3±0.4 Ma (Table 1). Chemically similar andesites (58-63% SiO_2: Ba/La=12-15; La/Ta=24-36; La/Yb=15-23) in the same chain to the west and south have K/Ar ages of 2.3±0.6, 2.1±0.4, 1.5±0.6, 1.5±0.4 and 1.1±0.4 Ma (Table 1). Their ages overlap those of domes with 60-65% SiO_2, steeper REEs (La/Yb=25-32; Sm/Yb=4-4.6), and more arc-like La/Ta (26-55) and Ba/La (15-21) ratios in the Ojos del Salado complex (<3.6 Ma) to the southwest (Mpodozis et al. 1996). Further west, similar age domes (~1.5 Ma) in the Tres Cruces complex are dacites (65-68% SiO_2) with arc-like Ba/La (20-25) and La/Ta (42-52) ratios and steep REEs (La/Yb>42). In the fourth stage, mafic andesitic lavas (52-56% SiO_2) erupted west and south of Laguna de Purulla and at Carachipampa. Their Ar/Ar ages are ~0.8 Ma (Risse et al., submitted). They have La/Yb=17-19 and non-arc-like Ba/La=12-13 and La/Ta=19-25 ratios. Pleistocene mafic lavas (53-57% SiO_2) at the CVZ Cerro Peinado center to the west have Ba/La (11-15), La/Ta (18-39) and La/Yb (15-27) ratios that extend to non-arc values (Kay et al, in prep). In the final stage, the Campo de la Piedra Pómez (0.55±0.1 Ma;

Table 2. Chemical and isotopic analyses. See Mpodozis et al. (1996) for analytical methods.

	SAF58	SAF60	SAF62	SAF63	SAF61	SAF59	SAF71	SAF76
			Dome near	Dome near	Cueros de		Carachi	Laguna
	Ig Rosada	Ig Rosada	crater	crater	Purulla	Ig. Blanca	Pampa flow	Purulla flow
Latitude	26°26.66	26°33.81'	26°40.26	26°40.63	26°34.06	26°30.84'	26°28.251	26° 39.3
Longitude	67°41.35	67°44.41'	67°45.90	67°45.1	67°44.97	67°41.93	67°24.94	67° 52
Altitude	3254	3780	4015	4020	3895	3517	3060	3830
SiO2	66.83	68.78	63.82	58.40	72.64	71.18	52.00	56.27
TiO2	0.55	0.58	0.89	1.12	0.17	0.32	1.90	1.30
Fe2O3	14.91	15.10	16.61	16.68	14.48	13.34	15.31	15.73
Al2O3	3.09	3.49	2.47	2.99	0.67	1.71	2.45	-
FeO	0.28	0.06	2.02	3.28	0.69	0.06	6.20	7.22
MnO	0.04	0.05	0.05	0.09	0.06	0.04	0.12	0.14
MgO	1.30	1.57	1.74	3.86	0.25	0.41	8.75	6.19
CaO	3.21	3.22	4.55	6.48	1.59	1.58	7.70	7.08
Na2O	5.61	3.82	4.27	3.51	3.63	3.95	3.66	3.48
K2O	3.51	2.90	2.50	2.35	3.90	5.17	1.44	2.37
P2O5	0.14	0.16	0.26	0.23	0.07	0.10	0.32	0.34
H20+C+S	0.20	0.10	0.70	0.73	1.49	1.93	0.11	-
Total	99.67	99.83	99.88	99.72	99.64	99.79	99.96	100.12
La	36.7	36.3	42.4	36.8	52.2	56.7	37.3	42.3
Ce	70.6	71.4	85.3	76.9	107.6	110.8	74.0	84.8
Nd	25.8	24.7	31.5	32.9	35.7	28.7	37.1	36.1
Sm	4.58	4.69	5.44	6.57	6.47	5.42	6.61	6.85
Eu	0.92	0.91	1.35	1.40	1.12	1.02	1.65	1.62
Tb	0.430	0.479	0.509	0.756	0.720	0.478	0.853	0.846
Yb	1.41	1.52	1.21	2.11	2.31	1.72	2.21	2.22
Lu	0.161	0.177	0.124	0.261	0.267	0.158	0.296	0.302
Y	12	16	11	21	24	15	22	-
Rb	111	124	96	121	177	167	45	-
Sr	421	374	655	532	247	290	743	638
Ba	678	627	776	464	563	780	451	556
Pb	13	14	14	10	26	19	3	-
Cs	1.3	4.2	4.3	6.4	7.3	7.2	1.4	2.3
U	4.3	4.5	3.6	5.7	5.9	7.4	1.4	2.3
Th	16.0	15.4	13.2	13.7	19.3	24.7	5.6	9.2
Zr	179	139	184	195	159	195	189	-
Hf	3.8	4.0	5.0	5.1	4.5	5.4	4.5	4.9
Nb	18	17	16	16	3	30	26	-
Ta	1.5	1.5	1.0	1.4	2.6	2.8	1.9	1.7
Sc	6.8	7.4	7.6	17.1	3.2	2.8	25.1	19.6
Cr	19	20	1	35	0	0	280	261
Ni	12	11	5	23	0	3	121	123
Zn	48	50	71	76	56	45	80	-
Cu	18	16	17	30	3	5	42	-
V	34	66	91	151	7	16	184	-
Ba/La	18.5	17.3	18.3	12.6	10.8	13.7	12.1	13.1
La/Sm	8.0	7.8	7.8	5.6	8.1	10.5	5.6	6.2
La/Yb	26.0	23.8	35.0	17.4	22.6	32.9	16.9	19.1
Eu/Eu*	0.75	0.70	0.92	0.74	0.61	0.71	0.83	0.73
Sm/Yb	3.24	3.07	4.50	3.11	2.81	3.14	2.99	3.09
La/Ta	24	25	43	27	20	20	19	25
Th/U	3.8	3.5	3.7	2.4	3.2	3.3	4.1	4.0
143Nd/144Nd					0.512444			
87Sr/86Sr					0.706582		0.706453	
206Pb/204Pb, 207Pb/204Pb, 208Pb/204Pb18.965, 15.648, 39.038								

Seggiaro and Hongn 1999) and Blanca Ignimbrite (0.2±0.1 Ma; Kraemer et al., 1999) erupted from the Cerro Blanco caldera complex and the Cueros de Purulla obsidian lava dome (0.4±0.1 Ma; Siebel et al., 2001) was emplaced. These rhyodacites (71-73% $SiO2$) have La/Yb=23-33 and non-arc Ba/La (11-14) and La/Ta (~20) ratios. The Blanca Ignimbrite and Laguna de Purulla mafic lava have similar 87Sr/86Sr ratios (~0.7065).

Notable features of the Cerro Blanco region volcanic rocks are the latest Miocene to Pleistocene trend from more to less arc-like trace element ratios, and the high La/Yb ratios of some late Miocene rocks. The distinctly low Ba/La and La/Ta ratios of the younger lavas suggest a peculiarly unhydrous and unoxidized mantle wedge compared to that found under most arcs. These features are in accord with arc migration and a particularly thick and hot mantle wedge in the aftermath of lower crustal and mantle delamination in the southern Puna (Kay et al., 1994). From a regional view, the E-NE trending faults that localize dome emplacement in the Cordillera de San Buenaventura and the eruption of the Cerro Blanco area ignimbrites reflect local complexities controlled by major structural blocks. Baldwin and Marrett (2004) suggest that the E-NE trending Cordillera de San Buenaventura could be related to a releasing bend connecting regional scale N-NE-trending faults.

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