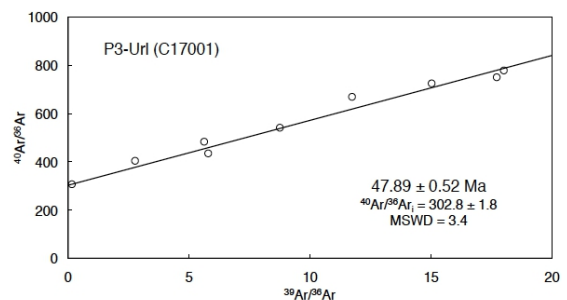
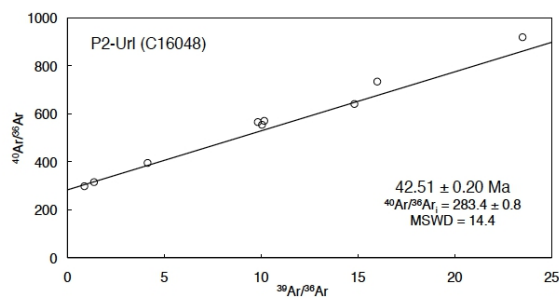
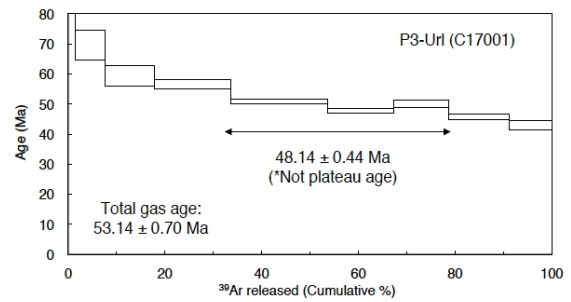
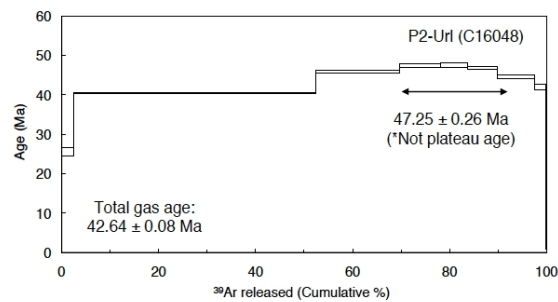
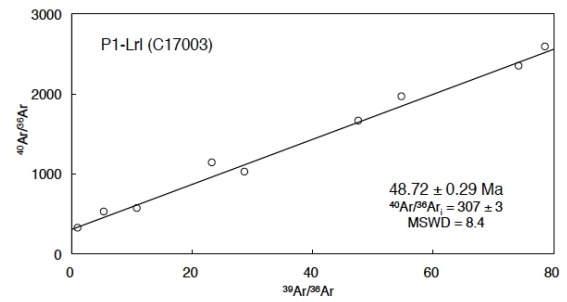
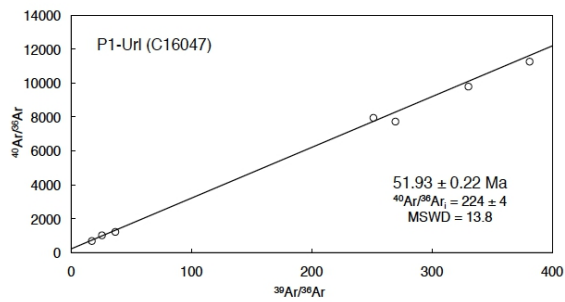
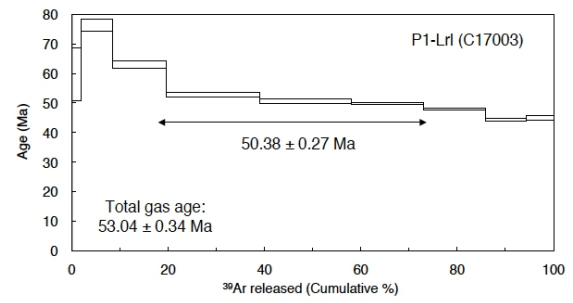
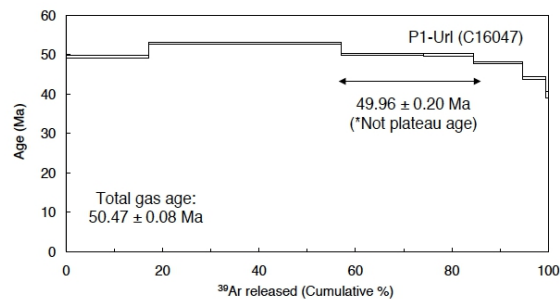
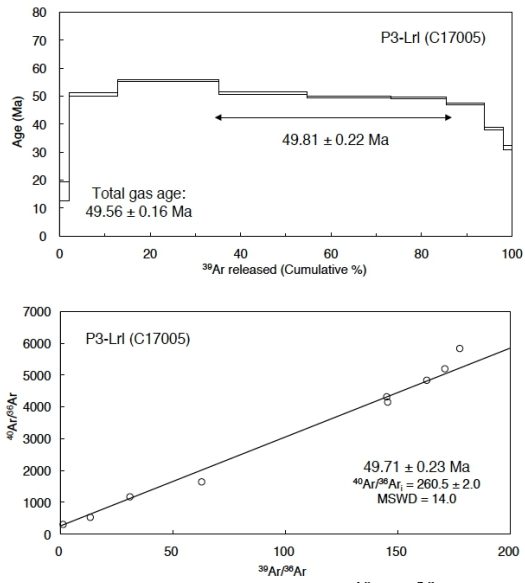


Origin of clay minerals in Early Eocene volcanic paleosols on King George Island, Maritime Antarctica

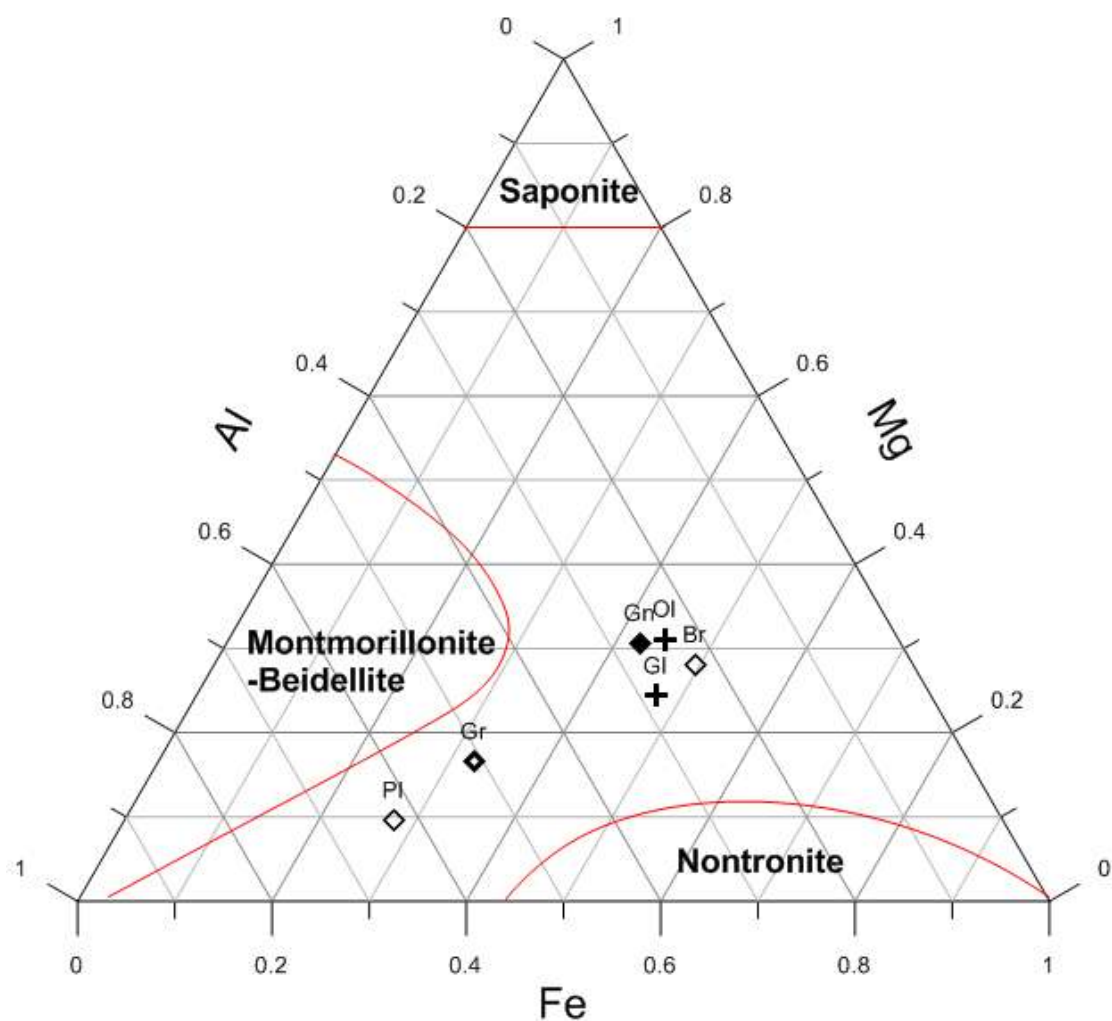
Diogo Noses Spinola, Teresa Pi-Puig, Elizabeth Solleiro-Rebolledo, Markus Egli, Masafumi

Sudo, Sergey Sedov, Peter Kühn





Supplementary Figure F1. $^{40}\text{Ar}/^{39}\text{Ar}$ age spectra and normal isochron plots obtained by the stepwise heating analysis of the other five groundmass samples than the sample P2-Lrl shown in Fig. 2 in the text. Sample-ID and Laboratory-ID are indicated in all figures. Closed circles in the isochron plot are derived from plateau steps instead open circles are not.



Supplementary Figure F2. Fe_2O_3 - Al_2O_3 - MgO Ternary diagram with the average chemical composition (EDS values) of each alteration. Br = brown infilling; Gr = grey infilling; Gn = green infilling; Ol = olivine alteration; Pl = plagioclase alteration; Gl = glass alteration.

Supplementary Table T1. Selected main macromorphological properties (after FAO, 2006).

Profile	Horizon	Depth	Horizon boundaries (distinctness - topography)	Structure ¹		Colour (Munsell)		Rock fragments	Plant fossil	Particle size %			Textural class
		[cm]		Type	Size	Dry	Name			Clay (<2μ)	Silt (2 μ-63 μ)	Sand (63μ - 2000μ)	
P1	Bwb1	0 - 23	clear - wavy	sb +pl	very fine	5YR 5/4	Dull reddish brown	many		15	18	67	Sandy loam
	Bwb2	23 - 34	gradual – smooth	sb+pl	fine/thin	2.5YR 5/4	Dull reddish brown	common		15	19	66	Sandy loam
	Bwb3	34 - 45	abrupt- smooth	ab	fine	2.5YR 5/4	Dull reddish brown	common		14	19	67	Sandy loam
	2ABb	45 - 60	clear - smooth	ab	fine	7.5YR 7/4	Dull orange	none		17	21	62	Sandy loam
	2BAb	60 - 73	abrupt - smooth	ab+pl	coarse	10YR 6/4	Dull yellow orange	none		20	22	58	Sandy clay loam
	3ABb	73+		pl+ab	medium	5Y 4/1	Gray	none	x	20	15	65	Sandy clay loam
P2	ABb	0 - 20	abrupt - smooth	sb	medium	2.5YR 5/4	Dull reddish brown	few		19	17	64	Sandy clay loam
	Bwb1	20 - 30	gradual - smooth	ab+pl	coarse	2.5YR 2/4	Reddish	few		15	19	66	Sandy loam
	Bwb2	30 - 53	diffuse - irregular	ab+pl	medium	2.5YR 5/4	Dull reddish brown	common		15	18	67	Sandy loam
	Bwb3	53+		ab+sb	medium	2.5YR 5/4	Dull reddish brown	many		15	13	72	Sandy loam

¹Structure type: ab= angular blocky., sb= subangular blocky., pl= platy. Size: vf= very fine/thin., fi= fine/thin., me=medium., co= coarse/thick

Supplementary Table T2. ⁴⁰Ar/³⁹Ar analytical results of basaltic lava flows, P1-Url, P1-Lrl, P2-Url, P3-Url and P3-Lrl.

Laser output	⁴⁰ Ar/ ³⁹ Ar		³⁷ Ar/ ³⁹ Ar		³⁶ Ar/ ³⁹ Ar		K/Ca	⁴⁰ Ar*	³⁹ Ar _K	⁴⁰ Ar*/ ³⁹ Ar _K Age (±1 σ)			
					(x10 ⁻³)			(%)	raction (%)				(Ma)
Sample ID: P1-Url Laboratory ID: C16047 Neutron irradiation ID: PO-5 J= #####													
1.6%	40.00	± 0.19	0.361	± 0.003	39.24	± 0.28	1.63	71.08	17.10	28.44	± 0.16	49.44	± 0.34
2.0%	31.59	± 0.04	0.521	± 0.001	4.12	± 0.02	1.13	96.28	39.85	30.43	± 0.04	52.85	± 0.22
2.2%	29.51	± 0.09	0.942	± 0.005	2.88	± 0.04	0.62	97.37	17.12	28.75	± 0.09	49.98	± 0.25
2.4%	29.59	± 0.14	1.265	± 0.007	3.37	± 0.07	0.46	96.98	10.46	28.72	± 0.14	49.93	± 0.31
2.8%	28.61	± 0.16	1.640	± 0.010	4.15	± 0.08	0.36	96.17	10.11	27.55	± 0.16	47.91	± 0.34
3.4%	33.29	± 0.23	2.451	± 0.017	27.90	± 0.29	0.24	75.83	4.74	25.28	± 0.20	44.02	± 0.39
4.0%	39.86	± 0.29	5.778	± 0.053	59.70	± 1.42	0.10	56.91	0.62	22.77	± 0.47	39.69	± 0.82
Plateau age (No Plateau)											±		
Total gas age											50.47 ± 0.08		
Normal isochron age (of all steps)											51.93 ± 0.22		
Inverse isochron age (of all steps)											52.52 ± 0.22		
Laser output ⁴⁰ Ar/ ³⁹ Ar ³⁷ Ar/ ³⁹ Ar ³⁶ Ar/ ³⁹ Ar K/Ca ⁴⁰ Ar* ³⁹ Ar _K ⁴⁰ Ar*/ ³⁹ Ar _K Age (±1 σ)													
Sample ID: P1-Lrl Laboratory ID: C17003 Neutron irradiation ID: PO-5 J= #####													
1.4%	345.24	± 6.14	1.613	± 0.049	#####	± #####	0.36	10.03	1.93	34.66	± 5.27	59.83	± 8.96
1.6%	100.1	± 1.5	1.86	± 0.03	189	± 2	0.32	44.33	6.55	44.4	± 1.2	76	± 2
1.8%	49.2	± 0.8	2.42	± 0.04	43.6	± 0.7	0.24	74.18	11.07	36.6	± 0.7	63.1	± 1.2
2.1%	35.9	± 0.5	3.83	± 0.05	19.3	± 0.3	0.15	85.00	19.39	30.6	± 0.4	52.9	± 0.8
2.4%	32.9	± 0.5	5.33	± 0.08	14.1	± 0.2	0.11	88.60	18.98	29.3	± 0.4	50.6	± 0.8
2.7%	34.91	± 0.15	6.06	± 0.04	22.60	± 0.18	0.10	82.27	15.13	28.83	± 0.14	49.9	± 0.3
3.1%	31.6	± 0.2	7.06	± 0.05	15.35	± 0.18	0.08	87.44	12.76	27.73	± 0.19	48.0	± 0.4
3.6%	35.7	± 0.3	10.46	± 0.10	37.5	± 0.5	0.06	71.29	8.45	25.6	± 0.3	44.4	± 0.5
4.2%	52.8	± 0.5	13.80	± 0.14	95.7	± 0.9	0.04	48.61	5.74	25.9	± 0.4	44.9	± 0.7
Plateau age (Plateau: 3 steps from 2.1% to 2.7%)											50.38 ± 0.27		
Total gas age											53.04 ± 0.34		
Normal isochron age (of all steps)											48.72 ± 0.29		
Inverse isochron age (of all steps)											48.57 ± 0.29		
Laser output ⁴⁰ Ar/ ³⁹ Ar ³⁷ Ar/ ³⁹ Ar ³⁶ Ar/ ³⁹ Ar K/Ca ⁴⁰ Ar* ³⁹ Ar _K ⁴⁰ Ar*/ ³⁹ Ar _K Age (±1 σ)													
Sample ID: P2-Url Laboratory ID: C16048 Neutron irradiation ID: PO-5 J= #####													
1.4%	230.86	± 1.16	0.370	± 0.006	731.7	± 3.8	1.59	6.35	2.51	14.67	± 0.60	25.46	± 1.04
1.6%	43.30	± 0.04	0.291	± 0.001	67.6	± 0.1	2.02	53.93	49.97	23.36	± 0.03	40.38	± 0.17
1.8%	39.15	± 0.15	0.275	± 0.002	42.6	± 0.2	2.14	67.87	17.17	26.57	± 0.13	45.87	± 0.28
2.0%	45.94	± 0.24	0.462	± 0.003	62.7	± 0.3	1.27	59.78	8.46	27.47	± 0.20	47.40	± 0.39
2.3%	57.61	± 0.32	0.601	± 0.004	101.9	± 0.6	0.98	47.80	5.61	27.55	± 0.28	47.52	± 0.52
2.7%	56.19	± 0.30	0.923	± 0.008	98.7	± 0.5	0.64	48.25	6.14	27.13	± 0.25	46.81	± 0.46
3.2%	55.19	± 0.28	1.877	± 0.012	100.0	± 0.6	0.31	46.73	7.67	25.82	± 0.25	44.58	± 0.47
3.7%	95.53	± 0.49	3.607	± 0.022	242.4	± 1.3	0.16	25.32	2.30	24.24	± 0.42	41.89	± 0.73
4.2%	343.02	± 4.26	4.044	± 0.067	1150.1	± 15.4	0.15	1.02	0.17	3.49	± 2.95	6.10	± 5.13
Plateau age (No Plateau)											±		
Total gas age											42.64 ± 0.08		
Normal isochron age (of all steps)											42.51 ± 0.20		
Inverse isochron age (of all steps)											42.66 ± 0.20		
Laser output ⁴⁰ Ar/ ³⁹ Ar ³⁷ Ar/ ³⁹ Ar ³⁶ Ar/ ³⁹ Ar K/Ca ⁴⁰ Ar* ³⁹ Ar _K ⁴⁰ Ar*/ ³⁹ Ar _K Age (±1 σ)													
Sample ID: P3-Url Laboratory ID: C17001 Neutron irradiation ID: PO-5 J= #####													
1.4%	2006.4	± 19.4	8.7	± 0.2	6539.6	± 66.5	0.07	3.72	1.49	75.05	± 12.38	130.55	± 20.79
1.6%	145.7	± 2.8	5.6	± 0.1	362.1	± 8.8	0.10	26.88	6.13	39.31	± 2.91	69.57	± 5.06
1.8%	85.5	± 2.1	8.3	± 0.2	179.2	± 5.4	0.07	38.86	10.16	33.43	± 1.99	59.32	± 3.48
2.0%	56.6	± 1.0	11.0	± 0.2	87.6	± 2.0	0.05	55.85	15.87	31.86	± 0.90	56.59	± 1.60
2.2%	47.8	± 0.5	13.9	± 0.2	69.8	± 0.8	0.04	59.23	19.91	28.58	± 0.43	50.84	± 0.78
2.4%	42.8	± 0.5	16.2	± 0.2	59.4	± 0.9	0.04	62.05	13.80	26.83	± 0.45	47.77	± 0.82
2.7%	61.2	± 0.8	16.4	± 0.2	117.5	± 1.9	0.04	45.41	11.30	28.10	± 0.73	50.00	± 1.29
3.2%	41.8	± 0.6	21.1	± 0.3	61.4	± 1.0	0.03	60.62	12.61	25.69	± 0.54	45.76	± 0.97
3.8%	73.6	± 1.0	31.8	± 0.4	177.9	± 2.5	0.02	32.05	8.72	24.09	± 0.82	42.94	± 1.45
Plateau age (No Plateau)											±		
Total gas age											53.14 ± 0.70		
Normal isochron age (of all steps)											47.89 ± 0.52		
Inverse isochron age (of all steps)											48.21 ± 0.52		
Laser output ⁴⁰ Ar/ ³⁹ Ar ³⁷ Ar/ ³⁹ Ar ³⁶ Ar/ ³⁹ Ar K/Ca ⁴⁰ Ar* ³⁹ Ar _K ⁴⁰ Ar*/ ³⁹ Ar _K Age (±1 σ)													
Sample ID: P3-Lrl Laboratory ID: C17005 Neutron irradiation ID: PO-5 J= #####													
1.4%	267.44	± 2.67	1.52	± 0.04	875.27	± 7.86	0.39	3.34	2.06	8.93	± 1.86	16.04	± 3.32
1.6%	38.01	± 0.47	0.87	± 0.01	32.63	± 0.38	0.67	74.81	10.69	28.45	± 0.42	50.62	± 0.76
1.8%	32.85	± 0.15	1.04	± 0.01	5.91	± 0.07	0.57	94.94	22.36	31.21	± 0.15	55.44	± 0.34
2.0%	30.36	± 0.25	2.26	± 0.02	6.46	± 0.09	0.26	94.31	19.52	28.68	± 0.24	51.01	± 0.46
2.2%	29.64	± 0.19	3.32	± 0.02	7.04	± 0.09	0.18	93.89	18.69	27.89	± 0.18	49.63	± 0.38
2.4%	29.68	± 0.16	4.20	± 0.02	8.02	± 0.12	0.14	93.15	12.21	27.72	± 0.15	49.33	± 0.33
2.7%	28.43	± 0.15	5.10	± 0.03	8.25	± 0.15	0.11	92.88	8.27	26.50	± 0.15	47.18	± 0.32
3.1%	26.04	± 0.28	8.37	± 0.09	18.14	± 0.31	0.07	82.01	4.33	21.48	± 0.27	38.34	± 0.50
3.7%	39.58	± 0.48	17.45	± 0.25	79.59	± 1.26	0.03	44.13	1.88	17.67	± 0.48	31.60	± 0.87
Plateau age (Plateau: 3 steps from 2.0% to 2.4%)											49.81 ± 0.22		
Total gas age											49.56 ± 0.16		
Normal isochron age (of all steps)											49.71 ± 0.23		
Inverse isochron age (of all steps)											50.83 ± 0.24		

100% corresponds to 50W output of CO

2 laser. All the errors indicate 1 sigma error.

⁴⁰Ar*: radiogenic ⁴⁰Ar

Supplementary Table T3. Selected main micromorphological characteristics.

Profile	Horizon	Depth	Pedality			Voids						Accomodation			Microstructure	Micromass				Plant residue	Pedofeatures			Zeolite		
			[cm]	sp	mp	wp	spv	cmv	cxp	ch	cm	ve	vu	a		pa	un	Colour			b-fabric		cc		pf	Fe/M n nod
																		ppl	oil		u	ssp				
P1	Bwb1	0 - 23	x				x			x	x		x	x	x	sb, (gr-cr)	br, rd, lb, bl	rd	x			x	x		x	
	Bwb2	23 - 34				x							x			(sb)	br, rd, lb, bl	rd	x				x			
	Bwb3	34 - 45		x						x			x	x	x	sb, (gr)	br, rd, lb, bl	rd	x				x			
	2ABb	45 - 60				x				x						(sb)	lb, br, rd	lb, br	x	(x)	(x)	x		x	x	
	2BAb	60 - 73		x									x	x		(gr)	lb, br, rd	lb, br	x	(x)	(x)	x		x	x	
	3ABb	73+															gr, lb, br	ol, lb	x	(x)	(x)			x	x	
P2	ABb	0 - 20		x			x	x	x	x			x	x	x	sb, gr	br, lb, rd, bl	rd	x		x			x		x
	Bwb1	20 - 30		x						x			x	x	x	sb, (gr-cr)	br, lb, rd, bl	rd	x				x		x	
	Bwb2	30 - 53				x				x		x	x	x		(sb)	br, lb, rd, bl	rd	x				x		x	
	Bwb3	53+				x				x			x	x	x	(sb)	br, lb, rd, bl	rd	x				x		x	

The micromorphological property is shown by the presence (cross) or absence (no cross).
The brackets are used when the property is weakly expressed
Pedality: sp=strongly developed pedality., mp=moderately developed., wp=weakly developed
Voids: spv= simple packing voids., cmv= compound packing voids., cxp= complex packing voids., ch= channels., cm= chamber., ve= vesicles., vu= vughs
Accomodation of planar voids: a= accommodated., pa= partially accommodated., un= unaccommodated
Microstructure: sb= subangular., gr= granular., cr= crumb
Colour: PPL (Plane Polarized Light); OIL (Oblique Incident Light): rd= red., br= brown., bl= black., lb= light brown., ol= olive, gr= grey
b-fabric: u= undifferentiated., ssp= stipple speckled., gs= granostriated
Pedofeatures: cc = clay coatings, pf= passage features, Fe/Mn nod = iron/manganese nodules

Supplementary Table T4. Alteration types distribution through the paleosols horizons.

Profile	Horizon	Depth (cm)	Alteration type					
			Transformation*			Neoformation**		
			Olivine	Plagioclase	Glass	Brown infilling	Grey infilling	Green infilling
P1	Bwb1	0-23	x	x	x	x		
	Bwb2	23-34	x	x	x	x		
	Bwb3	34-45	x	x	x	x		
	2ABb	45-60	x	x	x	x		
	2BAb	60-73	x	x	x	x		
	3ABb	73+	x	x	x	x		
P2	ABb	0-20	x	x	x	x	x	
	Bwb1	20-30	x	x	x	(x)	x	
	Bwb2	30-53	x	x	x	(x)	x	
	Bwb3	53+	x	x	x	(x)	x	x