Supplementary Material

A multi-millennial record of rock glacier ice chemistry (Lazaun, Italy)

Ulrike Nickus*, Hansjörg Thies, Karl Krainer, Kathrin Lang, Volkmar Mair and David Tonidandel

*** Correspondence:** Ulrike Nickus: ulrike.nickus@uibk.ac.at

Supplementary Tables

Supplementary Table 1. Spearman rank correlation matrix of chemical variables analysed in the ice matrix of the LZRG core. Values are given for levels of significance $p < 0.01$, *$p < 0.05$ in italics* and $p > 0.05$ in grey. (A) Upper lobe. (B) Lower lobe. Aluminum and iron were excluded because of too many samples with concentration <LOD.

(A)

SO4	Na	K	Mg	Ca	H+	Al	Ba	Co	Cu	Fe	Mn	Ni	Si	Sr	Zn	
1,00	0,53	0,62	0,90	0,97	0,65	0,68	0,77	0,75	0,49	0,54	0,68	0,75	0,46	0,97	0,71	SO4
	1,00	0,90	0,59	0,39	0,45	0,55	0,48	0,67	0,47	0,61	0,78	0,53	0,84	0,54	*0,27*	Na
		1,00	0,72	0,50	0,45	0,61	0,53	0,68	0,40	0,56	0,74	0,55	0,79	0,60	*0,33*	K
			1,00	0,87	0,63	0,69	0,73	0,79	0,48	0,53	0,74	0,77	0,52	0,84	0,69	Mg
				1,00	0,55	0,60	0,73	0,66	0,40	0,41	0,57	0,69	0,35	0,95	0,70	Ca
					1,00	0,79	0,68	0,79	0,80	0,80	0,70	0,87	0,40	0,54	0,71	H+
						1,00	0,62	0,81	0,81	0,73	0,64	0,81	0,47	0,64	0,64	Al
							1,00	0,71	0,60	0,64	0,58	0,76	0,46	0,77	0,74	Ba
								1,00	0,72	0,70	0,80	0,94	0,70	0,72	0,74	Co
									1,00	0,69	0,56	0,79	0,47	0,46	0,63	Cu
										1,00	0,71	0,72	0,48	0,48	0,51	Fe
											1,00	0,79	0,63	0,63	0,53	Mn
												1,00	0,56	0,71	0,83	Ni
													1,00	0,50	*0,34*	Si
														1,00	0,70	Sr
															1,00	Zn

(B)

SO4	Na	K	Mg	Ca	H+	Ba	Co	Cu	Mn	Ni	Si	Sr	Zn	
1,00	0,23	0,79	0,95	1,00	-0,02	0,66	0,46	-0,17	0,06	0,65	*0,34*	0,86	-0,08	SO4
	1,00	0,67	*0,36*	0,23	*-0,34*	-0,02	0,02	-0,26	0,02	-0,20	0,45	0,26	-0,19	Na
		1,00	0,84	0,79	-0,24	0,47	0,28	-0,34	-0,12	0,26	0,54	0,76	-0,07	K
			1,00	0,95	-0,09	0,61	0,40	-0,27	0,04	0,58	*0,34*	0,82	-0,18	Mg
				1,00	-0,06	0,67	0,43	-0,21	0,05	0,63	*0,34*	0,87	-0,10	Ca
					1,00	*-0,35*	0,42	0,27	0,28	0,49	0,02	*-0,30*	0,40	H+
						1,00	*0,29*	-0,05	0,12	*0,35*	0,15	0,70	-0,06	Ba
							1,00	0,19	0,62	0,68	0,24	*0,31*	0,27	Co
								1,00	*0,29*	0,04	-0,01	-0,27	0,50	Cu
									1,00	0,45	-0,01	-0,01	0,13	Mn
										1,00	0,06	0,38	0,14	Ni
											1,00	0,39	0,19	Si
												1,00	-0,06	Sr
													1,00	Zn

Supplementary Table 2. Factor loadings for ions and metals in the ice matrix of the LZRG core and explained variance (%) by 2 extracted factors. (A) upper lobe, (B) lower lobe. Loadings ≥ 0.7 are in bold. Extraction method: Principal component analysis, rotation method: Varimax.

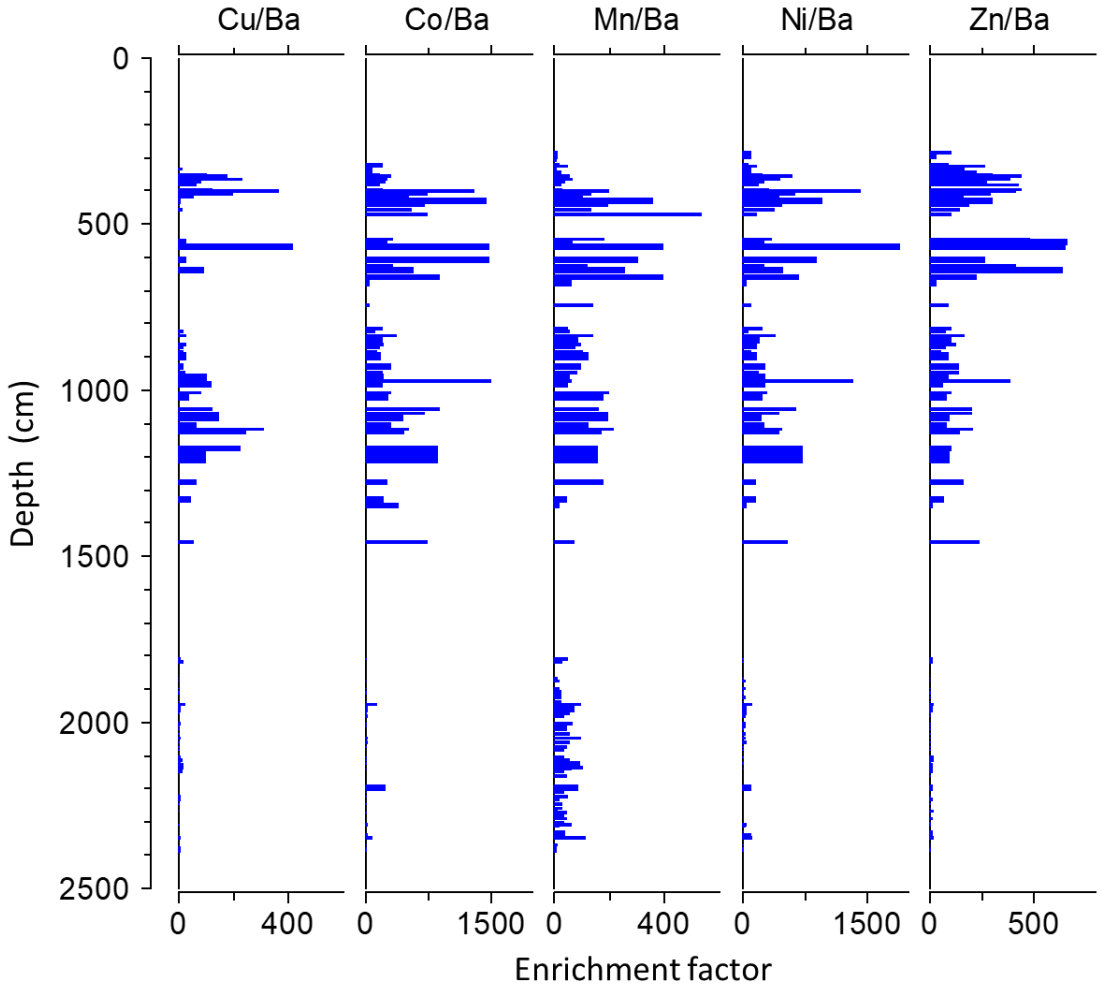
(A)

Variable	Factor 1	Factor 2
SO_4	**0.87**	0.30
Na	**0.80**	-0.13
K	**0.91**	-0.21
Mg	**0.84**	0.39
Ca	**0.84**	0.18
H^+	-0.04	**0.89**
Al	0.01	0.65
Ba	**0.80**	0.08
Co	0.09	**0.90**
Cu	-0.09	0.69
Fe	0.15	**0.80**
Mn	0.36	0.67
Ni	0.06	**0.98**
Si	0.56	0.14
Sr	**0.93**	-0.15
Zn	-0.06	**0.79**
Explained variance	40.0	29.7

(B)

Variable	Factor 1	Factor 2
SO_4	**0.94**	0.02
Na	0.58	-0.12
K	**0.87**	-0.08
Mg	**0.96**	-0.08
Ca	**0.92**	0.00
H^+	-0.11	**0.91**
Al	-0.19	**0.75**
Ba	0.55	-0.02
Co	0.38	0.61
Cu	-0.24	0.67
Fe	-0.19	**0.87**
Mn	0.15	0.58
Ni	0.52	0.69
Si	0.54	-0.08
Sr	**0.86**	-0.17
Zn	-0.11	0.65
Explained variance	35.9	26.2

Supplementary Figures



Supplementary Figure 1. Crustal enrichment factors EF – vertical profiles of the EF for copper (Cu/Ba), cobalt (Co/Ba), manganese (Mn/Ba), nickel (Ni/Ba) and zinc (Zn/Ba). As crustal tracer we used barium, and the element ratios in the Upper Continental Crust were taken from (Wedepohl, 1995).