

Table S1. Pearson correlation for major and trace elements of ferromanganese crusts

	Mn	Fe	Al	Si	Mn/Fe	Ca	P	Mg	K	Na	Ti	GR	Li	Be	Sc	V	Co	Ni	Cu	Zn	Ga	Rb	Sr	Zr	Nb	Mo
Mn	1																									
Fe	0.699*	1																								
Al	-0.807**	-0.332	1																							
Si	-0.652*	-0.092	0.540	1																						
Mn/Fe	0.377	-0.394	-0.642*	-0.684*	1																					
Ca	0.890**	0.487	-0.705*	-0.768**	0.505	1																				
P	-0.809**	-0.930**	0.457	0.238	0.176	-0.551	1																			
Mg	-0.048	0.426	0.527	0.184	-0.638*	-0.133	-0.304	1																		
K	-0.079	0.390	0.563	0.220	-0.643*	-0.008	-0.230	0.590*	1																	
Na	0.372	0.357	-0.387	0.074	0.025	0.247	-0.345	-0.330	0.209	1																
Ti	0.120	0.270	0.231	-0.226	-0.218	0.338	-0.205	0.412	0.448	-0.497	1															
GR	-0.063	0.201	0.008	0.353	-0.285	0.099	0.008	-0.032	0.166	0.027	0.406	1														
Li	-0.355	0.130	0.433	0.598*	-0.580*	-0.337	0.098	0.588*	0.215	-0.411	0.301	0.587*	1													
Be	-0.072	-0.235	-0.163	-0.160	0.234	0.190	0.344	-0.503	-0.088	0.060	0.212	0.386	-0.172	1												
Sc	-0.846**	-0.780**	0.494	0.388	-0.055	-0.628*	0.883**	-0.289	-0.202	-0.449	-0.011	0.251	0.257	0.473	1											
V	-0.044	-0.478	-0.202	-0.529	0.532	0.091	0.347	-0.572	-0.507	-0.136	-0.142	-0.289	-0.638*	0.437	0.321	1										
Co	0.721**	0.429	-0.521	-0.607*	0.337	0.487	-0.616*	0.083	-0.097	0.276	-0.224	-0.718**	-0.570	-0.375	-0.793**	0.060	1									
Ni	0.683*	0.729**	-0.350	-0.327	-0.054	0.564	-0.699*	0.567	0.110	-0.132	0.375	0.091	0.348	-0.340	-0.667*	-0.473	0.460	1								
Cu	0.277	0.494	0.008	-0.007	-0.254	0.399	-0.304	0.538	0.376	-0.229	0.658*	0.614*	0.695*	0.031	-0.195	-0.594*	-0.190	0.736**	1							
Zn	0.291	0.381	-0.179	-0.233	-0.098	0.436	-0.249	0.209	-0.020	-0.397	0.693*	0.638*	0.435	0.352	0.011	0.030	-0.255	0.525	0.712**	1						
Ga	0.549	0.732**	-0.387	-0.179	-0.219	0.456	-0.647*	0.254	-0.034	-0.060	0.397	0.497	0.320	-0.009	-0.387	-0.108	0.071	0.679*	0.569	0.820**	1					
Rb	-0.619*	-0.359	0.266	0.684*	-0.265	-0.541	0.515	-0.171	-0.224	-0.265	-0.010	0.677*	0.633*	0.314	0.746**	-0.125	-0.878**	-0.327	0.154	0.251	0.044	1				
Sr	0.256	-0.192	-0.463	-0.629*	0.552	0.313	0.044	-0.603*	-0.535	0.027	-0.146	-0.260	-0.709**	0.400	0.059	0.940**	0.257	-0.270	-0.521	0.126	0.120	-0.253	1			
Zr	0.310	0.292	-0.322	-0.311	0.037	0.463	-0.209	-0.175	-0.109	-0.169	0.562	0.616*	0.082	0.596*	0.094	0.327	-0.254	0.219	0.400	0.884**	0.734**	0.233	0.447	1		
Nb	0.380	0.592*	-0.240	-0.108	-0.234	0.412	-0.409	0.263	0.160	-0.130	0.595*	0.661*	0.464	0.357	-0.126	-0.257	-0.148	0.622*	0.785**	0.862**	0.801**	0.227	-0.111	0.760**	1	

Mo	0.329	-0.302	-0.463	-0.758**	0.775**	0.396	0.086	-0.544	-0.449	0.148	-0.294	-0.564	-0.859**	0.229	-0.115	0.824**	0.512	-0.229	-0.572	-0.212	-0.220	-0.545	0.846**	0.045	-0.383	1
	Mn	Fe	Al	Si	Mn/Fe	Ca	P	Mg	K	Na	Ti	GR	Li	Be	Sc	V	Co	Ni	Cu	Zn	Ga	Rb	Sr	Zr	Nb	Mo
Cd	0.869**	0.787**	-0.558	-0.602*	0.081	0.788**	-0.818**	0.238	0.042	0.110	0.348	0.044	-0.127	-0.107	-0.754**	0.014	0.571	0.764**	0.414	0.577*	0.797**	-0.542	0.287	0.519	0.544	0.191
Cs	-0.529	-0.163	0.283	0.724**	-0.399	-0.481	0.355	0.003	-0.067	-0.239	0.105	0.763**	0.761**	0.238	0.612*	-0.328	-0.850**	-0.147	0.342	0.333	0.167	0.970**	-0.422	0.250	0.377	-0.710**
Ba	0.458	0.244	-0.477	-0.512	0.290	0.659*	-0.211	-0.264	-0.184	-0.170	0.579*	0.546	-0.022	0.569	-0.002	0.328	-0.129	0.303	0.446	0.846**	0.661*	0.099	0.459	0.945**	0.713**	0.171
Hf	0.325	0.598*	-0.150	-0.012	-0.323	0.401	-0.415	0.267	0.239	-0.142	0.684*	0.775**	0.521	0.306	-0.105	-0.298	-0.278	0.564	0.815**	0.900**	0.823**	0.285	-0.153	0.797**	0.954**	-0.476
Ta	0.511	0.661*	-0.187	-0.229	-0.186	0.613*	-0.540	0.367	0.399	-0.087	0.803**	0.584*	0.349	0.222	-0.357	-0.377	-0.034	0.679*	0.855**	0.783**	0.690*	-0.044	-0.225	0.642*	0.866**	-0.364
W	0.883**	0.364	-0.805**	-0.871**	0.645*	0.868**	-0.533	-0.316	-0.254	0.305	0.031	-0.232	-0.653*	0.132	-0.621*	0.400	0.706*	0.387	-0.022	0.199	0.349	-0.669*	0.625*	0.354	0.179	0.713**
Tl	-0.787**	-0.838**	0.495	0.420	0.098	-0.572	0.887**	-0.206	-0.084	-0.315	-0.103	0.108	0.256	0.265	0.813**	-0.006	-0.649*	-0.586*	-0.126	-0.305	-0.704*	0.593*	-0.296	-0.327	-0.332	-0.174
Pb	0.649*	0.418	-0.467	-0.604*	0.258	0.421	-0.553	0.118	-0.136	0.208	-0.271	-0.703*	-0.500	-0.371	-0.699*	0.161	0.950**	0.460	-0.192	-0.167	0.169	-0.824**	0.350	-0.172	-0.107	0.526
Bi	0.859**	0.732**	-0.564	-0.599*	0.145	0.871**	-0.761**	0.102	0.115	0.146	0.499	0.261	-0.126	0.087	-0.648*	0.013	0.394	0.685*	0.508	0.661*	0.780**	-0.424	0.272	0.663*	0.642*	0.162
Th	0.016	0.057	-0.043	-0.030	-0.105	-0.200	-0.185	-0.178	-0.146	0.278	-0.456	-0.557	-0.571	-0.229	-0.192	0.445	0.391	-0.353	-0.761**	-0.406	-0.087	-0.375	0.515	-0.181	-0.518	0.414
U	0.641*	0.116	-0.645*	-0.807**	0.643*	0.527	-0.334	-0.315	-0.398	0.201	-0.288	-0.655*	-0.774**	-0.069	-0.488	0.526	0.845**	0.194	-0.387	-0.164	0.045	-0.742**	0.680*	-0.001	-0.184	0.843**
La	0.655*	0.259	-0.754**	-0.672*	0.497	0.502	-0.408	-0.418	-0.485	0.258	-0.305	-0.428	-0.669*	0.077	-0.417	0.532	0.716**	0.197	-0.340	0.030	0.287	-0.528	0.751**	0.247	0.028	0.715**
Ce	0.787**	0.680*	-0.434	-0.651*	0.110	0.797**	-0.727**	0.263	0.128	-0.135	0.650*	0.112	-0.067	-0.006	-0.606*	-0.020	0.446	0.764**	0.548	0.674*	0.725**	-0.477	0.202	0.597*	0.633*	0.113
Pr	0.321	0.050	-0.489	-0.453	0.323	0.272	-0.171	-0.545	-0.452	0.212	-0.228	-0.199	-0.659*	0.280	-0.089	0.797**	0.292	-0.223	-0.529	0.114	0.269	-0.247	0.932**	0.447	-0.075	0.695*
Nd	0.356	0.075	-0.518	-0.481	0.336	0.295	-0.199	-0.538	-0.457	0.218	-0.233	-0.215	-0.669*	0.260	-0.123	0.786**	0.331	-0.188	-0.520	0.113	0.284	-0.276	0.931**	0.442	-0.061	0.703*
Sm	0.338	0.051	-0.499	-0.480	0.342	0.281	-0.182	-0.539	-0.457	0.206	-0.242	-0.248	-0.680*	0.254	-0.109	0.796**	0.339	-0.204	-0.539	0.088	0.251	-0.287	0.935**	0.418	-0.094	0.718**
Eu	0.488	0.137	-0.617*	-0.600*	0.426	0.404	-0.302	-0.501	-0.493	0.157	-0.157	-0.306	-0.711**	0.243	-0.233	0.746**	0.480	-0.050	-0.464	0.138	0.302	-0.384	0.919**	0.436	-0.008	0.738**
Gd	0.419	0.151	-0.540	-0.518	0.319	0.378	-0.257	-0.502	-0.402	0.224	-0.150	-0.150	-0.637*	0.293	-0.163	0.756**	0.331	-0.113	-0.421	0.203	0.363	-0.292	0.920**	0.521	0.034	0.678*
Tb	0.413	0.144	-0.554	-0.479	0.321	0.319	-0.271	-0.503	-0.443	0.264	-0.256	-0.237	-0.669*	0.229	-0.197	0.740**	0.394	-0.131	-0.503	0.103	0.312	-0.315	0.906**	0.421	-0.041	0.693*
Dy	0.420	0.122	-0.569	-0.521	0.360	0.343	-0.248	-0.524	-0.452	0.260	-0.247	-0.235	-0.690*	0.247	-0.191	0.763**	0.394	-0.136	-0.502	0.105	0.302	-0.327	0.923**	0.428	-0.038	0.719**
Y	0.114	-0.136	-0.299	-0.497	0.316	0.302	0.149	-0.469	-0.367	-0.157	0.195	0.177	-0.341	0.658*	0.292	0.824**	-0.129	-0.197	-0.145	0.522	0.343	0.067	0.851**	0.778**	0.280	0.529
Ho	0.520	0.206	-0.636*	-0.581*	0.384	0.440	-0.333	-0.500	-0.434	0.259	-0.175	-0.195	-0.673*	0.260	-0.256	0.718**	0.438	-0.027	-0.404	0.182	0.382	-0.356	0.906**	0.493	0.068	0.706*
Er	0.602*	0.352	-0.664*	-0.565	0.303	0.505	-0.453	-0.422	-0.358	0.301	-0.115	-0.111	-0.599*	0.223	-0.350	0.611*	0.452	0.090	-0.285	0.262	0.503	-0.367	0.835**	0.545	0.179	0.613*
Tm	0.648*	0.425	-0.673*	-0.558	0.269	0.527	-0.530	-0.351	-0.346	0.280	-0.088	-0.105	-0.547	0.139	-0.419	0.544	0.486	0.180	-0.227	0.296	0.568	-0.387	0.788**	0.542	0.212	0.563
Yb	0.585*	0.362	-0.647*	-0.531	0.272	0.495	-0.453	-0.411	-0.353	0.280	-0.081	-0.046	-0.549	0.244	-0.322	0.603*	0.396	0.095	-0.248	0.318	0.547	-0.311	0.827**	0.596*	0.224	0.574

Lu	0.724**	0.550	-0.687*	-0.539	0.209	0.614*	-0.619*	-0.250	-0.243	0.330	0.006	0.033	-0.444	0.166	-0.501	0.429	0.455	0.297	-0.059	0.410	0.681*	-0.371	0.692*	0.613*	0.358	0.465
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	Cd	Cs	Ba	Hf	Ta	W	Tl	Pb	Bi	Th	U	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Y	Ho	Er	Tm	Yb	Lu
Cd	1																									
Cs	-0.434	1																								
Ba	0.564	0.112	1																							
Hf	0.534	0.437	0.738**	1																						
Ta	0.630*	0.137	0.675*	0.898**	1																					
W	0.743**	-0.681*	0.521	0.096	0.268	1																				
Tl	-0.907**	0.497	-0.301	-0.332	-0.393	-0.648*	1																			
Pb	0.605*	-0.812**	-0.093	-0.239	-0.093	0.671*	-0.690*	1																		
Bi	0.937**	-0.313	0.734**	0.662*	0.765**	0.754**	-0.779**	0.385	1																	
Th	0.096	-0.476	-0.313	-0.484	-0.542	0.151	-0.434	0.467	-0.100	1																
U	0.492	-0.817**	0.141	-0.324	-0.185	0.850**	-0.515	0.862**	0.383	0.423	1															
La	0.568	-0.598*	0.314	-0.093	-0.101	0.815**	-0.625*	0.788**	0.460	0.490	0.910**	1														
Ce	0.909**	-0.358	0.685*	0.636*	0.783**	0.677*	-0.720**	0.431	0.936**	-0.144	0.385	0.412	1													
Pr	0.386	-0.381	0.392	-0.078	-0.204	0.583*	-0.501	0.402	0.332	0.696*	0.622*	0.786**	0.213	1												
Nd	0.413	-0.405	0.395	-0.075	-0.192	0.613*	-0.528	0.440	0.354	0.690*	0.654*	0.815**	0.238	0.998**	1											
Sm	0.394	-0.421	0.372	-0.105	-0.221	0.604*	-0.509	0.450	0.332	0.704*	0.664*	0.817**	0.223	0.998**	0.998**	1										
Eu	0.503	-0.496	0.431	-0.054	-0.104	0.721**	-0.580*	0.546	0.436	0.632*	0.757**	0.886**	0.371	0.960**	0.969**	0.968**	1									
Gd	0.494	-0.403	0.478	0.026	-0.084	0.656*	-0.579*	0.443	0.450	0.635*	0.646*	0.818**	0.329	0.990**	0.993**	0.989**	0.965**	1								
Tb	0.459	-0.431	0.371	-0.066	-0.173	0.642*	-0.583*	0.496	0.386	0.702*	0.681*	0.843**	0.265	0.991**	0.995**	0.993**	0.974**	0.990**	1							
Dy	0.456	-0.445	0.394	-0.071	-0.166	0.665*	-0.570	0.493	0.390	0.675*	0.699*	0.849**	0.270	0.989**	0.995**	0.991**	0.975**	0.990**	0.997**	1						
Y	0.288	-0.054	0.738**	0.271	0.110	0.421	-0.185	0.012	0.349	0.197	0.316	0.490	0.287	0.771**	0.762**	0.753**	0.717**	0.789**	0.717**	0.739**	1					
Ho	0.545	-0.453	0.476	0.023	-0.055	0.740**	-0.624*	0.527	0.496	0.596*	0.731**	0.884**	0.381	0.968**	0.978**	0.971**	0.980**	0.986**	0.985**	0.990**	0.740**	1				
Er	0.647*	-0.429	0.522	0.144	0.067	0.759**	-0.723**	0.542	0.600*	0.556	0.696*	0.875**	0.474	0.932**	0.946**	0.934**	0.950**	0.968**	0.961**	0.963**	0.704*	0.987**	1			

Tm	0.709**	-0.430	0.521	0.185	0.112	0.765**	-0.782**	0.576*	0.649*	0.546	0.692*	0.872**	0.532	0.903**	0.919**	0.906**	0.931**	0.944**	0.938**	0.937**	0.654*	0.968**	0.994**	1		
Yb	0.652*	-0.369	0.559	0.200	0.101	0.734**	-0.717**	0.492	0.617*	0.531	0.647*	0.843**	0.484	0.929**	0.941**	0.928**	0.937**	0.966**	0.954**	0.954**	0.725**	0.979**	0.997**	0.992**	1	
Lu	0.799**	-0.374	0.587*	0.333	0.282	0.779**	-0.837**	0.527	0.760**	0.428	0.608*	0.793**	0.616*	0.819**	0.835**	0.814**	0.850**	0.879**	0.864**	0.863**	0.618*	0.909**	0.960**	0.974**	0.966**	1

GR-Growth rates

The values followed by * are correlations.at 95% confidence level.

The values followed by ** are correlations.at 99% confidence level.