

# Dissolution of Volcanic Ash in Alkaline Environment for Cold Consolidation of Inorganic Binders

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## SUPPLEMENTARY MATERIALS

**Table S1.** XRF data showing the minor element composition (expressed as ppm) of all fractions of DAR and VN volcanic ashes. Major elements are reported in Table 1. \*Recommended values for international reference material BE-N are from Govindaraju (1994, Geostandard Newsletter, Special Issue, v. 118, 158 p.).

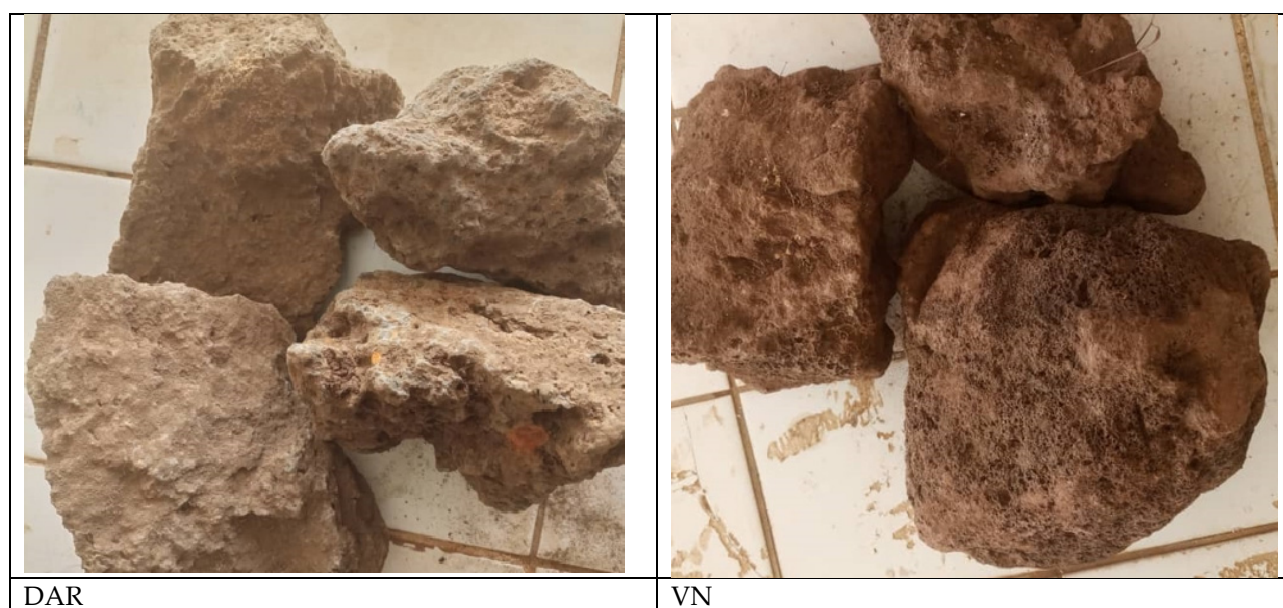
	VNm	VN	VNM	DARm	DAR	DARM	BE-N EXPER	BE-N *
<b>Ba</b>	1012	1005	1036	916	960	954	1102	1025
<b>Co</b>	31	31	35	38	40	39	58	60
<b>Cr</b>	110	130	104	185	207	164	376	360
<b>Cu</b>	30	39	28	40	55	42	95	72
<b>Ga</b>	30	31	30	29	31	31	17	17
<b>Hf</b>	9	9	9	11	9	8	5	5.6
<b>Nb</b>	96	102	97	107	108	110	102	105
<b>Ni</b>	64	61	61	145	134	135	266	267
<b>Pb</b>	3	4	4	6	4	3	3	4
<b>Rb</b>	42	45	43	34	36	35	52	47
<b>Sc</b>	13	23	11	10	30	10	27	22
<b>Sr</b>	978	1028	991	1171	1178	1180	1355	1370
<b>Th</b>	9	9	11	11	10	10	8	10.4
<b>V</b>	140	165	132	204	238	189	281	235
<b>Y</b>	31	27	27	37	26	27	26	30
<b>Zn</b>	139	145	127	139	135	132	150	120
<b>Zr</b>	489	415	428	540	392	416	257	260

**Table S2.** XRD mineralogical quantitative data of DAR volcanic ash powders. Kaer= kaersutite; Plag = plagioclase, Magn= magnetite; Diop= diopside; Then= thenardite; Forst= forsterite; Hem= hematite; Goet= goethite; Amor=amorphous.

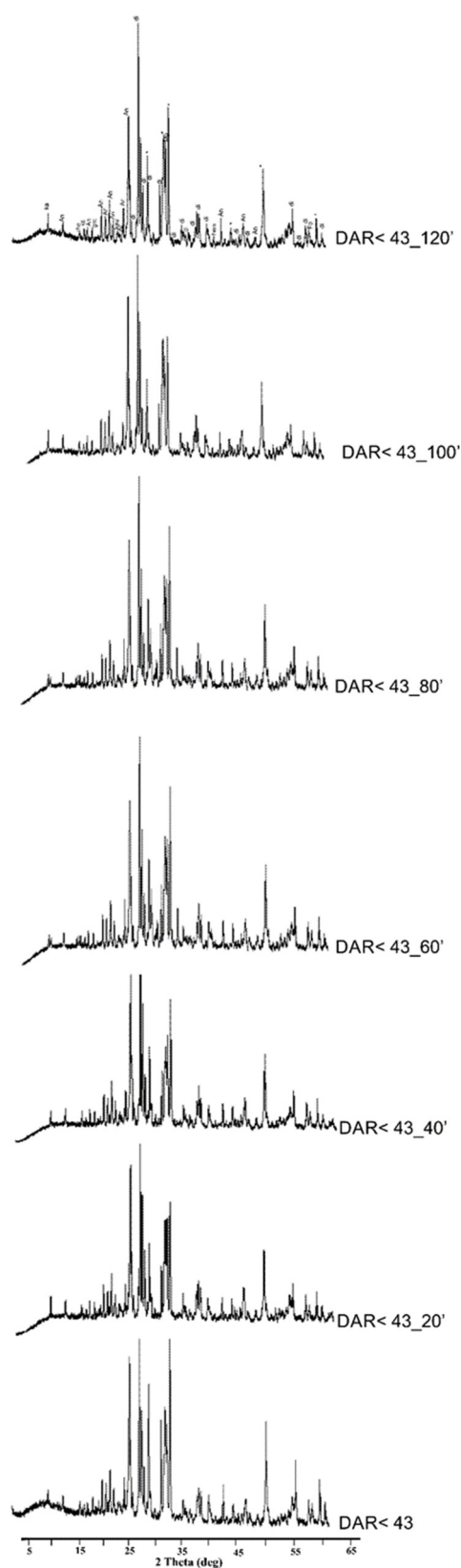
ID sample	Kaer	Plag	Magn	Diop	Then	Forst	Hem	Goet	Amor	TOT
DAR	2.70	13.84	3.60	22.22	0.60	4.76	-	0.52	51.76	100
DAR <75 8M_120'	2.83	26.88	5.96	37.33	2.46	-	0.21	0.82	23.51	100
DAR <43	2.84	12.90	3.34	22.14	0.50	4.38	-	-	53.90	100
DAR<43_12M_20	1.68	9.68	2.04	13.23	0.60	1.66	-	0.40	70.71	100
DAR<43_12M_40	3.34	22.04	3.78	34.21	1.06	5.84	0.10	0.40	29.23	100
DAR <43_12M_60	5.34	19.96	5.00	30.13	2.06	5.41	0.40	0.70	31.00	100
DAR <43_12M_80	5.19	25.29	6.32	41.26	1.39	7.68	0.10	0.30	12.47	100
DAR<43_12M_100	2.26	9.64	2.06	14.01	0.60	2.42	-	0.30	68.71	100
DAR <43_12M_120	4.28	22.48	5.56	33.31	1.05	6.70	0.20	0.50	25.92	100
DAR <43 12M_100	2.96	22.17	5.71	37.73	1.33	6.21	0.20	0.20	23.49	100
DAR >43	2.08	19.67	4.34	26.89	0.74	4.03	0.20	0.50	41.55	100
DAR>43_12M_20	4.34	25.39	5.82	37.71	0.90	6.48	0.10	0.90	18.36	100
DAR>43 12M_60	4.62	25.63	5.92	35.05	0.90	6.55	0.16	0.30	20.87	100
DAR>43 12M_80	1.63	19.04	4.38	26.07	1.94	5.09	0.15	0.60	41.10	100
DAR>43_12M_100	2.90	22.17	5.99	33.39	0.80	6.78	0.40	0.40	27.17	100
DAR>43 12M_120	3.19	24.69	6.34	34.62	1.80	6.28	0.10	0.40	22.58	100
DAR <75 10M_120	2.55	22.02	3.55	29.96	0.80	4.96	0.30	0.20	35.66	100

**Table S3.** XRD mineralogical quantitative data of VN volcanic ash powders. Kaer= kaersutite; Anort= sodian-anorthite; Plag = plagioclase, Aug= augite; Diop= diopside; Forst= forsterite; Amor=amorphous.

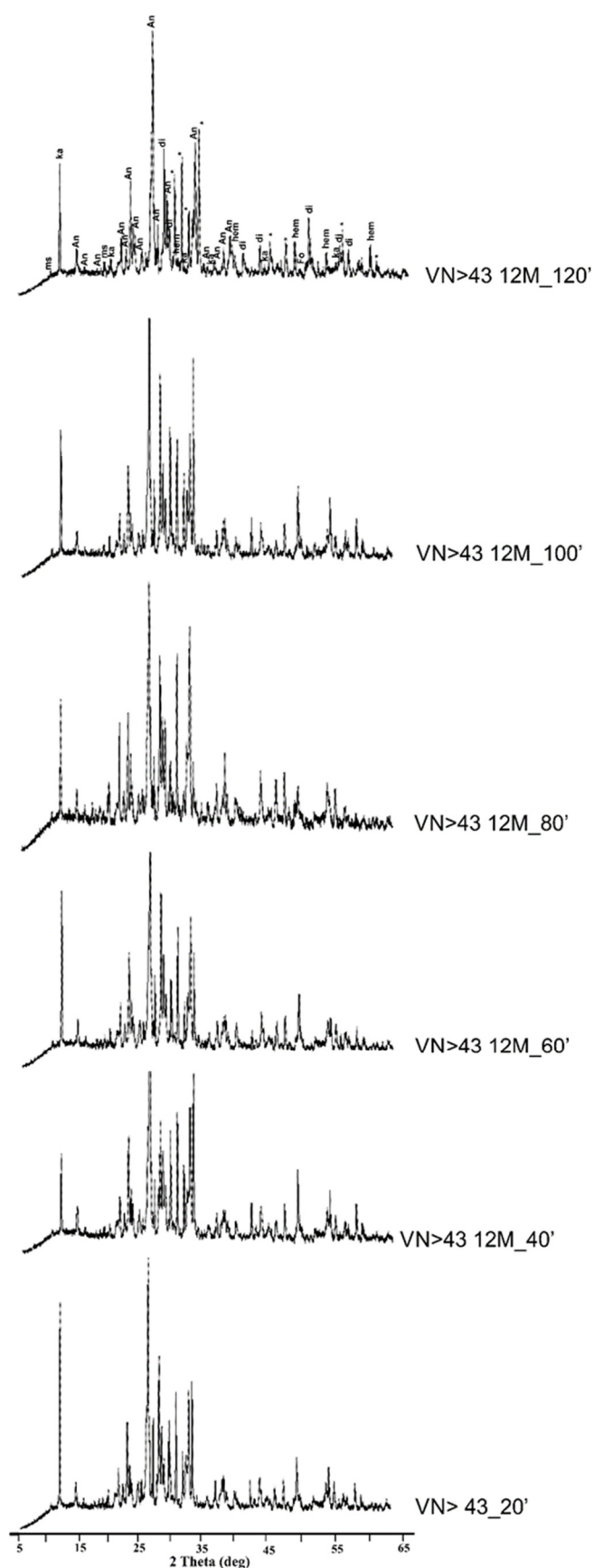
ID sample	Kaer	Anort	Plag	Augite	Diop	Forst	Amor	TOT
VN	4.60	2.44	9.58	2.55	5.17	1.23	74.43	100
VN >43	14.24	10.53	20.42	2.16	20.53	1.70	30.42	100
VN > 43_20_12M	15.01	8.23	28.64	2.02	21.05	1.80	23.25	100
VN > 43_40_12M	15.03	7.05	35.50	-	21.13	2.08	19.21	100
VN > 43_60_12M	10.54	5.77	24.91	1.48	22.08	3.24	31.98	100
VN > 43_80_12M	10.71	6.32	24.10	5.30	19.02	2.41	32.14	100
VN > 43_100_12M	11.01	6.49	24.02	8.14	16.01	2.03	32.30	100
VN > 43_120_12M	15.58	11.81	19.34	5.31	28.20	1.96	17.80	100
VN <43	6.63	3.92	7.86	0.40	13.82	0.87	66.50	100
VN<43_20_12M	15.90	22.02	15.17	26.99	14.19	2.19	3.54	100
VN<43_40_12M	13.25	6.43	30.80	10.39	17.28	3.10	18.75	100
VN<43_80_12M	9.07	2.19	21.29	18.55	3.26	1.64	44.00	100
VN<43_100_12M	10.14	4.09	17.96	3.19	12.00	1.40	51.22	100
VN<43_120_12M	20.30	-	28.70	-	47.00	1.24	2.76	100
VN 10M_120	16.11	8.54	29.98	14.34	14.06	2.73	14.24	100



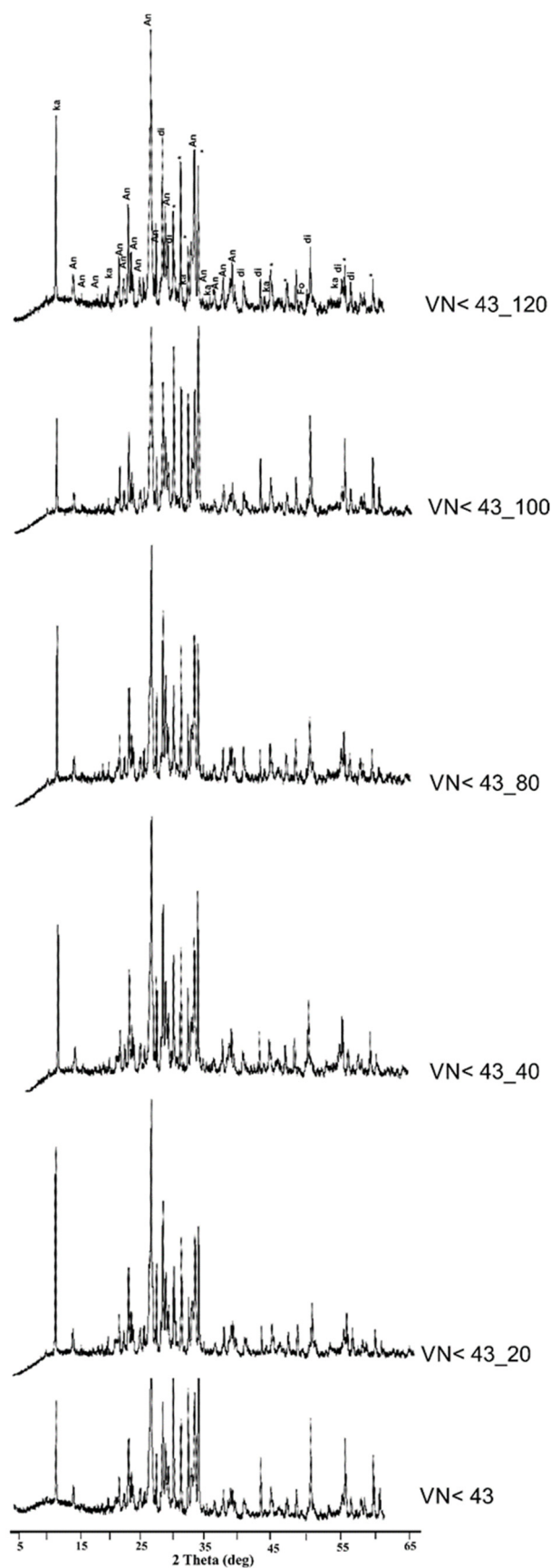
**Figure S0.** XRD patterns of DAR >43 powders before and after immersion in NaOH 12M at different times. di= diopside; hem= hematite; An= Anorthite; Ka= Kaersutite; gibb= gibbsite; ght= goethite; Mg= Magnetite; Fo= Forsterite; Au= Augite; \*= zincite (standard);.



**Figure S2.** XRD patterns of DAR <43 powders before and after immersion in NaOH 12M at different times. di= diopside; hem= hematite; An= Anorthite; Ka= Kaersutite; gibb= gibbsite; ght= goethite; Mg= Magnetite; Fo= Forsterite; Au= Augite; \*= zincite (standard).



**Figure S3.** XRD patterns of VN >43 powders before and after immersion in NaOH 12M at different times. di= diopside; hem= hematite; An= Anorthite; Ka= Kaersutite; gibb= gibbsite; ght= goethite; Mg= Magnetite; Fo= Forsterite; Au= Augite; \*= zincite (standard).



**Figure S4.** XRD patterns of VN <43 powders before and after immersion in NaOH 12M at different times. di= diopside; hem= hematite; An= Anorthite; Ka= Kaersutite; gibb= gibbsite; ght= goethite; Mg= Magnetite; Fo= Forsterite; Au= Augite; \*= zincite (standard).