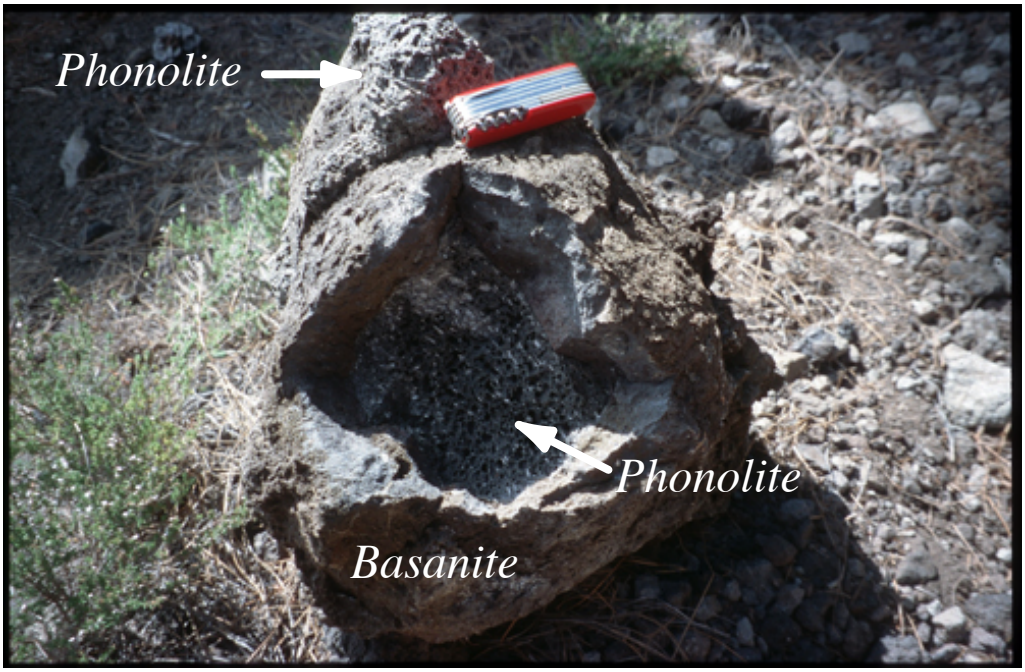
DR2005174

Picture DR1. Composite bomb from the 1585 eruption with a core of phonolite, covered with basanite. Note that phonolitic melt has been squeezed through cooling cracks in the basanite, and appears on the outer rim of the bomb.



DR2005###

Table DR2. XRF major element data of lava samples from the 1585 A.D. eruption on La Palma and syenites from the basal complex. Data are normalized to a volatile free basis except *.

1585 A.D.	Rock type	mg#	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O*	CO_2*	Total*
TLP 104-1	basanite	57.2	44.31	3.69	14.18	2.51	10.04	0.20	7.51	11.15	3.87	1.72	0.82	0.13	0.03	100.20
TLP 93-1	basanite	56.7	44.30	3.69	14.23	2.51	10.05	0.20	7.39	11.11	3.96	1.72	0.83	0.18	0.02	100.50
TLP 50-2	basanite	55.9	44.49	3.68	14.46	2.51	10.05	0.19	7.14	11.03	3.83	1.79	0.83	0.23	0.05	100.13
TLP 51-3	tephrite	45.2	46.83	3.22	17.11	2.13	8.50	0.21	3.93	9.05	5.62	2.53	0.88	0.26	0.03	99.94
TLP 105-1	tephrite	45.7	47.13	3.12	17.30	2.04	8.16	0.21	3.85	8.76	5.89	2.64	0.89	0.29	0.02	99.68
TLP 51-1	tephriphonolite	39.9	53.46	1.63	19.58	1.22	4.88	0.18	1.82	5.21	7.83	3.75	0.44	0.31	0.01	99.33
TLP 50-4	phonolite	34.5	55.92	1.07	20.28	0.90	3.59	0.17	1.06	3.76	8.61	4.38	0.27	0.25	0.03	98.76
TLP 50-6	phonolite	33.8	55.81	1.09	20.22	0.92	3.69	0.17	1.06	3.70	8.66	4.43	0.25	0.22	0.02	99.22
TLP 47-1	phonolite	33.6	55.79	1.08	20.26	0.93	3.70	0.17	1.05	3.67	8.57	4.52	0.26	0.25	0.01	98.74
TLP 50-3	phonolite	33.4	55.98	1.06	20.23	0.91	3.65	0.17	1.03	3.63	8.63	4.46	0.25	0.17	0.04	99.11
TLP 50-5	phonolite	33.3	55.94	1.05	20.32	0.90	3.61	0.17	1.01	3.53	8.69	4.53	0.24	0.24	0.02	99.55
TLP 50-1	phonolite	30.9	55.89	1.07	20.58	0.92	3.67	0.17	0.92	3.99	8.35	4.20	0.24	0.23	0.02	99.55
TLP 51-2	phonolite	29.3	55.99	1.05	20.64	0.91	3.62	0.17	0.84	3.83	8.44	4.25	0.24	0.26	0.01	99.31
Basal Complex																
TLP 52-12	syenite	48.0	64.20	0.48	18.74	0.38	0.10	0.01	0.20	4.69	10.93	0.09	0.19	0.29	3.12	96.33
TLP 52-14	syenite	51.6	64.91	0.61	19.26	0.17	0.67	0.01	0.40	2.79	10.87	0.07	0.24	0.43	1.00	98.33

Table DR2. Laser ablation ICPMS trace element data of titanite grains from phonolite samples of the 1585 eruption on La Palma

Titanites	Crystal	Rb	Sr	Ba	Y	Zr	Hf	Nb	Ta	Pb	Th	U
TLP 47-1	1	0.58-0.79	277-374	18.6-19.8	435-439	1704-2627	44-67	2062-3200	126-218	2.42-2.54	73-122	17.3-25.2
TLP 47-1	2	0.53-0.56	420 -444	17.0-17.6	532-546	2073-2173	56-58	1571-2101	142-190	2.37-2.38	66-74	13.0-14.1
TLP 50-3	1	1.05-1.16	373- 381	22.1-22.2	589-590	2679-2750	64-65	2972-3162	157-161	2.51-2.60	93-94	17.7-18.3
TLP 50-3	2	1.61-1.82	320 -324	24.1-25.7	500-508	2769-2772	63-65	2973-3056	127-131	2.61-2.66	92-93	19.9-20.1

Titanites	Crystal	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
TLP 47-1	1	1024-1489	3222-4415	344-425	1298-1465	227-231	77-78	152-153	19.1-19.7	109-116	17.0-18.4	43-48	5.96-6.82	35.7 -39.4	3.24-3.71
TLP 47-1	2	959-1066	2993-3168	368-391	154 -1625	291-299	92-96	206-207	26.3-26.5	143-147	22.6-22.8	53-54	6.89-7.05	36.7-38.6	3.43-3.62
TLP 50-3	1	1603-1677	4257-4462	474-475	1736-1749	273-281	87-89	182-189	24.2-24.3	140-140	22.8-23.1	57-58	7.98-8.19	47.9-48.0	4.64-4.73
TLP 50-3	2	1710-1730	4502-4615	44 -454	1543-1559	230-236	75-75	152-155	19.8-19.9	118-118	19.1-19.2	50-51	7.21-7.30	43.4-44.2	4.18-4.32

DR2005###

Table DR2. ICPMS trace element data of lava samples from the 1585 A.D. eruption on La Palma and syenites* from the basal complex. n.a. = not analyzed

Sample	TLP 104-1	TLP 93-1	TLP 50-2	TLP 51-3	TLP 105-1	TLP 51-1	TLP 50-4	TLP 50-6	TLP 47-1	TLP 50-3	TLP 50-5	TLP 50-1	TLP 51-2	TLP* 52-12	TLP* 52-14
Cs	0.45	0.43	0.45	0.72	0.78	1.44	1.72	1.75	1.8	1.61	1.72	1.53	1.49	0.03	0.01
Rb	38.4	40.2	43.2	68.2	68.0	111	133	136	140	135	139	136	138	0.62	0.76
Sr	1172	1187	1228	1621	1618	1419	1326	1209	1178	1244	1137	1566	1553	155	327
Ba	586	570	596	844	843	1118	1229	1204	1197	1231	1201	1221	1230	11.5	30.9
Y	33.2	34.0	35.4	40.1	37.7	26.7	23.1	23.5	23.6	22.9	22.9	25.2	25.4	41.5	21.3
Zr	351	334	358	479	502	654	752	756	771	759	766	711	732	1980	899
Hf	8.55	7.47	7.05	9.03	10.4	12.8	13.6	13.8	13.9	13.6	13.8	10.7	10.8	52.0	23.3
Nb	103	98.9	106	144	146	145	150	152	155	150	151	149	148	414	174
Ta	5.81	6.70	6.87	8.75	7.30	6.18	5.35	5.48	5.50	5.22	5.31	5.89	6.06	34.2	16.6
Pb	3.76	4.31	4.30	6.78	6.32	11.8	14.5	14.0	14.5	13.0	14.1	13.5	14.2	1.28	2.25
Th	8.4	6.80	7.60	11.3	13.3	22.4	25.6	26.4	26.4	25.8	26.5	19.7	20.8	46.1	20.5
U	2.08	1.89	2.02	3.10	3.44	6.57	7.71	7.86	7.75	7.6	7.81	6.34	6.43	12.6	5.77
Sc	25.6	24.0	24.7	13.5	12.2	4.56	2.16	2.07	2.09	2.13	1.99	2.32	2.17	n.a.	n.a.
V	339	300	313	242	240	116	80.7	80.5	83.0	80.9	79.1	79.1	77.0	17.0	19.1
Cr	275	284	281	10.3	6.69	3.16	2.9	2.54	2.71	2.85	2.23	3.27	2.86	n.a.	n.a.
Co	46.1	43.3	44.8	28.1	25.6	10.8	5.95	5.96	6.08	6.14	5.81	6.11	6.29	n.a.	n.a.
Ni	97.2	96.3	93.2	17.5	16.7	6.35	2.58	2.66	2.74	2.42	2.24	2.57	2.57	n.a.	n.a.
Cu	84.0	91.0	90.9	38.4	31.3	12.5	14.3	9.43	7.17	11.3	7.34	7.75	7.16	n.a.	n.a.
Zn	124	110	117	120	138	121	117	120	123	122	119	105	107	4.15	8.47
Ga	21.9	22.3	22.9	25.3	24.0	26.6	28.3	27.6	28.4	28.5	28.2	29.3	29.3	29.0	24.0
La	85.9	86.6	82.6	120	124	129	136	139	139	137	137	126	139	41.5	47.4
Ce	168	176	159	218	225	211	204	208	210	204	205	191	204	79.7	86.4
Pr	19.1	19.6	18.0	23.4	24.2	20.4	18.2	18.6	18.6	17.9	18.1	16.6	17.8	8.39	9.04
Nd	76.5	74.5	67.4	83.6	90.3	70.2	58.6	59.9	59.6	56.9	57.9	51.2	53.0	28.4	29.1
Sm	13.8	13.0	12.2	14.6	15.5	10.8	8.05	8.19	8.00	7.74	7.99	7.61	7.79	5.63	4.56
Eu	4.00	4.17	3.88	4.45	4.38	3.00	2.33	2.29	2.31	2.22	2.22	2.25	2.22	1.00	1.32
Gd	11.5	11.2	11.0	12.1	11.9	8.19	6.15	6.33	6.32	5.91	6.15	5.76	5.74	5.35	3.60
Tb	1.44	1.44	1.40	1.56	1.54	1.05	0.87	0.88	0.85	0.83	0.82	0.77	0.79	1.00	0.55
Dy	8.05	7.95	7.61	8.61	8.59	6.15	5.11	5.36	5.13	4.99	4.90	4.45	4.53	6.59	3.36
Ho	1.42	1.43	1.33	1.49	1.53	1.13	0.97	1.00	0.96	0.96	0.98	0.85	0.87	1.42	0.73
Er	3.37	3.47	3.42	3.94	3.83	3.10	2.79	2.85	2.72	2.70	2.72	2.52	2.41	4.69	2.41
Tm	0.43	0.49	0.45	0.52	0.48	0.42	0.42	0.42	0.42	0.41	0.44	0.41	0.39	0.85	0.44
Yb	2.63	2.58	2.50	2.94	2.98	2.87	2.74	2.80	2.71	2.72	2.7	2.48	2.36	6.81	3.55
Lu	0.35	0.33	0.31	0.39	0.44	0.41	0.42	0.45	0.42	0.42	0.43	0.35	0.35	1.10	0.57

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Table DR2. Sr-Nd-Pb isotope data and U-Th-Ra disequilibria data of volcanic rocks from the 1585 A.D. eruption on La Palma

Sample	Rock type	$^{87}Sr/^{86}Sr$	2σ	$^{143}Nd/^{144}Nd$	2 σ	$^{206}Pb/^{204}Pb$	2 σ	$^{207}Pb/^{204}Pb$	2 σ	$^{208}Pb/^{204}Pb$	2 σ
TLP 50-2	basanite	0.703082	0.000003	0.512898	0.000008	19.644	0.018	15.591	0.002	39.415	0.028
TLP 51-3	tephrite	0.703076	0.000006	0.512897	0.000008	19.653	0.001	15.592	0.002	39.426	0.008
TLP 50-1	phonolite	0.703095	0.000003	0.512892	0.000007	19.655	0.008	15.594	0.001	39.448	0.011
TLP 51-2	phonolite	0.703099	0.000003	0.512893	0.000004	19.660	0.006	15.599	0.001	39.468	0.008

2σ errors of Sr-Nd isotopes are within-run, whereas those of the Pb isotopic ratios are 2σ mean of up to three replicate analyses

Sample	Rock type / mineral phase	($^{238}U/^{232}Th$)	2 σ	($^{230}Th/^{232}Th$)	2 σ	($^{230}Th/^{238}U$)	2 σ	($^{226}Ra/^{230}Th$)	2 σ
TLP 93-1	basanite	0.806	0.006	1.131	0.023	1.402	0.039	1.435	0.028
TLP 50-2	basanite	0.845	0.005	1.128	0.020	1.335	0.021	1.462	0.023
TLP 51-3	tephrite	0.857	0.007	1.111	0.025	1.296	0.020	1.377	0.020
TLP 105-1	tephrite	0.866	0.008	1.119	0.015	1.293	0.016	1.404	0.003
TLP 51-1	tephriphonolite	0.970	0.011	1.125	0.020	1.159	0.009	1.475	0.003
TLP 47-1	phonolite	0.967	0.006	1.123	0.017	1.159	0.015	1.483	0.019
TLP 50-3	phonolite	0.979	0.003	1.127	0.007	1.152	0.011	1.520	0.021
TLP 50-5	phonolite	0.978	0.001	1.125	0.019	1.150	0.021	1.536	0.024
TLP 50-1	phonolite	0.990	0.003	1.125	0.002	1.136	0.001	1.541	0.022
TLP 51-2	phonolite	0.964	0.011	1.119	0.022	1.160	0.010	1.535	0.022
TLP 47-1 Tit	titanite	0.447	0.002	1.117	0.010	2.502	0.022	0.141	0.004
TLP 50-3 Tit	titanite	0.450	0.002	1.116	0.010	2.481	0.022	0.121	0.004

Sr-Nd isotopic ratios were determined on a TRITON thermal ionization mass spectrometer (TIMS) and Pb isotopes on a MAT262 RPQ^{2+} TIMS at IFM-GEOMAR. Both instruments operate in static multicollection. Sr and Nd isotopic ratios are normalized within-run to $^{86}Sr/^{88}Sr$= 0.1194 and $^{146}Nd/^{144}Nd$= 0.7219 respectively. Over the course of the study NBS987 gave $^{87}Sr/^{86}Sr$= 0.710257 ± 0.000007 (N=33), La Jolla $^{143}Nd/^{144}Nd$= 0.511848 ± 0.00005 (N=24) and our in-house Nd monitor Spex $^{143}Nd/^{144}Nd$= 0.511712 ± 0.00005 (N=30). The long term values for NBS 981 (N=97) in our laboratory are $^{206}Pb/^{204}Pb$= 16.898 ± 0.007, $^{207}Pb/^{204}Pb$= 15.436 ± 0.009, $^{208}Pb/^{204}Pb$= 36.524 ± 0.027 and are corrected to the NBS 981 values given in Todt et al. (1996). All aforementioned errors are 2 sigma of the mean. Total chemistry blanks were <100 pg for Sr, Nd and Pb and thus considered negligible.
U-series disequilibria were determined by TIMS at IFM-GEOMAR. For sample chemistry and TIMS protocols see Kokfelt et al. (2003).

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Table DR2. Replicate analyses of U-Th-Ra disequilibria for volcanic rocks from the 1585 A.D. eruption on La Palma. U-Th concentrations by TIMS ID

Sample	Rock type	Th (ppm)	U (ppm)	Th/U	($^{238}U/^{232}Th$)	2σ	($^{230}Th/^{232}Th$)	2σ	($^{230}Th/^{238}U$)	2σ	($^{226}Ra/^{230}Th$)	2σ
TLP 50-2	basanite	7.75	2.15	3.60	0.842	0.003	1.123	0.010	1.333	0.012		
TLP 50-2		7.73	2.16	3.58	0.847	0.004	1.140	0.012	1.346	0.015	1.462	0.023
TLP 50-2		7.66	2.14	3.58	0.846	0.004	1.121	0.011	1.325	0.013	1.474	0.019
TLP 93-1	basanite	7.57	2.02	3.75	0.808	0.003	1.122	0.010	1.389	0.012	1.445	0.037
TLP 93-1		7.56	2.00	3.77	0.804	0.004	1.139	0.013	1.416	0.018	1.425	0.022
TLP 51-3	tephrite	11.98	3.37	3.55	0.854	0.005	1.098	0.011	1.286	0.014		
TLP 51-3		11.71	3.30	3.54	0.856	0.006	1.111	0.010	1.297	0.014	1.377	0.020
TLP 51-3		11.73	3.33	3.53	0.860	0.004	1.124	0.008	1.306	0.010	1.383	0.040
TLP 105-1	tephrite	12.13	3.47	3.49	0.868	0.004	1.115	0.016	1.284	0.019		
TLP 105-1		12.74	3.65	3.50	0.868	0.003	1.119	0.010	1.289	0.012	1.405	0.022
TLP 105-1		12.50	3.57	3.50	0.867	0.006	1.129	0.018	1.303	0.022	1.403	0.029
TLP 105-1		11.99	3.40	3.53	0.860	0.005	1.113	0.011	1.294	0.014		
TLP 51-1	tephriphonolite	19.51	6.21	3.14	0.966	0.005	1.116	0.012	1.156	0.013	1.474	0.031
TLP 51-1		19.28	6.19	3.12	0.974	0.006	1.132	0.011	1.163	0.013	1.476	0.021
TLP 47-1	phonolite	23.01	7.32	3.14	0.965	0.004	1.118	0.010	1.159	0.010		
TLP 47-1		22.98	7.35	3.13	0.970	0.003	1.116	0.011	1.150	0.011		
TLP 47-1		22.60	7.21	3.13	0.968	0.004	1.131	0.012	1.168	0.013	1.483	0.019
TLP 47-1		23.48	7.46	3.15	0.964	0.004	1.115	0.011	1.156	0.012		
TLP 50-1	phonolite	21.02	6.85	3.07	0.989	0.004	1.124	0.015	1.137	0.016		
TLP 50-1		21.22	6.87	3.09	0.983	0.005	1.105	0.012	1.125	0.013	1.541	0.022
TLP 50-1		21.08	6.88	3.06	0.991	0.005	1.125	0.019	1.136	0.019	1.508	0.029
TLP 50-3	phonolite	23.08	7.44	3.10	0.978	0.004	1.130	0.012	1.156	0.012		
TLP 50-3		22.15					1.110	0.015			1.529	0.032
TLP 50-3		22.53	7.28	3.10	0.980	0.004	1.125	0.013	1.148	0.014	1.520	0.021
TLP 50-5	phonolite	22.90	7.38	3.10	0.978	0.004	1.132	0.011	1.157	0.011		
TLP 50-5		23.43	7.55	3.10	0.978	0.003	1.118	0.010	1.143	0.010	1.536	0.024
TLP 51-2	phonolite	21.30	6.74	3.16	0.960	0.005	1.111	0.009	1.157	0.010		
TLP 51-2		21.30	6.79	3.14	0.968	0.006	1.127	0.008	1.164	0.010	1.535	0.022

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References used in DR2.

Kokfelt, T.F., Hoernle, K., and Hauff, F., 2003, Upwelling and melting of the Iceland plume from radial variation of ^{238}U-^{230}Th disequilibria in postglacial volcanic rocks, Earth and Planetary Science Letters, v. 214, p. 167-186.

Todt, W., Cliff, R.A., Hanser, A., and Hofmann, A.W., 1996, Evaluation of a ^{202}Pb-^{205}Pb double spike for high precision lead isotope analyses, *in* Basu, A., and Hart, S., eds., Earth Processes: Reading the isotopic code, Volume 95: Geophysical Monograph: Washington, AGU, p. 429-437.

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Figure DR3. Total alkali-silica and Harker diagrams for the 1585 A.D. eruption of La Palma. Filled circles = basanites, open triangles = tephrite group, open squares = phonolite group. Shaded field = compositional range of the Cumbre Vieja (Johansen et al. unpublished data).

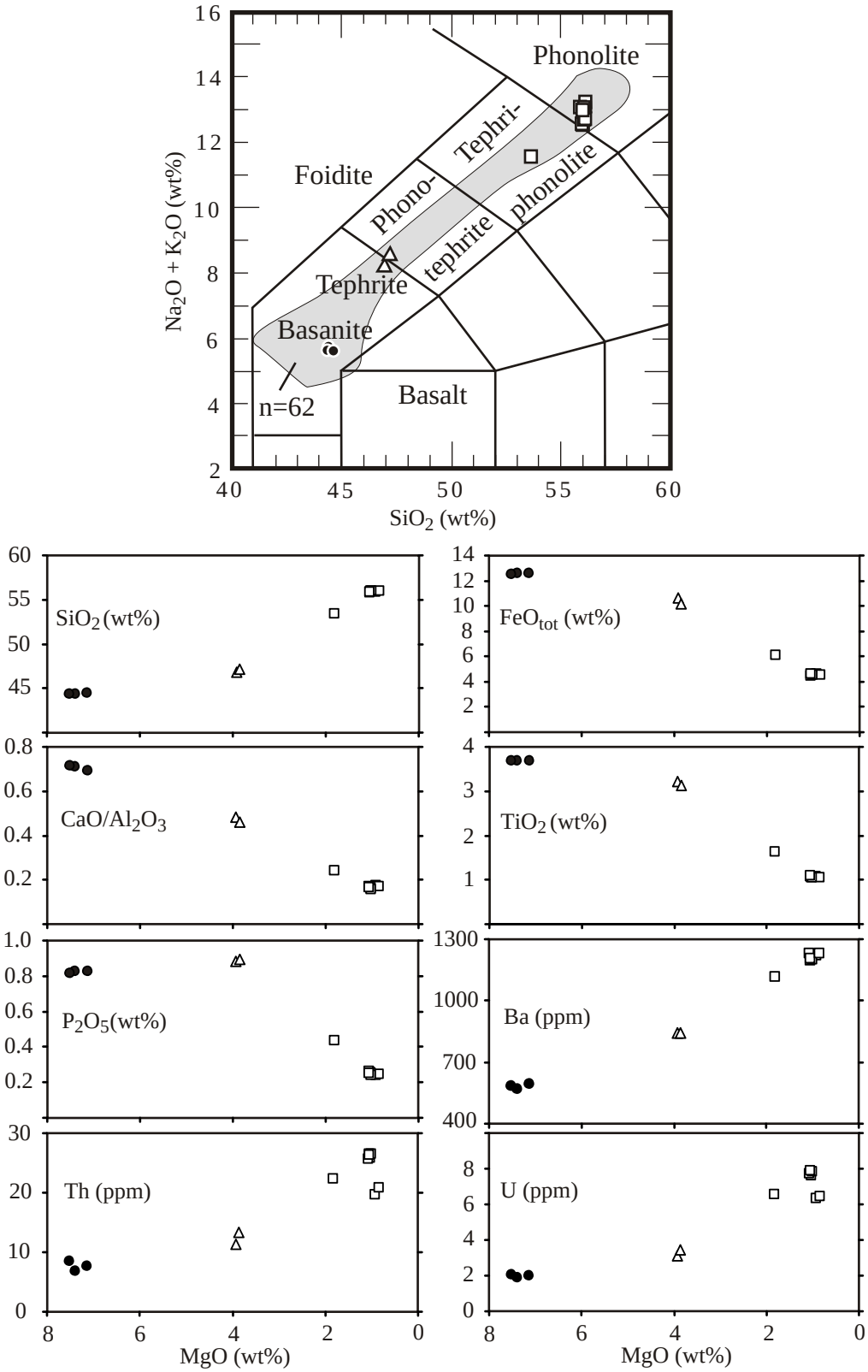

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Table DR4. Differentiation stages and modal proportions of mineral phenocrysts and melt at each stage. Mineral abbreviations: ol = olivine, cpx = clinopyroxene, amph = amphibole, tmt = titanomagnetite, tit = titanite, plag = plagioclase, h = haüyne, ap = apatite. RSS = $(ME_1^{measured} - ME_1^{modelled})^2 + \ldots + (ME_n^{measured} - ME_n^{modelled})^2$, where ME is an abbreviation for 'major element'. Mg# = 100*MgO/(MgO + FeO).

Differentiation step	Fractionating phases (%)									RSS	mg# change in melt
	ol	cpx	amph	tmt	tit	plag	h	ap	res. melt		
Basanite – tephrite	5.2	22.0	2.9	2.3					67.6	0.32	57-46
Tephrite – tephriphonolite		8.8	19.1	6.5	1.3	25.0	3.1	0.5	35.7	1.23	46-40
Tephriphonolite – phonolite		2.0	5.8	2.1	0.6	11.7	1.7	0.5	75.7	0.07	40-29
Basanite – phonolite	5.2	28.4	17.2	7.2	1.0	19.7	2.5	0.5	18.3	1.19	57-29

Table DR4. Composition of mineral phases used in the calculations for the various fractionation stages. Mineral abbreviations: ol = olivine, cpx = clinopyroxene, amph = amphibole, tmt = titanomagnetite, tit = titanite, plag = plagioclase, h = haüyne, ap = apatite.

Phase	Fractionation interval	SiO_2	TiO_2	Al_2O_3	FeO_{tot}	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Reference
ol	Basanite - Tephrite	38.03	0.00	0.05	15.43	0.26	44.44	0.30	0.00	0.00	0.00	Klügel
cpx	Basanite - Tephrite	42.03	3.55	10.11	11.34	0.27	9.03	21.57	0.95	0.00	0.00	Klügel
cpx	Tephrite - Tephriphonolite	46.51	2.23	6.56	10.27	0.32	10.39	22.11	1.28	0.01	0.00	Klügel*
cpx	Tephriphonol. - Phonolite	47.72	1.90	5.83	10.24	0.36	10.84	21.95	1.35	0.02	0.00	Klügel*
amph	Basanite - Tephrite	39.13	5.83	13.94	11.73	0.14	12.48	12.38	2.38	1.27	0.15	Klügel
amph	Tephrite - phonolite	39.93	4.76	12.26	11.61	0.27	12.93	11.60	3.07	1.26	0.00	Klügel*
tmt	Basanite - Phonolite.	0.09	10.90	2.24	77.69	1.20	1.75	0.04	0.00	0.00	0.00	Klügel
tit	Tephrite - Phonolite	29.88	36.16	1.53	1.39	0.13	0.00	25.39	0.00	0.00	0.00	Frikh-Kar
plag	Tephrite - Tephriphonolite	58.75	0.10	24.66	0.39	0.00	0.02	5.90	6.93	1.01	0.00	Klügel*
plag	Tephriphonolite - Phonolite	60.93	0.06	23.43	0.36	0.05	0.00	4.78	7.40	1.54	0.00	Klügel*
h	Tephrite. - Phonolite	32.85	0.00	25.40	0.28	0.00	0.15	10.00	16.01	0.84	0.00	Wulff-Pedersen
ap	Tephrite - Phonolite	0.55	0.00	0.00	0.16	0.01	0.00	56.51	0.29	0.00	41.01	Klügel

References:

Frikh-Kar, D.I., Ashikhmina, N.A., Muravitskaya, G.N., and Sevostyanov, M.A., 1988, Accessory minerals of effusive carbonatites and phonolites of Cape Verde Islands, Dokl. Acad. Sci. USSR, Earth Sci. Sect. v. 303, p. 1455-1459.

Klügel, A., 1997, Ascent rates of magmas and genesis, transport, and reactions of mantle and crustal xenoliths of the 1949 eruption on La Palma (Canary Islands), PhD thesis, University of Kiel, Germany, 209 p.

*Klügel, A., unpublished data

Wulff-Pedersen E., Neumann, E.R., Burke, E.A.J., Vannucci, R., Bottazzi, P., Ottolini, L., Gjønnes, J., and Hansen, V., 2000, Origin and structural character of haüyne$_{ss}$ in spinel dunite xenoliths from La Palma, Canary Islands, American Mineralogist, v. 85, p. 1397-1405.