Geochemical Perspectives Letters

Mantle depletion recorded by olivine and plagioclase megacrysts in oceanic basalts

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Supplementary Information

The Supplementary Information includes:

1. Mineral and Glass Major Element Compositions

Mineral and basalt glass major element compositions were determined using a Cameca SX100 electron microprobe at the Open University in wavelength-dispersive mode at an operating voltage of 20 kV and probe current of 20 nA (measured on a Faraday cage) with a beam 10 μm in diameter. Count times varied from 20 to 60 s per element, and data were corrected using a PAP correction procedure (Pouchou and Pichoir, 1991). The instrument was calibrated using natural mineral standards. The precision on the glass standard was better than 2 % r.s.d. for the major elements and 4 % and 15 % r.s.d for S and Cl, respectively.

2. Sample Preparation for Pb Isotope Chemistry

Glass, plagioclase, spinel, and melt inclusions and sulfides in olivine were hand-picked from crushed fragments of MORB, cleaned in ultrapure water and weighed using a microbalance. The different phases were then powdered and, with the exception of spinel, minerals and host glass digested using a concentrated HF–HNO_3 (3:1) mixture on a hotplate at ≥130 °C for 72 h. Spinel was digested in a Carius tube with a concentrated HCl–HNO_3 (5:4) mixture and sealed and heated at 220 °C for four days. Following dissolution all samples were sequentially brought into solution in concentrated HNO_3 and then HCl, refluxed in each on a hotplate for at least 24 h, and dried down prior to being brought completely into solution in dilute HNO_3.

3. Pb Isotope Chemistry and Mass Spectrometry

Lead isotopes were analysed using the double spike technique, following the same methodology described in Hunt *et al.* (2012) and brief details are given here. Sample solutions were loaded onto columns containing Sr-Spec resin and the Sr and Pb were separated from the matrix following the procedures of Deniel and Pin (2001). The samples were analysed for Pb isotopes using a ThermoFisher Neptune MC-ICP-MS at the either

the School of Earth and Environmental Sciences at the Open University or the School of Earth Sciences at the University of Bristol using identical analytical procedures.

After purification the Pb was taken up in 3 % HNO_3 to produce an approximately 20 ppb Pb solution and then split, so that an unspiked and spiked measurement could be undertaken. Both solutions were doped with ~6 ppb Tl, to allow comparison between double-spike and Tl-corrected data, and one solution was spiked with an optimal amount of a ^{207}Pb-^{204}Pb double spike. For each analytical session on the Neptune the same batch of 3 % HNO_3 was used to dilute samples and standards and was measured as an on-mass blank before each sample or standard and subtracted from each subsequent analysis. The solutions were aspirated into the MC-ICP-MS, fitted with H-cones, using a CETAC Aridus II desolvating nebulizer with an uptake rate of 50 ml min^{-1} that yields 6-8 volts of ^{208}Pb. Data on the MC-ICP-MS was collected in a static mode and any isobaric interference from ^{204}Hg on ^{204}Pb was corrected by measuring the ^{200}Hg and assuming a $^{200}Hg/^{204}Hg$ ratio of 3.3766. Unspiked and spiked runs were measured on separate days and the data deconvolved using a double-spike inversion method based on Albarède and Beard (2004). We monitored instrumental reproducibility by measuring the NBS 981 Pb standard throughout the study, which yields results within error of previous double-spike MC-ICP-MS studies (Thirlwall, 2002; Baker *et al*., 2004; Hunt *et al.*, 2012; Bewick *et al.*, 2022), with samples being run in the time period between the data collection in the last two references which represent records of long-term data collection at the Open University. To assess the analytical precision of the dissolution, chemical separation and mass spectrometry we also digested two rocks standards (BHVO-1 and BIR-1) and processed them in an identical manner to the samples. BHVO-1 yields a $^{206}Pb/^{204}Pb$ ratio of 18.6965±0.0013, a $^{207}Pb/^{204}Pb$ ratio 15.5773±0.0012 and a $^{208}Pb/^{204}Pb$ ratio of 38.3658±0.0034 whereas BIR-1 yields a $^{206}Pb/^{204}Pb$ ratio of 18.8450±0.0015, a $^{207}Pb/^{204}Pb$ ratio 15.6614±0.0013 and a $^{208}Pb/^{204}Pb$ ratio 38.4934±0.0036; these results are within error of the high-precision double-spike MC-ICP-MS study of Baker *et al*. (2004).

Table S-1 Major element data for basalt glass and minerals.

	SiO_2	TiO_2	Al_2O_3	FeO_t	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Cr_2O_3	NiO	SO_3	Cl	Total
FAMOUS, North Atlantic															
ARP1973-010-003															
matrix	50.21	1.06	11.57	11.25	0.25	8.42	14.22	1.52	0.10	0.07	0.14	0.03	0.47	0.00	99.33
glass 1	49.03	0.62	15.93	7.80	0.14	9.73	13.17	1.71	0.07	0.06	0.17	0.02	0.23	0.01	98.69
glass 2															
melt inclusions in olivine	49.12	0.58	13.06	8.89	0.12	15.36	11.04	1.34	0.01	0.03	0.10	0.06	0.26	0.00	99.96
sulfide 1															
sulfide 2															
spinel	0.15	0.32	26.02	13.83	0.22	15.98	0.01	0.03	0.00	0.00	38.43	0.20	0.02	0.00	95.21
plagioclase	49.06	0.05	30.49	0.51	0.01	0.32	14.28	3.24	0.04	0.00	0.00	0.02	0.01	0.02	98.04
ARP1974-014-013															
plagioclase	48.41	0.06	31.81	0.61	0.00	0.31	15.80	2.36	0.02	0.00	0.00	0.00	0.00	0.01	99.41
ALV 518-3-1															
glass	50.52	1.27	14.62	9.74	0.16	7.64	11.42	2.37	0.17	0.13	0.05	0.01	0.28	0.02	98.39
plagioclase	46.71	0.02	33.36	0.37	0.00	0.28	17.13	1.64	0.01	0.02	0.00	0.00	0.02	0.01	99.57
South Atlantic															
EW9309 12D															
glass	50.67	1.09	17.4	8.41	0.15	7.7	12.48	2.02	0.1	0.09					100.11
plagioclase	49.01	0.01	30.56	0.47	0.01	0.27	14.27	3.44	0.04	0.01	0.00	0.00	0.01	0.01	98.10

Table S-1 Continued

	SiO_2	TiO_2	Al_2O_3	FeO_t	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Cr_2O_3	NiO	SO_3	Cl	Total
Garrett fracture Zone, East Pacific															
GN4-11															
glass	50.13	1.11	15.4	9.07	0.19	8.95	12.24	2.18	0.03	0.05					99.35
plagioclase	45.54		34.52	0.28			18.47	1.12	0.02						99.94
GN12-10															
glass															
plagioclase	46.23		34.20	0.42			18.22	1.25	0.03						100.34
Iceland, Central rift zone															
Borgarhraun															
matrix	48.99	0.64	14.95	9.89	0.17	11.47	13.17	1.58	0.05	0.03					100.94
plagioclase	49.70		31.01	0.44			16.17	2.82	0.03						100.17

Supplementary Information References

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