

Supplementary material

Analytical techniques

Whole-rock analysis

Prior to bulk-rock analyses any apparent superficial crust due to post-solidification alteration and/or weathering effects was removed from our rock samples. Specimens for whole-rock analysis were sawn into chips (~5 mm in thickness) and washed once with tap water, then twice with purified water. After drying, the less weathered parts of each pulverized specimen were crushed further. The resultant particles were then washed with tap water, 2% HCl and deionized water. Finally, they were powdered to <200 mesh using an agate mortar. Bulk-rock sample powders were then fluxed with $\text{Li}_2\text{B}_4\text{O}_7$ (1:8) at 1150-1200 °C to make homogeneous glass discs using an Analymate Company V8C automatic fusion machine. Major-element oxide concentrations were determined by X-ray fluorescence (XRF) spectrometry with a Rigaku 100e instrument at the Wuhan Sample Solution Analytical Technology (WSSAT) Co, Wuhan (China). The analytical precision was better than 1% as assessed by regular screening of the standards AGV-2 and BHVO-2. Loss on ignition (LOI) was measured by gravimetric methods at a temperature (T) of ~1000 °C with a detection limit (DL) of 0.01 wt%.

Minor and trace element analyses were performed employing an inductively coupled plasma-mass spectrometer (ICP-MS) Thermo X Series II at the WSSAT Co. A total of 35 mg from each rock sample powder was weighed and digested with a distilled solution of HF-HNO₃ (4:1) in Savillex™ Teflon beakers at 110 °C for one day and then was heated at 120 °C to the beginning of dryness. A mixture of HF-HNO₃ solution was once more placed into beakers, and dissolution was achieved by heating of samples in an oven at 195 °C for more than 48 hours. The solutions were then dried until HF turned to vapor. The resultant residues were dissolved again in concentrated HNO₃ and were left to dry once more. Lastly, the sample residues were dissolved in a small volume (~8 ml) of 5% HNO₃ stock solution. Part of this solution was blended with an internal standard containing ⁶Li, ⁶¹Ni, ¹⁰³Rh, ¹¹⁵In, ¹⁸⁷Re, and ²³⁵U spikes and diluted with 2% HNO₃ to achieve a dilution factor of 1:5000 for minor element analyses. The standards AGV-2, BHVO-2, and BCR-2 were employed to monitor the accuracy of the analyses and were cross-checked with BIR-1. The average full procedural blank values of this study are 100 pg for large-ion lithophile elements (LILE) and less than 1 pg for high-field-strength elements (HFSE) and rare earth elements (REE: the lanthanides without Y and Sc). The concentrations of major-element oxides and trace elements of the investigated rocks are given in the supplementary Table S1.

Sr-Nd-Hf isotope analysis

Sr-Nd isotope ratios of bulk-rock samples were determined using a multicollector (MC)-ICP-MS (Nu Plasma HR) at the WSSAT Co. Almost 200 mg of powder from each rock sample was removed ultrasonically in a small volume (4 ml) of 4 N HCl at 50 °C for about 20 min. Each sample was then dissolved in a 20 ml Teflon beaker by the addition of a mixture of HNO₃ and HF at a 1:3 volume ratio, and was placed into a beaker at 80 °C during the night. Then the cap was tightly closed and each sample was heated at 140 °C to make sure that full dissolution will be achieved. The resultant solutions were initially dried at 80 °C and then ~1 ml of concentrated HNO₃ was put into each one of them before they were left to get dry once again at 80 °C. Subsequently, 10 ml of an acid solution composed of 1 N HCl and 0.25 N HNO₃ was added to the sample residues that were heated on hotplates for the whole night at 90 °C to achieve complete removal of fluorides. The ensuing solutions were left on a hotplate to dry and then 1 ml of 7 N HNO₃ was added to them to achieve full conversion to nitrites. Following completion of dryness 2 ml of 1 N HNO₃ solution were added to dissolve the residues at 80 °C.

We used a continuous column chemistry procedure with Sr-Spec resin for the purification of Sr, and Nd. In addition, the NBS-987 standard was used to monitor the detector efficiency of the analytical instrument and a ⁸⁶Sr/⁸⁸Sr of 0.1194 was used for mass fractionation corrections. The difference between the measured mean value ($0.710236 \pm 8, 2\sigma$) and the institute's obtained long-term

average of 0.710239 ± 5 (2σ) was used for ratio corrections. Lead isotopes were analyzed together with a Tl spike (^{203}Tl - ^{205}Tl isotopes) to correct for mass-dependent isotope fractionation. The entire procedure was monitored using standard SRM-981. BCR-2 was analyzed as an external standard to assess the accuracy of the analytical process. Nd was separated using TRU-Spec and Ln-Spec resins and the isotopic composition of the element was determined using a three-sequence dynamic procedure. $^{143}\text{Nd}/^{144}\text{Nd}$ were corrected for mass fractionation to $^{146}\text{Nd}/^{144}\text{Nd} = 0.7219$. The $^{143}\text{Nd}/^{144}\text{Nd}$ data are presented with respect to an Ames Nd metal $^{143}\text{Nd}/^{144}\text{Nd}$ value of 0.511966. Accuracy was monitored by analyzing the JNdi-1 reference standard and the USGS BHVO-2 rock standard. Procedural blanks were <1 ng for Sr and <25 pg for Nd. The Hf isotopes were separated from powder dissolutions by sequential ion exchange column chemistry. The exponential law was applied for mass bias correction using a $^{179}\text{Hf}/^{177}\text{Hf}$ of 0.7325. The reported $^{176}\text{Hf}/^{177}\text{Hf}$ were further adjusted relative to a JMC 475 Hf standard solution with a concentration of $200 \text{ ng}\cdot\text{ml}^{-1}$ and a typical $^{176}\text{Hf}/^{177}\text{Hf}$ of 0.282160. Each analytical run consisted of 20 cycles, in which one cycle had an integration time of 4.194 s. Shorter integration times (0.161 s, 0.262 s, 0.524 s) were performed with one run of 30 cycles. All results of $^{176}\text{Hf}/^{177}\text{Hf}$ are quite reproducible and accurate indicating that the isotopic composition of a small quantity of Hf (<20 ng) could be measured with high analytical precision and accuracy in a short time (<1 minute).

Bulk-rock Sr-Nd-Hf isotopic data of the investigated rocks are given in the supplementary Table S1.

Table S1. Major element oxide and trace element concentrations and Sr-Nd-Hf isotopes of the basalts from the Center Basin Fault in the West Philippine Basin

Sample	CP-1C	CP-2A	CP-4A	CP-5A	CP-6A	CP-7B	CP-9B	CP-9BR1	CP-10A
	Basalt	Replicate analysis	Basalt						
Major oxides (wt. %)									
SiO ₂	48.64	48.74	48.93	48.69	48.10	49.20	48.59	48.59	48.29
TiO ₂	1.60	1.60	1.55	1.59	1.61	1.55	1.58	1.58	1.58
Al ₂ O ₃	16.53	16.56	16.18	16.42	16.69	16.28	16.52	16.54	16.50
Fe ₂ O ₃ ^t	11.88	11.83	11.60	11.89	12.50	11.56	11.98	11.96	11.91
MnO	0.18	0.19	0.18	0.18	0.20	0.18	0.18	0.18	0.18
MgO	4.53	4.52	4.85	4.62	4.15	4.90	4.66	4.68	4.68
CaO	11.67	11.71	11.38	11.50	11.40	11.43	11.63	11.63	11.55
Na ₂ O	2.98	2.97	2.95	2.94	3.03	2.96	2.98	2.97	2.98
K ₂ O	0.19	0.20	0.22	0.22	0.28	0.22	0.21	0.21	0.21
P ₂ O ₅	0.14	0.14	0.13	0.14	0.18	0.13	0.14	0.15	0.14
L.O.I	1.70	1.43	1.32	1.30	1.41	1.37	1.40	1.33	1.45
Total	100.04	99.88	99.30	99.48	99.54	99.78	99.87	99.81	99.47
Mg#	47	47	49	47	44	50	48	48	48
Trace elements (ppm)									
Li	17.9	19.0	23.8	20.6	16.7	23.9	21.4	21.1	21.2
Be	0.43	0.51	0.45	0.44	0.51	0.45	0.48	0.46	0.46
Sc	40.3	40.9	40.3	40.8	41.9	41.0	40.7	40.5	42.0
Ti	9566	9584	9279	9506	9656	9303	9459	9447	9471
V	322	338	319	324	350	326	328	330	328
Cr	386	400	385	401	392	396	394	391	398
Co	51.9	54.5	54.6	51.2	50.5	53.9	50.6	50.0	49.5
Ni	142	151	141	140	164	141	141	144	143
Cu	62.1	66.3	68.0	66.4	88.5	68.6	69.0	69.1	69.8
Zn	82.9	95.0	97.8	91.2	104.3	100.0	98.5	97.3	97.7
Ga	17.8	18.7	17.7	17.8	20.2	18.1	18.3	18.3	18.3

Rb	4.14	3.88	4.19	4.14	6.52	4.19	4.26	4.24	4.27
Sr	126	129	126	127	135	128	128	129	130
Y	27.5	27.8	28.2	28.2	28.9	28.5	28.8	28.8	29.2
Zr	98.9	100.5	97.3	99.1	106.2	99.5	99.4	98.7	100.6
Nb	3.94	3.92	3.87	4.00	4.15	3.91	3.93	3.81	4.00
Sn	0.89	0.89	0.88	0.94	1.03	0.94	0.91	0.85	0.91
Cs	0.39	0.33	0.36	0.36	0.58	0.36	0.37	0.38	0.38
Ba	21.3	20.0	21.4	19.6	24.0	21.0	21.1	21.0	21.0
La	2.42	2.47	2.64	2.55	2.90	2.71	2.68	2.69	2.74
Ce	7.85	8.18	8.46	8.36	8.86	8.51	8.73	8.74	8.66
Pr	1.42	1.48	1.55	1.50	1.58	1.57	1.60	1.55	1.57
Nd	7.87	8.55	8.45	8.56	9.00	8.85	8.47	8.59	8.75
Sm	3.07	3.02	3.15	3.04	3.18	3.16	3.13	3.11	3.12
Eu	1.16	1.29	1.22	1.22	1.25	1.25	1.26	1.19	1.28
Gd	4.05	4.19	4.21	4.18	4.35	4.38	4.16	4.25	4.28
Tb	0.77	0.78	0.80	0.81	0.80	0.81	0.81	0.82	0.81
Dy	5.07	5.35	5.36	5.36	5.55	5.23	5.29	5.25	5.49
Ho	1.11	1.07	1.07	1.10	1.12	1.09	1.14	1.13	1.13
Er	2.92	2.91	3.00	3.00	2.98	3.01	3.03	3.02	3.23
Tm	0.47	0.48	0.47	0.48	0.48	0.48	0.51	0.48	0.50
Yb	2.75	2.86	2.91	2.94	2.89	3.00	2.97	2.97	2.89
Lu	0.39	0.41	0.42	0.43	0.42	0.43	0.42	0.41	0.43
Hf	2.82	2.74	2.71	2.77	2.91	2.81	2.80	2.76	2.81
Ta	0.27	0.26	0.25	0.26	0.27	0.24	0.27	0.27	0.27
Tl	0.05	0.11	0.17	0.08	0.23	0.16	0.13	0.14	0.13
Pb	0.44	0.53	0.46	0.51	0.94	0.45	0.50	0.49	0.48
Th	0.23	0.23	0.23	0.24	0.25	0.24	0.23	0.24	0.25
U	0.25	0.23	0.19	0.24	0.37	0.19	0.24	0.25	0.27

Sr–Nd–Hf isotopes

$^{87}\text{Sr}/^{86}\text{Sr}$	0.703361	0.703339	0.703408	0.703395	0.703455	0.703418	0.703403	0.703405
2σ	0.000012	0.000011	0.00001	0.000014	0.000012	0.000013	0.000012	0.000008
$^{87}\text{Sr}/^{86}\text{Sr}(\text{i})$	0.703321	0.703302	0.703367	0.703355	0.703395	0.703377	0.703363	0.703364
$^{143}\text{Nd}/^{144}\text{Nd}$	0.513084	0.513089	0.513084	0.513074	0.513050	0.513078	0.513070	0.513071
2σ	0.000007	0.000006	0.000007	0.000007	0.000009	0.000006	0.000006	0.000006
$^{143}\text{Nd}/^{144}\text{Nd}(\text{t})$	0.513038	0.513047	0.51304	0.513032	0.513008	0.513034	0.513028	0.513028
$\epsilon_{\text{Nd}}(\text{t})$	8.6	8.7	8.6	8.4	8.0	8.5	8.4	8.4
$^{176}\text{Hf}/^{177}\text{Hf}$	0.283199	0.283200	0.283214	0.283203	0.283209	0.283182	0.283214	0.283195
2σ	0.000007	0.000007	0.000008	0.000007	0.000008	0.000006	0.000007	0.000005
$\epsilon_{\text{Hf}}(\text{t})$	15.8	15.8	16.3	15.9	16.1	15.2	16.3	15.6

Note: $\text{Fe}_2\text{O}_3^{\text{t}}$ = Total Fe_2O_3 content; $\text{Mg}\# = \text{Mg}^{2+}/(\text{Mg}^{2+} + \text{Fe}^{2+}) \times 100$; LOI = Loss on ignition.