## Supplementary Materials

## Analytical methods

## Whole-rock analysis

Prior to whole-rock analyses any obvious crust related to post-magmatic alteration and/or weathering was removed from the investigated rock specimens. Samples for bulk-rock analysis were sawn into chips ( $\sim 5 \mathrm{~mm}$-thick) and washed twice with purified water. After drying, the crushed samples were pulverized and the ensuing particles were washed with a mixture of deionized water with $\mathrm{HCl}(2 \%)$. Then, they were powdered to $<200$ mesh using an agate mortar. Each powdered sample was fluxed with a solution of $\mathrm{Li}_{2} \mathrm{~B}_{4} \mathrm{O}_{7}(1: 8)$ at $1150-1200{ }^{\circ} \mathrm{C}$ to produce homogeneous glass discs employing an automatic fusion device (Analymate Company V8C). Major-element oxide contents were measured by X-ray fluorescence (XRF) spectrometry using a Rigaku 100e instrument at the Guangzhou Institute of Geochemistry, Chinese Academy of Sciences (GIG-CAS). Analytical accuracy was better than $1 \%$ as assessed by screening of reference samples of known composition (AGV-2, BHVO-2) [56]. Loss on ignition (LOI) was determined by gravimetric methods at $\sim 1000{ }^{\circ} \mathrm{C}$.

Trace element analyses were carried out using an inductively coupled plasma-mass spectrometer (ICP-MS) Thermo X Series II at the Radiogenic Isotope Facility, School of Earth and Environmental Sciences, University of Queensland (RIF-SEES-UQ), Brisbane, Australia. A small quantity $(\sim 35 \mathrm{mg})$ from each powdered sample was digested with a $\mathrm{HF}-\mathrm{HNO}_{3}$ (4:1) solution in a Savillex ${ }^{\mathrm{TM}}$ Teflon beaker at $110{ }^{\circ} \mathrm{C}$ for 24 hours and subsequently was heated at $120{ }^{\circ} \mathrm{C}$ until it started getting dry. The powdered samples were digested once more with a solution of $\mathrm{HF}-\mathrm{HNO}_{3}$ (4:1) and dissolution was done by heating at $195{ }^{\circ} \mathrm{C}$ for more than 48 hours. The residues were dissolved in $\mathrm{HNO}_{3}$ and were left to dry again. After this stage the resultant residues were dissolved in $\sim 8 \mathrm{ml}$ of a $5 \% \mathrm{HNO}_{3}$ solution. Part of this solution was mixed with an internal standard containing ${ }^{6} \mathrm{Li},{ }^{61} \mathrm{Ni},{ }^{103} \mathrm{Rh},{ }^{115} \mathrm{In},{ }^{187} \mathrm{Re}$, and ${ }^{235} \mathrm{U}$ and then was diluted with $2 \% \mathrm{HNO}_{3}$ to achieve a dilution factor of 1:5000 for trace element analyses. The reference materials AGV-2, BHVO-2, and BCR-2 were used to monitor the precision of the analyses and were cross-checked with BIR-1. The average full procedural blank values of the present work are 100 pg for the large-ion lithophile elements (LILE) and less than 1 pg for the high-field-strength elements (HFSE) and the rare-earth elements (REE: the lanthanides not including Y and Sc ). The concentrations of major-element oxides and trace elements of the investigated rocks are presented in Table S1.

## Strontium-Nd-Pb isotope analysis

Strontium- $\mathrm{Nd}-\mathrm{Pb}$ isotope ratios of whole-rock samples were measured using a multicollector (MC)-ICP-MS (Nu Plasma HR) at the RIF-SEES-UQ, following the analytical method described by [57]. Approximately 200 mg from each rock specimen was removed ultrasonically in 4 ml of a 4 N HCl solution at $50^{\circ} \mathrm{C}$ for $\sim 20 \mathrm{~min}$. Each sample was then dissolved in a 20 ml Teflon beaker by adding a mixture of $\mathrm{HNO}_{3}$ and $\mathrm{HF}(1: 3)$, and was put into a hotplate at $80^{\circ} \mathrm{C}$ for the whole night. Then the studied samples were heated at $140^{\circ} \mathrm{C}$ to achieve full dissolution. The ensuing solutions were dried at $80^{\circ} \mathrm{C}$ and $\sim 1 \mathrm{ml}$ of concentrated $\mathrm{HNO}_{3}$ solution was put into each one of them, before they were left to dry once more at $80^{\circ} \mathrm{C}$. Subsequently, 10 ml of a solution composed of 1 N HCl and $0.25 \mathrm{~N} \mathrm{HNO}_{3}$ was added to the residues. The resultant solutions were heated on beakers for the whole night at $90^{\circ} \mathrm{C}$ to achieve complete removal of fluorides and then were left on hotplates to dry. Subsequently, they were mixed with 1 ml of a $7 \mathrm{~N} \mathrm{HNO}_{3}$ solution to achieve full conversion to nitrites. Last of all, 2 ml of $1 \mathrm{NHNO}_{3}$ solution were added to dissolve the residues at $80^{\circ} \mathrm{C}$.

A continuous distillation column with Sr-Spec resin was used for the purification of $\mathrm{Sr}, \mathrm{Nd}$ and Pb . The detector efficiency of the instrument was monitored using the NBS-987 standard. A ${ }^{86} \mathrm{Sr} /{ }^{88} \mathrm{Sr}$ ratio of 0.1194 was used for mass fractionation corrections. The difference between the institute's long-term obtained average of $0.710239 \pm 5(2 \sigma)$ and the measured mean value $(0.710236 \pm 8,2 \sigma)$ was
used for isotopic ratio corrections. Lead isotopes were analyzed together with Tl isotopes $\left({ }^{203} \mathrm{Tl},{ }^{205} \mathrm{Tl}\right)$ to correct for mass-dependent isotope fractionation. The process was monitored using standard SRM-981. BCR-2 was analyzed as an external standard to check the accuracy of the method. Neodymium was separated using TRU-Spec and Ln-Spec resins. ${ }^{143} \mathrm{Nd} /{ }^{144} \mathrm{Nd}$ ratios were corrected for mass bias to ${ }^{146} \mathrm{Nd} /{ }^{144} \mathrm{Nd}$ equal to 0.7219 . The ${ }^{143} \mathrm{Nd} /{ }^{144} \mathrm{Nd}$ data are given with respect to an Ames Nd metal ${ }^{143} \mathrm{Nd} /{ }^{144} \mathrm{Nd}$ value of 0.511966 . Accuracy was monitored by analyzing the JNdi-1 reference standard and the USGS BHVO-2 rock standard. Procedural blanks were $<1 \mathrm{ng}$ for $\mathrm{Sr},<100 \mathrm{pg}$ for Pb and $<25 \mathrm{pg}$ for Nd . Whole-rock $\mathrm{Sr}-\mathrm{Nd}-\mathrm{Pb}$ isotopic data of the investigated rocks are presented in Table S1.

## Hafnium isotope analysis

Bulk-rock Hf isotopes were measured using the method described by [58]. Hafnium isotope analyses were performed using a Micromass IsoProbe MC-ICP-MS at the GIG-CAS. The Hf isotopes were separated from powder dissolutions by sequential ion exchange column chemistry. The exponential law was applied for mass fractionation correction using a ${ }^{179} \mathrm{Hf} /{ }^{177} \mathrm{Hf}$ ratio of 0.7325 . The ${ }^{176} \mathrm{Hf} /{ }^{177} \mathrm{Hf}$ ratios were corrected with respect to a JMC 475 Hf standard solution with a ${ }^{176} \mathrm{Hf} /{ }^{177} \mathrm{Hf}$ ratio of 0.282160 . Every analytical run included 20 cycles with an integration time of 4.194 s for a single cycle. The reproducibility of the resultant ${ }^{176} \mathrm{Hf} /{ }^{177} \mathrm{Hf}$ ratios is high, indicating that the isotopic composition of a small quantity of $\mathrm{Hf}(<20 \mathrm{ng})$ could be determined with high accuracy in a short time ( $<60 \mathrm{~s}$ ). Bulk-rock Hf isotopic data of the investigated rocks are presented in Table S1.

## Re and Os concentration measurements and Os isotope analysis

Osmium isotope analyses were performed employing a Thermo-Finnigan Triton thermal ionization mass spectrometer (TIMS) at the GIG-CAS. This instrument is equipped with nine Faraday collectors and a secondary electron multiplier. Almost 2.5 g from every powdered sample was spiked with ${ }^{185} \mathrm{Re}$ and ${ }^{190} \mathrm{Os}$, and digested in inverse aqua regia in sealed borosilicate Carius tubes at $240^{\circ} \mathrm{C}$ for 24 hours to obtain sample-spike equilibration. Osmium was purified using a $\mathrm{CCl}_{4}$ solvent extraction process [59], back-extracted into HBr and further purified by microdistillation [60]. Rhenium was separated from sample groundmass and interfering elements using a two-stage column chemistry method (AG1×8, 200-400 resin). Osmium isotope measurements were carried out by negative (N-)TIMS on a Thermo-Finnigan TRITON instrument [61]. Total blank levels were $3.0 \pm 0.9 \mathrm{pg}$ for Os and $10.6 \pm 0.5 \mathrm{pg}$ for Re. Osmium and Re were corrected for blanks. The blank ${ }^{187} \mathrm{Os} /{ }^{188} \mathrm{Os}$ ratio was $0.256 \pm 0.034$. Bulk-rock Os and Re concentrations and Re-Os isotopic data of the investigated rocks are presented in Table S1.

## ${ }^{40} \mathrm{Ar} /{ }^{39} \mathrm{Ar}$ geochronological dating

Samples for ${ }^{40} \mathrm{Ar} /{ }^{39} \mathrm{Ar}$ dating were prepared and analyzed at the Argon Geochronology Laboratory of the Oregon State University (AGL-OSU), Corvallis, USA. Samples were crushed and sieved to $125-355 \mu \mathrm{~m}$, washed and then passed through a Frantz magnetic separator to isolate groundmass from phenocrysts. Groundmass was cleaned by a procedure involving leaching for 1 hour with several acids ( $1 \mathrm{NHCL}, 6 \mathrm{~N} \mathrm{HCL}, 1 \mathrm{NHNO}_{3}, 3 \mathrm{NHNO}_{3}$ ) and finally cleansing with distilled $\mathrm{H}_{2} \mathrm{O}$. Groundmass wafers (weighing $10-50 \mathrm{mg}$ ) from each specimen were encapsulated in aluminum foil and loaded with the Fish Canyon Tuff sanidine flux monitor (FCT-NM with an age of $28.201 \pm 0.023 \mathrm{Ma}$ ) and vacuum-sealed in quartz vials. Sample heights were determined using a Vernier caliper. The samples and flux monitors were irradiated for 6-7 hours in the Cd-lined-in-core irradiation tube (CLICIT) of the TRIGA (Training, Research, Isotopes and General Atomics) nuclear reactor at the OSU.

The ${ }^{40} \mathrm{Ar} /{ }^{39} \mathrm{Ar}$ ages were determined by incremental heating age using a $\mathrm{CO}_{2}$ laser and analyzed using a MC ARGUS-VI MS at the AGL-OSU, equipped with $5 \times 10^{12} \Omega$ Faraday collectors and an ion-counting CuBe electron multiplier. Ages were calculated using the decay constant of $5.530 \pm$ $0.097 \times 10^{-10} \mathrm{yr}^{-1}(2 \sigma)$. Further details of this analytical method are given in [62,63]. Ages and
uncertainty estimates include corrections for baseline measurements, blanks, irradiation production ratios, radioactive decay, mass fractionation and the multiplier/Faraday collector calibration on Ar isotope mass $36 .{ }^{40} \mathrm{Ar} /{ }^{39} \mathrm{Ar}$ ages, including the weighted plateau age, total fusion age, normal isochron age and inverse isochron age were calculated and plotted using ArArCALC software [64]. Uncertainties of ages are reported at the $95 \%$ confidence level (2б). Age spectra, integrated and plateau ages, and isochron diagrams for the investigated rocks are given in Table S2.

Table S1. Major element oxide and trace element concentrations and $\mathrm{Sr}-\mathrm{Nd}-\mathrm{Pb}-\mathrm{Hf}-\mathrm{Os}$ isotopic compositions of the Nanyue basalts.

| Sample | $\begin{gathered} \text { HD66-1 } \\ \hline \text { Basalt } \end{gathered}$ | HD66-2 <br> Basalt | $\begin{gathered} \hline \text { HD66-3 } \\ \hline \text { Basalt } \end{gathered}$ | $\begin{gathered} \text { HD66-4 } \\ \hline \text { Basalt } \end{gathered}$ | AGV-2 |  | BHVO-2 |  | BCR-2 |  | BLANK(ng/g) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | Recommend | This work | Recommend | This work | Recommend | This work |  |
| Major oxides (wt. \%) |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{SiO}_{2}$ | 47.89 | 48.80 | 48.45 | 48.15 | 59.14 | 59.16 | 49.6 | 50.19 |  |  |  |
| $\mathrm{TiO}_{2}$ | 2.75 | 2.79 | 2.77 | 2.81 | 1.05 | 1.04 | 2.73 | 2.46 |  |  |  |
| $\mathrm{Al}_{2} \mathrm{O}_{3}$ | 16.4 | 16.41 | 16.41 | 16.73 | 17.03 | 16.86 | 13.44 | 13.35 |  |  |  |
| $\mathrm{Fe}_{2} \mathrm{O}_{3}{ }^{\text {t }}$ | 9.78 | 9.79 | 9.78 | 9.83 | 6.78 | 6.72 | 12.39 | 11.72 |  |  |  |
| MnO | 0.49 | 0.14 | 0.24 | 0.36 | 0.1 | 0.10 | 0.17 | 0.15 |  |  |  |
| MgO | 5.61 | 5.93 | 5.76 | 6.05 | 1.8 | 1.86 | 7.26 | 7.03 |  |  |  |
| CaO | 8.74 | 8.56 | 8.66 | 8.73 | 5.15 | 5.08 | 11.4 | 11.09 |  |  |  |
| $\mathrm{Na}_{2} \mathrm{O}$ | 3.34 | 2.9 | 3.07 | 3.01 | 4.204 | 4.10 | 2.22 | 2.02 |  |  |  |
| K2O | 2.04 | 2.13 | 2.09 | 2.11 | 2.9 | 2.87 | 0.51 | 0.52 |  |  |  |
| $\mathrm{P}_{2} \mathrm{O}_{5}$ | 0.87 | 0.63 | 0.79 | 0.75 | 0.48 | 0.46 | 0.27 | 0.28 |  |  |  |
| L.O.I | 1.73 | 1.51 | 1.61 | 1.82 |  | 1.78 |  | 1.57 |  |  |  |
| Total | 99.64 | 99.6 | 99.62 | 100.35 |  | 100.01 |  | 100.37 |  |  |  |
| Mg\# | 57 | 59 | 58 | 59 |  |  |  |  |  |  |  |
| Trace elements (ppm) |  |  |  |  |  |  |  |  |  |  |  |
| Sc | 18.9 | 20.2 | 19.2 | 20.9 | 13.1 | 12.6 | 31.8 | 32.0 |  |  | 0.0040 |
| Ti | 15977 | 16668 | 16359 | 16129 |  | 6432 |  | 17366 |  |  | 0.8476 |
| V | 171 | 187 | 174 | 181 | 119 | 112 | 318 | 320 |  |  | 0.4749 |
| Cr | 145 | 162 | 159 | 148 | 16.2 | 15.0 | 287 | 288 |  |  | 0.0585 |
| Mn | 3763 | 1047 | 1669 | 2031 |  | 16.3 |  | 46.1 |  |  | 0.0352 |
| Co | 39.2 | 31.1 | 32.9 | 37.6 | 15.5 | 15.4 | 44.9 | 44.7 |  |  | 0.0125 |
| Ni | 154 | 105 | 150 | 133 | 18.9 | 19.9 | 120 | 124 |  |  | 0.2513 |
| Cu | 65 | 44.4 | 53.8 | 59.6 | 51.5 | 50.4 | 129 | 128 |  |  | 0.0363 |


| Zn | 120 | 110 | 119 | 126 | 86.7 | 85.2 | 104 | 105 | 0.0782 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Ga | 18.7 | 18.9 | 18.9 | 19.1 | 20.4 | 21.1 | 21.4 | 21.5 | 0.0004 |
| Rb | 48.1 | 46.1 | 47 | 47.9 | 67.8 | 65.1 | 9.26 | 8.99 | 0.0185 |
| Sr | 757 | 760 | 764 | 812 | 660 | 653 | 394 | 399 | 0.0019 |
| Y | 23.3 | 20.7 | 21.2 | 22.4 | 19.1 | 19.9 | 25.9 | 26.4 | 0.0000 |
| Zr | 379 | 381 | 380 | 390 | 232 | 228 | 171 | 167 | 0.0074 |
| Nb | 65.3 | 65.7 | 65.4 | 66.1 | 14.1 | 14.2 | 18.1 | 18.6 | 0.0001 |
| Cs | 0.64 | 0.53 | 0.62 | 0.59 | 1.17 | 1.12 | 0.10 | 0.11 | 0.0010 |
| Ba | 727 | 695 | 700 | 715 | 1134 | 1135 | 131 | 123 | 0.0070 |
| La | 43.6 | 37.4 | 41.2 | 39.7 | 38.2 | 38.0 | 15.2 | 15.2 | 0.0002 |
| Ce | 84.7 | 72.6 | 80.5 | 77.3 | 69.4 | 69.1 | 37.5 | 37.0 | 0.0001 |
| Pr | 9.88 | 8.79 | 9.69 | 9.91 | 8.17 | 8.01 | 5.34 | 5.25 | 0.0003 |
| Nd | 38 | 34.4 | 35.8 | 36.1 | 30.5 | 30.3 | 24.3 | 24.1 | 0.0011 |
| Sm | 7.32 | 6.63 | 6.93 | 6.87 | 5.51 | 5.67 | 6.02 | 6.09 | 0.0001 |
| Eu | 2.44 | 2.27 | 2.4 | 2.38 | 1.55 | 1.55 | 2.04 | 2.04 | 0.0004 |
| Gd | 6.57 | 5.98 | 6.39 | 6.24 | 4.68 | 4.60 | 6.21 | 6.11 | 0.0001 |
| Tb | 0.92 | 0.82 | 0.92 | 0.87 | 0.65 | 0.66 | 0.94 | 0.95 | 0.0001 |
| Dy | 5.21 | 4.75 | 4.9 | 4.86 | 3.55 | 3.65 | 5.28 | 5.37 | 0.0001 |
| Ho | 0.99 | 0.89 | 0.98 | 0.82 | 0.68 | 0.66 | 0.99 | 0.99 | 0.0001 |
| Er | 2.52 | 2.22 | 2.32 | 2.18 | 1.83 | 1.86 | 2.51 | 2.44 | 0.0001 |
| Tm | 0.35 | 0.31 | 0.32 | 0.28 | 0.26 | 0.27 | 0.33 | 0.35 | 0.0001 |
| Yb | 2.06 | 1.84 | 1.92 | 1.89 | 1.65 | 1.69 | 1.99 | 1.93 | 0.0012 |
| Lu | 0.33 | 0.28 | 0.31 | 0.29 | 0.25 | 0.24 | 0.28 | 0.28 | 0.0002 |
| Hf | 7.7 | 7.5 | 7.6 | 8.12 | 5.14 | 5.18 | 4.47 | 4.30 | 0.0006 |
| Ta | 4.72 | 4.69 | 4.71 | 4.88 | 0.87 | 0.86 | 1.15 | 1.17 | 0.0008 |
| Pb | 3.52 | 3.17 | 2.17 | 2.79 | 13.1 | 13.3 | 1.65 | 1.74 | 0.0044 |
| Th | 6.28 | 5.52 | 5.76 | 7.39 | 6.17 | 6.14 | 1.22 | 1.20 | 0.0001 |


| U | 3.54 | 2.92 | 3.29 | 4.27 | 1.89 | 1.89 | 0.41 | 0.42 |  |  | 0.0005 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{87} \mathrm{Sr} /{ }^{86} \mathrm{Sr}$ | 0.704325 | 0.704222 | 0.704275 |  | 0.703992 | 0.703977 |  |  |  |  |  |
| $2 \sigma$ | 0.000013 | 0.000014 | 0.000014 |  | $\pm 0.000033$ | $\pm 0.000009$ |  |  |  |  |  |
| ${ }^{87} \mathrm{Sr} / 86 \mathrm{Sr}(\mathrm{i})$ | 0.704303 | 0.704201 | 0.704255 |  |  |  |  |  |  |  |  |
| ${ }^{143} \mathrm{Nd} /{ }^{144} \mathrm{Nd}$ | 0.512881 | 0.512839 | 0.512865 |  | 0.512786 | 0.512774 |  |  |  |  |  |
| $2 \sigma$ | 0.00001 | 0.00001 | 0.000012 |  | $\pm 0.000014$ | $\pm 0.000017$ |  |  |  |  |  |
| ${ }^{143} \mathrm{Nd} /{ }^{144} \mathrm{Nd}(\mathrm{t})$ | 0.512875 | 0.512833 | 0.512859 |  |  |  |  |  |  |  |  |
| $\varepsilon_{\mathrm{Na}}(\mathrm{t})$ | +4.8 | +4 | +4.5 |  |  |  |  |  |  |  |  |
| ${ }^{176} \mathrm{Hf} /{ }^{177} \mathrm{Hf}$ | 0.2829 | 0.282905 | 0.28291 |  |  |  |  |  | 0.282865 | 0.282883 |  |
| $2 \sigma$ | 0.000007 | 0.000005 | 0.000009 |  |  |  |  |  | $\pm 0.000013$ | $\pm 0.000006$ |  |
| $\varepsilon \mathrm{Hf}(\mathrm{t})$ | +4.7 | +4.9 | +5 |  |  |  |  |  |  |  |  |
| ${ }^{206} \mathrm{~Pb} / 204 \mathrm{~Pb}$ | 18.26 | 17.73 | 17.96 |  |  |  |  |  | 18.75 | 18.74 |  |
| $2 \sigma$ | 0.0006 | 0.0007 | 0.0009 |  |  |  |  |  | $\pm 0.009$ | $\pm 0.0003$ |  |
| ${ }^{207} \mathrm{~Pb} / 204 \mathrm{~Pb}$ | 15.6 | 15.51 | 15.61 |  |  |  |  |  | 15.62 | 15.63 |  |
| $2 \sigma$ | 0.0006 | 0.0006 | 0.0008 |  |  |  |  |  | $\pm 0.005$ | $\pm 0.0003$ |  |
| ${ }^{208} \mathrm{~Pb} / 2{ }^{204} \mathrm{~Pb}$ | 38.53 | 38.01 | 38.37 |  |  |  |  |  | 38.73 | 38.74 |  |
| $2 \sigma$ | 0.0015 | 0.0016 | 0.0018 |  |  |  |  |  | $\pm 0.022$ | $\pm 0.0001$ |  |
| Re conc (ppt) | 249.6 | 255.11 |  |  |  |  |  |  |  |  |  |
| $2 \sigma$ | 1.82 | 4.01 |  |  |  |  |  |  |  |  |  |
| Os conc (ppt) | 85.13 | 60.37 |  |  |  |  |  |  |  |  |  |
| $2 \sigma$ | 2.51 | 0.15 |  |  |  |  |  |  |  |  |  |
| ${ }^{187} \mathrm{Os} /{ }^{188} \mathrm{Os}$ | 0.2081 | 0.1856 |  |  |  |  |  |  |  |  |  |
| $2 \sigma$ | 0.0004 | 0.0007 |  |  |  |  |  |  |  |  |  |
| ${ }^{187} \mathrm{Re} /{ }^{188} \mathrm{Os}$ | 14.27 | 20.5 |  |  |  |  |  |  |  |  |  |
| $2 \sigma$ | 0.43 | 0.33 |  |  |  |  |  |  |  |  |  |

Note: $\mathrm{Fe}_{2} \mathrm{O}_{3}{ }^{\mathrm{t}}=$ Total $\mathrm{Fe}_{2} \mathrm{O}_{3}$ content; $\mathrm{Mg} \#=\mathrm{Mg}^{2+} /\left(\mathrm{Mg}^{2+}+\mathrm{Fe}^{2+}\right) \times 100$; $\mathrm{LOI}=$ Loss on ignition. GeoReM preferred Values can be found in http://georem.mpch-mainz.gwdg.de/sample_query_pref.asp.

Table S2. ${ }^{40} \mathrm{Ar} /{ }^{39} \mathrm{Ar}$ dating of the Nanyue basalts.

| Incremental Heating |  | ${ }^{36} \mathrm{Ar}(\mathrm{a})$ | ${ }^{37} \mathrm{Ar}$ (ca) | ${ }^{38} \mathrm{Ar}(\mathrm{cl})$ | ${ }^{39} \mathrm{Ar}(\mathrm{k})$ | ${ }^{40} \mathrm{Ar}(\mathrm{r})$ | Age | $\pm 2 \sigma$ | ${ }^{40} \mathrm{Ar}(\mathrm{r})$ | ${ }^{39} \mathrm{Ar}(\mathrm{k})$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Steps | Laser (\%) | [V] | [V] | [V] | [V] | [V] |  |  | (\%) | (\%) | K/Ca | $\pm 20$ |
| HD66-1 (Groundmass); $\mathrm{J}=0.00298119 \pm 0.00000563$ |  |  |  |  | $\mathrm{T} 1=8.29 \pm 0.06 \mathrm{Ma} ; \mathrm{T} 2=7.91 \pm 0.03 \mathrm{Ma} ; \mathrm{T} 3=8.14 \pm 0.06 \mathrm{Ma} ; \mathrm{T} 4=8.17 \pm 0.06 \mathrm{Ma}$ |  |  |  |  |  |  |  |
| 15D30083 | 1.5 \% | 2.822 | 119.582 | 7.615 | 262.879 | 446.586 | 9.14 | $\pm 0.12$ | 34.85 | 7.94 | 0.945 | $\pm 0.019$ |
| 15D30084 | 1.8 \% | 0.981 | 179.248 | 6.135 | 289.139 | 464.622 | 8.64 | $\pm 0.05$ | 61.50 | 8.73 | 0.694 | $\pm 0.011$ |
| 15D30086 | 2.2 \% | 0.399 | 309.369 | 4.858 | 350.687 | 552.731 | 8.48 | $\pm 0.02$ | 82.25 | 10.59 | 0.487 | $\pm 0.006$ |
| 15D30087 | 2.5 \% | 0.174 | 351.163 | 3.438 | 321.234 | 498.651 | 8.35 | $\pm 0.02$ | 90.47 | 9.70 | 0.393 | $\pm 0.005$ |
| 15D30088 | 2.8 \% | 0.065 | 233.935 | 1.735 | 185.240 | 286.345 | 8.31 | $\pm 0.02$ | 93.48 | 5.59 | 0.340 | $\pm 0.005$ |
| 15D30090 | 3.1 \% | 0.058 | 309.088 | 1.843 | 236.651 | 364.509 | 8.28 | $\pm 0.02$ | 95.28 | 7.14 | 0.329 | $\pm 0.004$ |
| 15D30091 | 3.4 \% | 0.043 | 228.836 | 1.165 | 163.523 | 251.013 | 8.26 | $\pm 0.03$ | 94.91 | 4.94 | 0.307 | $\pm 0.004$ |
| 15D30092 | 3.8 \% | 0.035 | 290.683 | 1.256 | 207.750 | 317.475 | 8.22 | $\pm 0.02$ | 96.64 | 6.27 | 0.307 | $\pm 0.004$ |
| 15D30094 | 4.2 \% | 0.023 | 223.748 | 0.839 | 155.408 | 236.087 | 8.17 | $\pm 0.03$ | 96.95 | 4.69 | 0.299 | $\pm 0.004$ |
| 15D30095 | 4.5 \% | 0.010 | 101.594 | 0.390 | 68.964 | 105.298 | 8.21 | $\pm 0.05$ | 97.04 | 2.08 | 0.292 | $\pm 0.007$ |
| 15D30096 | 5.0 \% | 0.011 | 106.265 | 0.400 | 72.582 | 110.106 | 8.16 | $\pm 0.04$ | 96.93 | 2.19 | 0.294 | $\pm 0.006$ |
| 15D30098 | $5.5 \%$ | 0.018 | 185.296 | 0.519 | 132.853 | 197.948 | 8.01 | $\pm 0.03$ | 97.17 | 4.01 | 0.308 | $\pm 0.005$ |
| 15D30099 | 6.1 \% | 0.011 | 121.129 | 0.297 | 82.176 | 122.283 | 8.00 | $\pm 0.04$ | 97.22 | 2.48 | 0.292 | $\pm 0.006$ |
| 15D30100 | $6.6 \%$ | 0.022 | 262.669 | 0.587 | 176.225 | 250.992 | 7.66 | $\pm 0.02$ | 97.20 | 5.32 | 0.288 | $\pm 0.004$ |
| 15D30102 | 7.2 \% | 0.016 | 176.097 | 0.474 | 106.494 | 144.254 | 7.29 | $\pm 0.03$ | 96.56 | 3.21 | 0.260 | $\pm 0.004$ |
| 15D30103 | 7.7 \% | 0.010 | 108.980 | 0.246 | 62.456 | 80.287 | 6.92 | $\pm 0.05$ | 96.05 | 1.89 | 0.246 | $\pm 0.005$ |
| 15D30104 | 8.3 \% | 0.011 | 107.696 | 0.284 | 55.643 | 68.784 | 6.65 | $\pm 0.05$ | 95.38 | 1.68 | 0.222 | $\pm 0.005$ |
| 15D30106 | 8.8 \% | 0.013 | 142.656 | 0.349 | 65.556 | 73.540 | 6.04 | $\pm 0.05$ | 94.83 | 1.98 | 0.198 | $\pm 0.003$ |
| 15D30107 | 9.5 \% | 0.009 | 108.569 | 0.208 | 36.711 | 39.529 | 5.80 | $\pm 0.08$ | 93.60 | 1.11 | 0.145 | $\pm 0.003$ |
| 15D30108 | 10.2 \% | 0.014 | 191.453 | 0.388 | 60.462 | 56.445 | 5.03 | $\pm 0.06$ | 92.90 | 1.83 | 0.136 | $\pm 0.002$ |
| 15D30110 | 11.0 \% | 0.012 | 139.037 | 0.240 | 40.109 | 35.920 | 4.82 | $\pm 0.08$ | 90.34 | 1.21 | 0.124 | $\pm 0.002$ |
| 15D30111 | 12.1 \% | 0.011 | 168.540 | 0.328 | 40.307 | 32.660 | 4.36 | $\pm 0.08$ | 90.70 | 1.22 | 0.103 | $\pm 0.002$ |
| 15D30112 | 13.8 \% | 0.014 | 295.531 | 0.387 | 45.761 | 31.661 | 3.73 | $\pm 0.08$ | 88.32 | 1.38 | 0.067 | $\pm 0.001$ |
| 15D30114 | 15.0 \% | 0.009 | 277.750 | 0.310 | 34.376 | 23.324 | 3.65 | $\pm 0.10$ | 89.13 | 1.04 | 0.053 | $\pm 0.001$ |
| 15D30115 | 17.1 \% | 0.008 | 158.635 | 0.224 | 20.893 | 14.473 | 3.73 | $\pm 0.14$ | 85.07 | 0.63 | 0.057 | $\pm 0.001$ |
| 15D30116 | 18.5 \% | 0.005 | 111.316 | 0.129 | 12.610 | 8.179 | 3.49 | $\pm 0.23$ | 85.42 | 0.38 | 0.049 | $\pm 0.001$ |
| 15D30118 | 19.7 \% | 0.005 | 156.669 | 0.107 | 11.624 | 6.917 | 3.20 | $\pm 0.26$ | 82.72 | 0.35 | 0.032 | $\pm 0.001$ |
| 15D30119 | 21.4 \% | 0.003 | 93.905 | 0.040 | 6.508 | 4.132 | 3.42 | $\pm 0.45$ | 80.48 | 0.20 | 0.030 | $\pm 0.001$ |
| 15D30121 | 23.7 \% | 0.005 | 111.562 | 0.024 | 7.715 | 4.453 | 3.11 | $\pm 0.39$ | 75.62 | 0.23 | 0.030 | $\pm 0.001$ |
| HD66-2 (Groundmass); J = $0.00298004 \pm 0.00000530$ |  |  |  |  | $\mathrm{T} 1=8.26 \pm 0.06 \mathrm{Ma} ; \mathrm{T} 2=7.84 \pm 0.03 \mathrm{Ma} ; \mathrm{T} 3=8.11 \pm 0.06 \mathrm{Ma} ; \mathrm{T} 4=8.15 \pm 0.06 \mathrm{Ma}$ |  |  |  |  |  |  |  |
| 15D30123 | 1.5 \% | 2.765 | 118.800 | 7.583 | 262.313 | 463.487 | 9.50 | $\pm 0.12$ | 36.17 | 7.94 | 0.949 | $\pm 0.019$ |
| 15D30124 | 1.8 \% | 0.960 | 178.079 | 6.104 | 288.517 | 470.649 | 8.77 | $\pm 0.05$ | 62.30 | 8.73 | 0.697 | $\pm 0.011$ |
| 15D30125 | 2.2 \% | 0.390 | 307.355 | 4.830 | 349.935 | 555.448 | 8.53 | $\pm 0.02$ | 82.65 | 10.59 | 0.490 | $\pm 0.006$ |


| 15D30126 | $2.5 \%$ | 0.169 | 348.878 | 3.416 | 320.545 | 500.072 | 8.39 | $\pm 0.02$ | 90.72 | 9.70 | 0.395 | $\pm 0.005$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 15D30127 | 2.8 \% | 0.063 | 232.416 | 1.724 | 184.844 | 286.994 | 8.35 | $\pm 0.02$ | 93.69 | 5.59 | 0.342 | $\pm 0.005$ |
| 15D30128 | 3.1 \% | 0.056 | 307.079 | 1.831 | 236.145 | 365.198 | 8.31 | $\pm 0.02$ | 95.46 | 7.14 | 0.331 | $\pm 0.004$ |
| 15D30129 | 3.4 \% | 0.042 | 227.350 | 1.157 | 163.173 | 251.528 | 8.29 | $\pm 0.02$ | 95.10 | 4.94 | 0.309 | $\pm 0.004$ |
| 15D30130 | 3.8 \% | 0.033 | 288.793 | 1.247 | 207.305 | 318.004 | 8.25 | $\pm 0.02$ | 96.79 | 6.27 | 0.309 | $\pm 0.004$ |
| 15D30131 | 4.2 \% | 0.022 | 222.292 | 0.832 | 155.075 | 236.470 | 8.20 | $\pm 0.02$ | 97.10 | 4.69 | 0.300 | $\pm 0.004$ |
| 15D30132 | 4.5 \% | 0.009 | 100.932 | 0.387 | 68.817 | 105.468 | 8.24 | $\pm 0.04$ | 97.19 | 2.08 | 0.293 | $\pm 0.007$ |
| 15D30133 | 5.0 \% | 0.010 | 105.571 | 0.396 | 72.425 | 110.284 | 8.19 | $\pm 0.04$ | 97.09 | 2.19 | 0.295 | $\pm 0.006$ |
| 15D30134 | $5.5 \%$ | 0.017 | 184.081 | 0.512 | 132.566 | 198.243 | 8.04 | $\pm 0.03$ | 97.32 | 4.01 | 0.310 | $\pm 0.005$ |
| 15D30135 | 6.1 \% | 0.010 | 120.330 | 0.292 | 81.996 | 122.462 | 8.03 | $\pm 0.03$ | 97.39 | 2.48 | 0.293 | $\pm 0.006$ |
| 15D30136 | $6.6 \%$ | 0.021 | 260.943 | 0.577 | 175.843 | 251.386 | 7.69 | $\pm 0.02$ | 97.36 | 5.32 | 0.290 | $\pm 0.004$ |
| 15D30137 | 7.2 \% | 0.015 | 174.927 | 0.466 | 106.259 | 144.507 | 7.31 | $\pm 0.03$ | 96.76 | 3.21 | 0.261 | $\pm 0.004$ |
| 15D30138 | 7.7 \% | 0.010 | 108.245 | 0.239 | 62.315 | 80.428 | 6.94 | $\pm 0.04$ | 96.30 | 1.89 | 0.248 | $\pm 0.005$ |
| 15D30139 | 8.3 \% | 0.010 | 106.966 | 0.276 | 55.515 | 68.919 | 6.68 | $\pm 0.05$ | 95.67 | 1.68 | 0.223 | $\pm 0.005$ |
| 15D30140 | 8.8 \% | 0.012 | 141.691 | 0.339 | 65.405 | 73.716 | 6.06 | $\pm 0.04$ | 95.17 | 1.98 | 0.198 | $\pm 0.004$ |
| 15D30141 | $9.5 \%$ | 0.008 | 107.822 | 0.198 | 36.622 | 39.639 | 5.82 | $\pm 0.07$ | 94.09 | 1.11 | 0.146 | $\pm 0.003$ |
| 15D30142 | 10.2 \% | 0.013 | 190.164 | 0.377 | 60.321 | 56.670 | 5.06 | $\pm 0.05$ | 93.44 | 1.82 | 0.136 | $\pm 0.002$ |
| 15D30143 | 11.0 \% | 0.012 | 138.086 | 0.229 | 40.010 | 36.077 | 4.85 | $\pm 0.07$ | 91.01 | 1.21 | 0.125 | $\pm 0.002$ |
| 15D30144 | 12.1 \% | 0.010 | 167.397 | 0.317 | 40.208 | 32.838 | 4.40 | $\pm 0.07$ | 91.50 | 1.22 | 0.103 | $\pm 0.002$ |
| 15D30145 | 13.8 \% | 0.012 | 293.561 | 0.376 | 45.651 | 31.992 | 3.77 | $\pm 0.07$ | 89.53 | 1.38 | 0.067 | $\pm 0.001$ |
| 15D30146 | 15.0 \% | 0.008 | 275.900 | 0.301 | 34.292 | 23.617 | 3.71 | $\pm 0.09$ | 90.62 | 1.04 | 0.053 | $\pm 0.001$ |
| 15D30147 | 17.1 \% | 0.007 | 157.566 | 0.216 | 20.839 | 14.640 | 3.78 | $\pm 0.13$ | 86.52 | 0.63 | 0.057 | $\pm 0.001$ |
| 15D30148 | 18.5 \% | 0.004 | 110.562 | 0.123 | 12.575 | 8.282 | 3.55 | $\pm 0.20$ | 87.19 | 0.38 | 0.049 | $\pm 0.001$ |
| 15D30149 | 19.7 \% | 0.004 | 155.636 | 0.104 | 11.596 | 7.096 | 3.29 | $\pm 0.24$ | 85.16 | 0.35 | 0.032 | $\pm 0.001$ |
| 15D30150 | 21.4 \% | 0.003 | 93.293 | 0.040 | 6.495 | 4.253 | 3.53 | $\pm 0.40$ | 82.81 | 0.20 | 0.030 | $\pm 0.001$ |
| 15D30151 | 23.7 \% | 0.004 | 110.868 | 0.031 | 7.708 | 4.650 | 3.25 | $\pm 0.35$ | 77.80 | 0.23 | 0.030 | $\pm 0.001$ |

$\mathrm{T} 1=$ Weighted plateau age; $\mathrm{T} 2=$ Total fusion age; T3 = Isochron age; T4 = Inverse Isochron age.

