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APPENDIXES

TABLES

APPENDIX DR1. DETAILED PETROGRAPHIC DESCRIPTIONS

Based on field occurrences, petrographic features, mineral modes, and major element data, the rocks in the Gemuchaka area can be classified into six types: tephrites, tephra-phonolites, phonolites, basaltic trachyandesites, and trachyandesites. Table I (below) summarizes the textural and mineralogical characteristics of the investigated samples, including highly vesicular and glassy types (samples 13ZB36, 13ZB37, and 13ZB41-13ZB47) and nearly holocrystalline types (13ZB37, 13ZB38, and 13ZB39) (Fig. DR1). All of them exhibit porphyritic texture with phenocrysts of clinopyroxene, sanidine, phlogopite, leucite, and rare olivine, and with accessory minerals of apatite, sphene, and ilmenite. The groundmass consists mainly of microcrystalline-glassy materials, e.g., diopside, sanidine, phlogopite, and Fe-Ti oxides (Table I). Below, we provide the detailed petrographic descriptions of the five rock types.

Tephrites

Tephrites include phenocrysts of clinopyroxene (diopside and hedenbergite), subordinate K-feldspar (sanidine and anorthoclase), olivine, phlogopite, and apatite (Figs. 2A and B). The groundmass consists of clinopyroxene, K-feldspar, leucite, phlogopite, apatite, Fe-Ti oxides, and glass. Clinopyroxene is the most abundant phenocryst phase (~2 vol.%). Most clinopyroxene phenocrysts appear patchy and have sieve textures, while some have colorless rims and green cores or zones. Some clinopyroxenes locally exhibit sieve-textured domains surrounding a clear core, or vice versa. Moreover, leucite phenocrysts occur in samples 13ZB36-1 and 13ZB36-2. Most of the leucite phenocrysts have been replaced by pseudomorphs (exhibiting a wheel texture) of other silicates (e.g., albite, sanidine), and only a few small grains are fresh. The sizes of leucite phenocrysts mostly range from 0.1 to 0.5 mm, with a few grains up to 1 mm.

Tephri-phonolites

Tephri-phonolites have phenocrysts similar to tephrites, containing clinopyroxene (diopside and hedenbergite), subordinate K-feldspar (sanidine and anorthoclase), phlogopite, and apatite (Fig. DR1C). The groundmass consists of clinopyroxene, K-feldspar, phlogopite, apatite, Fe-Ti oxides, and glass. Clinopyroxene is also the most abundant phenocryst phase. Most clinopyroxene phenocrysts display patchy and sieve textures. Some clinopyroxenes locally exhibit sieve-textured domains surrounding a clear core, or vice versa.

Phonolites

The phonolites have phenocrysts of clinopyroxene (diopside and hedenbergite), amphiboles (pargasite), phlogopite (Figs. DR1G and H), and subordinate sanidine. The groundmass consists of pyroxene, amphibole, sanidine, Fe-Ti oxides, apatite, sphene, and glass. Amphibole phenocrysts have brown color in plane-polarized light, and some show characteristic cleavage angles (124° or 56°) (Fig. DR1G). Some phlogopite grains show very dark color under plane-polarized light (PPL), which are in stark contrast to the light green clinopyroxene grains. These samples are fine-grained porphyritic rocks, and the feldspathoid minerals are either distributed in the groundmass as microlites that are too small to distinguish, or they have been replaced by other minerals as pseudomorphs (e.g., leucite).

Basaltic trachyandesites

The basaltic trachyandesites (samples 13ZB41-1 to -4, 13ZB42-1, 13ZB43-1 and -2, and 13ZB47-1 and -6) contain phenocrysts of sanidine, clinopyroxene, and phlogopite. Their groundmass is composed of sanidine + clinopyroxene + phlogopite + plagioclase + glass (Figs. DR1C and D). Clinopyroxene phenocrysts show sieve textures, and some have colorless rims and green cores. Sanidine phenocrysts in these rocks exhibit long columnar grains (Length: width = ~7: 1) and contain simple twins.

Trachyandesites

Trachyandesites (e.g., 13ZB37-1) show porphyritic textures with phenocrysts of sanidine, clinopyroxene, and phlogopite, and groundmass of sanidine microlites, black glass, and Fe-Ti oxides (Figs. DR1E and F). There are also some clinopyroxene grains with sieve textures and green cores. Fine-grained diopside crystals also exist in the groundmass of some samples.

TABLE I. THE LOCALITIES , COORDINATES, AND MINERAL CONSTITUENTS OF ALL SAMPLES FROM THE GEMUCHAKA REGION, CENTRAL QIANGTANG BLOCK

Sample	Location Number	K_2O/Na_2O	longitude	latitude	Rock type	Texture	Phenocrysts[1]	Groundmass[1]	Note
13ZB36-1	*LN 1*	1.1	E85°30′14″	N33°56′57″	tephrite	porphyritic	Cpx+Lc+Ol	Cpx+Lc+Sa+Ti-Mt+Glass	T1
13ZB36-2	*LN 1*	1.5	E85°30′14″	N33°56′57″	tephrite	porphyritic	Cpx+Lc+Sa+Phl	Cpx+Lc+Sa+Phl+Ti-Mt+Glass	T1
13ZB36-3	*LN 1*	2.1	E85°30′14″	N33°56′57″	tephri-phonolite	porphyritic	Cpx+Sa+Phl	Cpx+Sa+Phl+Ti-Mt+Glass	T2
13ZB36-4	*LN 1*	1.2	E85°30′14″	N33°56′57″	tephrite	porphyritic	Cpx+Sa+Phl	Cpx+Sa+Phl+Ti-Mt+Glass	T1
13ZB37-1	*LN 1*	2.3	E85°30′15″	N33°57′01″	tephri-phonolite	trachytic	Sa+Cpx	Sa+Cpx	T2;granular nearly holocrystalline
13ZB37-2	*LN 1*	2.4	E85°30′15″	N33°57′01″	tephri-phonolite	trachytic	Sa+Cpx	Sa+Cpx+Ti-Mt	T2;granular nearly holocrystalline
13ZB38-1	*LN 1*	1.4	E85°30′50″	N33°57′25″	tephrite	trachytic	Sa+Cpx	Sa+Cpx+Ti-Mt	T1;granular nearly holocrystalline
13ZB38-2	*LN 1*	1.4	E85°30′50″	N33°57′25″	tephrite	trachytic	Cpx+Sa+Phl	Sa+Cpx+Phl+Ti-Mt	T1;granular nearly holocrystalline
13ZB39-1	*LN 1*	1.4	E85°30′49″	N33°57′08″	phono-tephrite	trachytic	Cpx+Sa+Phl+Lc	Sa+Cpx+Phl+Lc+Ti-Mt	T1granular nearly holocrystalline
13ZB39-2	*LN 1*	1.4	E85°30′49″	N33°57′08″	phono-tephrite	trachytic	Cpx+Sa+Phl	Sa+Cpx+Ph+Ti-Mt	T1;granular nearly holocrystalline
13ZB40-1	*LN 2*	1.9	E85°30′46″	N33°57′24″	trachyandesite	porphyritic	Cpx+Sa	Cpx+Sa+Ti-Mt	T5;granular nearly holocrystalline
13ZB40-2	*LN 2*	1.6	E85°30′46″	N33°57′24″	tephrite	porphyritic	Cpx+Sa	Cpx+Sa+Ti-Mt	T1;granular nearly holocrystalline
13ZB40-3	*LN 2*	1.8	E85°30′46″	N33°57′24″	tephri-phonolite	porphyritic	Sa+Cpx	Sa+Cpx+Ti-Mt	T2;granular nearly holocrystalline
13ZB41-1	*LN 2*	1.0	E85°30′24″	N33°59′12″	basaltic trachyandesite	trachytic	Cpx+Sa	Cpx+Sa+Ti-Mt+Glass	T4
13ZB41-2	*LN 2*	0.9	E85°30′24″	N33°59′12″	basaltic trachyandesite	trachytic	Cpx+Sa	Cpx+Sa+Pl+Ti-Mt+Glass	T4
13ZB41-3	*LN 2*	1.3	E85°30′24″	N33°59′12″	basaltic trachyandesite	trachytic	Cpx+Sa	Cpx+Sa+Ti-Mt+Glass	T4
13ZB41-4	*LN 2*	1.0	E85°30′24″	N33°59′12″	basaltic trachyandesite	trachytic	Cpx+Sa	Cpx+Sa+Ti-Mt+Glass	T4
13ZB42-1	*LN 2*	1.3	E85°30′21″	N33°59′15″	basaltic trachyandesite	trachytic	Cpx+Sa	Cpx+Sa+Ti-Mt+Glass	T4
13ZB43-1	*LN 2*	1.1	E85°30′18″	N33°59′19″	basaltic trachyandesite	trachytic	Cpx+Sa	Cpx+Sa+Ti-Mt+Glass	T4
13ZB43-2	*LN 2*	1.2	E85°30′18″	N33°59′19″	basaltic trachyandesite	trachytic	Cpx+Sa	Cpx+Sa+Ti-Mt+Glass	T4
13ZB45-1	*LN 3*	1.8	E85°42′10″	N33°54′23″	tephri-phonolite	porphyritic	Sa+Cpx	Sa+Cpx+Ti-Mt+Glass	T2
13ZB45-2	*LN 3*	1.4	E85°42′10″	N33°54′23″	tephri-phonolite	porphyritic	Sa+Cpx	Sa+Cpx+Ti-Mt+Glass	T2
13ZB45-3	*LN 3*	1.8	E85°42′10″	N33°54′23″	tephri-phonolite	trachytic	Sa+Cpx	Sa+Cpx+Ti-Mt+Glass	T2
13ZB46-1	*LN 3*	1.0	E85°44′19″	N33°53′40″	phonolite	trachytic	Sa+Cpx	Cpx+Sa+Ti-Mt+Glass	T3
13ZB46-2	*LN 3*	1.0	E85°44′19″	N33°53′40″	phonolite	porphyritic	Sa+Cpx	Sa+Cpx+Ti-Mt+Glass	T3
13ZB47-1	*LN 4*	1.2	E85°44′22″	N33°55′05″	basaltic trachyandesite	porphyritic	Sa+Cpx+Phl+Bi	Sa+Cpx+Bi+Glass	T4
13ZB47-2	*LN 4*	1.3	E85°44′22″	N33°55′05″	phonolite	trachytic	Prg+Cpx+Phl+Bi	Cpx+Prg+Phl+Bi+Ap+Sph+Glass	T3
13ZB47-3	*LN 4*	1.6	E85°44′22″	N33°55′05″	basaltic trachyandesite	porphyritic	Sa+Cpx	Sa+Cpx+Ti-Mt+Glass	T4
13ZB47-4	*LN 4*	2.5	E85°44′22″	N33°55′05″	trachyandesite	porphyritic	Sa+Cpx	Sa+Cpx+Ti-Mt+Glass	T5
13ZB47-5	*LN 4*	-	E85°44′22″	N33°55′05″	trachyandesite	porphyritic	Sa+Cpx	Sa+Cpx+Ti-Mt+Glass	T5
13ZB47-6	*LN 4*	1.1	E85°44′22″	N33°55′05″	basaltic trachyandesite	porphyritic	Sa+Cpx	Sa+Cpx+Ti-Mt+Glass	T4

Note: [1]Ap = apatite, Bi = biotite, Cpx = clinopyroxene, Sa = sanidine, Lc = leucite, Ol = olivine, Pl = plagioclase, Phl = phlogopite, Prg = pargasite, Sph = sphene, Ti-Mt = Ti-Magnetite. Note: T1 to T5 is the subtype divided based on field occurrences, petrographic features, and mineral modes. LN1 to LN4 are the monadnock numbers shown in figure 1d. Latite is similar to trachyandesite with $Na_2O-2<K_2O$ (in wt.%). Mostly leucite phenocrysts are crystal pseudomorphism in our studied samples.

APPENDIX DR2. ANALYTICAL METHODS

Mineral composition analyses

All silicate mineral analyses were carried out at the State Key Laboratory of Isotope Geochemistry (SKLaBIG), Guangzhou Institute of Geochemistry (GIG), Chinese Academy of Sciences (CAS) with a JEOL JXA-8100 Superprobe. Operating conditions were as follows: 15 kV accelerating voltage, 20 nA beam current, 1–2 µm beam diameter, 10 second counting time, and ZAF correction procedure for data reduction. The analytical procedures were described in detail by Huang et al. (2007).

Zircon U-Pb dating

Zircons were separated using conventional heavy liquid and magnetic separation techniques, purified by hand-picking under a binocular microscope, mounted in an epoxy resin disk, and then polished. Their internal morphology was carefully examined and target sites for U-Pb dating were selected using cathodoluminescence at the SKLaBIG GIG CAS with a JEOL JXA-8100 Superprobe prior to U-Pb and Lu-Hf isotope analyses.

SIMS method

Secondary ion mass spectrometry (SIMS) zircon U-Pb analyses were conducted using a CAMECA IMS-1280-HR system at the SKLaBIG GIG CAS. The analytical procedure is identical to that described by Li et al. (2009). The O^-_2 primary ion beam with an intensity of ~10 nA was accelerated at –13kV. The ellipsoidal spot is ~20 µm × 30 µm in size. The aperture illumination mode (Kohler illumination) was used with a 200 µm primary beam mass filter (PBMF) aperture to produce even sputtering over the entire analyzed area. Oxygen flooding was used to increase the O_2 pressure to 5×10^{-6} Torr in the sample chamber, enhancing Pb^+ sensitivity to a value of ~25 cps/nA/ppm for zircon. This great enhancement of Pb^+ sensitivity is crucial to improve precision of $^{207}Pb/^{206}Pb$ zircon measurement. Positive secondary ions were extracted with a 10 kV potential. In the secondary ion beam optics, a 60 eV energy window was used, together with a mass resolution of ~5400. Rectangular lenses were activated in the secondary ion optics to increase the transmission at high mass resolution. A single electron multiplier was used in ion-counting mode to measure secondary ion beam intensities by the peak jumping sequence: 196 ($^{90}Zr_2{}^{16}O$, matrix reference), 200 ($^{92}Zr_2{}^{16}O$), 200.5 (background), 203.81 ($^{94}Zr_2{}^{16}O$, for mass calibration), 203.97 (Pb), 206 (Pb), 207 (Pb), 208 (Pb), 209 ($^{177}Hf^{16}O_2$), 238 (U), 248 ($^{232}Th^{16}O$), 270 ($^{238}U^{16}O_2$), and 270.1 (reference mass). The integration times for these masses are 1.04, 0.56, 4.16, 0.56, 6.24, 4.16, 6.24, 2.08, 1.04, 2.08, 2.08, 2.08, and 0.24 s, respectively. Each measurement consisted of seven cycles, and the total analytical time per measurement was ~12 min.

Calibration of Pb/U ratios is relative to the standard zircon Plesovice (337.13 Ma) (Sláma et al., 2008), which was analyzed once every four unknowns, based on an observed linear relationship between ln ($^{206}Pb/^{238}U$) and ln ($^{238}U^{16}O_2/^{238}U$) (Whitehouse et al., 1997). A long-term uncertainty of 1.5% (1 RSD) for $^{206}Pb/^{238}U$ measurements of the standard zircons was propagated to the unknowns (Li et al., 2010a), despite that the measured $^{206}Pb/^{238}U$ error in a specific session is generally around 1% (1 RSD) or less. U and Th concentrations of unknowns were also calibrated relative to the standard zircon Plesovice, with Th and U concentrations of 78 and 755ppm, respectively (Sláma et al., 2008). Measured compositions were corrected for common Pb using non-radiogenic ^{204}Pb. Common Pb is very low, and is largely derived from laboratory contamination introduced during sample preparation (Ireland and Williams, 2003). An average of present-day crustal composition (Stacey and Kramers, 1975) is used for the common Pb. A secondary standard zircon Qinghu (Li et al., 2013) was analyzed as an unknown to monitor the reliability of the whole procedure. Five spot analyses conducted during the course of this study yield a concordia age of 159.1 Ma, identical to its recommended value (159.5 Ma, Li et al., 2013). Uncertainties of single analyses are reported at the 1σ level; mean ages for pooled U-Pb analyses are quoted with a 95% confidence interval. Data reduction was carried out using the Isoplot/Ex 3 software (Ludwig, 2003).

LA-ICP-MS method

LA-ICP-MS (Laser Ablation Inductively Coupled Plasma Mass Spectrometry) zircon U-Pb ages and trace element concentrations were analyzed simultaneously with an Agilent Q-ICPMS connected to a 193 nm excimer laser ablation system at the Institute of Geology and Geophysics, Chinese Academy of Sciences in Beijing, China (IGG CAS). The GeoLas PLUS 193 nm excimer ArF laser ablation system is the upgrade product of GeoLas CQ made by Lambda Physik in Germany. Helium carrier gas transported the ablated sample materials from the laser-ablation cell via a mixing chamber to the ICPMS after mixing with Ar gas. Zircon 91500 was used as the standard, and the standard silicate glass NIST 610 was used to optimize the machine, with a beam diameter of 40 μm. Raw count rates for ^{29}Si, ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{232}Th, and ^{238}U were collected, and U, Th, and Pb concentrations were calibrated using ^{29}Si as the internal calibrant and NIST 610 as the reference material. Details of the analytical techniques are described by Wu et al. (2006). Common Pb was corrected by ComPbCorr#3 151 (Andersen, 2002) for those samples with common ^{206}Pb >1%. The U-Pb ages were calculated using the ICPMSDataCal (v8.0) recommended by Liu et al. (2010) and Isoplot/Ex 3 software (Ludwig, 2003). During the analyses in this study, GJ-1 analyzed as an unknown sample yielded a weighted $^{206}Pb/^{238}U$ age of 599 ± 5 Ma (2σ, MSWD = 3, n = 18), which is in good agreement with the recommended U-Pb age (610 ± 2 Ma) in allowed precision (Elhlou et al., 2006). Meanwhile, the standard zircon 91500 yielded a weighted $^{206}Pb/^{238}U$ age of 1063 ± 5 Ma (2σ, MSWD = 11, n = 41), which is in good agreement with the recommended U-Pb ages ($^{206}Pb/^{238}U$ = 1062.4 ± 0.4 Ma, $^{207}Pb/^{206}Pb$ = 1065.4 ± 0.3 Ma) to within errors (Wiedenbeck et al., 1995).

^{40}Ar-^{39}Ar age dating

Argon isotope analyses were conducted on a GV-5400 mass spectrometer at the Ministry of Education (MOE) Key Laboratory of Tectonics and Petroleum Resources, China University of Geosciences, Wuhan. Whole-rock chips of 30–60 mesh (0.6-0.25 mm) in size and mineral separates (potassium feldspar and pholopogite) were ultrasonically cleaned first in distilled water and then in deionized water, and then dried and handpicked to remove visible contaminations. The sample and a monitor standard (ZBH-2506 with an age of 132.5 ± 0.7 Ma) were irradiated in the 49-2 reactor in Beijing for 54 h. Details of the analytical procedure used have been given by Qiu et al. (2015). The ^{40}Ar-^{39}Ar dating results are calculated and plotted using the ArArCALC software of Koppers (2002).

Element and Nd-Sr-Hf-O isotope analyses

After petrographic examinations, the least-altered whole-rock samples were selected for geochemical and Sr-Nd isotopic analyses. The rocks were sawed into small chips, ultrasonically cleaned in distilled water with < 3% HNO_3 (immersion time around 10 s) and then in distilled water alone, and subsequently dried and handpicked to remove visible contaminations. Then the rocks were crushed and ground in a tungsten carbide ring mill subjected to 1 min milling each time for three times (total milling time around 3 min), and the resulting powders were used for analyses of major and trace elements and Sr-Nd isotopes at the SKLaBIG GIG CAS. Major element oxides were analyzed using a Rigaku RIX 2000 X-ray fluorescence spectrometer at the SKLaBIG GIG CAS on fused glass beads. Calibration lines used in quantifications were produced by bivariate regression of data from 36 reference materials encompassing a wide range of silicate compositions. The analytical results for the USGS reference standards (GSR-1, GSR-2, and GSR-3) indicate that the analytical uncertainties were generally less than 2%. Trace elements (including REEs) were analyzed using a Perkin-Elmer Sciex ELAN 6000 ICP-MS. Analytical Procedures are identical to those described in Li et al. (2006). The USGS reference standards (BHVO-2, AVG-2, GSR-1, GSR-2, GSR-3, W-2, SY-4, GSD-9, and SARM-4) were chosen as external calibration standards for calculating the elemental concentrations in the measured samples. The total procedure blank was treated in the same way as the samples, and was corrected for in all of the samples and reference standards. Analytical precision and accuracy are better than 3%.

Whole-rock Sr-Nd isotopic compositions of selected samples were determined using a Micromass Isoprobe multi-collector mass spectrometer (MC-ICPMS) at SKLaBIG GIG CAS. Analytical procedures are identical to those described in Li et al. (2004) and Wei et al. (2002). Reference standards were analyzed along with samples, yielding ^{87}Sr/^{86}Sr = 0.710249 ± 0.000008 (2σ) for NBS987 (recommended values, 0.71022–0.71030) and ^{143}Nd/^{144}Nd = 0.512094 ± 0.000004 (2σ) for Shin Etsu JNdi-1 (recommended values, 0.512080–0.512120). All measured ^{143}Nd/^{144}Nd and ^{87}Sr/^{86}Sr ratios were normalized to ^{146}Nd/^{144}Nd = 0.7219 and ^{86}Sr/^{88}Sr = 0.1194, respectively.

In situ zircon Hf isotope measurements were subsequently undertaken using LA-ICPMS with a beam size of 40 μm and laser pulse frequency of 8 Hz with age determinations at the MC-ICPMS laboratory of the IGG CAS. The detailed analytical technique and data correction procedure are described by Wu et al. (2006). The isobaric interference of ^{176}Lu on ^{176}Hf is negligible due to the extremely low $^{176}Lu/^{177}Hf$ in zircon (normally < 0.002). The standard zircon GJ-1 and Mud Tank were used for external corrections. During the analyses, the $^{176}Hf/^{177}Hf$ ratio of the standard zircon GJ-1 was 0.282012 ± 0.000007 (2σ, MSWD = 1.4, n = 51) and that of the Mud Tank (MUD) was 0.282506 ± 0.000041 (2σ, MSWD = 1.6, n = 99) (Table DR11), consistent with the recommended values (0.282000 ± 0.000005 and 0.282509 ± 0.000025, respectively) to within analytical errors (Geng et al., 2011; Morel et al., 2008).

Zircon oxygen isotopes were measured using the same Cameca IMS-1280-HR SIMS at the SKLaBIG GIG CAS. The detailed analytical procedures were identical to those described by Li et al. (2010a). The $^{133}Cs^+$ primary ion beam with a intensity of ~2 nA was accelerated at 10 kV and focused to an area of φ = 10 μm on the sample surface and the size of analytical spots is ~20 μm in diameter (10 μm beam diameter +10 μm raster). Oxygen isotopes were measured in multi-collector mode using two off-axis Faraday cups. Total analytical time per spot was ~3.5 min, including 30 s of pre-sputtering, 120 s of automatic tuning of the secondary beam, and 64 s of analysis. The measured oxygen isotopic data were corrected for instrumental mass fractionation (IMF) using the Penglai zircon standard ($\delta^{18}O_{VSMOW}$ = 5.3 ‰, Li et al., 2010b), which was analyzed once every four unknowns, using the sample-standard bracketing (SSB) method. The internal precision of a single analysis generally was better than 0.2‰ (1σ) for the $^{18}O/^{16}O$ ratio. As discussed by Kita et al. (2009) and Valley and Kita (2009), the internal precision for a single spot (commonly < 0.1‰, 1σ) is not a good index of analytical quality for stable isotope ratios measured by SIMS. Therefore the external precision, measured by the spot-to-spot reproducibility of repeated analyses of the Penglai standard, is 0.30‰ (2σ, n = 24) is adopted for data evulatuion. Fifteen measurements of the Qinghu zircon standard during the course of this study yielded a weighted mean of $\delta^{18}O$ = 5.6 ± 0.10‰ (2σ), which is consistent with the reported value of 5.4 ± 0.2‰ to within analytical errors (Li et al., 2013).

We have also listed the data of international reference materials in Table DR11.

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APPENDIX DR3. FIGURES RELATED TO MINERALS AND SOME ELEMENTS

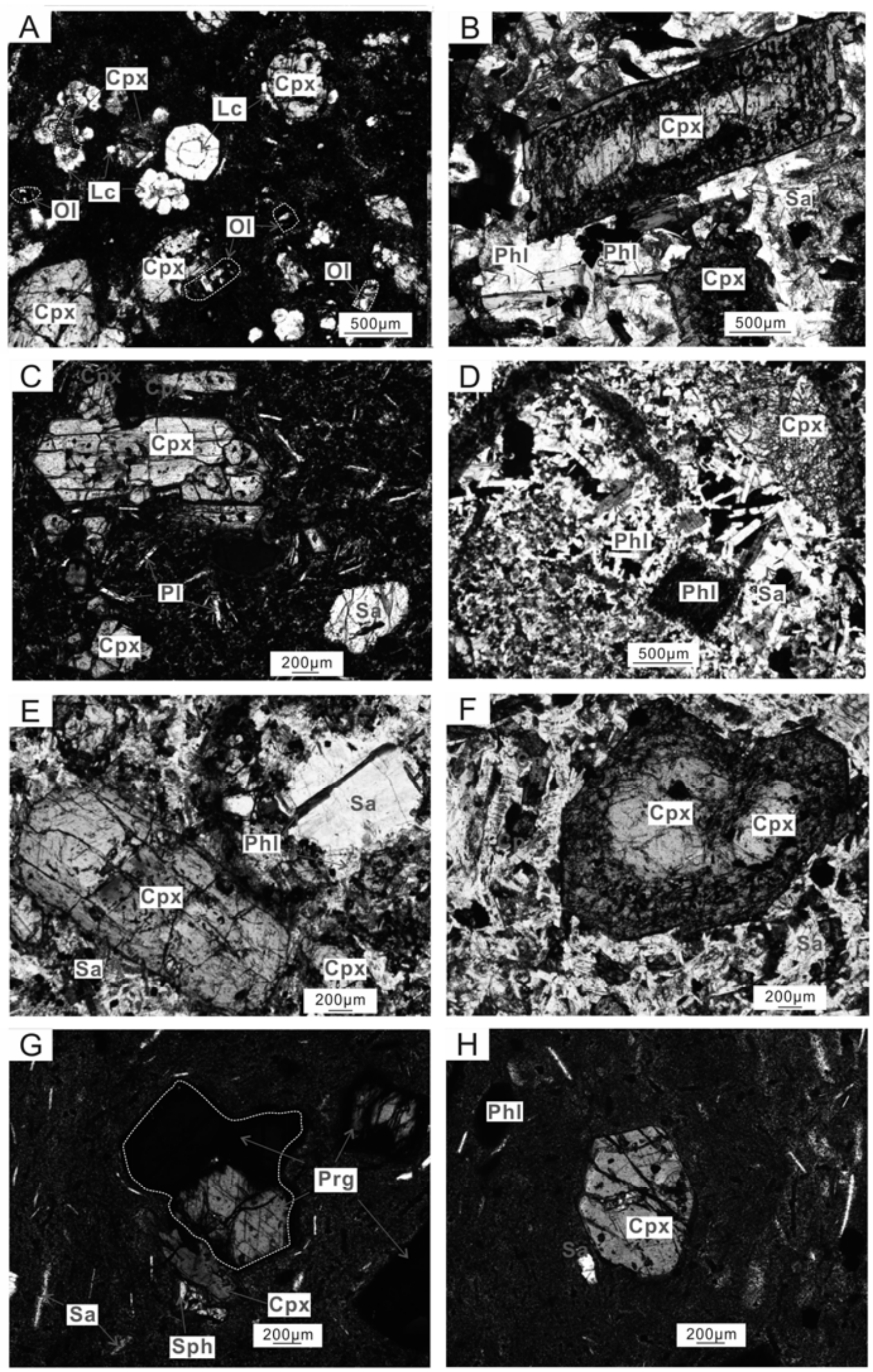

Fig. DR1. Photomicrocgraphs of the Gemuchaka K-rich lavas. (A)–(B) Leucite, clinopyroxene, olivine, phlogopite, and sanidine phenocrysts in the tephritic lavas [13ZB36-1, tephrite and 13ZB39-2, phono-tephrite (granular nearly holocrystalline), respectively; plane-polarized light (PPL)]. (C)–(D) Clinopyroxene, phlogopite, and sanidine phenocrysts in the basaltic trachyandesites (13ZB41-2 and 13ZB47-1, respectively; PPL). (E) Clinopyroxene, phlogopite, and sanidine phenocrysts in the tephra-phonolite (13ZB36-3; PPL). (F) Clinopyroxene, phlogopite, and sanidine phenocrysts in the trachyandesites (13ZB40-1; PPL) (G)–(H) Clinopyroxene, phlogopite, biotite, sanidine, pargasite, and sphene phenocrysts in the phonolite (13ZB47-2; PPL). Abbreviations: Bt, biotite; Cpx, clinopyroxene; Sa, Sanidine; Ol, Olivine; Pl, plagioclase; Phl, Phlogopite; Prg, Pargasite; Lc, Leucite.

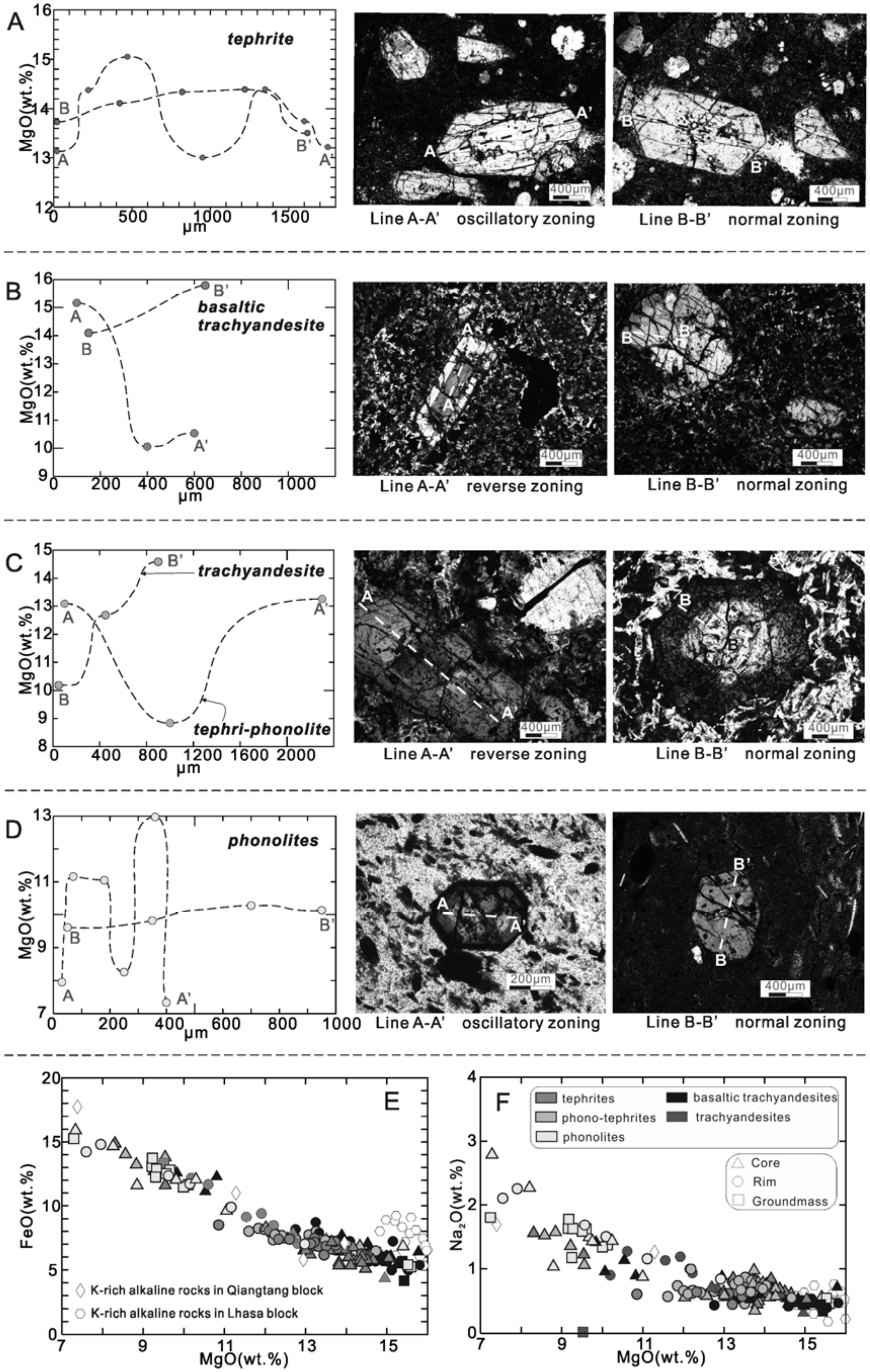
A
tephrite
MgO(wt.%)
μm
Line A-A' oscillatory zoning
Line B-B' normal zoning
400μm
B
basaltic trachyandesite
MgO(wt.%)
μm
Line A-A' reverse zoning
Line B-B' normal zoning
400μm
C
trachyandesite
tephri-phonolite
MgO(wt.%)
μm
Line A-A' reverse zoning
Line B-B' normal zoning
400μm
D
phonolites
MgO(wt.%)
μm
Line A-A' oscillatory zoning
Line B-B' normal zoning
200μm
400μm
E
FeO(wt.%)
MgO(wt.%)
K-rich alkaline rocks in Qiangtang block
K-rich alkaline rocks in Lhasa block
F
Na2O(wt.%)
MgO(wt.%)
tephrites
phono-tephrites
phonolites
basaltic trachyandesites
trachyandesites
Core
Rim
Groundmass

Fig. DR2. (A–D) Variations and core-rim structures of the clinopyroxene in all studied rocks. (A) 13ZB36-1 (tephrite), oscillatory and normal zoning; (B) 13ZB47-1 (basaltic trachyandesite), reverse and normal zoning. (C) 13ZB36-3 (tephri-phonolite) and 13ZB40-1 (trachyandesite), reverse and normal zoning, respectively. (D) 13ZB46-1 (phonolite) and 13ZB47-2 (phonolite), oscillatory and normal zoning, respectively. Plane polarized light images show normal zoning. Filled circles represent analytical spots and the interval between two circles indicate the relative locations of spots in A to D. (E–F) FeO and Na_2O versus MgO diagram for clinopyroxene of studied rocks. Data for K-rich alkaline rocks are from Ding et al. (2003) in Qiangtang Block, Gao et al. (2007) and Zhao et al. (2009b) in Lhasa Block.

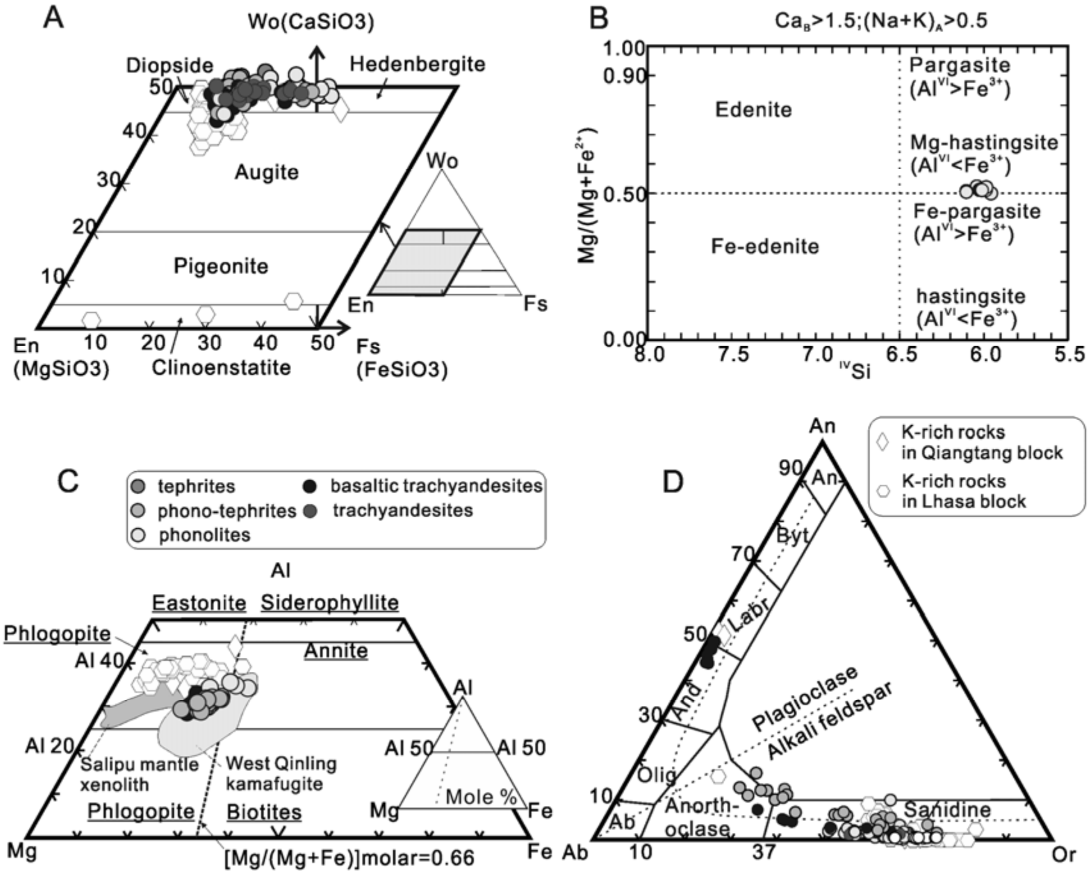

Fig. DR3. (A) Compositional variations of clinopyroxene in K-rich rocks in wollastonite-enstatite-ferrosilite (Wo-En-Fs) diagram (Morimoto, 1988); (B) Classification of calcic amphibole in terms of Mg / (Mg + Fe^{2+}) versus Si, according to the recommended International Mineralogical Association (IMA) criteria (Leake et al., 2004), with $Al^{VI} > Fe^{3+}$; (C) Micas from the Gemuchaka lavas plotted on an Al-Mg-Fe diagram (Sheppard and Taylor, 1992); (D) Compositions of feldspars expressed in the Or-Ab-An diagram (Smith, 1974). Ab, albite; Or, orthoclase; An, anorthite; Olig, oligoclase; And, andesine; Labr, labradorite; Byt, bytownite. Data for clinopyroxenes, phlogopites, and feldspars of the K-rich rocks are from Ding et al. (2003) in Qiangtang Block, Gao et al. (2007) and Zhao et al. (2009b) in Lhasa Block. Data for the Sailipu mantle xenolith are from Liu et al. (2011). Data for kamafugites of the west Qinling are from Yu (1994).

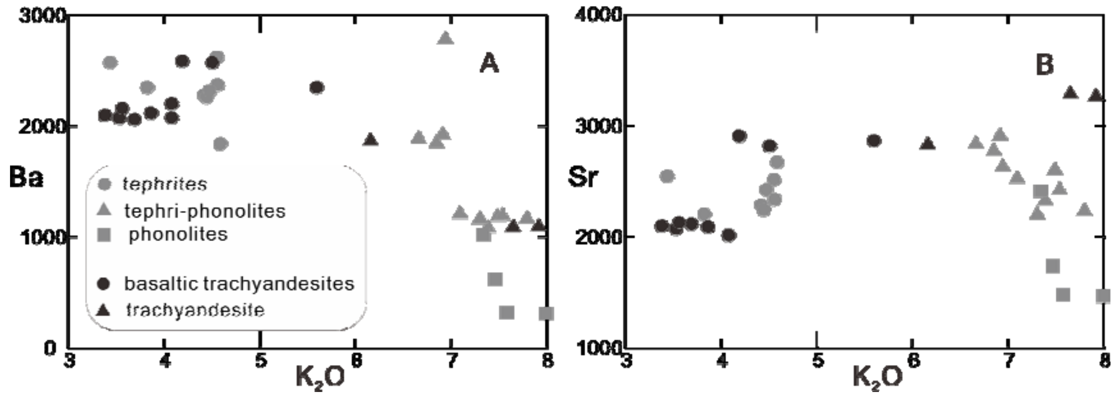

Fig. DR4. (A) Ba (ppm) and (B) Sr (ppm) versus K_2O (wt.%) diagrams.

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APPENDIX DR4. TRACE ELEMENT MODELING

Batch melting of average mélange model: REE

To evaluate quantitatively the relative roles of the degree of partial melting of average mélange, we use the modal batch melting model (Shaw, 1970) to simulate the average mélange source parital melting process. The detailed parameters, starting materials, and modeling results are listed in Tables A and B.

TABLE A. MODAL PROPORTIONS OF MINERALS IN THE MÉLANGE SOURCE REGION AND THEIR PARTITION COEFFICIENTS

	Modal (%)	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Ampibole	0.65	0.17	0.26	0.35	0.44	0.76	0.8	0.86	0.8	0.78	0.73	0.68	0.64	0.59	0.61
Plagioclase	0.10	0.27	0.2	0.17	0.14	0.11	0.7	0.06	0.0	0.05	0.04	0.04	0.03	0.03	0.02
Clinopyroxen	0.15	0.05	0.09	0.15	0.21	0.26	0.3	0.3	0.3	0.33	0.31	0.3	0.29	0.28	0.28
Garnet	0.10	0.01	0.02	0.05	0.08	0.21	0.3	0.49	0.7	1.06	1.53	2	3	4.03	5.5
D		0.15	0.21	0.27	0.34	0.57	0.7	0.66	0.6	0.67	0.68	0.69	0.76	0.83	0.99

Note: D, bulk partition coefficient. Data source: GERM (Geochemical Earth Reference Model) home page, http://www.earthref.org/.

TABLE B. RESULTS OF THE BATCH MELTING MODEL

	F	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
average		8.07	18.29	-	11.18	2.72	0.86	3.17	0.51	3.13	0.64	1.78	0.26	1.7	0.26
partial melts	F=0.05	42.64	74.50	-	29.96	4.63	1.17	4.68	0.75	4.57	0.92	2.52	0.34	2.02	0.26
	F=0.10	34.79	64.13	-	27.52	4.47	1.14	4.57	0.73	4.46	0.90	2.47	0.33	2.00	0.26
	F=0.15	29.39	56.29	-	25.46	4.31	1.12	4.46	0.71	4.36	0.88	2.41	0.33	1.98	0.26
	F=0.20	25.43	50.16	-	23.68	4.17	1.10	4.35	0.70	4.26	0.86	2.36	0.32	1.96	0.26
	F=0.25	22.42	45.23	-	22.13	4.03	1.09	4.25	0.68	4.17	0.84	2.32	0.32	1.95	0.26
	F=0.30	20.04	41.19	-	20.78	3.91	1.07	4.16	0.67	4.08	0.83	2.27	0.31	1.93	0.26

Note: For modal batch partial melting, the equation $C_L/C_o = 1/(D + F[1 - D])$ (Shaw, 1970) was used. C_L is the concentration of a trace element in the melt. C_o is the content of a trace element in the average mélange source (Marschall and Schumacher, 2012). F is the degree of partial melting. The REE contents (ppm) of average mélange and modeling results are listed.

Non-modal batch melting model: Rb/Sr versus Ba/Rb

Based on the discussion in the main text, we propose that the dominant constraints on the compositions of primitive magmas of the Gemuchaka area are the degrees of partial melting, the amounts of subducted sediment melt added to the mantle source, and the presence of residual phases in the source (e.g., phlogopite, amphibole, garnet). To evaluate quantitatively the relative roles of the degrees of partial melting and the amounts of subduction-derived sediment melt induced metasomatism, and simultaneously to minimize the effects of fractional crystallization on the compositions of the potassium-rich primitive magmas in Gemuchaka area, we have selected the incompatible trace element ratios Rb/Sr and Ba/Rb as simulated calculation parameters. Ratios of the incompatible trace elements (e.g., Rb/Sr, Ba/Rb) in the primitive Gemuchaka magmas should not have been significantly modified by the partial melting processes, although these ratios in the partial melt of the subducted sediment may be slightly increased compared to the subducted bulk sediment because of the slightly different incompatibilities between Rb and Sr, and those between Ba and Rb.

In this study, we use the non-modal batch melting model (Shaw, 1970) to simulate the mantle source parital melting process and to constrain changes in melt compositions, because some phase become preferentially exhausted in the residue as the degree of the partial melting increases. There are two dominat reasons: 1) it is clear that we cannot assume modal melting is not suitable to the mantle melting for the petrogenesis of the K-rich alkaline magmas because minor phases such as phlogopite, amphibole, and clinopyroxene preferentially enter the melt with respect to olivine, orthopyroxene, and garnet during mantle partial melting process (Wilson, 1989); and 2) the proportions of different mineral phases in the mantle source region will vary during progressive partial melting, and there is insufficient evidence to quantitatively determine whether there was a continuous change in the bulk composition of the system during the mantle partial melting process, using the fractional melting model.

We have used the Rb/Sr and Ba/Rb ratios of Songpan Ganzi subducted sedimentary rock (B9; She et al., 2006) to approximate those of a partial melt of the subducted sediment. The concentrations of the trace elements Rb, Sr, and Ba in the subducted sediment are 92.4, 99, and 437 ppm, respectively. In our modeling, we have used the normal MORB (i.e., N-MORB; Sun and McDonough, 1989) source mantle instead as the source material (depleted mantle); this is assumed to have 0.1 times N-MORB (Sun and McDonough, 1989) concentrations of the relevant trace elements (i.e., Rb 0.056 ppm, Sr 9 ppm, and Ba 0.63 ppm) based on the assumption that MORB magmas are the results of ~10% partial melting of their mantle source (Wilson, 1989).

Considering the formations of new mineral phases (e.g., phlogopite, amphibole) as a result of metasomatism of the mantle beneath the Gemuchaka in Qiangtang block, we have assumed that the resultant minerals and their modal proportions in the metasomatized mantle source region after introduction of the subduction-derived sediment partial melt are olivine (50%), orthopyroxene (20%), clinopyroxene (10%), garnet (12.6%), spinel (7%), phlogopite (0.1%), amphibole (0.3%).

The mineral-melt partition coefficients for Rb, Sr, and Ba in the mineral phases used in the model are based on those from the GERM (Geochemical Earth Reference Model) Web site (http://www.earthref.org/) and all are listed in Tabe C. Phlogopite and amphibole phenocrysts are present in the K-rich magmatic rocks in north Tibet (Table DR3), which suggests hydrous partial melting conditions. As discussed above, the additional mineral phases (e.g., phlogpoite and amphibole), which were formed during mantle metasomatism in Qiangtang block, are considered to be completely consumed into the melt before olivine and orthopyroxene. Taking the mineral consumption sequence into account, we assumed the following mineral melting mode (i.e., the proportions of the mineral phases entering the melt): clinopyroxene (0.55), olivine (–0.1), orthopyroxene (0.4), phlogopite (0.062), amphibole (0.048), garnet (0.02), and spinel (0.02).

All of our models followed the process provided by Guo et al. (2006). The detailed results of our non-modal batch melting model are shown in the "Subduction fingerprints and enriched components" section of the main text, Figure 10C, and Table D.

TABLE C. MODAL PROPORTIONS OF MINERALS IN THE MANTLE SOURCE REGION AND THEIR PARTITION COEFFICIENTS

Mineral	Modal (%)	Rb	Sr	Ba	P_i
Clinopyroxene	10	0.02	0.113	0.00015	0.55
Olivine	50	0.04	0.001	0.0001	-0.1
Orthopyroxene	20	0.0038	0.0038	0.0036	0.4
Phlogopite	0.1	2.48	0.159	2.48	0.062
Amphibole	0.3	0.2	0.298	0.6	0.048
Garnet	12.6	0.002	0.002	0.002	0.02
Spinel	7	0.029	0.0047	0.0006	0.02
D		0.03	0.01	0.01	
P		0.17	0.09	0.18	

Note: D, bulk partition coefficient; Pi is the proportion of phase i entering the melt and $P=\sum P_i D_i$, where D_i is its crystal-liquid partition coefficient. Data source: GERM (Geochemical Earth Reference Model) home page, http://www.earthref.org/.

TABLE D. RESULTS OF THE NON-MODAL BATCH MELTING MODEL

Proportion of sediment of melt (X_s)	0%		0.5%		1%		3%		5%		10%	
	Rb/Sr	Ba/Rb	Rb/Sr	Ba/Rb	Rb/Sr	Ba/Rb	Rb/Sr	Ba/Rb	Rb/Sr	Ba/Rb	Rb/Sr	Ba/Rb
Degree of melting (F)												
0.1%	0.0032	52.7431	0.0286	25.4630	0.0516	23.9033	0.1261	22.7604	0.1806	22.5209	0.2693	22.3387
1%	0.0040	30.2910	0.0351	14.6237	0.0634	13.7279	0.1547	13.0716	0.2217	12.9340	0.3306	12.8294
5%	0.0054	16.9403	0.0471	8.1783	0.0851	7.6774	0.2079	7.3103	0.2979	7.2334	0.4441	7.1749
10%	0.0059	14.3457	0.0941	6.5015	0.0925	6.6152	0.2297	6.1907	0.3291	6.1255	0.4907	6.0760
15%	0.0062	13.4083	0.0543	6.4732	0.0981	6.0767	0.2396	5.7861	0.3434	5.7252	0.5120	5.6789

Note: For non-modal batch partial melting, the equation $C_L/C_o = 1/(F + D - FP)$ (Shaw, 1970) was used. C_L is the concentration of a trace element in the melt. C_o is the content of a trace element in the metasomatized mantle source, which is modeled as a mixture of a depleted mantle component (m, similar to MORB-source) and subducted sediment-derived melt (s): $Co = X_sC_s + (1-X_s)C_m$, where X_s is the proportion of the subducted sediment-derived melt in the mantle source region, C_s is the concentration of a trace element in the subducted sediment-derived melt, C_m is the concentration of a trace element in the depleted mantle source region. D is the bulk distribution coefficient. $D = \sum X_iD_i$, where X_i is the weight fraction of phase i in the mineral assemblage and D_i is its crystal-liquid partition coefficient. $P=\sum P_iD_i$, where P_i is the proportion of phase i entering the melt. On the basis of the interpretated relative proportions of the mineral phases entering the melt during non-modal batch partial melting (see main text), we assumed $P = 0.55D_{clinopyroxene} - 0.1D_{olivine} + 0.4D_{orthopyroxene} + 0.062D_{phlogopite} + 0.048D_{amphibole} + 0.02D_{garnet} + 0.02D_{spinel}$. F is the degree of partial melting.

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TABLE DR1. REPRESENTATIVE ELECTRON MICROPROBE ANALYSES OF CLINOPYROXENES IN THE GEMUCHAKA LAVAS FROM THE CENTRAL QIANGTANG BLOCK

Sample	13ZB36-1	tephrite									
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	1	2	3	4	5	6	7	8	9	10	11
SiO_2	46.61	48.79	49.54	50.94	49.92	49.39	48.49	49.96	49.84	49.05	48.89
TiO_2	2.50	0.58	1.44	1.00	1.32	1.25	2.05	1.64	1.48	1.55	1.52
Al_2O_3	6.76	2.61	3.72	4.18	4.43	5.75	6.11	4.32	4.74	4.55	4.66
Cr_2O_3	0.19	0.04	0.08	0.11	0.06	0.07	0.13	0.11	0.02	0.08	0.08
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-
FeO	7.41	14.88	6.10	5.12	6.65	5.37	6.77	6.00	6.69	6.59	6.77
MnO	0.14	0.58	0.14	0.14	0.17	0.09	0.12	0.11	0.14	0.13	0.15
MgO	12.61	8.32	14.51	14.45	13.61	13.80	12.97	14.04	13.77	14.00	14.17
CaO	22.95	22.51	23.46	23.38	21.91	23.61	22.42	23.19	21.87	23.18	23.19
Na_2O	0.65	1.55	0.59	0.40	0.69	0.44	0.62	0.54	0.80	0.68	0.84
K_2O	-	0.01	0.02	0.02	0.04	0.03	0.03	0.01	0.02	0.01	0.00
P_2O_5	0.06	0.03	0.07	0.06	0.07	0.04	0.05	0.02	0.06	0.02	0.08
NiO	-	-	0.08	0.02	0.07	-	0.06	0.04	0.00	0.08	0.02
Total	99.89	99.91	99.75	99.83	98.94	99.86	99.82	100.00	99.43	99.91	100.37
Cations on the basis of 6 oxygens											
Si	1.754	1.900	1.852	1.883	1.873	1.831	1.810	1.855	1.860	1.833	1.822
Al(iv)	0.246	0.100	0.148	0.117	0.127	0.169	0.190	0.145	0.140	0.167	0.178
Al(vi)	0.053	0.020	0.016	0.065	0.069	0.083	0.078	0.044	0.069	0.033	0.027
Ti	0.071	0.017	0.040	0.028	0.037	0.035	0.057	0.046	0.041	0.044	0.043
Cr	0.006	0.001	0.002	0.003	0.002	0.002	0.004	0.003	0.001	0.002	0.002
Fe^{3+}	0.139	0.240	0.137	0.032	0.048	0.070	0.058	0.067	0.069	0.138	0.182
Fe^{2+}	0.091	0.235	0.051	0.126	0.160	0.096	0.153	0.119	0.138	0.066	0.025
Mn	0.004	0.019	0.004	0.004	0.005	0.003	0.004	0.003	0.004	0.004	0.005
Mg	0.707	0.483	0.808	0.796	0.761	0.763	0.722	0.777	0.766	0.780	0.787
Ca	0.925	0.939	0.940	0.926	0.881	0.938	0.897	0.923	0.875	0.928	0.926
Na	0.048	0.117	0.043	0.028	0.050	0.032	0.045	0.039	0.058	0.049	0.060
K	0.000	0.001	0.001	0.001	0.002	0.001	0.001	0.000	0.001	0.000	0.000
Wo	48.3	46.2	47.4	48.4	46.2	49.3	47.8	47.9	45.8	47.3	46.6
En	36.9	23.7	40.8	41.6	40.0	40.1	38.5	40.3	40.1	39.7	39.6
Fs	12.3	24.3	9.7	8.5	11.2	8.9	11.4	9.8	11.1	10.6	10.7
$Mg^{\#}$	75	50	81	83	78	82	77	81	79	79	79

TABLE DR1. CONTINUED

Sample	13ZB36-1	tephrite										
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	12	13	14	15	16	17	18	19	20	21	22	23
SiO_2	49.72	46.85	45.59	45.17	47.57	49.00	46.90	48.11	47.39	50.86	50.05	47.38
TiO_2	0.91	2.14	3.04	1.03	1.77	0.64	1.79	1.16	1.97	1.39	1.61	2.32
Al_2O_3	3.31	6.54	6.43	7.87	5.81	4.62	6.09	5.27	4.42	3.60	4.73	5.22
Cr_2O_3	0.04	0.05	0.22	0.16	0.05	-	0.12	0.01	0.04	0.03	0.04	0.23
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
FeO	5.77	7.49	7.41	8.52	6.79	6.22	6.85	11.62	7.18	5.79	6.97	7.05
MnO	0.17	0.14	0.11	0.12	0.16	0.10	0.14	0.25	0.11	0.11	0.19	0.15
MgO	14.67	13.22	12.34	10.86	13.24	13.11	13.32	9.53	13.22	14.49	13.74	13.13
CaO	24.49	23.10	23.46	24.50	22.81	25.08	23.31	22.12	23.60	22.64	21.53	23.74
Na_2O	0.61	0.80	0.64	0.60	0.85	0.56	0.64	1.22	0.45	0.64	0.82	0.62
K_2O	0.03	0.01	0.03	0.01	0.02	0.02	0.03	0.01	0.03	0.01	0.03	0.02
P_2O_5	0.04	0.09	0.12	0.03	0.07	-	0.08	0.06	0.10	0.06	0.10	0.09
NiO	0.01	0.02	0.06	0.01	0.01	-	0.03	-	0.03	0.03	0.10	0.04
Total	99.76	100.45	99.45	98.90	99.16	99.36	99.31	99.37	98.54	99.65	99.91	99.97
Cations on the basis of 6 oxygens												
Si	1.860	1.755	1.733	1.735	1.796	1.844	1.773	1.846	1.810	1.888	1.862	1.784
Al(iv)	0.140	0.245	0.267	0.265	0.204	0.156	0.227	0.154	0.190	0.112	0.138	0.216
Al(vi)	0.006	0.044	0.021	0.091	0.054	0.049	0.044	0.085	0.008	0.046	0.069	0.015
Ti	0.026	0.060	0.087	0.030	0.050	0.018	0.051	0.034	0.056	0.039	0.045	0.066
Cr	0.001	0.001	0.006	0.005	0.001	0.000	0.004	0.000	0.001	0.001	0.001	0.007
Fe^{3+}	0.187	0.203	0.168	0.230	0.164	0.166	0.186	0.136	0.152	0.051	0.058	0.161
Fe^{2+}	0.000	0.028	0.064	0.039	0.047	0.027	0.027	0.233	0.075	0.128	0.158	0.058
Mn	0.005	0.004	0.004	0.004	0.005	0.003	0.004	0.008	0.004	0.003	0.006	0.005
Mg	0.818	0.738	0.699	0.622	0.745	0.736	0.751	0.546	0.752	0.802	0.762	0.737
Ca	0.982	0.927	0.956	1.008	0.923	1.012	0.944	0.910	0.965	0.901	0.858	0.957
Na	0.044	0.058	0.047	0.045	0.062	0.041	0.047	0.090	0.033	0.046	0.059	0.045
K	0.001	0.000	0.001	0.001	0.001	0.001	0.002	0.000	0.001	0.000	0.002	0.001
Wo	48.4	47.3	49.3	51.8	47.4	51.0	48.2	47.3	48.7	46.7	45.1	48.8
En	40.4	37.7	36.1	31.9	38.3	37.1	38.3	28.4	38.0	41.5	40.1	37.5
Fs	9.0	12.0	12.2	14.0	11.1	9.9	11.1	19.6	11.6	9.5	11.7	11.4
$Mg^{\#}$	82	76	75	69	78	79	78	59	77	82	78	77

TABLE DR1. CONTINUED

Sample	13ZB36-1	tephrite										
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	24	25	26	27	28	29	30	31	32	33	34	35
SiO_2	49.07	50.07	47.76	49.39	48.35	50.77	49.89	49.56	48.66	48.47	48.17	47.30
TiO_2	1.46	1.23	0.85	1.38	1.45	0.93	1.73	0.89	1.59	1.48	1.29	1.99
Al_2O_3	4.37	3.50	5.80	3.75	4.80	4.05	4.72	3.34	4.36	5.04	4.88	5.31
Cr_2O_3	0.01	0.30	0.06	0.04	0.04	0.06	0.02	0.02	0.06	0.01	0.04	0.24
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
FeO	6.28	5.77	6.53	6.07	6.93	5.76	6.86	5.57	5.37	7.21	7.17	6.18
MnO	0.11	0.15	0.07	0.12	0.15	0.12	0.14	0.17	0.13	0.15	0.16	0.13
MgO	14.37	15.02	13.00	14.39	13.75	14.31	13.48	14.39	14.11	13.73	13.64	13.46
CaO	23.51	23.05	25.16	23.39	22.79	22.83	21.36	24.26	23.96	22.42	23.37	23.63
Na_2O	0.59	0.52	0.63	0.60	0.76	0.58	0.77	0.68	0.61	0.80	0.66	0.57
K_2O	0.01	0.02	0.04	0.01	0.02	0.03	0.01	0.04	0.04	0.02	0.01	0.03
P_2O_5	0.05	0.05	0.04	0.04	0.08	0.02	0.09	0.02	0.06	0.06	0.06	0.07
NiO	0.02	0.01	0.01	0.04	0.01	0.04	0.03	-	-	0.02	-	0.03
Total	99.86	99.70	99.99	99.21	99.13	99.58	99.12	98.98	98.95	99.43	99.47	98.94
Cations on the basis of 6 oxygens												
Si	1.833	1.865	1.795	1.854	1.825	1.887	1.867	1.867	1.832	1.823	1.817	1.791
Al(iv)	0.167	0.135	0.205	0.146	0.175	0.113	0.133	0.134	0.169	0.177	0.183	0.209
Al(vi)	0.026	0.019	0.052	0.020	0.038	0.064	0.075	0.015	0.025	0.046	0.033	0.028
Ti	0.041	0.034	0.024	0.039	0.041	0.026	0.049	0.025	0.045	0.042	0.037	0.057
Cr	0.000	0.009	0.002	0.001	0.001	0.002	0.001	0.001	0.002	0.000	0.001	0.007
Fe^{3+}	0.151	0.115	0.222	0.134	0.163	0.058	0.026	0.176	0.146	0.157	0.184	0.154
Fe^{2+}	0.042	0.063	0.000	0.055	0.052	0.121	0.189	0.000	0.021	0.067	0.039	0.039
Mn	0.003	0.005	0.002	0.004	0.005	0.004	0.004	0.005	0.004	0.005	0.005	0.004
Mg	0.800	0.834	0.729	0.806	0.773	0.793	0.752	0.808	0.792	0.770	0.767	0.760
Ca	0.941	0.920	1.013	0.941	0.922	0.909	0.856	0.979	0.966	0.903	0.944	0.958
Na	0.043	0.038	0.046	0.043	0.056	0.042	0.056	0.050	0.045	0.059	0.048	0.042
K	0.000	0.001	0.002	0.000	0.001	0.001	0.001	0.002	0.002	0.001	0.000	0.001
Wo	47.5	46.6	50.9	47.5	46.8	47.2	45.5	48.6	49.0	46.1	47.5	49.0
En	40.4	42.3	36.6	40.6	39.2	41.2	39.9	40.1	40.1	39.3	38.6	38.8
Fs	9.9	9.3	10.2	9.7	11.2	9.4	11.6	8.9	8.7	11.7	11.5	10.1
$Mg^{\#}$	80	82	78	81	78	82	78	82	82	77	77	80

TABLE DR1. CONTINUED

Sample	13ZB39-1	phono-tephrite									
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	50.46	50.12	48.47	48.59	49.62	48.47	49.21	47.99	50.05	48.28	48.74	48.35
TiO_2	1.18	1.67	1.85	2.23	1.73	1.52	1.59	2.06	1.72	1.76	1.77	1.47
Al_2O_3	2.23	4.56	4.77	3.87	3.24	5.26	4.44	5.55	2.70	4.66	3.75	4.86
Cr_2O_3	0.04	0.04	0.15	-	0.08	0.02	0.03	0.07	0.03	0.07	0.07	0.01
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
FeO	7.14	6.68	6.78	7.04	6.57	6.44	6.86	7.37	6.87	7.13	7.13	6.97
MnO	0.22	0.16	0.15	0.15	0.20	0.14	0.15	0.17	0.22	0.11	0.21	0.14
MgO	13.59	13.88	14.02	13.66	13.75	13.92	14.34	13.33	14.11	13.78	13.67	13.72
CaO	23.22	21.78	23.35	23.67	23.57	23.95	23.43	23.02	23.72	23.24	23.46	22.82
Na_2O	0.87	0.78	0.77	0.64	0.82	0.70	0.69	0.76	0.74	0.77	0.63	0.64
K_2O	0.02	-	0.02	0.01	0.01	0.01	0.00	0.03	0.01	0.04	0.01	-
P_2O_5	0.04	0.05	0.03	0.00	0.03	0.08	0.06	0.03	0.03	0.06	0.02	0.05
NiO	-	0.01	0.02	-	-	0.02	0.04	0.01	-	0.00	0.06	0.04
Total	99.01	99.75	100.39	99.86	99.62	100.54	100.84	100.40	100.20	99.91	99.52	99.08
Cations on the basis of 6 oxygens												
Si	1.906	1.864	1.809	1.825	1.862	1.805	1.826	1.793	1.870	1.813	1.838	1.825
Al(iv)	0.094	0.136	0.191	0.063	0.138	0.195	0.174	0.207	0.048	0.187	0.162	0.175
Al(vi)	0.006	0.063	0.018	0.000	0.005	0.036	0.020	0.038	0.000	0.019	0.005	0.041
Ti	0.033	0.047	0.052	0.063	0.049	0.043	0.045	0.058	0.048	0.050	0.050	0.042
Cr	0.001	0.001	0.004	0.000	0.002	0.001	0.001	0.002	0.001	0.002	0.002	0.000
Fe^{3+}	0.125	0.052	0.180	0.148	0.137	0.185	0.169	0.159	0.145	0.183	0.151	0.144
Fe^{2+}	0.098	0.155	0.029	0.071	0.067	0.013	0.041	0.068	0.067	0.037	0.071	0.073
Mn	0.007	0.005	0.005	0.005	0.006	0.004	0.005	0.005	0.007	0.004	0.007	0.004
Mg	0.765	0.769	0.780	0.765	0.769	0.772	0.793	0.742	0.786	0.771	0.769	0.772
Ca	0.940	0.868	0.933	0.952	0.948	0.956	0.931	0.922	0.950	0.935	0.948	0.923
Na	0.063	0.056	0.056	0.047	0.060	0.051	0.050	0.055	0.054	0.056	0.046	0.047
K	0.001	0.000	0.001	0.000	0.001	0.001	0.000	0.001	0.000	0.002	0.000	0.000
Wo	47.0	45.5	47.1	47.9	47.7	48.3	46.8	47.2	47.3	47.1	47.6	47.0
En	38.3	40.4	39.3	38.5	38.7	39.0	39.9	38.0	39.1	38.8	38.6	39.3
Fs	11.5	11.1	10.8	11.2	10.6	10.2	10.8	11.9	10.9	11.3	11.5	11.3
$Mg^{\#}$	77	79	79	78	79	79	79	76	79	78	77	78

TABLE DR1. CONTINUED

Sample	13ZB39-1	phono-tephrite										
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	13	14	15	16	17	18	19	20	21	22	23	24
SiO_2	49.01	48.79	47.54	48.47	48.10	45.02	49.11	48.72	49.79	46.07	48.77	49.33
TiO_2	0.61	0.75	2.30	1.27	1.69	3.03	1.54	1.84	1.45	2.02	1.52	1.80
Al_2O_3	4.96	4.72	4.45	4.17	5.01	7.89	4.00	3.90	3.70	5.90	4.73	3.16
Cr_2O_3	0.03	-	0.02	0.03	0.05	0.05	0.05	0.03	0.01	-	0.07	-
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
FeO	5.58	6.34	7.12	5.72	6.49	7.77	6.09	7.33	6.49	12.73	7.04	6.97
MnO	0.06	0.11	0.20	0.11	0.12	0.12	0.14	0.19	0.15	0.27	0.15	0.18
MgO	13.82	13.07	13.43	14.18	13.80	12.25	14.34	13.48	14.73	9.28	13.96	14.02
CaO	25.32	24.88	23.29	24.33	23.06	22.75	23.47	23.65	23.33	23.00	22.82	23.54
Na_2O	0.35	0.58	0.81	0.55	0.93	0.99	0.57	0.67	0.55	1.35	0.71	0.69
K_2O	0.01	0.00	0.01	-	0.02	0.03	0.02	0.01	0.02	0.03	0.03	0.02
P_2O_5	0.02	0.03	-	0.05	0.07	0.06	0.04	0.04	0.04	0.00	0.05	0.04
NiO	-	0.00	-	-	0.01	0.02	0.02	0.03	0.01	0.04	0.06	0.01
Total	99.77	99.30	99.19	98.90	99.38	99.99	99.38	99.89	100.28	100.70	99.90	99.76
Cations on the basis of 6 oxygens												
Si	1.832	1.839	1.802	1.830	1.810	1.701	1.842	1.832	1.851	1.769	1.826	1.853
Al(iv)	0.168	0.161	0.198	0.170	0.190	0.299	0.158	0.168	0.149	0.231	0.174	0.051
Al(vi)	0.050	0.049	0.000	0.016	0.033	0.052	0.019	0.005	0.014	0.036	0.035	0.000
Ti	0.017	0.021	0.066	0.036	0.048	0.086	0.043	0.052	0.040	0.058	0.043	0.051
Cr	0.001	0.000	0.001	0.001	0.002	0.001	0.002	0.001	0.000	0.000	0.002	0.000
Fe^{3+}	0.160	0.166	0.187	0.179	0.189	0.217	0.138	0.157	0.139	0.266	0.155	0.153
Fe^{2+}	0.012	0.031	0.035	0.000	0.012	0.024	0.051	0.070	0.060	0.134	0.062	0.063
Mn	0.002	0.004	0.006	0.004	0.004	0.004	0.004	0.006	0.005	0.009	0.005	0.006
Mg	0.770	0.735	0.759	0.798	0.775	0.690	0.802	0.756	0.816	0.531	0.779	0.785
Ca	1.014	1.005	0.946	0.984	0.930	0.921	0.943	0.953	0.929	0.946	0.916	0.947
Na	0.025	0.043	0.060	0.040	0.068	0.073	0.041	0.049	0.039	0.100	0.051	0.050
K	0.001	0.000	0.001	0.000	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001
Wo	51.1	50.7	47.5	49.1	47.0	47.8	47.6	47.9	46.7	47.6	46.5	47.3
En	38.8	37.0	38.1	39.8	39.2	35.8	40.5	38.0	41.0	26.7	39.6	39.2
Fs	8.8	10.1	11.5	9.1	10.4	12.7	9.8	11.7	10.3	20.6	11.3	11.1
$Mg^{\#}$	82	79	77	82	79	74	81	77	80	57	78	78

TABLE DR1. CONTINUED

Sample	13ZB47-1	basaltic trachyandesite							13ZB41-2	basaltic trachyandesite	
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	1	2	3	4	5	6	7	8	1	2	3
SiO_2	48.94	49.04	50.90	51.17	47.55	48.76	50.29	51.78	51.16	51.12	50.17
TiO_2	1.99	0.71	0.98	0.84	1.00	0.97	0.96	0.79	0.70	0.55	1.16
Al_2O_3	3.44	3.16	3.02	2.40	5.09	4.13	4.07	3.23	3.10	2.21	3.67
Cr_2O_3	-	-	0.08	-	-	-	-	-	0.07	0.05	0.30
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-
FeO	7.85	12.58	7.06	7.21	11.55	11.13	7.21	6.38	6.26	8.70	5.66
MnO	0.22	0.45	0.17	0.19	0.23	0.27	0.17	0.13	0.15	0.27	0.14
MgO	13.34	9.84	14.54	15.16	10.06	10.54	14.10	15.79	14.83	13.26	14.73
CaO	22.85	22.26	22.08	21.04	22.17	22.39	21.19	20.27	22.75	22.81	22.81
Na_2O	0.53	1.41	0.53	0.53	0.95	1.13	0.79	0.71	0.53	0.52	0.47
K_2O	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.01
P_2O_5	-	-	-	-	-	-	-	-	-	-	-
NiO	0.01	0.00	0.01	0.04	0.01	0.00	0.02	0.02	0.01	0.01	0.03
Total	99.18	99.43	99.38	98.91	98.61	99.31	98.83	99.16	99.56	99.50	99.16
Cations on the basis of 6 oxygens											
Si	1.836	1.860	1.891	1.912	1.816	1.844	1.876	1.913	1.890	1.913	1.861
Al(iv)	0.152	0.140	0.109	0.088	0.184	0.156	0.124	0.087	0.110	0.087	0.139
Al(vi)	0.000	0.002	0.023	0.018	0.045	0.028	0.055	0.054	0.025	0.010	0.022
Ti	0.056	0.020	0.027	0.024	0.029	0.028	0.027	0.022	0.020	0.016	0.032
Cr	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.009
Fe^{3+}	0.103	0.201	0.068	0.061	0.152	0.155	0.073	0.041	0.083	0.082	0.078
Fe^{2+}	0.143	0.198	0.151	0.164	0.217	0.196	0.152	0.157	0.111	0.190	0.098
Mn	0.007	0.014	0.005	0.006	0.008	0.009	0.005	0.004	0.005	0.008	0.004
Mg	0.746	0.557	0.805	0.845	0.573	0.594	0.784	0.870	0.817	0.740	0.814
Ca	0.918	0.905	0.879	0.843	0.907	0.907	0.847	0.802	0.900	0.914	0.907
Na	0.039	0.103	0.038	0.038	0.070	0.082	0.057	0.051	0.038	0.038	0.034
K	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.001
Wo	38.9	29.7	42.2	44.0	30.8	31.9	42.1	46.4	42.6	38.2	42.8
En	47.9	48.3	46.0	43.9	48.9	48.7	45.5	42.8	47.0	47.3	47.7
Fs	13.2	22.1	11.8	12.1	20.3	19.4	12.4	10.7	10.3	14.5	9.5
$Mg^{\#}$	75	58	79	79	61	63	78	82	81	73	82

TABLE DR1. CONTINUED

Sample	13ZB41-2	basaltic trachyandesite									
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	4	5	6	7	8	9	10	11	12	13	14
SiO_2	50.87	50.71	50.54	50.57	51.86	51.00	50.45	50.70	51.37	47.85	51.74
TiO_2	0.87	1.03	0.97	0.99	0.79	0.96	1.26	0.98	0.75	2.06	0.80
Al_2O_3	3.62	3.46	3.57	3.01	2.75	3.15	3.26	2.95	2.30	4.78	2.63
Cr_2O_3	0.39	0.25	0.23	0.04	0.13	0.19	0.16	0.18	0.06	0.11	0.20
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-
FeO	6.02	6.04	6.06	7.68	5.38	5.40	5.67	5.67	6.49	8.14	4.97
MnO	0.11	0.08	0.13	0.14	0.12	0.11	0.12	0.13	0.13	0.15	0.12
MgO	14.92	15.01	15.11	13.90	15.82	15.26	14.59	15.39	14.58	12.76	15.54
CaO	22.12	22.16	22.42	22.59	22.46	23.09	23.00	22.77	23.06	22.44	22.86
Na_2O	0.51	0.46	0.50	0.59	0.46	0.44	0.41	0.44	0.44	0.43	0.39
K_2O	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.01
P_2O_5	-	-	-	-	-	-	-	-	-	-	-
NiO	0.04	0.02	0.01	0.01	0.03	0.00	0.00	0.01	0.01	0.01	0.03
Total	99.46	99.23	99.53	99.53	99.80	99.59	99.18	99.24	99.19	98.74	99.28
Cations on the basis of 6 oxygens											
Si	1.881	1.880	1.866	1.881	1.904	1.880	1.879	1.875	1.911	1.806	1.911
Al(iv)	0.119	0.120	0.134	0.119	0.096	0.120	0.121	0.125	0.089	0.194	0.089
Al(vi)	0.039	0.031	0.021	0.013	0.023	0.017	0.022	0.004	0.012	0.019	0.025
Ti	0.024	0.029	0.027	0.028	0.022	0.027	0.035	0.027	0.021	0.058	0.022
Cr	0.011	0.007	0.007	0.001	0.004	0.005	0.005	0.005	0.002	0.003	0.006
Fe^{3+}	0.057	0.059	0.089	0.091	0.059	0.076	0.053	0.093	0.066	0.087	0.042
Fe^{2+}	0.129	0.129	0.097	0.148	0.106	0.090	0.123	0.083	0.136	0.169	0.112
Mn	0.003	0.003	0.004	0.005	0.004	0.003	0.004	0.004	0.004	0.005	0.004
Mg	0.823	0.829	0.831	0.771	0.866	0.838	0.810	0.849	0.809	0.718	0.856
Ca	0.876	0.880	0.887	0.900	0.883	0.912	0.918	0.903	0.919	0.908	0.905
Na	0.036	0.033	0.036	0.042	0.033	0.031	0.030	0.032	0.032	0.031	0.028
K	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.001
Wo	43.6	43.7	43.5	40.3	45.2	43.7	42.5	44.0	41.8	38.0	44.6
En	46.4	46.3	46.4	47.0	46.1	47.5	48.1	46.7	47.5	48.1	47.2
Fs	10.0	10.0	10.0	12.7	8.8	8.8	9.5	9.3	10.6	13.9	8.2
$Mg^{\#}$	82	82	82	76	84	83	82	83	80	74	85

TABLE DR1. CONTINUED

Sample	13ZB41-2	basaltic trachyandesite								
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	15	16	17	18	19	20	21	22	23	24
SiO_2	50.15	50.63	50.07	48.32	50.16	51.46	50.87	50.83	50.20	50.50
TiO_2	0.55	0.91	0.53	1.75	1.13	0.79	0.97	0.98	0.96	1.16
Al_2O_3	2.80	3.62	4.74	4.85	3.64	2.92	3.05	3.23	3.92	3.34
Cr_2O_3	0.03	0.43	0.06	0.32	0.26	0.66	0.25	0.04	0.04	0.30
Fe_2O_3	-	-	-	-	-	-	-	-	-	-
FeO	12.27	4.98	6.47	7.25	5.85	4.16	5.65	6.01	5.68	5.68
MnO	0.26	0.10	0.10	0.15	0.12	0.10	0.13	0.12	0.13	0.13
MgO	10.82	15.13	12.95	13.63	14.76	15.44	15.02	14.98	14.62	14.92
CaO	21.87	22.84	22.95	22.38	22.65	23.24	22.83	22.56	23.10	23.08
Na_2O	0.88	0.47	0.87	0.54	0.49	0.34	0.45	0.41	0.46	0.43
K_2O	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01
P_2O_5	-	-	-	-	-	-	-	-	-	-
NiO	0.01	0.06	0.01	0.04	0.00	0.02	0.01	0.03	0.00	0.01
Total	99.64	99.17	98.72	99.25	99.06	99.13	99.24	99.18	99.11	99.55
Cations on the basis of 6 oxygens										
Si	1.899	1.872	1.869	1.803	1.863	1.903	1.885	1.885	1.862	1.866
Al(iv)	0.101	0.128	0.131	0.197	0.137	0.097	0.115	0.115	0.138	0.134
Al(vi)	0.024	0.030	0.077	0.017	0.022	0.030	0.018	0.026	0.033	0.012
Ti	0.016	0.025	0.015	0.049	0.031	0.022	0.027	0.027	0.027	0.032
Cr	0.001	0.013	0.002	0.010	0.008	0.019	0.007	0.001	0.001	0.009
Fe^{3+}	0.111	0.069	0.086	0.112	0.081	0.028	0.069	0.063	0.083	0.080
Fe^{2+}	0.278	0.085	0.116	0.115	0.101	0.101	0.106	0.124	0.093	0.096
Mn	0.008	0.003	0.003	0.005	0.004	0.003	0.004	0.004	0.004	0.004
Mg	0.611	0.834	0.721	0.758	0.817	0.851	0.829	0.828	0.808	0.822
Ca	0.887	0.905	0.918	0.895	0.901	0.921	0.906	0.896	0.918	0.914
Na	0.065	0.034	0.063	0.039	0.035	0.024	0.032	0.030	0.033	0.031
K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wo	32.2	44.0	39.1	40.2	42.9	44.7	43.3	43.3	42.4	42.9
En	46.8	47.7	49.8	47.5	47.3	48.4	47.3	46.8	48.2	47.7
Fs	20.9	8.3	11.1	12.3	9.7	6.9	9.4	9.9	9.5	9.4
$Mg^{\#}$	61	84	78	77	82	87	83	82	82	82

TABLE DR1. CONTINUED

Sample	13ZB36-3	tephri-phonolite										
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	46.79	49.22	46.07	49.65	46.74	49.32	45.22	49.96	74.04	48.40	52.75	46.45
TiO_2	2.37	0.53	2.25	1.50	2.32	1.82	3.33	1.07	2.90	2.49	0.42	2.40
Al_2O_3	6.19	2.94	6.95	4.05	6.08	3.32	6.45	3.32	5.02	4.09	1.66	6.58
Cr_2O_3	0.07	0.01	0.04	0.08	0.14	-	-	-	-	-	-	-
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
FeO	7.90	13.79	8.22	6.93	7.37	7.29	7.99	6.98	7.33	7.44	6.26	8.13
MnO	0.14	0.43	0.15	0.12	0.10	0.16	0.16	0.16	0.17	0.15	0.12	0.14
MgO	12.15	9.55	11.85	13.88	12.57	13.35	11.61	13.85	12.21	12.76	16.05	12.00
CaO	22.44	21.88	21.98	22.70	22.85	23.24	22.95	23.07	22.89	22.86	21.84	22.13
Na_2O	0.63	1.05	0.73	0.56	0.57	0.54	0.56	0.49	0.61	0.64	0.42	0.65
K_2O	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00
P_2O_5	-	-	-	-	-	-	-	-	-	-	-	-
NiO	0.01	0.00	0.01	0.02	0.02	0.00	0.00	0.01	0.01	0.01	0.02	0.00
Total	98.70	99.41	98.50	99.50	98.77	99.06	98.29	99.05	98.22	98.95	99.60	98.56
Cations on the basis of 6 oxygens												
Si	1.765	1.880	1.745	1.845	1.758	1.849	1.720	1.868	2.238	1.823	1.945	1.756
Al(iv)	0.235	0.120	0.255	0.155	0.242	0.146	0.280	0.132	0.000	0.177	0.055	0.244
Al(vi)	0.040	0.012	0.055	0.022	0.027	0.000	0.009	0.014	0.179	0.004	0.017	0.050
Ti	0.067	0.015	0.064	0.042	0.066	0.051	0.095	0.030	0.066	0.071	0.012	0.068
Cr	0.002	0.000	0.001	0.002	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe^{3+}	0.106	0.155	0.124	0.087	0.122	0.091	0.122	0.094	0.000	0.079	0.046	0.105
Fe^{2+}	0.143	0.285	0.136	0.129	0.110	0.138	0.132	0.124	0.185	0.156	0.147	0.152
Mn	0.004	0.014	0.005	0.004	0.003	0.005	0.005	0.005	0.004	0.005	0.004	0.004
Mg	0.683	0.544	0.669	0.769	0.705	0.746	0.659	0.772	0.550	0.717	0.882	0.676
Ca	0.907	0.895	0.892	0.904	0.921	0.934	0.935	0.924	0.741	0.922	0.862	0.897
Na	0.046	0.078	0.054	0.040	0.042	0.039	0.042	0.036	0.036	0.047	0.030	0.048
K	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Wo	37.1	28.7	36.6	40.6	37.9	39.0	35.5	40.2	37.2	38.2	45.4	36.9
En	49.2	47.3	48.9	47.8	49.5	48.8	50.5	48.1	50.0	49.1	44.4	48.9
Fs	13.8	24.0	14.5	11.6	12.6	12.2	14.0	11.6	12.8	12.7	10.1	14.3
$Mg^{\#}$	73	55	72	78	75	77	72	78	75	75	82	72

TABLE DR1. CONTINUED

Sample	13ZB36-3	tephri-phonolite									13ZB40-1	trachyandesite
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	13	14	15	16	17	18	19	20	21	22	1	2
SiO_2	46.82	48.00	47.41	49.21	46.94	47.27	49.05	47.70	48.10	46.63	47.66	48.58
TiO_2	2.45	1.94	1.29	1.50	2.38	1.27	1.90	1.96	0.82	2.31	1.99	1.80
Al_2O_3	6.32	5.16	4.61	4.77	6.48	4.56	3.84	5.33	5.56	6.25	5.78	4.14
Cr_2O_3	-	-	-	-	0.10	0.00	0.19	0.36	0.11	0.09	0.16	0.12
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
FeO	7.90	7.71	13.22	8.00	7.66	14.02	7.06	7.09	8.25	8.06	7.84	8.06
MnO	0.14	0.16	0.29	0.15	0.13	0.33	0.11	0.15	0.11	0.12	0.18	0.22
MgO	12.23	13.09	8.84	13.27	12.42	8.57	13.51	13.10	12.03	12.11	12.70	12.15
CaO	22.39	22.08	22.06	21.40	22.25	22.06	23.23	22.61	23.96	22.60	22.16	23.19
Na_2O	0.66	0.60	1.56	0.77	0.63	1.51	0.45	0.61	0.55	0.61	0.71	0.99
K_2O	0.01	0.00	0.03	0.00	0.00	0.02	0.00	0.03	0.01	0.00	0.02	0.03
P_2O_5	-	-	-	-	-	-	-	-	-	-	-	-
NiO	0.03	0.01	0.00	0.01	0.01	0.00	0.02	0.03	0.00	0.01	0.02	0.00
Total	99.03	98.78	99.31	99.10	98.98	99.61	99.30	98.94	99.48	98.78	99.20	99.27
Cations on the basis of 6 oxygens												
Si	1.761	1.803	1.806	1.840	1.762	1.801	1.832	1.787	1.798	1.758	1.784	1.820
Al(iv)	0.239	0.197	0.194	0.160	0.238	0.199	0.168	0.213	0.202	0.242	0.216	0.180
Al(vi)	0.041	0.032	0.014	0.050	0.049	0.006	0.001	0.022	0.043	0.036	0.038	0.003
Ti	0.069	0.055	0.037	0.042	0.067	0.036	0.053	0.055	0.023	0.065	0.056	0.051
Cr	0.000	0.000	0.000	0.000	0.003	0.000	0.006	0.011	0.003	0.003	0.005	0.003
Fe^{3+}	0.108	0.099	0.223	0.082	0.097	0.233	0.087	0.115	0.151	0.117	0.114	0.145
Fe^{2+}	0.140	0.143	0.198	0.168	0.144	0.214	0.134	0.107	0.107	0.137	0.131	0.107
Mn	0.004	0.005	0.009	0.005	0.004	0.011	0.003	0.005	0.003	0.004	0.006	0.007
Mg	0.686	0.733	0.502	0.739	0.695	0.487	0.753	0.732	0.670	0.681	0.709	0.679
Ca	0.902	0.889	0.901	0.857	0.895	0.900	0.930	0.907	0.959	0.913	0.888	0.931
Na	0.048	0.044	0.115	0.056	0.046	0.112	0.033	0.044	0.040	0.044	0.052	0.072
K	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.001	0.001
Wo	37.3	39.2	27.4	39.9	37.9	26.4	39.5	39.2	35.4	36.8	38.3	36.3
En	49.0	47.6	49.1	46.3	48.8	48.8	48.8	48.6	50.7	49.3	48.1	49.8
Fs	13.7	13.2	23.5	13.8	13.3	24.8	11.8	12.2	13.8	13.9	13.6	13.9
$Mg^{\#}$	73	75	54	75	74	52	77	77	72	73	74	73

TABLE DR1. CONTINUED

Sample	13ZB40-1	trachyandesite											
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	3	4	5	6	7	8	9	10	11	12	13	14	15
SiO_2	47.89	47.57	48.77	47.75	50.70	49.38	49.07	47.53	50.41	49.94	47.08	50.62	48.24
TiO_2	1.94	1.83	1.49	2.15	1.01	1.44	1.57	2.24	1.29	0.57	2.19	1.14	0.92
Al_2O_3	5.07	4.23	2.89	5.66	3.65	3.23	4.62	4.95	2.77	2.15	6.03	3.28	2.88
Cr_2O_3	0.17	0.19	0.05	0.09	0.22	0.02	0.32	0.00	0.10	0.29	0.12	0.16	-
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-	-
FeO	7.08	9.12	11.67	7.05	4.34	9.40	7.37	8.47	7.24	12.17	7.38	6.06	13.34
MnO	0.15	0.27	0.33	0.12	0.09	0.30	0.16	0.19	0.22	0.40	0.13	0.15	0.44
MgO	13.02	11.55	10.61	12.81	14.96	11.92	13.52	12.22	13.68	10.19	12.69	14.59	9.52
CaO	22.81	22.93	22.66	22.90	24.21	22.76	21.92	22.67	23.17	23.17	22.81	22.52	22.59
Na_2O	0.55	1.13	1.27	0.68	0.31	1.18	0.65	0.93	0.67	0.90	0.69	0.45	0.01
K_2O	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
P_2O_5	-	-	-	-	-	-	-	-	-	-	-	-	-
NiO	0.03	0.03	0.00	0.00	0.01	0.03	0.02	0.01	0.01	0.00	0.02	0.02	0.02
Total	98.70	98.75	99.75	99.21	99.49	99.65	99.23	99.21	99.56	99.77	99.13	98.96	99.09
Cations on the basis of 6 oxygens													
Si	1.800	1.796	1.841	1.784	1.870	1.848	1.831	1.783	1.876	1.896	1.762	1.885	1.886
Al(iv)	0.200	0.188	0.129	0.216	0.130	0.143	0.169	0.217	0.121	0.096	0.238	0.115	0.114
Al(vi)	0.024	0.000	0.000	0.033	0.028	0.000	0.035	0.002	0.000	0.000	0.027	0.029	0.019
Ti	0.055	0.052	0.042	0.060	0.028	0.040	0.044	0.063	0.036	0.016	0.062	0.032	0.027
Cr	0.005	0.006	0.001	0.003	0.006	0.000	0.009	0.000	0.003	0.009	0.004	0.005	0.000
Fe^{3+}	0.102	0.192	0.195	0.109	0.062	0.165	0.084	0.155	0.100	0.137	0.135	0.050	0.042
Fe^{2+}	0.121	0.096	0.173	0.111	0.072	0.129	0.146	0.111	0.125	0.249	0.096	0.138	0.395
Mn	0.005	0.009	0.010	0.004	0.003	0.010	0.005	0.006	0.007	0.013	0.004	0.005	0.014
Mg	0.730	0.650	0.597	0.713	0.822	0.665	0.752	0.683	0.759	0.577	0.708	0.810	0.555
Ca	0.919	0.928	0.917	0.917	0.956	0.913	0.877	0.911	0.924	0.942	0.914	0.899	0.947
Na	0.040	0.082	0.093	0.049	0.022	0.086	0.047	0.068	0.048	0.066	0.050	0.032	0.001
K	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wo	38.9	34.7	31.6	38.5	42.9	35.3	40.4	36.6	39.6	30.1	38.1	42.6	28.4
En	49.0	49.5	48.4	49.4	49.9	48.5	47.0	48.8	48.2	49.1	49.2	47.2	48.5
Fs	12.1	15.8	20.0	12.1	7.1	16.1	12.6	14.6	12.1	20.8	12.7	10.2	23.1
$Mg^{\#}$	77	69	62	76	86	69	77	72	77	60	75	81	56

TABLE DR1. CONTINUED

Sample	13ZB46-1	phonolite						13ZB47-2	phonolite			
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	1	2	3	4	5	6	7	1	2	3	4	5
SiO_2	45.28	48.18	47.55	47.59	47.71	46.69	46.50	47.89	47.18	43.99	47.57	47.51
TiO_2	1.30	1.05	1.09	0.86	1.00	0.81	1.24	1.15	1.44	2.68	1.25	1.12
Al_2O_3	5.73	3.96	5.10	3.67	5.37	4.11	4.41	4.32	4.95	6.35	4.59	4.48
Cr_2O_3	-	-	0.03	-	0.04	0.03	0.02	0.04	-	0.08	-	-
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
FeO	9.63	14.82	9.91	14.68	7.03	15.92	14.24	12.48	12.54	15.26	13.10	12.90
MnO	0.23	0.66	0.27	0.58	0.15	0.63	0.56	0.47	0.39	0.53	0.45	0.46
MgO	11.06	7.96	11.17	8.27	12.98	7.34	7.61	9.64	9.57	7.30	9.22	9.34
CaO	24.57	21.26	23.11	21.58	23.17	21.09	21.42	22.01	22.59	22.17	22.08	22.74
Na_2O	0.87	2.25	1.15	2.26	0.84	2.78	2.10	1.61	1.58	1.80	1.63	1.62
K_2O	0.02	0.01	0.02	0.01	0.01	0.06	0.02	-	-	0.03	0.00	0.01
P_2O_5	0.04	-	0.04	0.04	0.02	0.06	0.05	0.05	0.04	0.05	0.04	0.02
NiO	0.05	-	0.02	-	0.01	0.01	-	0.00	-	-	0.02	0.00
Total	100.10	100.16	99.47	99.55	98.36	99.52	98.18	99.66	100.28	100.25	99.96	100.20
Cations on the basis of 6 oxygens												
Si	1.758	1.868	1.819	1.862	1.818	1.843	1.843	1.847	1.813	1.726	1.836	1.831
Al(iv)	0.242	0.132	0.181	0.138	0.182	0.157	0.157	0.153	0.187	0.274	0.164	0.169
Al(vi)	0.020	0.049	0.049	0.031	0.059	0.034	0.049	0.044	0.038	0.019	0.045	0.035
Ti	0.038	0.031	0.031	0.025	0.029	0.024	0.037	0.033	0.042	0.079	0.036	0.032
Cr	0.000	0.000	0.001	0.000	0.001	0.001	0.001	0.001	0.000	0.003	0.000	0.000
Fe^{3+}	0.312	0.280	0.228	0.334	0.188	0.420	0.288	0.238	0.269	0.339	0.247	0.279
Fe^{2+}	0.000	0.189	0.083	0.133	0.033	0.087	0.172	0.157	0.125	0.147	0.167	0.127
Mn	0.008	0.022	0.009	0.019	0.005	0.021	0.019	0.015	0.013	0.018	0.015	0.015
Mg	0.640	0.460	0.637	0.482	0.737	0.432	0.449	0.554	0.548	0.427	0.531	0.537
Ca	1.022	0.883	0.947	0.904	0.946	0.892	0.909	0.910	0.930	0.932	0.913	0.939
Na	0.066	0.169	0.086	0.172	0.062	0.213	0.161	0.121	0.118	0.137	0.122	0.121
K	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.000	0.000	0.002	0.000	0.000
Wo	50.1	44.1	47.6	44.2	48.0	43.2	45.5	45.6	46.4	46.6	45.8	46.5
En	31.4	23.0	32.0	23.6	37.4	20.9	22.5	27.8	27.4	21.4	26.6	26.6
Fs	15.3	24.5	16.1	23.8	11.4	25.6	24.0	20.6	20.3	25.2	21.5	20.9
$Mg^{\#}$	67	49	67	50	77	45	49	58	58	46	56	56

TABLE DR1. CONTINUED

Sample	13ZB47-2	phonolite										
Mineral	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
Spots	6	7	8	9	10	11	12	13	14	15	16	17
SiO_2	47.66	48.27	49.02	48.05	47.80	46.43	47.74	47.14	52.04	47.92	53.65	53.30
TiO_2	1.15	1.20	1.16	1.28	1.25	1.44	1.28	1.45	0.54	1.22	0.19	0.20
Al_2O_3	4.63	4.19	4.17	4.39	4.95	4.95	4.36	4.76	2.17	4.35	0.21	0.23
Cr_2O_3	0.03	0.21	-	0.03	0.17	0.12	0.01	0.11	20.00	0.04	0.10	0.01
Fe_2O_3	-	-	-	-	-	-	-	-	-	-	-	-
FeO	13.37	12.05	11.43	11.75	12.05	12.28	12.51	11.64	6.82	11.49	5.23	5.39
MnO	0.48	0.34	0.38	0.38	0.41	0.44	0.35	0.35	0.21	0.32	0.33	0.36
MgO	9.22	9.82	10.13	10.28	9.61	9.31	9.67	10.12	15.41	10.00	15.60	15.53
CaO	21.76	22.36	22.41	22.23	21.79	22.78	21.85	21.95	21.34	21.82	23.68	23.51
Na_2O	1.77	1.42	1.49	1.43	1.67	1.17	1.48	1.37	0.55	1.34	0.45	0.54
K_2O	-	0.01	-	-	-	0.07	0.00	0.01	0.02	0.00	0.03	0.00
P_2O_5	0.05	0.02	0.01	0.06	-	0.06	-	-	-	-	-	-
NiO	0.02	0.05	0.01	0.00	-	-	0.00	0.00	0.00	0.00	0.01	0.03
Total	100.13	99.93	100.21	99.87	99.69	99.04	99.25	98.90	99.11	98.51	99.47	99.10
Cations on the basis of 6 oxygens												
Si	1.838	1.853	1.866	1.842	1.837	1.809	1.813	1.792	1.684	1.830	1.981	1.975
Al(iv)	0.162	0.147	0.134	0.158	0.163	0.191	0.187	0.208	0.083	0.170	0.009	0.010
Al(vi)	0.048	0.042	0.053	0.040	0.061	0.036	0.008	0.005	0.000	0.026	0.000	0.000
Ti	0.033	0.035	0.033	0.037	0.036	0.042	0.037	0.041	0.013	0.035	0.005	0.005
Cr	0.001	0.006	0.000	0.001	0.005	0.004	0.000	0.003	0.512	0.001	0.003	0.000
Fe^{3+}	0.262	0.200	0.184	0.219	0.221	0.235	0.214	0.218	0.047	0.173	0.049	0.067
Fe^{2+}	0.159	0.180	0.174	0.151	0.160	0.158	0.183	0.153	0.137	0.194	0.113	0.100
Mn	0.016	0.011	0.012	0.012	0.013	0.014	0.011	0.011	0.006	0.010	0.010	0.011
Mg	0.530	0.562	0.575	0.588	0.550	0.541	0.548	0.573	0.743	0.569	0.859	0.858
Ca	0.899	0.919	0.914	0.913	0.897	0.951	0.889	0.894	0.740	0.893	0.937	0.933
Na	0.132	0.106	0.110	0.106	0.125	0.089	0.109	0.101	0.034	0.099	0.033	0.038
K	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.001	0.000	0.001	0.000
Wo	45.0	46.5	46.4	45.9	45.6	47.9	29.7	31.0	44.4	31.0	43.7	43.6
En	26.5	28.4	29.2	29.5	28.0	27.2	48.2	48.4	44.2	48.5	47.6	47.4
Fs	21.9	19.8	18.8	19.2	20.0	20.5	22.1	20.6	11.4	20.5	8.7	9.1
$Mg^{\#}$	55	59	61	61	59	57	58	61	80	61	84	84

Note: Cpx, clinopyroxene.

TABLE DR2. REPRESENTATIVE ELECTRON MICROPROBE ANALYSES OF FELDSPARS IN THE GEMUCHAKA LAVAS FROM THE CENTRAL QIANGTANG BLOCK

Sample	13ZB39-1	phono-tephrite															
Mineral	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Ano	Sa	Sa	Ano	Ano	Ano	Sa	Ano	Sa
Spot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
SiO_2	62.47	62.72	62.89	63.59	62.97	63.70	63.79	64.51	62.44	62.83	62.08	60.43	62.39	60.99	63.59	62.77	63.75
TiO_2	0.10	0.13	0.09	0.06	0.21	0.14	0.11	0.13	0.19	0.21	0.18	0.14	0.08	0.18	0.13	0.13	0.09
Al_2O_3	20.21	19.71	19.97	19.23	20.05	20.02	19.61	21.45	21.65	21.17	20.89	22.13	21.51	21.53	20.58	21.56	19.39
FeO	0.22	0.22	0.15	0.18	0.22	0.15	0.17	0.23	0.22	0.17	0.18	0.25	0.23	0.21	0.22	0.35	0.20
MnO	0.00	0.01	0.03	0.01	-	0.00	0.02	-	0.05	0.01	-	-	-	-	-	-	-
MgO	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.00	0.00	-	-
CaO	1.44	1.31	1.24	0.69	1.31	1.08	0.80	2.19	2.83	2.14	2.20	3.35	2.61	2.59	1.48	2.36	0.55
Na_2O	4.73	5.00	4.61	4.05	4.97	4.09	4.03	5.52	7.27	6.40	6.01	6.15	6.44	6.53	6.13	7.05	4.48
K_2O	8.79	8.53	8.80	10.84	8.79	10.31	10.46	5.87	4.55	6.08	6.17	4.51	5.54	5.26	7.21	4.96	11.30
Total	98.00	97.68	97.84	98.67	98.55	99.56	99.04	99.93	99.31	99.05	97.77	97.01	98.84	97.33	99.36	99.20	99.77
Cations on the basis of 8 oxygens																	
Si	2.899	2.918	2.917	2.945	2.908	2.920	2.938	2.893	2.836	2.865	2.867	2.804	2.846	2.829	2.896	2.850	2.933
Al	1.105	1.081	1.092	1.050	1.092	1.082	1.064	1.134	1.159	1.137	1.137	1.210	1.156	1.177	1.105	1.154	1.051
Ca	0.072	0.065	0.061	0.034	0.065	0.053	0.040	0.105	0.138	0.104	0.109	0.166	0.127	0.129	0.072	0.115	0.027
Na	0.425	0.451	0.414	0.363	0.445	0.364	0.360	0.480	0.640	0.566	0.538	0.553	0.569	0.588	0.541	0.620	0.399
K	0.520	0.506	0.520	0.640	0.518	0.603	0.615	0.336	0.264	0.354	0.364	0.267	0.322	0.311	0.419	0.287	0.663
An	7.0	6.4	6.2	3.3	6.3	5.2	3.9	11.4	13.2	10.2	10.8	16.9	12.5	12.5	7.0	11.2	2.5
Ab	41.8	44.1	41.6	35.0	43.3	35.7	35.5	52.1	61.5	55.3	53.3	56.1	55.9	57.2	52.4	60.7	36.7
Or	51.1	49.5	52.3	61.7	50.4	59.1	60.6	36.5	25.3	34.5	36.0	27.1	31.6	30.3	40.6	28.1	60.8

TABLE DR2. CONTINUED

Sample	13ZB47-1	basaltic trachyandesite					13ZB41-2	basaltic trachyandesite									
Mineral	Sa	Sa	Ano	Sa	Sa	Sa	And	And	And	And	Sa	And	And	And	And	And	And
Spot	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11
SiO_2	66.28	65.05	65.67	65.90	66.16	66.43	55.45	55.95	56.80	55.86	66.34	55.70	56.52	55.55	55.55	56.34	55.90
TiO_2	0.07	0.17	0.13	0.14	0.12	0.08	0.12	0.15	0.14	0.09	0.01	0.15	0.14	0.16	0.13	0.18	0.13
Al_2O_3	18.96	20.15	20.41	19.77	20.05	19.28	27.81	27.89	27.47	27.80	19.40	27.78	28.05	27.35	27.84	27.01	27.71
FeO	0.36	0.39	0.31	0.24	0.23	0.30	0.62	0.66	0.58	0.58	0.34	0.70	0.62	0.60	0.60	0.61	0.56
MnO	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00
MgO	0.00	0.00	0.00	0.02	0.00	0.00	0.05	0.04	0.07	0.06	0.01	0.05	0.03	0.05	0.09	0.06	0.08
CaO	0.41	1.02	1.52	0.91	0.99	0.62	9.61	9.33	8.76	9.11	0.59	9.38	9.73	8.87	9.79	8.55	9.35
Na_2O	3.83	6.13	6.74	6.03	6.27	5.26	5.31	5.39	5.77	5.64	4.40	5.52	5.27	5.65	5.25	5.61	5.42
K_2O	11.01	6.47	5.50	6.99	6.78	8.64	0.32	0.32	0.42	0.32	10.10	0.31	0.27	0.41	0.32	0.52	0.35
Total	100.92	99.40	100.28	100.01	100.60	100.60	99.30	99.74	100.01	99.47	101.21	99.58	99.43	99.60	99.56	98.88	99.49
Cations on the basis of 8 oxygens																	
Si	2.984	2.932	2.926	2.954	2.947	2.976	2.513	2.522	2.550	2.525	2.971	2.518	2.525	2.532	2.512	2.558	2.526
Al	1.006	1.070	1.072	1.044	1.052	1.018	1.486	1.482	1.453	1.481	1.024	1.480	1.477	1.470	1.484	1.445	1.475
Ca	0.020	0.049	0.072	0.044	0.047	0.030	0.467	0.450	0.421	0.441	0.029	0.454	0.466	0.433	0.474	0.416	0.453
Na	0.334	0.536	0.582	0.524	0.541	0.457	0.467	0.471	0.502	0.494	0.382	0.483	0.456	0.499	0.460	0.493	0.475
K	0.633	0.372	0.312	0.400	0.385	0.494	0.018	0.019	0.024	0.019	0.577	0.018	0.015	0.024	0.018	0.030	0.020
An	2.0	5.1	7.5	4.5	4.8	3.0	49.0	47.9	44.5	46.2	2.9	47.5	49.7	45.3	49.8	44.3	47.8
Ab	33.9	56.0	60.2	54.2	55.6	46.6	49.0	50.1	53.0	51.8	38.7	50.6	48.7	52.2	48.3	52.5	50.1
Or	64.1	38.9	32.3	41.3	39.6	50.3	1.9	2.0	2.5	2.0	58.4	1.9	1.6	2.5	1.9	3.2	2.2

TABLE DR2. CONTINUED

Sample	13ZB36-3	tephri-phonolite				13ZB40-1	trachyandesite			
Mineral	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa
Spot	1	2	3	4	5	1	2	3	4	5
SiO_2	64.31	65.60	64.87	65.03	64.58	66.25	66.01	66.17	64.49	65.97
TiO_2	0.12	0.12	0.11	0.09	0.12	0.08	0.10	0.09	0.09	0.08
Al_2O_3	21.79	19.63	20.37	19.78	20.08	18.92	19.22	19.34	20.03	19.41
FeO	0.20	0.18		0.17	0.23	0.43	0.33	0.39	0.46	0.34
MnO	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.02	0.02	0.01
MgO	0.01	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00
CaO	2.55	0.33	1.14	0.73	1.08	0.19	0.28	0.21	0.24	0.12
Na_2O	5.79	2.68	3.70	2.74	3.50	3.85	3.52	3.70	4.60	3.80
K_2O	6.06	12.57	10.06	11.82	10.28	11.20	11.04	11.11	8.95	11.07
Total	100.83	101.11	100.44	100.36	99.87	100.93	100.51	101.03	98.88	100.81
Cations on the basis of 8 oxygens										
Si	2.863	2.962	2.929	2.951	2.933	2.986	2.981	2.976	2.942	2.973
Al	1.143	1.044	1.084	1.058	1.075	1.005	1.023	1.025	1.077	1.031
Ca	0.122	0.016	0.055	0.036	0.052	0.009	0.014	0.010	0.012	0.006
Na	0.500	0.234	0.323	0.241	0.308	0.337	0.308	0.323	0.407	0.332
K	0.344	0.724	0.579	0.684	0.595	0.644	0.636	0.637	0.521	0.636
An	12.6	1.6	5.8	3.7	5.5	0.9	1.4	1.0	1.3	0.6
Ab	51.8	24.1	33.8	25.0	32.2	34.0	32.2	33.3	43.3	34.1
Or	35.6	74.3	60.5	71.2	62.3	65.0	66.4	65.7	55.4	65.3

TABLE DR2. CONTINUED

Sample	13ZB46-1	trachyandesite									13ZB47-2	phonolite				
Mineral	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa
Spot	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6
SiO_2	65.31	63.78	63.15	63.06	63.82	63.29	63.22	63.62	63.32	63.41	63.20	65.35	64.29	61.30	66.33	65.25
TiO_2	0.01	0.08	0.04	0.06	0.06	0.08	0.01	0.03	0.07	-	0.07	0.04	0.08	0.09	0.04	0.05
Al_2O_3	19.00	19.29	18.85	18.70	19.24	19.18	18.97	19.36	19.45	17.77	19.11	19.18	19.53	18.26	19.77	19.74
FeO	0.22	0.25	0.20	0.23	0.26	0.20	0.20	0.19	0.18	0.67	0.29	0.20	0.26	0.53	0.26	0.23
MnO	0.01	-	0.02	-	0.02	0.00	0.02	0.00	-	0.02	-	-	0.00	0.06	0.00	0.00
MgO	-	-	-	-	-	-	-	-	0.02	-	-	-	0.00	0.09	0.00	0.00
CaO	0.10	0.10	0.07	0.09	0.10	0.05	0.11	0.09	0.11	-	0.36	0.10	0.37	1.87	0.30	0.31
Na_2O	2.92	3.91	3.06	2.94	3.24	3.29	2.77	3.25	3.20	2.81	4.21	2.79	3.33	3.14	4.67	3.81
K_2O	11.96	11.48	12.13	12.12	11.48	11.99	12.60	11.80	11.92	12.84	8.56	12.50	10.50	9.54	9.24	10.46
Total	99.57	98.93	97.54	97.22	98.21	98.10	97.92	98.38	98.31	97.54	95.89	100.16	98.37	94.89	100.60	99.84
Cations on the basis of 8 oxygens																
Si	2.989	2.951	2.965	2.970	2.964	2.955	2.961	2.955	2.948	2.999	2.972	2.981	2.960	2.940	2.971	2.960
Al	1.025	1.052	1.043	1.038	1.053	1.055	1.047	1.060	1.067	0.991	1.059	1.031	1.060	1.032	1.044	1.055
Ca	0.005	0.005	0.004	0.005	0.005	0.002	0.005	0.004	0.005	0.000	0.018	0.005	0.018	0.096	0.014	0.015
Na	0.259	0.351	0.279	0.268	0.291	0.297	0.251	0.293	0.288	0.257	0.384	0.246	0.297	0.292	0.405	0.335
K	0.698	0.677	0.726	0.728	0.680	0.714	0.753	0.699	0.708	0.775	0.514	0.728	0.616	0.584	0.528	0.605
An	0.5	0.5	0.4	0.5	0.5	0.2	0.5	0.4	0.5	0.0	2.0	0.5	1.9	9.9	1.5	1.6
Ab	26.9	34.0	27.6	26.8	29.8	29.3	24.9	29.4	28.8	24.9	41.9	25.2	31.9	30.0	42.8	35.1
Or	72.5	65.6	72.0	72.7	69.7	70.4	74.6	70.2	70.7	75.1	56.1	74.3	66.1	60.1	55.7	63.4

TABLE DR2. CONTINUED

Sample	13ZB47-2	phonolite													
Mineral	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa
Spot	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
SiO_2	64.51	64.97	64.70	66.03	64.60	64.43	64.86	64.61	64.90	64.24	65.21	66.76	66.03	66.66	66.18	65.38
TiO_2	0.05	0.07	0.09	0.06	0.09	0.07	0.07	0.07	0.09	0.07	0.08	0.09	0.07	0.05	0.10	0.08
Al_2O_3	19.58	19.58	19.70	19.84	19.70	19.78	19.43	19.72	19.53	19.70	19.74	18.37	19.86	18.93	18.71	19.64
FeO	0.23	0.22	0.24	0.30	0.28	0.25	0.23	0.23	0.23	0.27	0.21	0.79	0.35	0.20	0.22	0.25
MnO	0.00	0.01	0.00	0.02	0.01	0.01	0.02	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
MgO	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
CaO	0.36	0.33	0.37	0.41	0.35	0.34	0.32	0.40	0.32	0.71	0.35	0.12	0.41	0.02	0.09	0.27
Na_2O	3.50	4.05	3.75	4.81	3.87	3.21	3.36	3.42	3.28	3.36	4.46	4.28	5.06	3.56	3.78	4.82
K_2O	10.79	10.02	10.20	9.03	9.67	10.99	10.87	10.23	11.08	10.68	9.54	10.49	8.19	11.41	10.99	9.14
Total	99.01	99.25	99.05	100.48	98.56	99.08	99.15	98.66	99.44	99.04	99.60	100.93	100.60	100.83	100.04	99.57
Cations on the basis of 8 oxygens																
Si	2.957	2.961	2.956	2.962	2.958	2.952	2.966	2.960	2.963	2.945	2.957	3.004	2.965	3.000	2.999	2.962
Al	1.057	1.052	1.061	1.049	1.063	1.068	1.048	1.064	1.051	1.065	1.055	0.974	1.051	1.004	0.999	1.048
Ca	0.018	0.016	0.018	0.020	0.017	0.017	0.015	0.020	0.016	0.035	0.017	0.006	0.020	0.001	0.004	0.013
Na	0.311	0.358	0.332	0.418	0.344	0.285	0.298	0.304	0.290	0.299	0.392	0.374	0.441	0.310	0.332	0.423
K	0.631	0.583	0.594	0.517	0.565	0.642	0.634	0.598	0.645	0.625	0.552	0.602	0.469	0.655	0.635	0.528
An	1.8	1.7	1.9	2.0	1.8	1.8	1.6	2.2	1.6	3.6	1.8	0.6	2.1	0.1	0.4	1.4
Ab	32.4	37.4	35.1	43.8	37.2	30.2	31.5	33.0	30.5	31.2	40.8	38.1	47.4	32.1	34.2	43.9
Or	65.8	60.9	62.9	54.2	61.0	68.1	66.9	64.9	67.8	65.2	57.4	61.4	50.5	67.8	65.4	54.8

TABLE DR2. CONTINUED

Sample	13ZB47-2	phonolite														
Mineral	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa
Spot	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
SiO_2	66.70	66.96	64.33	64.90	66.17	66.50	66.27	63.83	64.40	62.77	63.07	64.06	64.14	62.87	64.42	64.89
TiO_2	0.10	0.08	0.11	0.06	0.00	0.00	0.01	0.08	0.08	0.10	0.12	0.10	0.10	0.10	0.08	0.09
Al_2O_3	18.91	18.61	19.93	19.85	18.48	18.71	19.20	19.71	19.92	20.18	19.49	19.76	19.98	19.29	19.88	19.40
FeO	0.16	0.30	0.24	0.27	0.35	0.24	0.27	0.29	0.24	0.28	0.27	0.26	0.26	0.24	0.24	0.31
MnO	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.01
MgO	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00
CaO	0.13	0.05	0.54	0.31	0.13	0.14	0.17	0.35	0.43	0.54	0.37	0.34	0.35	0.39	0.36	0.32
Na_2O	3.73	3.75	4.96	4.72	4.03	3.25	4.02	3.91	4.46	3.75	3.19	3.43	4.20	3.76	4.12	4.34
K_2O	11.25	11.53	8.19	8.78	10.67	11.90	10.76	9.65	9.06	9.63	10.43	10.26	9.09	9.51	9.61	9.28
Total	100.98	101.29	98.29	98.90	99.84	100.75	100.71	97.83	98.59	97.29	96.94	98.20	98.13	96.16	98.75	98.63
Cations on the basis of 8 oxygens																
Si	2.997	3.005	2.943	2.955	3.005	3.003	2.984	2.948	2.946	2.920	2.948	2.951	2.945	2.953	2.947	2.967
Al	1.001	0.984	1.074	1.065	0.989	0.996	1.019	1.073	1.074	1.107	1.074	1.073	1.081	1.068	1.072	1.045
Ca	0.006	0.002	0.026	0.015	0.006	0.007	0.008	0.017	0.021	0.027	0.019	0.017	0.017	0.020	0.017	0.016
Na	0.325	0.327	0.440	0.417	0.355	0.285	0.351	0.350	0.395	0.338	0.289	0.306	0.374	0.343	0.366	0.384
K	0.645	0.660	0.478	0.510	0.618	0.685	0.618	0.568	0.528	0.571	0.622	0.603	0.533	0.570	0.561	0.541
An	0.6	0.2	2.8	1.6	0.6	0.7	0.9	1.9	2.2	2.9	2.0	1.8	1.9	2.1	1.9	1.7
Ab	33.3	33.0	46.6	44.2	36.3	29.1	35.9	37.4	41.9	36.1	31.1	33.1	40.5	36.7	38.7	40.8
Or	66.1	66.7	50.6	54.1	63.1	70.2	63.2	60.8	55.9	61.0	66.9	65.1	57.6	61.1	59.4	57.5

TABLE DR2. CONTINUED

Sample	13ZB47-2	phonolite													
Mineral	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa	Sa
Spot	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
SiO_2	63.92	64.94	62.86	64.03	64.34	64.57	64.66	66.50	65.80	66.67	64.63	64.86	64.57	66.25	65.97
TiO_2	0.09	0.10	0.13	0.11	0.08	0.07	0.10	0.01	0.00	0.00	0.09	0.10	0.08	0.02	0.06
Al_2O_3	19.58	19.50	19.95	19.57	19.78	19.64	19.44	18.98	18.66	18.73	19.94	19.77	19.68	18.96	19.42
FeO	0.24	0.26	0.31	0.24	0.25	0.26	0.24	0.20	0.21	0.27	0.26	0.25	0.24	0.27	0.27
MnO	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
MgO	0.02	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
CaO	0.34	0.35	0.52	0.36	0.37	0.39	0.37	0.17	0.14	0.13	0.43	0.31	0.36	0.09	0.22
Na_2O	3.44	3.97	4.36	3.89	4.02	3.89	3.45	3.40	3.48	3.52	4.17	4.13	4.44	3.90	4.56
K_2O	10.59	9.94	8.34	9.60	9.42	9.78	10.48	11.67	11.36	11.44	9.53	9.61	8.89	10.86	9.37
Total	98.22	99.06	96.48	97.81	98.26	98.61	98.73	100.95	99.65	100.76	99.05	99.02	98.26	100.35	99.87
Cations on the basis of 8 oxygens															
Si	2.951	2.964	2.931	2.956	2.954	2.958	2.965	2.994	2.999	3.380	3.684	4.065	4.437	4.864	5.212
Al	1.066	1.049	1.096	1.065	1.070	1.061	1.050	1.007	1.002	1.119	1.340	1.460	1.594	1.640	1.808
Ca	0.017	0.017	0.026	0.018	0.018	0.019	0.018	0.008	0.007	0.007	0.027	0.021	0.026	0.007	0.019
Na	0.308	0.351	0.394	0.348	0.358	0.345	0.307	0.296	0.307	0.346	0.461	0.502	0.591	0.555	0.699
K	0.624	0.579	0.496	0.565	0.552	0.571	0.613	0.670	0.660	0.740	0.693	0.769	0.779	1.017	0.944
An	1.8	1.8	2.8	1.9	2.0	2.1	1.9	0.8	0.7	0.6	2.2	1.6	1.9	0.4	1.1
Ab	32.5	37.1	43.0	37.4	38.6	36.9	32.7	30.4	31.5	31.7	39.1	38.9	42.3	35.2	42.1
Or	65.8	61.1	54.2	60.7	59.5	61.0	65.3	68.8	67.8	67.7	58.7	59.5	55.8	64.4	56.8

Note: Sa, sanidine; Ano, anothoclase; And, andesite.

TABLE DR3. REPRESENTATIVE ELECTRON MICROPROBE ANALYSES OF PARPASITE (Prg) AND PHLOGOPITE (Phl) IN THE CENOZOIC VOLCANIC ROCKS FROM THE CENTRAL QIANGTANG BLOCK

Sample	13ZB47-2	phonolite								
Mineral	Prg	Prg	Prg	Prg	Prg	Prg	Prg	Prg	Prg	Prg
Spots	1	2	3	4	5	6	7	8	9	10
SiO_2	39.27	39.55	39.27	38.57	38.88	39.45	38.77	39.22	39.00	39.04
TiO_2	3.40	3.43	3.20	3.48	3.34	3.38	3.20	3.14	3.20	3.36
Al_2O_3	11.58	12.02	11.75	11.87	11.85	11.79	11.55	11.61	10.44	10.57
Fe_2O_3										
FeO	16.31	16.79	16.80	17.24	16.85	16.93	16.75	17.18	17.25	17.31
MnO	0.42	0.41	0.39	0.42	0.40	0.46	0.45	0.37	0.35	0.40
MgO	10.03	9.89	9.92	9.66	9.88	10.08	10.19	10.07	9.81	9.59
CaO	11.67	11.61	11.89	11.79	11.77	11.76	11.80	11.89	11.45	11.35
Na_2O	2.41	2.26	2.42	2.19	2.19	2.28	2.44	2.38	2.50	2.41
K_2O	2.36	2.46	2.47	2.38	2.58	2.44	2.42	2.43	2.42	2.34
H_2O^+										
F			0.008							
Cl	0.066	0.066	0.069	0.078	0.067	0.068	0.05	0.058		
Total	97.58	98.49	98.24	97.77	97.84	98.65	97.65	98.40	96.42	96.40
Cations on the basis of 23 oxygens										
Si	6.042	6.028	6.021	5.958	5.988	6.016	5.987	6.012	6.108	6.111
Al^{IV}	1.958	1.972	1.979	2.042	2.012	1.984	2.013	1.988	1.892	1.889
Al^{VI}	0.143	0.187	0.143	0.120	0.140	0.134	0.088	0.109	0.036	0.063
Ti	0.393	0.394	0.369	0.405	0.387	0.387	0.372	0.362	0.378	0.395
Fe^{3+}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe^{2+}	2.099	2.140	2.154	2.228	2.170	2.160	2.163	2.203	2.260	2.266
Mn	0.055	0.053	0.051	0.055	0.052	0.059	0.058	0.048	0.046	0.053
Mg	2.301	2.246	2.267	2.226	2.268	2.291	2.346	2.301	2.289	2.238
Ca	1.924	1.897	1.954	1.952	1.942	1.922	1.952	1.953	1.921	1.904
Na	0.718	0.669	0.718	0.655	0.655	0.675	0.731	0.708	0.759	0.732
K	0.463	0.478	0.483	0.468	0.507	0.474	0.477	0.476	0.484	0.467
Total	16.096	16.064	16.139	16.108	16.121	16.103	16.188	16.161	16.172	16.117
Si_T*	6.042	6.028	6.021	5.958	5.988	6.016	5.987	6.012	6.108	6.111
Al_T	1.958	1.972	1.979	2.042	2.012	1.984	2.013	1.988	1.892	1.889
Al_C	0.143	0.187	0.143	0.120	0.140	0.134	0.088	0.109	0.036	0.063
Fe^{3+}_C	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ti_C	0.393	0.394	0.369	0.405	0.387	0.387	0.372	0.362	0.378	0.395
Mg_C	2.301	2.246	2.267	2.226	2.268	2.291	2.346	2.301	2.289	2.238
Fe^{2+}_C	2.099	2.140	2.154	2.228	2.170	2.160	2.163	2.203	2.260	2.266
Mn_C	0.055	0.033	0.051	0.022	0.035	0.027	0.031	0.024	0.038	0.038
Fe^{2+}_B	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mn_B	0.000	0.020	0.000	0.033	0.017	0.032	0.027	0.024	0.008	0.015
Ca_B	1.924	1.897	1.954	1.952	1.942	1.922	1.952	1.953	1.921	1.904
Na_B	0.076	0.083	0.046	0.016	0.041	0.046	0.021	0.023	0.071	0.082
Ca_A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Na_A	0.643	0.586	0.672	0.639	0.614	0.629	0.711	0.685	0.688	0.650
K_A	0.463	0.478	0.483	0.468	0.507	0.474	0.477	0.476	0.484	0.467

TABLE DR3. CONTINUED

Sample	13ZB39-1	phono-tephrite										
Mineral	Phl	Phl	Phl	Phl	Phl	Phl	Phl	Phl	Phl	Phl	Phl	Phl
Spots	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	37.76	37.31	37.69	36.94	37.04	37.37	37.11	38.19	37.75	37.52	38.65	38.21
TiO_2	7.40	8.80	7.87	8.38	8.79	8.09	8.58	8.16	8.85	8.69	4.73	8.36
Al_2O_3	12.48	12.62	12.60	12.73	12.94	12.55	12.63	12.70	13.03	12.87	12.41	12.71
Fe_2O_3												
FeO	11.86	12.84	10.62	11.14	11.86	11.94	11.48	11.52	12.97	11.61	12.31	10.78
MnO	0.13	0.14	0.08	0.15	0.10	0.12	0.10	0.12	0.15	0.11	0.13	0.09
MgO	15.55	14.38	16.59	15.38	15.07	15.75	15.24	16.06	14.88	15.61	17.38	16.53
CaO	0.01		0.02				0.01		0.01		0.01	
Na_2O	0.84	0.98	1.28	1.29	1.03	1.05	1.56	0.79	0.90	1.08	0.51	0.87
K_2O	8.94	8.78	9.15	8.95	8.51	8.86	8.61	9.14	8.86	8.73	9.54	9.05
H_2O^+												
F	1.44	1.30	1.76	1.38	1.41	1.47	1.42	1.39	0.93	1.35	2.68	1.67
Cl	0.03	0.02	0.02	0.04	0.04	0.03	0.23	0.02	0.01	0.03	0.02	0.02
Total	95.99	96.71	96.99	95.94	96.27	96.68	96.40	97.58	98.04	97.05	97.29	97.65
Cations on the basis of 11 oxygens												
Si	2.755	2.716	2.709	2.699	2.692	2.710	2.697	2.735	2.714	2.703	2.769	2.721
Al^{IV}	1.073	1.083	1.067	1.096	1.109	1.072	1.082	1.072	1.104	1.093	1.048	1.066
Al^{VI}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ti	0.406	0.482	0.426	0.461	0.481	0.441	0.469	0.440	0.479	0.471	0.255	0.448
Fe^{3+}	0.391	0.414	0.361	0.363	0.424	0.375	0.376	0.397	0.382	0.399	0.381	0.421
Fe^{2+}	0.333	0.368	0.277	0.318	0.297	0.349	0.322	0.293	0.397	0.301	0.357	0.221
Mn	0.008	0.009	0.005	0.009	0.006	0.007	0.006	0.007	0.009	0.007	0.008	0.005
Mg	1.691	1.561	1.777	1.675	1.633	1.703	1.652	1.714	1.594	1.676	1.857	1.754
Ca	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000
Na	0.118	0.139	0.179	0.182	0.146	0.147	0.220	0.109	0.125	0.151	0.071	0.120
K	0.832	0.815	0.839	0.834	0.789	0.820	0.799	0.835	0.813	0.803	0.872	0.822
Total	7.609	7.586	7.639	7.637	7.576	7.625	7.624	7.603	7.618	7.601	7.619	7.579
$Mg^{\#}$	70	67	74	71	69	70	70	71	67	71	72	73

TABLE DR3. CONTINUED

Sample	13ZB47-1	basaltic trachyandesite						
Mineral	Phl	Phl	Phl	Phl	Phl	Phl	Phl	Phl
Spots	1	2	3	4	5	6	7	8
SiO_2	36.38	35.98	38.35	38.20	37.69	37.96	37.43	37.53
TiO_2	9.20	9.27	9.34	7.39	10.07	9.99	9.88	9.99
Al_2O_3	13.90	13.90	12.45	12.10	12.52	12.40	12.44	12.56
Fe_2O_3								
FeO	11.11	10.36	10.69	10.56	10.73	10.18	10.08	10.90
MnO	0.07	0.07	0.12	0.09	0.11	0.07	0.07	0.07
MgO	16.43	16.65	17.06	18.13	16.57	17.16	17.03	16.51
CaO	0.03	0.04	0.00	0.00	0.02	0.00	0.00	0.00
Na_2O	0.82	0.79	0.84	0.85	0.77	0.78	0.73	0.81
K_2O	7.94	8.13	8.48	8.54	8.26	8.53	8.36	8.45
H_2O^+								
F	1.34	1.50	1.56	2.06	1.51	1.58	1.56	1.37
Cl	0.05	0.04	0.02	0.05	0.05	0.04	0.04	0.03
Total	96.71	96.11	98.28	97.11	97.64	98.03	96.98	97.67
Cations on the basis of 11 oxygens								
Si	2.615	2.597	2.705	2.721	2.677	2.681	2.671	2.673
Al^{IV}	1.177	1.183	1.035	1.016	1.048	1.032	1.047	1.054
Al^{VI}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ti	0.497	0.503	0.496	0.396	0.538	0.531	0.530	0.535
Fe^{3+}	0.434	0.435	0.454	0.413	0.484	0.469	0.472	0.451
Fe^{2+}	0.234	0.191	0.176	0.216	0.153	0.132	0.129	0.198
Mn	0.004	0.004	0.007	0.005	0.007	0.004	0.004	0.004
Mg	1.760	1.791	1.794	1.925	1.754	1.807	1.812	1.752
Ca	0.002	0.003	0.000	0.000	0.001	0.000	0.000	0.000
Na	0.114	0.110	0.115	0.117	0.106	0.106	0.101	0.112
K	0.728	0.749	0.763	0.776	0.748	0.768	0.761	0.768
Total	7.566	7.565	7.546	7.587	7.516	7.531	7.528	7.549
$Mg^{\#}$	73	74	74	75	73	75	75	73

TABLE DR3. CONTINUED

Sample	13ZB36-3	tephri-phonolite							
Mineral	Phl	Phl	Phl	Phl	Phl	Phl	Phl	Phl	Phl
Spots	1	2	3	4	5	6	7	8	9
SiO_2	36.48	37.47	37.29	37.06	37.29	38.29	37.08	37.23	37.97
TiO_2	9.74	9.00	9.46	9.41	8.45	8.62	9.10	8.73	8.04
Al_2O_3	12.42	12.29	12.82	12.50	12.14	12.44	12.59	12.36	12.09
Fe_2O_3									
FeO	12.29	12.25	10.74	10.69	11.88	9.64	11.64	11.78	11.50
MnO	0.11	0.09	0.09	0.09	0.12	0.10	0.11	0.08	0.13
MgO	15.43	15.99	17.11	16.41	15.96	18.35	16.45	16.69	16.97
CaO	0.02	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.03
Na_2O	0.48	0.45	0.80	0.79	0.76	0.78	0.71	0.37	0.40
K_2O	8.26	8.72	7.75	7.74	8.00	8.16	7.95	8.67	9.07
H_2O^+									
F	1.21	1.38	1.57	1.51	1.49	2.14	1.46	1.60	1.64
Cl	0.03	0.00	0.00	0.02	0.02	0.01	0.02	0.02	0.03
Total	95.93	97.12	96.99	95.59	95.50	97.64	96.51	96.87	97.19
Cations on the basis of 11 oxygens									
Si	2.664	2.701	2.659	2.683	2.720	2.693	2.674	2.682	2.725
Al^{IV}	1.069	1.044	1.077	1.067	1.043	1.031	1.070	1.049	1.023
Al^{VI}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ti	0.535	0.488	0.508	0.512	0.464	0.456	0.494	0.473	0.434
Fe^{3+}	0.456	0.437	0.474	0.489	0.452	0.484	0.456	0.439	0.415
Fe^{2+}	0.295	0.302	0.166	0.158	0.273	0.083	0.247	0.271	0.275
Mn	0.007	0.005	0.005	0.006	0.007	0.006	0.006	0.005	0.008
Mg	1.680	1.718	1.820	1.770	1.735	1.924	1.768	1.793	1.816
Ca	0.001	0.002	0.000	0.000	0.002	0.000	0.000	0.000	0.002
Na	0.069	0.062	0.110	0.111	0.107	0.107	0.099	0.052	0.056
K	0.769	0.802	0.705	0.715	0.744	0.732	0.731	0.797	0.831
Total	7.544	7.563	7.526	7.511	7.548	7.516	7.544	7.561	7.585
$Mg^{\#}$	69	70	74	73	71	77	72	72	72

TABLE DR3. CONTINUED

Sample	13ZB47-2	phonolite				
Mineral	Phl	Phl	Phl	Phl	Phl	Phl
Spots	1	2	3	4	5	6
SiO_2	34.79	36.62	36.16	35.27	35.67	35.24
TiO_2	6.94	5.37	5.37	8.31	8.39	8.53
Al_2O_3	14.65	13.92	13.52	13.96	14.48	14.09
Fe_2O_3						
FeO	16.27	13.81	13.23	13.72	11.45	12.72
MnO	0.46	0.41	0.52	0.48	0.12	0.43
MgO	13.24	15.50	15.83	13.04	15.52	13.13
CaO	0.03	0.05	0.02	0.05	0.02	0.44
Na_2O	1.35	0.82	0.79	0.66	0.79	0.67
K_2O	8.26	8.87	8.79	8.56	8.70	8.55
H_2O^+						
F	3.42	3.95	4.47	3.35	3.33	3.15
Cl	0.01	0.08	0.02	0.01		0.01
Total	98.01	97.86	96.86	96.11	97.16	95.72
Cations on the basis of 11 oxygens						
Si	2.523	2.620	2.602	2.578	2.548	2.579
Al^{IV}	1.252	1.174	1.146	1.202	1.219	1.215
Al^{VI}	0.000	0.000	0.000	0.000	0.000	0.000
Ti	0.378	0.289	0.291	0.457	0.451	0.470
Fe^{3+}	0.444	0.486	0.517	0.577	0.534	0.574
Fe^{2+}	0.543	0.340	0.279	0.261	0.150	0.204
Mn	0.028	0.025	0.032	0.030	0.008	0.027
Mg	1.431	1.653	1.698	1.421	1.653	1.432
Ca	0.002	0.004	0.002	0.004	0.001	0.035
Na	0.189	0.114	0.110	0.094	0.110	0.094
K	0.765	0.809	0.807	0.799	0.793	0.798
Total	7.556	7.514	7.483	7.423	7.466	7.426
$Mg^{\#}$	59	67	68	63	71	65

Note: Prg, Pargasite; Phl, Phlogopite.

TABLE DR4. REPRESENTATIVE ELECTRON MICROPROBE ANALYSES OF OLIVINE IN THE GEMUCHAKA LAVAS FROM THE CENTRAL QIANGTANG BLOCK

Sample	13ZB36-1 tephrite							
Minerals	Ol	Ol	Ol	Ol	Ol	Ol	Ol	Ol
Spots	1	2	3	4	5	6	7	8
SiO_2	37.67	38.37	38.42	37.89	37.57	37.84	37.97	38.00
TiO_2	0.05			0.01	0.09		0.07	
Al_2O_3	0.03	0.05	0.05	0.05	0.01	0.02	0.04	0.03
Cr_2O_3	0.03		0.05	0.00	0.03	0.02	0.06	0.00
FeO	23.10	23.07	21.52	22.95	22.20	23.66	22.88	22.91
MnO	0.53	0.50	0.45	0.53	0.55	0.59	0.57	0.58
MgO	37.55	38.32	39.57	37.99	38.81	38.08	38.14	37.99
NiO	0.15	0.22	0.15	0.12	0.12	0.14	0.13	0.10
CaO	0.29	0.31	0.26	0.30	0.30	0.29	0.29	0.29
Total	99.56	101.07	100.63	100.12	99.80	100.73	100.29	100.09
Cations on the basis of 4 oxygens								
Si	0.993	0.996	0.993	0.993	0.985	0.988	0.992	0.995
Ti	0.001	0.000	0.000	0.000	0.002	0.000	0.001	0.000
Al	0.001	0.001	0.001	0.002	0.000	0.001	0.001	0.001
Cr	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000
Fe^{2+}	0.510	0.501	0.465	0.503	0.487	0.516	0.500	0.502
Mn	0.012	0.011	0.010	0.012	0.012	0.013	0.013	0.013
Mg	1.476	1.482	1.525	1.485	1.516	1.482	1.486	1.483
Ni	0.003	0.004	0.003	0.003	0.002	0.003	0.003	0.002
Ca	0.008	0.009	0.007	0.008	0.009	0.008	0.008	0.008
Total	3.005	3.004	3.006	3.006	3.013	3.012	3.005	3.004
Fo	73.9	74.3	76.3	74.3	75.3	73.7	74.4	74.2
Fa	25.5	25.1	23.3	25.2	24.2	25.7	25.0	25.1
$Mg^{\#}$	74	75	77	75	76	74	75	75

Note: Ol, olivine.

TABLE DR5. LA-ICP-MS TRACE ELEMENT DATA FOR ZIRCONS FROM THE GEMUCHAKA VOLCANIC ROCKS

Sample	13ZB36-2 tephrite									
Sample spot	13ZB36-2 01	13ZB36-2 02	13ZB36-2 03	13ZB36-2 04	13ZB36-2 05	13ZB36-2 06	13ZB36-2 07	13ZB36-2 08	13ZB36-2 09	13ZB36-2 10
wt.%										
SiO_2	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7
ZrO_2	68.8	64.3	67.5	65.3	64.9	65.6	68.5	67.7	67.2	62.1
ppm										
Ti	30.3	13.1	10.7	15.4	9.8	7.5	19.0	19.7	17.2	14.0
Y	480	1857	630	548	623	846	1272	99	422	1263
Nb	2.11	2.73	3.09	3.12	2.36	2.26	2.93	1.98	2.03	4.11
La	0.09	0.00	0.00	0.04	8.50	14.49	17.73	0.03	0.02	1.70
Ce	33.5	11.3	4.2	33.3	39.4	34.8	60.0	1.4	26.2	60.7
Pr	0.66	2.29	0.33	0.80	3.06	5.72	9.49	0.03	0.66	2.90
Nd	3.66	11.03	1.08	2.82	5.85	8.66	17.62	0.05	2.75	10.83
Sm	4.03	19.06	2.70	4.74	4.75	6.15	15.54	0.13	4.52	16.82
Eu	1.54	0.94	0.26	1.36	1.28	1.77	4.54	0.11	1.31	4.67
Gd	16.6	64.0	13.2	16.6	15.6	19.4	45.8	0.5	15.2	48.8
Tb	4.07	18.72	4.53	4.61	4.31	6.08	11.42	0.49	4.12	12.45
Dy	42.8	204.4	55.5	51.6	48.0	70.0	123.6	8.1	42.8	121.9
Ho	15.1	65.0	21.0	17.3	17.4	25.5	40.1	3.0	13.8	39.9
Er	62.3	260.6	90.5	75.9	83.2	124.5	170.9	14.1	58.1	166.6
Tm	14.5	53.7	19.6	16.7	20.5	30.1	37.1	3.3	12.1	35.2
Yb	133	459	185	156	215	324	344	34	118	317
Lu	23.4	71.6	30.7	27.4	40.2	60.7	58.8	6.0	20.3	53.6
Hf	6987	9316	10885	7480	7862	10354	6930	12813	7441	6762
Ta	0.86	1.27	1.20	0.92	0.56	1.17	0.80	0.82	0.78	0.76
Pb	7.08	100.53	11.85	9.30	8.15	70.76	12.13	8.34	5.46	17.04
Th	207	144	111	303	302	381	422	9	163	718
U	210	695	160	368	355	594	322	220	213	480
Age	30	583	101	31	30	200	29	240	29	30
$T_{Zr\text{-}Ti}$(°C)	862	772	752	788	744	720	810	814	800	779

TABLE DR5. CONTINUED

Sample	13ZB36-2 tephrite									
Sample spot	13ZB36-2 11	13ZB36-2 12	13ZB36-2 13	13ZB36-2 14	13ZB36-2 15	13ZB36-2 16	13ZB36-2 17	13ZB36-2 18	13ZB36-2 19	13ZB36-2 20
wt.%										
SiO_2	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7
ZrO_2	67.4	72.0	69.2	67.2	73.3	74.1	66.7	66.9	66.8	64.5
ppm										
Ti	16.8	17.4	13.3	13.8	11.8	19.4	15.9	7.7	14.1	19.8
Y	503	585	665	690	873	399	646	1519	1072	861
Nb	2.94	3.81	3.60	5.81	3.29	2.44	5.03	3.79	5.56	4.53
La	0.14	38.03	0.04	3.03	5.32	0.02	124.49	0.00	20.55	22.83
Ce	35.2	62.8	36.7	58.9	37.2	37.5	157.8	43.4	90.6	56.3
Pr	0.63	11.59	0.99	1.93	3.30	0.39	38.07	0.90	9.74	8.70
Nd	3.82	10.57	4.43	4.37	9.69	1.74	41.71	5.03	14.75	13.60
Sm	4.41	5.02	5.92	4.13	7.79	2.14	9.33	9.46	8.99	9.67
Eu	1.40	1.62	1.74	1.15	2.64	0.91	2.03	1.33	2.36	2.16
Gd	16.7	14.5	19.4	13.5	29.1	10.1	16.7	37.1	26.5	26.9
Tb	4.43	4.21	5.47	4.22	8.17	2.63	4.39	11.37	7.91	7.06
Dy	45.7	48.0	61.8	48.3	87.0	30.5	49.5	137.2	89.4	76.4
Ho	16.0	17.6	21.0	19.4	27.9	11.2	17.7	52.5	31.0	26.6
Er	67.9	82.0	90.9	96.0	118.9	53.3	85.5	238.1	143.9	117.3
Tm	15.2	19.5	20.0	23.9	25.9	12.9	20.6	54.2	33.0	25.8
Yb	141	198	191	251	244	134	210	519	330	251
Lu	24.7	36.2	34.0	47.3	42.2	26.0	40.4	92.7	57.2	44.8
Hf	7840	8427	7889	8267	8304	9060	8204	10090	7527	7873
Ta	0.87	1.13	1.06	0.89	1.01	0.58	0.73	1.29	1.02	1.05
Pb	11.72	10.88	10.96	17.49	22.84	9.34	22.52	285.99	21.57	13.65
Th	346	248	352	527	299	267	806	119	786	486
U	366	366	392	612	353	346	601	138	594	536
Age	29	27	29	29	25	29	28	2370	29	29
T_{Zr-Ti}(°C)	797	801	773	777	762	812	792	721	779	814

TABLE DR5. CONTINUED

Sample	13ZB40-2 tephrite										
Sample spot	13ZB40-2 01	13ZB40-2 02	13ZB40-2 03	13ZB40-2 04	13ZB40-2 05	13ZB40-2 06	13ZB40-2 07	13ZB40-2 08	13ZB40-2 09	13ZB40-2 10	13ZB40-2 11
wt.%											
SiO_2	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7
ZrO_2	66.3	71.1	68.6	67.4	69.8	68.0	70.6	71.2	66.5	65.1	70.5
ppm											
Ti	840.0	25.1	24.9	16.8	46.3	19.8	34.7	229.8	24.4	40.0	46.7
Y	1901	495	566	1052	470	1624	1605	790	593	1206	640
Nb	15.28	3.17	3.37	11.82	1.90	17.65	1.74	26.32	0.70	3.67	3.12
La	0.37	0.04	0.19	0.12	3.93	0.77	0.09	0.48	0.01	0.28	6.85
Ce	65.7	46.8	53.8	35.4	41.9	59.8	8.2	46.3	2.8	20.7	65.3
Pr	1.12	0.46	0.52	0.28	3.75	0.67	0.64	2.47	0.17	0.97	8.10
Nd	5.03	2.91	3.11	1.03	8.70	2.59	2.70	9.69	0.91	4.10	18.40
Sm	7.36	3.41	3.76	2.61	5.88	4.77	4.92	9.10	1.67	5.22	7.61
Eu	2.52	0.95	1.11	0.76	1.93	1.27	1.79	2.56	0.90	3.49	2.22
Gd	32.9	10.3	10.8	13.8	15.8	24.8	28.0	22.1	9.7	22.2	21.5
Tb	12.42	3.21	4.00	5.92	4.35	9.79	10.22	6.55	3.47	8.37	5.71
Dy	151.1	35.6	42.8	78.6	42.5	126.9	129.4	66.7	44.2	103.1	57.4
Ho	59.5	13.4	16.1	32.0	15.3	50.8	49.3	22.4	17.6	39.9	20.0
Er	296.5	67.2	76.3	166.9	63.4	255.5	234.9	98.5	85.5	187.0	87.0
Tm	71.6	16.4	17.9	41.9	13.5	62.1	54.6	23.2	20.3	41.4	18.1
Yb	741	167	177	443	133	646	561	221	222	403	172
Lu	137.9	32.7	33.2	85.3	23.0	118.9	111.2	39.8	46.7	72.6	29.6
Hf	10868	8657	7980	12391	7575	11882	10121	8538	9376	11514	7750
Ta	5.19	0.65	0.78	6.21	0.68	8.29	0.51	0.76	0.26	1.40	0.84
Pb	112.02	12.09	20.56	83.32	6.45	130.29	46.79	18.21	15.06	273.28	10.23
Th	714	379	464	518	134	882	182	376	45	98	275
U	1078	479	496	1088	182	1500	609	432	181	445	309
Age	162	29	30	157	30	151	206	27	228	1964	28
T_{Zr-Ti}(°C	1449	840	840	797	913	814	878	1160	837	895	915

TABLE DR5. CONTINUED

Sample	13ZB40-2 tephrite										
Sample spot	13ZB40-2 12	13ZB40-2 13	13ZB40-2 14	13ZB40-2 15	13ZB40-2 16	13ZB40-2 18	13ZB40-2 17	13ZB40-2 19	13ZB40-2 20	13ZB40-2 21	13ZB40-2 22
wt.%											
SiO_2	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7
ZrO_2	66.2	70.8	64.5	69.5	71.8	72.6	72.2	71.5	70.1	66.5	73.3
ppm											
Ti	24.0	21.7	6.9	43.9	4.8	23.7	27.0	27.4	14.8	30.9	103.4
Y	1369	1040	1810	1458	1427	3181	1771	597	2424	593	402
Nb	2.96	9.12	5.64	9.73	5.97	7.57	6.14	3.48	14.04	3.70	5.84
La	1.23	0.26	0.90	2.01	0.34	0.14	0.76	0.01	0.03	0.31	0.16
Ce	9.5	45.9	20.9	111.4	18.2	26.2	79.5	37.6	16.7	35.0	38.8
Pr	1.68	1.28	1.90	4.36	0.80	0.75	1.62	0.22	0.18	0.71	0.75
Nd	6.34	6.39	5.83	17.05	2.17	5.40	8.64	3.23	1.64	3.52	3.25
Sm	5.57	8.13	5.58	16.48	2.78	8.79	13.25	4.62	4.73	5.20	3.33
Eu	0.59	2.59	0.65	4.95	0.44	1.47	4.37	1.68	0.78	1.44	1.10
Gd	27.3	27.1	26.9	52.9	17.2	49.9	51.0	15.8	30.2	16.8	9.3
Tb	9.68	8.18	10.87	14.21	7.25	19.71	15.81	4.97	12.29	5.14	2.65
Dy	118.7	86.1	141.2	145.7	100.3	258.8	167.7	49.1	180.1	53.7	31.0
Ho	44.0	30.7	58.1	47.5	44.0	101.0	57.9	17.6	77.0	18.6	11.4
Er	205.3	140.7	293.3	197.4	234.4	503.4	250.2	81.3	391.5	80.0	53.6
Tm	45.5	31.8	68.6	40.4	58.3	115.1	52.7	18.3	93.7	17.6	12.9
Yb	441	308	686	388	598	1133	495	176	958	163	131
Lu	80.7	56.0	127.8	69.2	117.3	213.2	94.3	32.2	177.5	29.7	25.2
Hf	9996	7979	11552	11655	13218	11123	11912	8388	10917	7656	9140
Ta	1.05	0.76	1.87	1.83	2.32	1.80	1.01	0.94	4.07	0.92	1.24
Pb	26.29	13.35	56.54	337.86	49.18	103.65	155.80	7.60	57.35	12.99	8.45
Th	164	363	259	1641	271	571	777	276	249	290	267
U	413	415	593	1046	650	886	812	356	781	373	358
Age	159	28	205	246	186	184	244	29	222	29	30
T_{Zr-Ti}(°C)	835	824	712	907	682	834	848	850	784	864	1026

TABLE DR5. CONTINUED

Sample	13ZB41-3 basaltic trachyandesite									
Sample spot	13ZB41-3 01	13ZB41-3 02	13ZB41-3 03	13ZB41-3 04	13ZB41-3 05	13ZB41-3 06	13ZB41-3 07	13ZB41-3 08	13ZB41-3 09	13ZB41-3 10
wt.%										
SiO_2	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7
ZrO_2	70.9	69.0	66.3	66.8	67.0	67.9	69.2	64.7	68.1	65.6
ppm										
Ti	35.3	27.6	32.3	12.4	43.9	20.3	12.7	20.7	21.3	21.7
Y	533	642	337	569	671	438	545	807	772	687
Nb	2.15	3.69	1.29	2.57	4.42	2.08	2.49	3.50	4.61	4.61
La	0.01	0.36	0.01	3.23	0.04	0.03	0.38	0.11	0.44	0.02
Ce	26.9	46.9	45.2	30.7	59.9	63.2	76.8	228.6	127.4	117.3
Pr	0.34	0.73	0.29	2.78	0.47	0.46	0.73	3.90	1.23	0.59
Nd	3.19	3.91	1.69	6.28	3.35	2.97	3.13	20.20	5.28	4.84
Sm	4.39	5.54	3.14	2.71	5.16	3.36	4.08	15.59	6.01	6.59
Eu	1.71	1.78	1.13	0.81	1.81	1.26	1.74	5.36	2.52	2.30
Gd	17.3	19.5	11.1	9.9	17.8	13.4	13.6	33.0	19.8	17.2
Tb	4.66	5.70	2.47	3.51	5.37	3.48	3.71	7.94	5.30	5.05
Dy	49.1	58.9	27.7	42.2	55.3	34.7	41.1	69.0	60.9	50.9
Ho	16.5	19.2	10.0	17.0	20.1	11.9	15.0	21.6	20.9	18.3
Er	72.9	85.7	44.1	85.7	94.2	56.7	71.7	95.7	97.6	85.2
Tm	16.2	18.4	10.1	21.0	21.3	13.2	16.4	21.0	22.4	19.7
Yb	159	178	99	228	203	134	165	214	228	205
Lu	29.2	31.2	18.3	46.9	35.0	25.0	31.4	39.5	42.7	38.4
Hf	7420	7896	7484	10551	7563	7724	8009	6347	8028	7765
Ta	0.77	1.04	0.25	1.35	0.63	0.34	0.34	0.28	0.50	0.49
Pb	4.25	14.29	13.00	65.35	30.28	17.81	19.65	50.56	40.99	38.07
Th	120	497	400	314	1033	714	770	1803	1583	1411
U	155	513	349	658	898	498	613	1301	1034	972
Age	29	30	28	215	30	28	30	30	29	30
T_{Zr-Ti}(°C	880	851	869	766	907	817	769	819	822	824

TABLE DR5. CONTINUED

Sample	13ZB41-3 basaltic trachyandesite									
Sample spot	13ZB41-3 11	13ZB41-3 12	13ZB41-3 13	13ZB41-3 14	13ZB41-3 15	13ZB41-3 16	13ZB41-3 17	13ZB41-3 18	13ZB41-3 19	13ZB41-3 20
wt.%										
SiO_2	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7
ZrO_2	71.7	68.0	69.2	68.2	72.6	74.1	72.3	62.1	66.9	71.5
ppm										
Ti	23.2	12.4	12.2	18.0	27.2	14.6	31.1	14.4	19.2	23.9
Y	408	399	528	980	466	340	639	464	1845	533
Nb	1.70	1.46	2.42	1.11	1.83	0.47	2.38	1.22	11.71	2.86
La	90.50	0.00	0.95	1.50	2.50	0.01	0.14	0.10	0.17	0.02
Ce	348.7	52.4	19.2	55.5	57.3	19.7	56.7	43.2	562.1	42.4
Pr	59.79	0.21	1.35	2.97	2.74	0.20	0.68	0.46	6.90	0.53
Nd	97.18	2.17	3.88	14.61	7.46	0.88	4.22	3.70	35.88	2.85
Sm	13.57	2.42	1.78	14.36	4.54	1.63	5.79	4.02	28.65	4.05
Eu	2.84	1.08	0.58	5.71	1.64	0.79	1.95	1.53	9.91	1.13
Gd	15.5	8.6	8.2	38.9	13.6	6.7	19.2	12.8	64.3	12.7
Tb	3.20	2.68	2.86	9.63	3.52	2.35	5.08	3.43	16.14	3.79
Dy	32.1	28.8	37.2	91.8	39.6	27.0	51.2	36.8	142.8	44.3
Ho	11.3	10.9	15.7	29.0	13.7	10.4	18.6	13.2	45.5	16.1
Er	52.4	52.0	82.3	123.1	62.1	49.6	84.0	60.2	187.7	74.4
Tm	12.3	11.8	21.3	26.5	13.7	11.5	19.4	13.9	40.5	16.8
Yb	123	121	239	252	137	114	193	144	391	162
Lu	22.8	22.7	50.1	45.4	25.1	19.4	36.0	26.9	66.4	29.7
Hf	8513	7870	13514	6862	7615	5984	7818	7328	5639	8263
Ta	0.25	0.26	1.84	0.21	0.32	0.09	0.39	0.24	0.69	0.76
Pb	18.13	11.01	62.44	14.60	11.42	4.24	13.72	14.90	137.21	8.38
Th	476	341	270	489	369	127	476	392	5101	273
U	468	413	988	312	344	163	426	372	2889	327
Age	28	27	199	29	30	26	30	28	30	30
T_{Zr-Ti}(°C)	832	767	765	804	849	783	865	782	811	835

Note: T_{Zr-Ti}, temperature based on titanium-in-zircon thermometer (Ferry and Watson, 2007), with two parameters adapted,

Reference

Ferry, J., and Watson, E., 2007, New thermodynamic models and revised calibrations for the Ti-in-zircon and Zr-in-rutile thermometers: Contributions to Mineralogy and Petrology, v. 154, p. 429-437.

TABLE DR6. LA-ICP-MS ZIRCON U-PB DATA OF THE VOLCANIC ROCKS IN THE GEMUCKAKA AREA, CENTRAL QIANGTANG BLOCK

sample spot	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$ Ratio	1σ	$^{207}Pb/^{235}U$ Ratio	1σ	$^{206}Pb/^{238}U$ Ratio	1σ	$^{207}Pb/^{206}Pb$ (Ma) Age	1σ	$^{207}Pb/^{235}U$ (Ma) Age	1σ	$^{206}Pb/^{238}U$ (Ma) Age	1σ
13ZB36-1															
13ZB36-2 01	207	201	1.03	0.05854	0.01728	0.03761	0.01096	0.00466	0.00022	550.0	570.0	37.0	11.0	30.0	1.0
13ZB36-2 02	150	692	0.22	0.05848	0.00111	0.76384	0.01447	0.09460	0.00098	548.0	24.0	576.0	8.0	583.0	6.0
13ZB36-2 03	112	155	0.73	0.06589	0.00765	0.14391	0.01624	0.01584	0.00043	803.0	255.0	137.0	14.0	101.0	3.0
13ZB36-2 04	314	364	0.86	0.08176	0.00814	0.04557	0.00337	0.00475	0.00015	1240.0	97.0	45.0	3.0	30.5	0.9
13ZB36-2 05	314	353	0.89	0.07837	0.01150	0.04235	0.00380	0.00467	0.00015	1156.0	128.0	42.0	4.0	30.0	0.9
13ZB36-2 06	392	585	0.67	0.05346	0.00195	0.23115	0.00791	0.03158	0.00042	348.0	53.0	211.0	7.0	200.0	3.0
13ZB36-2 07	422	309	1.37	0.05278	0.01352	0.03261	0.00818	0.00448	0.00023	319.0	472.0	33.0	8.0	29.0	1.0
13ZB36-2 08	9	212	1.00	0.05352	0.00291	0.27977	0.01448	0.03791	0.00064	351.0	126.0	250.0	11.0	240.0	4.0
13ZB36-2 09	166	207	0.80	0.05697	0.01256	0.03593	0.00770	0.00457	0.00024	490.0	441.0	36.0	8.0	29.0	2.0
13ZB36-2 10	768	491	1.56	0.06225	0.00685	0.03767	0.00409	0.00466	0.00022	683.0	151.0	38.0	4.0	30.0	1.0
13ZB36-2 11	350	355	0.99	0.05591	0.01280	0.03478	0.00781	0.00451	0.00020	449.0	446.0	35.0	8.0	29.0	1.0
13ZB36-2 12	240	339	0.71	0.05744	0.01915	0.03345	0.01095	0.00422	0.00026	508.0	631.0	33.0	11.0	27.0	2.0
13ZB36-2 13	351	374	0.94	0.07352	0.01491	0.04540	0.00905	0.00448	0.00017	1028.0	447.0	45.0	9.0	29.0	1.0
13ZB36-2 14	535	594	0.90	0.05283	0.00859	0.03252	0.00519	0.00446	0.00014	322.0	336.0	32.0	5.0	28.7	0.9
13ZB36-2 15	286	323	0.88	0.04605	0.00531	0.02505	0.00260	0.00394	0.00020		229.0	25.0	3.0	25.0	1.0
13ZB36-2 16	253	315	0.80	0.06219	0.01485	0.03875	0.00903	0.00452	0.00023	681.0	499.0	39.0	9.0	29.0	1.0
13ZB36-2 17	821	586	1.40	0.05047	0.00812	0.03077	0.00489	0.00442	0.00011	217.0	326.0	31.0	5.0	28.4	0.7
13ZB36-2 18	121	134	0.90	0.15259	0.00252	9.40063	0.14902	0.44435	0.00453	2375.0	14.0	2378.0	15.0	2370.0	20.0
13ZB36-2 19	800	579	1.38	0.04608	0.00807	0.02847	0.00492	0.00448	0.00013	2.0	306.0	29.0	5.0	28.8	0.8
13ZB36-2 20	507	535	0.95	0.05389	0.00772	0.03312	0.00467	0.00446	0.00012	367.0	321.0	33.0	5.0	28.7	0.7
13ZB40-2															
13ZB40-2 01	714	1078	0.66	0.05668	0.00129	0.19927	0.00468	0.02540	0.00027	479.0	33.0	185.0	4.0	162.0	2.0
13ZB40-2 02	379	479	0.79	0.04985	0.00532	0.03049	0.00319	0.00444	0.00009	188.0	239.0	30.0	3.0	28.5	0.6
13ZB40-2 03	464	496	0.94	0.06424	0.01122	0.04193	0.00722	0.00473	0.00014	750.0	391.0	42.0	7.0	30.4	0.9
13ZB40-2 04	518	1088	0.48	0.05190	0.00154	0.17673	0.00525	0.02466	0.00027	281.0	48.0	165.0	5.0	157.0	2.0
13ZB40-2 05	134	182	0.74	0.06259	0.01922	0.04089	0.01236	0.00474	0.00025	694.0	615.0	41.0	12.0	30.0	2.0
13ZB40-2 06	882	1500	0.59	0.04809	0.00129	0.15784	0.00439	0.02370	0.00025	104.0	45.0	149.0	4.0	151.0	2.0
13ZB40-2 07	182	609	0.30	0.05140	0.00283	0.22964	0.01228	0.03240	0.00043	259.0	129.0	210.0	10.0	206.0	3.0
13ZB40-2 08	376	432	0.87	0.04605	0.00733	0.02700	0.00389	0.00425	0.00029		282.0	27.0	4.0	27.0	2.0

TABLE DR6. CONTINUED

sample spot	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$ Ratio	1σ	$^{207}Pb/^{235}U$ Ratio	1σ	$^{206}Pb/^{238}U$ Ratio	1σ	$^{207}Pb/^{206}Pb$ (Ma) Age	1σ	$^{207}Pb/^{235}U$ (Ma) Age	1σ	$^{206}Pb/^{238}U$ (Ma) Age	1σ
13ZB40-2 09	45	181	0.25	0.05498	0.00489	0.27277	0.02362	0.03598	0.00073	411.0	203.0	245.0	19.0	228.0	5.0
13ZB40-2 10	98	445	0.22	0.12095	0.00195	5.97577	0.11565	0.35608	0.00430	1970.0	18.0	1972.0	17.0	1964.0	20.0
13ZB40-2 11	275	309	0.89	0.07413	0.02115	0.04450	0.01251	0.00435	0.00021	1045.0	606.0	44.0	12.0	28.0	1.0
13ZB40-2 12	164	413	0.40	0.05057	0.00236	0.17003	0.00771	0.02491	0.00042	221.0	74.0	159.0	7.0	159.0	3.0
13ZB40-2 13	363	415	0.87	0.05879	0.01182	0.03553	0.00702	0.00438	0.00016	559.0	421.0	35.0	7.0	28.0	1.0
13ZB40-2 14	259	593	0.44	0.05062	0.00174	0.22406	0.00723	0.03231	0.00042	224.0	51.0	205.0	6.0	205.0	3.0
13ZB40-2 15	1641	1046	1.57	0.05570	0.00141	0.29927	0.00770	0.03882	0.00050	440.0	35.0	266.0	6.0	246.0	3.0
13ZB40-2 16	271	650	0.42	0.05153	0.00186	0.20786	0.00745	0.02931	0.00037	264.0	59.0	192.0	6.0	186.0	2.0
13ZB40-2 18	571	886	0.64	0.05490	0.00397	0.21872	0.01543	0.02889	0.00045	408.0	166.0	201.0	13.0	184.0	3.0
13ZB40-2 17	777	812	0.96	0.05400	0.00162	0.27726	0.00793	0.03857	0.00165	371.0	49.0	248.0	6.0	244.0	10.0
13ZB40-2 19	276	356	0.78	0.09924	0.01043	0.05504	0.00436	0.00454	0.00023	1610.0	77.0	54.0	4.0	29.0	1.0
13ZB40-2 20	249	781	0.32	0.05205	0.00161	0.25158	0.00735	0.03508	0.00048	288.0	42.0	228.0	6.0	222.0	3.0
13ZB40-2 21	290	373	0.78	0.06618	0.01330	0.04075	0.00806	0.00447	0.00016	812.0	448.0	41.0	8.0	29.0	1.0
13ZB40-2 22	267	358	0.74	0.06656	0.01157	0.04283	0.00723	0.00467	0.00019	824.0	391.0	43.0	7.0	30.0	1.0
13ZB41-3															
13ZB41-3 01	120	155	0.77	0.06944	0.01634	0.04348	0.00991	0.00454	0.00027	912.0	510.0	43.0	10.0	29.0	2.0
13ZB41-3 02	497	513	0.97	0.06597	0.00582	0.03924	0.00314	0.00466	0.00016	805.0	111.0	39.0	3.0	30.0	1.0
13ZB41-3 03	400	349	1.15	0.04605	0.00427	0.02779	0.00231	0.00438	0.00018		198.0	28.0	2.0	28.0	1.0
13ZB41-3 04	314	658	0.48	0.05231	0.00183	0.24362	0.00839	0.03389	0.00042	299.0	56.0	221.0	7.0	215.0	3.0
13ZB41-3 05	1033	898	1.15	0.05450	0.00442	0.03311	0.00231	0.00467	0.00012	392.0	111.0	33.0	2.0	30.0	0.8
13ZB41-3 06	714	498	1.43	0.07638	0.00757	0.04261	0.00347	0.00437	0.00014	1105.0	113.0	42.0	3.0	28.1	0.9
13ZB41-3 07	770	613	1.26	0.05928	0.00338	0.03735	0.00192	0.00467	0.00011	577.0	71.0	37.0	2.0	30.0	0.7
13ZB41-3 08	1803	1301	1.39	0.04605	0.00310	0.02920	0.00177	0.00460	0.00013		148.0	29.0	2.0	29.6	0.9
13ZB41-3 09	1583	1034	1.53	0.04847	0.01197	0.02980	0.00728	0.00446	0.00016	122.0	424.0	30.0	7.0	29.0	1.0
13ZB41-3 10	1411	972	1.45	0.04606	0.00554	0.02923	0.00344	0.00460	0.00011	1.0	239.0	29.0	3.0	29.6	0.7
13ZB41-3 11	476	468	1.02	0.04605	0.00890	0.02730	0.00520	0.00430	0.00014		330.0	27.0	5.0	27.7	0.9
13ZB41-3 12	341	413	0.82	0.05333	0.00983	0.03031	0.00551	0.00412	0.00013	343.0	377.0	30.0	5.0	26.5	0.8
13ZB41-3 13	270	988	0.27	0.05154	0.00146	0.22347	0.00618	0.03132	0.00033	265.0	44.0	205.0	5.0	199.0	2.0
13ZB41-3 14	489	312	1.57	0.04846	0.01023	0.02972	0.00619	0.00445	0.00015	122.0	374.0	30.0	6.0	28.6	1.0
13ZB41-3 15	369	344	1.07	0.06138	0.00610	0.03513	0.00306	0.00461	0.00019	653.0	116.0	35.0	3.0	30.0	1.0

TABLE DR6. CONTINUED

sample spot	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$ Ratio	1σ	$^{207}Pb/^{235}U$ Ratio	1σ	$^{206}Pb/^{238}U$ Ratio	1σ	$^{207}Pb/^{206}Pb$ (Ma) Age	1σ	$^{207}Pb/^{235}U$ (Ma) Age	1σ	$^{206}Pb/^{238}U$ (Ma) Age	1σ
13ZB41-3 16	127	163	0.78	0.07791	0.02193	0.04408	0.01215	0.00410	0.00023	1145.0	602.0	44.0	12.0	26.0	1.0
13ZB41-3 17	476	426	1.12	0.08722	0.00799	0.04967	0.00335	0.00465	0.00016	1365.0	77.0	49.0	3.0	30.0	1.0
13ZB41-3 18	392	372	1.05	0.04698	0.01363	0.02851	0.00814	0.00440	0.00023	48.0	480.0	29.0	8.0	28.0	1.0
13ZB41-3 19	5101	2889	1.77	0.04729	0.00174	0.03040	0.00104	0.00466	0.00006	64.0	54.0	30.0	1.0	30.0	0.4
13ZB41-3 20	273	327	0.83	0.08547	0.00945	0.04742	0.00443	0.00466	0.00017	1326.0	124.0	47.0	4.0	30.0	1.0

TABLE DR7. SUMMARY OF ARGON ISOTOPIC DATA AND AGES FOR THE VOLCANIC ROCKS IN THE GEMUCHAKA AREA, CENTRAL QIANGTANG BLOCK

Incremental heating		$^{36}Ar(a)$	$^{37}Ar(ca)$	$^{38}Ar(cl)$	$^{39}Ar(k)$	$^{40}Ar(r)$	$^{40}Ar(r)$ (%)	$^{39}Ar(k)$ (%)	Age (Ma)	± 2σ
13ZB47-4 (Kf)										
16WHA0328-003	3.0%	0.084645	0.522453	0.150070	251.487455	643.968910	96.18	6.95	28.64	0.19
16WHA0328-004	3.5%	0.700267	1.078985	0.948823	923.542990	2356.870145	91.85	25.52	28.55	0.13
16WHA0328-005	4.0%	0.455613	0.659767	0.653084	684.749620	1750.243901	92.78	18.92	28.59	0.14
16WHA0328-006	4.5%	0.059043	0.000000	0.245544	295.722380	755.722519	97.66	8.17	28.59	0.15
16WHA0328-007	5.0%	0.046644	0.000000	0.051041	134.150722	342.656904	96.05	3.71	28.57	0.25
16WHA0328-009	5.5%	0.366143	0.000000	0.587226	643.343364	1643.954930	93.75	17.78	28.58	0.13
16WHA0328-010	6.0%	0.116438	0.000000	0.139463	230.868116	591.419240	94.42	6.38	28.65	0.15
16WHA0328-011	6.6%	0.037161	0.000000	0.000000	81.468700	207.525945	94.89	2.25	28.49	0.20
16WHA0328-012	7.2%	0.015260	0.000000	0.000000	35.789946	91.013624	95.20	0.99	28.45	0.43
16WHA0328-013	8.0%	0.006143	0.000000	0.000000	54.699589	139.981260	98.63	1.51	28.62	0.25
16WHA0328-014	8.8%	0.012840	0.260530	0.000000	40.853283	105.225516	96.44	1.13	28.81	0.43
16WHA0328-016	9.6%	0.012211	0.000000	0.000000	23.898886	61.257475	94.36	0.66	28.67	0.65

J = 0.00623485 ± 0.00001559, Tp (plateau age) = 28.59 ± 0.15 Ma, Tn (normal isochron age) = 28.65 ± 0.22 Ma, Ti (inverse isochron age) = 28.62 ± 0.22 Ma

Note: Kf, potassium feldspar. The alphabet a, ca, cl and k in the parenthesis represent atmosphere, calcium, chlorinum and potassium derived argon, respectively. The 'r' represents radiogenic argon.

TABLE DR8. MAJOR (wt.%) AND TRACE (ppm) ELEMENTS FOR THE VOLCANIC ROCKS IN THE GEMUCHAKA AREA, CENTRAL QIANGTANG BLOCK

Locality	SW Daxiong Lake								
Sample	13ZB36-1	13ZB36-2	13ZB36-3	13ZB36-4	13ZB37-1	13ZB37-2	13ZB38-1	13ZB38-2	13ZB39-1
Longitude	E85°30′14″	E85°30′14″	E85°30′14″	E85°30′14″	E85°30′15″	E85°30′15″	E85°30′50″	E85°30′50″	E85°30′49″
Latitude	N33°56′57″	N33°56′57″	N33°56′57″	N33°56′57″	N33°57′01″	N33°57′01″	N33°57′25″	N33°57′25″	N33°57′08″
Classify	tephrite	tephrite	tephri-phonolite	tephrite	tephri-phonolite	tephri-phonolite	tephrite	tephrite	phono-tephrite
SiO_2	47.66	47.49	54.33	48.42	53.16	53.16	48.45	48.49	49.3
TiO_2	1.94	1.88	0.97	1.96	0.96	1	1.95	1.92	1.78
Al_2O_3	13.37	13.8	16.16	13.96	15.79	15.73	14.07	13.97	14.19
$Fe_2O_3^T$	8.68	8.54	5.94	8.61	5.85	5.87	8.7	8.56	8.36
MnO	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
MgO	7.18	6.43	2.58	6.95	2.84	2.93	6.57	6.8	6.48
CaO	9.49	8.77	5.87	8.43	6.63	6.61	8.25	8.35	8
Na_2O	3.13	3.12	3.33	3.29	2.95	2.83	3.2	3.27	3.23
K_2O	3.44	4.55	6.94	3.82	6.91	6.85	4.56	4.42	4.45
P_2O_5	1.33	1.23	0.5	1.19	0.51	0.52	1.19	1.19	1.1
L.O.I	2.7	3.09	2.38	2.34	3.36	3.49	1.95	1.98	2.09
Total	99.68	99.65	99.7	99.67	99.68	99.7	99.61	99.63	99.66
$Mg^\#$	62	60	46	62	49	50	60	61	60
K_2O/Na_2O	1.1	1.5	2.1	1.2	2.3	2.4	1.4	1.4	1.4
Quartz (q)									
Nepheline(ne)	1.0	4.2	2.3	1	2.7	1.7	2.8	3.0	1.5
Q	-1.0	-4.2	-2.3	-1.0	-2.7	-1.7	-2.8	-3.0	-1.5
Sc	14.8	13.17	13.74	13.63	6.56	5.17	13.28	13.8	13.3
V	140.6	130.4	137.5	135.7	85.6	84.4	134.2	135.3	128.4
Cr	187	209	263	268	115	125	244	248	230
Co	28.52	26.14	28.45	28.11	11.21	11.11	28.11	28.63	24.91
Ni	109	101.5	118	120.6	40.6	40.9	121	119.9	108.5
Cu	36.9	40.9	42.8	43.7	18.6	20.8	38.3	39.5	35.4
Zn	110	112	105	106	129	123	110	109	114
Ga	20.7	21.4	20.7	20.9	26.2	25.4	21.6	21.2	22
Ge	3.47	3.46	3.66	3.32	3.09	3.07	3.38	3.3	3.17
Rb	108	152	108	118	273	260	99	88	90
Sr	2546	2516	2627	2206	2908	2771	2336	2287	2242
Y	34.52	34.33	34.95	32.12	39.78	38.76	32.29	32.57	33.08
Zr	410	449	416	448	735	744	453	447	468
Nb	42.7	49.7	44.1	45.5	53.4	52.8	46.3	45.5	43.4
Cs	3.38	3.1	3.6	3.25	16.06	14.42	3.37	3.57	4.39
Ba	2573	2622	2778	2349	1919	1843	2370	2280	2259
La	200.2	203	212.9	179.9	245.8	241.9	183.7	184.1	187.8
Ce	399.5	404	425.3	357.4	442.1	436.8	356.3	362.7	364.4
Pr	46.08	45.93	48.68	40.84	47.63	46.53	41.01	41.37	41.6
Nd	173.1	169	179.7	151.1	165.3	162.2	150.8	154	152.9
Sm	24.64	23.61	25.64	21.53	22.21	22.16	21.55	22.14	21.66
Eu	5.67	5.45	5.93	5.13	5.2	5.15	5.11	5.2	5.14
Gd	16.58	16.36	17.52	14.91	16.12	16.1	15.12	15.46	15.23
Tb	1.78	1.73	1.86	1.61	1.75	1.74	1.62	1.69	1.63
Dy	8.31	8.02	8.47	7.64	8.3	8.37	7.58	7.82	7.71
Ho	1.38	1.35	1.41	1.28	1.48	1.47	1.28	1.32	1.31
Er	3.16	3.14	3.22	2.98	3.61	3.62	2.98	3.08	3.05
Tm	0.41	0.42	0.42	0.39	0.51	0.52	0.39	0.41	0.4
Yb	2.43	2.45	2.49	2.37	3.17	3.18	2.32	2.38	2.43
Lu	0.35	0.36	0.36	0.34	0.46	0.46	0.34	0.34	0.35
Hf	8.74	9.11	8.83	9.37	15.21	15.34	9.35	9.35	9.59
Ta	2.2	2.52	2.28	2.38	2.51	2.53	2.41	2.39	2.25
Pb	37.8	50	52.2	46.4	100.3	100.1	47.9	47	50.8
Th	45.4	50.8	48.9	42.1	83.7	86.2	43.6	43.3	45.3
U	6.01	6.75	6.45	6.52	10.2	9.76	6.2	6.11	7.4
δEu	0.82	0.81	0.82	0.84	0.81	0.8	0.83	0.82	0.83
T_{Zrn} (°C)	789	803	858	817	905	908	817	814	828

TABLE 3. CONTINUED

Locality	SW Daxiong lake								
Sample	13ZB39	13ZB40-1	13ZB40-2	13ZB4	13ZB41-1	13ZB41-2	13ZB41-3	13ZB41-4	13ZB41-5
Longitude	E85°30′	E85°30′46″	E85°30′46″	E85°30	E85°30′24″	E85°30′24″	E85°30′24″	E85°30′24″	E85°30′24″
Latitude	N33°57	N33°57′24″	N33°57′24″	N33°5	N33°59′12″	N33°59′12″	N33°59′12″	N33°59′12″	N33°59′12″
Classify	phono- tephrite	trachyandesite	tephrite	tephri- phonoli	basaltic trachyandesite	basaltic trachyandesite	basaltic trachyandesite	basaltic trachyandesite	trachyandesite
SiO_2	49.25	54.68	47.16	54.39	52.77	52.66	52.45	51.98	56.42
TiO_2	1.83	0.99	1.83	0.98	1.68	1.69	1.73	1.68	0.84
Al_2O_3	14.36	16.43	13.47	16.33	14.99	14.95	14.88	14.73	18.78
$Fe_2O_3^T$	8.19	5.8	8.62	5.71	7.17	7.12	7.57	7.84	4.46
MnO	0.14	0.15	0.15	0.15	0.15	0.11	0.1	0.1	0.12
MgO	6.29	2.57	7.07	2.47	3.78	3.82	3.85	3.88	1.04
CaO	8.01	5.89	9.1	5.69	8.3	7.96	7.86	7.92	2.9
Na_2O	3.23	3.24	2.93	3.65	3.61	3.76	3.13	3.47	3.41
K_2O	4.48	6.16	4.59	6.66	3.69	3.38	4.08	3.53	7.65
P_2O_5	1.09	0.5	1.34	0.51	1.04	1.05	1.04	1.04	0.25
L.O.I	2.24	2.7	2.77	2.56	2.46	2.65	2.41	3	3.29
Total	99.65	99.68	99.66	99.66	99.66	99.66	99.61	99.66	99.69
$Mg^{\#}$	60	47	62	46	51	52	50	50	32
K_2O/Na_2O	1.4	1.9	1.6	1.8	1	0.9	1.3	1	2.2
Quartz (q)		0.2			1.6	2.1	2.8	2.4	0.2
Nepheline(ne)	1.5		4.4	2.6					
Q	-1.5	0.2	-4.4	-2.6	1.6	2.1	2.8	2.4	0.2
Sc	12.75	6.42	5.31	5.01	13.15	14.69	13.05	13.88	3.32
V	133	83.7	84.3	80.8	142.9	145	140.9	144	54.9
Cr	215	144	214	111	170	171	171	254	74
Co	25.74	11.09	11.15	10.63	19.32	19.32	20.14	21.05	5.17
Ni	106.3	40.9	44.9	38.2	69.6	67.8	65.9	72	10.2
Cu	32.9	21.4	26	18	31.2	28.3	28.4	34.6	11.8
Zn	110	132	125	120	92	153	125	117	124
Ga	22.2	27.1	26.1	27.2	22	22.4	22.1	21.9	28.8
Ge	3.31	3.19	3.11	3.05	3.01	2.96	3.02	2.81	2.7
Rb	100	263	261	246	48	52	60	52	278
Sr	2425	2827	2672	2834	2117	2100	2018	2075	3286
Y	32.57	41.02	39.1	39.18	29.88	30.28	29.89	28.84	40.93
Zr	496	756	681	645	393	404	395	392	829
Nb	46.8	56.2	53.4	54.5	36.8	37.4	37.3	36.4	69.5
Cs	4.7	19.47	19.09	19.39	7.61	8.51	5.21	7.14	21.79
Ba	2318	1863	1840	1884	2060	2095	2200	2072	1087
La	186.2	253.8	245.9	245.3	163.8	159.7	157.2	158.1	241.1
Ce	359.7	452	437.6	438.8	315.9	314.6	307.8	307.5	421.4
Pr	40.9	47.88	46.66	46.54	35.85	35.78	35.03	35.05	44.18
Nd	149.1	164.3	161.4	160.3	130.9	131.7	128.2	127.9	146.9
Sm	21.38	22.19	22.04	21.91	18.69	18.75	18.63	18.24	19.6
Eu	5.15	5.18	5.19	5.06	4.47	4.48	4.5	4.39	4.59
Gd	14.89	16.04	15.99	16	13.5	13.26	13.19	12.96	14.45
Tb	1.62	1.77	1.76	1.73	1.44	1.44	1.45	1.4	1.64
Dy	7.62	8.45	8.5	8.25	6.77	6.82	6.84	6.59	8.18
Ho	1.3	1.49	1.48	1.46	1.17	1.18	1.18	1.13	1.49
Er	3.05	3.77	3.67	3.63	2.78	2.79	2.8	2.66	3.83
Tm	0.41	0.53	0.52	0.51	0.37	0.38	0.38	0.35	0.57
Yb	2.41	3.34	3.23	3.19	2.21	2.27	2.27	2.17	3.65
Lu	0.35	0.48	0.48	0.47	0.32	0.33	0.33	0.31	0.55
Hf	10.03	15	14.14	14.3	8.32	8.43	8.49	8.39	17.39
Ta	2.39	2.55	2.46	2.45	1.96	1.98	1.97	1.95	3.31
Pb	54.1	108.3	98.1	102	39.6	41.6	40	40.5	79.4
Th	48.4	91.5	89	88.2	41.6	41.2	40.8	39.8	95.4
U	7.73	12.66	11.42	6.62	3.8	2.93	4.05	3.66	6.88
δEu	0.84	0.81	0.81	0.8	0.83	0.83	0.84	0.84	0.81
T_{Zrn} (°C)	835	930	834	905	829	835	835	831	983

TABLE 3. CONTINUED

Locality	SW Daxiong lake			W Mt Shuangjian					
Sample	13ZB42-1	13ZB43-1	13ZB43-2	13ZB45-1	13ZB45-2	13ZB45-3	13ZB45-4	13ZB45-5	13ZB45-6
Longitude	E85°30′21″	E85°30′18″	E85°30′18″	E85°42′10″	E85°42′10″	E85°42′10″	E85°42′10″	E85°42′10″	E85°42′10″
Latitude	N33°59′15″	N33°59′19″	N33°59′19″	N33°54′23	N33°54′23	N33°54′23	N33°54′23	N33°54′23	N33°54′23
Classify	basaltic trachyandesit	basaltic trachyandesit	basaltic trachyandesit	tephri- phonolite	tephri- phonolite	tephri- phonolite	tephri- phonolite	tephri- phonolite	tephri- phonolite
SiO_2	52.31	53.05	53.28	54.16	55.01	55	54.53	54.81	54.59
TiO_2	1.7	1.74	1.72	0.82	0.8	0.8	0.82	0.84	0.83
Al_2O_3	15	15.15	15.21	18.5	18.94	18.63	18.65	18.76	18.56
$Fe_2O_3^T$	7.33	6.72	6.28	4.85	4.75	4.8	4.76	4.85	4.67
MnO	0.22	0.14	0.12	0.15	0.16	0.15	0.15	0.15	0.14
MgO	3.58	3.79	3.88	1.44	1.13	1.02	1.41	1.09	1.12
CaO	7.89	7.86	7.87	3.47	3.14	3.28	3.22	3.49	3.87
Na_2O	3.25	3.31	3.17	4.34	5.25	4.15	4.57	4.03	3.29
K_2O	4.08	3.56	3.86	7.8	7.39	7.54	7.3	7.09	7.49
P_2O_5	1.03	1.04	1.04	0.21	0.21	0.21	0.22	0.23	0.22
L.O.I	2.75	2.82	2.73	3.49	2.92	3.71	3.64	3.9	4.51
Total	99.64	99.68	99.66	99.65	99.69	99.71	99.68	99.69	99.77
$Mg^{\#}$	49	53	55	37	32	30	37	31	32.25
K_2O/Na_2O	1.2	1.1	1.2	1.8	1.4	1.8	1.6	1.8	2.3
Quartz (q)	2.3	4.1	3.9						
Nepheline(ne)				8.6	10.9	4.6	7.0	2.7	0.6
Q	2.3	4.1	3.9	-8.6	-10.9	-4.6	-7.0	-2.7	-0.6
Sc	12.79	14.32	14.59	2.37	2.61	2.63	1.97	2.66	2.43
V	132.4	138	138.2	58.8	56.6	61.8	55.4	55.2	56.8
Cr	166	165	196	148	111	139	128	108	68.7
Co	24.23	21.31	19.24	5.34	4.88	5.2	4.96	5.23	4.68
Ni	70.5	64.4	63.5	13.4	11.3	13.3	11.5	11.3	7.6
Cu	26.1	28.7	30	18.9	16	16.2	17	16.3	11.1
Zn	167	162	161	133	133	132	128	132	129
Ga	22	22.8	22.7	29.6	29.4	29.3	29.2	30.1	29.6
Ge	2.88	2.97	2.84	2.42	2.4	2.47	2.37	2.53	2.44
Rb	68	59	65	263	301	265	225	258	330
Sr	2015	2128	2091	2230	2325	2420	2198	2522	2598
Y	28.1	30.08	30.08	31.36	32.22	36.49	30.71	35.27	30.82
Zr	391	404	405	990	1133	1146	1127	1052	1010
Nb	37	38	37.9	65.8	68.2	68.4	67.7	67	67
Cs	6.32	7.62	6.18	12.35	26.64	13.49	13.19	14.42	15.68
Ba	2074	2158	2118	1164	1078	1192	1159	1207	1182
La	154.5	164.5	160.5	164.1	158.8	162.3	144.9	169.2	160.1
Ce	302.6	319.9	314.1	321	319.6	321	302.8	332	318.7
Pr	34.14	36.46	35.76	35.17	33.89	34.9	32.42	35.84	34.51
Nd	126.2	134.7	131.9	121.3	117	121.2	112.9	124.3	120.6
Sm	18.15	18.99	18.87	17.26	16.66	17.19	16.26	17.71	17.05
Eu	4.39	4.5	4.48	4.19	4.07	4.23	3.93	4.3	4.2
Gd	12.84	13.24	13.15	12.41	12.09	12.64	11.76	12.6	12.48
Tb	1.39	1.43	1.44	1.44	1.42	1.47	1.41	1.51	1.42
Dy	6.65	6.81	6.84	7.08	7.07	7.44	7.1	7.52	6.97
Ho	1.12	1.19	1.18	1.24	1.26	1.35	1.31	1.35	1.23
Er	2.67	2.76	2.79	3.08	3.2	3.48	3.39	3.39	3.05
Tm	0.36	0.37	0.38	0.44	0.47	0.52	0.51	0.5	0.44
Yb	2.17	2.22	2.26	2.73	2.91	3.37	3.18	3.19	2.82
Lu	0.31	0.33	0.33	0.4	0.43	0.51	0.48	0.47	0.42
Hf	8.51	8.47	8.56	18.73	19.34	20.71	20.86	19.86	20.94
Ta	1.99	2	1.99	3.13	3.11	3.14	3.13	3.17	3.21
Pb	40.6	41.7	41.6	113.5	125.9	104.4	114.1	107.9	109.1
Th	41	41.3	41.4	83.4	88.1	80.8	62.7	81.3	82.2
U	4.31	3.87	4.06	5.15	4.2	3.46	5.41	2.62	2.16
δEu	0.84	0.83	0.83	0.84	0.84	0.85	0.84	0.85	0.85
T_{Zrn} (°C)	833	843	843	982	1001	1009	1004	1000	994

TABLE 3. CONTINUED

Locality	W Mt Shuangjian			Mt Shuangjian				
Sample	13ZB46-1	13ZB46-2	13ZB46-3	13ZB47-1	13ZB47-2	13ZB47-3	13ZB47-4	13ZB47-6
Longitude	E85°44′19″	E85°44′19″	E85°44′19″	E85°44′22″	E85°44′22″	E85°44′22″	E85°44′22″	E85°44′22″
Latitude	N33°53′40″	N33°53′40″	N33°53′40″	N33°55′05″	N33°55′05″	N33°55′05″	N33°55′05″	N33°55′05″
Classify	phonolite	phonolite	phonolite	basaltic trachyandesite	phonolite	basaltic trachyanessite	trachyandesite	basaltic trachyandesitte
SiO_2	55.23	55.72	55.76	51.19	56.64	52.59	56.54	51.53
TiO_2	0.44	0.57	0.45	1.87	0.8	1.56	0.84	1.86
Al_2O_3	20.38	20.03	20.64	14.88	17.76	15.85	18.72	15.25
$Fe_2O_3^T$	3.94	4.31	3.97	7.68	4.91	6.84	4.26	7.13
MnO	0.18	0.17	0.18	0.13	0.16	0.13	0.12	0.1
MgO	0.2	0.4	0.2	4.24	1.04	3.9	1.05	4.03
CaO	1.87	2.11	1.86	7.15	3.39	6.41	2.92	6.79
Na_2O	8.2	7.54	8.1	3.61	5.59	3.45	3.23	3.99
K_2O	8	7.47	7.58	4.19	7.34	5.6	7.92	4.51
P_2O_5	0.04	0.1	0.05	1.17	0.23	0.95	0.25	1.13
L.O.I	0.98	0.98	0.86	2.92	1.37	2.38	3.28	2.67
Total	99.44	99.63	99.65	99.67	99.62	99.65	99.65	99.64
$Mg^{\#}$	8.95	15.61	9.07	52.22	29.54	53.03	32.91	52.84
K_2O/Na_2O	1	1	0.9	1.2	1.3	1.6	2.4	1.1
Quartz (q)							0.3	
Nepheline(ne)	27.2	22	25.3		10.3			
Q	-27.2	-22	-25.3	0	-10.3	0	-0.3	0
Sc	1.4	2.43	2.47	11.22	3.77	8.34	3.36	9.75
V	31.2	42.3	32.9	116.4	57.4	103.9	53.3	112.9
Cr	195.1	224.5	217.2	123.2	216.4	232.1	50.9	101.5
Co	2.57	3.53	2.76	20.05	6.16	17.99	4.88	16.34
Ni	14.6	15.7	17.8	65.6	22.6	60	8.6	52.5
Cu	20.8	23.3	24.8	29.6	29.1	36	9.7	23.9
Zn	148	146	151	122	131	118	118	139
Ga	34.9	32.7	34.8	22.7	28.5	23.6	28.7	22.8
Ge	2.08	2.19	2.11	3.11	2.68	3.07	2.7	3.13
Rb	322	302	329	49	288	93	285	49
Sr	1470	1736	1479	2909	2416	2866	3262	2819
Y	36.99	36.77	37.59	33.48	39.75	34.46	40.1	34.66
Zr	1471	1368	1479	542	889	605	839	643
Nb	78.8	74.9	78.8	47.7	66.4	52.5	69.2	51.2
Cs	24.62	20.29	24.43	6.69	17.2	4.46	20.86	20.68
Ba	312	621	318	2585	1021	2349	1093	2571
La	138.8	149.2	140.8	185.9	222.6	195.2	239.4	189.8
Ce	272.6	296.1	275	356.4	394.5	367.6	420.3	360.9
Pr	29.69	31.7	30.03	40.55	41.6	40.92	43.89	40.94
Nd	99.04	107.3	99.75	149.5	138.8	146.4	147.2	149.2
Sm	14.45	15.34	14.39	20.99	18.56	20.71	19.52	21.26
Eu	3.59	3.73	3.51	5.1	4.37	4.99	4.64	5.11
Gd	11.15	11.08	10.67	14.71	13.9	14.81	14.42	14.93
Tb	1.38	1.39	1.36	1.6	1.59	1.64	1.62	1.65
Dy	7.29	7.13	7.1	7.64	7.92	7.77	8.14	7.75
Ho	1.38	1.34	1.34	1.29	1.45	1.33	1.46	1.33
Er	3.72	3.56	3.64	3.02	3.77	3.2	3.78	3.16
Tm	0.58	0.55	0.57	0.41	0.55	0.44	0.56	0.43
Yb	3.78	3.61	3.74	2.42	3.51	2.66	3.61	2.6
Lu	0.58	0.54	0.56	0.35	0.53	0.39	0.54	0.37
Hf	26.15	24.02	25.63	10.63	17.86	12.29	17.82	12.32
Ta	3.09	3.06	3.02	2.41	3.1	2.67	3.26	2.58
Pb	152.4	91.1	139.9	53.5	92.6	56.3	72.4	70.2
Th	117.1	104.6	113.2	39.9	86.2	50.9	95	43.4
U	24.68	19.09	24.53	5.52	17.94	9.12	6.8	7.74
δEu	0.84	0.84	0.84	0.85	0.81	0.84	0.82	0.84
T_{Zrn} (°C)	1026	1023	1034	864	961	890	985	885

Note: L.O.I: Loss on Ignition; $Fe_2O_3^T$ = Total Fe_2O_3 content; $Mg^{\#} = 100 \times Mg^{2+} / (Mg^{2+} + Fe^{2+})_{mole}$; $\delta Eu = Eu_N / (Sm_N \times Gd_N)^{1/2}$; T_{Zrn} (°C), temperature based on bulk-rock geochemical compositions (Watson and Harrison, 1983). Quartz (q) and Nepheline (ne) are the results of normative mineral calculation. Q (equal to q-ne-lc-kls) is the Si-saturated index based on normative mineral calculation (in there Q=q-ne-0-0)

TABLE DR9. ND-SR ISOTOPIC COMPOSITIONS FOR THE VOLCANIC ROCKS IN THE GEMUCHAKA AREA, CENTRAL QIANGTANG BLOCK

Locality	Sample	Age(Ma)	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	2σ	$(^{87}Sr/^{86}Sr)_i$	$^{147}Sm/^{144}Nd$	$^{143}Nd/^{144}Nd$	2σ	εNd(t)	TDM(Ga)
SW Daxiong lake	13ZB36-1		0.1228	0.708122	0.000008	0.708070	0.0861	0.512335	0.000005	-5.5	0.97
SW Daxiong lake	13ZB36-2	29.58	0.1752	0.708151	0.000007	0.708076	0.0845	0.512329	0.000005	-5.6	0.97
SW Daxiong lake	13ZB36-3		0.1196	0.708094	0.000007	0.708043	0.0863	0.512337	0.000005	-5.4	0.97
SW Daxiong lake	13ZB37-1		0.2716	0.708117	0.000007	0.708001	0.0812	0.512341	0.000004	-5.3	0.93
SW Daxiong lake	13ZB38-2		0.1110	0.707841	0.000007	0.707794	0.0869	0.512358	0.000004	-5.0	0.95
SW Daxiong lake	13ZB39-1		0.1168	0.707875	0.000007	0.707825	0.0856	0.512355	0.000004	-5.1	0.95
SW Daxiong lake	13ZB40-2	28.96	0.2826	0.708117	0.000006	0.707997	0.0826	0.512324	0.000005	-5.7	0.96
SW Daxiong lake	13ZB40-3		0.2515	0.708140	0.000007	0.708033	0.0826	0.512327	0.000004	-5.6	0.96
SW Daxiong lake	13ZB41-2		0.0711	0.707829	0.000008	0.707799	0.0861	0.512362	0.000005	-5.0	0.94
SW Daxiong lake	13ZB41-3	29.45	0.0855	0.707838	0.000006	0.707802	0.0879	0.512369	0.000006	-4.8	0.95
SW Daxiong lake	13ZB41-5		0.2448	0.708379	0.000007	0.708275	0.0807	0.512334	0.000004	-5.5	0.94
SW Daxiong lake	13ZB42-1		0.0974	0.707803	0.000006	0.707762	0.0869	0.512351	0.000005	-5.2	0.96
SW Daxiong lake	13ZB43-2		0.0900	0.707824	0.000008	0.707786	0.0865	0.512356	0.000004	-5.1	0.95
W Mt Shuangjian	13ZB45-1		0.3415	0.708055	0.000007	0.707909	0.0860	0.512336	0.000004	-5.5	0.97
W Mt Shuangjian	13ZB45-3		0.3173	0.708035	0.000008	0.707900	0.0857	0.512308	0.000005	-6.0	1.01
W Mt Shuangjian	13ZB45-5		0.2957	0.708087	0.000007	0.707961	0.0861	0.512326	0.000005	-5.7	0.99
W Mt Shuangjian	13ZB46-1		0.6341	0.708310	0.000007	0.708040	0.0882	0.512354	0.000006	-5.1	0.97
W Mt Shuangjian	13ZB46-3		0.6441	0.708322	0.000007	0.708048	0.0872	0.512341	0.000005	-5.4	0.98
Mt Shuangjian	13ZB47-1		0.0487	0.707826	0.000007	0.707805	0.0849	0.512351	0.000007	-5.2	0.95
Mt Shuangjian	13ZB47-4		0.2531	0.708442	0.000007	0.708334	0.0802	0.512355	0.000011	-5.1	0.91
Mt Shuangjian	13ZB47-6		0.0504	0.707866	0.000006	0.707845	0.0861	0.512364	0.000004	-4.9	0.94

Note: $(^{87}Sr/^{86}Sr)_i = (^{87}Sr/^{86}Sr)_S - (^{87}Rb/^{86}Sr)_S \times (e^{\lambda t} - 1)$; $^{87}Rb/^{86}Sr = (Rb/Sr) \times 2.8956$; $\lambda_{Rb\text{-}Sr} = 0.0142\ Ga^{-1}$;
$(^{143}Nd/^{144}Nd)_i = (^{143}Nd/^{144}Nd)_S - (^{147}Sm/^{144}Nd)_S \times (e^{\lambda T} - 1)$; $^{147}Sm/^{144}Nd = (Sm/Nd) \times 0.60456$; $\lambda_{Sm\text{-}Nd} = 0.00654\ Ga^{-1}$;
$\varepsilon_{Nd}(t) = [(^{143}Nd/^{144}Nd)_S(t) / (^{143}Nd/^{144}Nd)_{CHUR}(t) - 1] \times 10^4$; $(^{143}Nd/^{144}Nd)_{CHUR}(t) = 0.512638 - 0.1967 \times (e^{\lambda t} - 1)$;
T_{DM} (Ga) $= 1/\lambda \times \ln\{1 + [((^{143}Nd/^{144}Nd)_S - 0.51315) / ((^{147}Sm/^{144}Nd)_S - 0.2137)]\}$.

TABLE DR10. ZIRCON HF-O ISOTOPIC DATA FOR THE VOLCANIC ROCKS FROM THE GEMUCHAKA AREA,

CENTRAL QIANGTANG BLOCK

Sample	Spots	$^{176}Yb/^{177}Hf$	$^{176}Lu/^{177}Hf$	$^{176}Hf/^{177}Hf$	2σ	$^{176}Hf/^{177}Hf_i$	$\varepsilon_{Hf}(0)$	$\varepsilon_{Hf}(t)$	2σ	T_{DM} (Ma)	T_{DM}^C (Ma)	$f_{Lu/Hf}$	t (Ma)	$\delta^{18}O$(‰)	1SE
13ZB36-2 tephrite															
	1	0.013998	0.000533	0.282665	0.000023	0.282665	-3.79	-3.13	0.80	822	1306	-0.98	30		
	2	0.021073	0.000765	0.282486	0.000021	0.282477	-10.43	2.41	0.74	1078	1386	-0.98	583		
	3	0.009884	0.000386	0.282419	0.000016	0.282419	-12.50	-10.29	0.58	1159	1813	-0.99	101	7.68	0.07
	4	0.018303	0.000703	0.282721	0.000025	0.282720	-1.83	-1.16	0.87	748	1182	-0.98	30.5		
	5	0.013725	0.000571	0.282639	0.000021	0.282638	-4.73	-4.07	0.76	860	1366	-0.98	30	7.93	0.12
	6	0.023723	0.001003	0.282618	0.000018	0.282614	-5.59	-1.20	0.64	899	1317	-0.97	200	6.75	0.08
	7	0.023958	0.000919	0.282607	0.000023	0.282607	-5.85	-5.21	0.81	912	1437	-0.97	29	8.20	0.06
	8	0.003425	0.000144	0.282371	0.000016	0.282371	-14.20	-8.93	0.58	1218	1836	-1.00	240		
	9	0.014183	0.000543	0.282657	0.000027	0.282657	-4.07	-3.44	0.96	833	1325	-0.98	29	7.79	0.06
	10	0.023026	0.000859	0.282665	0.000025	0.282664	-3.81	-3.15	0.90	829	1307	-0.97	30		
	11	0.018302	0.000708	0.282683	0.000034	0.282682	-3.18	-2.54	1.21	801	1268	-0.98	29		
	12	0.015921	0.000616	0.282649	0.000032	0.282649	-4.36	-3.77	1.15	846	1344	-0.98	27		
	13	0.018079	0.000666	0.282599	0.000034	0.282598	-6.14	-5.51	1.21	918	1455	-0.98	29		
	14	0.023196	0.000885	0.282666	0.000017	0.282665	-3.78	-3.15	0.60	829	1307	-0.97	28.7	8.07	0.08
	15	0.016229	0.000647	0.282548	0.000027	0.282548	-7.94	-7.39	0.95	988	1571	-0.98	25		
	16	0.014740	0.000577	0.282391	0.000034	0.282390	-13.50	-12.87	1.19	1205	1918	-0.98	29		
	17	0.015362	0.000604	0.282700	0.000070	0.282700	-2.55	-1.92	2.48	774	1228	-0.98	28.4		
	18	0.031005	0.001182	0.281351	0.000032	0.281298	-52.13	0.94	1.15	2668	2864	-0.96	2370		
	19	0.019576	0.000756	0.282551	0.000034	0.282551	-7.82	-7.19	1.21	986	1561	-0.98	28.8		
	20	0.015215	0.000624	0.282617	0.000029	0.282617	-5.48	-4.85	1.02	890	1414	-0.98	28.7		
13ZB40-2 tephrite															
	1	0.038971	0.001641	0.282387	0.000024	0.282382	-13.80	-10.25	0.87	1245	1858	-0.95	162	5.97	0.09
	2	0.020528	0.000813	0.282669	0.000027	0.282669	-3.65	-3.02	0.95	822	1298	-0.98	28.5		
	3	0.021225	0.000829	0.282777	0.000031	0.282776	0.16	0.82	1.10	671	1056	-0.98	30.4	7.79	0.08
	4	0.025436	0.001082	0.282410	0.000020	0.282407	-12.91	-9.47	0.72	1194	1805	-0.97	157	6.39	0.08
	5	0.016598	0.000637	0.282695	0.000022	0.282695	-2.73	-2.07	0.78	782	1239	-0.98	30		

Sample	Spots	$^{176}Yb/^{177}Hf$	$^{176}Lu/^{177}Hf$	$^{176}Hf/^{177}Hf$	2σ	$^{176}Hf/^{177}Hf_i$	$\varepsilon_{Hf}(0)$	$\varepsilon_{Hf}(t)$	2σ	T_{DM} (Ma)	T_{DM}^C (Ma)	$f_{Lu/Hf}$	t (Ma)	$\delta^{18}O$(‰)	1SE
	6	0.030226	0.001252	0.282377	0.000020	0.282374	-14.08	-10.77	0.70	1245	1882	-0.96	151		
	7	0.040631	0.001700	0.282732	0.000034	0.282725	-1.65	2.87	1.20	752	1063	-0.95	206		
	8	0.024335	0.000875	0.282411	0.000050	0.282411	-12.77	-12.18	1.75	1185	1873	-0.97	27		
	9	0.020174	0.000867	0.282663	0.000037	0.282659	-3.99	1.01	1.33	832	1198	-0.97	228		
	10	0.033330	0.001302	0.281711	0.000024	0.281663	-39.23	4.59	0.84	2179	2317	-0.96	1964		
	11	0.019577	0.000738	0.282654	0.000031	0.282654	-4.17	-3.56	1.08	841	1332	-0.98	28		
	12	0.021644	0.000880	0.282531	0.000026	0.282528	-8.63	-5.15	0.92	1018	1535	-0.97	159		
	13	0.031812	0.001226	0.282589	0.000039	0.282588	-6.50	-5.89	1.37	945	1479	-0.96	28		
	14	0.051982	0.002038	0.282742	0.000022	0.282735	-1.32	3.18	0.79	743	1042	-0.94	205		
	15	0.022315	0.000937	0.282473	0.000035	0.282469	-10.73	-5.34	1.25	1101	1614	-0.97	246		
	16	0.042108	0.001687	0.282727	0.000040	0.282722	-1.78	2.30	1.43	758	1083	-0.95	186		
	19	0.023853	0.000921	0.282665	0.000039	0.282665	-3.79	-3.15	1.39	830	1307	-0.97	29		
	20	0.050939	0.002072	0.282616	0.000028	0.282608	-5.81	-0.93	0.98	927	1317	-0.94	222		
	21	0.019829	0.000737	0.282664	0.000025	0.282663	-3.85	-3.21	0.90	828	1311	-0.98	29		
	22	0.018382	0.000745	0.282633	0.000022	0.282632	-4.95	-4.29	0.79	872	1379	-0.98	30		
13ZB41-3 basaltic trachyandesite															
	1	0.021083	0.000778	0.282628	0.000024	0.282628	-5.10	-4.47	0.86	879	1390	-0.98	29	7.73	0.09
	2	0.022474	0.000820	0.282675	0.000026	0.282674	-3.46	-2.81	0.93	815	1286	-0.98	30		
	3	0.020559	0.000770	0.282601	0.000027	0.282600	-6.08	-5.46	0.97	917	1452	-0.98	28	7.06	0.06
	4	0.023084	0.000966	0.282611	0.000020	0.282608	-5.81	-1.10	0.70	907	1322	-0.97	215		
	5	0.026705	0.000927	0.282620	0.000033	0.282619	-5.41	-4.75	1.16	894	1408	-0.97	30	8.00	0.07
	6	0.015185	0.000564	0.282631	0.000024	0.282630	-5.01	-4.40	0.84	871	1385	-0.98	28.1		
	7	0.032595	0.001176	0.282550	0.000029	0.282550	-7.86	-7.20	1.01	998	1563	-0.96	30		
	8	0.031488	0.001238	0.282646	0.000027	0.282646	-4.47	-3.82	0.96	864	1349	-0.96	29.6		
	9	0.029938	0.001185	0.282624	0.000031	0.282624	-5.25	-4.61	1.09	894	1399	-0.96	29		
	10	0.020891	0.000827	0.282605	0.000023	0.282605	-5.92	-5.27	0.80	913	1441	-0.98	29.6		
	11	0.014737	0.000589	0.282594	0.000023	0.282594	-6.31	-5.70	0.81	922	1467	-0.98	27.7		
	12	0.009677	0.000377	0.282598	0.000022	0.282598	-6.17	-5.59	0.77	912	1458	-0.99	26.5		
	13	0.016248	0.000728	0.282645	0.000018	0.282642	-4.60	-0.23	0.65	855	1254	-0.98	199		
	14	0.020295	0.000783	0.282561	0.000023	0.282561	-7.46	-6.84	0.82	973	1539	-0.98	28.6		

Sample	Spots	$^{176}Yb/^{177}Hf$	$^{176}Lu/^{177}Hf$	$^{176}Hf/^{177}Hf$	2σ	$^{176}Hf/^{177}Hf_i$	$\varepsilon_{Hf}(0)$	$\varepsilon_{Hf}(t)$	2σ	T_{DM} (Ma)	T_{DM}^C (Ma)	$f_{Lu/Hf}$	t (Ma)	$\delta^{18}O$(‰)	1SE
	15	0.012786	0.000507	0.282581	0.000021	0.282581	-6.75	-6.09	0.74	938	1493	-0.98	30		
	16	0.012267	0.000449	0.282620	0.000024	0.282619	-5.40	-4.83	0.85	883	1410	-0.99	26		
	17	0.017338	0.000680	0.282566	0.000025	0.282566	-7.30	-6.64	0.87	964	1528	-0.98	30		
	18	0.011856	0.000476	0.282571	0.000021	0.282571	-7.11	-6.50	0.75	951	1517	-0.99	28		
	19	0.073898	0.002725	0.282622	0.000025	0.282620	-5.37	-4.72	0.90	936	1406	-0.92	30		
	20	0.017340	0.000688	0.282697	0.000020	0.282697	-2.66	-2.00	0.72	780	1235	-0.98	30		

Note: $\varepsilon_{Hf}(T) = [(^{176}Hf/^{177}Hf)_Z / (^{176}Hf/^{177}Hf)_{CHUR}(t)-1] \times 10,000$;

$^{176}Hf/^{177}Hf_{CHUR}(T) = {}^{176}Hf/^{177}Hf_{CHUR}(0) - {}^{176}Lu/^{177}Hf_{CHUR} \times (e^{\lambda T} - 1)$

$T_{DM} = (1 / \lambda) \times \ln[1+(^{176}Hf/^{177}Hf_{DM} - {}^{176}Hf/^{177}Hf_Z)/(^{176}Lu/^{177}Hf_{DM} - {}^{176}Lu/^{177}Hf_Z)]$;

$T_{DM}^C = T_{DM} - (T_{DM} - T) \times [(f_C^C - f_Z) / (f_C^C - f_{DM})]$;

$f_{Lu/Hf} = {}^{176}Hf/^{177}Hf_Z / {}^{176}Lu/^{177}Hf_{CHUR}-1$,

where f_C^C, f_{Zircon} and f_{DM} are the $f_{Lu/Hf}$ values of the continental crust, zircon sample and the depleted mantle; subscript Z = analyzed zircon sample, CHUR = chondritic uniform reservoir; DM = depleted mantle; T = Zircon U-Pb age of sample; $\lambda = 1.867\times10^{-11}$ $year^{-1}$, decay constant of ^{176}Lu (Söderlund et al., 2004); $^{176}Hf/^{177}Hf_{DM} = 0.28325$; $^{176}Lu/^{177}Hf_{DM} = 0.0384$; present-day $^{176}Hf/^{177}Hf_{CHUR}(0) = 0.282772$; $^{176}Hf/^{177}Hf_{CHUR} = 0.0332$; $^{176}Hf/^{177}Hf_C^C = 0.015$.

TABLE DR11-1 MAJOR (WT. %) AND TRACE (PPM) ELEMENT DATA FOR THE INTERNATIONAL REFERENCE SAMPLES

Sample	GSR-1 value[a]	GSR-1 value[b]	GSR-2 value[a]	GSR-2 value[b]	GSR-3 value[a]	GSR-3 value[b]	BHVO-2 value[a]	BHVO-2 SD%[a]	BHVO-2 value[b]	BHVO-2 SD%[b]	W-2 value[a]	W-2 SD%[a]	W-2 value[b]	W-2 SD%[b]	AGV-2 value[a]	AGV-2 SD%[a]	AGV-2 value[b]	AGV-2 SD%[b]
SiO_2	72.47	72.83	60.78	60.62	45.28	44.64												
TiO_2	0.32	0.29	0.54	0.52	2.34	2.36												
Al_2O_3	13.64	13.4	16.22	16.17	13.45	13.83												
$Fe_2O_3^T$	2.23	2.14	4.86	4.9	13.11	13.4												
MnO	0.07	0.06	0.08	0.08	0.17	0.17												
MgO	0.42	0.42	1.71	1.72	7.7	7.77												
CaO	1.53	1.55	5.16	5.2	8.81	8.81												
Na_2O	3.12	3.13	3.9	3.86	3.29	3.38												
K_2O	5.06	5.01	1.89	1.89	2.38	2.32												
P_2O_5	0.09	0.09	0.23	0.24	0.92	0.95												
Sc							33.2	7.3	32	1	38	7.8	35.9	0.8	11.9	7.2	13	1
V							322	5.7	317	11	272	5.8	268	10	111	4.8	122	4
Cr							280	6.6	280	19	90.5	4.3	93	6	19.9	4.1	16	1
Co							44.6	5.1	45	3	44.2	4.1	45	2	14.7	3.1	16	1
Ni							116	3.5	119	7	41.8	3.9	72	4	17.2	4.4	20	1
Ga							21.3	2.3	22	2	17.7	3	18	1	19.8	2.7	20	1
Cs							0.096	4	0.1	0.01	0.888	2.4	0.92	0.07	1.17	1.6	1.2	0.1
Rb							10.2	2.7	9.11	0.04	21.2	2.7	21	1	69.3	0.4	66.3	0.5
Ba							136	1.4	131	1	171	1.1	172	7	1108	2.3	1130	11
Th							1.24	1.1	1.22	0.06	2.24	2.6	2.17	0.09	6.11	2.5	6.1	0.2
U							0.429	3.1	0.403	0.001	0.517	2.1	0.51	0.02	1.89	0.7	1.86	0.09
Pb							1.19	0.7	1.6	0.3	7.12	1.5	7.7	0.6	12.7	1.7	13.2	0.5
Nb							16.9	3.5	18.1	1	7.61	2	7.5	0.6	14.4	1.6	14.5	0.8
Ta							1.38	4.5	1.14	0.06	0.48	3.3	0.47	0.04	0.852	4.7	0.87	0.08
Sr							401	1.9	396	1	200	1.7	196	5	638	0.9	661	6
Y							25.8	2.3	26	2	22.9	1.5	22	1	19.9	1.1	19	2
Zr							173	1	172	11	93.8	1.1	92	4	226	1.5	230	4
Hf							4.17	3.1	4.36	0.14	2.48	2.9	2.45	0.18	5.31	3.4	5	0.1
La							15.7	2.4	15.2	0.1	10.7	2	10.8	0.5	38	1.7	37.9	0.04

Ce	37.9	1.4	37.5	0.2	23.6	1.1	23.4	0.7	68.5	3.1		
Pr	5.47	2	5.35	0.17	3.15	1.3	3	0.1	8.35	1.8	7.84	0.31
Nd	25.6	2.5	24.5	0.1	13.6	2.1	13	0.5	31.3	1.2	30.5	0.1
Sm	6.26	1.6	6.07	0.01	3.39	2.3	3.3	0.08	5.65	0.9	5.49	0.03
Eu	2.09	2	2.07	0.02	1.09	2.1	1.08	0.03	1.5	2.6	1.53	0.02
Gd	6.38	3	6.24	0.03	3.78	1.1	3.66	0.12	4.44	1.6	4.52	0.05
Tb	0.989	3.1	0.92	0.03	0.66	2.4	0.62	0.03	0.68	0.9	0.64	0.01
Dy	5.41	2.5	5.31	0.02	3.95	5.3	3.79	0.09	3.49	2.2	3.47	0.03
Ho	1.05	2.7	0.98	0.04	0.842	1.7	0.79	0.03	0.68	1.7	0.65	0.03
Er	2.41	1.8	2.54	0.01	2.22	1.4	2.22	0.1	1.81	2.1	1.81	0.02
Tm	0.331	1.7	0.33	0.01	0.322	3.3	0.33	0.02	0.257	6.3	0.26	0.01
Yb	1.97	2.8	2	0.01	2.11	0.8	2.05	0.04	1.56	4	1.62	0.02
Lu	0.279	3.5	0.274	0.005	0.312	4.2	0.31	0.01	0.253	5.6	0.247	0.004

Note: a-in this study; b-recommoned values (http://georem.mpch-mainz.gwdg.de/)

TABLE DR11-2 SR-ND ISOTOPIC AND COMPOSITION FOR THE INTERNATIONAL REFERENCE SAMPLES

Sample	$^{143}Nd/^{144}Nd$	StdDev (abs)	Sample	$^{87}Sr/^{86}Sr$	StdDev (abs)
Jndi-1-1	0.512087	0.000004	NBS987-1	0.710231	0.000008
Jndi-1-2	0.512103	0.000004	NBS987-2	0.710253	0.000007
Jndi-1-3	0.512098	0.000005	NBS987-3	0.710242	0.000009
Jndi-1-4	0.512097	0.000004	NBS987-4	0.710269	0.000007
Jndi-1-5	0.512090	0.000003	NBS987-5	0.710235	0.000008
Jndi-1-6	0.512092	0.000004	NBS987-6	0.710263	0.000009
Jndi-1-7	0.512093	0.000005			
Mean	0.512094		Mean	0.710249	
Recommended value[1]	0.512115		Recommoned value[2]	0.710250	

Note: 1-Tanaka, T., Togashi, S., Kamioka, H., Amakawa, H., Kagami, H., Hamamoto, T., Yuhara, M., Orihashi, Y., Yoneda, S., Shimizu, H., Kunimaru, T., Takahashi, K., Yanagi, T., Nakano, T., Fujimaki, H., Shinjo, R., Asahara, Y., Tanimizu, M., and Dragusanu, C., 2000. JNdi-1: a neodymium isotopic reference in consistency with LaJolla neodymium: Chemical Geology, v. 168, p. 279-281.
2-McArthur,J.M., 1994. Recent trends in strontium isotope stratigraphy: Terra Nova, v. 6, p. 331-358.

TABLE DR11-3 LA-ICP-MS ZIRCON U-PB DATA OF STANDARD REFERENCES 91500 AND GJ-1 IN THIS STUDY

Sample spot	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$ Ratio	1σ	$^{207}Pb/^{235}U$ Ratio	1σ	$^{206}Pb/^{238}U$ Ratio	1σ	$^{207}Pb/^{206}Pb$ (Ma) Age	1σ	$^{207}Pb/^{235}U$ (Ma) Age	1σ	$^{206}Pb/^{238}U$ (Ma) Age	1σ
Standard reference		**91500**													
1	20.9	76.7	0.27	0.0758	0.0025	1.8710	0.0578	0.1791	0.0028	1071.0	38.0	1062.0	20.0	1080.0	15.0
2	29.8	106.1	0.28	0.0739	0.0023	1.8294	0.0555	0.1792	0.0026	1056.0	38.0	1063.0	20.0	1048.0	14.0
3	26.2	95.8	0.27	0.0763	0.0024	1.8816	0.0574	0.1791	0.0026	1075.0	38.0	1062.0	20.0	1111.0	14.0
4	26.9	95.7	0.28	0.0735	0.0026	1.8188	0.0657	0.1792	0.0026	1052.0	49.0	1063.0	24.0	1016.0	14.0
5	32.2	114.3	0.28	0.0770	0.0023	1.8977	0.0520	0.1792	0.0025	1080.0	32.0	1062.0	18.0	1046.0	14.0
6	36.6	128.5	0.29	0.0728	0.0021	1.8027	0.0517	0.1792	0.0022	1046.0	38.0	1062.0	19.0	1081.0	12.0
7	28.1	101.2	0.28	0.0766	0.0024	1.8891	0.0551	0.1791	0.0026	1077.0	35.0	1062.0	19.0	1033.0	14.0
8	24.9	92.8	0.27	0.0732	0.0023	1.8113	0.0534	0.1792	0.0026	1050.0	36.0	1063.0	19.0	1095.0	14.0
9	25.5	92.4	0.28	0.0707	0.0029	1.7535	0.0716	0.1792	0.0030	1028.0	56.0	1062.0	26.0	942.0	16.0
10	33.0	115.0	0.29	0.0740	0.0034	1.8155	0.0797	0.1781	0.0025	1051.0	96.0	1056.0	29.0	1057.0	14.0
11	27.0	96.1	0.28	0.0727	0.0021	1.8032	0.0520	0.1793	0.0025	1047.0	36.0	1063.0	19.0	1048.0	14.0
12	26.1	95.1	0.27	0.0770	0.0024	1.8972	0.0570	0.1791	0.0029	1080.0	35.0	1062.0	20.0	1080.0	16.0
13	28.3	101.4	0.28	0.0773	0.0024	1.9121	0.0554	0.1789	0.0026	1085.0	35.0	1061.0	19.0	1064.0	14.0
14	26.7	96.5	0.28	0.0724	0.0022	1.7883	0.0485	0.1795	0.0026	1041.0	32.0	1064.0	18.0	1064.0	14.0
15	27.5	86.5	0.32	0.0737	0.0022	1.8205	0.0549	0.1792	0.0024	1032.0	39.0	1053.0	20.0	1063.0	13.0
16	30.6	94.2	0.33	0.0761	0.0021	1.8799	0.0532	0.1791	0.0026	1098.0	34.0	1074.0	19.0	1062.0	14.0
17	22.9	79.7	0.29	0.0764	0.0023	1.8999	0.0636	0.1793	0.0026	1106.0	44.0	1081.0	22.0	1063.0	14.0
18	26.9	86.3	0.31	0.0733	0.0023	1.8005	0.0528	0.1791	0.0028	1023.0	35.0	1046.0	19.0	1062.0	15.0
19	30.0	94.6	0.32	0.0746	0.0023	1.8456	0.0554	0.1790	0.0026	1057.0	37.0	1062.0	20.0	1061.0	14.0
20	29.4	93.4	0.31	0.0752	0.0023	1.8549	0.0513	0.1794	0.0027	1074.0	32.0	1065.0	18.0	1064.0	15.0
21	29.7	91.7	0.32	0.0753	0.0025	1.8563	0.0557	0.1791	0.0024	1077.0	39.0	1066.0	20.0	1062.0	13.0
22	30.3	95.3	0.32	0.0745	0.0025	1.8441	0.0602	0.1793	0.0025	1054.0	43.0	1061.0	22.0	1063.0	14.0
23	15.2	57.3	0.27	0.0723	0.0023	1.7818	0.0556	0.1789	0.0025	995.0	40.0	1039.0	20.0	1061.0	14.0
24	21.6	76.6	0.28	0.0775	0.0022	1.9187	0.0536	0.1794	0.0024	1133.0	34.0	1088.0	19.0	1064.0	13.0
25	22.7	81.6	0.28	0.0761	0.0023	1.8828	0.0606	0.1793	0.0027	1098.0	41.0	1075.0	21.0	1063.0	14.0
26	23.9	84.6	0.28	0.0736	0.0021	1.8176	0.0519	0.1790	0.0024	1032.0	36.0	1052.0	19.0	1062.0	13.0
Sample spot	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$	$^{207}Pb/^{235}U$	$^{206}Pb/^{238}U$	$^{207}Pb/^{206}Pb$ (Ma)	$^{207}Pb/^{235}U$ (Ma)	$^{206}Pb/^{238}U$ (Ma)	Sample spot	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$	$^{207}Pb/^{235}U$

				Ratio	1σ	Ratio	1σ	Ratio	1σ					Ratio	1σ
27	23.7	86.7	0.27	0.0749	0.0024	1.8478	0.0547	0.1790	0.0027	1066.0	36.0	1063.0	20.0	1062.0	14.0
28	23.5	87.0	0.27	0.0748	0.0024	1.8526	0.0572	0.1793	0.0026	1064.0	39.0	1064.0	20.0	1063.0	14.0
29	33.5	117.9	0.28	0.0770	0.0020	1.8783	0.0498	0.1769	0.0022	1120.0	33.0	1073.0	18.0	1050.0	12.0
30	29.5	104.2	0.28	0.0728	0.0019	1.8221	0.0480	0.1815	0.0021	1009.0	35.0	1053.0	17.0	1075.0	12.0
31	33.5	116.9	0.29	0.0757	0.0023	1.8527	0.0531	0.1767	0.0024	1088.0	36.0	1064.0	19.0	1049.0	13.0
32	26.7	96.4	0.28	0.0740	0.0021	1.8478	0.0477	0.1817	0.0025	1042.0	30.0	1063.0	17.0	1076.0	14.0
33	32.8	117.4	0.28	0.0748	0.0014	1.8702	0.0335	0.1814	0.0018	1062.0	21.0	1071.0	12.0	1075.0	10.0
34	29.5	105.4	0.28	0.0750	0.0017	1.8302	0.0392	0.1769	0.0019	1069.0	26.0	1056.0	14.0	1050.0	11.0
35	26.7	101.4	0.26	0.0764	0.0015	1.8991	0.0341	0.1807	0.0017	1106.0	21.0	1081.0	12.0	1071.0	9.0
36	31.9	114.3	0.28	0.0734	0.0013	1.8013	0.0342	0.1776	0.0019	1024.0	22.0	1046.0	12.0	1054.0	10.0
37	33.2	118.1	0.28	0.0765	0.0019	1.8907	0.0435	0.1792	0.0021	1108.0	27.0	1078.0	15.0	1063.0	12.0
38	32.5	116.2	0.28	0.0733	0.0018	1.8097	0.0410	0.1791	0.0021	1021.0	28.0	1049.0	15.0	1062.0	11.0
39	32.3	115.2	0.28	0.0755	0.0015	1.8502	0.0370	0.1778	0.0019	1081.0	23.0	1063.0	13.0	1055.0	10.0
40	31.0	111.2	0.28	0.0743	0.0015	1.8502	0.0385	0.1806	0.0018	1049.0	26.0	1064.0	14.0	1070.0	10.0
41	33.9	121.3	0.28	0.0743	0.0015	1.8361	0.0372	0.1793	0.0019	1048.0	24.0	1058.0	13.0	1063.0	10.0
42	34.3	124.4	0.28	0.0755	0.0017	1.8643	0.0423	0.1791	0.0019	1082.0	29.0	1069.0	15.0	1062.0	10.0
Standard reference GJ-1															
1	16.6	268.5	0.06	0.0636	0.0018	0.9003	0.0247	0.1029	0.0013	652.0	36.0	631.0	13.0	654.0	8.0
2	17.6	281.1	0.06	0.0588	0.0015	0.8329	0.0209	0.1025	0.0012	615.0	34.0	629.0	12.0	599.0	7.0
3	18.1	292.7	0.06	0.0573	0.0015	0.7725	0.0208	0.0978	0.0012	581.0	37.0	602.0	12.0	660.0	7.0
4	17.9	291.5	0.06	0.0612	0.0015	0.8606	0.0209	0.1017	0.0012	630.0	32.0	625.0	11.0	676.0	7.0
5	19.5	315.1	0.06	0.0583	0.0017	0.7788	0.0224	0.0964	0.0012	585.0	41.0	593.0	13.0	599.0	7.0
6	18.5	295.2	0.06	0.0621	0.0020	0.8474	0.0254	0.0990	0.0012	623.0	71.0	608.0	14.0	606.0	7.0
7	18.0	287.7	0.06	0.0580	0.0017	0.8066	0.0232	0.1006	0.0012	601.0	41.0	618.0	13.0	629.0	7.0
8	18.5	292.7	0.06	0.0572	0.0015	0.7798	0.0193	0.0987	0.0012	585.0	33.0	607.0	11.0	669.0	7.0
9	21.2	288.5	0.07	0.0596	0.0026	0.7861	0.0342	0.0962	0.0020	588.0	58.0	589.0	19.0	592.0	12.0
10	21.2	288.7	0.07	0.0650	0.0018	0.8307	0.0219	0.0929	0.0012	775.0	34.0	614.0	12.0	573.0	7.0
11	20.6	289.3	0.07	0.0625	0.0017	0.8163	0.0219	0.0942	0.0012	692.0	36.0	606.0	12.0	580.0	7.0
Sample spot	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$	$^{207}Pb/^{235}U$	$^{206}Pb/^{238}U$	$^{207}Pb/^{206}Pb$ (Ma)	$^{207}Pb/^{235}U$ (Ma)	$^{206}Pb/^{238}U$ (Ma)	Sample spot	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$	$^{207}Pb/^{235}U$
12	21.0	288.9	0.07	0.0594	0.0016	0.7675	0.0200	0.0935	0.0012	583.0	35.0	578.0	11.0	576.0	7.0

13	21.1	286.0	0.07	0.0604	0.0017	0.8003	0.0214	0.0960	0.0012	616.0	36.0	597.0	12.0	591.0	7.0
14	13.1	207.6	0.06	0.0541	0.0017	0.7266	0.0226	0.0971	0.0013	374.0	46.0	555.0	13.0	598.0	7.0
15	13.7	219.4	0.06	0.0553	0.0017	0.7436	0.0217	0.0976	0.0012	426.0	43.0	565.0	13.0	600.0	7.0
16	15.8	252.5	0.06	0.0585	0.0016	0.7865	0.0216	0.0976	0.0012	547.0	38.0	589.0	12.0	600.0	7.0
17	16.3	264.5	0.06	0.0598	0.0016	0.8386	0.0218	0.1013	0.0013	598.0	34.0	618.0	12.0	622.0	8.0
18	17.1	277.8	0.06	0.0614	0.0016	0.8289	0.0216	0.0978	0.0013	652.0	34.0	613.0	12.0	602.0	7.0
19	18.6	300.2	0.06	0.0607	0.0016	0.8284	0.0226	0.0986	0.0013	628.0	36.0	613.0	13.0	606.0	8.0
20	21.1	333.6	0.06	0.0608	0.0013	0.8012	0.0149	0.0958	0.0009	630.0	24.0	597.0	8.0	590.0	5.0
21	21.0	339.2	0.06	0.0614	0.0012	0.8172	0.0158	0.0964	0.0009	653.0	25.0	607.0	9.0	593.0	5.0
22	21.9	349.7	0.06	0.0578	0.0013	0.7882	0.0177	0.0985	0.0011	522.0	31.0	590.0	10.0	606.0	6.0
23	22.9	358.8	0.06	0.0584	0.0013	0.7701	0.0160	0.0956	0.0009	546.0	29.0	580.0	9.0	589.0	5.0
24	22.4	360.6	0.06	0.0599	0.0013	0.7958	0.0159	0.0964	0.0009	601.0	28.0	594.0	9.0	593.0	5.0
25	22.6	361.3	0.06	0.0607	0.0013	0.8062	0.0152	0.0963	0.0008	630.0	45.0	600.0	9.0	592.0	5.0

Note: The international recommended values of Harved zircon 91500 is 1062.4 ± 0.4 Ma ($^{206}Pb/^{238}U$) or 1065.4 ± 0.3 Ma ($^{207}Pb/^{206}Pb$) by TIMS (Wiedenbeck et al., 1995) and GJ-1 is 610 ± 1.7 Ma ($^{206}Pb/^{238}U$) by LA-ICPMS (Elhlou S et al., 2006); Reference: Wiedenbeck, M., Alle, P., Corfu, F., Griffin, W., Meier, M., Oberli, F., Quadt, A., Roddick, J., and Spiegel, W. 1995. Three natural zircon standards for U–Th–Pb, Lu–Hf, trace element and REE analyses: Geostandards and Geoanalytical Research, v. 19, p. 1–23.

Elhlou, S., Belousova, E., Griffin, W., Pearson, N., and O'reilly, S., 2006, Trace element and isotopic composition of GJ–red zircon standard by laser ablation: Geochimica et Cosmochimica Acta, v. 70, A158.

TABLE DR11-4 SIMS ZIRCON U-PB DATA OF STANDARD REFERENCES QINGHU IN THIS STUDY

Sample spot	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$ Ratio	1σ	$^{207}Pb/^{235}U$ Ratio	1σ	$^{206}Pb/^{238}U$ Ratio	1σ	$^{207}Pb/^{206}Pb$ (Ma) Age	1σ	$^{207}Pb/^{235}U$ (Ma) Age	1σ	$^{206}Pb/^{238}U$ (Ma) Age	1σ
Qinghu@01	490.5	1331.3	0.44	0.0486	0.9346	0.1681	1.8558	0.0251	1.6032	127.7	21.8	157.8	2.7	159.8	2.5
Qinghu@02	548.7	1189.9	0.47	0.0492	1.1527	0.1733	1.9772	0.0256	1.6064	156.4	26.8	162.3	3.0	162.7	2.6
Qinghu@03	274.5	625.4	0.38	0.0496	0.9408	0.1660	1.8837	0.0243	1.6319	176.8	21.8	156.0	2.7	154.6	2.5
Qinghu@04	484.3	942.1	0.47	0.0494	0.8928	0.1709	1.8624	0.0251	1.6345	164.9	20.7	160.2	2.8	159.9	2.6
Qinghu@05	608.9	1444.1	0.41	0.0492	0.7880	0.1686	1.7900	0.0249	1.6072	156.0	18.3	158.2	2.6	158.4	2.5

Note:The international recommended values of zircon Qinghu is 159.5 ± 0.4 Ma ($^{206}Pb/^{238}U$) (Li et al., 2013); Reference: Li, X.H., Tang, G.Q., Gong, B., Yang, Y.H., Hou, K.J., Hu, Z.C., Li, Q.L., Liu, Y., and Li, W.X., 2013, Qinghu zircon: A working reference for microbeam analysis of U–Pb age and Hf and O isotopes: Chinese Science Bulletin, v. 58, p. 4647–4654.

TABLE DR11-5 ZIRCON LU-HF ISOTOPIC DATA OF STANDARD REFERENCE GJ-1 AND MUD IN THIS STUDY

Sample	GJ-1 01	GJ-1 02	GJ-1 03	GJ-1 04	GJ-1 05	GJ-1 06	GJ-1 07	GJ-1 08	GJ-1 09	GJ-1 10	GJ-1 11	GJ-1 12	GJ-1 13
$^{176}Yb/^{177}Hf$	0.006800	0.006673	0.006600	0.006187	0.006165	0.006198	0.006037	0.006041	0.006125	0.006250	0.006079	0.005990	0.006046
$^{176}Lu/^{177}Hf$	0.000250	0.000248	0.000248	0.000247	0.000246	0.000248	0.000244	0.000243	0.000247	0.000252	0.000247	0.000244	0.000246
$^{176}Hf/^{177}Hf$	0.282005	0.281991	0.281992	0.282029	0.282005	0.281978	0.282042	0.281955	0.282017	0.282015	0.281965	0.282001	0.282000
2σ	0.000023	0.000021	0.000024	0.000020	0.000022	0.000023	0.000021	0.000021	0.000023	0.000023	0.000021	0.000022	0.000021

Sample	GJ-1 14	GJ-1 15	GJ-1 16	GJ-1 17	GJ-1 18	GJ-1 19	GJ-1 20	GJ-1 21	GJ-1 22	GJ-1 23	GJ-1 24	GJ-1 25	GJ-1 26
$^{176}Yb/^{177}Hf$	0.005994	0.006111	0.006035	0.006129	0.005895	0.006150	0.006035	0.006052	0.006039	0.006075	0.006076	0.005939	0.006080
$^{176}Lu/^{177}Hf$	0.000246	0.000248	0.000245	0.000249	0.000242	0.000250	0.000246	0.000246	0.000245	0.000246	0.000248	0.000243	0.000246
$^{176}Hf/^{177}Hf$	0.282051	0.281978	0.282042	0.282021	0.282066	0.281974	0.282032	0.282018	0.282053	0.281990	0.282008	0.282023	0.281991
2σ	0.000023	0.000024	0.000021	0.000021	0.000023	0.000021	0.000021	0.000021	0.000023	0.000022	0.000022	0.000020	0.000021

Sample	GJ-1 27	GJ-1 28	GJ-1 29	GJ-1 30	GJ-1 31	GJ-1 32	GJ-1 33	GJ-1 34	GJ-1 35	GJ-1 36	GJ-1 37	GJ-1 38	GJ-1 39
$^{176}Yb/^{177}Hf$	0.006096	0.006227	0.006125	0.005993	0.005955	0.006003	0.006062	0.006128	0.006056	0.006209	0.006232	0.006047	0.006208
$^{176}Lu/^{177}Hf$	0.000248	0.000253	0.000249	0.000243	0.000242	0.000244	0.000247	0.000249	0.000247	0.000253	0.000251	0.000243	0.000251
$^{176}Hf/^{177}Hf$	0.282023	0.282010	0.282011	0.282037	0.282003	0.282040	0.282022	0.282018	0.282003	0.281994	0.282033	0.282026	0.282011
2σ	0.000023	0.000022	0.000020	0.000021	0.000020	0.000019	0.000021	0.000022	0.000026	0.000021	0.000020	0.000020	0.000021

Sample	GJ-1 40	GJ-1 41	GJ-1 42	GJ-1 43	GJ-1 44	GJ-1 45	GJ-1 46	GJ-1 47	GJ-1 48	GJ-1 49	GJ-1 50	GJ-1 51	MUD 01
$^{176}Yb/^{177}Hf$	0.006176	0.006053	0.006099	0.006035	0.006055	0.006049	0.006036	0.006086	0.006053	0.006049	0.005986	0.005996	0.002755
$^{176}Lu/^{177}Hf$	0.000251	0.000246	0.000247	0.000246	0.000246	0.000247	0.000245	0.000247	0.000247	0.000247	0.000245	0.000243	0.000080
$^{176}Hf/^{177}Hf$	0.282040	0.282023	0.282023	0.282009	0.282071	0.282034	0.281998	0.281972	0.281995	0.281974	0.281994	0.282002	0.282505
2σ	0.000020	0.000021	0.000022	0.000022	0.000020	0.000022	0.000020	0.000022	0.000021	0.000022	0.000022	0.000022	0.000017

Sample	MUD 02	MUD 03	MUD 04	MUD 05	MUD 06	MUD 07	MUD 08	MUD 09	MUD 10	MUD 11	MUD 12	MUD 13	MUD 14
$^{176}Yb/^{177}Hf$	0.002445	0.002319	0.002444	0.002097	0.002422	0.002352	0.002272	0.002235	0.002676	0.002324	0.002308	0.002156	0.002177
$^{176}Lu/^{177}Hf$	0.000072	0.000067	0.000070	0.000067	0.000076	0.000073	0.000072	0.000071	0.000084	0.000075	0.000073	0.000069	0.000070
$^{176}Hf/^{177}Hf$	0.282511	0.282478	0.282478	0.282500	0.282509	0.282495	0.282486	0.282480	0.282473	0.282533	0.282528	0.282493	0.282540
2σ	0.000016	0.000016	0.000016	0.000017	0.000018	0.000017	0.000016	0.000015	0.000015	0.000017	0.000017	0.000017	0.000017

Sample	MUD 15	MUD 16	MUD 17	MUD 18	MUD 19	MUD 20	MUD 21	MUD 22	MUD 23	MUD 24	MUD 25	MUD 26	MUD 27
$^{176}Yb/^{177}Hf$	0.002654	0.001689	0.001786	0.002082	0.002656	0.002617	0.002111	0.002326	0.002329	0.002436	0.002420	0.002117	0.001595
$^{176}Lu/^{177}Hf$	0.000085	0.000054	0.000058	0.000067	0.000085	0.000084	0.000069	0.000075	0.000075	0.000079	0.000078	0.000069	0.000052
$^{176}Hf/^{177}Hf$	0.282535	0.282471	0.282538	0.282494	0.282508	0.282499	0.282476	0.282503	0.282462	0.282461	0.282501	0.282524	0.282487
2σ	0.000017	0.000015	0.000016	0.000016	0.000015	0.000017	0.000017	0.000016	0.000015	0.000016	0.000016	0.000016	0.000018

Sample	MUD 28	MUD 29	MUD 30	MUD 31	MUD 32	MUD 33	MUD 34	MUD 35	MUD 36	MUD 37	MUD 38	MUD 39	MUD 40
$^{176}Yb/^{177}Hf$	0.002224	0.002014	0.002235	0.002260	0.002155	0.002135	0.002051	0.001918	0.002308	0.001921	0.001823	0.001878	0.002400
$^{176}Lu/^{177}Hf$	0.000071	0.000065	0.000072	0.000073	0.000071	0.000069	0.000066	0.000062	0.000074	0.000062	0.000060	0.000061	0.000077
$^{176}Hf/^{177}Hf$	0.282509	0.282490	0.282477	0.282500	0.282521	0.282529	0.282501	0.282529	0.282514	0.282522	0.282519	0.282488	0.282471
2σ	0.000016	0.000017	0.000018	0.000019	0.000017	0.000017	0.000017	0.000016	0.000016	0.000015	0.000015	0.000015	0.000015

Sample	MUD 41	MUD 42	MUD 43	MUD 44	MUD 45	MUD 46	MUD 47	MUD 48	MUD 49	MUD 50	MUD 51	MUD 52	MUD 53
$^{176}Yb/^{177}Hf$	0.002436	0.002074	0.002425	0.002534	0.002316	0.002332	0.002444	0.002633	0.002734	0.002157	0.002337	0.001985	0.002733
$^{176}Lu/^{177}Hf$	0.000078	0.000068	0.000078	0.000081	0.000075	0.000076	0.000079	0.000085	0.000088	0.000071	0.000076	0.000064	0.000088
$^{176}Hf/^{177}Hf$	0.282492	0.282507	0.282530	0.282494	0.282522	0.282482	0.282535	0.282480	0.282497	0.282504	0.282486	0.282500	0.282501
2σ	0.000016	0.000015	0.000017	0.000015	0.000018	0.000016	0.000017	0.000016	0.000017	0.000016	0.000015	0.000015	0.000015

Sample	MUD 54	MUD 55	MUD 56	MUD 57	MUD 58	MUD 59	MUD 60	MUD 61	MUD 62	MUD 63	MUD 64	MUD 65	MUD 66
$^{176}Yb/^{177}Hf$	0.003850	0.002277	0.002253	0.003436	0.002201	0.002152	0.001942	0.002200	0.002183	0.002191	0.002217	0.002230	0.001677
$^{176}Lu/^{177}Hf$	0.000120	0.000073	0.000072	0.000108	0.000071	0.000069	0.000063	0.000071	0.000071	0.000071	0.000072	0.000073	0.000055
$^{176}Hf/^{177}Hf$	0.282523	0.282466	0.282521	0.282511	0.282506	0.282473	0.282501	0.282485	0.282527	0.282491	0.282490	0.282515	0.282501
2σ	0.000015	0.000016	0.000015	0.000017	0.000017	0.000017	0.000017	0.000017	0.000014	0.000016	0.000016	0.000018	0.000017

Sample	MUD 67	MUD 68	MUD 69	MUD 70	MUD 71	MUD 72	MUD 73	MUD 74	MUD 75	MUD 76	MUD 77	MUD 78	MUD 79
$^{176}Yb/^{177}Hf$	0.001860	0.001434	0.002094	0.001096	0.001755	0.002653	0.002406	0.002334	0.002283	0.002086	0.002113	0.001688	0.002222
$^{176}Lu/^{177}Hf$	0.000061	0.000048	0.000066	0.000035	0.000057	0.000084	0.000077	0.000075	0.000073	0.000068	0.000068	0.000055	0.000071
$^{176}Hf/^{177}Hf$	0.282516	0.282517	0.282519	0.282509	0.282520	0.282509	0.282546	0.282530	0.282490	0.282558	0.282516	0.282542	0.282510
2σ	0.000016	0.000015	0.000014	0.000015	0.000016	0.000015	0.000016	0.000015	0.000017	0.000017	0.000014	0.000016	0.000016

Sample	MUD 80	MUD 81	MUD 82	MUD 83	MUD 84	MUD 85	MUD 86	MUD 87	MUD 88	MUD 89	MUD 90	MUD 91	MUD 92

$^{176}Yb/^{177}Hf$	0.002395	0.002127	0.002456	0.002155	0.002063	0.002873	0.002586	0.002388	0.002411	0.002477	0.002375	0.002481	0.002380
$^{176}Lu/^{177}Hf$	0.000077	0.000068	0.000078	0.000069	0.000066	0.000091	0.000082	0.000075	0.000075	0.000078	0.000076	0.000079	0.000076
$^{176}Hf/^{177}Hf$	0.282526	0.282544	0.282489	0.282486	0.282508	0.282495	0.282510	0.282503	0.282510	0.282484	0.282526	0.282490	0.282509
2σ	0.000017	0.000015	0.000015	0.000015	0.000016	0.000016	0.000017	0.000016	0.000015	0.000016	0.000016	0.000014	0.000017

Sample	MUD 93	MUD 94	MUD 95	MUD 96	MUD 97	MUD 98	MUD 99
$^{176}Yb/^{177}Hf$	0.002222	0.002280	0.002077	0.002307	0.002374	0.002587	0.002462
$^{176}Lu/^{177}Hf$	0.000071	0.000073	0.000067	0.000075	0.000076	0.000083	0.000078
$^{176}Hf/^{177}Hf$	0.282504	0.282523	0.282507	0.282524	0.282506	0.282514	0.282531
2σ	0.000017	0.000016	0.000017	0.000016	0.000016	0.000016	0.000015

Note: The international recommended values of zircon values 0.282000 ± 0.000005 for GJ-1 and 0.282509 ± 0.000025 for MUD (Geng et al., 2011; Morel et al., 2008); Reference: Geng, J.Z., Li, H.K., Zhang, J., Zhou, H.Y., and Li, H.M., 2011. Zircon Hf isotope analysis by means of LA–MC–ICP–MS: Geological Bulletin of China, v. 30, p. 1508–1513. Morel, M., Nebel, O., Nebel–Jacobsen, Y., Miller, J., and Vroon, P., 2008, Hafnium isotope characterization of the GJ–1 zircon reference material by solution and laser–ablation MC–ICPMS: Chemical Geology, v. 255, p. 231–235.