

Brueseke et al. Electronic Supplementary Material

Online Resource 1 – Volume calculations, sample preparation, and analytical procedures

Sampling, sample preparation, and petrography

Field sampling of JR lava flows was focused on exposures of JR from within the MB that were accessible from maintained roads and at other locations to the west (Fig. 3). Except for where discrete rhyolite domes are present, samples were collected in a stratigraphic context from sections of JR lava flows. Areas of mineralization were avoided during sampling and samples selected for geochemical and isotopic analysis had obvious post-eruptive alteration removed prior to crushing and powdering. Samples selected for geochemical, isotopic, and geochronologic analyses were split using a Rocklabs hydraulic splitter/crusher with tungsten carbide faces. Samples were split using the “knife edge” arms and reduced to a maximum size of 2.5 x 2 x 2 cm. Weathering rinds, apparent alteration, and any contaminant were removed using a diamond tipped rock saw, silica carbide sandpaper mounted on a grinding wheel, and hand picking. Using the rock saw, thin section blanks were cut to fit standard 24 x 44 mm size and blanks were sent to Spectrum Petrographics Inc. All samples were then washed in deionized water to remove any adhering powder or contaminant. Samples were further crushed using the Rocklabs crusher and reduced until sample pieces had a diameter of <5 mm. A cone and quarter method was used to obtain a 15-20 ml aliquot of randomized sample for further pulverizing, while other aliquots were set aside for geochronology and Oxygen isotope analyses. The aliquot set aside for further powdering was reduced to a clay size fraction by a Spex Industries aluminum oxide shatterbox.

Representative samples were point counted with a target of 1,000 counts per thin section and a step interval of 1 mm. Point counting was conducted using the 10x objective and mineral counts were kept on a counter. Photographs were taken using a 4-megapixel camera mounted to a Nikon petrographic microscope, using Spot software.

Volume calculations

Jarbridge rhyolite volume estimates were obtained using ArcGIS version 9.3.1. Two National Elevation Datasets (NEDs) at one-third arc second resolution were downloaded from the seamless map server (<http://seamless.usgs.gov/>). The NEDs were mosaiced using the mosaic tool in Arc toolbox. The resultant mosaiced raster’s cell dimension was reset to 10 x 10 meters. The Geologic Map of Elko County, NV (Coats, 1987) was scanned at a 720 dots per inch resolution, and georeferenced with a

resultant error smaller than the pixel size. All map datum and projections were set to UTM North 11 zone and world grid survey (WGS) of 1984. JR outcrops were digitized by point and click at ~1:5,000 scale. Spatial analyst, an ArcGIS extension, was used to calculate volumes. The zonal statistics function of spatial analyst determines maximum and minimum surface elevations of a defined area within an NED's boundary. The defined area is established by a polygon, which is a JR outcrop (as defined by Coats, 1987 and our field work) in this case. The lowest surface elevation within a polygon is treated as the lowest elevation of JR within that outcrop. The raster calculator was used to subtract the minimum elevation value from every cell value in the NED, and a new NED titled "calculation" was created. The raster calculator works on an individual cell basis, applying a function or operation to each cell in a raster. By multiplying "calculation" by the area of a cell, a third NED, "calculation 2" was created, and this NED represented the volume of earth within that cell. Zonal statistics was used to sum the values of cells within a polygon, and the sum is treated as an estimate of erupted material. Overall, this method is similar to that used by Wiart and Oppenheimer (2005) to estimate erupted volumes of silicic magmas in the Afar.

Major and trace element analyses

Major and trace element (Ba, Rb, Sr, Co, Cr, Cu, Nb, Ni, Sc, Y, V, Zn, Zr) analyses were performed by direct current argon plasma atomic emission spectrometry (DCP-AES) at Miami University following the procedures of Katoh et al. (1999). An initial solution of nitric acid and trace solution spike was added to a 125 ml plastic bottle. Masses of solution components were recorded and later used for calculating the equivalent dilution. Processed sample powder and a lithium metaborate flux were homogenized and placed in a muffle furnace, resulting in a molten bead. The resultant molten bead was dissolved in an initial solution, resulting in a sample solution. Aliquots of sample solution were used for major and trace element analyses. Blanks were created for the major, minor and spiked solutions and run with samples, in addition to commercial external standards from the United States Geological Survey (USGS) and Japanese Geological Survey. Multi-element cassettes were used for data collection. Major element concentrations of samples were determined by peak intensity comparison with standards of known concentrations. Separate runs for phosphorous concentration were completed. Thus the % differences between accepted and reported P₂O₅ for standards in the accompanying table are much higher than the actual analytical precision for this element for unknown Jarbidge samples. Trace element concentrations were determined by standard addition. Reported concentrations were the result

of averaging three runs. Data collection and reduction was performed on specific software written for the DCP-AES at Miami University and the methods follow those of Katoh et al.(1999).

The initial solution contains ~50 grams of 5% HNO₃, spiked with 3,000 ppm Li, 10 ppm Ge, and 20 ppm Cd. Two hundred milligrams of processed sample powder was mixed with 600 milligrams (with a maximum deviation of 0.5 mg) of lithium borate (LiBO₂) flux. Sample and flux mixture were placed in a graphite crucible. The crucibles were heated at 950° C in a muffle furnace for twenty minutes. A molten bead formed and was poured into the initial solution. This solution was shaken vigorously and placed on a reciprocating table. The samples stood at ambient temperature for at least twelve hours and if any solid residue remained the mixture was unusable.

Major and Trace Element Dilution:

Approximately one g of the sample solution was added to a 60 ml plastic bottle containing ~25 grams of spiked major solution. The equation to calculate equivalent dilution is: ((mass of major solution + mass of trace aliquot)/mass of trace aliquot)*(trace aliquot mass). Externally run standards for major element analyses include AGV-2, BCR-2, BHVO-2, DNC-1, G-2, GSP-2, and SY-2, JR-3, JG-2, and BE-N. Standard measurements are within acceptable error of accepted values. Trace element concentrations were determined by standard addition. Each sample required a set of solutions, one without spike, and two with varying amounts of acid and spike. Each bottle in a set has 10.000+- 0.006 grams of the original solution added. Then the three bottles had: 0.6 ml of 5% HNO₃, 0.3 ml of HNO₃ and 0.3 ml of trace element spike, and 0.6 mL of trace solution added to them, respectively. External standards that were run are the same as those run for majors. GSP-2 was run as a trace element standard.

Data Collection and Reduction:

Data collection and reduction was done by computer software specific to Miami University Geology Department's DCP-AES. The following corrections were applied to the analyses (LeMaitre, 1976).

$$\text{Oxidation ratio: } (\text{OX}) = \text{FeO}/(\text{FeO}+\text{Fe}_2\text{O}_3) = 0.93 - 0.0042 \text{ SiO}_2 - 0.022 \text{ (Na}_2\text{O+K}_2\text{O)}$$

$$\text{Fe}_2\text{O}_3 = [0.899813(\text{OX})(\text{Fe}_2\text{O}_3^*) - 0.899813(\text{Fe}_2\text{O}_3^*)]/[-0.899813 - 0.100187(\text{OX})]$$

$$\text{FeO} = (\text{Fe}_2\text{O}_3^* - \text{Fe}_2\text{O}_3)/1.111342$$

$$\text{Nb Correction: Nb(final)} = \text{Nb(measured)} - (0.108 \times V(\text{measured}))$$

Zr Correction: CaO, Al₂O₃, and Fe₂O₃ are converted to ppm

$$\text{Zr(final)} = \text{Zr(measured)} / [((\text{Ca} + \text{Al} + \text{Fe}) / \text{Zr(measured)}) \times 0.000021 + 1.009696]$$

Rare earth element (REE) and additional trace (Cs, Ga, Pb, U, Th, Ta, Hf) analyses were performed by inductively coupled plasma mass spectrometry (ICP-MS) at Miami University. For samples selected for REE and additional trace element analyses, 50 mg of sample powder was mixed with 75 mg of flux. The flux was a 3:2 mixture by weight of sodium tetraborate and potassium carbonate. The sample:flux mixture was fused in a graphite crucible in an oven at 950°C for 30 minutes. The bead was allowed to cool in the graphite crucible and then transferred into 125 ml of 1% HNO₃ (made from doubly distilled HNO₃ and quartz distilled water) in a clean, acid-washed 125 ml low-density polyethylene bottle. Samples were dissolved overnight and the resulting solutions were analyzed the following day using a Varian ICP-MS (prototype model, referred to by Varian as the “Red Top”). External calibration standards were made using ten certified reference material rock standards prepared under identical conditions at the same time. The standard run was RGM-1. A 100 ppb solution of Ge, In, Re, and Bi was used for internal standardization. Three replicates of thirty readings each were measured for each analytical solution. Geochemical results, including measured and accepted standard concentrations, are found in the accompanying excel spreadsheet (Table DR1). Iron was split into FeO and Fe₂O₃ after LeMaitre (1976).

Oxygen isotope analyses

Quartz and feldspar separates for oxygen isotope analyses come from samples that were previously selected for REE analyses and geochronology. Previously crushed samples were sieved and the >0.5mm size fraction was hand-picked for quartz and feldspar crystals using a binocular microscope. The mineral separates were sent to the Washington State University GeoAnalytical laboratory and analyzed following the method of Sharp (1990). Liberated oxygen was measured by a Finnigan™ Delta S Isotope Ratio Mass Spectrometer operated by an ISODAT NT software operating system. The oxygen isotope values were corrected by repeated analysis of the UWG-2 garnet standard ($\delta^{18}\text{O} = \sim 5.8\text{\textperthousand}$), and analytical precision ranged from 0.05‰ to 0.22‰ (Valley et al., 1995; Takeuchi and Larson, 2005).

⁴⁰Ar/³⁹Ar geochronologic analyses

Details (overall procedures and information for individual analyses) are found in the accompanying excel spreadsheet (Table DR2).

References

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Brueseke et al - Table DR1. Major and trace element geochemistry.
Major elements reported as raw data, in wt. % and trace elements in ppm

Jarbridge Rhyolite

Sample	JC-08-7	JC-08-8	JC-08-9	JC-08-10	JC-08-12	JC-08-13
SiO₂	77.37	76.36	76.79	75.18	73.88	73.62
TiO₂	0.33	0.26	0.29	0.28	0.41	0.37
Al₂O₃	12.70	12.48	12.68	12.26	12.82	12.60
Fe₂O₃	0.80	1.00	0.77	2.11	3.25	2.31
MnO	0.01	0.00	0.00	0.02	0.02	0.03
MgO	0.02	0.02	0.03	0.06	0.07	0.06
CaO	0.73	0.69	0.84	0.98	1.28	1.43
Na₂O	2.84	2.92	3.02	2.70	3.05	2.53
K₂O	5.44	5.48	5.60	5.61	4.85	5.45
P₂O₅	0.02	0.04	0.04	0.03	0.05	0.06
LOI	0.47	0.35	0.17	1.73	0.59	1.69
Total	100.73	99.59	100.23	100.98	100.27	100.15
Sample	JC-08-7	JC-08-8	JC-08-9	JC-08-10	JC-08-12	JC-08-13
Ba	1054	535	990	721	2108	2010
Cr	2.6	3.8	<1	1.2	6.3	3.3
Cu	5.8	3.5	3.8	7.5	8.4	10
Nb	22	25	29	21	23	26
Ni	1.9	21	3.7	7.8	9.3	<1
Rb	176	222	201	210	132	163
Sr	94	49	84	68	173	158
Sc	5.7	4.1	4.6	6.0	7.5	8.0
V	2.8	1.7	<1	21	15	5.9
Y	44	33	29	45	21	41
Zn	51	73	93	70	90	98
Zr	323	375	353	372	372	387
Co				0.6		
Ga				20.6		
Cs				2.8		
Hf				11.4		
Ta				2.0		
W				1.8		
Pb				19.0		
Th				33.8		
U				8.1		
La				94.5		
Ce				171.0		
Pr				18.2		
Nd				64.9		
Sm				11.6		
Eu				0.8		
Gd				10.6		
Tb				1.5		
Dy				8.0		
Ho				1.6		
Er				4.6		
Tm				0.7		
Yb				4.5		
Lu				0.7		

UTM coordinates (all zone 11T, NAD 27 CONUS datum)

Northing	628071	627098	627195	627116	626200	626014
Easting	4631772	4631662	4631813	4631561	4627812	4627777

Jarbridge Rhyolite

Sample	JC-08-20	JC-08-24	JC-08-25	JC-08-26	JC-09-2	JC-09-3
SiO₂	76.38	74.79	76.08	77.23	74.25	75.32
TiO₂	0.38	0.36	0.18	0.22	0.28	0.28
Al₂O₃	12.50	13.52	13.07	12.53	11.85	12.38
Fe₂O₃	1.74	1.36	1.41	0.78	2.77	1.31
MnO	0.02	0.01	0.02	0.00	0.03	0.01
MgO	0.04	0.06	0.04	0.02	0.10	0.02
CaO	1.17	1.41	0.80	0.63	0.98	0.71
Na₂O	3.01	2.96	2.59	2.87	2.84	2.92
K₂O	4.89	5.52	5.58	5.64	5.14	5.44
P₂O₅	0.07	0.07	0.03	0.01	0.03	0.04
LOI	0.40	0.27	0.60	0.28	0.59	0.24
Total	100.62	100.33	100.41	100.22	98.85	98.66
Sample	JC-08-20	JC-08-24	JC-08-25	JC-08-26	JC-09-2	JC-09-3
Ba	1894	1834	560	760	888	759
Cr	3.0	4.9	2.0	5.3	2.9	2.2
Cu	5.8	4.5	5.7	3.2	6.0	2.9
Nb	26	20	23	19	23	22
Ni	7.7	5.7	0.8	2.0	23	22
Rb	137	171	239	188	180	188
Sr	156	188	77	70	71	59
Sc	5.4	5.7	5.7	5.1	4.7	4.1
V	3.0	11	9.9	7.5	<1	<0
Y	32	30	58	39	76	34
Zn	71	59	48	48	72	65
Zr	385	305	223	258	405	417
Co	0.9	1.1	1.0			
Ga	20.2	22.3	22.7			
Cs	1.5	1.5	1.8			
Hf	11.1	10.8	7.9			
Ta	1.5	1.4	1.6			
W	4.0	2.6	2.1			
Pb	16.5	18.2	22.1			
Th	22.9	18.3	28.5			
U	4.8	3.9	5.4			
La	75.2	83.6	110.0			
Ce	139.0	157.0	209.0			
Pr	14.9	18.0	24.6			
Nd	53.9	65.0	89.9			
Sm	9.7	11.7	16.9			
Eu	2.0	1.9	0.8			
Gd	8.8	9.8	14.8			
Tb	1.2	1.3	2.0			
Dy	6.2	6.6	10.9			
Ho	1.2	1.2	2.1			
Er	3.5	3.5	6.0			
Tm	0.5	0.5	0.8			
Yb	3.5	3.2	5.6			
Lu	0.5	0.5	0.8			

UTM coordinates (all zone 11T, NAD 27 CONUS datum)

Northing	624540	591852	602571	601145	627259	627007
Easting	4606260	4619700	4620752	4613113	4628256	4628072

Jarbridge Rhyolite

Sample	JC-09-4	JC-09-5	JC-09-6	JC-09-8	JC-09-9	JC-09-10B
SiO₂	76.02	75.95	76.54	77.00	76.77	71.30
TiO₂	0.25	0.24	0.24	0.17	0.30	0.41
Al₂O₃	12.27	12.31	12.66	11.92	12.21	12.73
Fe₂O₃	0.93	1.96	1.34	0.58	1.91	3.44
MnO	0.00	0.02	0.01	0.00	0.01	0.05
MgO	0.01	0.05	0.02	0.02	0.03	0.13
CaO	0.69	0.83	0.66	0.69	0.71	1.70
Na₂O	2.93	2.97	2.91	2.99	2.82	2.67
K₂O	5.50	5.36	5.56	5.37	5.33	5.32
P₂O₅	0.04	0.02	0.03	0.03	0.03	0.09
LOI	0.25	0.23	0.33	0.26	0.31	1.87
Total	98.88	99.94	100.31	99.02	100.42	99.71
Sample	JC-09-4	JC-09-5	JC-09-6	JC-09-8	JC-09-9	JC-09-10B
Ba	532	527	388	408	943	2235
Cr	9.1	2.5	<1	3.4	11	8.2
Cu	3.3	5.6	2.2	2.4	6.0	6.3
Nb	25	25	17	27	20	19
Ni	14	24	13	11	20	24
Rb	243	241	167	254	184	131
Sr	47	46	35	42	69	164
Sc	3.3	3.8	2.7	2.9	4.7	6.4
V	<1	<1	<1	<1	4.0	<1
Y	33	46	23	43	33	38
Zn	62	57	37	65	61	81
Zr	387	397	279	306	408	434
Co	0.6			0.5		3.9
Ga	20.7			20.7		20.6
Cs	2.7			2.6		1.9
Hf	10.7			9.1		11.0
Ta	2.2			2.4		1.4
W	3.4			4.1		1.7
Pb	25.6			26.2		17.7
Th	37.7			40.9		20.0
U	9.0			9.0		3.9
La	85.7			103.0		76.8
Ce	129.0			168.0		136.0
Pr	16.4			19.0		14.8
Nd	56.9			64.7		54.2
Sm	10.1			11.4		10.0
Eu	0.6			0.5		2.4
Gd	8.7			9.8		9.1
Tb	1.2			1.3		1.3
Dy	6.4			7.2		7.0
Ho	1.2			1.4		1.4
Er	3.7			4.2		4.1
Tm	0.5			0.6		0.6
Yb	3.7			4.2		4.1
Lu	0.5			0.6		0.6

UTM coordinates (all zone 11T, NAD 27 CONUS datum)

Northing	626884	626646	626594	627427	627089	626907
Easting	4627950	4627924	4627936	4616651	4617012	4617098

Jarbridge Rhyolite

Sample	JC-09-11	JC-09-12	JC-09-14	JC-09-15	JC-09-16	JC-09-17
SiO₂	72.91	71.59	72.99	72.69	73.42	75.49
TiO₂	0.43	0.41	0.37	0.46	0.21	0.26
Al₂O₃	13.45	13.19	12.30	13.62	11.89	12.19
Fe₂O₃	2.99	2.66	3.77	1.69	1.99	1.85
MnO	0.02	0.03	0.01	0.01	0.02	0.01
MgO	0.04	0.05	0.08	0.03	0.05	0.04
CaO	1.29	1.59	1.00	1.54	0.88	0.74
Na₂O	3.22	2.98	2.74	2.89	2.33	2.91
K₂O	5.06	5.19	4.97	5.41	5.64	5.48
P₂O₅	0.09	0.08	0.07	0.11	0.03	0.08
LOI	0.39	1.60	0.64	0.28	2.39	0.54
Total	99.89	99.37	98.94	98.72	98.85	99.58
Sample	JC-09-11	JC-09-12	JC-09-14	JC-09-15	JC-09-16	JC-09-17
Ba	2433	2414	1966	2715	743	565
Cr	5.3	5.9	4.4	6.4	5.6	<1
Cu	7.1	6.4	6.5	5.3	4.2	4.8
Nb	21	23	21	27	18	24
Ni	18	21	22	32	16	18
Rb	140	139	161	133	198	229
Sr	177	186	142	328	59	55
Sc	6.8	6.9	6.3	8.4	4.3	3.9
V	<1	<1	<1	3.7	<1	<1
Y	44	40	37	52	42	56
Zn	67	96	73	92	58	65
Zr	492	454	509	660	324	405
Co				0.8		0.9
Ga				22.7		20.9
Cs				0.9		2.1
Hf				16.7		11.2
Ta				1.7		2.2
W				3.1		2.1
Pb				13.2		26.4
Th				11.0		37.0
U				2.9		7.6
La				90.6		122.0
Ce				172.0		194.0
Pr				20.7		25.2
Nd				78.9		90.8
Sm				15.2		16.7
Eu				3.6		0.7
Gd				13.2		15.1
Tb				1.8		2.0
Dy				9.6		10.5
Ho				1.8		1.9
Er				5.3		5.6
Tm				0.7		0.8
Yb				5.1		5.2
Lu				0.8		0.7

UTM coordinates (all zone 11T, NAD 27 CONUS datum)

Northing	626811	626785	626417	601263	598102	608066
Easting	4617104	4617085	4617462	4600283	4615934	4631173

Jarbridge Rhyolite

Sample	JC-09-18	JC-09-21A	JC-09-21B	JC-09-22
SiO₂	72.42	74.61	75.33	76.39
TiO₂	0.24	0.33	0.31	0.37
Al₂O₃	12.53	13.84	13.42	11.83
Fe₂O₃	2.15	1.25	1.17	1.42
MnO	0.03	0.01	0.01	0.01
MgO	0.05	0.05	0.05	0.05
CaO	0.85	1.21	1.10	0.95
Na₂O	2.73	2.97	2.86	2.79
K₂O	6.02	5.50	5.52	5.01
P₂O₅	0.06	0.07	0.07	0.08
LOI	2.13	0.34	0.48	0.33
Total	99.21	100.17	100.30	99.24

Sample	JC-09-18	JC-09-21A	JC-09-21B	JC-09-22
Ba	516	1597	1581	1798
Cr	1.0	3.7	3.0	4.2
Cu	8.2	3.7	3.2	4.0
Nb	22	22	19	22
Ni	21	10	13	19
Rb	229	184	180	155
Sr	45	173	165	131
Sc	4.0	6.6	6.0	4.1
V	1.2	5.7	3.6	3.2
Y	48	39	39	31
Zn	81	57	61	74
Zr	380	360	338	441
Co		1.0		
Ga		22.6		
Cs		1.6		
Hf		9.7		
Ta		1.4		
W		1.6		
Pb		16.1		
Th		18.5		
U		3.8		
La		94.3		
Ce		175.0		
Pr		20.1		
Nd		73.1		
Sm		13.6		
Eu		1.9		
Gd		11.5		
Tb		1.5		
Dy		8.0		
Ho		1.5		
Er		4.3		
Tm		0.6		
Yb		4.0		
Lu		0.6		

UTM coordinates (all zone 11T, NAD 27 CONUS datum)

Northing	607886	599562	599562	666387
Easting	4630336	4621420	4621420	4548547

Seventy-Six Basalt

Sample	JC-08-14	JC-08-15	JC-08-16	JC-09-19	JC-09-20
SiO₂	48.57	48.51	48.67	50.70	50.38
TiO₂	1.83	1.80	1.83	1.89	1.90
Al₂O₃	18.08	18.08	18.14	16.12	15.86
Fe₂O₃	11.41	11.31	11.17	13.37	13.04
MnO	0.17	0.17	0.17	0.18	0.19
MgO	4.20	4.36	4.07	5.60	5.27
CaO	8.24	8.12	8.19	7.93	8.26
Na₂O	3.89	3.63	3.80	3.04	2.85
K₂O	1.44	1.66	1.41	1.25	1.15
P₂O₅	0.52	0.51	0.52	0.47	0.46
LOI	0.76	0.92	0.48	0.20	0.66
Total	99.11	99.06	98.46	100.76	100.04
					100.08
Sample	JC-08-14	JC-08-15	JC-08-16	JC-09-19	JC-09-20
Ba	717	705	730	727	688
Cr	21.3	27.2	26.4	61.4	59.1
Cu	25.3	26.2	24.8	36.4	32.9
Nb					
Ni	19.9	21.8	192	35.4	34.1
Rb	27.7	41.9	28.0	11.1	20.4
Sr	566	602	582	421	409
Sc	22.5	22.7	21.3	31.8	29.3
V	102	103	101	166	155
Y	36.3	36.9	36.3	44.9	40.1
Zn	82	123	140	137	126
Zr	192	232	212	281	272
Co	32.9		44.7		
Ga	20.8		22.0		
Cs	0.7		0.5		
Hf	5.1		6.8		
Ta	1.4		1.3		
W	1.0		1.7		
Pb	0.9		2.3		
Th	2.1		2.6		
U	0.5		0.7		
La	32.6		40.9		
Ce	66.9		83.1		
Pr	8.2		9.8		
Nd	34.8		40.9		
Sm	7.7		9.2		
Eu	2.2		2.4		
Gd	7.4		8.8		
Tb	1.1		1.4		
Dy	6.6		8.0		
Ho	1.3		1.6		
Er	3.7		4.6		
Tm	0.5		0.6		
Yb	3.6		4.5		
Lu	0.5		0.7		

UTM coordinates (all zone 11T, NAD 27 CONUS datum)

Northing	628096	628219	628045	603659	598310
Easting	4623553	4623475	4623126	4623693	4625109

DCP major element standard data

Sample	measured			accepted			measured BCR-2	accepted BCR-2			% difference	measured BHVO-2	accepted BHVO-2			% difference	measured GSP-2	accepted GSP-2			% difference	measured JR-3	accepted JR-3			% difference
	AGV-2	accepted	% difference	BCR-2	accepted	% difference		BHVO-2	accepted	BHVO-2			BHVO-2	accepted	BHVO-2			GSP-2	accepted	% difference	JR-3	accepted	% difference	JR-3	accepted	% difference
SiO ₂	60.49	59.30	2.0	54.39	54.10	0.53	50.03	49.90	0.3	66.98	66.60	0.6	73.17	72.48	1.0											
TiO ₂	1.05	1.05	0.0	2.26	2.26	0.04	2.73	2.73	0.1	0.67	0.66	0.9	0.21	0.21	0.5											
Al ₂ O ₃	17.06	16.91	0.9	13.36	13.50	1.04	13.51	13.50	0.1	14.76	14.90	0.9	11.94	12.00	0.5											
Fe ₂ O ₃	6.79	6.69	1.5	13.70	13.80	0.71	12.36	12.30	0.5	4.84	4.90	1.3	4.65	4.74	1.9											
MnO	0.10	0.10	0.0	0.20	0.20	0.00	0.17	0.17	2.4	0.04	0.04	0.0	0.08	0.08	3.6											
MgO	1.78	1.79	0.8	3.60	3.59	0.31	7.04	7.23	2.7	0.95	0.96	0.7	0.05	0.05	3.9											
CaO	5.16	5.20	0.9	7.12	7.12	0.01	11.43	11.40	0.2	2.12	2.10	0.8	0.16	0.16	46.3											
Na ₂ O	4.20	4.19	0.2	3.10	3.16	1.79	2.22	2.22	0.1	2.76	2.78	0.8	4.71	4.69	0.5											
K ₂ O	2.96	2.88	2.8	1.79	1.79	0.11	0.51	0.52	1.7	5.35	5.38	0.5	4.23	4.31	1.8											
P ₂ O ₅	0.06	0.48	156.2	0.22	0.35	47.79	0.10	0.27	90.3	0.35	0.29	19.0	0.17	0.01	179.3											
Total	100.08	98.59	1.5	99.74	99.87	0.14	100.36	100.24	0.1	98.82	98.61	0.2	99.38	98.67	0.7											

ICP-MS trace/REE standard data (RGM-1)

DCP trace element standard data (GSP-2)

measured	accepted	% difference	Sample	measured	accepted	% difference	
Co	2.01	2	0.7	Ba	1308	1340	2.4
Ga	16.0	15	6.5	Cr	23	20	12.7
Cs	9.45	9.6	1.6	Cu	46	43	5.8
Hf	6.22	6.2	0.3	Nb	28	27	2.4
Ta	1.04	0.95	8.9	Ni	43	17	87.4
W	1.51	1.5	0.4	Rb	239	245	2.4
Pb	25.5	24	6.2	Sr	230	240	4.5
Th	14.7	15.1	2.8	Sc	7.2	6.3	12.7
U	5.75	5.8	0.8	V	49	52	6.5
La	24.7	24	3.0	Y	28	28	0.6
Ce	47.1	47	0.2	Zn	117	120	2.4
Pr	5.15	4.7	9.2	Zr	570	550	3.6
Nd	19.1	19	0.3				
Sm	4.04	4	3				
Eu	0.638	0.66	3.4				
Gd	3.68	3.7	0.6				
Tb	0.598	0.66	9.8				
Dy	3.68	4.08	10.4				
Ho	0.757	0.95	22.6				
Er	2.36	2.6	9.5				
Tm	0.362	0.37	2.1				
Yb	2.59	2.6	0.5				
Lu	0.415	0.41	1.3				

40Ar/39Ar data to accompany Brueseke et al., Table DR2.

Irradiation Package:	AU-15
Date of Irradiation:	6/22/10
Monitor Age	28.02 (Ma, FCS)
Air 40Ar/36Ar:	293.0 + 1.5
Mass Disc. (% per amu):	-0.0021 ± 0.00102

(36/37)Ca: 0.00030 ± 2.7E-06

(39/37)Ca: 0.00084 ± 3.8E-05

(40/39)K: 0 ± 4E-04

(38/39)Cl: 0.01 ± 0.01

Date of Irradiation: 6/22/10

All analyses were completed in October of 2010.

Samples were irradiated in the central core position of the McMaster nuclear reactor in Hamilton, Ontario, with cadmium shielding. Synthetic CaF₂ was included with the irradiation to determine calcium production factors, and Fish canyon sanidine (from an aliquot prepared at New Mexico Tech) was used to monitor production of 39ArK, with an assigned age of 28.02 Ma (Renne et al., 1998). Monitors were placed in five of eight possible positions (four alternating radial positions and one central position) for each layer of the irradiation package. Vertical variations in J-value for the five layers of the irradiation package for these samples were found to be negligible, but radial variations were significant (up to ~ 2% across a given layer). Aliquots of air from an air pipette were measured daily to evaluate mass discrimination, and procedural blanks were measured following every five analyses of unknowns. Samples were analyzed in the Auburn Noble Isotope Mass Analysis Laboratory (ANIMAL) following gas extraction with a CO₂ laser using an automated extraction line, with data collection on an electron multiplier detector. Date presented are in volts unless otherwise indicated, and are corrected for backgrounds, mass discrimination, and decay of short-lived isotopes. 'P' refers to the laser power and 't' to seconds for laser heating; 'R' is the 40Ar*/39ArK ratio. Errors in measurement, individual calculated ages and plateau ages are 1 standard deviation; means are reported at the 95% confidence level. Plateau and bisection mean calculations were made using Isoplot (Ludwig, K.R., 2003, *Isoplot v. 3.0, A geochronology toolkit for Microsoft Excel*, Special Publication #4, Berkeley Geochronology Center).

Representative photographs are provided for the sanidine of each sample. During final selection for analysis, preference would have been given to clear grains free of any matrix, and some samples were briefly washed with dilute HF in an ultrasonic cleaner prior to analysis.

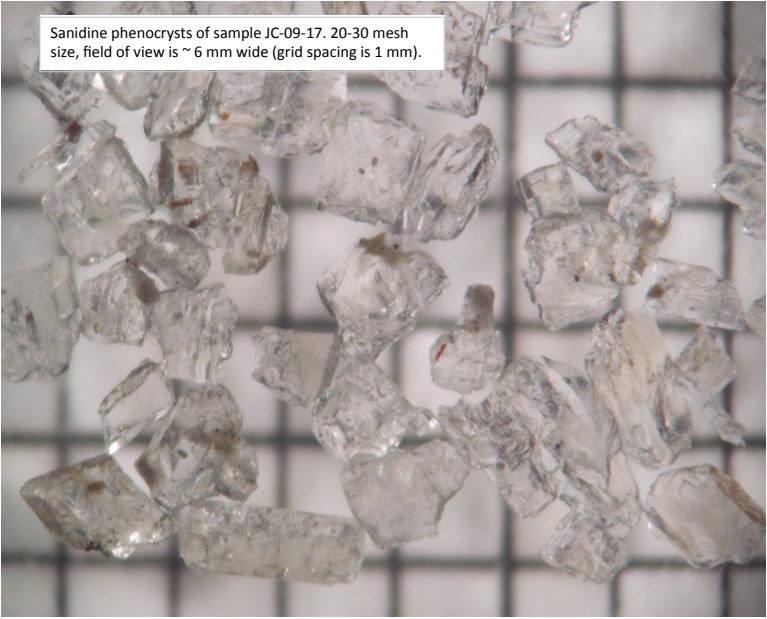


Irradiation Filename	P	t	40 V	39 V	38 V	37 V	36 V	Moles 40Ar*	%Rad	R	Age (Ma)	%-sd
Sample JC-09-04, Single Crystal Total Fusion Results (J=0.0030107+/-0.0000087, 0.29%, 1s)												
au15.1a.kfs.6a.txt	1.50	10	4.73867 ± 0.00163	1.6657 ± 0.00117	0.02019 ± 0.00008	0.03754 ± 0.00032	0.0000766 ± 0.0000213	2.57E-14	100%	2.83310	15.323 ± 0.024	0.15%
au15.1a.kfs.7a.txt	1.50	10	4.55945 ± 0.00384	1.6054 ± 0.00121	0.01951 ± 0.00011	0.03136 ± 0.00030	0.0000894 ± 0.0000197	2.47E-14	99%	2.82516	15.280 ± 0.026	0.17%
au15.1a.kfs.8a.txt	1.50	10	4.64142 ± 0.00358	1.6110 ± 0.00204	0.01971 ± 0.00010	0.03572 ± 0.00038	0.0002863 ± 0.0000182	2.52E-14	98%	2.83046	15.309 ± 0.029	0.19%
au15.1a.kfs.9a.txt	1.50	10	2.90232 ± 0.00155	1.0248 ± 0.00115	0.01254 ± 0.00009	0.02323 ± 0.00022	0.0000889 ± 0.0000173	1.58E-14	99%	2.80829	15.189 ± 0.033	0.22%
au15.1a.kfs.10a.txt	1.50	10	4.36393 ± 0.00280	1.4590 ± 0.00232	0.01761 ± 0.00007	0.04761 ± 0.00049	0.0000754 ± 0.0000220	2.37E-14	95%	2.84033	15.362 ± 0.037	0.24%
au15.1a.kfs.11a.txt	1.50	10	2.81081 ± 0.00150	0.9638 ± 0.00146	0.01177 ± 0.00006	0.02048 ± 0.00027	0.00003260 ± 0.0000220	1.53E-14	97%	2.81816	15.242 ± 0.044	0.29%
au15.1a.kfs.12a.txt	1.50	10	2.91734 ± 0.00261	1.0309 ± 0.00100	0.01256 ± 0.00009	0.02565 ± 0.00044	0.0000561 ± 0.0000182	1.58E-14	100%	2.81586	15.230 ± 0.035	0.23%
au15.1a.kfs.13a.txt	1.50	10	2.43521 ± 0.00208	0.85556 ± 0.00171	0.01025 ± 0.00007	0.02204 ± 0.00028	0.0000558 ± 0.0000178	1.32E-14	99%	2.82907	15.301 ± 0.047	0.31%
au15.1a.kfs.14a.txt	1.50	10	2.24388 ± 0.00366	0.7542 ± 0.00121	0.00905 ± 0.00006	0.01534 ± 0.00024	0.0004969 ± 0.0000190	1.22E-14	94%	2.78230	15.049 ± 0.055	0.36%
au15.1a.kfs.15a.txt	1.50	10	2.78095 ± 0.00226	0.9594 ± 0.00146	0.01208 ± 0.00017	0.02230 ± 0.00033	0.0002323 ± 0.0000198	1.51E-14	98%	2.82899	15.301 ± 0.043	0.28%
au15.1a.kfs.16a.txt	1.50	10	3.31969 ± 0.00282	1.1336 ± 0.00097	0.01381 ± 0.00007	0.04274 ± 0.00033	0.0002835 ± 0.0000180	1.80E-14	98%	2.85768	15.455 ± 0.032	0.21%
au15.1a.kfs.17a.txt	1.50	10	1.14167 ± 0.00118	0.4059 ± 0.00085	0.00494 ± 0.00007	0.00833 ± 0.00031	0.0000162 ± 0.0000205	6.20E-15	100%	2.80287	15.160 ± 0.088	0.58%
au15.1a.kfs.18a.txt	1.50	10	2.01285 ± 0.00253	0.6988 ± 0.00089	0.00845 ± 0.00005	0.01580 ± 0.00027	0.0000050 ± 0.0000170	1.09E-14	100%	2.88023	15.577 ± 0.048	0.31%
au15.1a.kfs.19a.txt	1.50	10	3.34833 ± 0.00338	1.1296 ± 0.00120	0.01366 ± 0.00008	0.03524 ± 0.00048	0.0000991 ± 0.0000185	1.82E-14	99%	2.94089	15.903 ± 0.035	0.22%
au15.1a.kfs.20a.txt	1.50	10	2.89498 ± 0.00242	0.9807 ± 0.00141	0.01192 ± 0.00009	0.02841 ± 0.00039	0.0004564 ± 0.0000222	1.57E-14	95%	2.81685	15.235 ± 0.045	0.29%
Single Crystal Total Gas Ages: 16.280 ± 0.260												
Biweight Mean = 15.297±0.061 (±0.175 with J-value error) at the 95% confidence level. MSWD = 22, probability = 0.000												
15.303 ± 0.039												
15.390 ± 0.140												

Brueseke et al. Table DR2

	Age = 15.093±0.041 Ma. (1s), MSWD = 0.86, probability = 0.62, 99.84% of the 39Ar, steps 2 through 19
au15.1c.kfs.41a.txt	0.50 20 0.01691 + 0.00029 0.0034 + 0.00005 0.00005 + 0.00004 0.00207 + 0.00019 0.0000007 + 0.0000160 9.18E-17 100% 5.0028693 25.96 ± 7.30 28%
au15.1c.kfs.41b.txt	0.54 20 0.00643 + 0.00014 0.0019 + 0.00004 -0.00003 + 0.00004 0.00120 + 0.00016 0.0000039 + 0.0000171 3.49E-17 83% 2.8718302 14.95 ± 14.10 94%
au15.1c.kfs.41c.txt	0.58 20 0.00921 + 0.00028 0.0029 + 0.00005 0.00005 + 0.00004 0.00233 + 0.00018 0.000020 + 0.0000156 5.00E-17 96% 3.0187825 15.71 ± 8.24 52%
au15.1c.kfs.41d.txt	0.62 20 0.06502 + 0.00027 0.0182 + 0.00013 0.00023 + 0.00004 0.01682 + 0.00047 0.0000473 + 0.0000134 3.53E-16 81% 2.8866182 15.024 ± 1.145 8%
au15.1c.kfs.41e.txt	0.66 20 0.04738 + 0.00027 0.0150 + 0.00015 0.00018 + 0.00004 0.01511 + 0.00026 0.0000333 + 0.0000152 2.57E-16 82% 2.5835487 13.452 ± 1.570 12%
au15.1c.kfs.41f.txt	0.70 20 0.02680 + 0.00022 0.0082 + 0.00007 0.00008 + 0.00004 0.00974 + 0.00026 0.0000373 + 0.0000161 1.45E-16 62% 2.0133576 10.49 ± 3.010 29%
au15.1c.kfs.41g.txt	0.73 20 0.11245 + 0.00037 0.0181 + 0.00012 0.00021 + 0.00005 0.02371 + 0.00039 0.0000203 + 0.0000174 6.10E-16 49% 3.0329692 15.782 ± 1.505 10%
au15.1c.kfs.41h.txt	0.76 20 0.09451 + 0.00024 0.0304 + 0.00023 0.00033 + 0.00004 0.03992 + 0.00041 -0.0000115 + 0.0000265 5.13E-16 107% 3.2238641 16.771 ± 1.347 8%
au15.1c.kfs.41i.txt	0.80 20 0.04094 + 0.00034 0.0139 + 0.00012 0.00014 + 0.00004 0.01773 + 0.00032 -0.0000089 + 0.0000123 2.22E-16 110% 3.0564247 15.904 ± 1.372 9%
au15.1c.kfs.41k.txt	0.90 20 0.00941 + 0.00022 0.0030 + 0.00006 0.0000 + 0.00004 0.00393 + 0.00013 0.0000010 + 0.0000198 5.11E-17 100% 3.1329356 16.30 ± 10.126 62%
au15.1c.kfs.41l.txt	0.95 20 0.02553 + 0.00015 0.0084 + 0.00008 0.00008 + 0.00003 0.01064 + 0.00030 0.0000048 + 0.0000204 1.39E-16 98% 2.9569094 15.388 ± 3.708 24%
au15.1c.kfs.41m.txt	1.00 20 0.09325 + 0.00017 0.0248 + 0.00016 0.00033 + 0.00004 0.03403 + 0.00082 0.0000886 + 0.0000218 5.06E-16 75% 2.8145148 14.650 ± 1.360 9%
au15.1c.kfs.41n.txt	1.10 20 0.01428 + 0.00020 0.0048 + 0.00007 0.00011 + 0.00004 0.00651 + 0.00026 0.0000109 + 0.0000190 7.75E-17 81% 2.4208938 12.61 ± 6.099 48%
au15.1c.kfs.41o.txt	1.20 20 0.11817 + 0.00034 0.0401 + 0.00030 0.00048 + 0.00003 0.05219 + 0.00061 -0.0000020 + 0.0000171 6.41E-16 104% 3.0541324 15.892 ± 0.666 4%
au15.1c.kfs.41p.txt	1.35 20 0.04755 + 0.00040 0.0163 + 0.00014 0.00016 + 0.00004 0.02098 + 0.00029 0.0000081 + 0.0000115 2.58E-16 99% 2.8837692 15.009 ± 1.100 7%
au15.1c.kfs.41q.txt	1.50 20 0.03260 + 0.00032 0.0108 + 0.00010 0.00005 + 0.00004 0.01412 + 0.00028 -0.0000446 + 0.0000131 1.77E-16 144% 3.1391523 16.33 ± 1.884 12%
au15.1c.kfs.41r.txt	1.65 20 0.04242 + 0.00017 0.0144 + 0.00020 0.00012 + 0.00003 0.01872 + 0.00032 -0.0000245 + 0.0000161 2.30E-16 121% 3.0475964 15.86 ± 1.732 11%
au15.1c.kfs.41s.txt	1.80 20 0.01791 + 0.00024 0.0059 + 0.00005 0.00006 + 0.00003 0.00778 + 0.00033 -0.0000203 + 0.0000170 9.72E-17 137% 3.1646983 16.46 ± 4.461 27%

Plateau Age = 15.48±0.37 Ma (1s), MSWD = 0.54, probability = 0.94, 100% of the 39Ar, steps 1 through 18



Sample JC-09-17, Total Fusion Analyses of Single Crystals (J=0.0029018+/-0.000135, 0.47%, 1s)

au15.1d.kfs.66a.txt	1.50 10 2.40173 ± 0.00257 0.8078 ± 0.00077 0.00980 ± 0.00009 0.02316 ± 0.00028 0.0000595 ± 0.0000195 1.30E-14 99% 2.95389 15.398 ± 0.043 0.28%																	
au15.1d.kfs.67a.txt	1.50 10 3.04975 ± 0.00267 1.0079 ± 0.00156 0.01220 ± 0.00009 0.02292 ± 0.00035 0.0002490 ± 0.0000210 1.66E-14 98% 2.95486 15.403 ± 0.043 0.28%																	
au15.1d.kfs.68a.txt	1.50 10 3.95572 ± 0.00291 1.3265 ± 0.00185 0.01620 ± 0.00008 0.04032 ± 0.00046 0.0001434 ± 0.0000191 2.15E-14 99% 2.95270 15.392 ± 0.033 0.21%																	
au15.1d.kfs.69a.txt	1.50 10 1.76510 ± 0.00209 0.5872 ± 0.00082 0.00718 ± 0.00009 0.01374 ± 0.00022 0.0001350 ± 0.0000202 9.58E-15 98% 2.93980 15.325 ± 0.060 0.39%																	
au15.1d.kfs.70a.txt	1.50 10 0.44043 ± 0.00053 0.1374 ± 0.00033 0.00164 ± 0.00005 0.18334 ± 0.00086 0.0001976 ± 0.0000223 2.39E-15 90% 2.89148 15.074 ± 0.254 1.68%																	
au15.1d.kfs.71a.txt	1.50 10 2.78837 ± 0.00174 0.93335 ± 0.00103 0.01138 ± 0.00011 0.02456 ± 0.00046 0.00001139 ± 0.0000204 1.51E-14 99% 2.95320 15.394 ± 0.039 0.25%																	
au15.1d.kfs.72a.txt	1.50 10 2.85789 ± 0.00221 0.9589 ± 0.00071 0.01173 ± 0.00009 0.02458 ± 0.00027 0.00001525 ± 0.0000205 1.55E-14 98% 2.93568 15.303 ± 0.037 0.24%																	
au15.1d.kfs.73a.txt	1.50 10 2.34522 ± 0.00260 0.7692 ± 0.00107 0.00932 ± 0.00006 0.02441 ± 0.00026 0.00002922 ± 0.0000220 1.27E-14 96% 2.93916 15.321 ± 0.052 0.34%																	
au15.1d.kfs.74a.txt	1.50 10 2.54723 ± 0.00354 0.7352 ± 0.00072 0.00919 ± 0.00010 0.02408 ± 0.00031 0.00012872 ± 0.0000242 1.38E-14 85% 2.95012 15.378 ± 0.059 0.39%																	
au15.1d.kfs.75a.txt	1.50 10 2.58984 ± 0.00232 0.8733 ± 0.00114 0.01059 ± 0.00007 0.02231 ± 0.00033 0.0000791 ± 0.0000310 1.41E-14 99% 2.94097 15.331 ± 0.060 0.39%																	
au15.1d.kfs.76a.txt	1.50 10 2.88723 ± 0.00191 0.9612 ± 0.00123 0.01171 ± 0.00010 0.03266 ± 0.00050 0.0002069 ± 0.0000230 1.57E-14 98% 2.94286 15.341 ± 0.043 0.28%																	
au15.1d.kfs.77a.txt	1.50 10 2.01440 ± 0.00223 0.6779 ± 0.00095 0.00810 ± 0.00008 0.01869 ± 0.00018 0.0000845 ± 0.0000199 1.09E-14 99% 2.93687 15.310 ± 0.053 0.35%																	
au15.1d.kfs.78a.txt	1.50 10 1.92896 ± 0.00188 0.6450 ± 0.00168 0.00785 ± 0.00006 0.01813 ± 0.00027 0.0000852 ± 0.0000230 1.05E-14 99% 2.95375 15.397 ± 0.070 0.45%																	
au15.1d.kfs.79a.txt	1.50 10 1.41055 ± 0.00149 0.4760 ± 0.00077 0.00594 ± 0.00010 0.01324 ± 0.00029 0.0001112 ± 0.0000225 7.66E-15 98% 2.89643 15.100 ± 0.079 0.52%																	
au15.1d.kfs.80a.txt	1.50 10 1.21948 ± 0.00165 0.4156 ± 0.00073 0.00499 ± 0.00007 0.00801 ± 0.00029 0.0000057 ± 0.0000206 6.62E-15 100% 2.93185 15.284 ± 0.084 0.55%																	
Single Crystal Total Gas Ages:																		
Biweight Mean = 15.342±0.050 (±0.194 with J-Value error) at the 95% confidence level. MSWD = 3.3, probability = 0.000																		
15.259 ± 0.063																		
15.298 ± 0.057																		
15.578 ± 0.038																		
15.360 ± 0.170																		

