## ***$^{40}Ar/^{39}Ar$ methodology – University of British Columbia***

RE-DC06-32 and RE-DC06-36

Mineral separates were hand-picked, washed in acetone, dried, wrapped in aluminum foil and stacked in an irradiation capsule with similar-aged samples and neutron flux monitors (Fish Canyon Tuff sanidine (FCs), 28.02 Ma (Renne et al., 1998).

The samples were irradiated on April 12, 2007 at the McMaster Nuclear Reactor in Hamilton, Ontario, for 27 MWH, with a neutron flux of approximately $6x10^{13}$ neutrons/cm$^2$/s. Analyses (n=40) of 10 neutron flux monitor positions produced errors of <0.5% in the J value.

The samples were analyzed on May 22 through June 4, 2007, at the Noble Gas Laboratory, Pacific Centre for Isotopic and Geochemical Research, University of British Columbia, Vancouver, BC, Canada. The mineral separates were step-heated at incrementally higher powers in the defocused beam of a 10W $CO_2$ laser (New Wave Research MIR10) until fused. The gas evolved from each step was analyzed by a VG5400 mass spectrometer equipped with an ion-counting electron multiplier. All measurements were corrected for total system blank, mass spectrometer sensitivity, mass discrimination, radioactive decay during and subsequent to irradiation, as well as interfering Ar from atmospheric contamination and the irradiation of Ca, Cl and K (Isotope production ratios: $(^{40}Ar/^{39}Ar)_K$=0.0302±0.00006, $(^{37}Ar/^{39}Ar)_{Ca}$=1416.4±0.5, $(^{36}Ar/^{39}Ar)_{Ca}$=0.3952±0.0004, Ca/K=1.83±0.01$(^{37}Ar_{Ca}/^{39}Ar_K)$.).

Details of the analyses, including plateau (spectrum) and inverse correlation plots, are presented in Excel spreadsheets. The plateau and correlation ages were calculated using Isoplot ver.3.09 (Ludwig, 2003). Errors are quoted at the $2\sigma$ (95% confidence) level and are propagated from all sources except mass spectrometer sensitivity and age of the flux monitor. The best statistically-justified plateau and plateau age were picked based on the following criteria:

1. Three or more contiguous steps comprising more than 50% of the $^{39}$Ar;
2. Probability of fit of the weighted mean age greater than 5%;
3. Slope of the error-weighted line through the plateau ages equals zero at 5% confidence;
4. Ages of the two outermost steps on a plateau are not significantly different from the weighted-mean plateau age (at $1.8\sigma$, six or more steps only);
5. Outermost two steps on either side of a plateau must not have nonzero slopes with the same sign (at $1.8\sigma$, nine or more steps only)

## ***$^{40}Ar/^{39}Ar$ methodology – University of Wisconsin***

SKC24

$^{40}Ar/^{39}Ar$ incremental heating experiments were undertaken on lava sample SKC24. Holocrystalline groundmass separates were prepared from porphyritic lava samples by crushing, sieving to 250-350 μm, magnetic sorting, density separation using methylene iodide, and ultimately hand picking under a binocular microscope. Purified groundmass separates were weighed and then wrapped in 99.99% copper foil packets placed into Al disks with the 28.201 Ma Fish Canyon sanidine (Kuiper et al., 2008), which monitors neutron fluence. The Al disks were irradiated for two hours at the Oregon State University TRIGA reactor in the Cadmium-Lined In-Core Irradiation Tube (CLICIT) where they a received fast neutron dose of ~1.5 x $10^{15}$ n/cm$^2$. Based on previous experiments, corrections for undesirable nucleogenic reactions on $^{40}K$ and $^{40}Ca$ are: $[^{40}Ar/^{39}Ar]_K = 0.00086$; $[^{36}Ar/^{37}Ar]_{Ca} = 0.000264$; $[^{39}Ar/^{37}Ar]_{Ca} = 0.000673$. J values were uniform within analytical error across individual Al disks, and the precision of the J values averaged ± 0.20 % (2σ). The age uncertainty determined for each sample is the 2σ analytical error, unless otherwise noted.

At the University of Wisconsin Rare Gas Geochronology Laboratory, ~ 200 mg groundmass packets were incrementally heated in a double-vacuum resistance furnace attached to a 350 cm$^3$ gas clean-up line. Prior to each incremental heating experiment, samples were degassed at 550 °C to potentially remove large amounts of atmospheric argon. Fully automated experiments consisted of 8-10 steps from 650-1275 °C; each step included a two-minute increase to the desired temperature that was maintained for 15 minutes, followed by an additional 15 minutes for gas cleanup. The gas was cleaned during and after the heating period with three SAES C50 getters. Argon isotope analyses were done using a MAP 215-50, and the isotopic data was reduced using ArArCalc software version 2.4 (Koppers, 2002).

Obtaining precise $^{40}Ar/^{39}Ar$ age determinations for latest Pleistocene volcanics requires careful characterization of: (1) blank levels in the analytical system and (2) mass discrimination of the instrument. Prior to sample introduction, furnace blanks were measured at 125 °C increments throughout the temperature range spanned by the incremental heating experiment and interpolated. Mass discrimination was monitored daily via an automated air pipette and averaged 1.0040 ± 0.02 per atomic mass unit (a.m.u.) during the analytical period. Isochron regressions (York, 1969) agree with plateau ages and do not reveal evidence that excess argon is present in any of the lavas, therefore, we consider the plateau ages to give the best estimate of the time elapsed since eruption (Table 1). All ages were calculated using the decay constants of Steiger and Jäger (1977). $^{40}Ar/^{39}Ar$ results are presented to three decimal places and uncertainties to four decimal places when possible.

### ***Supplemental References***


Koppers, A.P., 2002, ArArCalc – software for $^{40}Ar/^{39}Ar$ age calculations Computers and Geosciences, v. 28, p. 605-619, doi:10.1016/S0098-3004(01)00095-4.

Kuiper, K.F., Deino, A., Hilgen, F.J., Krijgsman, W., Renne, P.R., Wijbrans, J.R., 2008, Synchronizing Rock Clocks of Earth History: Science, v. 320, p. 500-504, *doi:* 10.1126/science.1154339.

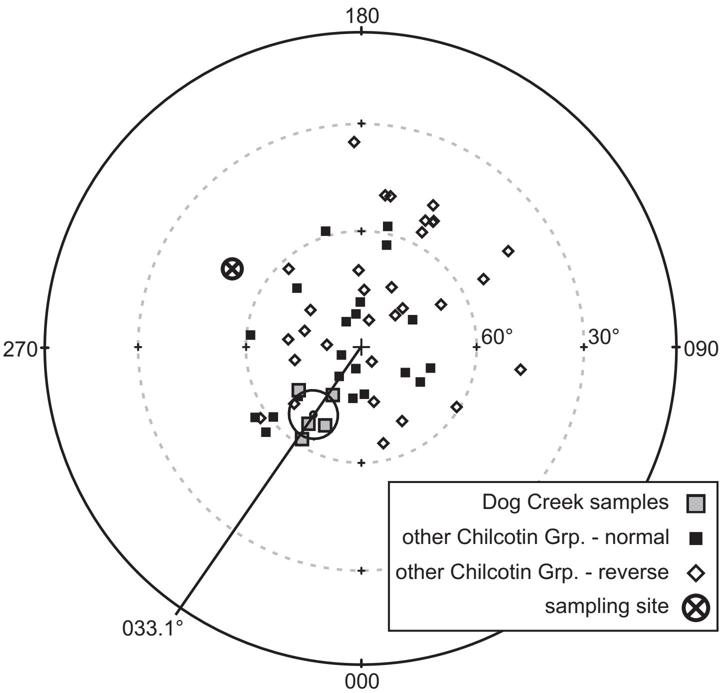
Ludwig, K.R., 2003. Isoplot 3.09, A Geochronological Toolkit for Microsoft Excel: Berkeley Geochronology Center, Special Publication No. 4.

Renne, P.R., C.Swisher, C.C., III, Deino, A.L., Karner, D.B., Owens, T., DePaolo, D.J., 1998, Intercalibration of standards, absolute ages and uncertainties in $^{40}Ar/^{39}Ar$ dating: Chemical Geology, v. 145 p. 117-152.

Steiger, R.H., Jäger, E., 1977, Subcommission on Geochronology: Convention on the use of Decay Constants in Geo- and Cosmochronology: Earth and Planetary Science Letters, v. 36, p. 359-362.

York, D., 1969, Least squares fitting of a straight line with correlated errors: Earth and Planetary Science Letters, v. 5, p. 320-324.

## Figure DR1





| Site | N | Dec | Inc | Kfisher | a95 | Pole Lat | Pole Long |
|---|---|---|---|---|---|---|---|
| | | [°] | [°] | | [°] | [°N] | [°E] |
| CCB36 | 10 | 31.4 | 62.7 | 110.7 | 4.6 | 67.8 | 335.1 |
| CCB37 | 12 | 22.5 | 66.5 | 114.8 | 4.1 | 75.5 | 329.2 |
| CCB38 | 14 | 32.7 | 70.8 | 55.1 | 5.4 | 70.4 | 304.4 |
| CCB39 | 16 | 41.2 | 62.5 | 206.9 | 2.6 | 61.6 | 327.1 |
| CCB40 | 12 | 36.2 | 64.7 | 263.2 | 2.7 | 66.0 | 325.3 |
| | | | | | | | |
| Dog Creek | 5 sites | 33.1 | 65.6 | 328.8 | 4.2 | | |
| | | | | 150.2 | 6.3 | 68.6 | 324.6 |
| | | | | | | | |
| All Chilcotin | 57 sites | 352.2 | 68.5 | 21.3 | 4.2 | | |
| | | | | 10.3 | 6.2 | 85.4 | 177.5 |

## Supplemental S1

### *Paleomagnetic data*

Five sites (see Table below) of orientated cores were collected from the bottom to the top (60 m) of the sub-aerial Dog Creek lava-dam (circled cross, 51.59°N, 122.25°W). The magnetic remanence of all samples, measured with an Agico JR5-A magnetometer, was completely unidirectional after removal of a small parasitic component with either 10 mT alternating field or 100°C thermal demagnetization. With median destructive fields around 50 mT and median destructive temperatures of 500°C, the remanence is evidently carried by highly stable single-domain magnetite.

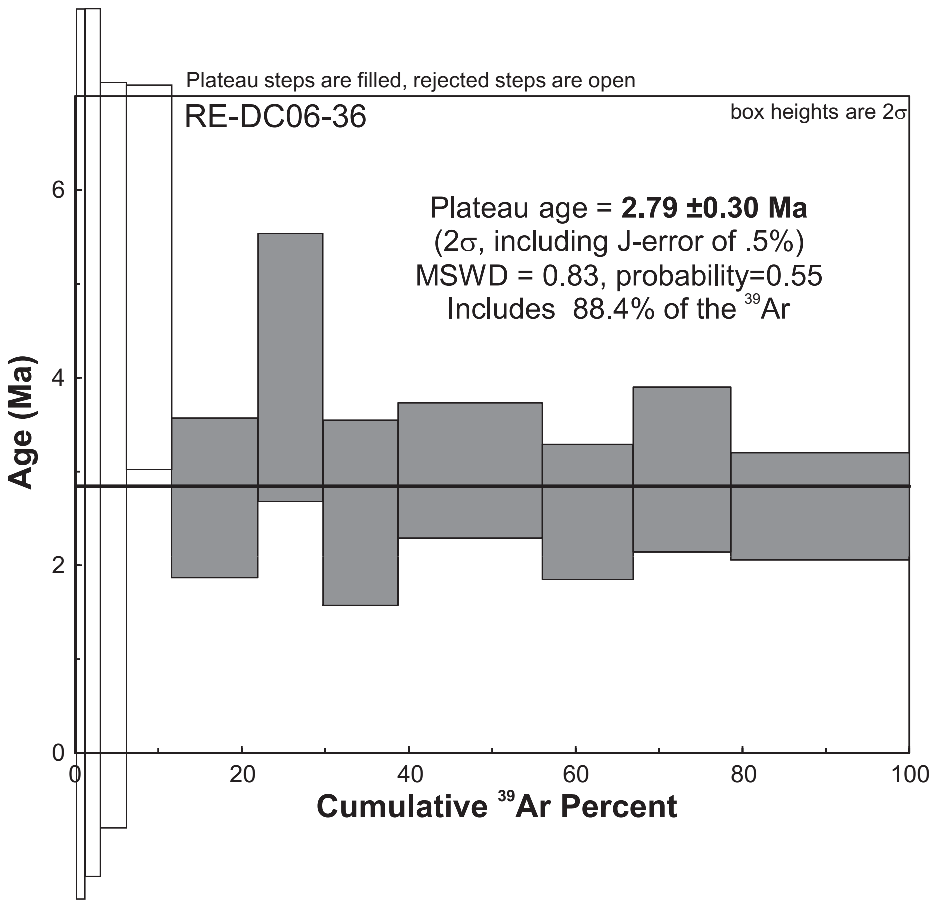
The paleomagnetic directions of the 5 sites from Dog Creek form a surprisingly tight cluster with a northeasterly direction, and their virtual geomagnetic poles are significantly offset from Earth's pole (red squares). In contrast, the Chilcotin Group basalts, in general, hold a relatively scattered distribution of paleomagnetic directions (green squares and blue diamonds for normal and reverse polarity sites), nearly evenly bipolar (26 of 57 sites have normal polarity), but with a mean paleomagnetic pole which is indistinguishable from Earth's pole (95% confidence).

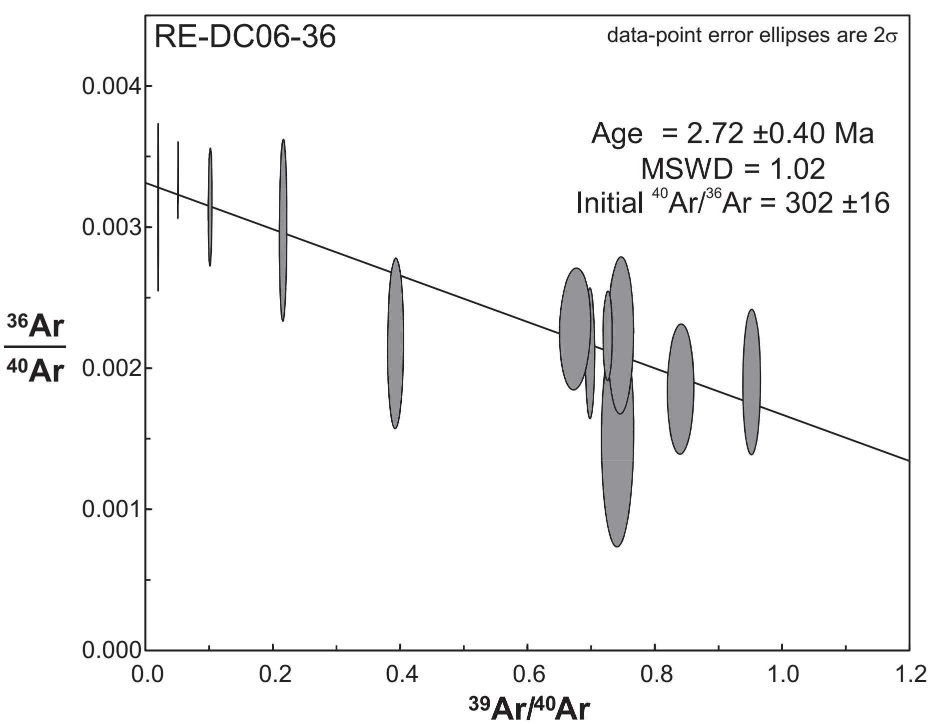
### *Interpretation*

The implication is that the Dog Creek lava-dam was emplaced rapidly enough to record a single snap-shot of geomagnetic secular variation during a normal polarity chron (2.8 Ma corresponding to the Upper Gauss chron). Compared to regional records of Holocene paleosecular variation (Verosub et al., 1986), the deviation from the pole and the amount of variation seen implies that the volcanic stack accumulated during less than 1000 years.


Verosub, K.L., Mehringer, P.J., Waterstraat, P., 1986, Holocene secular variation in western North America - paleomagnetic record from Fish Lake, Harney County, Oregon: Journal of Geophysical Research, v. 91, p. 3609-3623.

Figure DR2



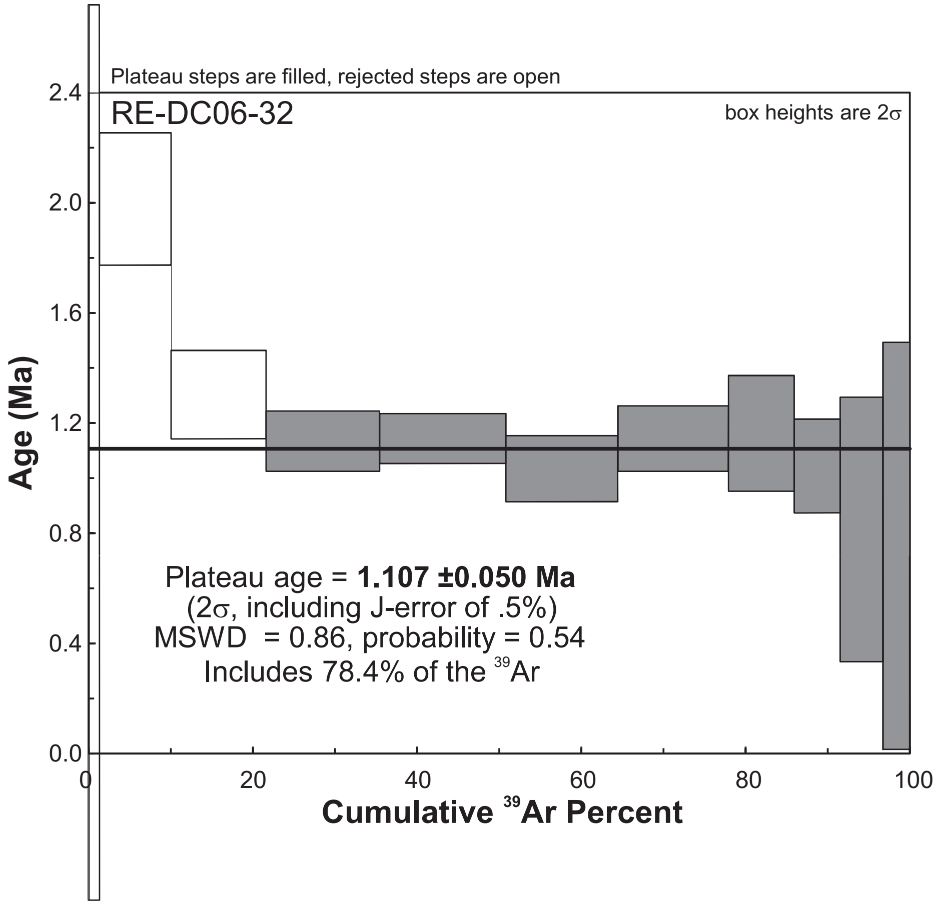

**Supplemental S2**

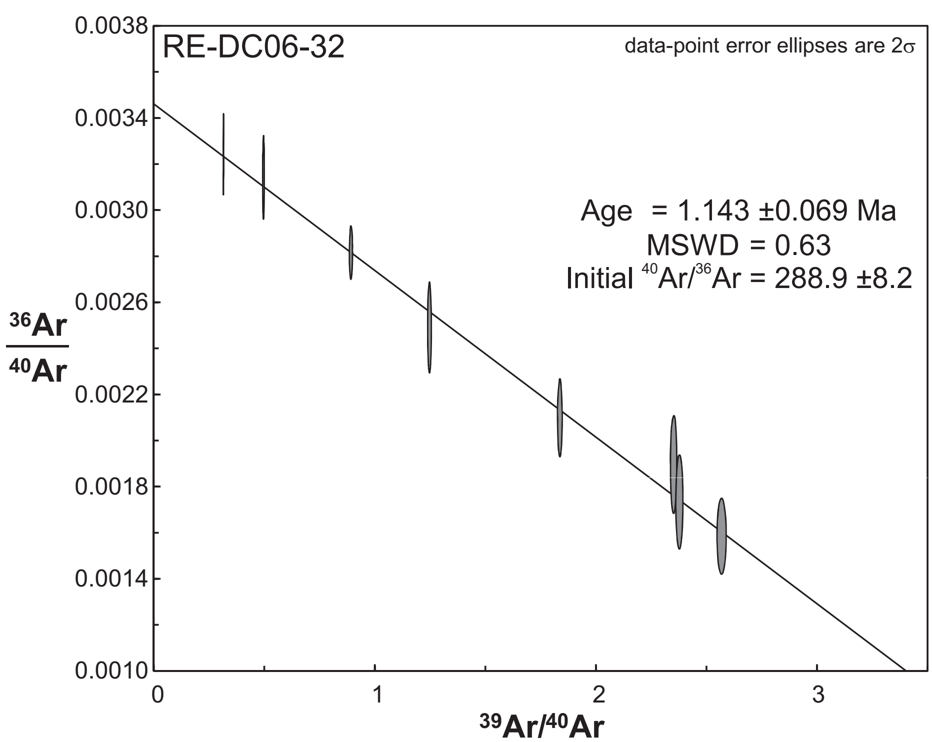
**Sample RE-DC06-36**
Olivine-phyric, diktytaxitic alkaline basalt lava forming the prominent cliffs at the base of the Dog Creek section. The lavas sit unconformably on a glacially-striated limestone surface, and are unconformably overlain by a 20 m thick sequence of sediments interpreted to be a pro-glacial succession (Mathews and Rouse, 1986).

Mathews and Rouse (1986) reported two K/Ar ages from this lava, 2.0 and 2.9 Ma.

**Preferred age - 2.79 ±0.30 Ma**

Sample analyzed at the Pacific Center for Isotopic and Geochemical Research (PCIGR), the University of British Columbia, by Tom Ullrich, June 24th 2007.




## Figure DR3

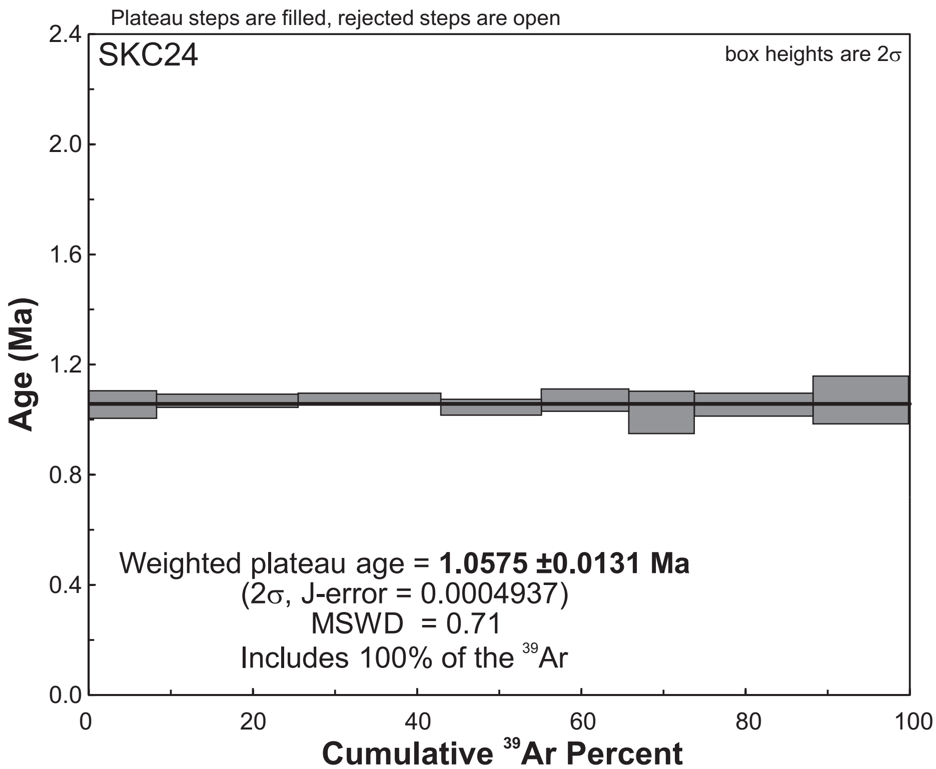
**Supplemental S3**

**Sample RE-DC06-32**
Olivine-phyric, diktytaxitic alkaline basalt lava at the top of the Dog Creek section ('lava cap' unit of Mathews and Rouse, 1986). Sits disconformably on an oxidized diamicton (till) at the top of a 200 m thick sequence of sediments interpreted to be a pro-glacial succession (Mathews and Rouse, 1986).

Mathews and Rouse (1986) obtained five K/Ar ages from this lava ranging between 1.0 and 1.2 Ma, and a reverse magnetic remanence, inferred to be Matuyama chron.

**Preferred age - 1.107 ±0.050 Ma**

Sample analyzed at the Pacific Center for Isotopic and Geochemical Research (PCIGR), the University of British Columbia, by Tom Ullrich, June 24$^{th}$ 2007.



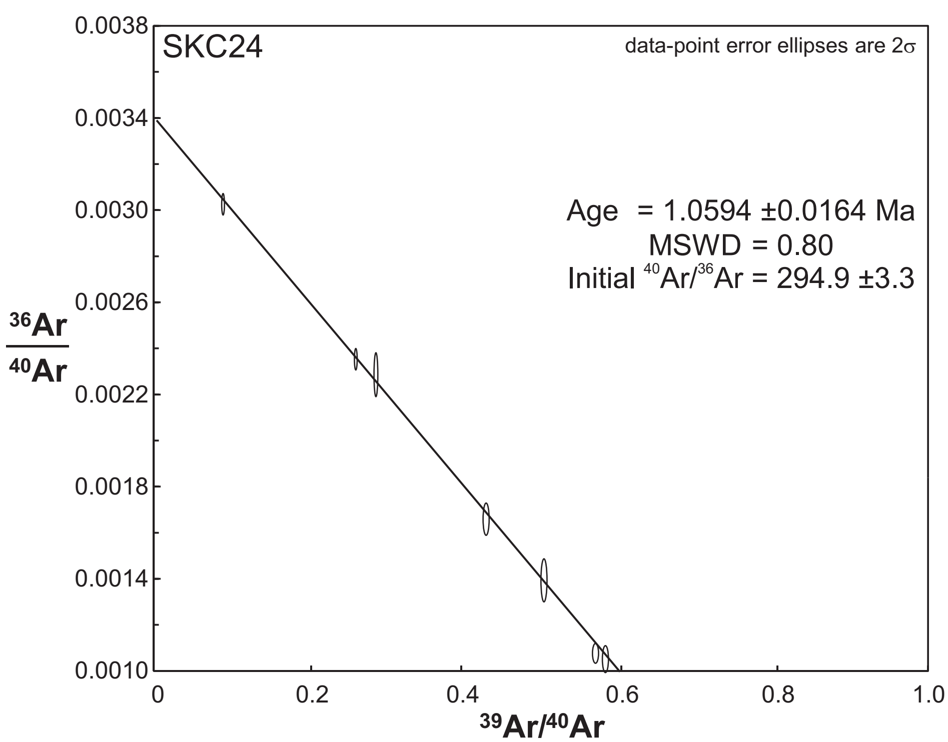




Figure DR4

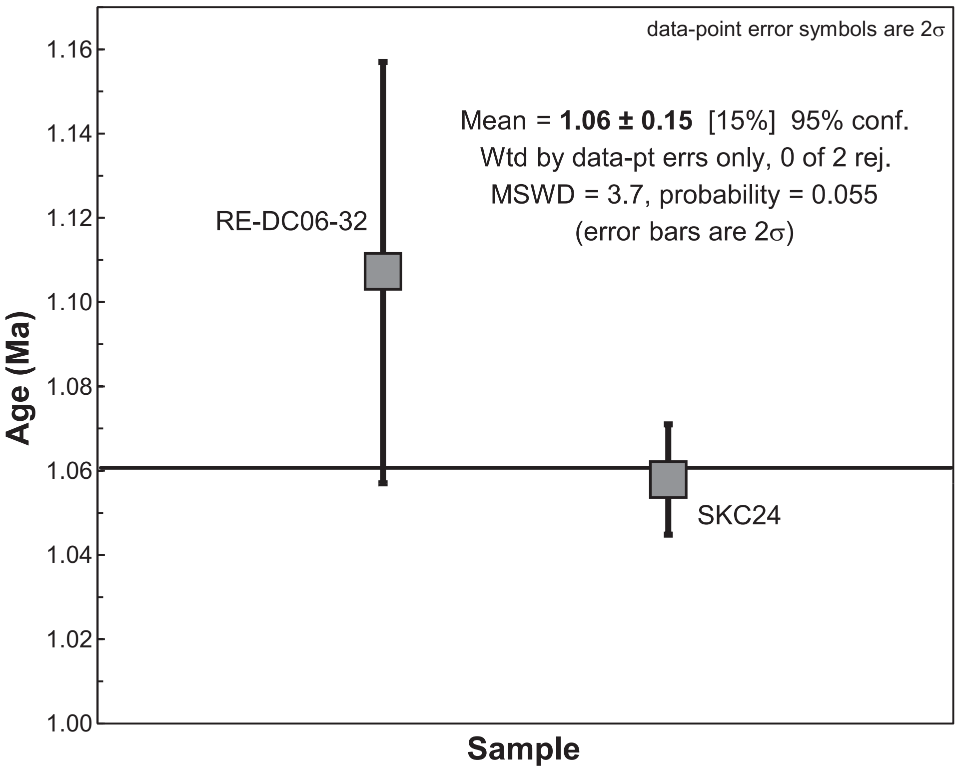
**Supplemental S4**

**Sample SKC24**
Olivine-phyric, diktytaxitic alkaline basalt lava on the west-side of the Fraser Canyon at the northern margin of Gang Ranch property, in Prentice Gulch.

Mathews and Rouse (1986) reported a K/Ar age from this lava of 1.3 ±0.2 Ma.

**Preferred age - 1.057 ±0.013 Ma**

Sample analyzed at the Rare Gas Laboratory, at the University of Madison - Wisconsin, by Brian Jicha, October 2009.




## Figure DR5

**Supplemental S5**

**Weighted mean age - 1.06 ±0.15 Ma**

Generated in IsoPlot v.3.0 (Ludwig, 2003).

Ludwig, K.R., 2003, User's manual for Isoplot/Ex rev. 3.00: a Geochronological Toolkit for Microsoft Excel: Special Publication, 4, Berkeley Geochronology Center, Berkeley, 70 p.