University of Alaska Fairbanks (UAF) 40Ar/39Ar Methods

For $^{40}Ar/^{39}Ar$ analysis, bulk rock samples were crushed, sieved, washed and hand-picked for pure hornblende, biotite, and muscovite mineral phase separates at the Geochronology laboratory at the University of Alaska Fairbanks. The monitor mineral MMhb-1 (Samson and Alexander, 1987) with an age of 523.5 Ma (Renne et al., 1994) was used to monitor neutron flux (and calculate the irradiation parameter, J). The samples and standards were wrapped in aluminum foil and loaded into aluminum cans of 2.5 cm diameter and 6 cm height. The samples were irradiated in position 5c of the uranium enriched research reactor of McMaster University in Hamilton, Ontario, Canada for 20 megawatt-hours.

Upon their return from the reactor, the sample and monitors were loaded into 2 mm diameter holes in a copper tray that was then loaded in a ultra-high vacuum extraction line. The monitors were fused, and samples heated, using a 6-watt argon-ion laser following the technique described in York et al. (1981), Layer et al. (1987) and Layer (2000). Argon purification was achieved using a liquid nitrogen cold trap and a SAES Zr-Al getter at 400 degrees C. The samples were analyzed in a VG-3600 mass spectrometer The argon isotopes were analyzed in a VG-3600 mass spectrometer fitted with a single Daly detector and operated in peak hopping mode at the Geophysical Institute, University of Alaska Fairbanks. The argon isotopes measured were corrected for system blank and mass discrimination, as well as calcium, potassium and chlorine interference reactions following procedures outlined in McDougall and Harrison (1999). Typical full-system 8 min laser blank values (in moles) were generally 2×10^{-16} mol ^{40}Ar, 3 × 10218 mol ^{39}Ar, 9×10^{-18} mol ^{38}Ar, 2 x 10^{-18} mol ^{37}Ar, and 2×10^{-18} mol ^{36}Ar, which are 10–50 times smaller than the sample/standard volume fractions. Correction factors for nucleogenic interferences during irradiation were determined from irradiated CaF_2 and K_2SO_4 as follows: $(^{39}Ar/^{37}Ar)Ca = 7.06 \times 10^{-4}$, $(^{36}Ar/^{37}Ar)Ca = 2.79 \times 10^{-4}$ and $(^{40}Ar/^{39}Ar)K = 0.0297$. Mass discrimination was monitored by running calibrated air shots. The mass discrimination during these experiments was 1.3 % per mass unit. While doing our experiments, calibration measurements were made on a weekly to monthly basis to check for changes in mass discrimination with no significant variation seen during these intervals. Ages with +/- 1 sigma error were calculated using the constants of Renne et al. (2010). The integrated age is the age given by the total gas measured and is equivalent to a potassium-argon (K-Ar) age. A plateau age is reported if three or more consecutive gas fractions representing at least 50 percent of the total gas released that are within two standard deviations of each other and with an overall Mean Square Weighted Deviation (MSWD) less than or equal to 2.5.

Benowitz, J., Layer, P.W., VanLaningham, S., 2014, Persistent Long-Term (~24 Ma) Exhumation in the Eastern Alaska Range Constrained by Stacked Thermochronology, Geological Society of London Special Volume, $^{40}Ar/^{39}Ar$ Dating: from Geochronology to Thermochronology, from Archaeology to Planetary Sciences.

Layer, P.W., 2000, Argon-40/argon-39 age of the El'gygytgyn impact event, Chukotka, Russia: Meteoritics and Planetary Science, v. 35, p. 591–599.

Layer, P.W., Hall, C.M. & York, D., 1987, The derivation of 40Ar/39Ar age spectra of single grains of hornblende and biotite by laser step heating, Geophys. Res. Lett., 14, 757-760.

McDougall, I. and Harrison, T.M., 1999, Geochronology and Thermochronology by the 40Ar/39Ar method-2nd ed, Oxford University Press, New York, 269pp.

Renne, P. R., Mundil, R., Balco, G., Min, K., and Ludwig, K. R., 2010. Joint determination of 40K decay constants and 40Ar∗/40K for the Fish Canyon sanidine standard, and improved accuracy for 40Ar/39Ar geochronology.Geochimica et Cosmochimica Acta, 74(18), 5349.

Renne, P. R., Deino, A. L., Walter, R. C., Turrin, B. D., Swisher, C. C., Becker, T. A., Curtis, G.H., Sharp. W.D., and Jaouni, A. R., 1994, Intercalibration of astronomical and radioisotopic time. Geology, 22(9), 783-786.

Samson S. D., and Alexander E. C. (1987) Calibration of the interlaboratory 40Ar/39Ar dating standard, MMhb1. Chem. Geol. 66, 27-34.

York, D., Hall, C.M., Yanase, Y., Hanes, J.A. & Kenyon, W.J., 1981. 40Ar/39Ar dating of terrestrial minerals with a continuous laser, Geophys. Res. Lett., 8, 1136-1138.