**Supplemental Methods and Data Tables**

***Geochronology Methods: Argon dating***

Whole rock and mineral separates were analyzed by 40Ar/39Ar methods from three samples during this study; two samples of basalt were analyzed as whole rock (samples 11-TR-01 and 21613a) as were separated grains of biotite (sample 17613a) and plagioclase (sample 21613a). The 40Ar/39Ar analyses were performed at the U.S. Geological Survey (USGS) in Denver, CO. The basalt whole rock fragments and mineral grains of biotite and plagioclase were prepared by crushing, washing in deionized water and hand picking. Together with the neutron fluence monitor Fish Canyon sanidine, samples were loaded into precise positions within 18 mm Al disks, stacked, wrapped in Al foil and encapsulated under vacuum in a quartz tube. The quartz tube was sealed into an Al canister and rotated at 1 rpm during neutron irradiation for either 0.25 MWH (sample 11-TR-01) or 5 MWH in the central thimble position of the USGS TRIGA reactor (Dalrymple et al., 1981). Following irradiation, the samples and fluence monitors were loaded with tweezers into a stainless-steel sample holder and then placed into a laser chamber with an externally pumped ZnSe window, which is attached to a custom-built ultra-high vacuum extraction line. The volume of the mostly stainless-steel vacuum line extraction line, including a cryogenic trap operated at -130°C and two SAES™ GP50 getters (one room temperature, one operated at 2.2A), is estimated at ~450 cc. A combination of turbo molecular pumps and ion pumps maintain steady pressures within the extraction line of < 1.33 x 10-7 Pa. Samples were incrementally heated in steps of 90 seconds, by controlled power output of a 50W CO2 laser equipped with a beam homogenizing lens resulting in uniform energy over the entire sample surface. The reported incremental heating data represent results from individual mineral grains. During laser heating any sample gas released was exposed to the cryogenic trap and was further purified for an additional 120 seconds by exposure to both the cryogenic trap and the SAES getters. The sample gas was expanded into a Thermo Scientific ARGUSVI™ mass spectrometer and argon isotopes were analyzed simultaneously using 4 Faraday detectors (40Ar, 39Ar, 38Ar, 37Ar) and 1 ion counter (36Ar). Following data acquisition of 10 minutes, time zero intercepts were fit to the data (using parabolic and/or linear best fits) and corrected for backgrounds, detector inter-calibrations, and nucleogenic interferences. The Massspec computer program written by A. Deino of the Berkeley Geochronology Center was used for data acquisition, age calculations, and plotting. All 40Ar/39Ar ages are referenced to an age of 28.201 ± 0.046 Ma for the Fish Canyon sanidine (Kuiper et al., 2008), the decay constants of Min et al. (2000), and an atmospheric 40Ar/36Ar ratio of 298.56 ± 0.31 (Lee et al., 2010). Laser fusion of >10 individual Fish Canyon Tuff sanidine crystals at each closely monitored position within the irradiation package resulted in neutron flux ratios reproducible to ≤ 0.25% (2σ). Isotopic production ratios were determined from irradiated CaF2 and KCl salts and for this study the following values were measured: (36Ar/37Ar)Ca = (2.4±0.05) x10-4; (39Ar/37Ar)Ca = (6.59±0.10) x10-4; and (38Ar/39Ar)K = (1.29±0.03) x10-2. Cadmium shielding during irradiation prevented any measurable (40Ar/39Ar)K. 40Ar/39Ar plateau ages (and uncertainties) are considered the best estimate of the cooling age of the minerals and were calculated from samples if three or more consecutive heating steps released ≥ 50% of the total 39Ar and also had statistically (2sd) indistinguishable 40Ar/39Ar ages.

***Fission Track Analysis Methodology***

Apatite and zircon fission track analysis was performed at the University of Arizona Fission Track Lab by S. Thomson. Apatite grains were mounted in epoxy resin, alumina and diamond polished, and spontaneous fission tracks revealed by etching with 5.5M HNO3 at 20 (±1)°C for 20 (±0.5) seconds (Donelick et al., 2005). Zircon grains were mounted in PFA Teflon, diamond polished, and etched in an oven at 220°C using a KOH-NaOH eutectic melt (Gleadow et al., 1976) in a zirconium crucible for between 9 and 33 hours. The optimum etch time is dependent on age and radiation damage, and was monitored by repeated etching and observation at 3-6 hour time intervals. Samples were analyzed by applying the external detector method (Gleadow, 1981) using very low uranium, annealed muscovite mica detectors, and irradiated at the Oregon State University Triga Reactor, Corvallis, USA. The neutron fluence was monitored using European Institute for Reference Materials and Measurements (IRMM) uranium-dosed glasses IRMM 540R (~15ppm U) for apatite and IRMM 541 (~49.4 ppm U) for zircon. After irradiation, induced tracks in the mica external detectors were revealed by etching with 48% HF for 18 minutes. Spontaneous and induced FT densities were counted using an Olympus BX61 microscope at 1250x magnification with automated Kinetek Stage system. Apatite FT lengths and Dpar values were measured using FTStage software, an attached drawing tube and digitizing tablet supplied by Trevor Dumitru of Stanford University calibrated against a stage micrometer. Central ages (Galbraith and Laslett, 1993; Galbraith, 2005), quoted with 1σ errors, were calculated using the IUGS recommended zeta-calibration approach of Hurford and Green (1983) with apatite and zircon IRMM 540R and IRMM541 zeta calibration factors of 368.1±14.9 and 121.1±3.5 respectively, obtained by repeated calibration against a number of internationally agreed age standards including Durango and Fish Canyon apatite, and Fish Canyon zircon, according to the recommendations of Hurford (1990)

***Apatite (U-Th)/He Analysis Methodology***

Apatite (U-Th)/He dating was performed at the University of Arizona Radiogenic Helium Dating Laboratory. Analyses followed the procedures outlined in Reiners et al. (2004) and Reiners (2005). Individual grains were selected from separates on the basis of size (>60µm diameter), morphology, and lack of inclusions. Grain dimensions were measured from digital photomicrographs and alpha ejection (FT) corrections calculated according to Farley (2002) assuming a hexagonal prism morphology. Single grains were then packed into 1-mm Nb foil envelopes. To extract radiogenic 4He, individual apatite packets were heated to ~1065°C for 3 minutes by a focused Nd-YAG or diode laser in a laser cell attached to an ultrahigh vacuum gas extraction line. Standards of Durango apatite (31.44 ± 0.18 Ma (2σ); McDowell et al., 2005) were analyzed between every 5 unknowns. Gas released from heated samples was spiked with 3He, and purified using cryogenic and gettering methods, and analyzed on a Balzers quadrupole mass spectrometer. Analysis of a known quantity of 4He was performed after every 4-5 unknown analyses to monitor instrumental sensitivity and drift. After He extraction and measurement, foil packets were retrieved and transferred to Teflon vials. Apatite grains were dissolved in HNO3 at 90 °C for 1 h. Vials were then spiked with 233U, 229Th and 147Sm. An additional 44Ca spike was used to calculate the stoichiometric apatite mass and volume. Natural-to-spike isotope ratios were then measured on an Element2 ICP-MS. Precision on measured U-Th ratios is typically better than 0.5%.

***HeFTy modeling***

Time-temperature (tT) modeling of AFT and AHE data from samples 11CAT05 and 11CAT15 was conducted using the software HeFTy, version 1.9.3 (Ketcham, 2005). To predict AFT data, the 5.5M etchant AFT annealing model of Ketcham et al. (2007) was applied using measured Dpar as the kinetic parameter, and the measured track lengths (n= 69 for 11CAT05; n=103 for 11CAT15). To predict AHe data from sample 11CAT15 the RDAAM model of Flowers et al. (2009) was used. AHe data from grain 2 (18.3 Ma) was excluded from the modeling, as no acceptable T-t paths were found to predict the data when it was included. This grain has very high U (113 ppm) and we suspect this age may be anomalously young.

The software randomly-generates tT paths to predicted AFT and AHe data including measured ages, Dpar values, and single grain AHe age and effective uranium (eU) values, until 100 good fits were found according to the above applied models. The goodness of fit value is a merit function that combines tests for the fit of the both the model predicted track length distribution and model predicted AFT age against the measured data using a Kuiper’s test to indicate the probability of failing the null hypothesis that the model and data are different (Willett, 1997). We used the default merit values of 0.5 for ‘good’ fit and 0.05 for ‘acceptable’ fit. When fitting multiple statistics HeFTy uses a mean merit value of 0.5 to define good fit, with an additional criterion imposed with the minimum merit value for any one statistic being 1/(N+1), where N is the number of statistics being evaluated (Ketcham et al., 2009).

The randomly generated tT paths were constrained by several tT boxes (and a present day surface temperature constraint of 10±10°C). Given that the dZFT grain ages from both these samples indicate an almost exclusive Niğde Massif source, and that some apatite grains in both modeled samples show older grain ages that may not have been fully reset by later post-depositional reheating, we constrain the early part of the tT paths by using the ZFT central age from the same sample, and a similar aged-surface temperature constraint to simulate the rapid Late Cretaceous tectonic exhumation and cooling of these rocks from which the apatite grains originate (e.g. Whitney et al., 2003; Idleman et al, 2014). A third tT constraint box is defined by the Paleocene-early Eocene depositional age of these samples (60-50 Ma; 10±10 °C). A fourth constraint box was used between the depositional age and the minimum age of the late Eocene- early Miocene unconformity with temperature range of 0°C to 180°C to allow HeFTy to explore a full range of possible tT histories following deposition. The late Eocene- early Miocene unconformity itself is defined by a 20-15 Ma minimum age and 10±10°C surface temperature constraint box. One final constraint box was used to allow randomly generated tT paths to simulate some sample burial by the overlying Miocene-Pliocene deposits of the Çukurbağ Formation and Pliocene Burç sub-basin.

***U-Pb geochronologic analyses of zircon (Element2 HR ICPMS)***

For detrital zircon analysis, a large split of grains (generally thousands of grains) was incorporated into a 1” epoxy mount together with fragments or loose grains of Sri Lanka, FC-1, and R33 zircon crystals that are used as primary standards. For igneous samples, ~50 high-quality grains were selected and mounted with standards, generally with four samples per mount. The mounts were sanded down to a depth of ~20 microns, polished, imaged, and cleaned prior to isotopic analysis.

U-Pb geochronology of zircons was conducted by laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) at the Arizona LaserChron Center (Gehrels et al., 2006, 2008; Gehrels and Pecha, 2014). The analyses involve ablation of zircon with a Photon Machines Analyte G2 excimer laser equipped with HelEx ablation cell using a spot diameter of 20 microns. The ablated material was carried in helium into the plasma source of an Element2 HR ICPMS, which sequences rapidly through U, Th, and Pb isotopes. Signal intensities were measured with an SEM that operates in pulse counting mode for signals less than 50K cps, in both pulse-counting and analog mode for signals between 50K and 5M cps, and in analog mode above 5M cps. The calibration between pulse-counting and analog signals was determined line-by-line for signals between 50K and 5M cps, and is applied to >5M cps signals. Four intensities were determined and averaged for each isotope, with dwell times of 0.0052 sec for 202, 0.0075 sec for 204, 0.0202 sec for 206, 0.0284 sec for 207, 0.0026 sec for 208, 0.0026 sec for 232, and 0.0104 sec for 238.

Laser energy density was set at ~5 J/cm2, a repetition rate of 8 hz, and an ablation time of 10 seconds, ablation pits are ~12 microns in depth. Sensitivity with these settings is approximately ~5,000 cps/ppm. Each analysis consists of 5 sec on peaks with the laser off (for backgrounds), 10 sec with the laser firing (for peak intensities), and a 20 second delay to purge the previous sample and save files.

Prior to analysis, BSE images of detrital grains were imaged to provide a guide for locating analysis pits in optimal locations, and to assist in interpreting results. Images were made with a Hitachi 3400N SEM and a Gatan CL2 detector system (www.geoarizonasem.org).

***U-Pb geochronologic analyses of zircon (Nu Plasma HR ICPMS)***

U-Pb geochronology of detrital zircon was also conducted on some of sample 11CAT13 using the Nu HR ICPMS at the Arizona LaserChron Center (Gehrels et al., 2006, 2008).  The analyses involve ablation of zircon with a Photon Machines Analyte G2 excimer laser using a spot diameter of 30 microns.  The ablated material was carried in helium into the plasma source of a Nu HR ICPMS equipped with a flight tube of sufficient width that U, Th, and Pb isotopes can be measured simultaneously.  All measurements were made in static mode, using Faraday detectors with 3x1011 ohm resistors for 238U, 232Th, 208Pb-206Pb, and discrete dynode ion counters for 204Pb and 202Hg.  Ion yields are ~0.8 mv per ppm.  Each analysis consists of one 15-second integration on peaks with the laser off (for backgrounds), 15 one-second integrations with the laser firing, and a 30 second delay to purge the previous sample and prepare for the next analysis.  The ablation pit is ~15 microns in depth.

For each analysis, the errors in determining 206Pb/238U and 206Pb/204Pb result in a measurement error of ~1-2% (at 2-sigma level) in the 206Pb/238U age.  The errors in measurement of 206Pb/207Pb and 206Pb/204Pb also result in ~1-2% (at 2-sigma level) uncertainty in age for grains that are >1.0 Ga, but are substantially larger for younger grains due to low intensity of the 207Pb signal.  For most analyses, the cross-over in precision of 206Pb/238U and 206Pb/207Pb ages occurs at ~1.0 Ga.

204Hg interference with 204Pb was accounted for by measurement of 202Hg during laser ablation and subtraction of 204Hg according to the natural 202Hg/204Hg of 4.34.  This Hg is correction is not significant for most analyses because our Hg backgrounds are low (generally ~150 cps at mass 204).

Common Pb correction was accomplished by using the Hg-corrected 204Pb and assuming an initial Pb composition from Stacey and Kramers (1975).  Uncertainties of 1.5 for 206Pb/204Pb and 0.3 for 207Pb/204Pb are applied to these compositional values based on the variation in Pb isotopic composition in modern crystal rocks.

Inter-element fractionation of Pb/U is generally ~5%, whereas apparent fractionation of Pb isotopes is generally <0.2%.  In-run analysis of fragments of a large zircon crystal (generally every fifth measurement) with known age of 563.5 ± 3.2 Ma (2-sigma error) is used to correct for this fractionation.  The uncertainty resulting from the calibration correction is generally 1-2% (2-sigma) for both 206Pb/207Pb and 206Pb/238U ages.

Concentrations of U and Th were calibrated relative to our Sri Lanka zircon, which contains ~518 ppm of U and ~68 ppm Th.

Following analysis on either machine, data reduction was performed with an in-house Python decoding routine and an Excel spreadsheet (E2agecalc) . For detrital analyses, the ages were plotted on cumulative age plots and on relative age-probability diagrams using the routines in Isoplot (Ludwig, 2008). The age-probability diagrams show each age and its uncertainty (for measurement error only) as a normal distribution, and sum all ages from a sample into a single curve.

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