# Ducea et al., Building the Pamirs: The view from the underside

# Data Repository item 2003129

## A. Methods

Thermobarometry. Major element phase chemistry measurements were determined at UCSB and University of Arizona using electron microprobes. Results and the choice of thermometer/barometer are given in Table DR1.

Ar-Ar geochronology. Ar-Ar age determinations were performed on mineral separates using the laser step heating technique at Stanford (Gansecki et al., 1996). Results and errors are given in Table DR2.

U-Pb geochronology. Zircons and monazites were analyzed *in–situ* in polished thin sections with the University of Arizona Micromass Isoprobe multicollector ICPMS equipped with 9 faraday collectors, an axial Daly detector, and 4 ion-counting channels. Results are given in Table DR3. The Isoprobe is equipped with an ArF Excimer laser, which has an emission wavelength of 193 nm. The analyses were conducted on 10 or 15 micron spots with an output energy of ~32 mJ and a repetition rate of 8 hz. Each analysis consisted of one 20-second integration on the backgrounds (on peaks with no laser firing) and twenty 1-second integrations on peaks with the laser firing. The depth of each ablation pit is ~15 microns. The collector configuration used allows simultaneous measurement of $^{204}$Pb in an ion-counting channel while $^{206}$Pb, $^{207}$Pb, $^{208}$Pb, $^{232}$Th, and $^{238}$U are measured with Faraday detectors. All analyses were conducted in static mode. Inter-element fractionation during the analyses was monitored by analyzing fragments of a large concordant zircon crystal that has a known (ID-TIMS) age of 564 ± 4 Ma (2-sigma). The reported ages for zircon grains are based on $^{206}$Pb/$^{238}$U ratios because errors of the $^{207}$Pb/$^{235}$U and $^{206}$Pb/$^{207}$Pb ratios are significantly greater. This is due primarily to the low intensity (commonly <1 mV) of the $^{207}$Pb signal from these young, U-poor grains. The monazite ages are also based on $^{206}$Pb/$^{238}$U ratios because a monazite standard was not analyzed during the study (prior analyses have shown that the Pb/U fractionation is similar for both zircon and monazite, whereas Pb/Th fraction is significantly different). For both zircon and monazite, the $^{206}$Pb/$^{238}$U ratios are corrected for common Pb by using

the measured $^{206}Pb/^{204}Pb$, a common Pb composition (Stacey and Kramers, 1975), and an uncertainty of 1.0 on the common $^{206}Pb/^{204}Pb$.

**B. Data Tables**

**Table DR1. Summary of thermobarometric results**.

| Rock | T (°C) | method | P (kb) | method |
|---|---|---|---|---|
| 337 | 760 ± 100 | Krogh-Ravna (2000) | 21.8 ± 0.7 | ab=jd+qz |
| 1154B rim | 1076 ± 213 | all reactions; THERMOCALC | 26.9 ± 5.6 | all reactions; THERMOCALC |
| 1309 | 1045 ± 100 | Krogh-Ravna (2000) | Ó23.8 ± 0.5 | ab=jd+qz aab=1 |
| 1283B | 1090 ± 100 | Krogh-Ravna (2000) | Ó24.0±0.7 | ab=jd+qz aab=1 |
| 1503A | >950–1050 | absence of mu and bi, THERMOCALC | Ó14 | ky=sill |
| 1154A | 1059 ± 185 | all reactions; THERMOCALC | 25.6 ± 4.5 | all reactions; THERMOCALC |

Temperatures calculated either from Fe–Mg partitioning between garnet and clinopyroxene, using the method of Krogh-Ravna (2000), which has an accuracy of ~100°C, or from intersections of all end-member reactions for equilibrium phases using THERMOCALC. Pressures calculated either from jadeite component of clinopyroxene in equilibrium with feldspar, using THERMOCALC, or from intersections of all end-member reactions for equilibrium phases using THERMOCALC. Uncertainties shown are ±1ω.

**Table DR2. Summary of $^{40}Ar$-$^{39}Ar$ age determinations.**

| Sample | Mineral | age |
|---|---|---|
| | *ultrapotassic volcanic pipe* | |
| D5 | K-feldspar | 10.8 ± 0.15 |
| | biotite | 10.9 ± 0.2 |
| D4 | K-feldspar | 10.9 ± 0.4 |
| | groundmass | 10.9 ± 0.14 |
| A2000 | hornblende | 11.1 ± 0.14 |
| | K-feldspar | 11.1 ± 0.14 |
| | | 10.9 ± 0.14 |
| B2000 | K-feldspar | 11.0 ± 0.14 |
| | *xenoliths* | |
| 337 | biotite | 11.5 ± 0.2 |
| 2014 | biotite | 11.2 ± 0.2 |

Uncertainties are ± 2ω. Analytical techniques in (Gansecki et al., 1996).

**Table DR3. U-Pb zircon and monazite analytical data.**

| Grain[%] | U (ppm) | $^{206}Pb/^{204}Pb$ | U/Th | $^{206}Pb^*/^{238}U$ | ± (%) | $^{206}Pb^*/^{238}U$ | ± (Ma) |
|---|---|---|---|---|---|---|---|
| **Metapelite P1503A** | | | | | | | |
| Zircons | | | | | | | |
| s1c1 | 45 | 316 | 10 | 0.00232 | 10.1 | 15.0 | 1.5 |
| s2c7g1a | 28 | 2366 | 299 | 0.00244 | 41.3 | 15.7 | 6.5 |
| s1c4g3 | 71 | 1300 | 22 | 0.00884 | 9.5 | 56.7 | 5.4 |
| scc6g1a | 86 | 9044 | 3 | 0.00843 | 8.9 | 58.1 | 4.8 |
| s1c4 | 88 | 2965 | 6 | 0.01156 | 7.4 | 74.1 | 5.5 |
| s1c3g3 | 183 | 11834 | 634 | 0.01312 | 3.8 | 84.0 | 3.2 |
| s1c3 | 274 | 48929 | 18 | 0.02305 | 8.9 | 146.9 | 13.3 |
| s1c2 | 132 | 9685 | 40 | 0.02666 | 6.5 | 169.6 | 11.1 |
| s1c3g2 | 86 | 39133 | 49 | 0.06609 | 3.3 | 412.6 | 13.9 |
| s2c10gc | 81 | 138466 | 6 | 0.06955 | 3.3 | 433.5 | 14.6 |
| s2c10g1 | 45 | 41727 | 8 | 0.07487 | 3.9 | 465.4 | 18.9 |
| s1c31 | 14 | 8000 | 4 | 0.14807 | 10.3 | 890.1 | 97.6 |
| s1c3g2 | 11 | 13747 | 6 | 0.24039 | 7.0 | 1388.7 | 107.6 |
| Monazites | | | | | | | |
| s2c5g1bm | 384 | 1255 | 0.20 | 0.00530 | 1.4 | 34.1 | 0.5 |
| s2c5g1am | 501 | 1726 | 0.17 | 0.00588 | 1.7 | 37.8 | 0.6 |
| s1c4gr31cm | 483 | 1739 | 0.23 | 0.00599 | 0.7 | 38.5 | 0.3 |
| s1c4g31dm | 568 | 1875 | 0.27 | 0.00600 | 1.5 | 38.6 | 0.6 |
| s1c4g31bm | 242 | 8408 | 0.29 | 0.00783 | 5.1 | 50.3 | 2.6 |
| **Sanidine eclogite P1309** | | | | | | | |
| Zircons | | | | | | | |
| s3c3g1c | 49 | 2813 | 15 | 0.00995 | 2.4 | 63.8 | 1.5 |
| s3c3g1b | 18 | 787 | 3 | 0.01368 | 7.3 | 87.6 | 6.4 |
| s3c11g1b | 79 | 20866 | 106 | 0.02070 | 22.5 | 132.1 | 29.9 |
| s3c10g1a | 58 | 81701 | 375 | 0.03081 | 18.1 | 195.6 | 35.9 |
| s4c3g1a | 35 | 6721 | 8 | 0.03874 | 6.5 | 245.0 | 16.2 |
| s4c3g1b | 29 | 2248 | 10 | 0.03990 | 13.1 | 252.2 | 33.6 |

[%]- Indicates individual grain analyses. * Indicates radiogenic Pb (corrected for initial Pb in zircons). $^{206}Pb/^{204}Pb$ is measured ratio. All uncertainties are at the 1-sigma level and reflect only random errors. Systematic errors from decay constants, calibration correction, and common Pb composition add ~2% (1-sigma) error. U concentration has an uncertainty of ~25%. Decay constants: $^{235}U=9.8485x10^{-10}$, $^{238}U=1.55125x10^{-10}$, $^{238}U/^{235}U=137.88$. Isotope ratios are corrected for Pb/U fractionation by comparison with standard zircon with an age of 564 ± 4 Ma (2-sigma). Initial Pb composition interpreted from Stacey and Kramers (1975), with uncertainty of 1.0 for $^{206}Pb/^{204}Pb$.