

*Tectonics*

Supporting Information for

**The Limpopo magma-rich transform margin (South Mozambique) – part 2: Implications for the Gondwana breakup**

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**Introduction**

The supporting information shows a general overview of the 40Ar/39Ar method the 40Ar/39Ar results.

**Text S1. 40Ar/39Ar Methodology**

Sample F1-1-1 was irradiated in the 8C facility of the Mac Master Nuclear Reactor (Hamilton, Ontario, Canada). Irradiation lasted 80 h with a global efficiency (J/h) of 6.755 x 10-5 h-1. The irradiation standard was sanidine TCRs (28.608 ± 0.033 Ma according to Renne *et al*., 1998, 2010 and 2011). Two whole rock single grains were analyzed by the 40Ar/39Ar method in step-heating using a CO2 laser probe coupled with a MAP 215 mass spectrometer. The procedure was described by Ruffet *et al*. (1991, 1995, 1997).

Blanks were performed routinely each first or third/fourth run, and are subtracted from the subsequent sample gas fractions. Apparent age errors are plotted at the 1σ level and do not include the errors on the 40Ar\*/39ArK ratio and age of the monitor and decay constant. Plateau ages were calculated if 70 % or more of the 39ArK was released in at least three or more contiguous steps which define apparent ages agreeing, to within 2σ, with the integrated age of the plateau segment. Pseudo-plateau ages (PPA) can be defined with less than 70 % of the 39ArK released. The errors on the 40Ar\*/39ArK ratio and age of the monitor and decay constant are included in the final calculation of the error margins on the plateau ages.

40Ar/39Ar ages are provided with 1σ errors. Analytical data and parameters used for calculations (*e.g.* isotopic ratios measured on pure K, Ca and Cl salts; mass discrimination; atmospheric argon ratios; J parameter; decay constants) are available in the Supporting Information 2.

**Text S2. References for 40Ar/39Ar Methodology**

Renne, P. R. *et al.* Intercalibration of standards, absolute ages and uncertainties in 40Ar/39Ar dating. *Chem. Geol.*145, 117–152 (1998).

Renne P.R., Mundil R., Balco G., Min K., Ludwig R.L., (2010). Joint determination of 40K decay constants and 40Ar∗/40K for the Fish Canyon sanidine standard, and improved accuracy for 40Ar/39Ar geochronology. Gechimica Cosmochimica Acta, 74, 5349–5367.

Renne P.R., Balco G., Ludwig R.L., Mundil R., Min K., (2011). Response to the comment by W.H. Schwarz *et al*. on "Joint determination of 40K decay constants and 40Ar∗/40K for the Fish Canyon sanidine standard, and improved accuracy for 40Ar/39Ar geochronology" by PR Renne *et al*. (2010). Geochimica Cosmochimica Acta, 75, 5097-5100. chimica Cosmochimica Acta, 75, 5097-5100.

Ruffet, G., Féraud, G., Amouric, M., 1991. Comparison of 40Ar-39Ar conventional and laser dating of biotites from the North Trégor Batholith. Geochimica Cosmochimica Acta 55, 1675–1688.

Ruffet, G., Féraud, G., Balèvre, M., Kiénast, J.-R., 1995. Plateau ages and excess argon in phengites: an 40Ar-39Ar laser probe study of Alpine micas (Sesia Zone, Western Alps, northern Italy). Chemical Geology 121, 327–343.

Ruffet, G., Gruau, G., Balèvre, M., Féraud, G., Philippot, P., 1997. Rb-Sr and 40Ar-39Ar laser probe dating of high-pressure phengites from the Sesia zone (Western Alps): underscoring of excess argon and new age constraints on the high-pressure metamorphism. Chemical Geology 141, 1–18.

**Text S3. References for 40Ar/39Ar parameters**

 [1] Lee, JY, Marti, K, Severinghaus, JP, Kawamura, K, Yoo, HS, Lee, JB, Kim, JS (2006). A redetermination of the isotopic abundances of atmospheric Ar. Geochimica Cosmochimica Acta, 70, 4507-4512.

[1'] Mark, DF, Stuart, FM, De Podesta, M (2011). New high-precision measurements of the isotopic composition of atmospheric argon. Geochimica Cosmochimica Acta, 75, 7494-7501.

[2] Renne, PR, Balco, G, Ludwig, RL, Mundil, R, Min, K, . (2011). Response to the comment by W.H. Schwarz et al. on "Joint determination of (40)K decay constants and (40)Ar\*/(40)K for the Fish Canyon sanidine standard, and improved accuracy for (40)Ar/(39)Ar geochronology" by PR Renne et al. (2010). Geochimica Cosmochimica Acta, 75, 5097-5100.

[3] York, D, Personnal Communication - McMaster reactor

Regression method: York, D. (1969). Least-squares fitting of a straight line with correlated errors. Earth Planet. Sci. Lett. 5, 320-4.

Ages and errors of Hb3gr and TCs monitors refers to: Rennes, PR, Balco, G, Ludwig, Mundil, R, Min, K, . (2011). Response to the comment by W.H. Schwarz et al. on "Joint determination of (40)K decay constants and (40)Ar\*/(40)K for the Fish Canyon sanidine standard, and improved accuracy for (40)Ar/(39)Ar geochronology" by PR Renne et al. (2010). Geochimica Cosmochimica Acta, 75, 5097-5100.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | J parameter | error J |  |  | Mass Discrimination (1+e) | Err Discrimination  |  |  |  |  |  |  |  |
|  | F1-1-1 Whole Rock |  | 5,40E-03 | 1,83E-05 |  |  | 1,009188 | 1,32E-03 |  |  |  |  |  |  |  |
| laser power | 40Ar  | Error 40Ar  | 39Ar  | Error 39Ar  | 38Ar  | Error 38Ar  | 37Ar  | Error 37Ar  | 36Ar  | Error 36Ar  | 40Ar\*/39ArK | Error 40Ar\*/39ArK | Apparent age (My) | Error Age (My) | Delay to irradiation (day) |
| 1 | 1555,064826 | 1,767361 | 10,942296 | 0,025818 | 0,001272 | 0,021832 | 3,204103 | 0,02472 | 5,09619 | 0,037849 | 8,449198 | 1,248882 | 80,719968 | 11,673587 | 120,830556 |
| 2 | 43,946623 | 0,147075 | 1,162368 | 0,031463 | 0,000001 | 0,017348 | 0,402238 | 0,030173 | 0,119395 | 0,010457 | 8,691531 | 2,637986 | 82,982774 | 24,619403 | 120,850694 |
| 3 | 352,670075 | 0,471075 | 10,05946 | 0,031823 | 0,01029 | 0,026375 | 3,46539 | 0,072332 | 0,558391 | 0,032476 | 19,65147 | 0,949362 | 182,470094 | 8,417341 | 120,870833 |
| 4 | 367,216032 | 0,519939 | 9,79928 | 0,035807 | 0,000001 | 0,015852 | 34,296447 | 0,084942 | 0,74659 | 0,028218 | 19,867818 | 0,876735 | 184,379901 | 7,771142 | 120,890972 |
| 5 | 201,190636 | 0,479321 | 6,143136 | 0,036553 | 0,000001 | 0,018143 | 87,505073 | 0,181034 | 0,640681 | 0,017637 | 19,836331 | 0,979207 | 184,102068 | 8,672726 | 120,930556 |
| 6 | 417,266509 | 0,529247 | 13,078911 | 0,063742 | 0,000001 | 0,024174 | 213,683531 | 0,262256 | 1,42391 | 0,019855 | 20,230993 | 0,563017 | 187,581286 | 5,016264 | 120,961111 |
| 7 | 356,194699 | 0,557079 | 12,834131 | 0,101029 | 0,000001 | 0,016479 | 270,858555 | 0,342047 | 1,468226 | 0,011035 | 20,177452 | 0,431326 | 187,109672 | 3,874357 | 120,980556 |
| 8 | 363,274574 | 0,222573 | 11,164099 | 0,037459 | 0,000001 | 0,012917 | 147,250905 | 0,261216 | 0,792492 | 0,011423 | 29,326037 | 0,400454 | 265,959436 | 3,539995 | 121,650694 |
| 9 | 25,191017 | 0,10911 | 0,639111 | 0,015141 | 0,000001 | 0,013112 | 0,527611 | 0,016992 | 0,002881 | 0,010339 | 39,580063 | 4,825643 | 350,432846 | 38,86405 | 121,670833 |
| Fusion | 18,096103 | 0,044659 | 0,459112 | 0,014863 | 0,000001 | 0,009633 | 0,243996 | 0,017229 | 0,025738 | 0,009823 | 24,139148 | 6,289684 | 221,677646 | 54,366917 | 121,690972 |

**Table S1.** 40Ar/39Ar step heating result of sample F1-1-1.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | J parameter | error J |  |  | Mass Discrimination (1+e) | Err Discrimination  |  |  |  |  |  |  |  |
|  | F1-1-1 Whole Rock |  | 5,40E-03 | 1,83E-05 |  |  | 1,009188 | 1,32E-03 |  |  |  |  |  |  |  |
| laser power | 40Ar  | Error 40Ar  | 39Ar  | Error 39Ar  | 38Ar  | Error 38Ar  | 37Ar  | Error 37Ar  | 36Ar  | Error 36Ar  | 40Ar\*/39ArK | Error 40Ar\*/39ArK | Apparent age (My) | Error Age (My) | Delay to irradiation (day) |
| 1 | 1207,747027 | 0,551878 | 37,083581 | 0,128416 | 0,018429 | 0,025782 | 18,657355 | 0,065737 | 1,06232 | 0,032017 | 25,160824 | 0,277245 | 230,486152 | 2,557641 | 121,740972 |
| 2 | 923,798307 | 0,713533 | 32,695716 | 0,077655 | 0,004313 | 0,028634 | 34,380672 | 0,065612 | 0,864704 | 0,015343 | 22,115748 | 0,163067 | 204,104962 | 1,643883 | 121,761111 |
| 3 | 421,661987 | 0,417968 | 17,264161 | 0,053171 | 0,000001 | 0,025404 | 42,401829 | 0,143742 | 0,495706 | 0,020936 | 19,276807 | 0,371011 | 179,157984 | 3,36202 | 121,780556 |
| 4 | 804,199597 | 0,341825 | 31,812346 | 0,064928 | 0,000001 | 0,014531 | 227,641995 | 0,349342 | 1,584841 | 0,015324 | 19,76336 | 0,182374 | 183,45805 | 1,772755 | 121,840972 |
| 5 | 1090,668606 | 0,754597 | 45,943435 | 0,064056 | 0,000001 | 0,014827 | 692,262228 | 0,698851 | 3,621616 | 0,016004 | 19,408189 | 0,196375 | 180,320128 | 1,883672 | 121,861111 |
| 6 | 863,169934 | 0,568664 | 31,762229 | 0,037671 | 0,002753 | 0,023289 | 574,323618 | 0,610606 | 3,275533 | 0,034187 | 19,517544 | 0,420978 | 181,286849 | 3,792231 | 121,880556 |
| 7 | 413,292611 | 0,497164 | 11,836143 | 0,032773 | 0,000001 | 0,012949 | 154,806545 | 0,239797 | 0,895352 | 0,013921 | 30,445429 | 0,445354 | 275,375335 | 3,894076 | 121,920833 |
| Fusion | 895,658186 | 0,892144 | 33,40344 | 0,064355 | 0,023259 | 0,012888 | 50,587455 | 0,159705 | 0,813512 | 0,026389 | 21,846685 | 0,245737 | 201,755301 | 2,296366 | 121,940972 |

**Table S2.** 40Ar/39Ar step heating result of sample F1-1-1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | (36Ar/37Ar)Ca | 0,000322 | 3 | % |
|  | (39Ar/37Ar)Ca | 0,000788 | 4 | % |
|  | (38Ar/37Ar)Ca | 0,000026 | 100 | % |
|  | (40Ar/37Ar)Ca | 0,0006 | 100 | % |
|  | (40Ar/39Ar)K | 0,00085 | 4 | % |
|  | (38A/39Ar)K | 0,011 | 91 | % |
| [3] | (36Cli/38Cl) | 316 | 5 | % |
| [1] and [1'] | (40Ar/36Ar)Atm | 298,56 | 0,104 | % |
| [1] and [1'] | (38Ar/36Ar)Atm | 0,1885 | 0,159 | % |
| [2] | Lambda 40 | 5,53E-10 | 1,35E-12 | y-1 |
|  | Lambda 39 | 2,58E-03 |  | y-1 |
|  | Lambda 37 | 1,98E-02 |  | d-1 |
|  | Lambda 36Cl | 2,26E-06 |  | y-1 |

**Table S3.** 40Ar/39Ar parameters