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# 743 ± 17 Ma granite clast from Jurassic conglomerate, Kamiaso, Mino Terrane, Japan: the case for South China Craton provenance (Korean Gyeonggi Block?)

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### Abstract

The polymict Kamiaso Conglomerate (Mino Terrane, Japan) contains Jurassic to Palaeoproterozoic clasts—probably derived from Korean basement that lay nearby to the northwest at time of deposition. Clast K2 broke cleanly into two halves during sampling (but the halves were recombined for zircon separation). A third of the K2 zircons are colourless euhedral prisms with oscillatory zoning, with no inheritance and yielded a SHRIMP U/Pb date of 743±17 Ma. Two thirds of K2 zircons are brown oscillatory-zoned corroded prisms with a date of 1860±8 Ma, with inherited cores up to ∼2460 Ma. A likely explanation for this could be that clast K2 might have been composite, and contained undistinguished 743 Ma and 1860 Ma granites. Kamiaso granitic clast K3 igneous zircons gave a date of 179.3/−2.1 Ma (Toarcian–Early Jurassic), with 2100–2300 Ma and ∼1860 Ma inherited cores. ∼740 Ma A-type magmatism related to the extension and break up of Rodinia occurs in both Korea (Gyeonggi Block) and the main part of the South China Craton, but is unknown in the Sino-Korean Craton. Thus from recognition of a 743 Ma clast, the Kamiaso detritus was probably derived from the northernmost part of the South China Craton in Korea.



### Keywords

17, ma, granite, clast, korean, jurassic, gyeonggi, conglomerate, kamiaso, 743, mino, block, terrane, japan, case, china, craton, south, provenance, GeoQUEST


### Disciplines

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# 743+/-17 Ma granite clast from Jurassic conglomerates, Kamiaso, Mino Terrane, Japan: the case for South China Craton provenance (Korean Gyeonggi Block?)

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~740 Ma A-type magmatism related to the extension and break up of Rodinia occurs in both Korea (Gyeonggi Block) and the main part of the South China Craton, but is unknown in the Sino-Korean Craton. Thus from recognition of a 743 Ma clast, the Kamiaso detritus was probably derived from the northernmost part of the South China Craton in Korea.

**Keywords:** Kamiaso, Asian terranes, Rodinia, U-Pb zircon geochronology, Precambrian in Japan

## 1. Introduction

Kamiaso is in the Mino terrane, one of the several Mesozoic accretionary terranes of central Japan (Fig. 1). Around Kamiaso Jurassic turbidite is an important lithology. Rare conglomerates in these turbidites (Adachi, 1971) contain clasts of paragneiss, orthogneiss and metagranitoids. Prior to opening of the Japan Sea in the Neogene, Korean crystalline basement would have formed the hinterland to the northwest when the sediments of the Mino terrane were deposited in the Jurassic. Some of these clasts were derived from Proterozoic crystalline basement (e.g. Shibata et al., 1971; Hidaka et al., 2002) and as such are the only known pieces of Precambrian rock in Japan. U-Pb zircon dating has already been used to date metasedimentary and volcano-sedimentary clasts from Kamiaso. The first Kamiaso U-Pb studies using the CHIME (U-Th-total Pb) method by Adachi and Suzuki (1993) found Mesoarchaean detritus in these sediments, indicating that some very old detritus occurs within the Mesozoic accretionary terranes of Japan. More precise and accurate zircon dating with the HU-SHRIMP (Hiroshima University Sensitive High Resolution Ion MicroProbe) by Sano et al. (2000) and Hidaka et al. (2002) also found Archaean and Palaeoproterozoic detritus in the Kamiaso sediments, again indicating derivation from a complex terrane in mainland Asia which included Precambrian crystalline basement rocks.

U-Pb zircon dating is a powerful tool in identifying source tectono-stratigraphic terranes of detrital material in sediments. Hidaka et al. (2002) pointed out that 3250 Ma zircons in their sample provided some link with the South China Craton (Fig. 1a), because rocks of that age occur there (Qiu et al., 2000) whereas to the north of the Mesozoic Dabieshan suture in the North China (formerly Sino-Korean) Craton, rocks of that age are presently unknown (e.g. Song et al., 1996). A South China Craton source for Kamiaso detritus is feasible because recent geological and geochronological results (reviewed by Li. Z.X. et al., 2003a) indicate that parts of Korea (definitely the Gyeonggi Block and possibly the Yeongam Block – Fig. 1a) represent the northernmost extremity of the South China Craton.

The strongest line of evidence for the Korean – South China Craton linkage comes from the presence of ~740 Ma volcanic and plutonic rocks with A-type / within plate chemistry in both Korea (e.g. Lee, K.S. et al., 1998; Lee, S.R. et al., 2003) and in the South China Craton *sensu stricto* (e.g. Li, Z.X. et al., 2003; Wang and Li, 2003). On the other hand ~740 Ma igneous rocks have *not* been identified in the North China (Sino-Korean) Craton. Thus, as surmised by Lee et al. (2003), the South China Craton including parts of Korea is a complex ancient terrane that from ~830 Ma underwent extension and anorogenic bimodal magmatism related to the break-up of the supercontinent Rodinia.

This paper reports zircon dating on granitic clasts from the Kamiaso conglomerate, and the recognition of ~750 Ma material in it. This is strong evidence supporting the suggestion of Hidaka et al. (2002) that the Jurassic conglomerates at Kamiaso contain material derived from the South China Craton – probably its northernmost part in Korea.

## 2. The Kamiaso conglomerate – Mino terrane

Around Kamiaso (35°32’N 137°08’E) in the Mino terrane of central Japan (Fig. 1b) Jurassic turbidite is an important lithology. Rare conglomerates in these turbidites (Adachi, 1971) contain clasts of paragneiss, orthogneiss and metagranitoids. The source terrane of at least some of these clasts underwent amphibolite facies metamorphism (Adachi, 1971, 1973; Shibata and Adachi, 1974). Rb-Sr and K-Ar dating of crystalline clasts from the Kamiaso conglomerate gave dates of 1000 to 2000 Ma (Shibata et al., 1971; Shibata and Adachi 1972, 1974), whereas some orthogneiss clasts gave an imprecise Sm-Nd date of 2070+/-60 Ma (Shimizu et al. 1996). CHIME single zircon and monazite dating (Adachi and Suzuki 1993) gave mostly dates of ca. 2000 and 1500-1750 Ma respectively, but some older zircons, up to 3040+/-180 Ma were detected. Using HU-SHRIMP, Sano et al. (2000) dated thirteen zircons from a volcaniclastic rock in the Kamiaso conglomerate and detected grains with ages of ca. 2550 Ma, 2000 Ma, 1300 Ma, 920 Ma, 250 Ma and 220 Ma. These results indicated a Permo-Triassic to Jurassic age for the volcanosedimentary clast, which had incorporated material from a complex Precambrian source. Also using HU-SHRIMP, Hidaka et al. (2002) dated zircons from a clast of coarse-grained gnt+bio metapelite and obtained ca. 3250, 2550 Ma, 2200-2000 Ma and 1860-1850 Ma zircons. As no younger zircons were found, this sample is probably a piece of Palaeoproterozoic paragneiss. Adachi and Suzuki (1993) reported limestone clasts in the conglomerate that are Carboniferous in age from palaeontological evidence. Thus the Kamiaso conglomerate contains a wide range of clasts, which are thought to be derived from a Precambrian continental basement and its Phanerozoic cover, which in the Jurassic was exposed and eroded not far to the north of the Kamiaso conglomerate site.

## 3. HU-SHRIMP dating of Kamiaso granitic clasts K2 and K3

Sample preparation, analytical protocol, data reduction and assignment of analytical errors follows Stern et al (1998), Williams et al. (1998) and Hidaka et al. (2002). In this study a few analyses of a fragment of the standard zircon SL13 (with a uniform U of 238 ppm) were used to calibrate U abundance, whereas a greater number of analyses of the 1099 Ma (Paces and Miller, 1993) multicrystal AS3 standard were used to calibrate $^{206}Pb/^{238}U$. The decay constants and present-day $^{238}U/^{235}U$ given by Steiger and Jaeger (1977) were used to calculate ages. Pooled ages presented in this paper are weighted means (95% confidence) calculated with Isoplot/Ex (Ludwig, 1999). For Palaeoproterozoic zircons $^{207}Pb/^{206}Pb$ ages and for Neoproterozoic and Mesozoic zircons

$^{206}Pb/^{238}U$ ages are emphasised. Correction for common Pb was made on the basis of measured $^{204}Pb$ and model Cumming and Richards (1975) common Pb compositions for the likely age of the rock.

### *3.1. Clast K2*

Clast K2 is ~8 cm long, and locally on its grey to buff coloured weathered surface a weakly to undeformed granitic texture is apparent. When extracting this clast from the sandstone matrix with a chisel, it broke cleanly into two pieces. Because of its small size, both parts of the clast were recombined for zircon separation.

Despite its small size, the clast yielded >100 non-metamict zircons. The zircon population is distinctly bimodal (Fig. 2). Approximately two thirds of the population are brown to yellow, prismatic, and slightly rounded/corroded and typically 150-200 microns long. From optical and CL imaging, these grains are locally metamict and show micron-scale oscillatory zoning parallel to grain exteriors (Fig. 2a,b). The CL imaging shows that there are rare inherited cores in these grains (Fig. 2b). The remaining third of the zircons are prisms of similar size, but are colourless to very pale yellow and completely euhedral (Fig. 2c,d). No cores of older zircon were found in these grains.

Thirty-one analyses were undertaken on twenty-five zircons (Table 1), with most yielding close to concordant dates (Fig. 3). Two older cores were dated in the brown, slightly corroded grains, one of which (analysis 19.2) is concordant at ~2450 Ma, whilst the other (analysis 8.1) with a $^{207}Pb/^{206}Pb$ age of ~2250 Ma is discordant. Excluding a few analyses of the brown zircon with the highest U, the rest with close to concordant dates yielded a weighted mean $^{207}Pb/^{206}Pb$ date of 1860+/-8 Ma (n=13, MSWD=1.2). The discordant domains might be 1860 Ma zircon that lost some radiogenic Pb in the Phanerozoic. Regression of the data yield upper and lower intercepts of 1859+/-11 Ma and 493+/-140 Ma (MSWD=0.96). All analyses of the euhedral colourless zircons are concordant within error and yielded a weighted mean $^{206}Pb/^{238}U$ date of 743+/-17 Ma (n=10, MSWD=0.48). Given the magmatic appearance of both the brown and the clear populations, and the lack of (1860 Ma) inheritance in the ca. 750 Ma population, it is suggested that the clast K2 was composite, consisting of granites of two different ages. This need not have been obvious in the field because of the weathering skin covering most of the clast.

### *3.2. Clast K3*

The granitic clast K3 also had a brownish weathering skin and was <10 cm long. It yielded abundant zircons. Most grains are clear, euhedral and prismatic with well developed oscillatory zoning in CL images (Fig. 2e,f). This is interpreted as the magmatic zircon. However, a minority of the grains contain cores of older zircon (Fig. 2e), with ages of >2300 Ma detected ($^{207}$Pb/$^{206}$Pb date on grains 5 and 22 – Table 1 and Fig. 3). All analyses of the dominant prismatic oscillatory zoned zircon yielded a weighted mean $^{206}$Pb/$^{238}$U date of 177.6+/-2.6 Ma (MSWD=1.5). Using a model of some loss of radiogenic Pb loss justified by multiple analyses on grains 10 and 17, a few analyses were culled until those remaining agreed with their mutual mean. This gives a $^{206}$Pb/$^{238}$U date of 179.3+/-2.1 Ma (MSWD=0.68).

## 4. Discussion

K3 with an age of 179.3+/-2.1 Ma indicates that this igneous clast is Toarcian (lower Jurassic) and gives the *maximum* age of deposition of the conglomerate. This is consistent with the revision of the age of the conglomerate from Permian (Adachi, 1971) to Jurassic (Niwa et al., 2002) based on Palaeontological evidence. The “old” K2 clast zircons indicates a granitic rock with an age of ~1860 Ma with some inherited older Palaeoproterozoic material. This 1860 Ma rock experienced Pb loss at 493±140 Ma, suggesting a thermal event in the source region prior to erosion and then deposition at Kamiaso in the Jurassic. The “young” K2 clast zircons (probably from another granitic phase in the clast) indicate a granitic rock with an age of 743+/-17 Ma with no older inherited zircon detected by either CL imaging or the HU-SHRIMP dating.

The 1860 Ma K2 date is not particularly diagnostic, because 1900-1800 Ma granitoids and high grade metamorphism occur in all the three main Precambrian crystalline blocks of east Asia (the South China Craton - e.g. Yuan et al., 1991; the North China Craton – summarised by Zhai and Liu, 2003; and the Aldan/Stonovoy Shield of Siberia – e.g. Nutman et al., 1992; Frost et al., 1998). These 1900-1800 Ma events are also common in the nearest crystalline basement in Korea (e.g. Chang et al., 1999: Lee et al., 2000; Sagong et al., 2003). Much more diagnostic is the 743+/-17 Ma date obtained from other K2 clast igneous zircons. In the South China Craton (*sensu stricto*) ~750 Ma is the time of the second pulse of bimodal magmatism and rifting equated with the break up of the supercontinent Rodinia (Li, Z.-X. et al., 2003b). A-type granitoids and volcanic rocks of this age have also been detected in Korea (Lee, K.S. et al., 1998; Lee, K.R. et al., 2003). Conversely magmatism of this age is presently unknown within the North China (Sino-Korean) Craton (summarised by Li et al., 2003b) north of the Mesozoic Qinling–Dabie suture. Thus 743+/-17 Ma magmatic zircons from a Kamiaso clast is the clearest evidence yet (first proposed by Hidaka et al.

2002 from the presence of ~3250 detrital grains in a Palaeoproterozoic paragneiss clast) that the source continental terrane for the Kamiaso conglomerate had affinities with the South China Craton. The most likely immediate source of the detritus would have been the northern extremity of this craton in Korea. A Korean source is also consistent with the presence of ~180 Ma granite clasts in the conglomerate indicated from dating of K3, because Jurassic granites are common in South Korea (e.g. Kim and Turek, 1996).

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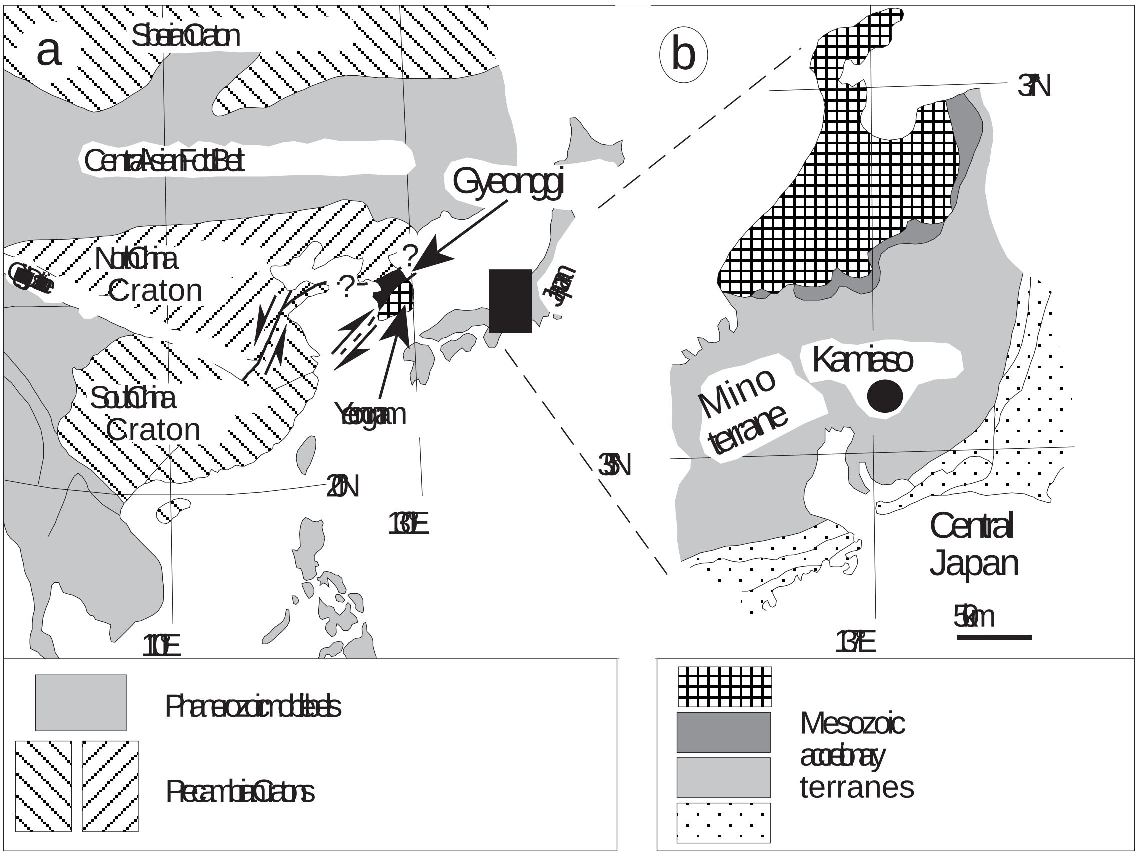
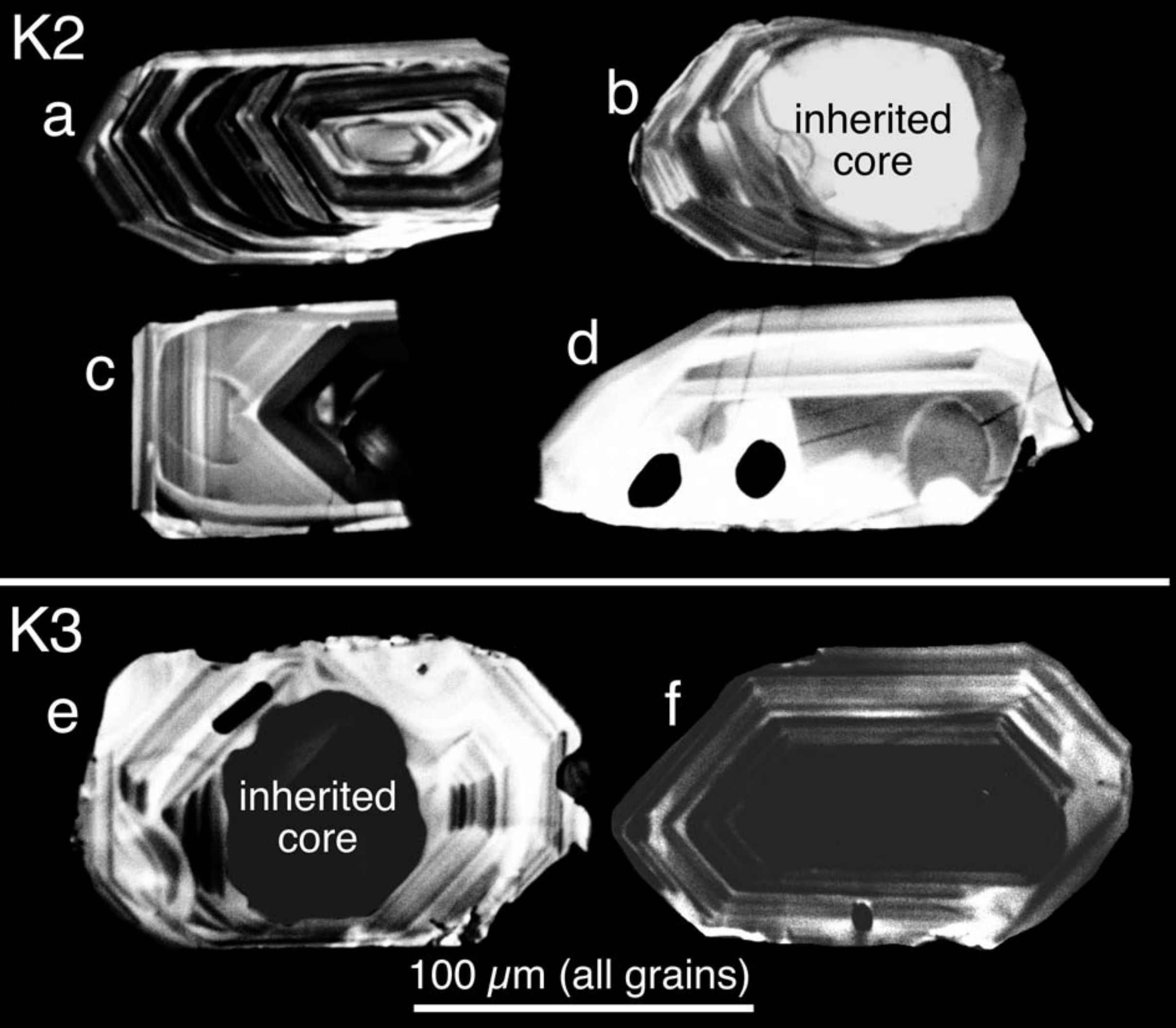
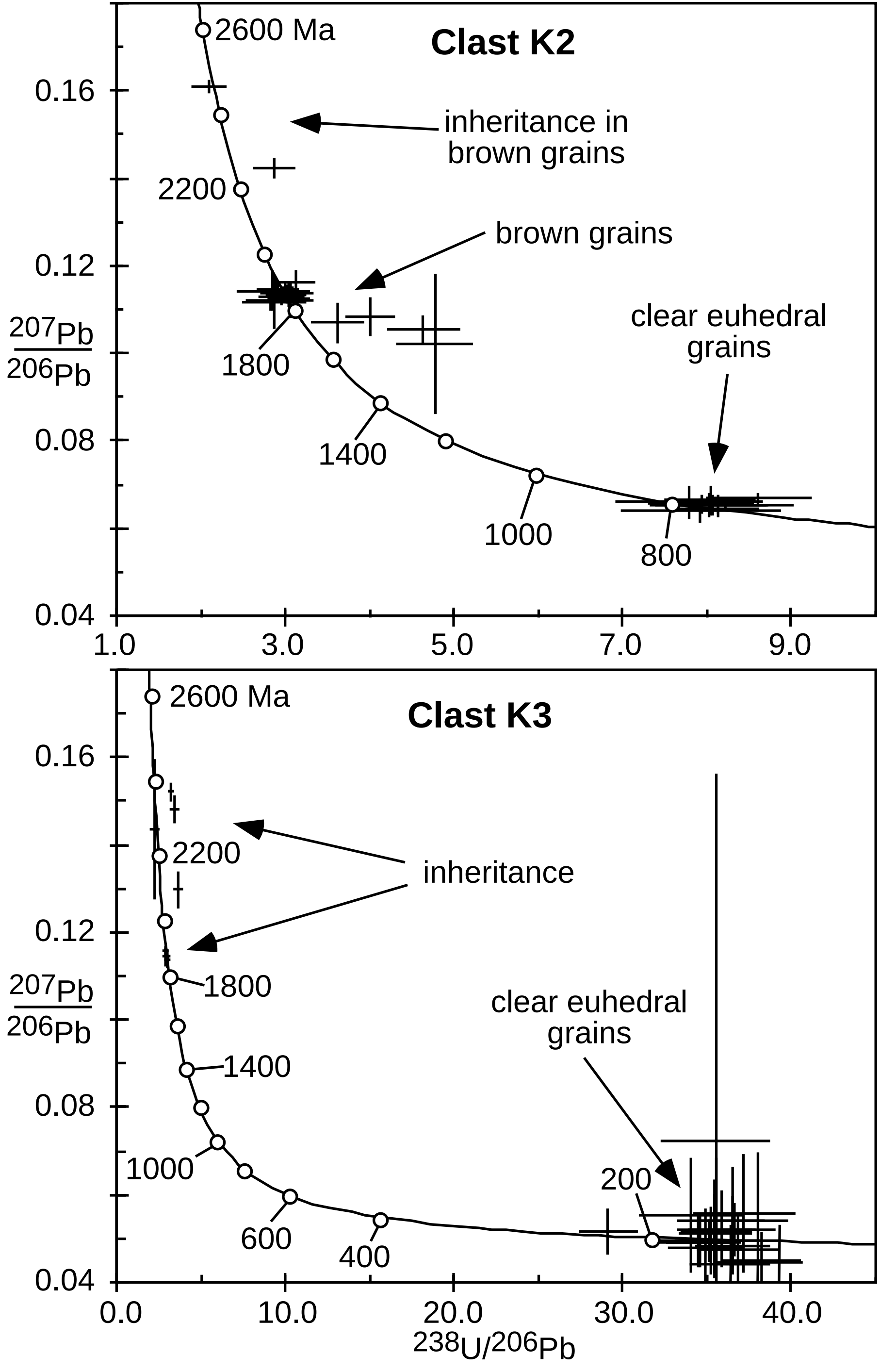
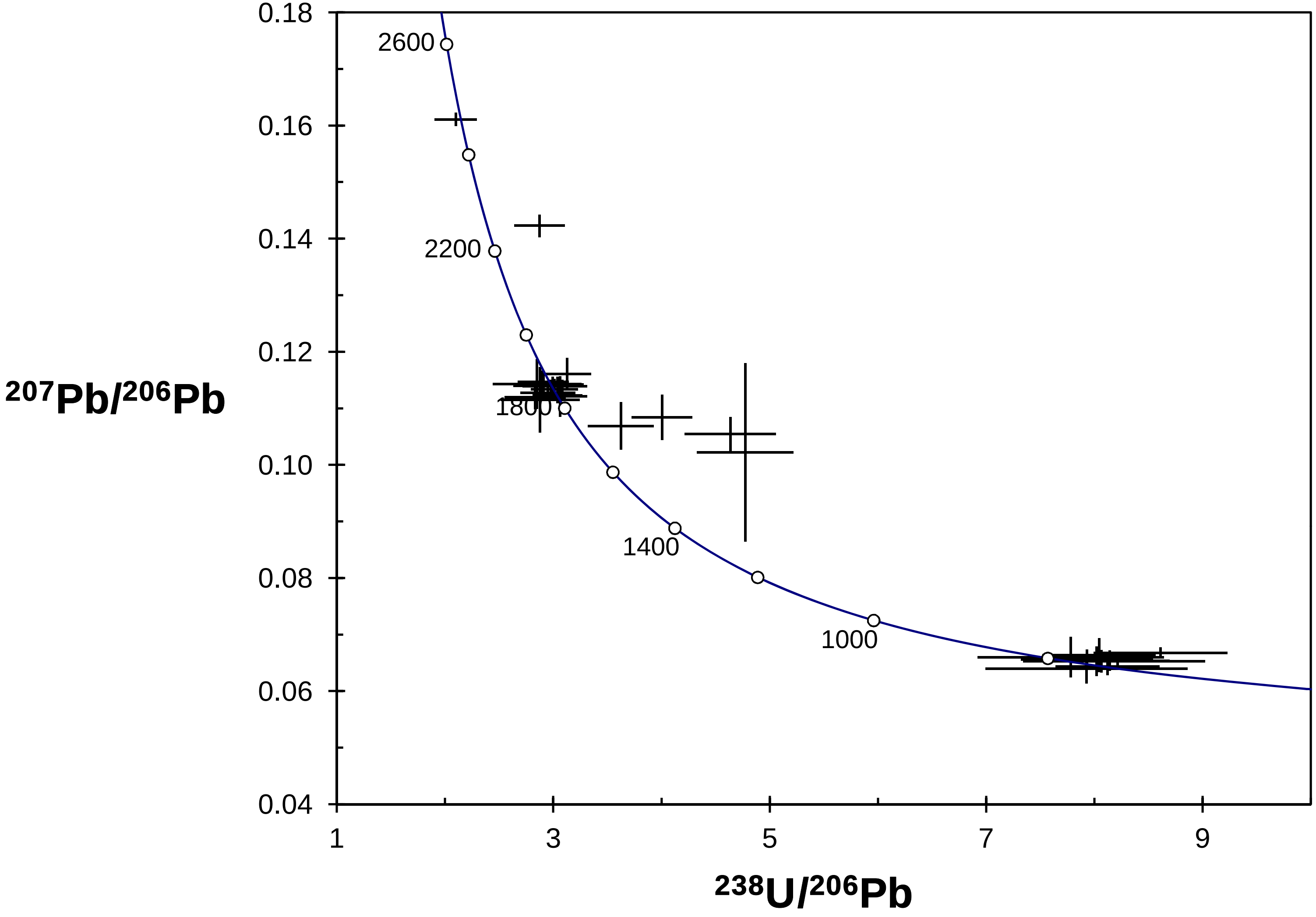
List of Figures:



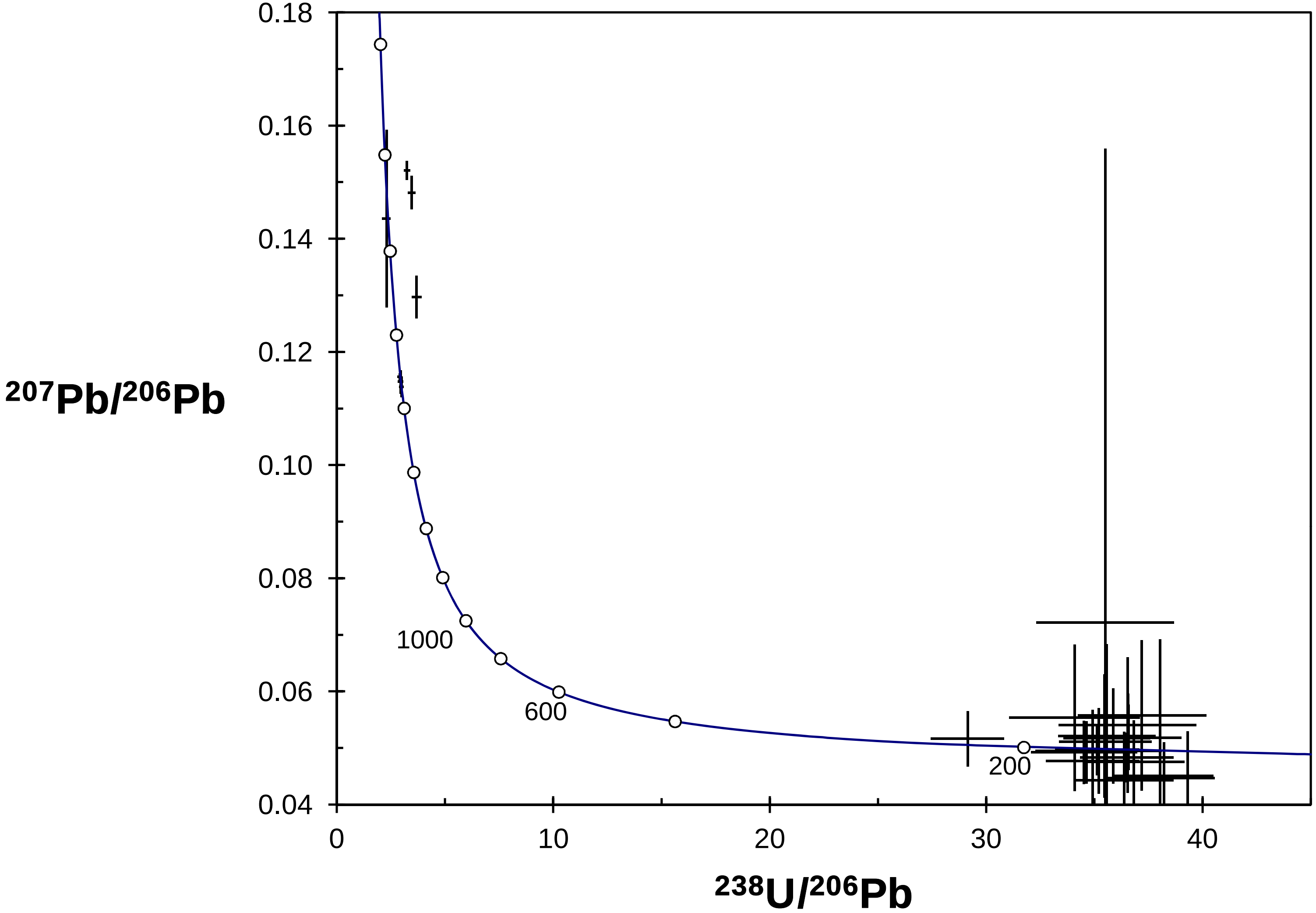
a
Siberian Craton
Central Asian Fold Belt
North China
Craton
South China
Craton
Gyeonggi
Yeongnam
Japan
?
b
Kamiaso
Mino
terrane
Central
Japan
Phanerozoic mobile belts
Precambrian Cratons
Mesozoic
accretionary
terranes


K2
a
b
inherited
core
c
d
K3
e
inherited
core
f
100 μm (all grains)


Clast K2
2600 Ma
2200
1800
1400
1000
800
inheritance in brown grains
brown grains
clear euhedral grains
0.16
0.12
0.08
0.04
1.0
3.0
5.0
7.0
9.0
207Pb/206Pb
Clast K3
2600 Ma
2200
1800
1400
1000
600
400
200
inheritance
clear euhedral grains
0.16
0.12
0.08
0.04
0.0
10.0
20.0
30.0
40.0
207Pb/206Pb
238U/206Pb



0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
1
3
5
7
9
2600
2200
1800
1400
1000
$^{207}Pb/^{206}Pb$
$^{238}U/^{206}Pb$



0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
$^{207}Pb/^{206}Pb$
1000
600
200
0
10
20
30
40
$^{238}U/^{206}Pb$

# Table 1 SHRIMP U/Pb zircon analyses

| spot | U | Th | Th/U | comm. | 238U / 206/Pb | 207Pb / 206Pb | Age | %con |
|---|---|---|---|---|---|---|---|---|
| | ppm | ppm | | 206Pb% | ratio | ratio | | |
| **Clast K2** | | | | | | | | |
| **brown and yellow grains** | | | | | | | | |
| 1.1 | 604 | 174 | 0.29 | 0.20 | 3.038 ± 0.115 | 0.1123 ± 0.0007 | *1837 ± 11* | 0 |
| 2.1 | 638 | 202 | 0.32 | 0.10 | 3.010 ± 0.109 | 0.1134 ± 0.0009 | *1855 ± 14* | 0 |
| 3.1 | 803 | 232 | 0.29 | 0.17 | 3.080 ± 0.116 | 0.1139 ± 0.0006 | *1863 ± 9* | -3 |
| 4.1 | 624 | 241 | 0.39 | 0.03 | 2.907 ± 0.118 | 0.1147 ± 0.0006 | *1875 ± 10* | 2 |
| 5.1 | 1578 | 1286 | 0.81 | 0.52 | 4.636 ± 0.210 | 0.1055 ± 0.0015 | *1723 ± 26* | -27 |
| 6.1 | 753 | 156 | 0.21 | 0.20 | 3.061 ± 0.125 | 0.1121 ± 0.0018 | *1833 ± 30* | -1 |
| 7.1 | 1036 | 943 | 0.91 | 3.01 | 4.773 ± 0.223 | 0.1022 ± 0.0079 | *1665 ± 150* | -26 |
| 8.1 | 1078 | 482 | 0.45 | 0.04 | 2.871 ± 0.117 | 0.1423 ± 0.0010 | *2256 ± 12* | -15 |
| 10.1 | 564 | 218 | 0.39 | 0.02 | 2.910 ± 0.140 | 0.1140 ± 0.0007 | *1864 ± 12* | 2 |
| 11.1 | 629 | 188 | 0.30 | 0.06 | 2.949 ± 0.127 | 0.1128 ± 0.0007 | *1845 ± 11* | 2 |
| 17.1 | 757 | 207 | 0.27 | <0.01 | 2.978 ± 0.131 | 0.1139 ± 0.0006 | *1862 ± 10* | 0 |
| 18.1 | 668 | 231 | 0.35 | 0.22 | 3.126 ± 0.111 | 0.1161 ± 0.0014 | *1897 ± 22* | -6 |
| 19.1 | 991 | 32 | 0.03 | 0.07 | 2.876 ± 0.183 | 0.1115 ± 0.0029 | *1824 ± 48* | 6 |
| 19.2 | 1403 | 1121 | 0.80 | <0.01 | 2.098 ± 0.098 | 0.1611 ± 0.0006 | *2468 ± 6* | 2 |
| 20.2 | 865 | 441 | 0.51 | 1.08 | 4.004 ± 0.140 | 0.1084 ± 0.0020 | *1773 ± 34* | -19 |
| 21.1 | 578 | 275 | 0.47 | 0.02 | 2.991 ± 0.127 | 0.1142 ± 0.0007 | *1868 ± 12* | 0 |
| 22.1 | 793 | 755 | 0.95 | 0.55 | 3.623 ± 0.152 | 0.1069 ± 0.0021 | *1747* ± 37 | -10 |
| 23.1 | 814 | 215 | 0.26 | 0.03 | 3.038 ± 0.121 | 0.1142 ± 0.0007 | *1867 ± 11* | -2 |
| 24.1 | 568 | 169 | 0.30 | 0.30 | 2.849 ± 0.205 | 0.1143 ± 0.0022 | *1870 ± 35* | 4 |
| 25.1 | 400 | 75 | 0.19 | <0.01 | 2.892 ± 0.101 | 0.1147 ± 0.0010 | *1875 ± 16* | 2 |
| 25.2 | 411 | 83 | 0.20 | 0.05 | 2.829 ± 0.141 | 0.1120 ± 0.0011 | *1833 ± 18* | 7 |
| **clear euhedral grains** | | | | | | | | |
| 9.1 | 201 | 172 | 0.85 | 0.88 | 8.043 ± 0.262 | 0.0664 ± 0.0015 | 749 ± 23 | |
| 12.1 | 236 | 147 | 0.62 | 0.78 | 7.930 ± 0.305 | 0.0656 ± 0.0009 | 760 ± 28 | |
| 12.2 | 537 | 864 | 1.61 | 0.58 | 7.925 ± 0.467 | 0.0640 ± 0.0013 | 762 ± 42 | |
| 13.1 | 740 | 372 | 0.50 | 0.74 | 8.064 ± 0.265 | 0.0653 ± 0.0010 | 748 ± 23 | |
| 13.2 | 1549 | 1106 | 0.71 | 0.75 | 8.212 ± 0.405 | 0.0653 ± 0.0004 | 736 ± 34 | |
| 14.1 | 247 | 127 | 0.51 | 0.76 | 8.141 ± 0.276 | 0.0654 ± 0.0009 | 742 ± 24 | |
| 15.1 | 1546 | 1315 | 0.85 | 0.92 | 8.610 ± 0.309 | 0.0668 ± 0.0005 | 702 ± 24 | |
| 15.2 | 548 | 306 | 0.56 | 0.63 | 8.121 ± 0.240 | 0.0644 ± 0.0008 | 744 ± 21 | |
| 16.1 | 387 | 208 | 0.54 | 0.75 | 8.021 ± 0.342 | 0.0653 ± 0.0013 | 752 ± 30 | |
| 16.2 | 125 | 98 | 0.78 | 0.83 | 7.780 ± 0.431 | 0.0660 ± 0.0018 | 773 ± 41 | |
| **Clast K3** | | | | | | | | |
| 1.1 | 673 | 592 | 0.88 | 0.36 | 29.137 ± 0.847 | 0.0517 ± 0.0025 | 218 ± 6 | |
| 1.2 | 427 | 194 | 0.45 | 0.76 | 38.205 ± 1.139 | 0.0451 ± 0.0030 | 167 ± 5 | |
| 2.1 | 266 | 153 | 0.58 | 1.31 | 35.461 ± 1.077 | 0.0521 ± 0.0054 | 179 ± 5 | |
| 3.1 | 1324 | 334 | 0.25 | 0.01 | 2.288 ± 0.098 | 0.1435 ± 0.0079 | *2270 ± 97* | 3 |
| 4.1 | 1744 | 252 | 0.14 | <0.01 | 2.897 ± 0.052 | 0.1156 ± 0.0003 | *1889 ± 5* | 1 |
| 5.1 | 664 | 312 | 0.47 | 0.07 | 3.233 ± 0.074 | 0.1521 ± 0.0008 | *2369 ± 10* | -27 |
| 6.1 | 509 | 506 | 0.99 | 0.47 | 36.812 ± 1.170 | 0.0476 ± 0.0037 | 173 ± 5 | |
| 7.1 | 1029 | 1028 | 1.00 | 5.48 | 35.499 ± 1.594 | 0.0721 ± 0.0391 | 179 ± 8 | |
| 8.1 | 719 | 191 | 0.27 | 0.06 | 2.944 ± 0.067 | 0.1147 ± 0.0010 | *1876 ± 16* | 1 |
| 9.1 | 467 | 431 | 0.92 | 0.35 | 36.571 ± 1.220 | 0.0519 ± 0.0029 | 174 ± 6 | |
| 10.1 | 259 | 212 | 0.82 | <0.01 | 37.185 ± 1.485 | 0.0558 ± 0.0067 | 171 ± 7 | |
| 10.2 | 289 | 173 | 0.60 | 0.89 | 35.195 ± 1.462 | 0.0495 ± 0.0037 | 181 ± 7 | |
| 11.1 | 505 | 581 | 1.15 | 0.72 | 34.631 ± 0.966 | 0.0492 ± 0.0027 | 184 ± 5 | |
| 12.1 | 674 | 297 | 0.44 | 0.31 | 3.673 ± 0.114 | 0.1297 ± 0.0019 | *2094 ± 26* | -26 |
| 13.1 | 543 | 451 | 0.83 | 0.55 | 36.486 ± 1.078 | 0.0483 ± 0.0022 | 174 ± 5 | |
| 14.1 | 596 | 365 | 0.61 | 0.28 | 34.512 ± 1.228 | 0.0493 ± 0.0028 | 184 ± 6 | |
| 15.1 | 420 | 337 | 0.80 | 0.68 | 35.492 ± 1.071 | 0.0511 ± 0.0044 | 179 ± 5 | |
| 16.1 | 631 | 473 | 0.75 | 0.66 | 35.117 ± 0.975 | 0.0497 ± 0.0023 | 181 ± 5 | |
| 17.1 | 413 | 353 | 0.85 | 0.75 | 35.861 ± 0.976 | 0.0521 ± 0.0042 | 177 ± 5 | |
| 17.2 | 231 | 144 | 0.62 | 3.39 | 39.301 ± 1.817 | 0.0321 ± 0.0099 | 162 ± 7 | |
| 17.3 | 289 | 172 | 0.60 | 2.57 | 38.034 ± 1.262 | 0.0446 ± 0.0119 | 167 ± 5 | |
| 18.1 | 686 | 565 | 0.82 | 1.96 | 35.562 ± 1.006 | 0.0517 ± 0.0081 | 179 ± 5 | |
| 19.1 | 553 | 402 | 0.73 | 1.30 | 36.361 ± 1.146 | 0.0443 ± 0.0042 | 175 ± 5 | |
| 20.1 | 245 | 137 | 0.56 | 1.81 | 36.527 ± 1.590 | 0.0541 ± 0.0059 | 174 ± 7 | |
| 21.1 | 2032 | 658 | 0.32 | 0.05 | 2.978 ± 0.053 | 0.1138 ± 0.0009 | *1861 ± 15* | 0 |
| 22.1 | 262 | 65 | 0.25 | 0.38 | 3.440 ± 0.087 | 0.1482 ± 0.0015 | *2325 ± 17* | -29 |
| 23.1 | 740 | 420 | 0.57 | 0.08 | 36.544 ± 0.922 | 0.0540 ± 0.0028 | 174 ± 4 | |
| 24.1 | 327 | 176 | 0.54 | 0.25 | 34.074 ± 1.510 | 0.0554 ± 0.0065 | 186 ± 8 | |
| 25.1 | 438 | 441 | 1.01 | 0.70 | 34.901 ± 1.081 | 0.0477 ± 0.0045 | 182 ± 6 | |

*All analytical errors are given at 1 sigma*

*Ages (after correction for common Pb): Italics - 207Pb/206Pb; Roman 206Pb/238U corrected with 1860, 750 and 180 Ma model Pb of Cumming and Richards, 1975*