

2020 and 2021 zircons to hit again

Jack Milton

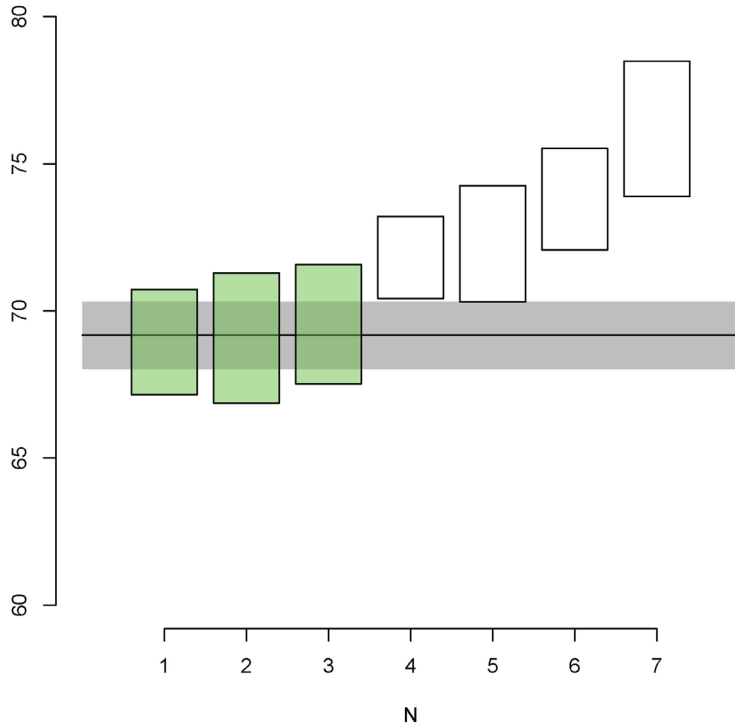
Framing

Additional zircon grains of interest were chosen for CL imaging and a second or third round of dating based on favourable, near Casino suite ages from the first or second round of analysis. Some grains had large errors or were highly discordant, and other grains were chosen in order to improve the precision on the age by using a weighted mean of the two (or more) spot analyses. The first and second round of analyses returned high LODs for some REEs, so the third round of analyses has instrument settings tweaked to improve LODs in order to calculate Ce/Ce* and Eu/Eu* anomalies for porphyry fertility.

In the following slides, 2SE absolute errors are stated on the grain labels, the 206/238-207/235 discordance is shown, and all ages are 207-corrected (Stacey and Kramers) 206Pb/238U ages. The weighted averages are only meaningful when a consistent CL zone is observed – the diagrams are just used to visualize the ages and errors.

20JM001B_47

mean = 69.17 ± 0.58 | 1.15 Ma (n=3/7)
MSWD = 0.10, $p(\chi^2) = 0.90$



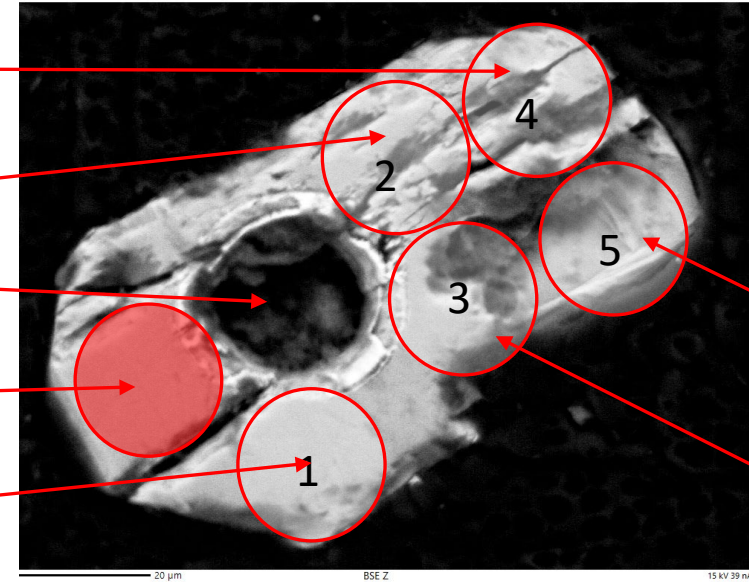
69 ± 1.9 Ma (21.5% disc.)

71.9 ± 1.5 Ma (4.5% disc.)

76.2 ± 2.4 Ma (2.2% disc.)

72.3 ± 2.0 Ma (15.8% disc.)

69.5 ± 2.1 Ma (6.4% disc.)

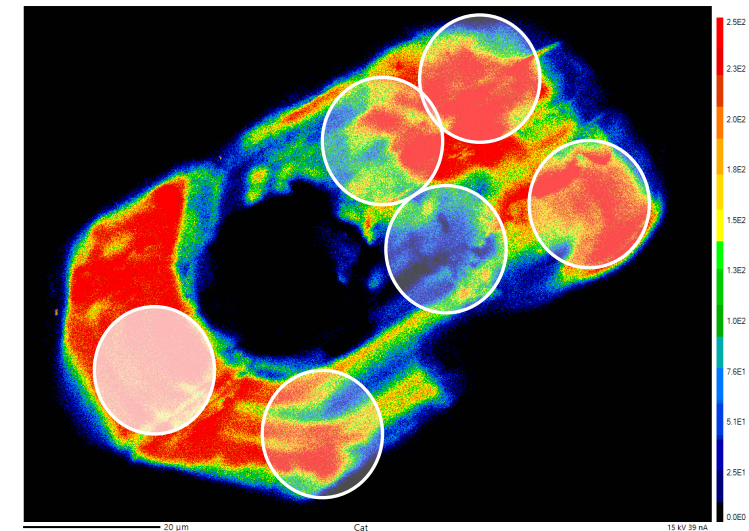


20 µm

69.1 ± 2.5 Ma
(35% disc.)

73.8 ± 1.8 Ma
(0.9% disc.)

Distinct difference in core-rim ages, and distinct CL response. Casino Suite age core to Prospector Mtn age rim.

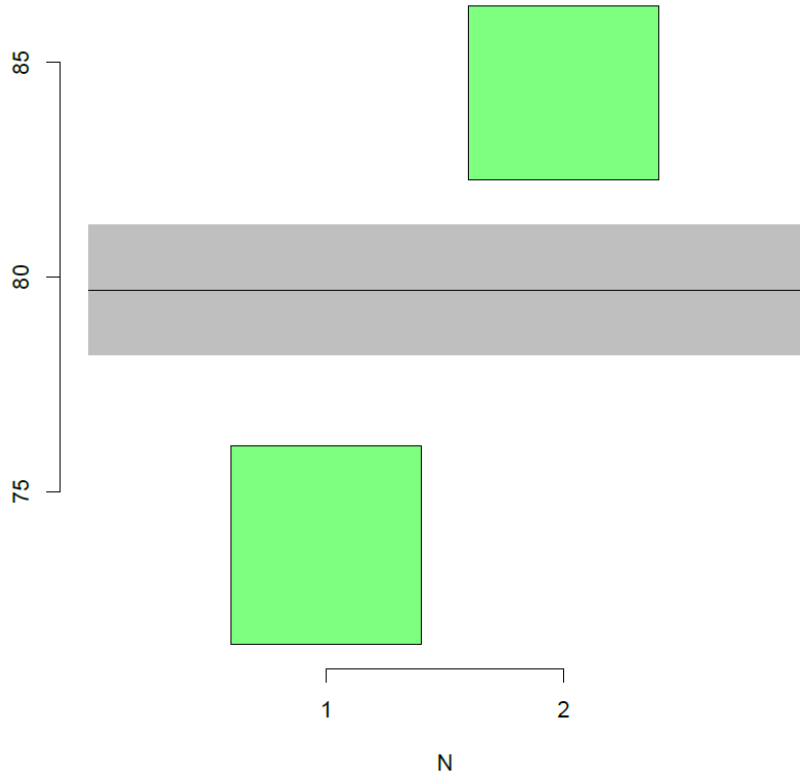


20 μm

20JM001B_90

No room for any more spots

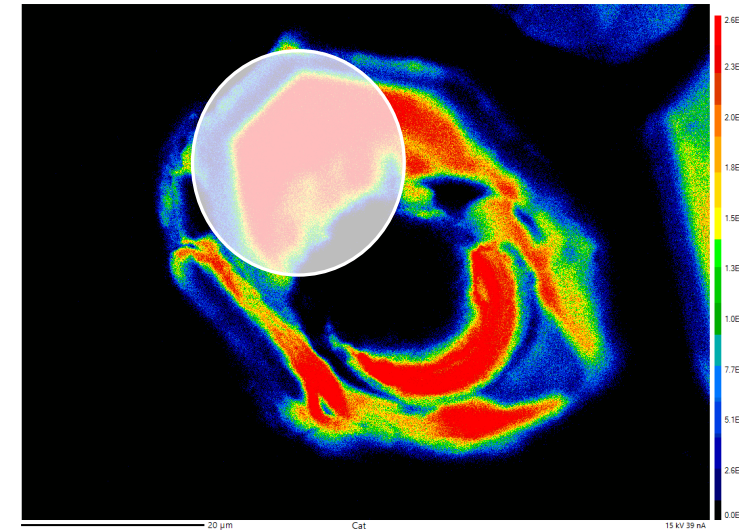
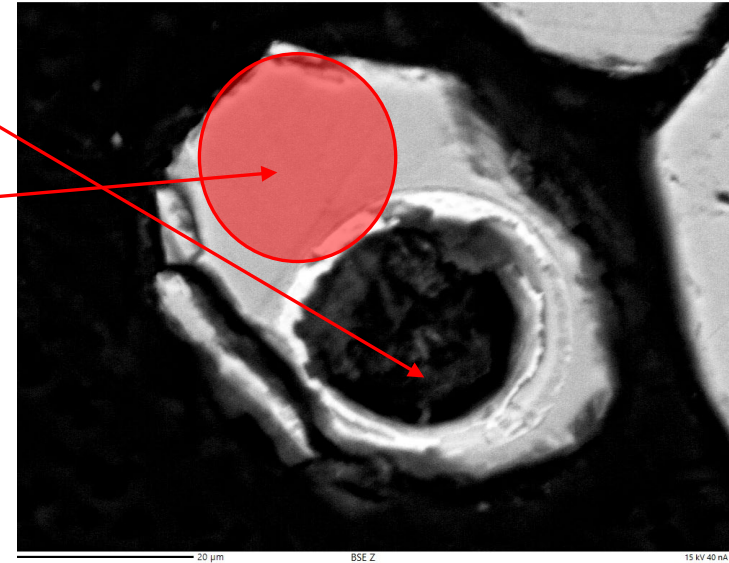
mean = 79.70 ± 0.77 | 1.52 | 66.31 Ma (n=2/2)
MSWD = 45.4, $p(\chi^2) = 0.000000000016$



74.2 ± 2.4 Ma (9.7% disc.)

84.3 ± 2.1 Ma (-1.7% disc.)

Inconsistent
ages returned

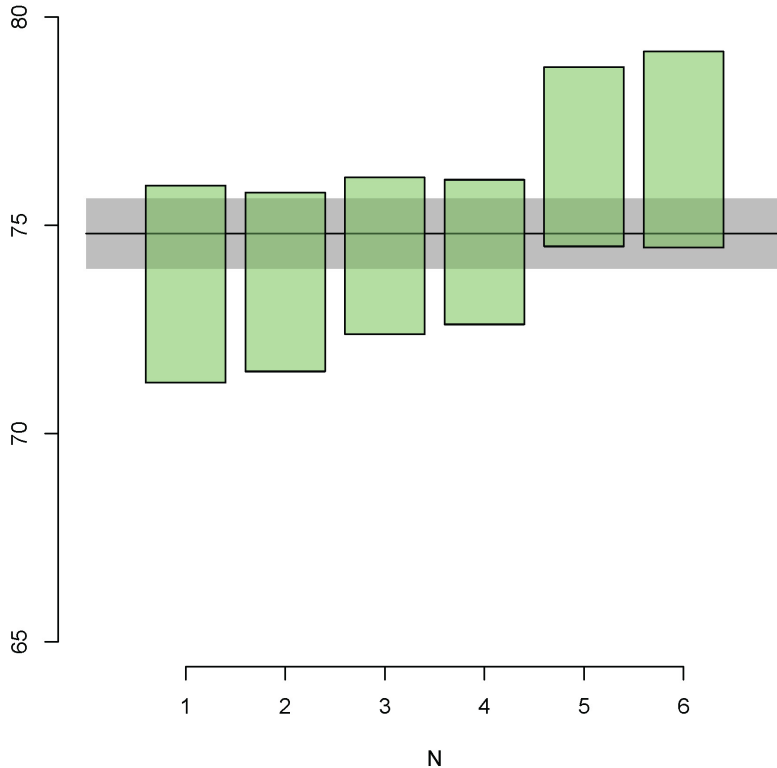


20 μm

20JM001B_103

In original 2020 run labelled 101

mean = 74.80 ± 0.43 | 0.84 Ma (n=6/6)
MSWD = 1.67, $p(\chi^2) = 0.14$



74.5 ± 2.0 Ma (-4.9% disc.)

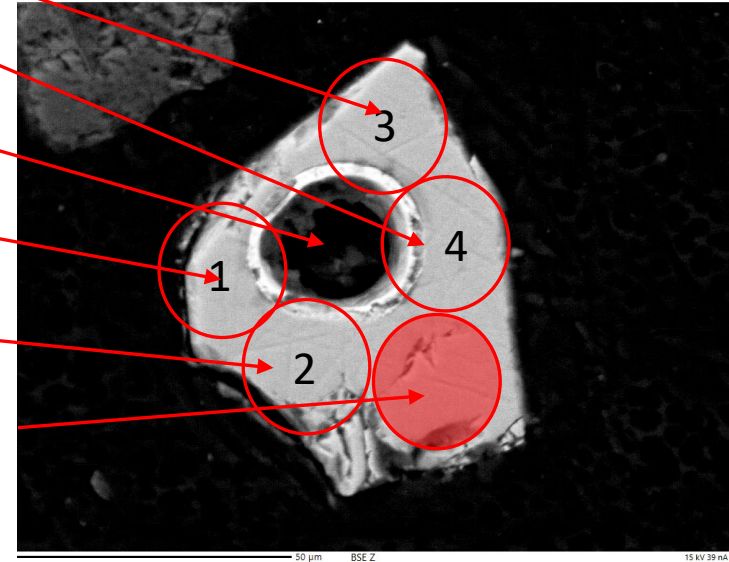
74.4 ± 1.8 Ma (1.6% disc.)

74.2 ± 2.5 Ma (15.9% disc.)

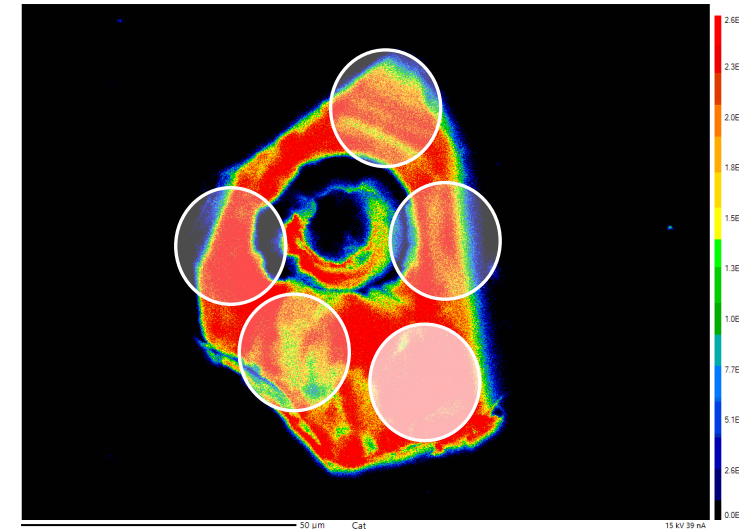
76.7 ± 2.2 Ma (7.1% disc.)

73.7 ± 2.3 Ma (2.5% disc.)

76.8 ± 2.4 Ma (18.3% disc.)



Statistically indistinguishable difference between rim and core. Good Casino Suite age.

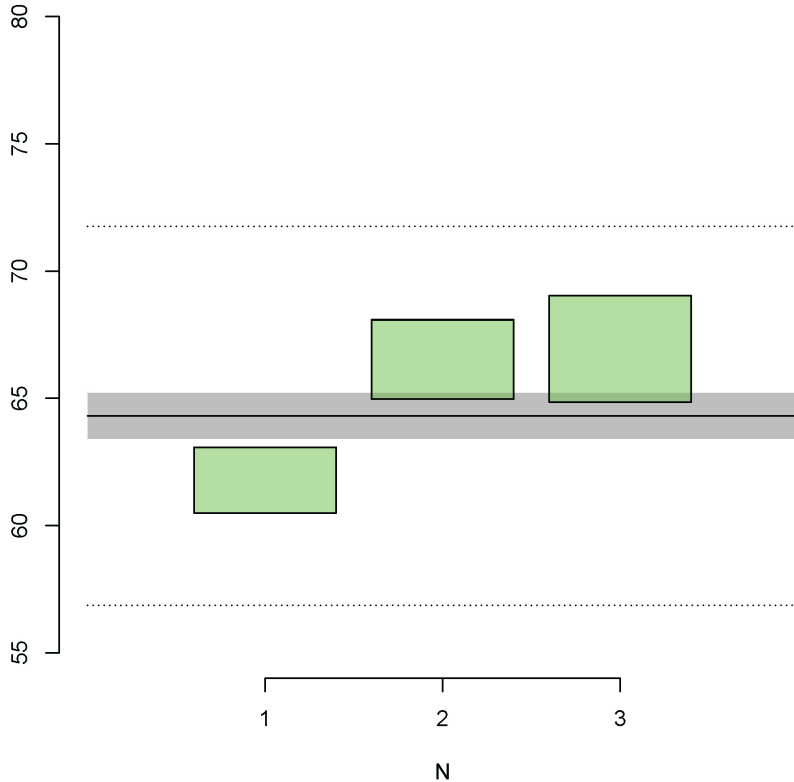


20 μm

20JM003B_9

From 2nd batch of 2020 grains

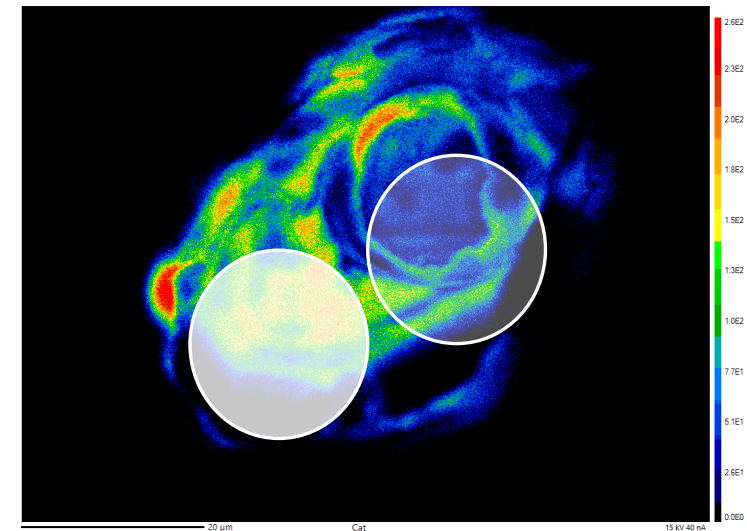
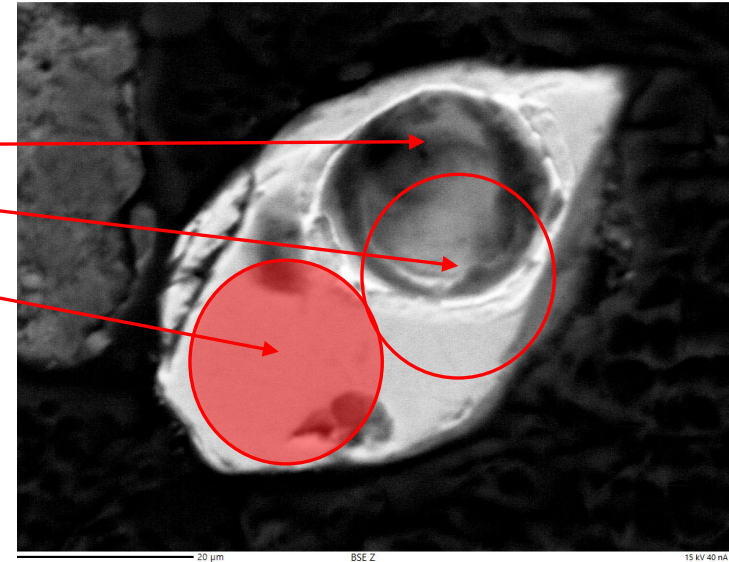
mean = 64.31 ± 0.46 | 0.90 | 7.45 Ma (n=3/3)
MSWD = 14.3, $p(\chi^2) = 0.00000063$



- 66.7 ± 1.6 Ma (-4.7% disc.)
- 67.0 ± 2.1 Ma (-2.9% disc.)
- 61.8 ± 1.3 Ma (-0.7% disc.)

Partially within a younger rim domain with dark CL response could explain the difference in ages.

Prospector Mtn age or younger.



20 μm

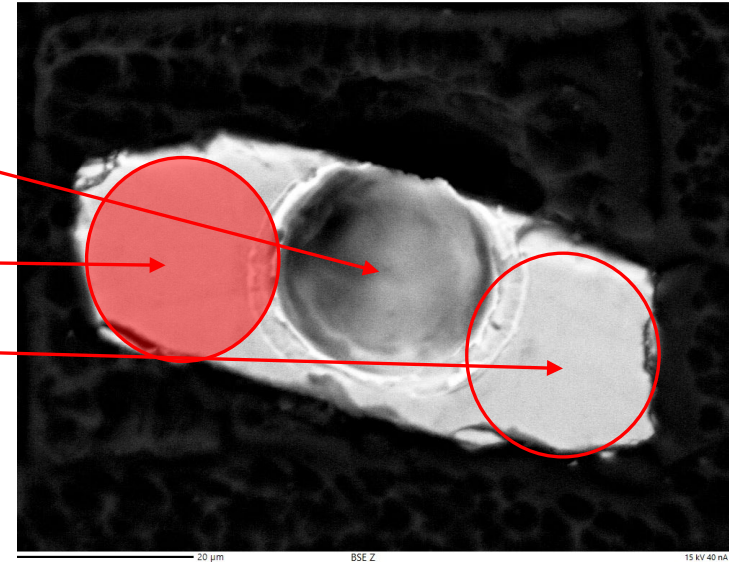
20JM003B_21

From 2nd batch of 2020 grains

67.6 ± 1.4 Ma (4.0% disc.)

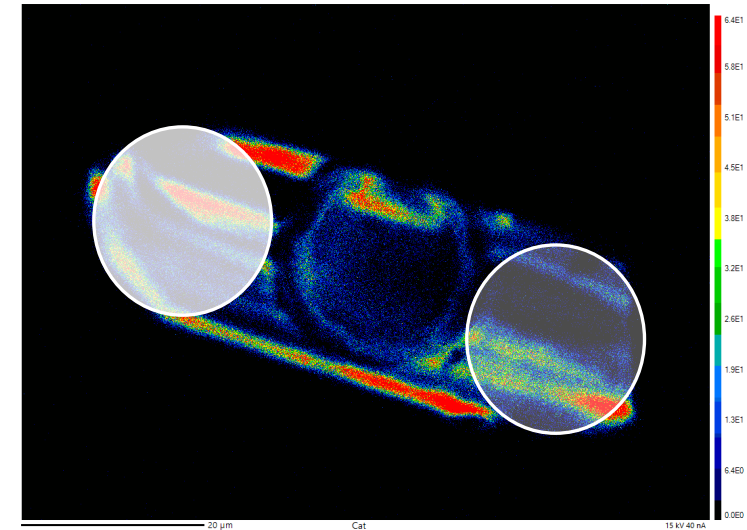
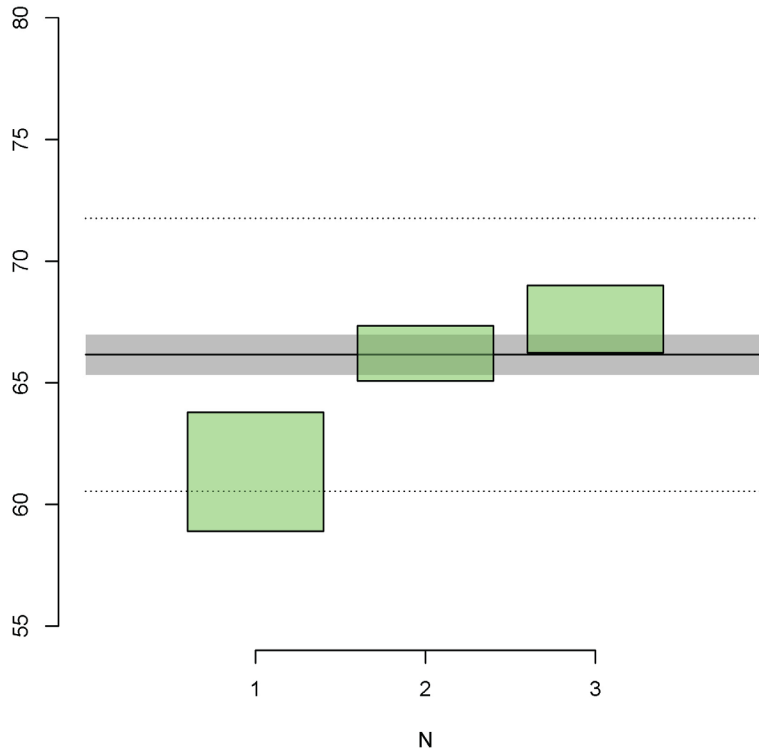
66.2 ± 1.2 Ma (8.6% disc.)

61.3 ± 2.5 Ma (9.7% disc.)



Likely Prospector Mtn Suite.

mean = 66.15 ± 0.42 | 0.82 | 5.61 Ma (n=3/3)
MSWD = 9.65, p(χ²) = 0.000065



20 μm

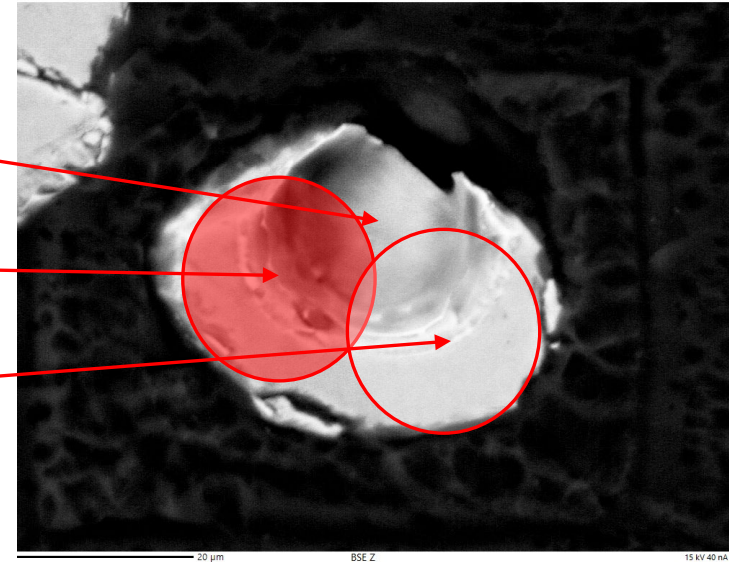
20JM003B_27

One more spot

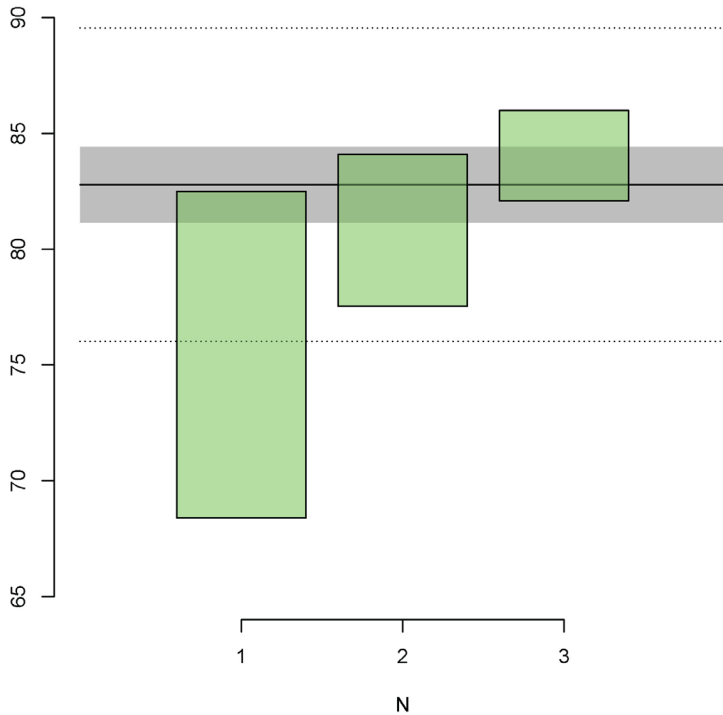
77.1 ± 2.5 Ma (6.6% disc.)

84.0 ± 2.0 Ma (11.2% disc.)

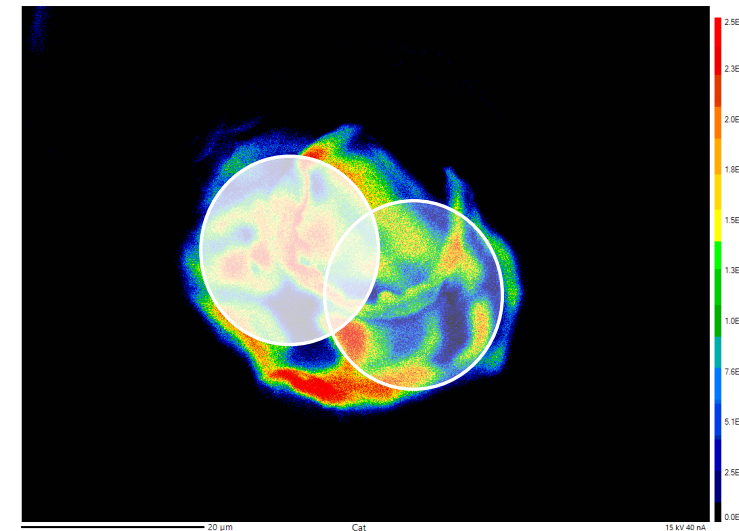
80.8 ± 3.4 Ma (10.4% disc.)



mean = 82.78 ± 0.83 | 1.63 | 6.76 Ma (n=3/3)
MSWD = 3.58, $p(\chi^2) = 0.028$



Overlapping ages
returned at approx. 83
Ma. Possibly Casino
Suite.



20 μm

20JM003B_54

One more spot

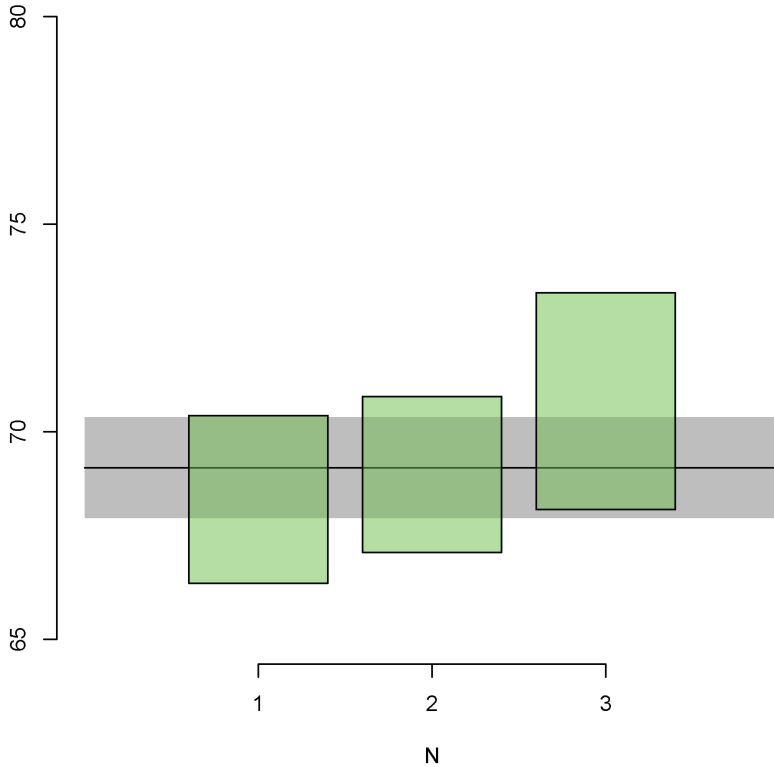
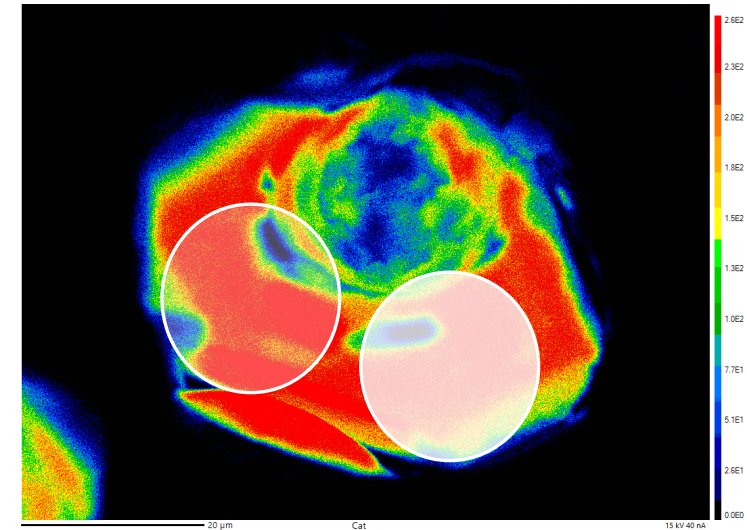
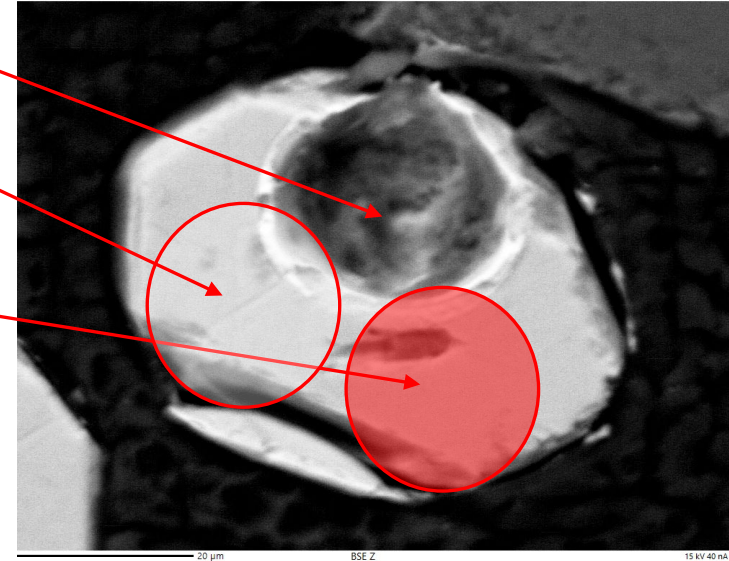
70.7 ± 2.8 Ma (4.2% disc.)

69.0 ± 2.0 Ma (4.4% disc.)

68.4 ± 2.1 Ma (-9.5% disc.)

mean = 69.13 ± 0.62 | 1.22 Ma (n=3/3)
MSWD = 1.01, p(χ²) = 0.36

Good consistent ages
in a single CL domain
show this to be
Prospector Mtn age.

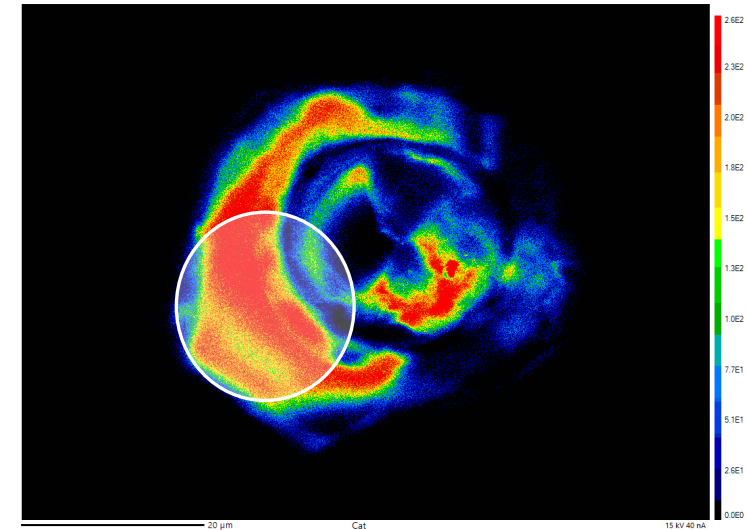
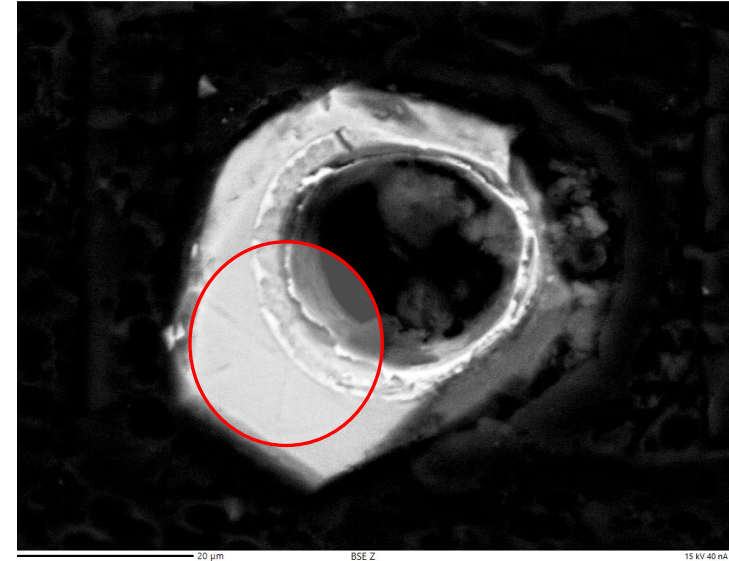


20 μm

20JM006B_1

No more spots needed

Some confusion over sample
Number – 12?



20 μm

20JM006B_25

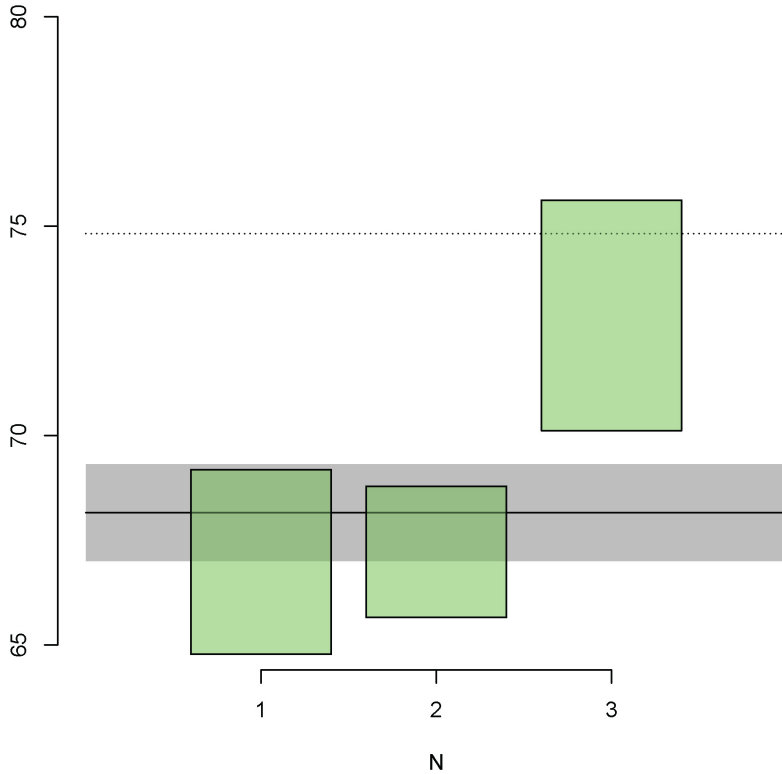
1st batch 2020 originally grain 24

72.9 ± 2.9 Ma (9.4% disc.)

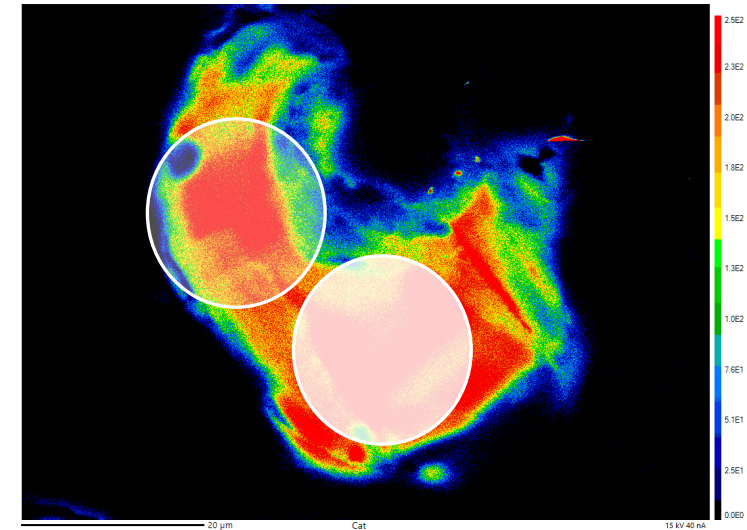
67.0 ± 2.3 Ma (9.9% disc.)

67.2 ± 1.6 Ma (-2.7% disc.)

mean = 68.16 ± 0.59 | 1.16 | 6.66 Ma (n=3/3)
MSWD = 6.87, $p(\chi^2) = 0.0010$



Likely Prospector
Mtn Suite



20 μm

20JM006B_35

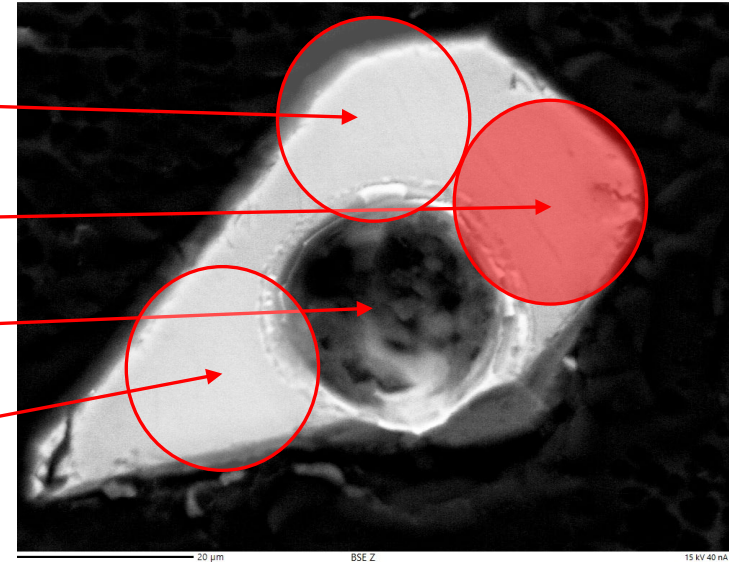
Two more spots

61.7 ± 2.0 Ma (9.8% disc.)

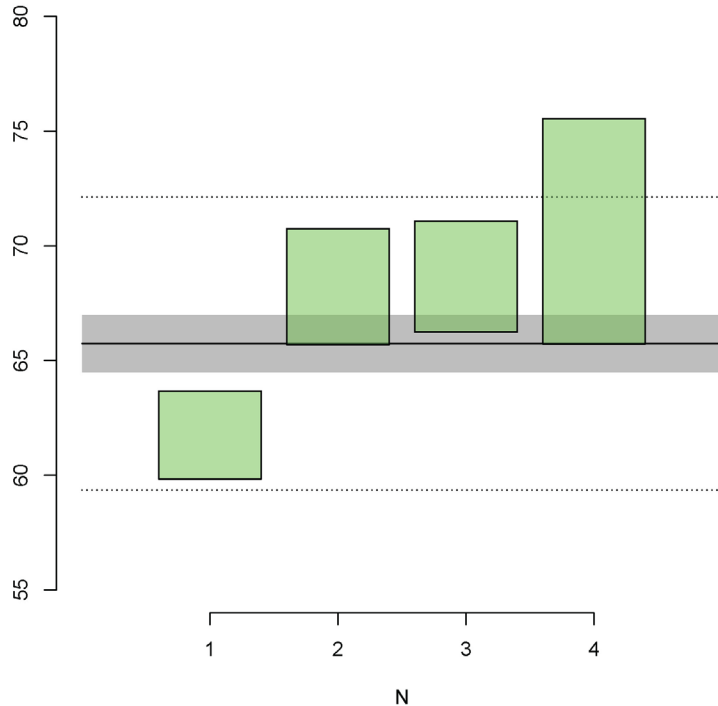
68.7 ± 2.5 Ma (-0.5% disc.)

70.6 ± 5.2 Ma (14.1% disc.)

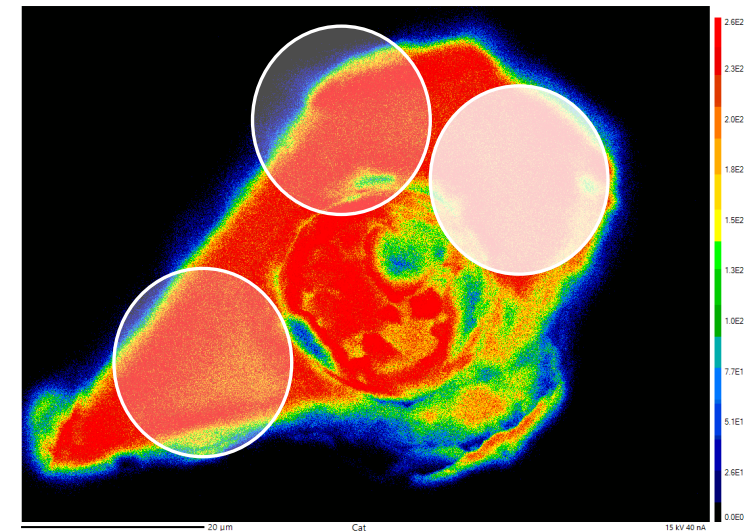
68.4 ± 2.7 Ma (-4.9% disc.)



mean = 65.74 ± 0.64 | 1.25 | 6.39 Ma (n=4/4)
MSWD = 9.94, p(χ²) = 0.0000015



Likely Prospector
Mtn Suite.



20 μm

20JM006B_44

2nd batch 2020 grains

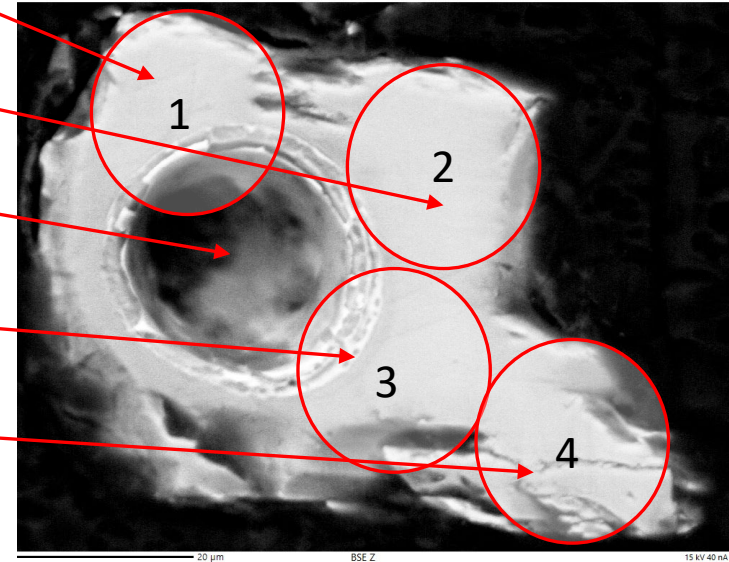
66.2 ± 2.3 Ma (7.0% disc.)

73.1 ± 1.9 Ma (28.4% disc.)

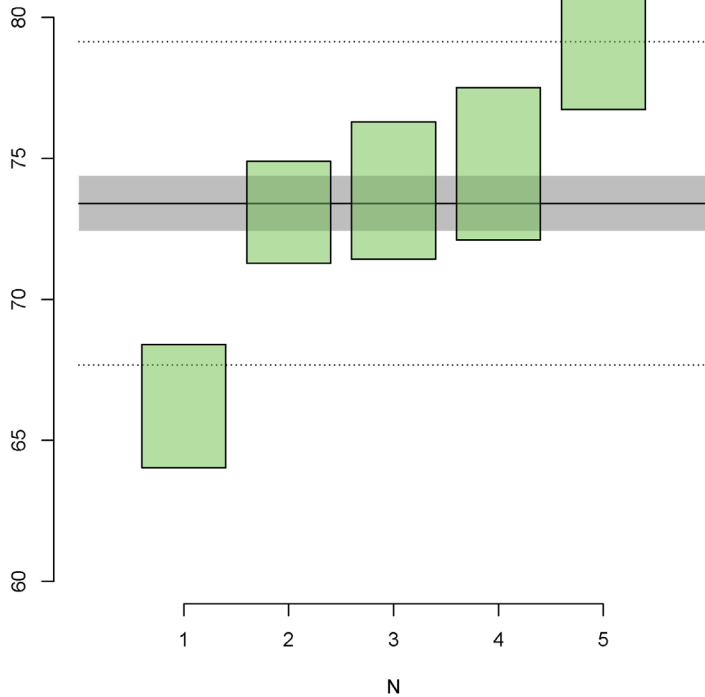
73.8 ± 2.6 Ma (8.0% disc.)

78.6 ± 2.1 Ma (-1.8% disc.)

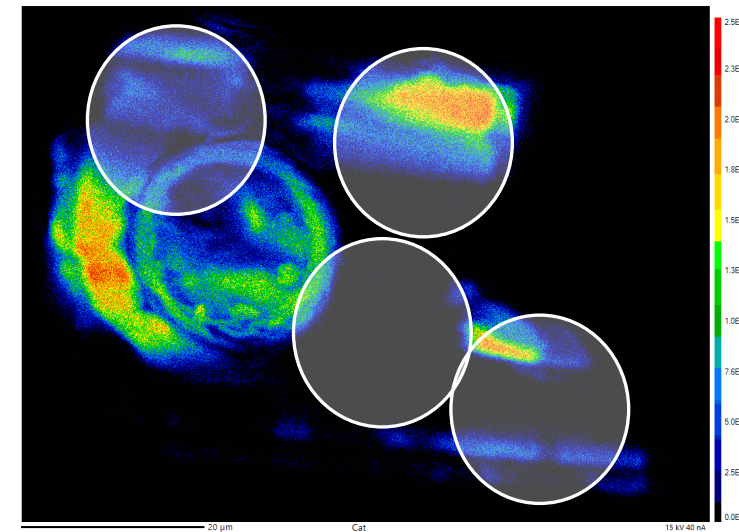
74.8 ± 2.7 Ma (-0.4% disc.)



mean = 73.40 ± 0.49 | 0.97 | 5.73 Ma (n=5/5)
MSWD = 17.6, p(χ²) = 0.000000000000020



Likely Casino Suite, but one analysis is younger



20 μm

20JM006B_46

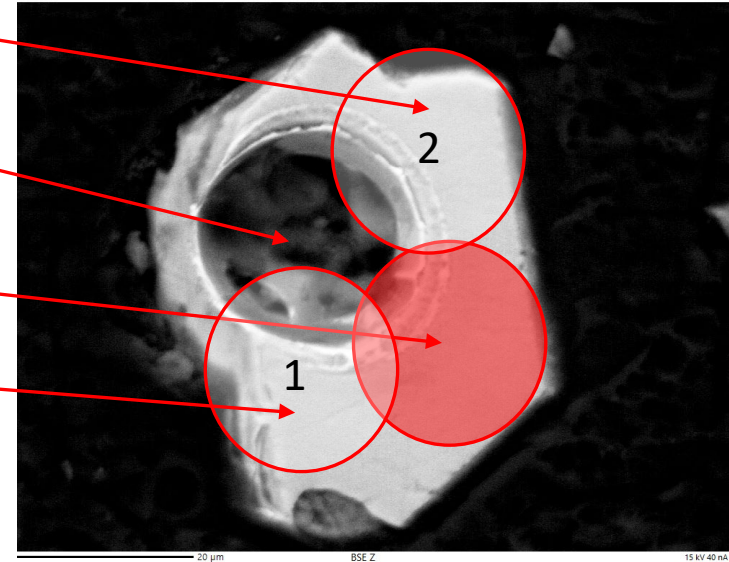
2nd batch 2020 grains

70.7 ± 1.8 Ma (0.4% disc.)

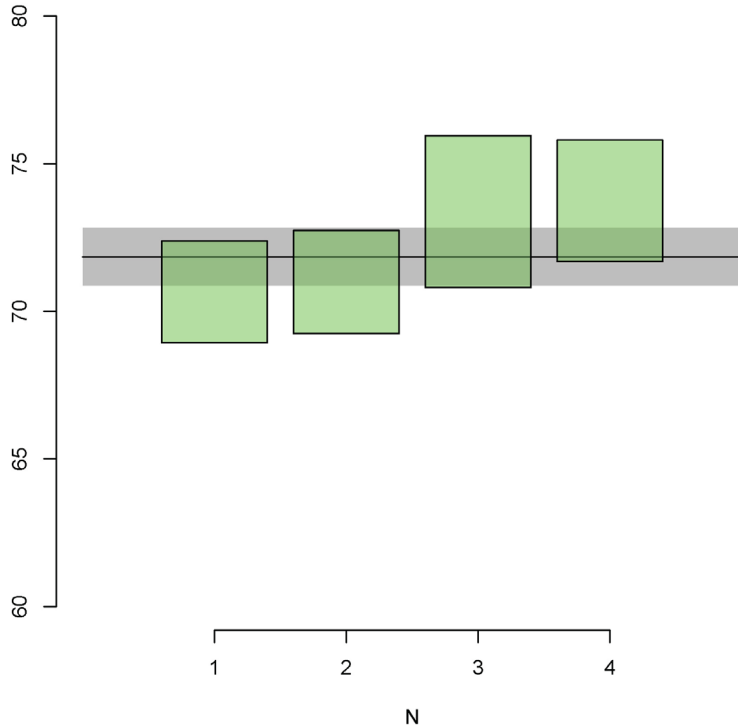
73.4 ± 2.7 Ma (3.3% disc.)

71.0 ± 1.8 Ma (10.9% disc.)

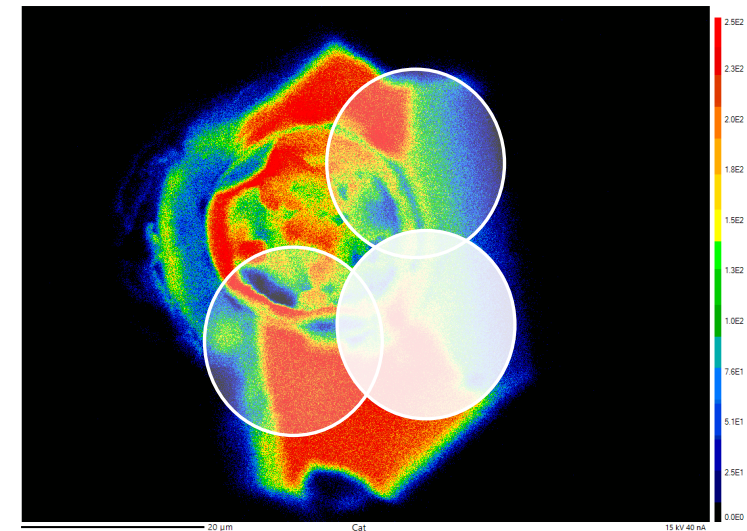
73.8 ± 2.2 Ma (15.7% disc.)



mean = 71.85 ± 0.50 | 0.97 Ma (n=4/4)
MSWD = 2.45, p(χ²) = 0.061



Good overlapping ages
in this single CL
domain show the grain
to be Casino Suite.



20 μm

20JM006B_91

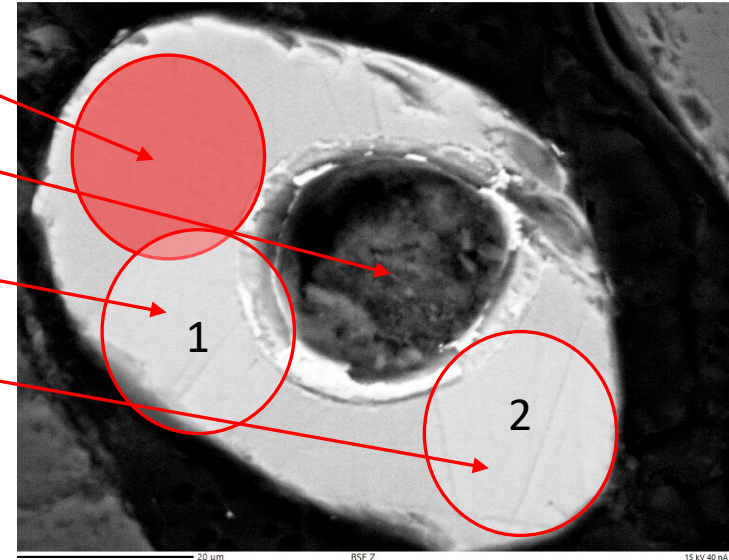
Originally grain 88 in 2020 1st batch

66.0 ± 2.8 Ma (-5.3% disc.)

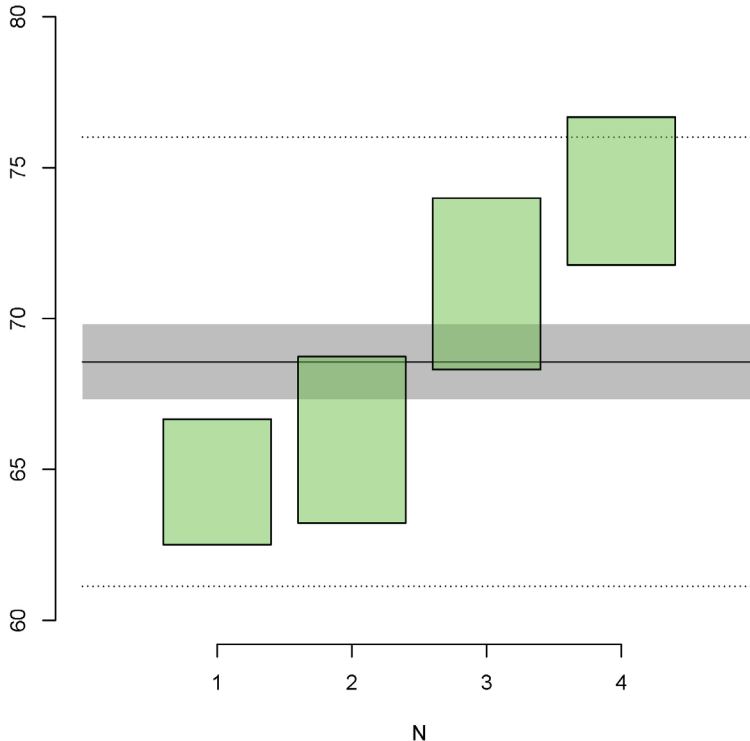
71.6 ± 3.0 Ma (13.4% disc.)

64.6 ± 2.2 Ma (1.7% disc.)

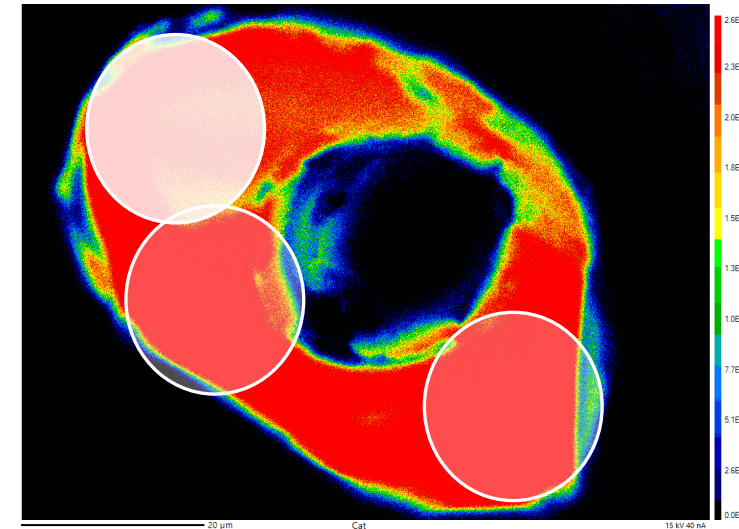
74.2 ± 2.6 Ma (6.1% disc.)



mean = 68.57 ± 0.63 | 1.24 | 7.44 Ma (n=4/4)
MSWD = 13.7, p(χ²) = 0.0000000060



Overlapping ages in what seems to be a cryptically zoned grain with Casino Suite to Prospector Mtn Suite ages. Likely Prospector Mtn Suite.

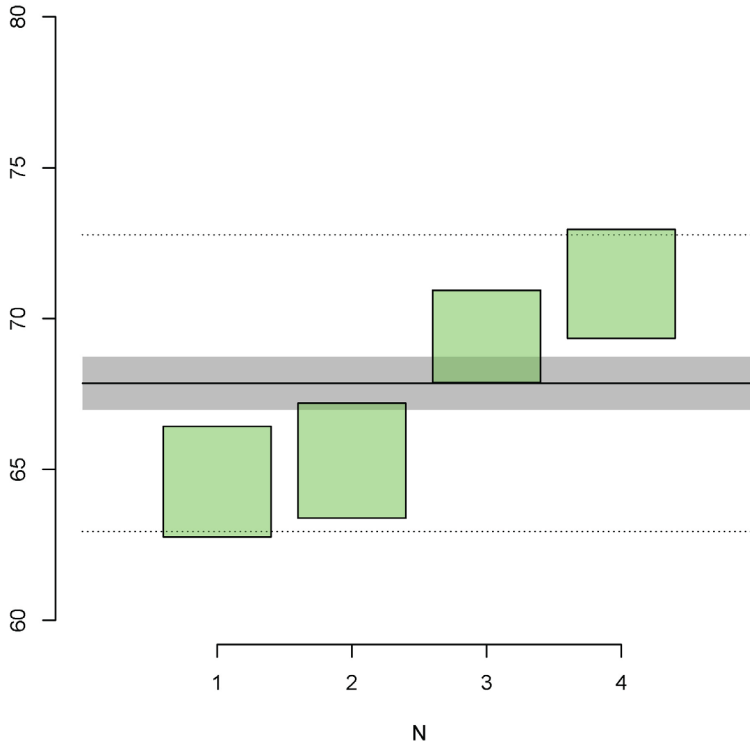


20 μm

20JM006B_116

Second 2020 batch of grains

mean = 67.85 ± 0.45 | 0.87 | 4.92 Ma (n=4/4)
MSWD = 12.0, $p(\chi^2) = 0.000000075$

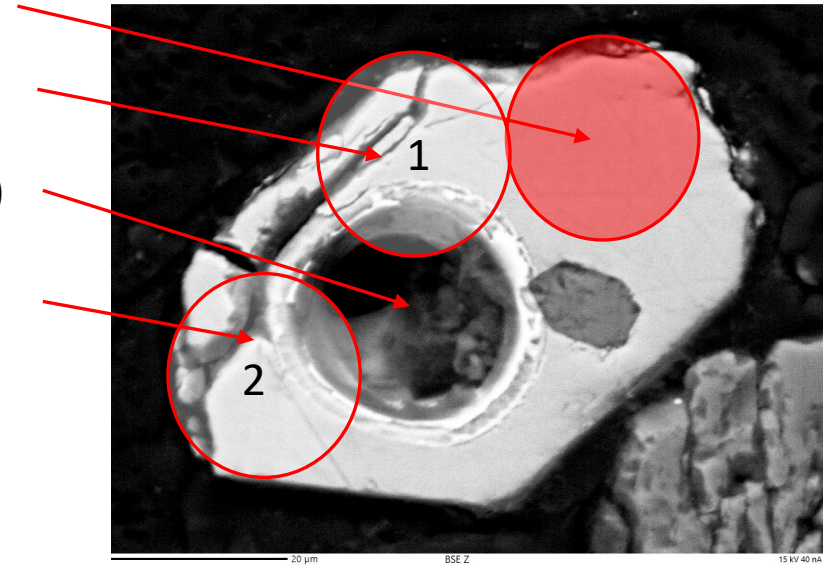


69.4 ± 1.6 Ma (-0.8% disc.)

64.5 ± 1.9 Ma (-1.7% disc.)

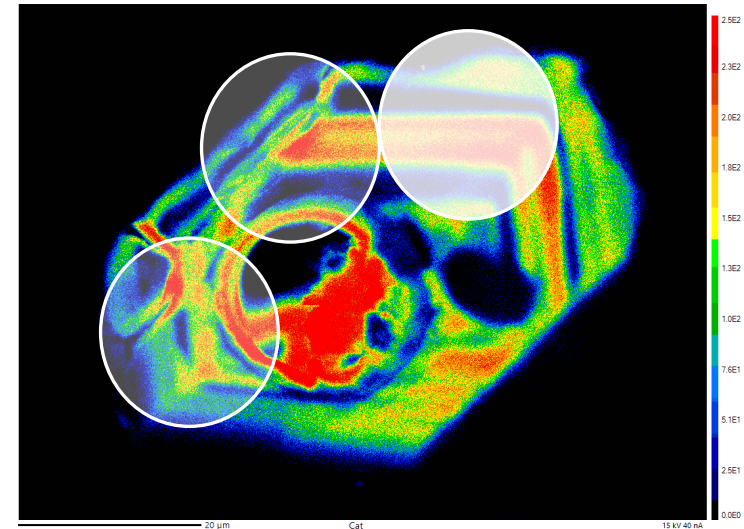
71.4 ± 1.9 Ma (-6.3% disc.)

65.3 ± 2.0 Ma (3.8% disc.)



Oscillatory zoned CL domains. Range of Casino through Prospector Mtn ages. Likely Prospector Mtn Suite.

Possible Pb loss along crack in grain?



20 μm

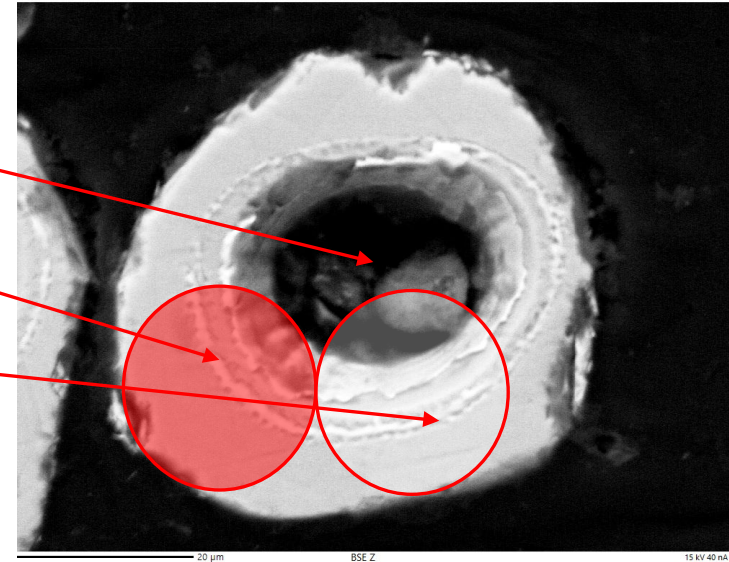
20JM006B_133

Originally grain 130 in 1st 2020 batch

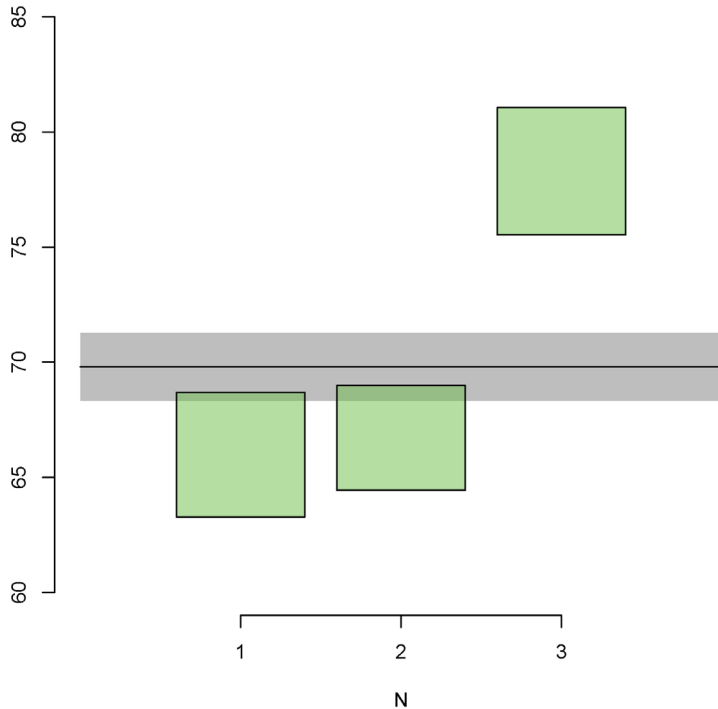
66.8 ± 2.8 Ma (26.9% disc.)

66.7 ± 2.3 Ma (-22.2% disc.)

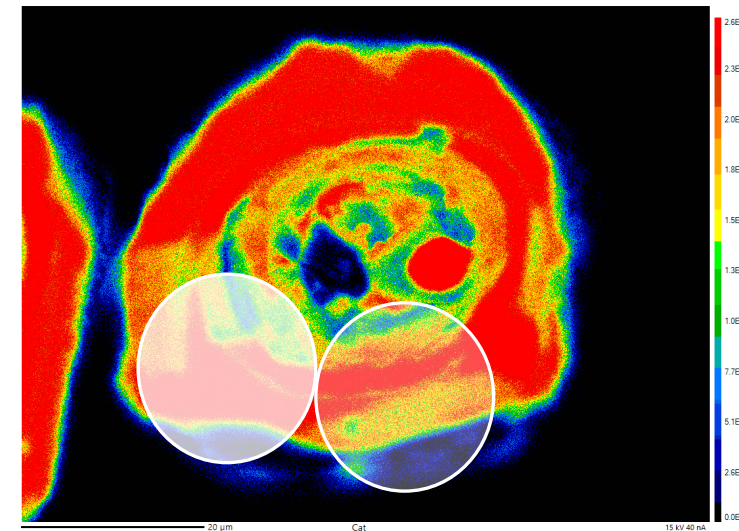
78.3 ± 3.0 Ma (25.3% disc.)



mean = 69.79 ± 0.75 | 1.47 | 16.34 Ma (n=3/3)
MSWD = 25.5, p(χ²) = 0.0000000000081



Discordant analyses
that do not overlap.
Likely Prospector Mtn
Suite.



2021 Grains

The following grains are from 2021 samples and have only had one shot so far.

30 μm

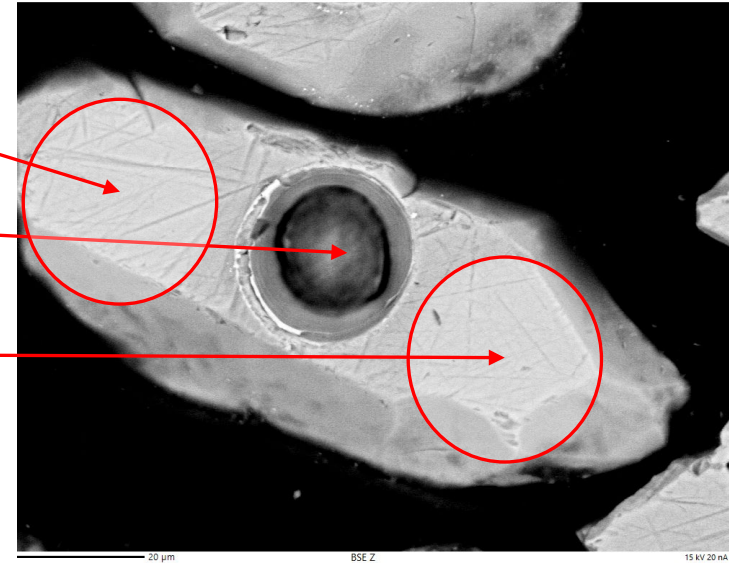
21JM001B_15

Two more spots

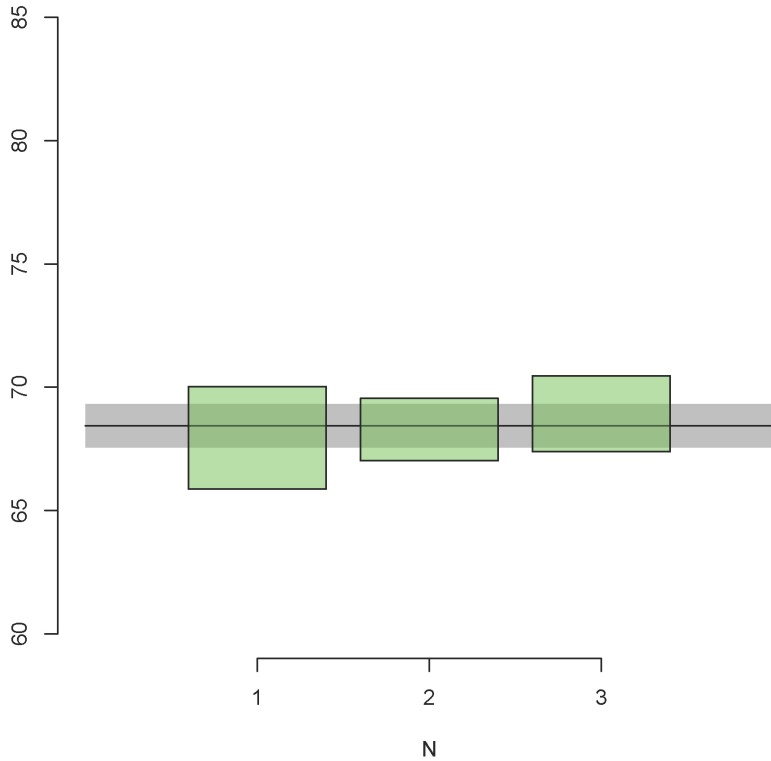
68.3 ± 1.3 Ma (3.4% disc.)

68.9 ± 2.1 Ma (11.9% disc.)

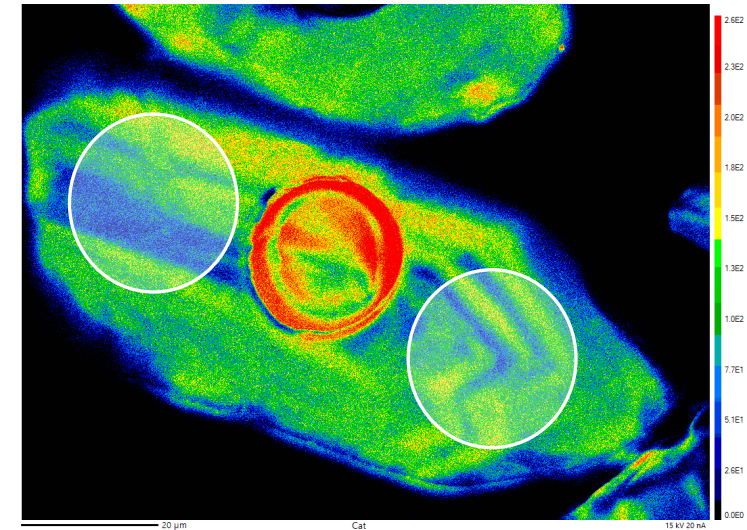
68.9 ± 1.6 Ma (5.3% disc.)



mean = 68.44 ± 0.45 | 0.88 Ma (n=3/3)
MSWD = 0.33, p(χ²) = 0.72



Good Prospector
Mtn age.



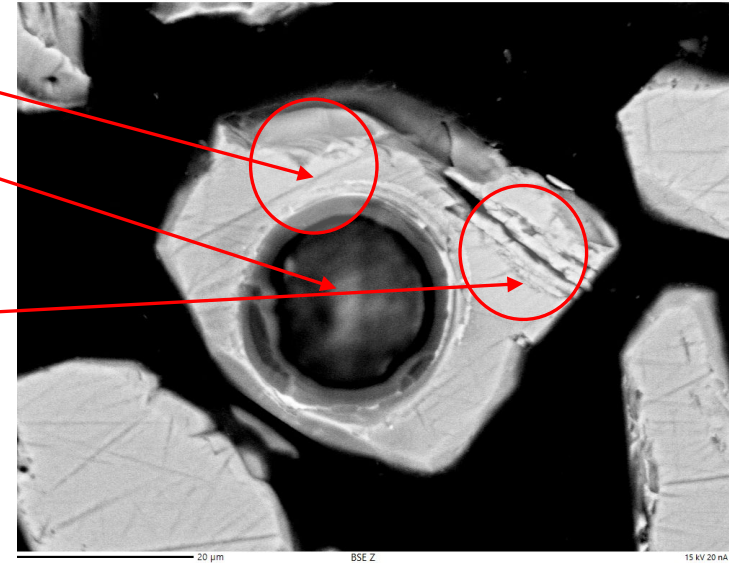
20 μ m

21JM001B_53

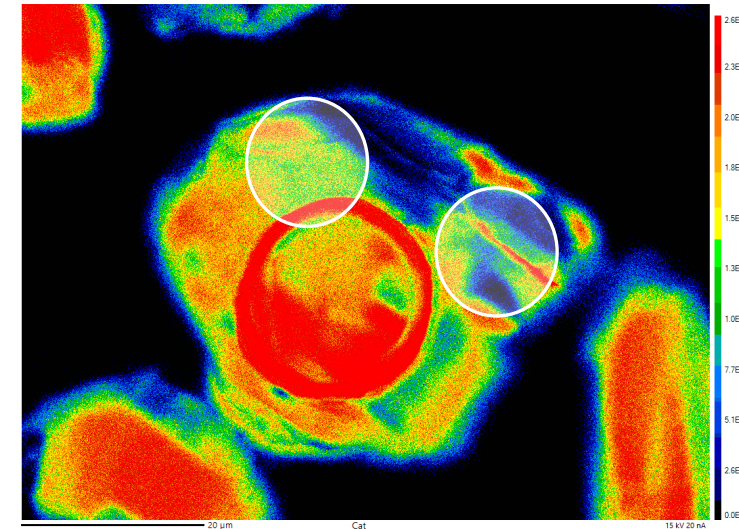
131 \pm 13 Ma (33.3% disc.)

66.9 \pm 2.5 Ma (60.8% disc.)

88.4 \pm 2.2 Ma (1.8% disc.)



Highly discordant ages, all over the place. Not reliable.



20 μm

21JM002B_41

Four more spots

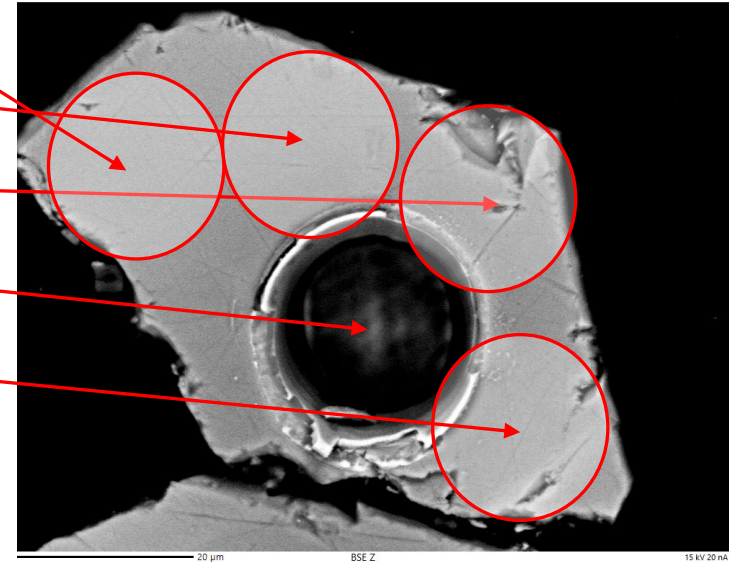
72.6 ± 1.3 Ma (-0.4% disc.)

69.3 ± 1.6 Ma (-0.1% disc.)

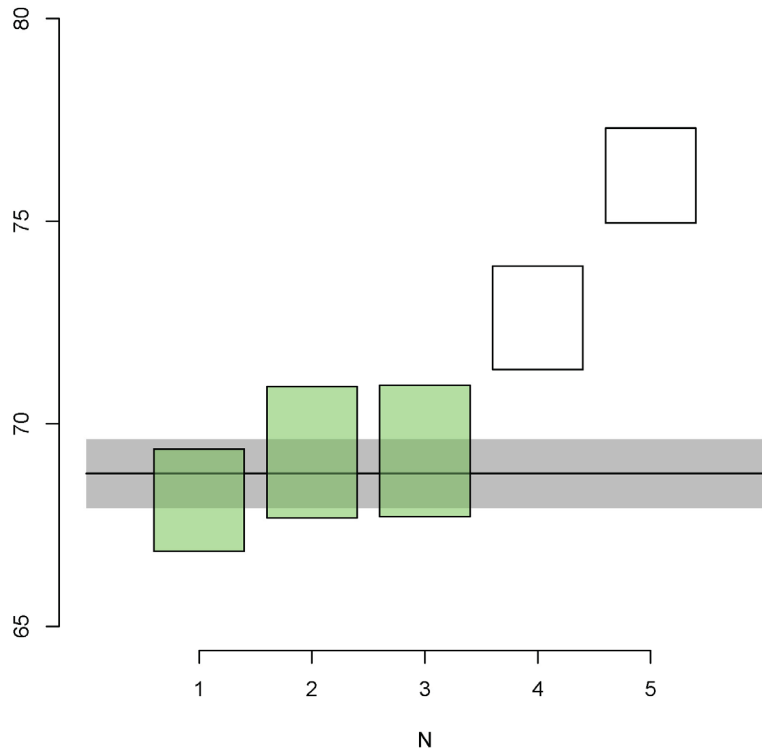
69.3 ± 1.7 Ma (2.1% disc.)

76.3 ± 1.2 Ma (0.0% disc.)

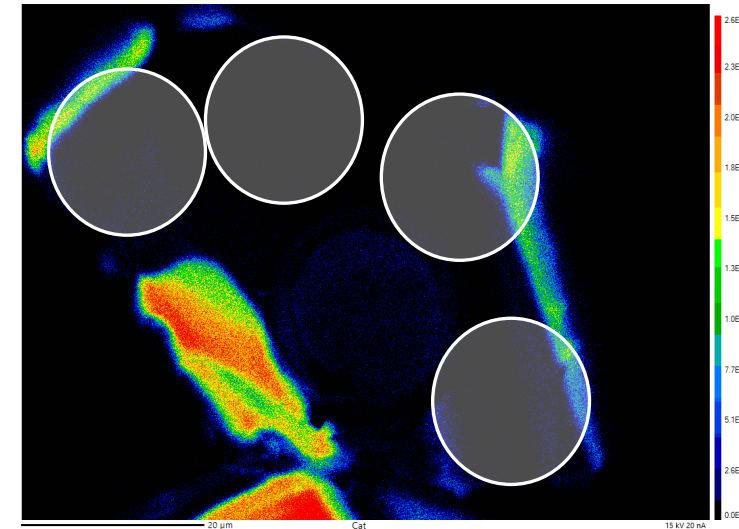
68.1 ± 1.3 Ma (0.9% disc.)



mean = 68.77 ± 0.43 | 0.85 Ma (n=3/5)
MSWD = 0.96, p(χ²) = 0.38



Older, Casino Age core with younger Prospector Mtn age rim.

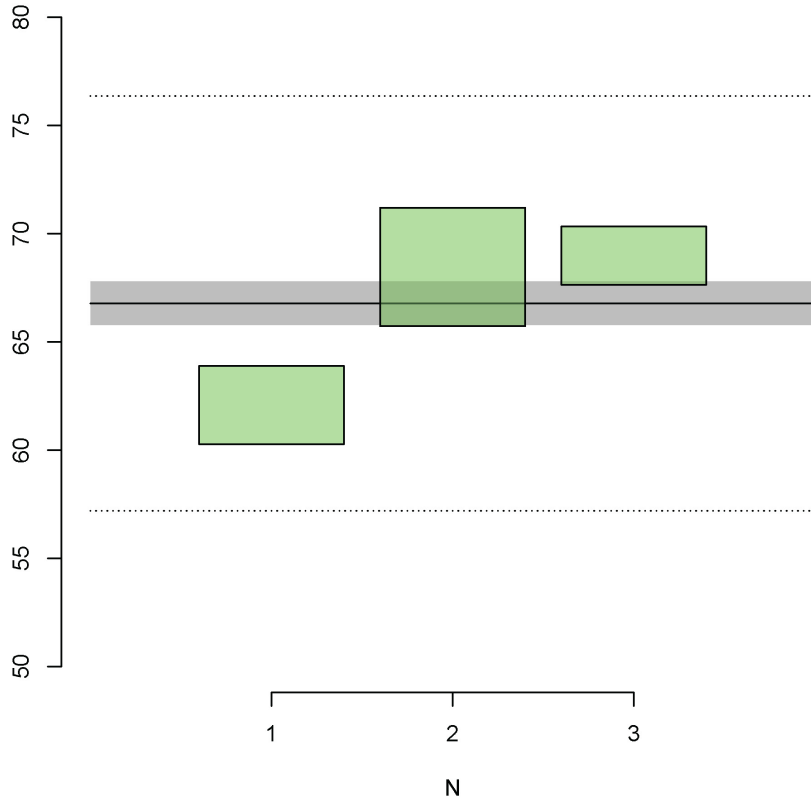


20 μm

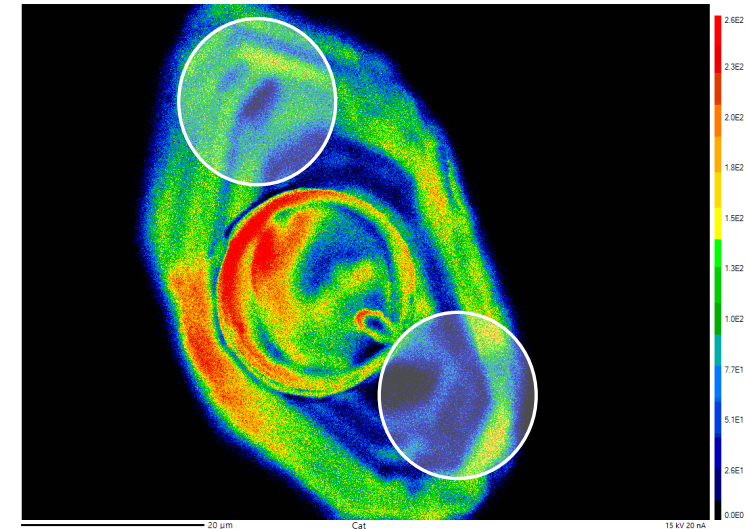
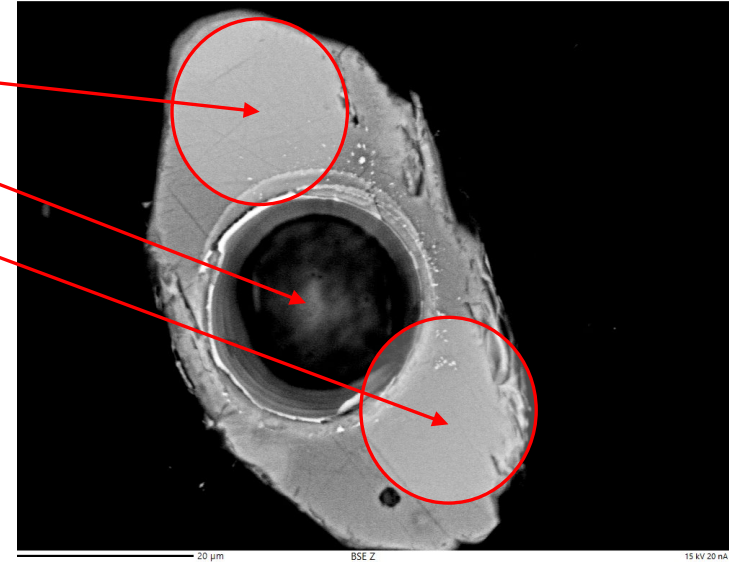
21JM002B_55

- 62.1 \pm 1.9 Ma (9.2% disc.)
- 69.2 \pm 1.4 Ma (0.5% disc.)
- 69.2 \pm 1.4 Ma (2.9% disc.)

mean = 66.78 \pm 0.51 | 1.00 | 9.59 Ma (n=3/3)
MSWD = 18.9, $p(\chi^2) = 0.0000000061$



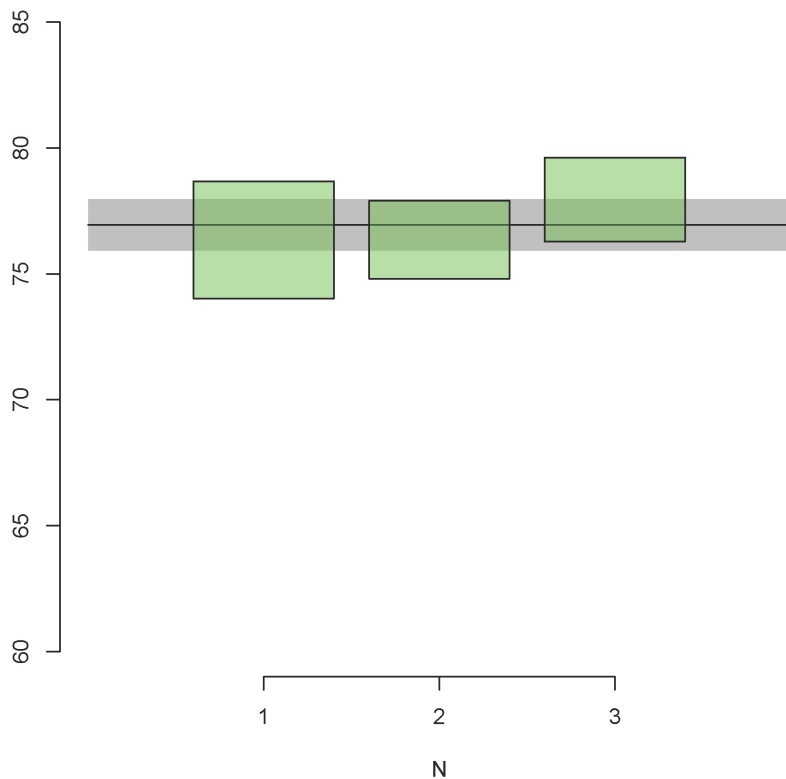
Older core, blue
in CL, Prospector
Mtn age, with
younger rim
green in CL



30 μm

21JM004B_22

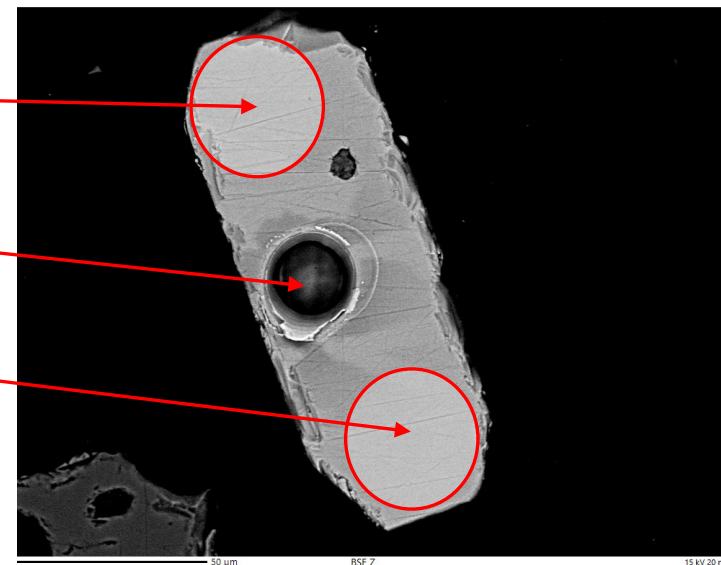
mean = 76.95 ± 0.52 | 1.02 Ma (n=3/3)
MSWD = 1.10, $p(\chi^2) = 0.33$



76.3 ± 1.6 Ma (13.6% disc.)

77.3 ± 2.4 Ma (6.9% disc.)

78.2 ± 1.7 Ma (-5.4% disc.)



Good Casino Suite age.

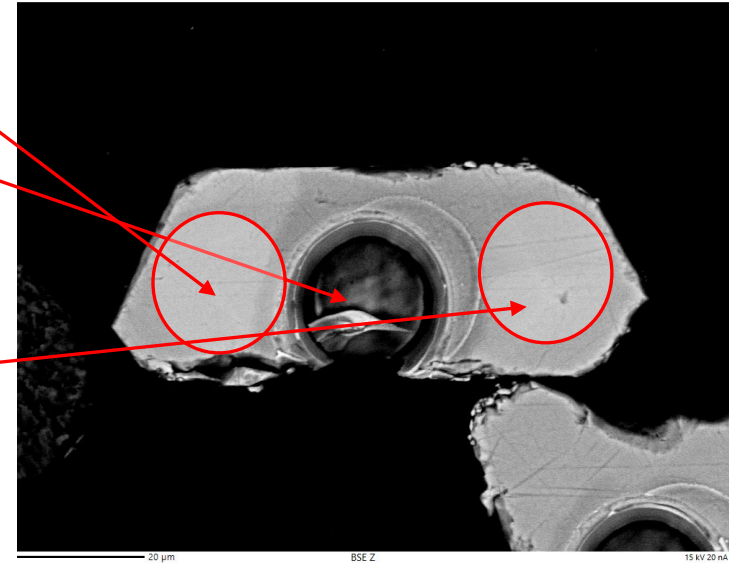
20 μm

21JM004B_26

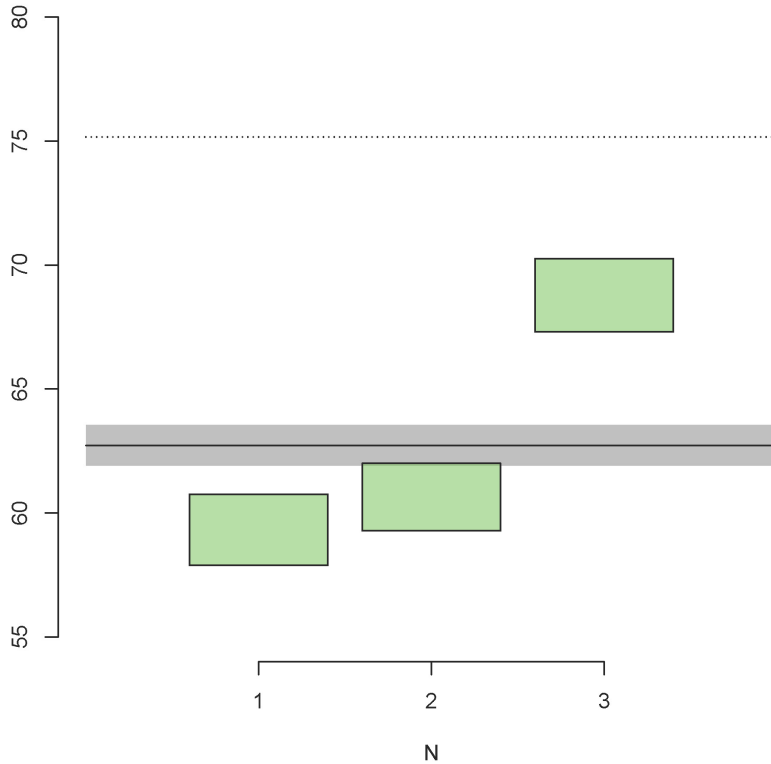
59.3 \pm 1.5 Ma (10.3% disc.)

69.2 \pm 1.5 Ma (2.2% disc.)

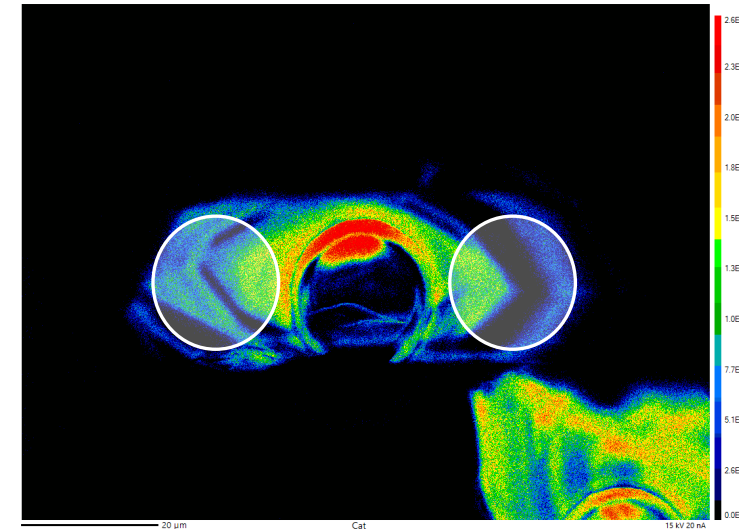
60.6 \pm 1.4 Ma (0.2% disc.)



mean = 62.73 \pm 0.42 | 0.82 | 12.44 Ma (n=3/3)
MSWD = 47.7, $p(\chi^2) = 0$



Distinctly younger rim.
~60 Ma, possibly late
Prospector Mtn.



20 μ m

21JM005B_25

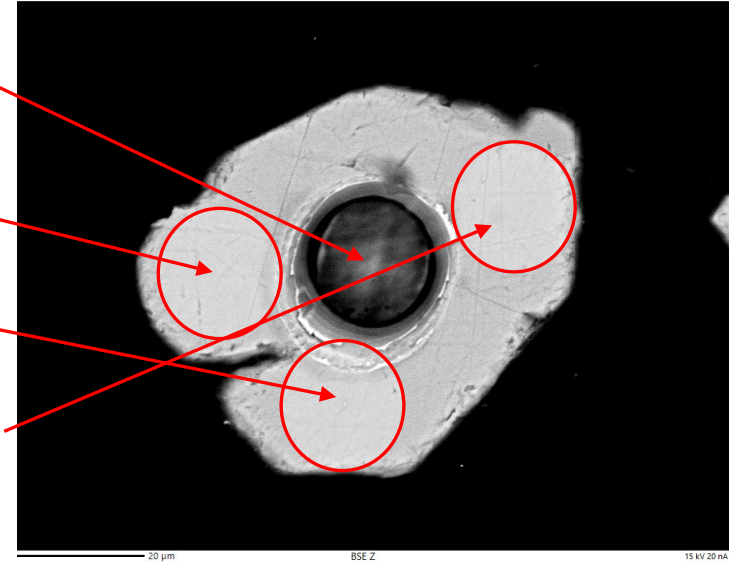
Three more spots

70.6 \pm 2.3 Ma (5.9% disc.)

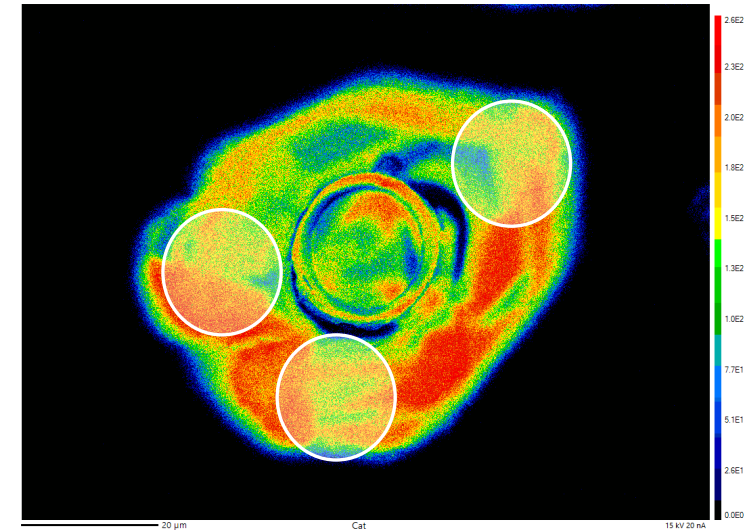
103.3 \pm 2.8 Ma (3.3% disc.)

105.8 \pm 3.0 Ma (1.6% disc.)

106.6 \pm 2.7 Ma (-3.3% disc.)



Very unusual age –
younger core than rim.
Possibly a sample mix
up?



30 μm

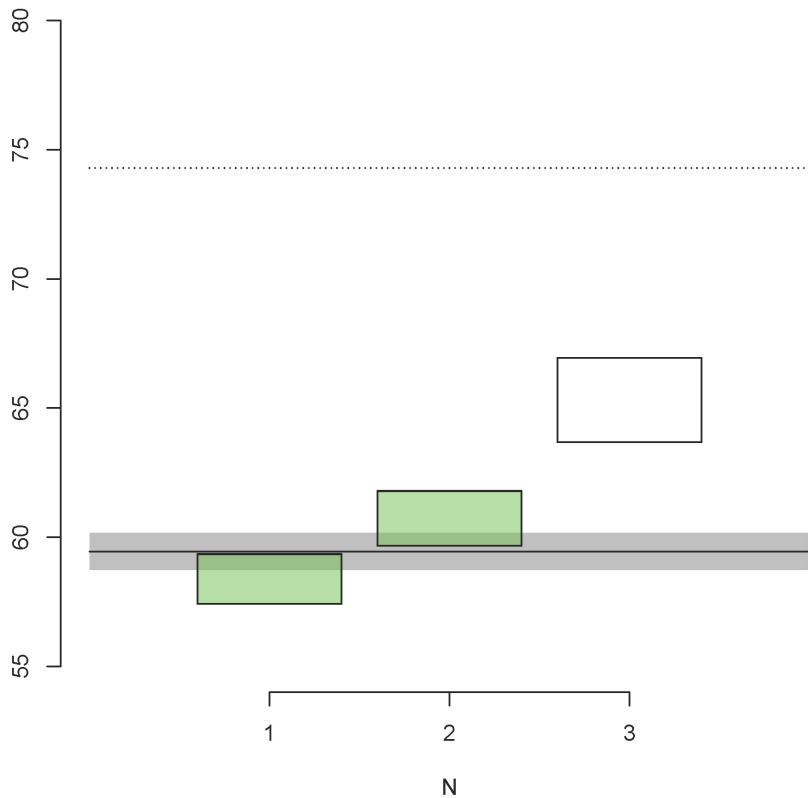
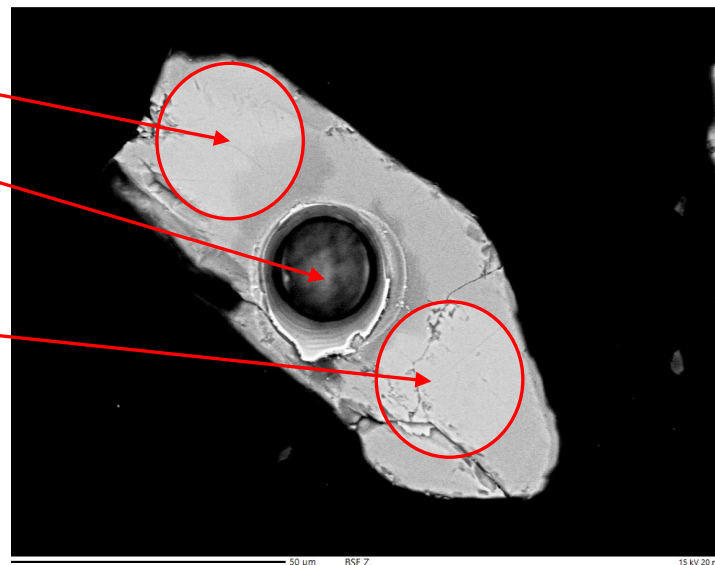
21JM006B_16

60.8 ± 1.1 Ma (7.7% disc.)

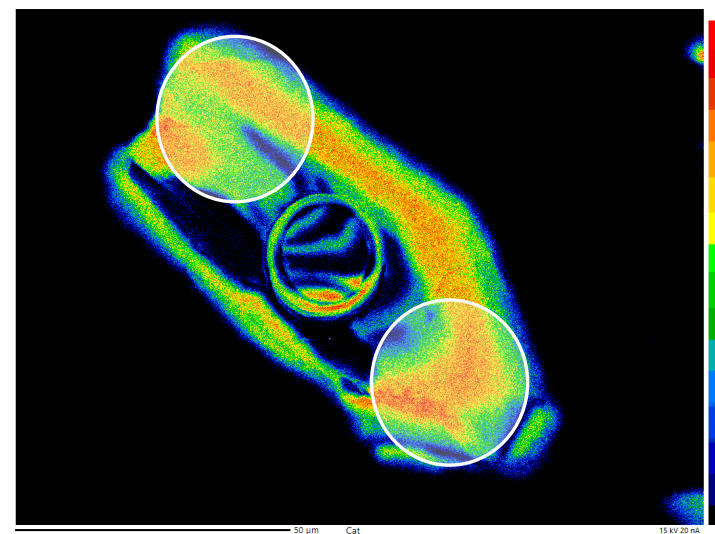
65.7 ± 1.7 Ma (1.1% disc.)

58.4 ± 1.0 Ma (3.1% disc.)

mean = 59.44 ± 0.36 | 0.71 | 14.85 Ma (n=2/3)
MSWD = 10.3, $p(\chi^2) = 0.0013$



Palaeocene age



20 μ m

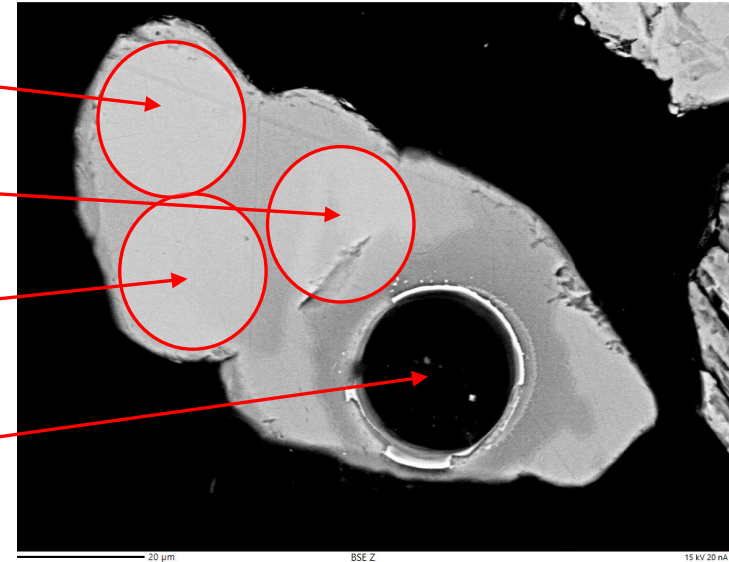
21JM006B_24

68.1 \pm 2.3 Ma (9.7% disc.)

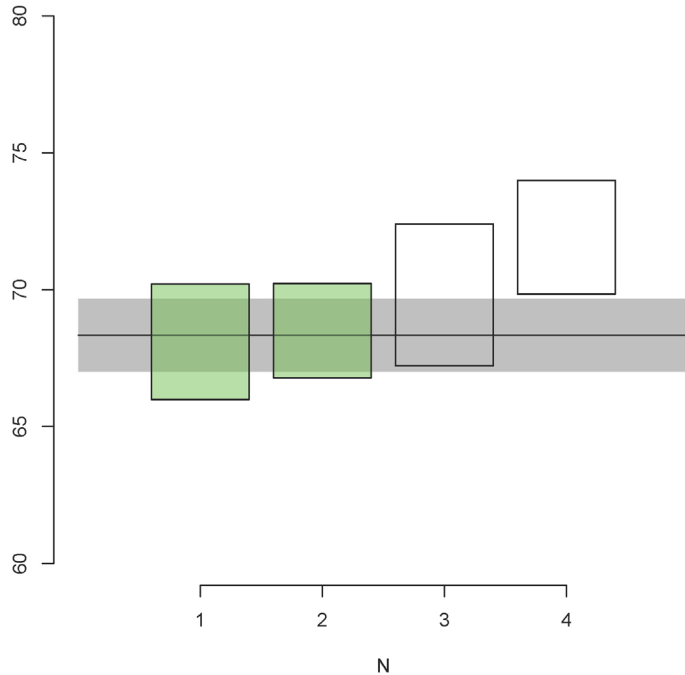
71.9 \pm 2.2 Ma (15.5% disc.)

68.5 \pm 1.8 Ma (9.5% disc.)

70.6 \pm 2.7 Ma (-5.0% disc.)

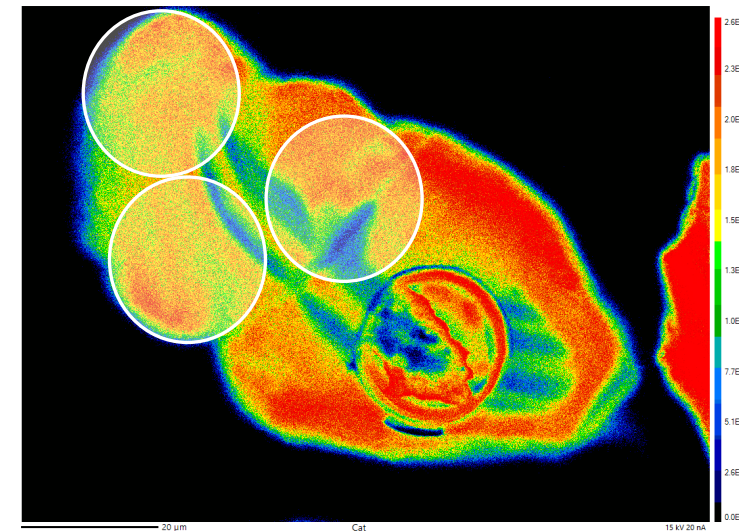


mean = 68.34 \pm 0.68 | 1.34 Ma (n=2/4)
MSWD = 0.086, p(χ^2) = 0.77



Good Prospector Mtn age, possibly overlapping Casino Suite or resorbing a core of Casino Suite.

Resorbed core texture?
Oscillatory growth zones cross-cut by homogeneous rim



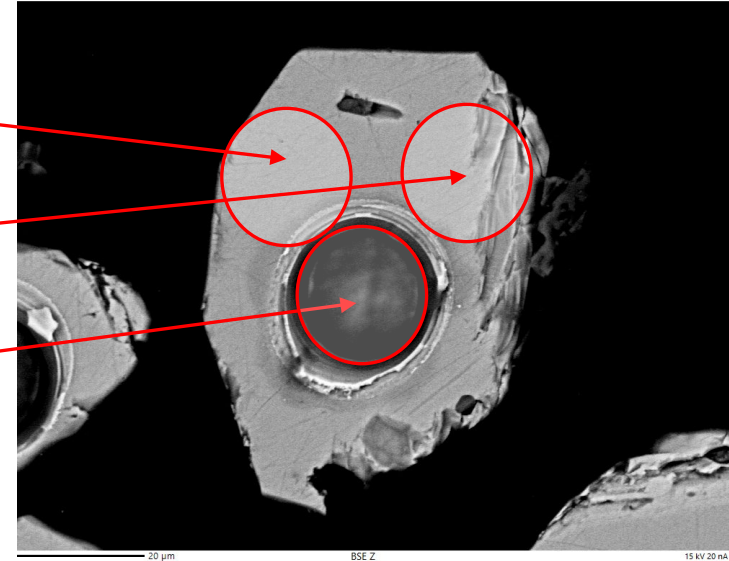
20 μm

21JM007B_02

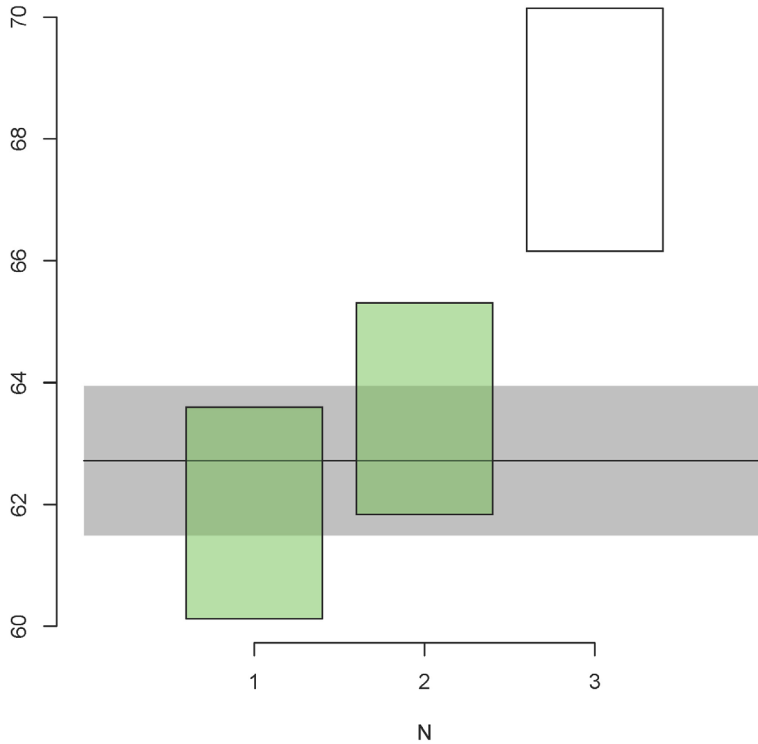
61.8 \pm 1.8 Ma (11.3% disc.)

63.7 \pm 1.8 Ma (-3.1% disc.)

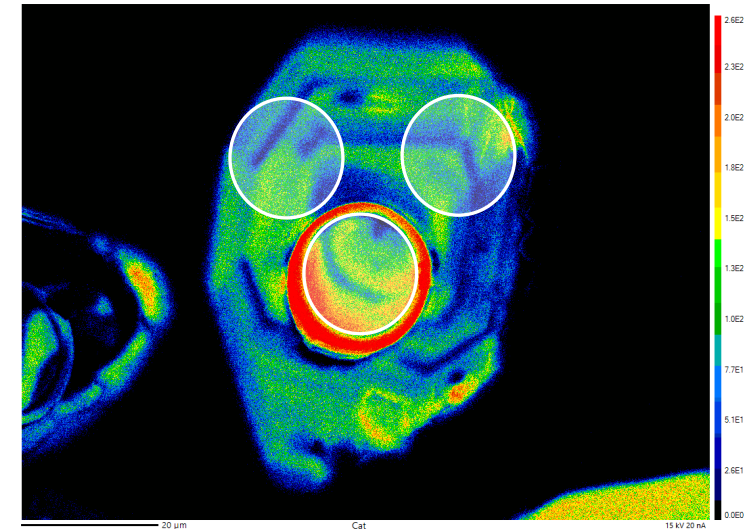
68.7 \pm 2.0 Ma (2.5% disc.)



mean = 62.72 \pm 0.63 | 1.23 Ma (n=2/3)
MSWD = 1.86, $\rho(\chi^2)$ = 0.17



Late Prospector Mtn
Suite? Or Younger \sim 63 Ma

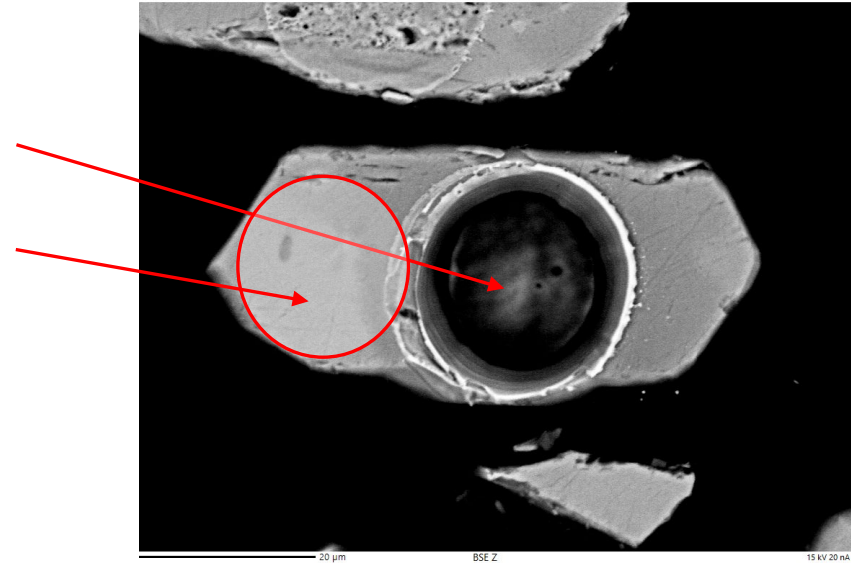


20 μ m

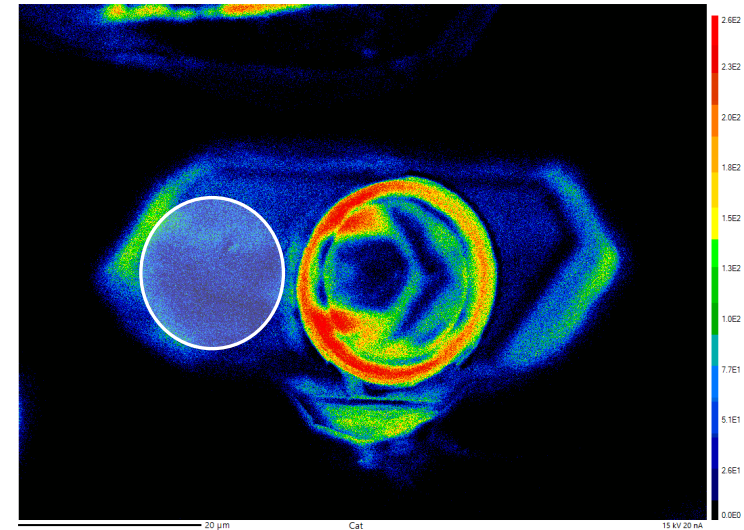
21JM007B_21

65.0 ± 1.3 Ma (5.5% disc.)

60.3 ± 2.1 Ma (0.2% disc.)



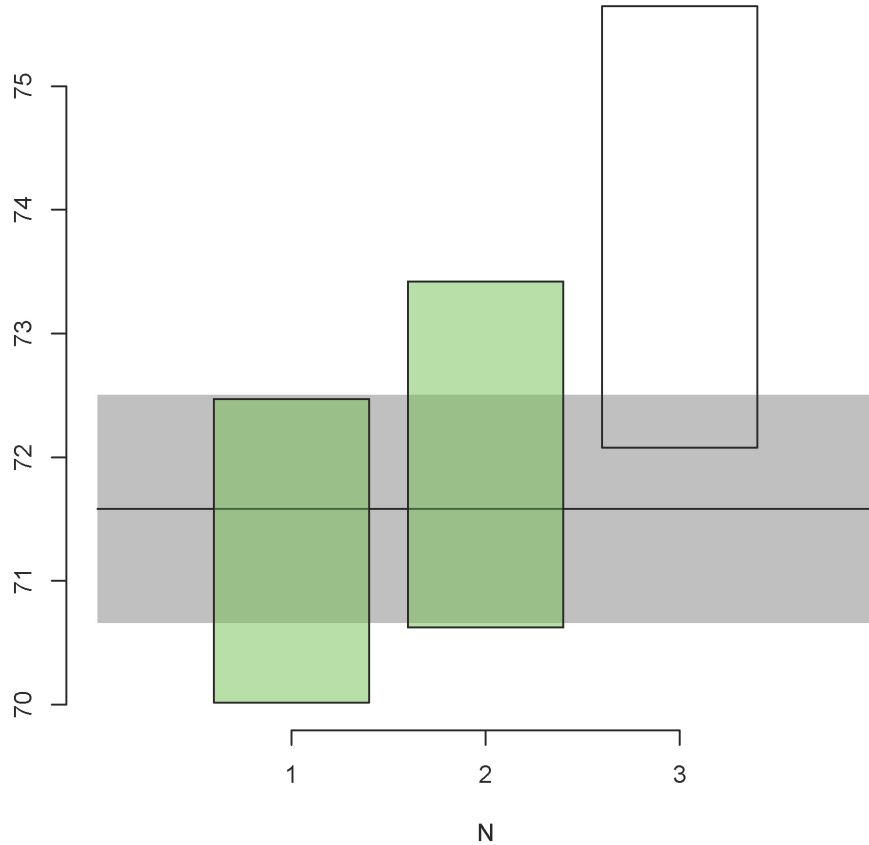
Younger than Prospector
Mtn, ~ 60 Ma



30 μm

21JM008B_15

mean = 71.58 ± 0.47 | 0.92 Ma (n=2/3)
MSWD = 0.67, $p(\chi^2) = 0.41$

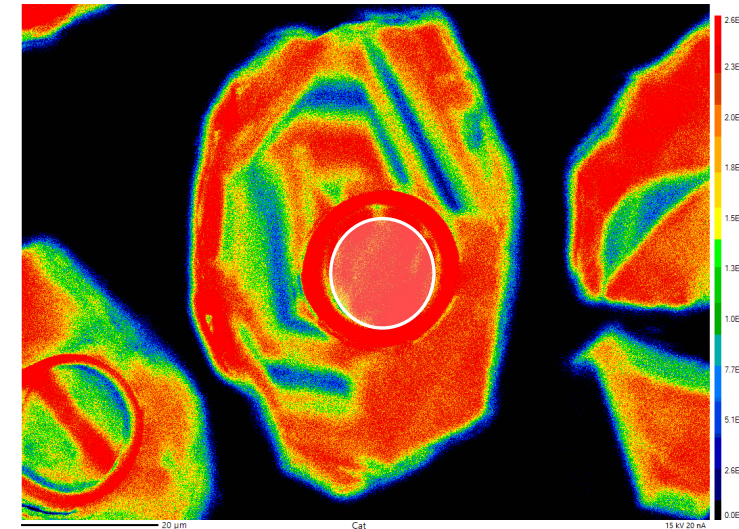
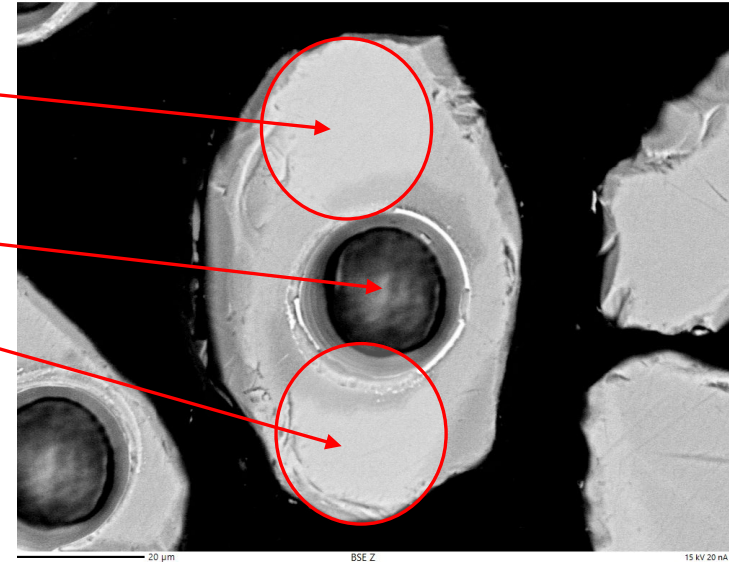


72.0 ± 1.5 Ma (5.4% disc.)

74.8 ± 1.9 Ma (13.9% disc.)

71.3 ± 1.4 Ma (22.9% disc.)

Good Casino Suite age rim, possible resorbed concentric core.



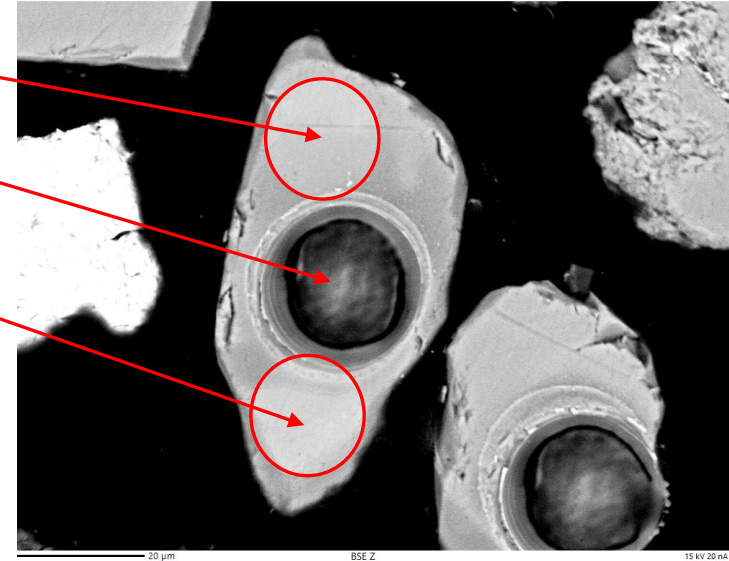
20 μm

21JM008B_20

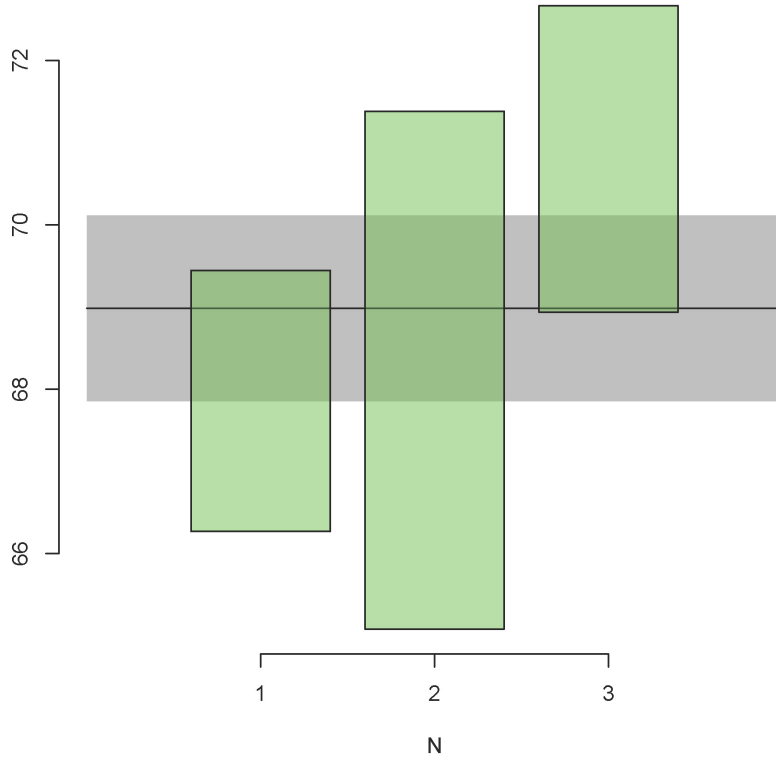
68.0 ± 1.7 Ma (-4.1% disc.)

69.6 ± 3.3 Ma (-0.6% disc.)

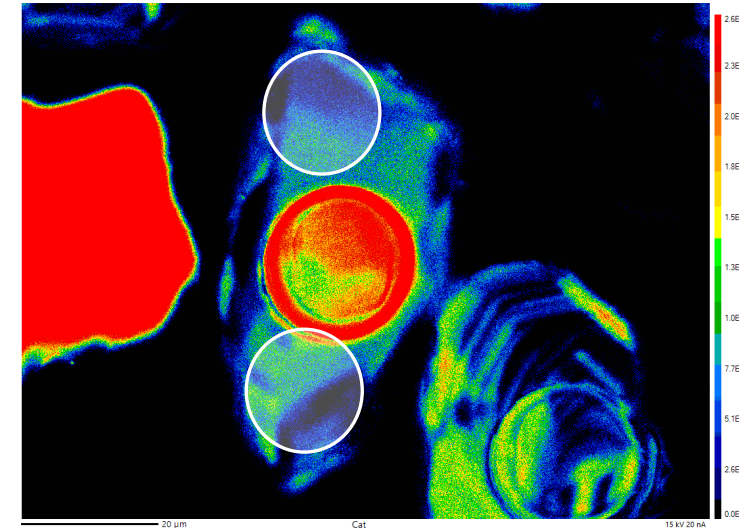
70.8 ± 1.9 Ma (0.8% disc.)



mean = 68.99 ± 0.58 | 1.13 Ma (n=3/3)
MSWD = 2.90, p(χ²) = 0.055



Good Prospector Mtn
age.



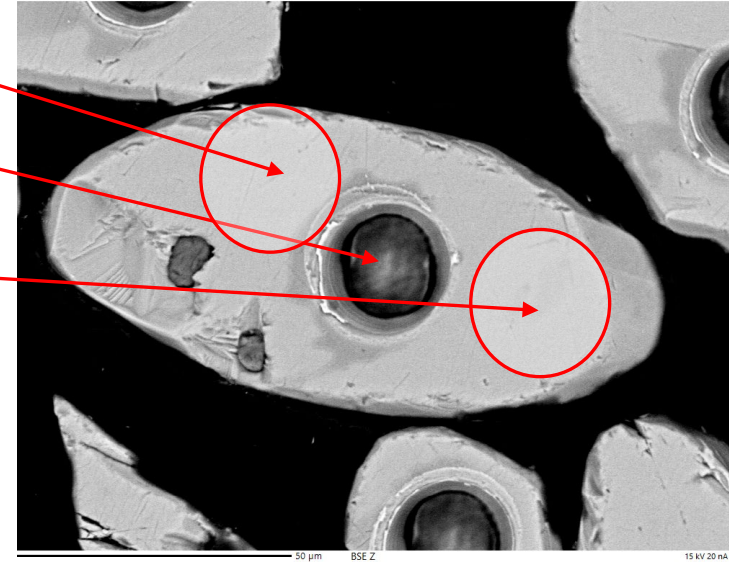
30 μm

21JM008B_23

67.5 ± 1.1 Ma (7.7% disc.)

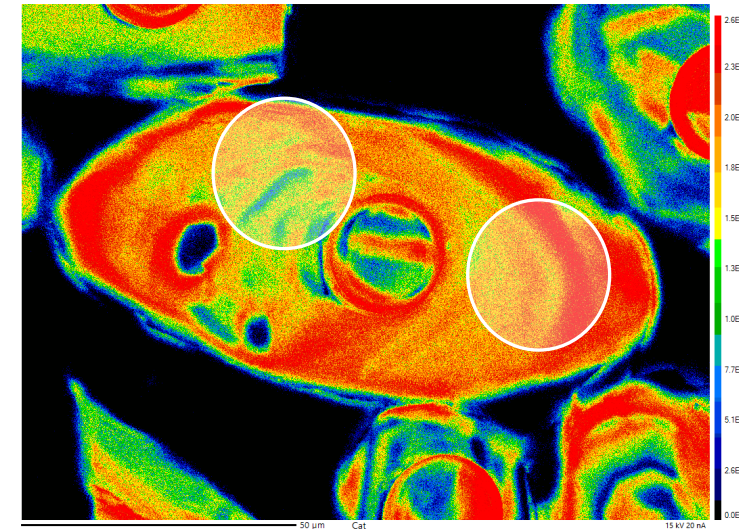
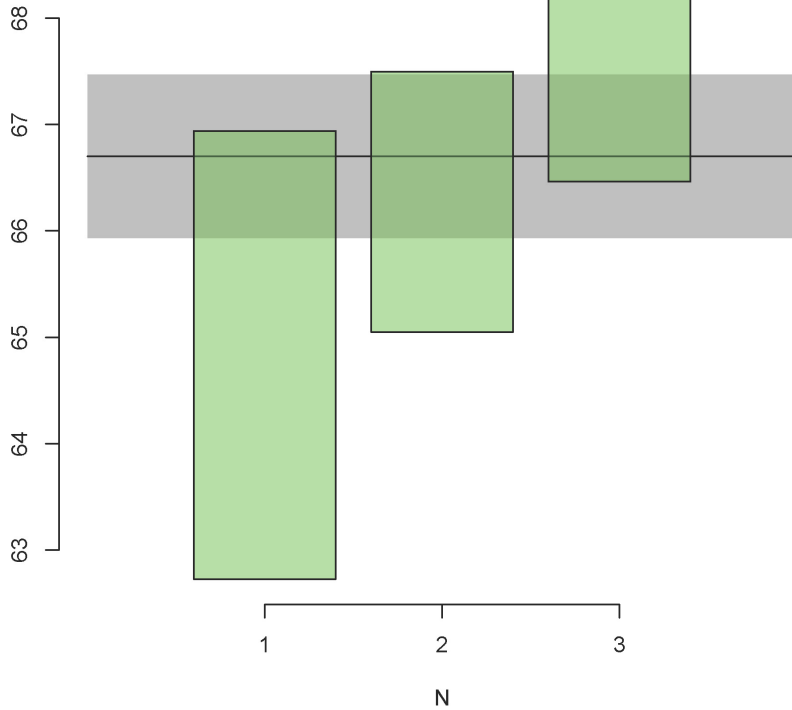
64.9 ± 2.0 Ma (5.2% disc.)

66.3 ± 1.3 Ma (5.8% disc.)



mean = 66.70 ± 0.39 | 0.77 Ma (n=3/3)
MSWD = 2.94, p(χ²) = 0.053

Good Prospector Mtn
age ~67 Ma



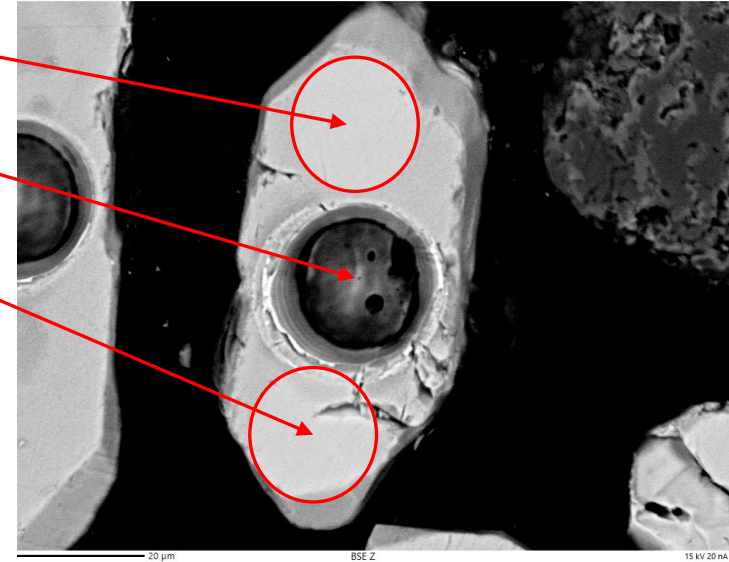
20 μm

21JM008B_29

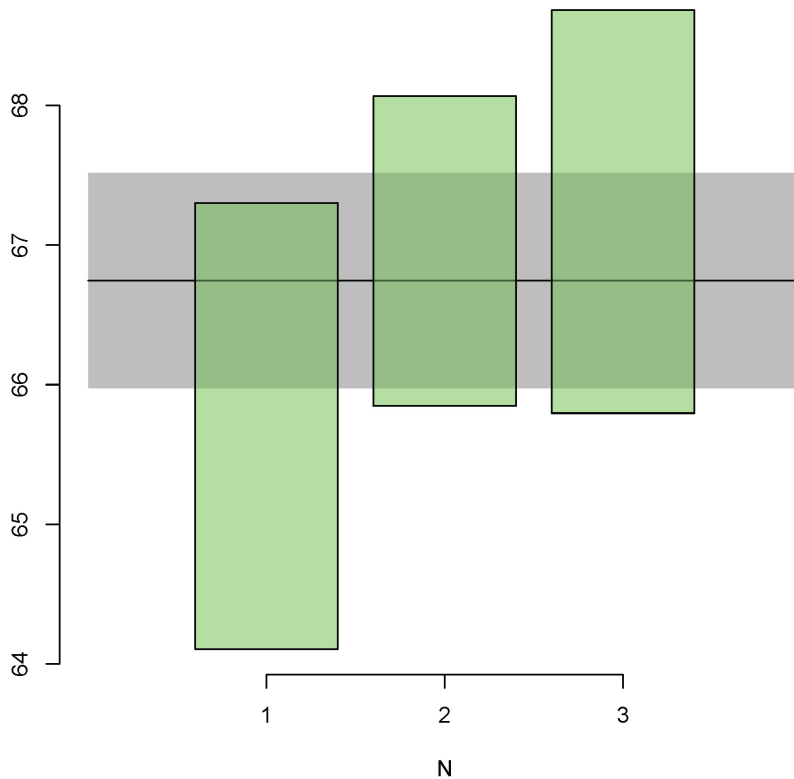
67.2 ± 1.5 Ma (-0.5% disc.)

67.3 ± 1.1 Ma (5.1% disc.)

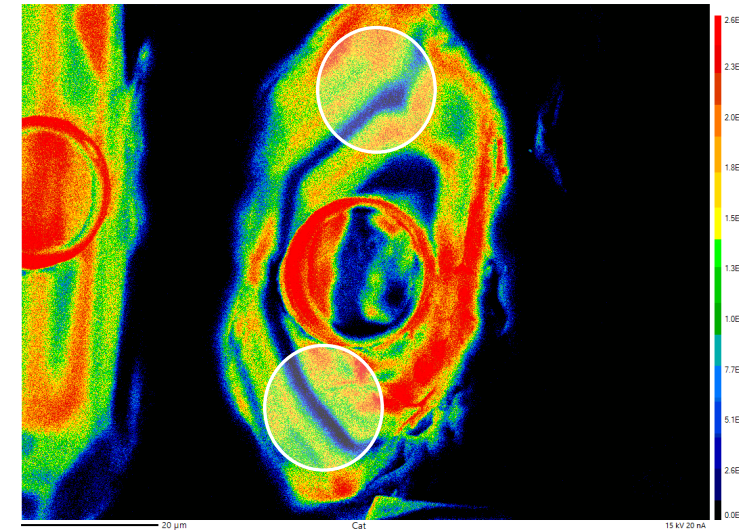
65.7 ± 1.6 Ma (5.0% disc.)



mean = 66.75 ± 0.39 | 0.77 Ma (n=3/3)
MSWD = 1.11, $p(\chi^2) = 0.33$



Good Prospector
Mtn age ~ 67 Ma

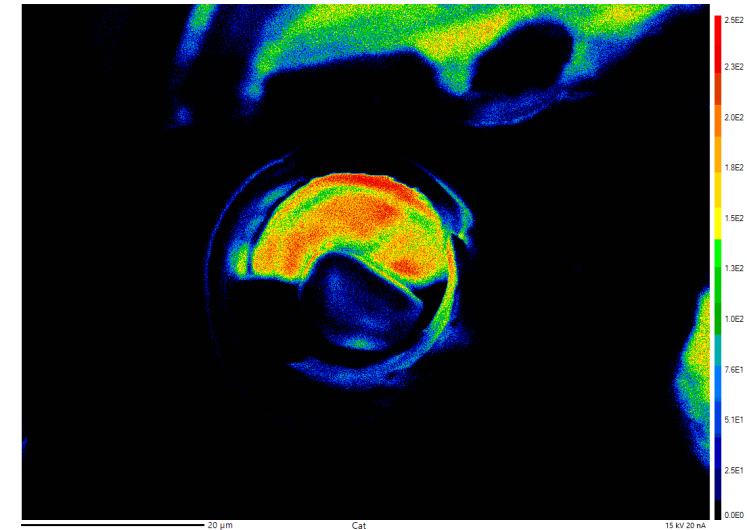
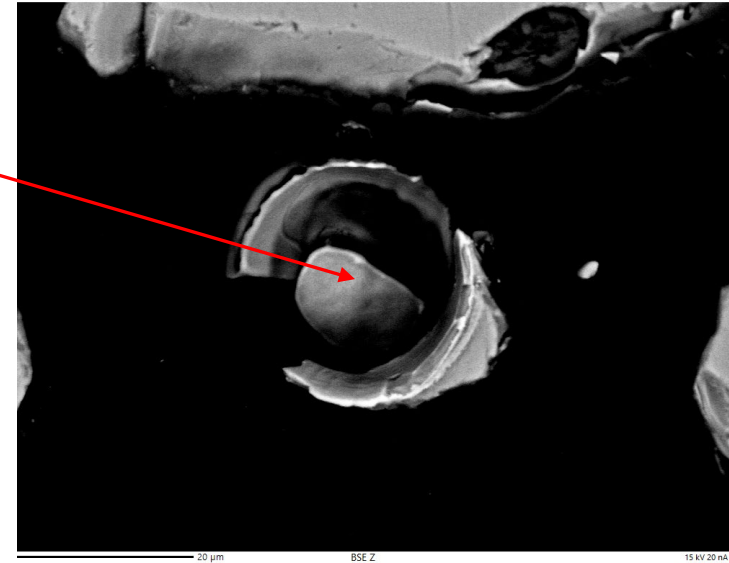
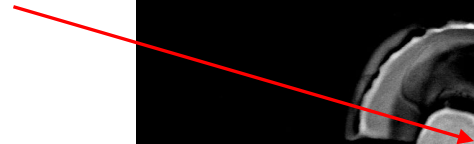


N/A μm

21JM009B_12

No additional spots possible.

$69.7 \pm 1.7 \text{ Ma}$ (8.1% disc.)

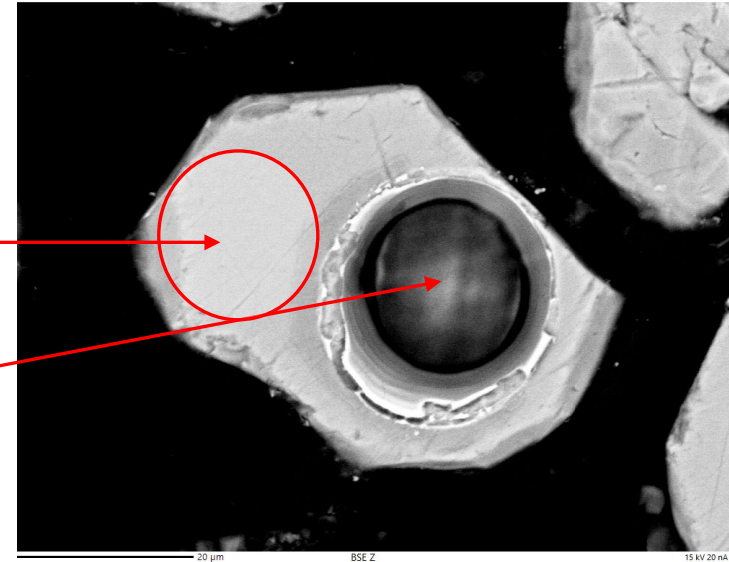


20 μm

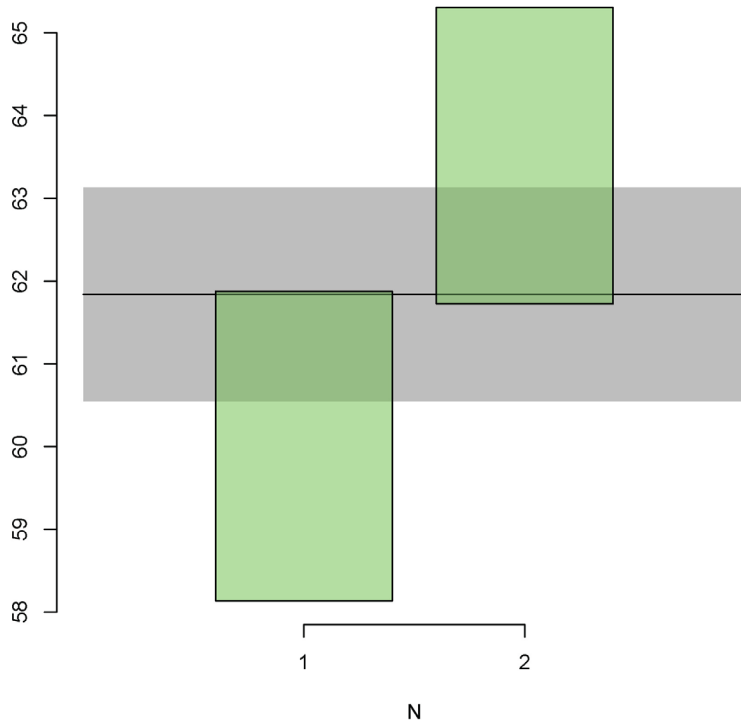
21JM010B_11

60.0 ± 1.9 Ma (2.0% disc.)

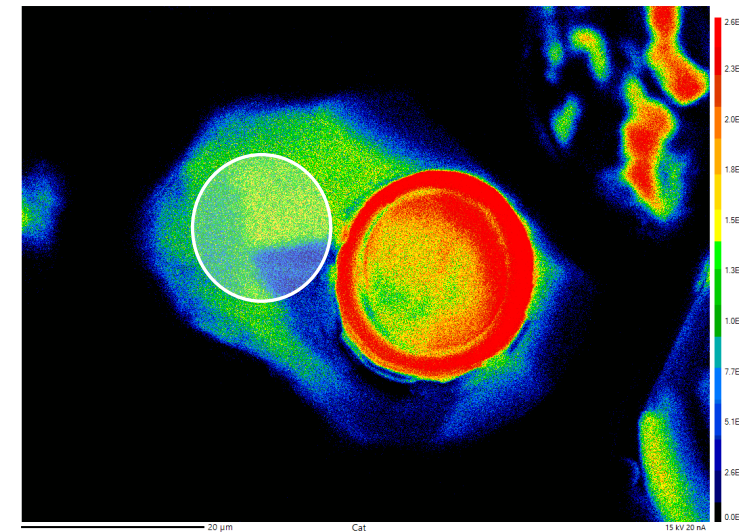
63.9 ± 1.8 Ma (-1.8% disc.)



mean = 61.84 ± 0.66 | 1.29 | 22.27 Ma (n=2/2)
MSWD = 7.06, p(χ²) = 0.0079



Younger than Prospector
Mtn Suite, ~62 Ma



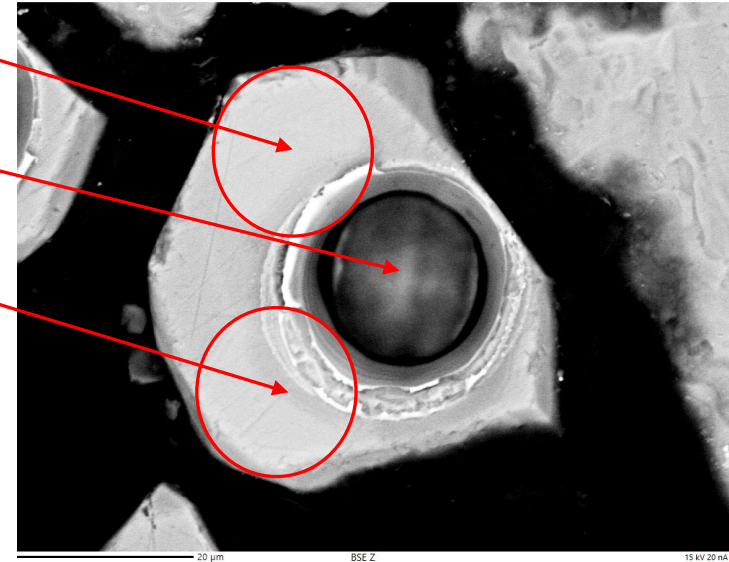
20 μm

21JM010B_12

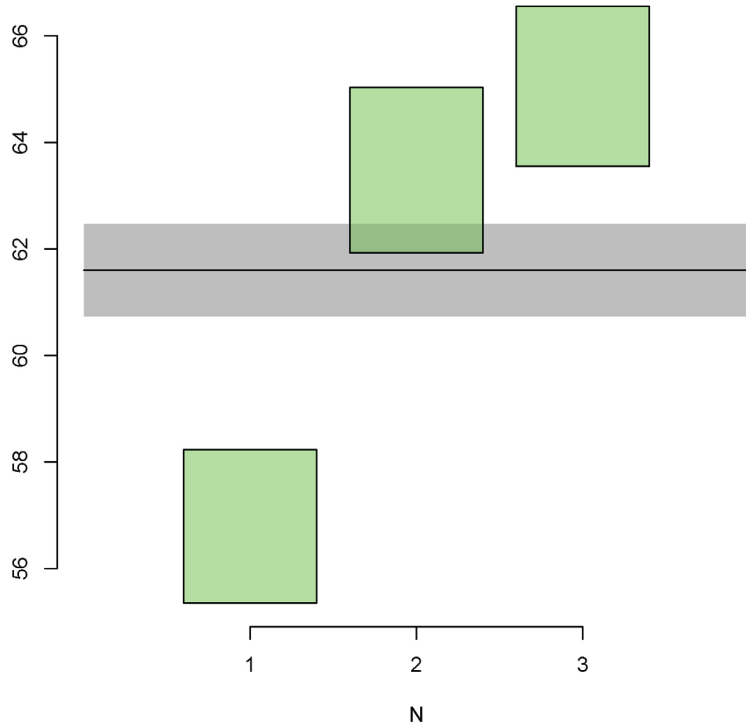
56.8 \pm 1.5 Ma (2.9% disc.)

65.4 \pm 1.5 Ma (0.2% disc.)

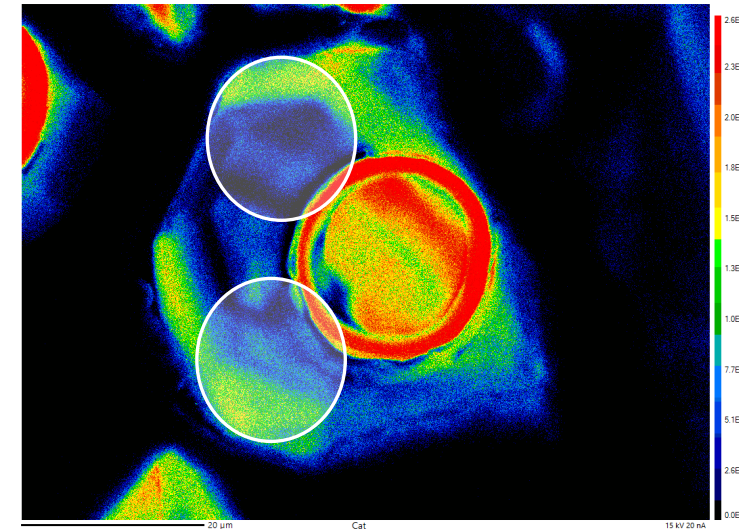
63.5 \pm 1.6 Ma (-0.5% disc.)



mean = 61.60 \pm 0.44 | 0.86 | 11.11 Ma (n=3/3)
MSWD = 34.5, $p(\chi^2) = 0.0000000000000011$



Inconsistent ages but generally younger than Prospector Mtn or Palaeocene



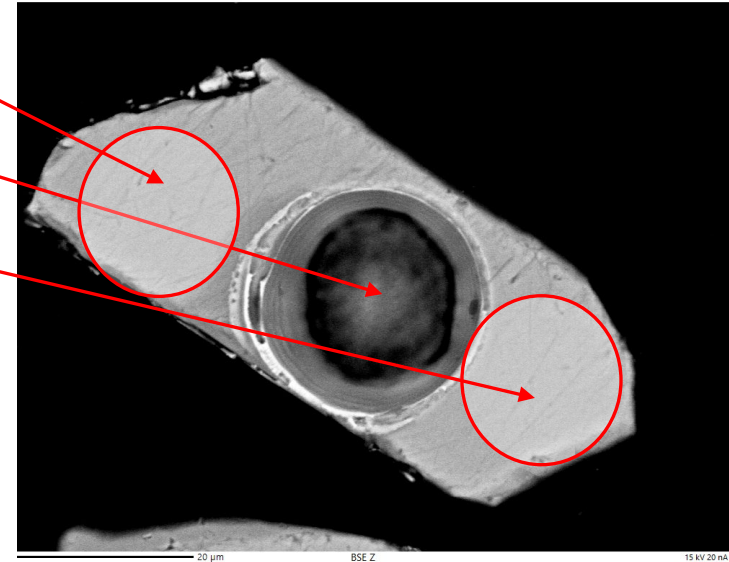
20 μm

21JM011B_02

70.9 ± 2.5 Ma (34.0% disc.)

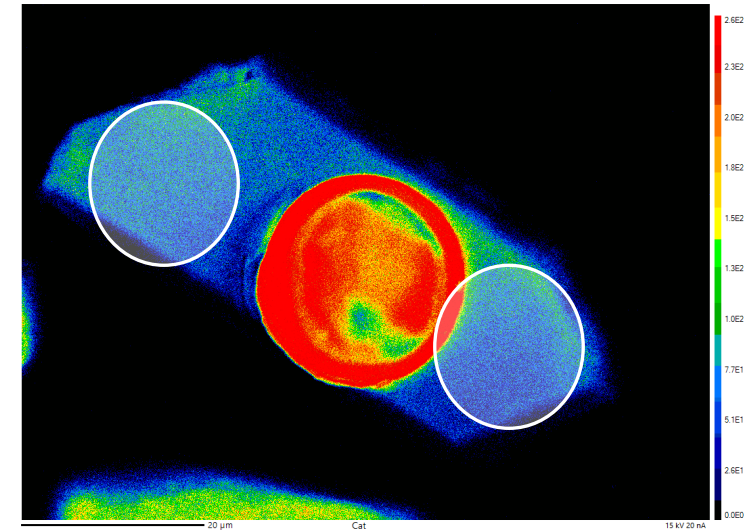
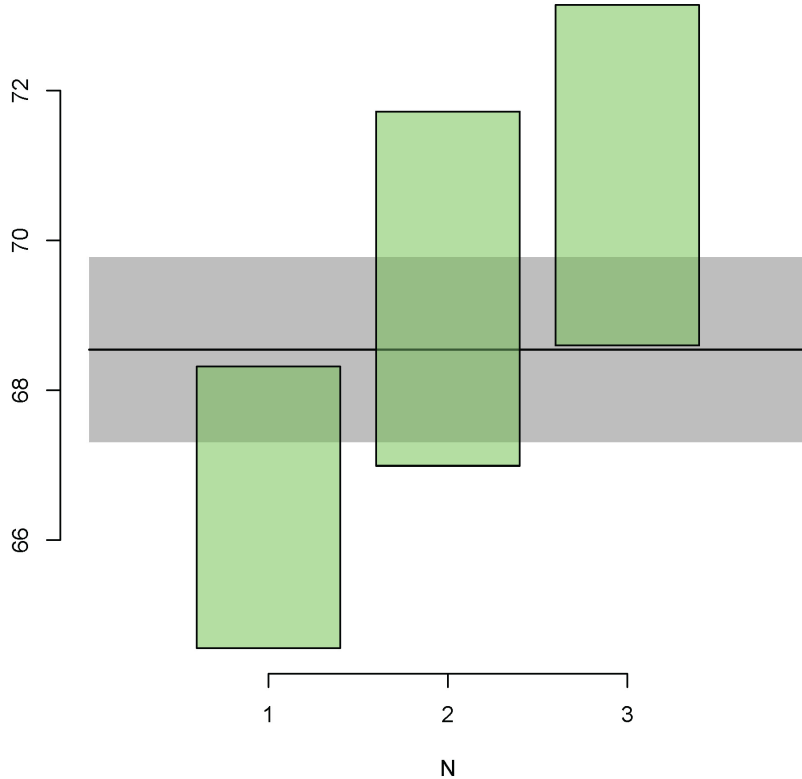
70.3 ± 2.5 Ma (5.4% disc.)

66.5 ± 1.9 Ma (0.5% disc.)



mean = 68.54 ± 0.63 | 1.23 | 5.85 Ma (n=3/3)
MSWD = 4.66, p(χ²) = 0.0095

Prospector Mtn age
~69 Ma



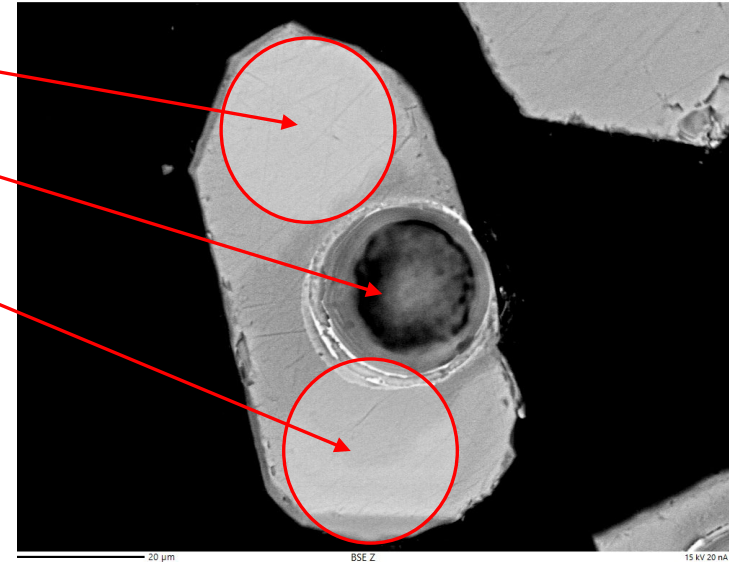
30 μm

21JM011B_04

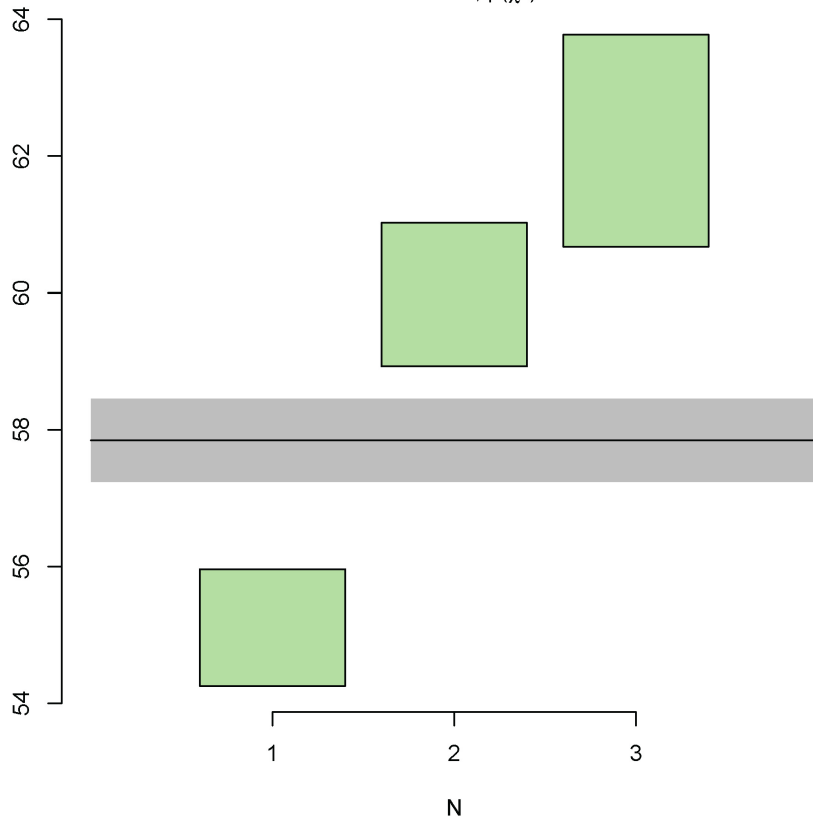
60.0 ± 1.1 Ma (5.5% disc.)

63.0 ± 1.6 Ma (9.4% disc.)

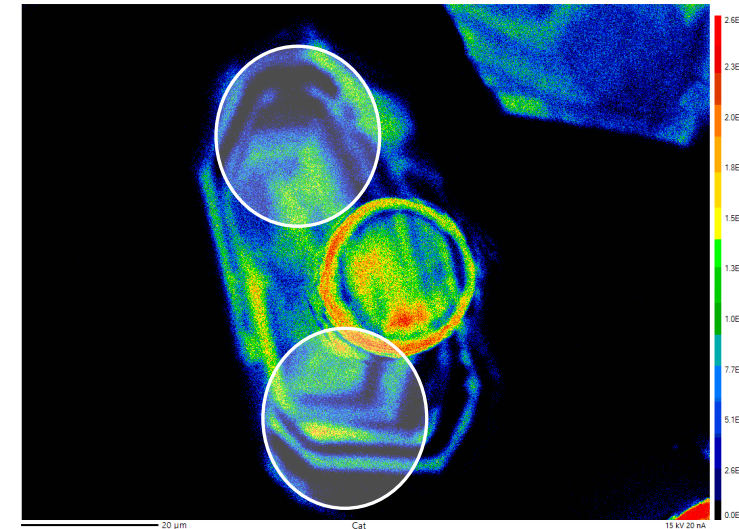
55.1 ± 0.9 Ma (13.1% disc.)



mean = 57.84 ± 0.31 | 0.61 | 8.77 Ma (n=3/3)
MSWD = 43.1, p(χ²) = 0



Mixed ages,
inconsistent but
generally
~Palaeocene



20 μm

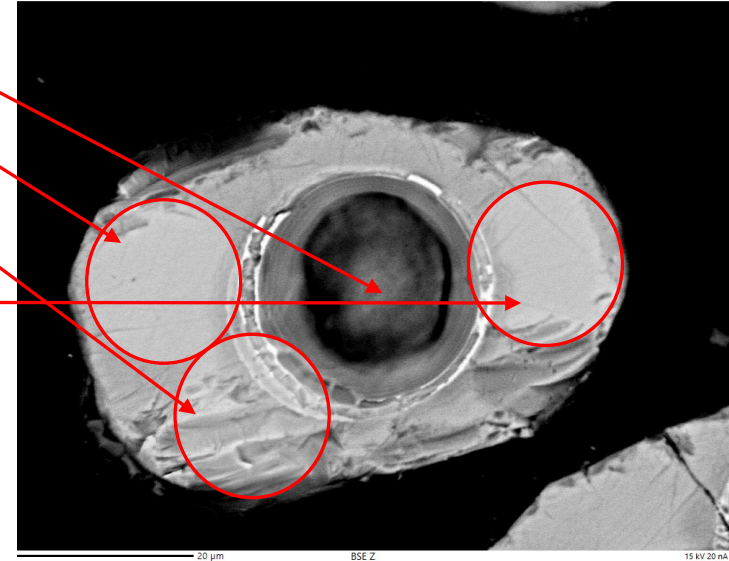
21JM011B_07

80.6 \pm 2.5 Ma (17.3% disc.)

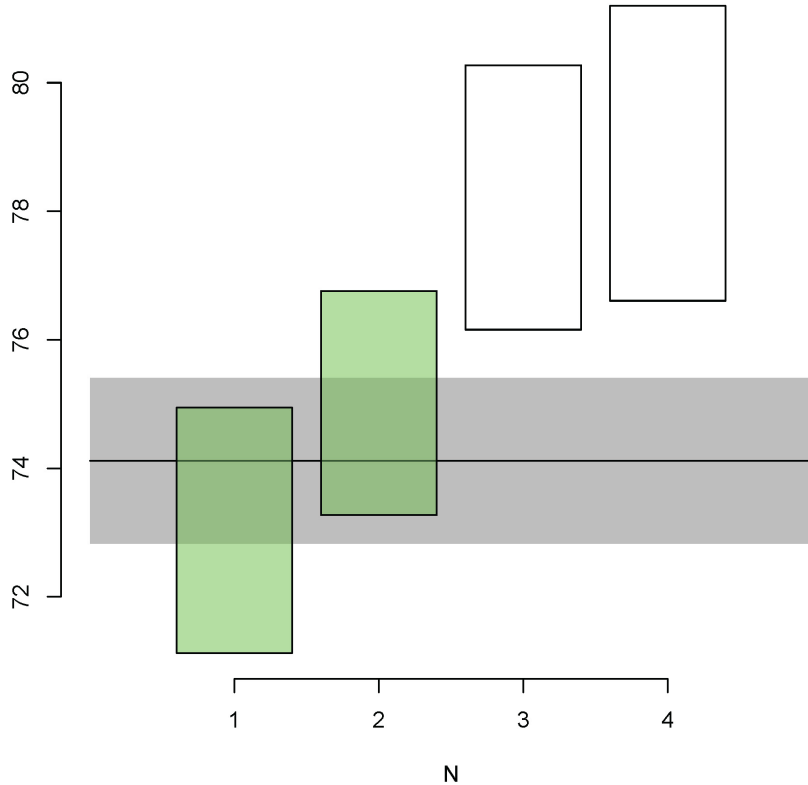
73.1 \pm 2.0 Ma (9.4% disc.)

75.1 \pm 1.8 Ma (9.3% disc.)

78.2 \pm 2.2 Ma (0.4% disc.)



mean = 74.12 \pm 0.66 | 1.29 Ma (n=2/4)
MSWD = 2.25, $p(\chi^2) = 0.13$



Core and rim domains. Rim ages agree on a good Casino Suite age \sim 74 Ma

