

Multi-stage emerald formation in the Eastern Cordillera of Colombia revealed by monazite and xenotime petrochronology

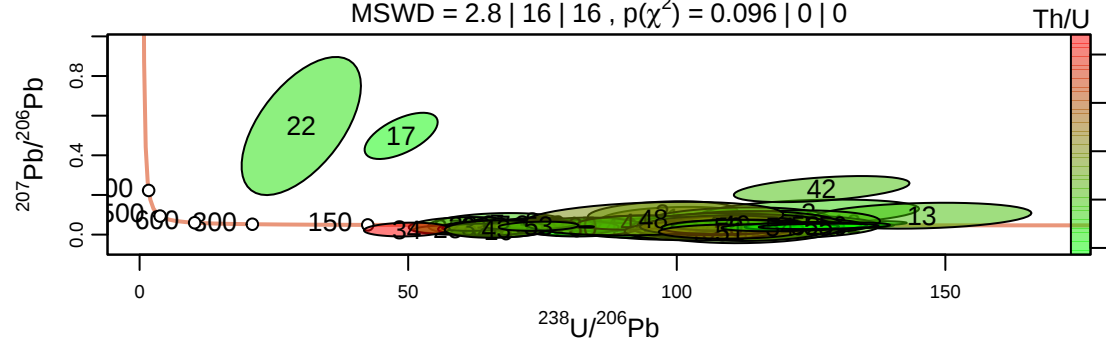
By Andrés Felipe González-Durán, Adam C. Simon, Robert Holder, Javier García-Toloza

Mineralium Deposita

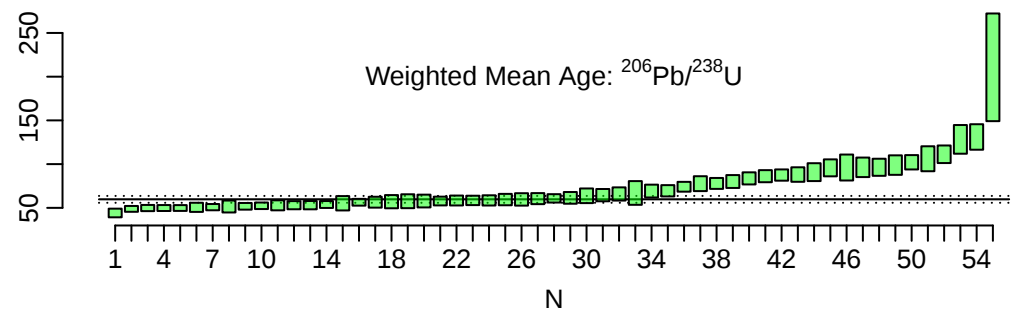
ELECTRONIC SUPPLEMENTARY MATERIAL (ESM) 2: Compilation of plots for all LASS analyses, including Tera-Wasserburg U–Pb and U–Th–Pb concordia diagrams, kernel density estimate plots (KDE), REE spiderplots, and scatterplots of trace element concentrations. The plots are grouped by sample and separated by mineral (monazite/xenotime).

REOCU-169 – Monazite

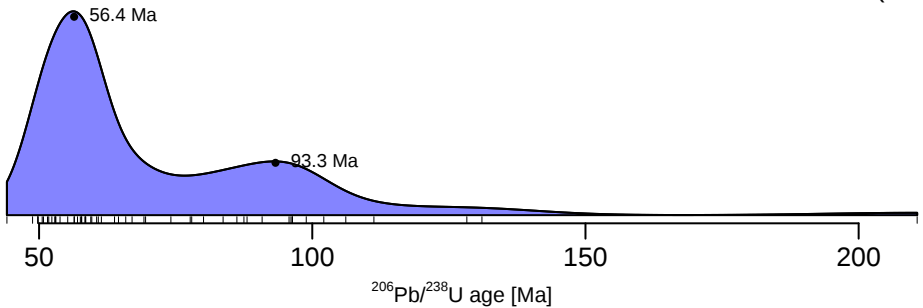
Tera-Wasserburg Concordia
concordia_age = 59.54 ± 0.76 | 3.01 Ma (n=55)
MSWD = 2.8 | 16 | 16, $p(\chi^2) = 0.096$ | 0 | 0



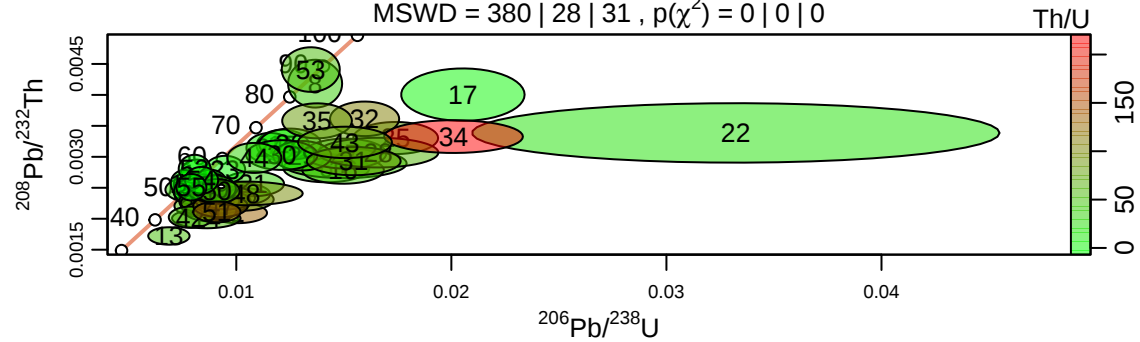
mean = 59.73 ± 0.78 | 3.93 Ma (55/55)
MSWD = 25, $p(\chi^2) = 0$



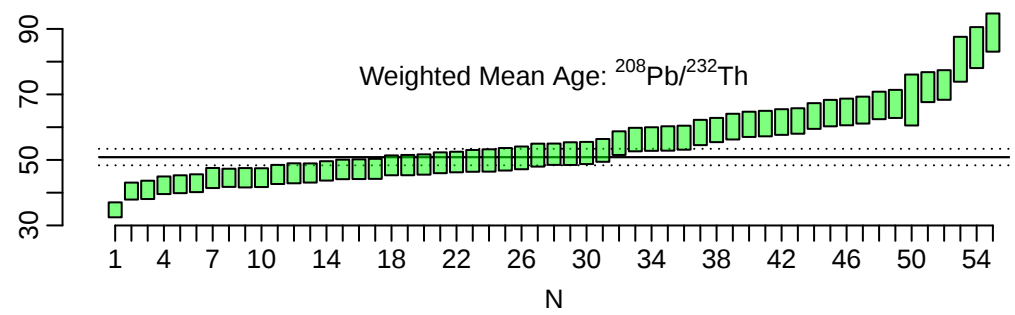
KDE: $^{206}\text{Pb}/^{238}\text{U}$ age (n=55)



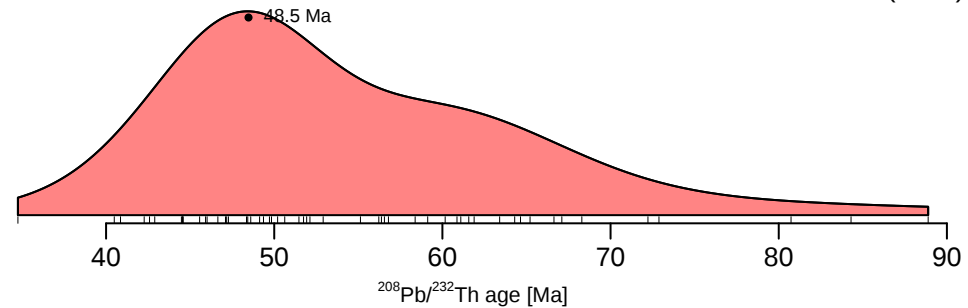
U-Th-Pb Concordia
concordia_age = 53.10 ± 0.39 | 2.19 Ma (n=55)
MSWD = 380 | 28 | 31, $p(\chi^2) = 0$ | 0 | 0



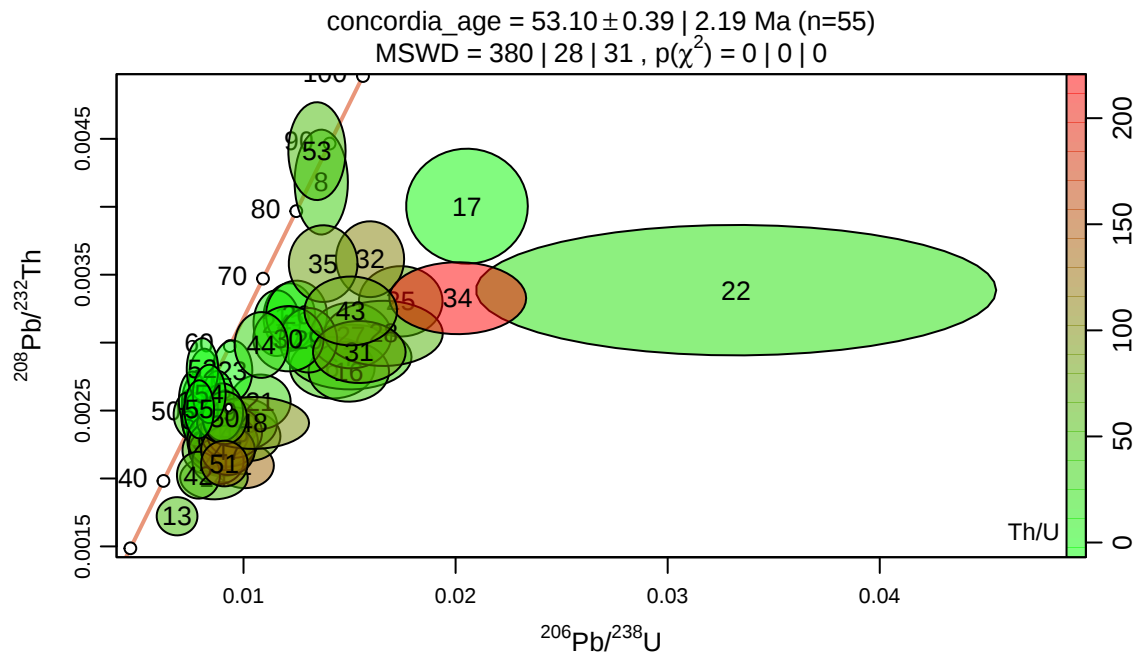
mean = 50.87 ± 0.46 | 2.52 Ma (55/55)
MSWD = 31, $p(\chi^2) = 0$



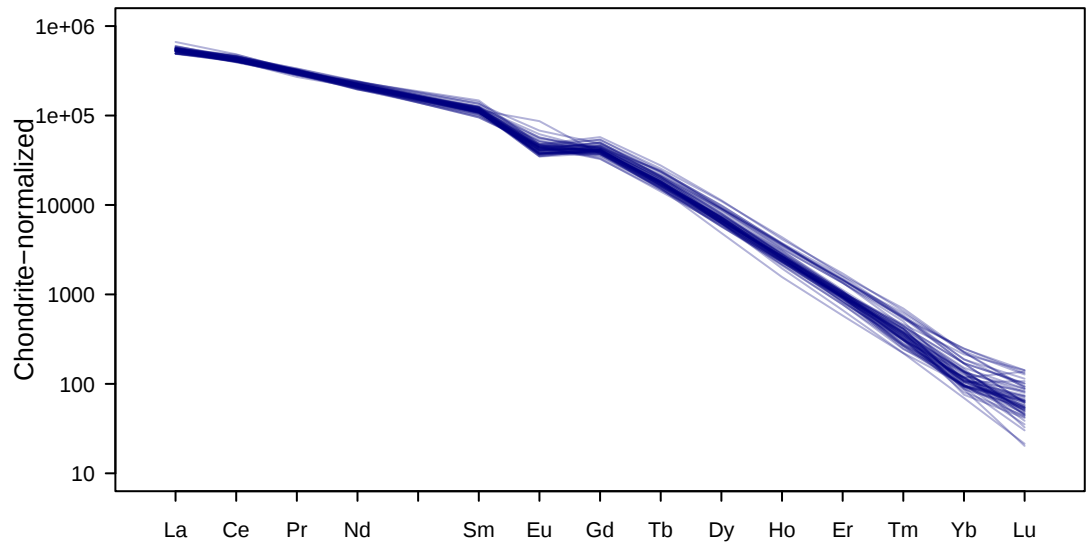
KDE: $^{208}\text{Pb}/^{232}\text{Th}$ age (n=55)



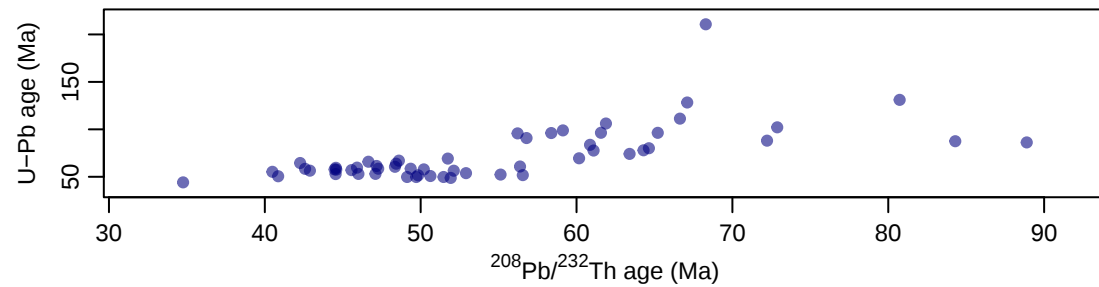
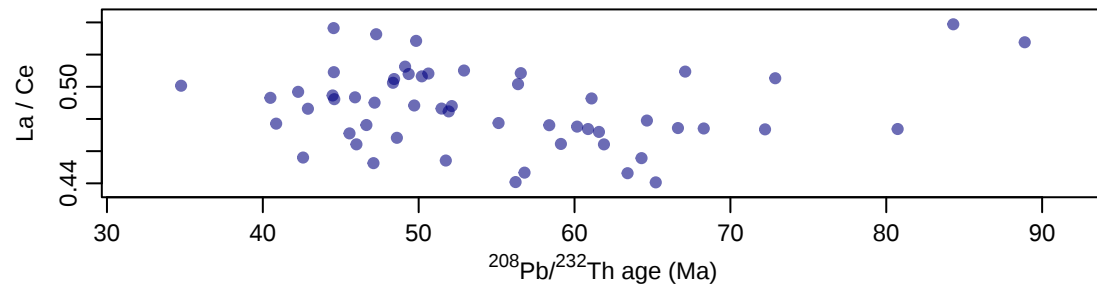
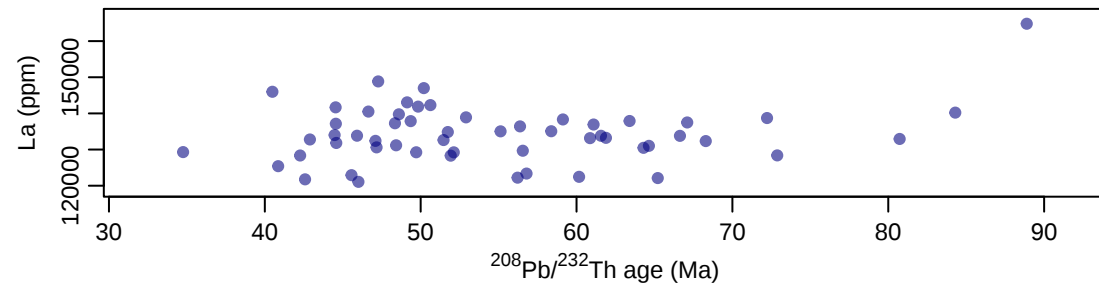
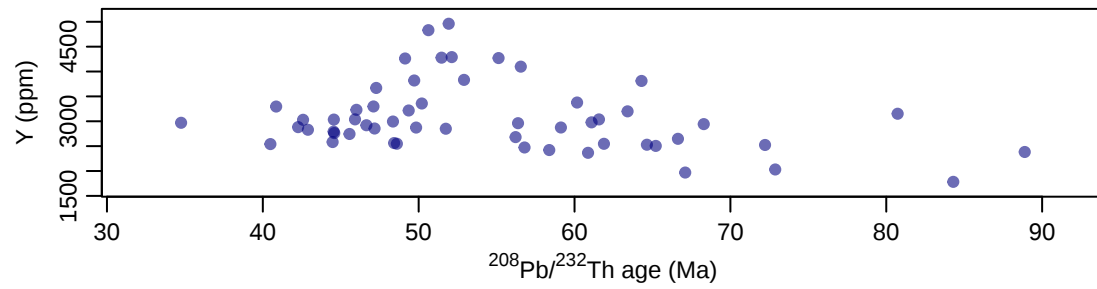
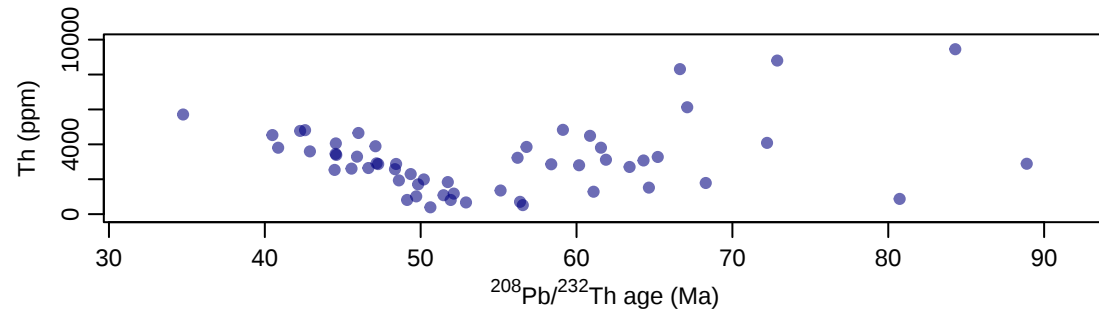
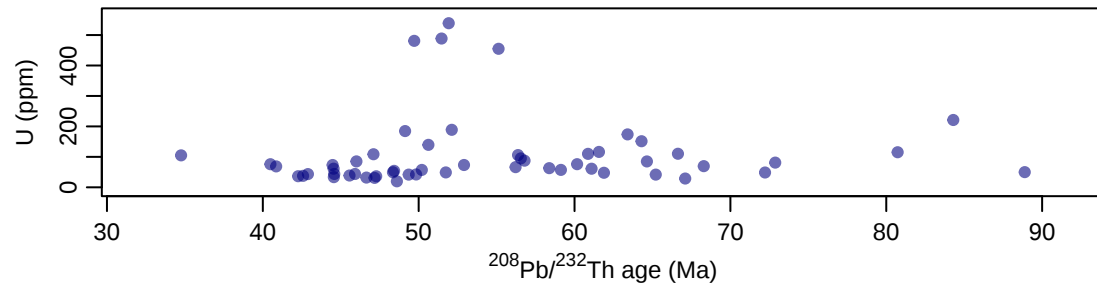
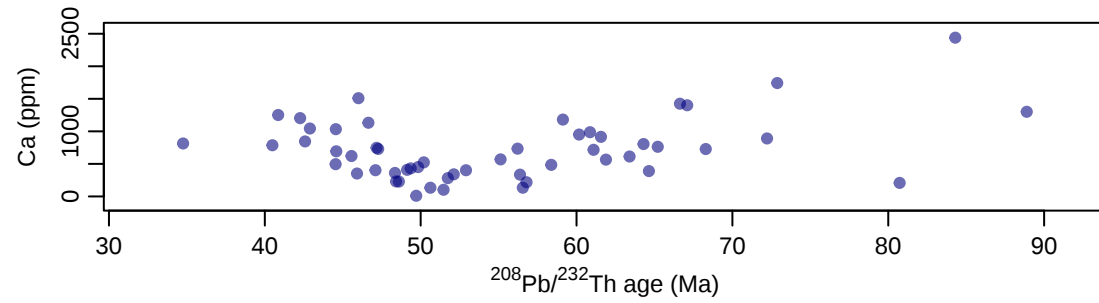
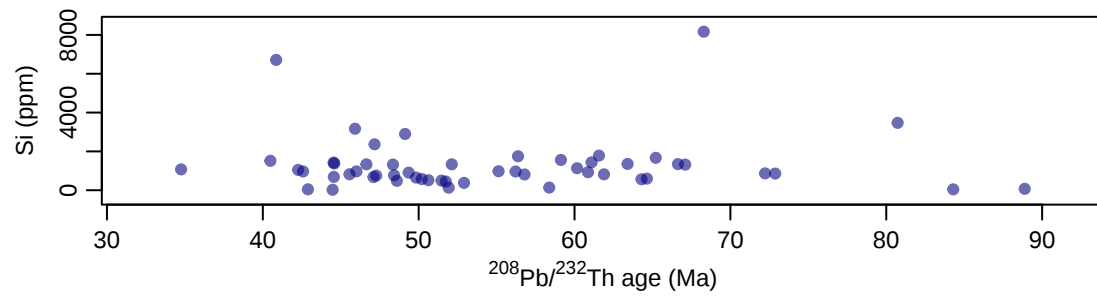
REOCU-169 – Monazite



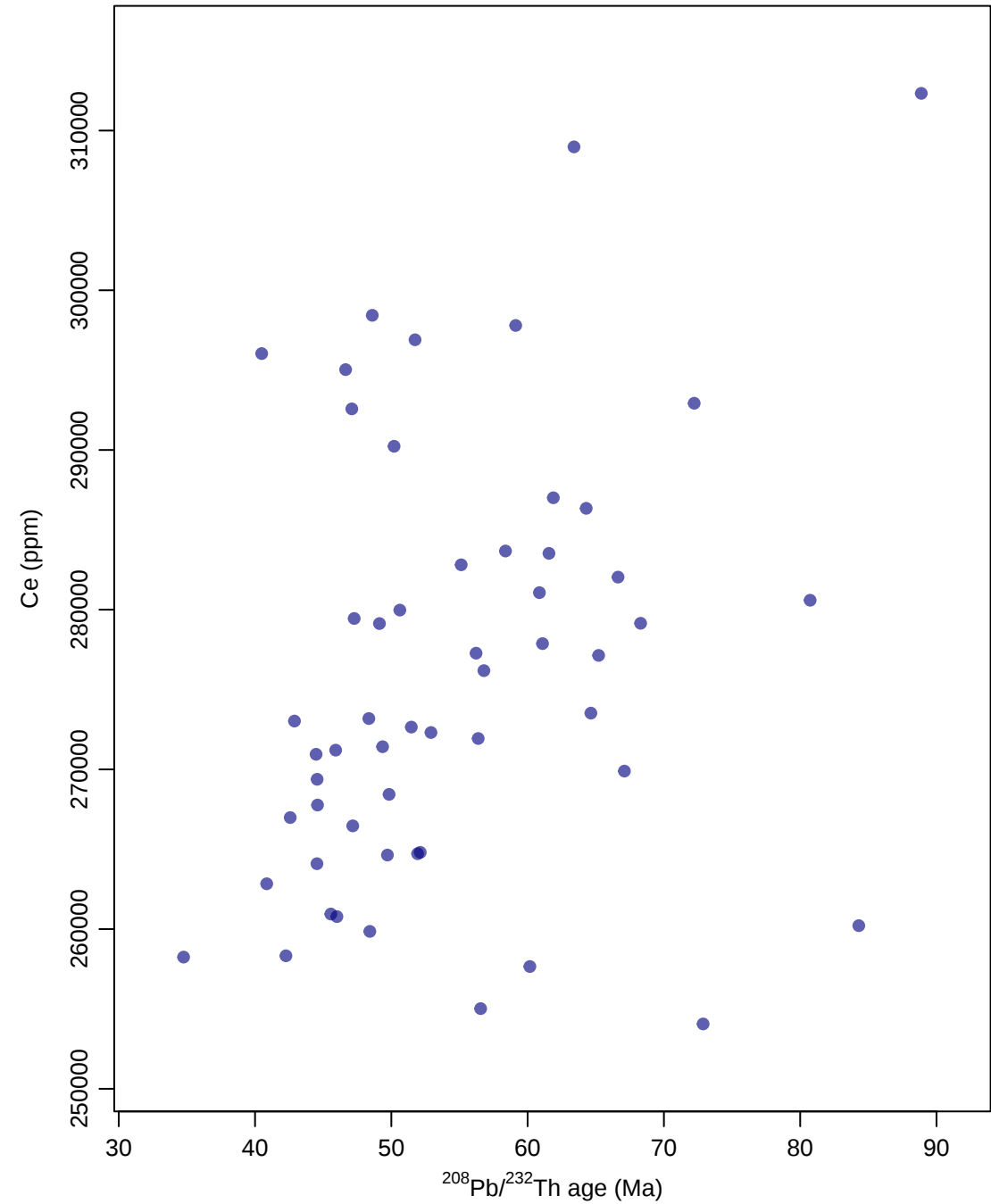
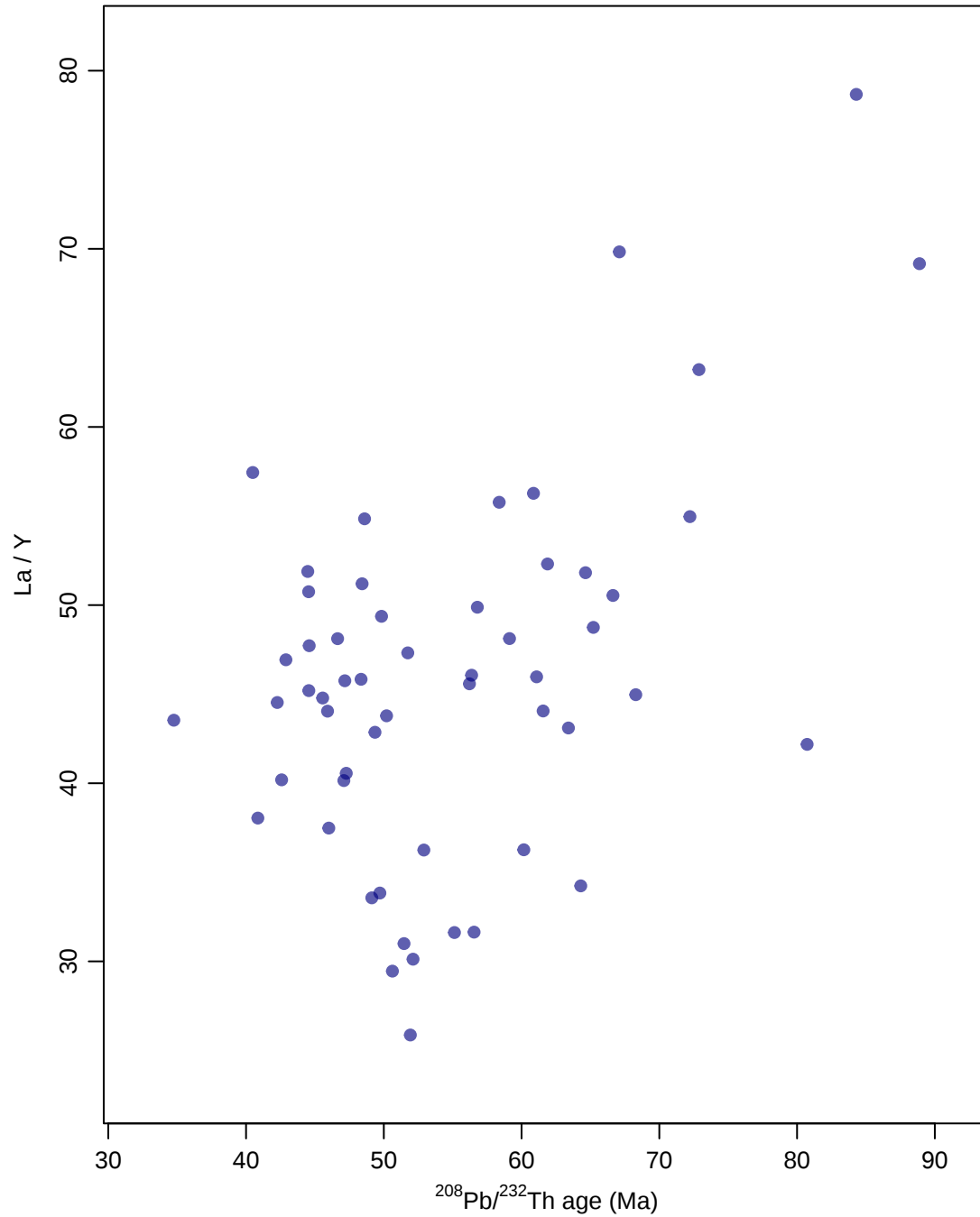
REE distribution



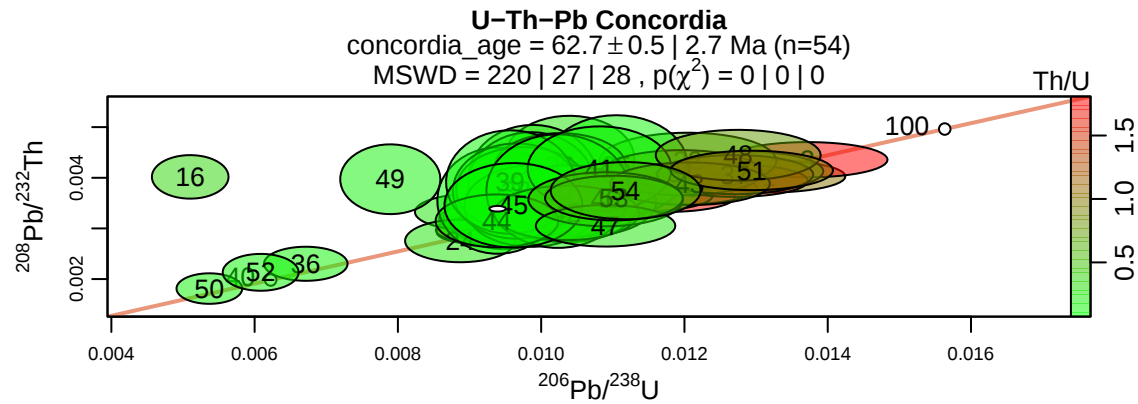
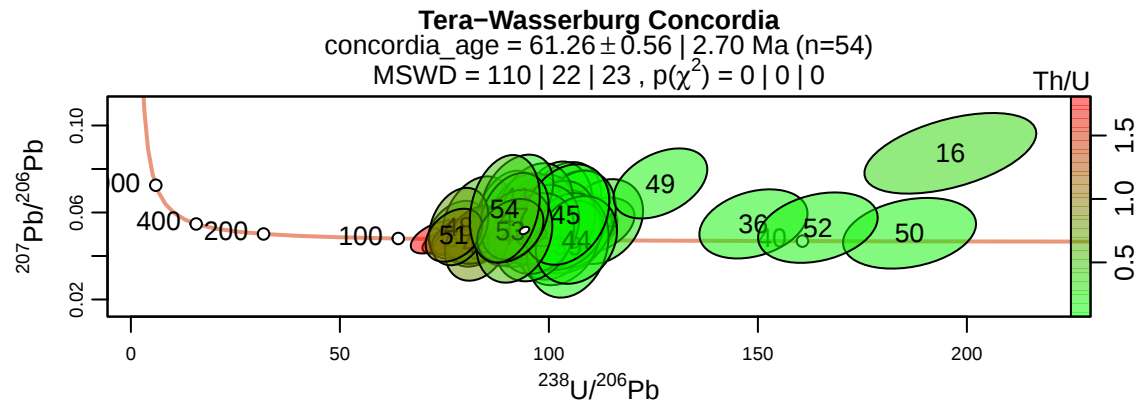
REOCU-169 – Monazite



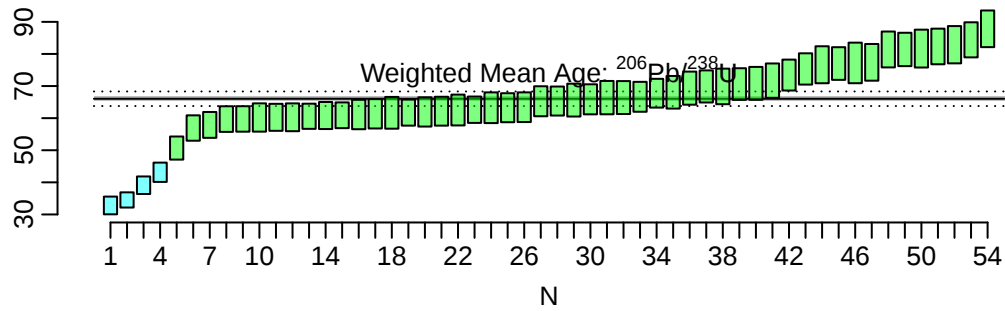
REOCU-169 – Monazite



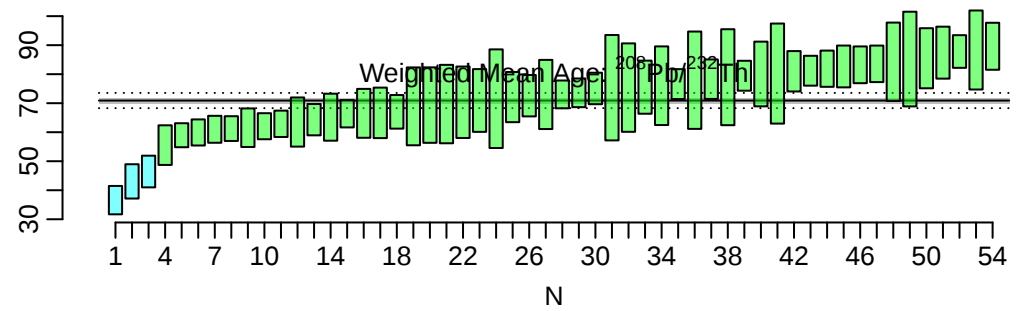
REOCU-169 – Xenotime



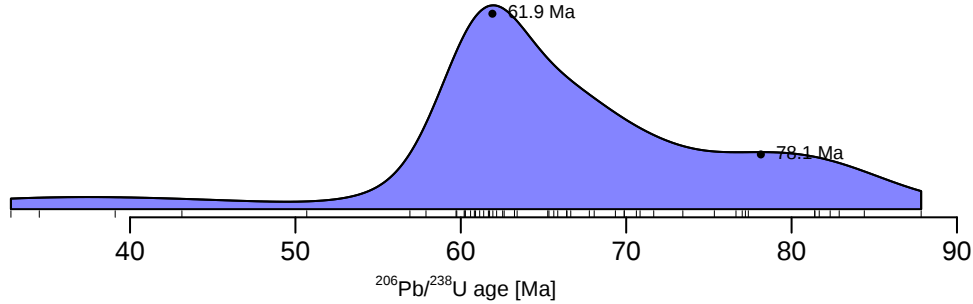
mean = 66.04 ± 0.67 | 2.28 Ma (50/54)
MSWD = 12, $p(\chi^2) = 0$



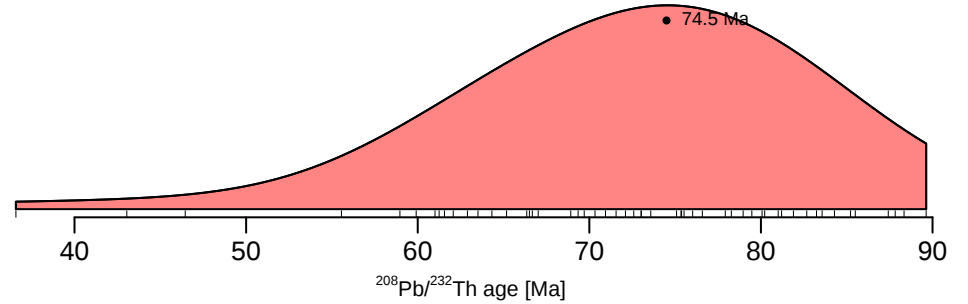
mean = 70.91 ± 0.96 | 2.63 Ma (51/54)
MSWD = 7.5, $p(\chi^2) = 0$



KDE: $^{206}\text{Pb}/^{238}\text{U}$ age (n=54)

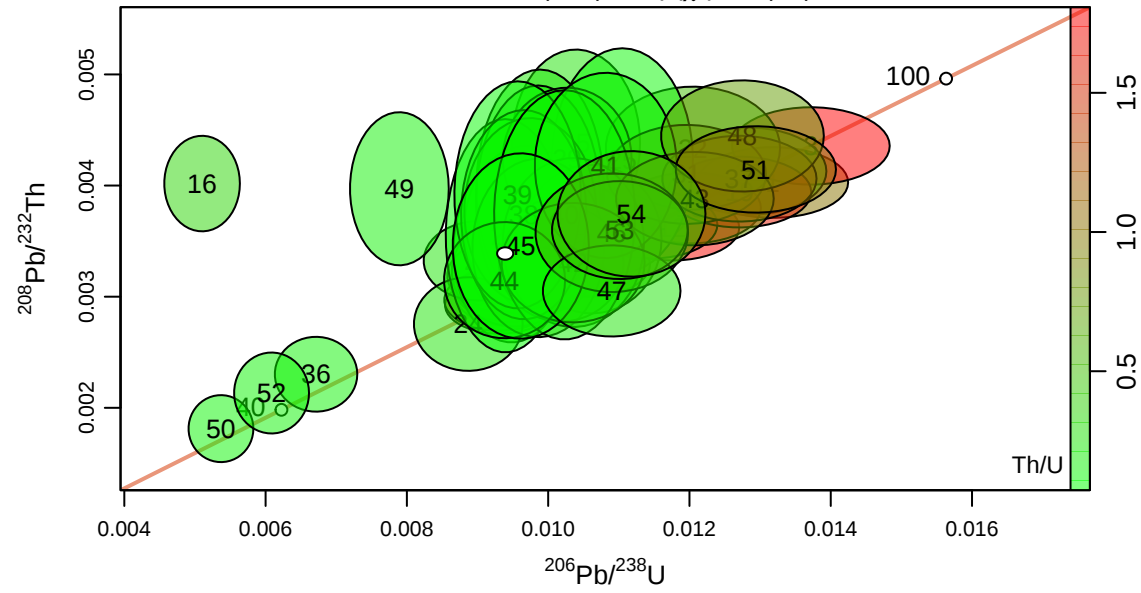


KDE: $^{208}\text{Pb}/^{232}\text{Th}$ age (n=54)

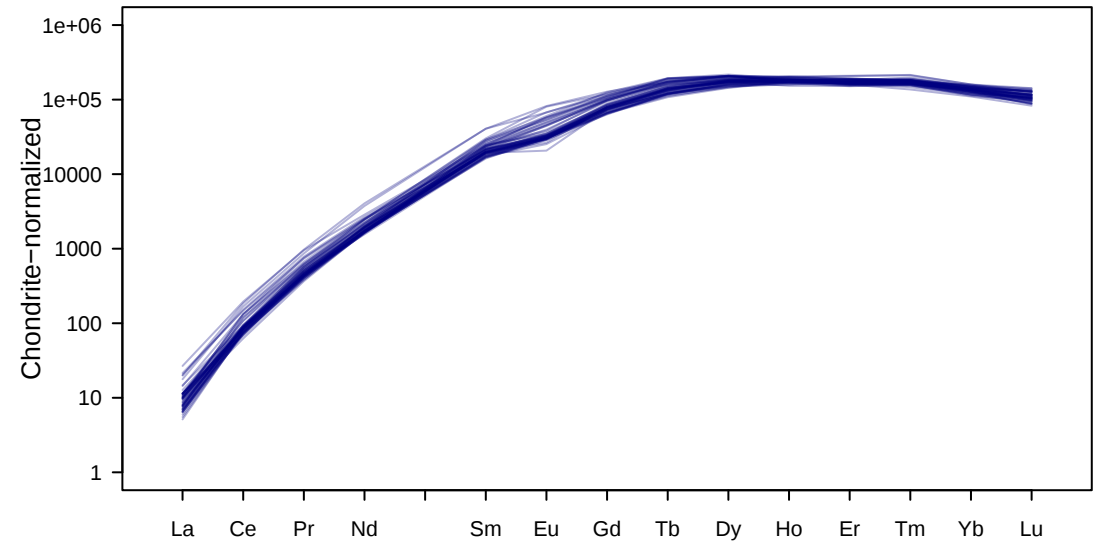


REOCU-169 – Xenotime

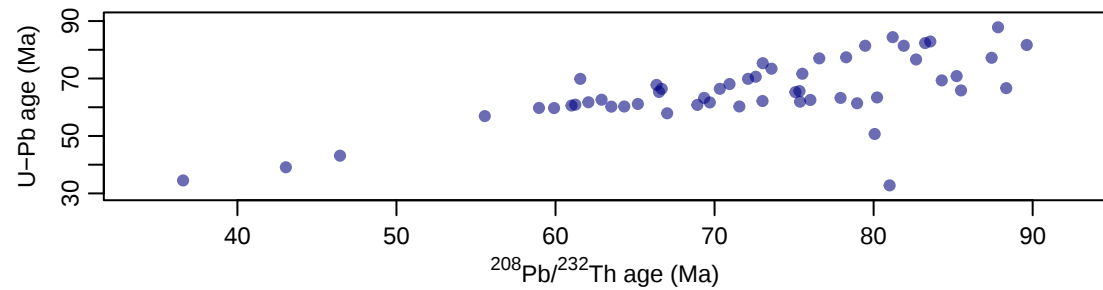
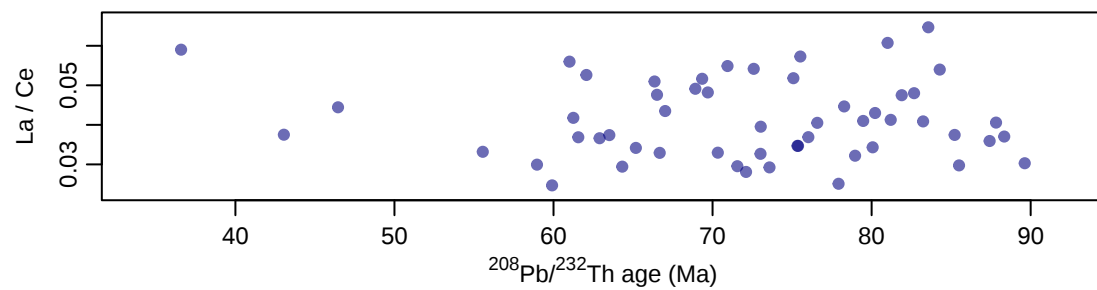
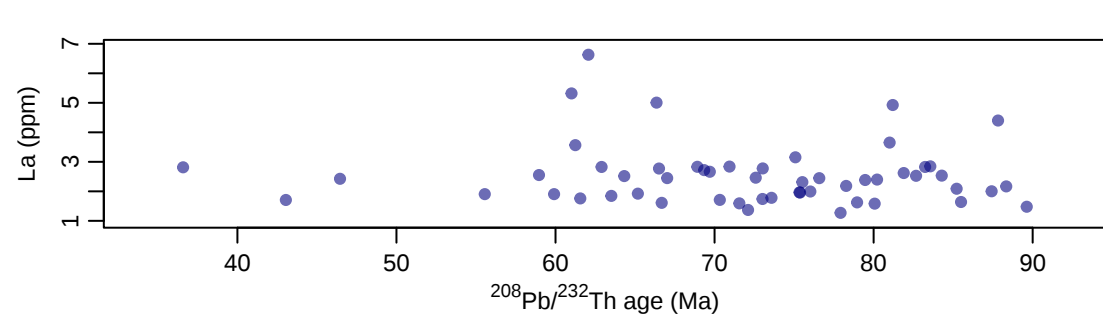
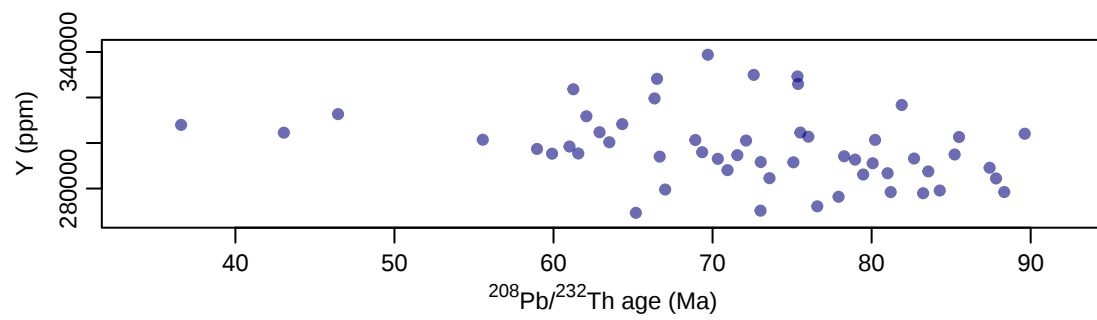
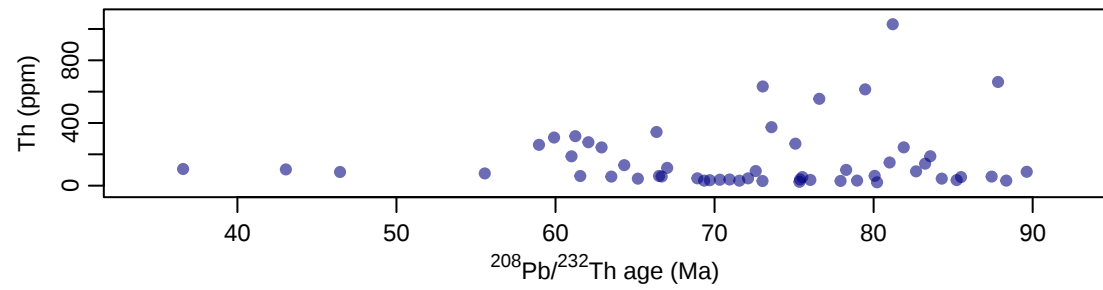
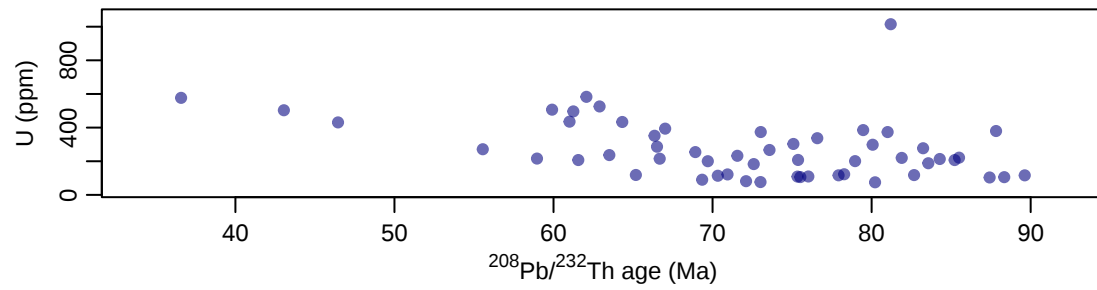
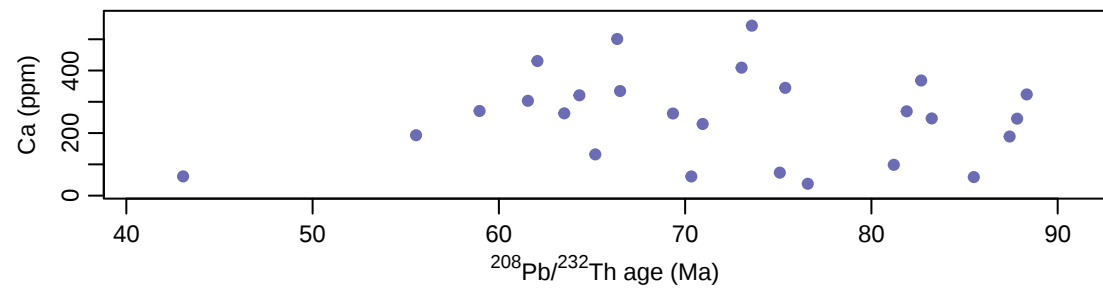
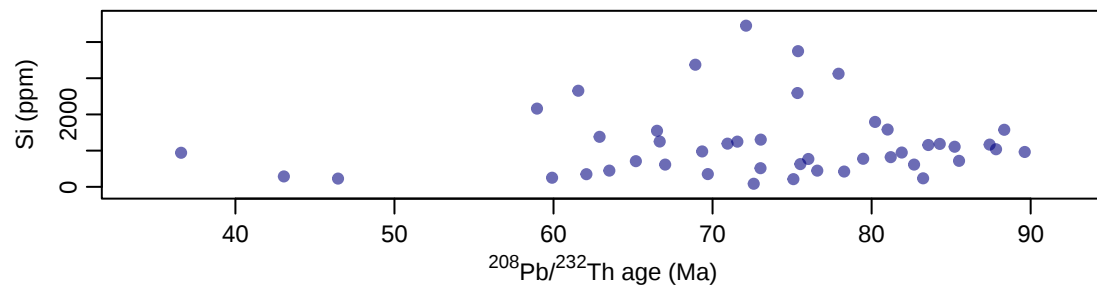
concordia_age = 62.7 ± 0.5 | 2.7 Ma (n=54)
MSWD = 220 | 27 | 28 , $p(\chi^2) = 0$ | 0 | 0



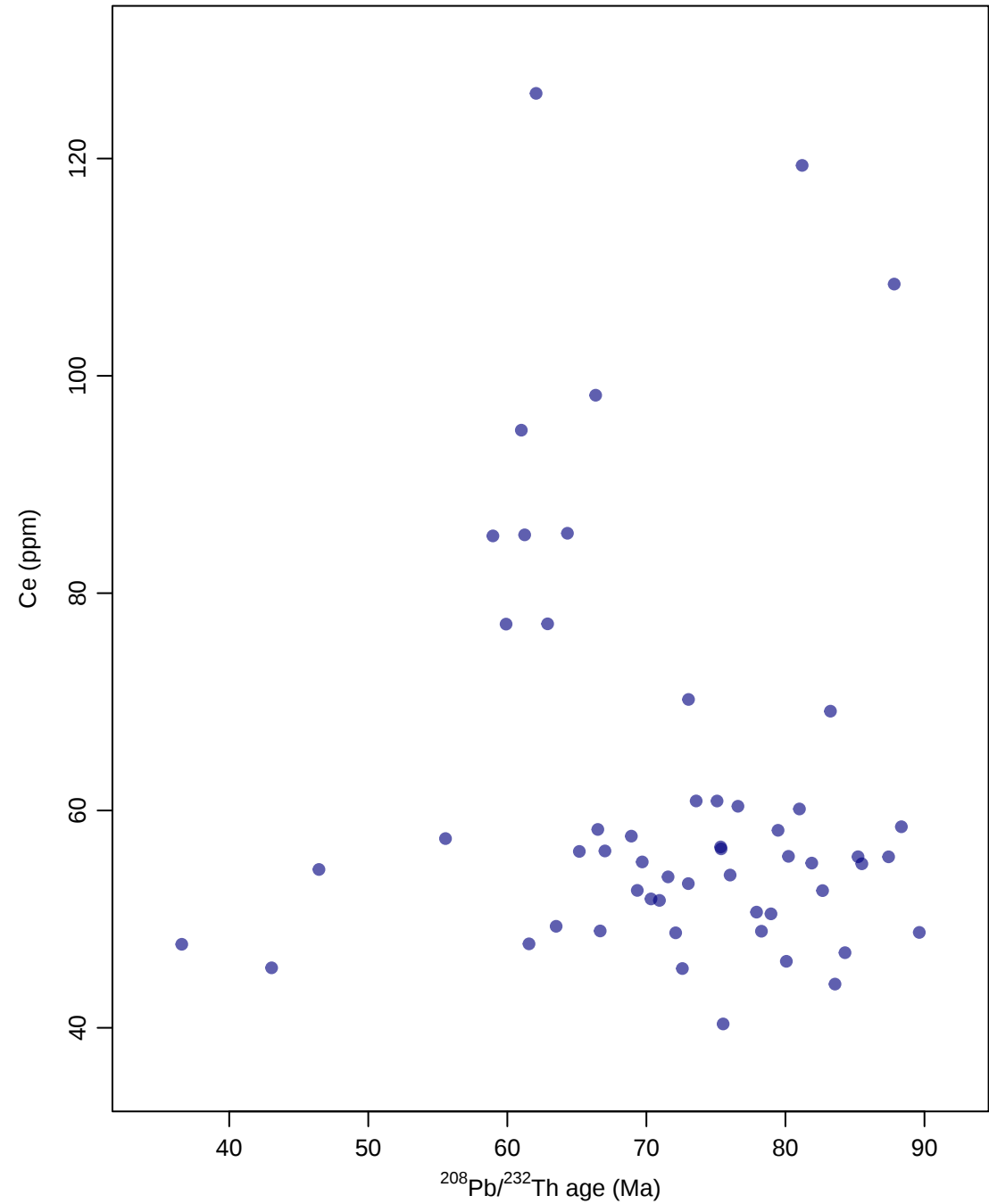
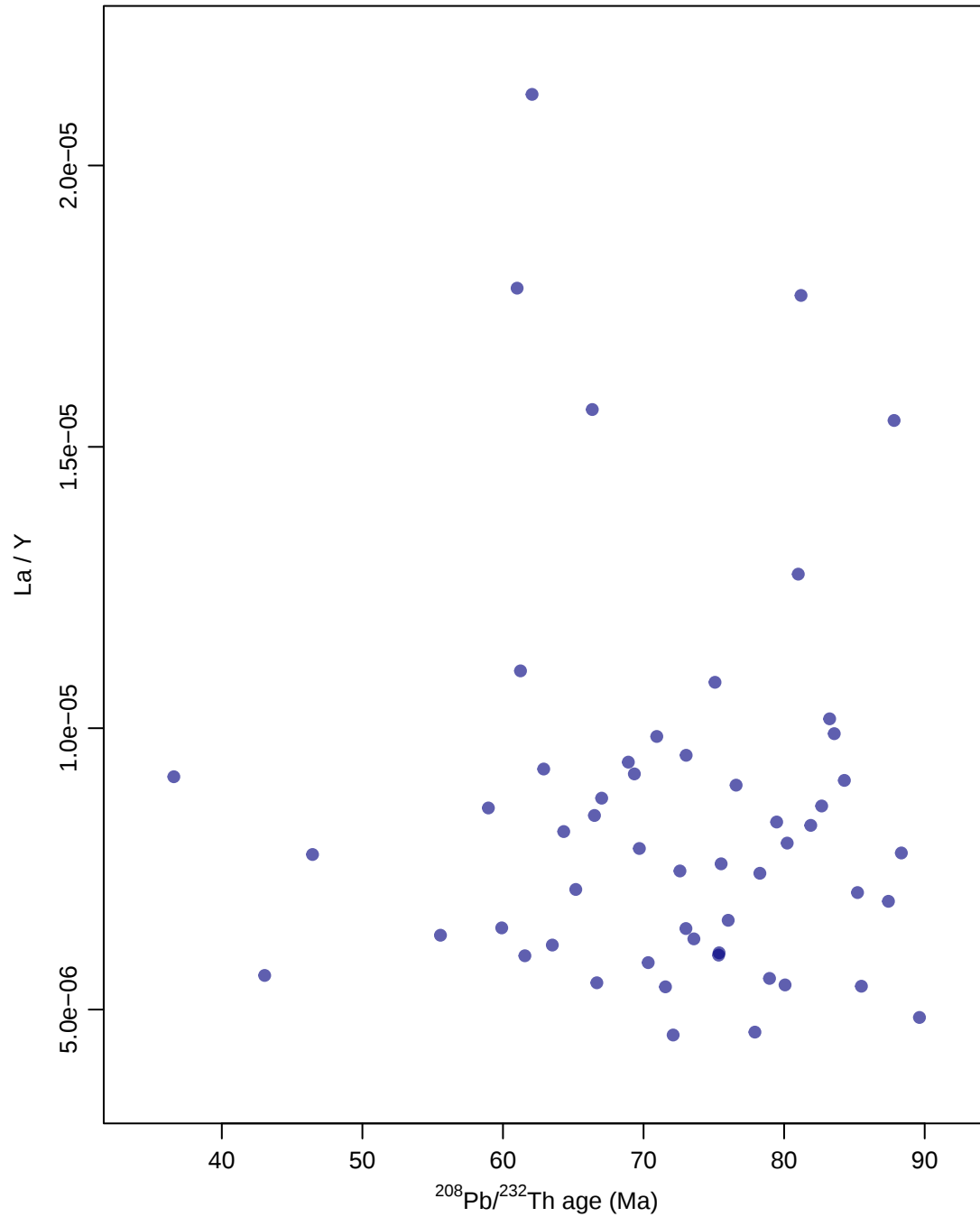
REE distribution



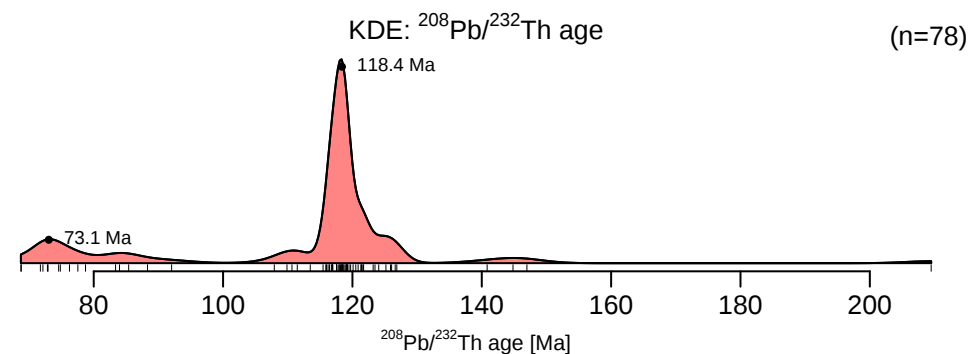
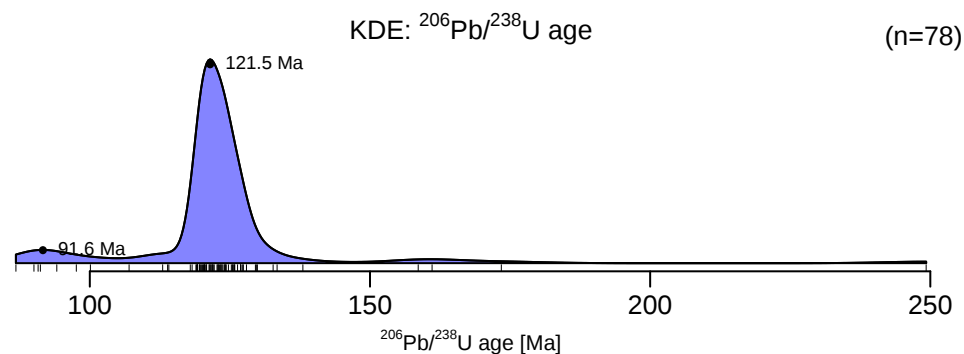
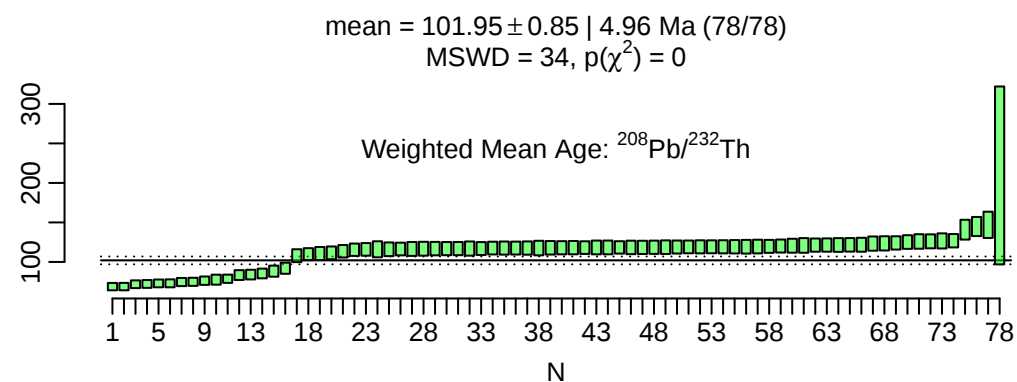
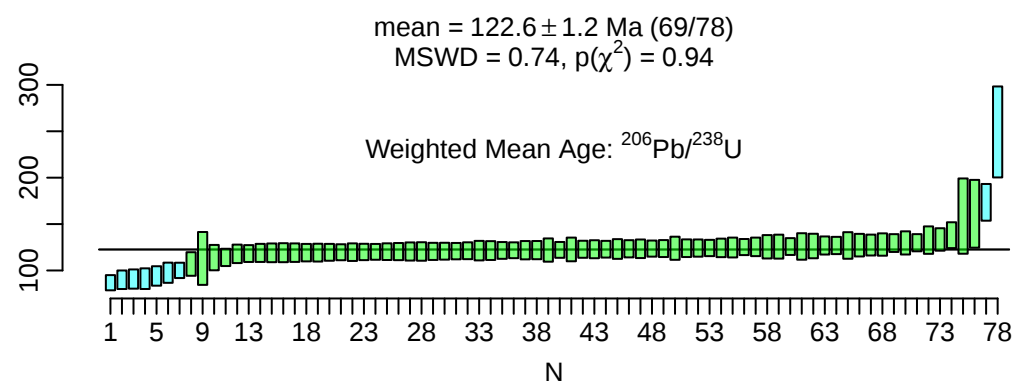
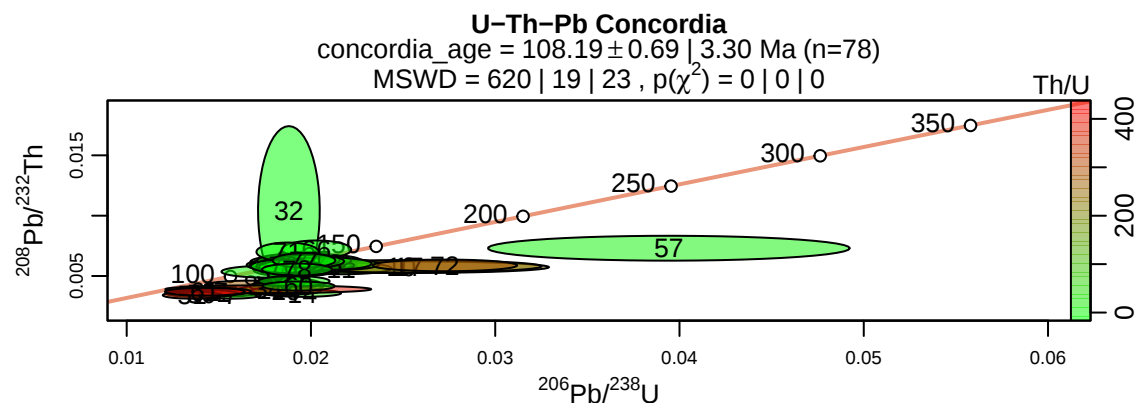
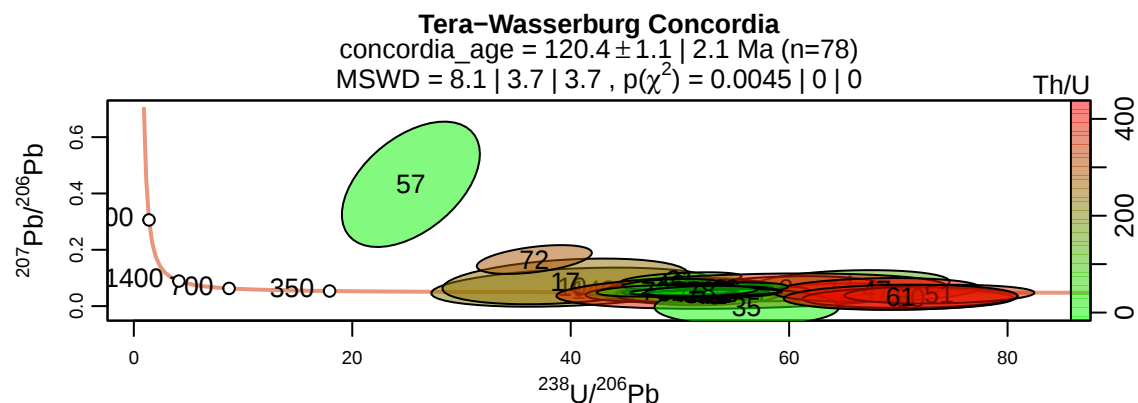
REOCU-169 – Xenotime



REOCU-169 – Xenotime

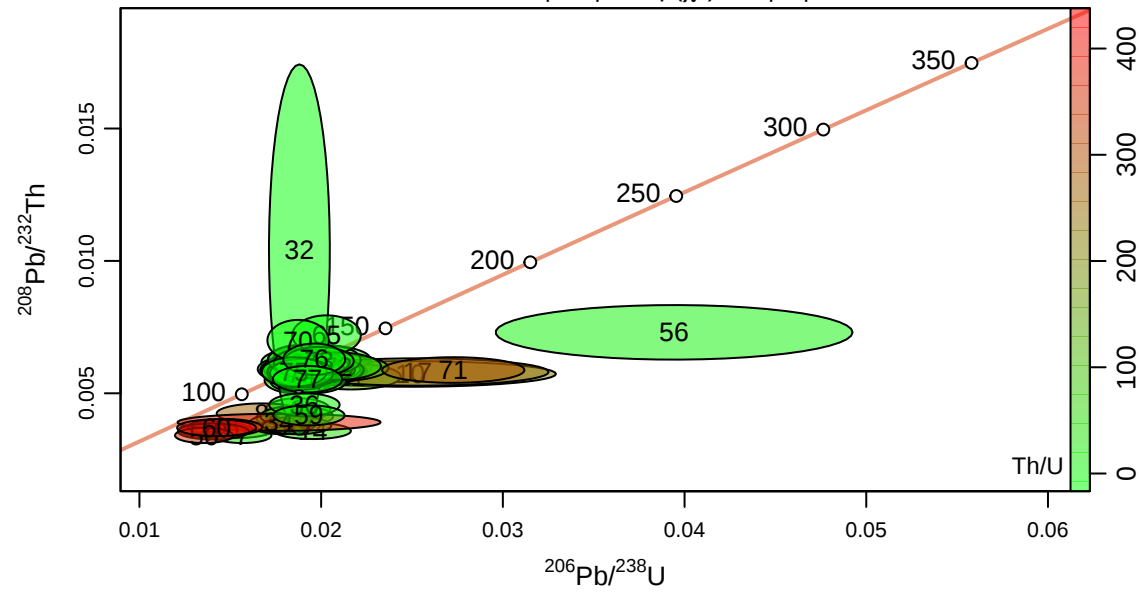


REOGA-092A – Monazite

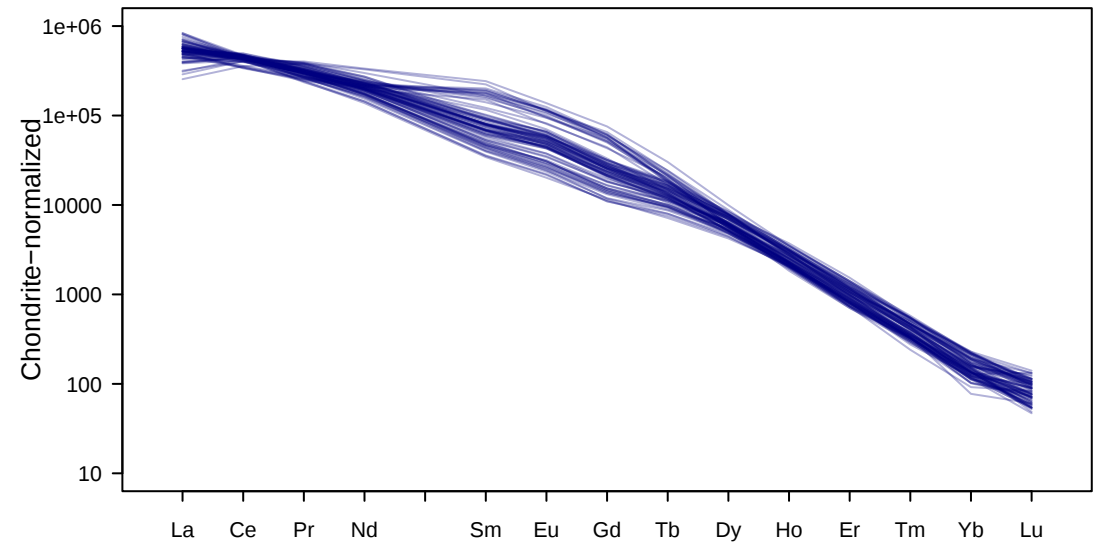


REOGA-092A – Monazite

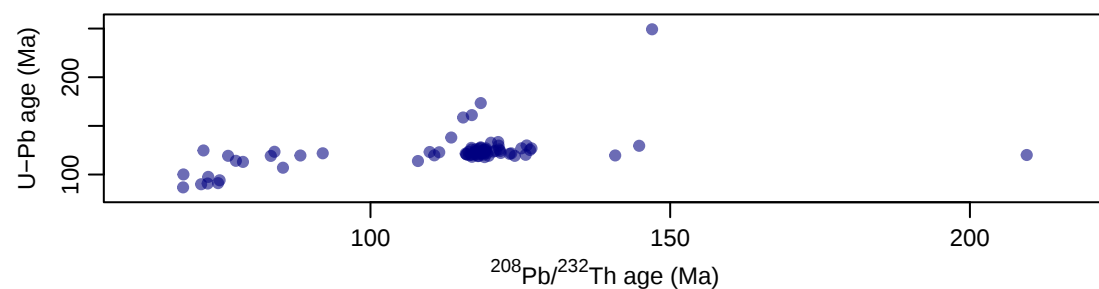
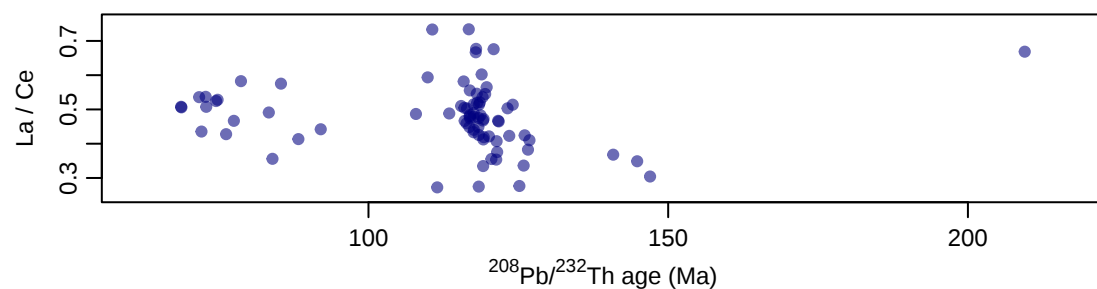
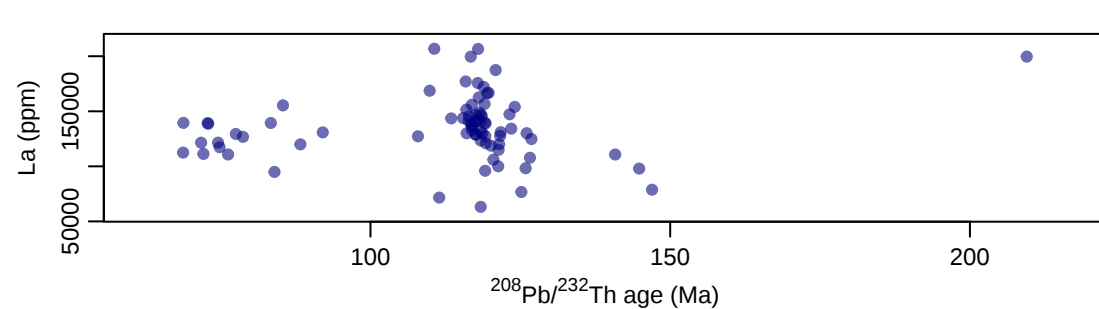
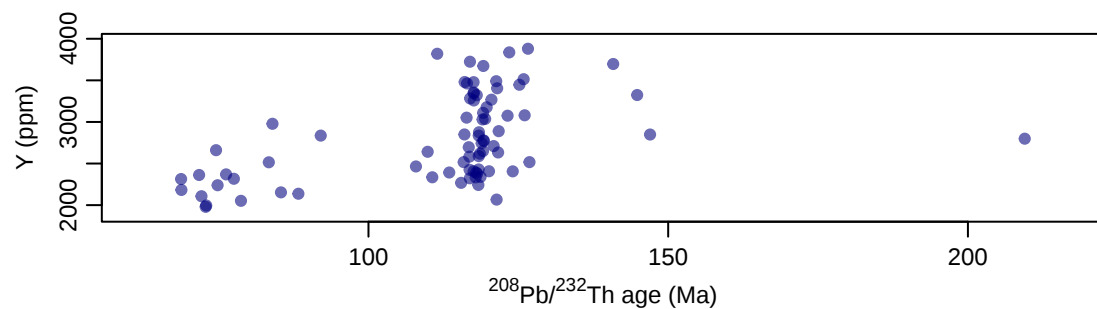
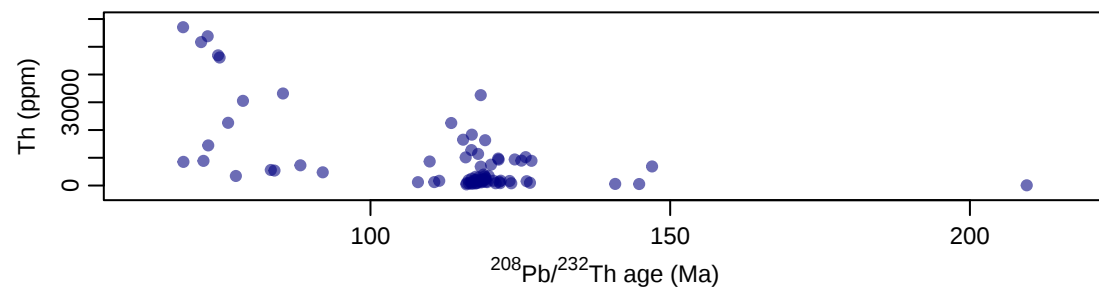
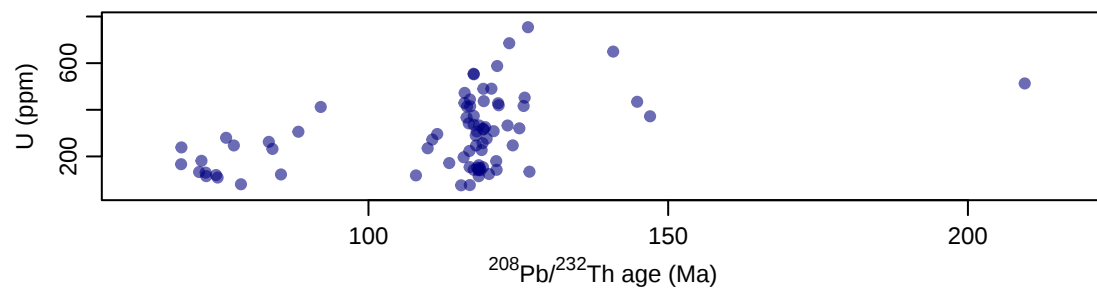
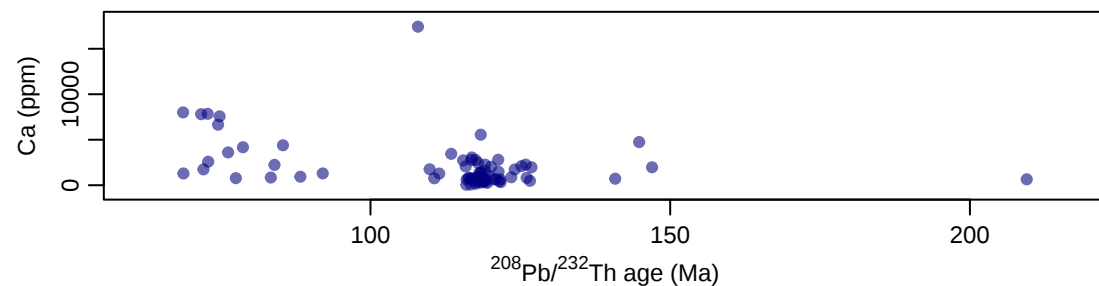
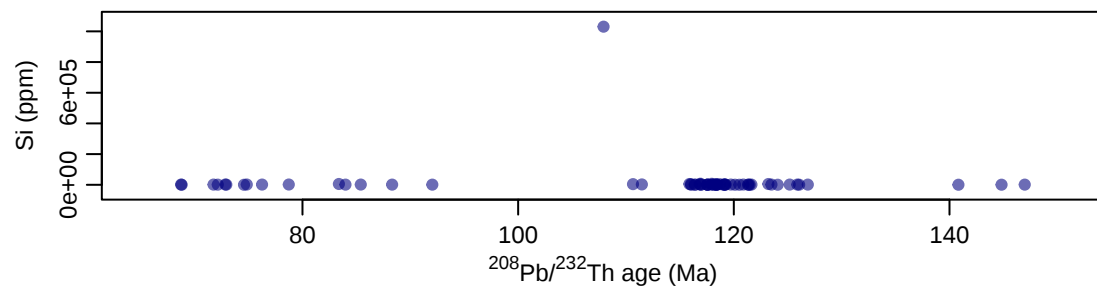
concordia_age = 108.17 ± 0.69 | 3.34 Ma (n=77)
MSWD = 620 | 19 | 23, $p(\chi^2) = 0$ | 0 | 0



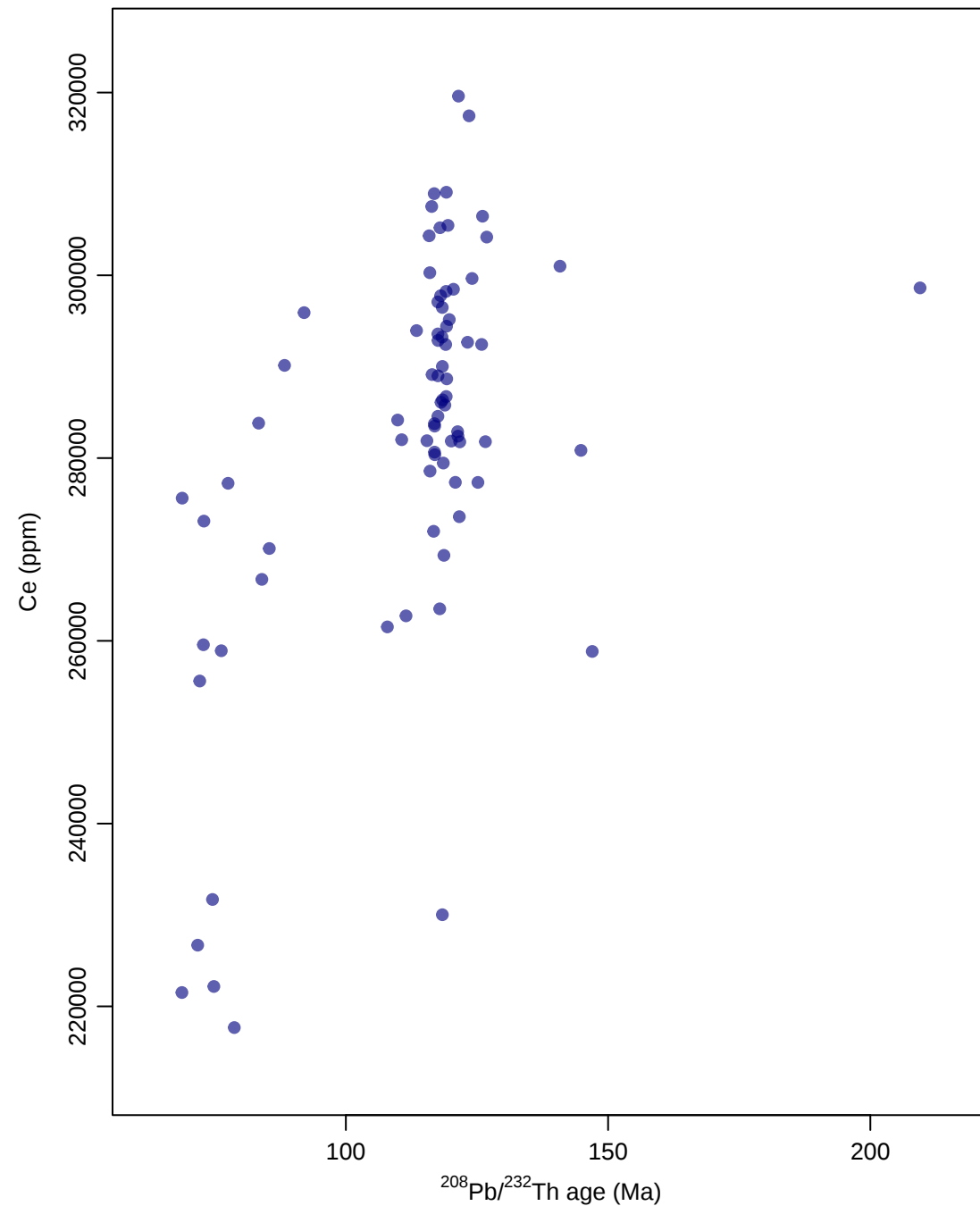
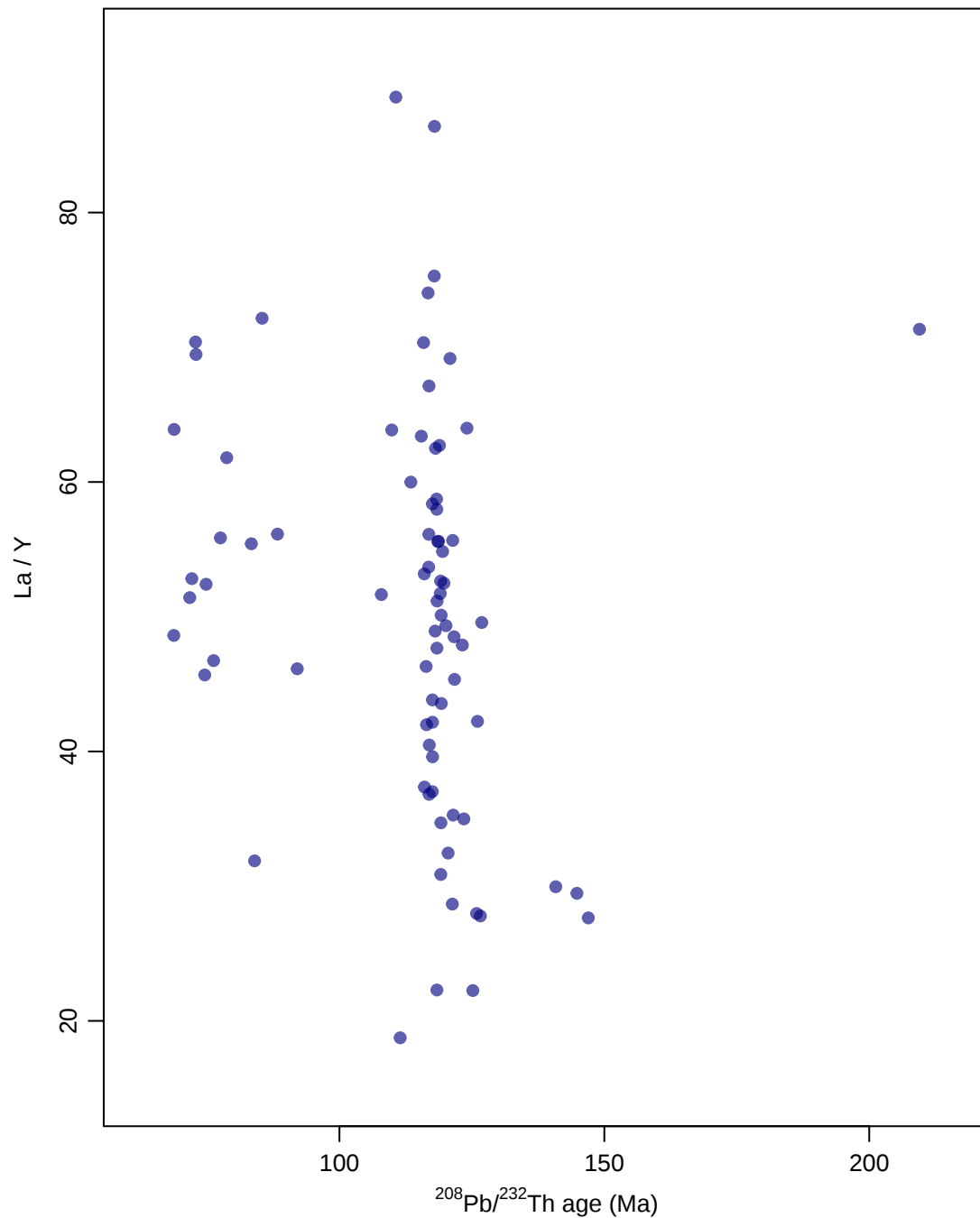
REE distribution



REOGA-092A - Monazite

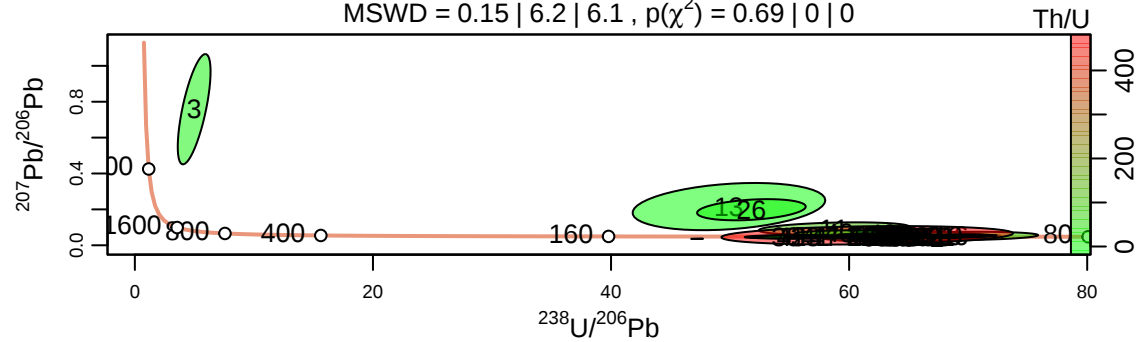


REOGA-092A - Monazite

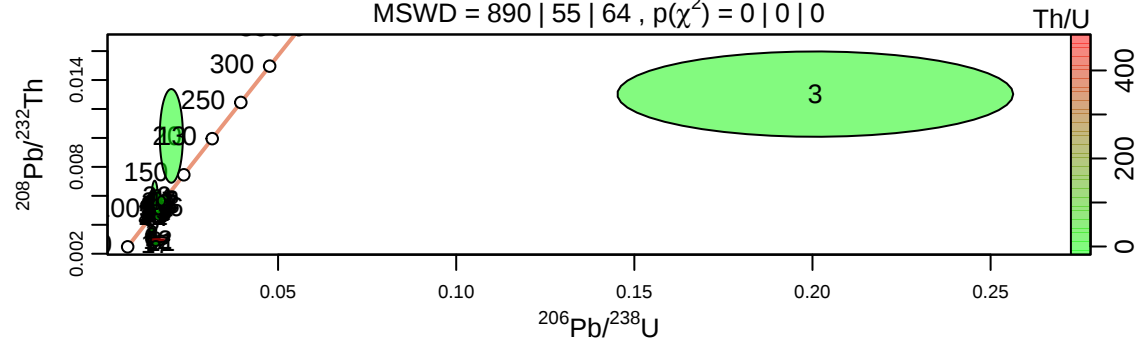


REOGA-137 – Monazite

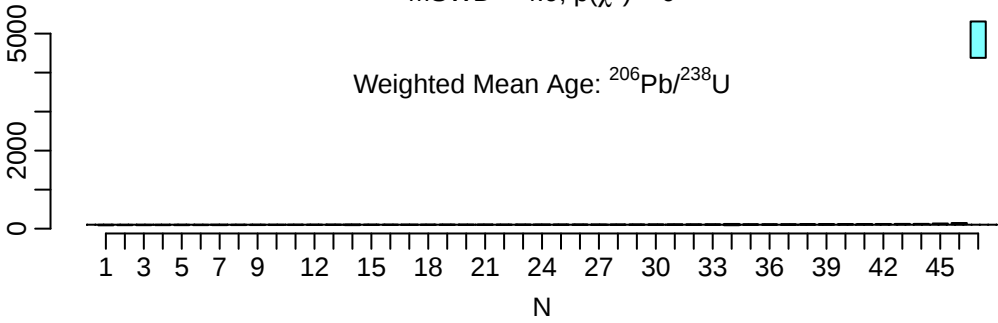
Tera-Wasserburg Concordia
concordia_age = 101.05 ± 0.67 | 1.66 Ma (n=47)
MSWD = 0.15 | 6.2 | 6.1, $p(\chi^2) = 0.69$ | 0 | 0



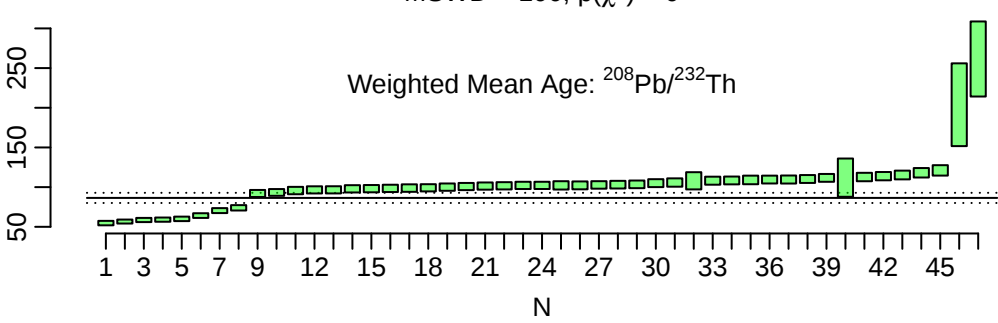
U-Th-Pb Concordia
concordia_age = 92.40 ± 0.49 | 3.87 Ma (n=47)
MSWD = 890 | 55 | 64, $p(\chi^2) = 0$ | 0 | 0



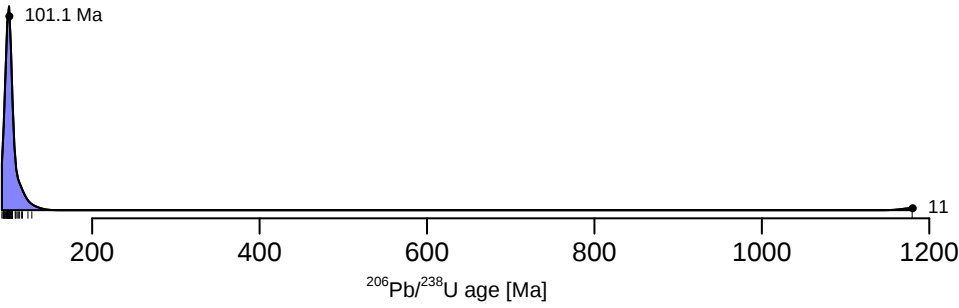
mean = 101.12 ± 0.76 | 1.69 Ma (46/47)
MSWD = 4.9, $p(\chi^2) = 0$



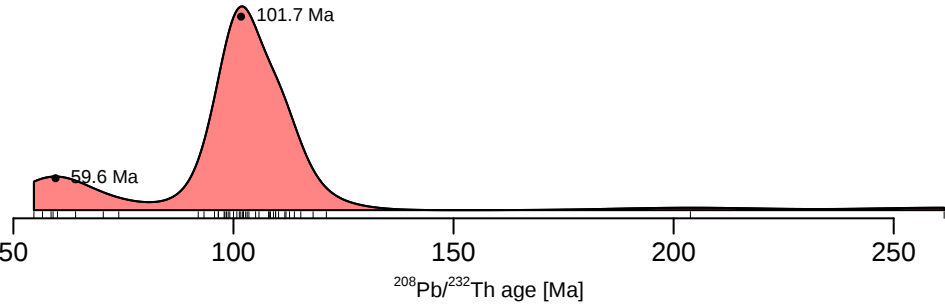
mean = 86.43 ± 0.63 | 6.41 Ma (47/47)
MSWD = 100, $p(\chi^2) = 0$



KDE: $^{206}\text{Pb}/^{238}\text{U}$ age (n=47)

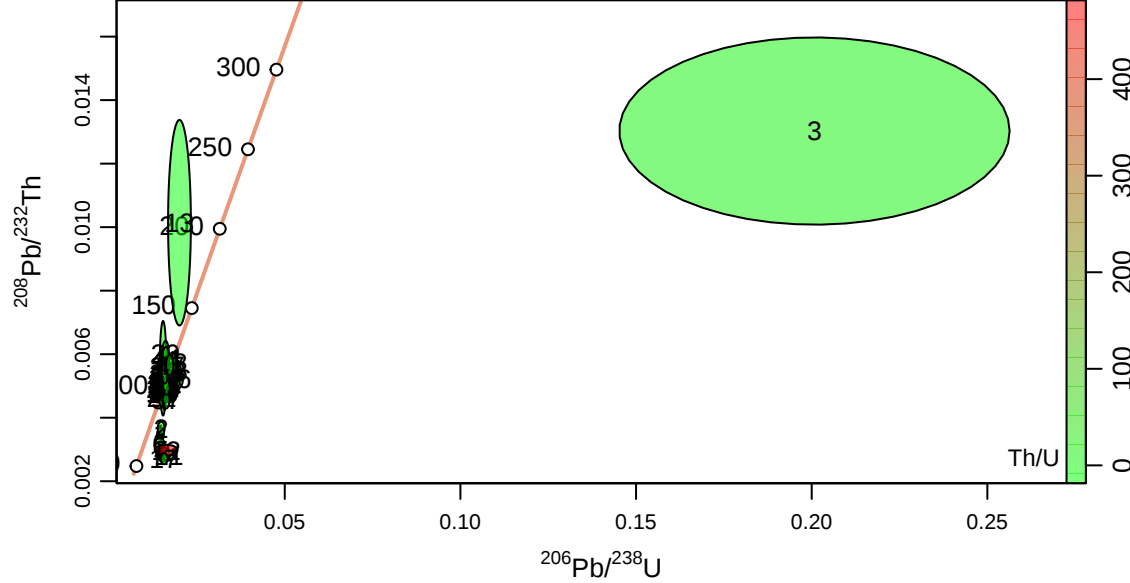


KDE: $^{208}\text{Pb}/^{232}\text{Th}$ age (n=47)

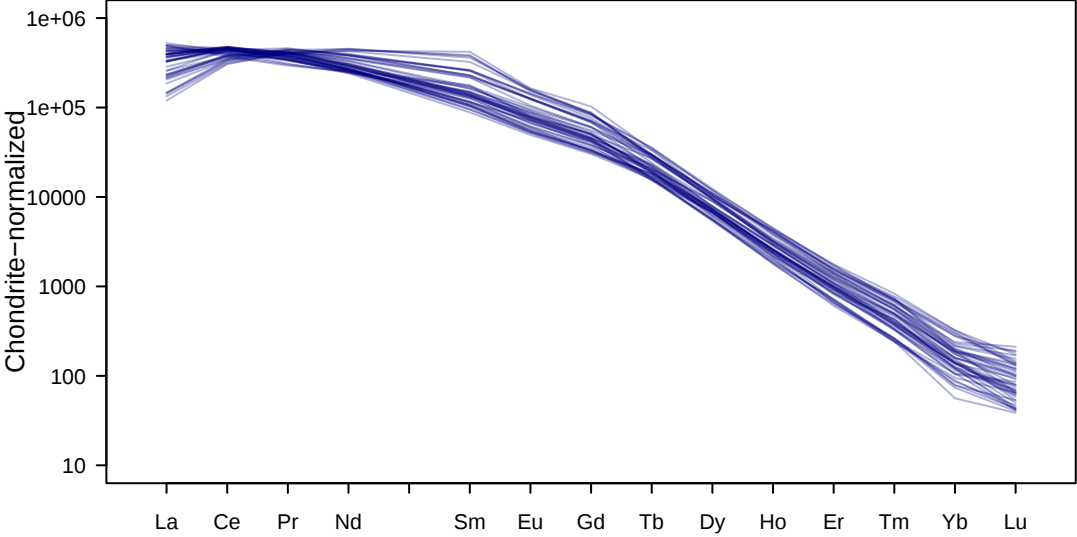


REOGA-137 – Monazite

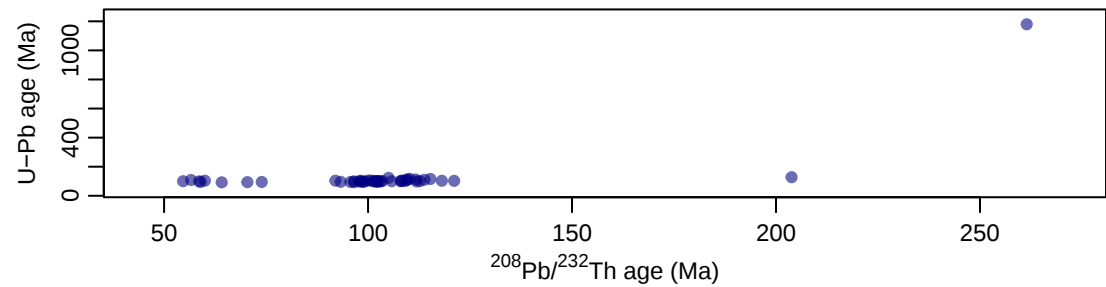
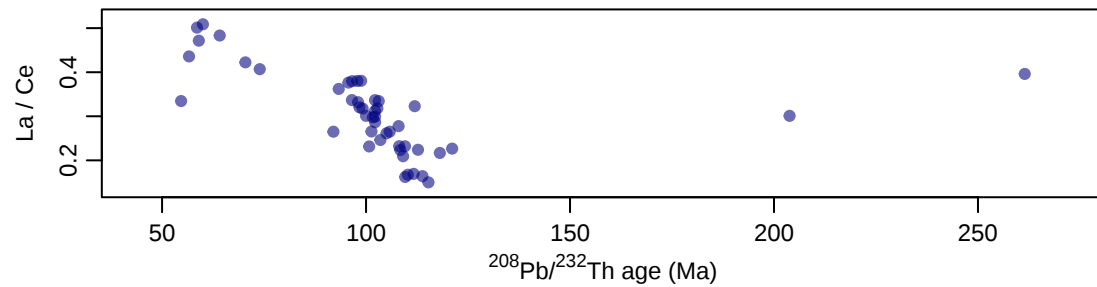
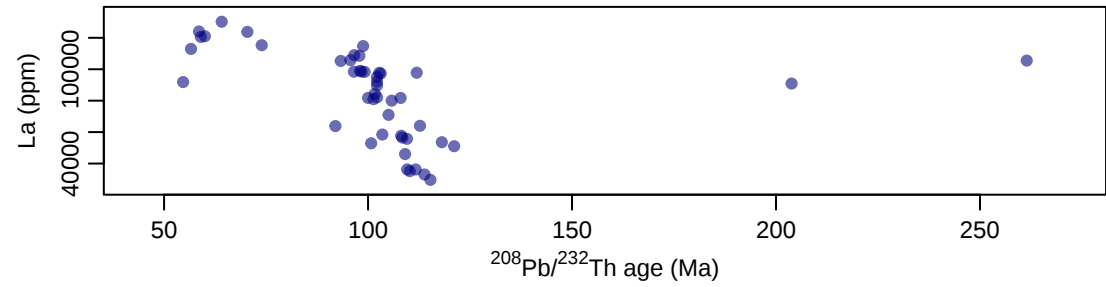
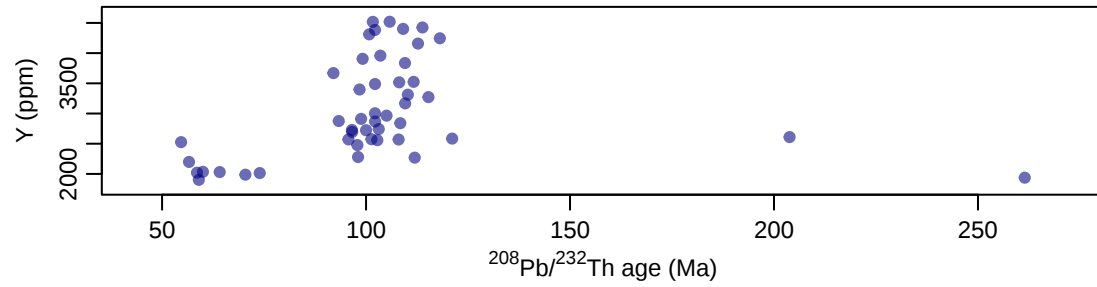
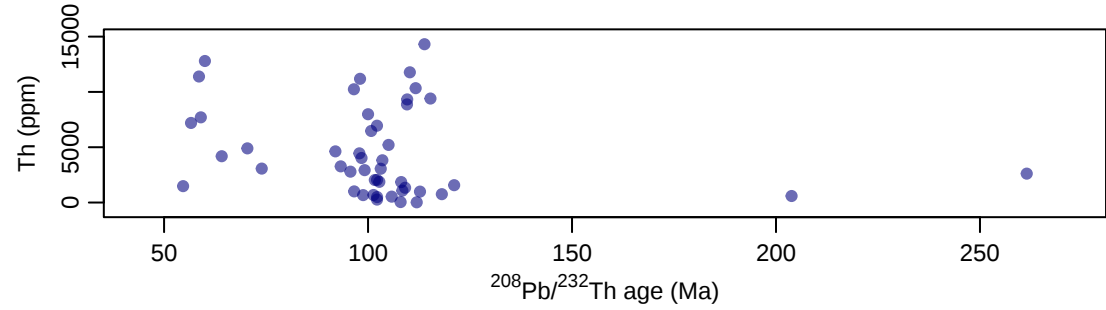
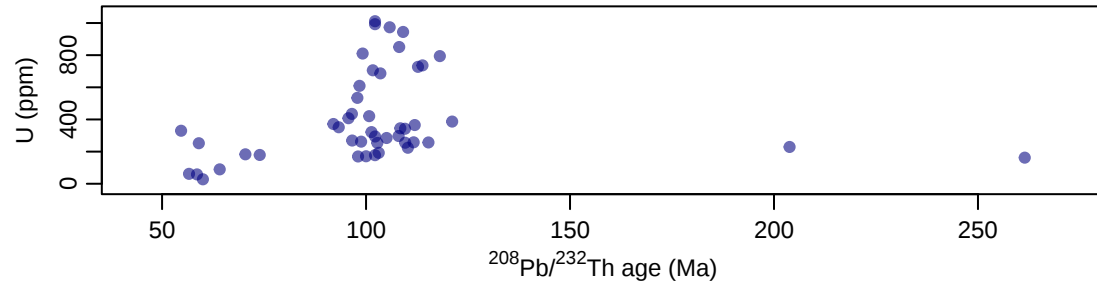
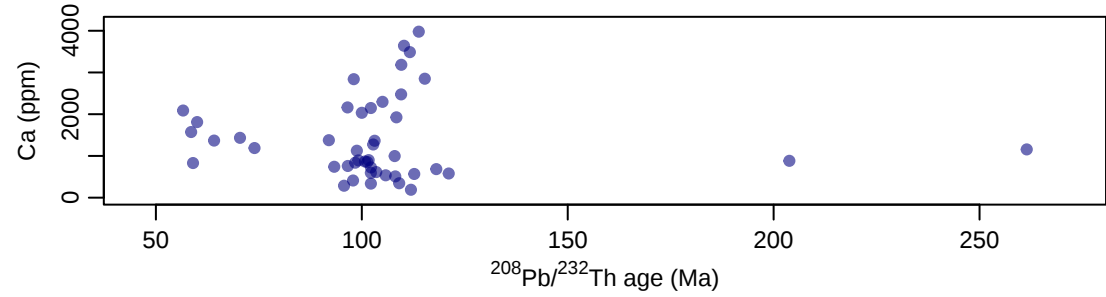
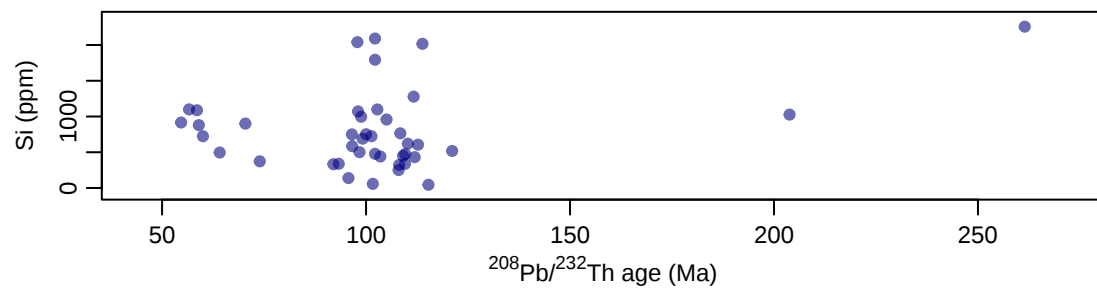
concordia_age = 92.40 ± 0.49 | 3.87 Ma (n=47)
MSWD = 890 | 55 | 64 , $p(\chi^2) = 0$ | 0 | 0



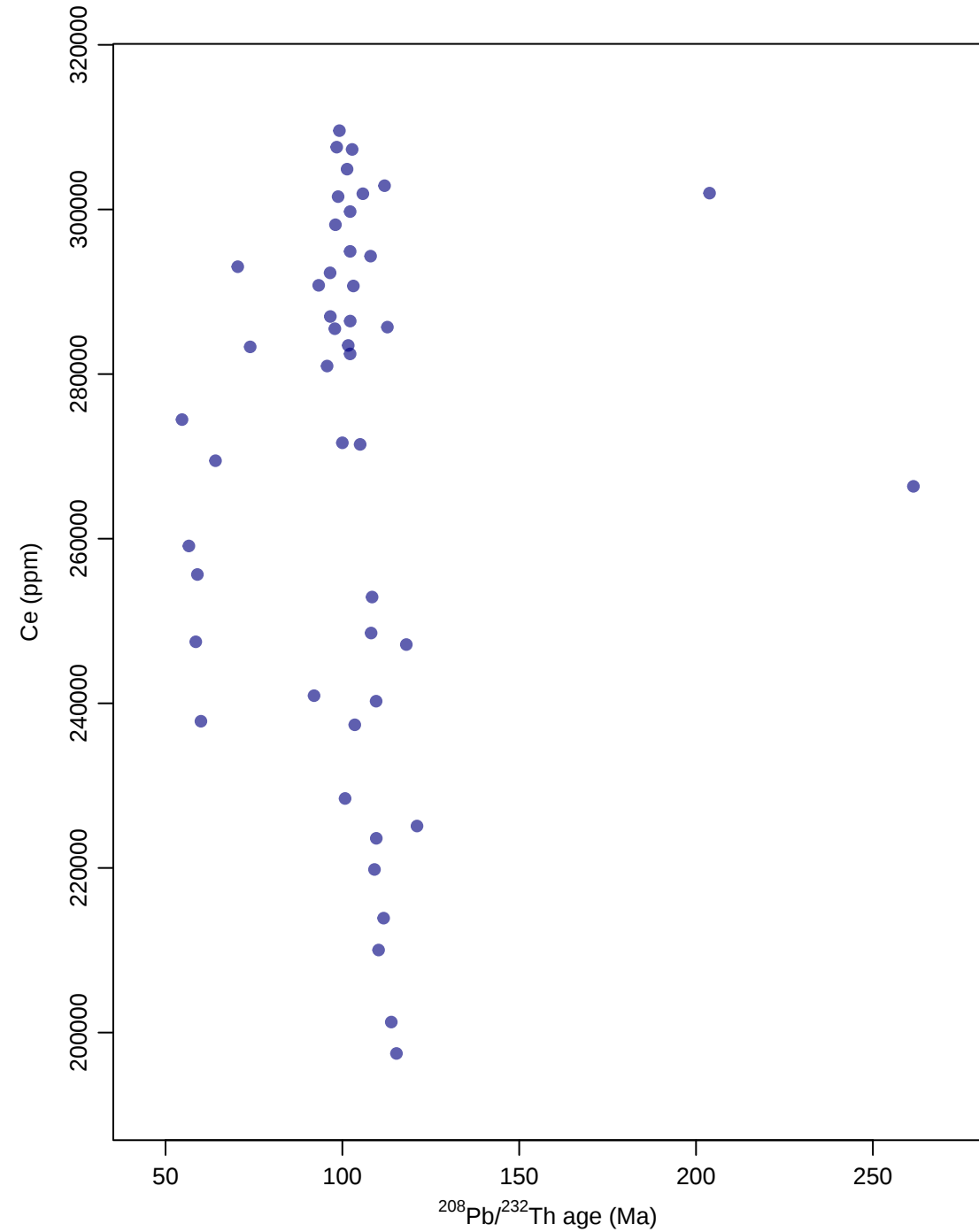
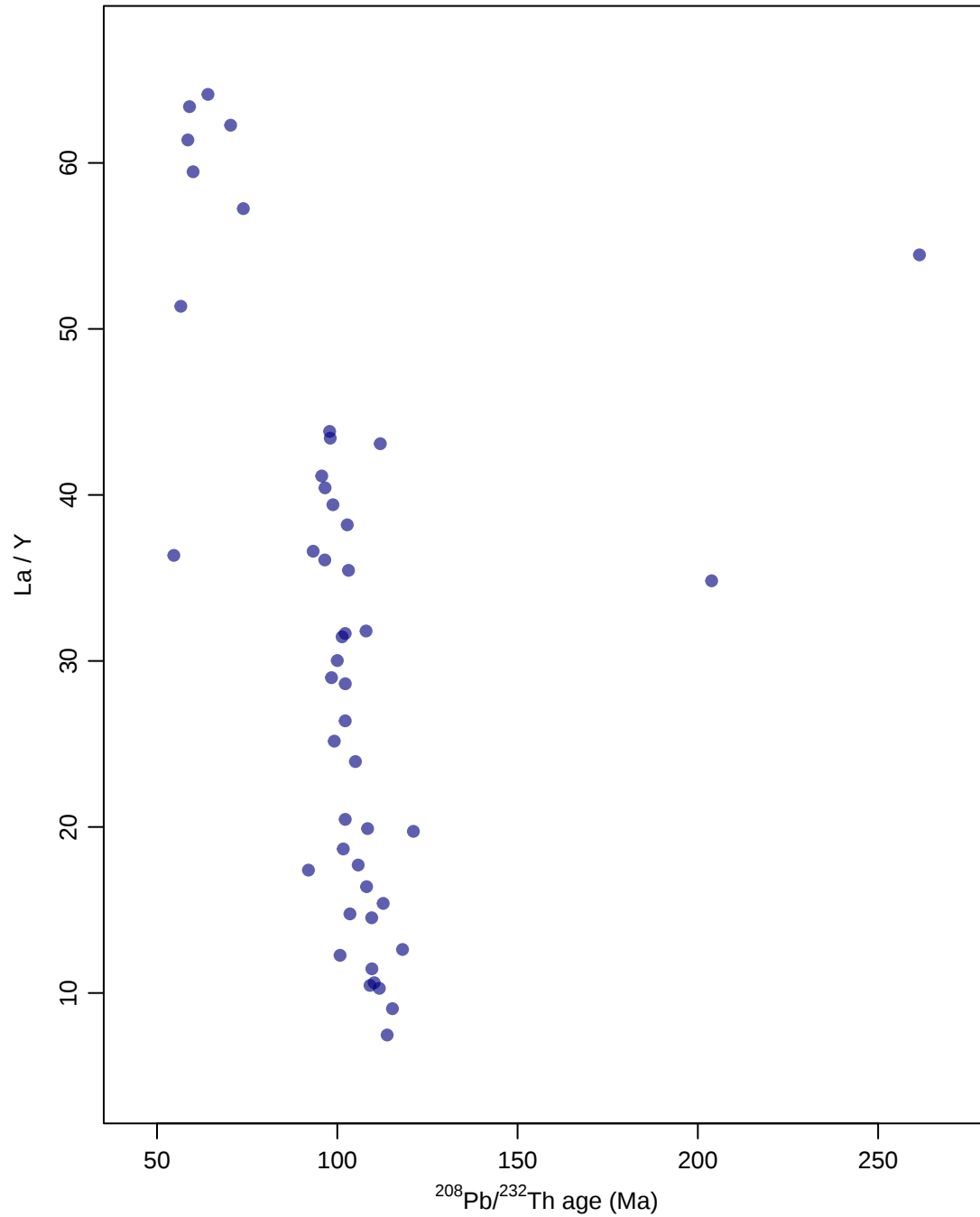
REE distribution



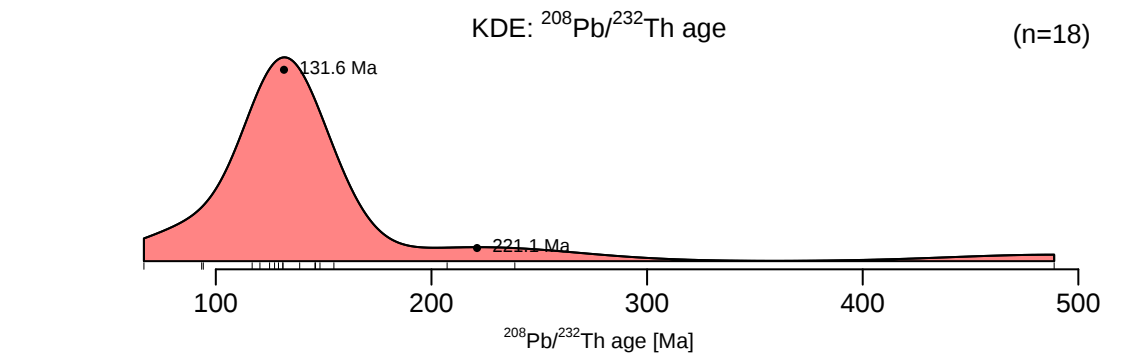
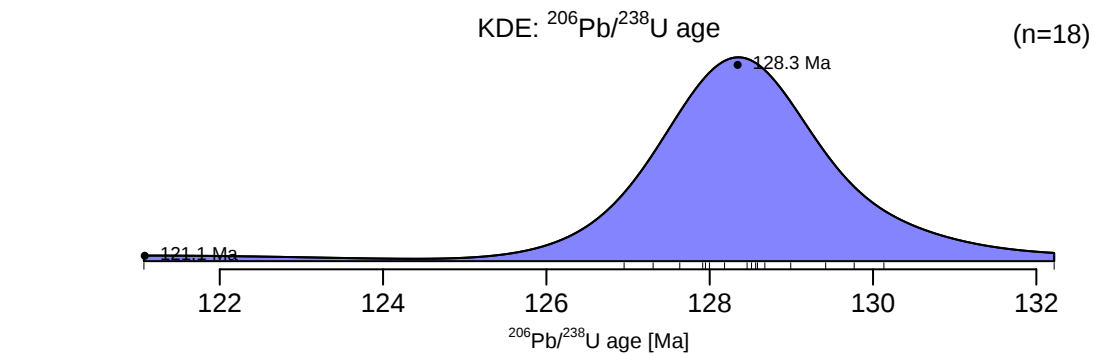
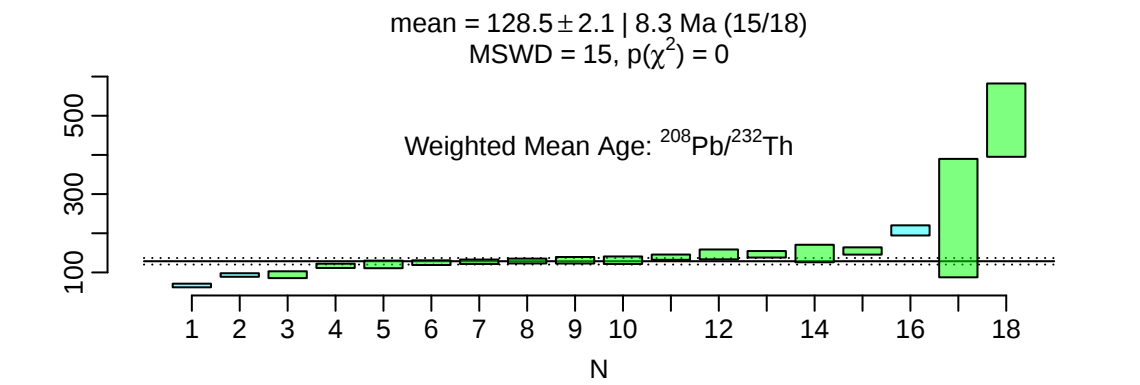
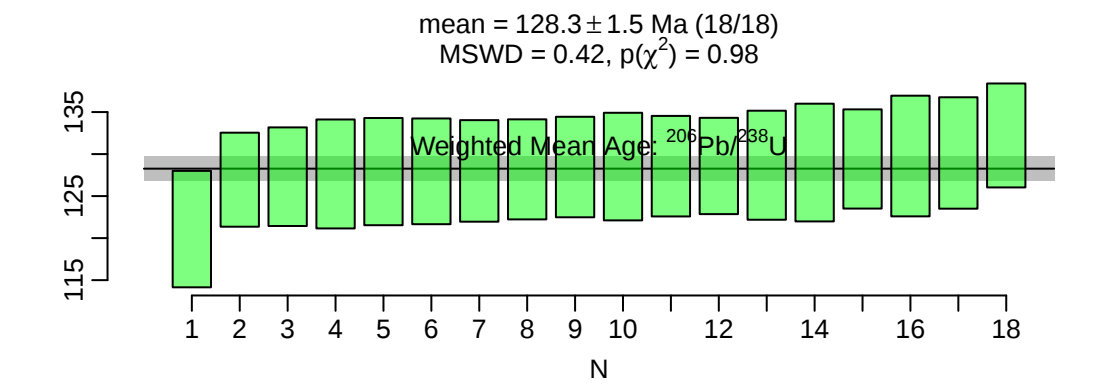
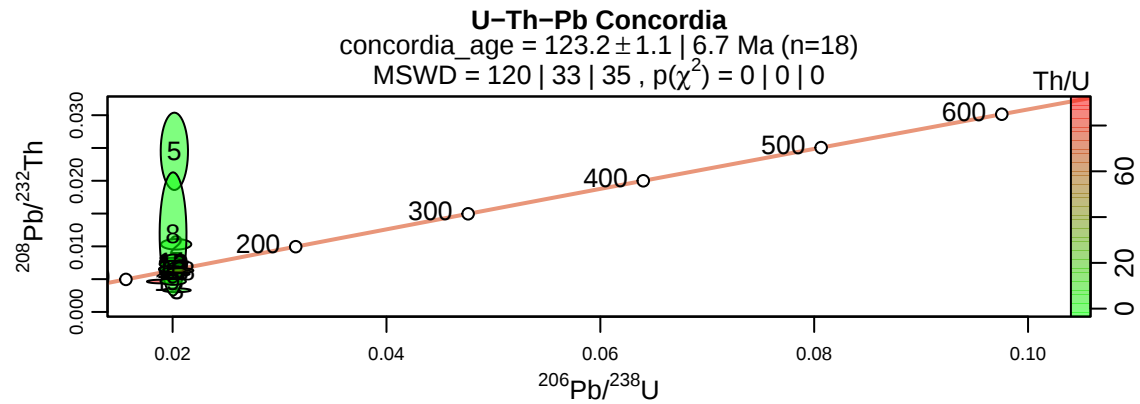
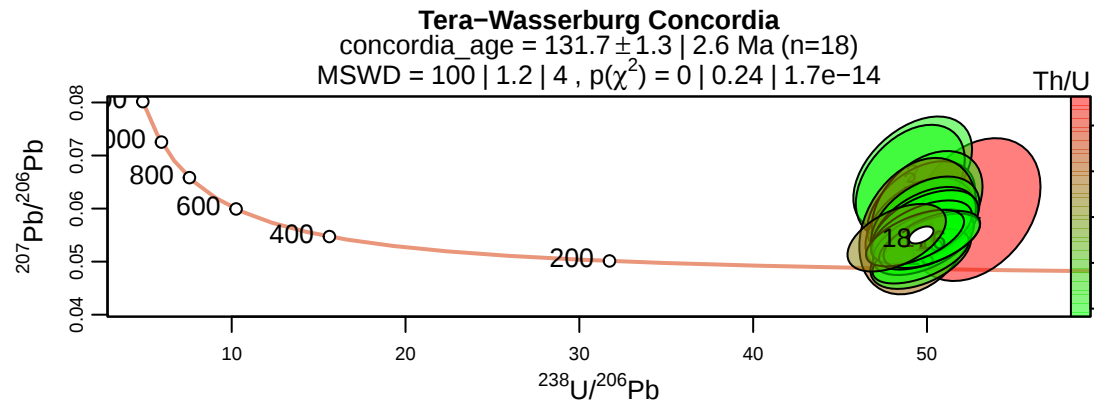
REOGA-137 - Monazite



REOGA-137 – Monazite

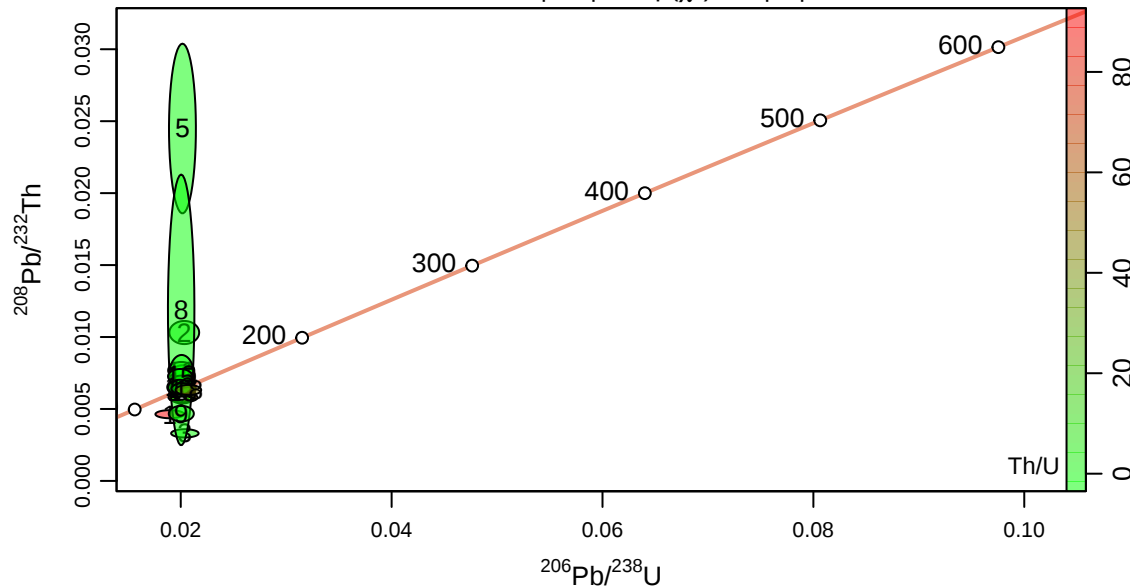


REOGAMONT-460_1 - Monazite

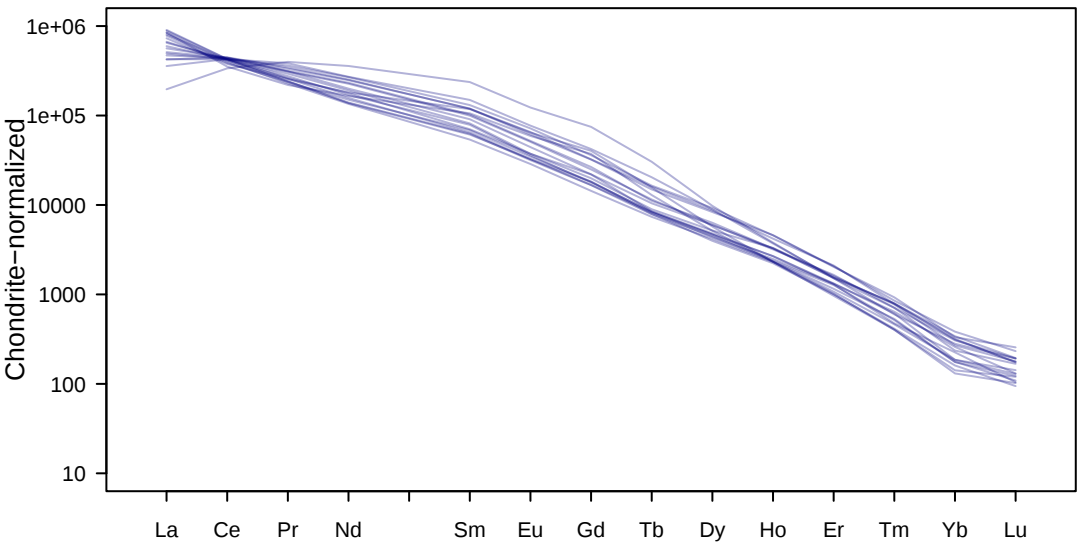


REOGAMONT-460_1 – Monazite

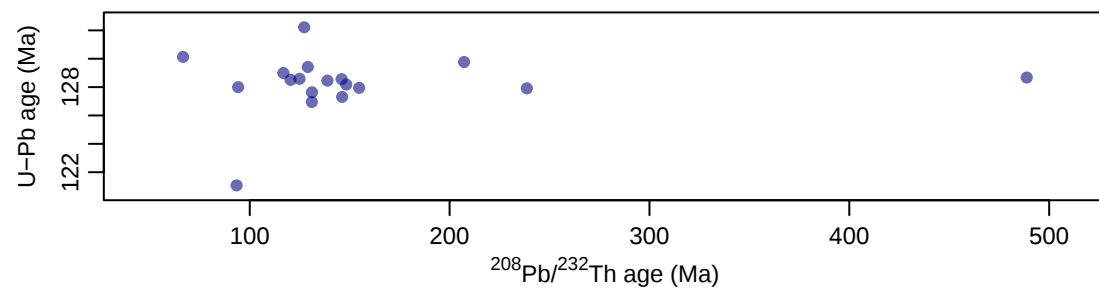
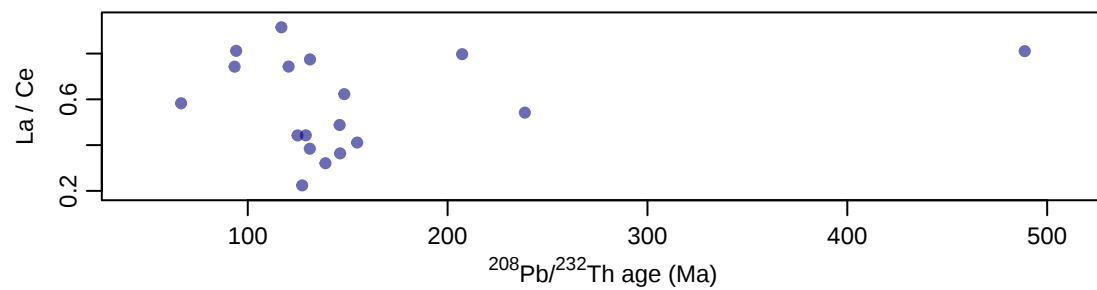
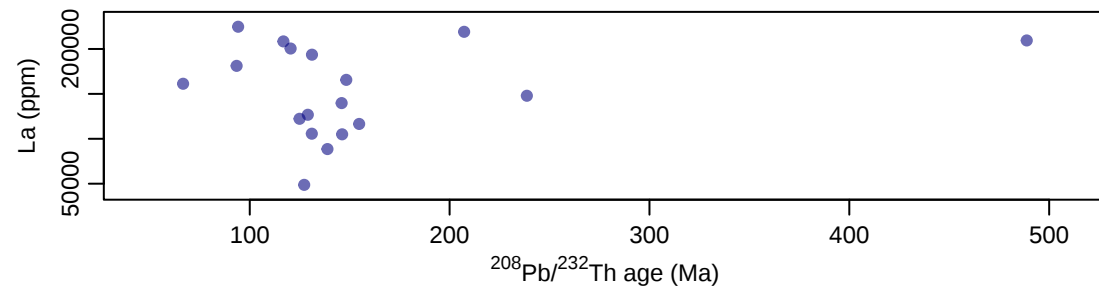
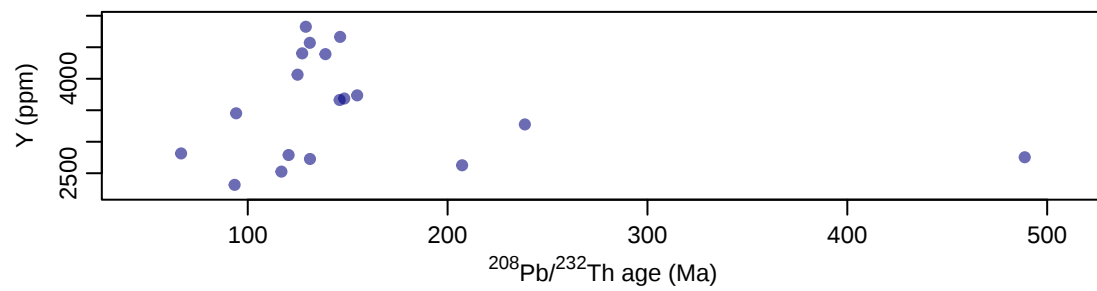
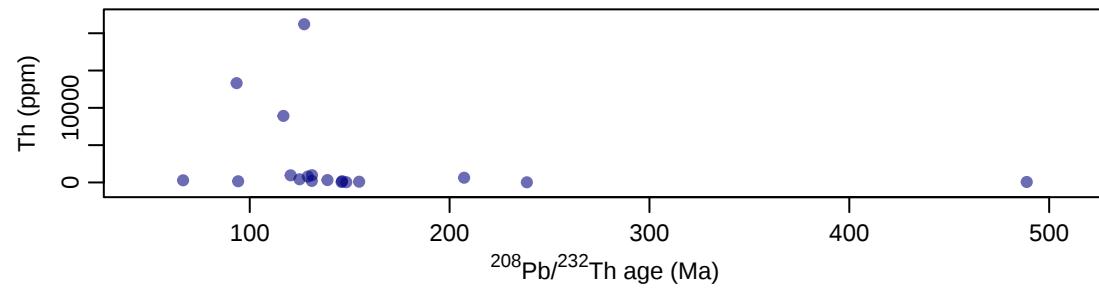
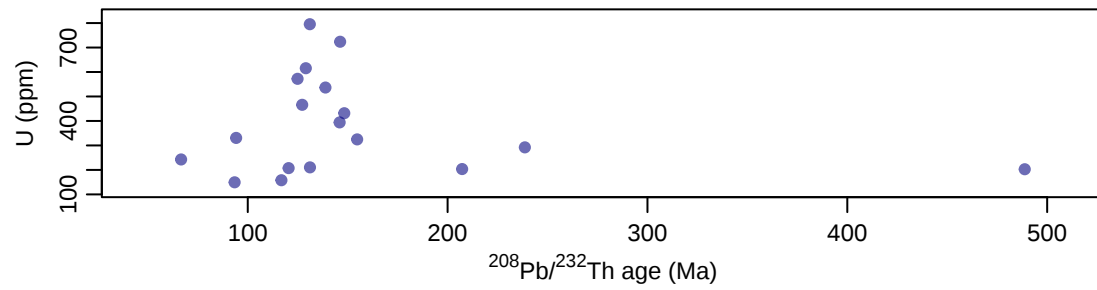
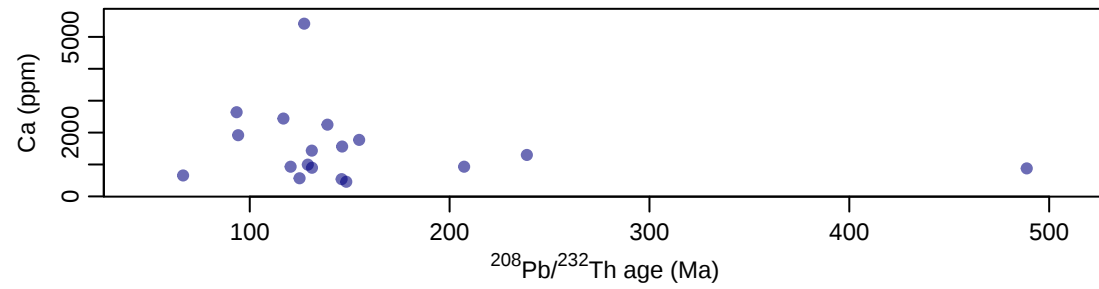
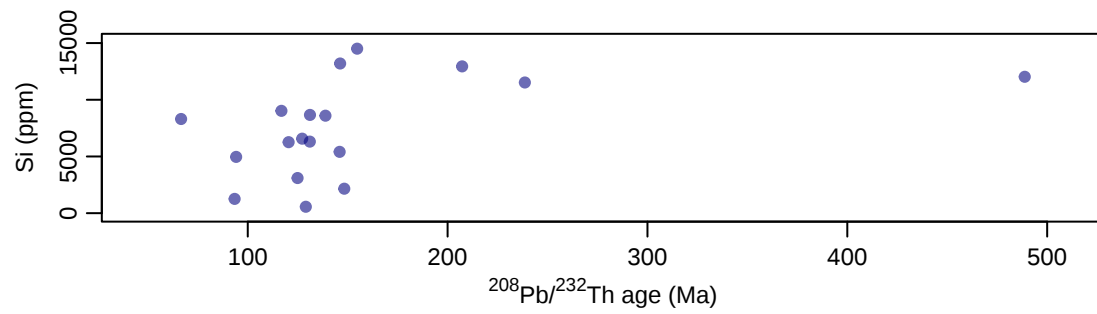
concordia_age = 123.2 ± 1.1 | 6.7 Ma (n=18)
MSWD = 120 | 33 | 35 , $p(\chi^2) = 0$ | 0 | 0



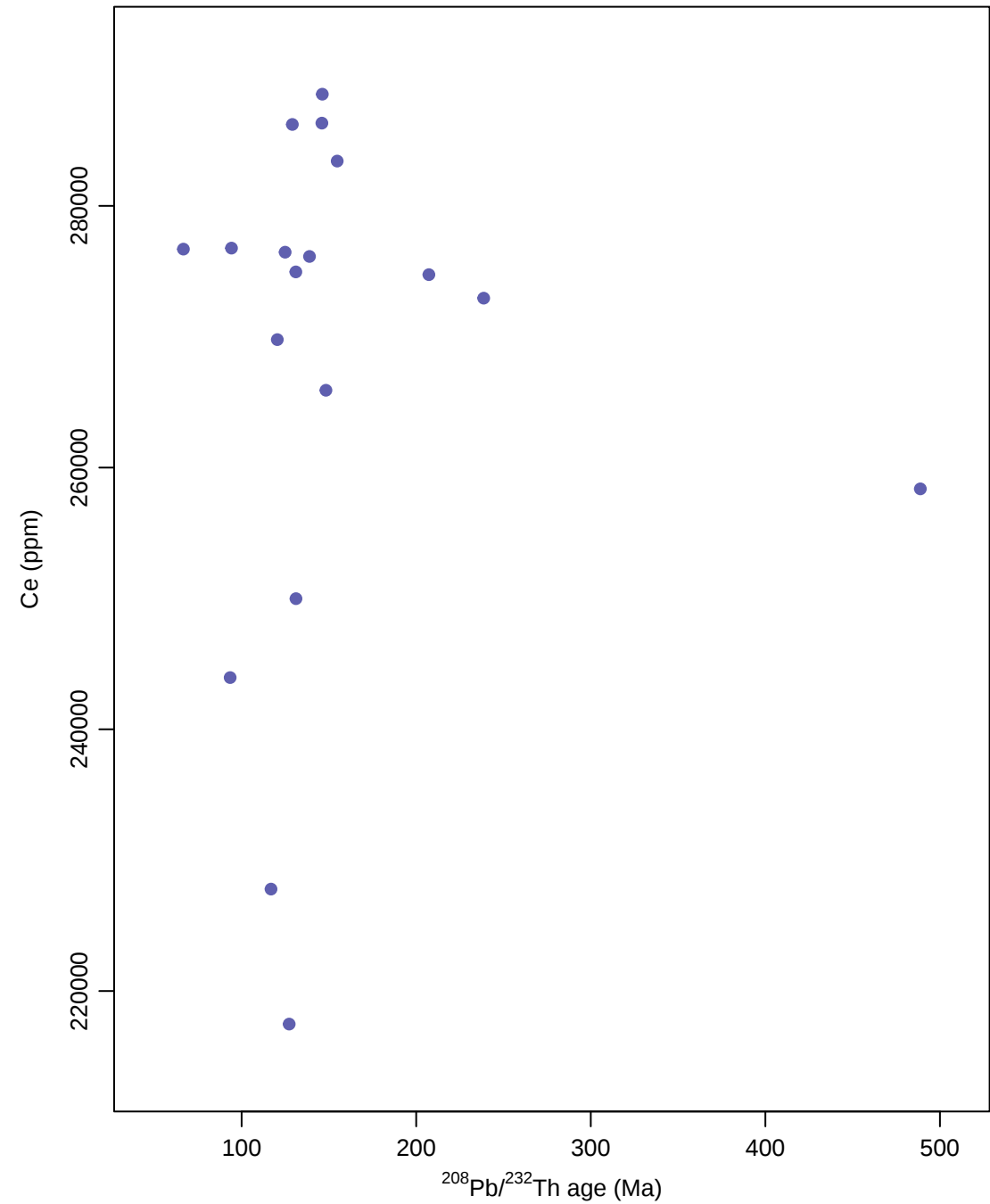
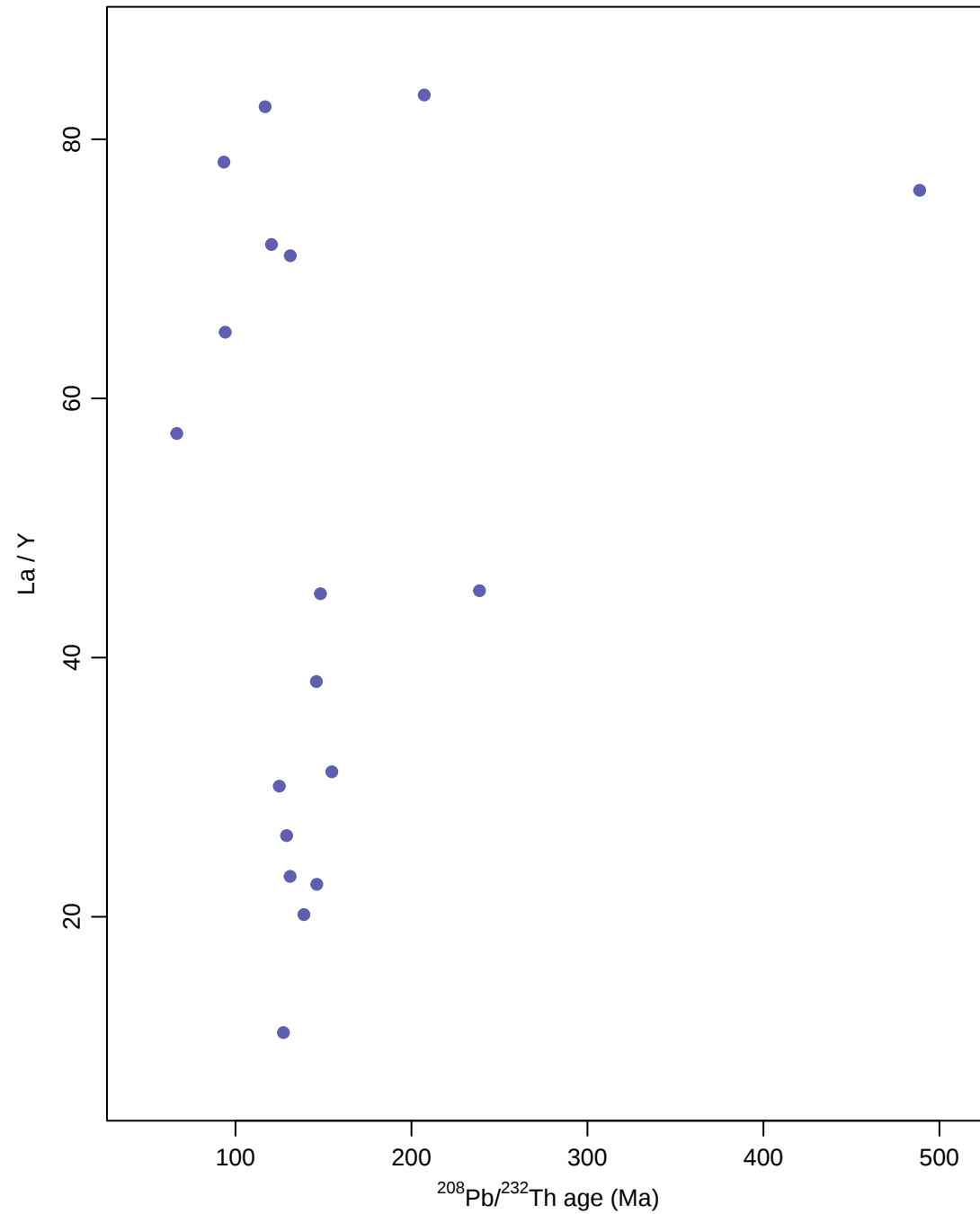
REE distribution



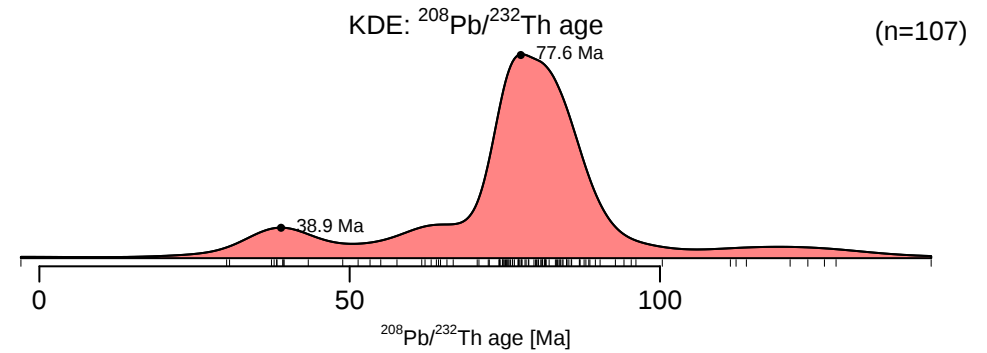
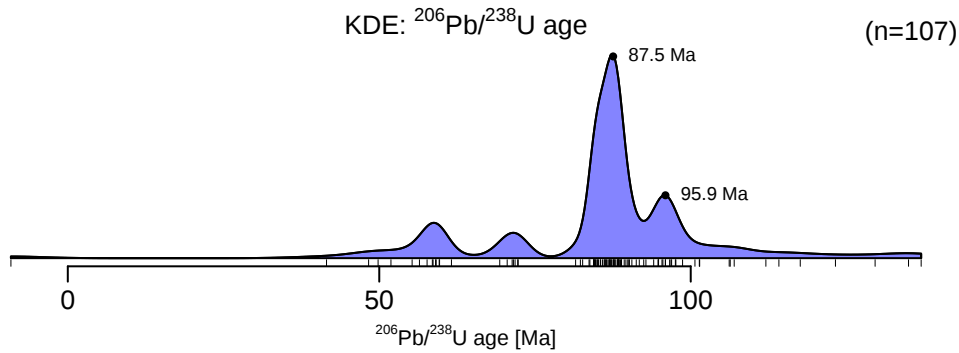
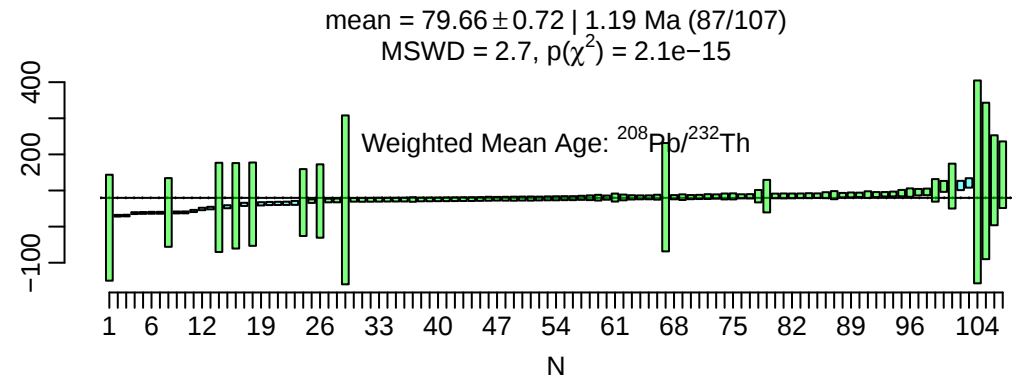
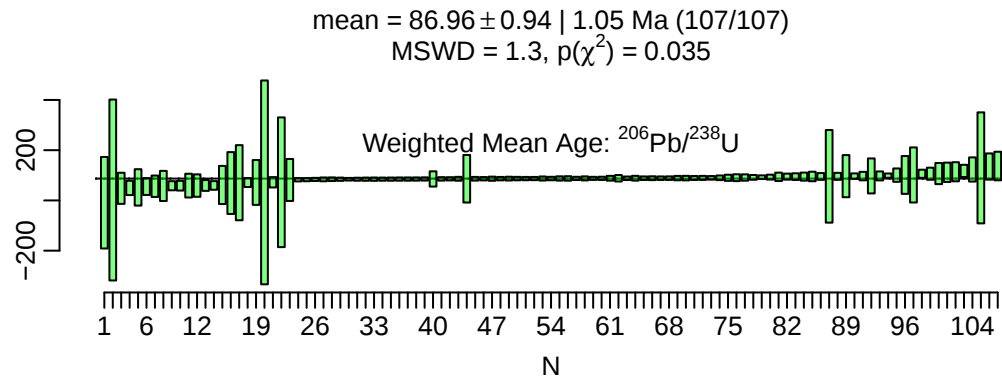
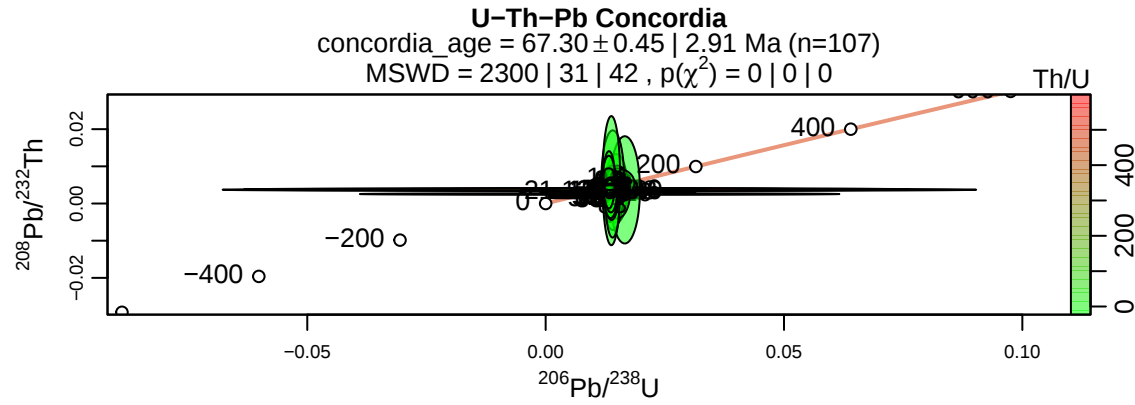
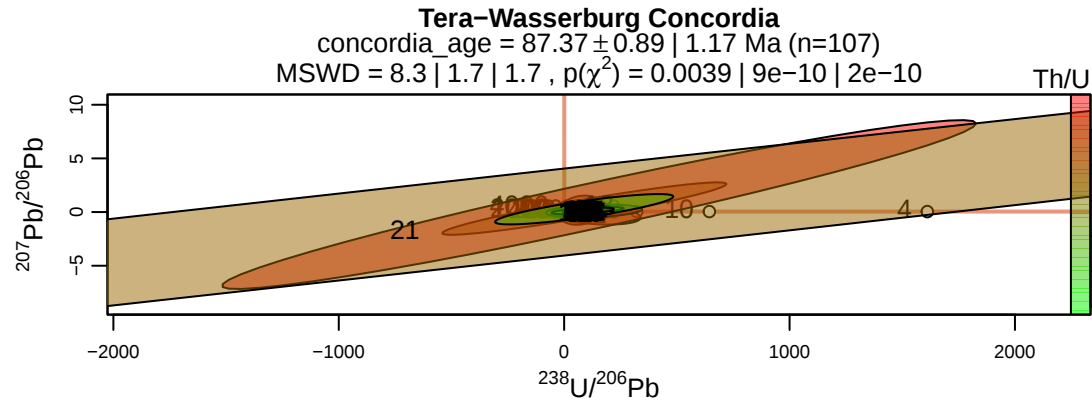
REOGAMONT-460_1 - Monazite



REOGAMONT-460_1 - Monazite

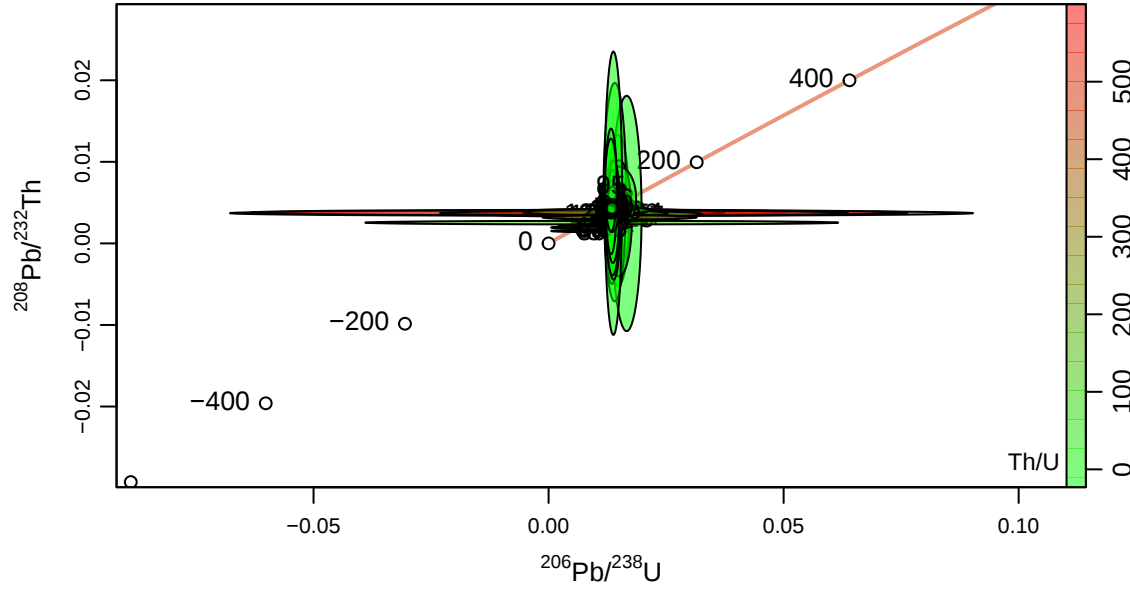


REOMA-065A – Monazite

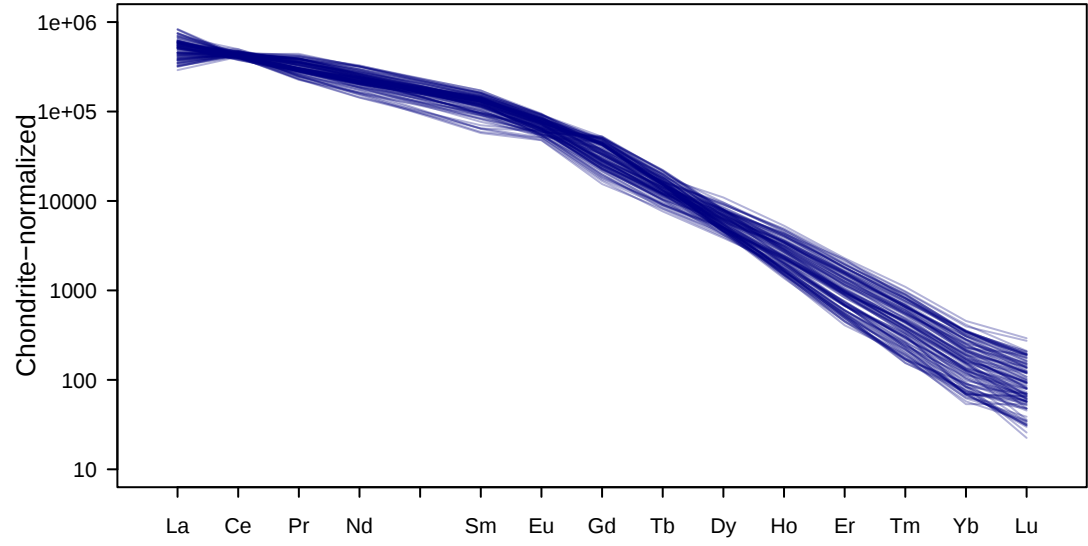


REOMA-065A – Monazite

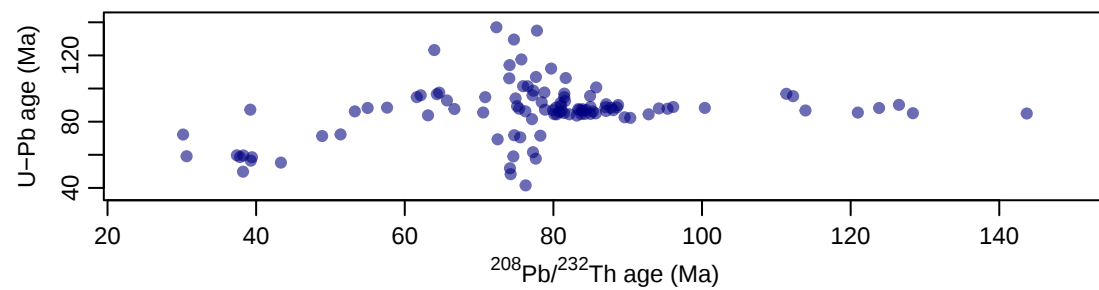
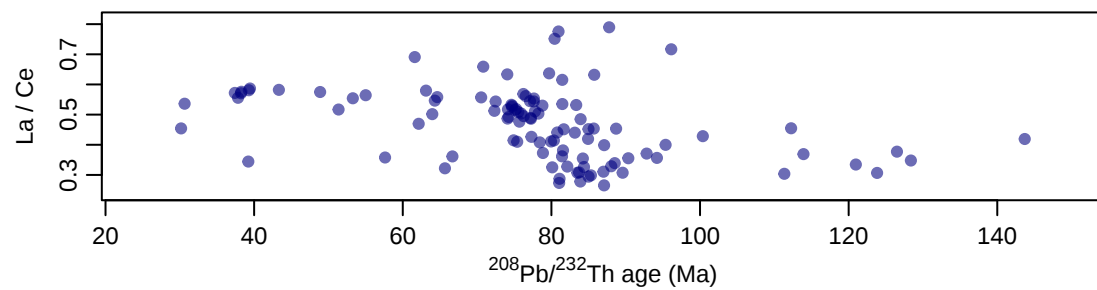
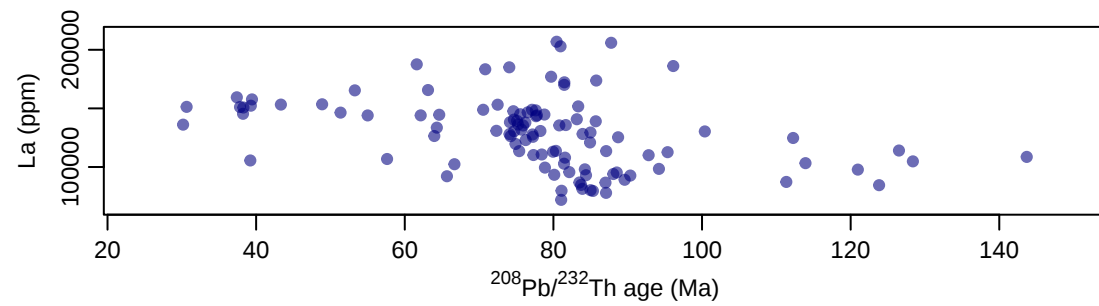
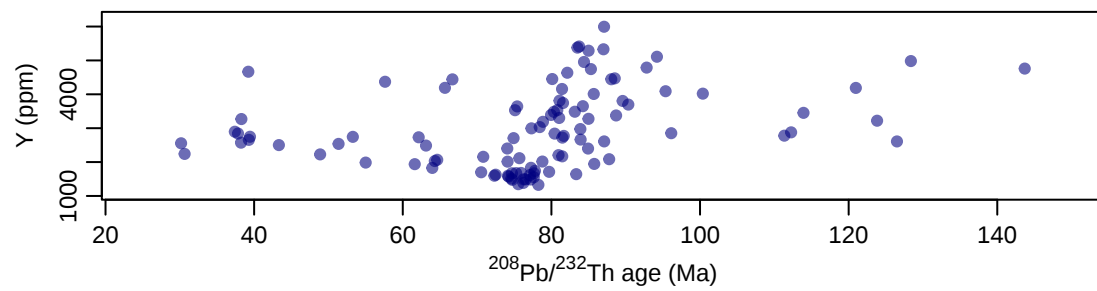
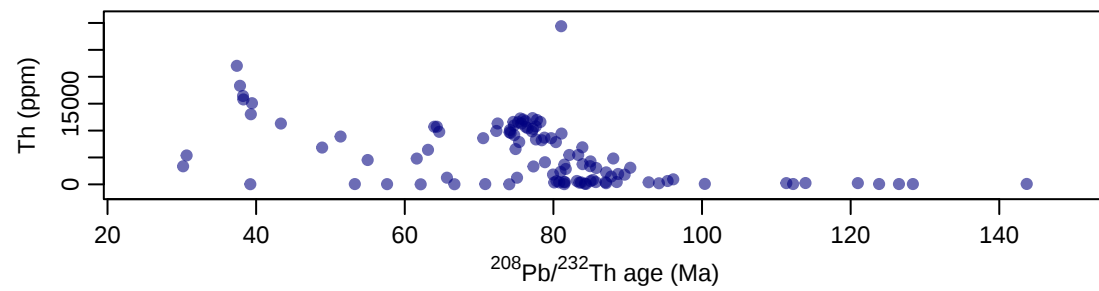
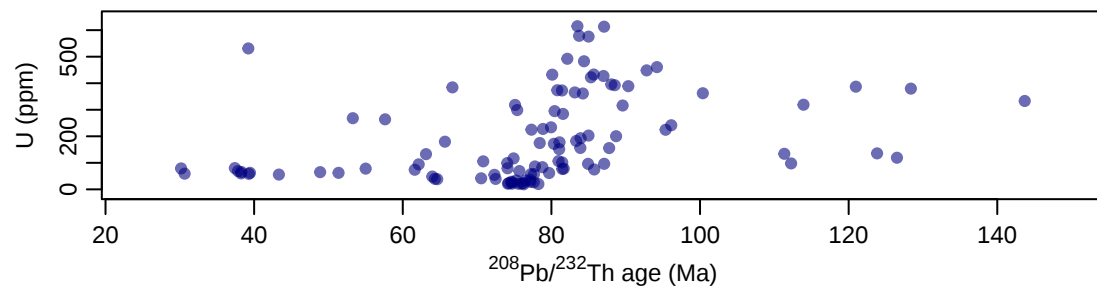
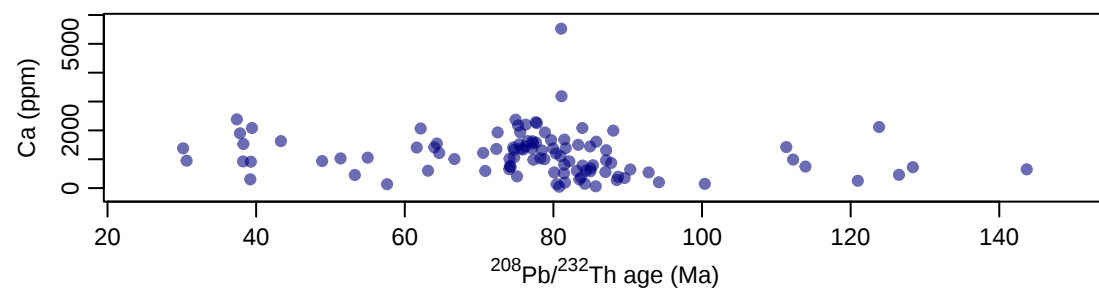
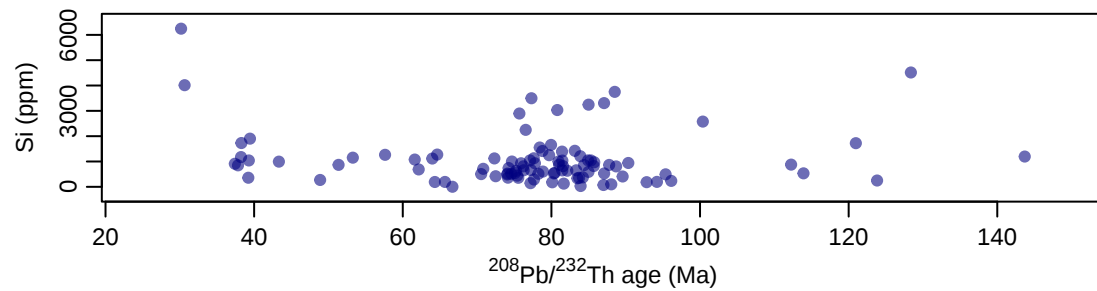
concordia_age = 68.28 ± 0.47 | 2.99 Ma (n=101)
MSWD = 2100 | 31 | 41 , $p(\chi^2) = 0$ | 0 | 0



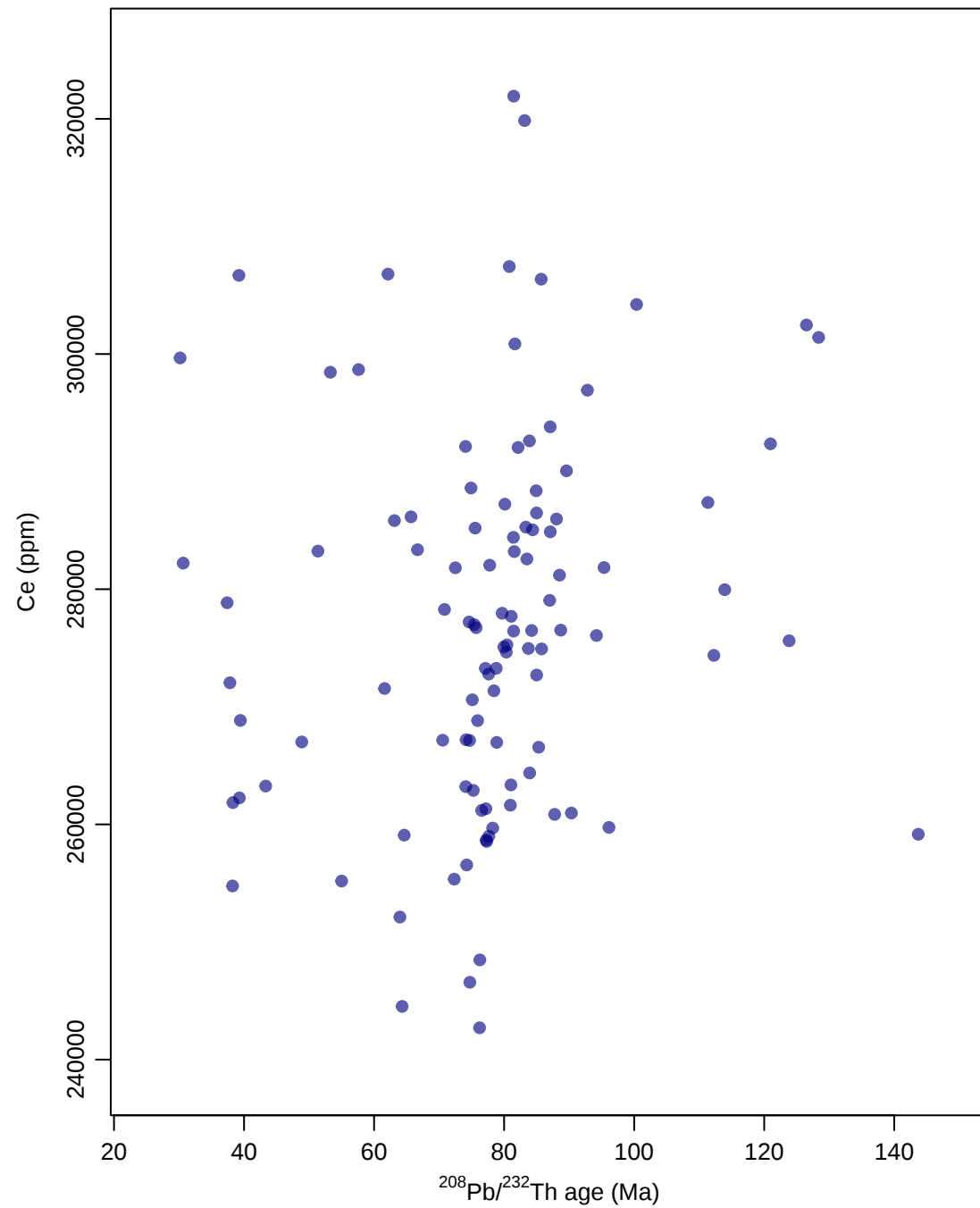
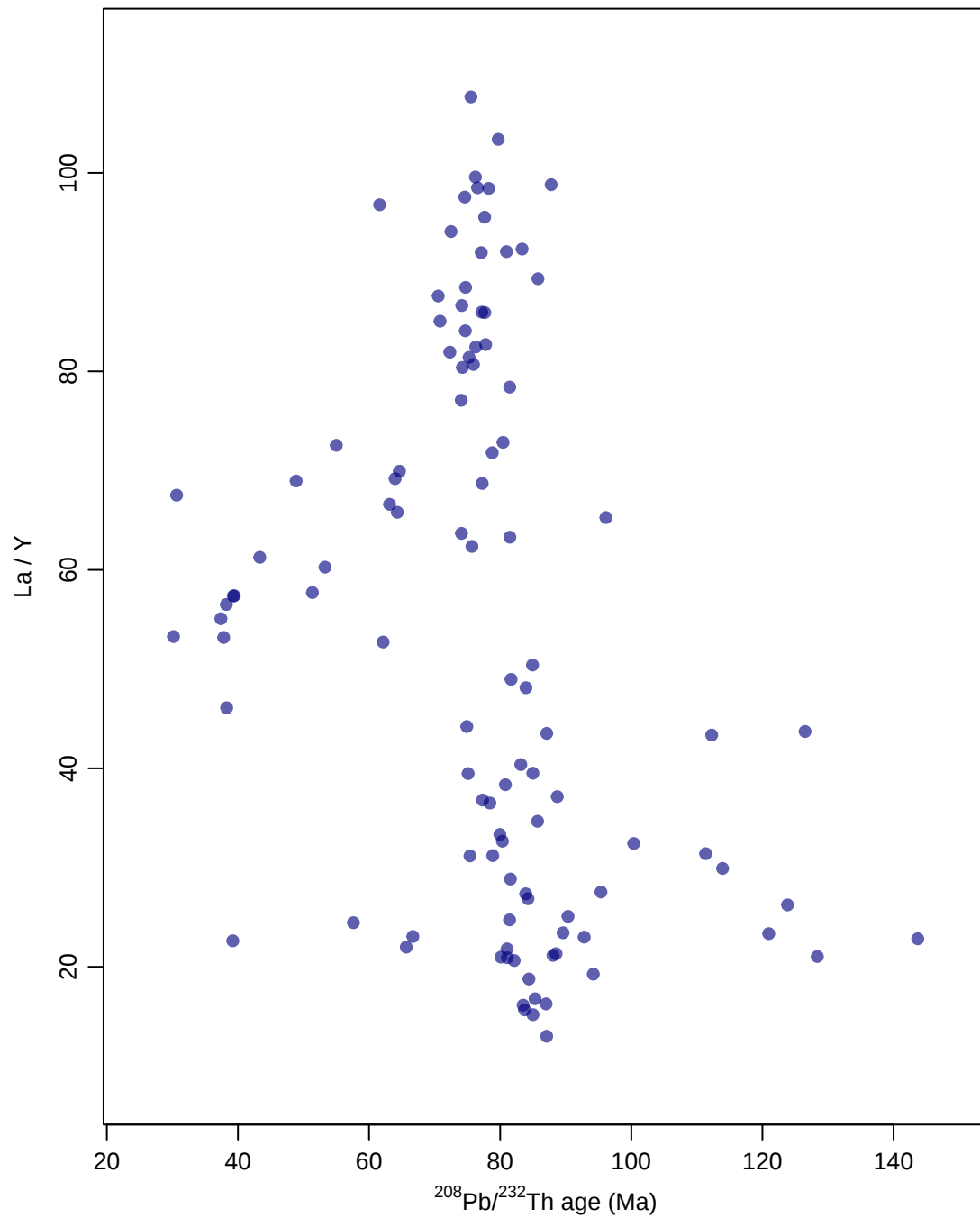
REE distribution



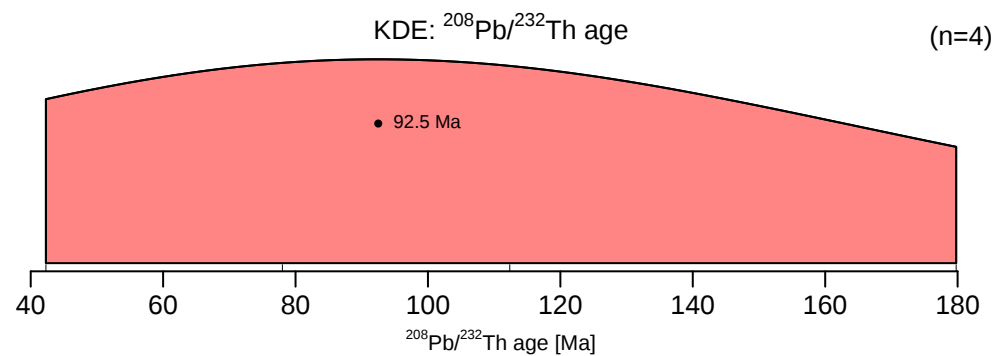
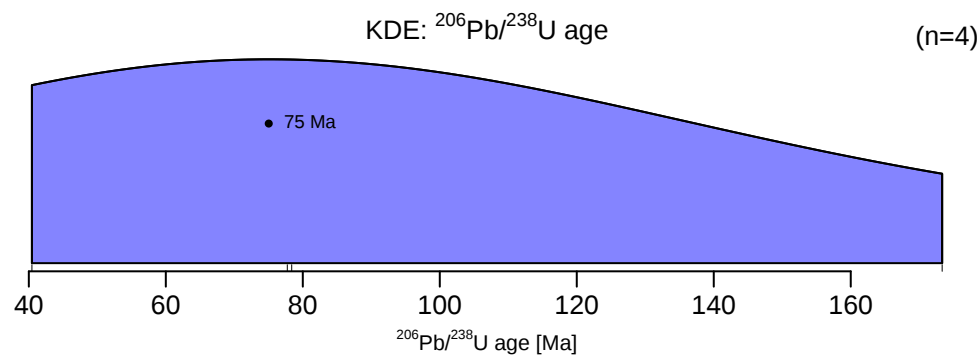
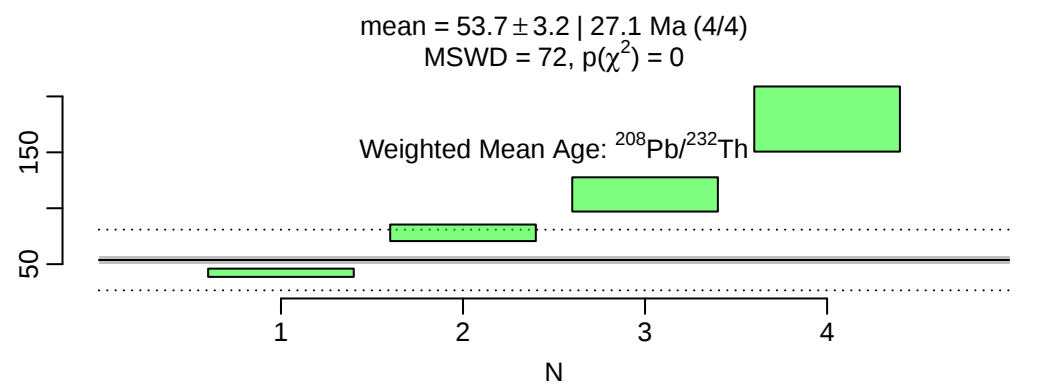
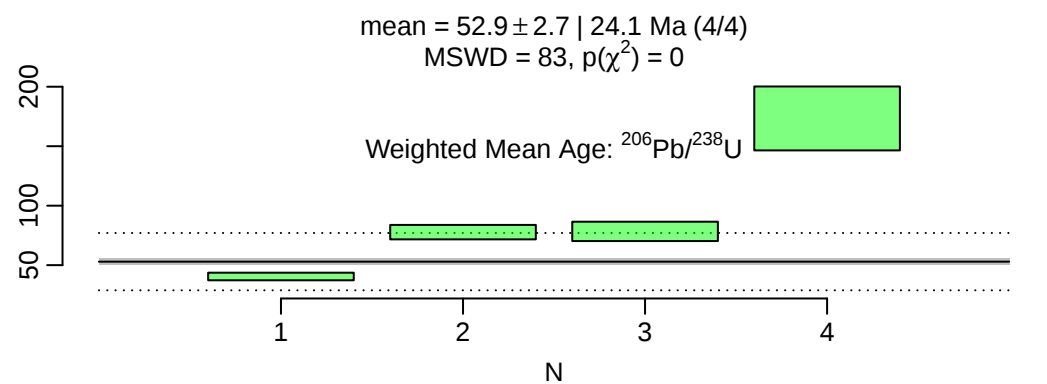
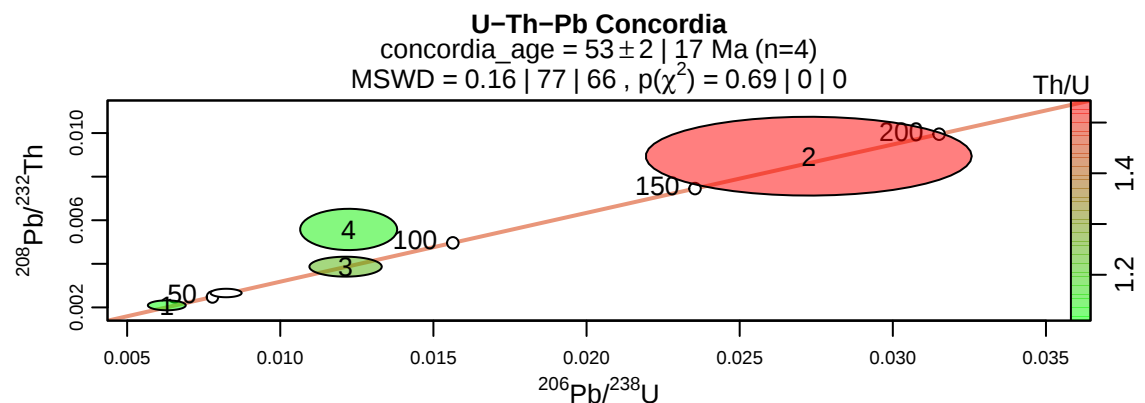
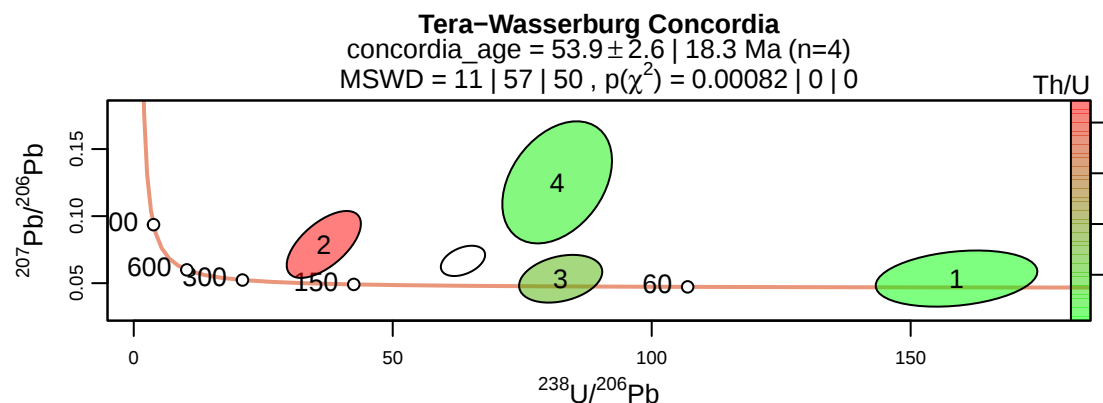
REOMA-065A - Monazite



REOMA-065A - Monazite

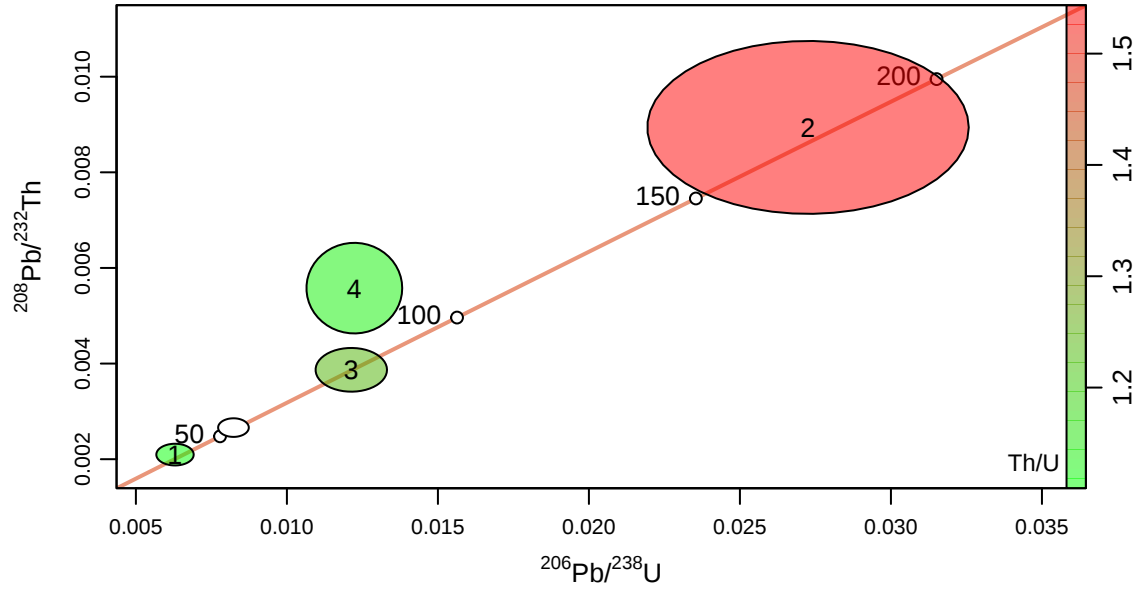


REOMA-065A – Xenotime

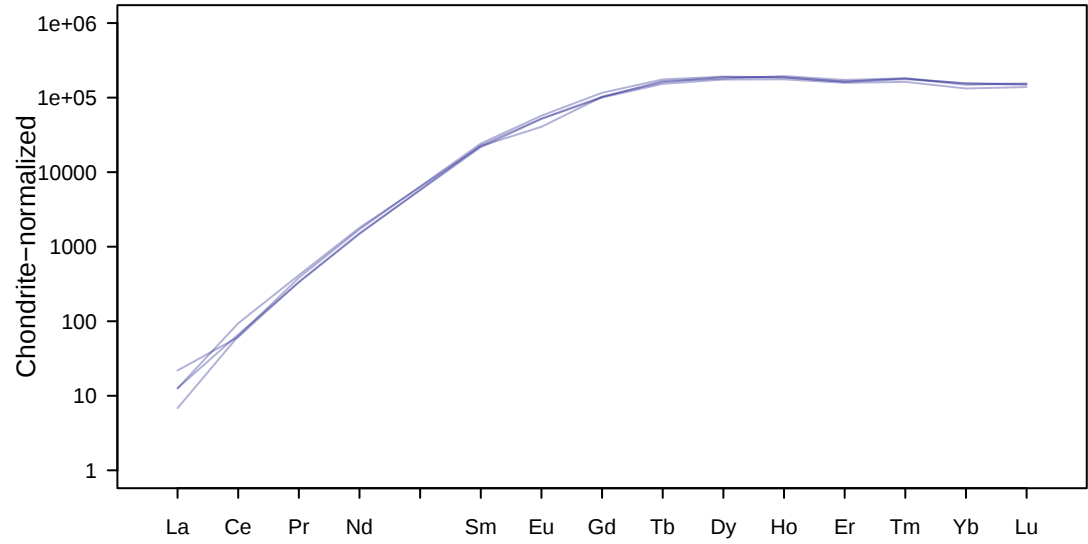


REOMA-065A – Xenotime

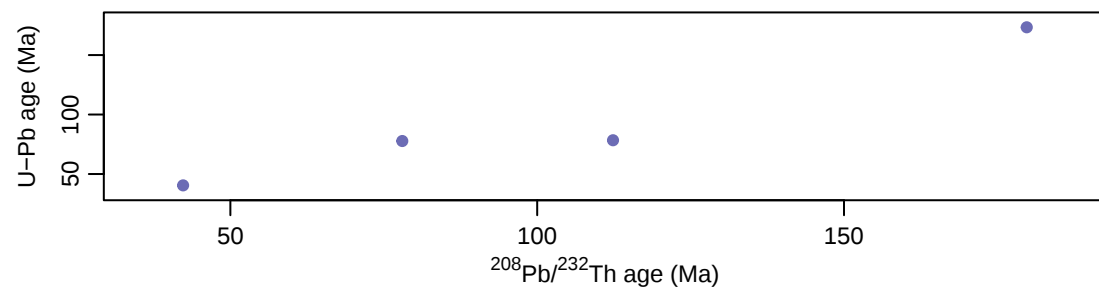
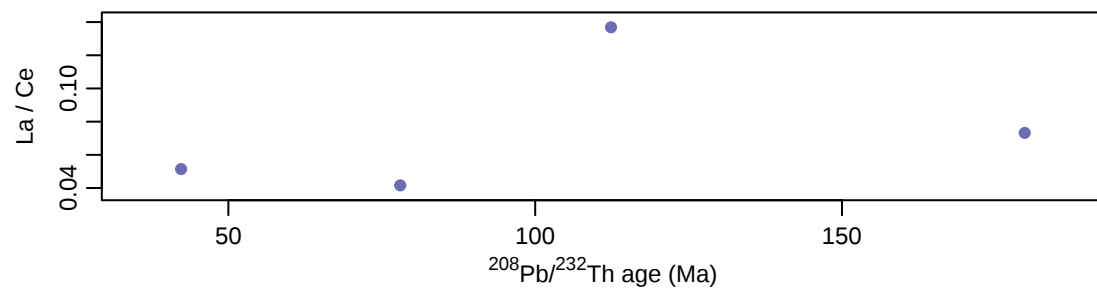
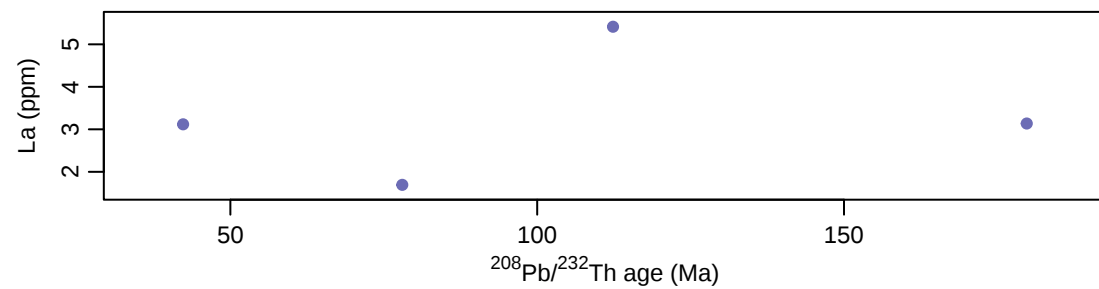
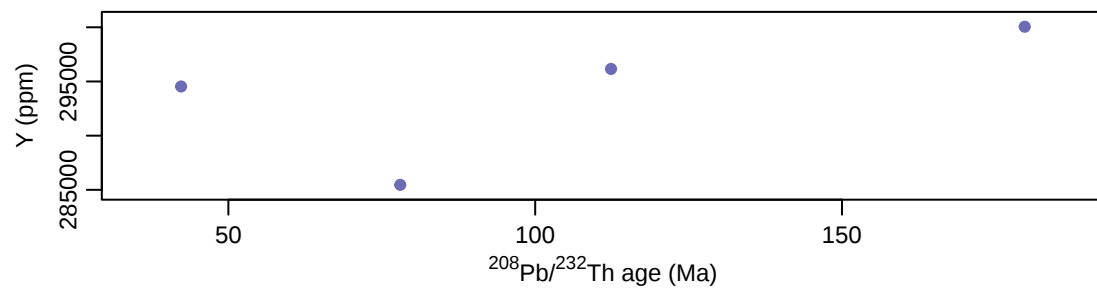
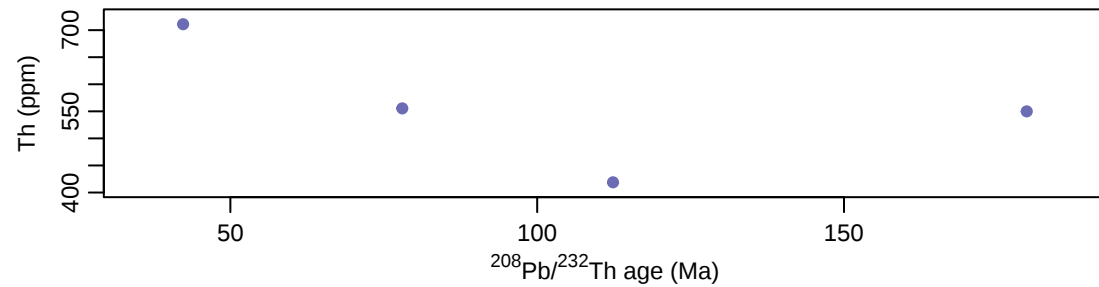
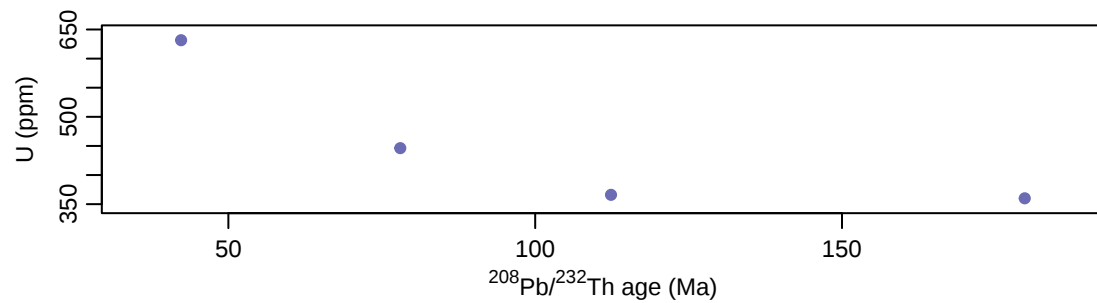
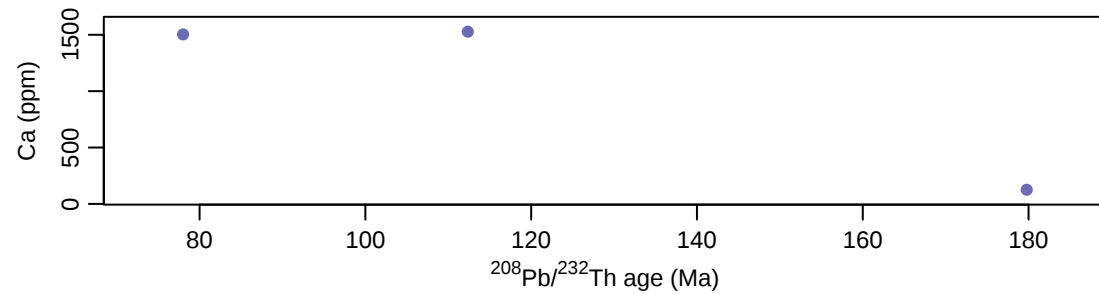
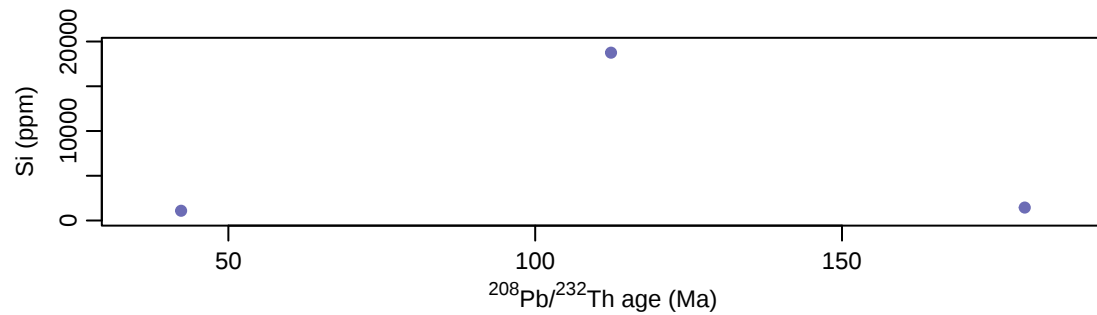
concordia_age = 53 ± 2 | 17 Ma (n=4)
MSWD = 0.16 | 77 | 66, $p(\chi^2) = 0.69$ | 0 | 0



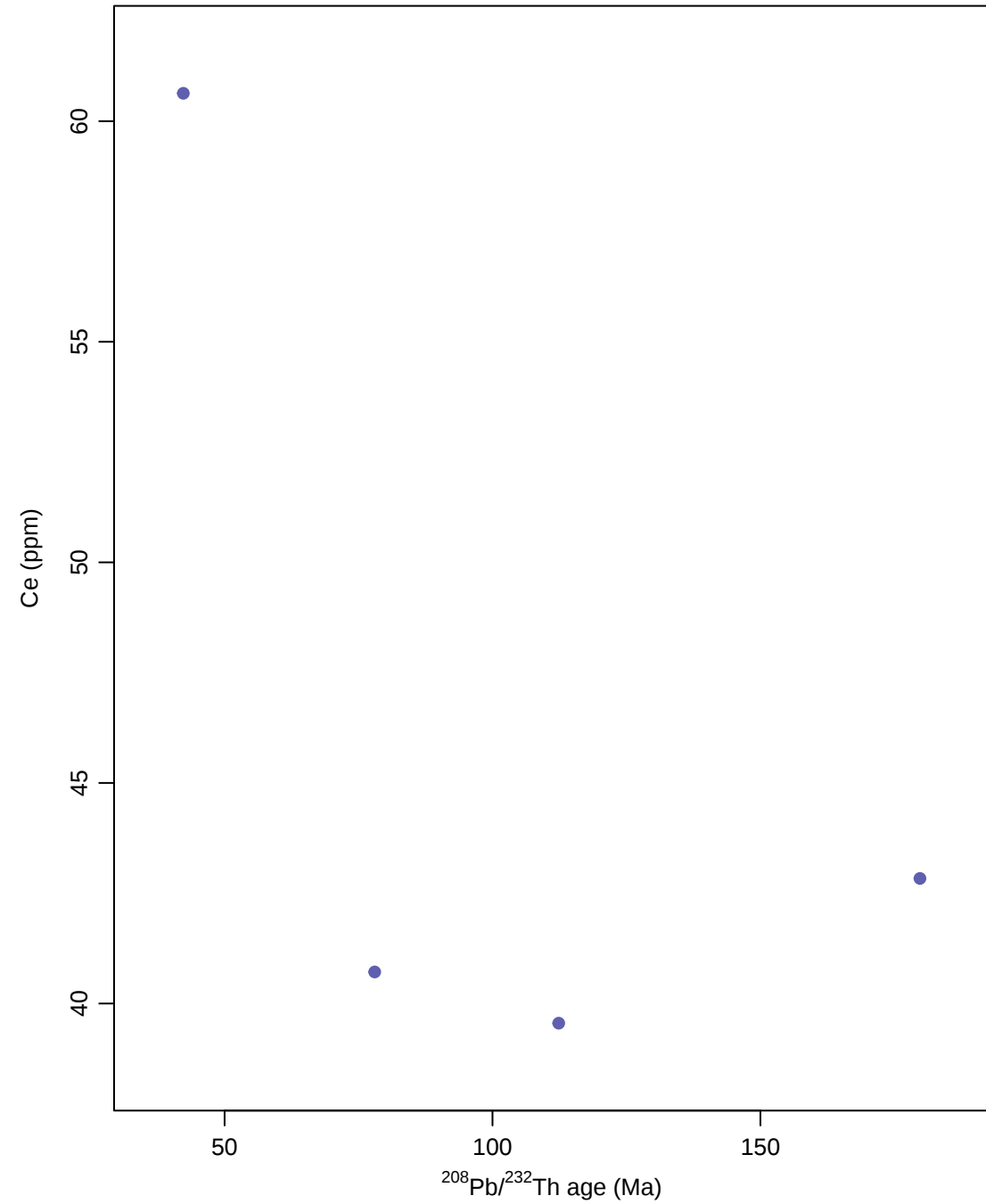
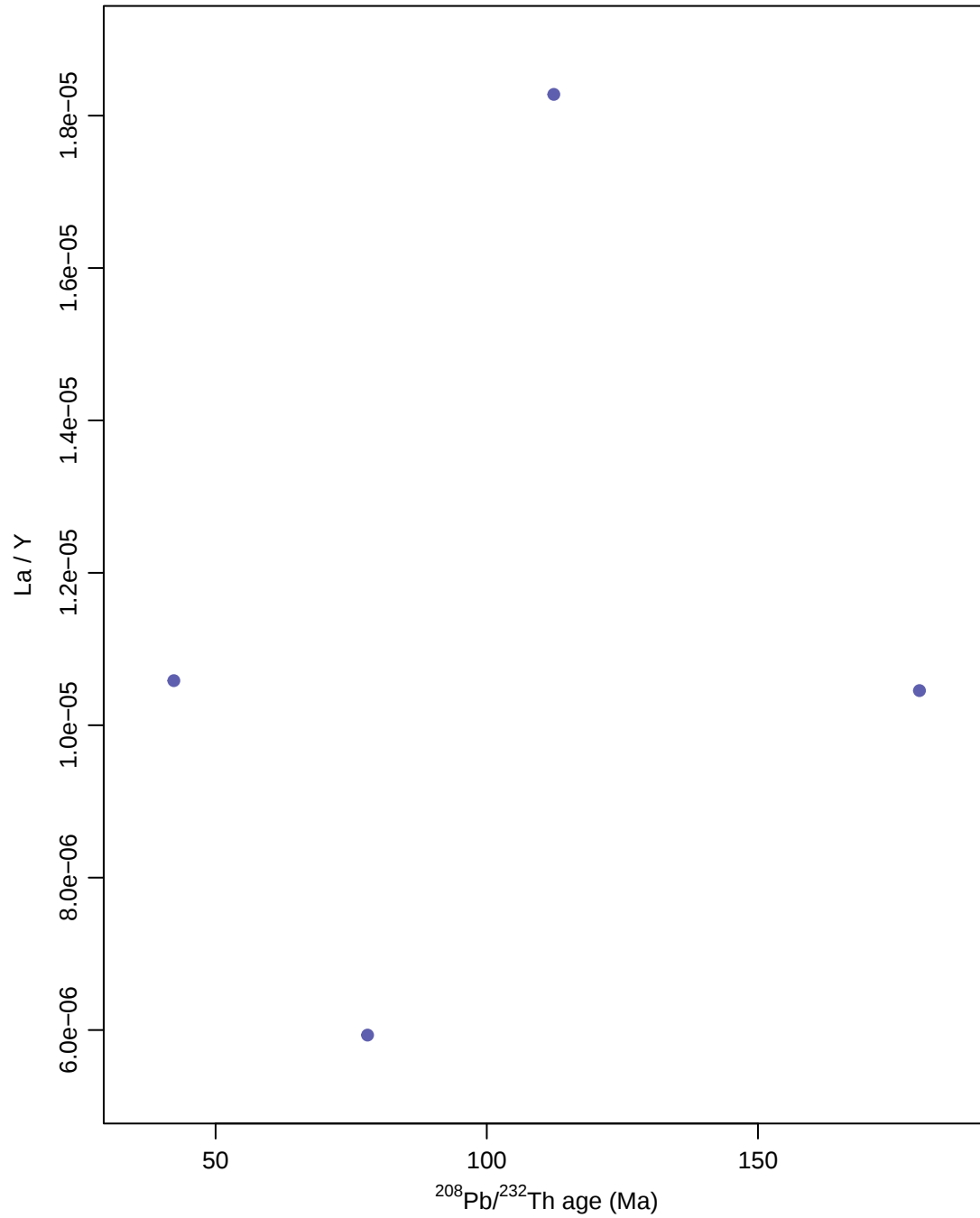
REE distribution



REOMA-065A - Xenotime

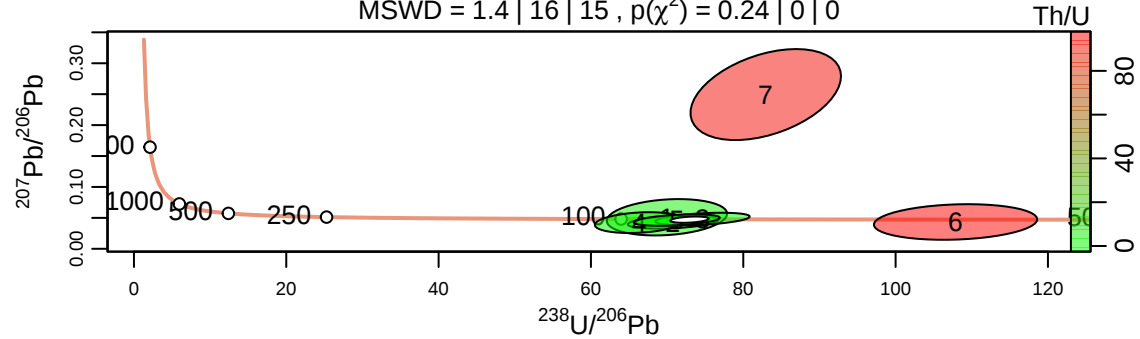


REOMA-065A - Xenotime

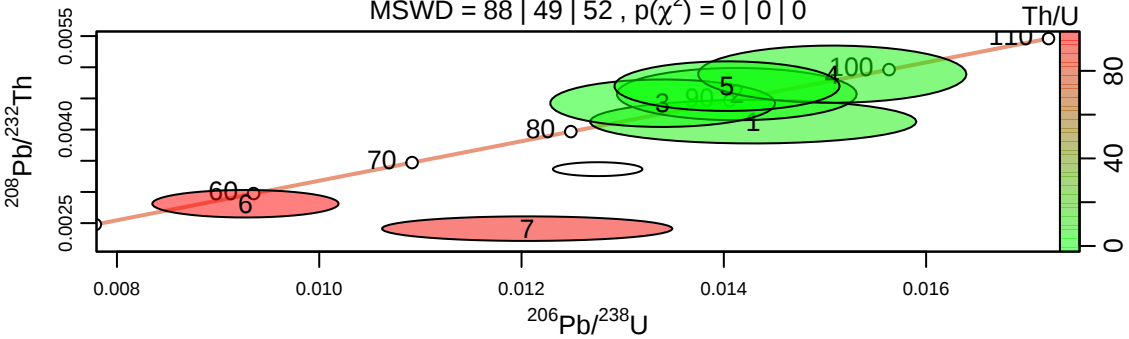


REOMU-229 – Monazite

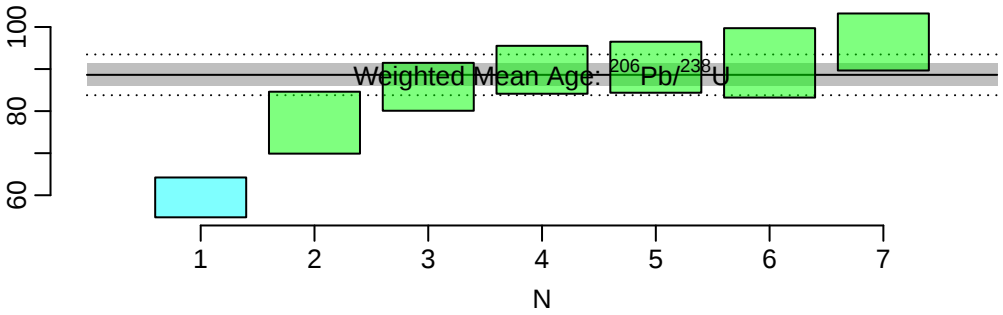
Tera-Wasserburg Concordia
concordia_age = 82.1 ± 2.2 | 8.4 Ma (n=7)
MSWD = 1.4 | 16 | 15 , $p(\chi^2) = 0.24$ | 0 | 0



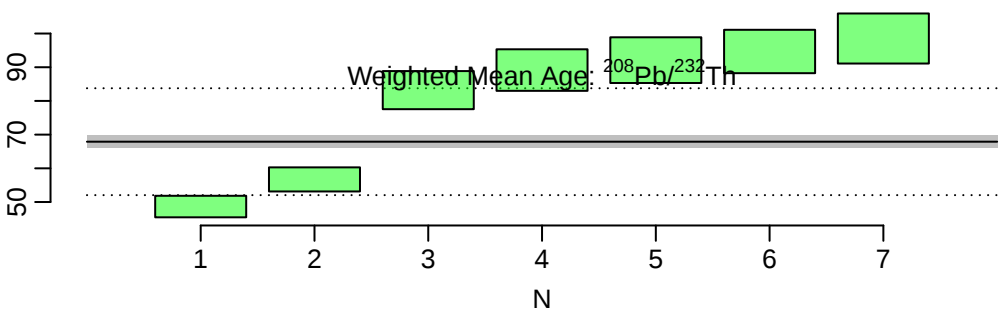
U-Th-Pb Concordia
concordia_age = 73.2 ± 1.4 | 10.3 Ma (n=7)
MSWD = 88 | 49 | 52 , $p(\chi^2) = 0$ | 0 | 0



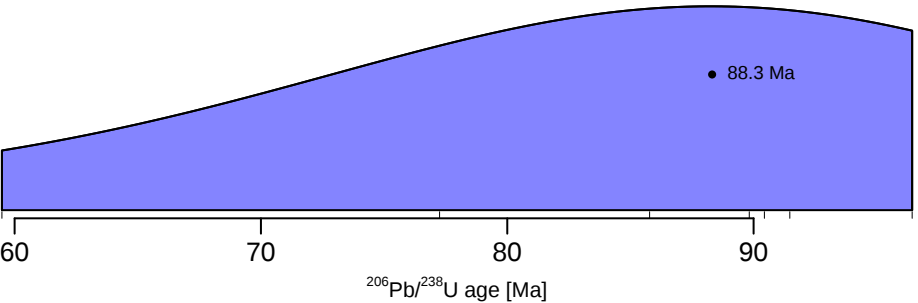
mean = 88.6 ± 2.6 | 4.8 Ma (6/7)
MSWD = 3.4 , $p(\chi^2) = 0.0047$



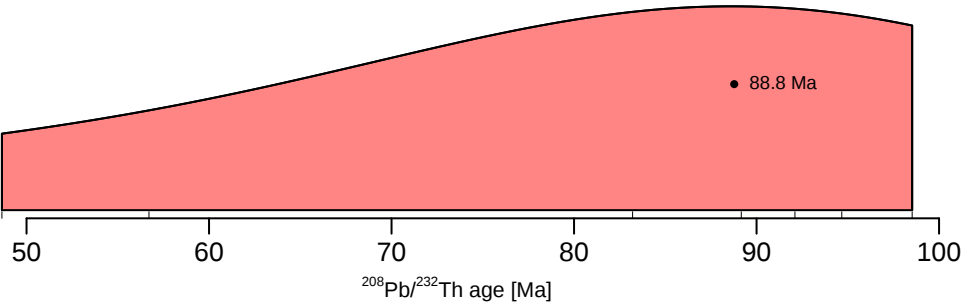
mean = 67.9 ± 1.8 | 15.9 Ma (7/7)
MSWD = 75 , $p(\chi^2) = 0$



KDE: $^{206}\text{Pb}/^{238}\text{U}$ age (n=7)

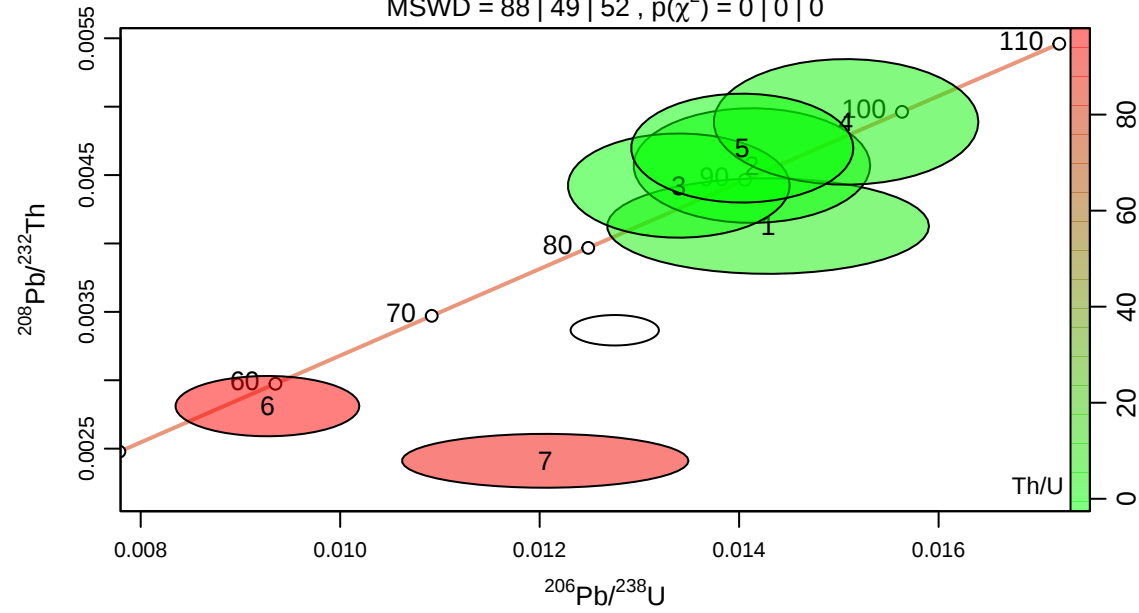


KDE: $^{208}\text{Pb}/^{232}\text{Th}$ age (n=7)

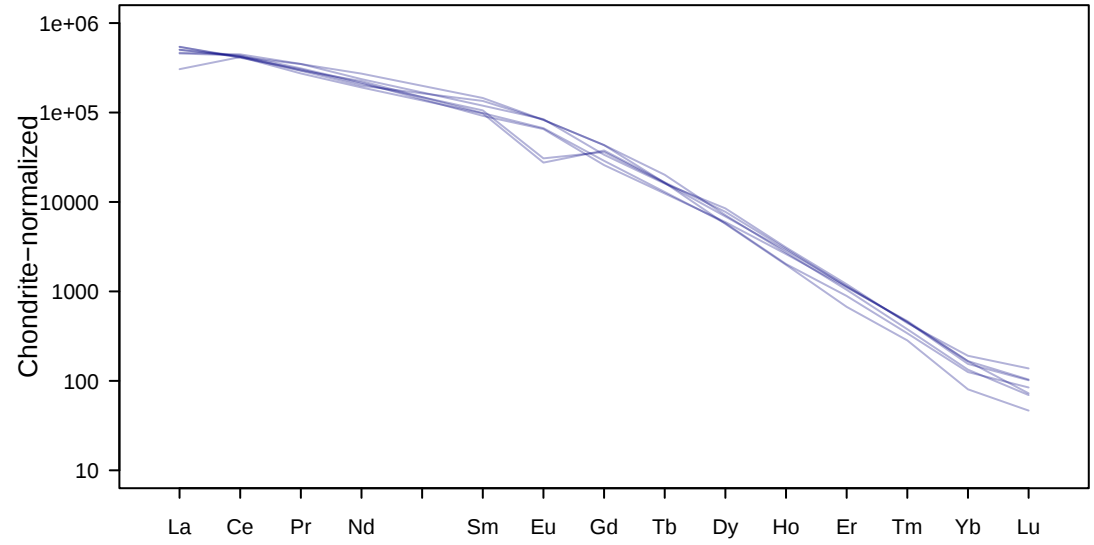


REOMU-229 – Monazite

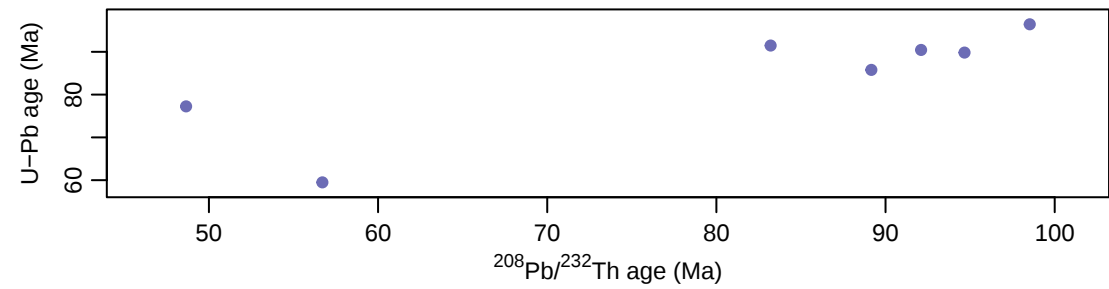
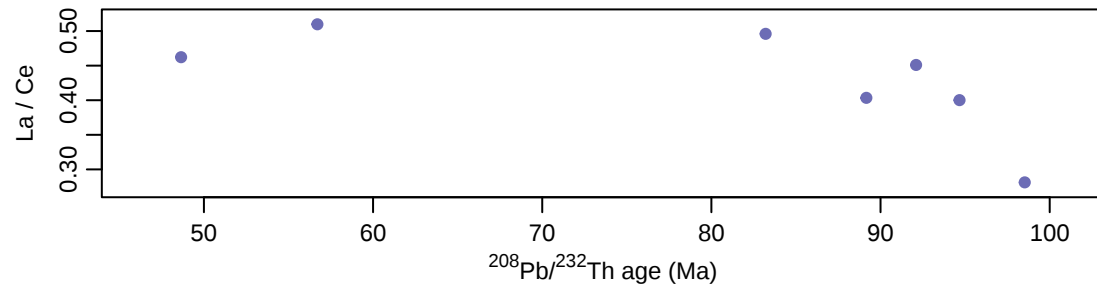
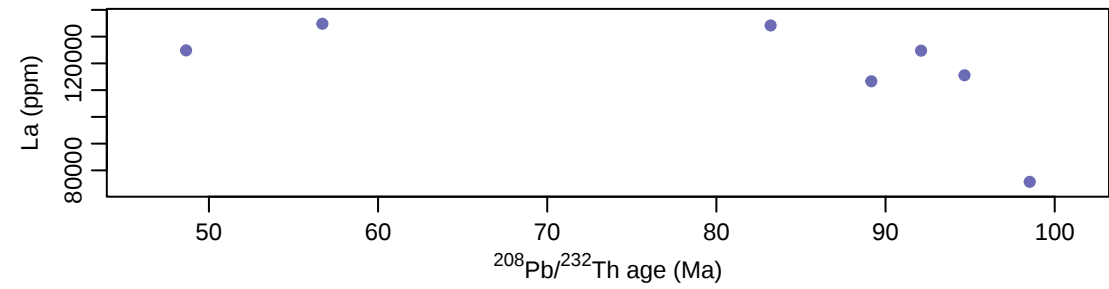
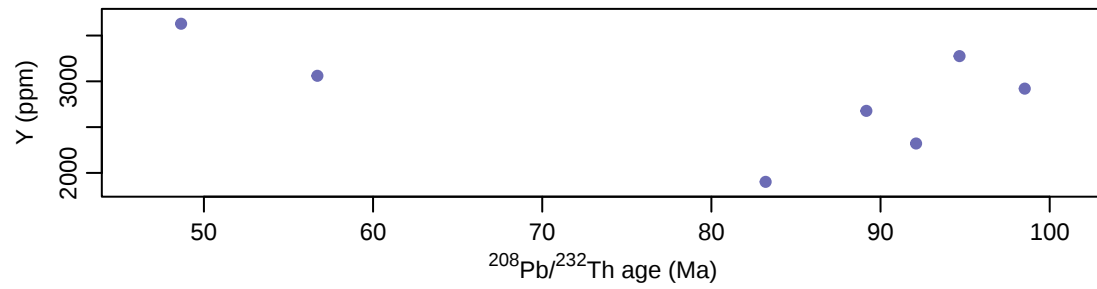
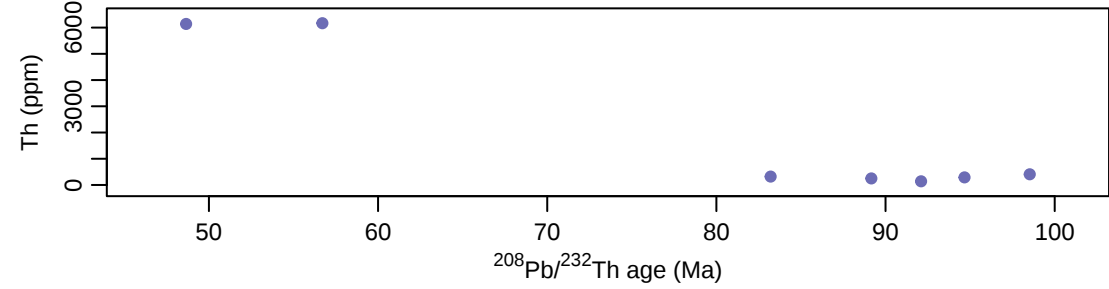
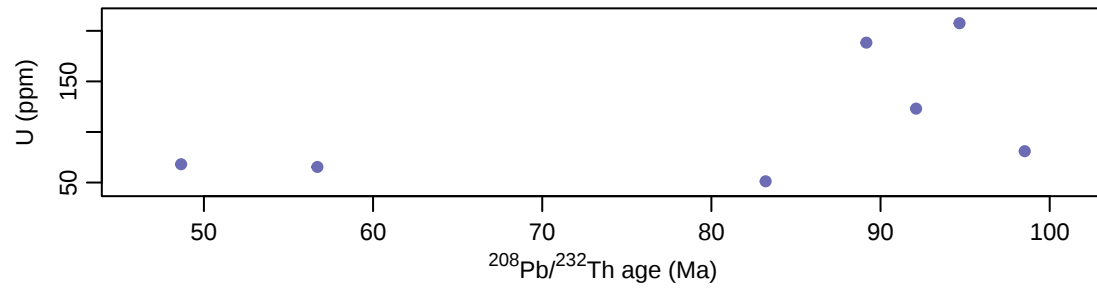
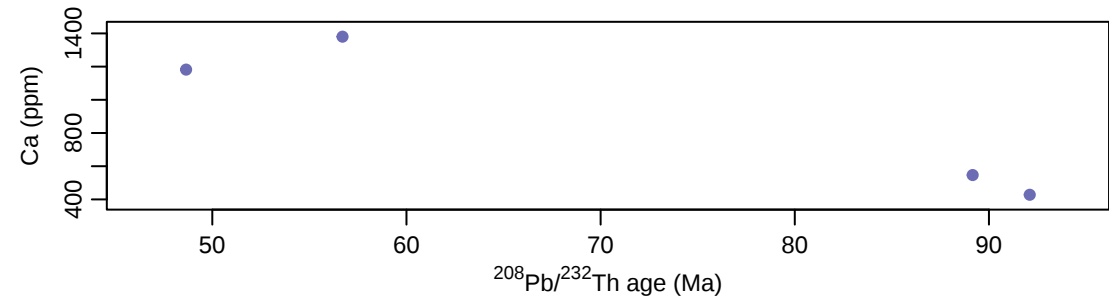
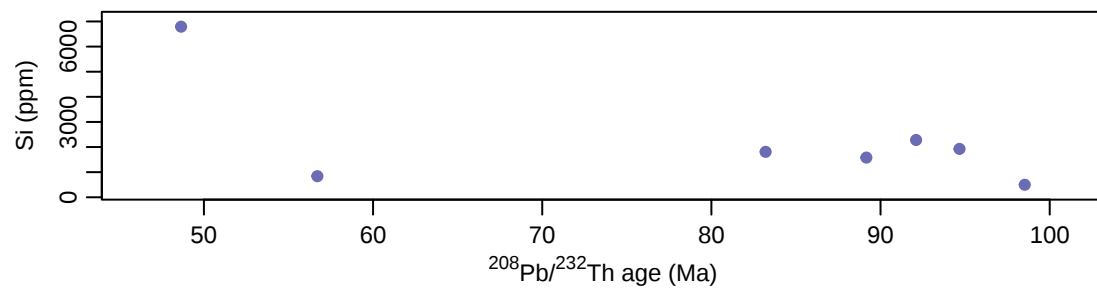
concordia_age = 73.2 ± 1.4 | 10.3 Ma (n=7)
MSWD = 88 | 49 | 52 , $p(\chi^2) = 0$ | 0 | 0



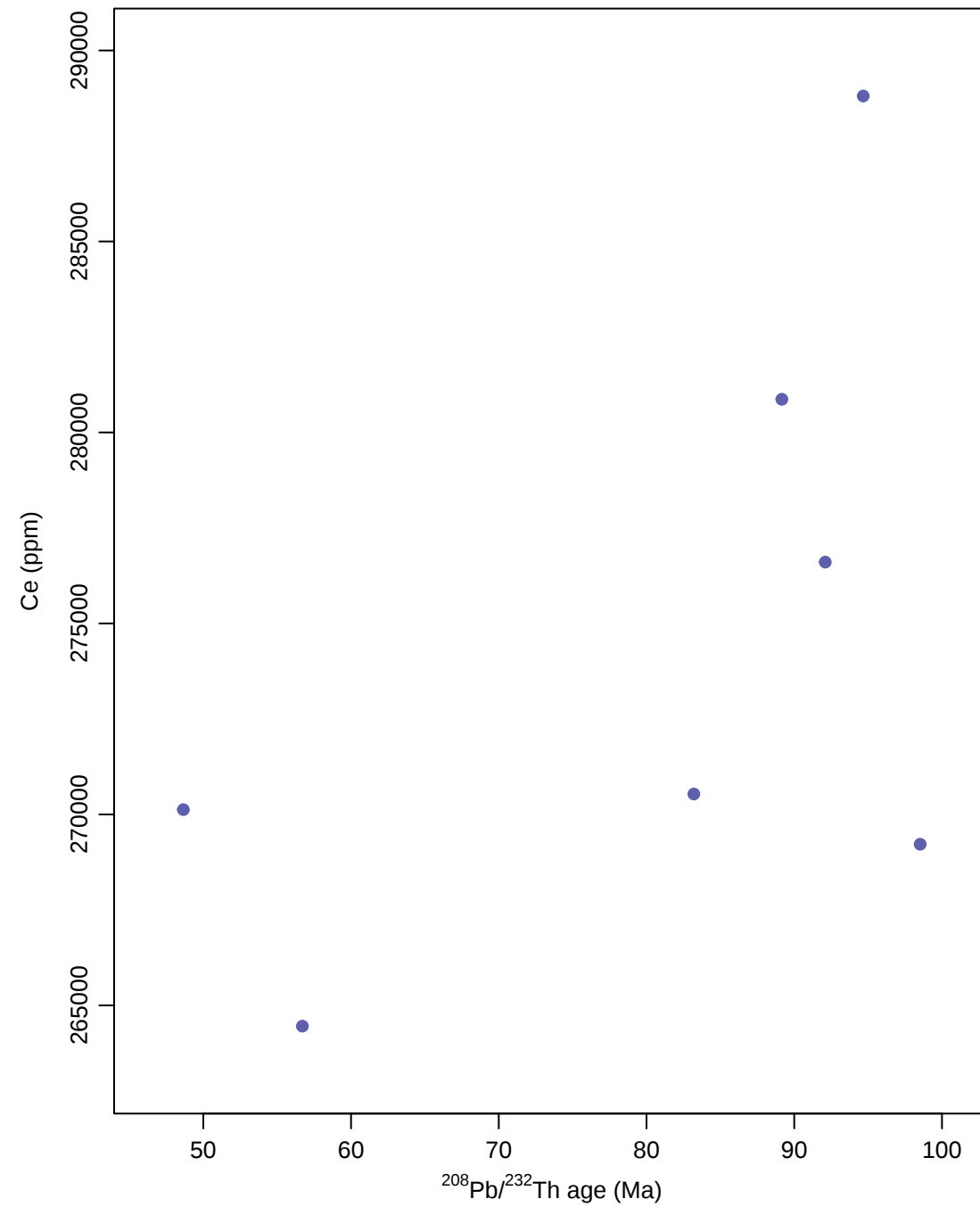
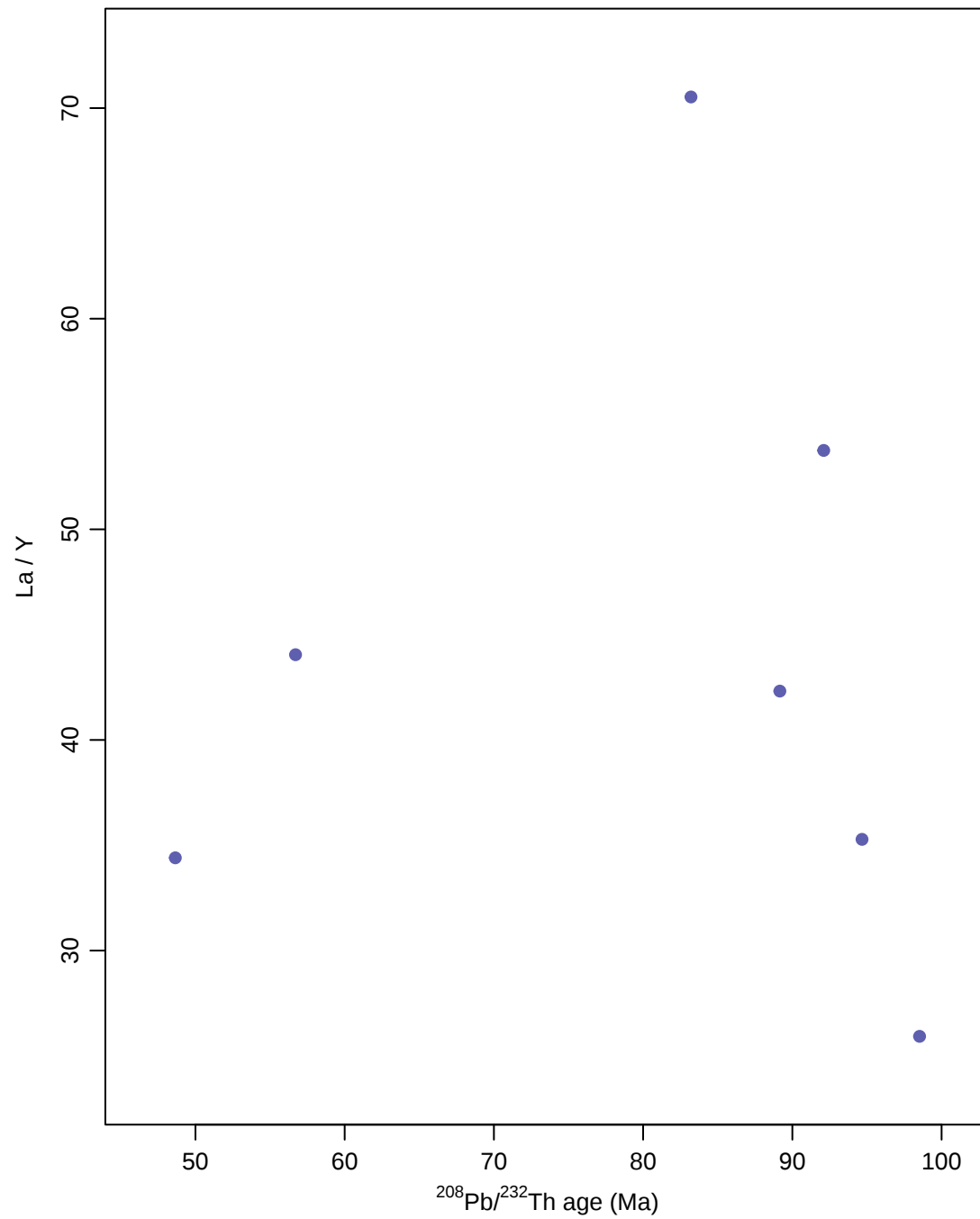
REE distribution



REOMU-229 – Monazite

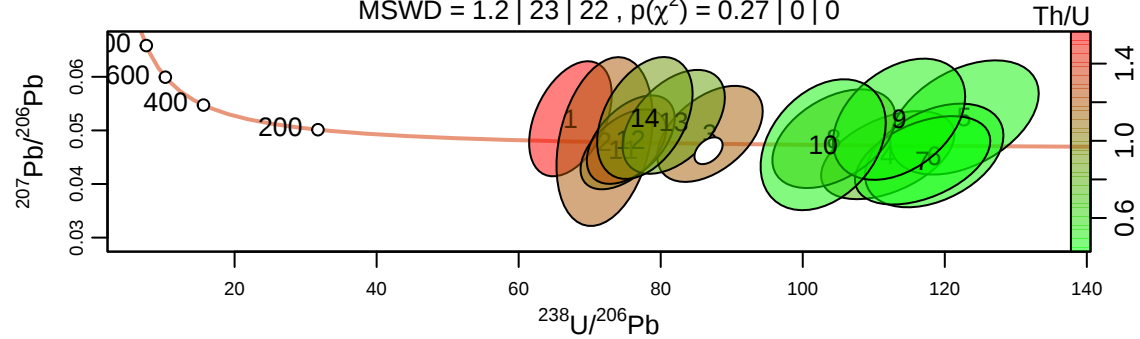


REOMU-229 – Monazite

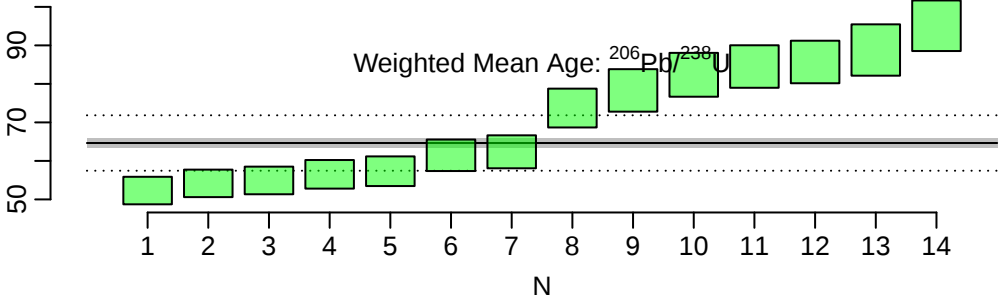


REOMU-229 – Xenotime

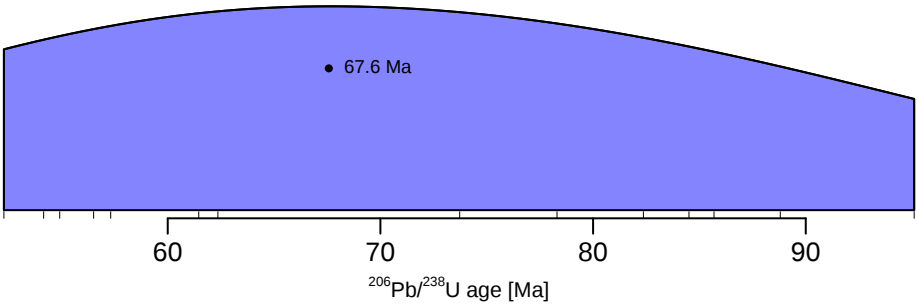
Tera-Wasserburg Concordia
concordia_age = 64.9 ± 1.1 | 5.1 Ma (n=14)
MSWD = 1.2 | 23 | 22, $p(\chi^2) = 0.27$ | 0 | 0



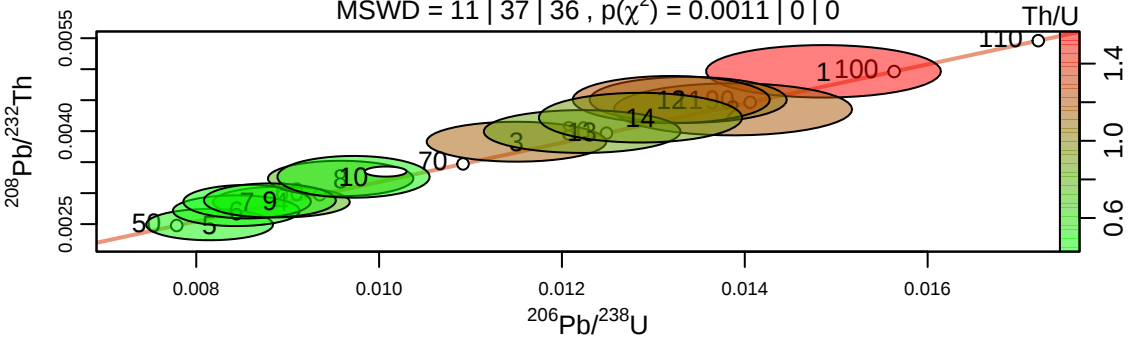
mean = 64.6 ± 1.2 | 7.2 Ma (14/14)
MSWD = 36, $p(\chi^2) = 0$



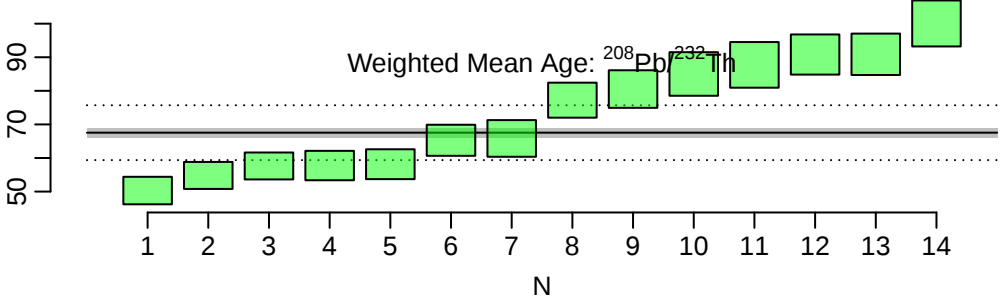
KDE: $^{206}\text{Pb}/^{238}\text{U}$ age (n=14)



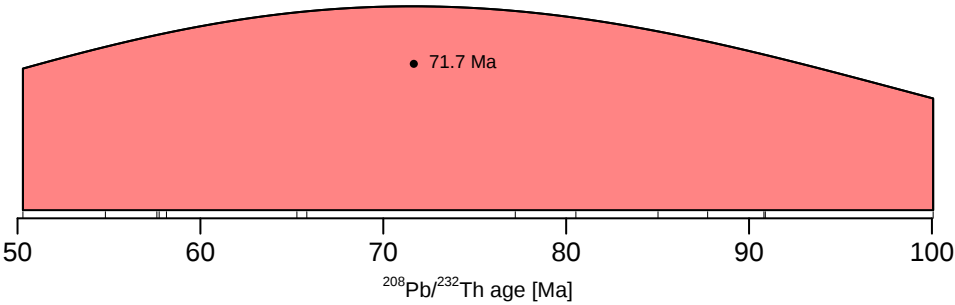
U-Th-Pb Concordia
concordia_age = 65.89 ± 0.89 | 5.33 Ma (n=14)
MSWD = 11 | 37 | 36, $p(\chi^2) = 0.0011$ | 0 | 0



mean = 67.5 ± 1.3 | 8.2 Ma (14/14)
MSWD = 37, $p(\chi^2) = 0$

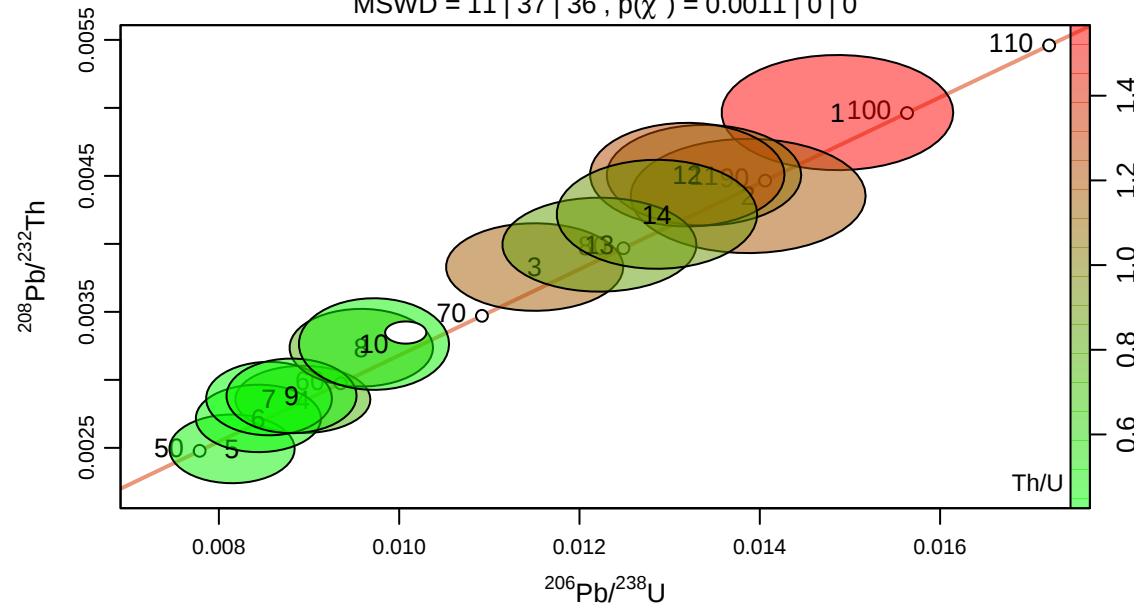


KDE: $^{208}\text{Pb}/^{232}\text{Th}$ age (n=14)

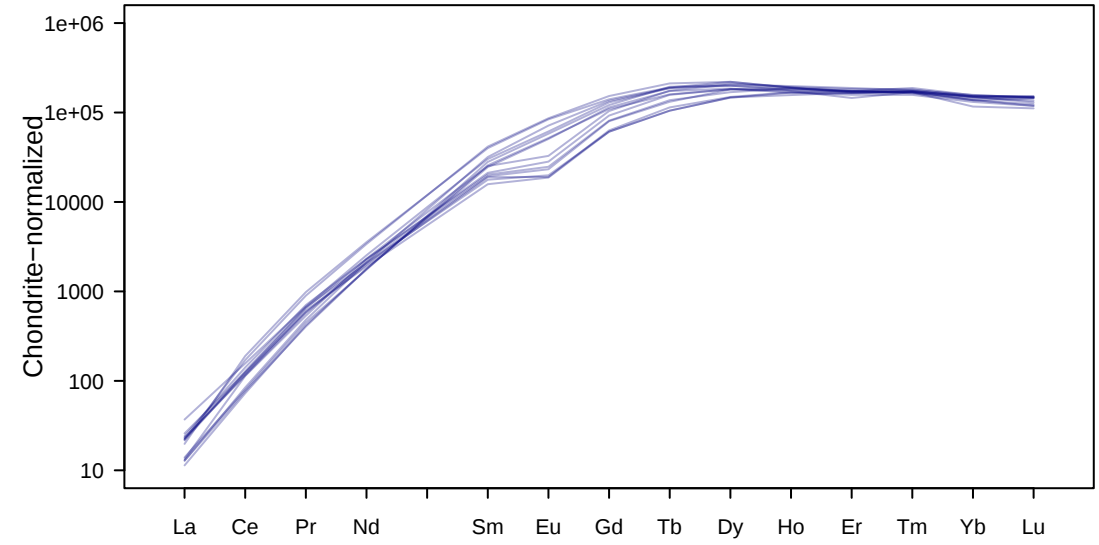


REOMU-229 – Xenotime

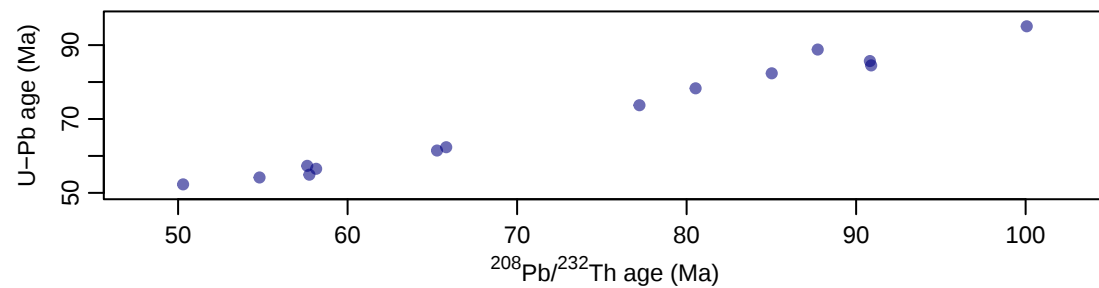
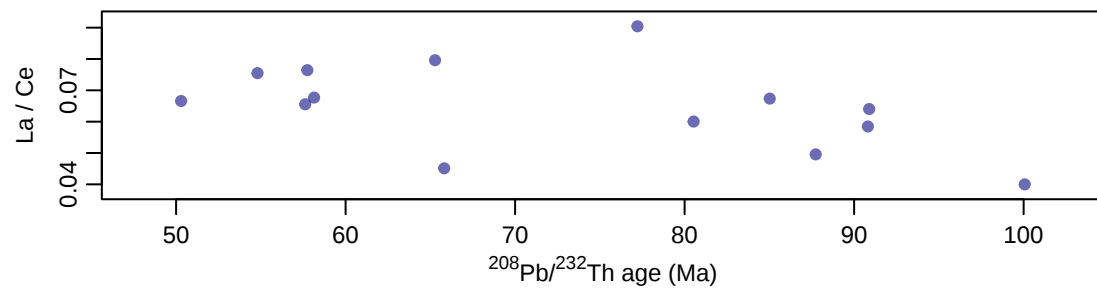
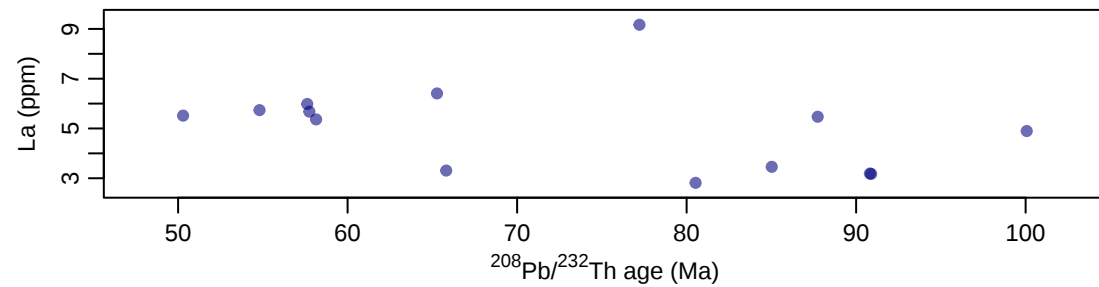
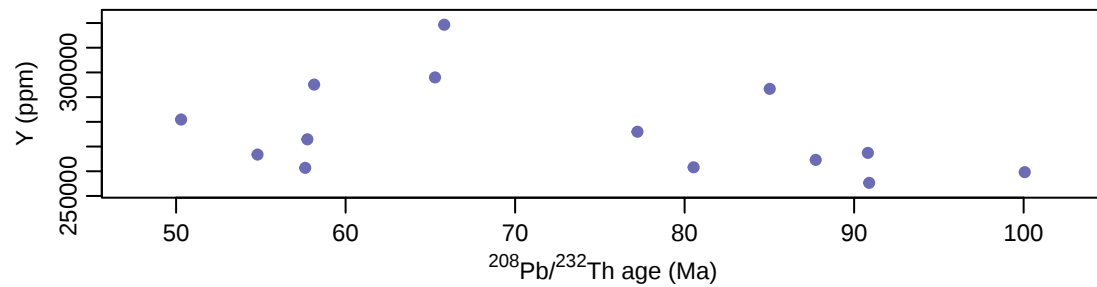
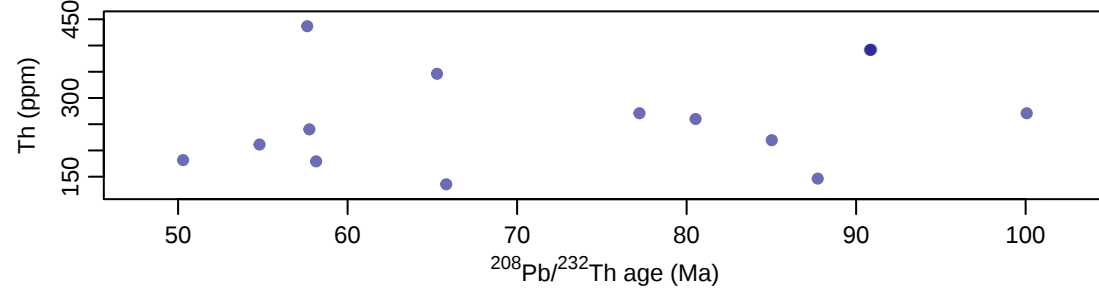
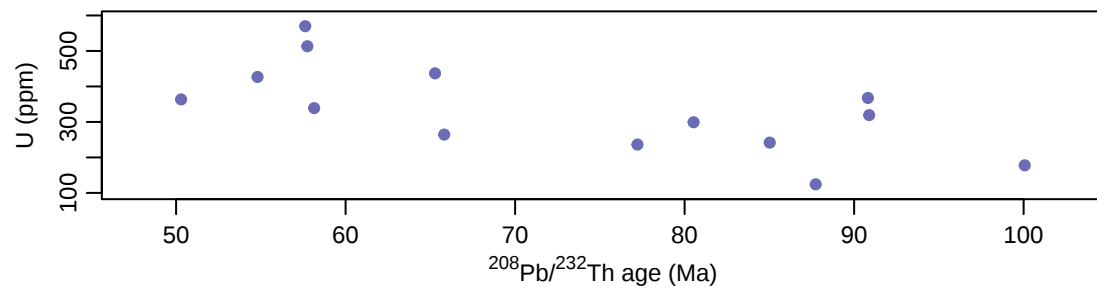
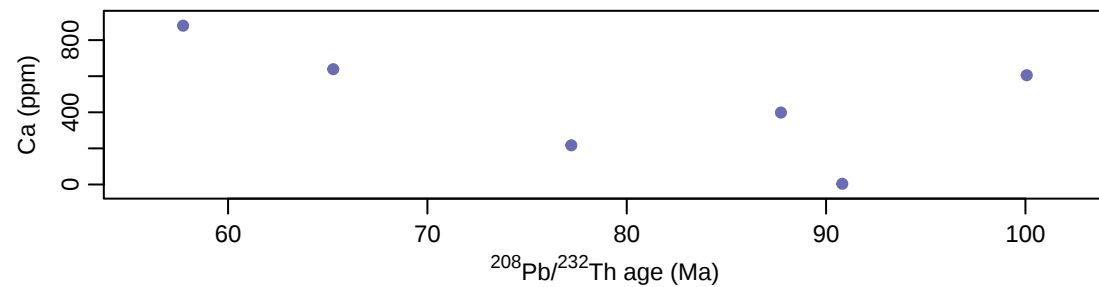
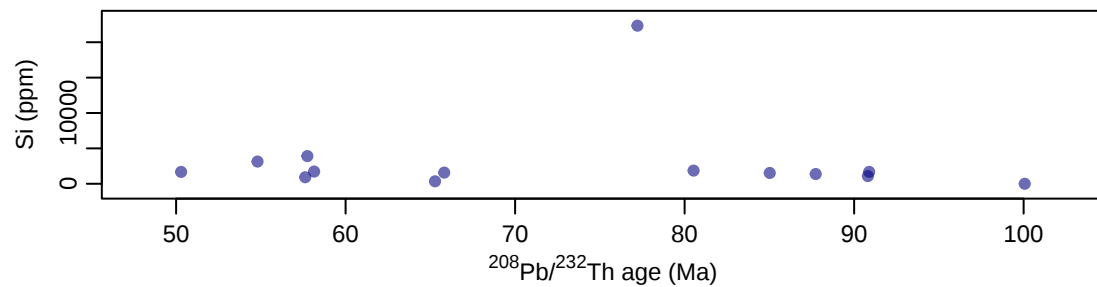
concordia_age = 65.89 ± 0.89 | 5.33 Ma (n=14)
 MSWD = 11 | 37 | 36 , $p(\chi^2) = 0.0011$ | 0 | 0



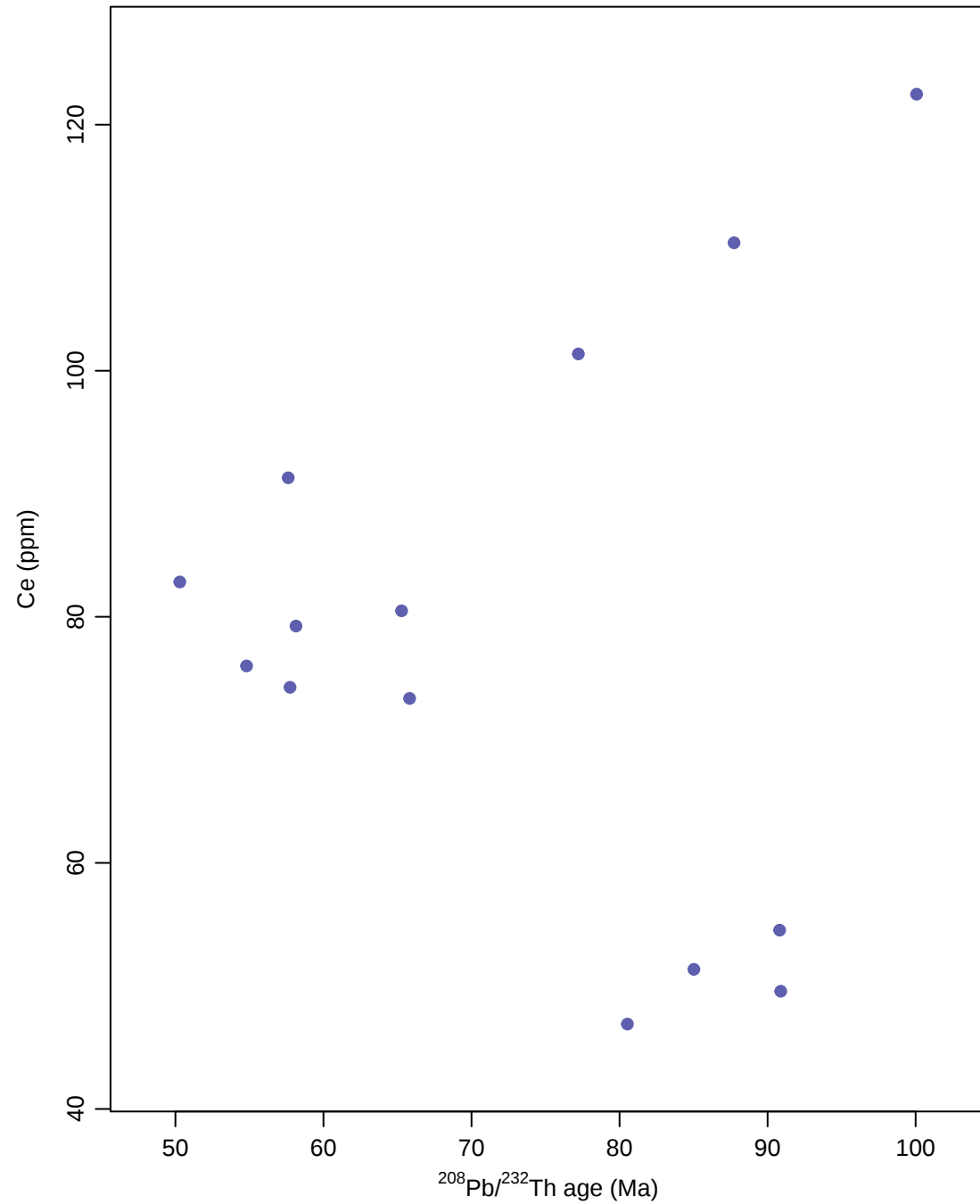
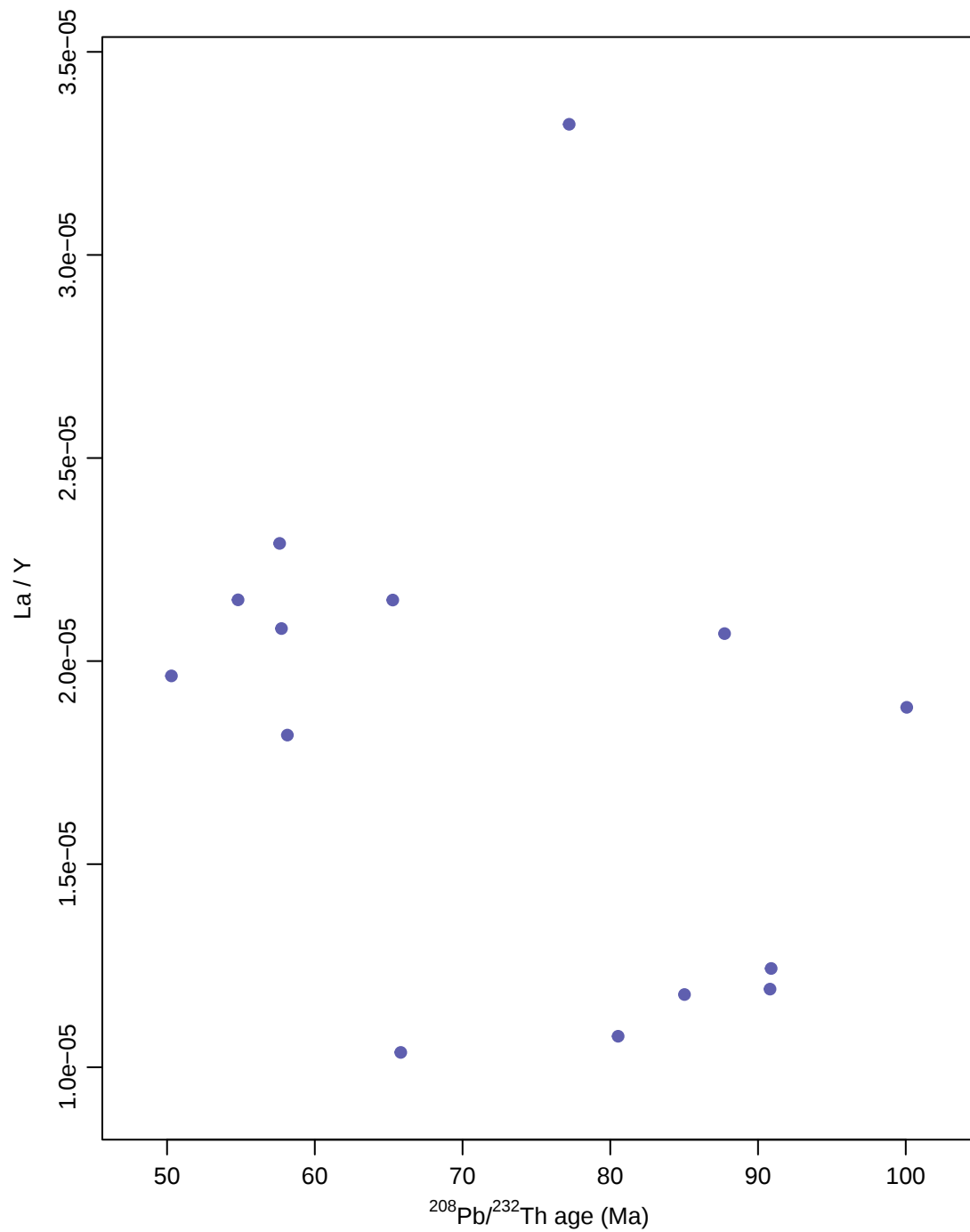
REE distribution



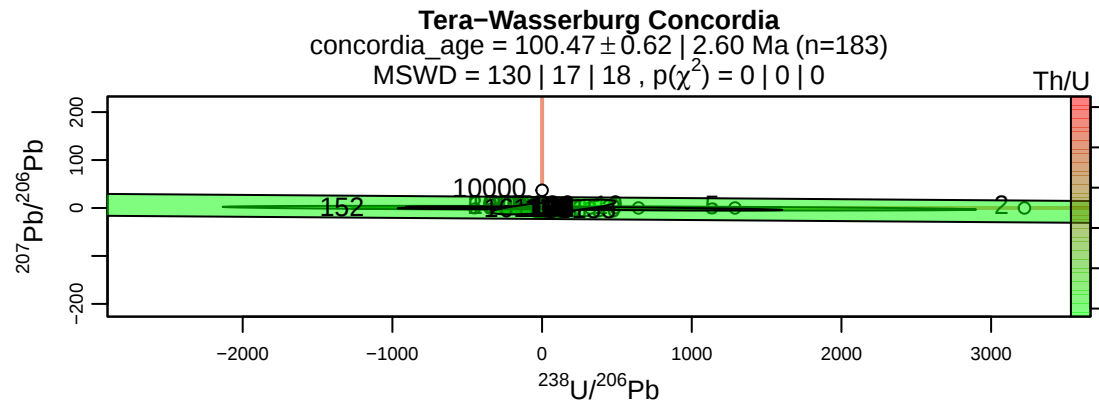
REOMU-229 - Xenotime



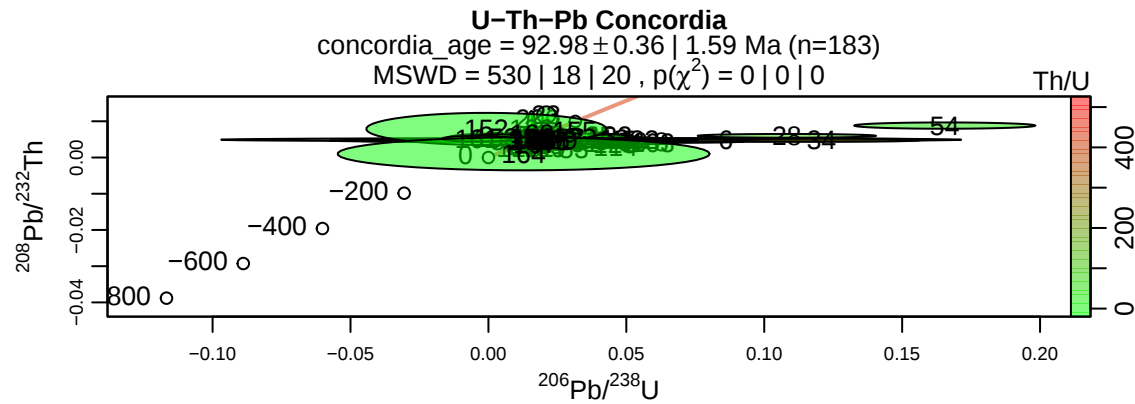
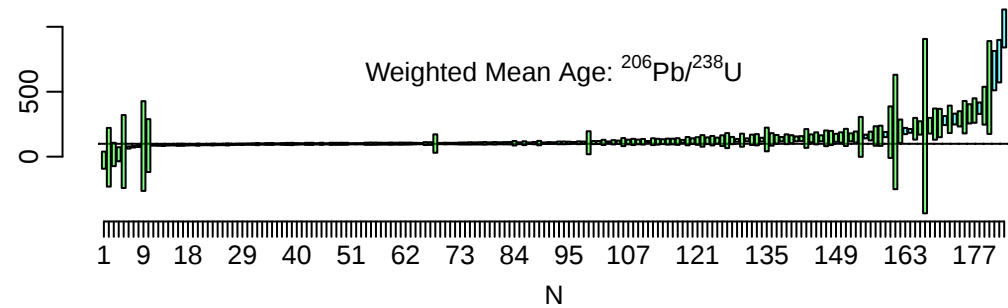
REOMU-229 – Xenotime



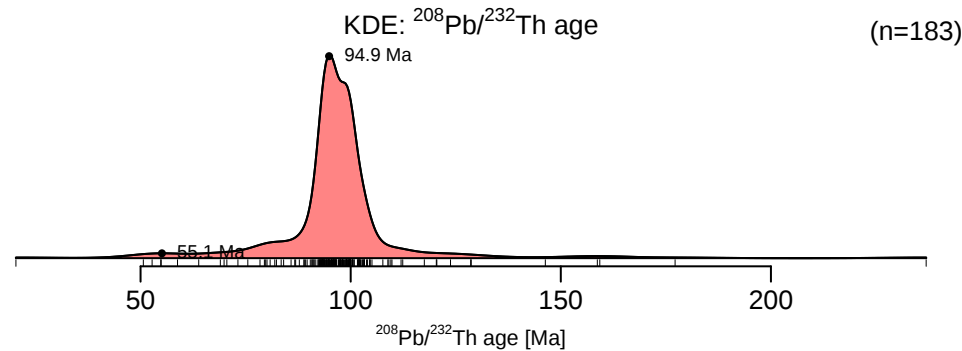
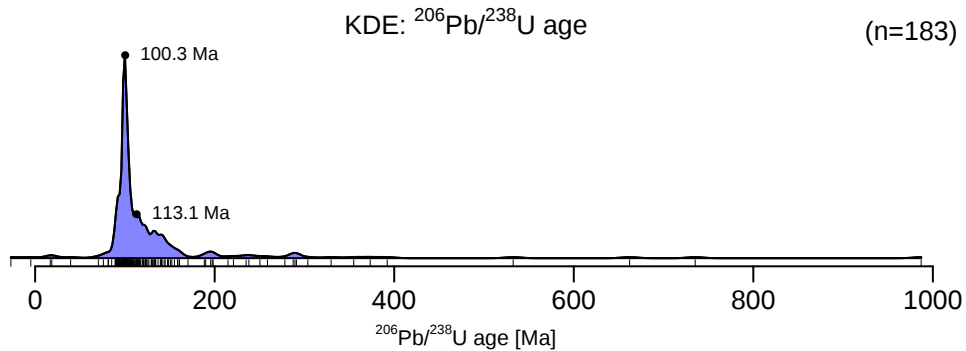
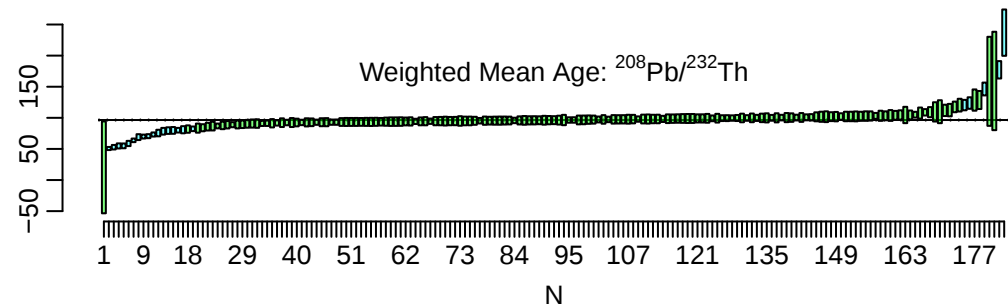
REOMU-LV-242 – Monazite



mean = 98.94 ± 0.66 | 1.47 Ma (172/183)
MSWD = 4.9, $p(\chi^2) = 0$

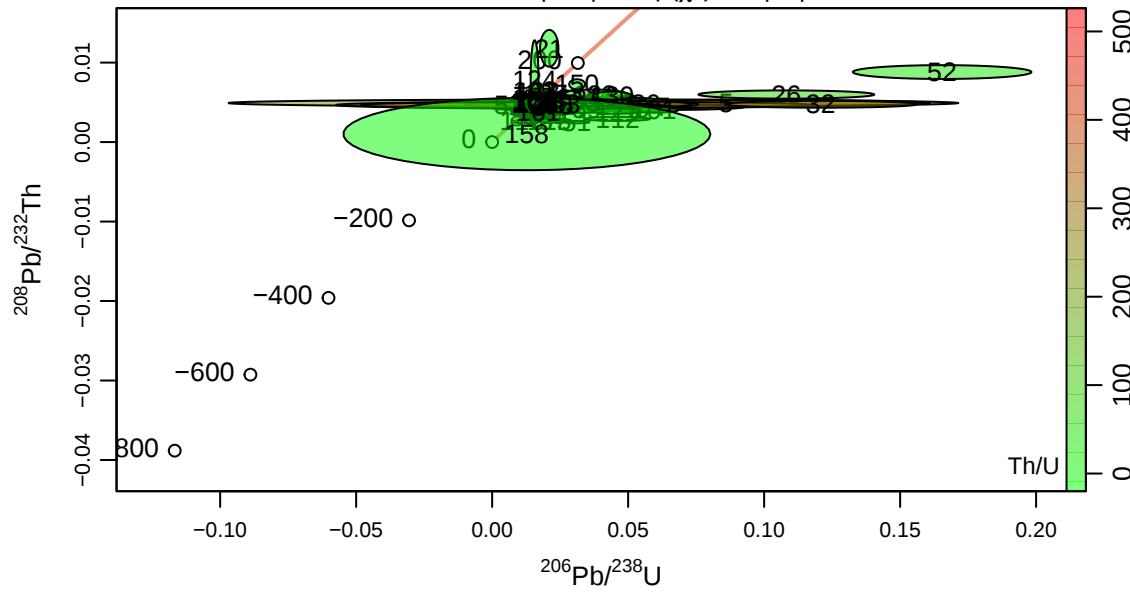


mean = 96.48 ± 0.48 | 0.84 Ma (161/183)
MSWD = 3, $p(\chi^2) = 0$

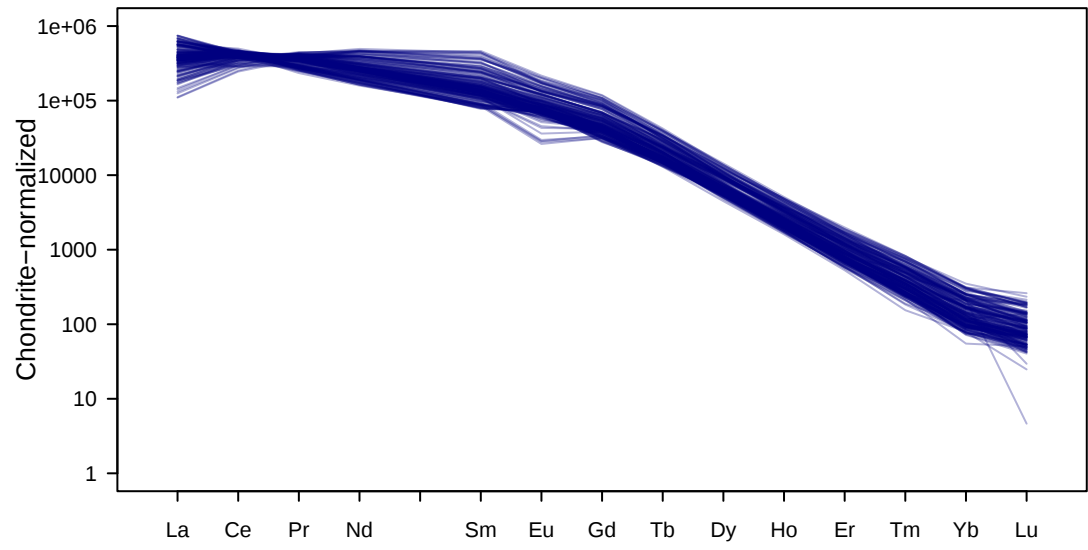


REOMU-LV-242 – Monazite

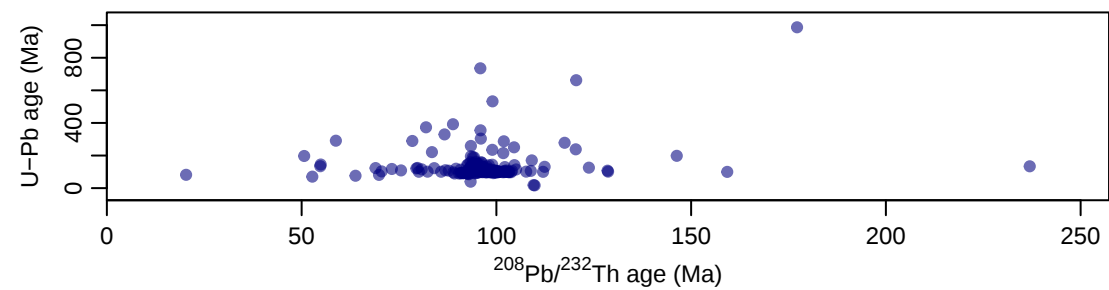
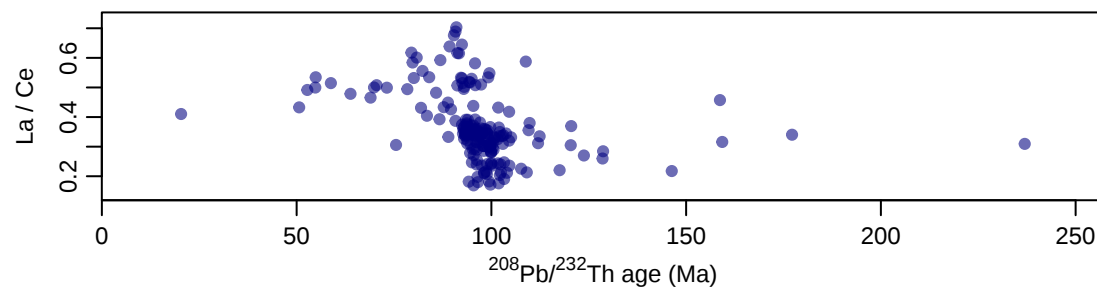
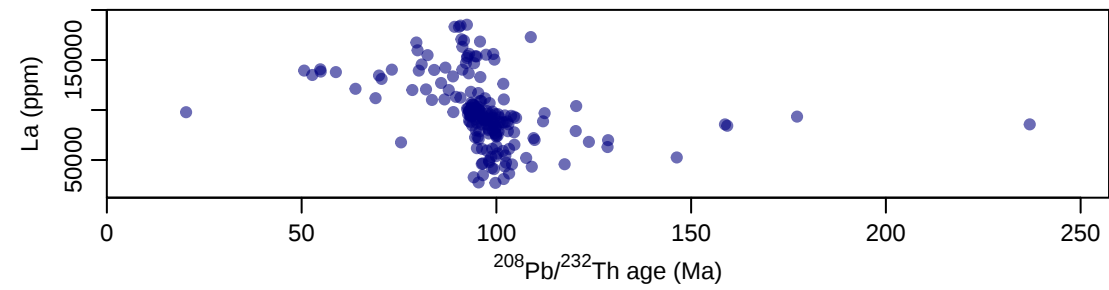
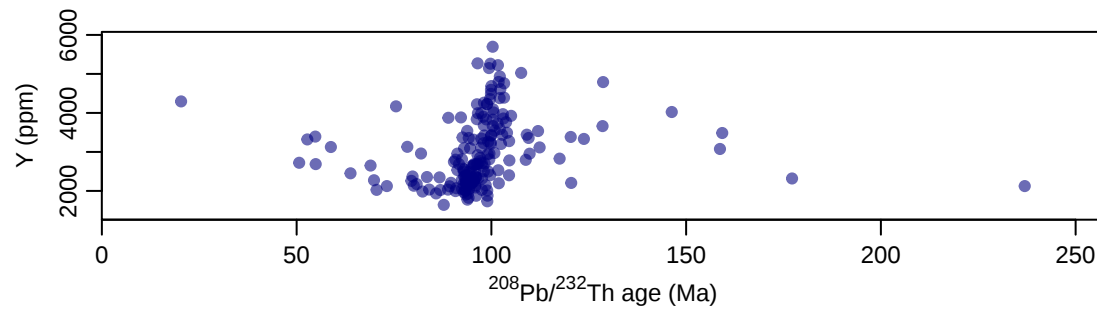
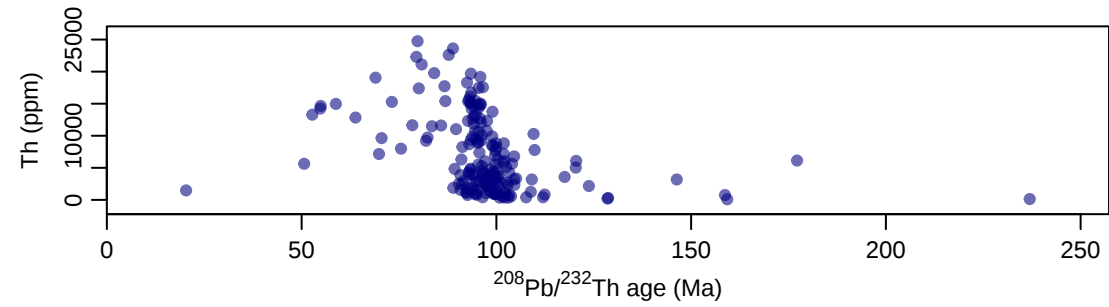
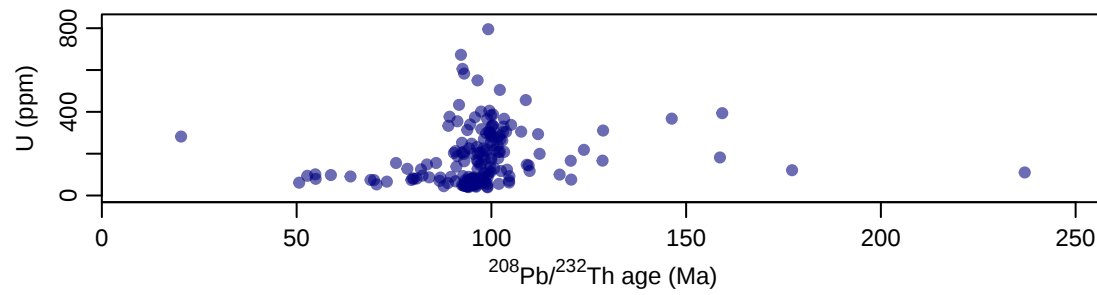
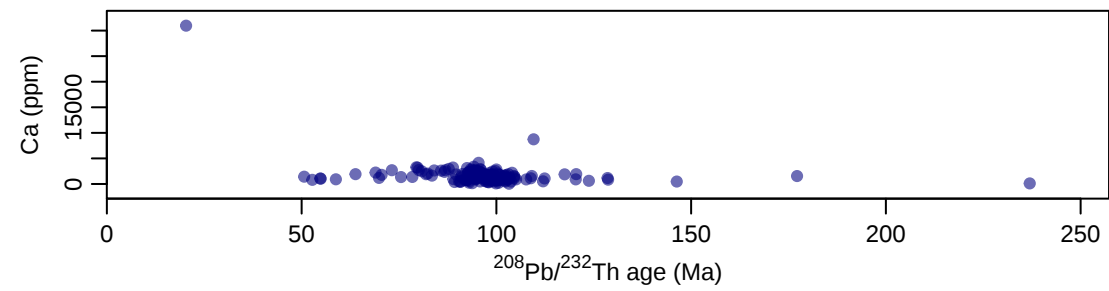
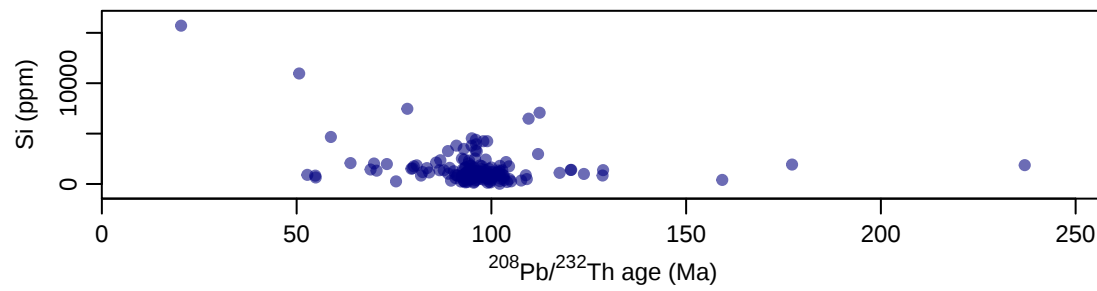
concordia_age = 92.96 ± 0.36 | 1.61 Ma (n=177)
MSWD = 530 | 19 | 20, $p(\chi^2) = 0$ | 0 | 0



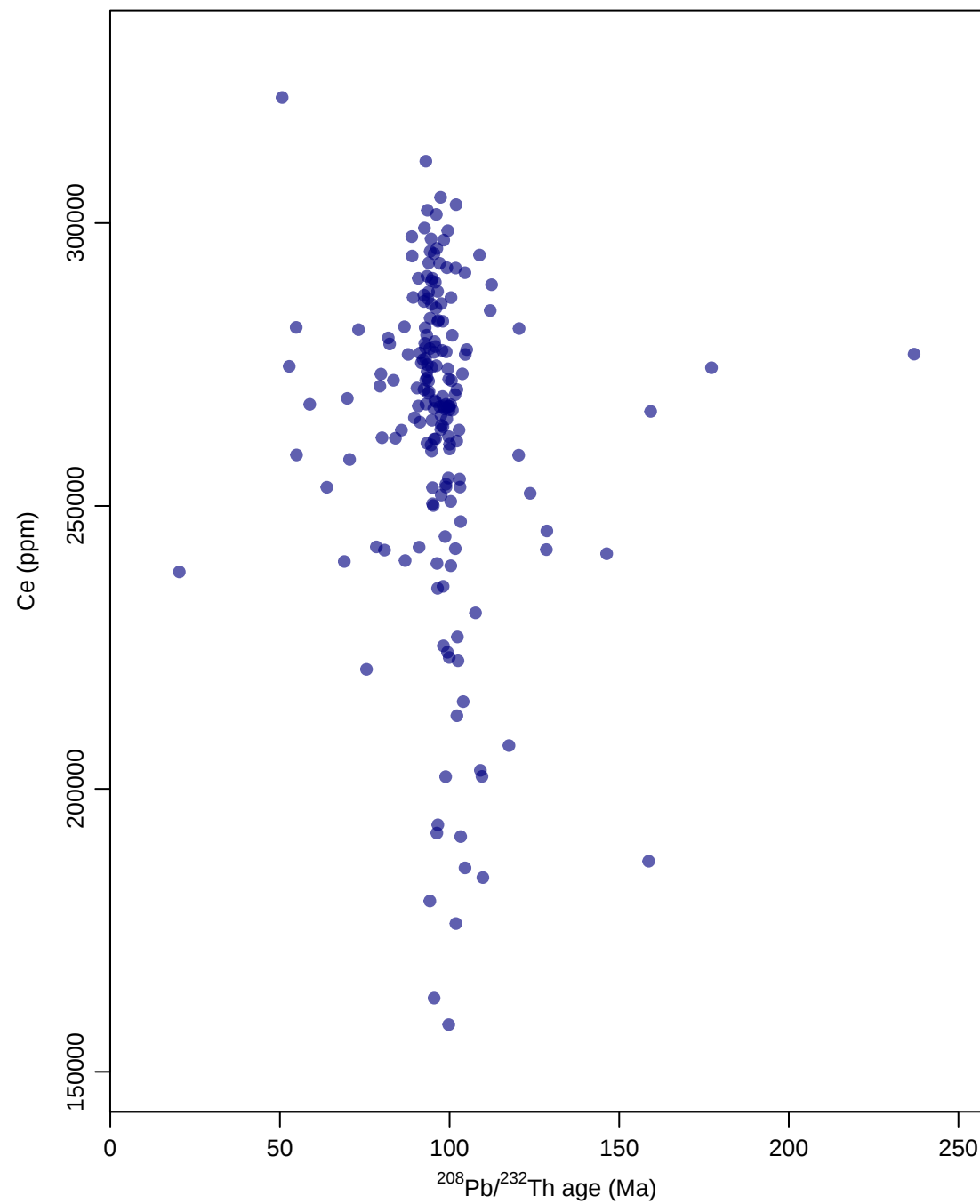
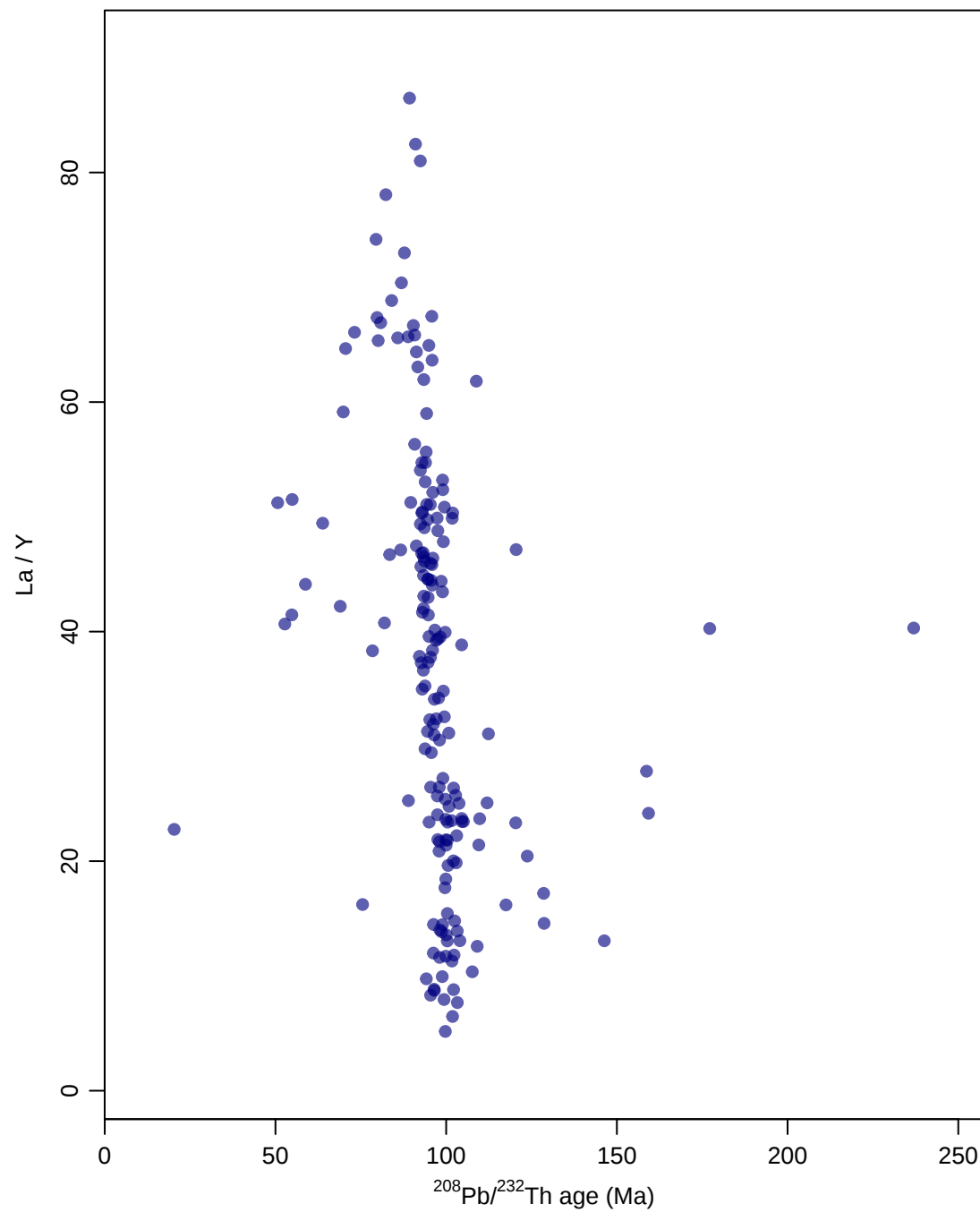
REE distribution



REOMU-LV-242 – Monazite

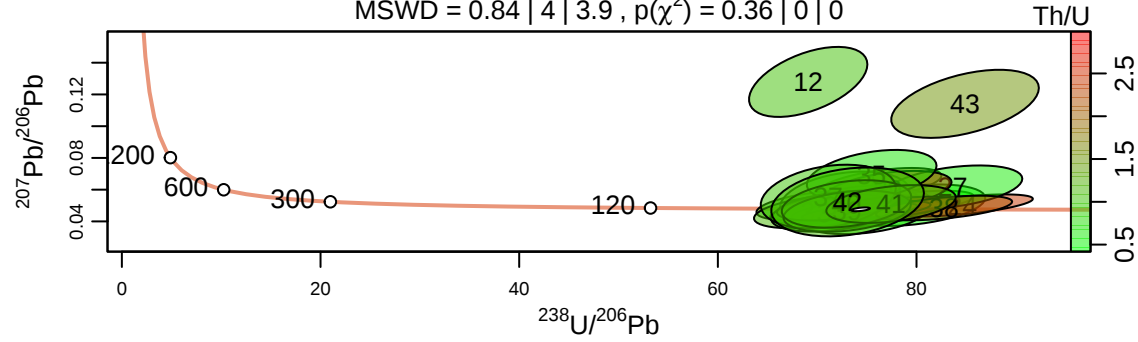


REOMU-LV-242 - Monazite

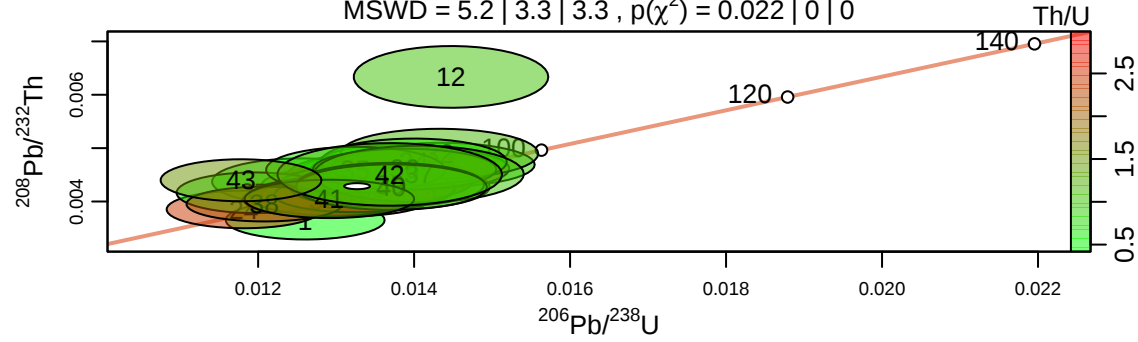


REOPAU-068A – Xenotime

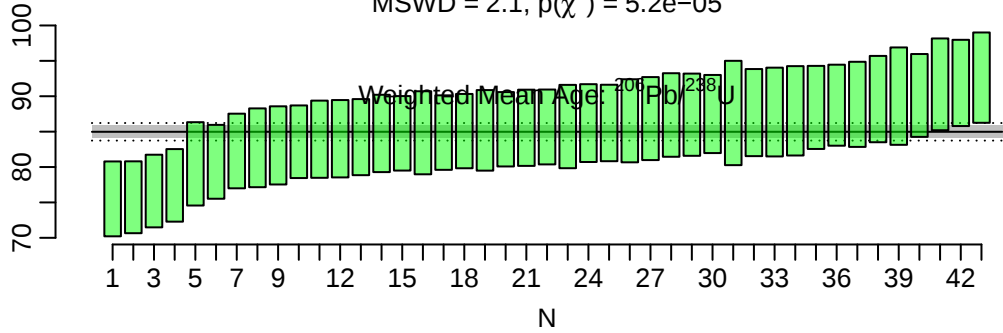
Tera-Wasserburg Concordia
concordia_age = 85.18 ± 0.74 | 1.47 Ma (n=43)
MSWD = 0.84 | 4 | 3.9, $p(\chi^2) = 0.36$ | 0 | 0



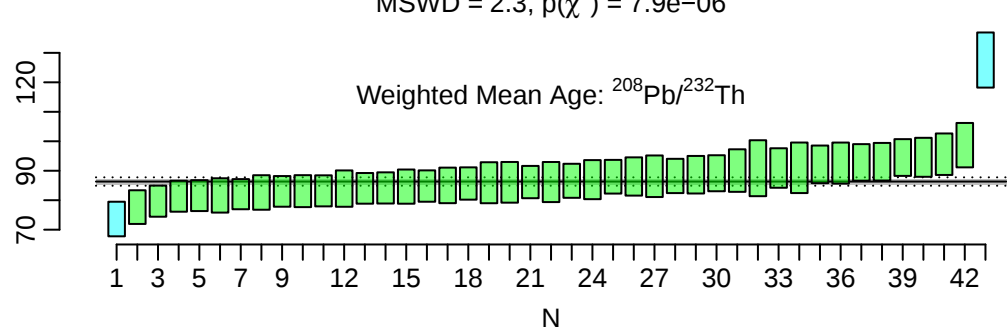
U-Th-Pb Concordia
concordia_age = 85.64 ± 0.63 | 1.15 Ma (n=43)
MSWD = 5.2 | 3.3 | 3.3, $p(\chi^2) = 0.022$ | 0 | 0



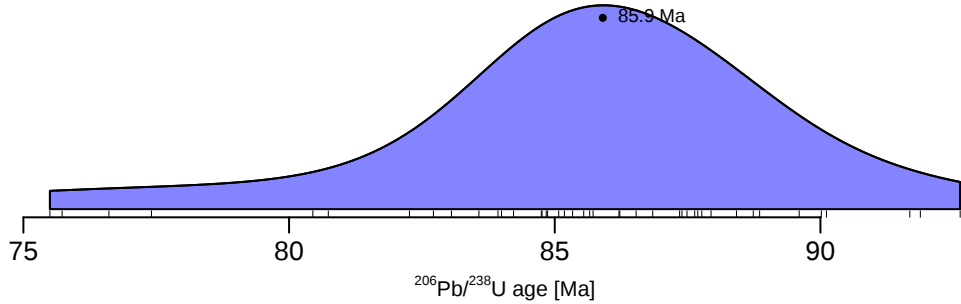
mean = 84.98 ± 0.86 | 1.24 Ma (43/43)
MSWD = 2.1, $p(\chi^2) = 5.2\text{e-}05$



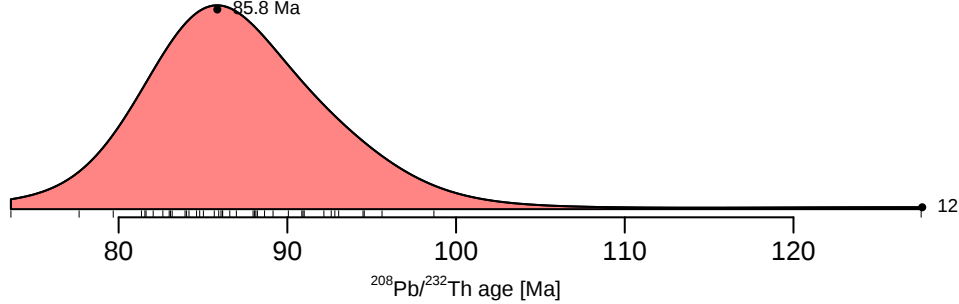
mean = 86.34 ± 0.94 | 1.42 Ma (41/43)
MSWD = 2.3, $p(\chi^2) = 7.9\text{e-}06$



KDE: $^{206}\text{Pb}/^{238}\text{U}$ age (n=43)

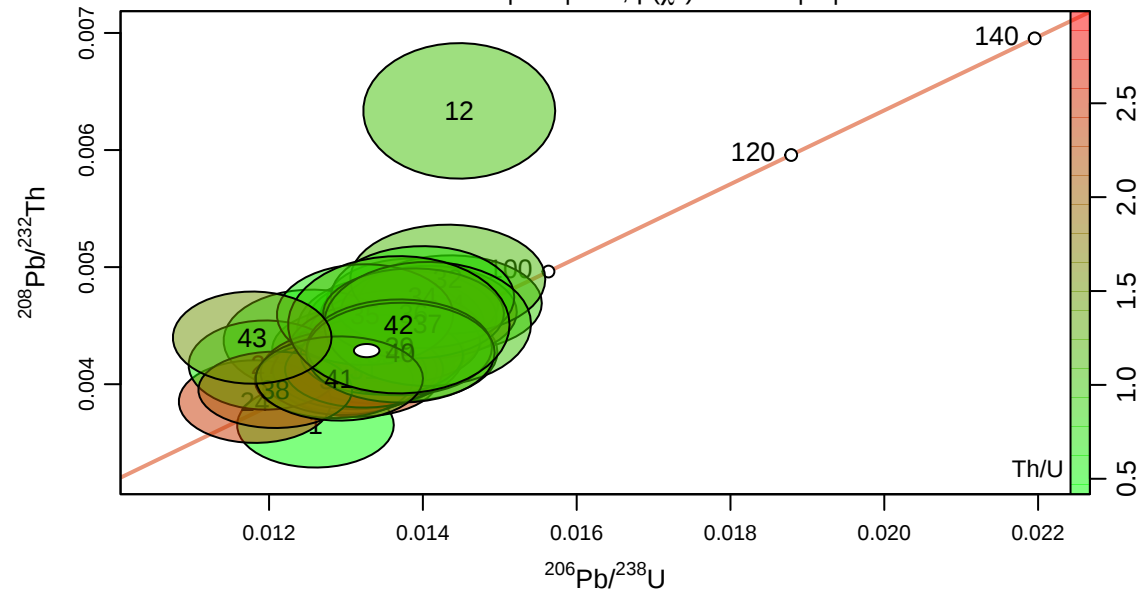


KDE: $^{208}\text{Pb}/^{232}\text{Th}$ age (n=43)

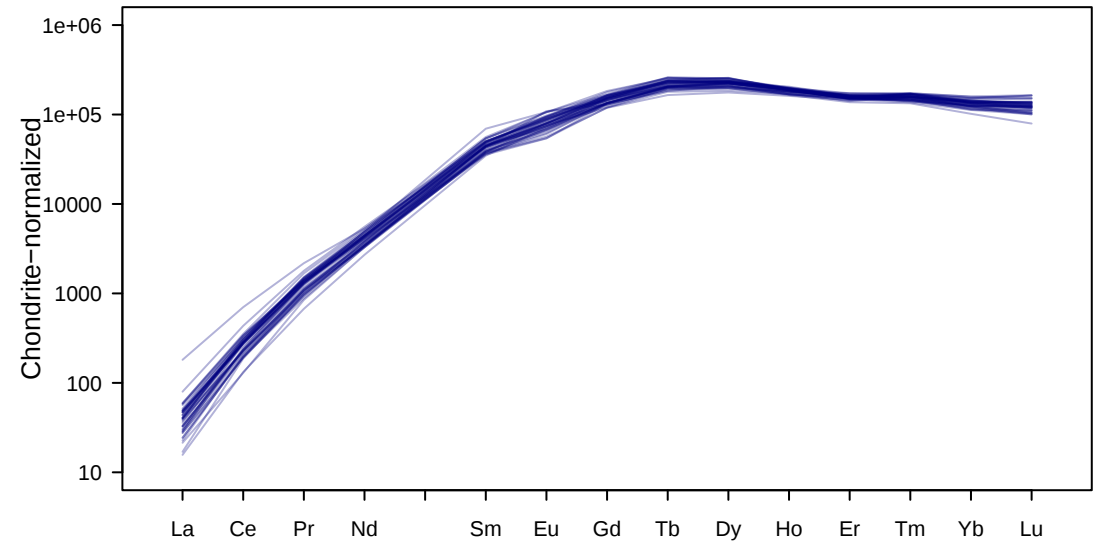


REOPAU-068A – Xenotime

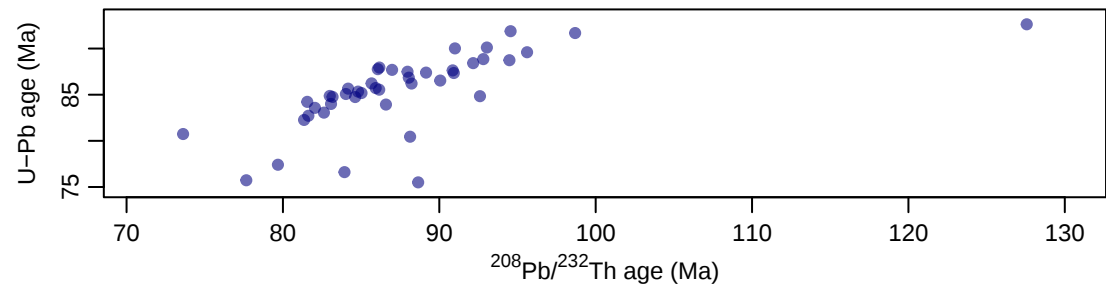
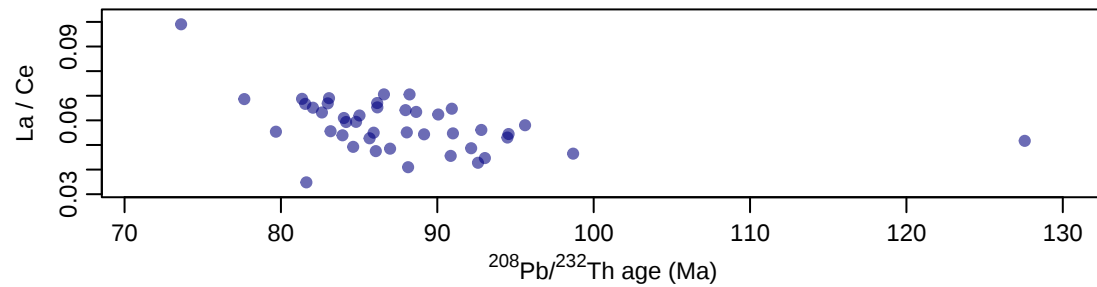
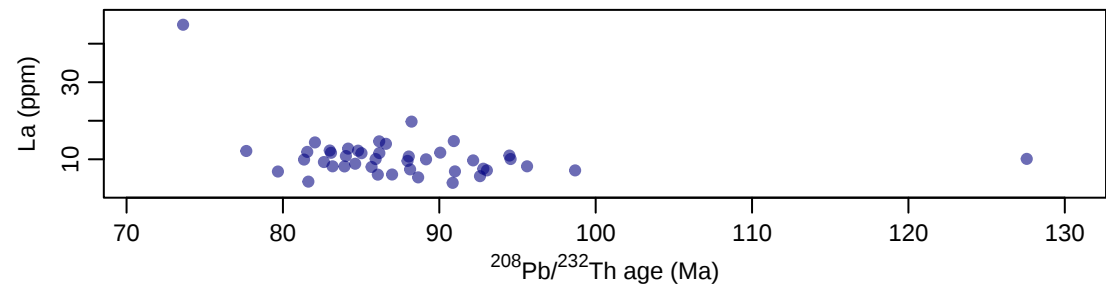
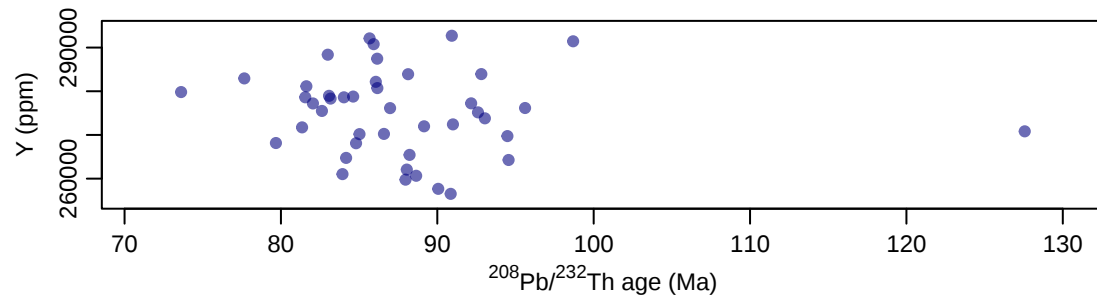
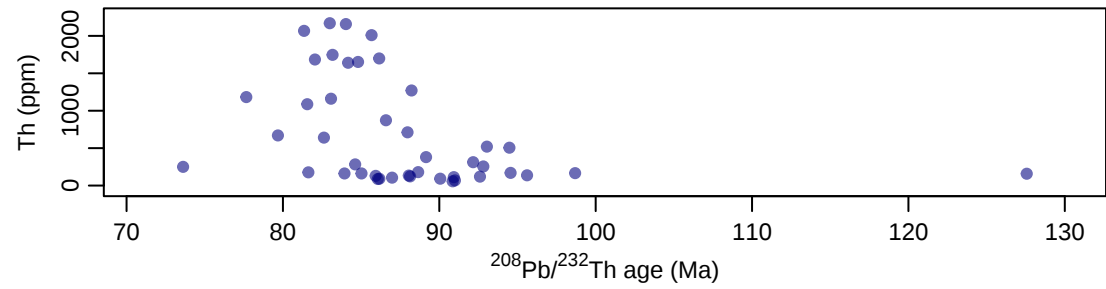
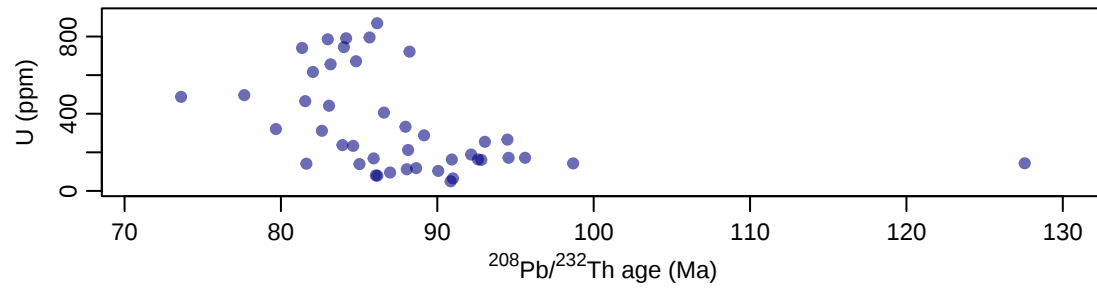
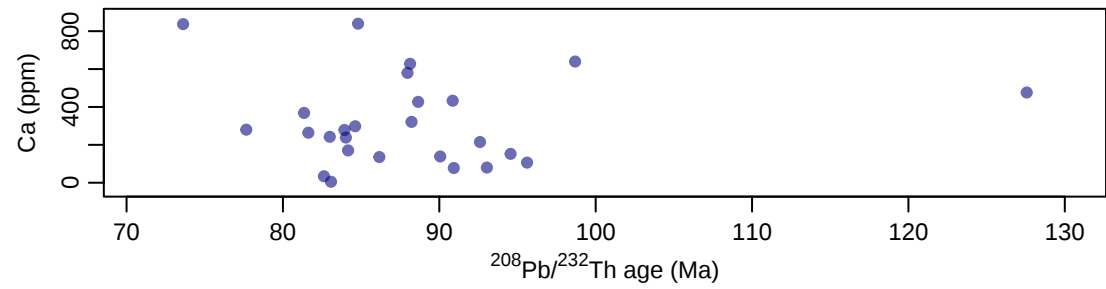
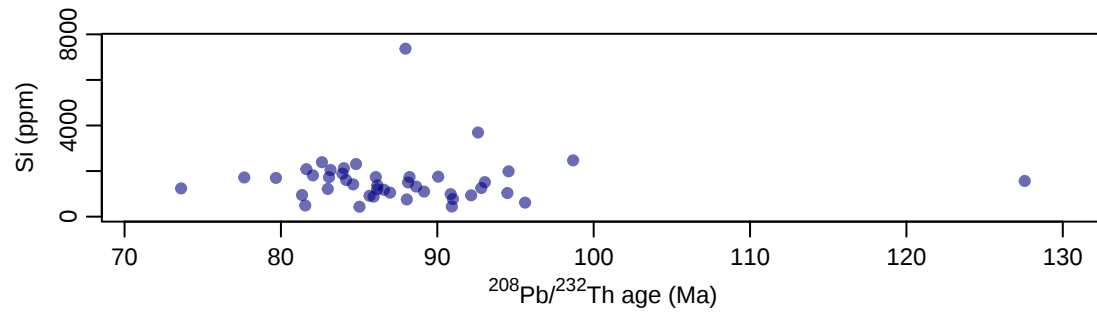
concordia_age = 85.64 ± 0.63 | 1.15 Ma (n=43)
 MSWD = 5.2 | 3.3 | 3.3, $p(\chi^2)$ = 0.022 | 0 | 0



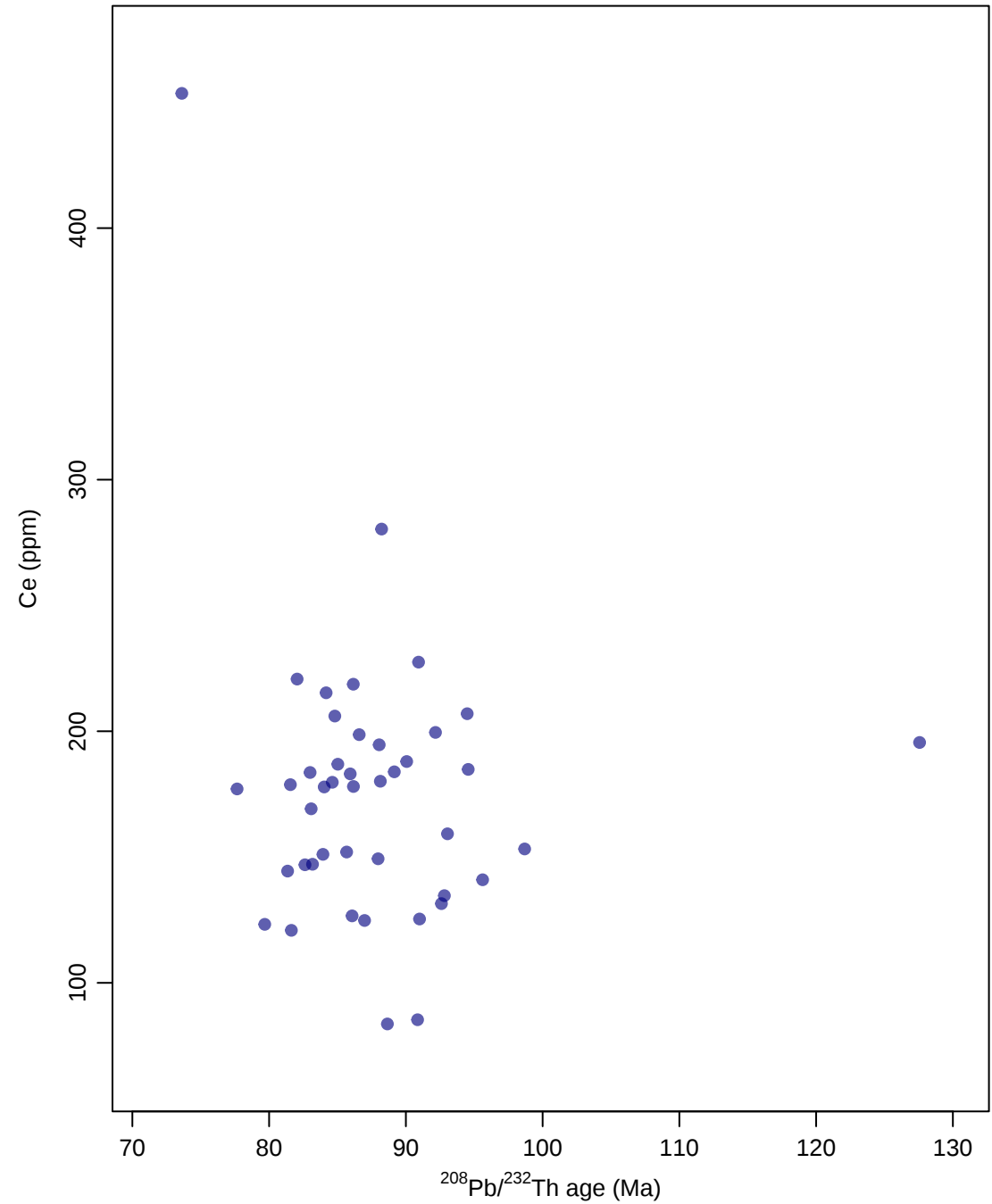
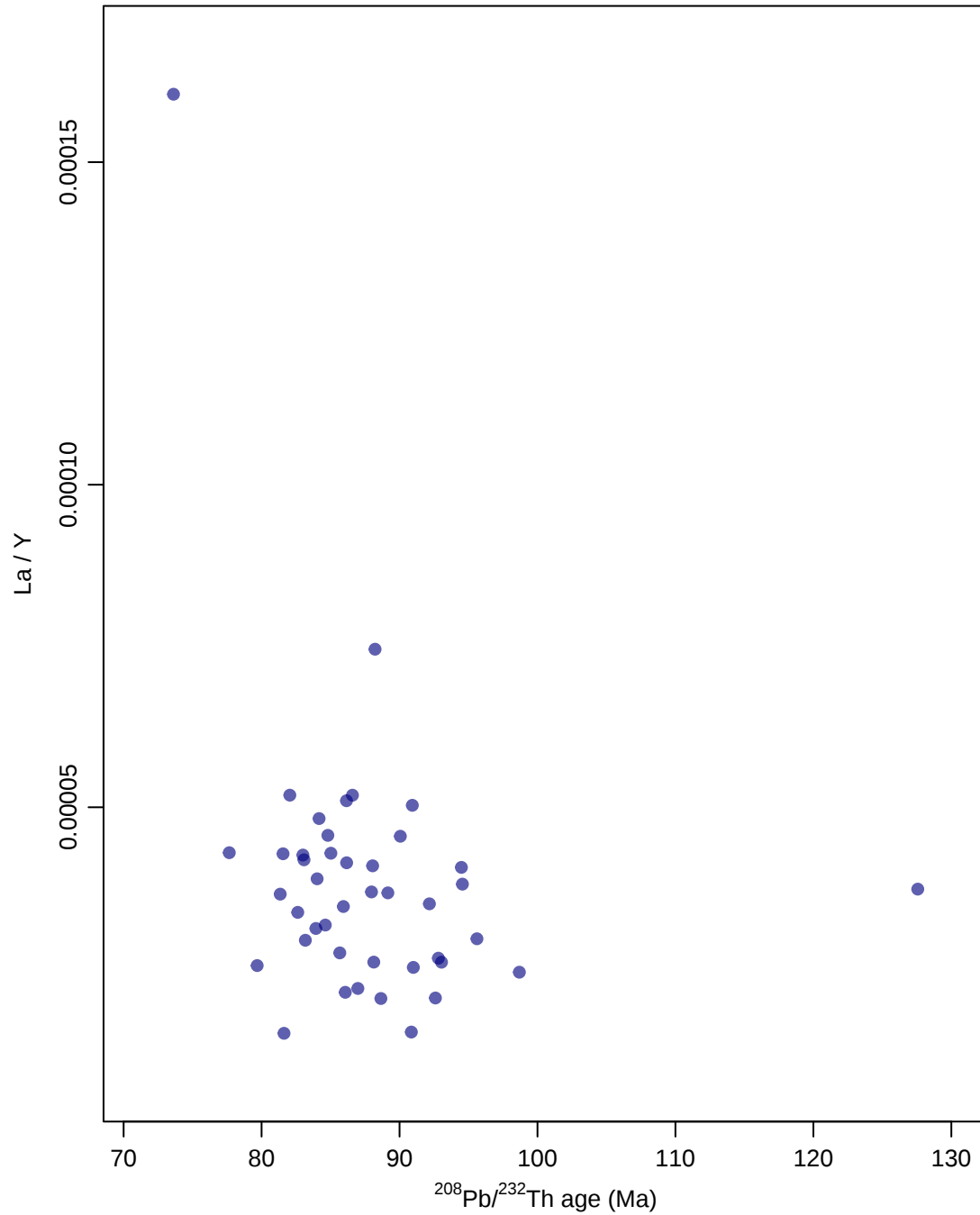
REE distribution



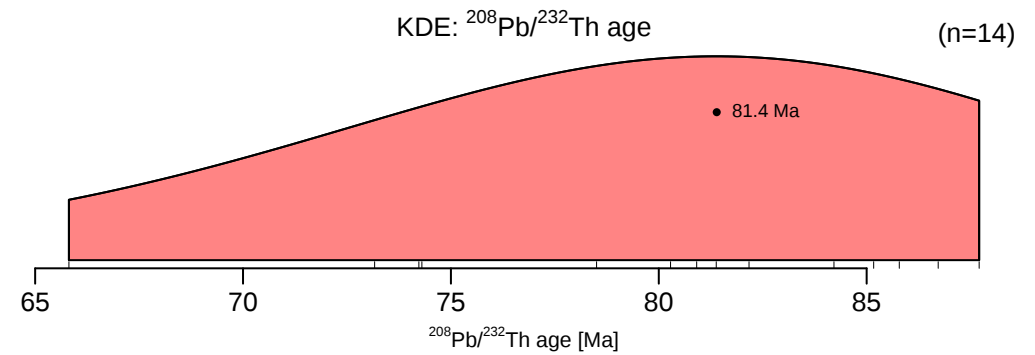
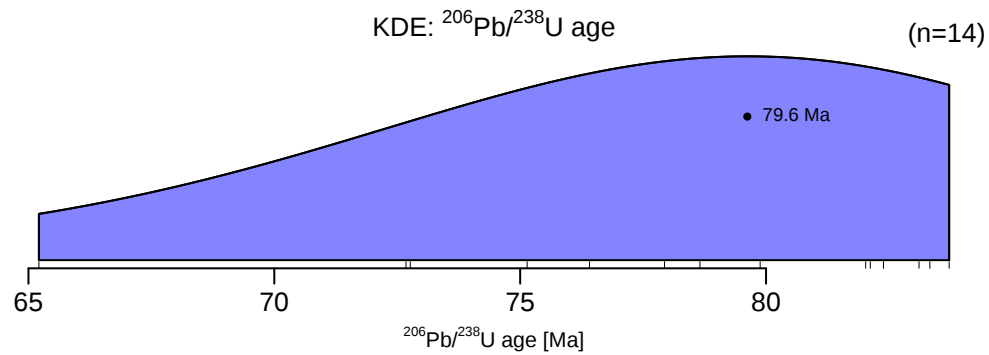
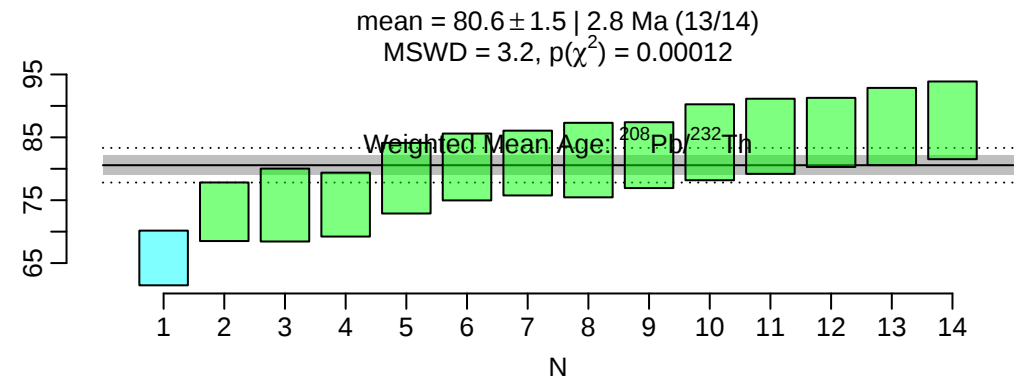
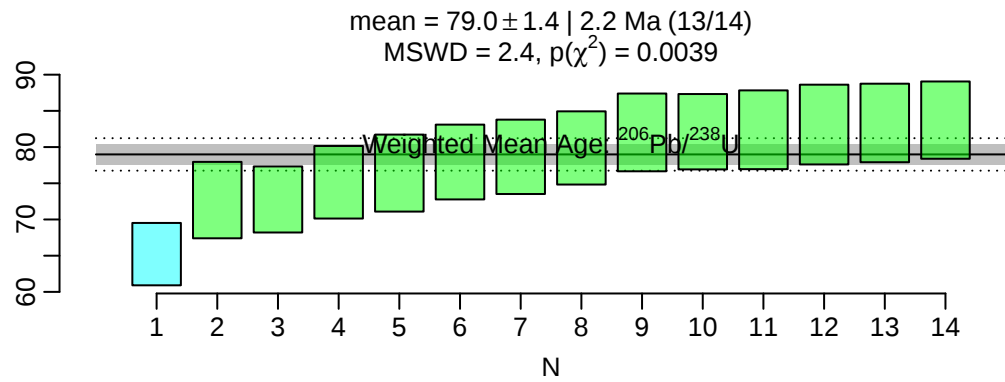
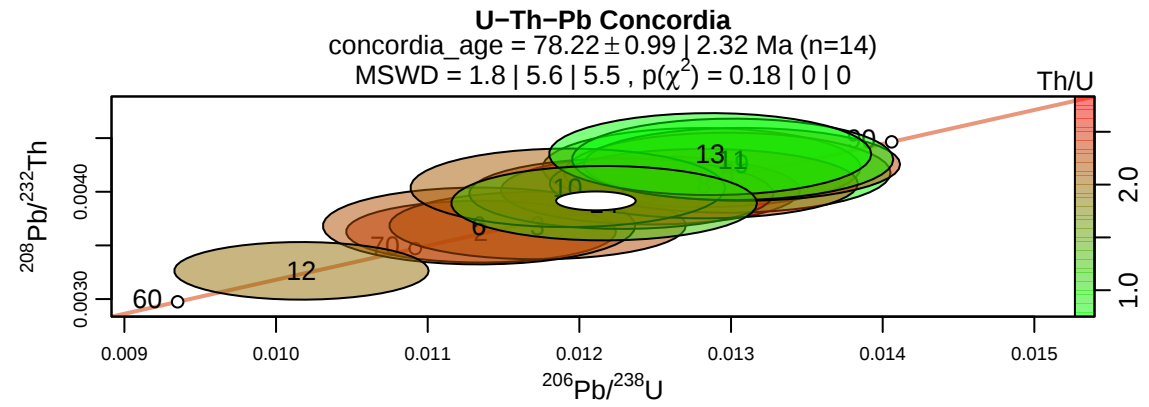
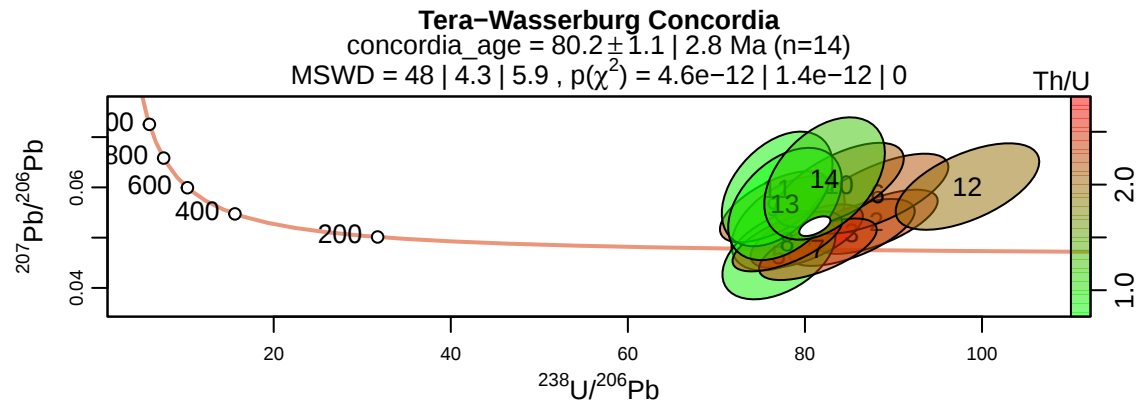
REOPAU-068A - Xenotime



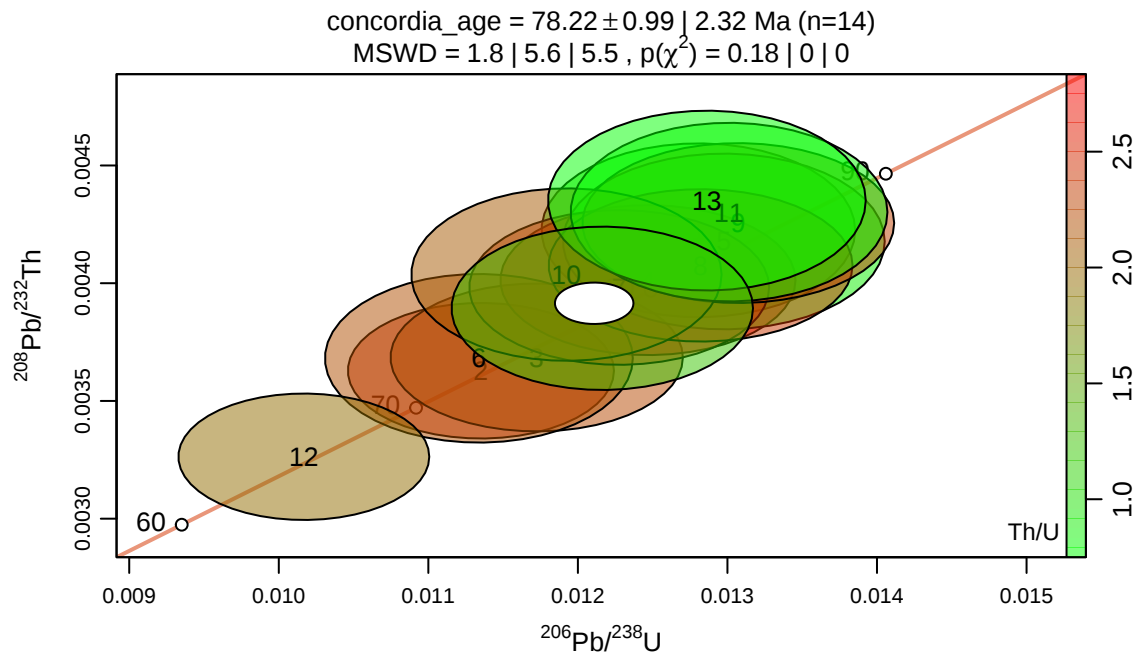
REOPAU-068A – Xenotime



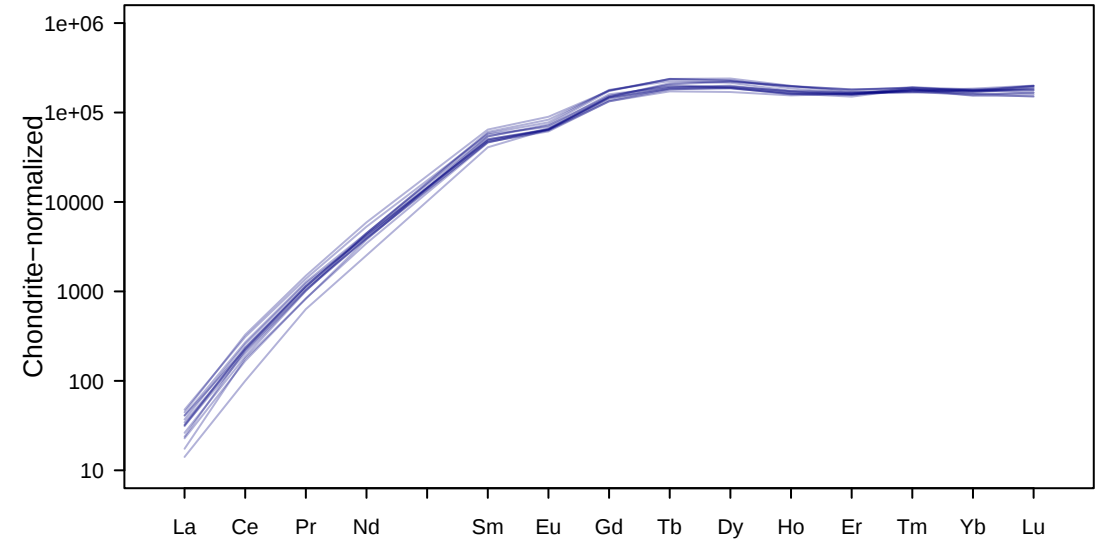
REOUB-100A – Xenotime



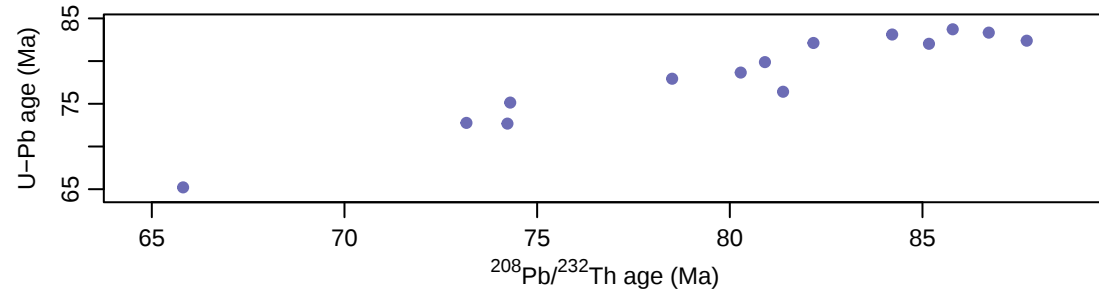
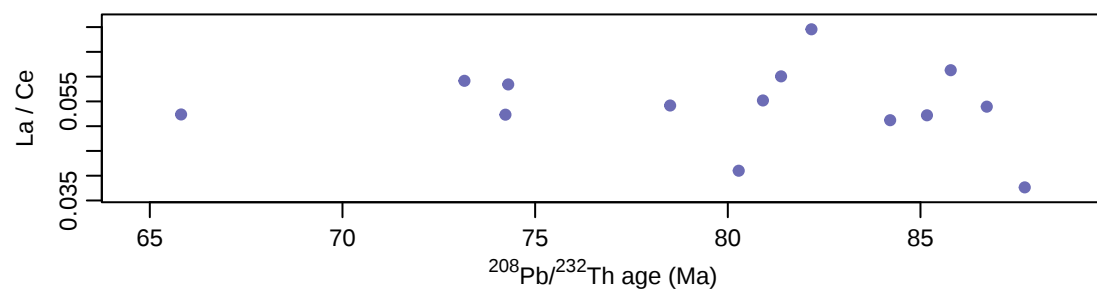
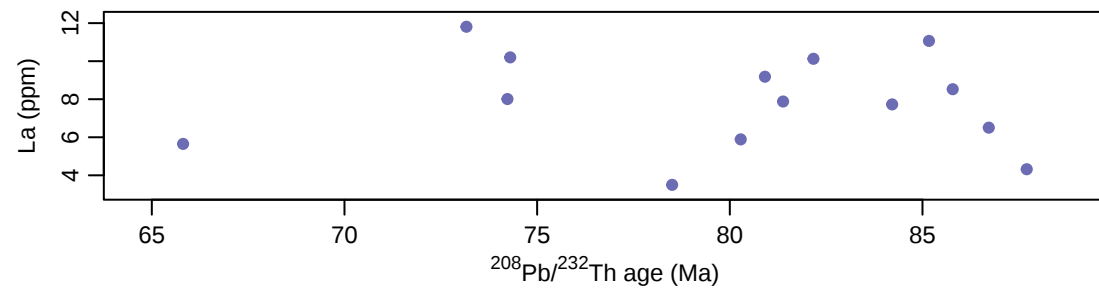
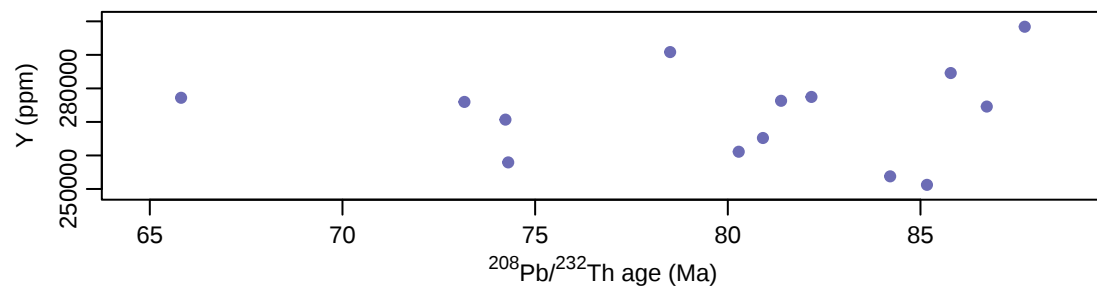
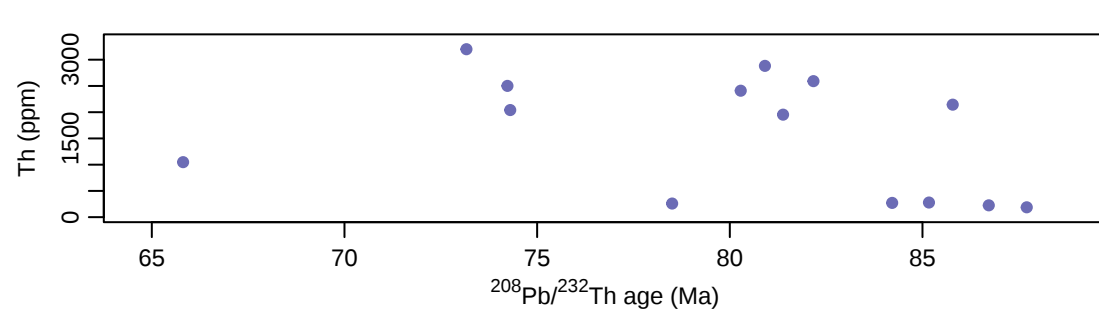
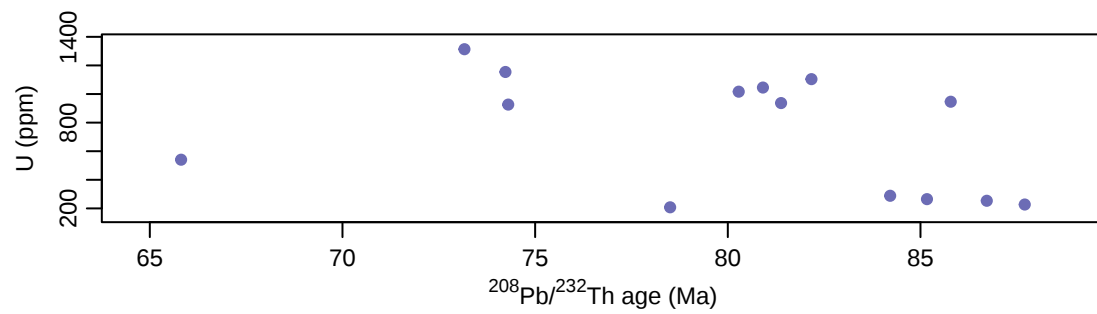
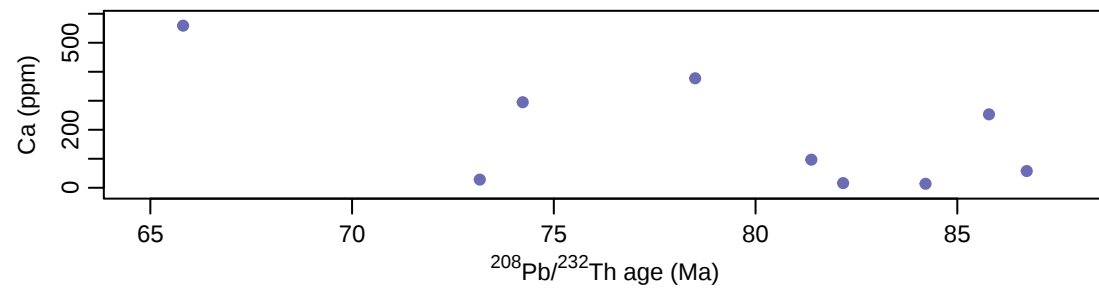
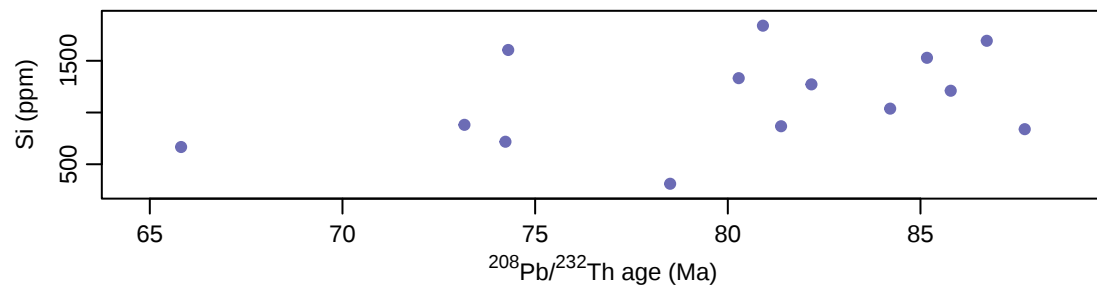
REOUB-100A – Xenotime



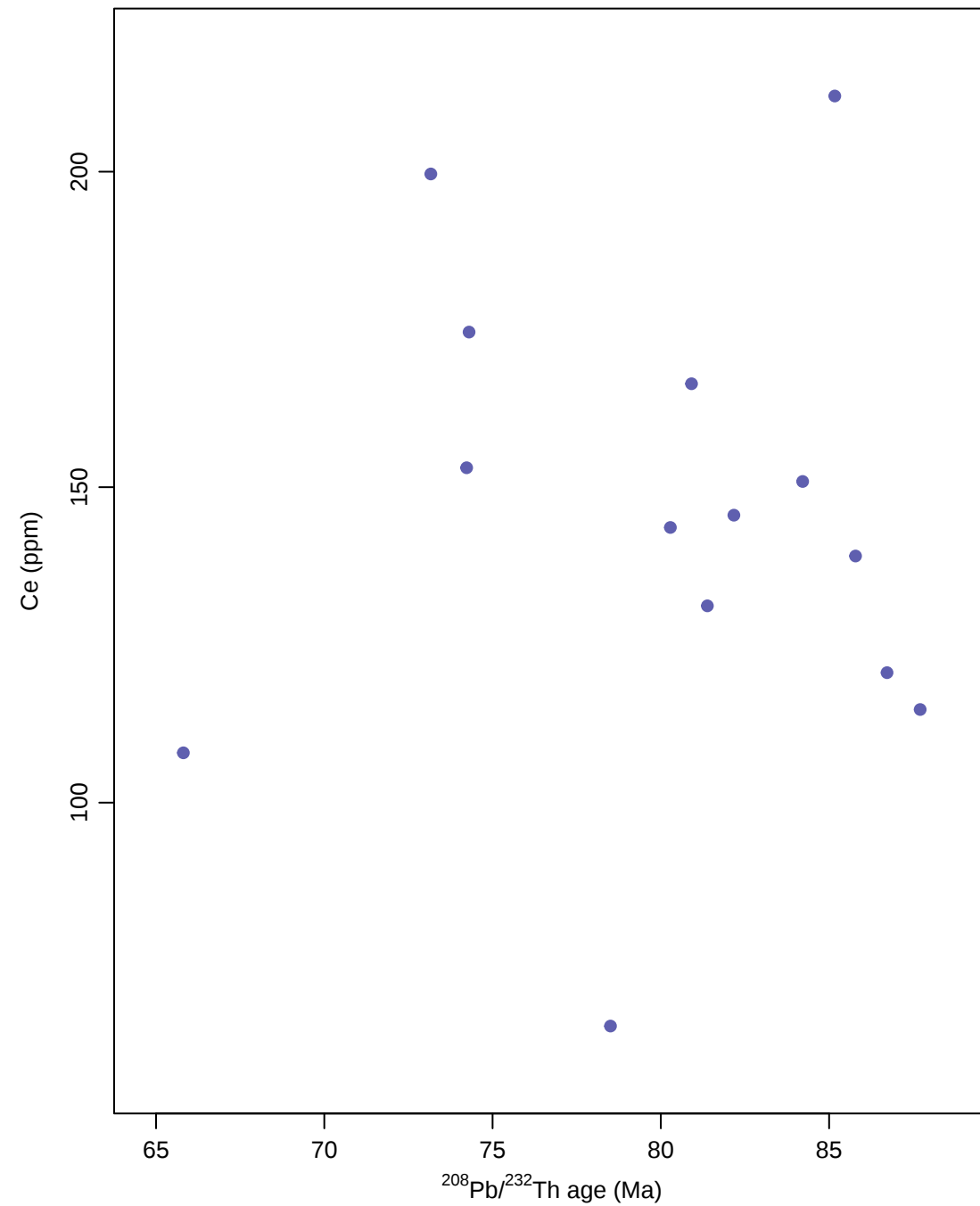
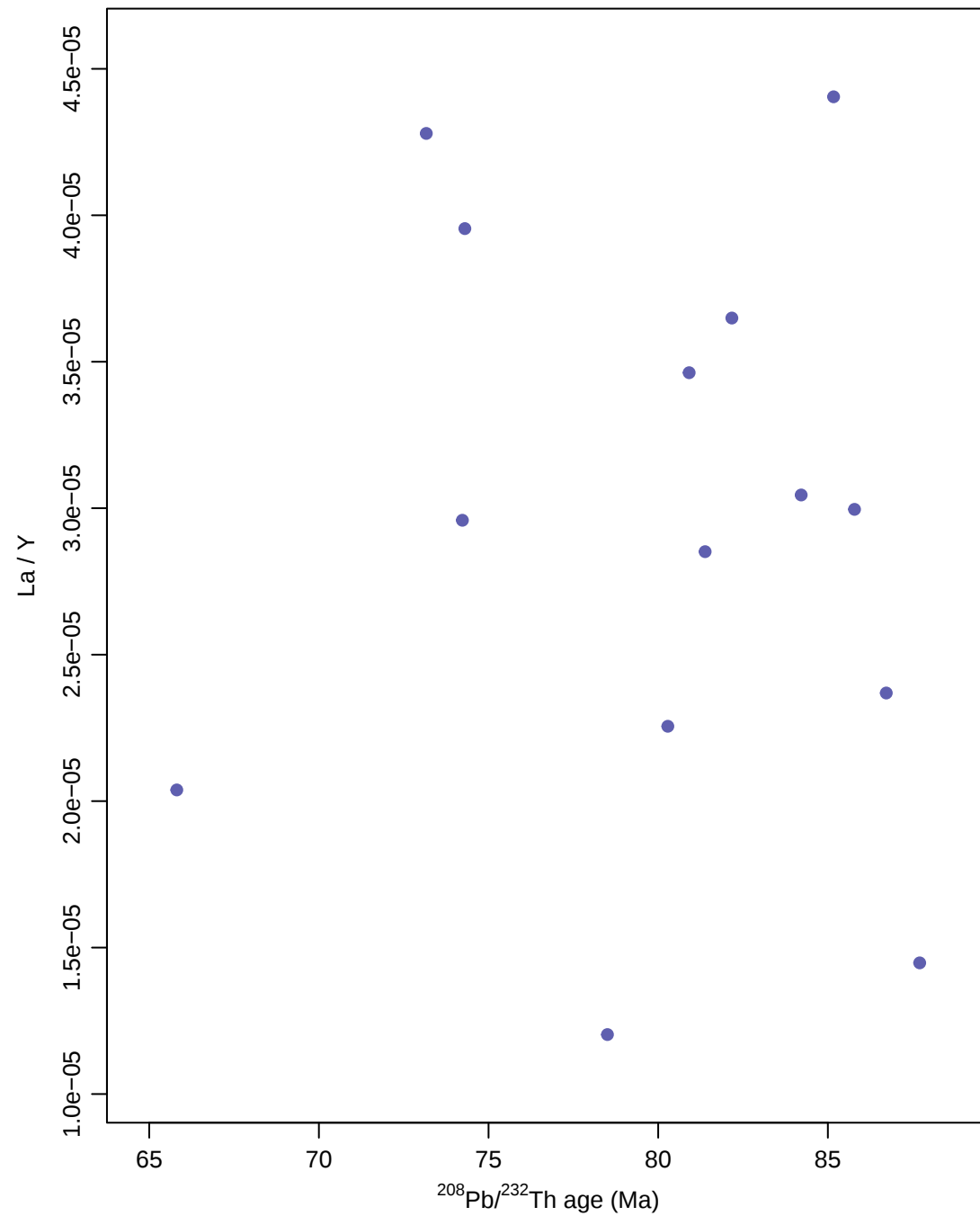
REE distribution



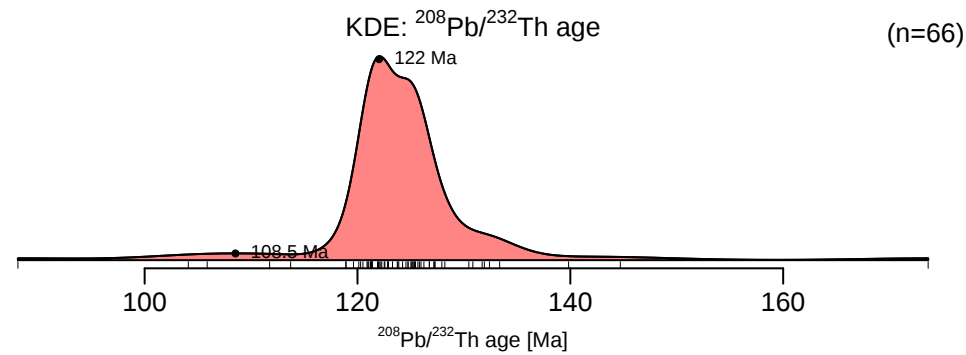
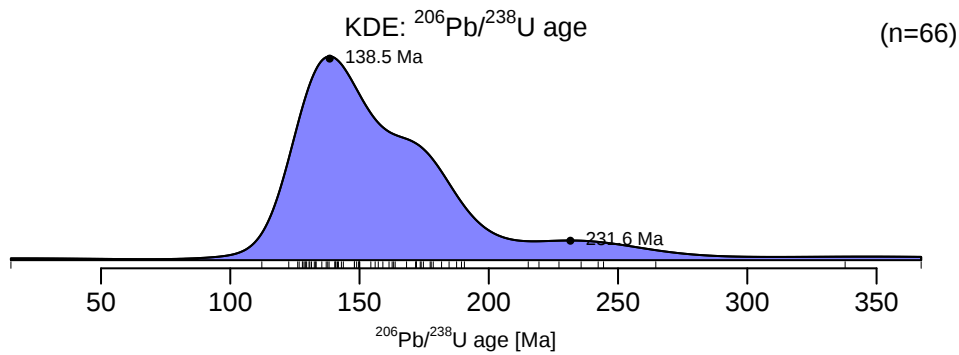
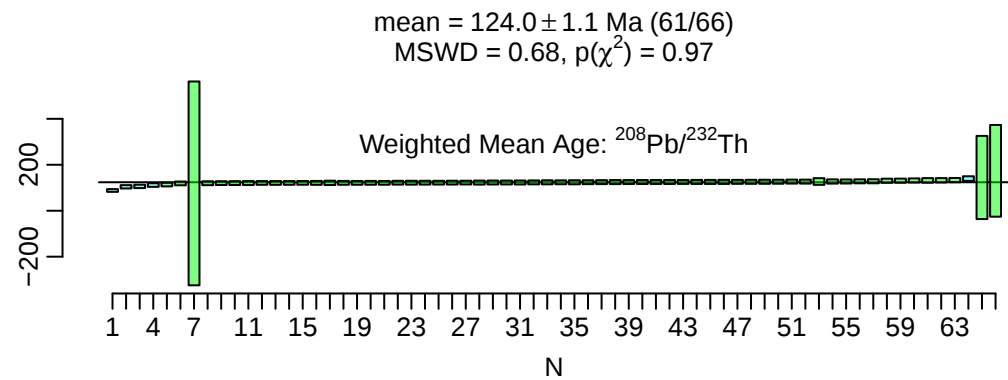
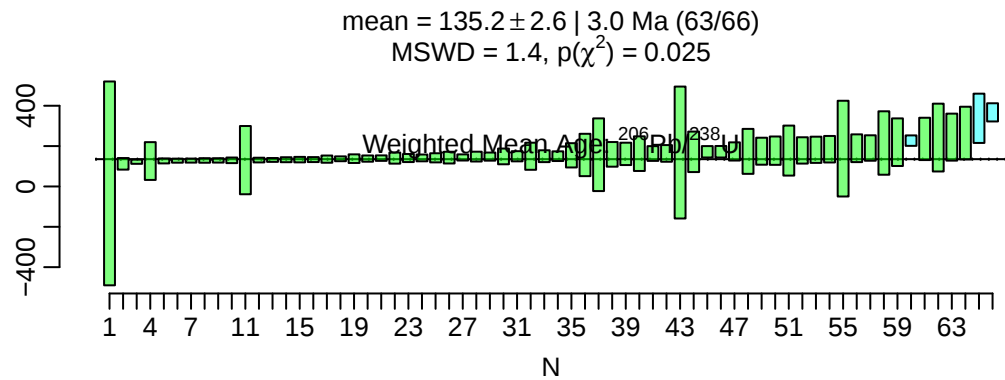
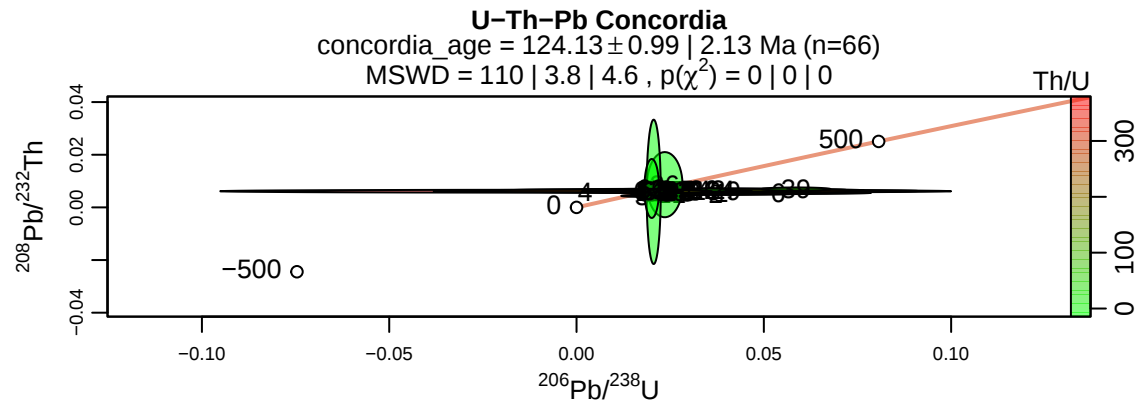
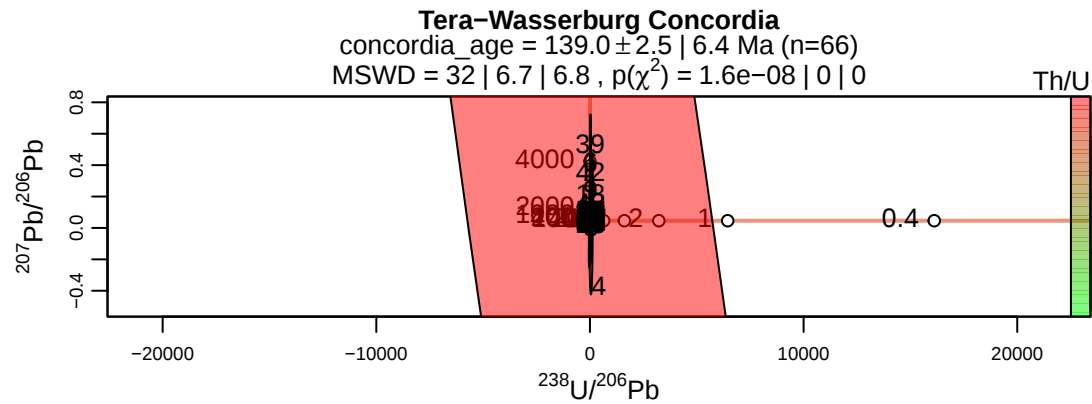
REOUB-100A - Xenotime



REOUB-100A - Xenotime

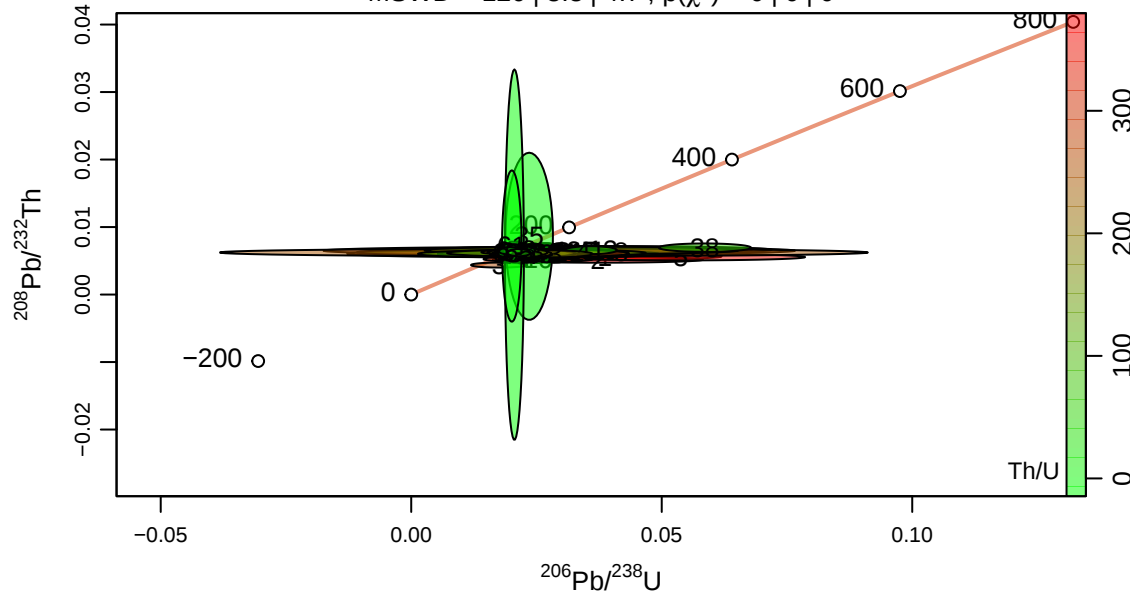


REOUB-119 – Monazite

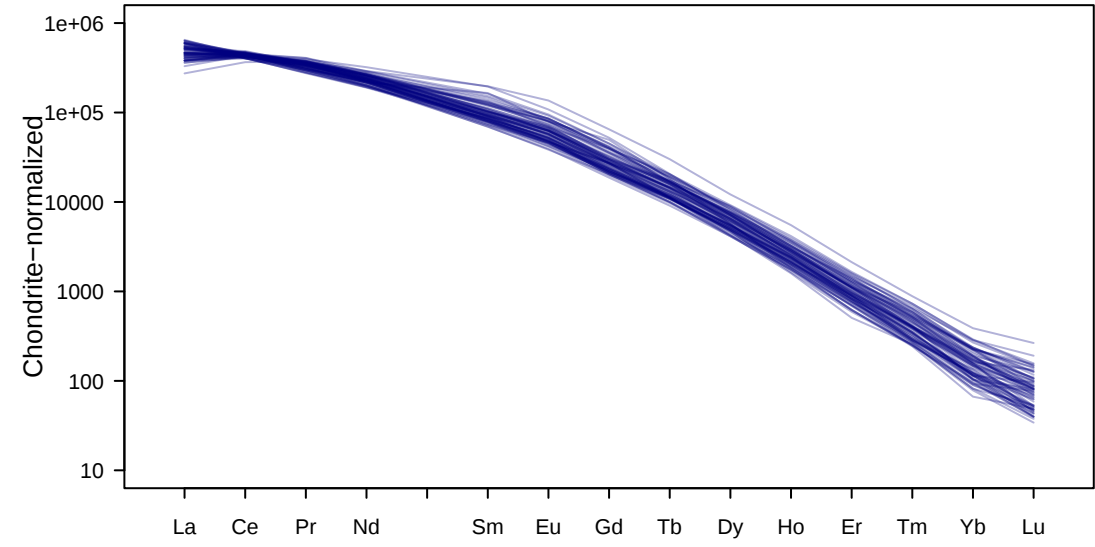


REOUB-119 – Monazite

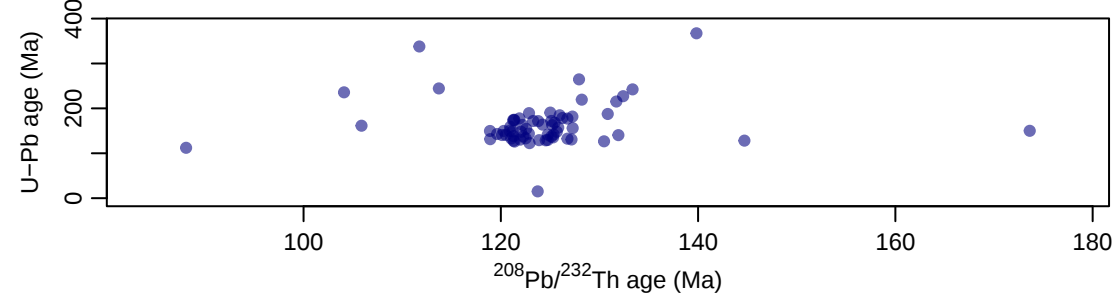
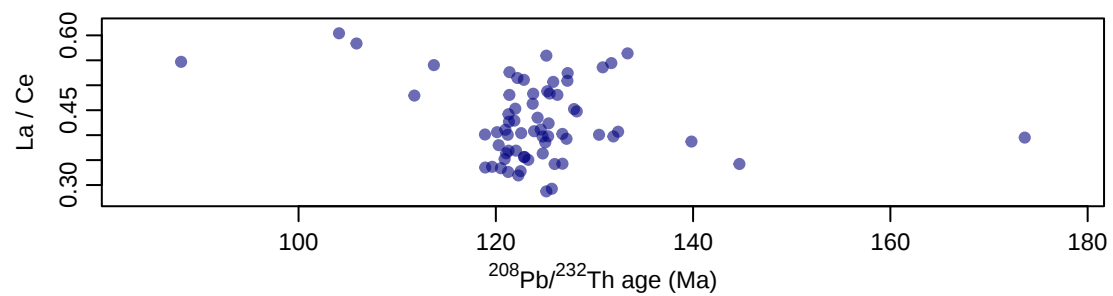
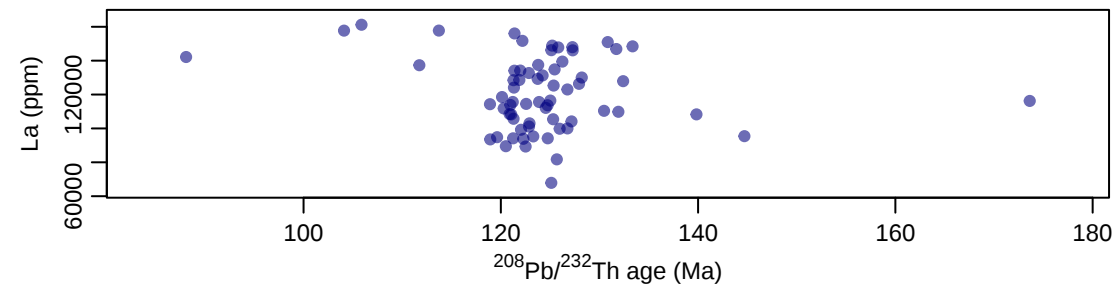
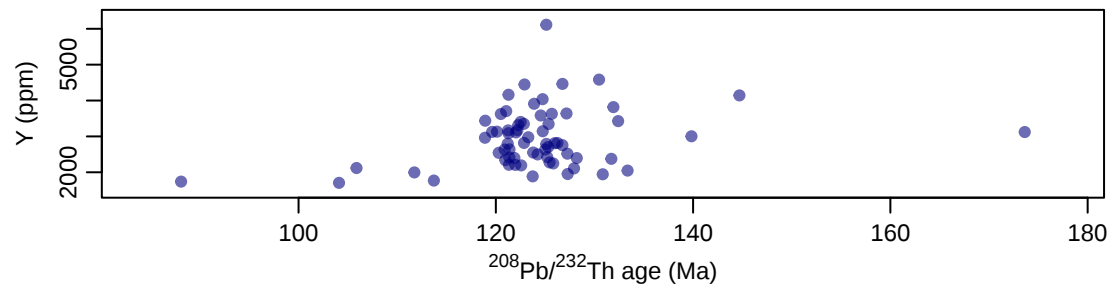
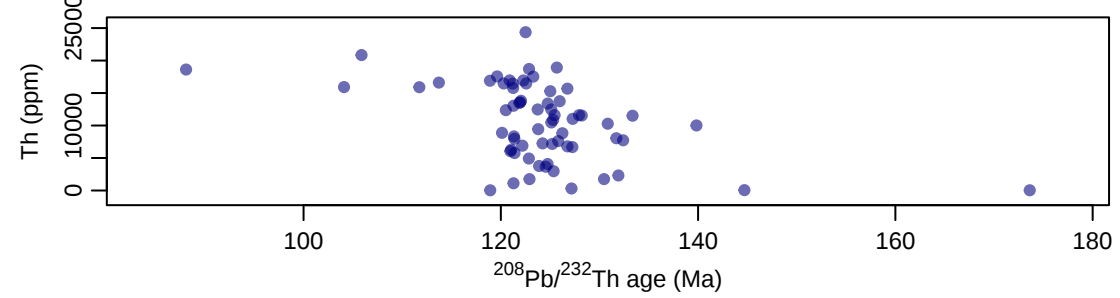
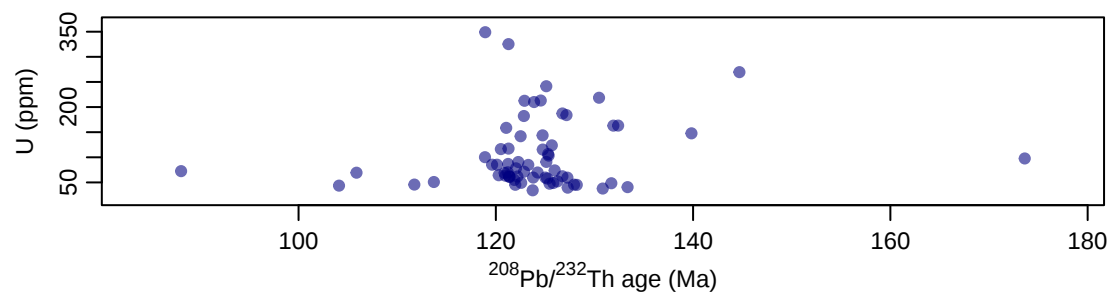
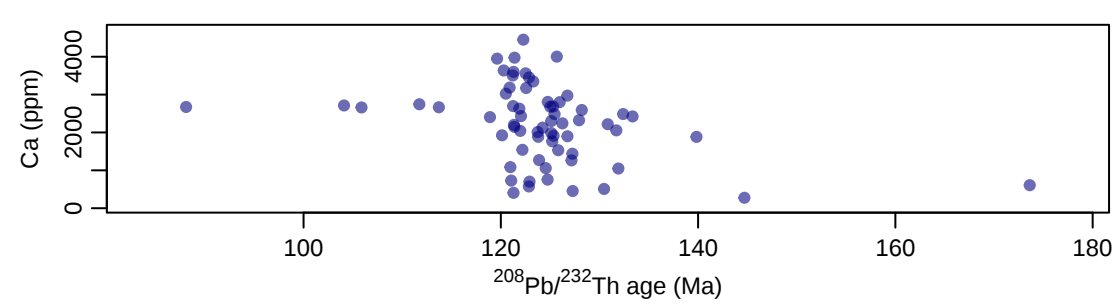
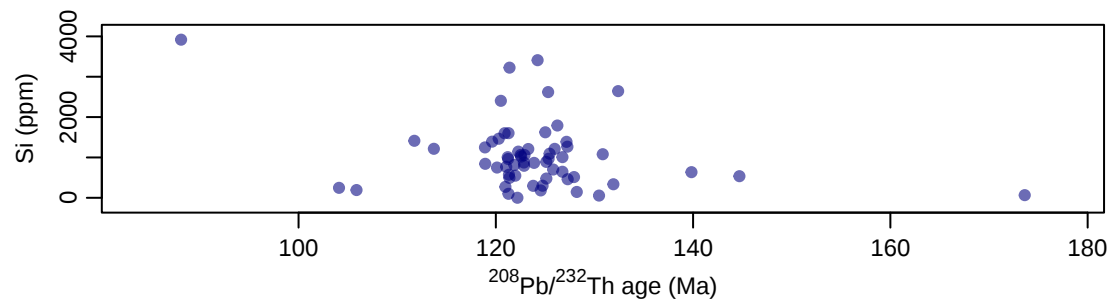
concordia_age = 124.1 ± 1.0 | 2.2 Ma (n=65)
MSWD = 120 | 3.8 | 4.7, $p(\chi^2) = 0 | 0 | 0$



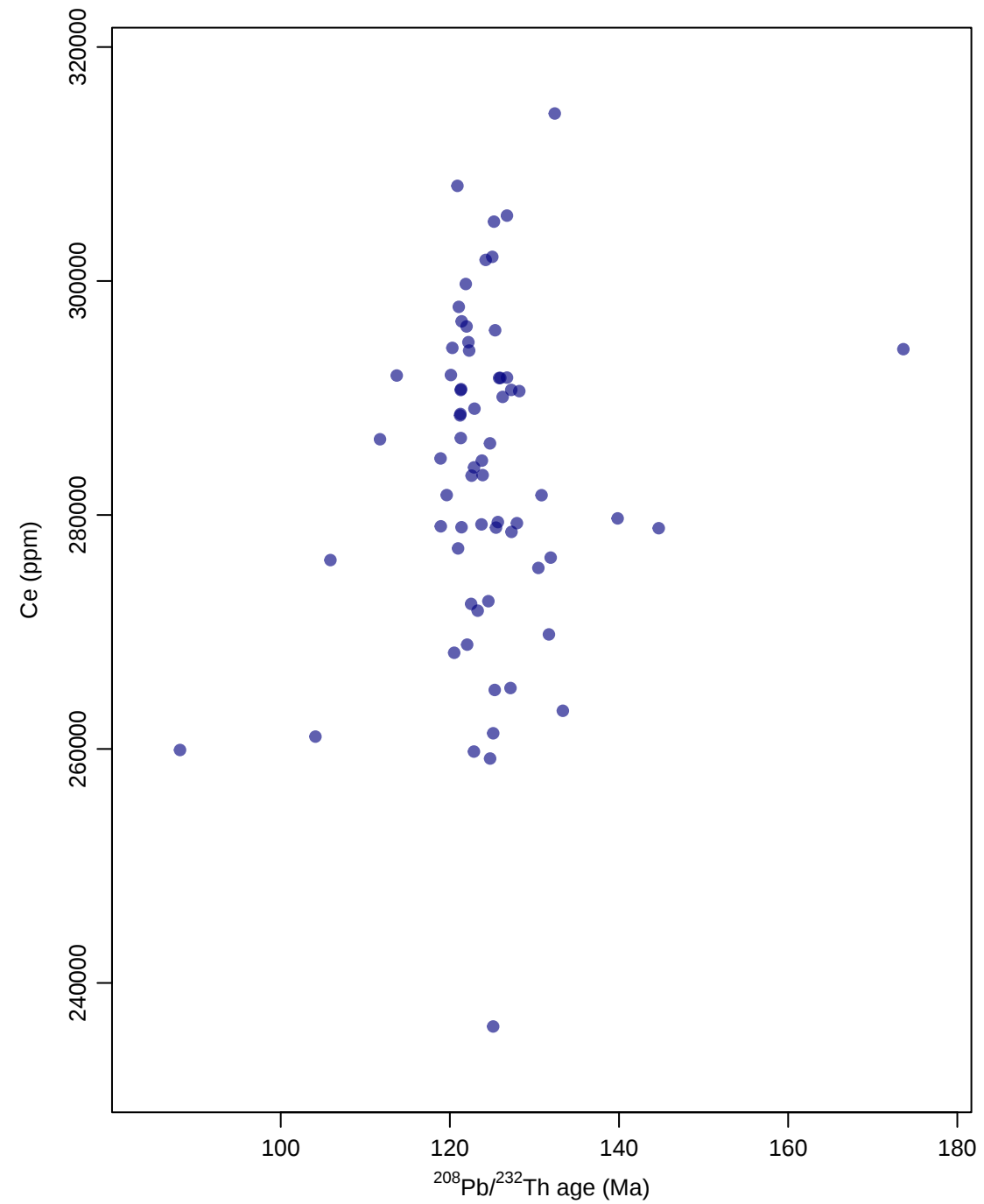
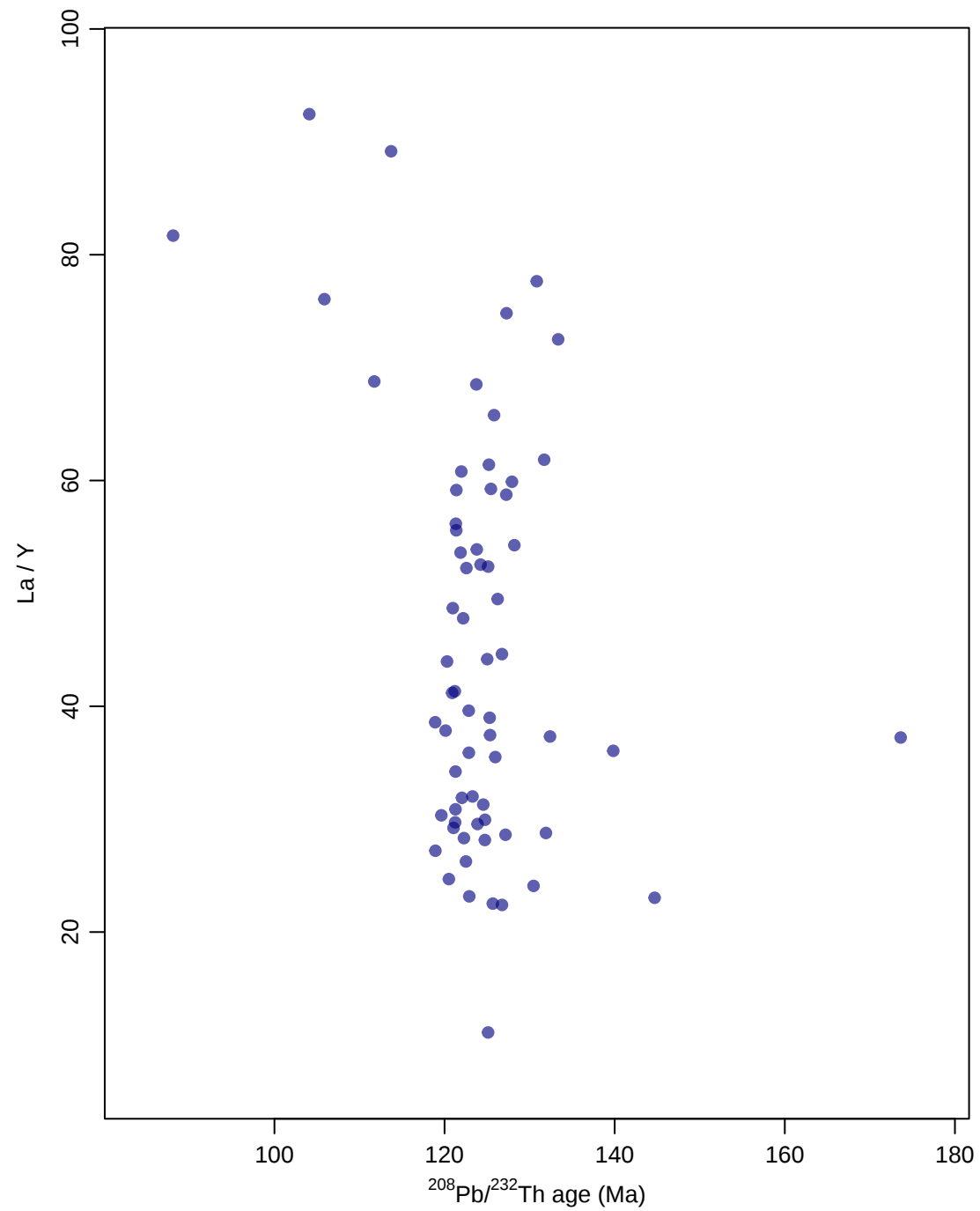
REE distribution



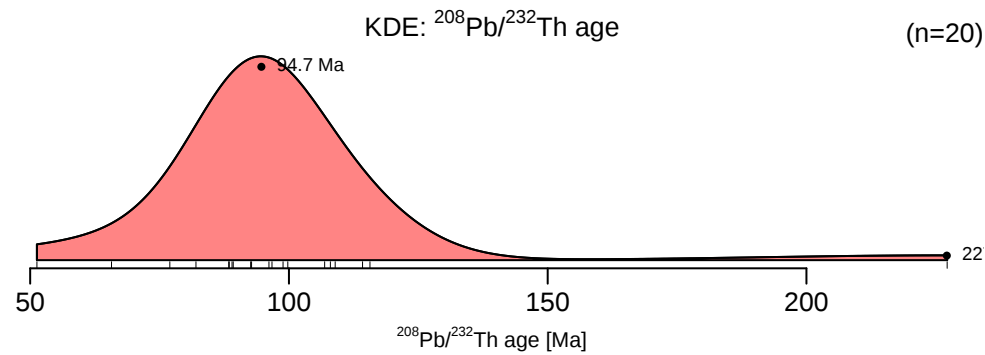
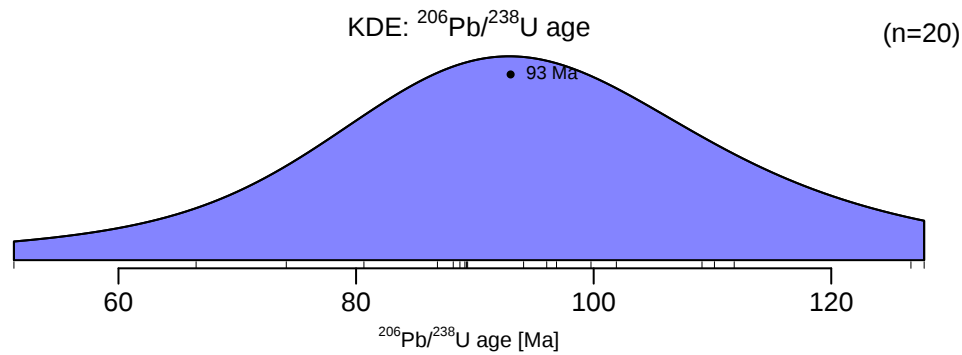
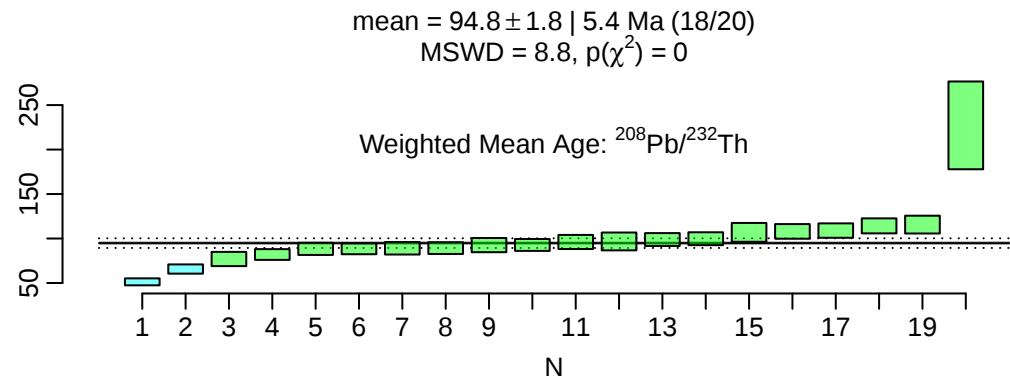
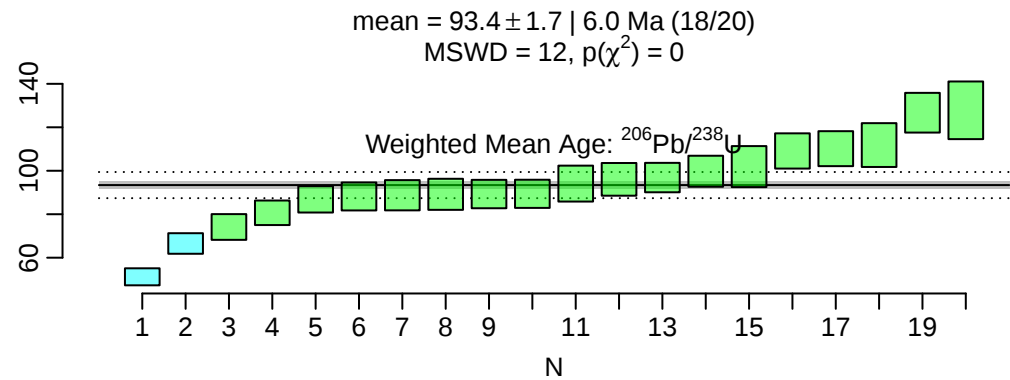
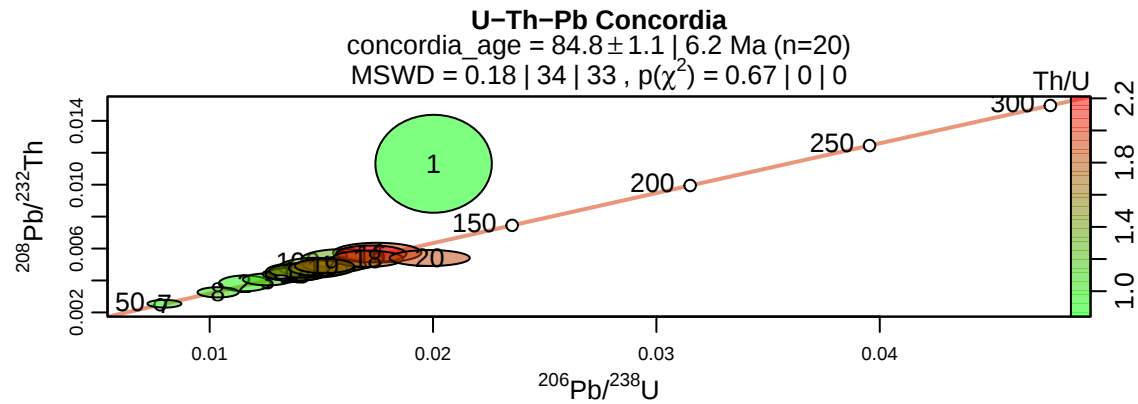
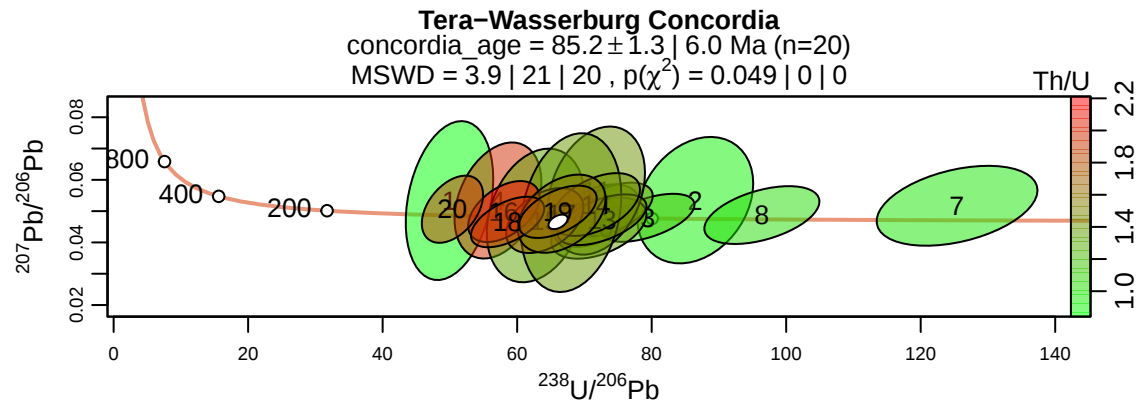
REOUB-119 - Monazite



REOUB-119 - Monazite

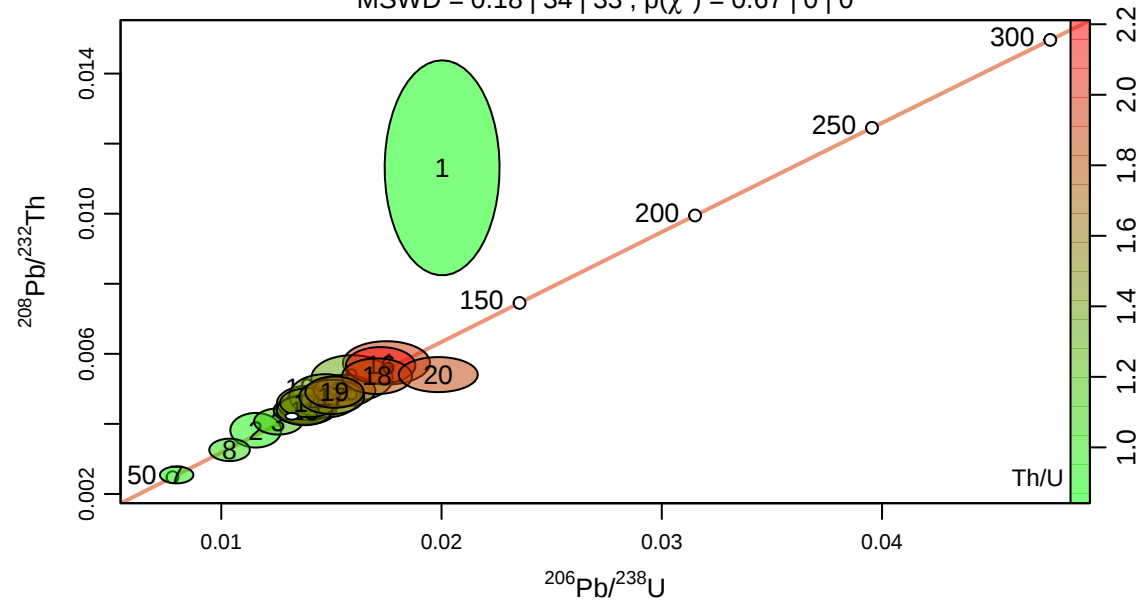


REOUB-119 – Xenotime

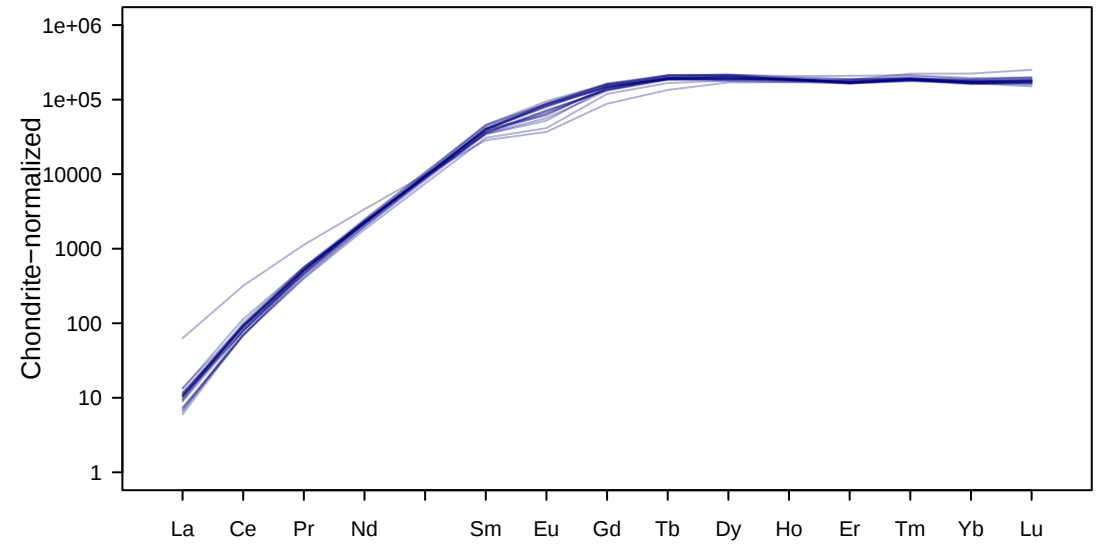


REOUB-119 – Xenotime

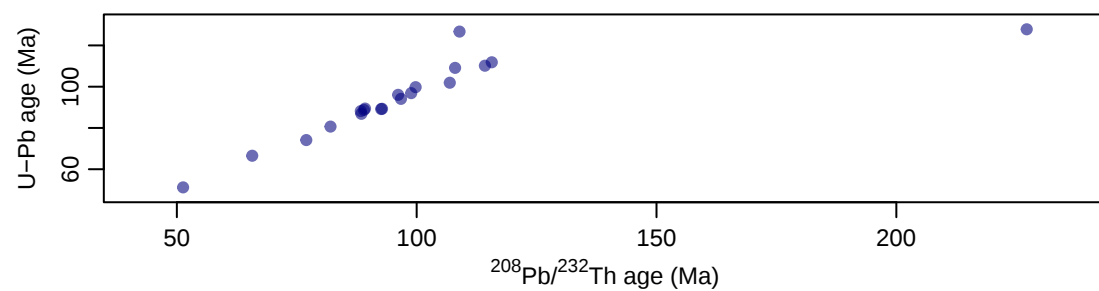
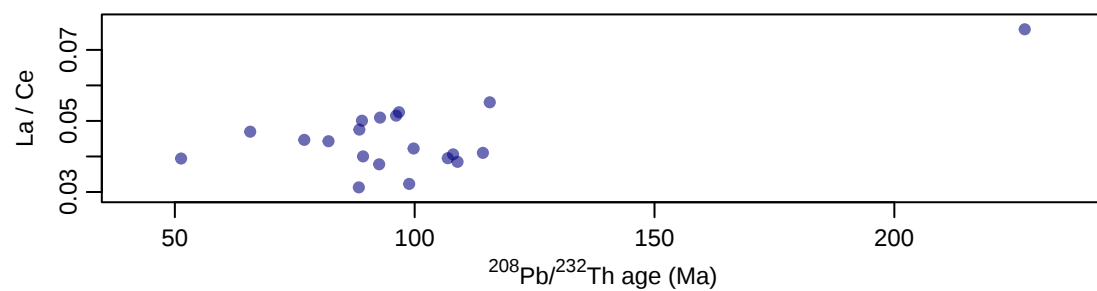
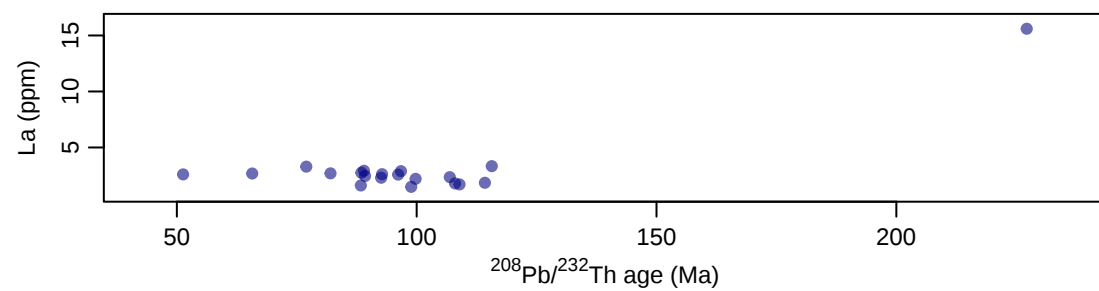
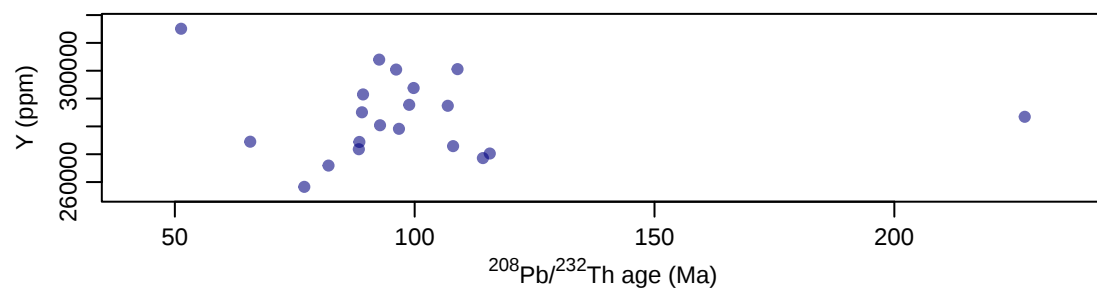
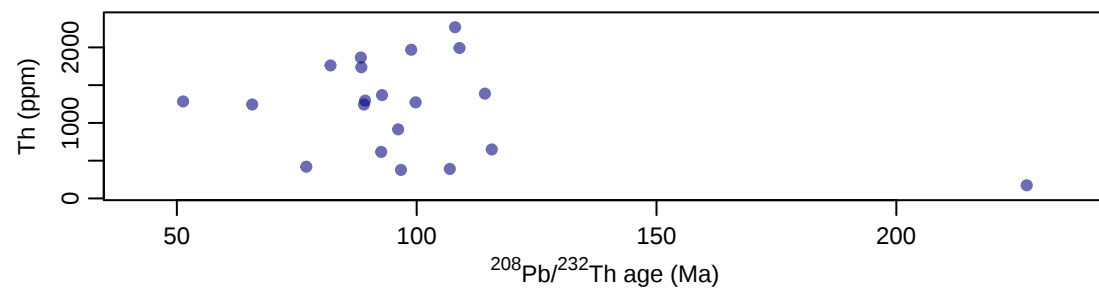
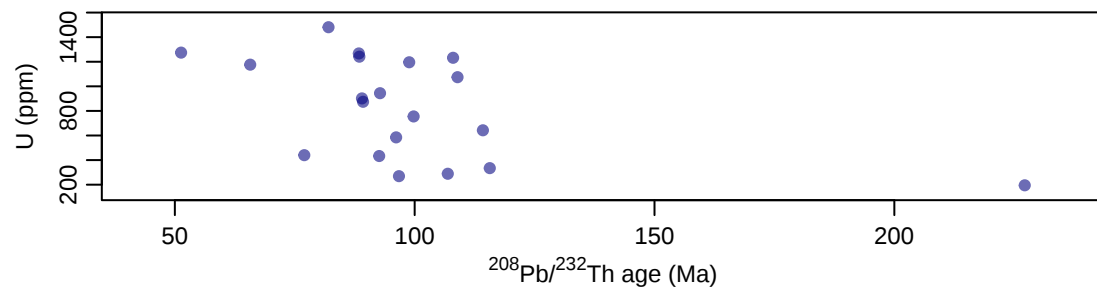
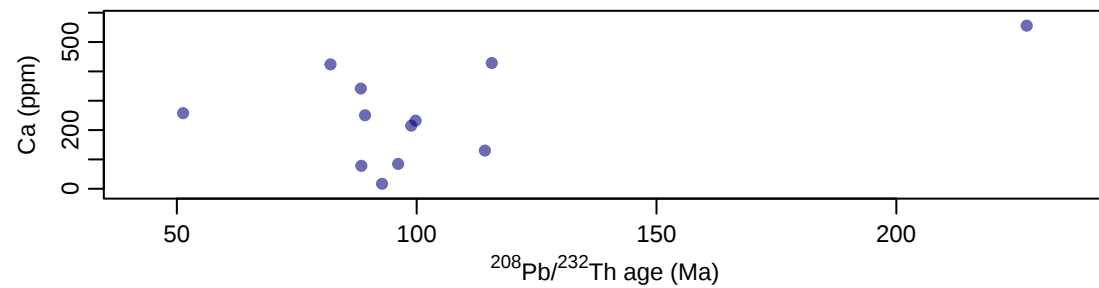
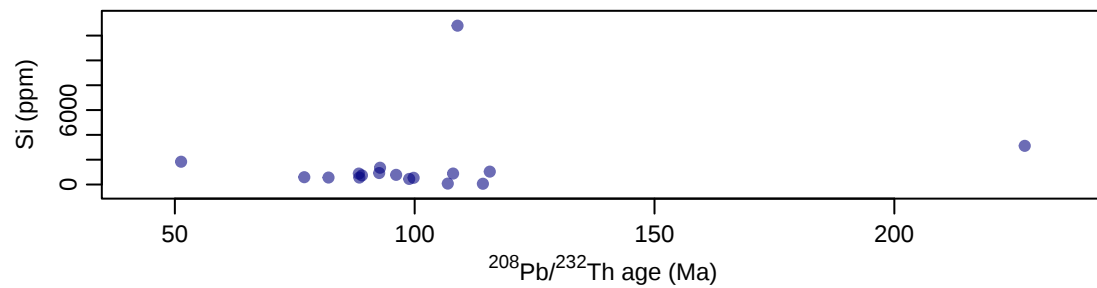
concordia_age = 84.8 ± 1.1 | 6.2 Ma (n=20)
 MSWD = 0.18 | 34 | 33 , $p(\chi^2) = 0.67$ | 0 | 0



REE distribution



REOUB-119 – Xenotime



REOUB-119 – Xenotime

