

Enkelmann, E., Lohff, S.S., Finzel, E.S., 2019, Detrital Zircon double-dating of forearc basin strata reveals magmatic, exhumational, and thermal history of sediment source areas: GSA Bulletin; <https://doi.org/10.1130/B35043.1>.

## Data Repository

**Table S1.** Detrital zircon single grain fission-track and U-Pb data

### PALYNOLOGY RESULTS AND INTERPRETATION

Excerpts from Report No. 1102 and 1115 prepared by Dr. Pierre Zippi at Biostratigraphy.com for samples analyzed for this study

#### CB53: STERLING FORMATION

**Mid?-Late Pliocene; Mid-Late Clamgulchian, fluvial-paludal environments, %Ro~0.32** Abundant Polypodium, Betula and Alnus with common Ericaceae. The palynoflora is characteristic of the later half of the Clamgulchian Stage in Cook Inlet. The taxa recovered are all terrestrial. Algae and Cyperaceae pollen suggest paludal standing water environments. The average spore color is saturated yellow, which is equivalent to an estimated %Ro of 0.32%. This level of maturity required a maximum temperature of approximately 38°C (100°F). Using a heat flow of 0.0104°F/ft estimated from the average geothermal gradient for three nearby wells, Cook Inlet St 17591 1, N Cook Inlet St 1 & S Cook Inlet St 2 (Peterson 2013), the estimated depth of burial was 5048' (1539 m). The sample lithology was coal.

Count Taxa

14 Alnus 4p  
5 Alnus 5p  
13 Betulaceae spp  
3 Cyperaceae cf Carex spp  
5 Ericaceae spp  
1 Retitricolpites cf Salix spp  
2 Sparganium spp  
5 Cupressaceae spp  
6 Piceapollenites spp  
4 Pinuspollenites spp  
3 Taxodiaceapollenites hiatus  
4 Tsugaepollenites cf canadensis  
26 Laevigatosporites spp  
9 Laevigatosporites spp very round  
1 Sigmopollis psilatus

## CB20: STERLING FORMATION

### **Latest Miocene/Early Pliocene, Early Clamgulchian, fluvial environments, est. %Ro~0.37**

Abundant *Alnus*, *Betula* and *Picea*. The palynoflora is characteristic of an Early Clamgulchian palynoflora in Cook Inlet. The taxa recovered are all terrestrial. No algae or aquatics were observed, so there is no evidence of paludal or lacustrine environments upstream of this position at the time of deposition. The average spore color is a saturated yellow-orange, which is equivalent to an estimated %Ro of 0.37%. This level of maturity required a maximum temperature of approximately 55°C (131°F). Using a heat flow of 0.0132°F/ft estimated from the average of geothermal gradients in two nearby wells, Ninilchik 1 and Ninilchik Unit 1 (Peterson 2013), the estimated depth of burial was 7376' (2248 m). The sample lithology was a lightly indurated gray carbonaceous mudstone.

#### Count Taxa

2 *Alnus* 3p  
30 *Alnus* 4p  
5 *Alnus* 5p  
14 *Betulaceae* spp  
1 *Ericaceae* spp  
1 *Pterocarya* 6p  
2 *Retitricolpites* cf *Salix* spp  
5 *Cupressaceae* spp  
22 *Piceapollenites* spp  
3 *Pinuspollenites* spp  
8 *Taxodiaceapollenites* hiatus  
2 *Tsugaepollenites* cf *canadensis*  
1 *Laevigatosporites* spp  
3 *Osmundacidites* cf *wellmanii*  
1 *Sphagnum* spp  
2 *Dyadosporites* verrucate-spinata

## CB-22: BELUGA FORMATION

### Latest Miocene, Late Homerian, fluvial environments, estimated %Ro~0.32

The palynoflora is a mixed conifer forest typical of the Late Homerian in Cook Inlet. The taxa recovered are all terrestrial. No algae or aquatics were observed, so there is no evidence of paludal or lacustrine environments upstream of this position at the time of deposition. The average spore color is a saturated yellow, which is equivalent to an estimated %Ro of 0.32%. This level of maturity required a maximum temperature of approximately 38°C (100°F). Assuming an average heat flow of 0.0126°F/ft for Cook Inlet (Peterson 2013), the estimated depth of burial was 4762' (1451 m).

#### Count Taxa

4 *Alnus* 5p  
1 *Alnus* 3p  
16 *Alnus* 4p  
1 *Carex*  
1 *Diervilla echinata*  
1 *Echitricolporites spinosus*  
6 *Cupressaceae* spp  
1 *Keteleeria* spp  
4 *Larix/Pseudotsuga* spp  
1 *Piceapollenites brevisaccate* type  
12 *Piceapollenites* spp  
4 *Pinuspollenites* spp  
6 *Taxodiaceae* spp  
4 *Tsuga* cf *canadensis*  
1 *Tsuga* cf *heterophylla*  
1 *Cyathidites australis*  
24 *Laevigatosporites* spp  
10 *Lycopodium* cf *annotinum*  
6 *Osmundacidites wellmani*  
1 *Sphagnum* spp

## CB-19: TYONEK FORMATION

### Late Middle Miocene, E. Homerian/Latest Seldovian, fluvial-paludal environments, estimated %Ro~0.4

Abundant *Tsuga*, *Taxodium*, *Alnus* and *Picea* with common *Graniticolporites*. The palynoflora is characteristic of a transition from Latest Seldovian to Early Homerian in Cook Inlet. The taxa recovered are all terrestrial. No algae were observed, but *Cyperaceae* pollen suggests paludal standing water environments. The average spore color is a yellow-orange, which is equivalent to an estimated %Ro of 0.4%. This level of maturity required a maximum temperature of approximately 71°C (159°F). Using a heat flow of 0.0115°F/ft estimated from the geothermal gradient contour map of Peterson (2013), the estimated depth of burial was 10643' (3244 m). The sample lithology was a lightly indurated gray carbonaceous mudstone.

#### Count Taxa

7 *Alnus* 4p  
5 *Alnus* 5p  
6 *Betulaceae* spp  
5 *Cyperaceae* cf *Carex* spp  
2 *Graniticolporites* (*Fagus*) spp  
1 *Pterocarya* 6p  
1 *Pterocarya* 8p  
1 *Quercus* spp  
1 *Ulmus* 6p  
1 *Abiespollenites* spp  
1 *Dacridium* spp  
20 *Piceapollenites* spp  
7 *Pinuspollenites* spp  
1 *Sciadopitys* spp  
19 *Taxodiaceapollenites* hiatus  
14 *Tsugaepollenites* cf *canadensis*  
8 *Tsugaepollenites* cf *heterophylla*  
2 *Laevigatosporites* spp  
2 *Lycopodium* cf *annotinum*  
2 *Osmundacidites* cf *wellmanii*  
1 *Osmunda* cf *claytoniana*

## CB50, CB-51, CB-52: HEMLOCK CONGLOMERATE

### Late Oligocene?, fluvial environments, estimated %Ro~0.6

The conifer-rich palynoflora is similar to assemblages seen in the pre-Seldovian Late Oligocene of Cook Inlet. Similar to the sample above, the assignment of age to a conifer-rich assemblage in an isolated sample is tenuous. There are no particular fossils restricted to the Late Oligocene in this sample. All palynomorphs are terrestrial. The spore-dominated flora may reflect wet marshlike conditions in an overall fluvial system. The average spore color is orange-light brown, which is equivalent to an estimated %Ro of 0.6%. This level of maturity required a maximum temperature of approximately 87°C (188°F). Using a heat flow of 0.011°F/ft from the nearby Redoubt Shoal St 1 well (Peterson 2013), the estimated depth of burial was 12773' (3893 m). The sample lithology was a medium indurated dark gray mudstone.

#### Count Taxa

4 Alnus 4p  
1 Alnus 5p  
1 Alnus 6p  
5 Betulaceae spp  
1 Granitricolporites (Fagus) spp  
10 Myrica spp  
1 Retitricolporites sp indet  
15 Abiespollenites spp  
28 Piceapollenites spp  
5 Pinuspollenites spp  
1 Taxodiaceapollenites hiatus  
6 Tsugaepollenites cf canadensis  
5 Tsugaepollenites cf heterophylla  
1 Cyathidites minor  
9 Laevigatosporites spp  
4 Osmundacidites cf wellmanii  
1 Sphagnum spp  
1 Biporipylonites bellulus  
1 Monoporiporonites ?smithii round

Samples that were collected at sites reported in Zippi & Loveland (2012).

CB-17: Beluga Formation is reported as 09JRM100

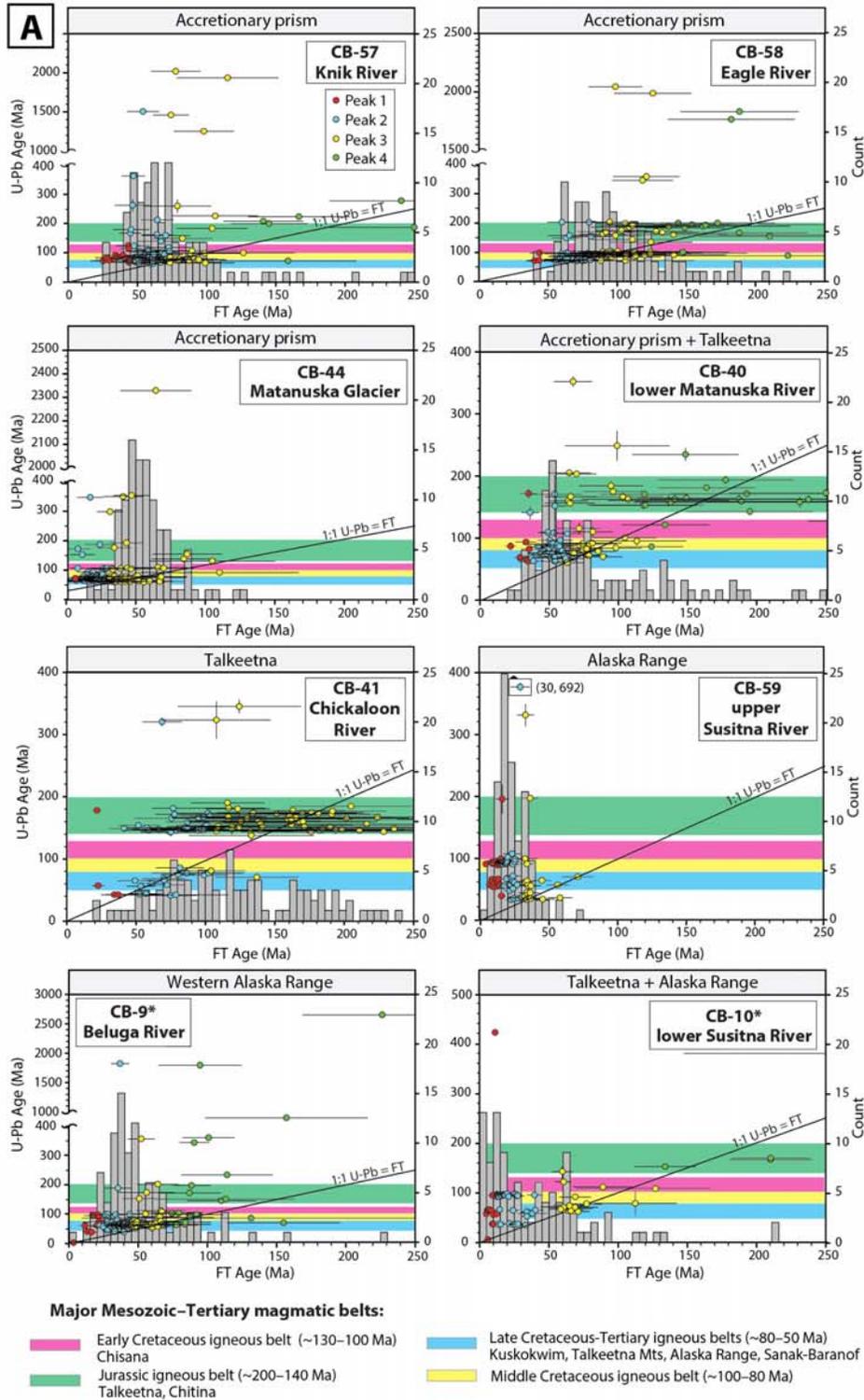
CB-16: Tyonek Formation is reported as 08DL050

CB-18: Tyonek Formation is reported as 07DL075

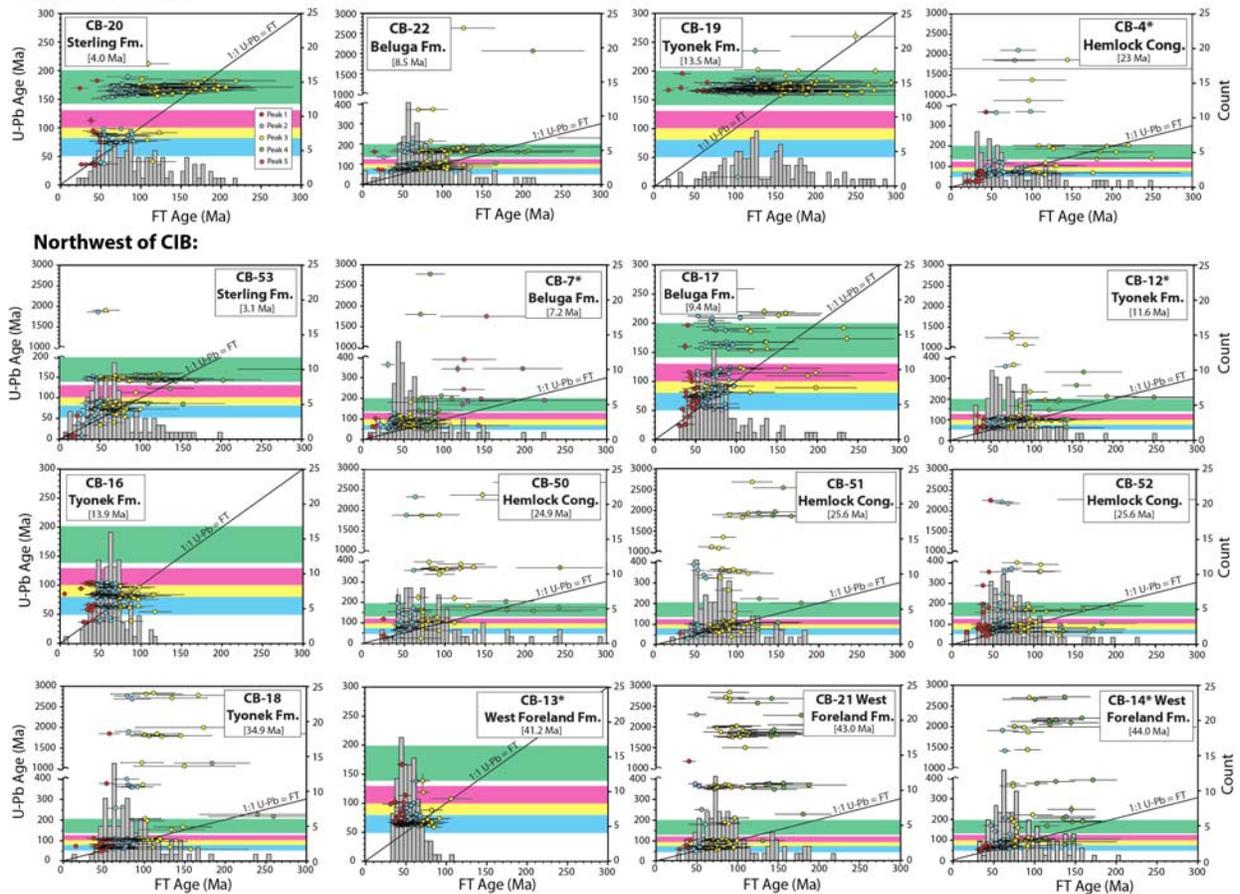
CB-21: West Foreland Formation is reported as 07DL073

## REFERENCES CITED

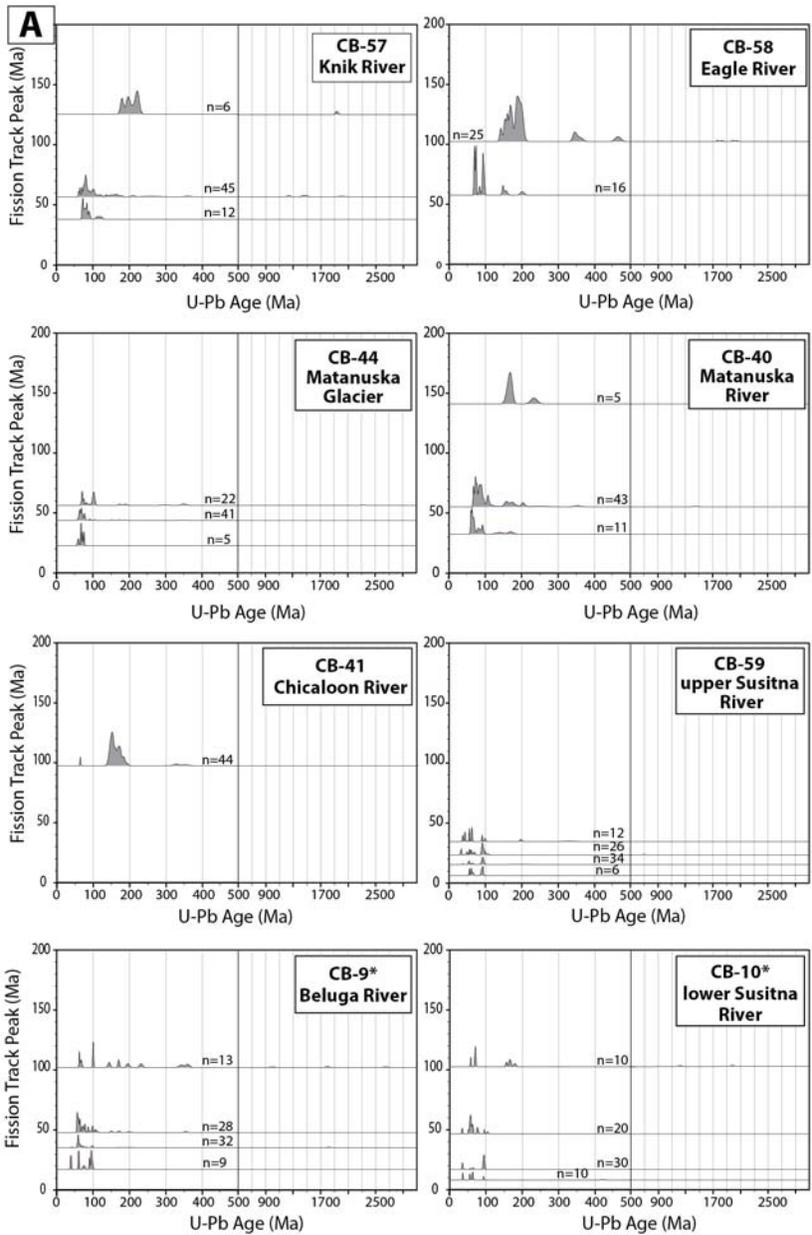
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- Zippi, P.A., and Loveland, A.M., 2012, Palynological analysis of 228 outcrop samples from the Kenai, Seldovia, and Tyonek quadrangles, Cook Inlet region, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2012-1, 10 p. <http://doi.org/10.14509/23723>.



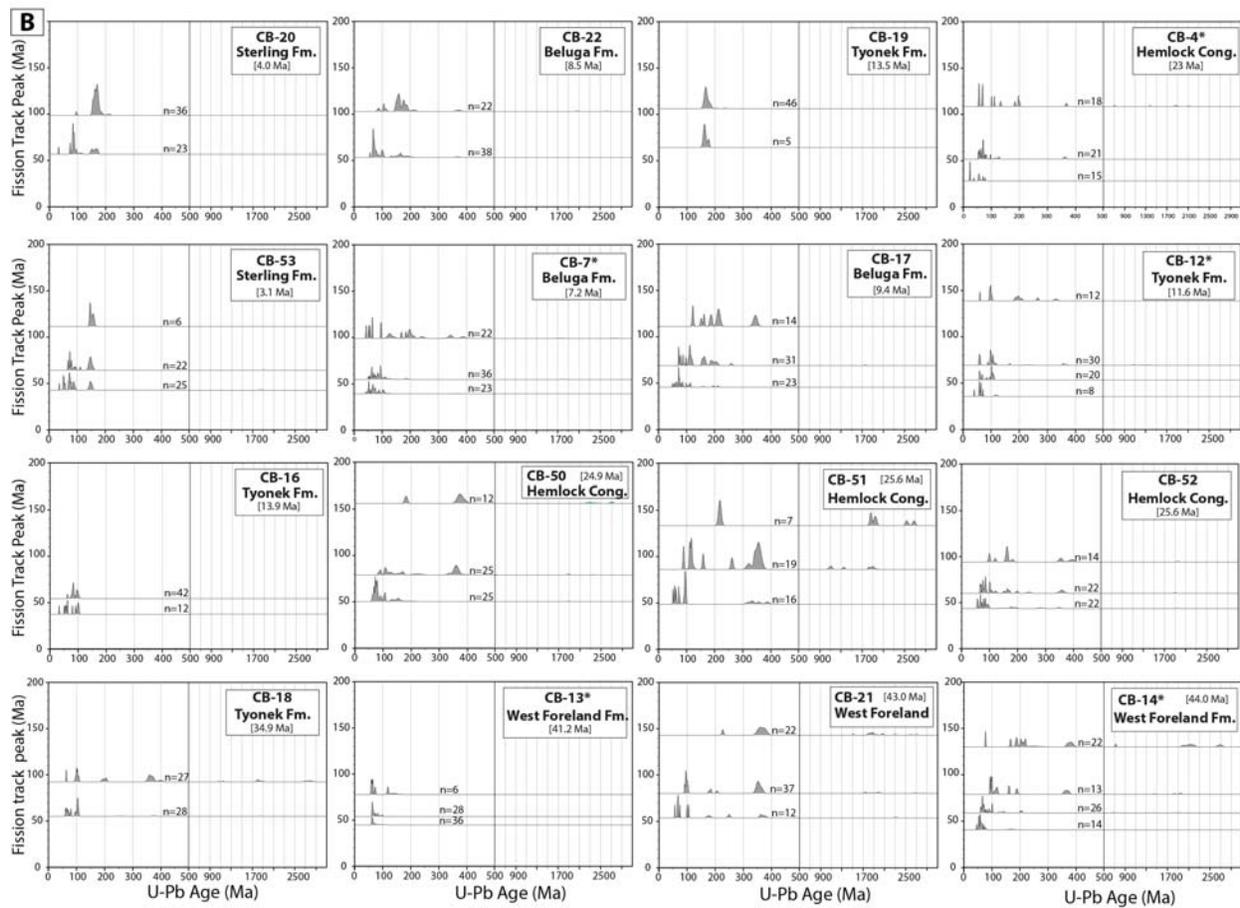
**Figure S1 (on this and following page).** (A) Single grain double dating results showing U-Pb versus fission track zircon ages for modern river samples, with associated 1 sigma errors depicted. The source region(s) is labeled for each individual sample in the gray box above the plot. Age populations (P1, P2, etc.) are shown in different colors. The colored bars indicated major Mesozoic-Tertiary magmatic belts (Finzel and Ridgway, 2017).

**B Kenai Peninsula:**

**Figure S1 (continued).** (B) Single grain double dating results showing U-Pb versus fission track zircon ages for Cenozoic samples, with associated 1 sigma errors depicted. The source region(s) is labeled for each individual sample in the gray box above the plot. Age populations (P1, P2, etc.) are shown in different colors. The colored bars indicated major Mesozoic-Tertiary magmatic belts (Finzel and Ridgway, 2017).



**Figure S2 (on this and following page).** The zircon U-Pb ages probability density distribution for individual exhumational cooled FT age populations. (A) Modern sand samples. The peak age of the age population is plotted along the y-axes. \* indicates samples from Finzel et al. (2016).



**Figure S2 (continued).** (B) Cenozoic strata samples. The peak age of the age population is plotted along the y-axes. \* indicates samples from Finzel et al. (2016).