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GSA Data Repository Item 2018274

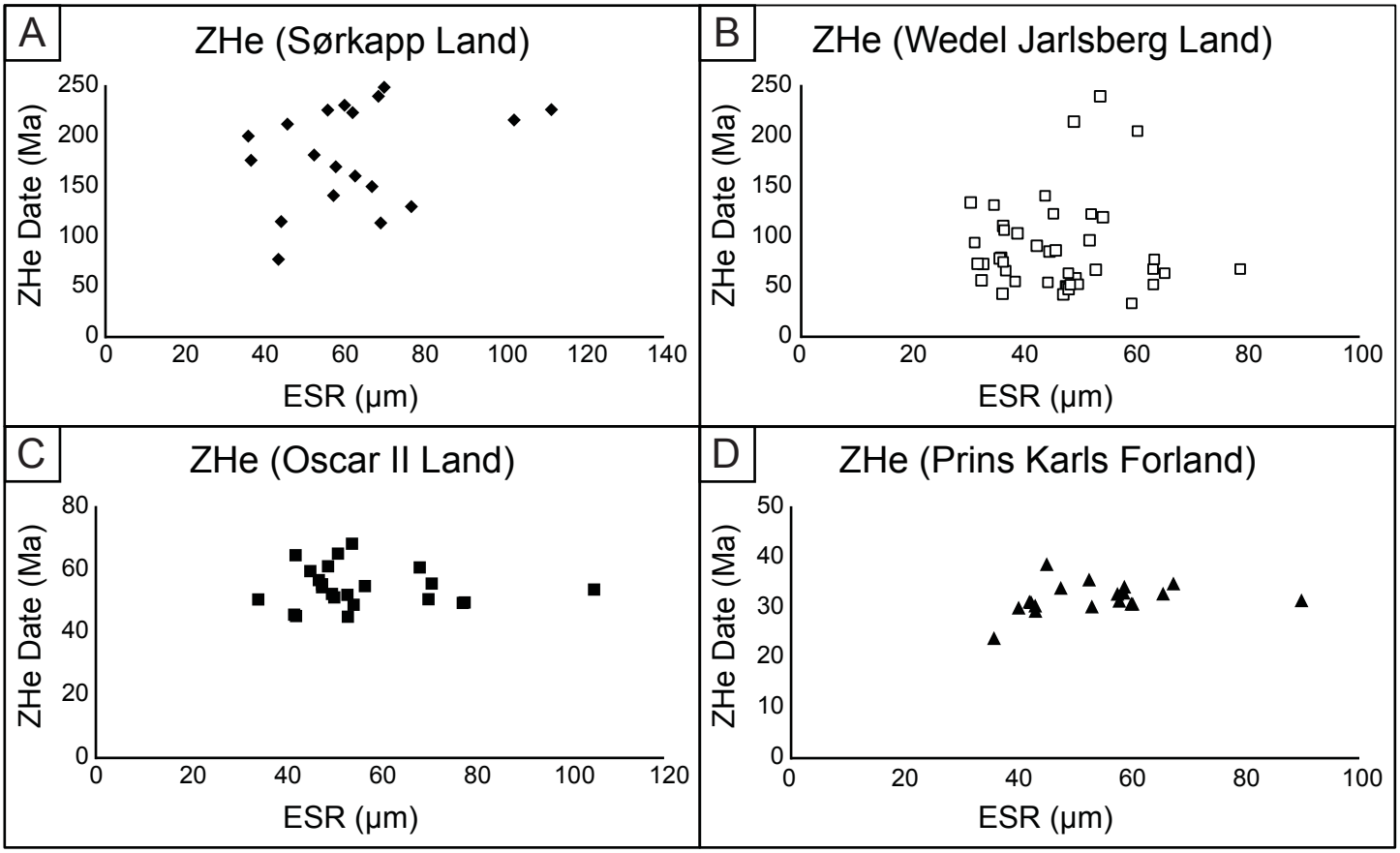

Figure A1

Fig. A1. ZHe date vs. Equivalent Spherical Radius (ESR) graphs, grouped by sample area. No definitive positive ZHe date vs. ESR correlations are observed in the ZHe datasets.

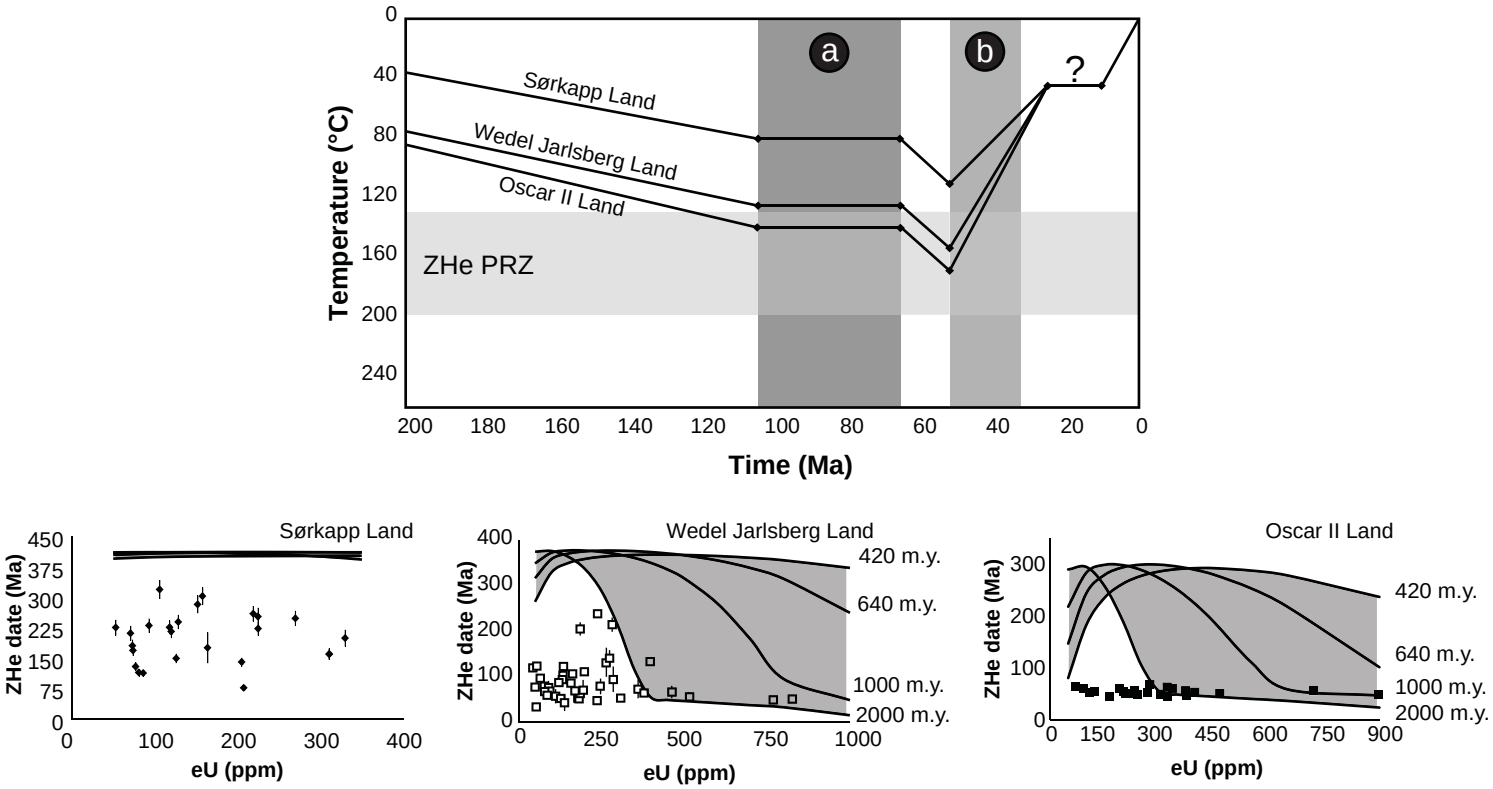

Figure A2

Fig. A2. Schematic time-temperature models and corresponding ZHe date-eU plots for Sørkapp Land, Wedel Jarlsberg Land and Oscar II Land depicting a scenario in which the Late Cretaceous depositional hiatus is treated as a period of non-deposition (c. 105-65 Ma) such that temperatures remain constant for this time period. Temperatures for each area are calculated based on a 40°C/km geothermal gradient and Carboniferous (Triassic for Sørkapp Land) to Cretaceous sedimentary overburden (Dallmann, unpublished data) of 1750, 2900, and 3200 m for Sørkapp Land, Wedel Jarlsberg Land and Oscar II Land, respectively. Results of the models do not produce an inheritance envelope (shaded grey on date-eU plot) that satisfies our ZHe datasets for any of the area. The inheritance envelope is defined by date-eU curves for detrital zircon grains which have been accumulating radiation damage for 420, 640, 1000 and 2000 m.y. Vertical grey bars on the t-T model indicate the amount of time represented by, (a) the Late Cretaceous hiatus and (b) duration of Eurekan deformation. The question mark on the t-T history model indicates poorly constrained temperatures. The timing of inflection points in t-T space are governed by our geological constraints and timing of key events. Timing of post-Eocene cooling history is based from the results of Dörr et al. (2013).

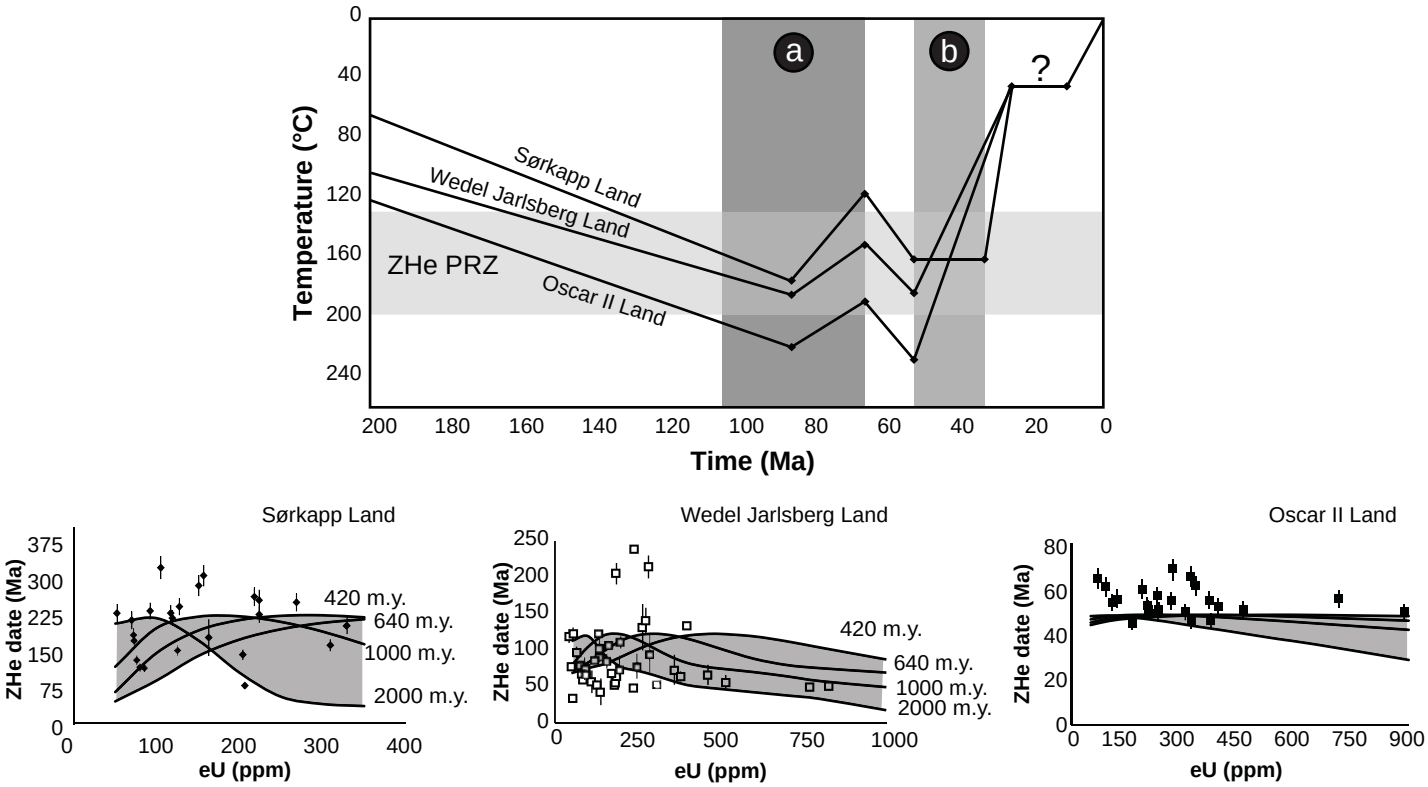

Figure A3

Fig. A3. Schematic time-temperature models and corresponding ZHe date-eU plots for Sørkapp Land, Wedel Jarlsberg Land and Oscar II Land depicting a scenario in which elevated Late Cretaceous temperatures result solely on a geothermal gradient of ~60°C/km while estimates of Carboniferous (Triassic for Sørkapp Land) to Cretaceous sedimentary overburden (Dallmann, unpublished data) of 1750, 2900, and 3200 m for Sørkapp Land, Wedel Jarlsberg Land and Oscar II Land, respectively. We also include an additional 900, 700 and 200 m of deposition from c. 105-85 Ma, for Sørkapp Land, Wedel Jarlsberg Land and Oscar II Land, respectively, based on sedimentary thicknesses of the Helveti-afjellet and Carolinefjellet Formations. The geothermal gradient is not modelled to change from the Late Cretaceous through Eocene. Results of the models are close to satisfying the Sørkapp Land dataset, however Wedel Jarlsberg Land and Oscar II Land datasets are not adequately explained by the inheri-tance envelope (shaded grey on date-eU plot). The envelope is defined by date-eU curves for detrital zircon grains which have been accumulating radiation damage for 420, 640, 1000 and 2000 m.y. Vertical grey bars on the t-T model indicate the amount of time represented by, (a) the Late Cretaceous hiatus and (b) duration of Eurekan deformation. The question mark on the t-T history model indicates poorly constrained temperatures. The timing of inflection points in t-T space are governed by our geological constraints and timing of key events. Timing of post-Eocene cooling history is based from the results of Dörr et al. (2013).

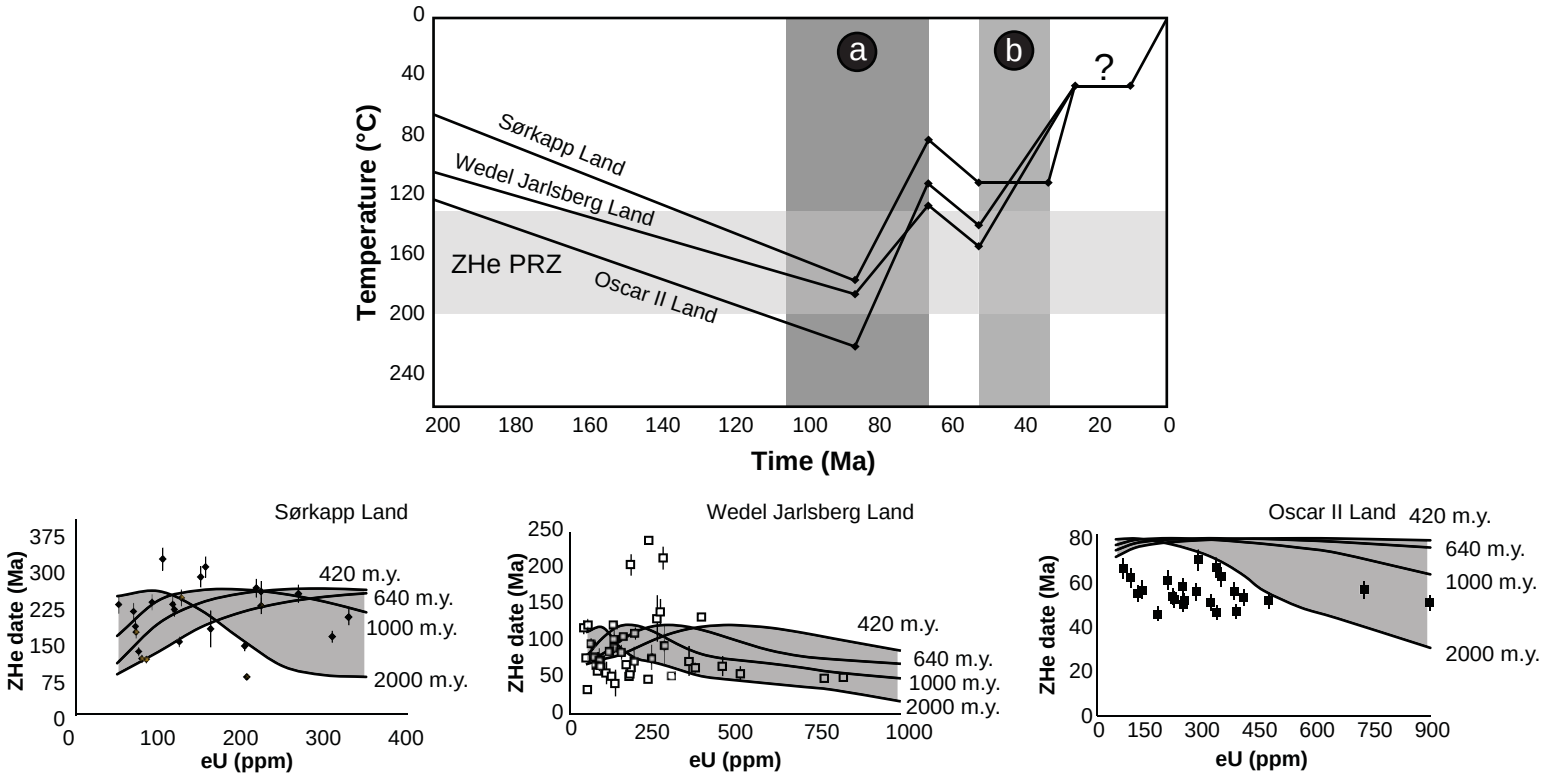

Figure A4

Fig. A4. Schematic time-temperature models and corresponding ZHe date-eU plots for Sørkapp Land, Wedel Jarlsberg Land and Oscar II Land depicting a scenario in which maximum sedimentary overburden is greater than estimated by isopach maps (Dallmann, unpublished data) and our inferred thickness of Late Cretaceous deposits. The geothermal gradient is assumed to be 40°C/km and is not modelled to change from the Late Cretaceous through Eocene. Results of the models are close to satisfying the Sørkapp Land dataset, however Wedel Jarlsberg Land and Oscar II Land datasets are not adequately explained by the inheritance envelope (shaded grey on date-eU plot). The envelope is defined by date-eU curves for detrital zircon grains which have been accumulating radiation damage for 420, 640, 1000 and 2000 m.y. Vertical grey bars on the t-T model indicate the amount of time represented by, (a) the Late Cretaceous hiatus and (b) duration of Eurekan deformation. The question mark on the t-T history model indicates poorly constrained temperatures. The timing of inflexion points in t-T space are governed by our geological constraints and timing of key events. Timing of post-Eocene cooling history is based from the results of Dörr et al. (2013).

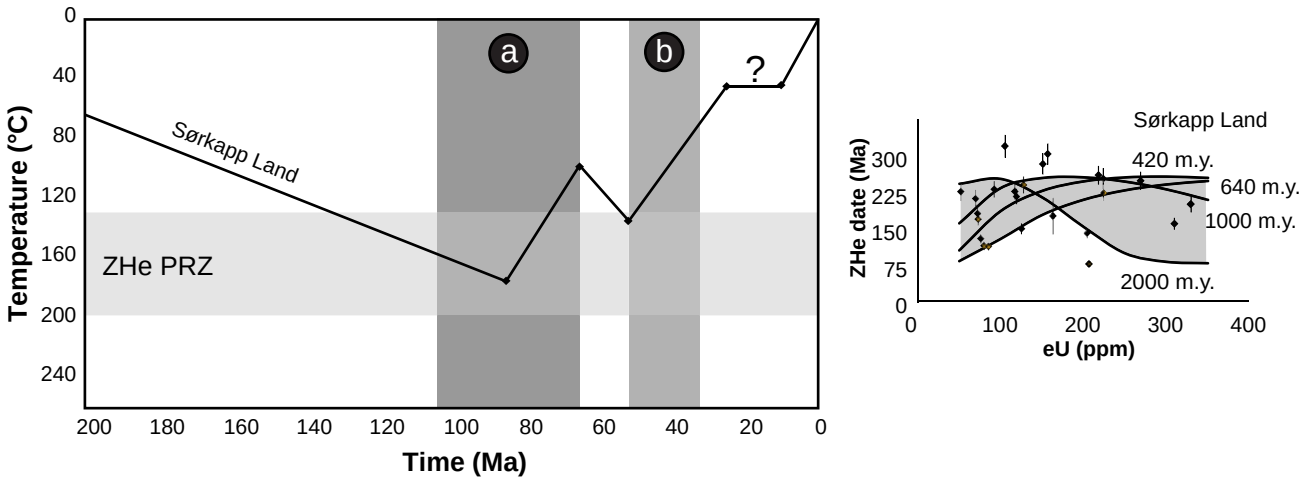

Figure A5

Fig. A5. Schematic time-temperature models and corresponding ZHe date-eU plots for Sørkapp Land testing the sensitivity of timing of cooling. This model uses the same model parameters as Model 2 in the main article such that temperatures realized in the Late Cretaceous result from greater than estimated sedimentary overburden and an elevated geothermal gradient (>40°C/km). Cooling for this model initiates at c. 53 Ma, corresponding to the onset of Eurekan tectonism in Svalbard and development of the West Spitsbergen Fold-and-Thrust Belt. However, Eurekan deformation did not directly affect our sample site. The geothermal gradient is not modelled to change from the Late Cretaceous through Eocene. Results of the models satisfy the Sørkapp Land dataset. The envelope is defined by date-eU curves for detrital zircon grains which have been accumulating radiation damage for 420, 640, 1000 and 2000 m.y. Vertical grey bars on the t-T model indicate the amount of time represented by, (a) the Late Cretaceous hiatus and (b) duration of Eurekan deformation. The question mark on the t-T history model indicates poorly constrained temperatures. The timing of inflection points in t-T space are governed by our geological constraints and timing of key events. Timing of post-Eocene cooling history is based from the results of Dörr et al. (2013).

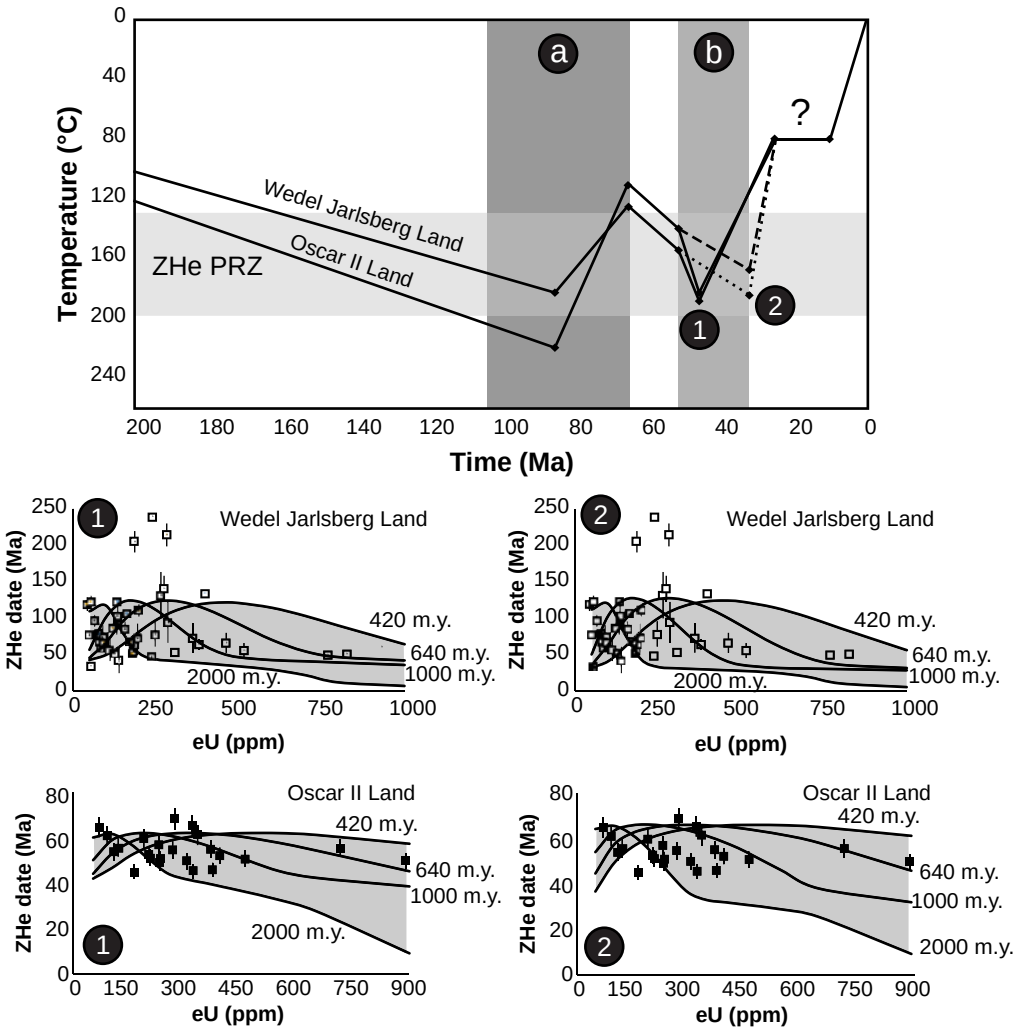

Figure A6

Fig. A6. Schematic time-temperature models and corresponding ZHe date-eU plots for Wedel Jarlsberg Land and Oscar II Land to test the sensitivity of the sample residing at hotter temperatures (~80°C) between c. 25-10 Ma than compared to Model 3 in the main article. Models parameters are the same as outlined for Model 3. The resulting inheritance envelopes (shaded grey on date-eU plot) satisfy the datasets for Wedel Jarlsberg Land and Oscar II Land. The envelope is defined by date-eU curves for detrital zircon grains which have been accumulating radiation damage for 420, 640, 1000 and 2000 m.y. Vertical grey bars on the t-T model indicate the amount of time represented by, (a) the Late Cretaceous hiatus and (b) duration of Eurekan deformation. The question mark on the t-T history model indicates poorly constrained temperatures. The timing of inflection points in t-T space are governed by our geological constraints and timing of key events. Timing of post-Eocene cooling history is based from the results of Dörr et al. (2013).