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Supplementary Materials for

A large-scale transcontinental river system crossed West Antarctica during the Eocene

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This PDF file includes:

Supplementary Figs. S1 to S9

Other Supplementary Materials for this manuscript include the following:

A spreadsheet with the supplementary tables

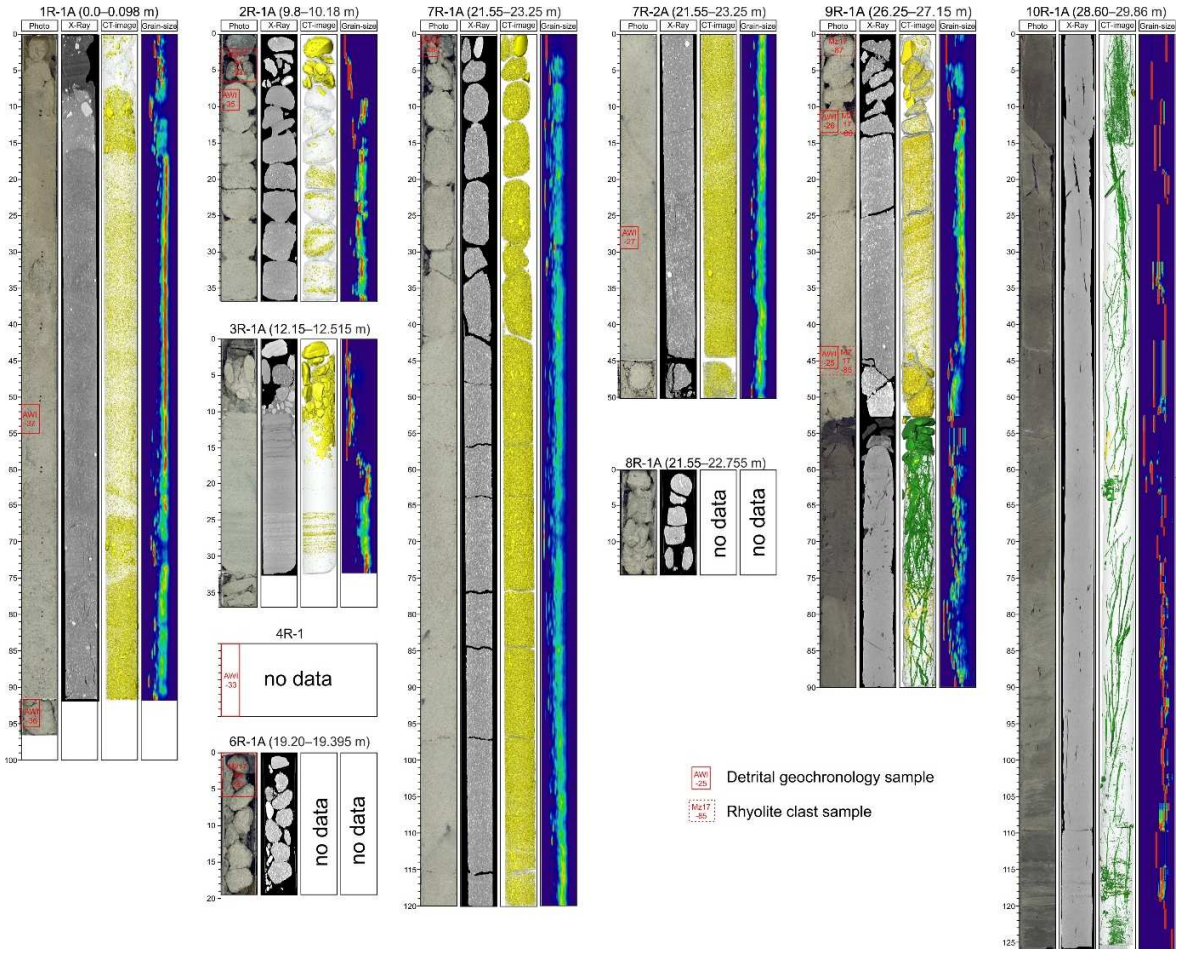

Fig. S1: Scans and grain-sized distribution from recovered core sections of site PS104_20-2. CT data processing was performed with the ZIB edition of the Amira software (version 2017.39, (114). CT-images show particles >1 mm in yellow while lignite fragments and roots are displayed in green. Grain-size distributions are scaled in phi values from -7 (left) to -1 (right), but need to be treated with care. Note that the number of clasts >1 mm below the hiatus (contained in segment 9R-1A) is very low.

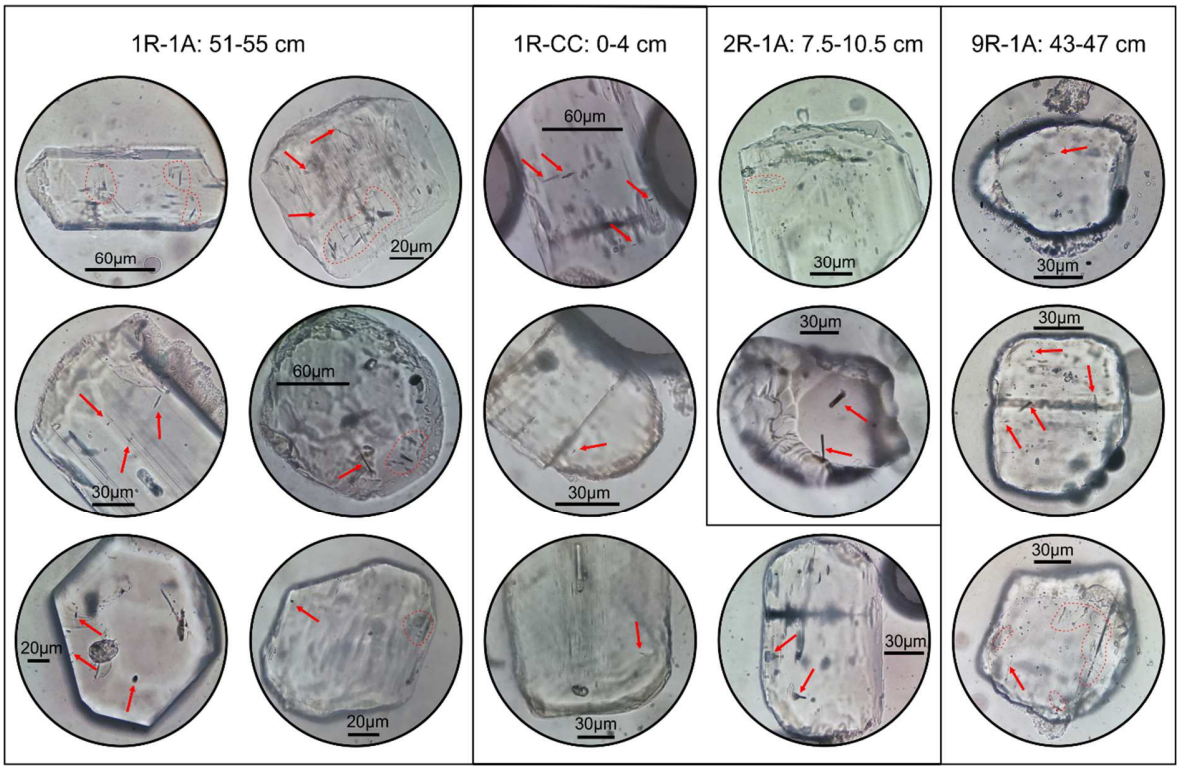

Fig. S2: Apatite crystals revealing naturally etched fission tracks and other crystal defects. Fission tracks and crystal defects are highlighted by red arrows and red dashed lines. Photomicrographs were taken of internal surfaces of apatite mounted in epoxy through an optical microscope at 1000x magnification with transmitted light.

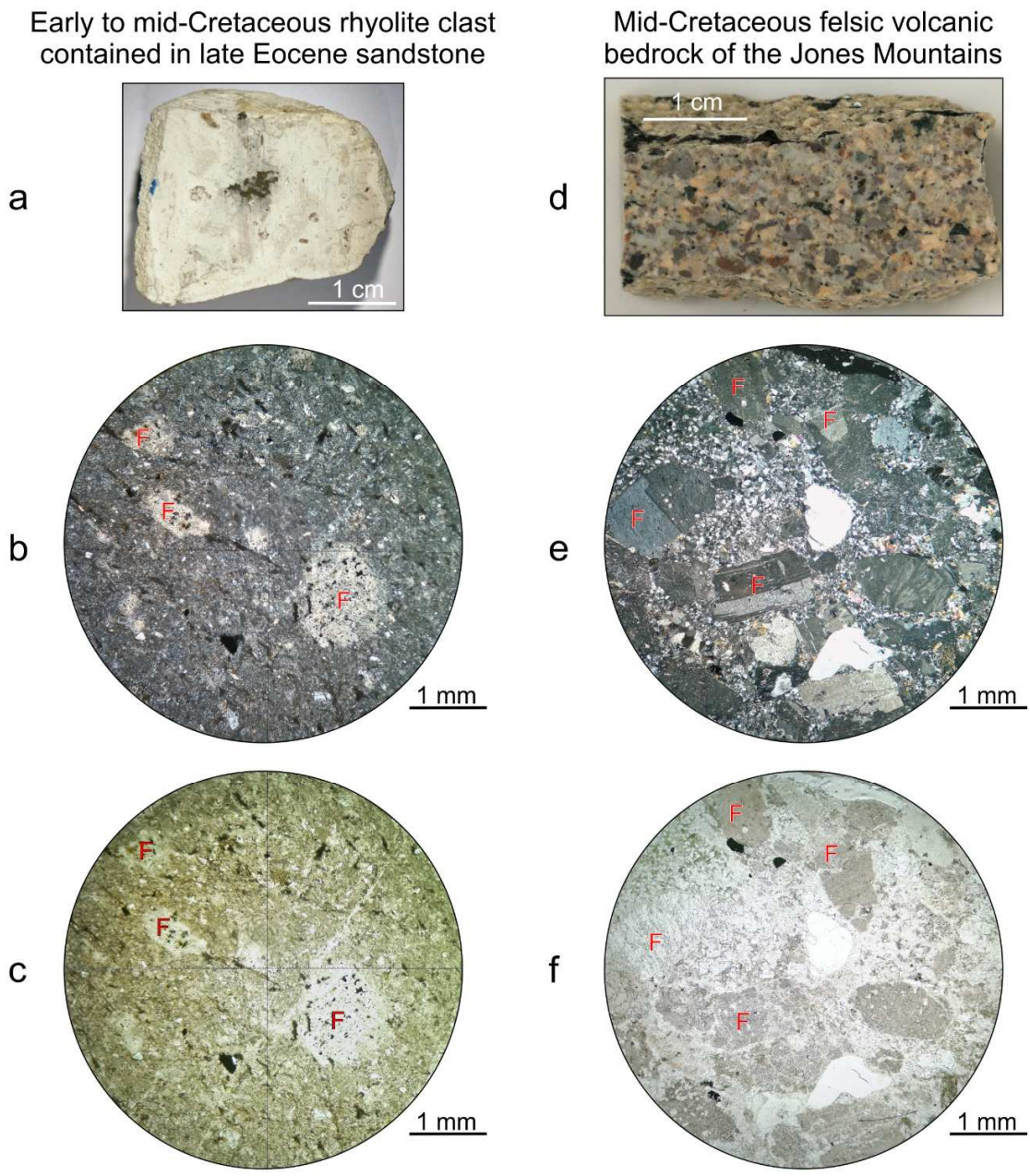

Fig. S3: Comparison of rhyolite bedrock from the Jones Mountains and rhyolite pebbles from the Polarstern Sandstone. a: Example of a rhyolite pebble contained in the Polarstern Sandstone; **b:** Thin section of the rhyolite pebble in cross-polarized light; **c**: Same thin section as (b) in plane-polarized light; **d:** Hand specimen of a rhyolitic bedrock from the Jones Mountains; **e**: Thin section of the rhyolitic bedrock in cross-polarized light; **f:** Same thin section as (e) in cross-polarized light. Note the alteration states of the feldspars (F).

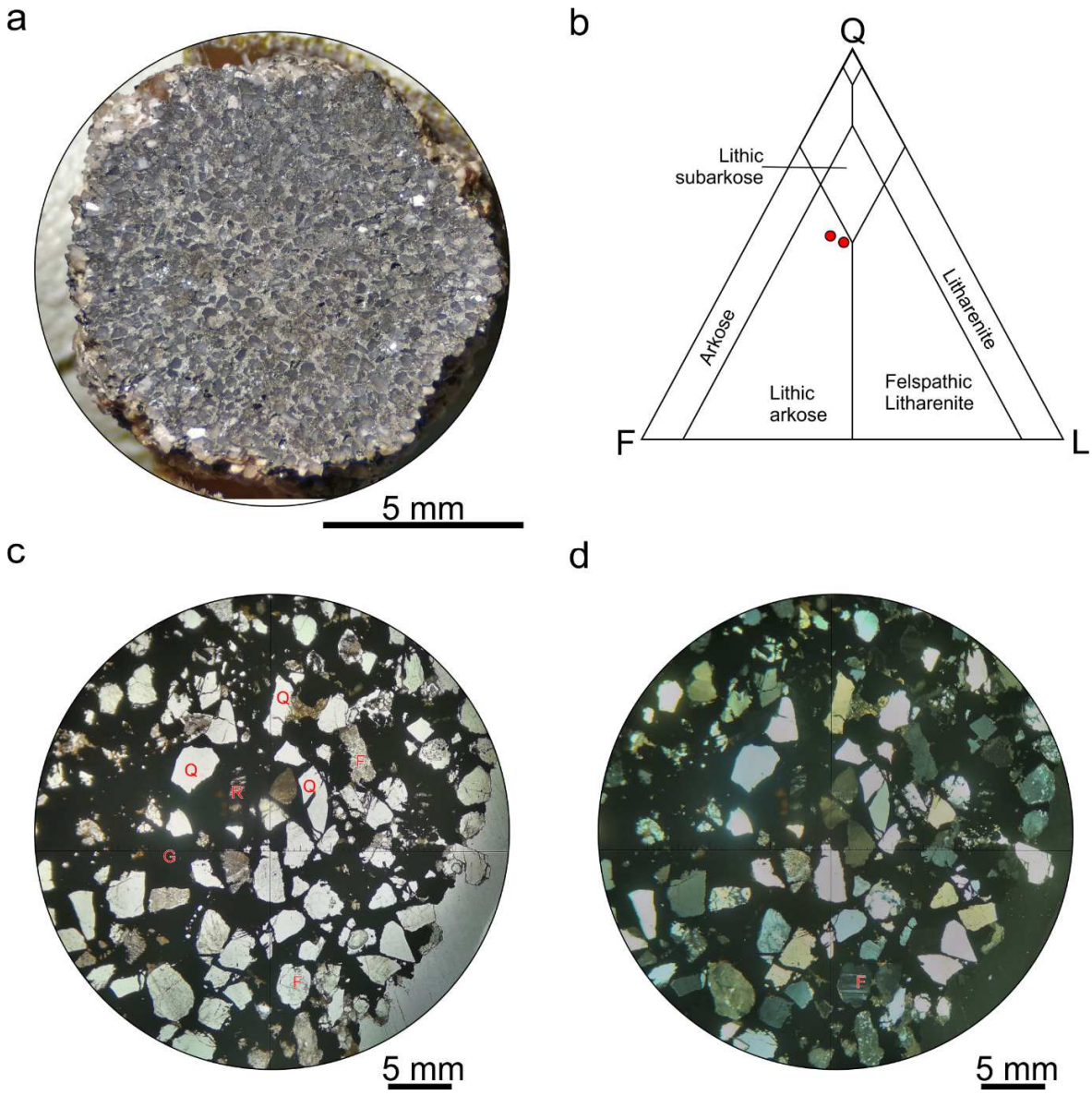

Fig. S4: Characterization of lithic arkose pebbles contained in the Polarstern Sandstone (at 26.37 and 23.04 mbsf). a: Pebble with angular grains embedded in fine-grained Fe-rich groundmass; **b**: Quartz-Feldspar-Lithic fragment (QFL)-diagram in which the sandstone pebbles (red dots) are classified as lithic arkoses based on data obtained by point-counting, using the software program JMicroVision (v1.3.1 ((*108*), see Material and Methods); **c:** Plane-polarised photomicrograph showing individual components of the lithic arkose pebble. Q=quartz; F=feldspar; L=lithic clasts; G=groundmass; **d:** Corresponding cross-polarised micrograph of (c).

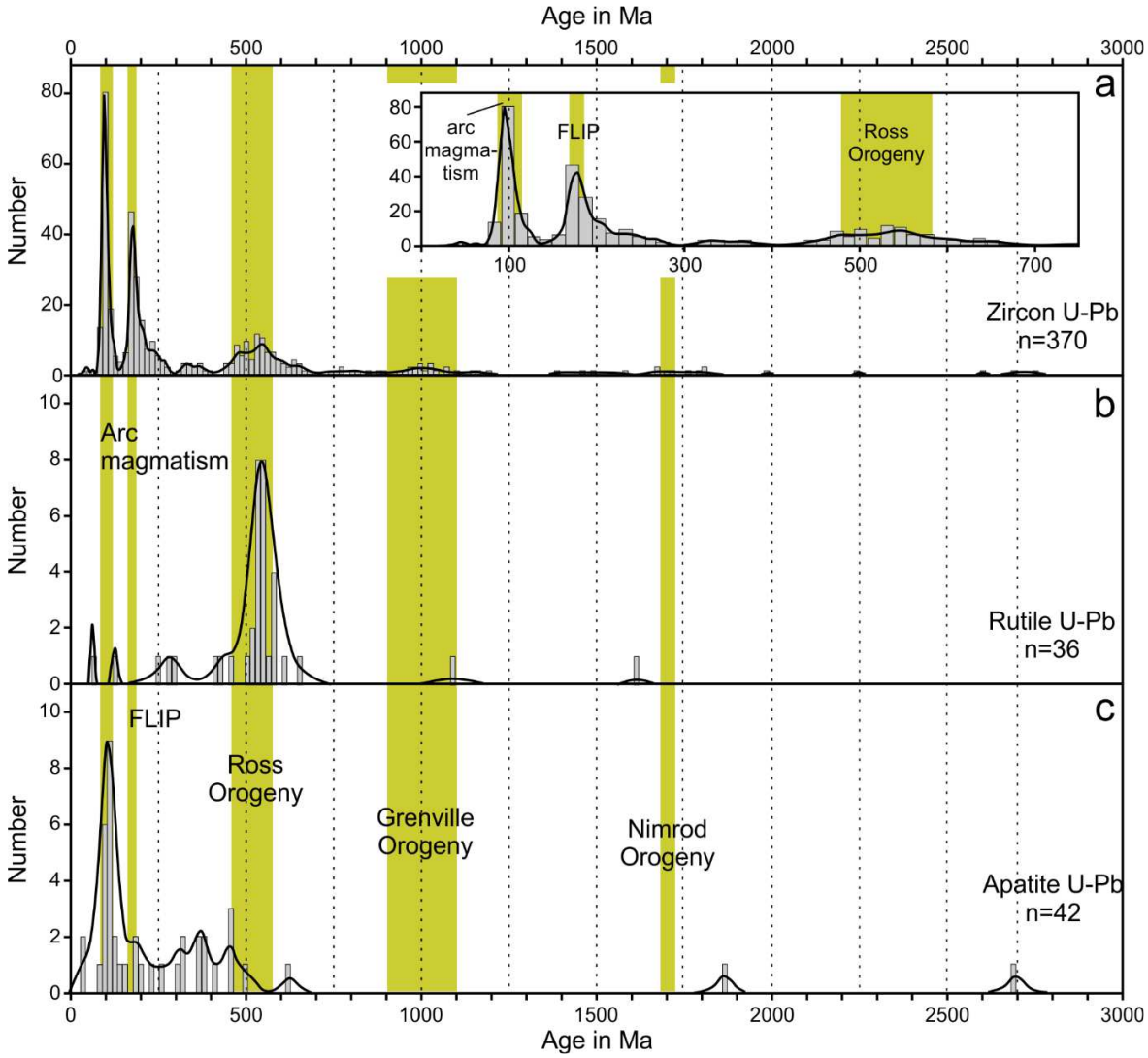

Fig. S5: Histogram and probability distribution curves of U-Pb ages. a: U-Pb ages of detrital zircon; **b:** U-Pb ages of detrital rutile; **c:** U-Pb ages of detrital apatite. Major magmatic events and orogenies are also indicated. FLIP = Ferrar Large Igneous Province.

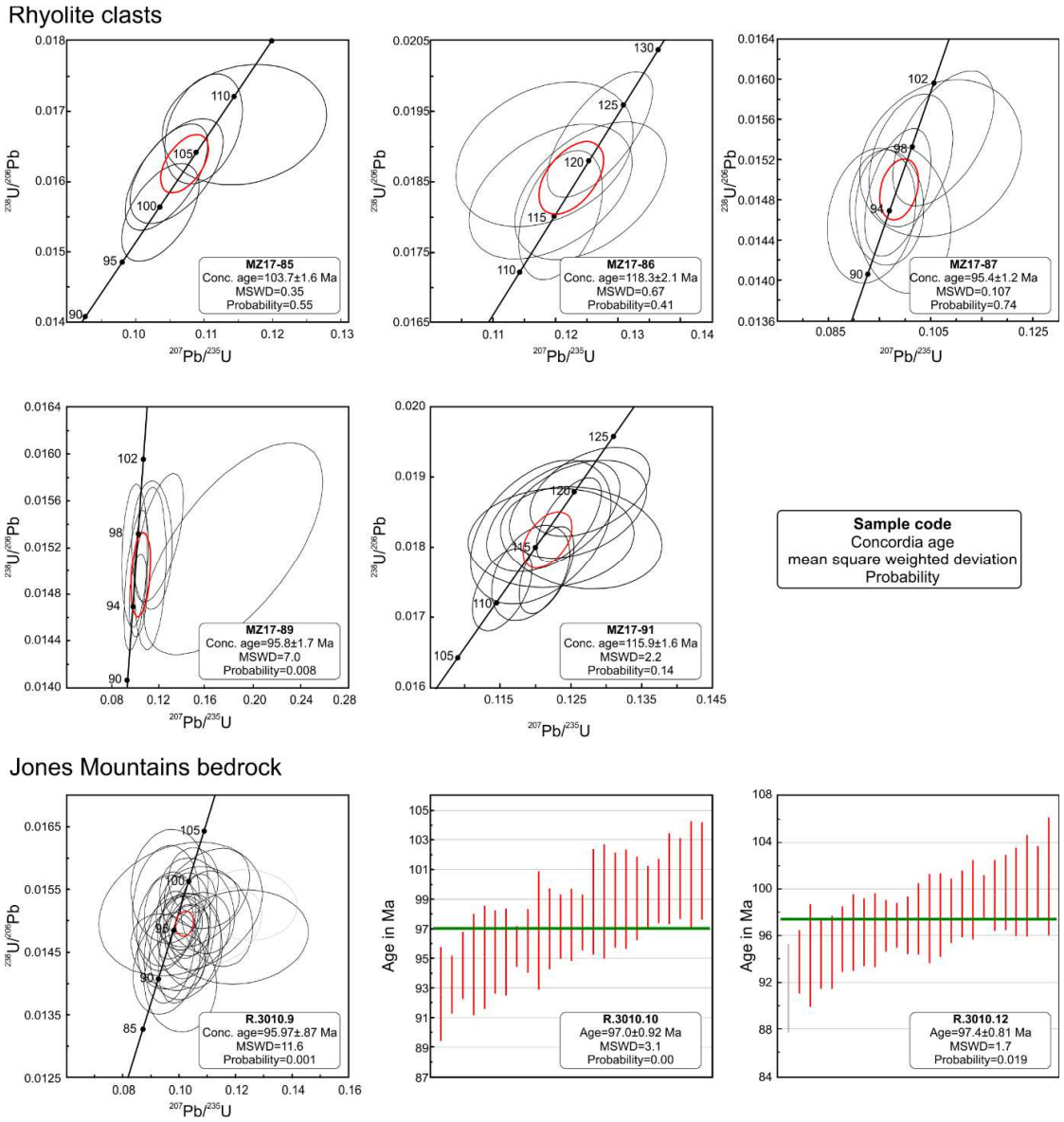

Fig. S6: Zircon U-Pb data from rhyolitic pebbles, compared to rhyolitic bedrock from the potential source area. Upper panels: Concordia plots of zircon U-Pb data for rhyolite pebbles contained in the middle to late Eocene Polarstern Sandstone. Lower panels: Bedrock volcanic and volcaniclastic rocks from the Jones Mountains. The red ellipse represents the concordia age. Note that ages displayed for samples R.3010.10 and R.3010.12 are weighted mean single-grain concordia ages.

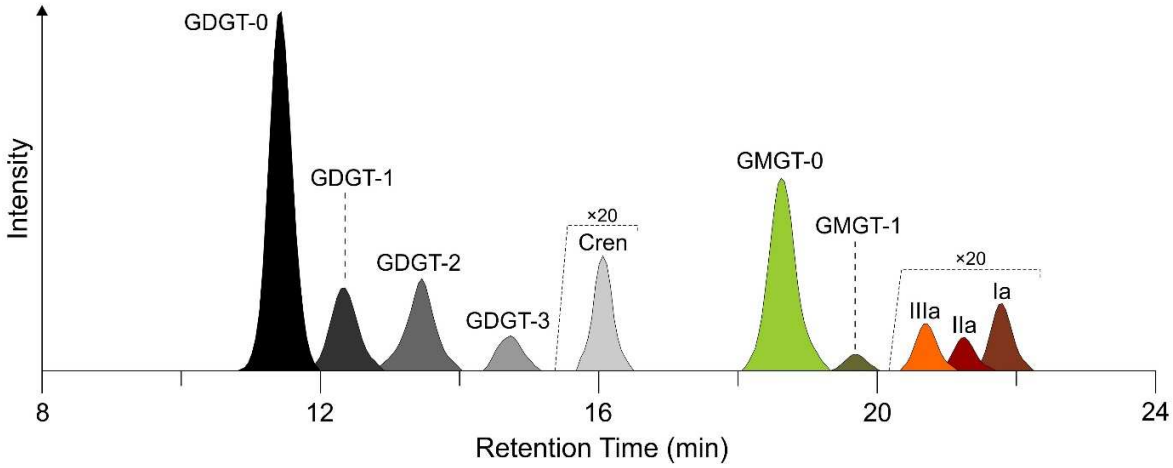

Fig. S7. Composite mass chromatogram showing the distribution of archaeal and bacterial tetraethers in the Polarstern Sandstone. Cren = crenarchaeol; GDGT= glycerol dialkyl glycerol tetraether; GMGT = glycerol monoalkyl glycerol tetraether. Numbers indicate the amount of cyclopentane rings in the molecule structure. Roman numerals refer to the different bacterial-derived GDGTs (Ia, IIa, IIIa) detected in the sandstone**.**

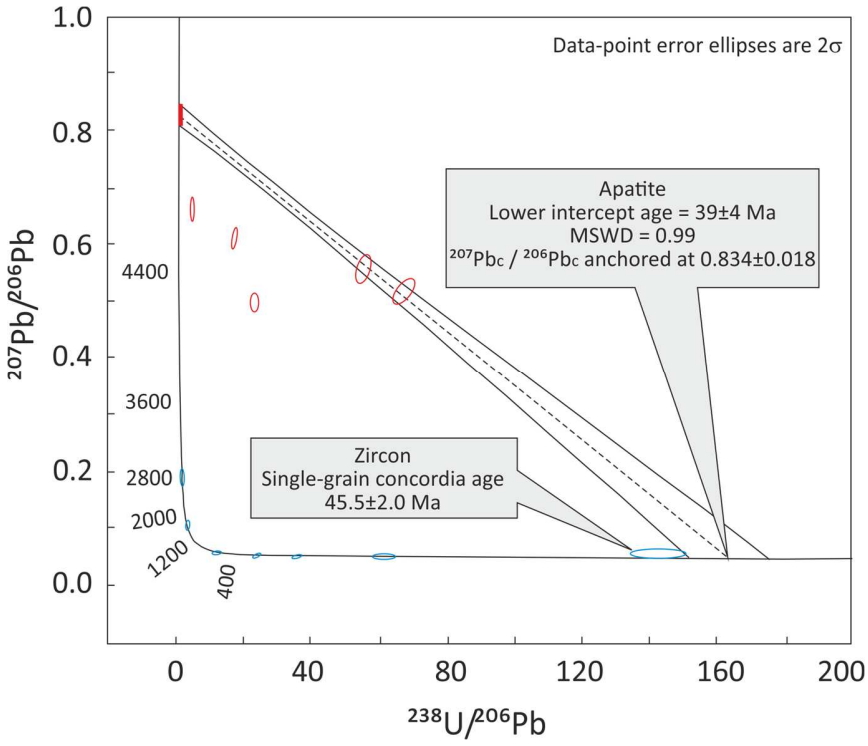

Fig. S8: Tera-Wasserburg diagram showing U-Pb data from apatite and zircon. Red symbols refer to apatite samples (9.9 mbsf); blue symbols refer to zircon samples (26.7 mbsf). Red bar at upper array intercept for Eocene apatite is the range of crystalline basement $^{207}Pb_c/^{206}Pb_c$ values for West Antarctica (*47*), which anchor the apatite age calculation.

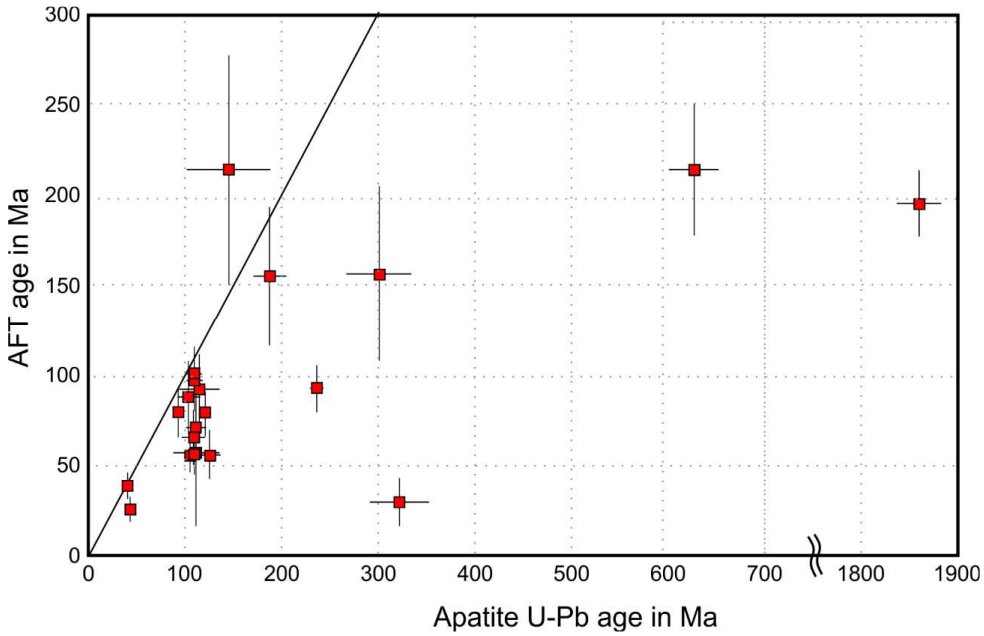

Fig. S9: Results of apatite U-Pb / FT double dating. The figure shows U-Pb ages vs AFT ages for all double-dated detrital apatite grains. Black line connects points of equal U-Pb and AFT age. U-Pb and AFT error bars are 2σ and 1σ, respectively.

The supplementary tables include:

- Table S1: The Science Team of Expedition PS104
- Table S2: Documentation and analytical information of individual samples analysed for this study.
- Table S3: Analytical details of LA-ICP-MS U-Pb, Lu-Hf isotopes and trace element measurements of detrital zircons contained in the sandstone of drill core PS104_20-2.
- Table S4: Analytical details of LA-ICP-MS U-Pb, Lu-Hf isotopes and trace element measurements of zircons contained in rhyolitic pebbles of drill core PS104_20-2.
- Table S5: Analytical details of LA-ICP-MS U-Pb and trace element measurements of zircons contained in rhyolitic bedrock from the Jones Mountains (Thurston Island Block).
- Table S6: Secondary standards measured during U-Pb analyses.
- Table S7: Analytical details of LA-ICP-MS U-Pb geochronology, Sm-Nd isotopes and trace elements measurements of detrital apatite contained in the sandstone of drill core PS104_20-2.
- Table S8: Analytical details of LA-ICP-MS U-Pb geochronology and trace elements measurements of detrital rutile contained in the sandstone of drill core PS104_20-2.
- Table S9: Standards measured during Hf and Nd isotopic analyses.
- Table S10: Analytical details of fission track analyses of detrital apatite contained in the sandstone of drill core PS104_20-2.
- Table S11: Results of XRD Analyses of rhyolitic bedrock from the Jones Mountains compared to rhyolitic pebbles contained in drill core PS104_20-2.

- Table S12: Compositional analysis of the clay fraction (<2 µm) contained in the drill core PS104_20-2.
- Table S13: Results of the biomarker analyses of the sandstone of drill core PS104_20-2.
- Table S14: Grain size distribution (sand, silt and clay) of the sedimentary rocks retrieved from drill core PS104_20-2.
- Table S15: Sphericity of grains <2 mm, contained in drill core PS104_20-2.
- Table S16: Convexity of grains <2 mm, contained in drill core PS104_20-2.
- Table S17: Aspect ratio of grains <2 mm, contained in drill core PS104_20-2