**Targeted *P–T* modelling and in-situ garnet dating on polymetamorphic metapelite provides the first compelling evidence for Rodinian tectonism recorded in south-west Tasmania**

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# Extended electron probe microanalysis (EPMA) methods

Ti Kα X-rays were counted using both PET and LPET crystals on five tuneable wavelength dispersive spectrometers, with the intensities from all five spectrometers aggregated for optimal sensitivity. Ti Kα was calibrated using a synthetic Ti standard and corrections for continuum artifacts were undertaken using the quantitative blank correction method of Donovan et al. (2011). Blank corrections were performed using Spectrosil Glass 3 (Ti = 3.94 ± 0.33 ppm) with a specified SiO2 concentration of 100% for matrix corrections. The electron microprobe operated with a 20 kV accelerating voltage, a 200 nA beam current, and beam sizes of 2 µm and 5 µm. Traditional 2-pt background was performed using the alternating On/Off peak method, with a peak counting time of 60 s and background of 30 s. Eight alternating On/Off peak measurements were made for a total count time per spot of ~1500 s. Individual measurements have a 2 ppm detection limit. To avoid secondary fluorescence effects, quartz inclusions in the vicinity of rutile and ilmenite were avoided and multiple measurements were made on individual quartz grains to test consistency. Additionally, secondary fluorescence boundary profiles were modelled using the Penepma module in Probe for EPMA software.

# Extended Lu–Hf geochronology (LA–ICP–MS/MS) methods

Lu–Hf analysis of apatite and garnet was performed via LA–ICP–MS/MS following the method of Simpson et al. (2021). The method utilises an ICP–MS/MS with two quadrupole mass analysers and a collision cell. These quadrupoles are synchronised such that they simultaneously cycle through masses of interest during analysis (e.g. 172Yb, 175Lu, 176Lu, 176Hf, and 176Yb), measuring the masses sequentially and rejecting off-mass ions. In order to accurately measure 176Hf, the first quadrupole is set to filter and reject all off-mass ions. 176Lu, 176Hf, and 176Yb pass into the collision cell and react with a mixture of 10% NH3 and 90% He, forming large cluster ions as the reaction products (e.g. +82 Yb, +16 Lu, +82 Lu, +82 Hf). The +82 product is equivalent to (Yb/Lu/Hf)((NH)(NH2)(NH3)3)+ and the +16 product is equivalent to Lu(NH2)+. The second quadrupole (situated after the reaction cell) is set to allow (178+82)Hf to pass to the detector, but filter all other masses. The NH3–He mixture is used (total flow rate of 3 mL/min) in order to minimise isobaric interference on 176Hf from Lu and Yb. The use of NH3 was found to maximise production of (176+82)Hf while maintaining sufficiently low (172+82)Yb (~0.00003%) and (175+82)Lu (~0.03%) given the proclivity for both Yb and Lu to react with one additional H atom than Hf, thereby allowing mass separation. Both quadrupoles can be set to filter identical masses in cases where elements do not react significantly with NH3, and do not have significant isobaric interferences.

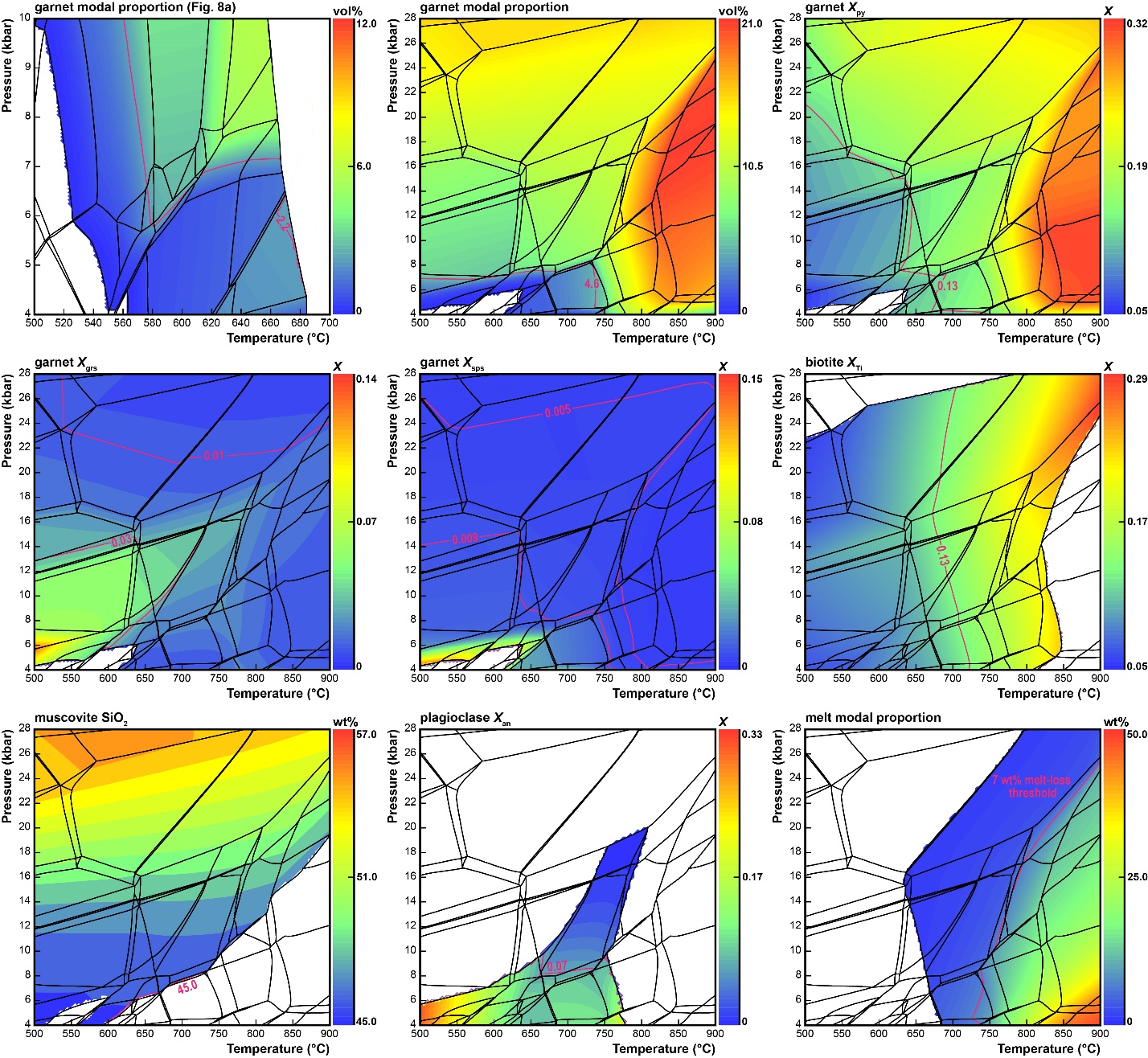
Given their higher abundances and lack of interferences, 175Lu and 178Hf were monitored as proxies for 176Lu and 177Hf, respectively. Background-subtracted 176Hf/176Lu, 176Lu/177Hf, and 176Hf/177Hf ratios for garnet were calculated using a two-stage normalisation procedure. First, ratios were calibrated to synthetic glass standard NIST-610 using LADR (Norris & Danyushevsky, 2018), as opposed to directly converting measured 175Lu and 178Hf into 176Lu and 178Hf. Implicit in this calculation is that the 176Lu/175Lu and 177Hf/178Hf ratios of NIST-610 and the analysed sample are the same, and therefore, the unknowns can be corrected by the offset between the NIST-610 175Lu/178Hf ratio and the published 176Lu/177Hf ratio (0.1379 ± 0.005; Nebel et al., 2009; Simpson et al., 2022). NIST-610 was analysed using a spot size of 30 µm, with the comparatively small spot size ensuring detection of both Lu and Hf in pulse mode (as opposed to analogue mode).

To account for laser induced elemental fractionation, Lu–Hf ratios were then normalised to the ‘pseudo-primary’ reference material Hogsbo garnet, with secondary reference material Black Point garnet used for accuracy checks (e.g. Simpson et al., 2021). All matrix-matched reference materials were analysed using a spot size of 100 µm, with a proportion of Hogsbo garnet analyses also acquired using a smaller spot size of 43 µm to ensure detection of the relevant isotopes in pulse mode. Sample-standard bracketing was implemented at every ~30 unknown analyses. Session-dependent fractionation correction factors were applied to the 176Lu/177Hf ratios of all unknowns. The correction is based on the difference between (1) the calculated lower-intercept date of an inverse regression through Hogsbo analyses and (2) the expected lower-intercept date based on the Hogsbo published date. Additionally, the uncertainty on the calculated date for Hogsbo was propagated to the uncertainties on the 176Lu/177Hf and 176Lu/176Hf ratios. In session one, Hogsbo yielded a lower-intercept linear regression date of 1068.9 ± 2.6 Ma (published date = 1029 ± 1.7 Ma; Romer & Smeds, 1996), resulting in a correction factor of ~3.7% (MSWD = 1.30, n = 179). Black Point garnet returned a lower-intercept linear regression date of 1750 ± 13.2 Ma (MSWD = 1.30, n = 24), which is within uncertainty of the expected date (1745 ± 14 Ma; Lane, 2011). In session two, Hogsbo yielded a lower-intercept linear regression date of 1070.3 ± 6.2 Ma (MSWD = 0.99, n = 30), resulting in a correction factor of ~3.9%. Black Point garnet returned a lower-intercept linear regression date of 1752 ± 16 Ma (MSWD = 1.00, n = 25).

Ca was used as the internal reference element for the calibration of a small selection of trace elements measured concurrently with Lu–Hf isotopes in apatite. For garnet, Al was used as the internal reference element. Stoichiometric concentrations of 39.4 wt% and 10.84 wt% were used for Ca and Al, respectively. Calibration was undertaken using NIST-610 (Jochum et al., 2011). The identification of contamination in apatite and garnet (primarily from zircon and rutile) was made based on trace element concentrations.

Inverse isochrons were used for the presentation of Lu–Hf data in this study (Li & Vermeesch, 2021). Given 177Hf is low in abundance in apatite, the 176Hf/177Hf and 176Lu/177Hf ratios, which are used for conventional isochrons, have large and correlated uncertainties, resulting in ‘flattened’ ellipses on a conventional isochron diagram (Gillespie et al., 2022). The utility of the inverse isochron in the context of Lu–Hf data is that it eliminates 177Hf from the denominator, instead using the ratios, 177Hf/176Hf and 176Lu/176Hf, resulting in data that is more easily interpreted (Li & Vermeesch, 2021). The isochron regressions were anchored to an initial 177Hf /176Hf ratio of 3.55 ± 0.07 which encompasses the full range of variation in the lithospheric reservoir (e.g. Simpson et al., 2022; Glorie et al., 2023).

# Extended phase equilibrium modelling results



**Fig. S1.** Modelled mineral modal proportions and compositions for the *P–T* pseudosections presented in Figure 9. Each isopleth marked pink represents the independently-calculated mode or composition of a given mineral.

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