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HT thermal history of the intermediate-pressure metamorphism of Naxos (Greece): insights from modelling intra-crystalline diffusion of major elements in garnet

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Naxos is a metamorphic and structural dome that has experienced HP (55-45 Ma) and HT-LP (21-12 Ma) metamorphic conditions, with the latter thermal event contemporaneous with Miocene extension. The two main thermal events are well constrained by thermochronology data, but the P-T-time path that links them is still disputed. Two such paths have been proposed: the first is a "classical" prograde one-stage P-T loop, while the second involves early decompression of HP rocks followed by isobaric heating to peak metamorphic conditions. We studied these two end-member thermal histories by forward modelling the mineral assemblages formed by each, and the major element garnet zoning established (by growth and intra-crystalline diffusion) along these paths.

Chemical zoning in garnet crystals is a particularly promising tool for determining P-T-time paths. In essence, careful forward modelling of temperature-time-dependent intra-crystalline diffusion in garnet can provide key constraints on the duration and magnitude of the HT history (T > 550 °C), by comparison with preserved natural chemical zoning. In order to calculate the garnet-growth rates, models generally assume constant heating/cooling rates and/or constant burial/exhumation paths. In our study, the P-T-time paths were obtained independently using a numerical 2D thermo-mechanical code for modelling extensional domes (I2ELVIS). These models account for phase transformations during the P-T history, crucially predicting major rheological changes associated with migmatisation. Coupling outputs from geodynamic modelling with predicted chemical zoning features allows us to decipher possible origins of the heat sources responsible for the intermediate-pressure metamorphism, such as post-collisional heat relaxation, asthenospheric upwelling, and shear heating.