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Geological significance of ^{40}Ar/^{39}Ar mica dates across a mid-crustal continental plate margin and implications for the evolution of lithospheric collisions

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The Connemara region of the Irish Caledonides is a world-class example of a regional-scale high-temperature metamorphic terrain. Its formation relates to calkalkaline magmatism in a double-vergent island arc-continent collisional setting, for which a protracted evolution was inferred based on a $>$ 75 Ma spread in U-Pb, Rb-Sr, and K-Ar mineral ages. Such a history is inconsistent with geological field observations, which imply a simple relationship between syntectonic magmatism, deformation and Barrovian-type metamorphism. Here, we explore the significance of the large spread in apparent cooling ages using ^{40}Ar/^{39}Ar mica thermochronometers of varying grain sizes and composition, which we collected across all metamorphic grades. We integrated geological and previously published geochronological evidence to identify a 32 Ma range (ca. 475 to 443 Ma) of permissible cooling ages and distinguished them from those dates not related to cooling after high-temperature metamorphism. Variations in ^{40}Ar/^{39}Ar dates at a single locality are $\leq$ 10 Ma, implying rapid cooling ($\geq$ 6 to 26°C/Ma) following metamorphism and deformation. A distinct cooling age variation ($\geq$ 15 Ma) occurs on the regional-scale, consistent with spatial differences in the metamorphic, magmatic, and deformational evolution across the Connemara region. This cooling record relates to a lateral thermal and strain-rate gradient in an evolving arc-continent collision, rather than to differential unroofing of the orogen. Our results imply that the large ($\geq$ 50 Ma) spread in thermochronometers commonly observed in orogens does not automatically translate into a protracted cooling history, but that only a small number of thermochronometers supply permissible cooling ages in context. The thermal evolution of the Connemara region proposed here may be explained in context with current models of arc-continent collision, but also involves deep-seated driving processes.