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Timing of ophiolite obduction and regional metamorphism in the Grampian orogen

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The Grampian terrane in the Caledonides of Scotland and NW Ireland is the type locality for Barrovian (regional) metamorphism, recognized in most mountain belts. It is thought to have resulted from the collision of the Laurentian margin with an oceanic arc and associated suprasubduction ophiolite during the Early Ordovician (van Staal et al., 1998). Here we address the timing and P-T conditions of Grampian ophiolite obduction and re-evaluate the link with regional metamorphism.

Magmatic zircons from the Highland Border Ophiolite, Scotland define a 499 $\pm$ 8 Ma U-Pb Concordia age. Its metamorphism is dated by a 490 $\pm$ 4 Ma ^{40}Ar-^{39}Ar hornblende age, and a 488 $\pm$ 1 Ma ^{40}Ar-^{39}Ar muscovite age from a metasedimentary xenolith within it, from which P-T estimates of 5.3 kbar and 580 ˚C relate to ophiolite obduction. Metamorphism of the Irish correlative of the Highland Border Ophiolite is constrained by a 514 $\pm$ 3 Ma ^{40}Ar-^{39}Ar hornblende age, while mica schist slivers within it yield detrital zircon U-Pb ages consistent with Laurentian provenance and Rb-Sr and ^{40}Ar-^{39}Ar muscovite ages of ca. 482 Ma. P-T values of 3.3 kbar and 580 ˚C for these rocks constrain the conditions of ophiolite obduction (Chew et al., 2010).

Peak Grampian metamorphism on the Laurentian margin (Dalradian Supergroup) is constrained to c. 475 – 465 Ma. This includes U-Pb zircon ages from Grampian syn-orogenic intrusives (a probable Andean-type arc which developed following subduction polarity reversal) and metamorphic mineral ages from Dalradian regions devoid of syn-orogenic intrusive rocks (Flowerdew et al., 2000; Chew et al., 2003). There is therefore a pronounced time gap between c. 470 Ma mineral ages in the Laurentian margin (Dalradian Supergroup) and c. 490 Ma mineral ages in the Grampian ophiolitic rocks. P-T conditions also differ markedly, with high T - low P metamorphism in the Grampian ophiolitic rocks and high P - low T (blueschist-facies) metamorphic conditions in the subducted Laurentian margin sediments of the Dalradian Supergroup.

It is envisaged that subduction of the leading edge of the Laurentian plate initiated at c. 490 Ma, contemporaneous with the start of ophiolite obduction and resulted in high-pressure metamorphism of the Laurentian margin. The high-pressure rocks were transferred to the hanging-wall plate and thrust back onto the margin, and exhumed shortly afterwards by extensional collapse preserving mineral cooling ages as old as ca. 475 Ma close to the margin. Away from the Laurentian margin, collisional thickening created the thick Dalradian nappe stack and associated Barrovian metamorphism, with possibly minimal involvement of obducted oceanic lithosphere. If conductive heat transfer in over-thickened crust is the major heating mechanism, then collisional thickening may have initiated shortly after ophiolite obduction started at ca. 490 Ma in order to generate the ca. 470 Ma Grampian peak metamorphism in the Dalradian.

References:

Chew et al. (2003). Journal of the Geological Society, 160, 911-924.

Chew et al. (2010). GSA Bulletin, 165, 675-685.

Flowerdew et al. (2000). Geological Magazine, 137, 419–435.

van Staal et al. (1998). Geological Society Special Publication, 143, 199–242.