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SUPERHYDROUS MAGMAS, FLAT SUBDUCTION AND COOL TRANSCRUSTAL CONTINENTAL ARC BATHOLITHS

WILLIAM J COLLINS[1], NATHAN DACZKO[2] AND J BRENDAN MURPHY[3]

[1]Curtin University
[2]Macquarie University
[3]St. Francis Xavier University

Pressure-Temperature (*P-T*) arrays from several iconic continental arc granitoid batholiths define cool, hydrous adiabatic ascent paths extending to depths >60 km, constrained between the 5–15 wt% H_2O granite liquidus curves. We suggest such cool (typically <800ºC), silicic (>60wt% SiO_2) granitoid magmas form during a flat subduction event under superhydrous conditions, which permanently establishes the thermal structure of the arc (Fig. 1).

Normal (steep) subduction of normal thickness (<35 km) arc crust produces dominantly decompression mantle melting (DM) with subordinate hydrous fluxed melting (FM) (ie., DM>FM: Fig. 1a) and Deep Crustal Hot Zones (DCHZ) are produced, but flat subduction does the opposite (DM<FM: Fig. 1b), so that water fluxed mantle melting becomes dominant, particularly in the flat subduction stage (DM<<FM: Fig. 1c). Simultaneously, the arc is doubly thickened to 1.2-1.4 GPa, and the entire process reflects a mafic flare-up event. Following subduction of the buoyant anomaly (which caused flat subduction), the mantle wedge re-opens and restores normal-thickness (~30-35 km) arc crust. As a result, the thickened lower crust melts extensively under superhydrous conditions to produce the cool (typically <800ºC) silicic granitic magmas of continental arc batholiths during a Stage 2 flareup (Collins et al 2025, Geology, *in press*).

The dense garnet-pyroxenite residue from batholith formation is progressively removed by vigorous corner flow in the mantle wedge. Ascending granitoid magmas remain cool and near water-saturated because water is incrementally degassed as P decreases, which explains the high H_2O content in many arc melt inclusions (MIs). This hydrous melting mechanism establishes cool, transcrustal continental arc batholiths even when episodically rejuvenated by hot, hydrous mafic infusions during mantle decompression melting, which again dominates crustal heat transfer (but not granitoid magma temperature) as the mantle wedge reopens during the transition back to normal mode subduction.