# Coast Belt Volcanic Arc in Relation to Rocky Mountain Foreland Basin

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## ABSTRACT

The clastic foreland wedge of the Western Canada Sedimentary Basin (WCSB) is a direct byproduct of cordilleran tectonics and mountain-building processes. Understanding the links between the two require synthesis and integration from diverse disciplines on a grand scale. Typically, however, research is often conducted independently in the two realms; whereas insights are gained from a holistic approach, integrating igneous, metamorphic, and sedimentary geology, from the hinterland of the orogen to the basin center.

Plate margin dynamics typically drive inland tectonics and structure from afar. Arc magmatism is arguably the most important mechanism responsible for crustal growth, while lithospheric subduction and terrain accretion provide the necessary push behind foreland fold and thrust belts. Here relationships are established between Cretaceous-Cenozoic volcanic arc assemblages and related events of the Coast Belt, with equivalent aged stratigraphy in the clastic foreland wedge of the WCSB, as well as similar aged thrust faults of the Rockies and Foothills. A regional synthesis is presented of relevant data, incorporating regional maps, radiogenic age dates of igneous rocks, igneous geochemistry, deformation events, burial-uplift profiles for clastic rocks, and faulting.

Establishing time-equivalent events is key. With the extensive coverage and availability of U-Pb zircon dates from the Coast Belt and orogen to the west, a strong correlation can now be made between the rate of igneous activity, or arc-tempo, with thrust fault activity, and sediment accumulation in the foreland. Granitic and volcanic rocks dominate the Coast Belt, where magmatic activity was largely continuous from middle Jurassic, through Cretaceous to Paleocene time, ending abruptly in the Eocene; the span corresponds closely to the principal phase of Rocky Mountain foreland clastic sediment accumulation, beginning with the Fernie Group, and ending with the Paskapoo Formation, totaling 4 km in thickness. Volcanic activity to the west closely matches 1D burial-uplift time-depth profiles in the basin, and a direct correlation is inferred.

Age equivalent stratigraphy is compared. Marine conditions persisted to the west across the Coast Belt during the Lower Cretaceous, as recorded in the stratigraphy of the Gambier Group and equivalent rocks, which were deposited in an offshore volcanic arc setting above an inferred west-dipping subduction zone, along the eastern flank of the Insular Super Terrane. The volcanic arc was developed unconformably over a Jurassic and older basement, featuring a well-developed granite-clast basal conglomerate. Lithofacies include tidal-flat and near-shore tidal channel IHS deposits alongside subaerial calc-alkalic volcanic edifices, with flanking offshore deposits of shale and euxinic shale. The Gambier arc developed outboard of the coeval and opposite facing Spences Bridge Arc to the east. The Albian volcanic and plutonic rocks of the Coast Belt arc system are also contemporaneous with landward volcanic rocks and plutons of the Crowsnest Formation and Howell Creek system, situated to the east within the southern Rocky Mountain fold and thrust belt. The geochemistry of these rocks however is markedly different, with the coastal system showing a calc-alkalic trend typical of volcanic arcs; whereas to the east the Crowsnest-Howell Creek rocks are strongly alkalic featuring trachitic to phonolitic compositions, occurring as the back-arc counterpart to the Spences Bridge fore-arc.

Bentonites in the Cretaceous of the WCSB demonstrate a direct link to volcanic activity. Apatite samples in Cretaceous strata of the foreland basin display track characteristics suggestive of a contemporaneous volcanic source for the apatite. This is consistent with the widespread presence of Lower Cretaceous bentonite deposits in the foreland basin, demonstrating a direct material link between far-field volcanic activity and airborne basin fill. Available Rare Earth Element data (REE) for Albian volcanic rocks and plutons, and from

foreland bentonite layers are compared, demonstrating a spread in values matching both back-arc and fore-arc compositions, indicating likely material contributions from both to the basin.

For accretion of the Gambier arc, the proposed suture runs along the axis of Coast Belt and eastern edge of the Insular Superterrane, extending from the Shuksan blueschist in the south, north through the Harrison Lake Shear Zone and Central Coast Belt Detachment along the western margins of peri-Laurentia terranes, and further north into the Coast Shear Zone and associated faults. Final accretion here is defined by the end of Lower Cretaceous marine conditions covering the Coast Belt, and by the record of overprinting Upper Cretaceous deformation. Correspondingly, the paleogeography for the stratigraphy of the foreland basin to the east can be grouped into pre-accretionary, and post-accretionary packages, both affected differently by Coast Belt tectonics. Nikanassin/Blairmore/Mannville and equivalent stratigraphy were deposited while the Gambier volcanic arc was active off the west coast under marine conditions; whereas younger stratigraphy corresponds with the elevated arc tempos related to accretionary suturing as well as post-accretionary deformation, and magmatism, terminating abruptly in the Eocene. Uplift and erosion are recorded throughout the Cenozoic for both the Coast Belt as well as the Rocky Mountain Fold and Thrust Belt, and is most pronounced in the period from 40 Ma to the present, once volcanic activity had largely ceased and arc tempo reduced to zero.