Shifts in deposition, sediment dispersal, and provenance for the late Jurassic-early Cretaceous Kootenay and Blairmore Groups: Implications for foreland basin dynamics in western Canada

Matthew Nix[1], Brian K. Horton[1,2], and Kurt Constenius[3]

1 – Department of Geosciences, Jackson School of Geosciences, The University of Texas at Austin

2 – Institute for Geophysics, Jackson School of Geosciences, The University of Texas at Austin

3 – Department of Geosciences, University of Arizona

Abstract

The most-proximal foredeep deposits of the Western Canada Sedimentary Basin (WCSB) are preserved in the Fernie basin, which forms a broad doubly plunging synclinorium in the Rocky Mountains of southeastern British Columbia. The basin contains a complete and continuous exposure of the Upper Jurassic to Lower Cretaceous foreland basin succession generated during earliest shortening and uplift of the North American Cordillera. Of particular interest in this proximal succession is the Kootenay Group and basal Blairmore Group (Cadomin Formation), which represent two contrasting phases of basin accumulation separated by the enigmatic "sub-Cretaceous unconformity". These stratigraphic units and the intervening unconformity are manifestations of dynamic changes in the WCSB. In this study, we conduct an in-depth analysis of their precise age and fluctuations in provenance within this westernmost proximal segment of the WCSB and determine their relationship with their more distal equivalents exposed in the imbricated thrusts of the Alberta foothills to the east.

New and previously collected stratigraphic, geochronologic, and sandstone petrologic data coupled with conglomerate clast counts and heavy mineral data reveal for the Fernie basin, a dominance in sediment supply sourced from the recycling and unroofing of the Paleozoic sedimentary rocks to the west in the Canadian Rockies. Paleocurrent data from fluvial strata of the Kootenay and Blairmore groups in the Fernie basin indicate dominant eastward transport, transverse to the mountain belt. Alternatively, paleocurrent data from these same units in the Alberta foothills suggest northerly directed or axial paleo-flow in the WCSB. In terms of provenance studies, the axial flow interpretation would predict an increase in detritus from distal southerly sources in the USA, whereas the Fernie basin section would be sourced from more proximal unroofing of thrust sheets in the Cordilleran foreland.

To test this model, we have conducted descriptive field studies including measured sections, clast counts and paleocurrent measurements combined with an extensive collection of detrital zircon (DZ) samples. We also compiled published DZ data of potential sediment sources which include: formations that comprise the Paleozoic miogeoclinal section, Precambrian meta-sedimentary rocks of the Purcell and Windermere Supergroups, and several accretionary terranes in the Intermontane Belt. The accreted terranes have been linked to the causation of initial contraction and uplift that led to the deposition of this entire stratigraphic succession. Detrital zircon mixture modeling using these sources as inputs reveal that the main contribution of sediment was derived from the Paleozoic miogeocline. Furthermore, the model results suggest variable contributions from Paleozoic formations that appear cyclical up section consistent with the unroofing pattern of a thrust sheet. That is, initial clast provenance in a cycle is dominated by detritus derived from Triassic-Pennsylvanian formations that gives way up-section to Ordovician, and eventually Cambrian formations. We observe two of these cycles in the Kootenay Group and a third in the Cadomin Formation, which we interpret to correlate with the emplacement and denudation of major thrust sheets over about a 40 Myr period. The DZ data

also reveal pronounced changes regarding the hiatus associated with the sub-Cretaceous unconformity. Maximum depositional ages combined with the results of two dated tonsteins, indicate that the time gap associated with the sub-Cretaceous unconformity is about 15 Myr in the Fernie basin, and increases in duration to about 30 Myr in the Alberta foothills. The results presented here underscore how variations in accommodation/subsidence interplay with discrete pulses of deformation and irregular flexure in a coupled fold-thrust belt and foreland basin system.

Supervisor Signature