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Initiation and Evolution of a Forearc Basin - Nanaimo Group, Georgia Basin, British Columbia, Canada

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Background Information and Methods

The complicated and variable stratigraphic architectures of forearc basins reflects their unique tectonic settings, coeval or post depositional deformation, and/or erosion. The complex sedimentary successions and architectures of these basins has necessitated the use of simple lithostratigraphic and/or biostratigraphic frameworks (Takashima *et al.*, 2004; Aksoy *et al.*, 2005; Huang *et al.*, 2019, 2022) to correlate disconnected and structurally deformed outcrops. Modern investigations employ detrital zircon (DZ) geochronology in conjunction with field-based outcrop mapping in resolving geologic problems within forearc basins, due to the abundance of contemporaneous DZ sourced from the active arc (Cawood *et al.*, 2012).

The Late Cretaceous Nanaimo Group is a coal-bearing siliciclastic succession that was deposited into the NW-SE trending forearc Georgia Basin exposed on Vancouver Island in western BC, Canada (yellow areas in inset map; Fig. 1). The lithostratigraphic frameworks describing the Nanaimo Group ignore the effects of paleotopography on the basal nonconformity and formations (Fm) are based on physical characteristics/grain size alternations, macrofaunal content and on their position relative to the basal nonconformity and to each other (Mahoney, 1999; Huang *et al.*, 2019, 2022; Kent *et al.*, 2020). As a result, strata that are neither temporally nor genetically related are assigned the same formation. This outcrop-based study integrates facies analysis, biostratigraphy and maximum depositional ages (MDAs) derived from DZ to assess the depositional architecture, facies relationships, and temporal/stratigraphic equivalency of strata between the Comox and Nanaimo SBs, and establishes a new framework for the lower Nanaimo Group.

Results

Basal coarse-clastic strata (Comox Fm) are preserved in paleotopographic depressions, mainly in the northern Georgia Basin, Canada and grade upwards into regional coal-bearing coastal plain and shallow marine deposits (QC, OR, BR, DC, TR, WF sections; Fig. 1). These strata are overlain in turn by marine mudstones and turbidites (Haslam Fm) that are regionally extensive and contain a glauconitic sandstone bed that is interpreted as a condensed section and disconformity that developed during deposition of the lower Nanaimo Group. A second major pulse of coarse-clastic sediment occurs 100s of meters above the glauconite bed and occurs in the central Georgia Basin; it comprises mainly continental facies that are equivalent to the Extension, Pender and Protection Fms. The shift in sedimentation from the northern Georgia Basin to the central Georgia Basin (LM, ER, WB, NR sections; Fig. 1) is interpreted to represent the emergence of an island in the central Georgia Basin that acted as a major sediment source

to the adjacent depocenter. Emergence of the island is interpreted to be related to syn-depositional tectonism that was contemporaneous with drowning of the northwest clastic source that debouched into the northern Georgia Basin. This younger coal-bearing paralic/terrestrial succession represents a secondary coal-field in the Georgia Basin that is genetically and spatially distinct from the earlier Comox Fm deposits.

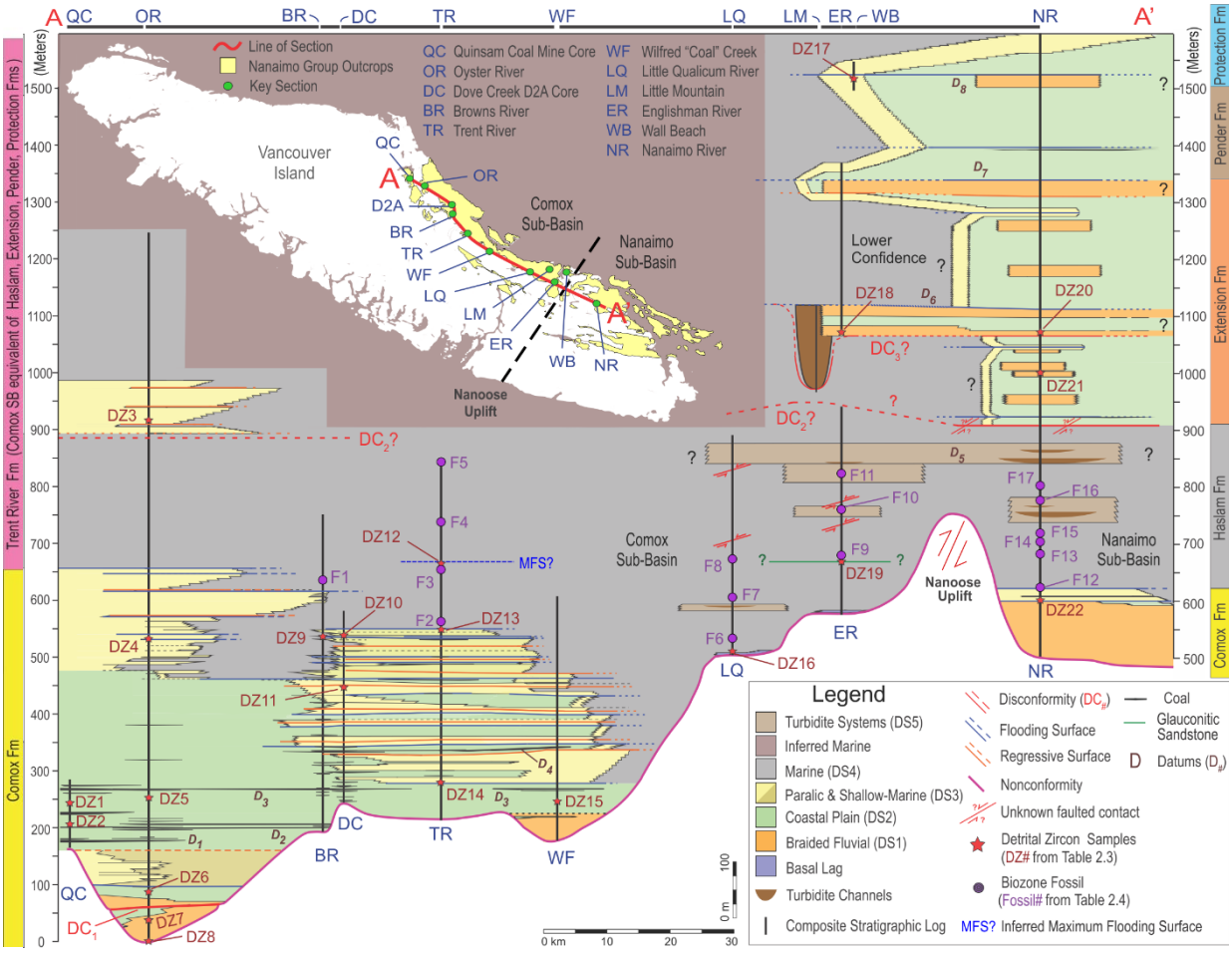

Figure 1. *Schematic stratigraphic cross-section of the lower Nanaimo Group in the Nanaimo (NR key section) and Comox (QC, OR, BR, DC, TR, WF, LQ, LM, ER, WB key sections) Sub Basins. Depositional systems and their architectures are illustrated. The stratigraphic position of detrital zircon and biostratigraphic samples are shown as red stars and purple circles. Inset map displays locations key outcrop locations on Vancouver Island, BC, Canada with Nanaimo Group outcrops outlined in yellow. Northern Comox SB stratigraphy (QC, OR, BR, DC, TR sections) is adapted from Kent et al. (2020).*

Additionally, depositional architectures observed in the lower Nanaimo Group suggest the presence of two major sediment routing systems operating between the Georgia Basin and the paleo-Pacific Ocean, herein named the Qualicum Canyon and Cowichan Canyon. Exposed upper Nanaimo Group strata consist almost entirely of submarine channel complexes (England, 1989;

Mustard, 1994; Katnick & Mustard, 2003; Bain & Hubbard, 2016; Englert *et al.*, 2018) suggesting that the Qualicum and Cowichan canyons predate and were eventually contemporaneous with deposition of the upper Nanaimo Group. Formation of these canyons was probably syntectonically controlled, and the canyons facilitated the transport of coarse-grained sediment out of the Georgia Basin during periods of higher base level.

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