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Late Cretaceous Georgia Basin: remapping a major forearc sedimentary basin on the Pacific margin of British Columbia

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Georgia Basin is a broad forearc basin that developed on the Pacific margin of North America during the Late Cretaceous. The basin is largely exhumed, with stratigraphic remnants extending 390 km along strike on eastern Vancouver Island and about 60 to 85 km wide. The preserved basin fill comprises: 1) Upper Cretaceous siliciclastic strata as old as Albian-Cenomanian penetrated only by deep wells drilled under the Fraser River delta and outcrops of Santonian-Campanian strata overlying quartz diorite of the Coast Complex; 2) thick Upper Cretaceous to lower Paleocene siliciclastic strata of the Nanaimo Group extending over eastern Vancouver Island and the Gulf Islands; 3) Late Paleocene to Eocene non-marine siliciclastics of the Huntingdon and Chuckanut formations, 4) Pliocene to Miocene non-marine siliciclastics of the Boundary Bay Formation, and 5) unconsolidated Quaternary-Holocene sediments.

The focus of this study is on bedrock mapping of the Nanaimo Group, which was the subject of exhaustive field investigations by both federal and provincial geological surveys, coal and petroleum exploration companies, and numerous academic institutions during the 1970's and 1980's. The historical field, borehole, and topographic data, and a modern multi-beam bathymetric swath mapping data set have been integrated within a GIS platform. The integrated project offers new insights and observations on the structural and stratigraphic continuity of the Nanaimo Group, particularly under the shallow, glacially scoured waters of the Strait of Georgia.

The lower Nanaimo Group comprises up to 2200 m of Turonian to lower Campanian conglomerate, sandstone and shale which infills a faulted terrane with moderate relief and is initially shallow marine or estuarine to fully marine, although extensive coal measures and terrestrial strata are present that are associated with basement highs in the Nanaimo and Comox areas. Fully marine conditions were established basin-wide as accommodation space increased rapidly from Campanian through Maastrichtian. The upper Nanaimo Group comprises up to 3300 m of upper Campanian to Paleocene marine sandstone, conglomerate and shale deposited in outer neritic to mid-bathyal water depths. Notably, there are major submarine canyon systems preserved, several hundred meters deep and several to perhaps tens of kilometres wide, which must have transported large volumes of sand and gravel to the west and northwest by sediment gravity flows. These sediments were likely sourced from contemporaneous orogenic uplifts of the interior Cordillera, although there is ongoing debate about the latitude of the provenance areas due to possible northwards translation of terranes during the Tertiary. The preserved basin area extends over about 15,000 km^2; however, the western limits of the latest Cretaceous basin are not preserved, and could well have extended much further to the west on the Pacific margin of North America.

The top of the Nanaimo Group is markedly truncated from southeast to northwest by a major unconformity with local relief of at least 2000 m. The unconformity separates latest Cretaceous to (?) early Paleocene

Nanaimo Group from the overlying late Paleocene strata, which are at least 400 m thick. Thus the extensive erosion of the southern Nanaimo Basin (and the southern margin of Wrangellia terrane) occurred between 65 Ma and about 58 Ma and would have involved contemporaneous uplift of the San Juan terrane which was already in place by that time. It is speculated that this uplift is related to the continued terrane accretion and underplating of the North American craton in some way, perhaps simply by northward rotation or translation of the San Juan terrane.

The entire Nanaimo Group and overlying Chuckanut Fm. in the field area was deformed through extensive folding and faulting in early Eocene, forming the broad Cowichan fold and thrust system, a southwest-verging linked thrust system formed by northeast-southwest, large-scale crustal contraction of the cover rock and its Wrangellian basement. Apatite fission-track analysis of samples from both cover and basement rock indicates that the uplift and cooling of the thrust belt occurred between 50 and 40 Ma, contemporaneous with the continued margin-normal contraction of the Pacific Rim terrane (and possibly the Crescent terrane) at about 45 Ma. Post 45 Ma, increasingly oblique and diminished rates of plate convergence have resulted in widespread basin uplift and erosion of Georgia Basin. Only a small depocentre in southeastern Georgia Basin accumulated significant sediment during the Neogene to present day.

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