Architecture, Stratigraphy, and Sedimentology of a Fjord-head Delta, Zeballos, British Columbia

Jeffrey E. Gutsell

This thesis presents the results of an integrated geophysical and geological study of a “Gilbert-type”, fjord-head delta near the village of Zeballos, British Columbia. The primary objective of the study was to better understand sedimentary processes operating in high energy, fjord-head delta environments.

A ground penetrating radar survey and air photo interpretation revealed the presence of two deltas: an elevated, incised, late Pleistocene delta and a Holocene delta graded to present sea level. The modern delta began to form after sea level fell below its present position in the early Holocene. Both deltas comprise topset, foreset, and bottomset units. A time domain electromagnetic (TDEM) survey, borehole data, and gravel pit exposures show that the delta deposits coarsen upward from silt in the bottomset unit to gravel in the topsets. The TDEM survey revealed a highly irregular, buried bedrock surface, ranging from 20 to 190 m deep, and it also delineated saltwater intrusion into the delta sediments.

Sediments of the delta plain are divisible into seven lithofacies, from bottom to top: 1) facies A: gravelly sand/sandy gravel, 2) facies B: single sand beds, 3) facies C: stratified organic-rich silt and sand, 4) facies D: organic-rich silt, 5) facies E: silt and sand beds/laminae, 6) facies F: silt bed(s), 7) facies G: peat. The vertical succession of lithofacies in section is repeated laterally across the delta plain, from distributary channels, to sand flats, to tidal marsh.

Sequential air photos from 1930 to 1995 and a radiocarbon age of 660 ± 50 years BP from the base of the silty and sandy delta plain sediments illustrate the ephemeral nature of the tidal marsh. The position of the Zeballos River channel and the extent of the tidal marsh have been altered through human activity, such as dike construction and river diversion.

A sand layer (facies B) near the top of the marsh sequence was traced throughout the delta plain and is attributed to a major flood in 1967. Two anomalous subsurface sedimentary facies were also found and correlated throughout the delta plain. A 1.5 – 14 cm thick bed comprising silt/sand couplets (facies E) and a 1 – 5 cm thick, massive silt bed (facies F) are interpreted to be reworked tailings carried by the Zeballos River from nearby mines. These sediments have elevated concentrations of arsenic, cadmium, gold, lead, mercury, silver, and zinc. The tailings thin away from tidal channels and thicken in an upriver direction, and have a dominantly freshwater diatom assemblage. Cesium 137 analysis shows that the tailings were deposited prior to 1952, which is consistent with the time of peak mining activity in the Zeballos Mining Camp (1937 – 1943). Concentrations of arsenic, cadmium, lead, and zinc exceed Canadian and U. S. marine sediment quality guidelines.