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Quaternary geology of the Duck Hawk Bluffs, southwest Banks Island, Arctic Canada: a re-investigation of a critical terrestrial type locality for glacial and interglacial events bordering the Arctic Ocean

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ABSTRACT

Duck Hawk Bluffs, southwest Banks Island, is a primary section (8 km long and 60 m high) in the western Canadian Arctic Archipelago exposing a long record of Quaternary sedimentation adjacent to the Arctic Ocean. A reinvestigation of Duck Hawk Bluffs demonstrates that it is a previously unrecognized thrust-block moraine emplaced from the northeast by Laurentide ice. Previous stratigraphic models of Duck Hawk Bluffs reported a basal unit of preglacial fluvial sand and gravel (Beaufort Fm, forested Arctic), overlain by a succession of three glaciations and at least two interglacials. Our observations dismiss the occurrence of preglacial sediments and amalgamate the entire record into three glacial intervals and one prominent interglacial. The first glacigenic sedimentation is recorded by an ice-contact sandur containing redeposited allochthonous organics previously assigned to the Beaufort Fm. This is overlain by fine-grained sediments with ice wedge pseudomorphs and well-preserved bryophyte assemblages corresponding to an interglacial environment similar to modern. The second glacial interval is recorded by ice-proximal mass flows and marine rhythmites that were glacitectonized when Laurentide ice overrode the site from Amundsen Gulf to the south. Sediments of this interval have been reported to be magnetically reversed (>780 ka). The third interval of glacigenic sedimentation includes glacifluvial sand and gravel recording the arrival of Laurentide ice that overrode the site from the northeast (island interior) depositing a glacitectonite and constructing the thrust block moraine that comprises Duck Hawk Bluffs. Sediments of this interval have been reported to be magnetically normal (<780 ka). The glacitectonite contains a highly deformed melange of pre-existing sediments that were previously assigned to several formally named, marine and interglacial deposits resting in an undeformed sequence. In contrast, the tectonism associated with the thrust block moraine imparted pervasive deformation throughout all underlying units, highlighted by a previously unrecognized raft of Cretaceous bedrock. During this advance, Laurentide ice from the interior of Banks Island coalesced with an ice stream in Amundsen Gulf, depositing the interlobate Sachs Moraine that contains shells as young as ~24 cal ka BP (Late Wisconsinan). During deglaciation, meltwater emanating from these separating ice lobes deposited outwash that extended to deglacial marine limit (11 m asl) along the west coast of Banks Island. Our new stratigraphic synthesis fundamentally revises and simplifies the record of past Quaternary environments preserved on southwest Banks Island, which serves as a key terrestrial archive for palaeoenvironmental change.

1. Introduction

Previous reconstructions of the Neogene and Quaternary history of Banks Island, NT, have featured a complex and apparently continuous multiple glaciation record, notably from Duck Hawk

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Bluffs (DHB, Fig. 1a, b). The Banks Island stratigraphy purportedly includes late Neogene fluvial sand and gravel (assigned to the Beaufort Fm), overlain by the preglacial Worth Point Fm and then the deposits of at least three glacial and interglacial intervals (Vincent, 1982, 1983, 1984, 1990; Vincent et al., 1983, 1984; Barendregt and Vincent, 1990; Barendregt et al., 1998). This model was initially proposed for the surficial record of the entire island (70,000 km^2) where multiple till sheets and moraine systems, glacioisostatically controlled raised marine deposits and expansive proglacial lake sediments were assigned to three discrete glaciations, spanning at least the last 780 ka (Fig. 1b, c). Subsequently, expansive coastal sections were proposed to replicate the same stratigraphic record of the multiple glacial and interglacial sequences in the surficial geology (Vincent, 1982, 1983). Fieldwork conducted during the past decade has proposed fundamental revisions of the surficial geology throughout Banks Island (England et al., 2009; Lakeman and England, 2012, 2013, in press; Vaughan et al., 2014). In contrast to previously proposed models (Vincent, 1982, 1983, 1984, 1990; Vincent et al., 1983, 1984; Barendregt and Vincent, 1990; Barendregt et al., 1998), the revised surficial record of glacial and marine landforms were assigned to the Late Wisconsinan. This has raised significant questions about the complexity and timescale of the previously reported stratigraphic record, given that Banks Island has been widely regarded as a critical type locality for glacial and interglacial events in the circumpolar Arctic (cf. Vincent et al., 1983, 1984; Clark et al., 1984;

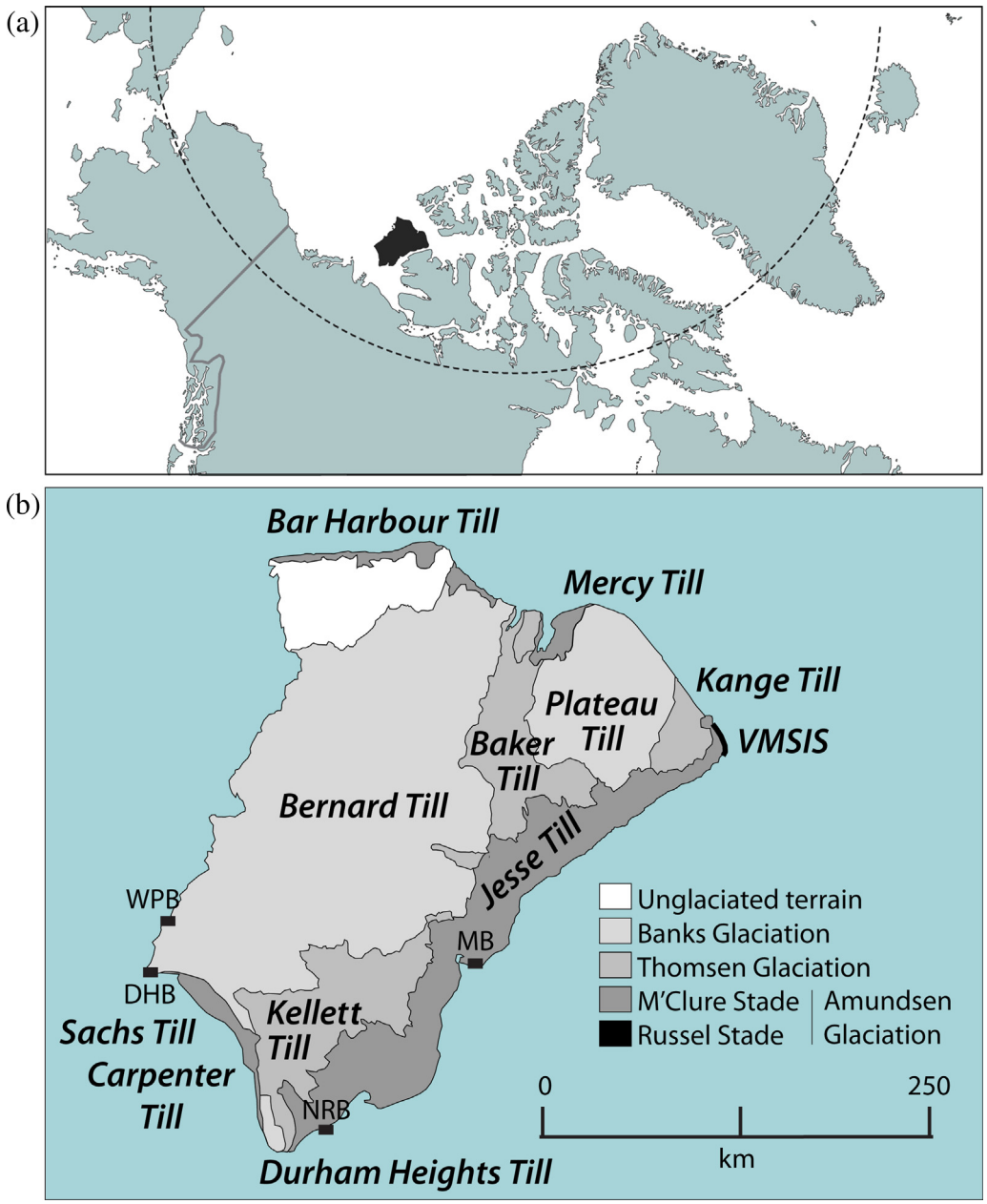

Fig. 1. Banks Island and the traditional Quaternary stratigraphy: a) location map of Banks Island in the western Canadian Arctic; b) map of the traditional proposals for the extent of glaciations based on surficial geology and Quaternary stratigraphy (from Vincent, 1983). WPB = Worth Point bluff, DHB = Duck Hawk Bluffs, VMSIS = Viscount Melville Sound Ice Shelf moraine location, MB = Morgan Bluffs, NRB = Nelson River bluff; c) summary of traditional stratigraphy, magnetostratigraphy and reconstructed glacial and interglacial events based on the Duck Hawk Bluffs Formation from SW Banks Island (after Barendregt and Vincent, 1990). Note that this is a composite section based upon Vincent et al. (1983) logs A–I in the "west" and "central" cliffs and that the upper details labelled "Bluffs E Mary Sachs Ck" are from their log J in the "Mary Sachs Creek Cliff" (see Figs. 3 and 4).

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