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Coalescence of late Wisconsinan Cordilleran and Laurentide ice sheets east of the Rocky Mountain Foothills in the Dawson Creek region, northeast British Columbia, Canada

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ABSTRACT

Geomorphic, stratigraphic and geochronological evidence from northeast British Columbia (Canada) indicates that, during the late Wisconsinan (approximately equivalent to marine oxygen isotope stage [MIS] 2), a major lobe of western-sourced ice coalesced with the northeastern-sourced Laurentide Ice Sheet (LIS). High-resolution digital elevation models reveal a continuous 75 km-long field of streamlined landforms that indicate the ice flow direction of a major northeast-flowing lobe of the Cordilleran Ice Sheet (CIS) or a montane glacier (>200 km wide) was deflected to a north-northwest trajectory as it coalesced with the retreating LIS. The streamlined landforms are composed of till containing clasts of eastern provenance that imply that the LIS reached its maximum extent before the western-sourced ice flow crossed the area. Since the LIS only reached this region in the late Wisconsinan, the CIS/montane ice responsible for the streamlined landforms must have occupied the area after the LIS withdrew. Stratigraphy from the Murray and Pine river valleys supports a late Wisconsinan age for the surface landforms and records two glacial events separated by a non-glacial interval that was dated to be of middle Wisconsinan (MIS 3) age.

Introduction

The timing and extent of the Cordilleran (CIS) and Laurentide (LIS) ice sheets in northeastern British Columbia has been the subject of debate for several decades. One view is that the two ice sheets coalesced during the late Wisconsinan glacial interval, approximately equivalent to marine oxygen isotope stage (MIS) 2 (Mathews, 1978, 1980; Dyke and Prest, 1987; Dyke et al., 2003; Bednarski and Smith, 2007; Hartman and Clague, 2008). Others have suggested, however, that coalescence, if it did occur, happened during an earlier glaciation (MIS 4 or older) and that the CIS was of limited extent in the region during MIS 2 (Reimchen, 1980; Bobrowsky, 1989; Bobrowsky and Rutter, 1992; Catto et al., 1996). Determining if coalescences occurred or if an unglaciated corridor existed during MIS 2 has important implications. The separation of the ice sheets may have provided a significant route for the migration and spread of flora and fauna, including people, in North America (cf. Reeves, 1973; Arnold, 2002; Goebel et al., 2008). Furthermore, establishing field evidence of ice-sheet dynamics and interactions, coupled with geochronological constrains of ice-sheet extent, is essential for validating ice-sheet models (e.g. Peltier, 2004; Rutt et al., 2009). Gregoire et al. (2012), for example, implicated the collapse of the ice saddle that connected the two ice-sheets in the Dawson Creek and surrounding area as a cause of major global sea level rise and freshening of the world's oceans.

This study presents new geomorphic, stratigraphic, geochemical and geochronologic evidence from northeastern British Columbia (Fig. 1A) that helps resolve this debate. The study takes advantage of high resolution digital elevation models (DEMs) constructed from light detecting and ranging (LiDAR) surveys in the study area. These techniques have enhanced our ability to delineate glacigenic geomorphic features, e.g., streamlined landforms that record former ice sheet dynamics and flow direction (cf. Clark, 1997; Smith

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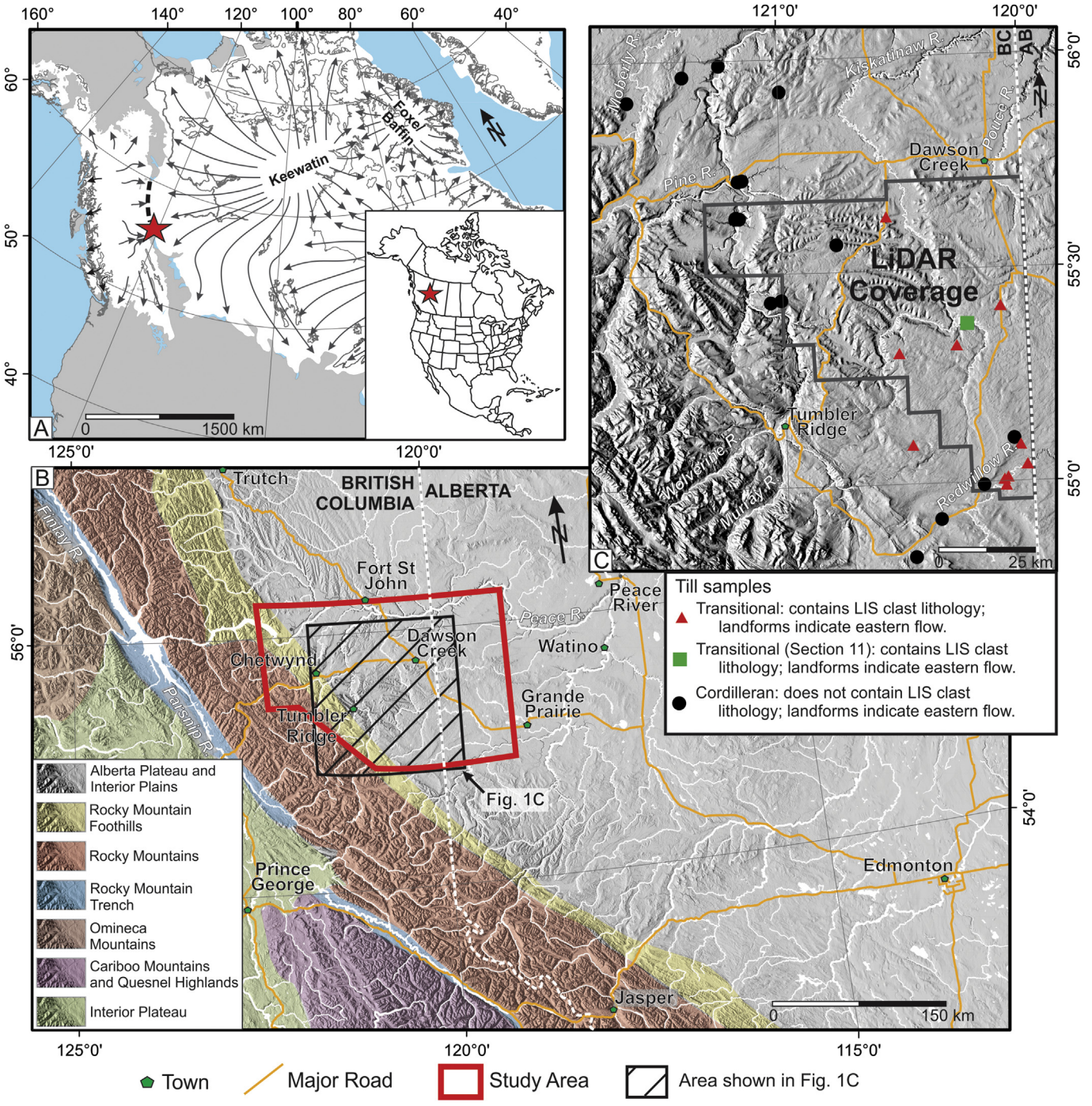

Figure 1. A) Location of the study area (red star) and the generalized ice-flow of the Laurentide and Cordilleran ice sheets during the retreat phase of the late Wisconsinan glaciation (ice-flow modified from Prest, 1983; ice position from Dyke et al., 2003); B) regional digital elevation model (DEM; 2x vertical exaggeration) of the study area (red box) in northeast British Columbia and northwest Alberta with physiographic regions (Mathews, 1986); and C) till sample locations and LiDAR coverage within the study area (2x vertical exaggeration).

and Clark, 2005). They directly inform the model of ice-flow trajectory and ice sheet interaction that we propose here for northeastern British Columbia.

Stratigraphic evidence is drawn from an extensive late Quaternary sedimentary record that is exposed in sections along the Murray–Pine drainage system and the Kiskatinaw River (Fig. 2) with chronological control based on radiocarbon and optical dating. The objective of this study is to reconstruct major paleo-ice flow from geomorphic features and establish temporal context for these surface landforms.

The study area encompasses Dawson Creek, Chetwynd and Tumbler Ridge in British Columbia and extends into northwest Alberta (Figs. 1B and 2). Here, the Rocky Mountain Foothills transition to the plains of the Alberta Plateau (Holland, 1976). The area is generally agreed to have been influenced by three glacial systems (Catto et al., 1996): 1) LIS sourced from the northeast; 2) CIS sourced from west of the Rocky Mountains; and 3) montane glaciers mainly sourced from within the Rocky Mountains. LIS deposits are generally differentiated from those of other glacial systems by the presence of allochthonous red, granitic and gneissic clasts derived