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# The stratigraphy, depositional environment, and geologic history of the Grimshaw gravel deposit, Peace River Lowlands, Alberta

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## Summary

The Grimshaw gravel deposit hosts a regionally important aquifer and aggregate resource in the Peace River Lowlands of northwestern Alberta. While the hydrostratigraphy and aggregate quality of the deposit has been described in detail from the perspective of resource management, its genesis and geologic history remain equivocal. This study involves the analysis of facies associations and sedimentary architecture to provide a novel interpretation of the depositional environment of the Grimshaw gravel, which helps constrain the stratigraphy and geologic history of the deposit.

## Introduction

The internal architecture, genesis, and geologic history of the Grimshaw gravel deposit, which hosts significant groundwater and aggregate resources in the Peace River Lowlands of northwestern Alberta, are poorly understood as a result of limited detailed sedimentological investigations and an absence of absolute dating control. Previous work suggests the Grimshaw gravel was deposited in fluvial (Jones, 1966; Tokarsky, 1967; PFRA, 1998; Scafe et al., 1989; Edwards and Scafe, 1996; and Leslie and Fenton, 2001), glaciofluvial (Reader and Odynsky, 1965; Scheeler and Odynsky, 1968), and ice-marginal (Rutherford, 1930) depositional environments. The deposit has been previously correlated to the Saskatchewan gravel and sand of southern Alberta (Jones, 1966; Scafe et al., 1989; Leslie and Fenton, 2001), local gravel units within the Peace River Lowlands (Tokarsky, 1967; Atkinson and Paulen, 2010), and regional gravel deposits physiographically positioned above bedrock valleys, but below upland gravel caps (Edwards and Scafe, 1996). Furthermore, the Grimshaw gravel has been interpreted by some workers to pre-date the incursion of Laurentide ice into the study area (Jones, 1966; Tokarsky, 1967; Scafe et al., 1989; Edwards and Scafe, 1996; Leslie and Fenton, 2001; Atkinson and Paulen, 2010), while others suggest the Grimshaw gravel is glacial in origin (Rutherford, 1930; Reader and Odynsky, 1965; Scheeler and Odynsky, 1968). A sound understanding of the genesis of the Grimshaw gravel is imperative for accurate delineation of the Cenozoic stratigraphy of northwestern Alberta, reconstructing the glacial history of the Laurentide Ice Sheet in western Canada, and understanding the interconnectivity of Grimshaw gravel with other coarse-grained units on a regional scale for groundwater and aggregate resource investigations.

## Theory and/or Method

The internal heterogeneity and sedimentary architecture of the Grimshaw gravel is analysed based on data recorded in eleven sedimentary logs from outcrop sections in gravel pits. Sedimentary logs include grain size, sedimentary structure, gravel clast shape, size, and lithology, paleocurrent measurements, facies types, and the nature of facies contacts. Sedimentary logs are superimposed on photomosaics of the outcrop face to correlate facies and major facies contacts between logs (**Figure 1**). The spatial relationship of genetically-related facies, and major facies contacts, allowed the identification of seven facies associations (FA1-7), which record fluvial, deltaic, and subglacial to ice-marginal depositional environments. The stratigraphic and lateral spatial relationships of FA1-7 were used to identify a fluvial to deltaic lateral transition within the Grimshaw gravel, which is overlain by a subglacial to ice-marginal unit.

## Examples

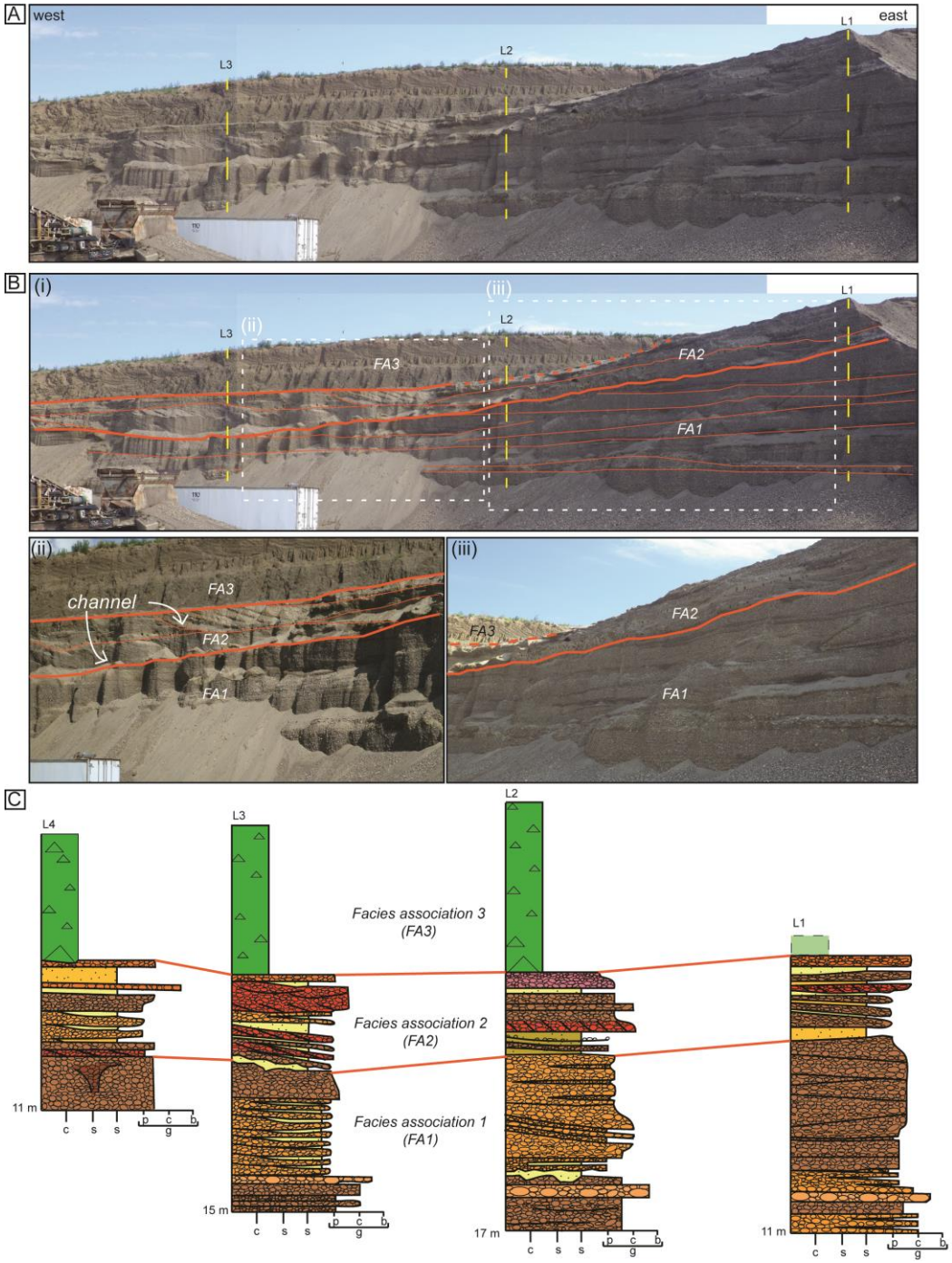


**Figure 1. Sedimentary architecture of the Grimshaw gravel based on a. sedimentary logs recorded from outcrop, b. correlation of facies contacts between logs, and c. identification and correlation of facies associations (FA1-3).**

## Conclusions

The paleoenvironmental reconstruction of the Grimshaw gravel facilitates a new genetic interpretation of the Grimshaw gravel deposit as a braid-delta complex. The Grimshaw fluvial system was likely supplied by an ice margin positioned west of the study area, and the Grimshaw delta supplied sediment to a lake that was dammed in the paleo-Peace River Lowland. We propose that the most likely mechanism to block drainage in the paleo-Peace River Lowland is by an ice dam at the margin of the Laurentide Ice Sheet; hence, the Grimshaw gravel likely records the presence of theLaurentide ice margin within or proximal to the study area. Consequently, the Grimshaw gravel deposit is not pre-glacial fluvial as previously interpreted, although it indeed pre-dates the most recent (Late Wisconsinan) Laurentide ice advance in the study area. The stratigraphic relationship of the Grimshaw gravel and bedrock valley sediments (radiocarbon dated to the Middle Wisconsinan) suggest that the Grimshaw gravel pre-dates the Middle Wisconsinan and, therefore, records a pre-Middle Wisconsinan advance of the Laurentide Ice Sheet in the study area. Insight to the stratigraphy and geologic history of the Grimshaw gravel provided in this study may aid resource evaluation and protection in the study area, including aggregate prospecting, hydrogeologic modeling, and environmental assessments.

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