Multi-proxy study of alluvial fan development during the Holocene in the Qu`Appelle Valley, Saskatchewan

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Sedimentation on alluvial fans is controlled by fluvial erosional processes occurring in upland drainage basins and slopes, as well as by the subsequent transport processes which deliver the sediments from the catchment area to the fan. Alluvial fan sediments may contain valuable information of climate change, anthropogenic influences and could function as an archive of landscape development. The deposits of the alluvial fans in the Qu’Appelle Valley, Saskatchewan comprise of weathered glacial till and glacial fluvial material transported from the upland drainage basin area. The purpose of this study is to establish a relative chronology of the alluvial fans in the Saskatchewan Prairies by exploring multiple proxies as well as to evaluate the weathering/leaching intensity of the modern upper catchment soil and the borehole core samples.

Two borehole cores (AG850 cm and FN350 cm), which were taken from two Holocene alluvial fans located in the Qu’Appelle Valley in southern Saskatchewan (Kotowich and Hardenbicker, 2014) were used for this study. Core sediment sample collection ranged from 2-10cm based on sediment physical properties. The upper catchment areas of the AG and FN cores have been dominated by agricultural fields since 1890’s and natural prairies accompanied with recent agricultural practises, respectively. Modern surface samples from natural prairie grasslands, agricultural fields, tree groves, and sloughs were also collected from the upland catchments to examine soil properties. Elemental composition analysis using an Energy Dispersive X-ray Spectroscopy was carried out to obtain weathering/leaching intensity of the samples. The Beavers Index CaO/ZrO_2 molar ratio, the Parker Index [(Na)a /0.35]+[(Mg)a / 0.9]+[(K)a / 0.25]+[(Ca)a / 0.7])*100, the Product Index [SiO2/(TiO2+Fe2O3+SiO2+Al2O3)]*100 were focused to quantify the degree of weathering/leaching in semi-arid environment (Souri and Watanabe, 2011; 2013). Particle size distribution, pH, organic content, and radiocarbon dating were obtained for the borehole cores and the surface soils of the upper catchment areas. Features of foraminifera were observed by stereomicroscopy in sediment/soil samples.

The weathering index values showed fluctuations by depth in the borehole profiles, although there was an inverse relationship between Product Index and sample depth. Beavers Index and Parker Index performed a similar fluctuation in the profiles. Borehole samples with smaller Parker, Beaver and Product values also had a larger content of finer particles. Physical features seem to coincide with chemical features. The indexes obtained for the modern surface soil showed differences in land use or vegetation coverage; prairie grassland or agriculture field versus forest or slough, which suggest their behavior as leaching intensity indicators. Foraminifera were also found in modern soil samples from the upland drainage basin of both alluvial fans. Moreover, the presence and abundance of foraminifera varied in the borehole samples. This may suggest that they could be used in combination with weathering indexes as an environmental proxy for reconstructing the environmental history of the Qu’Appelle Valley.

Keywords: Alluvial Fan, Chronology, Canadian Prairies, Holocene environment

