Radar Stratigraphy and Hydraulic Interpretation of Megaflood Gravel Dune

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1. Introduction

Undulating terrain in Altai Mountains of S. Siberia was interpreted by Carling (1996a&b) as large gravel dunes; the Kuray dune field. The dunes relate to the catastrophic emptying of the ice-dam glacial Lake Kuray-Chuja in the late Pleistocene from the lake basin. Detail of the internal structure of the features will ensure the correct geomorphological interpretation. A ground penetrating radar survey was made of the largest, 16m high asymmetric ridge of wavelength 180m and five other contiguous dunes. The initial stratigraphic interpretation is consistent with gravel dune bedding due to a flood. Flow-parallel GPR transects are pre-processed, migrated and corrected for the topography (Fig. 1). Note the ridge is asymmetry with a longer, less steep stoss slope as opposed to a shorter, steeper lee slope. The radar reflections within the dune are dominated by inclined reflections which dip from right to left in a downstream direction. These inclined reflections are interpreted to be from cross-stratification within the dunes. At the base of the dune is a sharp but irregular reflection interpreted as a basal erosion surface (arrowed). Reflections from cross-strata downlap onto this surface as the dune migrated downstream. Within the inclined reflections there are lower angle inclined reflections that truncate underlying reflections and are in turn downlapped by overlying reflections, these (arrowed) surfaces are interpreted as bounding surfaces where there has been a break in deposition a with a reshaping of the dune bedform. The packages of cross-strata separated by bounding surfaces indicate a vertical stacking of strata within the dune not just a simple downstream translation of a migrating bedform. This assemblage could be a response to a rapidly changing flood hydrograph where the bedform wavelength and height tries to adjust to the fluctuating discharge. The rising limb of the hydrograph is marked by the basal scour and initial dune construction. During peak discharge the giant dune is formed and this migrates downstream generating sets of cross-strata. As the discharge declines and flow depth decreases smaller dunes are formed but their development is constrained by the existing giant dune morphology so the small dunes generate bounding surfaces and smaller sets at the crest and downstream margins of the giant bedforms GPR profile across a giant gravel dune collected with 100 MHz antennas, processing includes AGC gain, migration and topographic correction using a velocity of 0.135 mns⁻¹. The strata dip downstream at angles up to 30° and are truncated by reactivation surfaces attributed to reshaping of the dune during the flood. The basal surface of the dune is erosive and cuts down 5m into the underlying gravels indicating scour development as the dune migrates downstream from west to east. A basin-scale lake drainage hydraulic model simulating lake drainage provides estimates of the flow duration, velocities and applied shear stresses associated with dune development.

Figure 1: GPR profile across a giant gravel dune collected with 100 MHz antennas, processing includes AGC gain, migration and topographic correction using a velocity of 0.135 mns⁻¹. The strata dip downstream at angles up to 30° and are truncated by reactivation surfaces attributed to reshaping of the dune during the flood.

3. Conclusions

The radar strata are consistent with an interpretation of these landforms as dunes. Dune cross-bedding does not occur as set packages in the vertical so the environment was not aggrading, rather dunes represent a single event or possibly reactivation of dunes by several events without aggradation. The hydraulic model data allow the evidence of dune progression derived from radar facies to be mapped onto a qualitative flood hydrograph.

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References

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