GROUND PENETRATING RADAR STRATIGRAPHY AND DYNAMICS OF MEGAFLOOD GRAVEL DUNES

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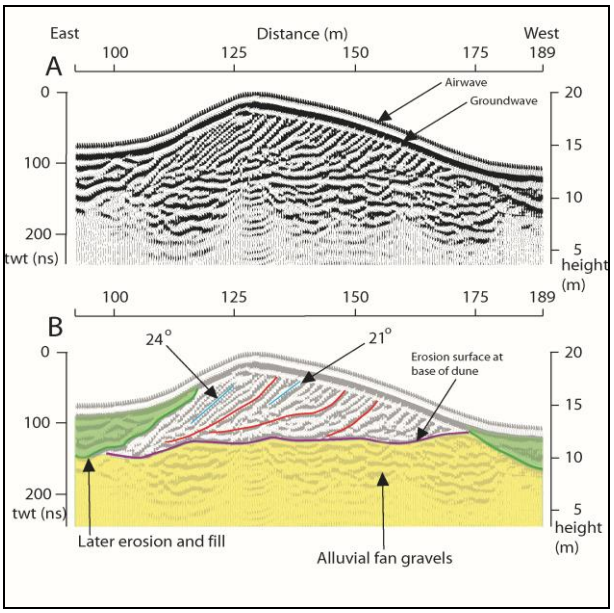
1. INTRODUCTION

Ground-penetrating radar was used to elucidate the stratigraphy of Pleistocene gravel dunes in Kuray Basin of the Altai mountains, southern Siberia (Fig. 1). Dunes formed when the Kuray-Chuja lake emptied catastrophically due to ice-dam failure (Carling, 1996a & b). Lake drainage was rapid but with steady reduction in water level and flow direction (Bohorquez et al., 2015). GPR survey-lines acquired across five prominent dunes had a resolution of decimetres, with depth penetration of around 20m. The reflections are interpreted using seismic methodology in identifying bounding surfaces and radar facies supplemented by stratigraphic descriptions from excavated pits. Two significant classes of unconformities are identified: (i) a single erosional unconformity at the dunes base; (ii) several steeply-inclined unconformities within the dunes which truncate underlying reflections but are also downlapped by overlying inclined reflections within the dunes.

1. Location of the Kuray Basin (K) and the Chuja Basin (C) in the Altai mountains of southern Siberia.

2. View to the southwest across the dunefield with the pine forest of the Tetyo River immediately behind. Steep leeside dune slopes are shadowed.

We identify six radar facies: Facies 1, basal sub-horizontal discontinuous discordant reflections; Facies 2, poorly-defined discordant reflections within the stoss-toes; Facies 3, planar inclined reflections; Facies 4, sigmoidal inclined reflections; Facies 5, trough fills; Facies 6, low-



3. (A) 2012 Radar reflectors for Dune 4; (B) Interpretation of the 2012 radar facies for Dune 4. The well-defined cross-sets (e.g. blue curves) are relatively steep. The radar stratigraphy shows reactivation surfaces (red curves) and the unconformable interface (purple curve) with the underlying gravel deposits. Later fill in the dune troughs (green) has subdued the modern topography. Palaeoflow right to left.

angle upstream inclined reflections. The basal unconformity represents the surface cut by flood flows, across which the dunes migrated in a non-aggradational setting. The inclined unconformities may be interpreted in two ways: (a) As erosional surfaces induced by unsteady flow within one flood event, or (b) as erosional surfaces developed by a series of flood events reactivating dunes left stranded by previous floods. Arguments are presented in favour of the latter model, which interpretation is consistent with there having been several dune-forming events within the lake basin.

4. Cartoon interpretation of four packages (1 – 4) of cross-strata separated by bounding reactivation surfaces above a basal unconformity, down-lap and truncation of reflections are represented by small arrows. Package 1 consists of irregular stratification, in the upflow position, deposited as an incipient bedform against which steep cross-sets were deposited once steady flow and the bedform were established. Reactivation surface 1 represents cutting of the lee-side of package 1 during falling flow. RS2 and RS3 represent reactivation surfaces associated with two subsequent events. Packages 2, 3 and 4 represents renewed deposition of cross-sets in the lee of the bedform stranded after three repeated floods to give a history due to four floods in total.

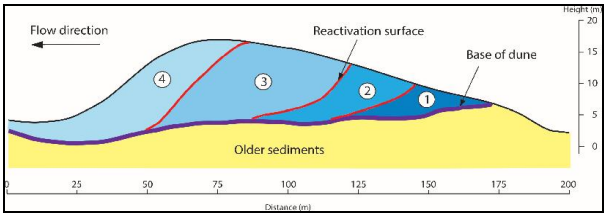


Figure 12: Cartoon interpretation of four packages (1 – 4) of cross-strata separated by bounding reactivation surfaces above a basal unconformity, down-lap and truncation of reflections are represented by small arrows. Package 1 consists of irregular stratification, in the upflow position, deposited as an incipient bedform against which steep cross-sets were deposited once steady flow and the bedform were established. Reactivation surface 1 represents cutting of the lee-side of package 1 during falling flow. RS2 and RS3 represent reactivation surfaces associated with two subsequent events. Packages 2, 3 and 4 represents renewed deposition of cross-sets in the lee of the bedform stranded after three repeated floods to give a history due to four floods in total.

2. CONCLUSIONS

Large gravel dunes were formed by catastrophic rapid drainage of a Pleistocene ice dammed lake. GPR survey reflections highlight cross-sets due to dune progression in three to four flood events.

Three to four unconformities represent reactivation surfaces that separate each cross-set package that developed when the dunes moved on each flood. During lake drainage the dunes migrated for short periods of time. During periods of lake refilling the dunes were submerged by the rising lake water and remained inactive on the lake bed.

3. REFERENCES

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