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EverDrill

Englacial debris content of a Himalayan debris-covered glacier revealed by an optical televiewer

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NERC SCIENCE OF THE ENVIRONMENT

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1. Motivation

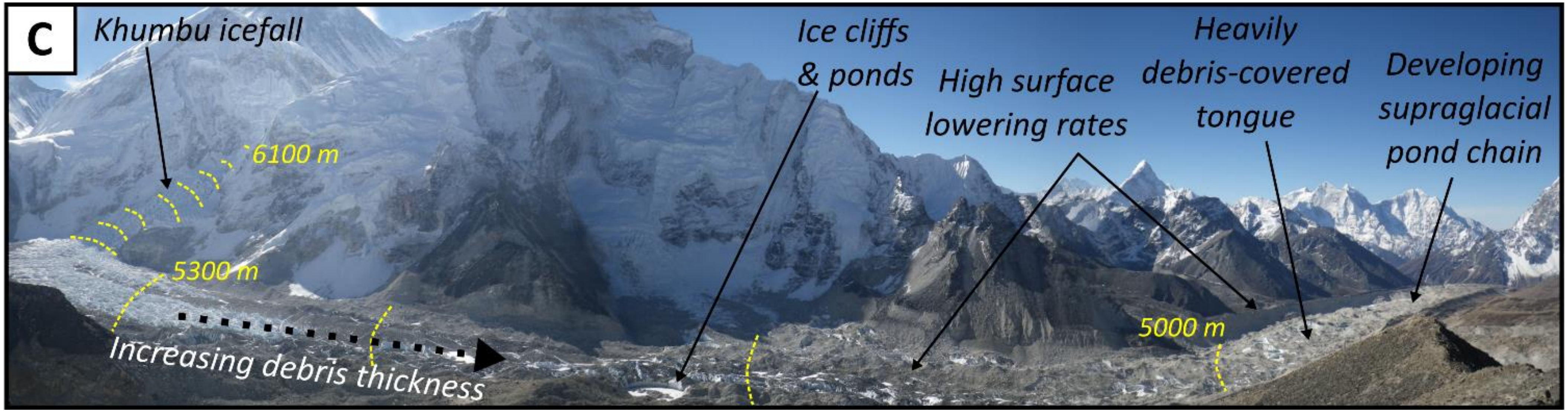

Figure 1 – Labelled schematic of a debris-covered glacier (Khumbu Glacier, Nepal); Miles et al. (in review)

- Glaciers across High Mountain Asia provide water resources to huge populations
- Debris-covered glacier melt rate controlled by **spatially variable supraglacial debris layer**
- Supraglacial debris thickness controlled partly by **englacial debris melt-out**
- Englacial debris contents are **unknown** and simplified even in most sophisticated models

2. Method

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- Four boreholes
  - Drilled by hot, pressurised water
  - Logged by optical televiewer (OPTV; a borehole-based camera)
- Four OPTV image logs
  - 360° high-resolution images
  - Total 345.5 m of glacier's interior
- Analysed for englacial debris

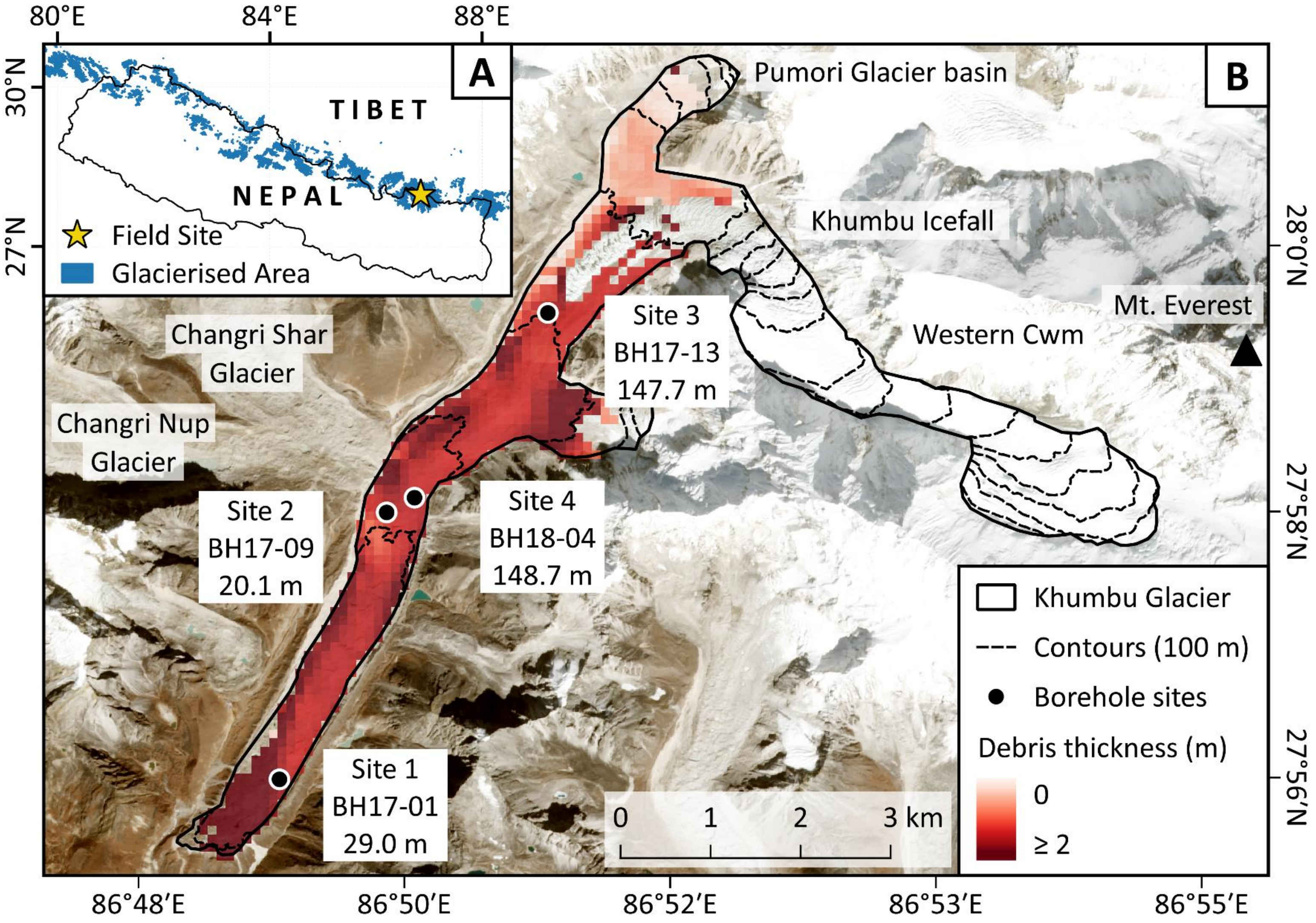

Figure 2 – Location of study site; Miles et al. (submitted)

3. OPTV image sections & results

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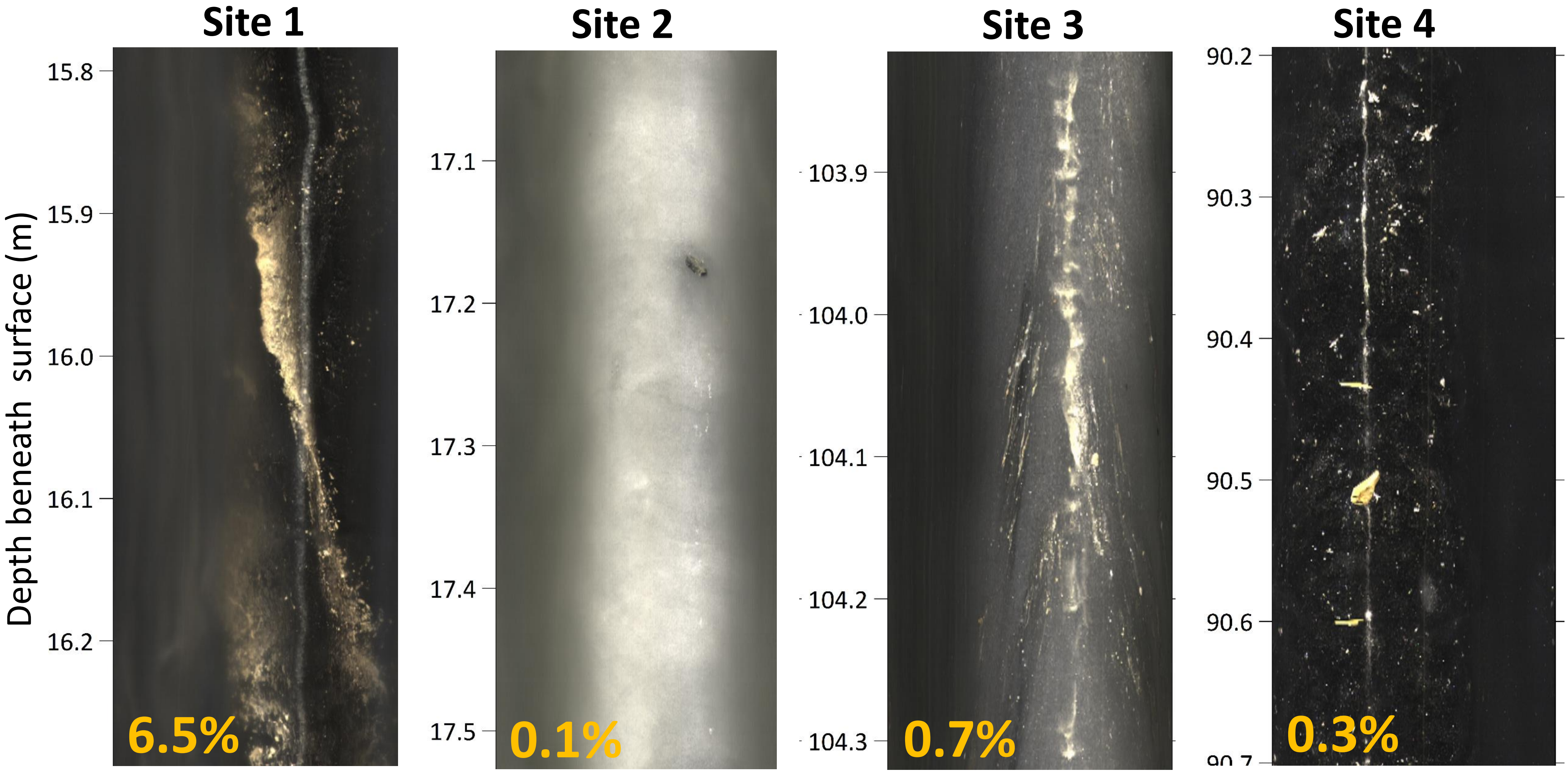

Mean borehole englacial debris concentrations (% by volume)

Englacial debris contents, from OPTV images, are:

i) **Higher** than at other glaciers around the world

ii) **Lower** than assumed in few models that can consider englacial debris

4. Influence on future melt rates

- Simple model projections, using OPTV-derived englacial debris concentrations:
  - To predict englacial debris melt-out and surface melt rates in the currently **clean-ice** upper ablation area (Fig. 3)
  - Show **importance of vertical distribution of higher concentration englacial debris layers** for future melt-out, predicting ~20 years of enhanced melt before supraglacial debris layer is thick enough to insulate the ice surface (black dotted line; Fig. 3A)
  - The variable debris content with depth (Fig. 3A) acts both to:
    - i) delay peak melt rate and time to insulation compared to a uniform mean debris content (Fig. 3B)
    - ii) speed up time to insulation compared to a low englacial debris content (not reached at all in Fig. 3C)

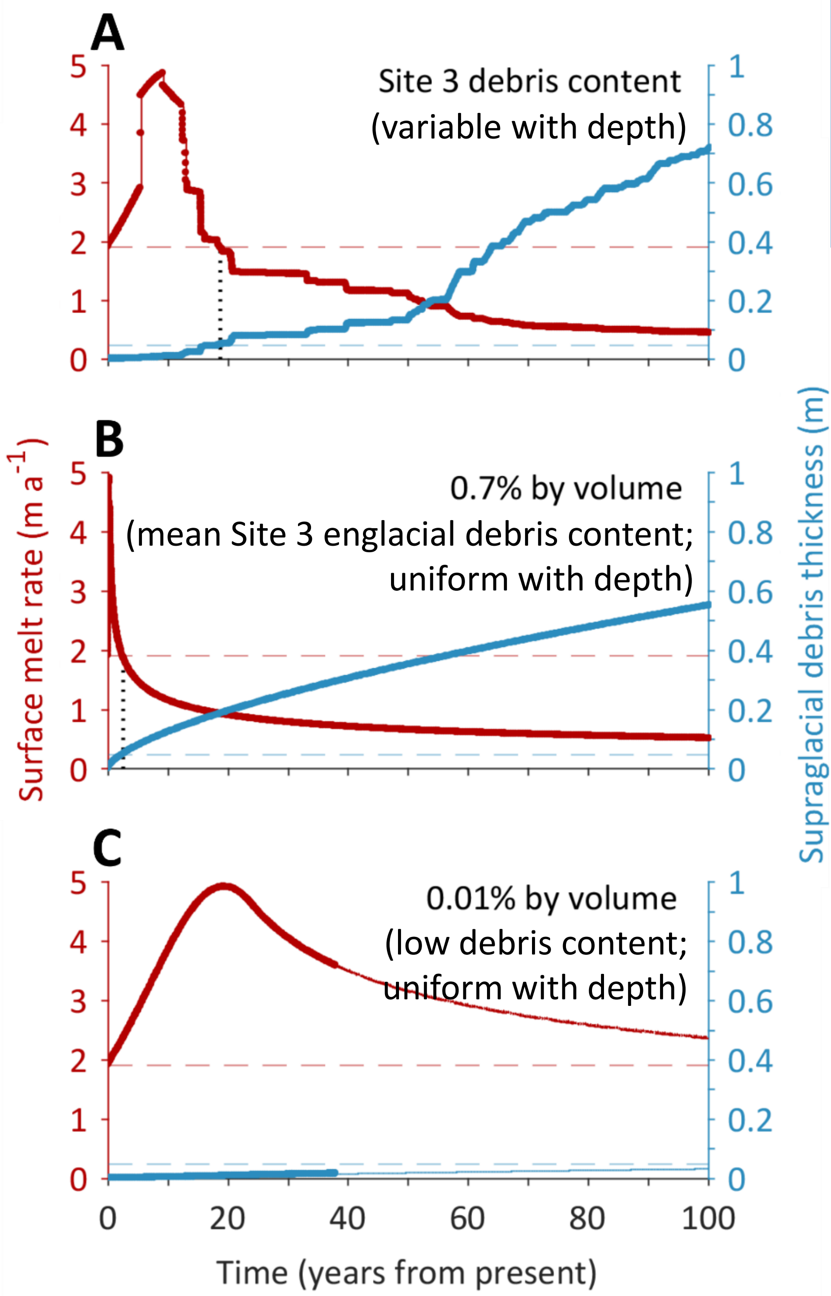

Figure 3 – Results from simple model projections; Miles et al. (submitted)