

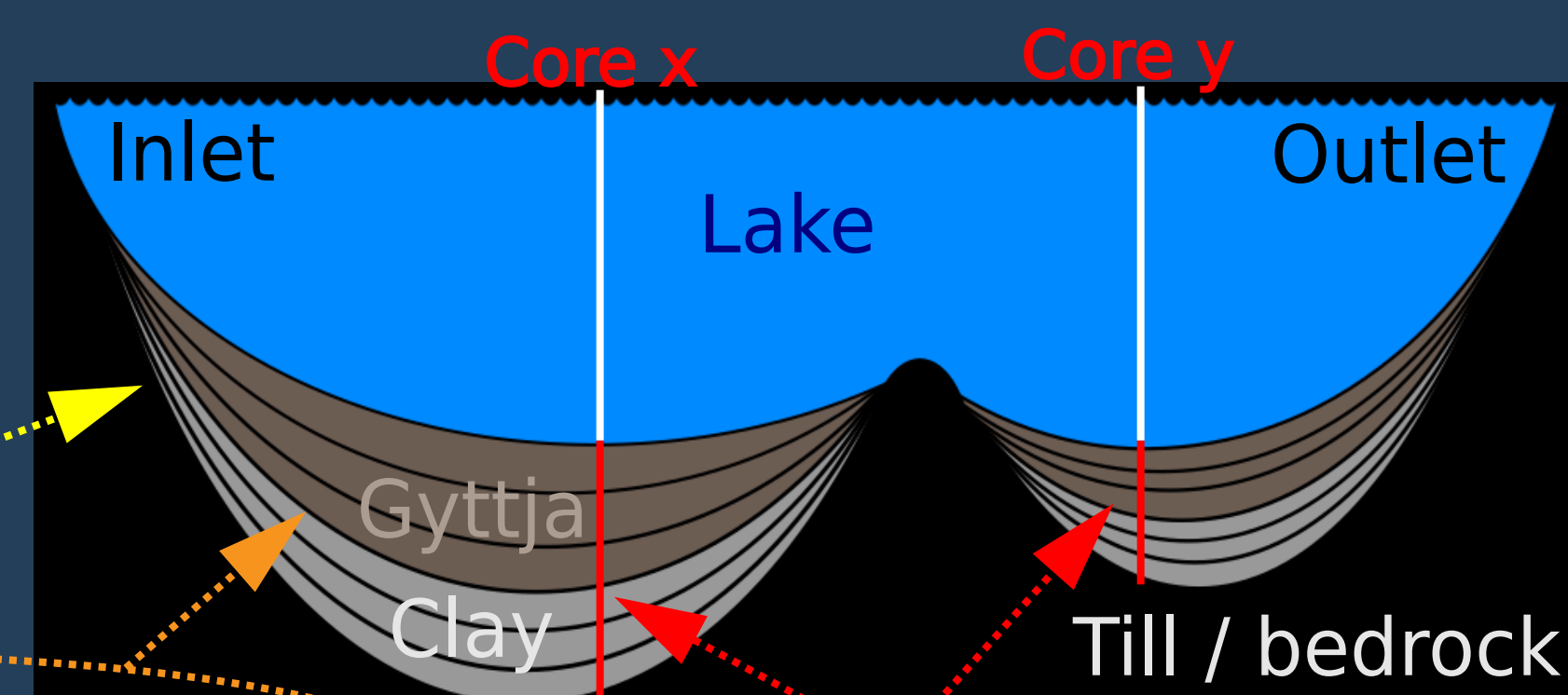
Sedimentary architecture and accumulation rates of two lakes in Maine

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Introduction

The sedimentary architecture of lakes in previously-glaciated landscapes records geomorphological history that can shed light on the nature of late-glacial, periglacial, postglacial, and anthropogenic landscape change. Unfortunately, the sedimentary architecture of most lakes is not well understood, since they are most often studied using point-source sediment collection. Although coring is a useful way to gain extremely detailed information on sediment columns at specific points in space, coring locations are often sparse and thus not well suited to document change spatially. Reliance on core records for sedimentation rates, for example, assumes that derived rates represent the broader lake basin. Recent ground-penetrating radar (GPR) surveys in Vermont and New Hampshire, in comparison with core data, show that this assumption can be highly erroneous. We conducted ground-penetrating radar (GPR) and two lakes in Maine, USA, representative of different basin types and landscape histories since the retreat of the Laurentide Ice Sheet. Combined with coring, the results suggest very slow (on the order of 0.1 m / kyr) accumulation over the majority of the Holocene, and on the order of 100 m / kyr over the last century in some highly disturbed areas), likely related to agricultural and construction activities, and increased trap efficiency of reservoirs due to dam emplacement. Geophysical results suggest accumulation may also have been faster in the late-glacial and periglacial periods, though the age and duration of these periods are difficult to constrain. Maine's many lakes and ponds likely provide a buffer to sediment and solute transport from inland to coastal areas.

Background



Exhibits control on sedimentation (Arcone, 2018)

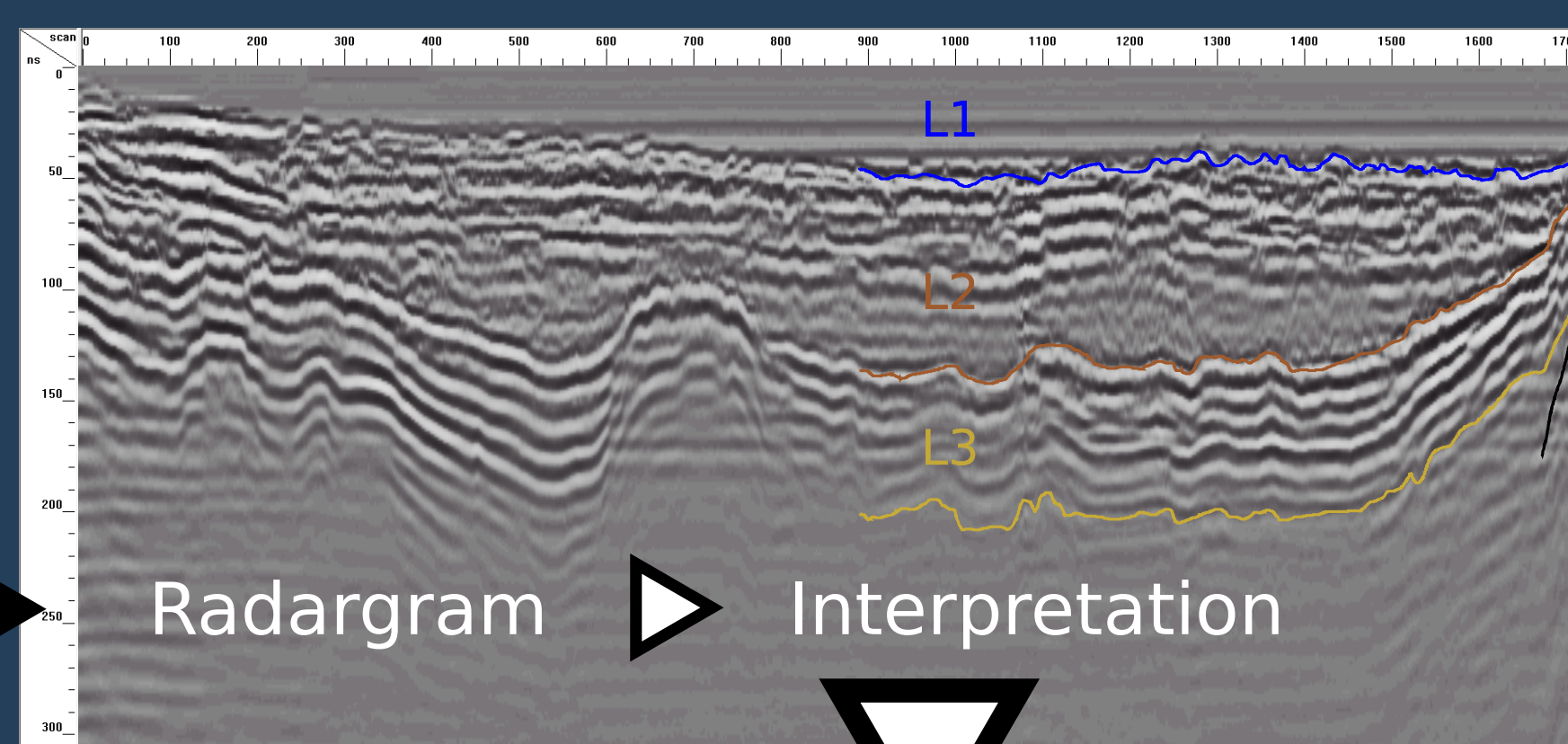
Core-derived rates: high error! (Davis and Ford, 1982; Arcone, 2018)

GPR: portable profiling of sediment beneath shallow, fresh water and/or ice

Geophysical Survey Systems Incorporated
100 MHz fixed-aperture antenna

Winter survey

Summer survey



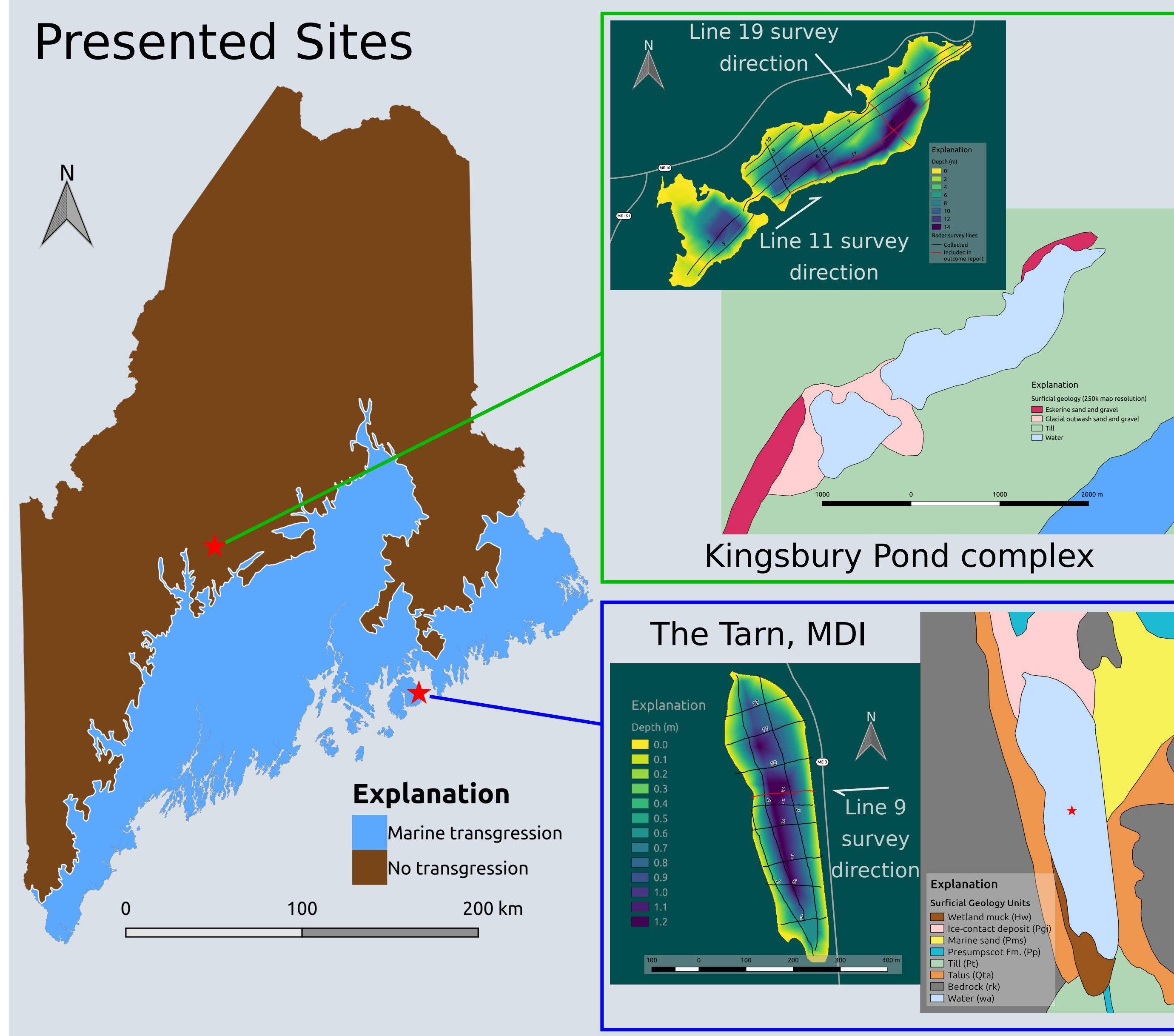
$$d = \frac{t_n - t_{n-1}}{2} * \frac{c}{\sqrt{\epsilon_r}}$$

d — depth (m)
 t — two-way travel time (ns)
 n — layer number
 c — speed of light (m/ns)
 ϵ_r — relative permittivity ($\mu\text{s}/\text{cm}$)

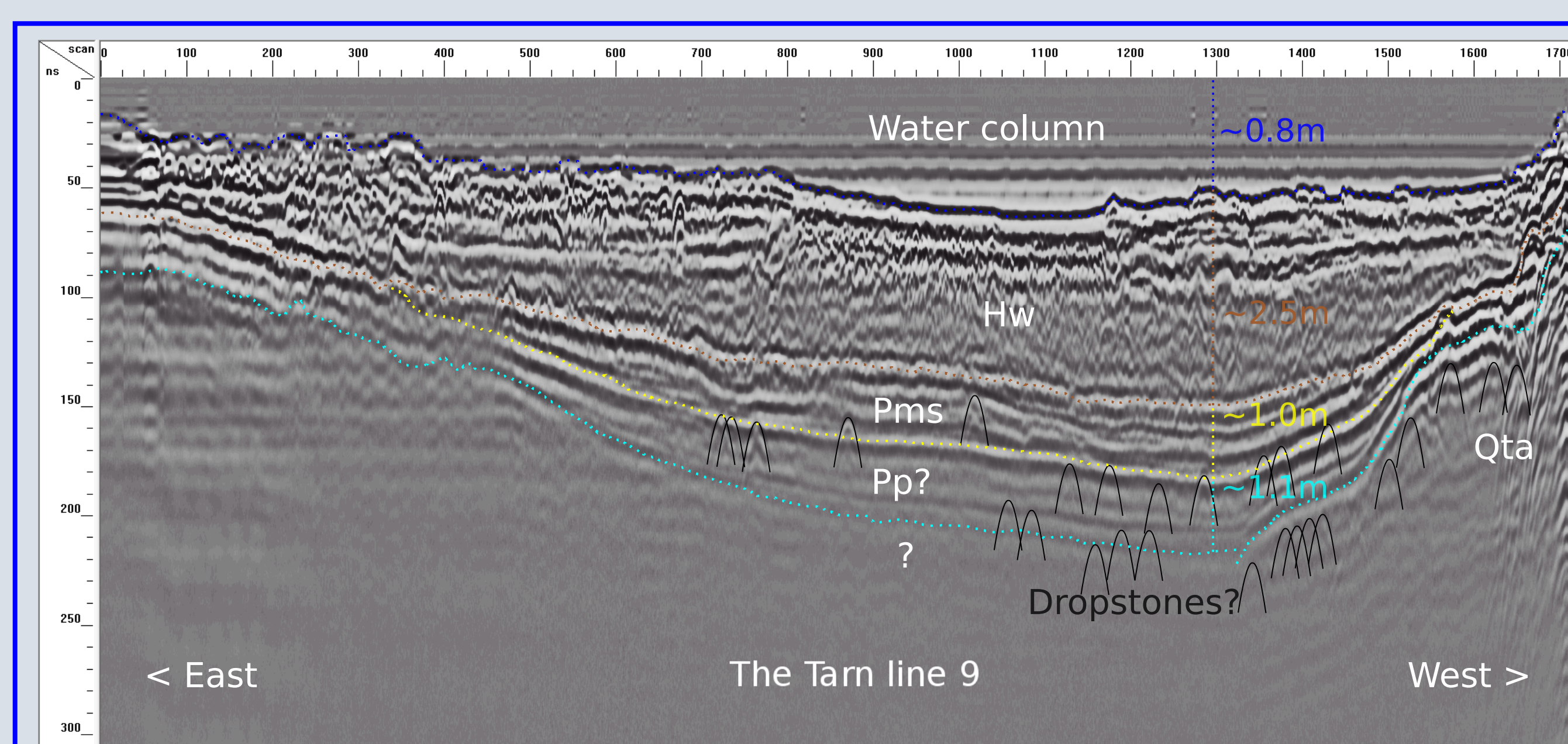
Layer thickness estimates

L1 $\approx$ 0.8m
L2 $\approx$ 2.1m
L3 $\approx$ 1.9m

Presented Sites

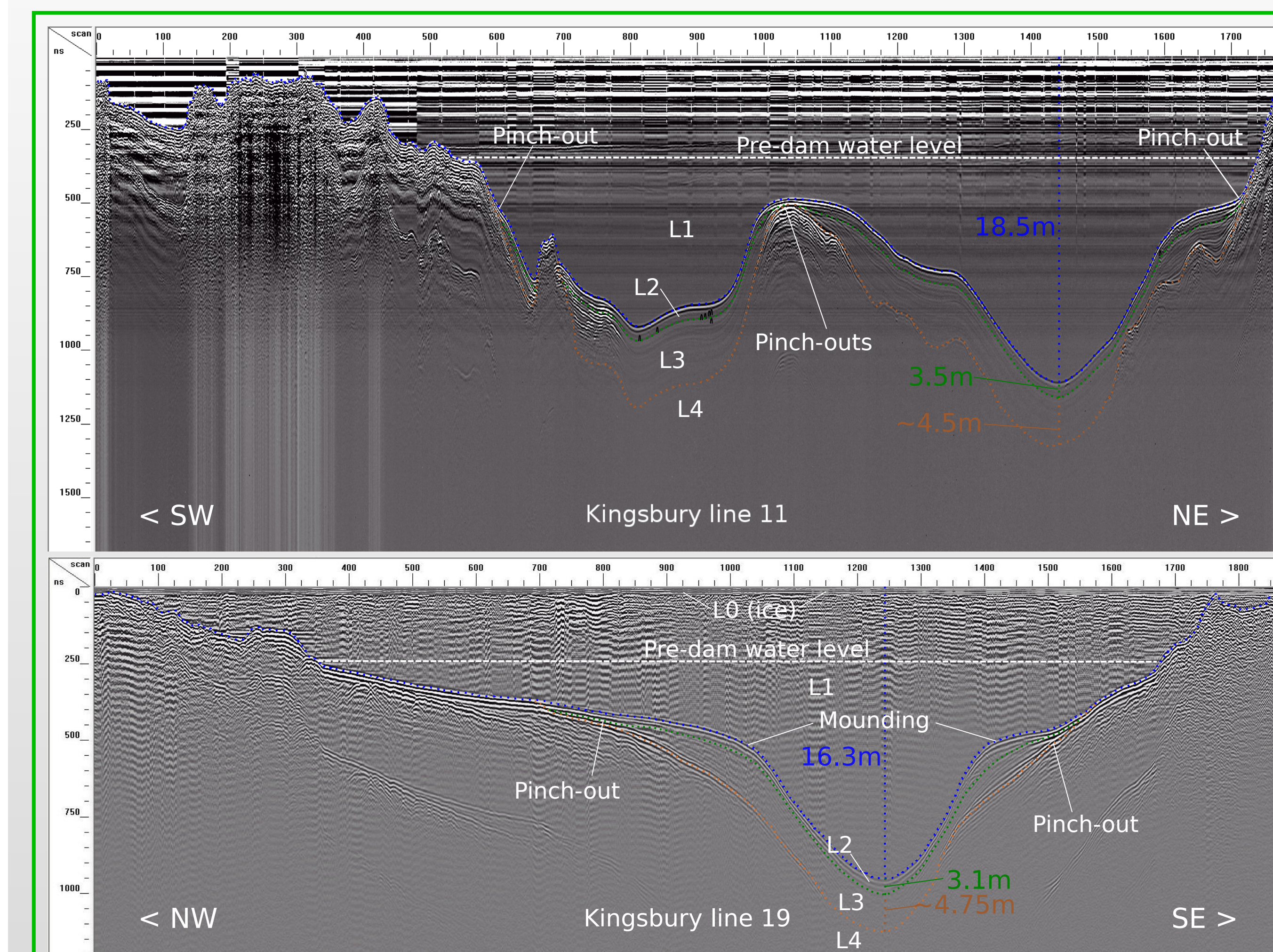


Results and Discussion



Features of Interest in Tarn dataset

- Evidence of multiple stages of Quaternary geologic record
- Multiple unconformity signatures (esp. in unit interpreted as Pms)
- ^{210}Pb concentration in 0.5 m push core suggests nearly 2 cm / yr accumulation since ~1920 CE
- Human influence of road, dam likely cause jump in sedimentation rate during historical time



Features of Interest in Kingsbury Pond dataset

- L1 = water; L2 = gyttja; L3 = clay and sand; L4 = till or bedrock
- Evidence of erosion, turbidity, and sediment focusing
- Hypsometry at depth controlled by settling of turbidite material
- GPR can provide stratigraphic context to inform coring location
- Pre-dam sediment dominates, unsure if dam-related signal
- Core through L2 (in progress) shows 0.2 mm / yr Holocene accumulation

Conclusions and Future Work

- Human influence in highly altered watersheds is reflected in sediment samples and (in some areas) radar profiles.
- Sediment thickness maps (not shown) facilitate estimate of total volume delivered to basins over the course of the Holocene. Higher-frequency GPR may further resolve human influences on sedimentation.
- Correlation of radar reflectors with core records where available will allow better contextual analysis of stratigraphy.

Arcone, S.A., 2018, Sedimentary architecture beneath lakes subjected to storms: Control by turbidity current bypass and turbidite armouring, interpreted from ground-penetrating radar images (N. Mountney, Ed.): Sedimentology, doi: 10.1111/sed.12429.

Davis, M.B., and Ford, M.S. (Jesse), 1982, Sediment focusing in Mirror Lake, New Hampshire: Limnology and Oceanography, v. 27, p. 137-150, doi: 10.4319/lo.1982.27.1.0137.

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