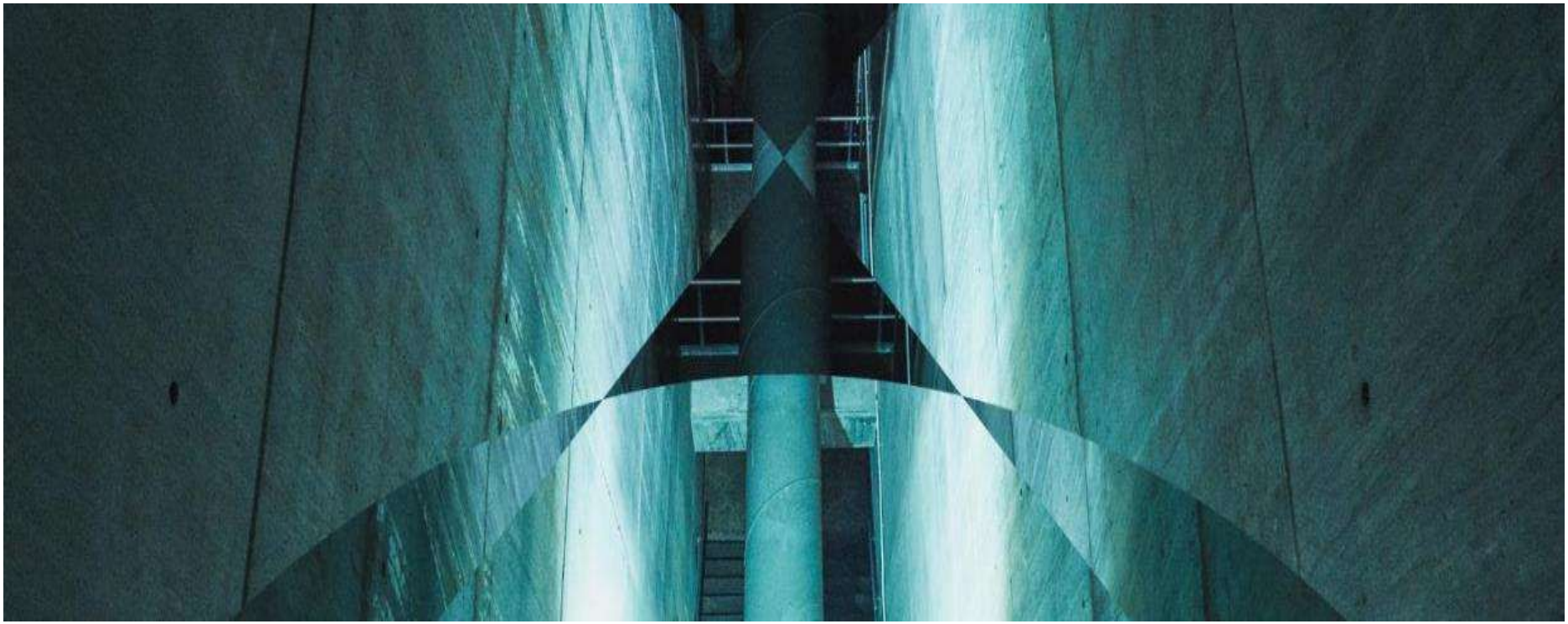
An Experimental Study of Unfrozen Water Content in Fine Grained Permafrost Soils

Marte Sundby Nybo



Source: https://snowbrains.com

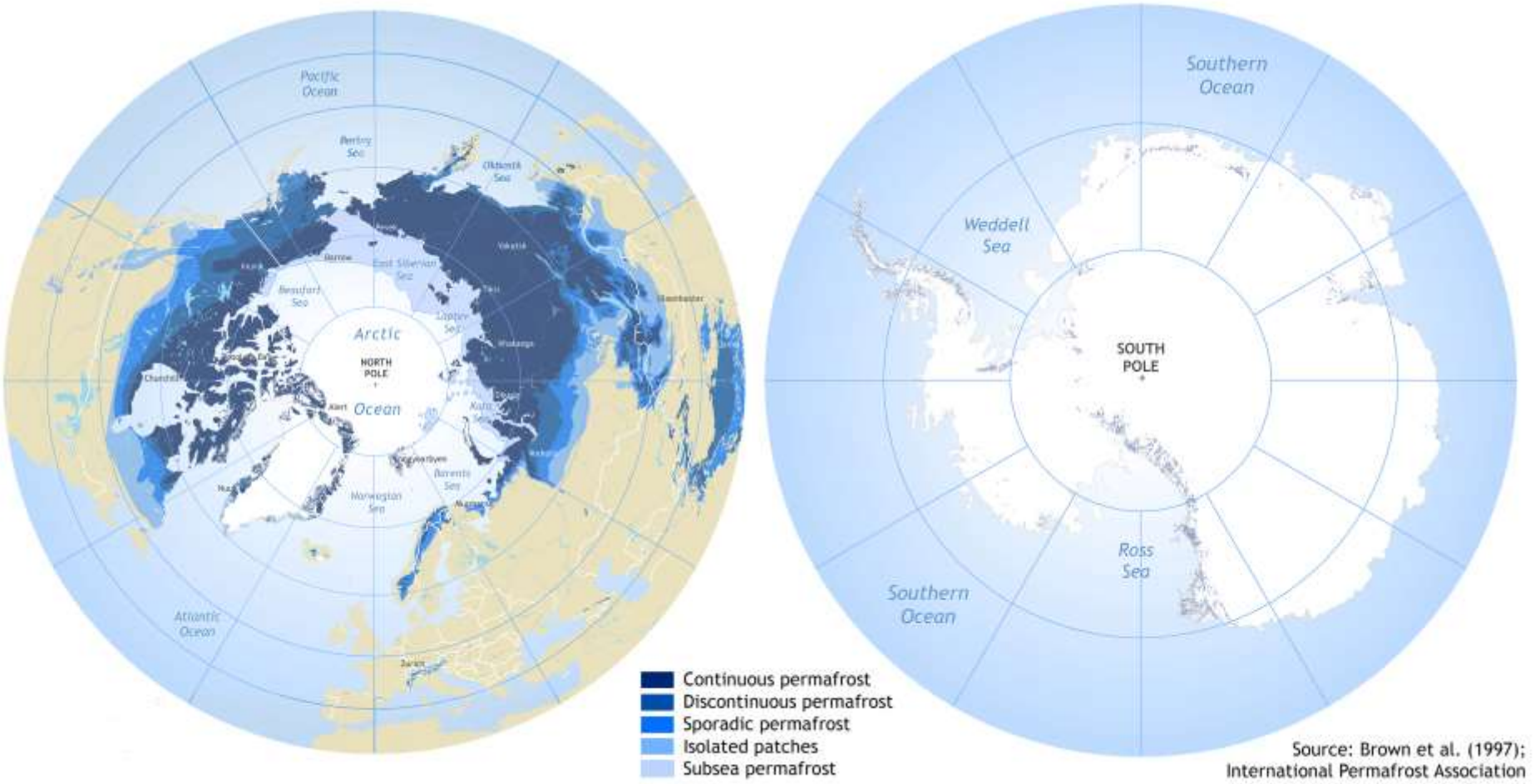
Marte Sundby Nybo

- Graduated spring 2017, NTNU
- Geotechnical engineer, Norconsult AS
- Master Thesis spring 2017
  - UNIS
  - NGTS

Agenda

- Geotechnical engineering in permafrost areas
- Unfrozen water content in frozen soil
- Methods for estimating unfrozen water content in frozen soil

Permafrost



Norconsult

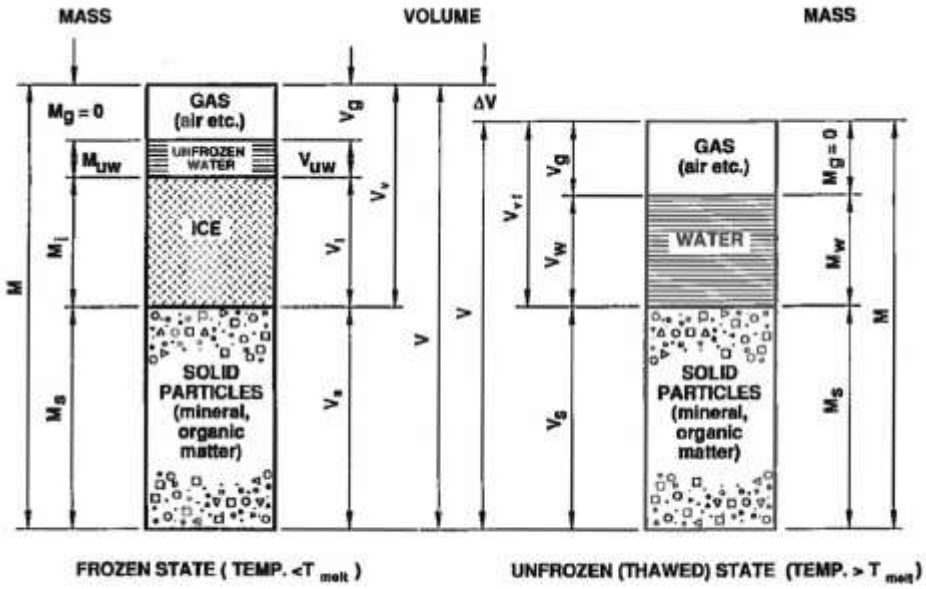
Geotechnical Engineering in Cold Areas

Unfrozen Water Content

$$w = w_u + w_i = \frac{M_w}{M_s}$$

$$w_u = \frac{M_u}{M_s}$$

- Supply heat
- Reduce strength
- Increased settlements



Mass-volume relationships for frozen and unfrozen soil (Andersland and Ladanyi, 1994)

Methods for Estimating Unfrozen Water Contents

- Liquid limit determination
- Water potential determination

Unfrozen Water Content from Liquid Limit Determination

$$w_u = \alpha\theta^{\beta} \quad [\%]$$

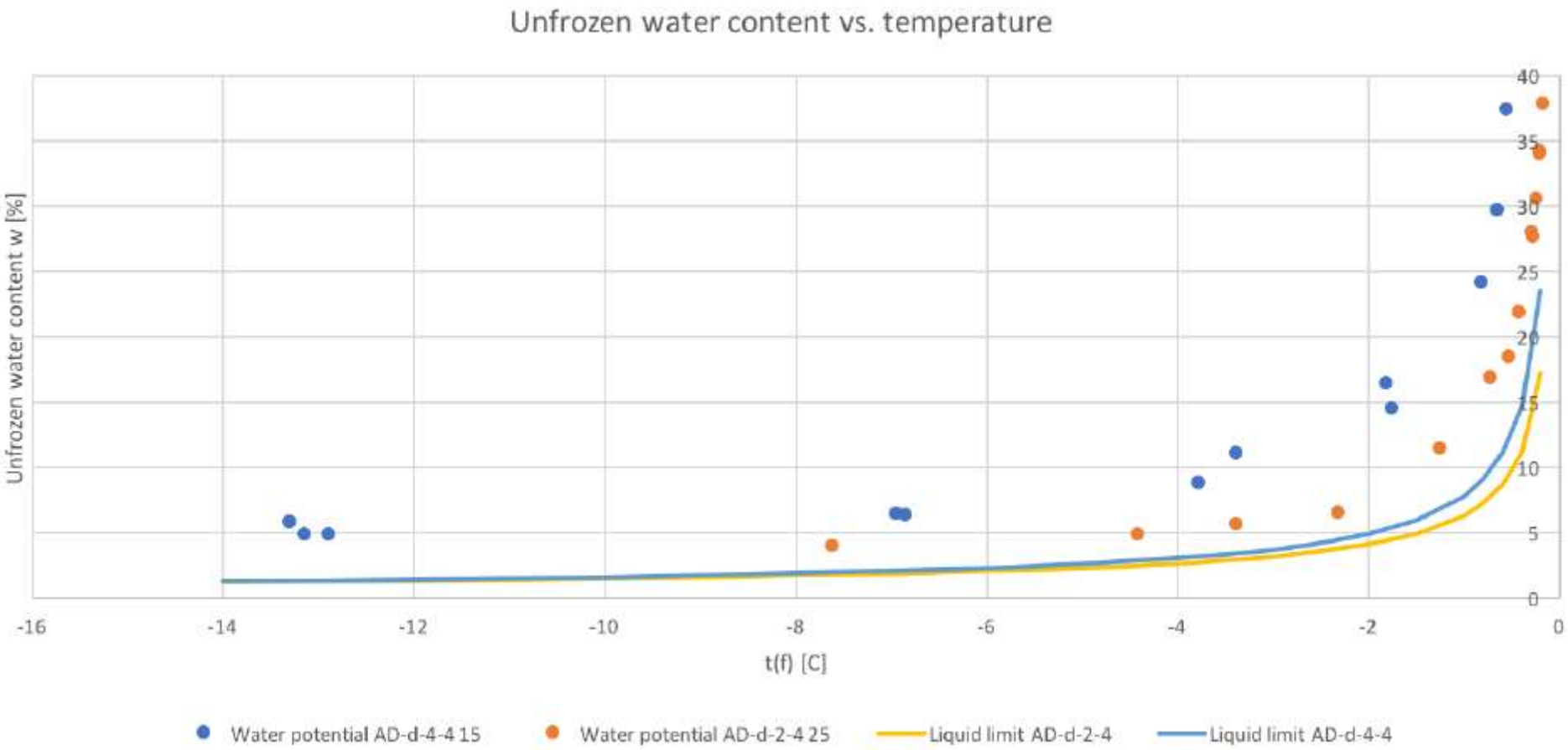
$$w_{u,\theta=1} = 0.346 \cdot w_{N=25} - 3.01$$

$$w_{u,\theta=2} = 0.338 \cdot w_{N=100} - 3.72$$

Unfrozen Water Content from Water Potential Determination

- Proposed by Istomin et. al. (2015, 2017)
- Based on experimental correlations and thermodynamic calculations

Comparison of the Results



Experiences and Comparison of the Methods

Liquid Limit Determination	Water Potential Determination
Cumbersome	Easy
Time-consuming	Rather effective
Dependent on operator	Less dependent on operator

Summary and Further Work

- Liquid limit testing gave lower estimated unfrozen water content w_u
- Water potential method provides more accurate estimates?
- Water potential method should to be further tested and developed


Norconsult