MAPPING OF GEOLOGICAL FRACTURES: A CNN APPROACH

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INTRODUCTION

- Natural fractures can create permeable fluid pathways that are important for geo-energy applications such as CO_2 sequestration and geothermal projects [1].
- Drone and LiDAR-based acquisition methods produce high-resolution 2D data, suitable for detailed fracture mapping [2].
- Manual and semi-automated fracture mapping is time-consuming and susceptible to interpreter bias [3].

Interactive results ▼

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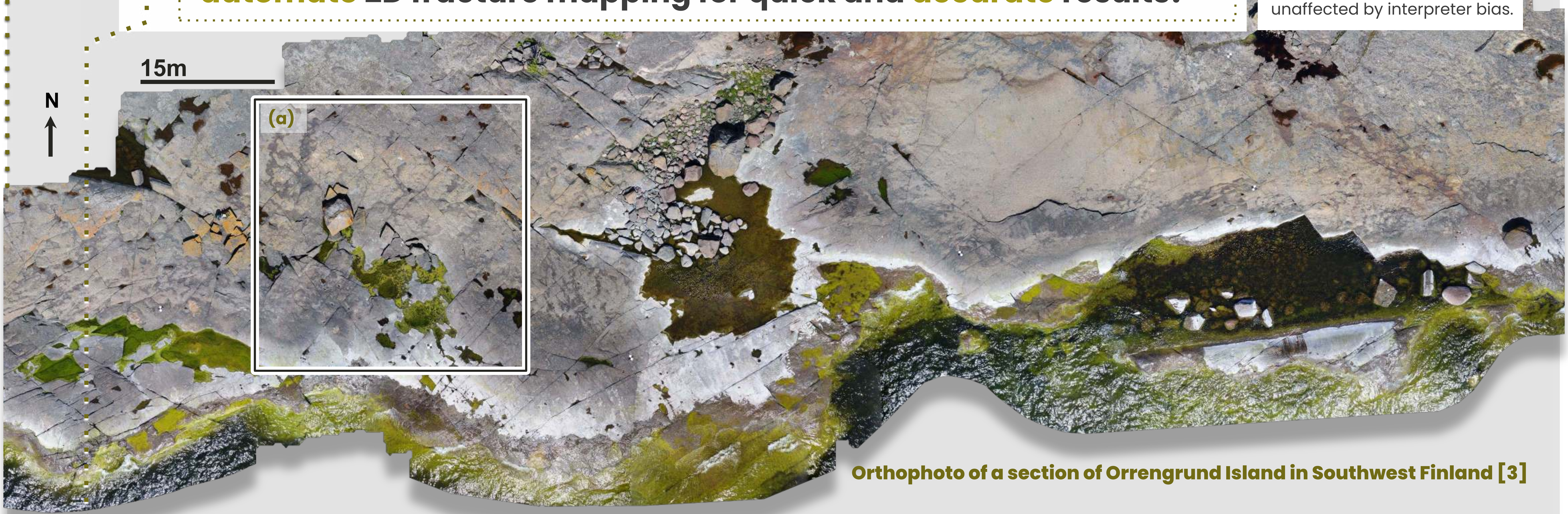
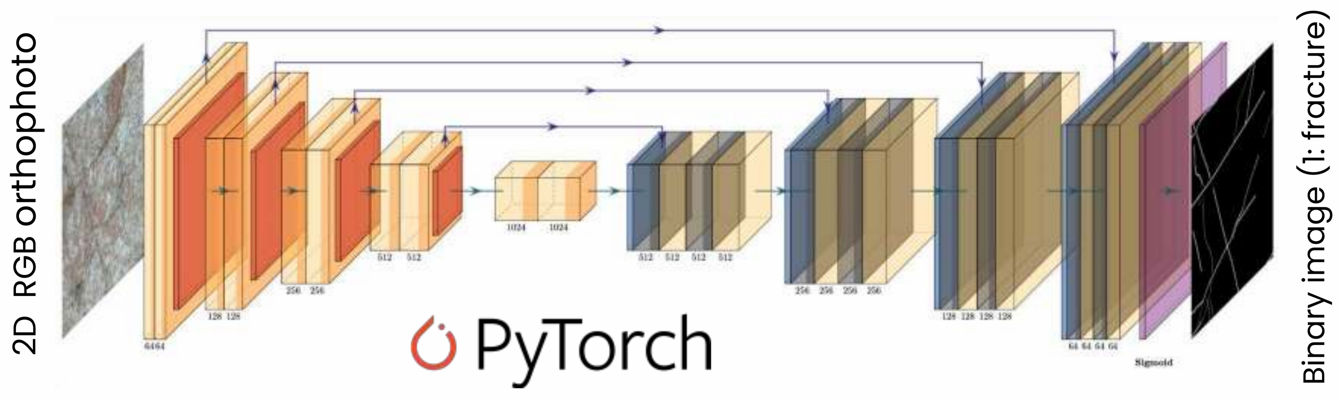
Can we use deep learning (Convolutional Neural Networks) to automate 2D fracture mapping for quick and accurate results?

Automatic: No manual intervention required;
Accurate: Results closely match real fractures and unaffected by interpreter bias.



Orthophoto of a section of Orrengrund Island in Southwest Finland [3]

METHODS



MODELS:

All based on convolutions

- **U-Net** [4]
- DeepLabV3+ [5]
- PAN [6]

Post-processing

a.Thin
b.Smooth
c.Vectorize

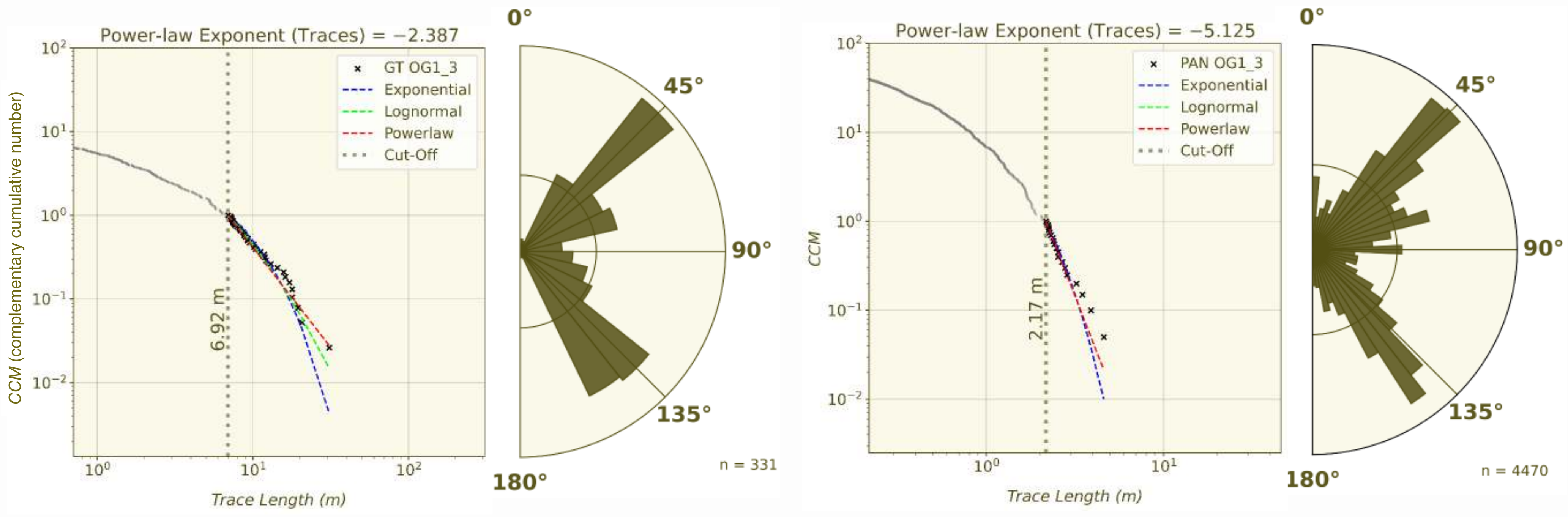
RESULTS AND DISCUSSION

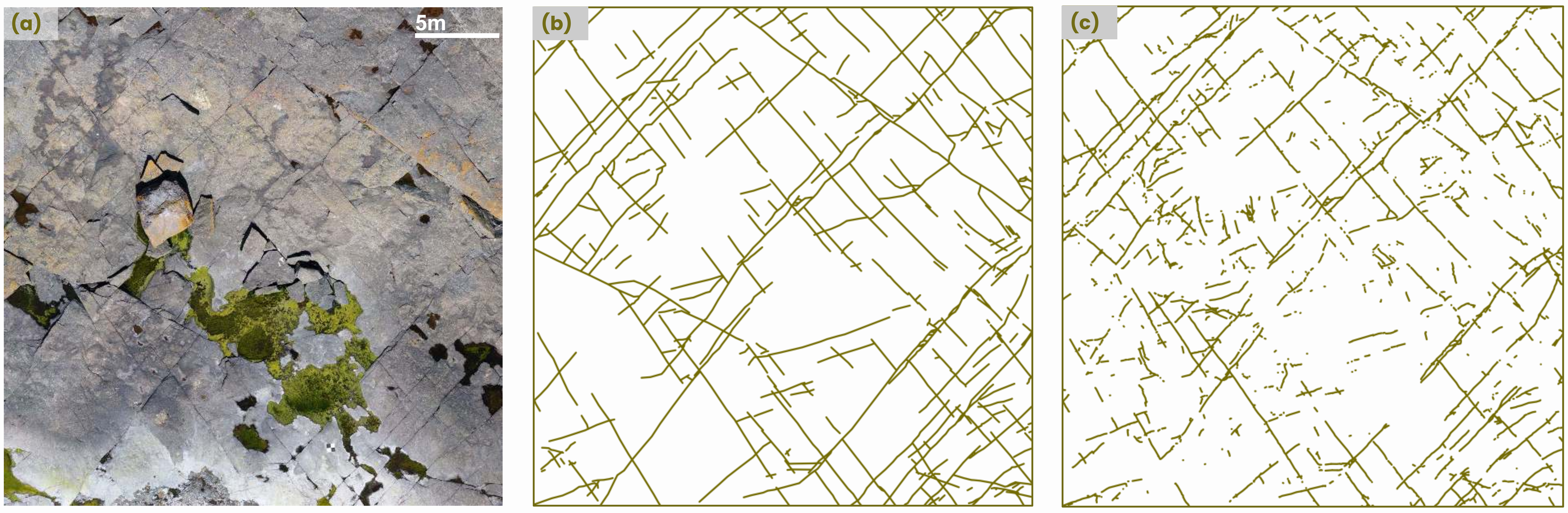
Results

- **The model generates more segments, with some being very short (noise)**
- **The model's trace length distribution has a lower cut-off value**
- **Rose diagrams have similar directional pattern**

(a) Portion of the test dataset (OG1) [3]
(b) **Manual mapping** (geologists' interpretations): Ground truth [7] and its respective fracture trace length distribution and rose diagram created using *fractopo* [8]
(c) **Automated mapping**: Predictions of the PAN model and its respective fracture trace length distribution and rose diagram [8]

✓ **Automatic** ✓ **Quick** ⚠ **Accurate**





[1] Matthaï S., 2004, Geophysical Research Letters, Volume 31 - [2] Bemis S., 2014, Journal of Structural Geology - [3] Nordbäck N., 2022, zenodo.7077519 - [4] Ronneberger O., 2015, Lecture Notes in Computer Science, 9351 - [5] Chen L., 2018, arXiv: 1802.02611 - [6] Li H., 2018, arXiv: 1805.10180 - [7] Ovaskainen N., 2022, zenodo.7077846 - [8] Ovaskainen N., 2023, joss.05300