# The Crustal Structure in the Hälsingland Region, Central Sweden and Implications for Seismotectonics


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## SCOPE & CONTEXT

Hälsingland (central Sweden) lies within the Fennoscandian Shield and exhibits complex geology and a number of tectonic/geological boundaries (Figure 1). The region is also seismically active, with earthquake clusters potentially linked to crustal heterogeneity and inherited fault systems. Seismicity forms a ~20–40 km wide NE–SW–trending corridor, with events predominantly occurring in the upper–mid crust (Figure 2 and 3). The origin of the activity is debated as there is no clear fault or deformation zone along the corridor.

To investigate the relationship between seismicity and crustal structure, we apply receiver-function and apparent S-wave velocity (RF–$V_{s,app}$) joint inversion to develop a crustal model and compare it with observed seismicity.

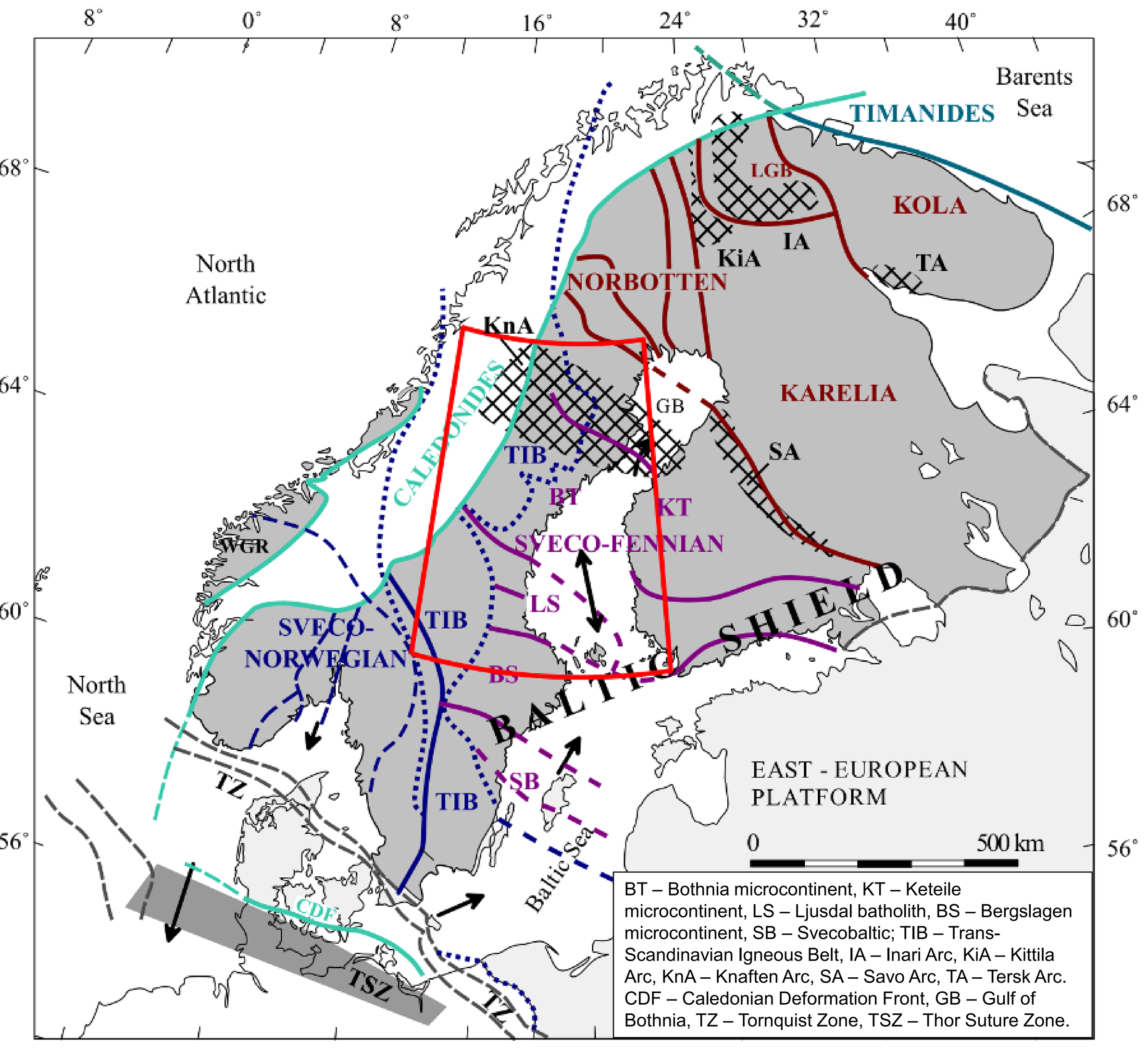


*Figure 1. The location and simplified tectonic map of the study area (Schiffer et al., 2024).*

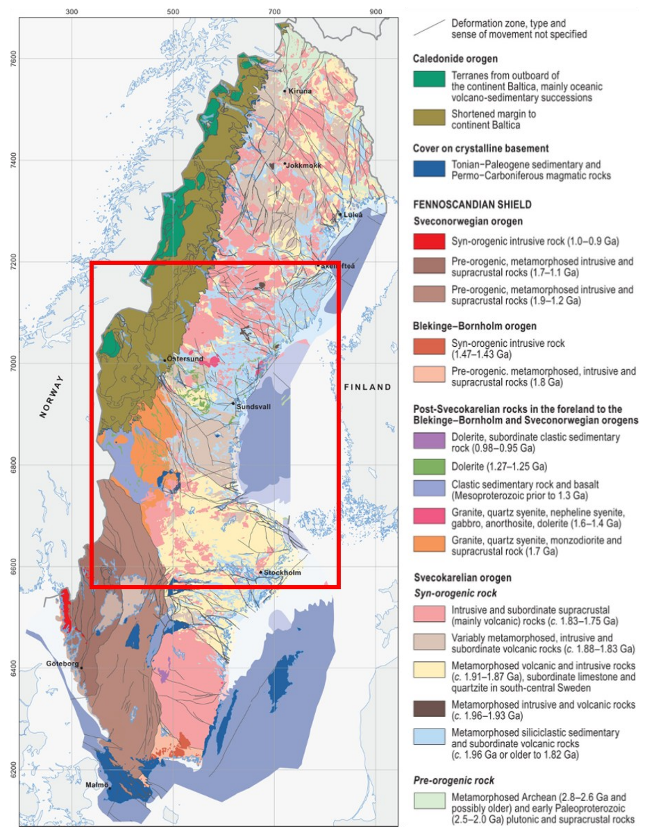

*Figure 2. The simplified geologic map of the study area shown as red rectangle.*

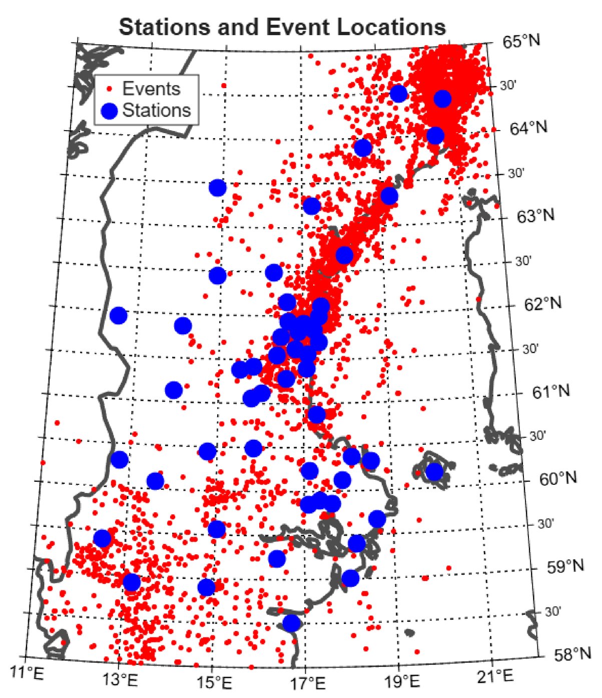


*Figure 3. The location of seismic stations and seismicity.*

## 3D CRUSTAL STRUCTURE OF HÄLSINGLAND

### Methodology

**Data**
Teleseismic waveforms (3-component)

**Preprocessing**
Filtering → Rotation (Z–R–T) → Event selection

**Receiver Functions (RFs)**
Deconvolution → QC → Stacking

**Apparent S-wave Velocity ($V_{s,app}$) Estimation**
Zero-lag RF amplitude ratio → $V_{s,app}$ constraint

**Joint Inversion**
RFs + $V_{s,app}$ → Ensemble of 1D $V_s$ models

**Interpretation**
Moho • Mid-crust • HVLC

**3D Model + Uncertainty**
Interpolation + smoothing → Bootstrap

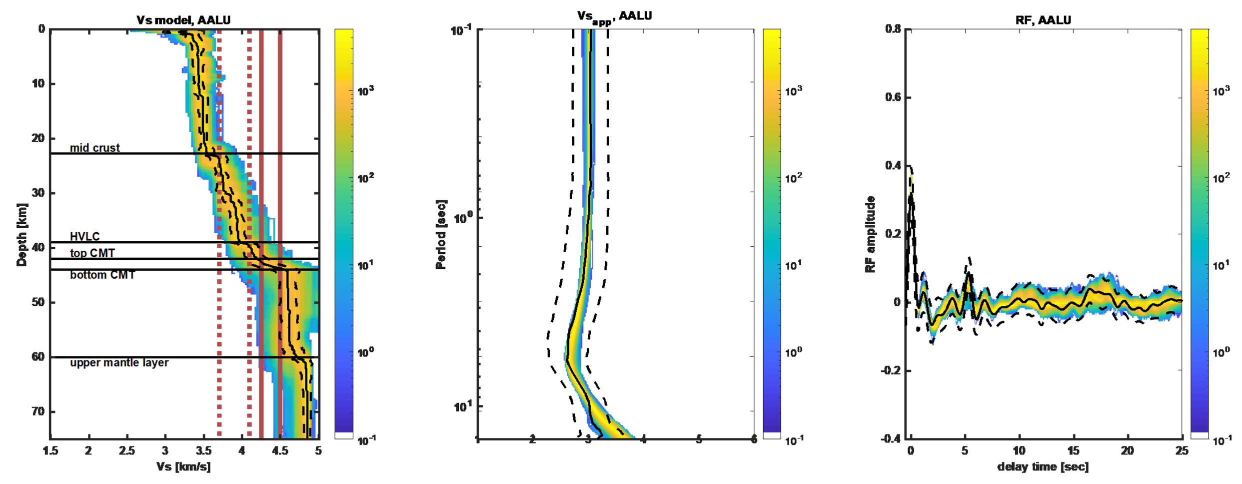


*Figure 3. Example RF–$V_{s,app}$ inversion showing velocity structure and data fit. Moho and intracrustal layers are resolved beneath each station.*

### Key Results

- Moho depth: ~40–50 km, deepening toward the SE
- Strong lateral crustal heterogeneity
- High velocity lower crust (HVLC) is complex with variations between 4 and 16 km thickness
- Upper crust thickens SE; lower crust is more variable
- Moho uncertainty: ~2–4 km (robust regional trends)

***Main takeaway: Hälsingland crust is laterally heterogeneous—not a simple layered system.***

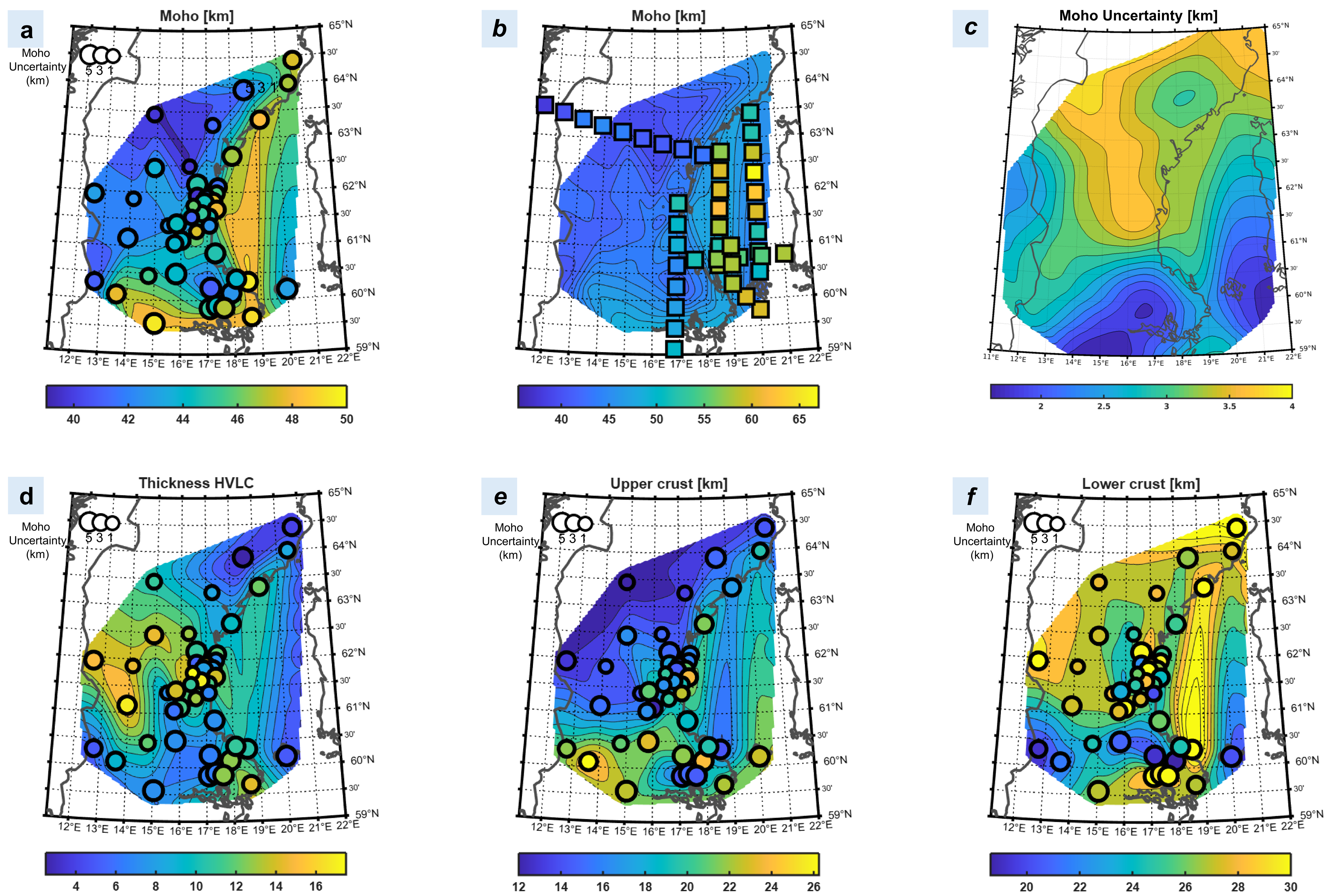


*Figure 4. Crustal structure and model uncertainty derived from RF–$V_s$,app inversion. a) Moho depth. b) Moho depth shown in panel (a) with the seismic section/profiles from the literature superimposed as squares. Moho depth shows a clear southeastward deepening and lateral variability across the study area (a–b). The bootstrap uncertainty estimate (c) indicates spatially variable uncertainty of ~2–4 km, confirming the robustness of large-scale Moho trends while limiting interpretation of small-scale features. Thickness variations in d) the high-velocity lower crust (HVLC), e) upper crust, and f) lower crust indicate a heterogeneous crustal architecture. Colors show depth/thickness (km); circles indicate station constraints.*

## SEISMICITY & INTERPRETATION

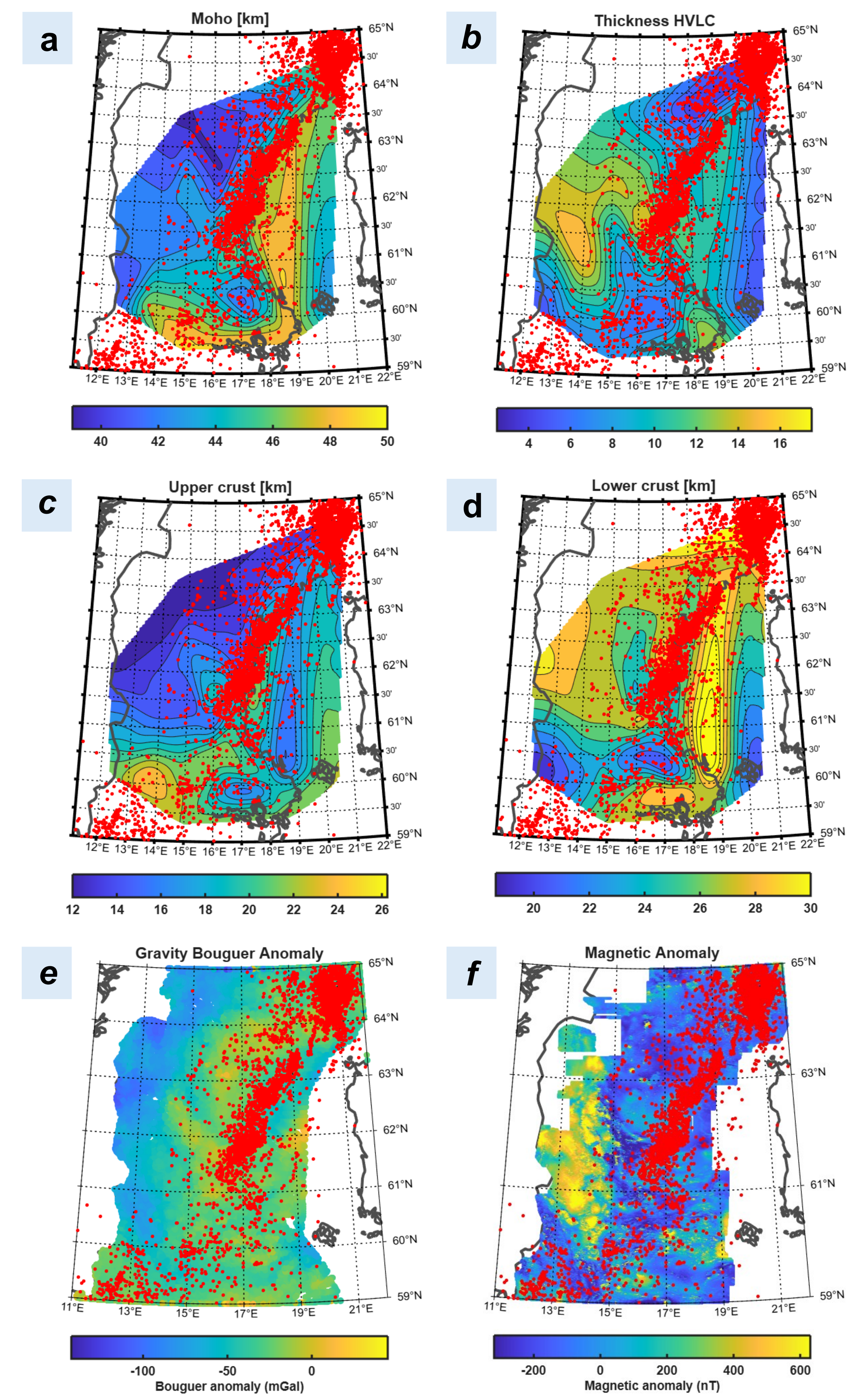


*Figure 5. Seismicity relative to crustal structure and potential-field anomalies. Earthquakes cluster along a NE–SW corridor coinciding with transitions in Moho depth, crustal thickness, and gravity anomalies. Seismicity is concentrated near structural boundaries.*

### Interpretation & Conclusion

- Strong lateral variability in the Hälsingland crust, reflected in Moho depth and crustal layering
- Distributed seismicity aligned with structural transitions, reflecting lithospheric variation and reactivation of inherited structures
- Incorporating 3D structure may improve earthquake location accuracy
- *Limitation*: Resolution limited by ~50 km average station spacing; leaving small-scale structures unresolved

Check also poster EGU26-17331 by Gunnar Eggertsson on May 6, at 14:00–18:00!

### References


- Ak, E. (2026) '*Crustal Structure and Seismicity of the Hälsingland Region from Seismic Waveform Analysis, Receiver Functions, and Its Relationship to Seismicity*'. Mater's Thesis. Uppsala University.
- Schiffer, C., Rondenay, S. and Shomali, Z.H. (2024) 'Seismic probing of buried ancient terrane boundaries: Insight into Fennoscandia's Palaeoproterozoic continental formation', *Precambrian Research*, 405, 107376. doi:10.1016/j.precamres.2024.107376.