The use of geophysical methods in assessment of natural stone prospects

P. Härmä[1*], T. Huotari-Halkosaari[1] & O. Selonen[2]
[1]Geological Survey of Finland, P.O.Box 96, FI-02151 Espoo, FINLAND
(*correspondence: paavo.harma@gtk.fi)
[2]Åbo Akademi University, 20500 Turku, FINLAND

Granite is the most important group of rocks quarried for natural stone production in Finland and the most quarried granite rock is rapakivi granite, in southwestern and southeastern Finland. Wiborgite and pyterlite are the main rock types produced in the Wiborg batholith, in the eastern and southeastern parts of the batholith (Härmä et al. 2015).

A typical feature of rapakivi granite is the distinct surface weathering of outcrops. This feature creates a challenge for the natural stone exploration and quality evaluations, especially regarding the appearance and soundness of rock. The Wiborg batholith has been targeted by several investigation activities of the Geological Survey of Finland (GTK). These investigations include geophysical and geological studies on the different rock types as well as regional explorations, detailed site investigations, and development of exploration methods (e.g. Arponen et al. 2009, Härmä & Selonen 2008). Subsurface soundness has been investigated with GPR and core drilling during detailed investigations. In addition, selected ground geophysical methods have been tested experimentally. The latest investigation project was a three-year ENPI project (http://projects.gtk.fi/ENPI), finished at the end of 2014 and lead by the GTK.

The scope of this study was to test ground geophysical exploration methods in the assessment of the natural stone prospects in the rapakivi granite area in southeastern Finland. The measurements in the field included ground penetrating radar (GPR), electrical resistivity tomography (ERT) and induced polarization (IP) as well as ground magnetic intensity measurements (Luodes et al. 2014). Further, geophysical in situ measurements were done in ten drill holes in the target area. Also, petrophysical measurements were carried out for the drill core samples and mini drill samples at GTK's petrophysical laboratory.

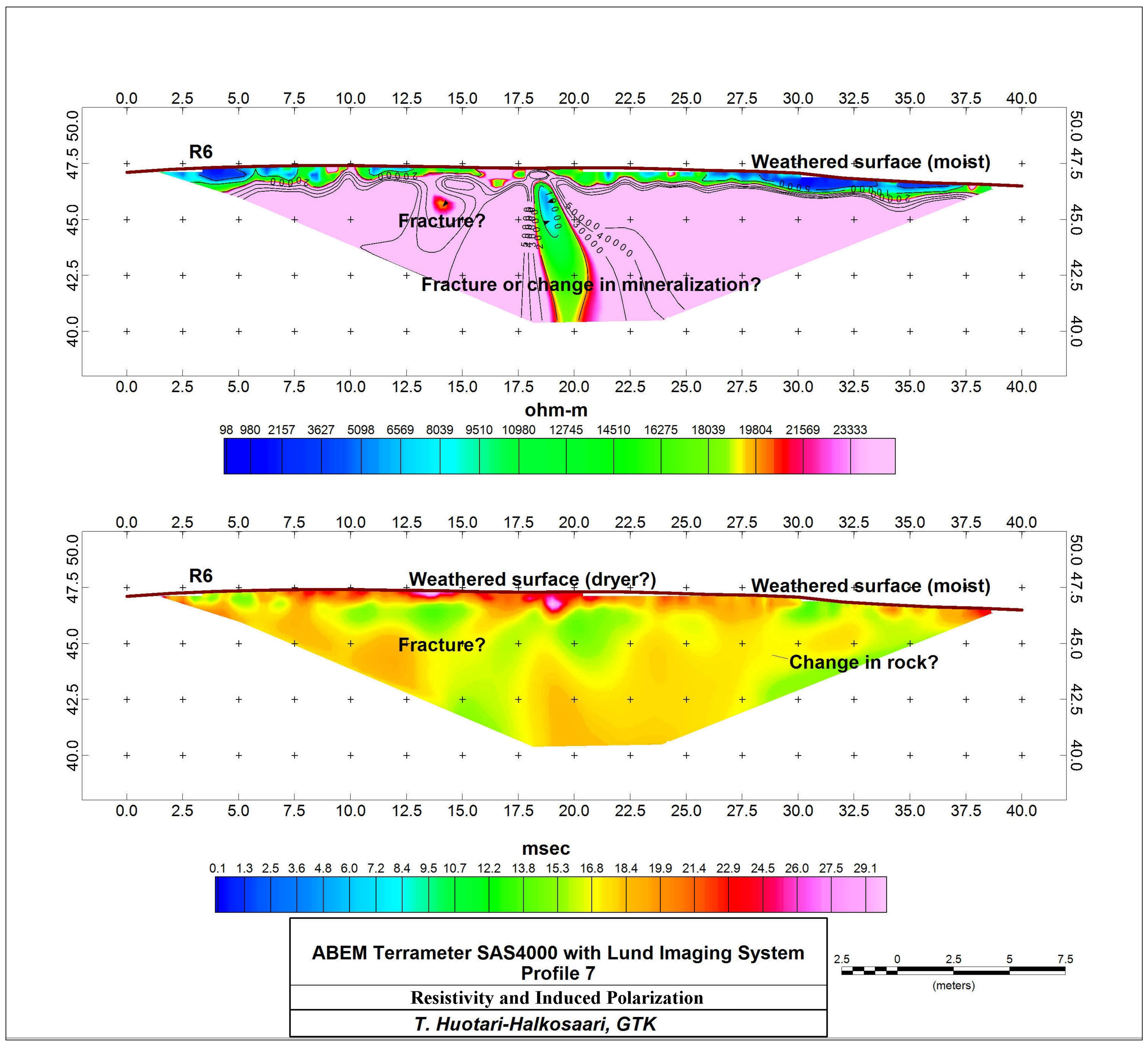

Fig. 1. ERT profile 7, resistivity and induced polarization. Location of drill hole R6 is also included. Anomalies in the measured profiles were interpreted to caused by weathered surface and possible fractures in bedrock.

The ERT method with IP revealed valuable data and information about inside the solid rock (Fig. 1).The drill hole measurements (Fig. 2) were also good adds for the studies of natural stone quality. The petrophysical data of the drill core samples showed up a good estimate for the quality of the rock as well as reference data for the drill hole measurements. The samples taken from the surface of outcrops were not only enough for the petrophysical studies due to weathered rock on the surfaces. However, it is also important to know the thickness of the weathered zone and it can be estimated with petrophysical samples taken by mini drill. The ERT and IP measurement should be measured before the moss is taken away from the bedrock surfaces. By that way, all of the ground geophysical profiles can be executed in the same location.

Ground geophysical magnetic measurement gave valuable data from the bedrock in the study area. With high resolution ground magnetic intensity data it is possible to get hints from smaller structures or features in the bedrock (Fig. 3).

Fig. 2. The geophysical drill hole measurements were also carried out in the prospect area. Photo: Paavo Härmä, GTK.

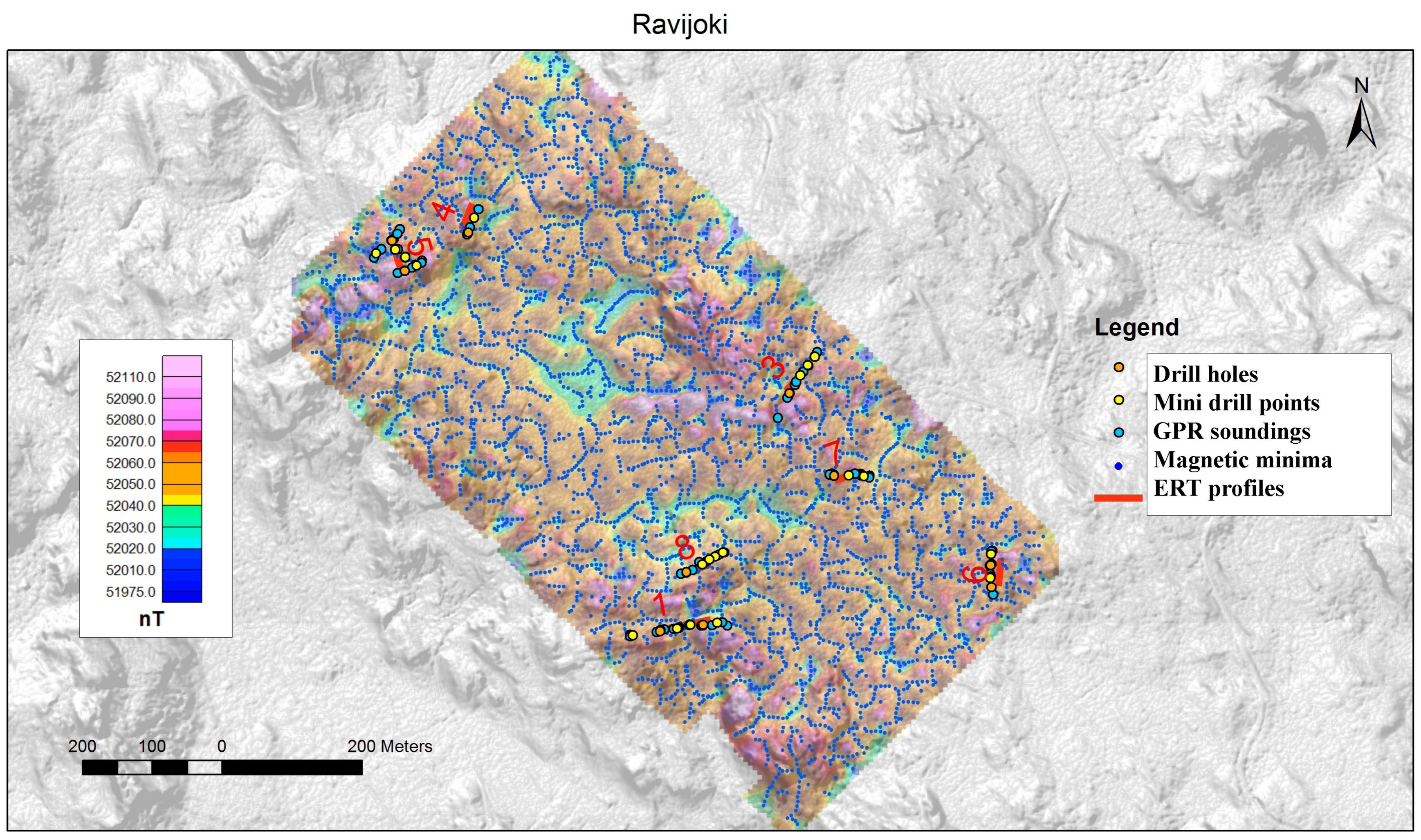

Fig. 3. LiDAR data with magnetic minima, ERT lines, GPR profiles, mini drill, drill hole locations and magnetic grid. Contains 03/2013 data from the Topographic Database of the National Land Survey of Finland © NLS and HALTIK. LIDAR data 2013.

References

Arponen, E., Härmä, P., Selonen, O. Luodes, H. & Pokki J. 2009. Anorthosite and spectrolite in the Wiborg rapakivi granite batholith and the lithological control of spectrolite deposits. Geological Survey of Finland, Report of Investigation 178. Espoo, Finland. 41 p. (in Finnish with English summary).

Härmä P. & Selonen, O. 2008. Surface weathering of rapakivi granite outcrops – implications for natural stone exploration and quality evaluation. Estonian Journal of Earth Sciences 57, 3. 135-148.

Härmä, P., Selonen, O. & Luodes, H. 2015. The Wiborg granite batholith - the main production area for granite in Finland. In: G. Lollino et al. (eds.), Engineering Geology for Society and Territory – Volume 5, 259-262.

Luodes, H., Huotari-Halkosaari, T., Sutinen, H., Härmä, P. & Selonen, O. 2014. Document of best practices on natural stone evaluation and research. ENPI Report. 22p. Available at http://projects.gtk.fi/export/sites/projects/ENPI/results/documents/Document_of_best_practices_on_natural_stone.pdf