# BRIDGING GEOPHYSICAL AND GEOTECHNICAL RESULTS: AN AUTOMATED CAD VISUALIZATION METHOD FOR 2D DATA

## Sebastian Buntin[1], Omid Ahmadi[1], and Mats Svensson[2]

### KEYWORDS

geophysical methods, geotechnical engineering, 2D visualization, AutoCAD.

### ABSTRACT

Geophysical methods play a crucial role in early subsurface investigations for construction and infrastructure projects, providing valuable complementary data. However, the lack of standardized file formats and visualization protocols across different geophysical techniques hinders seamless interoperability with traditional geotechnical approaches. This paper presents a method designed to address these challenges by enabling the visualization of 2D geophysical results alongside geotechnical soundings within the AutoCAD environment. The methodology is developed in Sweden with consideration of standards set by the Swedish Geotechnical Society (SGF). This approach utilizes automation techniques to simplify the integration process.

By bridging the gap between geophysical and geotechnical data, this method enhances the joint interpretation and utilization of common geophysical techniques, including seismic refraction tomography (SRT), ground penetration radar (GPR), and electrical resistivity tomography (ERT). This approach not only improves the efficiency and effectiveness of subsurface investigations but also encourages the simultaneous use of geophysical methods and traditional geotechnical soundings, fostering a more holistic approach in geotechnical engineering.

### 1. INTRODUCTION

In modern engineering projects, the integration of geophysical methods with traditional geotechnical approaches has become increasingly essential for comprehensive subsurface investigations [1]. Geophysical techniques, includ-

[1] Bjerking AB, Kungsgatan 36A, 753 20 Uppsala, Sweden

[2] Tyréns, Kungstorget 8, 252 78 Helsingborg, Sweden

ing seismic refraction tomography, ground penetration radar, and electrical resistivity tomography, provide important insights into subsurface conditions, enabling the rapid coverage of larger areas. This, in turn, aids in optimizing the selection of locations for geotechnical soundings and leads to lower uncertainty in the results [2]. However, the visualization of geophysical data alongside geotechnical results poses significant challenges due to different file formats and visualization protocols.

## 2. CHALLENGES IN VISUALIZATION PRACTICES

Geophysical methods normally produce 2D profile data, typically visualized using specialized geophysical software. The prevalent software tools for near-surface geophysical processing include Res2DInv for resistivity measurements, ReflexW and Rayfract for seismics, and ReflexW for ground-penetrating radar measurements. However, the incompatibility of these software tools with CAD-systems, coupled with the general absence of standardized file formats across different techniques, complicates interaction with geotechnical soundings.

Geotechnical soundings adhere to well-established standards primarily conveyed through CAD systems, using the standard designation system of the Swedish Geotechnical Society[3,4] in Sweden. The current designation system, established in 2001, is not adapted for use with modern geophysical processing software, leading to its infrequent application for presenting geophysical results. Consequently, geophysical, and geotechnical findings are often segregated into separate reports, impeding joint interpretation, and limiting the integration of geophysical methods with traditional geotechnical investigations.

One proposed solution is visualizing both geophysical and geotechnical data through BIM platforms[5]. For example, the GeoBIM concept offers a solution by proposing the combined visualization of not only geotechnical and geophysical information, but also all other relevant geotechnical data. [6]. In this concept all data types are collected in the same database via a complete digital workflow from field planning to interpreted 2D or 3D models, see Figure 1. Developments within GeoBIM have enabled seamless visualization of all data types within BIM tools like Navisworks.

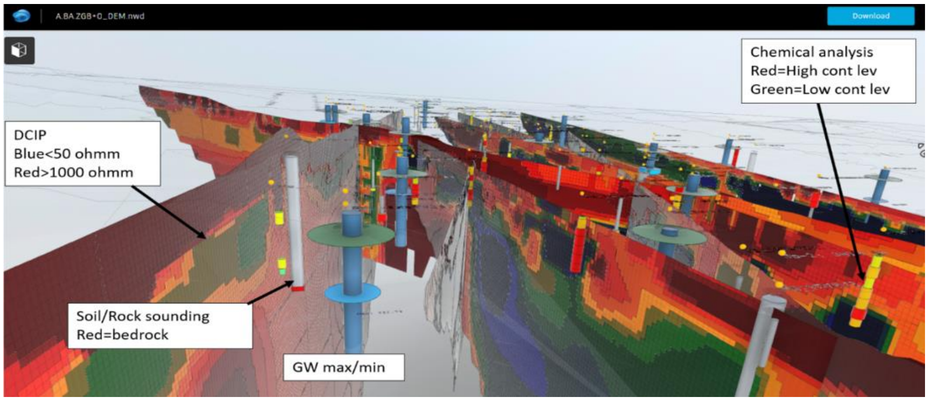


*Figure 1. Geophysical DCIP data visualized together with data from hydrogeology, geotechnical sampling and sounding and environmental sampling [6].*

But the dominance of CAD software and the relative simplicity of adhering to current standards within those programs presents a challenge for gaining traction for the BIM solutions.

## 3. PROPOSED SOLUTION

To address the complexities inherent in integrating 2D geophysical results with geotechnical data, this paper introduces a novel method designed for seamless visualization within the AutoCAD environment. The method, developed in Sweden, considers standards provided by the Swedish Geotechnical Society and accommodates diverse geophysical techniques.

We have developed GEOSYNK, a specialized software solution that empowers users to effortlessly store geophysical results as images in an AutoCAD-friendly format, preserving the aspect ratio consistent with the 2D sections in AutoCAD. GEOSYNK supports various data file formats, such as SEG-Y for seismic and ground penetration radar data, and r2r, a data format supported by Res2dinv for ERT data. Additionally, compatibility extends to simple ASCII xyz grid files, including those generated using software like Surfer. This makes it suitable for using it with the most common geophysical software in engineering e.g. ReflexW, Rayfract and Res2dinv.

Moreover, GEOSYNK streamlines the creation of profile lines in AutoCAD by leveraging the coordinates from measured geophysical profiles. This generated line, coupled with the associated image, can be seamlessly imported into the AutoCAD environment. Illustrated in Figure 2 are the results of the combined visualization of geophysical and geotechnical data employing different geophysical methods. The visual representation demonstrates how GEOSYNK supports the joint interpretation for identifying specific layers in the subsurface.

This integration facilitates a cohesive visualization of geophysical results alongside geotechnical drilling data, enhancing the overall analytical capabilities of the AutoCAD platform.

## 4. CONCLUSIONS

In summary, the integration of geophysical and geotechnical data using the automated 2D visualization method in AutoCAD represents a practical advancement in subsurface investigations. The optimized approach has proven successful in enhancing the efficiency of combined interpretation, providing geotechnical engineers with a detailed representation of subsurface characteristics.

The method's capability to integrate various geophysical techniques ensures versatility and broad applicability, addressing the diverse needs of infrastructure projects. By offering a unified platform for data interpretation, it mitigates challenges associated with disparate visualization practices, and contributes to a more cohesive understanding of subsurface conditions.

As a notable implication, the adoption of this automated method may lead to an increased utilization of geophysical methods in subsurface investigations. The efficiency and accuracy demonstrated in this approach could potentially encourage a broader application of geophysical techniques, further advancing the field and contributing to the evolution of standard practices in geotechnical engineering.

In conclusion, the proposed automated method serves as a practical tool for geotechnical engineers, streamlining the interpretation process and potentially fostering a wider acceptance and utilization of geophysical methods in subsurface analysis for infrastructure development.

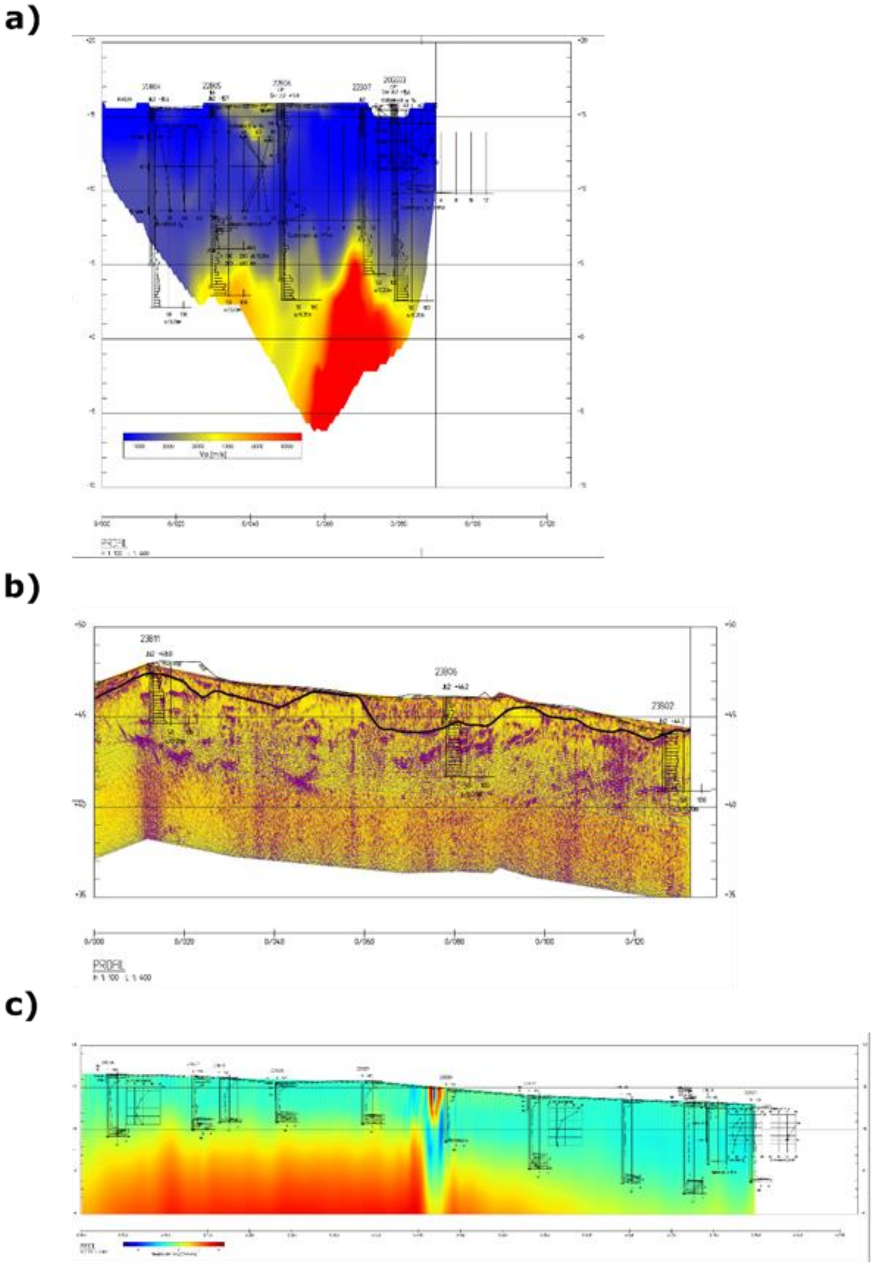


*Figure 2. Three examples of the proposed visualization method for geophysical and geotechnical data aligned with the SGF's standards. a) a seismic refraction profile b) a GPR profile c) an ERT profile. All the data have been acquired and processed in Sweden.*

## ACKNOWLEDGEMENT

The development of GEOSYNK was funded by the Swedish geotechnical society (SGF, project number: 522304), Bjerking AB, Structorstiftelsen and Tyréns AB, which are gratefully acknowledged.

## REFERENCES

[1] A. B. Medhus; K. Lone, eds.: Engineering Geophysics. CRC Press, 2022.

[2] M. Svensson: Slutrapport Osäkerhetsmodeller (in Swedish). Project 13493, SBUF, 2022.

[3] SGF: SGF/BGS Beteckningssystem 1, Version 2001:2. Swedish Geotechnical Society, Linköping, 2001.

[4] SGF: SGF:s dataformat, SGF Rapport 3:2012 (in Swedish). Swedish Geotechnical Society, Linköping, 2012.

[5] M. Svensson; O. Friberg: Communication of geophysics in underground infrastructure projects. SAGEEP 2018, Nashville Tennessee USA, 2018.

[6] M. Svensson, Friberg O., 2019, BIM – the key for implementation of geophysics in infrastructure planning, EAGE Near Surface Geoscience, Netherland, September