EGU24-654, updated on 14 Aug 2024
https://doi.org/10.5194/egusphere-egu24-654
EGU General Assembly 2024

Geoelectrical and electromagnetic imaging methods applied to groundwater systems: recent advances and future potentials

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The impacts of climate change, combined with population growth, necessitate practical and effective solutions for locating groundwater resources and ensuring drinking water quality. Our contribution explores recent advances in geoelectrical and electromagnetic imaging methods applied to investigate groundwater systems. Geoelectrical and electromagnetic imaging techniques are popular methods for characterising subsurface properties, such as electrical resistivity or dielectric permittivity. These electrical properties are strongly related to the hydrogeological characteristics of the subsurface. Therefore, geoelectrical and electromagnetic investigations can provide valuable insights into finding groundwater resources, assessing the water quality in terms of contaminations and conducting effective groundwater management.

Our study examines state-of-the-art approaches in modelling and instrumentation of induced polarisation and electrical resistivity tomography, as well as time- and frequency-domain electromagnetics and ground-penetrating radar methods. We review recent impactful and innovative groundwater case studies where the above-mentioned methods were applied and further developed. Emphasising the combination of geoelectrical and electromagnetic methods, the studies provide insights into the variation of electrical subsurface properties at different scales, contributing to an improved understanding of the hydrological dynamics in the studied areas. Furthermore, we provide an outlook on the potential for applying geoelectrical and electromagnetic imaging techniques for large-scale groundwater investigations in the exascale computing area.