Referee Comments (RC1):

Hasan and Su tried to get the permeability of deep hard rock by a geophysical approach. They used the CSAMT to get the resistivity of the subsurface for several 2D profiles and then built an empirical equation to describe the relationship between permeability and resistivity using 37 permeabilities from boreholes. Then they applied the equation to all 2D profiles and finally extrapolated 2D profiles to a 3D field. They argued that the advantage of their approach is that it is able to get the information of the deep subsurface to 1 km depth. They also said their approach is low-cost than borehole drilling. I am sorry I am not that encouraging to this work. I don't think this work is novel enough for publication in HESS, a top journal in hydrology and water resources. I suggest rejecting it for publication in other journals of geology. Following are my reasons:

Response:

Dear Anonymous Reviewer,

Thank you for your detailed and thoughtful review of our manuscript. We sincerely appreciate the time and effort you dedicated to evaluating our work.

We greatly appreciate HESS's reputation as a leading journal in the fields of hydrology and water resources. As groundwater assessment inherently depends on a comprehensive understanding of subsurface geology, we believe that the integration of geophysical methods, particularly in complex geological settings, adds significant value to the scope of the journal.

This work builds upon our extensive experience in applying geophysical techniques to groundwater hydrology, with previous publications in the high-impact journals. Given the focus and scientific standards of HESS, as well as the novelty of our current approach, we believe that this manuscript aligns well with the journal's objectives.

It is worth noting that the handling editors initially assessed the novelty and relevance of our submission before inviting peer review. Additionally, the other reviewers have recommended only minor revisions and expressed strong support for the publication of this work, further reinforcing its contribution and suitability for HESS.

We acknowledge that many of your comments are highly constructive and have been very helpful in improving our manuscript. These include your observation regarding the correct unit of permeability (mD, not m/d), your suggestion to expand the dataset, and your recommendation to discuss theoretical relationships such as the Archie and Kozeny-Carman equations, etc. All of these aspects have been carefully addressed in the revised version.

However, we also feel that certain criticisms may have overlooked the broader context and significance of our contributions, especially when compared with the existing body of literature. Although many studies in the past have explored the estimation of permeability (k) or other hydraulic parameters using geophysical data, this work introduces several key innovations that distinguish it from previous research.

When compared to existing literature, the following contributions represent significant advancements:

1. **First-time measurement of permeability (k) at depths exceeding 1 km** in a hard-rock environment.

2. **Generation of 2D and 3D k models**, to our knowledge, the first of their kind for deep groundwater assessments using any geophysical method.
3. **Innovative use of CSAMT** to derive volumetric estimations of hydraulic parameters such as permeability, which has not been attempted previously.
4. **Application in a highly heterogeneous lithological context** involving sandstone, granite, and hornstone, where such estimation of k had never been conducted before.
5. **Efficient integration of sparse borehole data** to produce high-resolution subsurface models over a large hard-rock terrain, demonstrating a practical alternative to intensive drilling.
6. **Significant reduction in the need for costly deep boreholes**, which would otherwise be required in the hundreds to achieve a similar level of spatial resolution.

We hope these clarifications help illustrate the novelty and importance of this work, and we remain grateful for your review, which ultimately contributed to strengthening our manuscript. We look forward to the opportunity to share this contribution with the HESS readership.

Comment 1:

Either component of this work is very old. The CSAMT can date back to 1970s. The relationship between the permeability and resistivity has also been largely studied so far. The inversion of permeability/hydraulic conductivity using geophysical approaches is so well-known.

Response 1:

We thank the reviewer for this important comment.

We agree that both CSAMT and the general concept of relating resistivity to permeability have a long history in geophysical and hydrogeological research. However, the key contribution of our study lies not in the introduction of entirely new methods, but in the **novel integration and application** of established techniques to a unique and challenging geological context, resulting in unprecedented outcomes.

Specifically, while CSAMT has traditionally been used for deep geophysical investigations, its application in **hydrogeology for constructing 2D and 3D models of permeability (k) at depths exceeding 1 km**, especially in a **highly heterogeneous hard-rock setting** comprising sandstone, granite, and hornstone, has **not been demonstrated in any previous work**, to the best of our knowledge.

In fact, no past studies have reported the generation of **volumetric (2D and 3D) models of k or any hydraulic parameter** using either direct (drilling-based) or indirect (geophysical, etc) methods at such depths and across such varied lithologies. In our earlier work, we demonstrated for the first time the use of **ERT** to generate shallow-depth 2D and 3D models of hydraulic conductivity in a tuff rock environment. Building on that, this study extends the concept both **methodologically and spatially** by using CSAMT to model permeability at much greater depths and over geologically complex terrain.

Furthermore, we have now included **a more detailed discussion in the revised manuscript** regarding the relationship between resistivity and permeability (e.g., using the Archie and Kozeny-Carman equations), along with how our approach advances existing methodologies.

We hope this clarification better highlights the **novelty, scale, and practical significance** of our work within the context of existing literature.

Comment 2:

Authors even didn’t well discuss the previous studies of relationship between permeability and resistivity, such as the Archie equation and Kozeny-Carman equation.

Response 2:

We thank the reviewer for this insightful comment. In response, we have included a detailed discussion in the revised manuscript regarding previous studies on the relationship between resistivity and permeability, specifically addressing the Archie equation and the Kozeny-Carman equation. These models are fundamental in petrophysical and hydrogeophysical studies and serve as a theoretical basis for linking electrical resistivity measurements to hydraulic properties. Their relevance, limitations in heterogeneous geological settings, and how our approach builds upon these foundations are now clearly articulated in the revised version of the manuscript.

A brief discussion is given below:

Discussion on the Relationship between Permeability and Resistivity

Several foundational studies have established empirical and theoretical relationships between electrical resistivity and hydraulic properties such as permeability. The **Archie equation**, introduced by Archie (1942), is widely used in clean, saturated sedimentary formations. It relates formation resistivity to porosity and water saturation but assumes the absence of clay minerals and thus has limitations in more complex lithologies.

The **Kozeny-Carman equation** is another widely accepted model that links permeability to porosity and specific surface area. While it does not directly involve resistivity, it is often used alongside petrophysical models to interpret hydrogeological characteristics based on geophysical data.

Although these relationships are well-established, their application is often restricted to homogeneous or semi-homogeneous geological settings. In contrast, our study extends the use of these principles into a **highly heterogeneous hard rock context**, including sandstone, granite, and hornstone, at depths exceeding 1 km. By integrating borehole-derived permeability with CSAMT-based resistivity data, we derive a site-specific empirical model that enables the construction of 2D and 3D permeability distributions across the entire study area, an approach not previously demonstrated in the literature.

Archie's Equation

Archie's law (Archie, 1942) relates the bulk electrical resistivity of a fully saturated porous medium to its porosity and fluid resistivity. It is commonly expressed as:

$$\rho b = a \cdot \rho f \cdot \phi^{-m}$$

where:

ρb is the bulk resistivity,

ρf is the fluid resistivity,

ϕ is the porosity,

a and m are empirical constants.

Although Archie's law does not directly estimate permeability, porosity is often used as a proxy because of its influence on fluid flow. The resistivity-porosity relationship can be indirectly extended to infer permeability, especially when combined with other petrophysical models.

Kozeny-Carman Equation

The Kozeny-Carman equation provides a direct relationship between permeability (kkk) and porosity and is given by:

$$k = \frac{C \cdot \phi^3}{(1-\phi)^2 . S^2}$$

where:

k is the permeability,

ϕ is the porosity,

S is the specific surface area,

C is a constant related to pore structure and tortuosity.

By combining the Kozeny-Carman equation with Archie’s law, researchers have developed empirical and semi-empirical models to relate geophysical measurements (like resistivity) to permeability.

Relevance to This Study

While these classical models provide important theoretical underpinnings, their direct application in complex geological environments, such as heterogeneous hard rock formations (e.g., granite, sandstone, hornstone), is often limited due to variability in mineralogy, pore structure, and anisotropy. In this study, we established an empirical relationship between resistivity and permeability based on field measurements from boreholes and CSAMT profiles. This site-specific correlation enables the generation of 2D and 3D permeability models in geologically complex settings where traditional models may fall short.

Comment 3:

A perfect equation (Fig. 3) was built using only 37 known permeabilities. It is hard to convince me the number of k values is enough to build an equation for a domain of 1.8 km*1.8 km*1km of high heterogeneity. It is hard to say this equation is still available for other positions and depths in the domain. As the authors also mentioned, the resistivity is determined by many other factors, not only the permeability.

Response 3:

We thank the reviewer for this important comment regarding the validity and representativeness of the empirical relationship established in Figure 3. We fully agree that both resistivity and permeability (*k*) are influenced by multiple geological and physical factors, such as lithology, degree of weathering, fluid content, porosity, fracturing, saturation, and jointing, among others. This complexity underscores the need for careful calibration of any empirical relationship.

As mentioned in the original manuscript, the initial empirical equation ($R^2 = 0.97$) was built using 37 carefully selected borehole-derived *k* values. These were not arbitrarily chosen; rather, they were distributed across all three major rock types in the area, sandstone, granite, and hornstone, and covered the full observed range of resistivity (72–4765 Ω·m) and permeability (0.01–19.8 mD). Our intention was to ensure the equation's applicability across the domain by capturing the full variability of both geological conditions and resistivity-permeability values within the study area.

To further address the concern about sample size and enhance the robustness of our model, **we have now expanded the dataset by adding 79 new data points**, bringing the total to 116. This expanded dataset includes wider spatial coverage and continues to represent all three lithologies. The updated empirical equation based on 116 data points has a slightly adjusted but still strong correlation ($R^2 = 0.96$), confirming the reliability of the established relationship. The new data spans a resistivity range of **35–4765 Ω·m** and a permeability range of **0.01–19.9 mD**, reflecting a comprehensive coverage of the variability in the study domain (1.8 × 1.8 × 1.0 km).

The drilling locations were strategically selected to capture both spatial and geological heterogeneities, ensuring that the derived empirical model can be confidently applied to the entire domain—even at locations and depths where no direct permeability measurements were available. This approach significantly enhances the feasibility of deep permeability modeling in data-scarce regions and reduces the need for excessive drilling, which is costly and often impractical in hard rock terrains.

A more detailed explanation, including updated figures and statistical analyses, is provided in the revised manuscript. Please also refer to the attached file for the updated figures, particularly Figures 3 and 4, which now include additional data points to support the revised empirical model.

Comment 4:

The fitted line is too perfect to believe. I always saw the fitting as follows (very noisy):

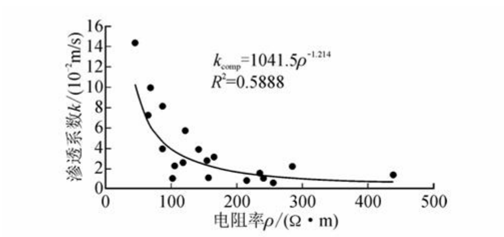
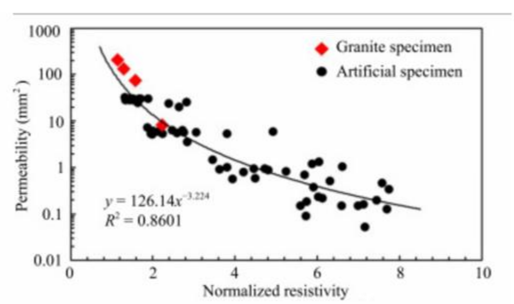


图 1 经验公式法求解的渗透系数与电阻率的关系

Fig. 1 Relationship between hydraulic conductivity and resistivity calculated by empirical formula method



Response 4:

We appreciate the reviewer’s observation and understand the concern regarding the quality of the curve fitting. However, the smoothness or “perfection” of a fitted relationship between resistivity and permeability (k) is highly dependent on a number of factors that vary significantly across different studies. These factors include the geological setting, the distribution and range of data points, the lithology, the degree of heterogeneity, and the accuracy of both resistivity and k measurements.

In our study, the resistivity values span a wide range (approximately 35 to 4765 Ω·m), and the permeability values range from 0.01 to 19.9 mD. This wide dynamic range helps to better resolve trends, especially in high-resistivity rocks such as granite, where permeability remains very low and changes minimally. In such cases, large differences in resistivity correspond to small variations in permeability, naturally resulting in a smoother inverse curve.

We agree that in many past studies, the relationship appears noisy, often because the resistivity data is concentrated in a narrower range (e.g., 50–300 Ω·m as shown in the figs provided by the reviewer), and the variations in k may be more influenced by local heterogeneities. In contrast, the broader data spread in our study, combined with careful selection of measurement locations to capture the variability of all three dominant lithologies (sandstone, granite, and hornstone), contributes to a more stable empirical trend.

In the revised manuscript, we have increased the number of data points from 37 to 116, yet the curve still maintains a high degree of correlation ($R^2 = 0.96$), suggesting the robustness of the relationship rather than overfitting. The updated Figures 3 and 4 (attached) show the expanded dataset and reaffirm this trend.

Additionally, we have emphasized in the manuscript that both resistivity and k are influenced by a range of factors, such as porosity, saturation, fluid content, fractures, and lithology, which are inherently linked in this geological context. While some scatter exists, particularly at lower resistivity values (<1500 Ω·m), the overall trend aligns well with the theoretical and empirical basis established in previous research showing an inverse relationship between resistivity and permeability.

We hope this clarifies the rationale behind the nature of the fitted curve and addresses the reviewer's concern.

A more detailed discussion on this point has been included in the revised manuscript to clarify the methodology and support the reliability of the derived empirical relationship.

Comment 5:

I am not sure the resolution of the resistivity obtained by CSAMT and the permeability obtained by pumping test. Do the scales match well? i.e., what's the size of the pixel in the maps in Fig. 4? The k obtained by pumping test always represents the average hydraulic conductivity of an area, so do this range and your pixel size match?

Response 5:

Thank you for raising this important point regarding the consistency between the resolution of resistivity measurements from CSAMT and the permeability (k) values derived from borehole tests.

The accuracy of the estimated k values from our empirical relationship is primarily dependent on the quality of the input data: (1) the resistivity values derived from CSAMT and (2) the k values obtained from boreholes. In our study, we ensured a high-quality CSAMT dataset through optimized survey design, careful data acquisition, and advanced processing and inversion techniques. The resulting models achieved a root mean square (RMS) misfit of less than 5%, ensuring reliable subsurface resistivity measurements. Additional details on data acquisition and processing are provided in the revised manuscript.

Regarding k measurements, we acknowledge that **pumping tests yield average hydraulic conductivity over relatively large volumes**, which are suitable for 1D correlations with averaged geophysical data. However, our objective in this study was to construct **high-resolution 2D and 3D permeability models**, which require point-based permeability measurements that are more compatible with the spatial resolution of CSAMT-derived resistivity data. To achieve this, we relied on **rock core tests** rather than pumping tests. Rock core analysis allows for permeability measurements at specific depths and locations, enabling a more precise match with the local resistivity values at those points.

As for the model resolution, each pixel in the 2D maps represents an area of approximately **50 m × 50 m** in the horizontal direction, which directly corresponds to the CSAMT station spacing. The **vertical resolution** varies with depth but generally falls within **tens of meters** across the total investigated depth of **approximately 1300 m**, depending on signal penetration and inversion sensitivity. This level of resolution is well-suited for resolving key subsurface features and provides a robust basis for the reliability of the derived permeability models.

Therefore, both the k values and resistivity measurements were acquired and processed at compatible spatial scales, ensuring that the empirical relationship and resulting 2D/3D k models are internally consistent and scientifically robust. Further explanation of this methodology is included in the revised version of the manuscript.

Comment 6:

Table 2, the same problem, even for the pumping test itself, the k values obtained are with large uncertainties, the deviations of one order of magnitude is not surprising. However, the differences of k values between the CSAMT and borehole drilling are less than 1 or 0.1, which is unbelievable.

Response 6:

Thank you for this valuable observation. We would like to clarify that **Table 2 presents a comparison between the predicted and measured *k* values for only 12 selected data points**. These points were chosen to highlight instances of close agreement; however, they do not represent the full variability in the dataset.

The reviewer noted that "the differences of *k* values between the CSAMT and borehole drilling are less than 1 or 0.1," but this is **not consistently true**, even within the selected 12 data points. For instance, a difference of **3.6 mD** and **2.7 mD** was observed between predicted and measured *k* values for sounding number **P6-1** and well **4** at depths of **10 m** and **45 m**, respectively.

Furthermore, **many data points in the full dataset of 116 borehole locations** exhibit larger differences between predicted and measured *k* values, and we have included a selection of these in the **revised version of the manuscript** to provide a more comprehensive view. These updates better reflect the natural uncertainty and variability in both field measurements and predictions.

Comment 7:

I am not sure why very deep k is necessary. A latest study found that groundwater deep than 500 m is not an active component in terrestrial hydrologic cycle and the water there might be brine. You may say your work found there are a lot of sandy rocks in depth. However, given the large uncertainties of your approach, did you compare the findings with the results of local or national geologic survey? DOI:10.1038/s43247-023-00697-6

Response 7:

Thank you for this insightful comment and for highlighting the referenced study.

While it is true that deep groundwater (below 500 m) is often less connected to the active terrestrial hydrologic cycle and may contain brine, the necessity for deep groundwater exploration in our study area arises from several critical and site-specific factors:

1. **Surface water resources in the study area are limited and unreliable**, making deep groundwater a potentially vital alternative water source.
2. **Shallow zones are predominantly composed of fresh granite**, which typically has low permeability and limited groundwater potential. In contrast, **fractured granite, sandstone, and hornstone formations that can host significant groundwater resources are found at greater depths**.
3. In China, recent national groundwater resource assessment initiatives have prioritized **deep earth exploration** in areas with potential for deep aquifers, to support sustainable development and ensure long-term water security, especially in regions experiencing severe water stress.

4. Deep groundwater investigations are essential for:
    - Identifying **hidden but critical water sources**.
    - **Characterizing deep aquifers** and understanding their storage and recharge potential.
    - Supporting **strategic water resource planning** in response to increasing demand and climate variability.

To address concerns regarding uncertainty:

- We employed a **robust CSAMT survey design**, followed by **accurate resistivity inversion and low-RMS models**.
- **Rock core testing** was used to measure *k* values at multiple depths with high confidence.
- An **empirical equation based on a representative and extensive dataset (116 points)** was used to derive 2D and 3D *k* models.

Furthermore, we **compared our findings with existing geological information from both local and national geological surveys**, and found our results to be consistent with the known stratigraphy and hydrogeological features of the region. Additional information on this comparison has been included in the revised manuscript.

We believe that, despite the challenges, this deep groundwater investigation provides valuable insights and practical relevance, especially in arid and semi-arid regions where shallow resources are scarce or overexploited.

A more detailed explanation and supporting discussion on this point has been incorporated into the revised version of the manuscript.

Comment 8:

I found a work of the authors just published in scientific reports https://www.nature.com/articles/s41598-025-85626-7 It is exactly the same workflow with this one. Many sentences are the same. I am not supportive for research of such a style in the community.

Response 8:

We appreciate the reviewer's observation and the opportunity to clarify the distinction between the two works.

The paper recently published in *Scientific Reports* (DOI: 10.1038/s41598-025-85626-7) focuses on the evaluation of **site suitability** for the installation of China's Next Generation Neutrino Detector, the **Jiangmen Underground Neutrino Observatory (JUNO)**. That study utilizes CSAMT-derived **geomechanical properties**, specifically the **Rock Quality Designation (RQD)**, to assess the **rock mass stability and integrity** for large-scale underground construction.

In contrast, the current manuscript focuses on a **hydrogeological application**, using CSAMT and borehole core data to derive **permeability (k)** models for **deep groundwater resource assessment**. While both studies are conducted within the broader Kaiping region of South Guangdong, a region of high scientific and strategic interest characterized by complex geological heterogeneity, their **objectives, methodologies, and scientific contributions are fundamentally different**.

We acknowledge that there may be some overlap in structure due to the use of similar geophysical techniques in similar geological settings. However, the purpose and interpretation of CSAMT data in each study differ significantly:

- In the *Scientific Reports* paper, CSAMT data were used to evaluate **mechanical stability** (RQD) for a construction project.
- In the present study, CSAMT data are employed to estimate **hydraulic conductivity** (k) and to develop **2D and 3D permeability models** relevant to deep groundwater systems.

In response to this concern and to ensure the novelty of our current submission, we have:

1. **Redrawn all figures** to reflect the unique objectives of this study.
2. **Substantially revised the entire manuscript text**, including the introduction, methodology, results/discussion, and conclusions to emphasize the hydrogeological focus.
3. **Incorporated reviewer suggestions and community feedback** to further distinguish this work from previous publications.

We would also like to highlight that both papers are part of **different national-level projects**, each addressing unique scientific challenges: one in geotechnical engineering, and the other in deep groundwater exploration. These investigations are aligned with China's broader strategy for deep subsurface resource development.

We respectfully believe that the current manuscript stands as an **original and independent contribution**, both in scope and significance, and adds value to the scientific understanding of subsurface hydrogeological processes.

Comment 9:

The structure of the manuscript is OK, however, the writing is still unshaped. Many sentences are duplicated, such as lines 306-308 which appear many times. I think once you clarified the strengths of your approaches in the introduction, you only need to describe you approach in methodology and it is redundant to say this again. Also line 218 “About 1300 meters was the depth of investigation (DOI) in the CSAMT investigation.”, such an expression is awkward. Why not “the depth of investigation (DOI) in the CSAMT investigation was about 1300 meters”.

Response 9:

We thank the reviewer for their constructive feedback regarding the manuscript’s writing quality and structure.

In response, we have **carefully revised and reshaped the manuscript** in accordance with the suggestions provided. Specifically:

- **All duplicate or repetitive sentences**, including those previously appearing in multiple sections (e.g., lines 306–308), have been removed or appropriately rephrased to avoid redundancy.
- We have **streamlined the narrative** by presenting the strengths of our approach clearly in the **Introduction** and limiting their repetition in subsequent sections.
- As suggested, we have improved awkward or unclear expressions, such as line 218. The sentence now reads: *“The depth of investigation (DOI) in the CSAMT survey was approximately 1300 meters.”*

We believe these revisions enhance the overall clarity, coherence, and professionalism of the manuscript and we appreciate the reviewer's guidance in helping us improve the quality of the submission.

Comment 10:

What are you trying to get? Permeability or hydraulic conductivity? I don't think the unit of permeability is L/T.

Response 10:

We appreciate the reviewer's comment and the opportunity to clarify this point.

Our study focuses on **permeability**, and the correct unit is **milliDarcy (mD)**. In the initial version of the manuscript, permeability was mistakenly written using the unit **m/d**, which may have caused confusion with **hydraulic conductivity**, typically expressed in length per time (L/T) units such as m/day.

To address this:

- The **methodology section has been revised** to clearly state that permeability is measured in **mD**.
- This correction has been **applied consistently throughout the manuscript and all figures**.

We thank the reviewer for catching this important detail, which has now been rectified in the revised version.

Revised Figures

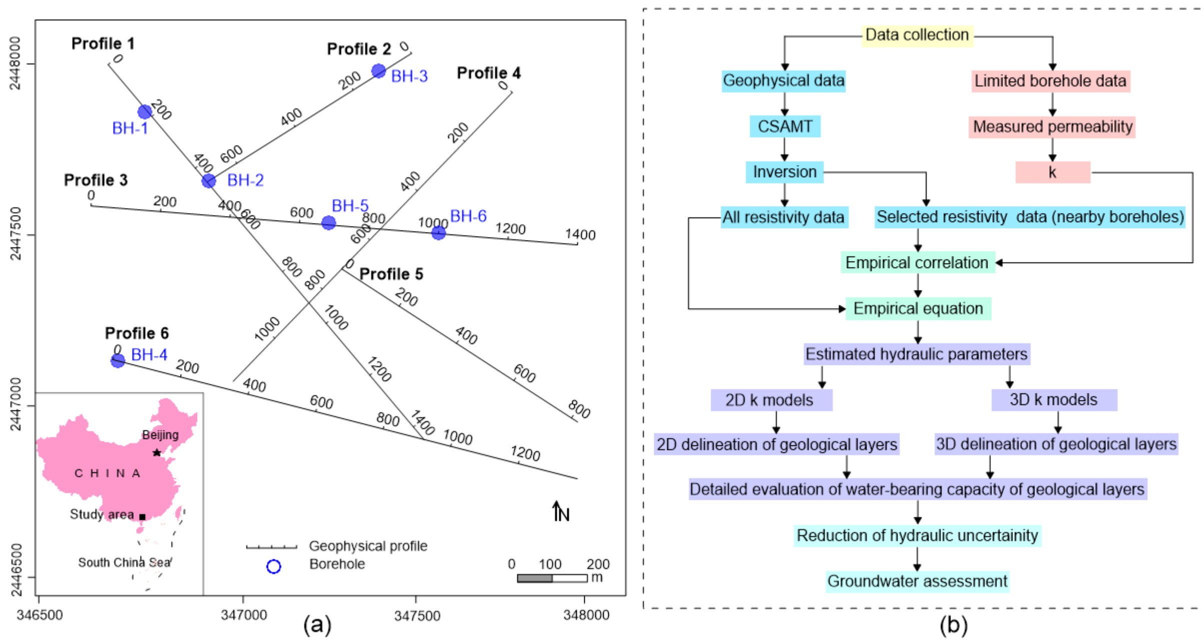


Fig. 1. (a) The location of the project site, with six boreholes BH1–BH6 (blue circles) and six CSAMT profiles 1-6 (black lines), (b) Flow diagram outlining the planned method for getting 2D and 3D k models for better, more thorough assessments of groundwater resources over large regions

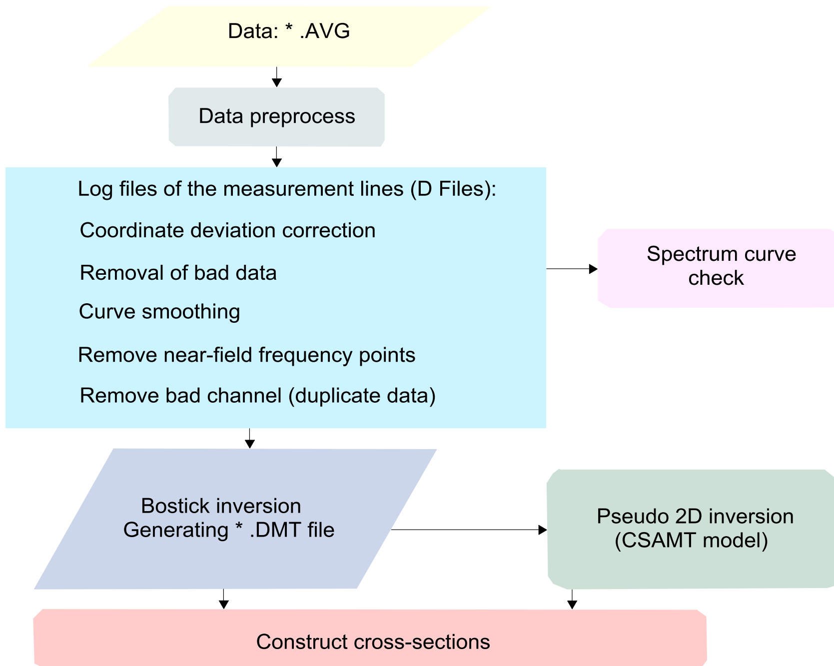


Fig. 2. Displaying the procedure of 2D inversion of CSAMT data by the use of Bostick inversion

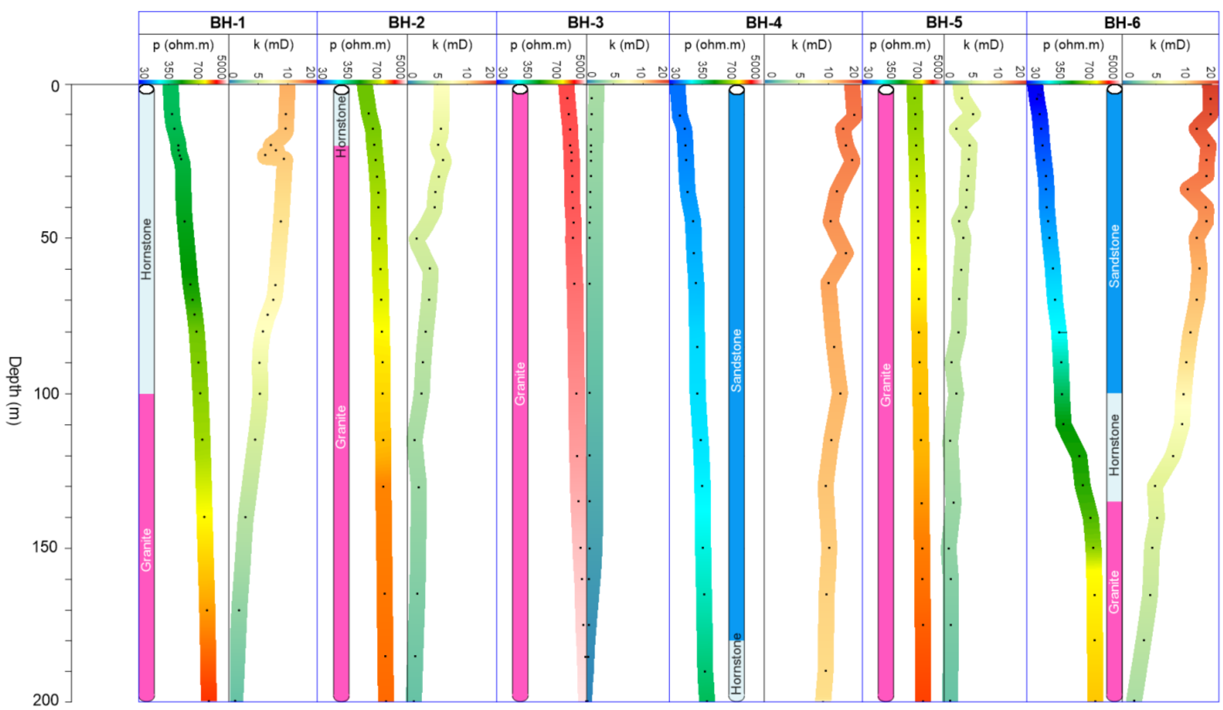


Fig 3. The evaluation of hornstone (HS), sandstone (SS), and granite (G) carried out by presenting 116 resistivity-k data points at depths ranging from 5 to 200 m using 6 drilled tests

(BH1–BH6) and associated resistivity (ρ) from CSAMT soundings. The small black dots show the data points

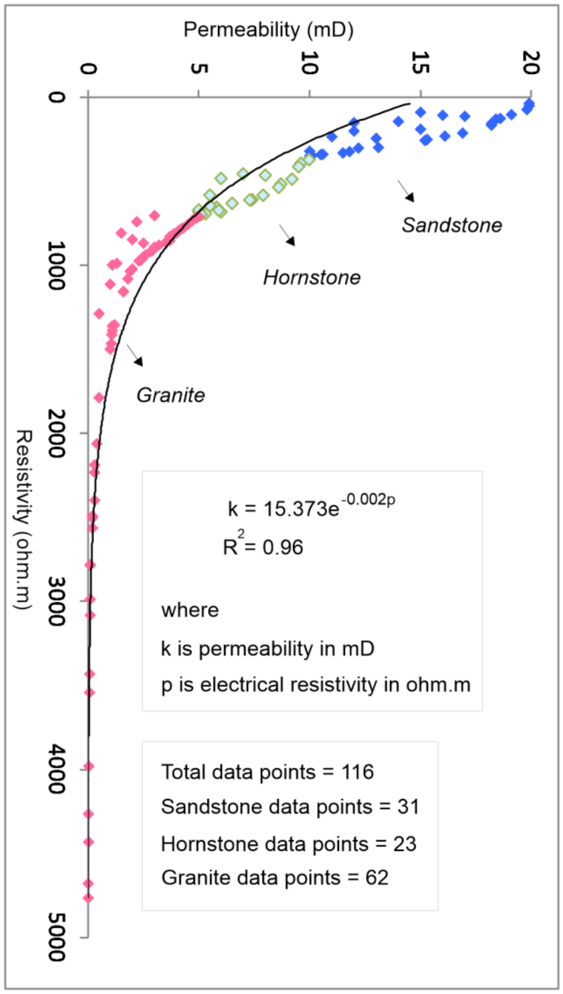


Fig 4. Using a total of 116 data points, the geophysical-borehole correlation for the predicted k

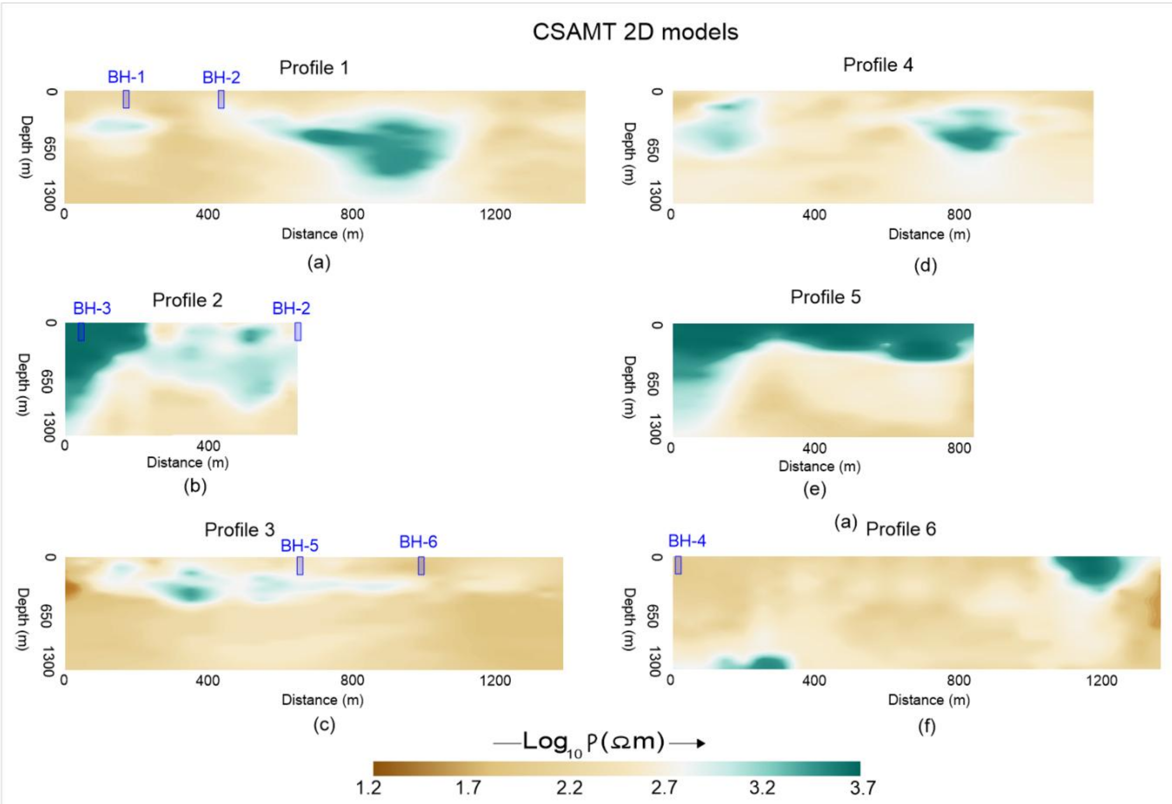


Fig. 5 2D CSAMT models along six geophysical profiles 1-6. Where resistivity increases from brown to green on a color bar.

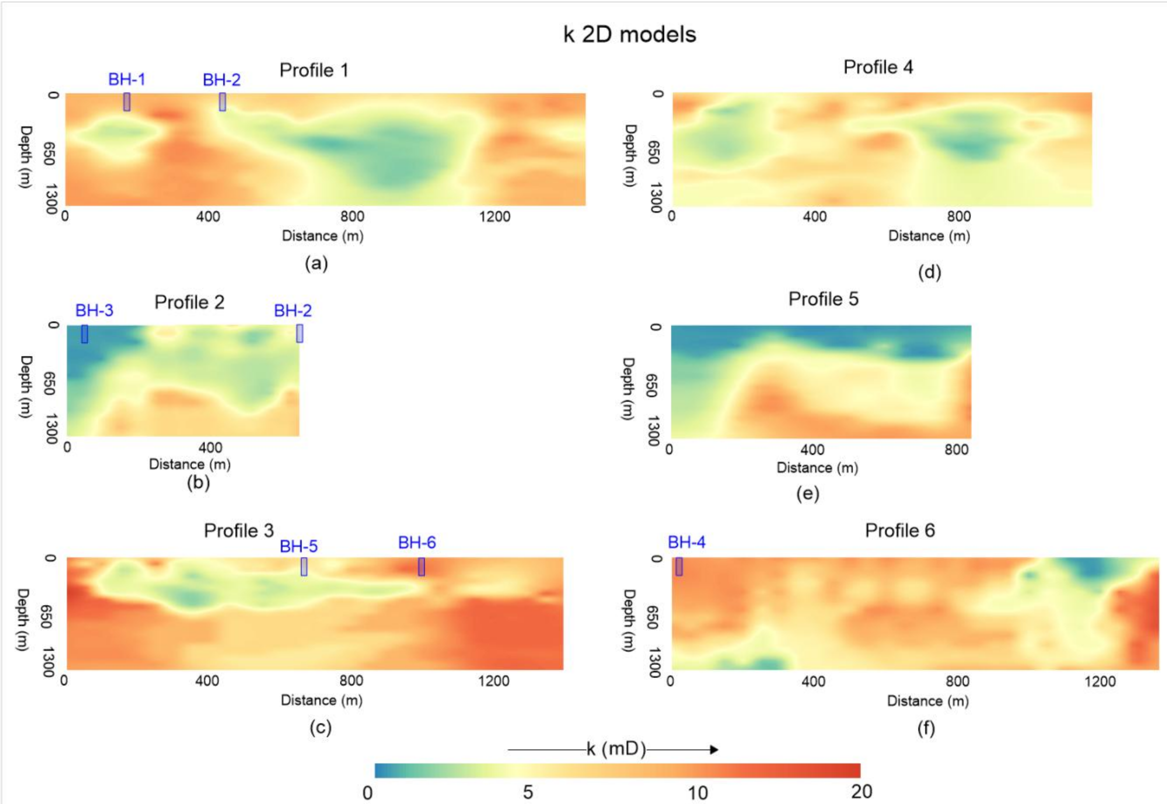


Fig. 6 The predicted 2D k models obtained from CSAMT data along six geophysical profiles 1-6. Where k increases from light green to red on a color scale

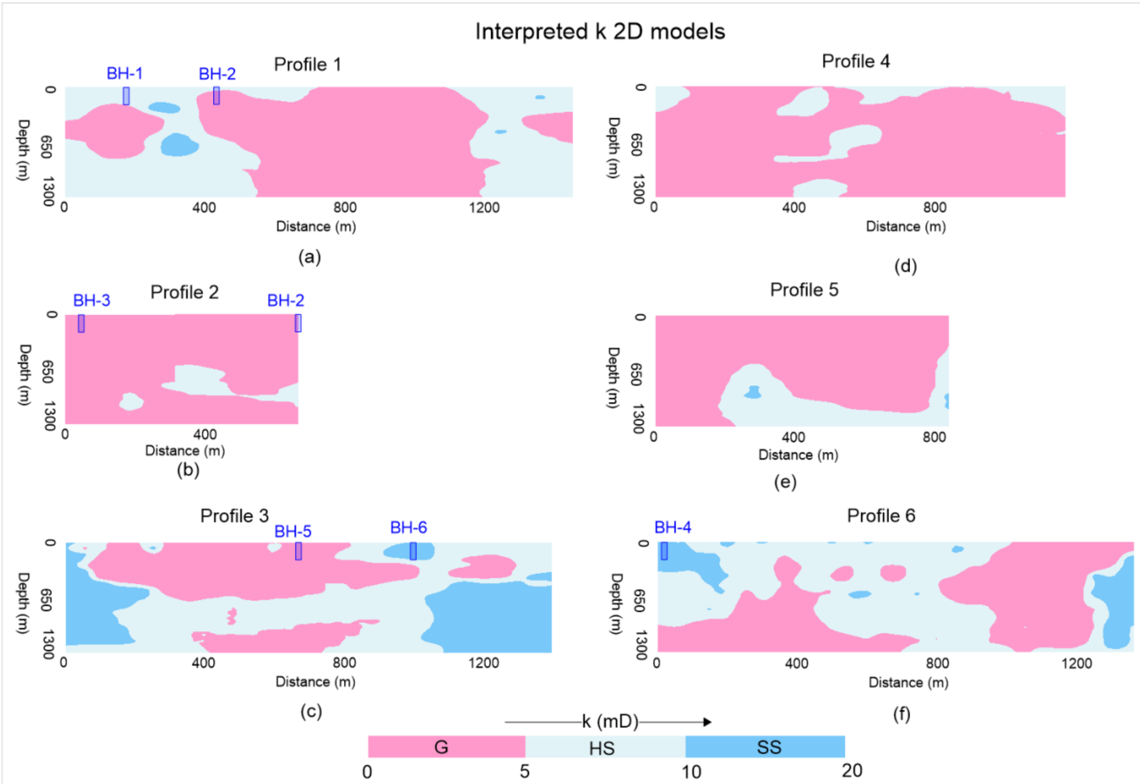


Fig.7 The interpreted (hydrogeological) 2D models along six geophysical profiles 1–6 obtained via geophysical-borehole correlation, facilitates groundwater assessment through high potential aquifer (HPA), medium potential aquifer (MPA), and low potential aquifer (LPA) associated with sandstone (SS), hornstone (HS), and granite (G), respectively

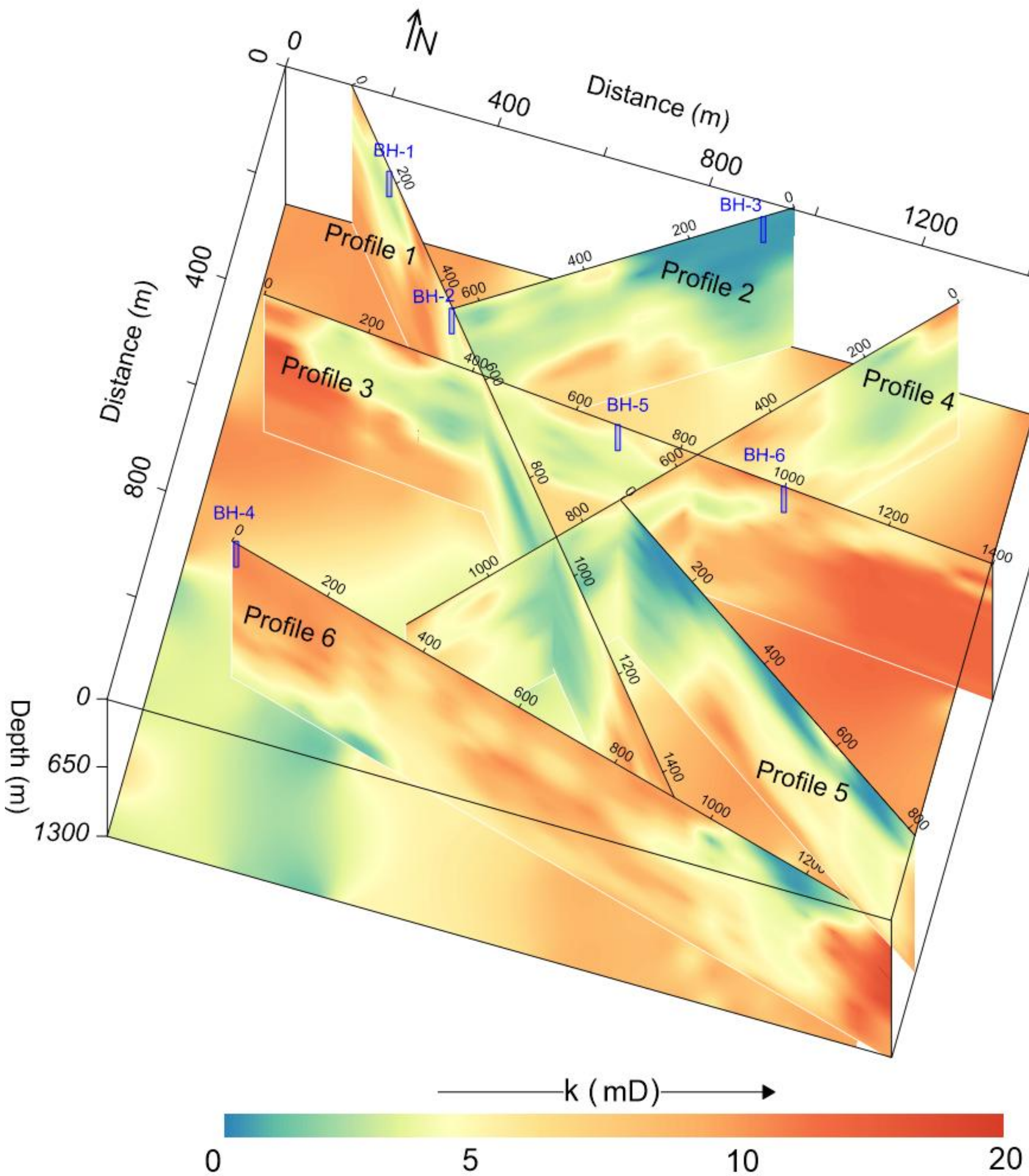


Fig. 8 The integrated 2D k models derived from the incorporation of geophysical and drilling data, with k represented on a color bar spanning from green to red

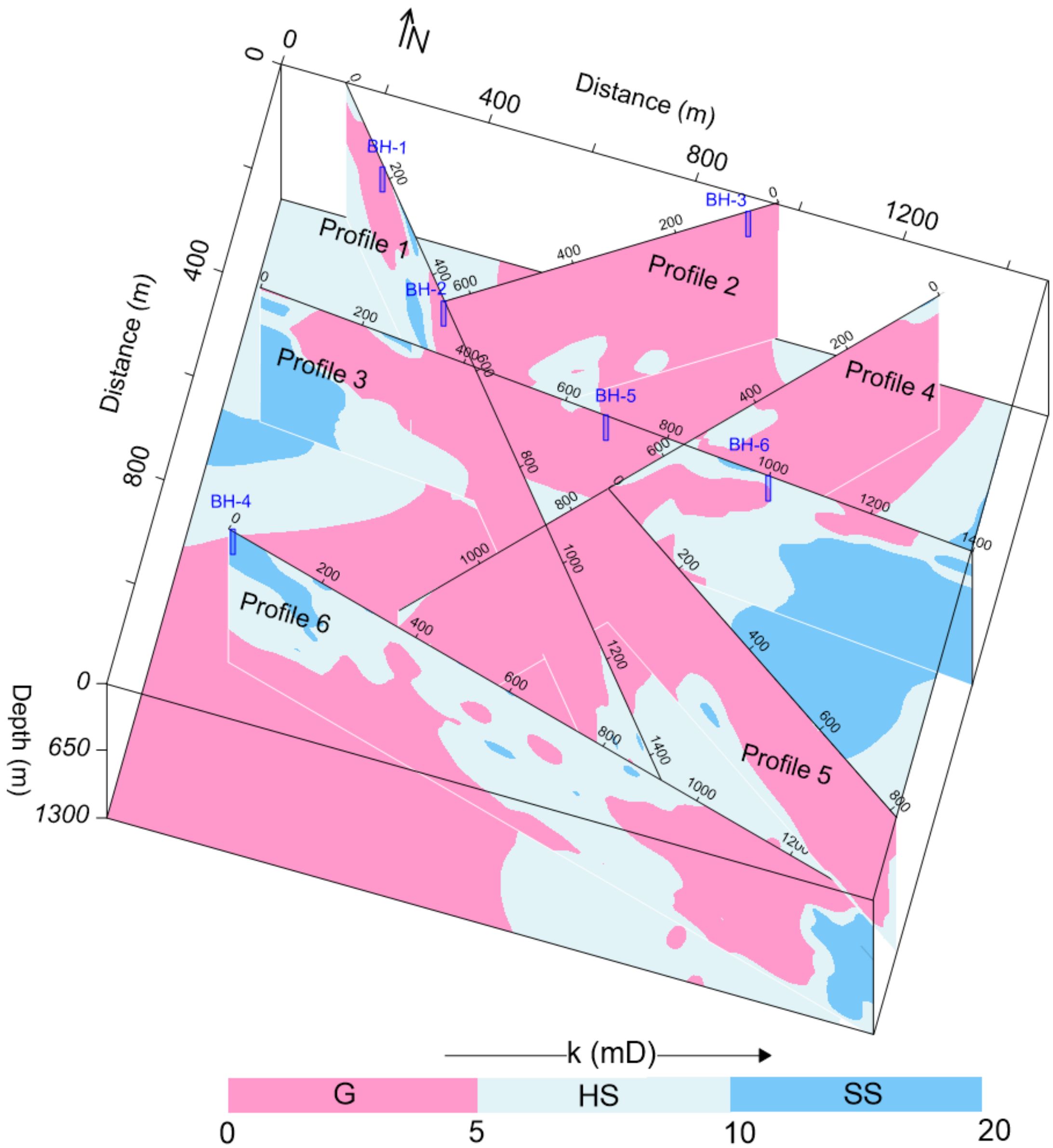


Fig. 9 Analysis of the integrated 2D k models (derived from designated k ranges) for three groundwater potential aquifers: low potential aquifer (LPA), medium potential aquifer (MPA), and high potential aquifer (HPA), associated with three geological formations: granite (G), hornstone (HS), and sandstone (SS), respectively

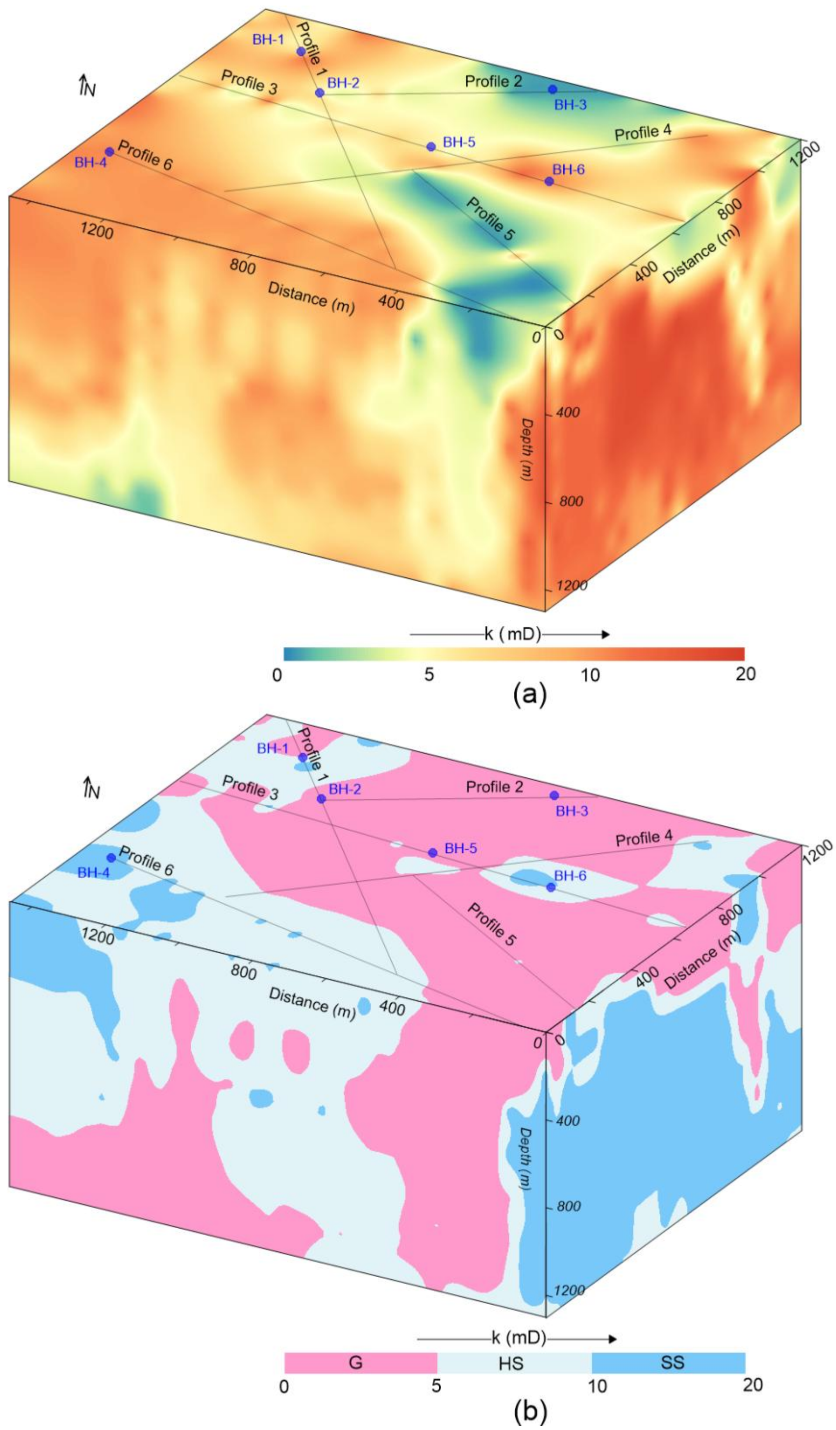


Fig. 10 The 3D k models, generated from the correlation of CSAMT and borehole data (with k represented on a color scale ranging from green to red), correspond to three groundwater potential aquifers: low potential aquifer (LPA), medium potential aquifer (MPA), and high

potential aquifer (HPA), associated with three geological strata: granite (G), hornstone (HS), and sandstone (SS), respectively, for (a) the external view of the 3D k model, and (b) the analysis of the 3D k model from an external perspective

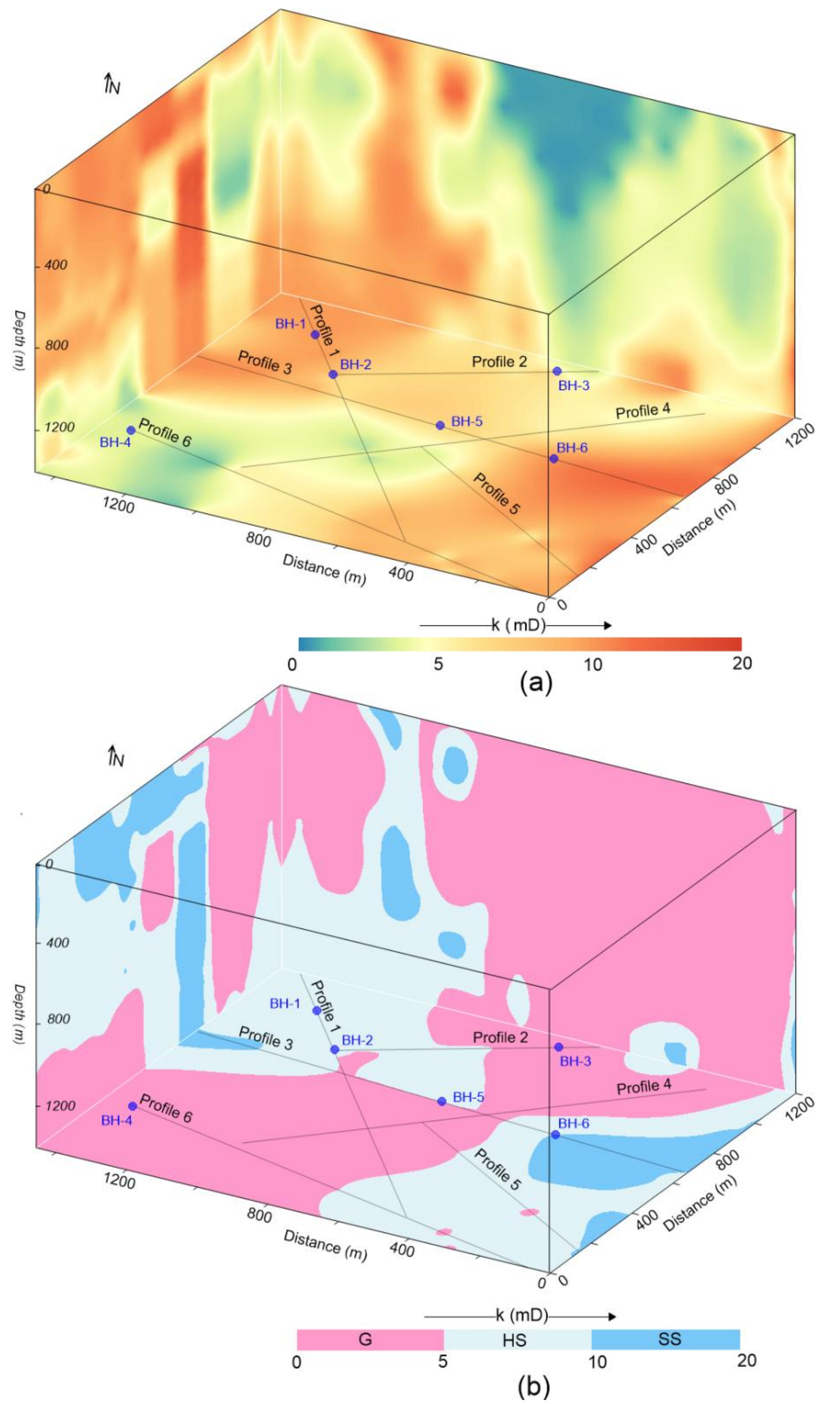


Fig. 11 The 3D k models, obtained from the correlation of CSAMT and borehole data (with k represented on a color scale ranging from green to red), illustrate three groundwater potential aquifers: low potential aquifer (LPA), medium potential aquifer (MPA), and high potential aquifer (HPA), associated with three geological strata: granite (G), hornstone (HS), and sandstone (SS), respectively, for (a) the internal view of the 3D k model, and (b) the analysis of the 3D (internal perspective) k model

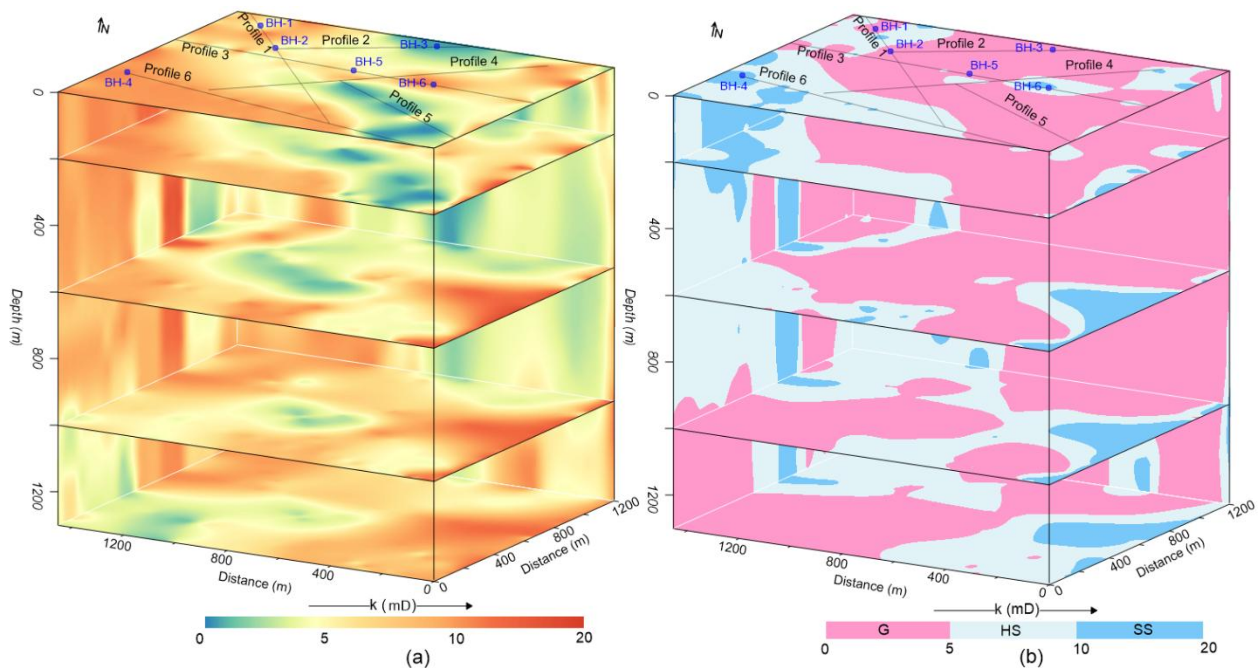


Fig. 12 (a) Geophysical-based k imaging at various depths (0, 200, 600, 1000, and 1300 m) with inner 3D view is represented by K on a color bar that goes from green to red, (b) Assessment of geophysical-derived k (using specified k ranges) at different depths for various types of aquifers: low potential aquifer (LPA) granite (G), medium potential aquifer (MPA) hornstone (HS), and high potential aquifer (HPA) sandstone (SS)