

An example, from geophysical study using the Audio-Magnetotelluric method in Region of Kabylia (Algeria)

In the context of the drinking supply water reinforcement of a village, located in an area of passage to Upper Kabylia from Akbou (Béjaia), a geophysical survey using the Audio-Magnetotelluric method was carried out in order to:

- Identify the geological nature of local formations
- Find the infiltration catchment areas of the underlying aquifer
- Highlight probable faults zones which are able to guide groundwater flow
- Determine the impact of drilling project.

Presentation of the AMT method and the data acquisition system:

The AMT method uses measurements of natural variations of the electromagnetic field in the range of audible or near-audible frequencies, i.e. for frequencies between 1 and 20000 Hz. In AMT two horizontal components of the electric field are measured using non-polarized electrodes and two magnetic field components are measured using magnetic induction coils (orthogonal sensors). The Geode EM3D system was deployed during this mission. The figure below shows the configuration of one measuring station.

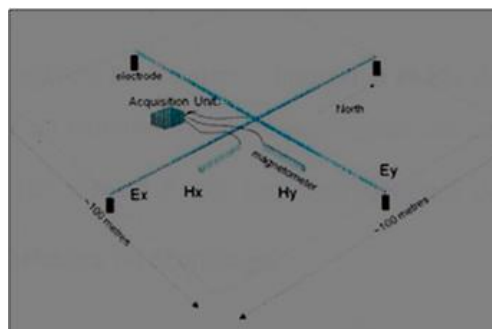


Fig. 1 : Device of one measuring AMT station

The measured quantities of the two fields (electric and magnetic) correspond to signals that, when amplified and filtered, are interpreted in terms of apparent resistivity and phase.

Implementation of the study and results:

For the purposes of the study, twenty-one (21) measurement stations spread over three profiles were conducted. The direction of each measurement line is chosen so that it is perpendicular as much as possible to the direction of the geological strike.

The results so obtained appear less affected by noise and show coherence distribution of resistivity values. Data for each station is collected as two graphs. The figure n°2 below shows an example of this data showing frequencies as the horizontal axis and apparent resistivity (ohm-m) or phase (degrees) as the vertical axis.

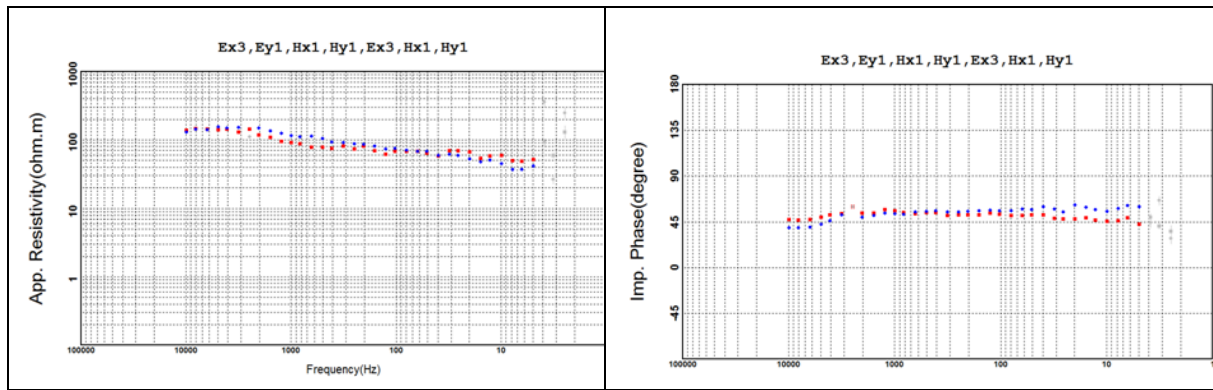


Fig.2 : Example of resistivity and phase variation curves as a function of frequencies

The interpretation of the apparent resistivity curves using 1-D was made by comparing the theoretical response of a model that will be refined successively, with the measured data. The maximum rotation of the impedance tensor following the TM mode (Z_{xy}) provided additional information to those of the apparent resistivity curves and which can be used in a 2-D interpretation model.

In the 2-D interpretation, focus will be on highlighting major regional-type formations and the parameters associated with them (depth, resistivity, etc.) rather than anomalies attached to a single survey. Three models for the 2-D inversion for a closer approximation of the geologic response were executed using Zonge SCS2D software.

This inversion method has allowed imaging the subsurface to 1000 meters deep. The geo-electric section shown below is the result of a 2-D inversion along one profile of resistivities, indicating a most favorable site for water drilling.

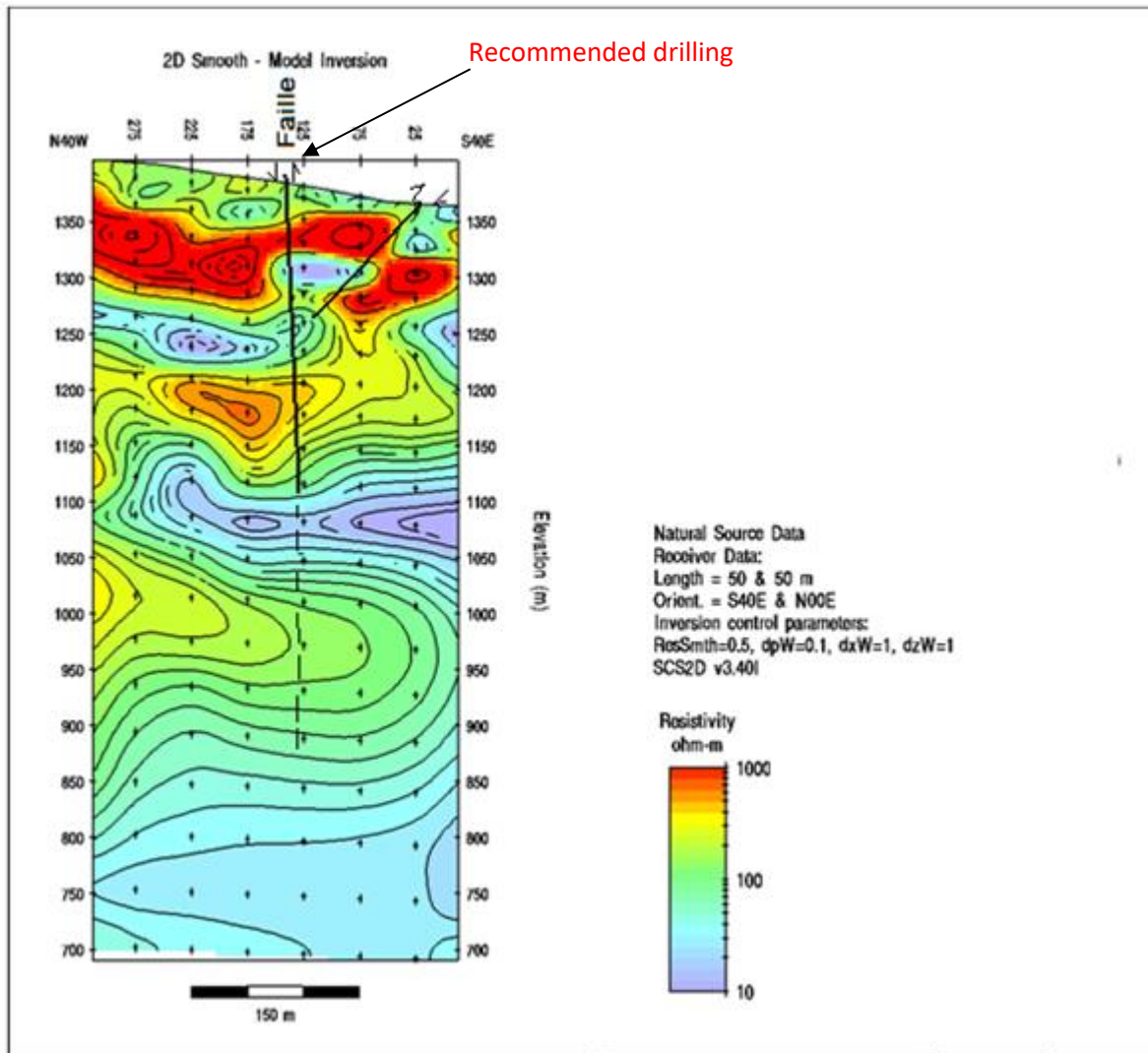


Fig3 : 2-D data inversion model along one section crossing an ideal site for water drilling

Conclusion and recommendations:

The audio-magnetotelluric method using the Geode EM3D allowed a better understanding of the geological context in an area as complex as Djurdjura.

The formations that are likely to be aquifers correspond to the Liasic limestone scree (red color) and red sandstone of the Triassic complex (ochre color). Relatively permeable shales have also been detected below the depth of 200m. The presence of a communicative fault, subsequently confirmed by further additional measurements, helped to choose the most favorable site in the corridor of this accident for a drilling water at 250m depth.

This drilling was successfully carried out during the period 2019-2020 and offered a good water flow, sufficient to supply the entire village.

Annexe 1 : **Équipements Audio-Magnétotellurique GEODE EM3D utilisés pour l'étude hydrogéologique** – The Audio-Magnetotelluri equipment GEODE EM3D used during the investigation.

 <p>Système Audio-Magnétotellurique GEODE EM3D CES NOUVEAUX EQUIPEMENTS PERFORMANTS ACCOMPAGNENT POUR UNE MEILLEURE CONNAISSANCE DU SOUS SOL. C'EST A LA FOIS UNE TECHNIQUE DE DETECTION DIRECTE ET UN OUTIL DE CARTOGRAPHIE HYDROGEOLOGIQUE PRECIS.</p> <p>Acquisition des données AMT dans le massif du Djurdjura où nous intervenons beaucoup plus ces dernières années (image à droite).</p>	
 <p>Dispositif de mesures des Sondages Electriques Verticaux (S.E.V).</p>	 <p>Système d'enregistrement des mesures par la méthode électrique.</p>

Annexe 2 : Drilling Development Test Phase (march 2020)

