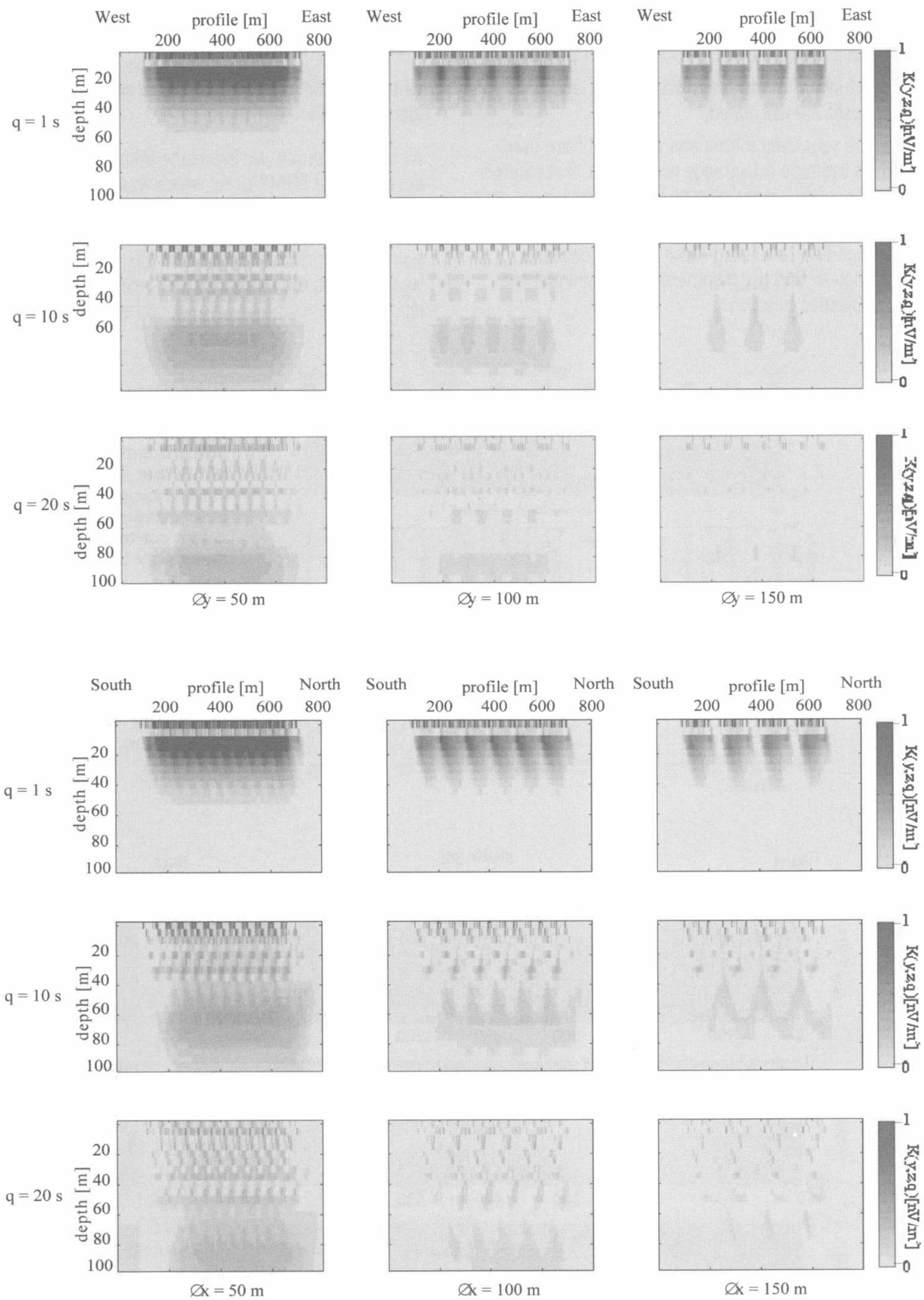


Figure 4: 2-D sensitivities for SNMR sections in west-east (top) and south-north (bottom) for sounding point intervals: 50 m (left), 100 m (center) and 150 m (right); earth magnetic field B_0 = 48000 nT; I = 60°; circular loop of radius 50 m, 1 turn.

This section describes the inversion routine which tries to find the smoothest model that fits the data to an a priori value of χ^2. The steps of process are

- a forward model, sensitivity matrix, and data misfit are calculated,
- the sensitivity matrix and data misfit are used to estimate a Lagrange multiplier a that controls the relative weighting of smoothness versus data fitting in the objective function, and
- modified Levenberg-Marquardt algorithm is used to find the parameters that minimize the objective function.

The Levenberg-Marquardt algorithm

$$\mathbf{m} = (\mathbf{G}^T\mathbf{G} + \alpha\mathbf{I})^{-1}\mathbf{G}^T\,\mathbf{d}$$

where α is the damping parameter and $\mathbf{I}$ is the identity matrix.

As a first example, we invert the initial amplitude & decay time of SNMR data, which was produced by a single water lens having water content of 40% and decay time 150 ms (Figure 5). There are 11 sounding point data of measurement and 1% gaussian noise was added to the data prior. The recovered water lens model, shown here, is a good representation of

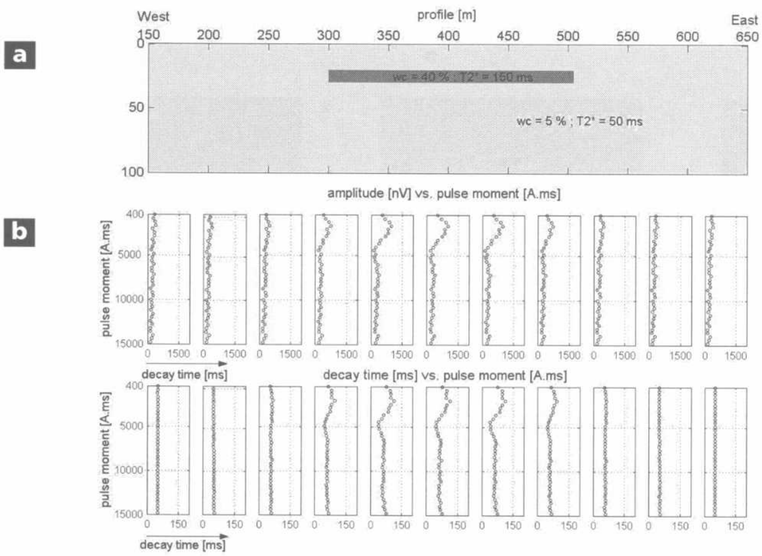
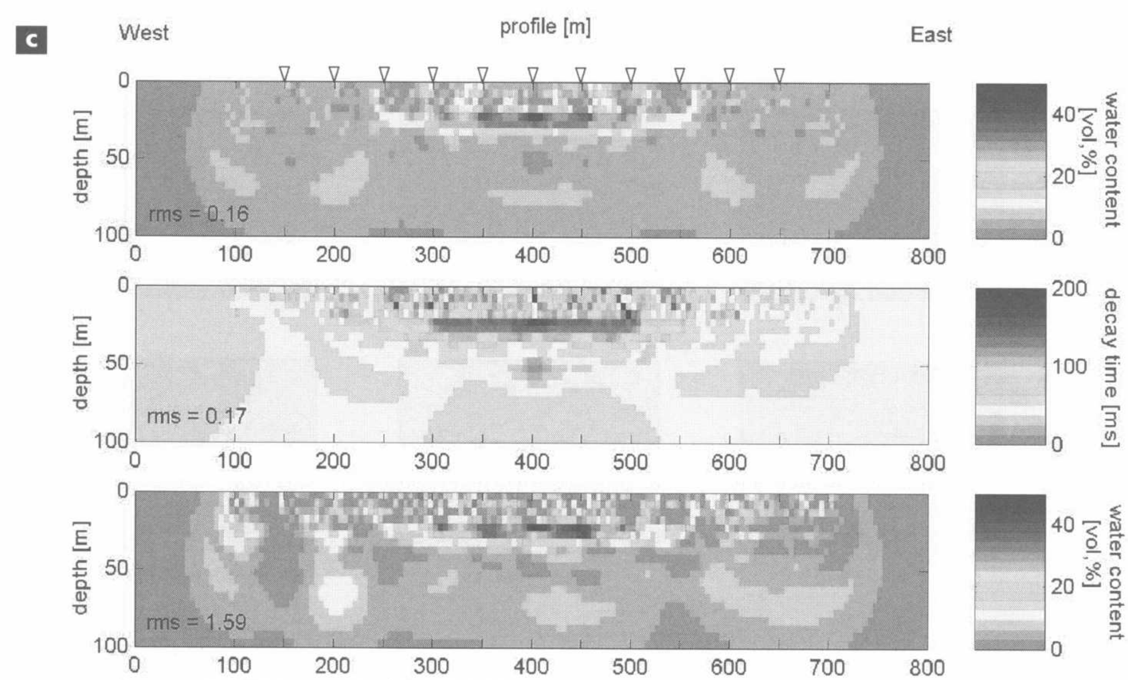


Figure 5: (a) 2-D water lens model having a water content of 40 vol. percent and decay time of 150 ms. The surrounding material is associated with a water content of 5 vol. % and decay time of 50 ms.

(b) Synthetic SNMR amplitudes;

(c) 2-D inversion result; earth magnetic field B_0 = 48000 nT; I = 60°; circular loop of radius 50 m, 1 turn.



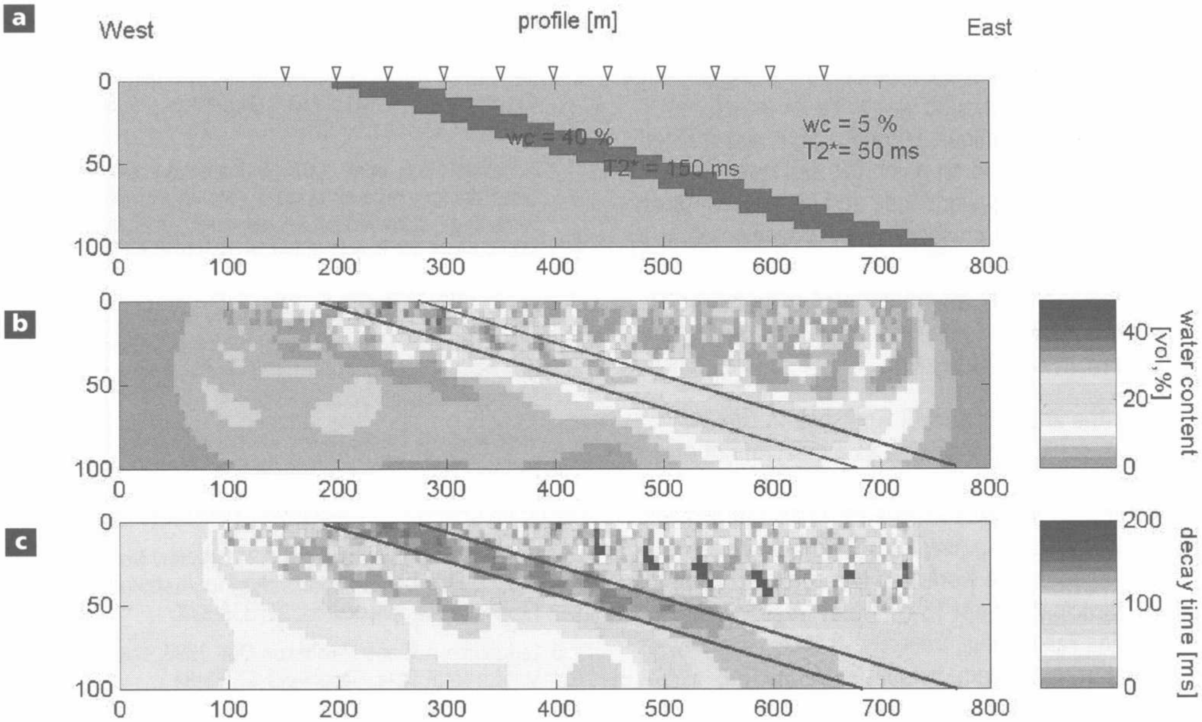


Figure 6: (a) 2-D dipping layer model having a water content of 40 vol.% and decay time of 150 ms. (b) & (c) 2-D inversion result water content and decay time

the true model. The recovered value is slightly lower than the true value.

Figure 6a shows a 2D model of a dipping bearing layer (dipping angle = 7°) striking from north to south, e.g. an aquifer underneath a hillside. The model has been computed using a grid size of _x = _y = _z = 0.5 m. A water content (WC) of 40 vol. % and a decay time (T_2*) of 100 ms is assigned to the aquifer. The surrounding material has a water content of 5 vol. % and decay time 50 ms.

The 2D inversions (water content and decay time) of the dipping layer model using a smooth inversion scheme are presented in Figure 6b & c. The smooth inversion was performed using Levenberg-Marquardt algorithm up to a maximum depth of 100 m. At a distance of 50 m to the west from the outcrop of the dipping layer no signal contribution of the aquifer is observed. Corresponding to the model the inversions show constant water content of approximately 5 vol. % and decay times of about 30 ms up to 100 m depth. At the outcrop of the aquifer (profile 150 m) the inversions indicate a slight increase of both water content (<20 vol. %) and decay times (<90 ms) near the surface. The water content and the decay times of the aquifer as well as its thickness the depth of the aquifer are in good agreement with the model. Naturally, the sensitivity of the SNMR method gets smaller with increasing depths.

Conclusions

3D modeling of SNMR data is necessary to predict the SNMR signal response of aquifers. Use this method for optimisation of field layouts for appropriate measurement on given 2D situation. 2D SNMR sensitivities are necessary to evaluate lateral and vertical resolution of 2D. We have developed a reliable technique for 2-D inversion of SNMR.

Improved inversion algorithm will be investigated consist of model parameterizations regularization schemes. This inversion will be applied for the SNMR field data hydrogeology. At the end, the SNMR can be applied to dectect subsurface water in suitable geological formation to a depth of 100 m and more depending on the presence of natural and cultural electromagnetic noise. In the future this new method may be applied as an attempt to bring long-term solutions to the water supply problems and also to protect groundwater from the degradation of aquifers.

Outlooks

It was realized that the method passed experimental stage and is on a good way to be an established geophysical technique. Furthermore, it was realized that there is broad on-going focused research in different group's worldwide and increased interest by the end users prospecting for groundwater. As a researcher in developing country, I will continue the collaboration with Interpretational program improvement, and applied some field data. Design for new field measurement.

From the 2nd MRS/SNMR workshop in Orleans-France could be considered as a meeting not only to those involved in SNMR development and application, but also for geophysicists and hydro-geologists seeking new tools for groundwater investigation. The workshop was attended more than 70 participants from 15 countries (Algeria, Australia, Burkina Faso, Chine, Denmark, France, Germany, Great Brittany, India, Indonesia, Jordan, The Netherlands, Nigeria, Russia, Spain and USA). There clearly should be something for everyone interested in aquifer characterization and localization.

What the components of learning in our project are to find out the relationship between aquifer characterizations (water content and permeability) using SNMR and disaster risk. Finally, a combination of methods is proposed by which near-surface geophysics can contribute regard to the water content and the water distribution.

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