Impact of Time-domain IP Pulse Length on Measured Data and Inverted Models

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Impact of time-domain induced polarization pulse length on measured data and inverted models

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Conclusion

- Induced polarization field data is affected by the on-time duration of the injected current.
- It is possible to compensate for the on-time duration effect if the IP response and current waveforms are included in the inversion.
- It can be misleading to only consider integral chargeability data and makes it more ambiguous when relating IP models to geology or tabular reference data.
- Longer on-time duration gives higher signal-to-noise ratio for IP data.

Results

FIELD IP DECAYS

Figure 1 shows acquired field IP decays for the same quadruple from the four different on-time data sets. As seen in Figure 1, the starting values of the measured IP decays are increasing with increasing on-time. Furthermore, the magnitudes of the longer on-time decays are higher than for the shorter on-times for the full length of the decays. One direct effect of this is, assuming that noise levels are independent of on-time, is an increase in SNR with increasing on-time

PSEUDOSECTIONS

Figure 2 shows pseudosections of apparent chargeability for the 3rd IP-window for three data sets with different on-time. Clearly data space is different for the three data sets even if they were acquired on the same measurement line. More specific, is the apparent chargeability generally increasing when on-time is increased, which is also shown by the individual full decays in Figure 1. One effect of this difference in data space is that inversions not considering the full waveform will produce different inversion models for data acquired with different on-time. Since not only decay duration but also magnitude is different it is not enough to only fix the integration time to for example the Newmont polarization standard, but full waveform inversion is needed.

INVERSION MODELS

Figure 3 shows inversion models retrieved with Res2dinv and Aarhusinv for three data sets acquired on the same measurement line but with different on-time. The resistivity sections are similar for all data sets independent on inversion software. However, as expected when considering the difference in data space, the chargeability models retrieved from the integral chargeability inversions are quite different (Figure 3, 2nd profile from top). On the contrary, more similar inversion models are retrieved when inverting for the CPA-model and taking the waveform of the injected current into account (Figure 3, bottom profile).

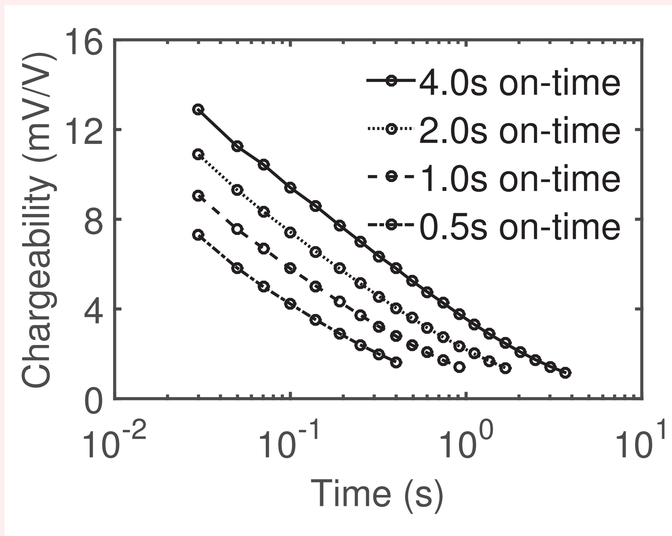

Figure 1. Acquired field IP decays corresponding to the same quadruple from each of the four data sets with different on-time. Note that the magnitude of the decays are increasing with longer on-time.

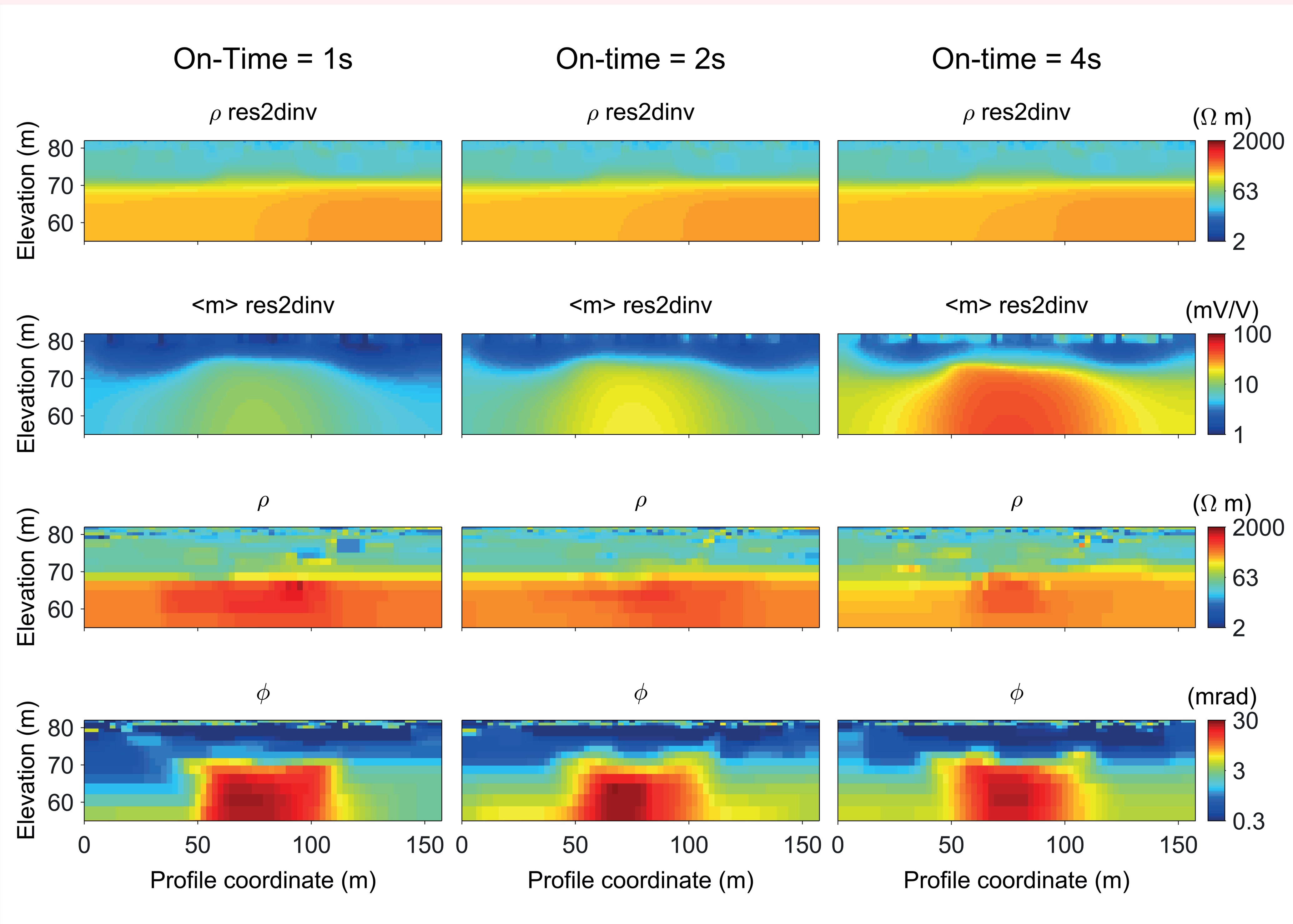

Figure 3. Inversion models of field data from the same measurement line but with different on-time/off-time. Sections shown are (from top to bottom): resistivity (Res2dinv), integral chargeability (Res2dinv), resistivity (Aarhusinv) and CPA phase shift (Aarhusinv). Clearly, the resulting inversion models for integral chargeability are very different from each other even if they represent inversion of data acquired on the same profile. In contrast, similar inversion models are retrieved when inverting for phase shift and including the waveform of the injected current in the inversion.

Introduction

In this poster we show that the duration of current injections has significant impact on the acquired induced polarization data as well as on the inversion models, if the standard evaluation procedure is followed. The commonly applied inversion of the induced polarization data is only considering the integral chargeability, without taking the waveform of the injected current or the waveform of the IP response into account. Our results show that, with these full waveform considerations included in the inversion, it is possible to retrieve similar inversion models for the induced polarization, independent of the on-time duration. Our results also show that the signal-to-noise ratio (SNR) for the IP information increases with increasing duration of the current injections.

Method

FIELD TEST

A field test was conducted with an ABEM Terrameter LS for transmitting current and measuring potentials. Four field data sets were acquired on the same measurement line, using a 50% duty cycle current injection waveform with different on-time and off-time durations: half second, one second, two seconds and four seconds. The retrieved IP decays were gated with approximately log-increasing IP-gates with the same temporal distribution, but with more gates for the longer on-time acquisitions. All other data acquisition parameters were identical.

IP MODEL

For simplicity, and in order to compare the same amount of parameters for both inversion methods, was the constant phase angle (CPA) model was used for the Aarhusinv inversions (Fiandaca et al., 2013, 2012). This model contains only two parameters, in contrast to the more general Cole-Cole model which contains four parameters.

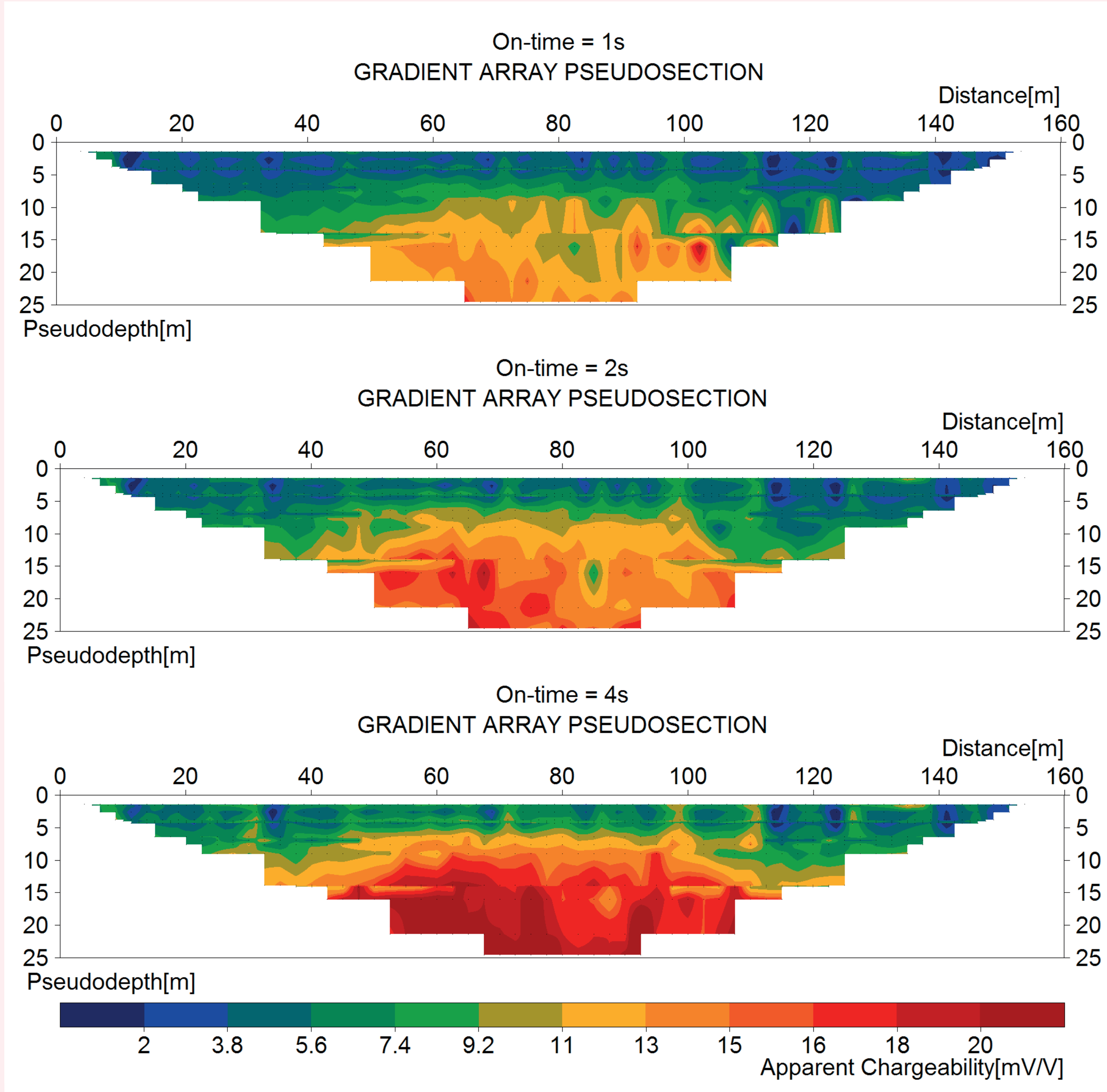

Figure 2. Pseudosections for apparent chargeability (3rd IP-window) of three different field data sets (on-time=1, 2 and 4 seconds). As seen in the figure is the magnitude of the apparent chargeability increasing with increasing on-time (from top to bottom). This effect can also be seen in the full decays shown in Figure 1.

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