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Good practice in high-resolution EMI data processing for archaeological prospection

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As the application of frequency domain electromagnetic induction (EMI) sensors in archaeology is rising, the need for adaptive processing schemes that allow exploiting the full potential of EMI data grows. The ability for conducting expeditious EMI surveys is rapidly expanding, generating large-scale datasets using fine measurements grids. While most emphasis in archaeo geophysical prospection has historically been on processing magnetometry data, EMI data requires a different set of processing steps related to the inherent characteristics of survey instruments. Although often ignored in archaeo-geophysical literature, the issue of signal instability with time (or drift) can have the most severe influence on EMI survey data, sometimes even rendering interpretation impossible. While levelling procedures from

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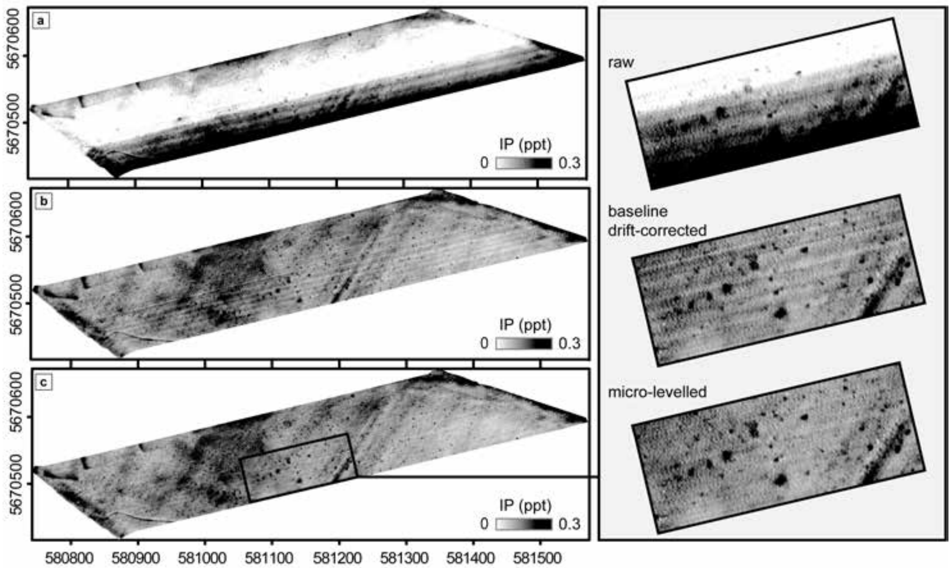

Fig. 1. The impact of adaptive EMI processing. Comparison of pre- and post-processed in-phase (IP) EMI data gathered with the 1 m perpendicular (PRP) coil configuration of a Dualem-21s sensor. Raw IP data is shown in (a), while (b) shows the same data after base-line drift correction. In (c), aberrant corrugations, i.e., remanent micro-drift, has been removed through micro-levelling. On the right hand side, a detailed view is provided of the impact of each step on data visualisation

resistance or magnetometry processing can be (and sometimes unfortunately are) transferred to EMI data, these often cause drift overcompensation. This can result in rejecting subsurface information from the survey datasets.

Drift-correcting strategies for EMI surveying are commonly available (e.g., Minsley *et al.* 2012; Delefortrie *et al.* 2014) and, especially when tie-line data is available, effortlessly implemented into survey and processing workflows. When drift correcting procedures are applied, these do not guarantee a noise- or fully drift-free dataset. Often, although sometimes unnoticed, micro-drift remains present in corrected datasets. The most common effects of such systematic errors are broad corrugations, accounting for 1% to even 20% of the data range (example presented in Fig. 1). While some coil pairs suffer more than others from such aberrant fluctuations, even when only little micro-drift is attested in original data plots, errors can build up in further processing stages (e.g., through image enhancement, geostatistical analyses or inversion procedures). The attention to such remanent drift is particularly relevant in archaeological prospection as, being the most aesthetic application of geophysics, it is also the most demanding in terms of data resolution and signal stability.

The discussion of consecutive processing steps needed to warrant accurate EMI data interpretation forms the core of this paper. Emphasis lies on different drift and noise levels present in the EMI survey data and the final visualization of the obtained results. However, the inevitable starting point is good practice in field strategies, and taking into account the practical considerations of EMI survey in early project stages.

Advocating widespread implementation of EMI in archaeological prospection, we would like to motivate archaeological geophysicist to adopt EMI-specific processing schemes, warranting substantiated and transparent data use.

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