Getting a better control of IP acquisitions with GDD's new IP Post-Processing software

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SUMMARY

There was a time when an entire day of Resistivity / Induced Polarization (IP) acquisition would have to be re-surveyed because wrong survey parameters had been set, timing errors had occurred, wind or external noise had prevented acceptable repeatability of readings, etc. This frustrating and costly outcome was due to the absence of full wave data available for the geophysicist to process. For both ground and borehole EM and IP surveys, the lack of data for post-processing and post-processing capabilities remained for a long time, until more recently some manufacturers started offering access to time series along with software to visualise and process the data.

Instrumentation GDD, a Canadian manufacturer of geophysical instruments since 1976, is one of them. The GDD IP receivers' full wave data were accessible since 2009 but users can now use the IP post-processing software. This paper will include many examples of real data collected in different part of the world for which it has been possible to: validate the nature of external noise to adjust acquisition parameters and fix final survey results, correct synchronization offset between the transmitter and the receiver, manually discard noisy half-cycles to recover data in specific cases for which the receiver algorithm did not yield satisfactory results, modify the secondary voltage (Vs) decay windows scheme in order to fine-tune chargeability responses in specific geological environments, and more.

Key words: Full wave, Resistivity / IP survey, Post-Processing.

INTRODUCTION

It is well known that in order to maximise Resistivity / Induced Polarization (IP) survey data quality in the field, good electrode / porous pots contacts are needed at the transmitter and receiver site. Injected current needs to be optimised (more current not always being the best option) and signal collected at every receiver dipoles (i.e. Vp) should be maximized.

In absence of time series, the best way to improve the overall Signal-to-Noise (S/R) ratio of a given geophysical survey is to increase the amount of stacking to cancel some of the noise through statistics and to repeat readings at every survey station so that the noisier repetitions may be discarded afterwards. When the averaged and binned data is the only information available from the receiver, limited Quality Control and Analysis (QA/QC) can be achieved. Qualifying sources of interference from these final binned output values may be challenging.

FULL WAVE RECORDING

Full wave or time-series refer to the complete raw signal measured at the receiver (i.e. every electrical potential signal digitized at a sample rate defined by the receiver's ADC converter). Where "processed output files" provide only final Vp and chargeability values, the "raw" files make it possible to evaluate each Vp and to re-compute chargeability from the secondary voltage (Vs).

The full wave allows to visualize the complete signal acquired at all active dipoles. This raw data thus show the polarity of the signal for each dipole, the variation of Vp with respect to time and the symmetry between positive and negative half-cycles. This information can be very handy to diagnose transmitter or motor generator problems, to identify that a Tx contact is drying out, or to confirm the geometry of dipoles for a given 3D survey. Additionally, full wave visualization allows to confirm the presence of negative Vs overshoots likely explained by EM coupling or of sporadic noise spikes such as telluric. Figure 1 presents an example of full wave IP data.

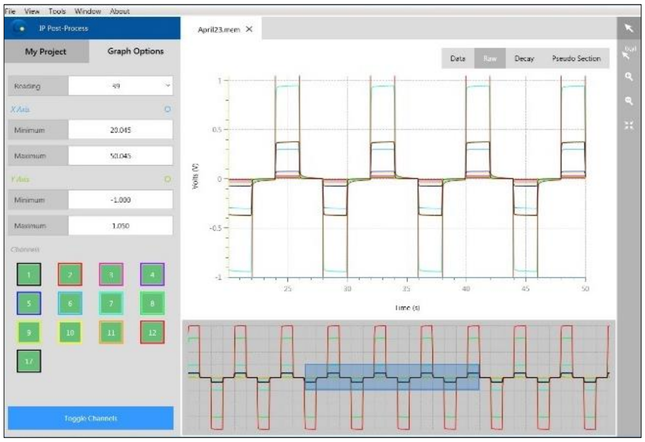

Figure 1: Example of full wave data from a Pole-Dipole survey (a=10m, n=1-16).

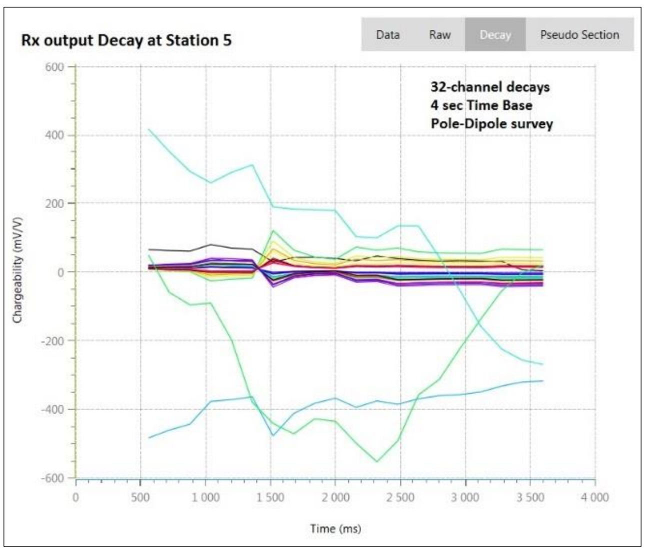

Figure 2: Original decays (reading 5) heavily affected by noise.

The following examples reflect very common situations for which the availability of full wave data and access to post-processing capabilities makes the difference between re-surveying, with all the costly consequences, or fixing/enhancing the IP dataset in *post-priori*.

EXAMPLE 1: RANDOM NOISE SPIKES

In 2016, Southern Geoscience Consultants, a geophysical consultancy, was supervising an IP survey in Europe on behalf of a mining corporation using GDD equipment for copper-gold exploration. The consultant contacted GDD as the data from the offset Pole-Dipole survey (a=50m, n=1-32, time base of 4 sec) being acquired by the field crew was of poor quality and they were not sure if it was due to an equipment issue, or an external source. The receiver seemed to detect a randomly changing Vp through the ground even when the transmitter was OFF. As far as they could tell, there was no easily identified source of the noise (powerlines or near-by geophysical surveys). Figure 2 presents the chargeability decays (M) of a given survey station resulting from the original dataset.

After a few days surveying and testing, the full wave data was provided to GDD's technical team for advice. The time series were analysed using GDD's new IP Post-Processing software and allowed determination of the following: the half-cycles showed a good amplitude and were symmetrical, electrode contacts seemed acceptable as good quality half-cycles were observed from the beginning to the end of the stacking period and synchronization between the transmitter and the receiver signal was accurate. However, strong sporadic noise affecting every dipole was visible in the full wave data (Figure 3).

These observations suggested that the problem did not come from the transmitter or receiver themselves, but from the environment. After investigation of the local and regional area, no definite source could be identified. However, there is an airfield located around 15 kilometres from the survey area, and there is speculation that signals of some type broadcast from there could be strong enough to interfere with the sensitive IP receiver.

The next step was to recover the data collected since the start of the survey and adjust the survey parameters to minimise the external noise moving forward. The latter involved monitoring the signal and its level of symmetry during acquisition, collecting as many stacks as possible (within a reasonable daily productivity limit), and as usual, ensuring good electrode contacts and wire connections. Figure 4 presents a specific reading for which noisy half-cycles were discarded, greatly improving the overall chargeability decay quality.

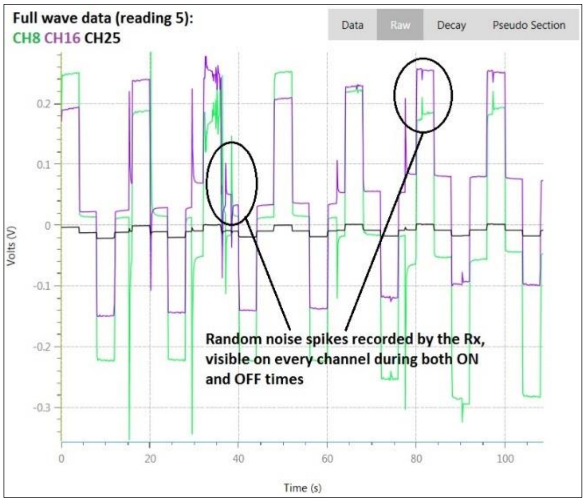

Figure 3: Full wave data (reading 5, channels 8, 16 and 25) from a survey reading heavily affected by noise.

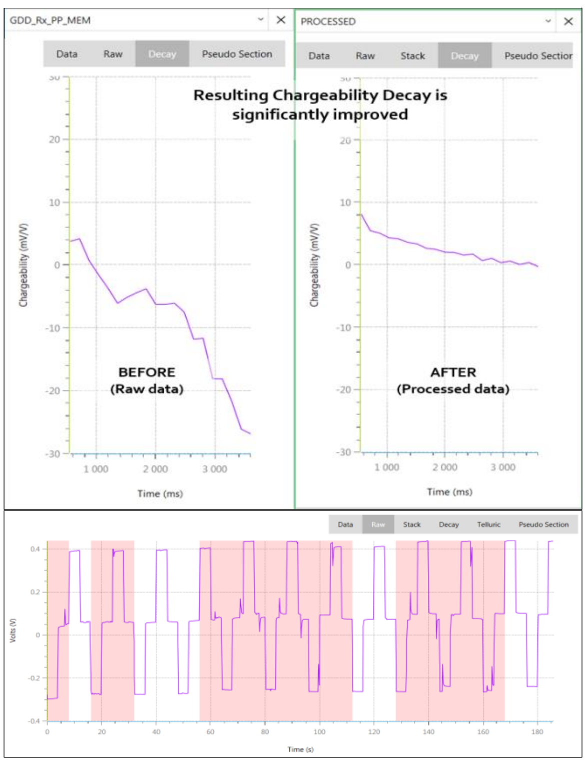

Figure 4: (Top) Discarded noisy half-cycles of reading 2, in red. (Bottom) Original noisy decay (left) vs post- processed decay (right).

This example showed a case for which the full wave allowed evaluating and determining the nature of the noise affecting the data, in which case was most-likely not related to the instruments. On the other hand, it is just as useful to be able to detect an equipment problem, especially at the beginning of a survey, and time series visualization is definitely valuable. Once the full wave time series are accessible, and of reasonable quality, QA/QC and processing options become possible.

EXAMPLE 2: SYNCHRONIZATION / TIMING

In June 2016, an IP survey was carried out by a contractor in Northern Québec, Canada. The aim of this work was to detect resistive and chargeable anomalies associated to narrow gold bearing quartz veins.

The survey consisted in a Dipole-Dipole configuration (a=25m, n=1 – 8, time base of 2 sec) using GDD IP transmitter, IP receiver and EM-IP Tx Controller to achieve GPS synchronization. The crew was unfamiliar with the instrument and began the acquisition without being properly synchronized with the satellite signal. The first five stations were consequently showing abnormally high chargeability. After a moment, the operator took a look at the decay shape and realised there was something wrong (Figure 5, top). The crew ensured that GPS synchronization was achieve and called GDD to ask whether or not they should re-do those survey station. They were relieved to learn that they could move forward and fix everything later in post-processing.

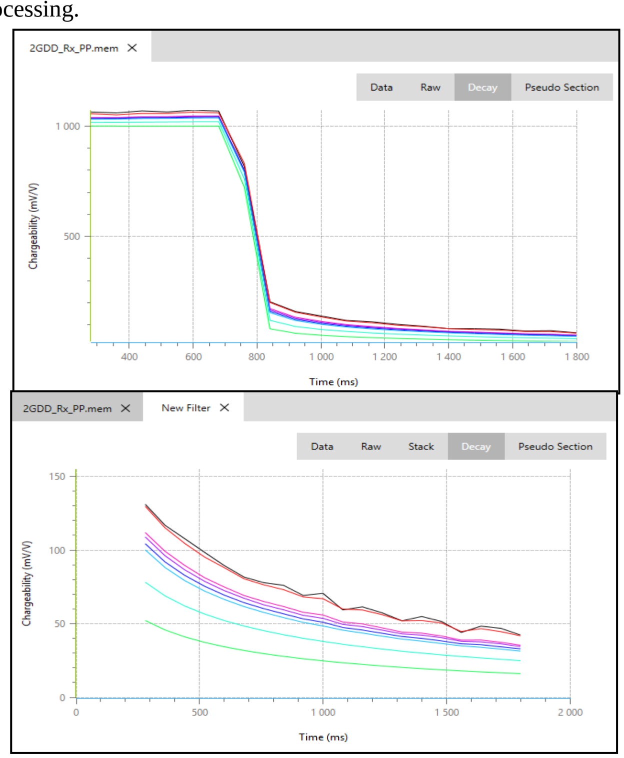

Figure 5: (Top) Original decay with timing error resulting in an over-estimated chargeability value of 400 mV/V, (Bottom) Resulting decay from fixed timing between Tx and Rx with chargeability value of 65 mV/V.

Using the IP post-processing software, the synchronization was delayed by 720 ms and the decay was recovered saving the crew precious production time (Figure 5).

EXAMPLE 3: WINDOWS SCHEME

As a more generic example, one may want to re-window the secondary voltage of a given IP survey to compare the resulting chargeability (M) with historical IP datasets. From the full wave data, it is possible to define basically any initial delay and windows' length to re-compute M out of the Vs.

For example, a Newmont standard chargeability can be recalculated from an arithmetic dataset by integrating time windows from 450ms to 1,100ms. Figure 6 presents the original chargeability pseudosection with the arithmetic window scheme for 2-second time base survey against the re-processed pseudosection using the Newmont scheme.

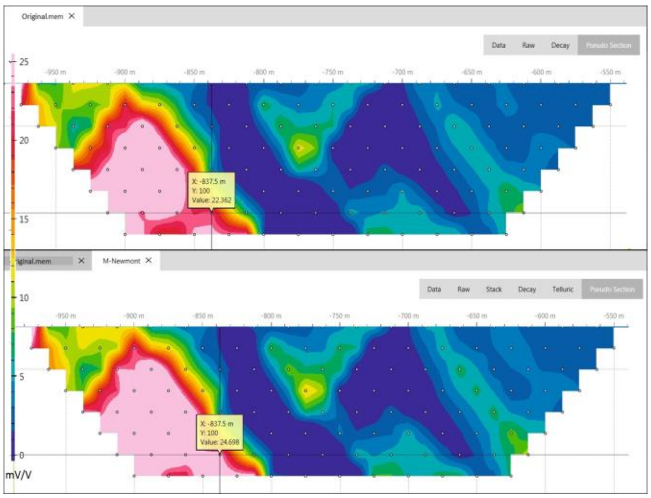

Figure 6: (Top) Original chargeability pseudosection using the arithmetic windows scheme, (Bottom) Processed chargeability pseudosection using the Newmont scheme.

CONCLUSION

In the last decade, geophysical manufacturers have adapted their instruments to offer access to full wave data and to a post-processing software. On top of the applications presented above, other post-processing possibilities include enhancing the apparent resistivity calculation using real-time current measurements at the transmitter site, subtracting external noise, such as telluric events, from an IP survey using the signal of a remote station and dipole summing to extract additional information out of a single-pass survey.

Achieving good quality IP surveys requires significant effort on the field. Having access to full wave data and a post-processing platform may not be necessary every time, but will definitely make the difference that day when everything goes wrong, or a few months later when merging two datasets from a large-scale 3D inversion.

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