David Goldak w/ Acquistion Control and Data Storage

Analog Signal Conditioning

GRG-3 Induction Coil Magnetometer

DAVID GOLDAK, M.Sc., P.Eng.
President

PO Box 968
Dalmeny SK Canada S0K1E0
(306) 254 4844
info@empulse.ca
www.empulse.ca

a sparrowhaus design ©2005
www.sparrowhaus.com

EMPULSE GEOPHYSICS

We specialize in the application of natural source electromagnetics for earth resource exploration. We have thus far conducted surveys for uranium, diamond, massive sulphide and groundwater exploration.

www.empulse.ca
info@empulse.ca
(306) 254 4844

WHAT IS TRANSIENT AMT ?

AUDIO FREQUENCY MAGNETOTELLURICS, or AMT, is a method by which earth resistivity can be measured from depths as great as several kilometres to as shallow as a few tens of metres. The method relies on the principle of induction: a changing magnetic field induces an electric field, the size of which is determined by local earth resistivity.

Lightning discharges are the dominant source of naturally occurring electromagnetic (EM) energy for AMT. This energy essentially consists of two parts, a low level quasi-continuous component and a transient component. The much larger transient component is due to relatively nearby, and/or, very large *individual* lightning discharges while the continuing component is due to the random sum of near global lightning activity.

TRANSIENT AMT refers to the recording of naturally occurring EM transients in a time localized fashion. This is contrasted with conventional AMT, where data is aquired continuously for some period of time under the assumption that there is a continuous inflow of energy.

While the continuing component is appreciable in certain frequency ranges, most notably below 100 Hz, the largest naturally occurring signals in the audio bandwidth are transients and are thus time localized phenomena.

An example is shown in Figure 1. Even though the SNR is quite high around the location of the transient, the SNR of the entire window as a whole is much lower due to the long periods of relative inactivity which occupy most of the window.

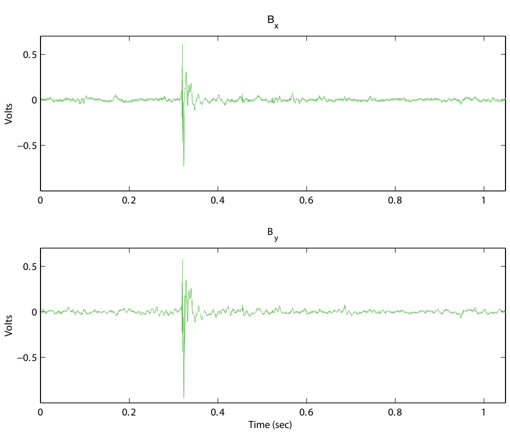

Figure 1: Transient and Continuing components, 10 Hz - 10 kHz

Therefore, by triggering on individual transient events, and recording narrow time windows around each, we obtain the best possible SNR.

However, each transient is strongly linearly polarized. This simply means that a plot of B_y vs. B_x forms a straight line. If we examine the polarization properties of a group of recorded transients, we typically see something similar to Figure 2.

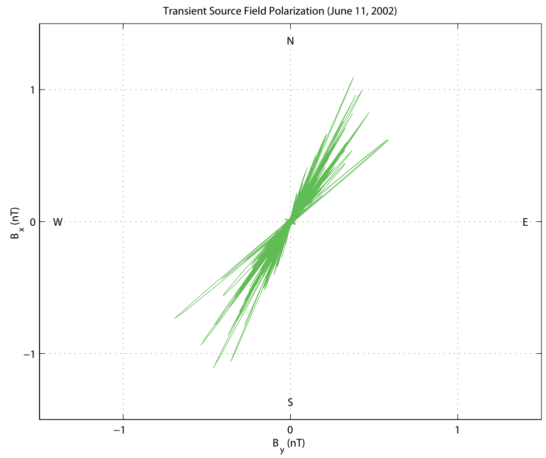

Figure 2: Scatter Plot of *B* for a group of transients

The polarization diversity of the recorded data is very important as it strongly affects the stability with which earth response curves can be estimated. A confined distribution of bearings leads to an unstable system; conversely, as the distribution widens, stability increases.

This was the motivation behind the development of our Adaptive Polarization Stacking (APS) algorithm. We desired an algorithm that produces essentially unbiased parameter and error estimates, but also properly senses the polarization diversity of the data, the SNR and the sample size.

This represents an enhancement over conventional Remote-Reference (RR) analysis which assumes the perfect case of a circularly polarized source field with infinite sample size. In practice, RR estimates are indeed biased to some extent with sometimes quite poorly estimated error bars.

Conversely, our APS algorithm is properly linked to the polarization properties of the source field, the SNR of the data and the sample size to obtain solid parameter and error estimates.

SFERIC TRANSIENT AMT SYSTEM

SFERIC is designed to record naturally occurring transient electromagnetic energy for estimation of the impedance tensor and/or magnetic field tipper over the bandwidth 5 Hz to 32 kHz. Large transient amplitude coupled with time localized recording ensures the highest possible SNR. Essentially unbiased estimation of earth response curves is obtained with our proprietary Adaptive Polarization Stacking (APS) algorithm, designed to work specifically with linearly polarized transient data.

Technical

Channel Count: 8
A/D Resolution: 16 bit
Sample Rate: 125 kHz
Instrument Bandwidth: 5 Hz - 32 kHz
Acquisition Control: Ruggedized Laptop
Power Consumption: 25 W
Power Supply: Ni-Mh Battery Packs
Weight: 40 kg
Case: High Impact ABS

Analog Signal Flow

- Switch selectable high input impedance buffer
- AC coupled differential amplifier with shelf response, 3 levels, 6 dB steps
- Active Twin-T notch filters, 1, 3, 5, 7 and 9th harmonic of 50/60 Hz
- Signal Mixer, three bands, 21 settings, 6 dB steps
- 30 kHz anti-alias filter, Butterworth type
- Differential output

Innovations

- Active electric field cables to minimize capacitive distortion of the high frequency electric field
- Low noise, field feedback induction coil magnetometers
- Time localized capture of transient energy ensures the highest possible SNR
- APS algorithm properly accounts for source field polarization, resulting in well estimated parameters and errors