Glossary of Terms

Atomic Dielectric Resonance (ADR) Statistical Log Measures

Adrok has developed the following statistical signal processing techniques to assist information extraction of the resonant signal returns obtained from their ADR sensors following transmission through soil, sediment and rock layers and reception by a matched bistatic ADR receiver.

The resulting processed data suite is a specific set of logs which display signal frequency returns and a specific set of logs which display signal energy returns. To evaluate mathematically and statistically the exact nature of the signal oscillations through time and space (distance), Adrok has developed a series of precise “measures” which examine:

(1) The degree of REFLECTIFITY of the signal
(2) The degree of RESONANCE of the signal
(3) The AVERAGE or MEAN oscillations of the signal
(4) The STANDARD DEVIATION of the signal oscillations about the MEAN

Each Statistical Log parameter has a given name or abbreviation which is defined and described as follows:

E-ADR: is the basic measure of Energy Resonance of the signal returns through each stratigraphic layer. Mathematically it is described as follows:

E-ADR = (Emean / Esd)

This means that the RESONANCE of the signal energy through each layer is calculated from the ratio of the energy mean divided by the energy standard deviation. The ground layers are usually quantised (in equal steps) in 1m layers or 0.5m layers. In imperial units current quantisation of signal returns is done every 3ft or every 2ft for greater precision, depending on what the client wants. For deep returns going down 10,000ft, for example, the returns may be quantised every 10ft or every 5ft, depending on the client requirements.

E-GAMMA: is the basic measure of Energy Reflectivity. Mathematically it is described as follows:

E-GAMMA = ((Emax –Emin)/ (Emax+Emin))

This means that the REFLECTIVITY of the signal energy is simply the ratio of the maximum signal difference parameters (Maximum Energy (%) minus Minimum Energy (%)) divided by the sum of the maximum signal energy (%) plus the minimum signal energy (%). The analogy is the E-Gamma, also called “modulation” in the literature, of a photographic film in terms of grey level returns.

E-Log (Energy Log): During a stationary scan (“Stare” scan) the ADR transmitter and receiver antennas are positioned at known grid co-ordinates and aimed downward. The energy log (“E-log”) indicator is produced by dividing the Stare scan image data in time windows. Windowing is carried out in equal time intervals or the time axis is migrated to depth after our WARR tracking of dielectric and windowing is performed equal spatial intervals. The data windows are subsequently analyzed and/or enhanced utilizing a suite of signal and image processing techniques such as Fourier analysis, wavelet decomposition, and image enhancement algorithms using RADAMATIC, Adrok’s proprietary data analysis software. Amongst other indicators, this analysis produces the E-Logs which represent estimated energy values as a function of depth and were found to be excellent indicators. They are usually plotted on a logarithmic scale.

E-Mean: is the average measure of the signal energy returns over each quantised ground layer selected and is an essential ingredient in the E-ADR estimation of Energy RESONANCE. In mathematical terms the mean is simply written as: Em = $(\sum_1^n E)\ /n$ where Em is the mean value of the energy for each quantised ground layer.

E-SD: is the standard deviation of the signal returns over each quantised ground layer. The SD is the soundest indication of scatter in mathematical terms and is an essential ingredient in the E-ADR estimation of signal energy RESONANCE about the mean.

In mathematical terms: if E is a typical signal energy return per layer and Em is the mean energy return of that layer then the Mean deviation =$\sum|E - Em|/n$ and the standard deviation or SD (σ) = $\sqrt{\sum(E - Em)^2/n}$

F-ADR: is the basic measure of Frequency Resonance of the signal returns through each stratigraphic layer. Mathematically it is described as follows:

F-ADR = (Fmean / Fsd)

This means that the RESONANCE of the signal frequency through each layer is calculated from the ratio of the frequency mean divided by the frequency standard deviation. The ground layers are usually quantised (in equal steps) in 1m layers or 0.5m layers. In imperial units current quantisation of signal returns is done every 3ft or every 2ft for greater precision, depending on what the client wants. For deep returns going down 10,000ft, for example, the returns may be quantised every 10ft or every 5ft, depending on the client requirements.

F-GAMMA: is the basic measure of Frequency Reflectivity. Mathematically it is described as follows:

F-GAMMA = ((Fmax –Fmin)/ (Fmax+Fmin))

This means that the REFLECTIVITY of the signal frequency is simply the ratio of the maximum signal difference parameters (Maximum Frequency minus Minimum Frequency) divided by the sum of the maximum signal frequency plus the minimum signal frequency. The analogy is the F-Gamma of a photographic film in terms of grey level returns.

F-Mean: is the average measure of the signal frequency returns over each quantised ground layer selected and is an essential ingredient in the F-ADR estimation of signal RESONANCE. In mathematical terms the mean is simply written as: Fm = $(\sum_1^n f) /n$ where Fm is the mean value of the frequency for each quantised ground layer.

F-SD: is the standard deviation of the signal returns over each quantised ground layer. The SD is the soundest indication of scatter in mathematical terms and is an essential ingredient in the F-ADR estimation of signal frequency RESONANCE about the mean.

In mathematical terms: if f is a typical signal frequency return per layer and fm is the mean frequency return of that layer then the Mean deviation $=\sum|f - fm|/n$ and the standard deviation or SD (σ) = $\sqrt{\sum(f - fm)^2/n}$

Log Type	Adrok Glossary of ADR Logs: Description
E-ADR	Energy-ADR is the resonant energy measurement of a subsurface layer of measured thickness.
E-Gamma	Energy reflectivity measurement of a subsurface layer of measured thickness.
E-Log	Energy response measurement
E-Mean	Energy-Mean
E-SD	Energy-Standard Deviation
F-ADR	Frequency-ADR is the resonant frequency measurement of a subsurface layer of measured thickness.
F-Gamma	Frequency reflectivity measurement of a subsurface layer of measured thickness.
F-Mean	Frequency-Mean
F-SD	Frequency-Standard Deviation

Table 1a: Glossary of Logs

ssGlossary of key terms used in Adrok's Survey Reports to Clients

Term	Description
Dielectric constant (ϵr) or DC	The index of the rate of transmission of our ADR wave packet through a medium relative to the transmission rate of the beam through vacuum. This is also sometimes called the transmissivity index, or relative permittivity. The vacuum has a dielectric constant of 1. For a medium such as limestone the dielectric constant (ϵr) is typically 9.
FFT Analysis	"Fast Fourier Transform Analysis" is a technique for spectral analysis of signals.
Harmonic Analysis	"Harmonic Analysis" is a widely accepted mathematical method that studies the functions of signals as the superposition of waves. Using Fourier transforms to analyse the "harmonics" the technique is often used for assessing materials in a laboratory setting in the chemical industry. Unique harmonic energy frequency and phase peaks are produced and can be analysed in a number of ways producing a range of parametric statistical tests. Different rock types with different mineral assemblages will exhibit different spectral harmonic relationships over these levels.
Harmonic Phase	The phase information is stored such that a pixel with a phase angle of zero will have an intensity of zero. The intensity increases linearly with phase angle, until almost 360 degrees.
RADAMATIC	Adrok's proprietary suite of processing software.
Spectral Analysis	Comparing specific frequencies of both emission and absorption observed in training and blind layers with measured frequencies from other databases
Sub-Images	2-dimensional cross-sectional images of the subsurface are produced from the Stare scans. "Sub-images" are specific blocks of these images.
Survey Points	The ground location of the Adrok Virtual Borehole scan (akin to the collar position of a physically drilled borehole).
V-bore	Short for "Virtual Borehole" produced by the Adrok Scanner.
WARR	"Wide Angle Reflection and Refraction" scan to triangulate subsurface depths from the surface ground level. The transmitting antenna is moved at ground level along the scan line, away from the stationary receiving antenna which is positioned at the start of the scan line. Collected by ADR Scanner at ground level (produces depth calculations).
Weighted Mean Frequency (WMF)	The frequency and energy values are combined to produce a Weighted Mean Frequency for each measured depth interval. WMF is the energy weighted mean of the frequencies. Therefore, frequency values with a high weight contribute more to the WMF than frequency values with a low weight.

Table 1b: Glossary of terms