Novel New Method for the Acquisition of High Resolution Outcrop Gamma Ray Profiles That Replicate Well Logs and Allow for Seamless Integration of the Two.

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ABSTRACT

We present a new method for rapid and efficient acquisition of outcrop-based gamma ray profiles with the same resolution and statistical qualities as subsurface well logs. Gamma ray scintillometers in both hand-held units and sondes acquire gamma ray data in the time domain, using gamma ray counts from the isotopes of U, Th, K, per unit time to determine rock radioactivity. Each measurement is recorded in the instrument as counts/unit time. Gamma ray production is statistical, so acquisition times are varied in order to achieve meaningful counting statistics depending on rock radioactivity. Outcrop measurements are done at discrete depth intervals (e.g. 1 foot) on a measured section. This requires tedious measurement of each depth and starting and stopping the instrument at each location. Many users record the measurements by hand, further increasing the time for each measurement point. The resulting gamma ray profiles lack detail and are woefully under sampled relative to the variability in rock radioactivity and subsurface data sets, which are the linchpin of stratigraphic correlation and analysis in subsurface data sets. Subsurface gamma rays are acquired with essentially the same instruments that convert unit time to depth by using a sensor that measures the cable as it winds on the spool in the logging truck. Key components of the subsurface method are that the instrument records continuously at some short time step and that it travels at a constant rate from the bottom to the top of the well bore. Thus, subsurface datasets are characterized by small sampling intervals that are typically averaged to a larger interval for analysis and interpretation. Our method is based on the recognition that a measuring depth for subsurface acquisition is potentially superfluous because if the starting and ending depths and times are known and travel rate is constant , the depth of each measurement can be calculated. We use this principle to create outcrop datasets which closely replicate subsurface datasets (which is really the aim of surface datasets). In our approach, the measured section is divided into 1.5 meter intervals and/or between important lithologic contacts. The instrument is set on a short acquisition window (1 second) and data recorded continuously across each interval at a spacing of 3” (10cm), pausing at each point for 4 seconds. The data are stored in the memory of the instrument which records the starting and ending times of each interval’s acquisition. The instrument MUST move at the same rate throughout the entire measurement interval in order to determine the correct depth for each measurement. To post-process the data we simply convert instrument-time to distance along the stratigraphic section. Because intervals might be measured at different rates, we then use cubic spline interpolation to present all section with a uniform sampling interval, usually about 0.25 feet. This resultant series can be resampled at any desired interval and subsequently converted to API units. Using this method, outcrop gamma ray profiles capture all of the detail seen in well logs and have very similar statistical properties. Detailed bed-by-bed correlations between surface and subsurface datasets are possible and the link between the two datasets is seamless. A method for the acquisition of spectral data is currently under development.