Generating Multi-Scale Geological Logs from Drill Hole Data

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Data can be collected from drill holes either by analysing consecutive samples down the hole (e.g., geochemical assays) or by passing a sensor down the hole during or after drilling (e.g. gamma logs). The result is spatially located information that can be used to interpret the subsurface geology. In the mineral exploration industry this information is typically manually interpreted, a process which is time-consuming and subject to human bias. In order to overcome these problems we are developing techniques to partially automate the interpretation of drill hole data. We have applied the method to drill hole data collected as part of the Deep Exploration Technologies Co-operative Research Centre (DET CRC) drilling project.

Previously the scale-space plot of a wavelet transform of the data has been used to detect geological boundaries in drill hole data, a common practice in interpretation of geophysical data from borehole logging. The wavelet transform is a useful boundary detection method as it can detect boundaries at a range of scales simultaneously. However, the resulting scale-space plot contains a lot of information and is difficult for the non-expert to interpret. In order to simplify the interpretation of the scale-space plot it is typically reduced to a single line by removing small scale variations in the data, a process called blocking or zoning. However, this reduction process results in the loss of hierarchical and scale information.

We present an alternative representation of the scale-space plot in the form of a rectangular tessellation, which greatly reduces the amount of information presented in the plot. The tessellation is simple to interpret and, unlike the blocking method, retains the scale and hierarchical information provided by the scale-space plot. In the tessellated wavelet transform, each rectangle represents a geologically distinct domain, which is defined both spatially and over a particular scale range. The tessellation can be filtered to remove noise and other undesirable weak boundaries from the geological log. This is achieved by removing domains that represent weak features; i.e., domains with small wavelet coefficients.

We also show how the wavelet transform can be used to distinguish between sharp boundaries (e.g. primary lithological boundaries) and gradational boundaries (e.g. alteration fronts). The ability to distinguish gradational boundaries is important when determining the edges of geological domains for lithological classification purposes.