Information theory and hydrothermal processes

F.J.A. van Ruitenbeek[a], J. Goseling[a], W.H. Bakker[a], K.A.A. Hein[b]

[a] University of Twente, the Netherlands
[b] University of the Witwatersrand, Johannesburg, South Africa

Hydrothermal processes modify the chemical and mineralogical composition of a rock. These modifications can be regarded as a form of information imposed on the rock by hydrothermal processes and may potentially be quantifiable. However, there are no existing single measures to quantify these effects, nor do we have a good notion of what such a parameter should measure precisely. In this presentation, concepts from information theory are used to provide new insights into the effect of hydrothermal processes on rock and they enable the measurement and quantification of it. The Shannon entropy was used to quantify the differences in chemical compositions and shortwave infrared spectral response between altered and unaltered rocks. The results showed that the Shannon entropy can capture these differences in compositions, where hydrothermally altered rocks have lower entropies compared to their precursors. A relationship was found between heat of a magma source and Shannon entropy, where the heat of a cooling sub volcanic intrusion drove fluid circulation in the hydrothermal system causing intense alteration of rock and a decrease in Shannon entropy. We show that the Shannon entropy has potential to be used as a proxy for parts of the thermodynamic entropy of hydrothermally altered environments. The insights from this study enable new directions of research on the relationships between hydrothermal processes, entropies, information and the effects on mineralized and early life environments.