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Abstract

Shannon Entropy and Hydrothermal Processes †

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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 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 parameters should be measured. In this presentation, concepts from information theory are used to provide new insights into the effect of hydrothermal processes on rock, which enable measurement and quantification.

We used the Shannon entropy to quantify the differences in chemical compositions, and the 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 the 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 the 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.