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Correlation between zooclast reflectance and Rock-Eval T_{max} in the Upper Ordovician Cape Phillips Formation, Nunavut, Canada

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Abstract

This study examines the reflectance of two common zooclasts (graptolites, chitinozoans) and the Tmax parameter obtained from Rock-Eval Pyrolysis in order to evaluate and quantify the correlations between these parameters as thermal maturity indicators. Forty-nine samples from organic- and carbonate-rich shale of the Upper Ordovician Cape Phillips Formation of Nunavut, Canada were powdered for Rock-Eval testing, and prepared into slides for measurement of reflectance. Reflectance was measured approximately 100 times per sample across as many individual zooclasts as possible. Following the protocols of Peters (1986) samples with S_2<0.2 mgHC/g or TOC<0.5 wt% were removed from the statistical analysis because of unreliable T_{max} in samples with low organic content. Eighteen samples were eliminated due to unreliable results caused by low total organic carbon (TOC) or lack of zooclasts.

Rock-Eval is an established, reliable method of obtaining thermal maturity data (converted to VR_{eqv} using VR_{eqv}=0.018*T_{max}-7.16) and is used as a baseline to examine the suitability of zooclast reflectance. Statistical evaluation shows a reasonable correlation within a prediction interval and an R^2 value of 0.47 for Chitinozoans and R^2=0.55 for Graptolites compared to Tmax values. The following formulas were determined for the conversion of Chitinozoan and Graptolite reflectance to VR_{eqv}:

$$T_{\max}(\%Rovit) = 0.23226 + 0.49918 * (Graptolite\ Reflectance\ (\%Ro))$$
$$T_{\max}(\%Rovit) = 0.23145 + 0.48150 * (Chitinozoan\ Reflectance\ (\%Ro))$$

Results suggest that zooclast reflectance can be reliably used as a tool in thermal maturity studies and allow the relationship to be better quantified. These findings confirm the conclusions of Bertrand and Heroux (1987), Goodarzi and Norford (1989), Link et al. (1990), and Cole (1994) for Graptolites, and Tricker et al. (1992), Cole (1994), and Obermajer et al. (1996) for Chitinozoan measurements.

Rock-Eval pyrograms show that the response does not return to baseline between the S_1 and S_2 peaks, indicating a possible interference between the S_1 and S_2 peaks. Four samples were solvent extracted and re-run for Rock-Eval. The S_2 peak declined by pp to one-third compared to the non-extracted sample. The extracted material is dominated by heavy hydrocarbons. T_{max} of extracted samples was much closer to the line of regression, indicating that extractable, fluid-like hydrocarbon residue can increase or decrease T_{max}.