Reconstructing the middle Devonian Paleoclimate using black shale geochemistry

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Geochemical signatures preserved in the Union Springs member of the Marcellus shale can be utilized to reconstruct the paleoclimate during the middle Devonian (416-359.2ma). Recent reconstructions place the Appalachian basin in the southern tropics between (15-30°S) where the Acadian Orogen likely formed a major rainshadow resulting in a seasonally variable semi-arid climate subject to intense storms. By utilizing major element abundances obtained via XRF analysis, provenance as well as weathering trends within the stratigraphic profile can be determined. Here, I plan to utilize the Chemical Index of Alteration (CIA) to infer chemical weathering rates of the source rocks throughout the depositional period. In addition, potassium/ aluminium ratios will be utilized to further infer continental weathering rates associated with the Union Springs member. A ratio between the clay minerals of illite and kaolinite obtained via XRD analysis can also be incorporated to provide further insight towards variations in the climate, effectively aiding in creating a continental weathering profile.

While major element abundances can be used to infer continental precipitation and weathering trends, minor and trace elements can potentially be utilized to infer redox conditions present in the depositional basin throughout the period of deposition. The presence of the elements uranium and vanadium are interpreted to be associated with iron sulfides or catalyzed by interactions with hydrogen sulfide. Whereas the concentrations of elements such as nickle and chromium are reflective of organic carbon concentrations in sediments. Therefore, creating ratios between elements associated with hydrogen sulfide and elements associated with organic matter with the redox sensitive proxies of V/(V+Ni), V/Cr, and U/Th we can infer redox conditions throughout the stratigraphic record. Moreover, organic carbon content can be compared to the aforementioned trace element proxies in order to further validate the reliability of the ratios used to determine redox conditions. Here we should see a positive relationship between organic carbon content and the associated trace elements of Cu, Ni, Co, and Cr. Thereby creating a better understanding of conditions favorable for black shale deposition during the middle Devonian.