Identification of paleoredox thresholds based on differential responses of elemental proxies

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Elemental proxies such as Mo can provide approximate paleoredox information based on their raw or normalized concentrations, but the thresholds between different redox states (i.e., oxic, suboxic, euxinic) are not precisely defined and can be variable for different marine units. An approach permitting more precise quantification of key redox thresholds may be possible based on the differential response of two or more elemental proxies to specific redox states. This approach can be shown to yield accurate assessments of ambient redox conditions in the modern Black Sea and Saanich Inlet. Similar patterns of elemental covariation can be observed in many paleomarine formations, including Middle Ordovician Welsh shales, Upper Pennsylvanian North American Midcontinent shales, and Lower Jurassic English shales. One important finding is that the proxy values associated with specific redox thresholds vary considerably between marine units, and, for this reason, proxy thresholds must be 'tuned' for each paleomarine unit individually. For example, the suboxic/euxinic threshold associated with the Fepy/FeHR (or DOP) proxy ranges from a low of 0.42 for some Upper Pennsylvanian shales to a high of 0.75 for modern Black Sea sediments. The same threshold for authigenic Mo concentrations ranges from 5 to 20 ppm for various modern and paleomarine units. Also significant is that our approach reveals a strong relationship between total organic carbon (TOC) and redox conditions in almost all marine units, indicating that TOC is a useful paleoredox proxy, and that redox conditions are generally a dominant control on organic matter accumulation in marine systems.