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Pyrite trace element chemistry of the Velkerri Formation, Roper Group, McArthur Basin: Evidence for atmospheric oxygenation during the Boring Billion

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Abstract: The trace element content of sedimentary pyrite in black shales of varying ages has recently been used to construct secular trends of trace element variation in the ocean. The approach also has potential to be used as a proxy for estimating evolution of the redox state of the ocean/atmosphere system through time. Here, we apply a combination of whole-rock chemostratigraphy and laser ablation-inductively coupled plasma-mass spectrometer (LA-ICP-MS) analyses of marine pyrite to the carbonaceous mudstones of the Mesoproterozoic (~1400 Ma) Velkerri Formation, and underlying Corcoran Formation, Roper Group, McArthur Basin to interpret and compare basin water conditions and basinal trace element chemistry at the time of sedimentation.

Our results suggest that the black shales of the Velkerri Formation deposited under different geochemical conditions in comparison to the underlying Corcoran Formation. This proportionate difference is manifested in the form of high total organic carbon (TOC) contents coupled with an increase of trace elements such as P, Mo, Cd, Se, Ni, Se/Co, Ni/Co in the mudstones of Upper Velkerri Formation in comparison to Lower Velkerri and underlying Corcoran Formation. Cobalt on the other hand, exhibits an opposite trend compared to other redox sensitive trace elements (Mo, Se) due to its unique redox chemistry, particularly the cationic nature of its soluble species making Se/Co a useful proxy for redox conditions of the atmosphere. This progressive increment in trace elements (P, Mo, Cd, Se, Ni, Se/Co, Ni/Co) up stratigraphy from Corcoran Formation to Lower Velkerri Formation to Upper Velkerri is herein attributed to an increase in nutrient trace element supply into the marine reservoir, possibly in response to tectonic activity and an increase in