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# Seawater contribution to the early Cambrian (ca. 521 Ma) polymetallic Mo-V mineralization in the Yangtze Block and widespread oceanic oxygenation: Clues from V isotopes

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The early Cambrian black shales in Yangtze Block (South China), host characteristic polymetallic Mo-V mineralization layers. Several hypotheses have been proposed for their metallogenic mechanism, including hydrothermal venting, seawater, and combined origins, but no consensus exists. In this study, we present authigenic V isotope compositions ($\delta^{51}V_{auth}$) of the Ni-Mo sulfide ores, V ores, and host black shales from the lower Cambrian Niutitang Formation deposited in the protected basin of the Yangtze Block, to constrain their elemental origin and metallogenic mechanism.

The $\delta^{51}V_{auth}$ of the Ni-Mo sulfide ores are extremely low from –1.33‰ to –0.77‰, close to those of the modern Fe-Mn crusts/nodules and pelagic sediments, which likely resulted from the operation of 'particulate Fe-Mn shuttle' near the chemocline in the euxinic environment. In contrast, the host shales of the Ni-Mo sulfide ores, V ores, and host shales of the V ores record higher $\delta^{51}V_{auth}$ from –0.62‰ to +0.08‰, close to those of the modern anoxic and euxinic sediments, possibly reflecting the reductive scavenging of oceanic V in anoxic to euxinic environments. Sensitivity analyses demonstrate that the open ocean at ca. 521 Ma was widespread oxygenated possibly reaching the modern level. In this scenario, upwelling of the oxic pelagic seawater could supply abundant ore-forming elements (including dissolved Mo and V) into the protected basin of the Yangtze Block, and ultimately lead to the formations of V ores in the deeper part and Ni-Mo sulfide ores in the shallower part.