What Lies Beneath? Sub-Seafloor Drilling of the Inactive Ultramafic-Hosted Semenov-1 Seafloor Massive Sulfide Deposit, 13°30’N on the Mid-Atlantic Ridge

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Our understanding of seafloor massive sulfide (SMS) deposit formation is largely based on the study of ancient on-land volcanogenic massive sulfide (VMS) deposits and observations made at the seafloor, and these observations are heavily biased toward the sampling of active “black smoker” chimneys. Uncertainty remains when using seafloor observations to evaluate sub-seafloor characteristics of SMS deposits, such as deposit tonnage, how the composition of collected seafloor samples compares to sub-seafloor composition, and how metal enrichment processes vary between these two environments. However, internal core samples from seafloor drilling have only been recovered from a few SMS deposits, largely due to the expense and technical challenges associated with deep-sea drilling. Here we present data from the inactive Semenov-1 hydrothermal field located on the 13°30’N oceanic core complex on the Mid-Atlantic Ridge. In 2022 aboard the RRS *James Cook*, project ULTRA recovered cores to a depth of ~20 meters below the seafloor using the British Geological Survey’s Rock Drill II. The aim of the project was to assess the resource potential of an ultramafic-hosted SMS deposit that has previously been reported to contain elevated Ni, Co, Au, and Te contents. Near the surface, below a layer of sediment, recovered core contains poorly cemented sulfide gravel and sand, with abundant chalcopyrite, pyrrhotite, and pyrite with native Au. Deeper in the section, the dominant sulfide mineral assemblage alternates between marcasite and pyrite-rich with elevated Ni and Zn, respectively, occurring as disseminations in clay-rich material that often exhibits sub-horizontal deformation fabrics. Our preliminary geochemical analyses indicate systematic trends in bulk chemistry, trace metal sulfide chemistry, and sulfur isotope composition of sulfide minerals with depth below the seafloor. These data provide a new perspective to understand the formation of ultramafic-hosted SMS deposits and to investigate metal enrichment processes below the seafloor in SMS deposits more widely.