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Geochemical and isotopic fingerprints of subglacial meltwater plume deposits and ice-rafted debris in the Southern Ocean

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Terrigenous input to the ocean surrounding Antarctica is largely controlled by glacial processes that produce and transport sediment. We use marine sediment records from the continental shelf and slope to track spatiotemporal changes in subglacial meltwater drainage since the Last Glacial Maximum, focusing on sedimentologically and geochemically distinctive silt layers within glacial-marine and marine facies. Interspersed ice-rafted debris (IRD) layers record sediment delivery from freely floating icebergs. We distinguish these two key sediment sources from various regions offshore of Antarctica with a multi-proxy approach combining quantitative measurements of physical properties and micromorphology, trace element concentrations, and magnetic susceptibility, together with core descriptions, imagery, and Computed Tomography scans to resolve stratigraphic relationships. To identify paleo–meltwater plumes in the Amundsen Sea, we integrate stable isotopes of sediment pore water with beryllium isotopes in bulk sediments, with elevated $^{10}Be/^{9}Be$ ratios indicating subglacial meteoric beryllium inputs. We further develop a semi-quantitative index for fine IRD (<2 mm) and show that magnetic susceptibility and Fe and Ti concentrations are the most robust and consistent indicators of IRD. This improved characterization of meltwater plume deposits and IRD enhances the use of Antarctic marine sediments to reconstruct past and modern glacial processes and their variability.