Magnetic susceptibility variations in southern Ocean sediments induced by iron fertilization

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In the Southern Ocean, magnetic mineral concentration increases in glacial periods. The variation pattern closely resembles eolian dust flux records from Antarctic ice cores, but the cause of the linkage remains unclear, as the dust flux is too small for the source of terrigenous materials in the Southern Ocean. We have conducted an environmental magnetic study of late Pleistocene sediments from the south Indian Ocean to investigate the origin of the magnetic concentration changes. Biogenic magnetites can be detected using the characteristics of almost no magnetostatic interactions and narrow coercivity distribution, reflecting occurrence of single-domain magnetites in a chain. We interpret that a non-interacting component on first-order reversal curve diagrams and low-coercivity components with small dispersion from isothermal remanent magnetization (IRM) component analyses represent biogenic magnetites, and that the interacting and middle-coercivity components represent terrigenous maghemites. The ratio of anhysteretic remanent magnetization susceptibility to saturation IRM reflects relative abundance of the biogenic and terrigenous components. It was revealed that biogenic magnetites are a dominant constituent of the magnetic minerals. In glacials, the abundance of both biogenic and terrigenous components increased with increased proportions of the latter. Increased ocean productivity in glacials is suggested from increased proportions of biogenic magnetites with elongated morphologies, indicative of less-oxic conditions, and increased sedimentation rates. These observations suggest that the increased magnetic concentration in glacials in the Southern Ocean may be explained by iron fertilization; the production of biogenic magnetites was enhanced associated with increased ocean productivity, which was fueled by increased eolian dust flux.