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The unstable geomagnetic field during the last glacial

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Detailed stratigraphic analyses of a sediment composite record from three different sites in the southeastern Black Sea yielded a high-resolution, well-dated paleomagnetic record of the past 14 to 68 ka. Age constraints are provided by 16 AMS ^{14}C ages, identification of the Campanian Ignimbrite tephra (39.28$\pm$0.11 ka), and by detailed tuning of sedimentologic parameters of the Black Sea sediments to the oxygen isotope record from the Greenland NGRIP ice core. Dansgaard-Oeschger events 3 through 18 are very well expressed in the Black Sea sedimentary records of Ca-content, oxygen isotopes as well as in records of ice-rafted detritus. Though hampered by some larger hiatusses at one site, and patchy contaminations by diagenetically formed greigite, the paleomagnetic composite record obtained from the preserved primary detrital magnetite phase reflects a highly dynamic geomagnetic field during the last glacial period. Relative variations of paleointensity inferred from the sediments' magnetisations were converted into a record of the virtual axial dipole moment (VADM). Thus, the Black Sea paleomagnetic record comprises evidence for the Norwegian-Greenland-Sea excursion at 64.5 ka (VADM = 1.5×10^{22} Am^2), a full reversal of the geomagnetic field during the Laschamp excursion at 41 ka and several subsequent excursions with low northern virtual geomagnetic pole (VGP) latitudes, including the Mono Lake excursion at 34.5 ka (VADM = 3.0×10^{22} Am^2). According to the derived age model, VGP positions during the Laschamp excursion persisted at high southern latitudes in Antarctica for an estimated 440 years, making the Laschamp excursion a short-lived event with fully reversed polarity directions. Recorded field reversals of the Laschamp excursion, lasting only an estimated $\sim$250 years, are characterized by very low paleointensities with VADMs as low as 0.50×10^{22} Am^2. The reversed phase of the Laschamp excursion is associated with a significant field recovery with a VADM of 2.0×10^{22} Am^2, which is about 25% of the present day field (2010 dipole moment = 7.745×10^{22} Am^2). The central, fully reversed phase of the Laschamp excursion is bracketed by VGP excursions to the Sargasso Sea ($\sim$41.9 ka) and to the Labrador Sea ($\sim$39.6 ka). Paleomagnetic results from the Black Sea are in excellent agreement with VGP data from the French type locality which facilitates the chronological ordering of the non-superposed lavas that crop out at Laschamp-Olby. Rates of change calculated from the Black Sea VADM record also give some information on how to assess the global decay of the present-day geomagnetic field, which is significantly enhanced in the area of the South Atlantic Anomaly.