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Lower mantle superplume growth excites geomagnetic reversals

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Seismic images of the lower mantle reveal two large-scale, low shear wave velocity provinces beneath Africa and the Pacific that are variously interpreted as superplumes, plume clusters or piles of dense mantle material associated with the D" layer. Here we show that time variations in the height of these structures produce variations in heat flux across the core-mantle boundary that can control the rate at which geomagnetic polarity reversals occur. Superplume growth increases the mean core-mantle boundary heat flux and its lateral heterogeneity, thereby stimulating polarity reversals, whereas piles collapse decreases the mean core-mantle boundary heat flux and its lateral heterogeneity, inhibiting polarity reversals. Our results suggest that the long, stable polarity geomagnetic superchrons such as occurred in the Cretaceous, Permian, and earlier in the geologic record were initiated and terminated by the collapse and growth of lower mantle superplumes, respectively.