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50 Years of Polarity Transition Records: Understanding the Geodynamo Reversal Process

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Fifty years ago van Zijl et al. published the first account of transitional geomagnetic field behavior during a polarity change. Textbooks even then often debated whether or not the paleomagnetic finding of reverse polarity—-dating back to the findings of David and Brunhes at the start of the 20th Century—-was an actual geomagnetic phenomenon. Van Zijl's publication on the Stromberg lavas of South Africa proved to be the "smoking gun" which revealed the process of reversal fossilized in the paleomagnetic record.

Implicit in that moment was the notion that the attainment of additional records of transitional field behavior would foster a growing understanding of the phenomenon. Although geomagnetic reversal is global in nature, each dataset of transitional behavior offers only a window onto the process experienced at one particular site. Even with this limitation, our knowledge about the phenomenon has greatly evolved over the past fifty years of research. Here we focus on findings relevant to two crucial questions: (1) Does the reversal process possess systematics and recurring deterministic features? (2) In what way, if any, is the reversing dynamo controlled by interactions with the lower mantle?

In this talk we will discuss the evolution in our understanding of dynamo reversal, mostly through paleomagnetic observation obtained from lava sequences. In particular, our most recent findings offer strong evidence that the dynamo process of polarity reversal may be dual-tiered. These findings further support the existence of a shallow core generated (SCOR) field—-tied to long-held stationary control by conditions of the lower-most mantle—-which undergoes both demise and regeneration quasi-independently from that of nearly the entire axial dipole (AD) component. We suggest that separation of the sources of magnetic flux for the AD and SCOR fields through some form of stratification within the fluid outer core may be a possible explanation.