A Case for Catastrophic True Polar Wander in the Cambrian

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Of all the periods in the Phanerozoic time scale, the Cambrian system is the most perplexing. Several lines of evidence which together suggest that the Cambrian Earth may have experienced a large, rapid episode of true polar wander (TPW) include: (1) The Cambrian is short. Once thought to have a duration approaching 100 Ma, stratigraphic Rb/Sr and U/Pb geochronometry now suggests a time span of about 20 Ma. (2) Lithostratigraphic analyses suggest that Northern Africa went from high to low and back to high latitudes within this time interval. North America at least moved into the carbonate belt during the early Cambrian. (3) Improvements in biostratigraphy, magnetostratigraphy, and carbon isotopic stratigraphy around the Precambrian-Cambrian boundary now allow precise correlations to be made between strata in Siberia, China, Morocco, Australia, and with somewhat less precision to North America. Isochronous poles from Australia and Africa demonstrate that they were moving separately in the late Precambrian. (4) Paleomagnetic poles, derived from biostratigraphically-dated units, suggest nearly 90^{o} of APW for many, if not all, of these continents during Cambrian time. We interpret these effects as an episode of TPW resulting from the collision of East and West Gondwana during the early Cambrian. This suturing event would stop subduction of a large equatorial plate dipping under Africa (responsible at least in part for the Pan-African metamorphic events). Thermal warming of the orphaned slab then removes its mass anomaly, causing the magnitudes of the minimum and intermediate eigenvectors of the total earth moment of inertia tensor to switch, leading to a 90^{o} TPW reorientation of the crust. The Cambrian sea-level transgression may then be the result of moving a large ocean basin from the polar region onto the equatorial buldge. Similarly, the enormously accelerated rates of organic evolution observed during Cambrian time may be the result of paleoenvironmental dislocation driven by TPW.