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Magmatic origin of the Dewar magnetic anomaly: Implications for an early lunar dynamo

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The Moon's ancient magnetic field provides critical insights into its thermal and magnetic evolution, yet the lifetime of its dynamo remains debated. Returned samples yield complex and contradictory paleomagnetic records, while orbital data reveal crustal magnetic anomalies of uncertain origin from either a core dynamo or transient impact-generated fields. Here we jointly invert gravity and magnetic observations in the region around the Dewar swirl, a high-albedo feature associated with the Dewar magnetic anomaly. We identify a shallow, magnetized, high-density body consistent with buried mare basalt. Its formation requires paleointensity exceeding 11 μT, suggesting a lunar dynamo was active at about 4.2 Ga, as constrained by the superposed basin ejecta. Results also show that swirl formation requires horizontal magnetization and iron oxide enrichment. These findings link a magnetic anomaly to its geologic source and the state of the lunar dynamo, providing new constraints on the lunar magnetic and volcanic history.