Antarctic lava yields clues to Earth's past magnetic field

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Rock samples collected near the Antarctic volcano Mount Erebus, seen here in the distance, harbor fingerprints of Earth's ancient magnetic field. A new analysis delves into discrepancies between these fingerprints and predictions from a long-standing approximation of the field. Credit: Hanna Asefaw

The movement of molten metals in Earth's outer core generates a vast magnetic field that protects the planet from potentially harmful space weather. Throughout Earth's history, the structure of the magnetic field has fluctuated. However, data suggest that averaged over sufficient time, the field may be accurately approximated by a geocentric axial dipole (GAD) field—the magnetic field that would result from a bar magnet centered within Earth and aligned along its axis of rotation.

Now Asefaw et al. present evidence demonstrating that the GAD approximation may not represent the intensity of the paleomagnetic field over the past 5 million years as well as it represents the directions of the field.

Clues to the direction and intensity of the paleomagnetic field at a given moment in Earth's history can be preserved in magnetic grains in rocks that formed at that time. The new research stemmed from observations that rocks in Antarctica indicate a lower paleomagnetic field intensity than would be predicted by a GAD field for that latitude when compared with global paleomagnetic field intensities.

To determine whether these seemingly low intensities accurately represent the paleomagnetic field, the researchers reevaluated previously published data and collected new samples from lava flows around the Erebus Volcanic Province in Antarctica. They analyzed the magnetic properties of the samples and followed a strict protocol to weed out potentially poor data.

The analysis yielded estimates for directional features of the paleomagnetic field that are in line with the GAD hypothesis. However, estimates of field intensity remained lower than expected. The reason, according to the researchers, may be that the average intensity of the paleomagnetic field over the past 5 million years was weaker than the modern geomagnetic field. Or, the field may have included stronger deviations from a GAD field structure.

The authors say they intend to analyze paleointensity and paleodirections from several other latitudes over the same time period to resolve these outstanding questions. The resulting insights could improve reconstructions of Earth's paleomagnetic history and inform models of past and future changes to Earth's magnetic field.

More information: H. Asefaw et al. Four-Dimensional Paleomagnetic Dataset: Plio-Pleistocene Paleodirection and Paleointensity Results From the Erebus Volcanic Province, Antarctica, *Journal of Geophysical Research: Solid Earth* (2020). DOI: 10.1029/2020JB020834

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