

GENERAL SCIENCE NOTES

REVERSAL OF EARTH'S MAGNETIC FIELD

By R. H. Brown, Geoscience Research Institute

WHAT THIS ARTICLE IS ABOUT

Paleomagnetic analysis of a Miocene basalt flow on Steens Mountain, Oregon, has forced the conclusion that reversal of the geomagnetic field may be accomplished within a few months, rather than requiring thousands of years as indicated by current widely accepted models for geomagnetism. This development is of particular interest to individuals who adhere to a geochronology that incorporates the chronological data in the Bible.

INTRODUCTION

Everyone is familiar with a compass needle — a small magnetized object, freely pivoted so that it lines up in a magnetic North-South direction. The behavior of a compass needle is the composite behavior of the molecular-domain-sized components in its structure. If the needle were ground into powder and the powder allowed to fall freely, the individual powder grains would maintain a magnetic North-South orientation as they fell. In a similar manner a sediment can preserve a record of Earth's magnetic field direction at the time the sediment accumulated. Volcanic ash or lava may contain magnetic particles that preserve a record of Earth's magnetic field at the time the ash falls or the lava hardens. The investigation of such records comes under the classification of paleomagnetism. For anyone who wishes a broad orientation to this fascinating field, the book *The Earth's Magnetic Field* (Merrill & McElhinny 1983) can be recommended.

REVERSED GEOMAGNETISM

About half the rock samples representing earlier stages in the history of Earth's crust are reversely magnetized (Jacobs 1984, p 47-48), i.e., the molecular-domain-sized "compass needles" in them point southward, rather than northward as they would if unrestrained at the present time. The surprising implication is that the geomagnetic field has reversed at some time, or times, in the past. A sequence of 26 reversals has been recognized for rocks extending from the Upper Miocene to the present,

representing only 5.5 million years of the conventional Phanerozoic spread of nearly 600 million years from the lowest metazoan fossils to modern conditions (Merrill & McElhinny 1983, p 140).

The phenomenon of magnetism appears whenever electric charge is in motion. A “compass needle” can be a coil of wire in which an electric current is maintained, or a bar in which there is an alignment of the natural motions of electrons about the centers of some of the atoms of which the bar is composed. The geomagnetic field is generally considered to be associated with electric currents in the interior region of the planet. These currents are presumed to be produced by the slow circulation of molten material that carries unequal amounts of positive and negative electric charge (unequal numbers of protons and electrons) (Jacobs 1984, p 13-18; Merrill & McElhinny 1983, p 209-263).

GEOMAGNETIC REVERSALS IN RELATION TO BIBLICAL CHRONOLOGY

Reversal of a magnetic field produced by the circulation of molten material within a planetary interior would be expected to be a slow process. Several thousand years have been presumed necessary for the completion of one reversal (Opdyke, Kent & Lowrie 1973). The large number of geomagnetic reversals recorded in the sequence of fossil-bearing geologic layers presents a severe difficulty for placing the accumulation of these layers within a time span of less than 10,000 years, as constrained by chronological data in the Bible. The difficulty is compounded by the need to assign deposition of most of the Phanerozoic geologic layers to one calendar year as specified in Genesis 7 and 8. A typical response among biblical creationists has been to ignore or deny the evidence for geomagnetic reversal (Barnes 1972). A more satisfactory approach has been to recognize the vast amount of evidence for repeated geomagnetic reversal, and propose that each of these reversals occurred rapidly, possibly within days (Humphreys 1987).

If the major component of the geomagnetic field is due to circulation of large masses of electrically charged molten material below Earth's crust, net reversal of such circulation within hours, or days, is incomprehensible. Consequently acceptance of a Phanerozoic time frame that is consistent with the chronologic data in the Bible has required strong implicit faith, coupled with confidence that the scientific data currently available is inadequate for the development of an accurate model for geomagnetism. These considerations give unusual significance

to a recent research report, “Evidence Suggesting Extremely Rapid Field Variation During a Geomagnetic Reversal” (Coe & Prevot 1989).

EVIDENCE FOR RAPID GEOMAGNETIC REVERSAL

Coe and Prevot have analyzed paleomagnetism in a Miocene basalt flow at Steens Mountain in southeastern Oregon, U.S.A. Using cooling models, they obtained good estimates of the time lapse between when various levels of the basalt flow cooled to a sufficiently low temperature for the magnetic characteristics to remain fixed (be recorded). From an analysis of the paleomagnetism at various levels in the flow, together with the associated time differences, they were able to establish geomagnetic field change rates of at least 3 degrees direction and 300 gammas intensity per day. At 3 degrees change per day a reversal (180 degrees change) could be completed in two months. Three hundred gammas is in the vicinity of $1/_{150}$ of the present geomagnetic intensity. The available evidence indicates that although the geomagnetic field intensity decreased during reversals, it did not drop to zero.

Coe and Prevot describe 3 degrees per day as “an astonishingly rapid rate of variation of the geomagnetic field direction”, and state further that “the rapidity and large amplitude of geomagnetic variation that we infer..., even when regarded as an impulse during polarity transition, truly strains the imagination.” They conclude that the most probable explanation for the observations on which their conclusions are based “is the occurrence of a large and extremely rapid change in the geomagnetic field during cooling of the flow, and that this change most likely originated in the core [of the earth].”

CONCLUSION

There will now be a stimulus for effort to develop models to explain geomagnetic field reversals on a time scale of days, rather than thousands of years. Whether or not these efforts become successful, we can expect more research data that confirm and broaden the conclusions which have been presented by Coe and Prevot, and that makes acceptance of biblical chronology a less stressful experience of faith. The scientific literature already includes one response by an individual who maintains the view that thousands of years are necessary for a geomagnetic reversal, yet is unable to challenge the data presented by Coe and Prevot, or the analysis by which they arrived at their conclusions (Fuller 1989).

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