Geophysical Research Abstracts
Vol. 15, EGU2013-5947, 2013
EGU General Assembly 2013

Precursor to the Matuyama/Brunhes Polarity Transition 0.78 Million Years Ago at Bishop, CA

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Van Zijl et al.'s 1962 report of a polarity transition in Stormberg lavas was the first of many investigations of the Matuyama/Brunhes polarity transition (MBPT) about 0.78 m.y. ago. Among the earliest of those investigations was a study of bathyal siltstone in the Boso Peninsula in Japan (Niitsuma, 1971; Okada and Niitsuma, 1989). That investigation was preceded by a report that the relative intensity of the palaeomagnetic field as recorded in a marine core is reduced for a longer period of time than is required for the field directions to reverse (Ninkovich et al., 1966), a discovery that was summarized for other reversals in cored marine sediment (Opdyke, 1973). In the U.S., Hillhouse and Cox (1976) documented the field directions and relative intensity during the MBPT using exposed Pleistocene Lake Tecopa sediments in southeastern California. They reported a generally smooth path of the Virtual Geomagnetic Poles (VGPs) as the field changed from reverse to normal that does not coincide with the VGP path for the MBPT in Japan, concluding that the transitional field is predominantly the non-dipole field. At Lake Tecopa, as in the marine record, the reduction in field strength occurred sooner and lasted longer by a factor of at least two the time required for the directions to reverse polarity, which was confirmed by Valet et al. (1988) in a restudy of the Lake Tecopa sediments.

The Lake Tecopa study by Hillhouse and Cox (1976) was followed by one of Pleistocene lacustrine sediments exposed beneath the Bishop Tuff (Dalrymple et al., 1965) near Bishop, California (37.4° N, 241° E) (Liddicoat, 1982, 1993). The data we report are for directional and normalized relative intensity measurements of additional samples from each horizon at the Bishop locality that indicate the time spanned by the reduction in relative intensity for the full transition exceeds by about 20 percent the time during which the palaeomagnetic directions reverse. Although the change in field direction is difficult to establish with much certainty because there is a large scatter of directions for multiple (usually six) samples for each measured horizon (Liddicoat, 1993), it is possible to record a brief interval of opposite polarity near each end of the transition. During the onset of the transition, an estimated 1,000 years of normal polarity occurs at three sites separated along strike by 15 m. The change in polarity is in unweathered siltstone in cubes 2 cm on a side that were either demagnetized in an alternating field to 100 mT or heated to 600°C. The interval of normal polarity has approximately 0.5 m of reverse polarity above it, which is overlain by 5 m of unconsolidated coarse sand. The time represented by the sand bed is not known, but it is reasonable to expect it could be considerable, but maybe no longer than 10,000 years. On that assumption, the normal polarity at Bishop might be the precursor to the MBPT Hartl and Tauxe (1996) discovered at ODP Hole 804C in the equatorial Pacific Ocean (1.0° N, 161.4° E.), or is in loess in China (35.7° N, 109.4° E) and elsewhere as referenced in Jin et al. (2012). In the upper third of the MBPT there is a partial recovery of the relative intensity, and in the Brunhes Normal Chron there is a brief interval of reverse polarity that might be the reverse interval Coe et al. (2004) located in volcanic rocks at Maui, Hawaii (20.8° N, 203.7° E).