An 40Ar/39Ar Based Geomagnetic Instability Timescale (GITS) for the Brunhes and Matuyama Chrons

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Using modern 40Ar/39Ar incremental heating techniques we have obtained high precision ages for transitionally magnetized lava flows in several volcanic sequences distributed about the globe. Radioisotopically dated periods of geomagnetic instability include: (1) short excursions of the field when VGPs approach or cross the equator, (2) brief periods of opposing polarity bounded by full reversals, or (3) full reversals that define Chron or Subchron boundaries. The timing of the Punaruu Event (1120 " 10 ka; " 2 sigma), the onset and termination of the Jaramillo Subchron (1068 " 12 ka and 1001 " 10 ka), the Santa Rosa Event (936 " 8 ka), the Kamikatsura Event (900 " 5 ka), the Matuyama-Brunhes reversal (798 to 776 ka), and the Big Lost Event (579 " 8 ka) provide the initial calibration points of a new time scale for the Matuyama and Brunhes Chrons. These transitional periods recorded in lavas, as well as many others that are not yet 40Ar/39Ar dated, have been correlated with directional changes or paleointensity lows in high sedimentation rate marine sediment cores. We hesitate to include lavas dated at 822 " 9 ka that possess weakly transitional VGPs over southern Africa prior to the Matuyama-Brunhes reversal in the compilation, thereby highlighting the need to develop criteria by which periods of instability may be distinguished from normal secular variation. Notwithstanding, we contend that an accurate geochronology of reversals and events, together with a detailed accounting of paleomagnetic field behavior, are critical to a complete understanding of geomagnetic processes, and may provide important input regarding the dynamics of Earth's interior from the mantle on down. For example, Gubbins [1999] claimed that the occurrence of excursions 10 times more frequently than reversals--consistent with our dating results thus far-- may reflect the probability of exceeding the characteristic time required to diffuse the magnetic field from the outer vs. the inner core. Moreover, numerical simulations of the geodynamo [Glatzmaeir et al., 1999] that impose various heat flux patterns

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at the core-mantle boundary also spontaneously generate a variable number of excursions and reversals over several hundred thousand year periods that can be evaluated against our observations. We thus propose that a Geomagnetic Instability Timescale (GITS) be pursued on the basis of a more systematic and rigorous characterization of both the known and suspected geomagnetic instabilities of the past several million years. The GITS will be of great value to advancing not only geodynamo theory and testing future numerical simulations, but also to quantifying the next generation of stratigraphic, paleoclimatic and oceanographic studies founded upon the global marine sediment record. Finally, a note of caution: The 40Ar/39Ar ages reported above are calculated relative to those of standard minerals based on a recent intercalibration of several standards that resulted in an age of the Fish Canyon Tuff sanidine of 28.02 Ma which is 1% older than the standard values used in the Cande and Kent [1995] GPTS. It is important to note which standard ages are used in each study that involves 40Ar/39Ar dating and, where appropriate, to normalize ages to a common standard value.