How many volcanic rocks do we need to estimate time averaged geomagnetic dipole moment?

*Yutaka Yoshimura[1], Toshitsugu Yamazaki[1]

1. Atmosphere and Ocean Research Institute, The University of Tokyo

In the past two decades, many studies have tried to calculate the time averaged virtual dipole moment (VDM) or virtual axial dipole moment (VADM) from volcanic rocks for the last few million years [e.g. Juarez et al., 1998; Juarez & Tauxe, 2000; Yamamoto & Tsunakawa, 2005]. However, the criteria of the number to determine average V(A)DM has not yet been established. Specifically, the problem is how many absolute paleointensities do we need to determine the average value of the true V(A)DM? It is not easy to determine absolute paleointensities from volcanic rocks. However, as a goal of paleomagnetic studies is to understand the accurate image of the earth's magnetic field, we should not avoid this problem. Therefore, we propose the criteria for the number of paleointensity data to estimate the geomagnetic dipole moment using Monte Carlo simulation. We randomly draw two or more data from a continuous VADM curve since 1.5 Ma, which is the PISO-1500 [Channell et al., 2009] stack of high resolution relative paleointensity records from ocean sediments (we call 'parent population'), and average them (we call the value averaged here 'sample average'). Then, we repeat this try in 100 times to calculate the probability of being included within the mean VADM: 7.2×10^22 Am^2 with its 5~10% range, and stop when it reaches 100%. We found 19 samples when the sample mean was 100% included in the parent population average value ± 10%, 27 for ±9%, 28 for ±8%, 47 for ±7%, 76 for ±6% and 89 for ±5%. At least about 20 absolute paleointensities are needed to estimate when the sample averages are included with the accuracy of parent population mean ±10%, but about 100 intensities are needed to estimate the strict V(A)DM average value from their sample average. PISO-1500 is a standard curve at 1 kyr interval. Therefore, when calculated number of absolute paleointensities to the ratio for the time range, 1.3% and 6.7% of the whole, respectively. We suggest that previous estimations need to be re-assessed by this new criteria.

Keywords: Geomagnetism, Virtual Dipole Moment (VDM), Paleomagnetism, Monte Carlo simulation, absolute paleointensity

