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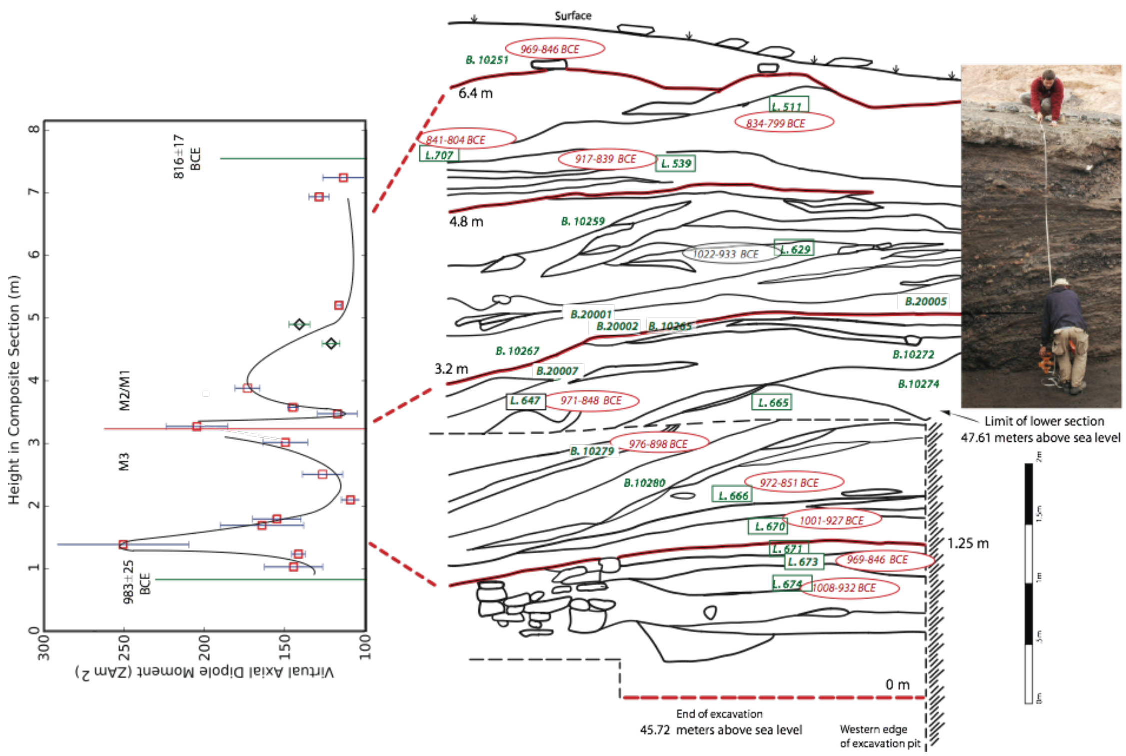
Research Interests: Behavior of the ancient geomagnetic field. Statistical analysis of paleomagnetic data. Applications of paleomagnetic data to geological problems.

My research over the past year has been in a few major themes including: 1) obtaining new data to contrain the statistical properties of the secular variation of the geomagnetic field, 2) variations in the strength of the geomagnetic field over the past seven millennia as recorded in Israeli and Jordanian copper mining slag heaps, and 3) applications of statistical models of the geomagnetic field for purpose of diagnosing and compensating for sedimentary errors in magnetic recording processes

Topic #1: “Too shallow” inclinations in paleomagnetic datasets have variously been interpreted as plate motion, permanent non-dipole field components or bias in inclination from sedimentary processes. Statistical paleosecular variation models could be used to resolve the cause of inclination anomalies because there is a simple relationship between the elongation of the distribution of directions in the vertical plane and the average inclination. Shallowing of inclinations from sedimentary processes results in a progressive transformation of the elongation direction in the vertical plane containing the average direction into a pronounced elongation in the plane perpendicular to that. However, the applicability of statistical models based on the last 5 Myr for more ancient times is an open question. In Tauxe and Kodama (2009), we presented new data from the (~1.1 Ga) Keeweenawan North Shore Volcanics which are consistent with statistical PSV model predictions for the last 5 Myr. We also found support for the contention that the asymmetric reversal(s) observed in Keweenawan aged rocks along the North shore of Lake Superior can be explained as an age progression. Finally, we reconsidered implications from an analysis of inclinations from the Global Paleomagnetic Database for the Paleozoic and Pre-Cambrian finding that the data are inconsistent with a random sampling of any simple geomagnetic field model.

Topic #2: Sediments provide a continuous record of past geomagnetic field variations. Although it is theoretically possible to get both the direction and intensity of the geomagnetic field from sediment records, the mechanism is not fully understood. Previous workers have postulated that flocculation plays an important role in detrital remanent magnetism (DRM). Flocs are porous, loose and highly fragile aggregates of microscopic clay particles and their behavior in a viscous medium is likely to be different than single particles of magnetic minerals. In order to understand the role of flocculation in sediment magnetization, Mitra and Tauxe (2009) carried out a set of redeposition experiments at different field intensities and a quasi-constant field inclination of 45°. We presented a simple numerical model of flocculation, incorporating both magnetic and hydrodynamic torques to explain the experimental data. At small floc sizes DRM acquisition is likely to be non-linear in field strengths comparable to the Earth's, but the sediments may be able to record the directions accurately. With increasing floc sizes sediments may retain a record of the intensity that is linearly related to the applied field or a direction parallel to the applied field, but are unlikely to do both at the same time. Also, the majority of the magnetic particles in the sediments may not contribute significantly towards the net DRM and any bulk normalizing parameter may be unsuitable if the depositional environment has changed over the depositional period.

Topic #3: In general, periods of high field intensity have been largely ignored in paleomagnetic research, in favor of the more spectacular directional changes associated with low field intensity periods of excursions and reversals. Hence, questions such as how strong the field can get and how fast changes occur are still open. In Ben- Yosef et al. (2009), we reported on data obtained from an excavation in the Middle East, designed specifically for archaeomagnetic sampling (Figure 1). We measured samples collected from a 6.1 meter mound of well stratified copper production debris at the early Iron Age (12th-9th centuries BCE) site of Khirbat en-Nahas in southern Jordan. Our results demonstrate rapid changes in field



intensity in a period of overall high field values.

Figure 1: right: drawing of southern wall of excavation pit in a 'slag mound' depicting a sequence of copper production debris and location of samples with 'successful' archaeointensity specimens (green 'B' numbers for Baskets), from the associated excavation (green 'L' numbers for Loci). Results from radiocarbon samples are marked by circles while red indicates a charcoal and blue a date seed. Also indicated in red are the reference baselines for composite stratigraphic height measurements. left: Virtual axial dipole moments of successful samples as a function of composite height.

Relevant Publications

Tauxe, L., and Kodama, K.P., Paleosecular variation models for ancient times: Clues from Keweenawan lava flows, Phys. Earth Planet. Int.,177, 31-45, doi:10.1016/j.pepi.2009.07.006, 2009.

Mitra, R. and Tauxe, L., Full vector model for magnetization in sediments, Earth Planet. Sci. Lett.,doi:10.1016/j.epsl.2009.07.019, 2009.

Ben-Yosef, E., Tauxe, L., Levy, T.E., Shaar, R., Ron, H., and Najjar, M., Archaeomagnetic intensity spike recorded in high resolution slag deposit from historical biblical archaeology site in Southern Jordan, Earth Planet. Sci. Lett., doi:10.1016/j.epsl.2009.09.001, 2009.