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Experimental Constraints on DRM lock-in and pDRM

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Although sediments have provided some of the longest and most continuous records of earth's magnetic field, our understanding of the physical processes that control the acquisition of detrital remanent magnetization (DRM) is underdeveloped. Two fundamental questions regarding the physics of DRM remain poorly constrained: 1) at what level in the sediment column is the magnetization mechanically locked-in and 2) why does DRM theory as well as most redeposition experiments yield magnetizations that are much stronger than those found in nature? These questions can be asked more generally: how is the pristine signal of the earth's magnetic field convolved to give what we measure as the magnetization of sediments? The difficulty in answering these questions is in no small part due to the experimental difficulties involved in performing redeposition experiments in the laboratory, i.e., under gravity alone fine-grained sediment can stabilize at very high water concentrations, $\sim$80 weight-%. Previous studies have simply measured wet, unconsolidated samples using a SQUID magnetometer, allowing measurement without physically disturbing the sediment. In fact, such experiments have been used as evidence to suggest that magnetic grains are already mechanically locked (in terms of earth's magnetic field) at very low water concentrations, and thus just below the water-sediment interface. This technique is problematic, however, as measurement of the sample is made in a zero field; any magnetic grains which are not ìlocked inî could rotate away from their magnetized state when removed from the field where the deposition takes place. To overcome this difficulty, we performed sediment redeposition experiments in a dilute solution of gelatin, $\sim$5%. Depositions are performed at 40^{o}C, where the gelatin is completely liquid; before measurement samples are cooled to $\sim$10^{o}C, where the gelatin solidifies the solution and ensures that the sediment is mechanically locked, albeit artificially. Control experiments confirm that the gelling does not disturb the samples' magnetiza-

tion.

Specifically we performed redeposition experiments in the following manner: the samples are 1) stirred in a vertical field, 2) gelled and measured, 3) reliquefied—by reheating to $\sim$40^{o}C—in a horizontal field, 4) regelled in the horizontal field and measured. This experiment was completed for sediments from ODP sites 851 and 854, carbonate and clay-rich, respectively, as a function of sediment concentration (c_s) ranging from $\sim$60% to 5%. For both sediments these experiments yield two critical results: 1) DRM/ARM (normalized to account for the variability of magnetic material in the sample and to allow direct comparison to what was measured for the sediment cores) decreases with increasing sediment concentration and is essentially zero for $c_s >\sim$55% and 2) post depositional remanent magnetization (pDRM) is important for $c_s <\sim$55%. For site 851 sediment with $c_s <\sim$47%, flocculation alone (the experiments were performed in a solution of 3.5% NaCl) does not appear to lower DRM/ARM enough to explain the data from the sediment cores, and suggests that the magnetization was acquired at depth in the sediment column, specifically where $c_s =\sim$47%. pDRM and its smoothing of earth's magnetic field at this site would then be an important factor for depths where $\sim$47%$<$ $c_s <\sim$55%. Indeed, if the concentration profile for the uppermost sediment at 851 was known one could define the filter-function for the convolution of earth's field at this site. Finally, if, at a given site, the depth of bioturbation changed with time (as it does in pelagic ecosystems on a decadal time-scale) and thereby changing c_s where the DRM is acquired then the intensity of DRM/ARM would also vary regardless of changes in earth's field. In this case the convolution filter at a given site may vary as a function of time, complicating data interpretation and emphasizing the importance of using stacked records of paleointensity.