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A linear theory of relative paleointensity in inhomogeneous sediments

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Sedimentary records of relative paleointensity are commonly obtained by normalizing the natural remanent magnetization with respect to concentration of the remanence carriers. Experimental investigations have produced a number of practical criteria to estimate the reliability of this procedure. A theoretical study of its basic assumptions is missing. Here, a linear sediment model is used to study the influence of compositional variations upon natural and synthetic remanence acquisition. This allows to develop a theory of relative paleointensity determination in a setting, which is more general than the scenario implicitly used in the current methodology. The sediment is regarded as a mixture of different components, each of which represents a sediment fraction behaving uniformly with respect to both, natural and synthetic remanence acquisition. The concentration of each sediment component is assumed to vary linearly with a common 'environmental' signal. The model clearly separates between different types of influences upon the relative paleointensity record: Purely sedimentary properties are uni-causality and sediment linearity. The former ensures that all concentration variations depend only on one common environmental signal, the latter ensures that these dependencies are linear. Remanence acquisition in each sediment component also must be linear in external field and concentration of the component. It is demonstrated that in contrast to current practice, the correct normalization procedure for relative paleointensity determination is to divide the natural remanent magnetization by a *biased* normalizer. However, standard magnetic cleaning techniques efficiently reduce the necessary bias to the normalizer and allow to neglect it. Within the presented theory it is sufficient for reliable paleointensity recording that *either* the sediment is homogeneous *or* the normalizer activates the same magnetic particles which carry the NRM. Current quality criteria require both.