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Calcareous rhythmites - how to read the environmental signal behind diagenesis

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Limestone-marl alternations appeal to the eye as apparently high-resolution archives of environmental fluctuations, and they usually are interpreted as such. In many cases, their rhythmic appearance is interpreted as a direct response to orbital forcing. Nevertheless, unequivocal proof of a sedimentary origin of the rhythmic intercalation of the two lithologies is far from trivial, and ignoring these difficulties might lead to misleading results. The problem arises from differential diagenesis that alters limestone beds in different ways than interlayers (marls), causing a loss of comparability between the lithologies. Differential diagenesis, between other effects, causes passive enrichment of the inert non-carbonate fraction in interlayers, where calcium carbonate is being dissolved, as well as passive dilution in limestone beds, that are cemented by imported calcium carbonate. Therefore unequivocal information about systematic differences in the precursor sediments of limestones and interlayers is preserved only in parameters that are not modified during diagenesis. Such diagenetically inert parameters include the spectra of organic microfossils (but not their absolute concentration in the bulk sediment) and the ratios of diagenetically inert trace elements (again not the absolute concentrations). Systematic differences in diagenetically inert parameters can provide unequivocal proof of primary differences. In the studied limestone-marl alternations, however, such parameters do not directly reflect the lithological rhythm, shedding doubt on limestone-marl alternations as direct archives of environmental change. Here we present a set of sedimentological, geochemical, mineralogical, and paleontological tools for looking behind diagenetic alterations and for unveiling unequivocal paleoenvironmental information from limestone-marl alternations.