In the Neogene, the presence of extensive dolomite intervals exhibiting multigenic crystal morphologies, distinctive δ13C signatures and variable concentrations of Fe and Mn, strongly suggest the involvement of various microbial heterotrophic pathways in both dolomite nucleation and ageing [1,2]. However, the relevance of enhanced organic burial, and the catalytic role of microbes in post-depositional dolomite formation, and as an overall control of the Cenozoic abundance of dolomite, remains to be demonstrated.

Most recently, the anaerobic oxidation of methane (AOM), typically by a consortium involving archaea and sulfate reducer bacteria, has been found to be a significant geochemical process in marine sediments [3,4,5]. The activity of microbial communities capable of AOM is usually recorded by a distinctively depleted 13C signal in their carbonate by-products [3]. However, in diffusion-dominated sediments more positive δ13C could be the result of an admixture of methanogenic 13CO2, or alternatively from extensive AOM, which may also increase the residual carbon pool in 13C [5]. In Neogene sequences, the occurrence of multigenic dolomite-rich intervals with δ13C varying from markedly negative to positive values points to AOM as a likely mechanism of ageing, and potentially extends the microbial dolomite induction zone a few hundred meters below the sediment water interface [e.g., ref. 4].

To fully understand the burial diagenetic history of such intervals, and by extrapolation, their ancient analogues, a comprehensive analytical approach is required. For instance, in addition to the possible presence of 13C-depleted lipid biomarkers [3], when compared with their near-surface precursors dolomite cements formed under the influence of syntrophic AOM should exhibit relatively higher Fe, Mn, and probably bioactive Ni, Zn and Cu concentrations [6]. Unravelling the role of AOM in dolomite formation during burial into the methanogenic zone may provide new insights into the long-standing dolomite problem.