Biostratigraphic distribution of Miocene carbonates associated with gas hydrates in the northern Apennines (Italy) and their relationship with sea-level lowering

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Gas hydrates are widespread in modern continental margin sediments, and their stability is related to temperature, pressure, and the availability of gas and water. Their sensitivity to tectonic activity and climate is still poorly constrained, and more efforts are needed to understand how they respond to these forcing processes. Gas hydrates are frequently associated with carbonates called clathrites that may form bodies of large dimension and are marked by geochemical indicators, such as ^{13}C-depleted and enriched $\delta^{18}O$ values.

A number of Miocene seep-carbonates crop out in different geological settings in the northern Apennines of Italy (Argentino et al., 2019), with characteristics that suggest palaeo-gas hydrate occurrences, and thus can be considered to be clathrites. Our biostratigraphic investigation of the sediments containing the gas-hydrate-associated carbonates showed that they are generally concentrated in three main intervals – the Langhian (Subzone MNN5a), the Upper Serravallian–Lower Tortonian (Subzone MNN6b to Zone MNN7) and the Upper Tortonian–lowermost Messinian (Zones MNN10 and MNN11). By comparing seep distributions with the third-order eustatic curves of Haq et al. (1987), they appear to match phases of sea-level lowering.

Determining the relationship among gas hydrate destabilisation, climate change, sea-level variations, tectonic activity and fluid circulation is particularly challenging in the fossil record. In the examined carbonates, a drop in the hydraulic pressure of the plumbing system during sea-level lowering would have shifted the base of the gas hydrate stability zone into shallower depths, inducing gas-hydrate destabilisation. The uplift of the different sectors of the wedge-top foredeep system during tectonic migration could have increased the effect of the concomitant eustatic sea-level drop, reducing the hydrostatic load on the seafloor and inducing gas-hydrate decomposition. Thus, a precise biostratigraphic framework of palaeo-clathrites in the sedimentary record may help to shed light on gas-hydrate long-term evolution and the relation with sea-level changes and tectonics.

References

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