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To drown or not to drown: carbonate platforms during Cretaceous oceanic anoxic events

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Many carbonate platforms of the Tethyan realm drowned below the photic zone during Cretaceous oceanic anoxic events. High rates of eustatic sea-level rise have been documented for the time intervals of OAE 1a and OAE 2 but studies on recent reefs show that a healthy photozoan carbonate factory can keep pace even with the fastest rate of glacio-eustatic sea-level rise. Therefore the common story is that drowning platforms were stressed by some combination of environmental factors. Spreading of anoxic waters onto the platform or increased nutrient supply have been commonly invoked as the causative mechanisms of suppression, or at least dramatic reduction, of shallow-water carbonate production. An increase in pCO_2, triggered by volcanic outgassing and/or methane release, and a rise in atmospheric and sea surface temperature, are also common ingredients of models of oceanic anoxic events. Since many recent studies demonstrated the detrimental effect of high $pCO_2$and high temperature on coral reefs, these two environmental factors have been added to the list of suspects. So we have at least four causes of environmental stress which could be implicated in platform drowning: spreading of anoxic waters, elevated nutrient levels, high $pCO_2$and high temperature. The first suspect can be dismissed, because it is difficult to envisage how anoxia could be established and maintained on a more than local scale on shallow platforms, where water is continuously stirred by waves and currents. Can we narrow further the list of suspects or should we come to the more prudent conclusion

that platform drowning resulted from the synergistic effect of high levels of nutrients, $pCO_2$and temperature?

The strategy we are using to tackle this question hinges on a single piece of evidence: drowning was not the fate of all Tethyan platforms.

Resilient platforms, i.e. platforms which were able to escape drowning, are common on the southern margin of the Tethyan Ocean. In this study we present data from the middle Cretaceous of the southern Apennines (Italy) and from the Cenomanian-Turonian of Kefalonia (Ionian Islands, Greece). We use a combination of biostratigraphy and carbon isotope stratigraphy to bracket in our sections the intervals corresponding to anoxic events. Across these intervals we looked at facies and biotic changes to test the hypothesis that one or more of the aforementioned factors of environmental stress were at work. Remarkable differences emerged between the response of the carbonate platform sedimentary system and biota to OAE 1a and OAE 2. These differences are used to test the hypothesis that the recipe of environmental change was basically different between the two events.

Finally, we go back to literature and look at the pattern of palaeogeographic distribution of resilient *vs.* drowning platforms to explore some relevant questions: did latitude make a difference? Did isolated platforms fare better than land-attached ones?