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# Marine biota response to clastic sediment influx: A quantitative approach

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ABSTRACT

There have been few quantitative studies of the effects of siliciclastic and volcaniclastic sediment influx on carbonate producing organisms from the geological record. This study presents the results of quantitative field, petrographic and acid digestion analyses of samples from three Cenozoic shallow-water mixed carbonate-volcani/siliciclastic depositional environments—the Miocene Wonosari Formation of south Java, the Miocene Batu Putih Limestone of east Borneo, and the Eocene Collsuspina Limestone of northeast Spain. Carbonate production in these systems is dominated by larger benthic foraminifera, coralline algae and corals. Analyses of the quantity, grainsize and type of volcani/siliciclastic sediment within these mixed successions have allowed assessment of the influence of these factors on shallow-water carbonate producers.

Larger benthic foraminifera and coralline algae exhibit the greatest tolerance to siliciclastic sediment influx (abundant up to 55 and 38 wt.%, respectively) at a range of grain sizes (to coarse sand). Platy corals are also present within sediments containing a large proportion of insoluble material (<80%); however, these are limited to clay-dominated horizons with a maximum siliciclastic size of fine sand grade. Branching and massive corals exhibit the least tolerance to large quantities of insoluble material (usually <40% up to medium sand, and usually <25% up to very fine sand, respectively). These variations probably reflect organism: 1) mobility, 2) ability to self clean, 3) morphology and 4) feeding mechanisms relative to: a) sediment settling, b) turbidity, c) abrasion, d) energy, e) water depth, f) light levels, and g) nutrients. The influx of volcaniclastic and siliciclastic grains of comparable size does not appear to have any differential effect on carbonate producers; although corals may be more susceptible to damage by angular volcanic shards.

Geologically averaged rates of clastic accumulation and their potential influences on carbonate producers inferred herein may be difficult to compare directly with the daily and seasonal fluctuations experienced by modern clastic influenced systems. However, this study may aid our understanding of the likely effects of increased clastic influx (today commonly anthropogenically related) to marine carbonate environments over longer time periods.

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## 1. Introduction

There is a long-standing hypothesis that either constant or punctuated clastic input to the marine environment prohibits the development of carbonate producing organisms. This supposition is still widely promoted despite recent research (Mount, 1984; Doyle and Roberts, 1988; Woolfe and Larcombe, 1999; Wilson and Lokier, 2002; Sanders and Baron-Szabo, 2005) demonstrating that carbonate production has been common in areas with significant silici/volcaniclastic influx throughout geologic time and continues today (Fig. 1). Few studies have attempted, however, to quantify the effects of silici/volcaniclastic sediment influx on carbonate producers in the rock record. This lack of data hinders our ability to understand the dynamic interactions in these mixed sedimentary systems or to assess the future of sediment-impacted reef systems.

This paper provides quantitative data on the effects of siliciclastic and volcaniclastic sediment influx on Cenozoic carbonate producing biota from three locations that formed in different shallow-water environments in a variety of tectonic settings (Fig. 1). The Neogene Wonosari Formation of south Java, Indonesia accumulated as a large-scale carbonate platform affected by volcaniclastic input in a tropical forearc setting. The Batu Putih Limestone, also of Neogene age, formed as equatorial patch-reefs interbedded with proximal deposits of the Mahakan Delta in the Indonesian portion of Borneo. The Paleogene Collsuspina Limestone at Calders was deposited as subtropical shelfal sediments within the south Pyrenean foreland basin system of northern Spain. These three locations were selected as they allow us to address the following specific objectives of this study. 1) To compare and assess possible organism responses to varying quantities of non-carbonate sediment influx during different epochs of the Cenozoic. 2) To establish the response of organisms to various sediment grain sizes. 3) To ascertain any differences in biotic responses to siliciclastic versus volcaniclastic sediment influx. There will always be problems drawing direct comparisons between geologically averaged rates of clastic influx

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