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Selective transport of palynomorphs in marine turbiditic deposits: An example from the Ascension-Monterey Canyon system offshore central California

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ABSTRACT

The pollen assemblage of a deep-sea core (15G) collected at lower bathyal depths (3491 m) on a levee of Monterey Canyon off central California was investigated to gain insights into the delivery processes of terrigenous material to submarine fans and the effect this transport has on the palynological record. Thirty-two samples were obtained down the length of the core, 19 from hemipelagic and mixed mud deposits considered to be the background record, and 13 others from displaced flow deposits. The pollen record obtained from the background samples documents variations in the terrestrial flora as it adapted to changing climatic conditions over the last 19,000 cal yrs BP. A Q-mode cluster analysis defined three pollen zones: a Glacial Pollen Zone (ca. 20,000–17,000 cal yr BP), an overlying Transitional Pollen Zone (ca. 17,000–11,500 cal yr BP), and an Interglacial Pollen Zone (ca. 11,500 cal yr BP to present). Another Q-mode cluster analysis, of both the background mud and flow deposits, also defined these three pollen zones, but four of the 13 turbiditic deposits were assigned to pollen zones older than expected by their stratigraphic position. This was due to these samples containing statistically significant fewer palynomorphs than the background muds as well as being enriched (~10–35% in some cases) in hydraulically-efficient *Pinus* pollen. A selective bias in the pollen assemblage, such as demonstrated here, may result in incorrect interpretations (e.g., climatic shifts or environmental perturbations) based on the floral record, indicating turbiditic deposits should be avoided in marine palynological studies. Particularly in the case of fine-grained flow deposits that may not be visually distinct, granulometry and grain size frequency distribution curves may not be enough to identify these biased deposits. Determining the relative abundance and source of displaced shallow-water benthic foraminifera entrained in these sediments serves as an excellent additional tool to do so.

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1. Introduction

Although palynological investigations typically utilize terrestrial records deposited in local lacustrine settings (e.g., Worona and Whitlock, 1995; West, 2003; Walsh et al., 2008), marine palynology can provide insight into geographically broader, and temporally longer and more continuous floral patterns and terrestrial climate of the adjacent continent from where the pollen and spores were derived (Groot and Groot, 1964, 1966; Cronin et al., 1981; Gardner et al., 1988; Mudie and McCarthy, 1994). As discussed in Mudie and McCarthy (1994), marine pollen records can also be compared directly to other proxies commonly used as a basis for climate change studies (e.g., foraminifera, diatoms, % $CaCO_3$, and alkenones) when the same samples are analyzed (e.g., Balsam and Heusser, 1976; Barron et al., 2003; McGann, 2015b), thereby reducing or eliminating uncertainties in marine and terrestrial correlations, especially in regard to the chronologic methods used in each.

In the late 1970s, the U.S. Geological Survey conducted field investigations off central California to explore the biologic and geologic effects of climate change, as well as the sediment depositional processes associated with those changes. As part of this effort, nine piston and six gravity cores were obtained in May and June of 1978 on a geophysical and sediment sampling cruise by the R/V *Sea Sounder* (USGS cruise S3-78-SC) from depths of 1851 m–3650 m. One of the longest cores, 15G, was a 4.72 m-long gravity core collected at a depth of 3491 m approximately 18 km

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from the crest of the western levee of the Monterey Fan Valley. The site was 200 m below the confluence of the Ascension Fan Valley and Monterey Fan Valley (Greene and Hicks, 1990), and 135 km southwest of Santa Cruz, CA (36°23.53′N, 123°20.52′W; Fig. 1).

Because of its length, location, and depth of acquisition, this deep-sea core was eventually selected for detailed quantitative palynological and benthic foraminiferal analysis. Ultimately, it provided excellent paleoclimatologic and paleoceanographic records over the last ca. 19,000 cal yrs BP (McGann, 2015a, 2015b), as well as insights into submarine canyon depositional processes (McGann, 2014). What is presented here is a further investigation of those depositional processes and how they impact palynological records in a marine environment. The palynological assemblages from 19 mud samples are considered the background record to which those from 13 turbiditic samples are compared in order to understand the delivery processes of terrigenous material to submarine fans based on the biological component entrained in those sediments.

2. Regional setting

2.1. The Ascension-Monterey Canyon system

The Ascension-Monterey Canyon system is one of the largest marine features located off central California (Fig. 1). To the north is the Ascension Canyon system, comprised of Ascension, Año Neuvo, and Cabrillo Canyons; to the south is the Monterey Canyon system, made up of Soquel, Monterey, and Carmel Canyons (Greene and Hicks, 1990). Both canyon systems transport sediment to Monterey Fan. Because the Ascension Canyon system heads on the upper slope, it is most active during low stands (Normark and Hess, 1980; Normark et al., 1984; Greene and Hicks, 1990) although it still appears to be so today (Greene and Hicks, 1990), whereas the Monterey Canyon system transects the entire continental shelf, thereby being active during the low stand, the Holocene transgression, and the high stand that followed (Normark and Hess, 1980; Normark et al., 1980; Greene and Hicks, 1990; Paull et al., 2005; Fildani et al., 2006; Piper and Normark, 2009).

Monterey Fan is the largest of several submarine fans off central California (Normark, 1970a, 1999; Hess and Normark, 1976; Normark et al., 1984; EEZ-SCAN 84 Scientific Staff, 1986) and one of the largest found off the contiguous United States (Greene and Hicks, 1990). Presently, it is characterized by an area of active fan growth that extends for more than 300 km from the base of the continental slope (Normark and Hess, 1980) resulting from the deposition of hemipelagic and turbidity current-derived sediments, similar to those of many other submarine canyons (Fildani et al., 1999; Normark, 1970a, 1999; Normark and Hess, 1980; Normark et al., 1984).

The Monterey Fan Valley features an abrupt channel meander

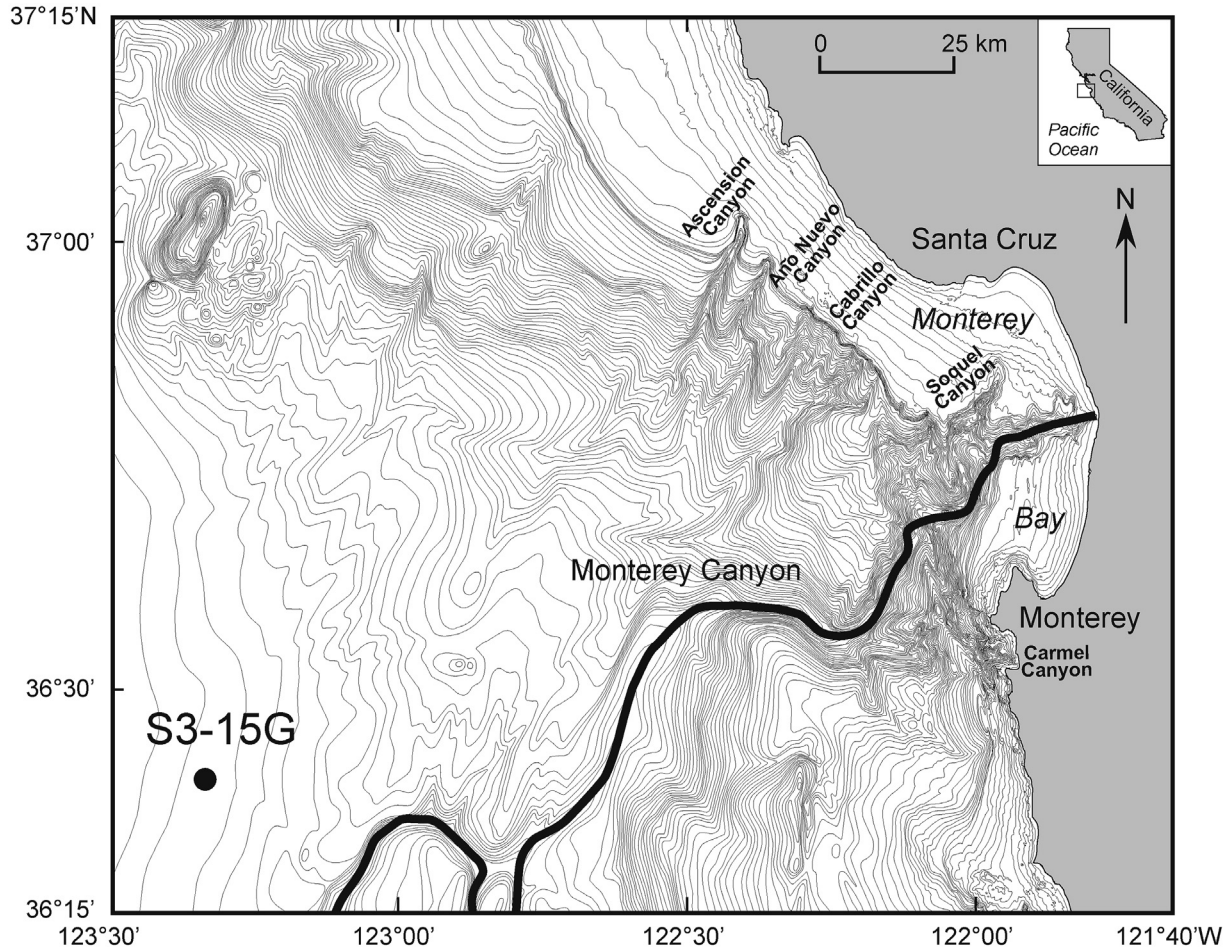

Fig. 1. Location map of the Ascension-Monterey Canyon system off central California and the site of core 15G. The Ascension Canyon system is comprised of Ascension, Año Neuvo, and Cabrillo Canyons, whereas the Monterey Canyon system includes Soquel, Monterey, and Carmel Canyons (Greene and Hicks, 1990). The channel of Monterey Canyon is outlined in black.

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