

VARIATIONS IN CYANOBACTERIAL POPULATIONS ASSOCIATED WITH ENVIRONMENTAL CHANGES DURING THE EARLY APTIAN OCEANIC ANOXIC EVENT

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2-Methylhopanoids have been widely reported in sedimentary rocks (Fig. 1a) and provide a signature for cyanobacterial contributions to organic matter (OM) (1). Their prevalence in sediments deposited during oceanic anoxic events (OAEs) suggests that the environmental conditions during OAEs favored cyanobacteria among the phytoplankton community (2, 3). This contribution aims to explore molecular (i.e., the 2-methylhopanoid index or 2-MHI) and isotopic (i.e., $\delta^{15}\text{N}$) markers as measures of cyanobacterial populations during the Early Aptian OAE (OAE1a; 120 Ma) at Shatsky Rise in the Pacific. We examine relationships among variations in cyanobacterial signatures and changes in depositional environment, especially water-column oxygenation, assessed using biogeochemical proxies. Temperature records reconstructed using TEX_{86} for these ancient sediments (4) further permit evaluation of evidence for linkages between cyanobacterial populations and climate.

The abundance of 2 β -methylhopanoids (Fig. 1b) recorded by high 2-MHI values (Fig. 1a) in OAE1a sediments reflects substantial cyanobacterial contributions to OM. Low $\delta^{15}\text{N}$ values ($< -2\text{‰}$) indicative of nitrogen (N_2) fixation by cyanobacteria occur throughout the OAE1a interval (5), whereas 2-MHI values increase during time intervals characterized by cooler sea surface temperatures (4) and oxygenated waters. Thus, environmental changes during OAE1a appear to have affected cyanobacterial populations. In the modern ocean, higher temperatures are known to favor filamentous, non-heterocystous, N_2 -fixing cyanobacteria, and exclude heterocystous species, whereas low $p\text{O}_2$ environments seem to favor species of unicellular cyanobacteria (6,7). Therefore, temporal fluctuations in the populations of N_2 -fixing cyanobacteria accompany episodes of carbon cycle perturbation such as OAE1a. Our results illustrate the viability of using biogeochemical proxies (i.e., 2-MHI), to infer variations in cyanobacterial speciation coupled to environmental changes during OAEs, and prompt assessment of similar phenomena at other times in Earth history.

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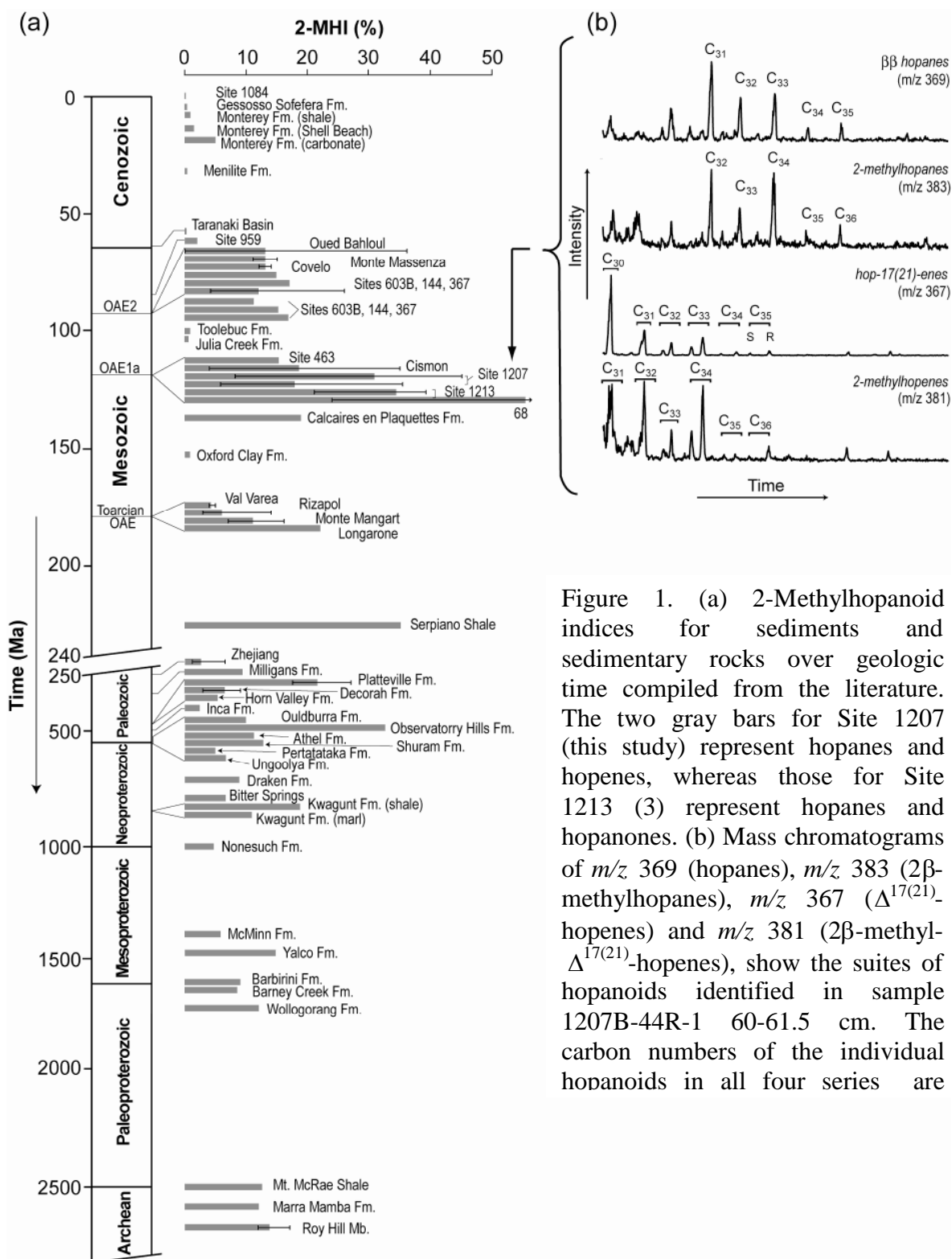


Figure 1. (a) 2-Methylhopanoid indices for sediments and sedimentary rocks over geologic time compiled from the literature. The two gray bars for Site 1207 (this study) represent hopanes and hopenes, whereas those for Site 1213 (3) represent hopanes and hopanones. (b) Mass chromatograms of m/z 369 (hopanes), m/z 383 (2β -methylhopanes), m/z 367 ($\Delta^{17(21)}$ -hopanes) and m/z 381 (2β -methyl- $\Delta^{17(21)}$ -hopanes), show the suites of hopanoids identified in sample 1207B-44R-1 60-61.5 cm. The carbon numbers of the individual hopanoids in all four series are