Marine hypoxia, lithistid sponge-microbial communities, and the cause of the Cambrian 'reef gap'

JEONG-HYUN LEE[1], ROBERT RIDING[2]

[1]Department of Geology & Earth Environmental Sciences, Chungnam National University, Daejeon, Republic of Korea (jeonghyunlee@cnu.ac.kr)

[2]Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN, USA (rriding@utk.edu)

Microbial carbonates were major components of reefs throughout the early Paleozoic, until coral-stromatoporoid-bryozoan reefs appeared in the mid-Ordovician. During the Cambrian and Early Ordovician, microbial reefs were locally augmented by sponges: archaeocyaths in the early Cambrian, and lithistids in the Early Ordovician. It is now known that lithistid sponge-microbial reefs also occur in the mid-late Cambrian; effectively filling the 'metazoan reef gap' that was thought to have intervened between early Cambrian archaeocyath-microbial reefs and the diverse metazoan reefs of the Great Ordovician Biodiversification Event (GOBE). Lithistid sponge-microbial reefs had a global distribution during this ~40 Ma interval, but the factors responsible for such a prolonged presence remain uncertain. We suggest that lithistid sponges and microbes were pre-adapted to withstand episodes of low marine oxygen that repeatedly contributed to the extinctions of phytoplankton, trilobites and other metazoans during the mid-late Cambrian. Early Paleozoic 'greenhouse' conditions of relatively high sea-level and CO_2, resulted in higher temperatures, increased marine productivity, and lower oxygen solubility. Together these promoted thermal stratification and marine hypoxia. They also led to widespread carbonate platform development that further limited shallow-water circulation. These conditions suppressed development of reef-building metazoans until declining Ordovician temperatures promoted ocean ventilation and triggered the GOBE. We propose that the ability of lithistid sponges and microbial communities to withstand 'greenhouse' hypoxia is a key to understanding not only the 'Cambrian reef gap' and the GOBE, but also why the Cambrian radiation itself was stalled for so long.