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A New Model of Formation of Guyots

David M. Buchs (1), Rebecca Williams (2), Shin-ichi Sano (3), and V. Paul Wright (4)

(1) Cardiff University, School of Earth and Ocean Sciences, United Kingdom (buchsd@cardiff.ac.uk), (2) University of Hull, School of Environmental Sciences, United Kingdom, (3) Fukui Prefectural Dinosaur Museum, Muroko, Japan, (4) National Museum of Wales, Cardiff, United Kingdom

Guyots are large seamounts with a flat summit that is generally believed to form due to constructional biogenic and/or erosional processes during the formation of volcanic islands. However, despite large abundance of guyots in the oceans, there are very few direct constraints on the geology of their summit and how this relates to their formation. To address this problem we conducted a lithostratigraphic analysis of cores collected during IODP Expedition 330 from the summit of three Louisville guyots (South Pacific) [1].

Thirteen lithofacies of sedimentary and volcanic deposits were recognized, which include facies not previously documented on the top of guyots, and support complex interplay of erosional and constructional volcanic processes in the coastal environment of high-latitude islands. The lithostratigraphy of Louisville seamounts preserves a very consistent record of the formation and drowning of volcanic islands, with from bottom to top: (i) volcaniclastic sequences with degassed volcanic glass [2] that form thick lava-fed delta deposits, (ii) submarine to subaerial shield lava flows, (iii) erosional boundaries followed by post-volcanic shallow to deeper marine sedimentary rocks that lack thick reef deposits, (iv) post-erosional volcanic rocks emplaced during magmatic rejuvenation, and (v) pelagic sediments.

High abundance of lava-fed delta deposits in the summit of Louisville seamounts is a significant observation that has not been made yet in the summit of other guyots. For instance, the stratigraphy of Hawaiian-Emperor seamounts that have formed in similar environmental and tectonic conditions (i.e., high-latitude and fast-moving plate setting) is dominated by thick stacks of lava flows with low abundance of volcaniclastic deposits (ODP Leg 197). This suggests that Louisville and Hawaiian-Emperor seamounts represent two distinct mode of formation of volcanic islands and guyots in the Pacific Ocean. Our lithostratigraphic observations [1] and the alkaline character of volcanic rocks at Louisville [2] suggest that slower magmatic growth and increased coastal erosion occurred during the formation of Louisville islands. We suggest this controlled formation of islands with a smaller shield volcano surrounded by extended shallow-marine platforms with lava-fed deltas, and that this represents as an early, syn-volcanic shaping phase of the flat summit of guyots. Hawaiian-type volcanoes and guyots are unusually large in the population of intraplate ocean volcanoes. Louisville-type guyots as defined in this study could therefore represent the most common mode of oceanic island formation in the Pacific Ocean and other similar fast-moving plate settings. Overall, our results indicate that additional work is needed to better comprehend mechanisms controlling the formation of guyots.

[1] Buchs, D.M., Williams, R., Sano, S.-i., Paul Wright, V. Non-Hawaiian lithostratigraphy of Louisville seamounts and the formation of high-latitude oceanic islands and guyots. Journal of Volcanology and Geothermal Research, in press, DOI: 10.1016/j.jvolgeores.2017.12.019

[2] Nichols, A.R.L., Beier, C., Brandl, P.A., Buchs, D.M., Krumm, S.H. Geochemistry of volcanic glasses from the Louisville Seamount Trail (IODP Expedition 330): Implications for eruption environments and mantle melting. Geochemistry, Geophysics, Geosystems, 2014, DOI: 10.1002/2013GC005086