CYCLES IN FOSSIL BIODIVERSITY: STATISTICAL TESTS AND CAUSAL CLUES. A. L. Melott[1] and R.K. Bambach[2] [1]Department of Physics and Astronomy, University of Kansas, Lawrence, KS 66045 (melott@ku.edu) and [2]Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, PO Box 37012, MRC 121, Washington, DC 20013-7012 (richard.bambach@verizon.net)

Introduction: After decades of tantalizing partial results, the existence of periodicity in fossil biodiversity has finally been put on a firm statistical basis: there is a highly significant 62 Myr cycle in fossil biodiversity, with amazing agreement between independent analyses. I will present new results analyzing independent data sets, and present a number of findings on what may be causing the regular variation—which raise yet more questions.

An ubiquitous ~62 Myr periodic fluctuation superimposed on general trends in fossil biodiversity: Part I, Documentation: We use Fourier Analysis and related techniques to investigate the question of periodicities in fossil biodiversity. These techniques are able to identify cycles superimposed on the long-term trends of the Phanerozoic. We briefly summarize prior results [1-5] and analyze other data previously reduced and published. [6] Joint time series analysis of various reductions of the Sepkoski Data, Paleobiology Database, and Fossil Record 2 indicate the same periodicity in biodiversity of marine animals at 62 Myr. We have not found this periodicity in the terrestrial fossil record. We have found that the signal strength apparently decreases with time because of the accumulation of apparently "resistant" long-lived genera. The existence of a 62 Myr periodicity despite very different treatment of systematic error, particularly sampling-strength biases, in all three major databases strongly argues for its reality in the fossil record.

Part II, Co-varying geological and isotopic trends, and possible causes.

We use Fourier Analysis to investigate geological and isotopic data possibly related to periodicities in fossil biodiversity. Testing for cycles similar to the 62 Myr cycle in fossil biodiversity superimposed on the long-term trends of the Phanerozoic [6]. We find a significant (but weaker) signal in sedimentary rock packages, particularly carbonates, which suggests a connection. Coincidence in timing is more consistent with a common cause than a basis in sampling bias. We find that Exxon sea level shows no significant periodicity, but one component of its fluctuation is consistent in period and phase with the biodiversity and sedimentation periodicities. A previously identified set of mass extinctions are found to lie preferentially on the declining phase of the 62 Myr periodicity, supporting the idea that the periodicity relates to variation in biotically important stresses. When detrended, the ratio of $^{87}Sr/^{86}Sr$ in sea water shows a strong periodicity near the same period, but almost perfectly out of phase: high values are nearly coincident with the low values of the periodicity in biodiversity. Periodic increase in continental freeboard could account for all these ~60 Myr periodic phenomena. Further work should focus on finding the underlying cause of the 62 Myr periodicity that links fossil biodiversity, sedimentary packages, and strontium isotope ratios.

References:

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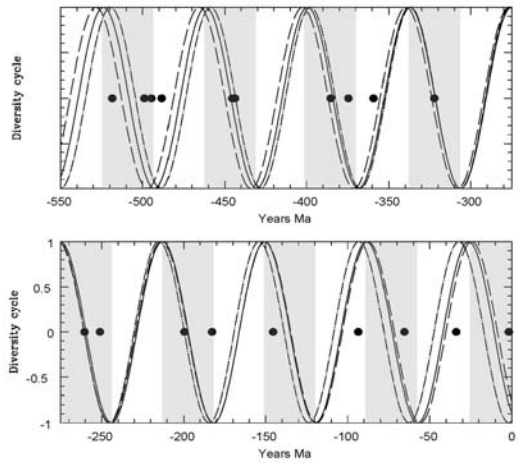

Figure: The sine curves are the ~62 Myr component based on 3 different fossil data sets, and the filled circles are the times of 19 mass extinctions identified by Bambach (2006); grey shading is the cycle downturn.