

The origin of the Pleistocene carbonate cycles

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Cycles in the abundance of calcium carbonate first recognised by Gustaf Arrhenius during the Swedish Deep Sea Expedition 1947-48 are a fundamental characteristic of the geological record of oceanic sediments. The dominant frequency, and the relationship between the carbonate cycles and “climate”, changes significantly through time. In some cases, changes in deep ocean carbonate storage have no expression in long-term records of atmospheric pCO₂ whereas in other cases they parallel pCO₂ fluctuations. Despite its obvious importance and a significant body of research, major questions remain about the deep ocean calcium carbonate reservoir. We know its abundance is cyclic and linked to the Cenozoic Milankovitch climate oscillations but don’t know which cycles, and when they were important. We know that there has been glacial-interglacial fluctuation between out-of-phase cycles in the relative preservation records of the Pacific and the Atlantic oceans but don’t know when this pattern was established. We have little idea of the size of each oceanic reservoir through time and whether there have been major changes in the overall reservoir size. Given the pervasive nature of cycles in carbonate content in ocean sediments throughout the geological record, the important question is whether these cycles represent changes in deep ocean carbonate chemistry which will be expressed as fluctuations in atmospheric pCO₂; that is are active. Alternatively, whether the atmosphere is “blind” to the cycles because the changes in carbonate accumulation are somehow buffered or balanced by carbonate deposition/dissolution elsewhere; that is are passive. The crucial test of whether the carbonate cycles influence the atmosphere is whether the cycles are associated with changes in the global deep ocean carbonate ion concentration. [CO₃²⁻] mediates the alkalinity balance, and is inversely proportional to pCO₂. This is now possible because we have a proven quantitative proxy for [CO₃²⁻] which can be applied to large sample sets. The ultimate goal is to understand the role of the alkalinity balance of the ocean in forcing or amplifying secular trends and Milankovitch oscillations in atmospheric pCO₂.

*Gustaf Arrhenius about to
spike Roger Revelle
(wrapped in cables)
on board ship,
Capricorn Expedition 1953
Scripps Institution
of Oceanography Archives*

