Decrypting Sea Level Variations in Deep Time

Bilal Haq
Institue of Earth Sciences, Sorbonne University, Paris France

Earth's sedimentary record holds physical and chemical clues that allow us to decipher sea level variations in the deep past in fair amount of detail and time resolution, even though many issues remain that stifle precision. On the longer time scales (multiple million years) sea level trajectories can also be reconstructed from paleogeographic data (marine floodings of continents) and geophysical modeling (sea floor geodynamics and basin volume changes). The last few decades have seen significant advances in our understanding of the behavior of sea level at both regional (eurybatic) and global (eustatic) spatial scales and updated sea-level curves have been published for the entire Phanerozoic, albeit with different degree of accuracy and resolution that generally decrease further back in deep time due to increasing uncertainties about timing and amplitudes of eustatic variations. One major recent discovery made through geophysical modeling has been the long-wavelength and relatively slow (multiple million years) warping of continental margins due to mantle driven dynamic topographic changes that significantly affect amplitudes estimates and often go undetected. On the positive side, for some parts of the Mesozoic and for all of the Cenozoic oxygen-isotopic data ($\delta^{18}$O) of marine benthic foraminifera have proven useful in constraining both the timings and (to a lesser extent) the amplitudes of sea-level rises and falls. Digitizing sea-level variations in deep time poses a challenge, as multiple streams of parallel data have to be correlated with meaningful precision, each dataset having its own inherent degree(s) of uncertainties. Nonetheless, For most portions of the Phanerozoic sea-level variations data, especially the timing of sea-level withdrawals, has been arrived at through calibration to several different scales (i.e., magnetic reversal, biochronologic, isotopic), as well as absolute time. The Cenozoic (the last 66 Myr.) has also been fine tuned through astronomical (orbital) cyclostratigraphy. Nevertheless deep time eustatic history should be regarded as work in advanced progress and, with periodic revisions (as new bio-chronological data and new technologies become available), it can be kept current for enhanced utility. In this presentation, the advances made in recent years and the state of the art of our current understanding of sea level in deep time will follow the discussion of the technological limitations.