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Implications of mantle convection for eustatic and relative sea level change

R. Moucha (1), A. M. Forte (1), D. B. Rowley (2), J. X. Mitrovica (3), N. A. Simmons (4), S. P. Grand (5)

(1) GEOTOP, Université du Québec à Montréal, Quebec, Canada, (moucha@sca.uqam.ca), (2) The Department of the Geophysical Sciences, University of Chicago, Illinois, USA, (3) Department of Physics, University of Toronto, Ontario, Canada, (4) Atmospheric, Earth & Energy Division, CMELS Directorate, Lawrence Livermore National, California, USA, (5) Jackson School of Geological Sciences, University of Texas at Austin, Texas, USA

Long-term sea-level change has been attributed to changes in the rate of sea-floor spreading and associated increase in ridge volumes (e.g. Pitman, 1979; Sahagian, 1987; Gurnis, 1990; Van Sickel et al., 2004), as well as to epeirogeny (e.g. Bond, 1979; Harrison, 1990; Lithgow-Bertelloni & Gurnis, 1997). Sea level curves derived from backstripping or seismic stratigraphy can be heuristically corrected for epeirogeny by using average continental uplift (or subsidence) as suggested by Bond (1979), with the exception of the New Jersey margin, where the effect of epeirogeny is assumed to be negligible (Steckler et al., 1988). Following this assumption, long-term sea level change estimates from borehole backstripping analyses (e.g. Kominz et al., 1998; Van Sickel et. al., 2004) only correct for regional tectonism by overlapping data coverage and tectonic subsidence is estimated with models of thermal subsidence and sediment loading (Steckler et al., 1988). We test the validity of these assumptions by carrying out backward mantle flow simulations starting with present-day heterogeneity derived from a high resolution joint seismic-geodynamic tomography model (Simmons et al. 2007) that yields excellent fits to present day surface observables (e.g. dynamic topography and the geoid). We find that both the New Jersey coastal plain and the western African margin have been subject to orders of 100 meters of dynamic topography change over the last 30 Ma. We also show that the changing pattern of downwelling mantle flow associated with plate subduction is a significant contributor

to the background eustatic sea-level trend, which is also of order 100 m during the 30 Ma time window. Thus, even if the observed trend could be accurately corrected for local dynamic topography variation, the residual eustatic signal does not merely reflect changes in mean spreading rates at mid-ocean ridges. We conclude that the observed long term sea-level variations at so-called "stable" sites cannot be interpreted as eustatic.