Persistence of Relief and Erosion on the Eastern Passive Margin

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Despite the absence of thermally-driven uplift, the eastern passive margin is not static. Erosion drives ongoing isostatic compensation (Matmon et al., 2003) and relief has been maintained despite significant erosion over the Cenozoic (Pazzaglia and Gardner, 2000). Neogene uplift may have been significant, as shown by a pulse of Miocene sedimentation on the Atlantic shelf (Poag and Sevon, 1989; Pazzaglia and Brandon, 1996). Relief has apparently increased in some Appalachian river valleys during the Neogene and localized acceleration in bedrock river incision has occurred in the last 40 kyr (Resusser et al., 2004). The most recent Laurentide ice loading and unloading over the past 70 kyr has caused measurable, ongoing deformation of the lithosphere (Pelltier, 1996). These observations suggest that a simple decay model for Cenozoic passive margin evolution (Davis, 1899; Ahnert, 1970) does not provide sufficient explanation of the Cenozoic landscape evolution of this region. Neotectonic landforms (e.g. uplifted plateau and escarpments, incised valleys) sediment stratigraphy (Pazzaglia and Brandon, 1996), faulting (Mixon and Newell, 1977; Prowell, 1988) and seismicity (reviewed in Gardner, 1989) provide evidence for active lithospheric processes in the eastern lithosphere.

Relating geomorphic process studies to dynamic topography can provide information about mantle processes. The dynamic surface topography of North America shows that it stands low relative to a purely isostatic model. In other words, the topography is overcompensated by the crustal root and lithospheric structure. Contemporary increases in mean elevation of the Appalachians may be an isostatic response of ongoing changes in the crustal root compositional and density structure. Thermochronology, particularly He/U-Th of apatites, provides additional long-term data on rates of orogen unroofing. Regional strain is thus measurable over a range of timescales. Deploying a GPS array to measure contemporary strain is a high priority; such an array will have to be maintained for decades to discern a measurable signal. Relating temporal and spatial scales of contemporary deformation to longer-term deformation provides important information about the possible drivers of lithospheric strain.

We now have techniques to study the dynamics of topographic change over the range of annual to million year timescales. Rates of topographic change, particularly changes in mean elevation (surface uplift) and relief (river incision vs. landscape erosion) can be measured over decades using GPS and related geodetic measurements and over millennia using studies of river long profiles, paleo-long profiles (terraces), modern erosion rates, and paleo-erosion rates. Age data for these millennia-scale studies are provided by biostratigraphy, and increasingly, cosmogenic techniques that are particularly effective at determining modern and paelo-rates of erosion. New data from the Appalachians (Reuter et al., in review) show a strong relation of erosion rate based on *in situ* ^{10}Be to mean basin slope. These data provide information at the million-year time scale, and support hypotheses for topographic rejuvenation in the Appalachians in the late Cenozoic. Cosmogenic isotopic measurement of erosion rates should, therefore, be a critical component of quantifying the geomorphic evolution of this passive margin.

Coupling of measurable rates of landscape change with measurable lithosperic processes promises to yield fundamentally new models of the geologic evolution of passive margins. We have evidence for ongoing vertical deformation in the mid-Atlantic region due to unloading of Laurentide ice. Forebulge advance and retreat is recorded in a variety of landforms close to the last Laurentide ice margin (Balco et al., 1998). Unloading of the Laurentide ice changed the North American stress field and may have triggered to intraplate seismicity (Grollimund and Zoback, 2001). Models of asthenosphere deformation can be improved by studying processes such as the lithospheric response to ice sheet loading and unloading, as well as to longer-term and longer wavelength deformations.

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