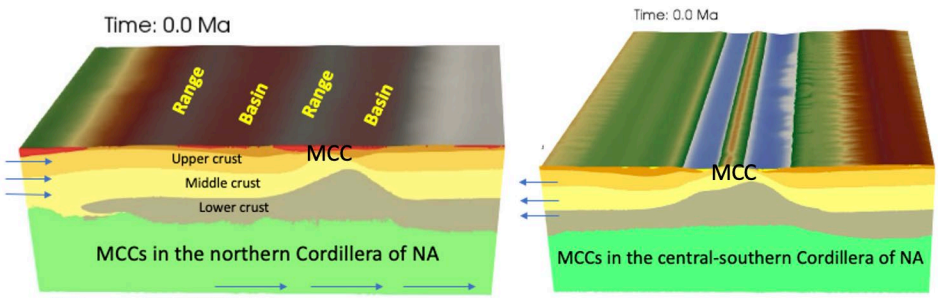
Stony Brook University

GEOLOGY OPEN NIGHT

LITHOSPHERE AND MANTLE DYNAMICS IN THE BASIN AND RANGE PROVINCE AND COLORADO PLATEAU: LANDSCAPE EVOLUTION AND GRAND CANYON DEVELOPMENT

DR. WILLIAM HOLT

Professor, Department of Geosciences



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The Basin and Range Province and the Colorado Plateau provide an exceptional setting to study how deep Earth processes shape landscapes. The relative roles of crustal rebound, mantle-driven uplift, and lithospheric forces in driving Cenozoic extension and canyon formation remain debated. We use numerical models that combine mantle flow, lithospheric stresses, plate boundary changes, and surface processes to reconstruct the region's history since the late Eocene. Our results show that high topography supported by a thick crustal root generated strong gravitational forces that drove large-scale crustal stretching and the rise of metamorphic core complexes as the crust collapsed. These forces, together with the shift from subduction to Pacific–North America plate motion, explain the observed directions and magnitudes of extension. Slab rollback and related mantle flow mainly weakened the lithosphere by adding heat, melts, and fluids. The models also reproduce drainage reorganizations—from northeast-directed flow onto the Colorado Plateau, to later southward and then southwestward flow—helping explain the timing and pathways of Grand Canyon development. Together, these results highlight how mantle processes, lithosphere dynamics, and surface evolution combine to sculpt landscapes in southwestern North America.

William E. Holt is a Professor of Geosciences at Stony Brook University. His research focuses on the kinematics and dynamics of the lithosphere, integrating geodesy, seismology, and mantle convection modeling to understand how solid Earth processes interact with climate and surface evolution. He was elected a Fellow of the American Geophysical Union in 2004 for his contributions to lithospheric dynamics, and he has led or co-led several major community initiatives, including development of the Global Strain Rate Map. Holt has authored more than 150 scientific papers, with recent work spanning the dynamics of western North America, intraplate stress in eastern North America, and tectonic–climate–ecological linkages in the Basin and Range and East African Rift.