Summary. This proposal addresses the fundamental question of whether plumes cause a significant and long−lasting modification of the lithosphere. This question is of critical importance to understanding the long−term evolution of both continental and oceanic lithosphere, and indeed has been advanced as the explanation for many major lithospheric features and events (e.g. uplift and subsidence, regional metamorphism, anatexis, crustal extension, flood basalts development, rifting, geoid anomaly, chemical heterogeneities). Here we focus on a region of old oceanic lithosphere in the western Atlantic, which is unique in having both a well−documented plume track and tomographic evidence of anomalous lithospheric structure that might possibly be due to erosion by the plume.

This part of the western Atlantic, offshore of New England, appears to be a site of extreme erosion of continental lithosphere and possibly mature (Jurassic age) oceanic lithosphere. In the surface−wave tomographic model of Van der Lee & Nolet [1997] for North America, lithospheric erosion is implied by a lineament of low (by 5%) shear wave velocities, 300−500 km wide, that extends from the North American coastal provinces to at least 1000 km seaward. These low velocities delimit a region where lithosphere appears to be substantially (50%) thinned. The erosion of New England continental lithosphere may reflect some past event associated with either continental assembly (~400 Ma), continental rifting (~200 Ma) or plume erosion (~100 Ma; the hot spot that created the New England seamounts), or some as−yet unrecognized ongoing tectonic process. The extension of the anomaly into the oceanic lithosphere of the western Atlantic, which we further document with new surface wave data discussed here, suggest that at least the oceanic part of the anomaly is post−rifting in origin and thus possibly plume−related. Ongoing lithospheric erosion would imply a thermal anomaly; fossil erosion would imply a compositional anomaly. I f erosion is ongoing, it may have initiated in the Cretaceous (~100 Ma), with the passage of the hot spot. However the persistence of a thermal anomaly through the present era would imply some continuing process to maintain the thinning, to counteract lithospheric thickening by conductive cooling. Such a process could be responsible for a low−velocity anomaly that extends far offshore into the Atlantic. If the seismic anomaly is compositional it would indicate that some past process has permanently modified the lithosphere in some major way. Resolution of offshore (i.e. oceanic) upper−mantle seismic structure is therefore key to determining the origin of this puzzling seismic anomaly.

The Western Atlantic Lithospheric Erosion (WALE) Experiment seeks to make new, high resolution seismic measurements of the eroded lithosphere and underlying asthenosphere that can distinguish between potential causative processes. An array of 18 Ocean Bottom Seismometers (all equipped with Differential Pressure Transducers; at least 10 with horizontal seismometers) will be deployed in a 650 x 550 km array that crosses the low−velocity anomaly near Kelvin seamount (i.e. on Mesozoic−age oceanic crust near Kelvin seamount, 600 km off the coast of Massachusetts), and operated for one year. Recordings of teleseisms will be used to construct both body and Rayleigh wave images of the upper mantle, and to quantify its seismic anisotropy and attenuation. These data will be used to answer the following fundamental questions about the nature of lithospheric erosion: 1) How much of the lithosphere (if any) was eroded?; 2) Is the remaining original lithosphere normal, or has it been altered?; 3) What is the cause for the slow velocities? Is this region lithosphere or asthenosphere? 4) Is there any deep−rooted perturbation in the asthenosphere? This study thus provides a means of testing the still−controversial hypothesis that the passage of a plume can cause a significant and long−lasting modification of the lithosphere.