

## Project Summary

Lamont-Doherty Earth Observatory proposes to replace the Research Vessel *Maurice Ewing* with an existing industry seismic vessel that will be capable of towing four 6 kilometer-long hydrophone arrays, or a single 10 kilometer-long array, towing two conventional linear source arrays, launching and recovering in excess of 100 ocean bottom seismometers, as well as many general oceanographic operations e.g., state-of-the-art swath bathymetry, dynamic positioning for coring, ROV operations and physical oceanography as well as abundant laboratory and deck space capable of supporting most programs requiring an ocean-class research vessel. The vessel, *Western Legend*, and a substantial suite of state-of-the-art seismic equipment will be purchased from the geophysical survey company, WesternGeco. A shipyard will perform the necessary ship modifications to satisfy US flagging requirements and to convert the vessel into a highly capable general purpose oceanographic vessel. The vessel will be operated for the US academic community as part of the UNOLS fleet, with guidance upon its capabilities and outfitting being provided by a standing oversight committee of experienced community leaders. This proposal is motivated by the determination that *Maurice Ewing* could not be upgraded to satisfy key requirements articulated by the research community: the most fundamental of which is the ability to efficiently carry out seismic imaging in three dimensions.

The understanding of complex earth processes beneath the ocean floor has reached a level of sophistication that demands imaging capabilities that are superior to those currently available to the academic community. The demands for spatial resolution are substantially greater than even those of ten years ago (e.g., magma distribution and movement beneath mid-ocean ridges at volumes of a few hundred cubic meters, or fluid flow within the deep seismogenic zones of convergent margins, or mapping of the complex heterogeneities of gas hydrate deposits). Spatial resolution comes only with spatial sampling, and it is essential to tow multiple hydrophone streamers in order to carry out the necessary sampling in a reasonable timeframe. The *Western Legend's* linear source arrays will provide a consistency in signature impossible to attain with *Ewing's* source system, significantly improving resolution of both 2D and 3D images.

Following modifications, the new vessel will have substantial general purpose laboratory space, a 1° by 1° multibeam sonar system, basic dynamic positioning capability, and the ability to handle most standard oceanographic over-the-side equipment. Importantly ship design modifications will make this vessel a superior platform for observing marine mammal activity.

Broader Impacts. The seismic capabilities of the *Western Legend* will allow imaging of deep earth structure. The seismic cross section, like CAT scans and sonograms in medicine, provides a “direct look” into the earth that very effectively communicates the importance of understanding the interior of the planet upon which we live. Examples of scientific problems significant for society include understanding earthquake source mechanisms and associated hazards and understanding the amount and distribution of sediment hosted gas beneath the world’s oceans.

Intellectual Merit. The unique capabilities of the *Western Legend* will improve the efficiency, quality and reliability of multichannel seismic data acquisition for the US academic community, enabling the widest range of problems in marine earth sciences to be tackled with substantially improved imaging capabilities.