Measuring Sea Floor Motion: New Technology for Continental Margin Geodesy

The giant earthquakes and tsunamis of 2004 (Sumatra) and 2011 (Japan) were wake up calls that our ability to estimate future earthquake magnitude and tsunami potential is weak. The difficulty of measuring offshore strain accumulation in this challenging environment is a contributing factor. The proposed research will lead to new technology for measurement of sea floor motion and deformation in the shallow continental shelf environment, including strain accumulation and release in the critical shallow offshore region of subduction zones. If successful, the proposed technology could augment current on-land monitoring in the Cascadia subduction zone in the Pacific Northwest, a key US priority because of the likelihood of a major earthquake and tsunami here in the future.

Existing technology for sea floor geodesy has limitations in terms of sensitivity, drift, and cost, limiting precise, long term, continuous, and spatially dense observations. This is especially true in the shallow continental shelf environment, where salinity and temperature variations in the ocean mean that the speed of sound in water is highly variable, challenging acoustic ranging techniques, and where oceanographic transients can confuse interpretation of sea floor pressure records. We propose to develop a new type of sea floor geodetic system, suitable for the shallow (less than 200 m) continental shelf environment. Our concept is based on a successful Italian design that uses high precision GPS mounted on a semi-rigid structure, moored to the sea floor. The system has been tested at 100 meters water depth on the flank of an active volcano. A network of such instruments would be economically feasible (ship operations are only required for initial installation and periodic maintenance, not data retrieval) and promises precise, accurate, continuous, real time deformation measurements, with fidelity nearly equivalent to land-based GPS networks. This research will develop and demonstrate such a system.