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Monitoring Seafloor Deformation: Acoustic Ranging Geodesy with Millimeter Precision

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The seafloor stores crucial information on sub-seafloor processes such as stress, strain, and earthquakes. This information can be extracted through the nascent scientific field of seafloor geodesy. Insitu measurements of seafloor deformation in millimeter-level precision on normal, thrust and strike-slip faults have the capability to improve our understanding of oceanic plate creation, destruction or sliding alongside and provide valuable information to the physical behavior of fault systems or nontectonic areas as flank instabilities of ocean volcanoes or continental margins. In the last decade technological achievements enabled an increasing amount of acoustic seafloor geodetic deployments. The acoustic ranging transponder networks measure relative positioning with millimeter precision for a period of up to 3.5 years. The transponders also include high-precision pressure sensors to monitor vertical movements and dual-axis inclinometers in order to measure their altitude as well as subsidence or uplift of submarine fault zones. Further components as a self-steering autonomous surface vehicle (Wave Glider) or moored buoys are able to monitor transponders health and are able to download the seafloor geodetic data to the sea surface and to transfer it via satellite.

We discuss the acoustic ranging method and processing strategies, in particular the uncertainties imposed from variations of the water column result in water sound speed temporal changes. Furthermore, we discuss results with millimeter-scale resolution capabilities of different network configurations of ongoing geodetic deployments from Mt Etna, North Anatolian Fault and offshore Northern Chile.