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Abstract:
The utilization of autonomous underwater vehicles (AUVs) as a platform from which to conduct seafloor mapping has witnessed proliferated use particularly in deep-sea petroleum exploration applications. In this paper we present recent novel applications of small man-portable coastal AUVs equipped with an advanced phase measuring bathymetric sonar system (GeoSwath-Plus) to shallow seafloor mapping efforts. Data are presented from various settings and applications including coral reef habitat mapping in Bonaire to shipwreck and artificial reef surveys in Delaware Bay.

In this presentation we examine some of the specific challenges and benefits that come from seafloor mapping with sonar equipped AUVs. Specifically we detail the operational and configuration challenges and data results from hydrographic data collected with a GeoSwath Plus enabled Gavia AUV. Technical challenges include issues of positioning, time-sync control, and electrical and acoustic noise suppression. Operational challenges include launch and recovery, environmental conditions, diver and vessel traffic, and mission planning (elevation, speed, line spacing, etc.). Through the illustration from recent field surveys we present how these various challenges have been addressed and discuss areas for future development and improvement.

As well as the standard range of sensors (e.g. pressure, GPS, altimeter, camera) the AUV presented carried several special seafloor mapping payloads: a DVL-aided INS (Kearfott T-24) and a 500 kHz GeoSwath wide swath bathymetric sonar from GeoAcoustics Ltd. The GeoSwath sonar operates at a ping rate of approximately 15 Hz. As the AUV swims over the seabed at about 4 knots (2 m/s) the GeoSwath is continually mapping what lies beneath with swath widths of 70 m at a typical terrain following elevation of 15 m. Because AUVs can fly in close proximity to the bottom (in terrain-following mode) they provided advantages for carrying sensitive sensors right to the survey site compared to using a surface boat. During recent operations in Bonaire the AUV was operated from the shore to depths up to 220 m deep, flying survey patterns at a constant 15 m altitude and accumulating a total of >40 km of trackline survey over 8 days of missions. The surveys were run using the ‘side-scan search pattern’ with parallel lines up to 1.2 km long spaced at 30 m & 60 m. Typically the GeoSwath data was inspected as scrolling waterfalls and processed to a 0.5 m grid: the

Kearfott T24 inertial navigation system (INS), when aided by the RDI Doppler velocity log (DVL), gave a position error with less than 0.5 m drift per hour, so the missions were kept fairly short (typically 2-3 hours) to ensure that high-resolution binning could be used.

One of the key features of the GeoSwath is that it collects simultaneous true digital side-scan data with the bathymetry. The side-scan resolution of the 500 kHz system is 0.5 degree along track and 3 cm across track, giving highly detailed images of the sea floor, corals and even the fish in the water column. The backscatter data is also useful in mapping and classifying the seafloor bottom type over the survey area. We present examples of efforts to implement automated classification systems (e.g. Geotexture and Geocoder) to the AUV gathered bathymetric sonar data.

Bios:

Dr. Art Trembanis is an Assistant professor of Geological Sciences and Director of the Coastal Sediments, Hydrodynamics, and Engineering Laboratory (CSHEL) at the University of Delaware. Prior to UD, he worked in the AUV industry and then conducted postdoctoral research at Woods Hole Oceangraphic Instiution. His research interests are in the measuring and modeling of coastal morphodynamics particularly beach erosion, beach nourishment, bedform behavior, and scour processes associated with seafloor objects including shipwrecks and mines.

Dr. Tom Hiller trained as an experimental physicist in the semiconductor industry. Since coming to the marine field Tom has worked in technical sales, application engineering and product management for several UK sonar manufacturers. In early 2003 Tom set up Anka Ltd of Bristol, UK, to provide hydrographic consultancy, systems engineering and training to the marine survey industry and government organisations. Since January 2005 Tom has been based full time at GeoAcoustics Ltd. in Great Yarmouth, UK, working on the development of a range of new technologies for the sonar survey market.

Dr. Luciano Fonseca received a PhD in Ocean Engineering from the University of New Hampshire and a Master Degree in Electrical Engineering from the University of Campinas. He joined the Center in 2003 after 12 years of experience in research and development in oil the industry. Dr. Fonseca's research is focused on developing tools for extracting quantitative seafloor property information from multibeam backscatter and on modeling acoustic backscatter response of gassy sediments.

Professor Larry Mayer received a Ph.D. from the Scripps Institution of Oceanography in Marine Geophysics. In 2000 he became the founding director of the Center for Coastal and Ocean Mapping at the University of New Hampshire and the co-director of the NOAA/UNH Joint Hydrographic Center. Dr. Mayer has participated in more than 50 cruises (over 60 months at sea!) during the last 30 years and has been chief or co-chief scientist of numerous

expeditions including two legs of the Ocean Drilling Program. He has served on, or chaired, far too many international panels and committees and has the requisite large number of publications on a variety of topics in marine geology and geophysics. His research deals with sonar imaging, remote characterization of the seafloor, and advanced applications of 3-D visualization to ocean mapping problems.