Multidisciplinary Observatory Development in Monterey Bay

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Monterey Bay Aquarium Research Institute has several ongoing parallel development efforts that have a common goal of providing long-term multi-sensor measurements of ground motion and fluid flow on the seafloor. Instrument packages are being designed to operate in a low-power, autonomous mode, but a planned logger/controller will provide ethernet connection to available cables to either a shore laboratory or a telemetered mooring.

Seismometer development was initiated at MBARI in 1996 with the development of a short-period corehole seismometer, designed and fabricated by the JPL Microdevice laboratory. This sensor package uses three standard 4.5 hz geophones with an extended response to about 0.8 hz,. The sensor package is placed into small-diameter boreholes drilled into basement outcrops to provide superior coupling and greatly reduced noise. A new low-power datalogger, the GeoSense LP1, was developed in 1997, and can provide more than 24 GB on less than 0.3 watt of power, easily supporting 12 month deployments.

Methodologies to deploy broadband seismic sensor packages has been undertaken in collaboration with UC Berkeley. In the summer of 1997, a suite of geophysical instrument packages was deployed on the ocean floor for 3 months using MBARI's ROV Ventana, under the aegis of MOISE (Monterey Bay Ocean Bottom International Seismic Experiment), an international cooperative pilot experiment between MBARI, DT/INSU,IPGP and UBO (France) and UC Berkeley. The deployment site was in Monterey Bay, 40km offshore and 10km west of the San Gregorio fault at a water depth of 1015m. The instruments deployed included; a 3 component Guralp CMG-3T broadband seismometer system, mounted on leveling gymbals, with a self-recentering program designed by DT/INSU. The sensor package was half buried in the sediments. The broadband was connected on the seafloor by the ROV to an L-CHEAPO recording system (designed by Scripps/IGPP and modified by MBARI) and to an external battery pack. A CTD/Paroscientific pressure gauge package and an S4 current meter were placed nearby to measure local bottom currents. A stand-alone electromagnetic sensor package, contributed by UBO was also deployed by the ROV and recovered via elevator. In addition, two MBARI well-coupled corehole seismometers were deployed at adjacent sites along with a variety of conventional short-period seismometers and hydrophones deployed as stand-alone, contemporaneous measurements. On three separate dives a connection was made from the ship to the L-CHEAPO via the ROV RS232 with command and data links through the datalogger to the seismometer package. Through this link we were able to a) successfully level and initiate the data collection and recentering routines, b) extract samples of both historical and real-time data to the state-of-health of the system and c) re-level the seismometer sensors. This experiment was, in particular, a successful feasibility test for ocean floor deployment of broadband sensors using an ROV.

As a follow-up to the MOISE experiment, in a cooperative project between MBARI and UC Berkeley, with partial support from NSF, we are currently planning the permanent deployment of a broadband, three component seismometer package, in Monterey Bay. The deployment will comprise a Guralp CMG-1T sensor package, which will be completely buried under the seafloor, a modified LP1 data logger, current meter and pressure gauges, and will be initially configured for stand-alone operation for at least 1 year. The deployment is planned for September 2001. The data will be available through the NCEDC (Northern California Earthquake Data Center) at UC Berkeley, as part of the Berkeley Digital Seismic Network. Eventually, data telemetry to

UC Berkeley will be achieved by hooking up the seafloor packages to the buoy system and/or ocean floor cable developed in the framework of the MOOS program at MBARI.

Five MBARI corehole seismometers were deployed in Monterey Bay during 9 months in 1998 as part of the MBARI Margin Seismology Project. The sensors were placed into holes in granite outcrops drilled by the ROV diamond coring system. On sedimented seafloor, the instruments were deployed within low-provide cement "portable" boreholes. The data from these extended deployments have constrained the distribution of seismicity on the off-shore segments of the San Gregorio fault, identifying the northern San Gregorio as a zone of anomalously high seismicity (Begnaud and Stakes, 2000) with dominantly thrust focal mechanisms. An improved local crustal velocity model permitted the relocation of all moderate events dating back to 1926 (Begnaud et al., 2000). Based on these results, the southern San Gregorio is apparently aseismic. During 2001, three of these corehole instruments will be deployed to both supplement data from the land-based array and to provide developmental sites for a planned logger development to the LP2. This advanced datalogger will use a new cpu for faster computations and insitu data analyses. The LP2 will also provide an ethernet connection for faster data transfers. We envision the LP2 as the core of a mini-observatory to operate in an autonomous mode or as a multiple sensor node on a larger cabled experiment.

During the next two years our goal will be to interface multiple sensors onto the LP2 logger/controller for studies of fluid flow in volcanically and tectonically active sections of the mid-ocean ridge. This effort will combine the achievements of the seismology efforts with new chemical sensors developed at MBARI and MOOS, the MBARI Ocean Observatory System, a telemetered mooring capable of providing near real-time communication to instruments on the seafloor. As part of this latter effort, the ROV will be used to install thin cables between instruments and a central node.

Chemical sensor systems with long-term (order 1 year) endurance and stability now exist for several chemicals of relevance to hydrothermal systems including sulfide, bromide and iron. These systems can be deployed in an observatory network to couple seismic, heat flow and chemical observations in an integrated study of the processes that transport and transform mantle energy into hydrothermal ecosystems. The Fe-Osmoanalyzer has successfully deployed on Axial Seamount, monitoring Fe-variations in vent fluids. The new sensors will be supplemented by conventional physical sensors to measure temperature and particulates adapted to the extended periods of observation. The Osmosampler collects continuous small volumes of fluid into capillary tubes. These samples will be used to supplement the data provided by the in-situ analyzers. Other, more complex, fluid and microbial samplers have yet to be adapted to seafloor deployments.

References cited:

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