

The ADWBC cruise will likely involve the oceanographic research vessel *R/V Knorr*, a U.S. Navy-owned ship operated by the Woods Hole Oceanographic Institution (WHOI). However, another vessel may ultimately be chosen for the survey. Other possible vessels include, but are not limited to, the *R/V Maurice Ewing* or a vessel from the University-National Oceanographic Laboratory System (UNOLS). The vessel would be using a portable LDEO seismic system to conduct the seismic survey. The vessel will deploy 2 General Injector guns as an energy source, plus a towed streamer containing hydrophones to receive the returning acoustic signals. The hydrophone array will consist of a 600-m (1969 ft) solid state streamer with a 200-m (656 ft) tow leader. The energy to the airgun array is compressed air supplied by compressors on board the source vessel. As the 2 GI guns are towed along the survey line, the hydrophone array will receive the returning signals and transfer the data to the onboard processing system. All planned geophysical activities will be conducted by the scientists who have proposed the study, while LDEO will provide the portable high-resolution seismic system that will support the seismic surveys for the proposed study. The ADWBC program will consist of 4334 km (2340 n.mi.) of seismic profiles that will be shot over a period of 20 days. The most detailed grids of seismic lines are proposed for the southern end of J Anomaly Ridge and for moats around seamounts on the crest of the Southeast Newfoundland Ridge - both are areas where there appear to be extensive pre-Neogene outcrops. Water depths in the area will vary from 4000 to 5000 m (13,124–16,405 ft).

The procedures to be used for the two seismic studies will be similar to those used during previous seismic surveys by LDEO, e.g., in the equatorial Pacific Ocean (Carbotte *et al.*, 1998, 2000). The proposed seismic surveys will use conventional seismic methodology with a towed airgun array as the energy source, and either a towed hydrophone streamer or OBH and OBS receivers placed on the bottom to receive the reflected signals. For the TAG survey, eighteen OBHs will be deployed (and recovered) by the *Maurice Ewing* - eight along each of the long axis lines and two on the across axis line. After the seismic lines are shot, the data will be downloaded and the OBSs will be retrieved during an, as of yet, unscheduled cruise in the summer of 2004 (during which no seismic sound sources will be used). Along three selected seismic lines, 13 OBS receivers

will be placed in the proposed study area by the *R/V Alvin* from 7–24 June 2003, before the arrival of the *Maurice Ewing*. In addition, a multi-beam bathymetric sonar will be operated from the source vessel continuously throughout both cruises, and a lower-energy sub-bottom profiler will also be operated during most of both surveys. During the ADWBC study, coring of numerous sedimentary outcrops known to exist on the ridges will also take place. During both cruises, there will be additional operations associated with equipment testing, startup, line changes, and repeat coverage of any areas where initial data quality is sub-standard.

The *R/V Maurice Ewing* will be used as the source vessel during the TAG cruise, and the *R/V Knorr* will likely be used as the source vessel during the ADWBC cruise. Both vessels will tow airgun arrays along predetermined lines, and will also serve as platforms from which vessel-based marine mammal observers will watch for marine mammals before and during airgun operations.

During TAG-study airgun operations, the vessel will travel at 7.4–9.3 km/hr (4–5 knots), and seismic pulses will be emitted at intervals of 60–90 seconds (OBS lines during the TAG cruise). The 60–90 sec. spacing along OBS lines is to minimize reverberation from previous shot noise during OBS data acquisition, and the exact spacing will depend on water depth. The airgun array to be used will consist of 20 2000 psi Bolt airguns, towed at a depth of 7.5 m (24.5 ft). The 20-gun array will include airguns ranging in chamber volume from 80 to 850 in³, with a total volume of 8,575 in³. These airguns will be spaced in an approximate rectangle with dimensions of 35 m (115 ft) (across track) by 9 m (30 ft) (along track).

The ADWBC seismic survey will be high-resolution, consisting of two 105 in³ GI airguns with a total volume of approximately 210 in³, spaced 7.8 m (26 ft) apart, and towed 37 m (121 ft) behind the vessel at a depth of 2–3 m (7–10 ft). Towing airguns at this shallow depth is accomplished by suspending the guns from floats, and the resulting short-period free surface “ghosting” keeps the spectral content broad with usable signals up to 300–350 Hz. These airguns produce an unusually clean impulse with sufficient energy to penetrate many hundreds of meters of sediment. Airgun firing, timing, and synchronizing is handled by a LDEO-built controller, which is integrated with a SUN workstation-based DGPS navigation, data logging, and fire control system. The air is produced by a standalone Price Co. 2000 psi compressor, and the

seismic signals are detected by a solid state ITI hydrophone “Stealtharray”, with 48 12.5-m (41 ft) long channels, and a total length of 600 m (1969 ft).

The dominant frequency components for both airgun arrays is 0 - 188 Hz. The 2-airgun array will have a peak sound source output level of 237 dB re 1 µPa or 243 dB peak-to-peak (P-P). The 20-airgun array will have a peak sound source output level of 255 dB re 1 µPa or 262 dB P-P. Because the actual source is a distributed sound source (2 or 20 airguns) rather than a single point source, the highest sound levels measurable at any location in the water will be less than the nominal source level. Also, because of the downward directional nature of the sound from these airgun arrays, the effective source level for sound propagating in near-horizontal directions will be substantially lower.

Along with the airgun operations, several additional acoustical data acquisition systems will be operated during most or all of the cruises. The ocean floor will be mapped with an Atlas Hydrosweep DS-2 multi-beam 15.5-kHz bathymetric sonar, and/or a 3.5-kHz sub-bottom profiler. These mid-frequency sound sources are commonly operated from research vessels simultaneous with airgun arrays as well as in the absence of airgun activity.

The Atlas Hydrosweep sonar will be used during cruises by the *R/V Maurice Ewing*, is mounted in the hull of the vessel, and operates in three modes depending on the water depth. The first is a shallow-water mode when water depth is <400 m (1312.3 ft); source output is 210 dB re 1 µPa-m rms and a single 1-millisecond (ms) pulse or “ping” per second is transmitted, with a beamwidth of 2.67 degrees fore-aft and 90 degrees in athwartship. The beamwidth is measured to the -3 dB point, as is usually quoted for sonars. The other two modes are deep-water modes: The Omni mode is identical to the shallow-water mode except that the source output is 220 dB rms (normally used only during start up). The Rotational Directional Transmission (RDT) mode is normally used during deep-water operation and has a 237 dB rms source output. In the RDT mode, each “ping” consists of five successive transmissions, each ensonifying a beam that extends 2.67 degrees fore-aft and approximately 30 degrees in the cross-track direction. The five successive transmissions (segments) sweep from port to starboard with minor overlap, spanning an overall cross-track angular extent of about 140 degrees, with tiny (<1 millisecond) gaps between the pulses for successive 30-degree segments. The