The HAWAII MR1 Seafloor Mapping System

HAWAI`I MAPPING RESEARCH GROUP

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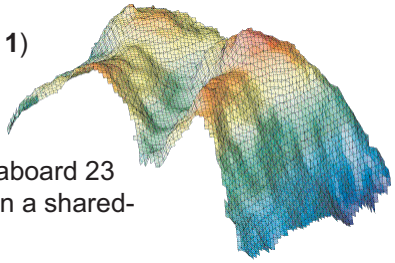
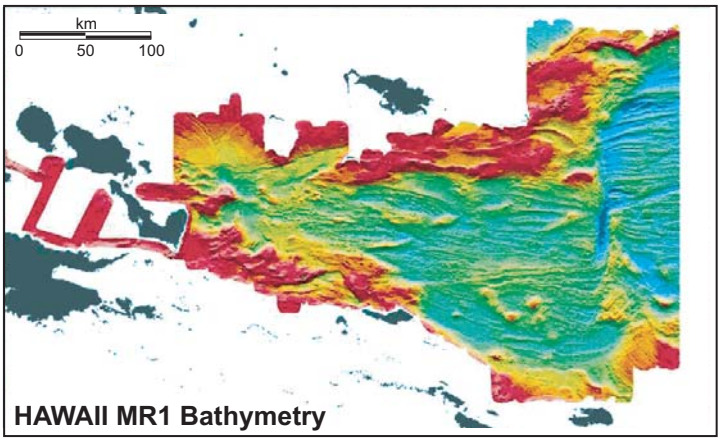


The HAWAII MR1 (**H**IG **A**coustic **W**ide-**A**ngle **I**maging **I**nstrument, **M**odel **R**evision **1**) seafloor imaging system is a wide swath side-scanning sonar instrument that acquires digital bathymetry and acoustic backscatter (sidescan sonar) in full ocean depths. MR1 was designed and built by the Hawai`i Mapping Research Group (HMRG) at the University of Hawaii in 1991, and has since been deployed aboard 23 different vessels on 32 separate research surveys. The MR1 system is available on a shared-use basis for U.S. research groups via NSF, ONR or other federal funding.

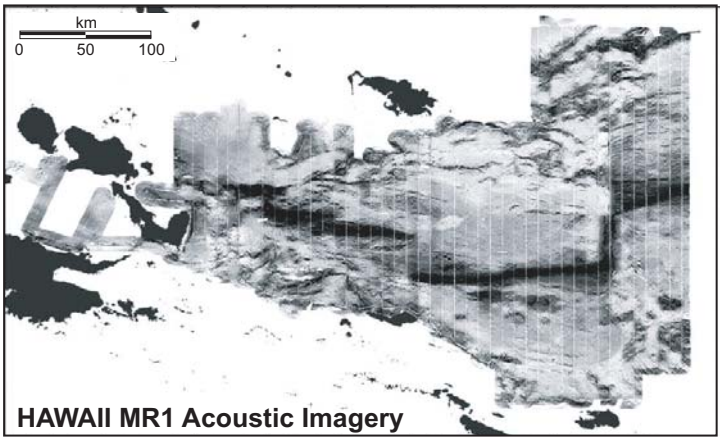
MR1 System. MR1 is a portable side-scanning seafloor imaging system that simultaneously acquires digital bathymetry (swath width > 3.4 times water depth) and sidescan sonar imagery (swath width > 7.5 times water depth). The system's sonar transducers are housed in a 5-meter-long vehicle that is towed beneath the surface mixed layer (80 to 100 m) at ship speeds of 3 to 10 knots. The MR1 towfish is extremely stable due to its multi-body towing configuration and large righting moment. As a result, MR1 has successfully operated in rough sea conditions (up to sea state 8) that typically cause performance degradation in hull-mounted systems due to bubble masking and violent ship motion.

MR1 Bathymetry. MR1 uses the phase difference method to measure a swath of depth soundings. Flexible data processing software allows power, ping rate and beam spacing to vary in order to maximize the swath width and data quality with changing seafloor depth and acoustic properties. MR1 accounts for acoustic ray bending during the phase-to-geometric angle conversion, using data collected during a calibration test at the beginning of each survey. The system can be re-calibrated at any time during the survey to account for changing water column properties. The MR1 has successfully completed mapping missions where IHO bathymetric standards were required.



HAWAII MR1 Bathymetry

MR1 Data Acquisition. MR1 transmit power, pulse length and repetition rate can be varied so that each parameter is appropriate for the survey objectives. MR1's high power and 11/12 kHz frequency enable sidescan swath widths up to 30 km. Pulse lengths are user-selectable from 1 to 10 milliseconds, and repetition rates as long as 21 seconds are supported. Raw acoustic data are logged and archived as 16-bit floating point numbers plus their exponents. This high dynamic range allows the entire range of echo strengths to be acquired without applying system gain. The system automatically records all raw acoustic data from the time of transmission until the end of the tranmsmit cycle, ensuring that all raw data are recorded and archived. As a result, MR1 can be operated without any real-time watchstanders.



HAWAII MR1 Acoustic Imagery

HAWAII MR1 data from the Woodlark Basin (Soloman Sea) collected over a 21-day period in 1993. This survey was conducted by Drs. Brian Taylor, Richard Hey and Fernando Martinez (University of Hawaii) to study structural processes associated with the propagation of a seafloor spreading center into continental crust of Papua New Guinea.

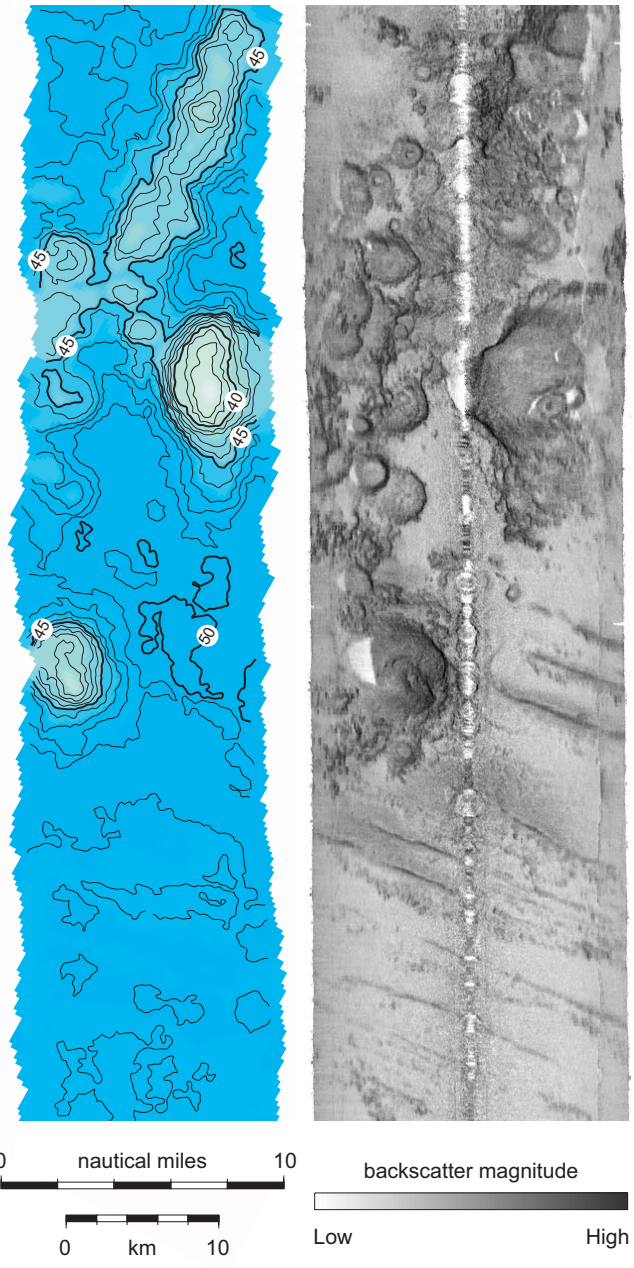


HAWAII MR1
LAUNCH & RECOVERY SYSTEM


Shipboard Operations. The MR1 system was designed for portability and ease of use on different ships. The MR1 towfish is deployed using a hydraulic Launch and Recovery System (LRS) mounted at the ship's stern. The LRS contains a hydraulic tilt-bed assembly that requires only two people to operate. The towfish is attached to a 50 m-long umbilical that in turn is attached to a one-ton depressor weight. This two-body towing configuration decouples the towfish from the heave of the ship. The depressor weight is attached to the ship by a 0.68" armored coaxial cable that passes through a tow point on the LRS to a winch mounted forward of the LRS.

Shipboard MR1 Data Processing. As bathymetry and acoustic data are collected, real-time images of each are displayed on the acquisition computer monitor. Data acquisition and display are controlled by a Sun Microsystems workstation, and raw acoustic data are redundantly archived on dual 8mm data cartridges. A backup acquisition computer system is maintained at sea to serve as an immediate replacement if the primary system fails. Bathymetry and imagery are merged with navigation and processed offline to create charts in near-real time. Sidescan image processing tools include beam pattern correction, amplitude normalization, destriping and despeckling routines that can be applied interactively or in batch-processing mode. MR1 data processing software is freely available from HMRG, and MR1 users are encouraged to learn and participate in data processing at sea, and to install and use HMRG processing software at their research institutions.

Data Products. HMRG produces shipboard charts of bathymetry and acoustic imagery in near-real time. Gridded data can be displayed in geographic coordinates within 15 minutes of acquisition, and A0-sized 1:100,000 scale charts are printed on large-format plotters within 6 hours of data acquisition. Standard products (delivered at the end of the survey) include bathymetry and sidescan charts at a mutually agreed scale and projection, a copy of raw digital acoustic data, and copies of processed digital data in MR1 format. On request, digital data can be provided in ascii xy(z,i) or gridded format suitable for use with the Generic Mapping Tools (GMT) or other GIS packages. Raw digital acoustic data, processed data and charts are all written to CD-ROM and archived at University of Hawaii.



MR1 bathymetry and acoustic imagery of small volcanoes (top) and abyssal hills (bottom) in the North Pacific Ocean. Bathymetry contour interval is 100 m, annotated in hundreds of meters. Sidescan swath width is 20 km. These images contain 3 hours of data that were processed, gridded and charted at sea -- no additional data processing has been performed.