The information most fundamental to the study of marine geology is the shape of the sea floor. Information obtained by seafloor mapping systems can be categorized as (1) sea floor depth (bathymetry), (2) acoustic backscatter character (side-scan sonar), (3) optical character (photography and direct observations), and (4) sub bottom profiles (low-frequency sonar and seismics). Primary trade-offs associated with these systems are (1) coverage vs. detail of resolution, (2) specialization vs. generalization, and (3) hull-mounted vs. towed vs. autonomous.

Hull-mounted systems for acoustic mapping have several distinct advantages. They tend to be easy to operate, as they do not require specific deployment on each cruise, thus leading to lower operational costs and greater use. Hull-mounted systems maximized the mapping of the global sea floor by providing data from track lines of ships that are concentrating on other types on other types of oceanographic studies. Another advantage is the lack of “over the side” equipment (i.e., deployed by cable into the water), so maintaining a finite velocity is not required. They can also be used for real-time positioning relative to sea floor features and this position can be accurately maintained with small course and speed adjustments. Accurately maintaining a single position can be very advantageous for sampling, instrument deployment, and a wide range of other studies.

Hull-mounted systems have several drawbacks. They tend to be acoustically noisy as they are near the surface turbulence and ship noise. Depth and position accuracy suffer from poorly constrained and spatially and temporally variable velocity profiles. Collection of detailed information is more difficult then with a deep-towed system. Accessing major components of the in-hull system require dry-docking the vessel, which is great deal more difficult then simply dismantling a towed sensor. Finally, as transducer placement is critical, only certain hull designs are capable of housing a sensor array.

Conversely, towed systems are easier to move from ship to ship and operate in quieter and thermally more consistent waters below the thermocline, a distinct advantage during high seas. Towed instruments offer a wider variety of coarse/fine resolutions based on the depth of tow. Disadvantages of towed systems include increased difficulty and cost of handling associated with towing an instrument. Rough weather my limit the ability to recover a deployed instrument and increases risks associated with damage or loss of the instrument. Knowing the position of data collection is more difficult with a deeply towed system so a transponder network is often needed.

Autonomous seafloor mapping technology is limited by the labor intensive nature of deployment and recovery, which limits the length of a single deployment. They do have several exceptional advantages: accessing hard-to-reach sites, hovering over a site, determining the exact setting of sampling. Making real-time decisions based on the highest resolution visual information, and precisely placing in context measurements and experiments.

Bathymetric systems have two basic classes: profiles (collect a single line of data below the instrument) and swath mappers (simultaneously produce multiple lines). Swath systems include multi-beam (beams are electronically “steered” over a set of beam
tracks) and split-beam (interferometric difference in phase). Both systems calculate along track point data, but split-beam is generally less accurate.

Side scan sonar does not determine bathymetry, but rather the shape and dimensions of features of the sea floor structure. Side scan systems operate by receiving a transmitted “ping” and sequentially rating the return by assigning a digital intensity (0-255) to reflection amplitude.