



Case study: Submarine Crashes into Uncharted Seamount

On January 8, 2005, the nuclear submarine *USS San Francisco* ran aground enroute from Guam to Brisbane, Australia. In one of the worst submarine accidents in U.S. naval history, the sub crashed into a large seamount (an underwater volcano) that rose 2000 m from the surrounding ocean floor. The seamount could have been avoided if it had appeared on the navigational charts used by the sub'. Four minutes before the crash the submarine's sonar measured a false depth of 2000 m. The crash actually occurred at a depth of ~160 m, while traveling at a speed of 33 knots or ~38 mph (by comparison the average cruising speed of most oceanographic research vessels is 10-12 knots). The impact of the collision punched huge holes in the forward ballast tanks of the sub (Figure 1), which in turn shut down the throttles, and caused the sub to drift listlessly, its bow pointing down. Luckily, the sub's nuclear reactor and the crew's quarters were not compromised. However, one crewman was killed in the accident and 115 were injured. The rest of the crew managed to keep the sub from sinking during a harrowing 30-hour, 360-mile transit back to Guam.

The commander of the *USS San Francisco* accepted full blame for the incident, acknowledging several critical mistakes, including traveling too fast given the lack of existing data on their navigational chart, not taking enough forward soundings to ensure that their path was really clear, and failing to cross-check the route with other charts. Subsequent interviews with the commander, with fifteen other officers and enlisted men, as well as a review of Navy reports, raised questions about the training and support of U.S. submariners in general, but also the relatively primitive state of nautical charts upon which the crews rely. Navy officials reported that the main navigational chart in use by the crew was prepared in 1989 by the Defense Mapping Agency (DMA) and had never been revised. The chart did not show any potential obstacles within three nautical miles of the crash (Figure 2). Soon after the incident, Department of Defense (DoD) officials reported finding a Landsat satellite image from 1999 showing a seamount rising to within 100 feet of the sea surface in the area of the crash (as indicated by subtle variations in water color). Why hadn't the DMA updated their 1989 charts to show this feature? Navy officials said that the incident occurred in an area that was no longer of high priority for updating bathymetry (ocean floor topography) due to the cessation of the Cold War. Although the Navy began basing submarines out of Guam in 2002, it has focused improvement of its nautical charts in the shallow coastal waters of the Middle East as part of the "war on terror." The DMA had also consistently lacked the resources to properly compile, convert and interpret satellite data for the systematic updating of charts, nor had it been able to fully ensure the accuracy, precision, resolution, and validity of current charts. This agency has since been absorbed into the DoD's National Geospatial-Intelligence Agency (NGA), for the provision of maps, nautical charts and other geographic intelligence to the nation's combat forces.

Mapping the global ocean floor remains one of the grand challenges of oceanography. Humankind has made more progress during the past 20 years of mapping the surface of our moon, Venus and Mars than during the past 500 years of mapping the oceans. Sandwell et al. (2003) estimate that it will take another 125 years to fully map the ocean floor at a resolution of 200 m, the level of detail needed for most geological studies and deep nautical charts. An even

higher resolution is needed for global nearshore ocean resource management, conservation, and spatial planning. The cost of this effort is estimated at \$1 billion. The damage to the *USS San Francisco* was estimated at \$1 billion. How many oceanographic mapping expeditions or satellite altimeter missions could have been funded with that lost money?

Partly as a result of the *USS San Francisco* incident, the NGA entered into a memorandum of agreement (MOA) with the Naval Meteorology and Oceanography Command, the National Oceanic and Atmospheric Administration, and the Scripps Institution of Oceanography to improve predicted bathymetry for the world's oceans. This July 2005 MOA includes ongoing efforts to:

- 1) retrack all satellite radar altimetry data for gravity field improvement (funded by NSF, NOAA, and petroleum exploration companies and now mostly complete);
- 2) edit/rescue bathymetry data from about 1800 archived seagoing expeditions (funded by the Office of Naval Research or ONR);
- 3) construct a 1-minute global bathymetry grid for delivery to the parties of the MOA (funded by ONR and recently completed); and
- 4) perform scientific studies with the improved data (ongoing).

Knowing that many years will pass before improved bathymetric maps will become available, the U.S. Navy has invited you to brief its training personnel on how navigators can minimize risk to its ships and crews. As a representative of the GIS profession, what are your ethical obligations?



Fig. 1. Photograph of the *USS San Francisco* in dry dock after the accident (courtesy of David Sandwell, Scripps Institution of Oceanography). Note the men walking within the orange, gated area on top of the submarine for scale.

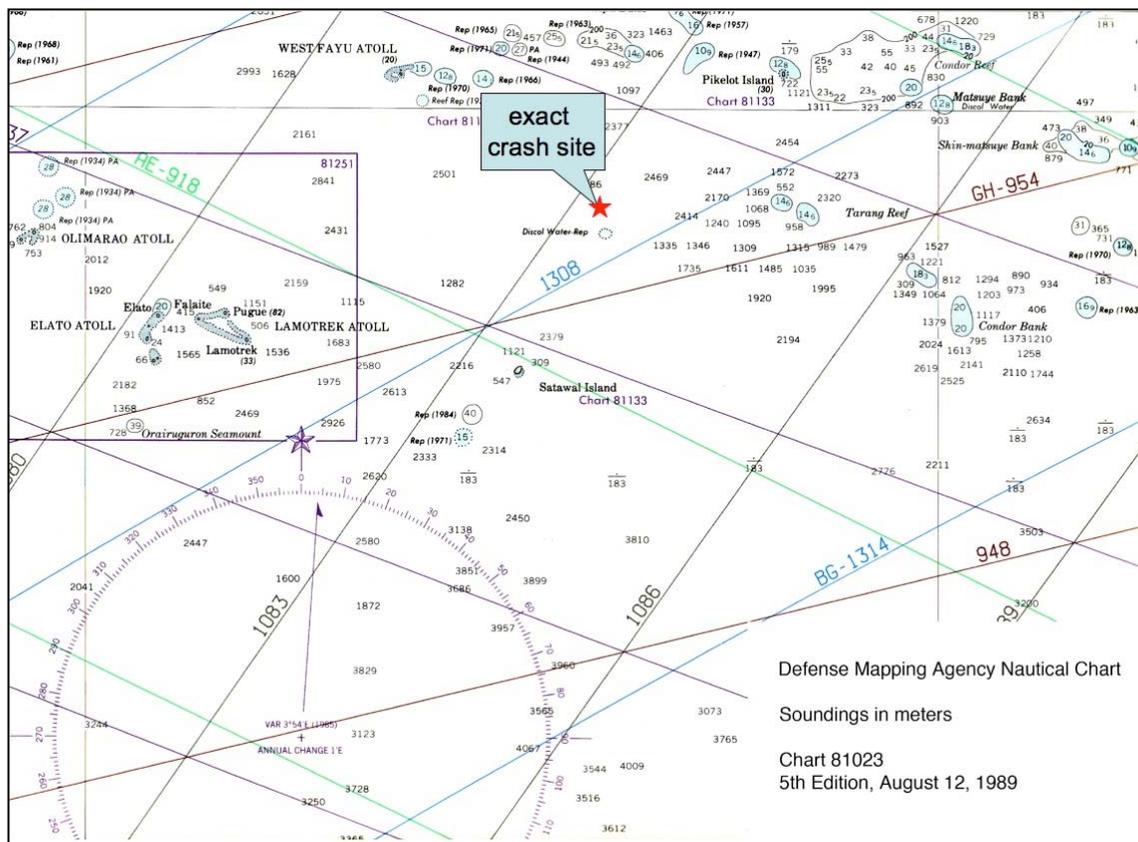


Fig. 2. Defense Mapping Agency (DMA) nautical chart of 1989 with the location marked of the submarine's collision with the seamount (Sandwell and Wessel, 2006). Note the paucity of soundings in the DMA's database for this part of the western Pacific.

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Resources for educators

Suggested discussion points, relevant GISCI Rules of Conduct, and further resources related to this case study are available on request. Send request to David DiBiase (dibiase@psu.edu) along with contact information (including your position and affiliation) and a brief description of how you plan to use the case.

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