TOBI

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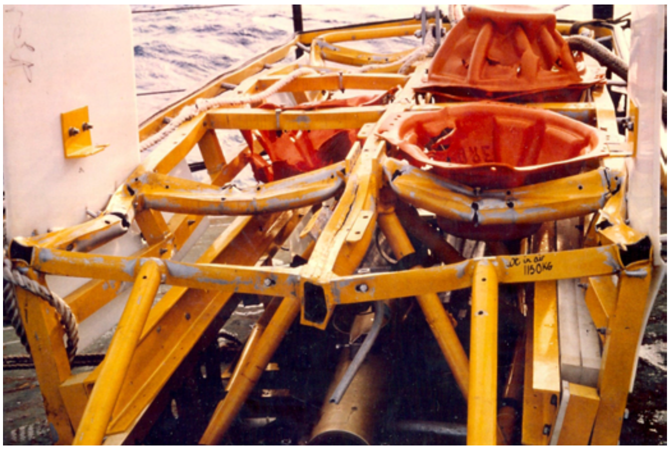
Beginnings

TOBI stands for Towed Ocean Bottom Instrument, but being a common dog's name, it perhaps also suggests a dog on a lead – quite appropriate for a 1- ton instrument pulled on the end of 6-8 km of cable!

TOBI's core instrumentation comprises a 30 kHz sidescan sonar (with two sets of transducers, to look to port and starboard), three-component magnetometer, ~7kHz broad-band sub-bottom profiler, and CTD. It has also been used as a platform for other instruments, such as NOAA's MAPR (Miniature Autonomous Plume Recorder). TOBI also provided swath bathymetry by measuring the phase difference between two closely spaced transducer arrays (within the two yellow housings in this image), but the in-house development lacked support and produced only moderate results. In the late 2000s there was an attempt to use a commercial bathymetric sonar.

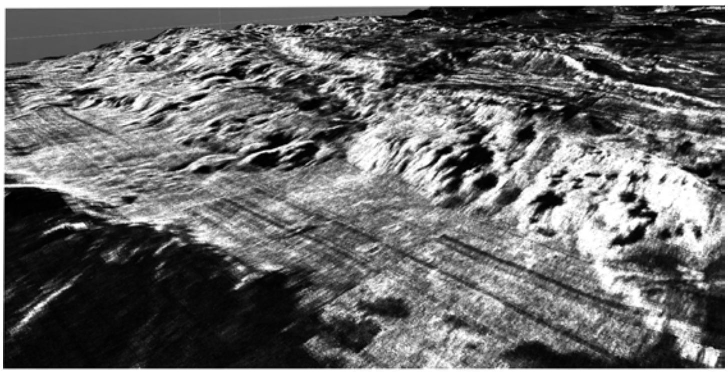


TOBI was developed in the 1980s. At that time GLORIA was at the height of her powers, but it was becoming clear that there was a need for higher-resolution data (GLORIA's pixel size was ~50 – 100 m). This required use of a higher frequency, with consequent increased attenuation, which meant the instrument had to be near the seabed. The final design [1] used a 30 kHz sonar frequency on a vehicle towed ~400 m above the seafloor. In the event, this proved to be a near-perfect combination, producing a pixel size of ~10 m. The design expertise on deep-ocean acoustic transducers built up at Wormley over many years was crucial to the project.

Initial testing at sea [2] in October 1984 on Discovery, down to 3000 m, concentrated on developing safe procedures for launch and recovery, and towing stability was examined using data telemetered from sensors within the instrument. A subsequent trials cruise in August 1985 was intended to prove the sonar system was only partially successful. TOBI's first deep-sea test deployment [3] on Charles Darwin cruise 9B/85 was dramatic! After paying out 5.4 km of wire, with the vehicle at a depth of 4000 m, all signals were lost. A difficult recovery followed lasting over 4 hours, at the end of which we discovered that the vehicle had been completely destroyed by an implosion of its glass sphere buoyancy. The result looked as though a bomb had gone off (at that depth, the potential energy of one 17-inch sphere is 0.8 MJ, equivalent to 0.4 pounds of high explosive). A revised design moved away from glass spheres to syntactic foam for buoyancy. This, painted orange, provides TOBI with its distinctive appearance, and has proven incredibly robust.

TOBI's great strength is its sidescan which, with a frequency of 30 kHz and consequently a wavelength of 5 cm, proved to be ideally suited to imaging a great variety of volcanic, tectonic, sedimentary, and biogenic structures on the seafloor. These have provided new insights, and often paradigm shifts, in many areas of seafloor geology, including: the distribution and nature of volcanoes at mid-ocean ridge spreading centres; the nature of MOR faulting including recently-recognised detachment faults; underwater erosional features at a range of scales; sediment waves and other distribution features; tsunamigenic sediment slides; submarine canyons; deep-sea coral mounds.

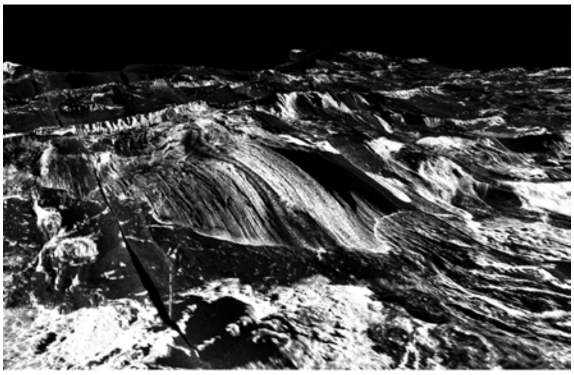
Mid-Ocean Ridge spreading centres



An _10 km-wide oblique view of the axial volcanic ridge on the Mid-Atlantic Ridge near 45°N, showing thousands of individual volcanic cones that compose it.

Many TOBI cruises targeted mid-ocean ridges. The sidescan was ideal for mapping volcanic [4] and tectonic [5] terrain, and produces spectacular images when draped over the seafloor bathymetry, as in the two images here. Early results identified Axial Volcanic Ridges [6] as the loci of new plate construction, and many studies examined their details along substantial parts of the Mid-Atlantic and SW Indian Ridges [7]. These studies also demonstrated that erosion and mass-wasting of steep slopes, such as fault scarps, are common underwater, despite the absence of 'weather' (note gullies in scarp at rear of image below)!

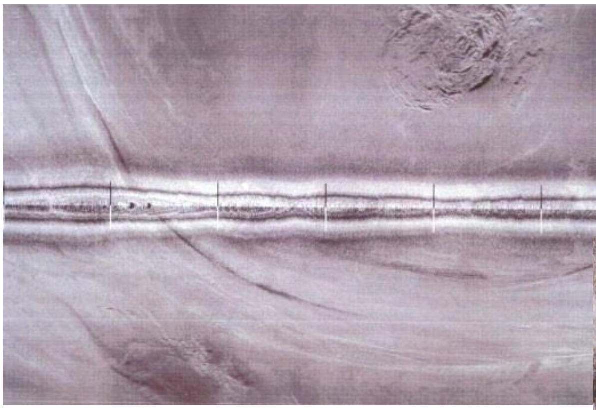
More recently, TOBI has been used to study the newly-discovered 'detachment faults' [8] and related Oceanic Core Complexes (right, image ~15 km wide). These are places where new lithosphere is created not as a result of mantle melting and crustal volcanism, but by ductile material being drawn up directly out of the mantle onto the seafloor.



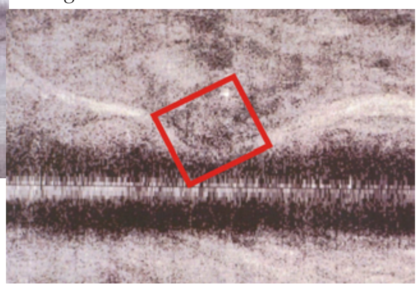
~15 km-wide oblique view of an Oceanic Core Complex on the Mid-Atlantic Ridge near 13°N. The OCC forms a broad mound, whose striated surface is the emerging detachment fault, taking up most of the motion of tectonic plate separation here. Young volcanoes in the axial volcanic ridge (bright, foreground) die out opposite the OCC. An eroded, gullied fault scarp is seen in the left background.

Sediments

A great deal of TOBI work has concentrated on underwater channels [9], sediment slides [10], sediment waves [11], and even coral mounds. These structures often originate on continental or volcanic island slopes, and much fundamental work has been carried out on the details of these structures and processes. There is a clear link here to societal benefit, since slides may be catastrophic in nature and tsunamigenic. Many of these studies have built on earlier GLORIA work in the same areas, as shown by the images on the left: the lower is from GLORIA, the upper the TOBI image, about 6 km wide, of the highlighted square, showing the great increase in resolution.



Left:4 km-wide TOBI image of part of submarine channel meandering past obstacle (mud volcano?) on West African continental rise.Below: GLORIA image, with area of TOBI image outlined..



Selected references

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