

CalCOFI Bottle Sampling

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CalCOFI deploys a Seabird 911+ CTD with 24-place Seabird carousel mounted inside a 24-10L bottle, epoxy-coated rosette frame. Bottle sampling is based on the historical "bottles-hung-on-wire" sampling method utilized by CalCOFI oceanographers from 1949-1993. Twenty Niskin (5L), Nansen (1.25L), or Wally (2.5L) bottles with messengers were attached to a winch wire and suspended vertically in (typically) 500m of ocean depth. The spring-loaded bottles go into the ocean open so seawater can easily flush through them. Once all 20 bottles were deployed and after a 10+ minute soak for the reversing thermometers to equilibrate. A messenger - 1-2lb metal weight that can clamp & slide freely on the wire - was clamped to the wire and released, dropping onto the first bottle submerged at surface. When closed, the bottles trap seawater from a particular depth with a water-tight seal. This is important since the characteristics of seawater such as salinity and oxygen change with depth. It is critical to the integrity of the measurement that the bottles do not leak and become contaminated by seawater from different depths.

- Nansen bottles: the top end of the Nansen bottle would release from the wire, inverting the bottle, releasing its messenger. The inversion of the thermometers would "break" the mercury in the reversing thermometers, locking in the temperature readings. When inverted, the open bottle ends closed, trapping seawater from that depth for later analyses. Three thermometers - two protected, one unprotected were used on bottles 200m and deeper to derive corrected bottle depth; two thermometers were mounted on bottle shallower than 200m. The released messenger would slide down the wire to trip the next bottle - this would continue until all 20 bottles had closed. Calculating actual bottle depth by comparing protected and unprotected reversing thermometer readings would correct for any inaccuracy due to wire angle or winch-error. In use by CalCOFI 1949 - 1966, and occasionally after until CTD-Rosette implementation in 1993.
- Niskin bottles: the messenger would strike a plunger, releasing a rotating thermometer rack that would spin 180°, "breaking" the mercury to lock-in the temperature readings of the reversing thermometers. An internal spring would close the o-ringed end caps trapping seawater. CalCOFI Niskins were metal-free & latex-free to allow 14C primary productivity incubation experiments to be conducted with the seawater collected. Epoxy-coated springs and viton o-rings were used to reduce latex toxicity and iron fertilization. After the 1st bottle tripped, the messenger would travel down the wire to the next bottle and so on. The person dropping the messenger would often hold the wire to feel the vibration up the wire of the bottles closing. Eight minutes would elapse for all the bottles to close before the bottle array would be recovered. In use by CalCOFI 1966-1993.
- "Wally" bottles were 2.5L PVC/ABS bottles designed by CalCOFI techs George Anderson & Walt Bryant, similar to Niskins but easier to deploy. They used a single broad wire book-clamp and collected smaller water volumes so were easier-quicker to attach and remove from the wire. They also used epoxy-coated springs and Viton o-rings. During their use, 2.5L of seawater was plenty of volume for the at-sea analyses: salts, nutrients, chlorophylls, oxygens. Like Niskin bottles, after the surface bottle tripped, the messenger would travel down the wire striking the next bottle plunger, closing the bottle, and releasing the next messenger. In use by CalCOFI 1988-1993.
- CTD-rosette: 10L PVC/ABS plastic bottles are equipped with epoxy-spring loaded with Viton o-rings on all surfaces that contact the seawater samples. Unlike a series of bottles clamped to a winch wire, the CTD-rosette is tethered and deployed on a electrically-conductive winch wire. 24-10L bottles encircle the CTD electronics and are rigged open using lanyards attached to the central carousel hub. The CTD sensors display real-time seawater measurements to a computer screen on the ship for the operator & other scientists to see. Based on the downcast profiles of chlorophyll-a and mixed layer depth, as the CTD-rosette is raised, bottles are closed electronically at specific depths by the operator. Reversing thermometers have been replaced by dual CTD temperature sensors. Bottles still trap seawater from specific depths in leak-proof bottles for analyses on-board the ship. In use by CalCOFI 1993-present.