

Deep water properties, velocities, and dynamics over ocean trenches

GC Johnson and LD Talley, 1998.

Eos Trans. AGU, 79(1), Ocean Sciences Meeting, Abstract OS21F-04 1998.

Observations of water properties and deep currents over several trenches in the Pacific Ocean give consistent evidence for recent ventilation of water below the trench sills and cyclonic recirculations over the trenches. That is, where trenches are oriented meridionally they have deep equatorward flow over their west side and deep poleward flow over their east side. Where the trenches are oriented zonally, westward flow is over their poleward side and eastward flow over their equatorward side. First, a review of previous work using hydrographic data reveals that the trenches are strongly ventilated, that bottom water within the trenches moves away from its source, and that water properties suggest a cyclonic recirculation over some trenches. Then, deep current meter records are shown to reveal a cyclonic recirculation over the trenches. Finally, trench bathymetry is used to motivate a simple dynamical framework for flow over trenches. The bottom water below each trench sill is renewed through localized sinking near its source. Flow below the sill transports the dense bottom water away from the sinking region, and this water upwells over the trench. If the trench sides are sufficiently steep and the trench is sufficiently removed from the equator to ensure closed geostrophic contours, then the upwelling drives a strong deep cyclonic recirculation through vortex stretching within these closed geostrophic contours. The dynamical balance is between the upwelling-driven vortex stretching and bottom drag on the component of flow that is tangential to the closed geostrophic contour. This recirculation is much stronger than the flow predicted by a linear planetary geostrophic balance for upwelling-driven flow across open geostrophic contours.