

Vertical Density Currents: Implications for the Deposition and Interpretation of Deep-sea Ash Beds

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Volcanic ash layers form important chronostratigraphic markers that can be correlated over huge areas and diverse depositional environments. They have also been used as guides to the pattern, timing, composition, magnitude, and frequency of volcanic eruptions and to syn-eruptive atmospheric conditions and volcanic processes. However, such interpretations are based on two assumptions: that the deep ocean is an essentially quiescent environment; and that ash particles landing on the ocean surface reach the seafloor by pure suspension settling. Modern oceanography has demonstrated that the first assumption is frequently untrue, while recent work has cast doubts on the second. Interception of distal Pinatubo ash in the deep-sea indicates tephra settling rates several orders of magnitude faster than predicted by Stokes Law, while laboratory experiments have shown that under typical eruption conditions, tephra particles landing on water can become entrained into equally rapid vertical density currents. If tephra fall on the oceans does indeed generate vertical density currents, then the mid-water and seabed behaviour of these sediment-laden plumes has major implications for the interpretation of deep-sea ash layers. Mid-water transport likely occurs by a combination of both Stokesian settling of coarse/dense individual particles, and mass transport in descending plumes. Seafloor deposition is achieved by a combination of independent settling of the coarse/dense particles from the ocean surface and suspension fall-out from a polydisperse turbid layer delivered by the plumes. The latter is vulnerable to entrainment and advection by deep ocean currents, or on sloping substrates to self-mobilisation as a dilute turbidity current, either of which will modify the grain-size distribution of the final ash layer. Aside from complications arising from post-depositional reworking, deep-sea ash layers reflect both subaerial and subaqueous tephra transport, and hence may not directly reflect either an eruption signal or accurately record the order, rate, and location of ash particles arriving at the sea surface.