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The use of deep-sea tephra layers to assess sediment reworking: examples from the Mediterranean

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Constructing precise age-depth models for Quaternary marine sequences is frequently problematic because of the influence of a number of factors, including (a) a deficiency of material for 14C dating in, for example, sediments lying below the CCD or where calcareous fossils are disseminated in terrigenous deposits; (b) a preponderance of carbonate tests which have been recycled from shallower (shelf) environments or older bodies of sediment; and (c) severely condensed intervals or erosional hiatuses which may not readily be detectable using conventional seismic methods. Layers of vitreous volcanic ejecta (tephras, including distal, fine-ash layers) can help to constrain, and occasionally resolve, some of these difficulties. Because they are deposited extremely rapidly, tephra layers that have distinctive chemical signatures can provide time-parallel markers within and between marine sequences. Hence precise correlations can be established, even when the age of the tephras or the precise eruption sources are not known, so long as they have diagnostic chemistries, can be traced widely, and occur in a consistent stratigraphic succession. As such, tephras provide considerable potential for improving age models based upon other methods, such as radiocarbon dating. But they also have other advantages; here we focus on their potential as proxies for deciphering former marine sedimentary processes.

Tephra layers in marine basins are not uniform, but frequently show significant variations in distribution and thickness which reflect three main factors: 1) the vagaries of wind dispersal during transport from the volcanic conduits to the sea; 2) settling through the water column, which is a function of both the physical characteristics of the tephra shards (composition, size and shape) and of water depth; and 3) mechanical and biological processes operating on the seafloor during and subsequent to tephra deposition, including gravity-driven flows and bioturbation. As a result, tephra layers become disturbed and individual shards may become severely degraded through chemical alteration. Current flow may lead to the selective removal of an individual tephra layer, with the constituent shards being re deposited some considerable distance away from the original point of deposition, perhaps to become disseminated throughout younger, co-deposited lithoclastic and bioclastic material. In such cases, their value as stratigraphic markers is severely reduced. However, they retain value as proxies of sea-bottom processes. Our observations of a number of tephras and distal ash layers detected in many sediment cores located throughout the SW Adriatic Margin (central Mediterranean) lead us to recognise where tephras have been deposited under conditions of strong bottom current flow. When the occurrence of tephra layers is well constrained for a particular sector of the ocean bed, two key indicators emerge: 1) markedly uneven distribution of a tephra layer, probably reflecting localised winnowing and preferential deposition under enhanced bottom current activity, providing information on bottom current pathways; and 2) degree of dispersal of tephra shards, which reflects intervals of enhanced bottom current strength.