Correlating multiple tephra records with heuristic matching

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Establishing a detailed record of past volcanic events is important for probabilistic forecasting. The timing of future events is dependent on what has occurred in the past and hence the accuracy of any forecast relies on the completeness of historical eruption records. Acquiring a detailed record is difficult since tephra dispersal and preservation is highly variable. Using eruption records obtained from a single site can result in an underrepresentation of the frequency of eruptions. However, the use of records obtained from multiple sites is made difficult by the fact that records may contain events in common, as well as events not represented in the other core. Correctly merging eruption records can offer a more complete catalogue of events. However, the combination of data from multiple sources is a statistical problem of some significance.

There is a need for an automated procedure for correlating event records obtained from the radiocarbon dating of tephra deposits. We are developing a system that is based on finding the most feasible set of event matches by employing stochastic local optimization techniques. This sophisticated approach eliminates certain matches through careful reasoning, while heuristically searching over the remaining alternatives. If individual radiocarbon age determinations are judged not to be significantly different then they can be combined by pooling the ages to offer a more precise date of the eruption.

Matches are identified by considering the radiocarbon age and associated age error of each event. Additionally statistical analysis of the titanomagnetite chemistry is used to confirm, or rule out, any possible matches returned by the procedure. This is further complicated by the fact that the algorithm must not violate the stratigraphy of events. The algorithm uses geochemical data but the aim is to adapt the procedure to work with any auxiliary variable.

Our method of identifying plausible matches is demonstrated through the application to stratigraphic records obtained for Mt Taranaki (New Zealand). Data collected from five different sites at different directions around the volcano are used to illustrate the matching procedure and to compile the amalgamated record.