Liberating microfossils from indurated carbonates: comparison of three disaggregation methods

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\section*{Study objectives}

Indurated carbonate-rich sedimentary rocks can be extremely difficult to disaggregate in order to conduct either geochemical or taxonomic analyses. As such, a new, minimally destructive method for disaggregating heavily cemented carbonates was sought; known as Electric Pulse Fragmentation (EPF) this method is more commonly used for liberation of coarse zircon grains for geochronological studies. This new technique was compared to two more traditional disaggregation methods of Calgon (buffered sodium hexametaphosphate) and acetic acid.

\section*{Materials}

- Field samples from United Arab Emirates, Malta and Tanzania (Figure 1)
- Heavily lithified carbonate-rich sediments
- Deposited in dominantly shallow (<250 m) water environment
- Range of diagenetic cements and secondary infilling: calcite, quartz, clays
- Samples dominated by larger benthic foraminifera (LBF), but smaller foraminifera, ostracods, bryozoans, and red and green algae were also observed

\section*{Methods for comparison}

\textbf{Calgon:} Immersion of samples into buffered sodium hexametaphosphate ([NaPO\textsubscript{3}]\textsubscript{6} with Na\textsubscript{2}CO\textsubscript{3}) for at least 4 days, interspersed with 2 hour intervals on a shaker table. Samples then washed over 63 µm sieve and dried overnight at 50°C.

\textbf{Acetic acid:} Samples immersed in 80% acetic acid, 20% de-ionised water mixture for 24 hours, then washed thoroughly with de-ionised water over a 63 µm sieve and dried overnight at 50°C.

\textbf{EPF:} Pulsed electrical discharges break apart composite materials, submerged in a process medium (water), along internal compositional or mechanical boundaries (Figure 2). Samples were subjected to 10 pulses in the first instance; any disaggregated material then falls through a sieve (4–10 mm aperture for this study) in the processing vessel in order to be protected from further treatment.

\begin{itemize}
  \item Acetic acid proved effective in some highly lithified samples, however, the time taken to process the samples is significantly longer and larger foraminiferal preservation was compromised.
  \item Calgon was unable to disaggregate any of the carbonate samples successfully (i.e., \textit{few or no LF were liberated}) and so is unsuitable for processing these highly lithified sedimentary rocks.
  \item The EPF method is highly efficient and effective as a disaggregation technique for liberating larger microfossils (>500 µm).
  \item EPF indiscriminately disaggregated indurated carbonates with a mixture of calcitic, silicic, and clay matrices/cements; it has also previously been shown to liberate microfossils from sandstones and shales (Saini-Eidukat and Weiblen, 1996), showing it to be a broadly applicable method to micropalaeontology.
  \item We suggest that the EPF method could be tailored to effectively liberate smaller (<500 µm) microfossils by using repeated rounds of processing and progressively smaller sieve aperture sizes, although further investigation is required.
  \item Compared to the traditional methods of disaggregation, soaking in Calgon and acetic acid, the time required is significantly reduced and the preservation of liberated material is excellent (Figure 3).
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