Use of Electric Pulse Disaggregation to Liberate Fossils from North and South Dakota Sediments

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A novel method has been developed for liberating fossils from their rock matrices. The method, called Electric Pulse Disaggregation, is being applied using newly constructed instrumentation at the Department of Geology and Geophysics at the University of Minnesota, Minneapolis.

Electric pulse disaggregation replaces the compressive forces of normal mechanical crushing with tension, introduced by the application of an electric current to whole rock samples immersed in a fluid (in this case, water). At low voltages (<50 kV), the spark discharges through the water, circumventing the sample. However, at voltages greater than 50 kV, the rock breaks down electrically before the water. According to Rudashevsky et al. (1), this breakdown forms a plasma, leading to an explosion which preferentially takes place along zones of weakness of the solid material. In the case of rocks, these zones of weakness seem to be along grain boundaries of mineral phases, particularly when the minerals have different dielectric constants. The discharge may move through the rock preferentially along grain boundaries because of the presence of better conducting paths there, possibly in the form of interstitial fluids or ions. The result is unbroken, individual mineral grains in their original shape, form, and grain size.

Research done to date has focused on separating trace minerals from igneous or metamorphic rocks. We applied this technique for the first time to a variety of fossiliferous sediments from North and South Dakota to investigate its possible use in fossil liberation. Run products were size classified and examined using optical and scanning electron microscopy.

A drill core sample of Cretaceous Mowry Formation (2) from Burleigh County, ND, was subjected to electric pulse disaggregation. Numerous macrofossils were found including belemnite fragments, fish teeth and scales, and delicate scale casts. No microfossils have been found to date in this sample.

Samples of the Carlisle Formation (3), a shark tooth-bearing limestone of Cretaceous (Turonian?) age from near Milbank, SD, were also subjected to electric pulse disaggregation. Although some of the cm-size shark teeth suffered breakage or charring from electric pulse disaggregation, the method worked well to liberate a diverse pyritized microfossil assemblage (0.2 - 0.6 mm) including juvenile ammonites, possible larval clams, snails, ostracodes, foraminifera, and unidentified spheroids (perhaps plant spores?). The large difference in electric conductivity between the pyritized fossils and their matrix is probably responsible for the excellent physical separation achieved by electric pulse disaggregation — the microfossils were completely freed from their matrix with delicate three-dimensional surface features perfectly preserved. This preservation is demonstrated in the recovered ammonitellas from the Milbank sample, which clearly show the prosuture and primary constriction at the aperture, suggesting they were newly hatched (4).

Samples of the Cretaceous Minnelusa Formation of SD were also investigated using electric pulse disaggregation, and non-pyritized conodont fragments were recovered from them.

Electric pulse disaggregation shows promise as a new tool of fossil liberation. It should be viewed as a complement to existing methods, rather than as a replacement, because not all fossils are amenable to its use. Considerable instrument development needs to occur before the method can become widespread.

1. Rudashevsky, N.S., Burakov, B.E., Lupal, S.D., Thalhammer, O.A.R., and Saini-Eidukat, B. (in press) Trans Inst Mining Metall.
2. Well Kleven #1A, NDGS Well #4592, sampled at 2,887 feet (880.0 m).
3. As assigned by E.A. Merewether (1983) Outcrop B, Table 2, USGS Prof Paper 1253.
4. N. Landman, personal communication, 1994.

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