SMASHING UP STONES

A critical, but often neglected, aspect of the entire geoanalytical process involves how one actually gets one's sample from the field and back to the laboratory for analysis. Clearly collecting material that is representative of the process being studied is the first critical step. But what does one do once the specimen arrives back home? I can well remember the many hours I spent as a graduate student some decades ago in the crushing lab reducing kilograms of sample down to grams of "representative" powder; this powder would be the starting material for my assigned tasks as a budding geochemist. Jaw mill to reduce to centimetre-size – puck and ring mill to reduce to coarse powder – agate ball mill to reduce to fine powder – hours of processing – keep everything clean – don't contaminate, don't fractionate… Tedious, to say the least.

So what technological progress has this aspect of mineralogy/geochemistry seen of late? Over roughly the past decade interest has grown in the use of electrodynamic disaggregation. In this procedure, a high-voltage electrical impulse creates a shockwave either within the material itself or within the fluid medium – typically water – that surrounds it. This method of using "lightning strikes" to reduce walnut-size rock chips down to individual mineral grains first came to my attention at the Goldschmidt 2009 meeting in Davos, Switzerland, where hardware from the Swiss company Selfrag AG (www.selfrag.com) was on display. Subsequently a paper by Giese et al. (2010) described in detail the physical process involved in the various forms of electrodynamic disaggregation and also demonstrated that the high temperatures that briefly affect the sample do not bias apatite fission-track ages.

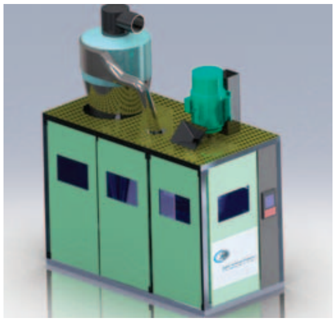

Figure 1 Model of the Aerodynamic Impact Reactor (patent pending). The reactor's height is approximately 2 metres.

Here I would like to describe briefly an alternative technology which I learned about a year or so ago. It is being developed by Zybek Advanced Products (www.zapmaterials.com), a small company located in Boulder, Colorado, USA. Zybek's Aerodynamic Impact Reactor (Fig. 1) employs a high-pressure air stream created by a series of impellers. Within the reactor chamber, the airflow is directed into a vortex geometry with a high-speed pneumatic flow established along the margin of the vessel. Within seconds centimetre-size rock chips introduced into this environment undergo a grain-size reduction through collisions within the reactor. The processed material is ultimately ejected through a port in the base of the reaction chamber (Fig. 2). The device has been integrated with multiple cyclone separators, which allow the processed material to be binned by grain size and which also remove particulates down to roughly 1 µm grain size from the exhaust air. A number of parameters can be adjusted on this apparatus, but it is commonly set to produce grain size fractions smaller than 100 or even 50 microns. By reprocessing the coarser-grained materials separated by the cyclone, it is possible to produce ultimately a very fine-grained end product (Fig. 3).

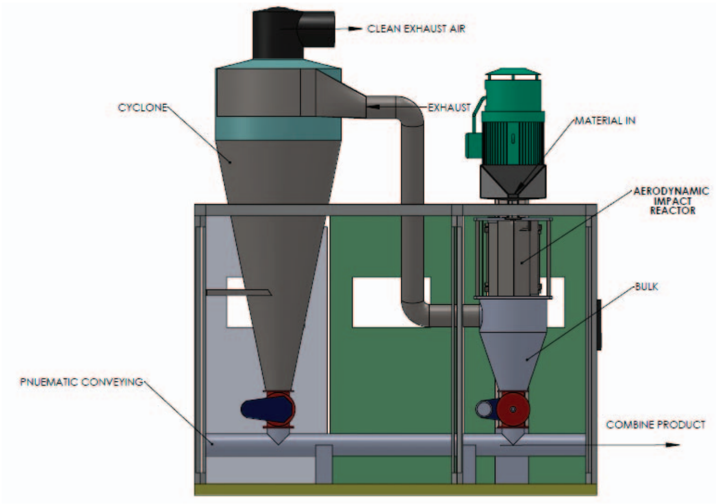

Figure 2 Diagram of the individual components within the Aerodynamic Impact Reactor processor integrated with cyclone separators

Figure 3 An example of a phosphate starting material and end product from the Aerodynamic Impact Reactor

So what are the advantages of this new approach to sample processing? Though I have yet to see any concrete data, the method is supposed to be relatively contamination free. High processing rates of up to several metric tons per hour could be of interest to the mining industry. Compared to some of the other competing methods, the Aerodynamic Impact Reactor is energy efficient, meaning lower operating costs. It is flexible in terms of the grain-size distribution it can produce and the nature of the feed stock. In fact, the method has been applied to the processing of coal and even switch grass (Fig. 4). It tends to liberate material along grain boundaries, but it also has been found to favour high surface-to-volume ratios for the end product – a benefit if subsequent chemical treatment is planned.

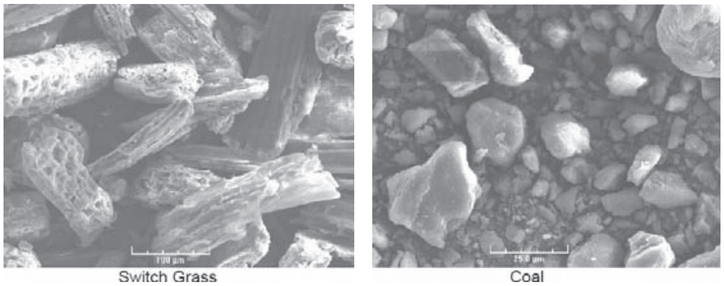

Figure 4 Scanning electron microscope images of two of the more unusual material types on which the device has been used

What is the future of this technology in either the mining industry or basic research? This is hard to say as the technology has not yet been widely disseminated. Time will tell.

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REFERENCE

Giese J, Seward D, Finlay MS, Wüthrich E, Gnos E, Kurz D, Eggenberger U, Schreurs G (2010) Electrodynamic disaggregation: Does it affect apatite fission-track and (U-Th)/He analyses? Geostandards and Geoanalytical Research 34: 39-48