Elelectrodynamic disaggregation of geologic material.

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A series of tests were run on the commercially available selFrag electrodynamic disaggregation machine produced by Ammann AG, Langenthal. The electrodynamic disaggregation method (short sel-frag), allows cracking rocks, mineral aggregates, and monomineralic crystals or glass along grain boundaries or material-internal discontinuities (impurity trails, fluid inclusion trails, exsolution lamellae).

The operation principle is an electrical discharge passing trough a dielectric material (e.g., rock) immersed in a liquid. In general the dielectric constants or electrical strength of a solid material is higher than the strength of dielectric liquids (e.g., water, oils). However, the physical behavior changes when electrical pulses are of very short duration, and the dielectric strength of the liquid exceeds that of the solid. In other words, the solid material is in this case the better conductor, and hence the “discharge channel” will search its path through the solid material. High amount of energy are deposited along this discharge channel leading to local temperature of up to 10000 ºK and pressures of up to 10^{10} Pa (Rudashevsky et al., 1995, Andres & Timoshkin, 1997), thus conditions reached by using conventional explosives. The resulting compressional waves refract along grain boundaries, grain-internal impurities, and surfaces, and they induce tensional stresses along this boundaries leading to disaggregation. Only material consisting entirely of metal cannot be fragmented or disaggregated with this method. However, the presence of high amounts of conductive material in the sample enlarges the energy consumption.

The tests with different geologic material immersed in deionized water were very encouraging. They showed that electrical discharges as low as 20 kV and a few hundred pulses at a frequency of 1- 5Hz are commonly sufficient to disintegrate rocks or other mineral aggregates. The experiments showed that liberation of grains of variable size is possible with much less production of fines compared with conventional methods. Accessory minerals (Fig. 1) are generally separated retaining their original shape (e.g. zircon, apatite, allanite, magnetite …); they may break under increased energy input. Artifacts of the method are formation of melt films (generally on better-conducting mineral grains like magnetite or biotite), and small particles derived from the electrode material (Fe-Cr-Ni steel). However, grains displaying a melt film are easily recognized optically or by electron microscope, and the amount of contamination from the electrode material is much lower than by using conventional crushing methods. Moreover, the electrode can be easily exchanged and adapted to the problem (e.g., Cu or Al electrodes).

The major advantage in comparison with commercial methods (chaw breaker, swing mill, or ball mill) lies in the reduction of fines, the production of isometrically shaped products, and in most cases reduction of energy consumption.

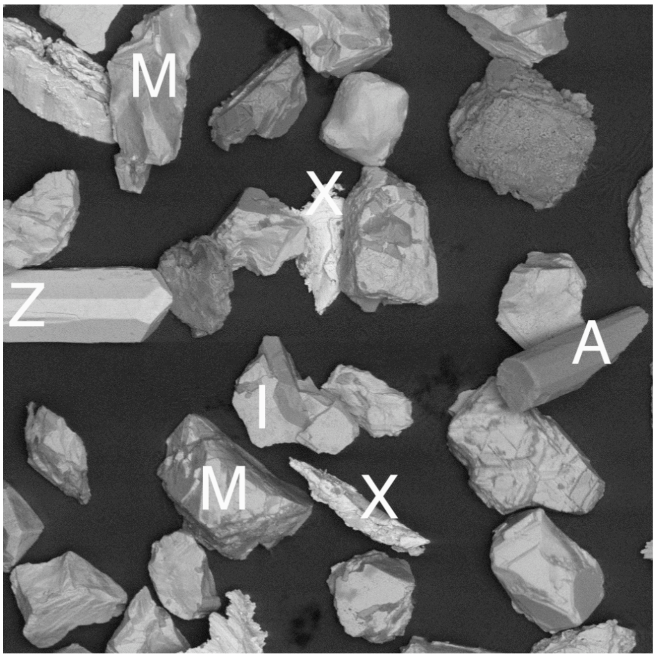

Figure 1. Backscatter electron image of 125 – 250 µm fraction of the Habkern Granite after separation in dense liquid (> 3.1 gcm^{-3}). Machine conditions applied were 20 kV, 3Hz and 300 pulses. Z = zircon; A = apatite; M = magnetite; I = intergrowth apatite with biotite; X = Fe-Cr-Ni steel from electrode; the remaining grains are magnetite or mineral-magnetite intergrowths. Width of image is 0.72 mm.

REFERENCES

Andres, U. & Timoshkin, U.A. (1997): Energy consumption at electrical disintegration of brittle solids. 1998 IEEE International Conference on Conduction and Breakdown in solid Dielectrics, Västerås, Sweden: 452-455.

Rudashevsky, N.S., Burakov, B.E., Lupal, S.D., Thalhammer, O.A.R. & Saini-Eidukat, B. (1995): Liberation of accessory minerals from various rock types by electric pulse disintegration — method and applications. Transactions of the Institute of Mining and Metallurgy 104: C25-C29.