ABRASIVE (SAND) BLASTING AS A MEANS OF CLEANING WEAKLY LITHIFIED IMPACT-RELATED DRILL CORE FROM THE WETUMPKA IMPACT STRUCTURE, ELMORE COUNTY, ALABAMA. R. C. Johnson[1], and D. T. King, Jr.[2], [1]Auburn University, Dept. Geology, Auburn, AL, 36849 (johnsrc@auburn.edu), [2]Auburn University, Dept. Geology, Auburn, AL, 36849 (kingdat@auburn.edu).

Introduction: Impact structures are unlike most geologic features because there commonly is little or no surface manifestation of their complex crater-filling stratigraphy. Further, many impact structures lie completely buried by as much as several hundred meters of sediment. Frequently, the only means of accessing tangible material from within such structures is by drilling.

Of the 172 proven impact structures on Earth, 99 have been drilled [1], and 12 to 15 still have core in existence. In 1998, two core holes were drilled within the Late Cretaceous, 7.6 km diameter Wetumpka shallow-marine impact structure in Elmore Co., AL. (32° 31.2'N, 86° 10.4'W) [2].

Drilling recovered NX core in 10-foot (3-meter) legs from depth ranges of 31.9 m to 191.6 m for Well 1, and 73.0 m to 179.5 m for Well 2. Well locations are 32° 31.368'N, 86° 10.369'W and 32° 31.303'N, 86° 10.379'W, respectively [2].

These two core sets would later show a bimodal crater-filling stratigraphy with a basal unit of clast- and matrix-supported polymict breccias having a poorly consolidated coarse to fine sandy matrix; this unit is overlain by a chaotically deformed unit of friable Cretaceous target blocks (sandstones and mudstones) also in a poorly consolidated coarse to fine sandy matrix [2].

However, before these discoveries, extensive portions of the core were boxed immediately after drilling while still covered with ~2 mm of drilling mud. This procedure was contrary to that typically practiced wherein drill mud is washed from the core with a water hose upon removal from the drill hole resulting in significant erosion of the core and removal of fines. Because most of the Wetumpka core was not water washed, it remained largely unaltered by artificial erosion, but almost fully encased in mud that later dried to a hard crust. Removal of the mud crust had to be achieved before the core could be thoroughly studied. Problematically, the core was too weakly lithified and friable to be cleaned with liquid solvents such as water or alcohol, and too clay-rich for cleaning by brushing or scraping, as this only polished it and obliterated structural details at every scale.

Cleaning by abrasive (sand) blasting: Recently, a successful means of removing the undesired mud crust has been achieved through a process of abrasive (sand) blasting using commercially produced 20/30 sieve-size crystalline silica sand blown through a common sand blaster. This effective method of mud removal proved to be a relatively quick, easy, and inexpensive one- or two-person job utilizing readily available equipment. Nonetheless, blasting with crystalline silica posed a serious health hazard, which had to be addressed in order to do this work.

Health hazard mitigation. Freshly broken, aerosolized silica dust is considered a carcinogen and represents a Class-3 (severe) pulmonary health hazard [3]. It was essential that all blasting operations take place in a "fully enclosed" blasting cabinet under a partial vacuum (Fig. 1). By fully enclosed we mean with exception to an ambient-air intake port which allows for proper air flow between periods of actual blasting. The vacuum unit is a commercially available shop-type model that incorporates a 95% efficient, 0.1-micron collection bag surrounding a 99.7% efficient, 0.3-micron HEPA filter (purchased separately as manufacturer-approved add-on accessories).

Figure 1: "Fully enclosed" blasting cabinet with gloved portals. Interior workspace dimensions are approximately 0.6 m wide x 0.4 m deep x 0.4 m high.

As an extra precaution, the vacuum unit was set up to exhaust into a fume hood. Finally, a respirator equipped with two P-100 HEPA filters was used during all blasting operations and while conducting any handling of the sand. It is important to note that use of these filter types is acceptable only in combination, and when the actual blasting takes place within a "fully enclosed" blasting cabinet under partial vacuum such that the concentration of aerosolized silica dust outside the cabinet falls below 10x the mandated personal exposure limits according to Material Safety Data Sheets (MSDS) provided by U.S. Silica [4] and Mallincrodt Baker Inc. [3].

Apparatus setup. A diaphragm-type compressed air source delivering 5.5 peak horsepower, and capable of sustaining 5.1 standard cubic feet per minute (SCFM) (2.4 *l/s*) at a working pressure of 90 psi (620.5 kPa) was used to supply air to the blasting apparatus through a typical air hose with standard ¼-inch NPT fittings (6.35-mm fittings). A pressure gauge and regulator mounted on the blasting cabinet allow for convenient adjustment of the supplied pressure, usually set between 40 to 90 psi (275.8 to 620.5 kPa). Within the "fully enclosed" blasting cabinet are a work light and trigger-operated sand blasting gun with its air supply and sand feed hoses. These items rest on a heavy screen that functions as a work surface and separates the tools and core from the blasting media (20/30 sieve-size crystalline silica sand) stored in the hopper/reservoir below. The screen lets sand fall through back to the hopper/reservoir after it is sprayed from the gun, but prevents any core fragments >3mm from entering the hopper/reservoir from where they may later enter and plug the blasting gun. It is sometimes convenient to have a piece of 50-grit sandpaper in the cabinet to aid with mud removal.

The window through which the operator views the blasting operation is susceptible to frosting by errant sand grains and must have its interior side shielded with strips of clear plastic packing tape that can be replaced once frosted.

A 12-gallon (45.4-liter) shop-type vacuum connected to the cabinet's upper back exterior draws dust and aerosolized silica from the cabinet through the vacuum's 2.5-inch (6.35-cm) diameter suction hose into a 95% efficient 0.1-micron collection bag inside the vacuum. This bag contains all the dust, stray sand grains, and any other material drawn from the cabinet during blasting, making for easy disposal. Air leaving the collection bag then passes through a 99.7% efficient, 0.3-micron HEPA filter also within the vacuum before being exhausted into a fume hood as an added precaution. The fume hood draws air at a rate in excess to that expelled by the vacuum.

The operator is advised to wear eye and ear protection as well as a respirator equipped with two P-100 HEPA filters. A full-face air-fed respirator is recommended, and in some cases, required by law [3], [4].

Alternate blasting media are safer and readily available in a variety of shapes, sizes, and hardness. They include walnut shell fragments; pellets of plastic, foam or gel; and beads of glass, or metal.

Results and Discussion: Results have been better than expected (Fig. 2). The mud crust virtually melts away leaving the core's true lithology almost completely intact. Further, blasting pressures can be adjusted according to the friability of the material being worked on. For example, a blast pressure of 40 psi (275.8 kPa) gently removes drill mud and enhances numerous structural details in the lithology that would otherwise be difficult to discern by other cleaning methods. Similarly, higher blasting pressures such as 90 psi (620.5 kPa) can be used on more durable core segments thereby speeding the process of mud removal. Little fine component is removed from the core, especially at low blasting pressures, and the core remains largely unaffected by artificial compressed-air erosion similar to that caused by water washing. The overall result is not unlike natural weathering of an outcrop.

Figure 2: Before and after images of core cleaned by abrasive (sand) blasting. Note the colors and structures not visible before blasting. In spite of the core being poorly lithified, little material has been artificially eroded by the abrasive blasting process.

References: [1] Whitehead J. and Spray J. (2005) *Earth Impact Database, http://www.unb.ca/passc/ImpactDatabase*. [2] King D. T. Jr. et al. (2002) *Earth & Planet. Sci. Lett., 202,* 541–549. [3] Mallincrodt B. (2003) *Material Safety Data Sheet–Sand, Washed and Dried, MSDS No. S0722.* 7. [4] Silica U. S. (1997) *Material Safety Data Sheet–Silica Sand,* 8.