Assessment and interpretation of diamond breakage

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Diamond breakage is an important parameter in assessing the economic potential of diamond deposits. Diamond breakage caused during the diamond recovery process can negatively affect grade and value forecasts for actively-mined orebodies, as well as for early stage exploration projects. Breakage cannot be assessed from diamond shape alone because of the complex forms that diamonds can exhibit. Since the late 1970s it has been recognized that dissolution (resorption) surface textures form on diamonds during their residency in the mantle and during their transport in the kimberlite magma. Each surface texture has features that are unique to the diamond crystallography, making it possible to interpret stages of diamond growth and resorption even in complex crystals. Diamonds can break during their residency in the kimberlite magma, and those breakage surfaces will also develop distinctive resorption textures. These textures make it possible also to distinguish between natural, resorbed breakage surfaces and mechanically caused unresorbed breakage surfaces that can occur during the mining and extraction processes. Broken diamonds can therefore be classified by their increasing fragmentation from “perfect” crystals, to chipped, half-crystals, remnant crystal faces, and fragments. On each fragmented diamond, the un-resorbed breakage surfaces are classified by their increasing severity of breakage. Diamonds that exhibit natural internal weaknesses such as mineral inclusions, gletzs and ruts are more easily broken, so these surfaces are ranked low in the forces required to mechanically break them. A breakage surface associated with a mineral inclusion is distinguished by the inclusion pit within the surface, whereas a breakage surface that exploited a rut is classified as etched by the presence of resorption patterns along its perimeter. With increasing severity of mechanical breakage, natural weaknesses become less relevant and distinctive surfaces that are unconstrained by predisposed weaknesses become common. These surfaces include abrasion features, percussion marks (or scars) and Newton’s Rings (internal rainbow colors), which can form from grinding and impact processes. Diamonds exposed to particularly aggressive breakage can shatter resulting in many fragments (shards) with all showing fresh breakage surfaces. Once a classification protocol is established, the proportions of mechanically induced breakage can be quickly and effectively acquired for a large number of diamonds over a broad size range. Collectively, these data have proven to be very effective in identifying and eliminating or mitigating diamond recovery processes that cause damage and hence value loss. Examples of diamond breakage and related studies will comprise this presentation.

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