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A simple model for the pressure preservation index of inclusions in diamond

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ABSTRACT

The isovolume locus for a diamond-mineral inclusion pair occurs where the relative volumes of the two minerals respond identically to changes in pressure-temperature (*P-T*) conditions. Thirty potential inclusion minerals have been assessed with a simple linear model of this system. The remnant pressure on the inclusion (diamond at the Earth's surface) can be estimated by extrapolating the conditions of diamond formation to 0 °C using the slope of the isovolume locus. Remnant pressures can be positive (isovolume locus lower than formation pressure) or negative (locus higher than formation pressure), the latter indicating the inclusion has decompressed completely. When placed in order of increasing isovolume slope, this mineral list defines a pressure preservation index (PPI). Published work confirms that the model is quantitative up to diamond formation pressures of 50 Kb and qualitative beyond. Ten minerals are identified as key PPI indicators—in decreasing order of PPI they are: sanidine, coesite, dolomite, (sphene, garnet, diopside, zircon), magnesiowüstite, spinel, $Mg_{0.9}Fe_{0.1}SiO_3$ perovskite. For most diamond formation conditions, inclusions of the first three minerals will retain high remnant pressures, whereas the last three will decompress completely. The central four minerals in brackets will have a highly variable response because their isovolume loci pass through diamond formation conditions. Preliminary calculations suggest that fluid inclusions (H_2O, CO_2) fall at or near the top of the list.

For inclusion-bearing diamonds at the Earth's surface, the model predicts: (1) remnant pressures; (2) confining pressure on inclusion during delivery; (3) the stability of high-pressure polymorphs; (4) retention vs. resetting of radiometric ages; (5) those minerals suited for determining the conditions of formation based on measured remnant pressure; (6) those minerals capable of stabilizing a microdiamond inclusion; and (7) that supercritical fluids preserve inclusions of microdiamond in most minerals.