DIAMOND: JUST ANOTHER METAMORPHIC MINERAL? L. A. Taylor, G. A. Snyder, and A. Camacho, Planetary Geosciences Institute, The University of Tennessee, Knoxville TN 37996, USA (lataylor@utk.edu).

The once-held concept that diamonds are minerals crystallized from silicate melts within the upper mantle has been steadily changing. There is mounting evidence that many diamonds are products of metamorphism, more specifically metasomatism. This is particularly true for many eclogitic diamonds collected from kimberlitic xenoliths. In this paper, we will present many of the evidences and thoughts along these lines. Due to lack of space, we will omit some references, for which we apologize.

Diamondiferous eclogites are now generally considered to be mainly the products of subduction and metamorphism of oceanic crust [e.g., 1–4]. The evidences supporting this theory are (1) Gt and Cpx $\delta^{18}O$ values outside of mantle (5.5 ± 0.4‰), indicating a crustal component; (2) +Eu anomalies in Gt and Cpx, both within eclogites and as inclusions in diamond, certifying the involvement of plag; (3) $\delta^{13}C$ values of +5 to –34‰ in eclogitic diamonds, possibly of biogenic origin; (4) $\delta^{34}S$ values of +15 to –14‰ in sulfide inclusions in diamonds; (5) elevated $^{87}Sr/^{86}Sr$, best explained by interactions with seawater; (6) ε_{Nd} values up to 250, attributed to effects of partial melting upon subduction; (7) bulk compositions of many diamondiferous eclogites representative of restites rather than magmas; and (8) the Archean TTG suite as a logical product of crystallization of the partial melt extracted from eclogites upon subduction [5]. However, since their transport to diamond P-T conditions by subduction of crustal protoliths, it is probable that most diamondiferous eclogites, collected from kimberlites (particularly Group B/C of Shervais et al. [6]), have never experienced a major melt stage. How then could the diamonds in these eclogites be magmatic?

Mineral inclusions in diamonds, the “time capsules” of Bulanova [7], are thought to provide us with pristine mineral chemistry relating to the P-T-x conditions during the time of the diamond formation. A check of this assumption is that many diamond inclusions (DIs) are similar to those same minerals in the host eclogites [8]. In contrast, there is an increasing body of data indicating notable differences among multiple DIs from the same diamond [e.g., 5,7,9,10–14]. In fact, compositions of multiple DIs can differ so markedly that they may indicate mixed inclusion paragenesis (peridotite + eclogite) within a single diamond [15–16]. It appears that DI chemistry and diamond stratigraphy represent changes in the chemical environment as crystallization of the diamond progressed These changes resulted in the observed discontinuous growth and chemical variations of the diamonds and their inclusions (but without presence of silicate magma). The evolution of compositions of the Cpx DIs from core to rim is contrary to that expected from igneous crystallization [14]. Indeed, it is probable that later growth of the outer portions of the diamond formed long after the present xenolith crystallization and involved C- and N-bearing fluids, such as those suggested by Deines and Harris [17], Stachel and Harris [18], and Taylor et al. [14].

In a quest to further understand diamonds and their host eclogites, our research group [19–21] has recently performed 3-D, X-ray tomography and continues a detailed “pull-apart” of a diamondiferous eclogite from Yakutia, found to contain 30 macrodiamonds. The diamonds are associated with zones of Cpx alteration, indicating possible paths of fluid flow. The Cpx and Gt inclusions of each diamond are different in major- and trace-element composi-tions and are not the same as those of the host eclogite. Even multiple diamond inclusions in the same diamond are different. Cathodoluminescence of polished surfaces of the diamonds reveals complex growth patterns representing alternating episodes of crystallization and resorption, accompanied by extreme fluctations in N aggregation states, possibly indicating grossly different residence times in the mantle for cores vs. rims of the diamonds.

It would appear that each diamond represents a different environment during its formation. There is not even evidence that the diamonds grew in the presence of the present host minerals. This eclogite is but the last residence place of the diamonds. This is the first such detailed dissection of diamondiferous eclogite, with greatly unexpected results. Is this xenolith the exception or the rule among eclogites?

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