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Diamonds in an Archean greenstone belt: Diamond suites in unconventional rocks of Wawa, Northern Ontario (Canada)

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Diamonds typically are found on Archean cratons entrained by younger Phanerozoic kimberlites. In contrast, Wawa diamonds are hosted in "unconventional", non-kimberlitic rocks that formed contemporaneously with the mafic and sedimentary rocks of the Archean Michipicoten Greenstone Belt (MGB). We studied two diamond suites that occur within the 2.9-2.7 Ga greenschist facies rocks of MGB located in the southwest portion of the Superior Craton (E. Canada). The first diamond suite henceforth referred to as the Wawa breccia diamonds (384 stones), are hosted in the 2618-2744 Ma calc-alkaline lamprophyres and volcaniclastic breccias, contemporaneous with pillow basalts and felsic volcanics of MGB. The second suite, the Wawa conglomerate diamonds (80 crystals), are hosted in the 2697-2700 Ma poorly sorted sedimentary polymictic conglomerate which is interpreted as a proximal alluvial fan debris flow in a fan-delta environment. The majority of the diamonds was found within the matrix of the conglomerate. The diamondiferous breccia occurs 20 km north of the town of Wawa, whereas the conglomerate is found 12 km northeast of Wawa.

Diamonds from the 2 occurrences were characterized and described for provenance studies. Both the breccia and conglomerate diamonds show similar crystal habits, with the predominance of octahedral single crystals and $\sim$ 10% of cubes. The conglomerate diamonds are significantly less resorbed (no resorbtion in 43% of the stones) than the breccia diamonds (8% non-resorbed stones). In both suites, only 21-24% show high degrees of resorption. The majority of crystals in both suites are colourless, with some yellow, brown and grey stones. Conglomerate diamonds had a wider variety of colours that were not seen in the breccia diamonds, including green and pink. The breccia diamonds contain 0–740 ppm N and show two modes of N aggregation at 0–30 and 60–95%. Among the breccia diamonds, Type IaA stones comprise 17%, whereas IaAB stones make up 49% of the population. Diamonds from the conglomerate have nitrogen contents below 400 ppm N, with 47% of the suite being Type IaA stones. Approximately one third of the conglomerate and breccia diamonds belongs to Type II having no measurable N.

The two suites of Wawa diamonds, according to the morphology and nitrogen studies, are deemed to be different. The conglomerate diamonds are significantly less resorbed and contain less aggregated N. The diamonds that occur in the Wawa breccia and conglomerate have different primary volcanic sources. We suggest that the primary volcanic rock of the conglomerate diamonds may be a kimberlite, as kimberlitic indicator minerals are found in the matrix of the conglomerate. These indicator minerals garnet, Cr diopside and ilmenite are absent from the diamoniferous lamprophyric breccias. The hypothetical kimberlites may have occured in proximity to the conglomerates as suggested by low mechanical abrasion of the conglomerate diamonds and indicator minerals, and the preservation of garnet kelyphitic rims and Cr-diopside. Our study infers an episode of the Archean, pre-2.7 Ga kimberlite magmatism in MGB, which also experienced multiple emplacement episodes of the 2.7 Ga syn-orogenic diamondiferous calc-alkaline lamprophyres.

Despite the distinct origins of the breccia and conglomerate diamonds, they all have similar red-orange-green cathodoluminescence colours controlled by the CL emission mainly at 520 nm. This contrasts with the prevalent CL emission at 415-440 nm commonly observed in kimberlitic and detrital diamonds. We ascribe the red-orange-green CL colours of the two diamond suites of Wawa to the late imprint of metamorphism.