ANCIENT OCEANIC CRUST SUBDUCTED BENEATH THE KAAPVAAL CRATON: THE GENESIS OF ECLOGITES IN KIMBERLITES. Brett PYLE, Clive R. NEAL, and Lawrence A. TAYLOR, Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996.

Subducted oceanic crust has been reported as the progenitor of certain eclogites from kimberlites [1-5]. These eclogites, from beneath the Kaapvaal craton of southern Africa, indicate an underplating of the craton by various components of oceanic crust. Removal of the overprinting of various geologic processes that have affected these eclogites is requisite to determination of the mineralogical, geochemical, and isotopic affinities between the different eclogites and their parent material. As we have reported previously [4,5], there are three groups of eclogites: Group A of mantle cumulate origin; 2) Group B representing modified MORB; and 3) Group C as derived from a crustal anorthositic gabbro. (These groups follow the chemical classification of Coleman et al., [6].)

In this present study, we report on the finding of all three types from one kimberlite - the Bellsbank.

METHODS
Six eclogites were chosen from 36 nodules to give a more representative sampling, based on our previous groupings [4,5]. Using our previous data provided a total of 9 samples, two belong to Group A, four to Group B, and three to Group C. Ultra-pure mineral separates of garnet and cpx were prepared utilizing acid washes and K spikes to check for purity. These eclogites were analyzed by: a) EMP for mineral compositions; b) XRF for whole-rock compositions; c) INAA for REE, especially REE, in the mineral separates; and d) Mass Spec for Sm-Nd, Rb-Sr, O/18O, and Pb of the mineral phases.

PETROGRAPHY
Group A is characterized by wine-red garnet, apple-green cpx (with opx exsolution), and pale-olive opx. These samples are garnet poor (only 10-20% of the rock), highly fractured and serpentinized, and they possess a tight interlocking fabric with 120 grain intersections. Groups B and C share many characteristics. They contain more garnet (40-55%) than Group A, pale-orange garnets, dark-green cpx, no opx, garnet alteration rims of phlogopite and amphibole, and not so tightly interlocking textures as those of Group A. Groups B and C are distinguished by: 1) a kyanite assemblage in Group C (not always present); 2) serpentine alteration present in some Group B samples; and 3) the larger amount of alteration between grains in Group C.

Modal analyses were performed with particular attention to the alteration associated with the primary phases. Reconstructed modal proportions were calculated assuming primary phases of garnet and cpx with opx in Group A and kyanite in Group C. Reconstructed Group A whole rocks were dominated by pyroxene (up to 80% cpx + opx), whereas Groups B and C were more garnet rich (Group B 43-79% gt, Group C 52-70% gt). MINERAL CHEMISTRY Group A garnets are Mg-rich (19.6-21.4%) with a higher Cr2O3 content (1.06-1.71%) than the other groups. Group B garnets are Fe-rich (14.4-16.1%), while Group C garnets are Ca-rich (14.2-18.6%). Cpxs are distinguished primarily on Na2O content. Group C has the highest (7.75-8.02% Na2O) followed by Groups B (3.71-4.53% Na2O) and A (1.69-2.08% Na2O). The presence of three distinct groups is displayed in Figure 1 (garnet and cpx compositions) and Figure 2 (Na2O vs. MgO in cpx). For Figure 2, the data of Smyth and Caperucchio [7] was incorporated to increase the validity of the groupings.
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WHOLE ROCK GEOCHEMISTRY The REE signatures of the groups display distinct differences (Fig. 3). The differences between the whole-rock and reconstructed whole-rock patterns (primarily the LREE) are due to kimberlite contamination of the eclogites. Therefore, the reconstructed patterns should represent those of the eclogites before they were incorporated into the kimberlite. Group A is heavily enriched in LREE (50-60 x C1) and depleted in HREE (2-6 x C1). Group B is depleted in LREE (0.7-4 x C1) and enriched in HREE (20-40 x C1). Group C is depleted in LREE (0.3-0.5 x C1) and HREE (2-4 x C1) but displays a distinct positive Eu anomaly. Our Group B is equivalent to the Type A of Jagoutz et al. [1] and the Type I of MacGregor and Manton [3].

DISCUSSION Our three groups of eclogites are based on differences in: a) compositions of the co-existing garnet and cpx; b) major and trace elements in the whole rock; and c) isotopic variations and systematics in garnet and cpx. The different characteristics of the three groups imply different origins.

Group B eclogites display features characteristic of a basaltic oceanic origin. During subduction, the hydrous, spilitized, basaltic rocks of an oceanic plate undergo dehydration and partial melting. This affects the eclogite in two ways. First, the essentially flat REE pattern of a MORB [8] will be depleted in the LREE during dehydration and enriched in HREE during partial melting as the HREE are held in the garnet. Group B eclogites display this pattern overprinted by a more recent enrichment of the LREE. The recent influx of the LREE is indicated by a depleted Nd isotopic signature (0.5187-0.5254) and an enriched Sm/Nd ratio (0.5-0.85) [4,5].

Second, Na would be lost during the dehydration process reflected by less jadeite-rich pyroxene in the eclogites. The variable changes generated during dehydration would undoubtedly produce a wide variability in mineral compositions, as reflected in the Na,O content of the pyroxene (Fig. 2). The Na,O contents of seafloor basalts are subjected to numerous changes; but depletion by high temperature seawater alteration during the subduction process leaves our Group B eclogites with a depleted Na signature (3.0-3.4) indicative of oceanic crustal heritage.

The characteristics of Group C eclogites indicate an anorthositic-gabbroic composition of oceanic origin. The reconstructed REE pattern has a positive Eu anomaly and LREE depletion corresponding to that of the gabbroic portion of an ophiolite sequence [9]. The Na,O-rich cpx (7-8 wt.% CaO-rich garnets (14-19 wt.% CaO) are also characteristic of an anorthositic-gabbroic origin. The initial gabbroic portion was less hydrated than the basalt (Group B) and would be less susceptible to large scale dehydration which would remove Na, and/or partial melting which could alter the REE signature. The enrichment of 180 above the mantle value in Group C, as observed by others [1-5], is indicative of low temperature seawater alteration [10].

Group A eclogites contain characteristics indicative of a mantle cumulate origin. The abundance of pyroxene (up to 80 modal % cpx + cpx), the high magnesium numbers (86-90 whole rock, 79-82 garnet, and 95-96 cpx), the presence of enstatite and relict olivine(?), and the high Cr content (1.0-1.75 wt.% in gt., 0.75-1.3 wt.% in cpx) are characteristic of refractory mantle peridotites [4,5,11].

CONCLUSIONS Recent studies of eclogite xenoliths in kimberlites [1-5] have led to proposals of an oceanic crustal origin for the eclogites, and as we [4-5] have determined, there is also a mantle dike origin for the third type. The Archean age of our oceanic crust eclogites substantiates the theory that plate tectonic processes have been active for at least 2.5 Gyr.