TECTONIC SETTING AND MANTLE COMPOSITION INFERRED FROM PERIDOTITE XENOLITHS, GIBEON KIMBERLITE FIELD, NAMIBIA.

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The Gibeon kimberlite field is situated within the Namibia Province, a poorly exposed domain commonly considered part of the western Proterozoic margin to the Archaean Kaapvaal craton (Fig. 1). Xenoliths in the kimberlites provide a window to crustal basement and mantle lithosphere beneath considerable thicknesses of younger rocks in an area more than 400 km west of the Kalahari Line. This study covers aspects of the tectonic setting of mantle xenoliths from the ca. 75 Ma old Louwrensia kimberlite in the Gibeon kimberlite field. Several hundred samples have now been collected and are stored at the Geological Survey of Namibia.

Recent geophysical evidence suggests that the Kaapvaal craton and its associated lithosphere may extend into the Namibia Province. Although the Kalahari Line is generally considered to represent the craton margin, deep seismic reflection profiles indicate that this is an extensional feature (Hall et al., 1990). Regional gravity and magnetic patterns are continuous across the northern part of the Kalahari Line (Corner, pers. comm., 1994), consistent with the westward continuation of thinned cratonic basement at depth. The substantial change in magnetic character of deep basement from the northern to the southern part of the Namibia Province further suggests the presence of two distinct domains termed the Tses and Aroab Subprovinces respectively. U-Pb sphene determinations on gneissic basement drilled along the Kalahari Line yield an age of 2926 ± 2 Ma (Key, pers. comm., 1995), considerably older than the age of ca. 2.0 Ga usually attributed to the Kheis-Magondi Belt. This is in agreement with the Nd model ages of ca. 3.0 Ga obtained by Harris et al. (1987) for granites and sediments in the same belt. Similar lithologies have been mapped to the west of the Kalahari Line by Blignault et al. (1974), suggesting that the Kheis-Magondi Belt may constitute part of the Aroab Subprovince.

Peridotite xenoliths from Louwrensia are predominantly low-temperature garnet lherzolites. Major element compositions of these lherzolites are between those of typical cratonic and oceanic lithosphere, suggesting a transitional origin for sub-Gibeon lithosphere (Boyd et al., 1994). Metasomatism is dominated by mica (phlogopite) and subordinate diopside; no amphiboles have been observed. Mica occurs as discrete grains in contact with olivine, diopside and orthopyroxene; as

inclusions within diopside and garnet; and as rims on garnet and earlier formed mica. Mica compositions reflect different episodes of metasomatism which affected peridotites prior to and during kimberlite eruption. Over 80 mica analyses from 14 samples show ranges in composition of FeO (2.7-5.3 wt%), TiO_2 (0.1-6.0 wt%), BaO (0.01-0.66 wt%), and K_2O (7.8-10.5 wt%). Within individual samples, discrete mica grains are compositionally similar and may represent equilibrium compositions. They have low FeO and TiO_2 and are probably not in equilibrium with the host kimberlite. Micas which occur as rims (on mica and garnet), inclusions, and in contact with secondary diopside have relatively high FeO and TiO_2 contents, suggesting formation or equilibration at the time of kimberlite emplacement. The composition of each mica type differs in each sample, reflecting the combined effects of host rock composition, mica crystallisation age, mineral reactions and diffusion.

Oldest Re depletion model ages for peridotite xenoliths from the Gibeon kimberlite field are about 2.1 Ga (Pearson et al. 1994). These mantle ages are similar to the oldest U-Pb zircon ages for the inferred crustal basement but younger than Nd model age estimates of up to 3.0 Ga. Early Proterozoic age determinations for the crust and mantle underlying the Gibeon kimberlite field could indicate a link between the formation of crust and mantle lithosphere. However, geophysical evidence and Nd model age data support the more regional extension of Archaean crust into the Namibia Province. Post-Archaean extensional tectonics may have allowed upwelling suboceanic mantle to interact with attenuated cratonic margin lithosphere in order to produce the off-craton lithosphere beneath the Gibeon kimberlite field.

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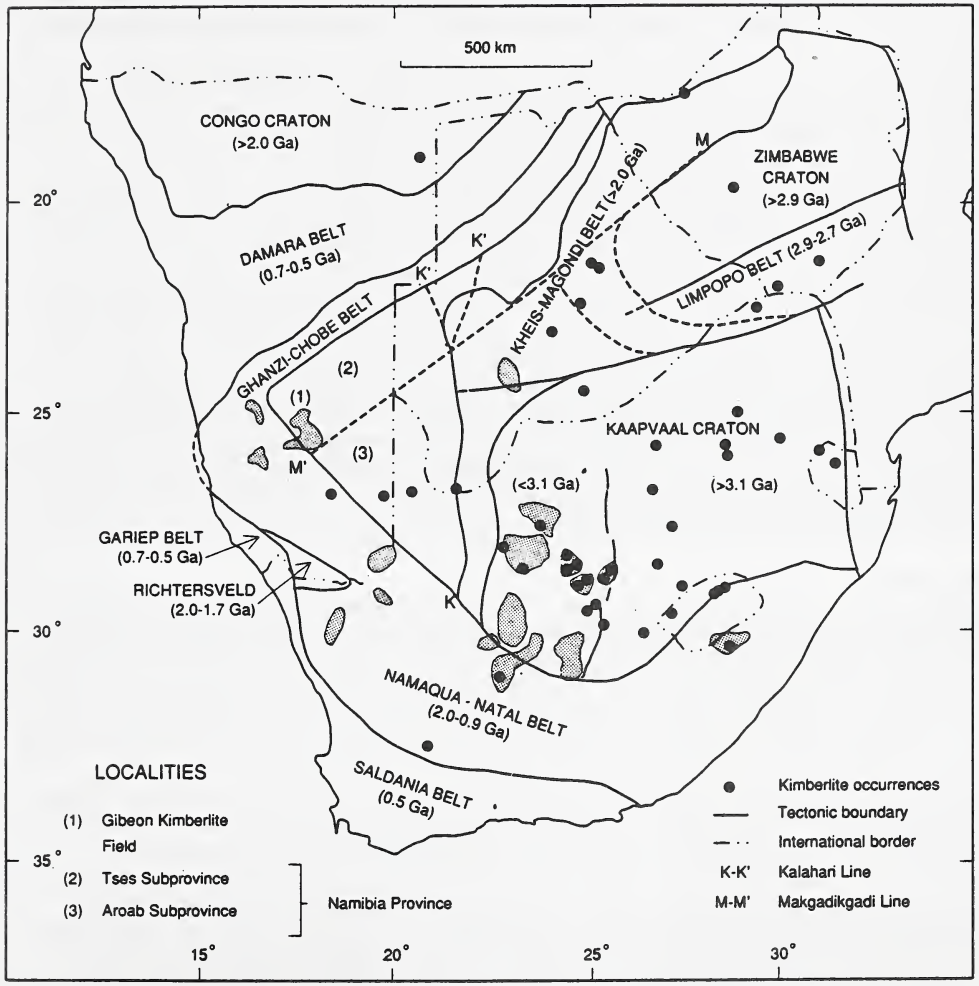

Figure 1: Map of kimberlite occurrences in relation to the tectonic framework of southern Africa (Hoal et al., 1995).