DIAMONDS AND MANTLE XENOLITHS IN KIMBERLITES FROM THE NORTH CHINA CRATON AND THE CANADIAN NORTHWEST TERRITORIES

by

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Dedicated to
my families, in China and here in the United States, especially to my wife Qinglan Liu and children Sijia and Sihua.

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to be asked and to be answered, by children and also by adults. Yes, to the universe and mankind, every individual human being is just like a naive child to an adult. The road to explore the truths of both the universe and mankind will never end. The goal of perfection may never be accomplished. However, for the happiness of the people related or not related, I will continue to explore, to pursue, and to struggle.

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ABSTRACT

This dissertation focuses on mantle compositions and processes. Mineral inclusions in diamonds from the Liaoning kimberlites, China belong mainly to a harzburgitic assemblage. The diamonds crystallized at depths of 140 to 200 km. Mineral inclusions in chromites from the same locality include silicates, carbonates, hydrous silicates and sulfides. Composite inclusions of carbonates+silicates in chromites might represent entrapped and crystallized kimberlitic magma. A garnet-olivine-chromite assemblage indicates that the depth where chromites formed is ~140 km. Similarities and differences between the inclusion assemblages in diamonds and in chromites suggest that minerals in diamonds and in chromites came from different depths, and that most mineral inclusions in chromites were probably trapped during the stage of the formation of kimberlite.

Mantle xenoliths from the Nikos kimberlites, Somerset Island, and the Zulu kimberlites, Brodeur Peninsula, Baffin Island, Canada are mainly coarse, protogranular, low-temperature lherzolites. High-temperature xenoliths, which are common in the Kaapvaal and Siberian cratons, were not found at Nikos. Garnet-spinel lherzolite xenoliths are common at Nikos. The calculated pressures and temperatures follow a continental geotherm. The fO_2 from olivine-orthopyroxene-spinel is from 1.3 log units above to 0.6 log units below EMOD (enstatite-magnesite-olivine-diamond), suggesting that diamond may or may not be stable relative to carbonates.

A MORID vein (mica-orthopyroxene-rutile-ilmenite-diopside±chromite) in a garnet-spinel lherzolite is characterized by high K, Fe, Ti and OH components. A method (referred to as RI) is developed to calculate oxygen fugacity from rutile-ilmenite for a MORID or similar suite with the reaction $2Fe_2O_3$ (in ilmenite) + $4TiO_2$ (rutile) = $4FeTiO_3$ (in ilmenite) + O_2. The RI is applicable to many rutile-ilmenite-bearing assemblages.