Geochemically, kimberlite rocks have high volatile contents (H₂O and CO₂), high MgO and incompatible trace elements, and low SiO₂, Al₂O₃ and alkalis, with K>Na and Na+K/Al < 1. Kimberlites are thus silica undersaturated, but neither potassic nor alkaline. A significant kimberlite problem is the relationship between rock compositions, and magma and melt compositions; poor quantification of the latter precludes the basis for sound experimental studies to determine basic knowledge of volatile solubilities, which in turn impacts any discussion of eruption styles.

The fundamental rock versus melt composition issue is mainly related to the ‘olivine problem’. Recent studies on hypabyssal/coherent kimberlites show that the amount of entrained xenocrystal olivine is highly variable, ranging from <20% to >80% of the total olivine population. Since olivine comprises <10% to >50% (modal) of a kimberlite, this has an enormous effect on the major- and trace-element contents. However, it is still possible to define intra- and inter-cratonic kimberlite compositional variations, that must reflect differing source region characteristics and/or partial melting regimes. These differences cannot be reconciled as merely due to the effects of craton specific lithospheric mantle contamination of kimberlite. Furthermore, there is no a priori reason that all kimberlite magmas have the same volatile speciation, and/or total volatile budget. Hence the different styles of kimberlite volcanism can be explained by differing kimberlite magma compositions (specifically volatile content and/or speciation), or by a combination of variable magma compositions and interaction with external water (phreatomagmatic processes). Examples will be presented to illustrate these ideas.