

COMPOSITION AND PETROGENESIS OF PARENTAL KOMATIITE LIQUIDS:  
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Komatiites are ultramafic volcanic rocks with >18 wt.% MgO [1]. They classically have been considered to be restricted to the Archaen, but recent discoveries of broadly similar magmas from younger terrains have been reported [2,3]. One of the most important problems in understanding the origin of komatiites is constraining the compositions of parental komatiite liquids. Although the MgO contents are often chosen as the prime indicators of differentiation in komatiites, the abundances of most other elements are correlated with MgO and any constraint on the MgO content constrains most of the other elements as well. Most investigators appear to accept the proposal [4,5], based whole-rock compositions and olivine-liquid equilibria, that parental komatiite liquids have up to 32 wt.% MgO, with cumulate rocks characterized by even higher MgO contents.

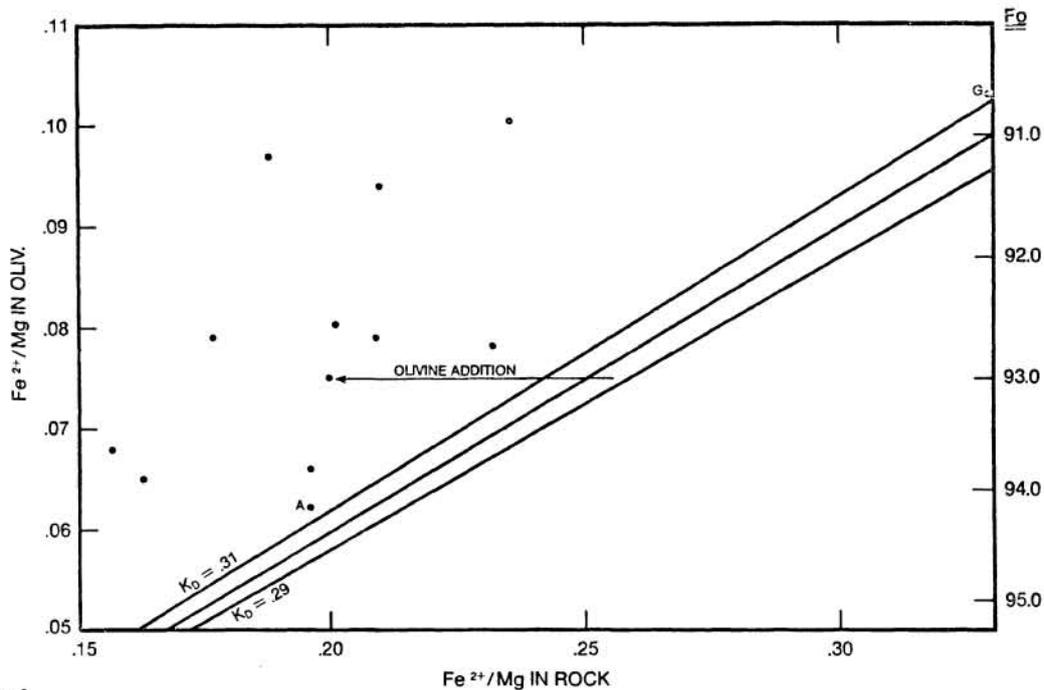
Although the whole-rock compositions of certain komatiites may represent liquid compositions, they cannot be used reliably for this purpose for two reasons. One is that the pervasive hydrothermal alteration found in most komatiites may be accompanied by metasomatism, which might substantially increase the MgO contents as it does in basaltic and peridotitic rocks [6,7]. The MgO content of altered oceanic basalts, for example, increases by 1.0 to 1.5 wt.% for each 1.0 wt.% increase in water in the metabasalt. Because komatiites generally contain 7-15 wt.% water, the potential for substantial MgO addition certainly exists. The second reason is olivine enrichment in a sample commonly occurs during settling and/or the growth of spinifex-textured olivine, introducing the uncertainty of how much olivine, if any, has accumulated in a specific sample.

For these reasons, the most quantitative manner to address the MgO contents of komatiite parental liquids is to perform mineral-liquid matching tests with Fe/Mg olivine-liquid distribution coefficients. The Fe is partitioned assuming that komatiite olivine crystallization occurred at ~1 atm under QFM oxygen fugacity conditions. In the following discussion, Fe refers to iron in the ferrous state.

Ford et al. [8] provide coefficients for the calculation of olivine-liquid equilibria at pressures up to 25 kbars and 1600°C. These (cation) distribution coefficients range from 0.29 to 0.30 for komatiites with >22 wt.% MgO and 0.30 to 0.31 at lower MgO contents. These values are much lower than those used (0.35-0.44) previously [4,5], which were based principally on high-pressure experiments. The lines with a slope of 0.29-0.30, therefore, define olivines and komatiite liquids in equilibrium (Fig. 1). The olivines in komatiites range up to ~Fo94.2, which would be in equilibrium with liquids that have

$Fe/Mg > 0.208-0.215$  (Fig. 1). Most komatiites lie substantially to the left of this equilibrium line and are consistent with either olivine enrichment or MgO metasomatic processes. The two samples that lie closest to the equilibrium values are the Gorgona (G) and Alexo (A) komatiites [2,9].

Komatiite liquids with  $Fe/Mg = 0.208-0.215$  have ~24 to 26.5 wt.% MgO, indicating that parental komatiite liquids probably have only 24 to 26.5 wt. % MgO; more MgO-rich komatiites have probably become enriched in MgO as a consequence of metasomatism or olivine enrichment. Eruption (1 atm liquidus) temperatures of these parental komatiites are 1500-1550°C.



**Fig.1**

Cation  $Fe^{2+}/Mg$  in komatiites versus Fo in olivine. The lines for  $K_D = 0.29-0.31$  are for equilibrium between olivines and komatiite liquids. Each data point is for an olivine in a komatiite. See text for discussion.

**REFERENCES:**

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