Which of slab melting or magma differentiation is suitable for the petrogenesis of an adakitic pluton?

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Various models such as slab melting (Martin, 1987), thickened-crust melting (Atherton and Petford, 1993), and/or magma differentiation (Takahashi et al., 2005) have recently been invoked to explain the petrogenesis of adakitic plutons. For identification of an adakitic pluton derived from thickened-crust melting, thickness of crust would give important information. On the other hand, MgO, Ni, and Cr contents of rocks may be available keys for judging the petrogenesis whether slab melting or magma differentiation because adakitic magmas derived from slab melting are rich in these elements due to interaction between slab melt and mantle peridotite (Martin et al., 2005). However, identification of the main petrogenetic process is difficult in differentiated adakitic rocks derived from slab melt because many adakitic plutons are generally affected by a peculiar fractional crystallization of hornblende + plagioclase (Martin and Moyen, 2002). This fractional crystallization causes depression of MgO, Ni, and Cr contents in the magma on the grounds that the hornblende/liquid partition coefficients of these elements in felsic liquids are very high. Therefore, MgO, Ni, and Cr contents of adakitic rocks cannot be used directly to judge the petrogenesis whether slab melting or magma differentiation.

To solve this problem, I propose that an estimation of the parental magma composition by Rayleigh law is an effective method. An adakitic pluton lies on the central part of Kyushu Island, southwest Japan arc. Kamei (2004) reported that the plutonic magma was produced by the partial melting of subducted oceanic slab and subsequent fractional crystallization of plagioclase + hornblende. However, the magma differentiation model for the petrogenesis of the adakitic pluton in Kyushu has never been studied so far. In this study, the parental magma composition of the adakitic pluton is estimated by Rayleigh law. The result shows that Cr content in the calculated intermediate magma (SiO_2=ca60wt%) extend to 300ppm or more. The Cr content exceeds upper limits of adakites (ca300ppm: Martin and Moyen, 2002) and average compotion of volcanic arc basalts (191ppm: Shiraki, 1978). Therefore, there is no possibility that the adakitic pluton was produced by a differentiation of basaltic magma. These results lead us to the conclusion that an estimation of the parental magma composition by Rayleigh law is an useful method for the petrogenetic consideration of adakitic rocks.