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The Relationship and Evolution of the intermediate-Mafic Volcanic-Intrusive Rocks in Luzong Volcanic Basin, the Lower Yangtze River Belt, Eastern China

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The relationship between volcanic and intrusive rocks is crucial for understanding magma plumbing systems. While studies often focus on high-silica systems, intermediate-mafic systems remain understudied. In the Luzong Basin, Lower Yangtze River Belt (LYRB), we investigate trachyandesite, trachyte, pyroxene monzonite, and quartz syenite to explore intermediate-mafic magma dynamics. Zircon U-Pb dating reveals Early Cretaceous ages (130–133 Ma) for all units, indicating contemporaneous formation. Geochemical analyses show consistent Nd-Hf isotopic compositions (εNd(t): -13.0 to -3.6; εHf(t): -17.7 to -3.7), suggesting a shared magma source. The clinopyroxene (cpx)-dominated, amphibole-scarce system indicates a relatively “dry” magma environment. Cpx crystallization occurred at 980–1079°C but over varying pressures: Longmenyuan (0.4–4.7 kbar), Zhuanqiao (4.1–6.7 kbar), Bajiatan (0.5–5.5 kbar), and Huangmeijian (0.9–8.6 kbar), with Huangmeijian cpx interpreted as cumulates from Bajiatan. This pressure range implies multi-depth magma reservoirs with dynamic interactions. Geochemical modeling reveals no complementarity between volcanic rocks (Longmenyuan, Zhuanqiao) and the Bajiatan pluton, challenging the melt extraction-crystal accumulation model. However, Huangmeijian and Bajiatan exhibit complementary relationships, suggesting fractionated melt origins. The isotopically depleted Huangmeijian pluton may reflect crystal mush reactivation by mantle-derived magma in an extensional setting. This study highlights the limitations of the crystal mush model for intermediate-mafic systems and underscores the utility of whole-rock and cpx geochemistry in deciphering alkali-rich magma chamber processes.