Magma evolution and open system processes for Mesozoic andesitic volcanics from the Ningwu basin in South China: Constraints from clinopyroxene geochemistry

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Andesitic volcanics are commonly rich in phenocrysts with complex textures and compositions, providing an excellent object to decipher magmatic processes in andesite petrogenesis. This is illustrated by clinopyroxene phenocrysts in andesitic rocks from the Ningwu basin in the Middle-Lower Yangtze Valley, South China. The phenocrysts show complex textural features and compositional zoning, in association with variable REE distribution patterns. Three types of clinopyroxene can be distinguished from their distinct REE distribution patterns. Type I clinopyroxene shows smooth REE distribution patterns and significant negative Eu anomalies, Type II clinopyroxene exhibits enrichment in LREE and MREE over HREE with moderate negative Eu anomalies, and Type III clinopyroxene shows depletion in MREE and significant negative Eu anomalies. The distinct compositional correlation patterns between the three types of clinopyroxenes suggest that these clinopyroxenes were crystallized from two kinds of primary melts. Among which, Type I clinopyroxene was crystallized from less REE-enriched primary melts, whereas Types II and III clinopyroxenes were crystallized at different evolution stages of the more REE-enriched primary melts. The transition from Type II clinopyroxene to Type III clinopyroxene indicates that large amounts of plagioclase and amphibole crystals were crystallized from the magmas. However, the host rocks of these phenocrysts show insignificant Eu negative anomalies and negligible MREE depletion. This suggests that the majority of plagioclase and amphibole antecrysts were not separated from the host magmas and thus have negligible contribution to the final composition of andesitic volcanics. The patchy and reverse zoned clinopyroxene phenocrysts clearly record the magma recharge processes that operated during the magma evolution. Such persistent magma recharge spans the magmatic circles of interest and thus may be responsible for the relatively restricted composition of the Ningwu andesitic rocks.