The ZrO_2-Al_2O_3-FeO*-SiO_2-rich inclusions in corundum megacrysts: Microscopic analyses and geological implications

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The current controversies on the origin of zircon, corundum, titanomagnetite and quartz megacrysts in alkali basalts are mostly due to the lack of direct evidences for a "melt reservoir" required for their formation. In this study, we report some novel inclusions in corundum megacrysts in alkali basalts from eastern China, and we attribute their origin to the existence of a ZrO_2-Al_2O_3-FeO*-SiO_2-rich melt. The inclusions, analyzed using electron microprobe and Raman microscope, can be divided into two types. Type I consists of a dark part (DP) composed of quartz, corundum and amorphous phase (AP-1) and a bright part (BP) composed of baddeleyite, and another amorphous phase (AP-2). Compared with AP-1, AP-2 contains higher concentrations of ZrO_2 and FeO* but lower concentrations of Al_2O_3 and SiO_2, giving rise to its brighter appearance under electron beams. Our results indicate that the formation temperature of type I inclusion is over 1200 ℃ , and the separation of its BP and DP may be attributed to the immiscibility of the parent melt at its metastable state. Type II inclusion is composed of zircon, quartz and amorphous substance-3 and does not exhibit two distinct parts as in type I. Nevertheless, the general chemical compositions of both types of inclusions are similar, and they basically represent the ZrO_2-Al_2O_3-FeO*-SiO_2-rich melts at the boundary during host corundum growth and enclosed later. This study provides new insight into the genesis of the corundum and we suggest it is derived from the partial melting of deep subducted mixture of carbonatitic sediments, which should also play an important role for the modification of the lithospheric mantle.