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Immiscible-melt inclusions in corundum megacrysts: Microanalyses and geological implications

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Abstract

Controversies on the origin of zircon, corundum, titanomagnetite, and quartz megacrysts in alkali basalts mostly reflect the lack of direct evidence of a "melt reservoir" required for their formation. Various mineral megacrysts are carried up by Cenozoic (mostly younger than 25 Ma) alkali basalts that extend more than 4000 km along eastern China. Here we report unusual inclusions in corundum megacrysts from Changle, and we attribute their origin to the existence of a FeO*-SiO_2-Al_2O_3-ZrO_2-rich melt. The inclusions, analyzed using electron microprobe and Raman microscopy, may be divided into two types. Type I inclusions are dominated by glassy materials, may exhibit a dark part in backscattered eletron (BSE) images composed of quartz, corundum, and an amorphous substance (AS-1), and a bright part in BSE images composed of baddeleyite and a second distinct amorphous substance (AS-2). Compared with AS-1, AS-2 has higher concentrations of ZrO_2 and FeO* but lower concentrations of Al_2O_3 and SiO_2. We argue that the formation temperature of Type I inclusions is ~1200 °C, and the generation of their bright and dark parts in BSE images may be attributed to the coexistence of immiscible melts. Type II inclusions are composed of zircon, quartz, and an amorphous substance (AS-3). Both types of inclusions might be derived from a similar parent melt, which is FeO*-SiO_2-Al_2O_3-ZrO_2-rich. New secondary ion mass spectroscopy (SIMS) in situ U-Pb ages of 18 Ma and 13–14 Ma for zircon inclusions suggest that the corundum megacrysts, occurring in basaltic host rocks distributed along the middle segment of the north and south-trending Tanlu fault zone, formed from precursor residual magmas related to underplating basalts stalled at the crust-mantle boundary, and were brought to the surface by entrainment in later basalts. This study provides new insights into the genesis of the corundum-related megacryst suite.

Keywords: Corundum megacrysts, immiscible-melt inclusions, underplating basalts, geochemical analysis, BSE imaging