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Petrology and Geochronology of Monzonite Porphyry Intruding in Xiong'er Volcanic Rocks in Xiaoshan Area, Western Henan Province

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Xiong'er volcanic rocks cover an area of more than 6×10^4 km^2 along the southern margin of North China Craton. The Xiong'er group has been divided, from bottom to top, into the Dagushi, Xushan, Jidanping and Majiahe formations, which are dominated by basaltic andesite and andesite. The volcanic rocks distributed in the Waifangshan, Xiong'ershan and Xiaoshan areas have experienced wide and intense hydrothermal alteration. Coeval mafic to felsic subvolcanic rocks intruding in Xiong'er volcanic rocks and the metamorphic basement can be found.

Co-occurrence of baddeleyite and zircon, including zircon overgrowths on baddeleyite are found in a granophyric monzonite porphyry intruding in volcanic rocks of the Majiahe formation in Xiaoshan area. Baddeleyite occurs as euhedral, platy and monoclinic crystal within most rock-forming minerals, indicating that the baddeleyite formed at the early stage of crystallization and that the initial magma has low silica activity, which is also supported by absence of inherited zircon. SHRIMP U-Pb dating of baddeleyite yields a weighted mean $^{207}Pb/^{206}Pb$ age of 1779 ± 8 Ma, representing the initial crystallization of the porphyry.

Isolated zircon grains in the porphyry are small, anhedral to needle-shaped, and are often clustered together along K-feldspar stringers. Some acicular zircon grains grew along the interface of quartz and K-feldspar in the granophyric groundmass, which are suggestive of undercooling likely due to rapid emplacement. Survival of baddeleyite also implies the magma became silica-saturated during a rapid cooling process. The above observations indicate that zircon did not crystallize until final emplacement. SHRIMP U-Pb analyses of zircon get a weighed mean $^{207}Pb/^{206}Pb$ age of 1777 ± 8 Ma, defining the upper age limit of the Majiahe formation there.

Subsequent medium- to high-temperature hydrothermal alteration caused subsolidus pressure and temperature (470-580℃) estimates as determined by amphibole-plagioclase thermobarometry. Related alterations such as albitization of plagioclase, crystallization of secondary apatite and sporadic zircon overgrowths on baddeleyite indicate the fluid phase is enriched in Si, Na and halogens (e.g., F, Cl). Electron microprobe analyses show that Zr concentration in altered hornblende is significantly higher than that of the whole rock. We have sound reasons to believe that, in addition to direct replacement of baddeleyite, zirconium required for the development of zircon overgrowths have been available through the alteration of Zr-bearing matrix phases, such as amphibole and ilmenite.

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