Early Devonian Ultrapotassic Magmatism in the North China Craton: Geochemical and Isotopic Evidence for Subcontinental Lithospheric Mantle Metasomatism by Subducted Sediment–Derived Fluid

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The North China Craton (NCC) represents one of the oldest and largest cratons in the earth with a nearly complete record of Precambrian history. In the northern part of the NCC, the earliest phase of alkaline magmatism occurred in discrete pulses in the Early and Middle Devonian; whereas the next episode of alkaline magmatism took place in the early Mesozoic. The Gucheng pluton is exposed in the northern part of the NCC and forms a composite intrusion, consisting of K-feldspar–bearing clinopyroxenite, clinopyroxene–bearing syenite and alkali-feldspar syenite. Mineral phases in these lithologies include clinopyroxene ($Wo_{43-48}En_{19-35}Fs_{18-38}$), sanidine ($An_{0}Ab_{3-11}Or_{89-97}$), and subordinate titanite, andradite and Na-feldspar. These rocks show homogeneous Sr but variable Nd isotopic compositions, and have relatively high zircon in-situ oxygen isotopes ($\delta^{18}O$ = 5.2–6.7). The Gucheng plutonic rocks formed through fractional crystallization and accumulation from ultrapotassic magmas, which were originated from partial melting of metasomatic vein systems in the subcontinental lithospheric mantle of the NCC. These vein networks developed as a result of the reactions of fluids derived from subducted pelitic sediments on the downgoing Palaeo-Asian ocean floor with the enriched, subcontinental lithospheric mantle peridotites. SHRIMP U-Pb zircon dating has revealed a crystallization age of 415 Ma for the timing of the emplacement of the Gucheng pluton that marks the early stages of alkaline magmatism associated with the Andean-type continental margin evolution along the northern edge of the NCC facing the Palaeo-Asian Ocean.