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Petrogenesis of granites and associated microgranular mafic enclaves in Ngoura–Colomines (Eastern. Cameroon): Insights from U–Pb Zircon Geochronology and Sr–Nd–Pb Isotopes

JONAS DIDERO TAKODJOU WAMBO[1], SYLVESTRE GANNO[2], ARKADEEP ROY[3], DONALD HERMANN FOSSI[4], PATRICK AYONTA KENNE[5], OLIVER D WILNER[6], JEAN PAUL NZENTI[2] AND PAUL D. ASIMOW[6]

[1]Lamar University
[2]University of Yaoundé I
[3]University of Arizona
[4]Lakehead University
[5]University of Dschang
[6]California Institute of Technology

Granitoids constitute a major portion of the upper continental crust and archive key information about magmatic processes through time. Yet, interpreting their origins remains challenging because many different petrogenetic mechanisms can produce granitoid magmas. In this context, microgranular mafic enclaves (MMEs) provide valuable constraints, as their presence, composition, and textures often clarify the interactions between coexisting mafic and felsic magmas and the broader evolution of continental crust. The Ngoura–Colomines batholith of eastern Cameroon represents an important case study because it contains abundant MMEs distributed throughout the intrusion. Located within the Central African Fold Belt, this batholith has also drawn interest due to the gold mineralization found in the region. However, the precise timing of emplacement of its granitoid units remains uncertain, with proposed ages ranging from the Early to Late Neoproterozoic. In addition, the significance of inherited Paleoproterozoic to Neoproterozoic zircon grains in these rocks is still not well understood. This study offers the first integrated characterization of the widespread MMEs within the Ngoura–Colomines batholith to better constrain its emplacement history, magmatic evolution, the nature of the underlying pre-Neoproterozoic crust, and the tectonic setting of central Gondwana during the late Neoproterozoic. Our approach combines detailed petrography and mineral chemistry with zircon U–Pb geochronology and Sr–Nd–Pb isotopic analyses of both the granitoid host rocks and their associated MMEs. The batholith consists of concentrically zoned biotite granites containing abundant, fine-grained dioritic to syenodioritic MMEs that exhibit sharp boundaries and dominantly magmatic textures. Mineral assemblages—including magnesio-hastingsite amphibole, oligoclase–andesine plagioclase, and biotite–phlogopite—along with high-K calc-alkaline I-type whole-rock compositions and LREE-enriched trace-element patterns, indicate a primarily magmatic origin with minor metamorphic overprinting and repeated mafic recharge. LA-ICP-MS U–Pb zircon ages of ~640 Ma for the MMEs and 628 ± 4 Ma for the host granite reveal a 10–15 Myr offset, implying that the MMEs represent earlier mafic pulses later remobilized and mingled with younger felsic magmas during incremental pluton assembly. Whole-rock isotopic signatures further show that the MMEs derive from mantle-based magmas modified by crustal input, whereas the granites reflect stronger assimilation of ancient, Paleoproterozoic crust.