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Module 2.3: New geochronological data on granitoids from central Côte d'Ivoire and their geodynamic implications

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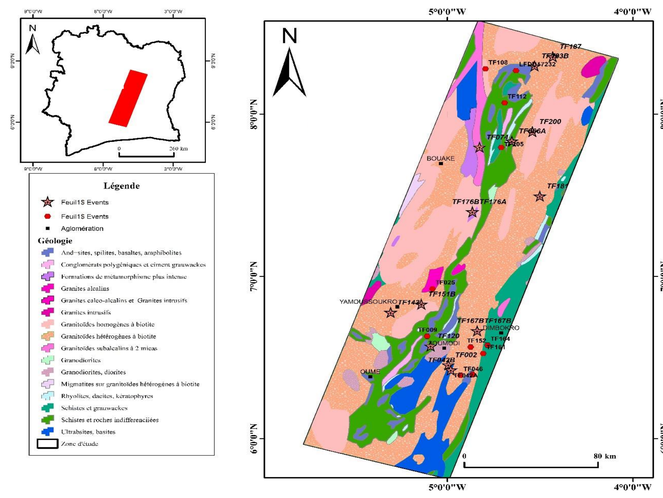
Introduction

The Toumodi-Fétékro Belt, located in central Côte d'Ivoire, is one of the main Paleoproterozoic volcano-sedimentary belts of the West African Craton. It tren mainly NNE–SSW and extends for more than 300 km. The belt is composed of volcanic, volcano-sedimentary and plutonic formations emplaced during tl Eburnean orogeny. It represents a major component of the Birimian domain and provides a key area for investigating Paleoproterozoic magmatic evolutic and continental crustal growth. Previous studies have characterized the lithology, geochemistry and geochronology of several units within the be highlighting the coexistence of mafic and felsic rocks related to different magmatic episodes. However, available geochronological data remain unever distributed, particularly for granitoids, which limits the reconstruction of the magmatic history of the entire belt and the correlation between its differe geological units. In this study, we present new U-Pb zircon ages obtained from granitoids of the Toumodi-Fétékro Belt. These results are compared wi previously published geochronological data in order to identify already recognized magmatic episodes, refine their temporal extent, and highlight possib magmatic events that have not yet been documented. This approach allows us to improve the chronological framework of the magmatic evolution of tl Toumodi-Fétékro Belt and provides new constraints on the geodynamic evolution of the Birimian domain in Côte d'Ivoire.



Data acquisition

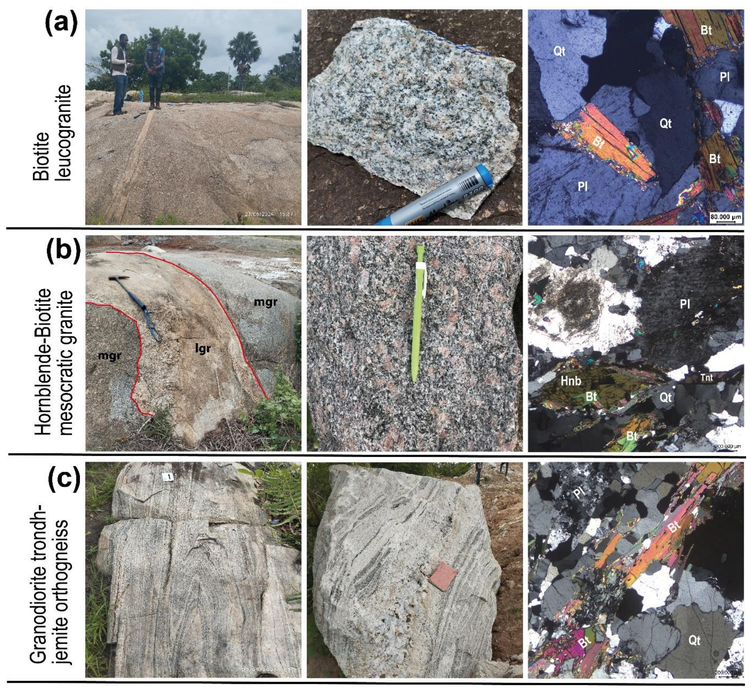
❑ Sampling and petrographic analysis

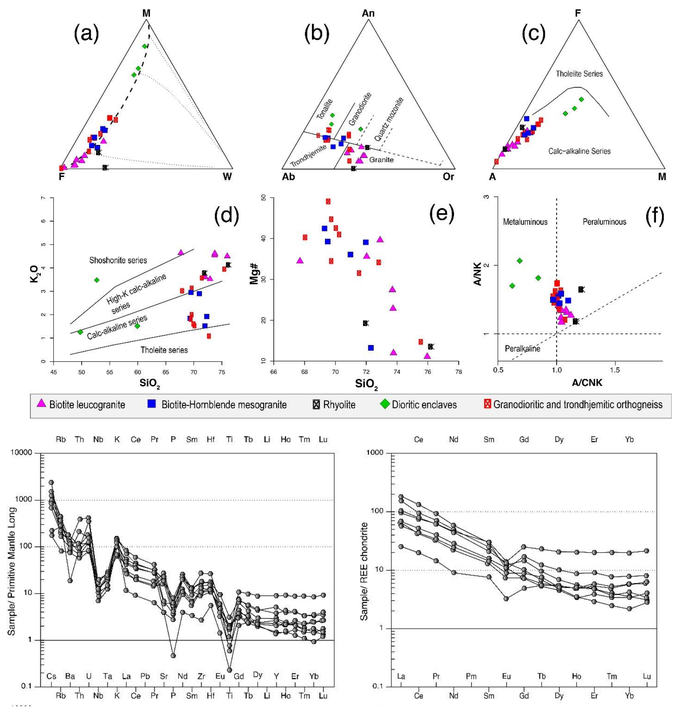
Field investigations were conducted across the Toumodi-Fétékro Belt to identify the main lithological units and document the relationships between mafic and felsic rocks. Representative granitoid samples were selected following geological mapping and petrographic observations. Twenty-nine fresh samples were prepared as standard thin sections and examined under transmitted light to characterize their mineralogical and textural features. This study focuses on the granitoid dataset, which is integrated with published geochemical and geochronological data for mafic rocks.

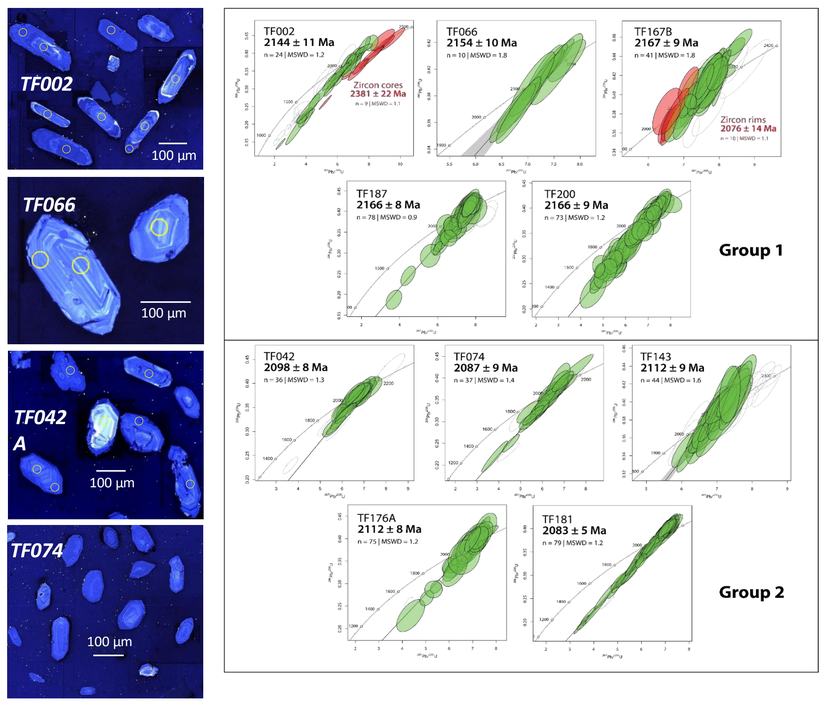
❑ Sampling and petrographic analysis

U–Th–Pb analyses were carried out on zircons from a rhyolite and a dozen plutonic rocks of the Toumodi–Fétékro Belt using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) at Geosciences Environnement Toulouse (France). Ablation was performed with a ThermoFinnigan Element XR mass spectrometer coupled to a Lambda Physik COMpex 102 excimer laser, following the analytical procedures of Schoene (2014) and Bosch et al. (2011). U/Pb and Pb/Pb isotopic ratios were calibrated against the zircon reference G91500 (Wiedenbeck et al., 1995), while GJ-1 (Jackson et al., 2004) was used as a quality control standard. Data reduction and age calculations were performed using Iolite (Paton et al., 2011) and Isoplot (Ludwig, 2003, 2009). Raw U–Pb data are presented in Table 1, and ages are reported at the 2σ confidence level.

Results







❑ Petrographical features

Biotite leucogranite (n = 5) displays a porphyritic texture with euhedral feldspar phenocrysts defining a magmatic fabric. It is composed mainly of quartz, plagioclase, microcline, and biotite. Dioritic mafic enclaves and aplite–pegmatite dykes are locally present.

Hornblende–biotite mesocratic granite exhibits granular to locally porphyritic textures. It consists mainly of quartz, altered plagioclase, hornblende, and biotite, with accessory titanite, allanite, Fe–Ti oxides, epidote, and chlorite.

Granodioritic–trondhjemitic orthogneiss display medium- to coarse-grained gneissic textures. The trondhjemitic facies is leucocratic whereas the granodioritic facies is characterized by hornblende and biotite defining the gneissic banding.

❑ Whole rock chemistry

The granitoids define a coherent high-K calc-alkaline trend from dioritic enclaves to trondhjemitic orthogneisses and biotite leucogranites. Increasing SiO_2 and K_2O contents, coupled with decreasing Mg#, indicate progressive magmatic differentiation by fractional crystallization. Most granitoids are weakly peraluminous to metaluminous (A/CNK ≈ 1) and belong to the I-type granite series. Primitive mantle-normalized multi-element patterns are enriched in LILE and LREE and display pronounced negative Nb–Ta, Ti, P, and Eu anomalies. Chondrite-normalized REE patterns show LREE enrichment, HREE depletion, and weak to moderate Eu anomalies, indicating a common magmatic source and evolution in a subduction-related calc-alkaline setting.

❑ U-Pb data and magmatic evolution

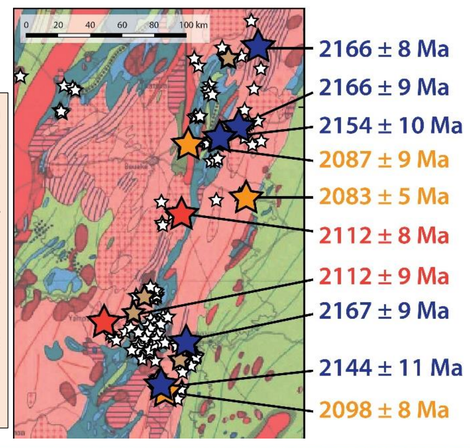
The U–Pb zircon data indicate that granitoid magmatism in the Toumodi–Fétékro Belt occurred between ca. 2.17 and 2.08 Ga and was characterized by two main episodes of emplacement. The first episode (2168–2144 Ma) is recorded by samples TF167A, TF167B (zircon cores), TF200, TF066 and TF002, whereas the second episode (2112–2083 Ma) includes TF143, TF176A, TF042, TF074 and TF181. Zircon rims from TF167B yield a younger age of **2076 ± 14 Ma**, suggesting a late magmatic or post-magmatic overprint. A few inherited zircon domains from TF002 record older Paleoproterozoic ages (2354–2291 Ma), indicating limited incorporation of pre-existing crust. Overall, the geochronological data reveal two successive Eburnean magmatic episodes within the Toumodi–Fétékro Belt.

Discussion

U–Pb zircon ages identify three major episodes of silicic magmatism, consistent with previously reported ages for granitoids and volcanic rocks from the Toumodi–Fétékro Belt (TFB) [5–9]. These magmatic episodes coincide with the main stages of TFB stratigraphic development, suggesting that granitoid emplacement was closely linked to the evolution of the volcano-sedimentary basin.

Group 1 granitoids (2.18–2.13 Ga), characterized by TTG affinities, record the development of an intra-oceanic volcanic arc, as supported by their geochemical signatures and NNE–SSW linear distribution. Their emplacement was contemporaneous with the formation of the intermediate and upper volcano-sedimentary sequences of the TFB. In contrast, Group 2 granodiorites and granites (2.12–2.08 Ga) represent a late syn- to post-collisional magmatic episode that was contemporaneous with, or slightly preceded, the deposition of the uppermost siliciclastic sediments. This event may reflect the accretion of an intra-oceanic arc onto a continental margin, marking the final stages of TFB tectonic evolution.

Overall, these observations support a geodynamic model involving a transition from an intraplate regime to a convergent tectonic setting between ca. 2.30 and 2.20 Ga. This scenario is consistent with the formation of felsic continental crust on an oceanic plateau, followed by subduction initiation along its margins, in agreement with models proposed for Archean felsic crust formation [14,15].



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