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Table of Contents

The Ngoc Linh Complex in Central Kon Tum Massif: an exposed remnant of the Early Paleozoic collisional tectonism in East Central Indochina mainland

Hai Thanh Tran, Truong Tai Nguyen, Hau Vinh Bui, Thanh Xuan Ngo, Monsup Cho, Chi Kim Ngo, Dao Anh Vu, Hiep Huu Nguyen, Binh Van Phan, Hung Quoc Nguyen..... 1

Late Cretaceous Magmatism in the Nui Sam Area (An Giang Province, Southwestern Vietnam): Implications for the Tectono-Magmatic Evolution of the Ankroet Complex

Bui Vinh Hau, Tran Thanh Hai, Nguyen Truong Tai, Ngo Thi Kim Chi, Phan Van Binh, Vu Anh Dao, Nguyen Huu Hiep, Nguyen Quoc Hung, Ngo Xuan Thanh 10

U–Pb zircon geochronology of meta-diorite in the Vit Thu Lu area, northern Quang Tri, central Vietnam

Dinh Trong Tuong, Nguyen Quoc Hung, Tran My Dung, Ha Tri Dung, Dang My Cung, Ngo Xuan Thanh 16

Post-collisional extension during the Early Paleozoic in Northeast Vietnam: Evidence from syenitic complex

Chu Van Dung, Tran My Dung, Ngo Xuan Thanh 23

Zircon U–Pb constraints on episodic magmatism of the Hai Van granitoid complex and implications for the Indosinian orogeny in central Vietnam

Dinh Trong Tuong, Ngo Xuan Thanh, Tran My Dung Ha Tri Dung 34

Controlling factors on mineralization in the Tram Tau felsic volcanic formation (Tu Le Basin, North Vietnam)

Tran Thi Huong, Nguyen Hoang, Tran Thanh Hai 42

Distribution and Metamorphic Evolution of REE-bearing Minerals in Metapelite Rocks of the Nam Co Formation, Song Ma Suture Zone, NW Vietnam

Bui Vinh Hau 56

Technology for rare earth ore beneficiation in Vietnam

Thanh Hai Pham 63

Structural and tectonic controls on gold mineralization in the northern Kon Tum massif, Vietnam

Vu Tien Thanh, Nguyen Van Vuong, Luong Thi Thu Hoai 73

Potential for Marine Ion-Adsorption Rare Earth Deposits: Sedimentary Facies Controls in Southwestern Vietnam

Nguyen Huu Hiep, Phan Van Binh, Tran Thanh Hai, Bui Hoang Bac 85

Fluvial geomorphology and weathering crust controls on ion-adsorption rare earth element mineralization in Northwestern Vietnam

Dinh Thi Hue, Vu Anh Dao 93

Tectonic – Geomorphology and its relation to geo-hazards in the Southwest region of Vietnam

Nguyen Xuan Nam, Tran Thanh Hai, Ngo Thi Kim Chi, Hoang Ngo Tu Do, Vu Anh Dao, Nguyen Xuan Quang 100

Grain-size and mineralogical characteristics of surface sediments in the Con Co Island area and their environmental significance

Late Cretaceous Magmatism in the Nui Sam Area (An Giang Province, Southwestern Vietnam): Implications for the Tectono-Magmatic Evolution of the Ankroet Complex

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ABSTRACT

Granitic intrusions exposed as isolated inselbergs in the Nui Sam area (An Giang Province, southwestern Vietnam) have traditionally been assigned to the Ankroet Complex and interpreted as Cenozoic in age. However, the lack of precise geochronological constraints has limited understanding of their origin and tectonic significance. This study presents new petrographic observations and zircon U–Pb geochronological data from representative granite samples. Petrographic analysis reveals light-colored, two-mica granites with inequigranular to porphyritic textures and felsic mineral compositions dominated by plagioclase, K-feldspar, and quartz. Zircon U–Pb dating yields a concordant crystallization age of $\sim 70.71 \pm 0.76$ Ma, indicating a Late Cretaceous magmatic event. These results challenge previous interpretations and suggest that the Nui Sam granitoids formed during post-orogenic extension or lithospheric reworking following the Indosinian orogeny. The findings provide new constraints on the tectono-magmatic evolution of southwestern Vietnam and contribute to refining the geodynamic framework of the Indochina block.

Keywords: *Nui Sam granite; U–Pb zircon dating; Late Cretaceous magmatism; Ankroet Complex;*

1. Introduction

Granitic magmatism plays a fundamental role in understanding crustal evolution and tectonic processes, particularly in continental collision zones and post-orogenic settings (Chappell and White, 1992; Sylvester, 1998). In Southeast Asia, granitoid intrusions record multiple phases of magmatic activity associated with major tectonic events, including the Indosinian orogeny and subsequent Mesozoic–Cenozoic reactivation (Liu et al. 2012).

In Vietnam, granitoids are widely distributed across the Indochina block; however, the southwestern region, especially the Mekong Delta, is largely covered by Quaternary sediments, limiting exposure of crystalline basement rocks. Isolated granitoid bodies such as those in the Nui Sam area therefore provide rare and valuable insights into the deeper crustal structure and magmatic history of this region.

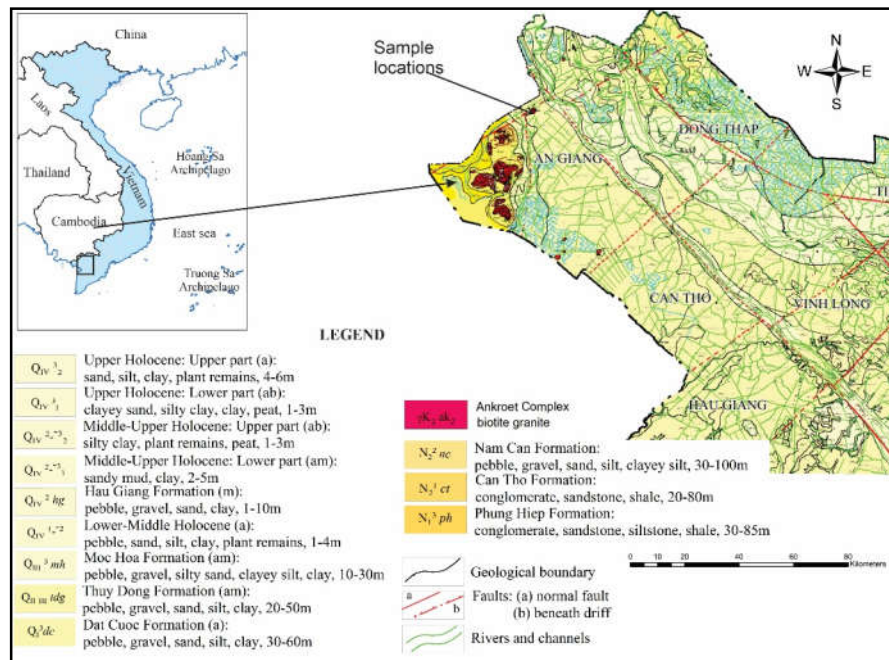


Figure 1. Geological map of study area showing the sample locations

The Ankroet Complex consists mainly of medium- to coarse-grained biotite granites, with its principal distribution in the Da Lat–Lam Dong region and minor exposures in An Giang Province. Zircon U–Pb ages reported for this complex range from 93.4 ± 2.0 Ma to 96.1 ± 1.1 Ma (Thuy et al., 2004; Hiep et al., 2020). Previous studies (e.g., Huỳnh Trung et al., 1979) assigned the Nui Sam granitoids to the Ankroet Complex and tentatively interpreted them as Cenozoic. However, the absence of reliable geochronological data has resulted in significant uncertainty regarding their age, origin, and tectonic significance. This study provides the first robust geochronological constraints for the Nui Sam granitoids and contributes to refining the tectono-magmatic evolution of southwestern Vietnam.

2. Geological Setting

The Nui Sam area is located near Chau Doc City in An Giang Province, southwestern Vietnam, close to the Vietnam–Cambodia border (Figure 1). This region lies along the southwestern margin of the Indochina block, a major continental fragment in Southeast Asia that has experienced a complex tectonic history involving multiple orogenic and post-orogenic events.

From a geomorphological perspective, the study area is part of the Mekong Delta lowland, which is extensively covered by Quaternary sediments (Figure 1). These unconsolidated deposits obscure most of the pre-Cenozoic basement, making direct observations of crystalline rocks relatively rare. In this context, the granitoid bodies exposed at Nui Sam form prominent inselbergs rising abruptly above the surrounding plains, representing erosional remnants of more extensive basement rocks. Their isolation highlights their resistance to weathering and provides important windows into the otherwise concealed crust beneath the delta (Figure 1).

Geologically, the exposed granitoids have been traditionally assigned to the Ankroet Complex (Huỳnh Trung et al., 1979), which is widely distributed across southern Vietnam, particularly in the Da Lat zone. The complex is dominated by felsic intrusive rocks, including granites and granodiorites, and has been variably interpreted as forming during either the Mesozoic or Cenozoic (Huỳnh Trung et al., 1979). However, due to the scarcity of reliable geochronological

data in the southwestern region, the age and tectonic affinity of the Nui Sam granitoids have remained uncertain.

3. Materials and Methods

3.1. Sampling

Two representative granite samples were collected from fresh outcrops in the Nui Sam area. One sample was selected for detailed petrographic and geochronological analysis (Figure 1).

3.2. Petrographic Analysis

Thin sections were prepared following standard procedures and examined under a polarizing microscope at magnifications up to 10 $\times$. Mineral assemblages, textures, and deformation features were documented.

Table 1. Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) U–Th–Pb Zircon of the studied granite sample.

Spot	U(ppm)	Th(ppm)	Th/U	U–Th–Pb ratios								Ages (Ma)							
				$^{207}\text{Pb}/^{206}\text{Pb}$	1 σ	$^{207}\text{Pb}/^{235}\text{U}$	1 σ	$^{206}\text{Pb}/^{238}\text{U}$	1 σ	$^{208}\text{Pb}/^{232}\text{Th}$	1 σ	$^{207}\text{Pb}/^{206}\text{Pb}$	1 σ	$^{207}\text{Pb}/^{235}\text{U}$	1 σ	$^{206}\text{Pb}/^{238}\text{U}$	1 σ	$^{208}\text{Pb}/^{232}\text{Th}$	1 σ
G-01	8	1	0.17	0.05216	0.00051	0.07853	0.00176	0.01092	0.00022	0.00332	0.0001	292	21	77	2	70	1	67	2
G-06	6	1	0.23	0.04994	0.0005	0.07467	0.00171	0.01084	0.00023	0.00328	0.0001	192	21	73	2	70	1	66	2
G-07	6	1	0.21	0.05441	0.00056	0.08221	0.00195	0.01096	0.00023	0.00369	0.00014	388	21	80	2	70	1	74	3
G-08	6	1	0.14	0.04734	0.00091	0.07145	0.00235	0.01095	0.00022	0.00348	0.00008	66	41	70	2	70	1	70	2
G-04	6	1	0.20	0.04812	0.00047	0.07337	0.00163	0.01106	0.00023	0.00356	0.00011	105	21	72	2	71	1	72	2
G-02	36	15	0.42	0.04827	0.0005	0.0743	0.00175	0.01116	0.00023	0.0036	0.00011	113	22	73	2	72	1	73	2
G-03	4	1	0.18	0.04841	0.00046	0.07535	0.00165	0.01129	0.00023	0.00413	0.00013	119	21	74	2	72	1	83	3
G-10	202	162	0.80	0.05094	0.0169	0.08979	0.03218	0.01278	0.00042	0.00403	0.00058	238	497	87	30	82	3	81	12
G-05	132	62	0.47	0.04964	0.00061	0.09098	0.00247	0.01329	0.00028	0.00397	0.00012	178	26	88	2	85	2	80	2

3.3. Zircon U–Pb Geochronology

Zircon grains were separated using conventional crushing, heavy liquid, and magnetic separation techniques at the Center for Excellence in Analyses and Experiments (CEAE)-Hanoi University of Mining and Geology. U–Pb isotopic analyses were conducted using MC-ICP-MS at OC-KBSI. Data reduction and age calculations were performed using established protocols, and uncertainties are reported at the 1 σ level (Table 1, Figure 3).

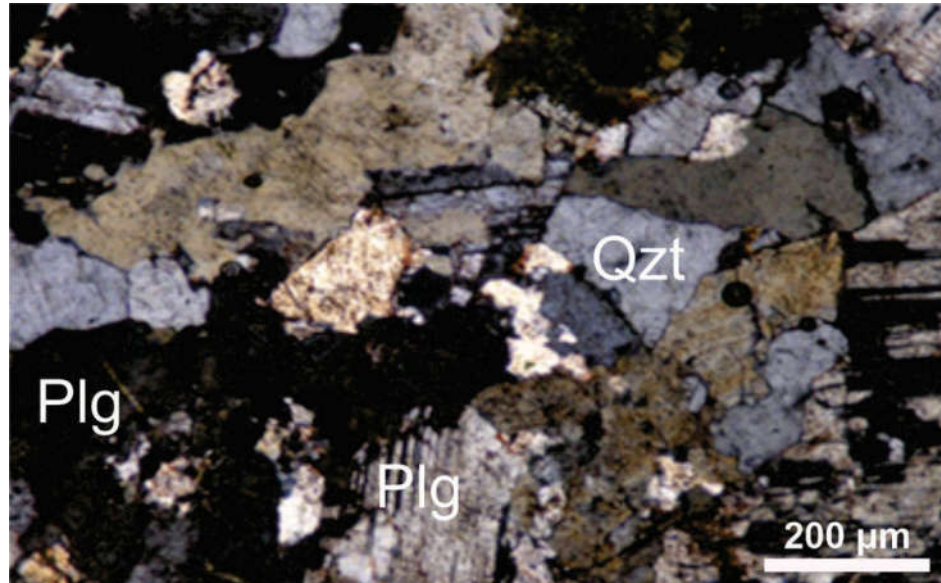


Figure 2. Photomicrographs showing representative mineral assemblages of the studied granite sample. Qtz: quartz, Plg: Plagioclase

4. Results