

Research Advances

New Chronology of the Quaternary Tengchong Volcanic Swarm, SW China and the Discovery of a Holocene Volcano

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Objective

The Tengchong volcanic field is located at the eastern edge of the convergence zone between India and Eurasia. New tomographic results show that the subducting Indian Plate is imaged clearly as high-V anomalies beneath Burma and dips eastward with a high angle in the upper mantle, and then it flattens in the mantle transition zone. Due to the continuous dipping of the Indian Plate into the Eurasia Plate, the Tengchong volcanic field has been suffering strong volcanism as well as earthquakes and geothermal activities in Quaternary, and is known as a famous Quaternary volcanic field containing more than 70 volcanoes in China.

It is believed the volcanism in the Tengchong volcanic field is pervasive in Quaternary, while the eruption types of the Tengchong volcanoes roughly fell into two categories: explosive eruption with a large amount of dacitic debris and central eruption with relatively small amounts of trachy-basaltic scoria and lava. According to the seasonal field investigation and geological mapping, we found that the explosive eruptions occurred generally earlier than the central lava effusion, as the thick-layered dacitic debris and volcanoclastic rocks formed by huge heat and compaction were located at the bottom of the Tengchong Basin and covered by later trachy-basaltic volcanic rocks after eruption, which was also verified by borehole data. Though previous researchers have published some K-Ar isotopic ages of the Tengchong volcanic rocks, the common geological dating methods such as K-Ar dating are not applicable to the young volcano whose eruption age is younger than several thousands of years. It is thus urgent for us to try some new chronology dating methods in order to determine the young volcano exactly and understand the eruption sequence as well as the rule of eruption migration.

Methods

We have collected many fresh volcanic rock samples in the Tengchong volcanic field in the past few years, and have also luckily got several valuable charcoal and organic sediment samples baked by the volcanic eruption and buried in the soil just beneath the lava layer, which give us the best opportunity to determine the young eruption age exactly. Thus, the Tengchong volcanism could be determined by the combination of several geological dating methods, such as AMS ¹⁴C measurement, optically stimulated luminescence (including Post-IR SL, Post-IR IRSL, TT-OSL), K-Ar and Ar-Ar isotopic dating, which have never been used in previous studies. For those AMS ¹⁴C measurements, the calendar dates were carefully calculated by using OxCal v4.2 and the Northern Hemisphere terrestrial radiocarbon curve IntCal 13. The fine-grained quartz and mixed crystals in the organic sediment were tested objects of the luminescence dating. In addition, the fine-grained whole rock samples which carefully eliminate dolomite crystals were prepared for the K-Ar and Ar-Ar isotopic dating. Most dating was conducted in the State Key Laboratory of Earthquake Dynamics, Institute of Geology, China Earthquake Administration, and the Ar-Ar isotopic dating was performed at Argon Geochronology Laboratory in Oregon State University, USA. It is worth mentioning that OSL dating for mixed crystals from the volcanic rocks is relatively a new attempt to determine the younger eruption age of a volcano especially since the late Quaternary.

Results

We got the new younger chronology data as follows (Table 1), i.e., 10 OSL and 2 AMS ¹⁴C results in addition to 22 K-Ar and six Ar-Ar isotopic dating results, which clearly define the age of volcanic activities in the Tengchong Basin and the eruption sequence of the

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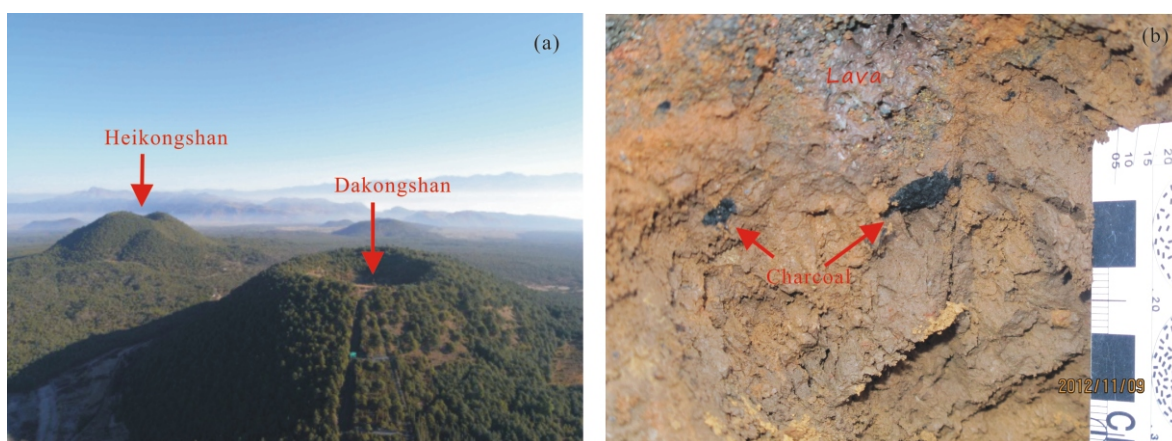


Fig. 1. The Heikongshan volcano (a) and the charcoal beneath its lava (b).

Table 1 Dating results of the younger Tengchong samples

Location	Sample	OSL(a)	AMS ^{14}C (a)
Heikongshan	F1-1	3600±400	5031±103
		4600±200	
		5000±300	
		5300±300	
Dayingshan	F2-1	46400±2900	
		47800±2700	
		56000±3000	
		83200±2000	
Longchuan River (Chengzilou)	F3-1	78100±2200	10020±90
		180000±11000	

Quaternary Tengchong volcanic swarm has been confirmed as well.

Among all the volcanoes in the Tengchong volcanic field, the Heikongshan is determined to be the only Holocene volcano by both geological dating and field investigation (Fig. 1), as its AMS ^{14}C result well agrees with OSL results and both give the definitely young age between 3600 and 5300 a, which are the first set of younger ages never published before; whereas the other three relatively young volcanoes of the Dayingshan, Ma'anshan and Laoguipo volcanos once believed to have Holocene eruptions, are not identified as Holocene volcanoes from our research. However, the Chengzilou volcano is perhaps another Holocene volcano according to both the AMS ^{14}C and K-Ar results (but its OSL results are older), which still need more evidence to support it.

Our analyzing results also show that OSL dating is acceptable in comparison to AMS ^{14}C measurements, while the latter dating is the best way to determine the relatively younger volcanic eruption less than thousands of years ago.

Conclusions

(1) In this study, the Heikongshan volcano is confirmed to be the only Holocene volcano among all the volcanoes in the Tengchong volcanic swarm according to both AMS ^{14}C and OSL results between 3600 and 5300 a.

(2) The comprehensive research suggests the eruption sequence of the Tengchong volcanic swarm in Quaternary could be divided into three subsequences: all the dacitic volcaniclasts in the Daliuchong, Laifengshan, Qincaitang, Laoyanghe volcanoes had early to mid-Pleistocene eruption ages and constituted the bottom layer of the Tengchong Basin, while most trachy-basaltic and trachy-andesitic volcanoes as Dayingshan, Ma'anshan, Laoguipo, Dakongshan, Xiaokongshan, Tieguoshan, Chengzilou, Tuanshan erupted successively in the Late Pleistocene; in the mean time the Tengchong volcanism reached its climax. The Heikongshan volcano is a Holocene volcano.

(3) The volcanic rocks in the central Tengchong Basin generally has the younger age than the margin ones, implying the Tengchong volcanism in Quaternary moved from the periphery to the central basin and ended in Heikongshan eruption about 5000 years ago.

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