

6th International Maar Conference

A Guidebook for Post-conference Field Trip to Mt. Changbai volcano

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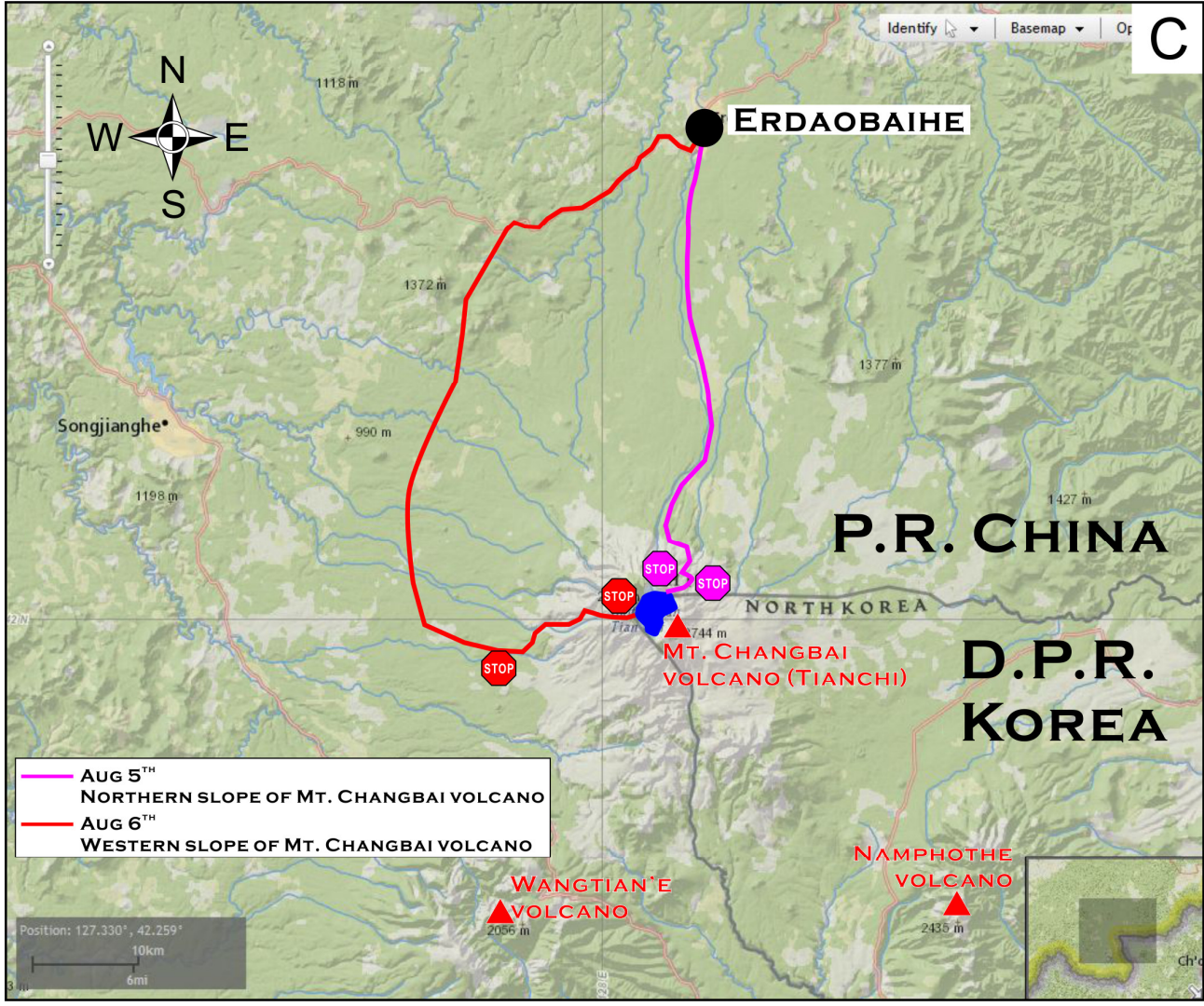
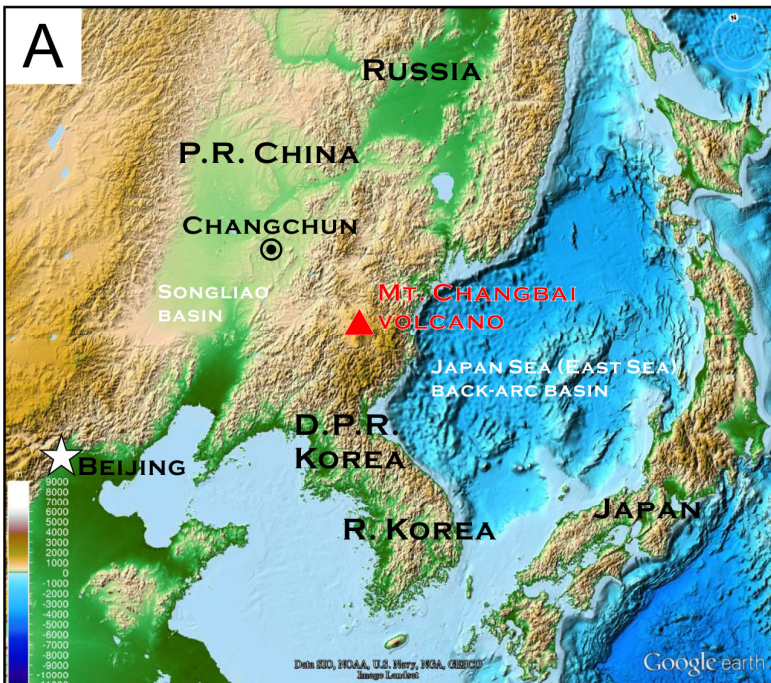
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Changchun, China

August 4th – 7th, 2016

SIMPLIFIED ROUTE MAP OF POST-CONFERENCE FIELD TRIP TO MT. CHANGBAI VOLCANO



General Information

Date

The post-conference field trip is planned to start on August 4th, leaving Changchun for Erdaobaihe (the closest town to Mt. Changbai volcano), followed by a two-day (August 5th – 6th) field trip at Mt. Changbai volcano, and end with a return journey from Erdaobaihe to Changchun on August 7th.

Accommodation

All delegates will check in the Changbai Paradise Resort of the Erdaobaihe town. For more information, please visit the website below:
https://www.tripadvisor.com/Hotel_Review-g1190798-d6702952-Reviews-Changbai_Paradise_Resort-Antu_County_Jilin.html

Transportation

During the whole field trip, all delegates will take bus for (1) the round trip between Changchun and Erdaobaihe, and (2) the field trip between Changbai Paradise Resort and viewing sites at Mt. Changbai volcano.

Breakfasts, Lunches & Dinners

Breakfasts will be provided by the hotel in Changchun (August 4th) and Changbai Paradise Resort in Erdaobaihe town (August 5th – 7th). Lunches will be arranged in reserved restaurants or be supplied as box lunches during the field trip. Dinners will also be arranged by Organizing Committee of the 6th International Maar Conference. Bottled Mineral Water and snacks will be supplied during breaks of the field trip.

Weather & Clothing

In early August, it often rains in the Mt. Changbai volcanic field, especially for places near summit of Mt. Changbai volcano (rainy, windy and usually cold). Therefore, we recommend that umbrellas and/or raincoats are necessary items for you when preparing for the post-conference field trip. According to local meteorological records, the temperature may vary in 15–30 °C during the post-conference field trip. Jeans and T-shirts are suitable for daytime, but still waterproof outdoor coats are recommended for early morning and night (and for the visit to summit of Mt. Changbai volcano with elevation >2700 m). A pair of slip-resistant hiking shoes is also necessary for safety during outdoor activities (especially in rainy days).

Safety, Insurance & Responsibility

Given that the Mt. Changbai volcano is right on boundary between China and North Korea, it is highly recommended to avoid unnecessary trouble (e.g., political events). Liability insurance is the responsibility of each individual delegate. Delegates should have their own medical coverage. The Organizing Committee assumes no responsibility for accident, loses, damage, delays, or any modifications to the program arising from unforeseeable circumstances.

Smoking Policy

To prevent risk of potential forest fire, smoking is not permitted during the field trip, especially when staying out of doors.

Sampling Policy

Mt. Changbai volcano is an important Chinese nature reserve. All delegates should not collect any types of samples without permission. The Organizing Committee appreciates for your understanding.

Help & Emergency Contact

Prof. Zhengfu Guo (Institute of Geology and Geophysics, Chinese Academy of Sciences, IGGCAS) will be chief guider of the post-conference field trip to Mt. Changbai volcano. Additionally, Drs. Guoming Liu, Shuangshuang Chen and Maoliang Zhang will be assistants during the field trip. If you have need help (e.g., queries, getting lost and medical aid), please do not hesitate to contact them. Detailed contact information is as follows:

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Regional Geological Setting

Mt. Changbai volcano (also known as Baekdusan in North/South Korea) lies in the uplifted area between the Japan Sea back-arc basin and the Songliao basin in NE China (Fig. 1A). The volcano covers an area of 12,000 km² and is characterized by the presence of three main eruptive cones (i.e., Tianchi, Wangtian'e, and Namphothe), with the elevation gradually decreasing from crater to surrounding area (Fig. 1B).

Tianchi volcano is located in the central zone of Mt. Changbai volcano, and Wangtian'e and Namphothe are 35 km southwest to Tianchi and 45 km southeast to Tianchi, respectively (Fig. 1B; Fan et al., 2007; Wei et al., 2003, 2004, 2007). The main peak of Tianchi (2749 m) is characterized by a large crater lake and a composite volcano, which was created by many volcanic eruptions. As for structure of Tianchi (Fig. 2), it mainly comprises extensive basaltic lava platform, volcanic cone of trachytes, and pantellerites at the summit (Fan et al., 2001, 2005, 2006, 2007; Liu and Wang, 1982; Liu et al., 1996, 1998a, 1998b; Wang et al., 1983; Wang et al., 2003; Wei et al., 2004, 2007, 2013).

Table 1. Lithological stratigraphy of Mt. Changbai volcano (Wei et al., 2013)

Stages	Formation and age	Lithologies
Late-stage: Ignimbrite-forming	Liuhaojie Tuff Ring (1903 AD?)	Pantellerite layers
	Wuhaojie (1702 AD?)	White gray pantellerite fine glass
	Baguamiao (1668 AD?)	Dark gray trachyte ignimbrite and pumice
	Millennium eruption (939–946 AD)	White gray pantellerite ignimbrite and air fall pumice with minor trachyte ignimbrite and air fall pumice
	Qixiangzhan (17 ka)	pantellerite lava and pyroclasts
Middle-stage: Cone construction	Baitoushan III (0.02–.22 Ma)	Trachyte and pantellerite lava
	Baitoushan II (0.25–0.44 Ma)	Trachyte with Laohudong basalt
	Baitoushan I (0.53–0.61 Ma)	Trachyte
	Laofangzixiaoshan (0.75–1.17 Ma)	Basalt
	Xiaobaishan (1–1.49 Ma)	Trachyandesite and trachyte
Early-stage: Shield-forming	Baishan (1.48–1.66 Ma)	Basalt
	Toudao (2.35–5.02 Ma)	Basalt
	Naitoushan (15.6–22.64 Ma)	Basanite, Basalt

Wangtian'e volcano (2051 m) consists of early-stage basalt–trachybasalts, middle-stage trachyandesite–trachytes, and late-stage pantellerite outcrops (Chen et al., 2008; Fan et al., 1998, 1999, 2007). Namphothe volcano (2343 m)

is composed of trachytes in the volcanic cone, and pantellerites and welded tuff in the upper part and large areas of pumice in surrounding areas (Cao et al., 1998; Jin and Lin, 1995; Jin et al., 2000; Ri Don, 1993). There are about 380 volcanic cones in North Korea, which are of different sizes and lithologies and occupy an area of 5350 km² (Ri Don, 1993).

Additionally, the main mountains of Mt. Changbai are the sources of the Songhua, Tumen and Yalu rivers (Fan et al., 2001). Mt. Changbai volcano is known for its attractive scenery, especially the Tianchi (crater lake) and other natural features such as waterfalls, hot springs, virgin forest and alpine tundra (Fan et al., 2007; Liu et al., 1998a, 1998b).

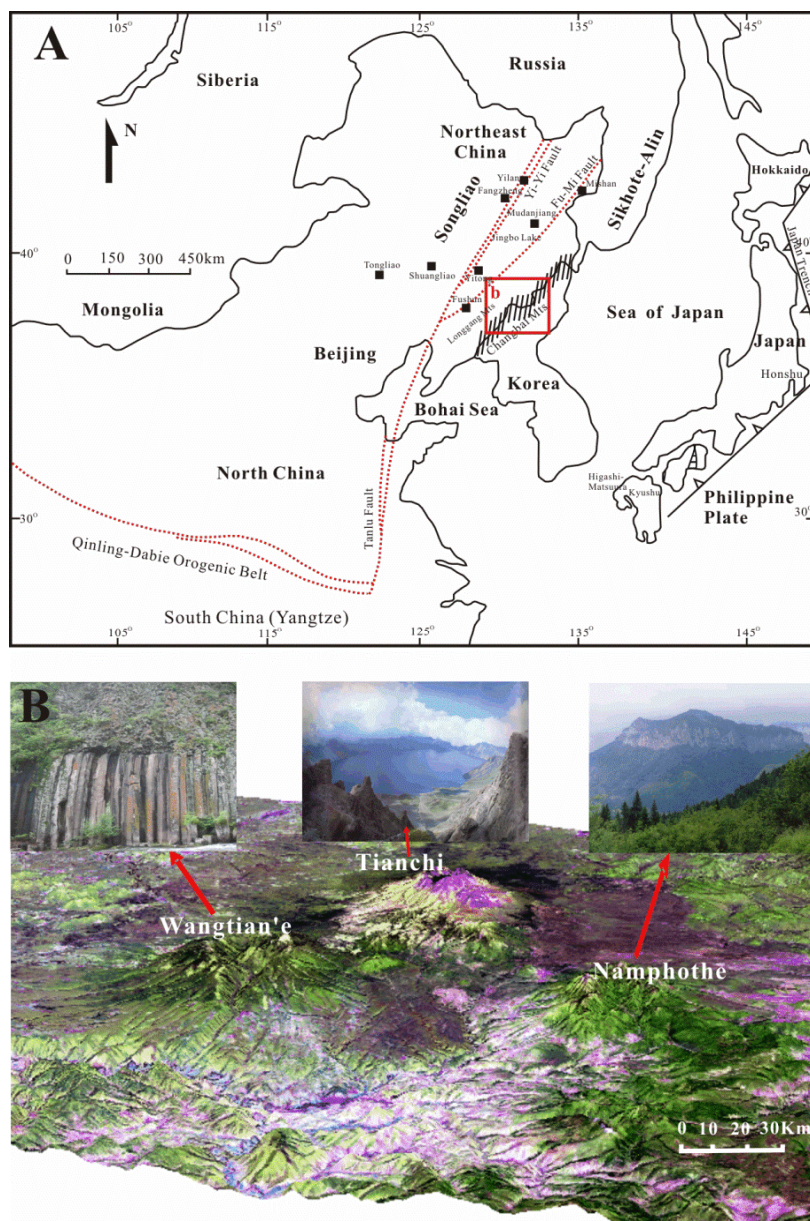


Fig.1 (A). Simplified geological map of northeast Asian continental margin; (B). The full view of Mt. Changbai volcanoes, the landscape map of Wangtian'e, Tianchi and Namphothe volcano (Liu et al., 2015).

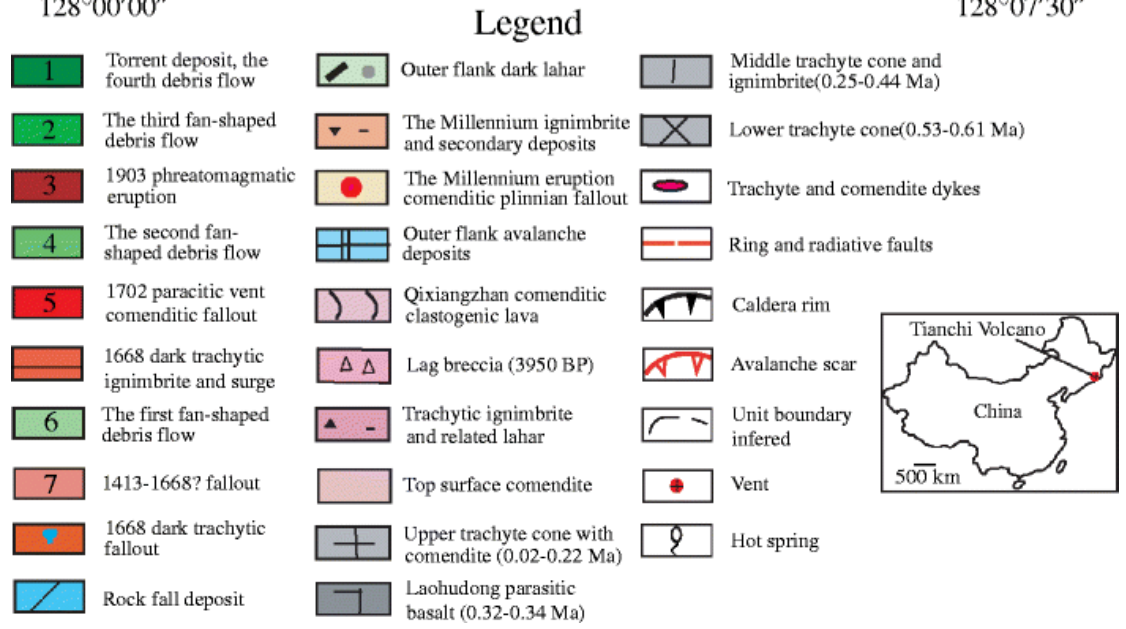
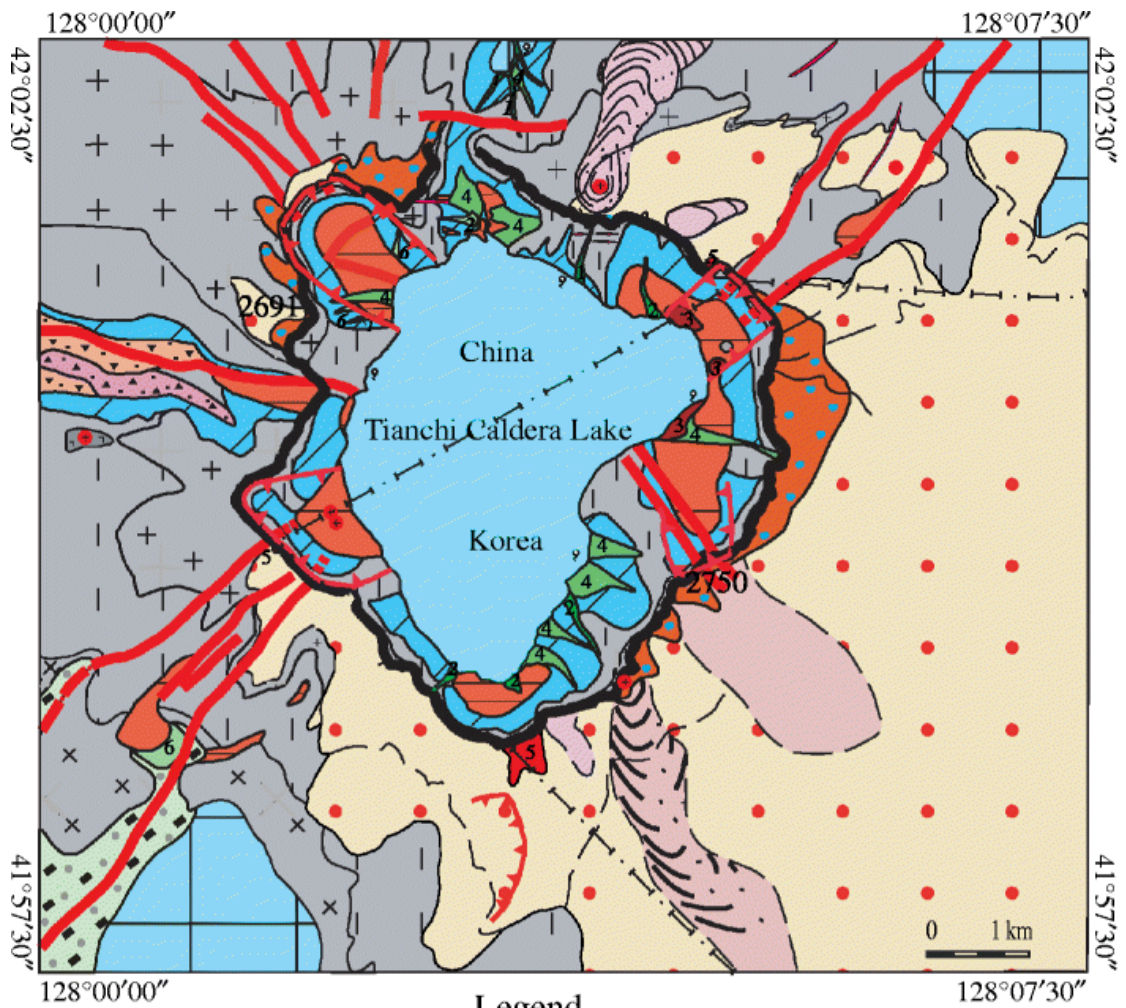


Fig.2. Geological map of the top area of Mt. Changbai volcanic cone (modified from Wei et al., 2013).

Route and Time Table

DAY 1 --- (August 4th, Thursday)

A long-distance (ca. 700 km) journey by bus from Changchun to Erdaobaihe (the closest town to Mt. Changbai volcano), as scheduled below:

07:30-08:30	Breakfast
08:30-12:00	On the road to Erdaobaihe
12:00-13:00	Lunch time, picnic
13:00-18:00	On the road to Erdaobaihe, arriving at Hotel
18:30-20:30	Dinner

DAY 2 --- (August 5th, Friday)

A field trip to northern slope of Mt. Changbai volcano, as scheduled below:

07:30-08:30	Breakfast
08:30-09:00	Taking bus to northern gate of Mt. Changbai volcano
09:00-12:00	Taking bus to northern summit of Mt. Changbai volcano STOP 1: Holocene volcanic rocks STOP 2: Qixiangzhan (Meteorological station) pantellerite STOP 3: Tianchi crater lake
12:00-12:30	Lunch time, picnic
12:30-13:30	Leaving northern summit for Tianchi Grand Valley
13:30-16:30	Visiting Tianchi Grand Valley on foot STOP 4: Tianchi waterfall and trachyte; STOP 5: Julong hot springs STOP 6: Tianchi Grand Valley STOP 7: Mt. Changbai volcano monitoring station;
16:30-18:00	Gathering and going back to hotel
18:30-20:30	Dinner

DAY 3 --- (August 6th, Saturday)

A field trip to western slope of Mt. Changbai volcano, as scheduled below:

- 07:30-08:30** Breakfast
- 08:30-10:00** Taking bus to the western gate of Mt. Changbai volcano
- 10:00-11:30** Taking bus to western slope parking lot
- 11:30-12:00** **STOP 1:** western slope parking lot, trachytic lava flow
- 12:00-12:30** Lunch time, picnic
- 12:30-14:30** Climbing to **STOP 2**, the western top of Mt. Changbai volcano, for crater lake and upper unit of trachyte and historical eruption volcanic ash
- 14:30-15:30** Leaving western summit for Jinjiang Grand Valley
- 15:30-16:30** **STOP 3:** Jinjiang Grand Valley
- 16:30-18:00** Gathering and going back to hotel
- 18:30-20:30** Dinner

DAY 4 --- (August 7th, Sunday)

A return journey by bus from Erdaobaihe to Changchun, as scheduled below:

- 07:30-08:30** Breakfast
- 08:30-10:00** **STOP 1:** Natural museum of Mt. Changbai volcano
- 10:00-17:00** Leaving Erdaobaihe for Changchun, including box lunch

Introduction to Viewing Sites

DAY 2 --- (August 5th, Friday)

On the second day, we will visit the northern slope of Mt. Changbai, including (1) Holocene volcanic eruptive rock on the Tianwenfeng profile, (2) Qixiangzhan (meteorological station) pantellerite, (3) Tianchi caldera lake, (4) Tianchi waterfall trachyte, (5) Julong hot spring, (6) Tianchi Grand Valley, (7) Volcano station (Fig. 4).

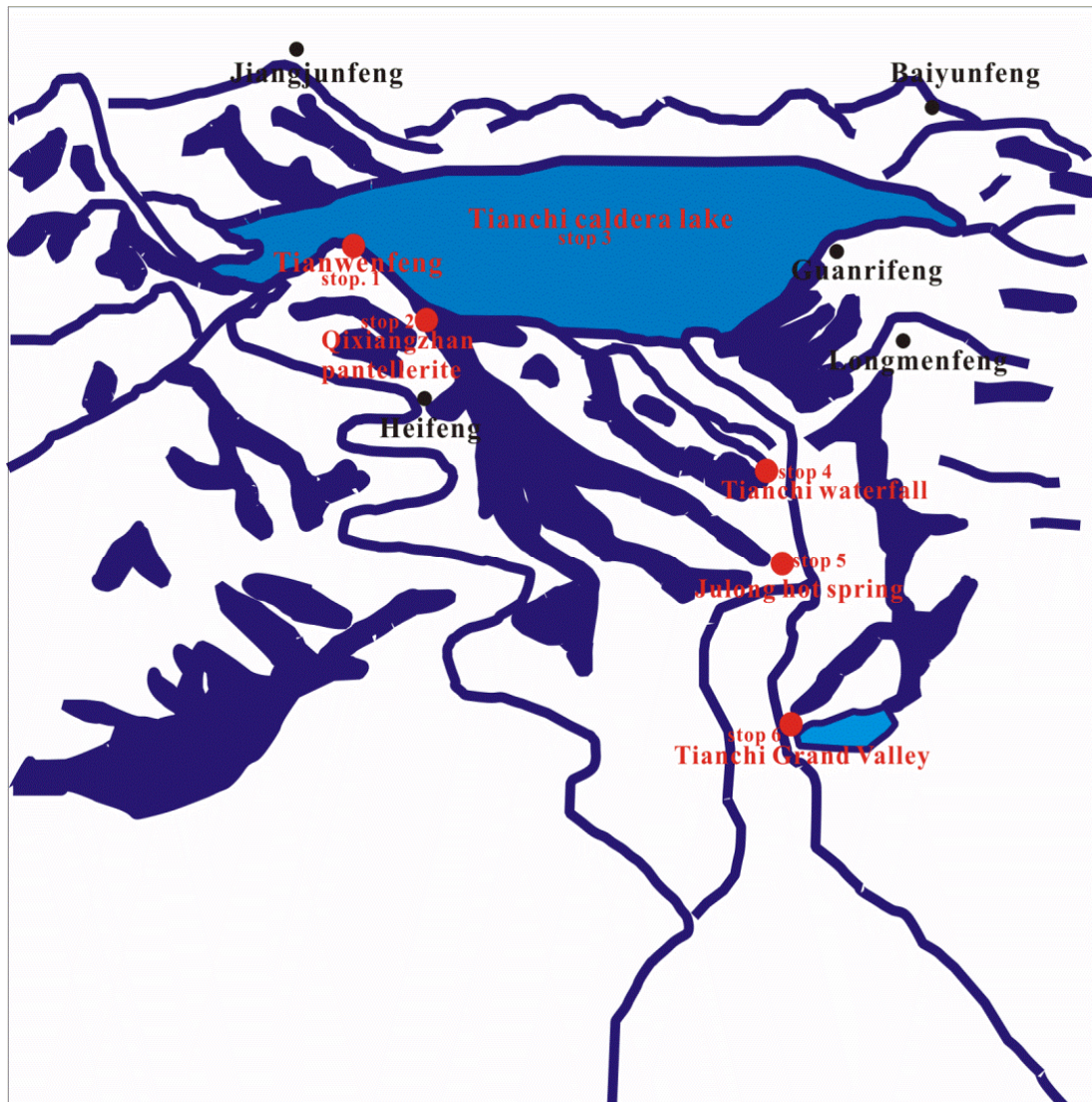


Fig. 4. The tourist routes of the northern slope of Mt. Changbai.

STOP 1: Holocene volcanic rocks on the northern summit

Tianwenfeng is the highest peak of Tianchi crater rim. It's also the typical profile for the historically recorded Tianchi eruptions (Fig. 5), directly covering the Tianchi trachyte cone. From the top to the bottom, the eruption deposits

consist of black pumice (~50 cm in thickness), grey pumice (~200 cm), yellow pumice (~1000 cm) and dark grey pumice (~1000 cm) (Fig. 5). The historical report shows that eruptions from the Tianchi volcano took place in 1668, 1702 and 1903 AD. Liu (2000) and some other Chinese researchers believe that the black pumice on the top belongs to 1668 AD eruption, and the grey pumice is produced by “Millennium Eruption”, the yellow pumice and dark grey pumice belong to 4000 B.P. and 5000 B.P. respectively, but the age of these sequences are controversial. Most researcher paid much attention to the age of “Millennium Eruption”, hundreds of outcome of ^{14}C age are all near 1000 A.D. (e.g. Xu et al 2012), and the historical record show that during 1014~1019 A.D. and 1199~1201 AD. Tianchi volcano had both erupted massive grey ash.



Fig. 5. The pumices of various colors produced by the Tianchi volcano at Tianwenfeng.

STOP 2: Qixiangzhan/ Meteorological station pantellerite

Based on the existing chronological evidence in China, the Holocene volcanic strata of the Tianchi volcano consist of the Bingchang, Qixiangzhan, Baiyunfeng and Baguamiao pantellerite. The Qixiangzhan pantellerite is a typical clastogenic lava flow originating from satellite comenditic volcanism near the top of the Tianchi Cone (Fig. 6). The lava flows down the slope shaped like a tongue or a snake with its greatest thickness of 60 m (Fig. 4). Qixiangzhan comenditic lava flow was recently dated to be 17 ± 1 ka by high-precision Ar-Ar using K-feldspar phenocrysts.



Fig. 6. Satellite image showing the lava flow from northern slope of Mt. Changbai volcano.

STOP 3: Tianchi crater lake

Mt. Changbai is a sleeping volcano, and the latest eruption occurred several hundred years ago. Volcanic eruption led to a plateau formed on the top of the mountain and, over the years, water gradually filled the volcanic crater. Due to its high elevation, people started calling it the Lake of Heaven. The lake is oval in shape, 13 square kilometers in area (Fig. 7), and 200 meters deep on average with the deepest of 373 meters. There are 16 mountain peaks surrounding the Tianchi. The most fantastic view comes on a sunny day, when the white clouds are reflected in the water it seems as if the mountain and the lake in the clouds (Fig. 7).

Apart from the crystal clear water, there are big impressive rock formations around Tianchi. No plants, no animals, just a mountain top setting with water and stone. It's really special! In the local legend, there is a monster living in the lake, and people can often see it swimming. Over the years, this put off some visitors. But after long-term observation, scientists deemed that no such monster existed and, apart from a black bear once taking a bath in it, Lake Tianchi had no animals living in it. Water from Lake Tianchi forms the Changbai Grand Waterfall about 1000 meters below the mountaintop (Fig. 7). The waterfall is over 60 meters high and its roar can be heard as far as 200 meters away. The water flows into the Songhua River, one of the most important rivers in northeast China. There are many other lakes and waterfalls in Changbaishan. For example, just aside Tianchi, there is a lake called the little Tianchi or the Changbai Lake. Several smaller waterfalls go through the forests, bringing drinking water to the birds and animals living there.



Fig. 7. Tianchi crater lake

STOP 4: Tianchi waterfall trachyte

Overflowing the trough between the Tianhuo Peak and the Longmen Peak, the Chengcuo River runs 1,250 meters along the cliffs. It's also named Heaven River. The famous Changbai Waterfall falls down all of sudden from the cliff with 68 meters of drop. It is the origin of the Songhua River.

STOP 5: Julong hot spring

Magma degassing is one of the most common phenomena during volcanic eruptions. Depending on different stages and intensities, it may result various hazards around the volcano, which can be indicative for the magma activity beneath the volcano. There exist rather strong hydrothermal activities around the Tianchi volcano, and the main hydrothermal domains include Julong hot spring group (70–83 °C) (Fig. 7) and Tianchi Hubin hot spring (20–40 °C) in northern Tianchi district as well as Jinjiang hot spring group (58 °C or so) in southwestern Tianchi district. Of these hot springs, the Julong hot spring group seems the strongest hydrothermal activities.

The chemical and isotopic features of the Julong hot springs and the Jinjiang hot springs show a deep fluid and magmatic gas source and a component derived from the mantle. From the Carbon isotope characteristics, the gas release regime at the Julong hot springs is related to a thermal reservoir (Fig. 7)

while the Jinjiang hot springs to a fault system. The recent fluid monitoring shows that gas geochemistry and isotope features were abnormally changed between 2002 and 2003. The gas emission features changed and the He isotope corresponded to the trend of seismic activities in the Tianchi Volcano area between 1998 and 2004. Hot springs at Tianchi volcano have been monitored since 1985 by the Jilin provincial government who seasonally measured the chemical composition and temperature of the spring water. A more extensive monitoring program has been carried out by CHVO staff since 1999, and is supplemented periodically by more specialized studies by the Institute of Geology, CEA (China Earthquake Administration), and other organizations.



Fig. 8. Julong hot spring.

STOP 6: Changbai grand valley

Mt. Changbai U-shape valley, named Tianchi Grand Valley formed by Holocene glacial action, which cuts the Tianchi main volcanic cone. From this valley we can clearly observed the profile of Trachytic and comenditic lavas (the Baitoushan Formation), which was grouped into three sections: Lower, Middle and Upper (Fig. 9; Wei et. al., 2007).

The lower Member has a thickness of 207 m measured from the north flank profile. From the bottom to the top, the stratigraphic sequence is consisted of

brown and grey trachyte – dark trachytic welded base tuff with breccia-brown and grey trachyte – dark grey trachytic welded tuff – grey and green alkali trachyte – dark grey trachyte – purple red trachyte – palaeo soil. The K-Ar ages for this strata vary from 0.53 to 0.61 Ma (Liu and Wang, 1982).

The middle Member has a thickness of 221 m and the sequence from the base to the top is: dark grey trachyte – dark grey alkali trachyte – purple red vesicular trachyte – palm palaeosoil. This member is much thicker in the northern inner wall of the caldera (profile at Tianwenfeng-Tianchi Lake) and reaches up to 490 m. There are at least 3 transitions between the pyroclastic rocks and the lavas. The strata sequence is, from low to high order: yellow, brown and various color trachytic breccias – dark grey and grayish green alkali trachyte – grayish green and grayish yellow tuff breccias – grayish green alkali trachyte – black green alkali trachyte – purple red palaeo soil.

The upper member has a sequence thickness of 214 m and the sequence is interbedded welded tuffs – yellow and brown trachyte and alkaline tract – dark gray obsidian welded tuff – dark gray trachyte with obsidian tract and comendite. The generally accepted ages for this upper member of the cone sequence is between 0.22 and 0.1 Ma (Liu, 1999). Wei et al. (2007) obtained some young ages; 0.04 and 0.02 Ma, which are consistent with the U-series dating of 23 ka from Dunlop (1996).



Fig. 9. The Tianchi Grand Valley

STOP 7: Mt. Changbai volcano monitoring station

Mt. Changbai volcano monitoring station is located near the Tianchi waterfall. Standing inside the monitoring station, we can enjoy the beautiful sight of “Tianchi waterfall”.

DAY 3 --- (August 6th, Saturday)

STOP 1: lower unit of trachytic lava flow

The eruption deposits of the western slope of Changbaishan volcano are much like the northern slope, with trachyte unit outcropping at the bottom overlaid by volcanic ash deposits generated by historically recorded eruptions. The difference between volcanic sequence between the northern slope and the western slope is that typical comenditic lava flows are not found here. According to Tianchi stratigraphic division scheme (Wei et al., 2013), western slope parking lot is just near the border area between upper member (Baitoushan III) and middle member of the trachytic lava flow (Fig. 10). We will climb to the top along the stepwise path, and you can see the beautiful trachytic lava flow morphology on both sides.

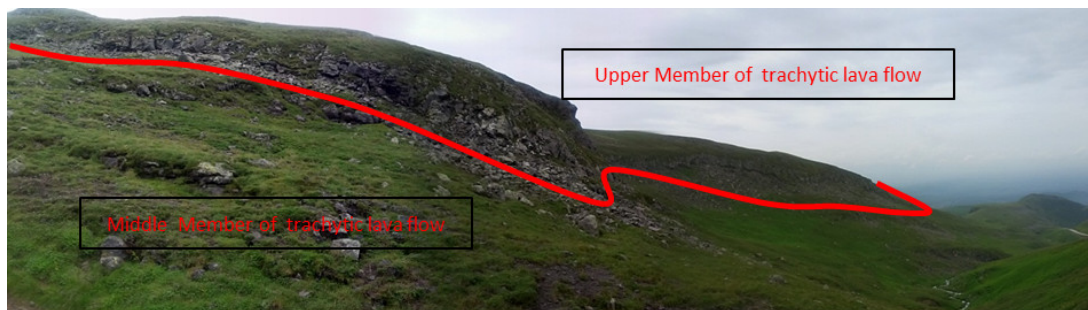


Fig. 10. Lower and middle members of trachytic lava flow



Fig. 11. The upper member of trachytic lava flow (left) and historical eruptions deposits (right) on the western top of Mt. Changbai volcano.

STOP 2: upper trachyte and volcanic ash of historical eruption

When arriving at the western top of Mt. Changbai volcano, you can see the Heaven Lake (Tianchi in Chinese) if the weather is fine. Here is the border area between China and North Korea, please be careful and do not cross the border line. Now we can see the upper member of trachytic lava flow, which is covered by some white and dark gray volcanic pyroclastic deposits and

fragments (Fig. 11). The lower unit of gray pumice and volcanic ashes is considered to be the product of the Millennium Eruption, while the upper unit of dark gray and black pumice and fragments is considered to represent the product of 1668 AD eruption and other subsequent eruptions.

STOP 3: Jinjiang Grand Valley

Jinjiang Grand Valley, is located at the southwestern slope of Mt. Changbai volcano, about 14 km long, over 80 m deep and 100 m wide. Volcanic products outcropping here mainly consist of olivine basalt, trachyte, ignimbrite and volcanic breccia. The valley is controlled by NW-trending faults and experienced fluvial erosion, giving rise to a typical V-shaped valley. In the event of a large-volume eruption, pyroclastic flows pose the most serious potential hazard and could affect large areas in any direction from the volcano. Flows from the Millennium Eruption reached a maximum thickness of 100 m and extended 60 km away from the crater. The resulting ignimbrite is tens of meters thick at the Pumice Forest, Underground Forest, Jinjiang Grand Valley (Fig. 12), and Yalujiang Grand Valley, all of which today are heavily visited tourist attractions (Wei et al. 2013). The three most populated towns, Erdao, Songjianghe, and Changbai, all could be affected by a large ignimbrite and associated ash-cloud surge.



Fig. 12. Jinjiang Grand Valley filled with pyroclastic flows.

DAY 4 --- (August 7th, Sunday)

STOP 1: Natural museum of Mt. Changbai volcano

The natural museum in Changbai Mountain was founded in 1986, the old building area is of 2600 square meters with exhibition area of 1800 square meters. In 2006 the administrative committee of Changbai Mountain was established, the local government pay great importance to nature conservation, scientific research and popular science education, and they increase investment constantly. In 2006, the administrative committee of Changbai Mountain invested 28 million to build new Changbai Mountain Natural Museum, covers an area of 10000 square meters, construction area of 5600 square meters, display area of about 4000 square meters.

The newly established Changbai Mountain nature museum mainly consists of the preface of Changbai Mountain, the formation of Changbai Mountain, Changbai Mountain animal resources, Changbai Mountain forest ecology, Changbai Mountain plant resources, Changbai Mountain comprehensive resources, and so on. The museum is designed with modern concept, according to the requirements of modern exhibition design, they use multimedia technology to control the halls of the sound, light, electricity, made of modern simulation technology models, sand table, made of three-dimensional imaging technique of volcanic eruption hall, with a three-dimensional projection pull like technology, the monsters of legend Hall, Changbai Mountain natural landscape and plant resources show in front of an audience, fully embodies the Museum of natural history exhibition, research, collection function, to meet the needs of the people of cultural and scientific knowledge. On January 17, 2010, Chinese Museum of Natural Science Association organized experts to Changbai Mountain Natural Museum basic display demonstration. The experts agreed that Changbai Mountain Natural Museum has a sense of innovation, highlight the local characteristics and is the first-class museum in our country natural protection District Museum.

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