Post-symposium Field Trip Guidebook

June 13-14, 2011

Geology and Geomorphology along the Ishikari River in central Hokkaido

Hitoshi Hasegawa¹, Takanobu Sawagaki¹, Reishi Takashima², Masanobu Yamamoto¹, Tomohisa Irino¹

(¹Hokkaido University; ²Tohoku University)
1. TRIP SCHEDULE

Welcome to the post-symposium field trip of IGCP581 2nd Annual Symposium (June 13-14, 2011) in central Hokkaido. We will stop at geological, geographical and historical sites along the Ishikari River to explore the modern and past river systems. We plan nine stops of the itinerary for participants, in which several stops on landscape scene are included (Fig. 1-1; Table 1). In the night of the first day, we will stay at Choyo Resort Hotel in Souunkyou.

Stop D1-1: Bibai Coal Mine (Middle Eocene coal-bearing fluvial deposits)
Stop D1-2: Kamuikotan (high-P/T metamorphosed accretionary complex)
Stop D1-3: Souunkyou and Obako (Pleistocene welded pyroclastic rocks)
Stop D1-4: Taisetus Lake and Dam (view of Ishikari River catchment)
Stop D1-5: Mikuni pass (view of Tokachi-Mitsumata caldera)
Stop D2-1: Biei (Periglacial landform)
Stop D2-2: Furano (Pleistocene fault and resulted landscape)
Stop D2-3: Sandantaki Park (Late Cretaceous submarine fan turbidite deposits)
Stop D2-4: Mikasa City Museum (Cretaceous Ammonoid collections)

![Field trip route and locations of stop-points.](image)
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<td>Departure from Hokkaido University, Sapporo (9:00)</td>
<td>Stop D1-1</td>
<td>Middle Eocene coal-bearing fluvial deposits</td>
<td>2011/6/14</td>
<td>Departure from Choyo Resort Hotel in Souunkyou (8:30)</td>
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<td>Departure from Sunagawa SA (14:00)</td>
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<td>view of Ishikari River catchment</td>
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<td>Departure from fault outcrop (12:20)</td>
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<td>Arrival of Furano and lunch (12:40)</td>
<td>Stop D2-3</td>
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<td>Arrival of Sandantaki park (14:00)</td>
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<td>Arrival of Hokkaido University (17:00)</td>
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*Choyo Resort Hotel* (Address: Sounkyo Onsen, Kamikawa-cho, 078-1795, Hokkaido; **Tel:** +81-1658-5-3911; **Fax:** +81-1658-5-3922; **Web:** [http://www.choyo-resort.com/fl/english/index.html](http://www.choyo-resort.com/fl/english/index.html)
2. General Geology and Geomorphology of Hokkaido

Hokkaido, the northernmost island of the four main islands of Japan, is characterized by unique geologic and geomorphologic settings. Hokkaido is geologically situated at a junction of two arc-trench systems, Northeast Japan (NE Japan) and Kuril arcs (Fig. 2-1), and several striking tectonic events have occurred in and around Hokkaido. The triple junction of the Pacific, North America and Eurasia plates was located south of Hokkaido at present, but the boundary between the North America and Eurasia plates was situated from central Hokkaido to Sakhalin during the Cretaceous (Fig. 2-1). The Pacific plate has been subducting beneath the North America and Eurasia plates since that time. Two back-arc basins, the Japan and Kuril basins were formed until the middle Miocene. Subsequently, the Kuril arc has been moving westward, colliding with the NE Japan arc, due to oblique subduction of the Pacific plate, since the late Miocene. According to the distributions of earthquake centers, the present plate boundary between the North America (or Okhotsk) and Eurasia plates is considered to be located along the eastern rim of the Japan Sea.

The landforms of Hokkaido are characterized by the smaller area of mountains than other main islands. Topography in the Hokkaido is characterized by gentle slopes and broad lowland plains, contrasts to the rest of Japan. It is considered as the result of broad erosion due to the glaciated process. The highest mountain in the Hokkaido Island is Asahi-dake (Taisetus Mountain), 2,291 m (7,510 ft) above sea level. The most extensive plains are the lowstands of the Ishikari, Tokachi, Nemuro, Teshio, and Kushiro (Fig. 2-2). Of these the Ishikari Plain and the Ishikari River (*key target of this field excursion) are by far the largest and longest in Hokkaido (The second largest catchment area and the third longest river length in Japan).

This field trip gives an opportunity to investigate the geology and geomorphology along the Ishikari River in central Hokkaido. We will observe several marked outcrops to understand the evolution of geology and geomorphology in central Hokkaido, such as high-P/T metamorphosed accretionary complex of Cretaceous time (Stop D1-2), Cretaceous submarine fan turbidite deposits (Stop D2-3), Cretaceous ammonoid collections (Stop D2-4), Eocene fluvial deposits with abundant coal seams (Stop D1-1), Pleistocene fault and resulted landscape (Stop D2-2), Late Pleistocene welded pyroclastic rocks (Stop D1-3), Quaternary landform evolution of headwater area of the Ishikari River (Stop D1-4) and periglacial landform (Stop D2-1).
Fig. 2-1. Tectonic setting and plate boundaries around Hokkaido.

Fig. 2-2. Major river systems in Hokkaido and their drainage areas.
2.1 Geologic setting in Hokkaido

Hokkaido, the northernmost island of the four main islands, was formed by which the Kuril Arc collided with the Northeast Japan Arc at the central part of Hokkaido after the Middle Miocene. Therefore, Hokkaido is geologically divided into three parts: the eastern region in the Northeast Japan Arc, the central region in the arc-arc collision zone, and the western region in the Kuril Arc (Figs. 2-1, 2-3, 2-4). The volcanic front lies nearly east-west from the eastern region through the central region and turns to the south in the western region. This front line is parallel to the Kuril and Japan Trenches. It is thought that the plate boundary which was in the central region moved to the margin of the Sea of Japan in late Cenozoic or the early Quaternary (Fig. 2-1).

Western region

The Ishikari Plain is alluvial lowland to the west of the Yubari Mountains (Fig. 2-3). The Oshima Peninsula is located on the west of the Ishikari Plain, which is a stretching part of the Northeast Japan Arc. Mountains, volcanoes, and plains in the peninsula are distributed complicatedly. This irregular arrangement is a feature different from the central and eastern regions with the zonal distribution of landforms. A Jurassic accretionary complex intruded by Cretaceous granite is found in this region, which is uncoformably covered with Neogene-Quaternary volcanic rocks and formations. Some volcanoes such as the Shikotsu volcano and Toya volcano in this region have large calderas and pyroclastic plateau.

Central region

The Teshio Mountains and Yubari Mountains are located north-south in the central region (Fig. 2-3). The Teshio Mountains consist of Cretaceous-Tertiary folded formations affecting the morphology. The Yubari Mountains have Jurassic-Cretaceous formations (Sorachi Group consisting of greenstone [including basaltic pillow lava, hyaloclastite, and diabase], chert, micrite limestone, and sandstone with felsic tuff) and serpentinite in and around the main ridge. Cretaceous forearc sediments (Yezo Group; Stop D2-3) are widely distributed in Sorachi-Yezo belt (see Sorachi-Yezo belt). Paleogene formations with interbedded coal seams (Ishikari Group; Stop D1-1) are found on the west of the Cretaceous sedimentary rocks. These mountains were upheaved by the collision of the two island arcs.

The Hidaka Mountains in the western margin of the Kuril Outer Arc are situated to the southeast of the Yubari Mountains. This mountain range was also uplifted in association with the colliding Kuril Arc. A depression zone is placed between the Teshio-Yubari Mountains and the Kitami-Yubari Mountains. In the Hidaka Mountains, Hidaka metamorphic rocks, the Cretaceous-Paleogene system, and the Cretaceous system are distributed in the central part, eastern part, and western part, respectively. The crust of the island arc and the upper mantle were thrusted up on the metamorphosed oceanic crust along the Hidaka thrust fault. The Hidaka metamorphic zone, therefore, is regarded as the exposed cross section of the island arc crust. High
pressure type metamorphic rock zone (Kamuikotan Belt; Stop D1-2) is found on the west of the Hidaka metamorphic zone. The Taisetsu and Tokachi volcanic area (Stop D1-3 to Stop D1-5) between the Hidaka Mountains and Kitami Mountains are the highest elevation area in Hokkaido (the highest peak is 2290 m high).

**Eastern region**

In the eastern region, northeast-trending uplift areas with volcanoes are arranged in East-West directions toward the Kuril Islands, including the Akan volcanoes, Shiretoko Peninsula, Kunasir Island and Etorofu Island (Fig. 2-3). The Konsen Plateau, Kushiro Plain, and Tokachi Plain spread in the Kuril outer arc on the south of volcanic area. The volcanoes provided massive volcanic products and clastic material produced by erosion of the volcanoes to the Konsen Plateau and Kushiro Plain to form plateaus and hills. These volcaniclastic sediments cover Cretaceous and Paleogene rocks. The Shiranuka Hills situated between the Kushiro Plain and the Tokachi Plain are a low relief uplift area. Mountains in the central part of the Shiranuka Hills comprise Cretaceous and Paleogene rocks, and they are surrounded by hills consisting of Neogene and Quaternary formations. Pliocene-Quaternary formations are distributed in the Tokachi Plain. The parallel arrangement of the uplift areas in the eastern region is attributed to the oblique subduction of the Pacific Plate along the Kuril Trench.

![Fig. 2-3 Map showing distribution of major mountain ranges and volcanos in Hokkaido.](image)
Sorachi-Yezo belt in central Hokkaido

Hokkaido, the north island of Japan, having a rhombic or cubic shape with a N-S trending diagonal line, comprises six major tectonostratigraphic units from west to east, i) Oshima, ii) Rebun-Kabato, iii) Sorachi-Yezo, iv) Hidaka, v) Tokoro and vi) Nemuro Belts, on the basis of the lithofacies and tectonic features of the Mesozoic and the lower Cenozoic (Ando, 2003; Takashima et al., 2004; Fig. 2-4). The N-S trending zonal geologic framework is a product of subduction and collision processes in the northeastern margin of the Eurasia plate. The western four belts are regarded as elements of the Paleo-Japan arc-trench system (Oshima, Rebun-Kabato, Sorachi-Yezo and Hidaka Belts). The Rebun-Kabato and Oshima belts represent an Early Cretaceous volcanic arc and the underlying Jurassic accretionary complexes, respectively. The Sorachi-Yezo Belt was formed in the Cretaceous-Paleocene forearc basin and the eastern trench slope. The Hidaka Belt may be an accretionary complex formed by westward subduction of the Izanagi-Kula plates beneath the Eurasia continental margin during early Paleogene (Fig. 2-5). On the other hand, the eastern two belts may represent the Paleo-Kuril arc-trench system composed of forearc basin sediments (Nemuro Belt) and associated accretionary complex (Tokoro Belt). After the Izanagi-Kula plate had subducted northward beneath the Okhotsk paleoland/microplate during late Cretaceous and Paleogene, two belts collided to create the four belts of the Paleo-Japan arc-trench system with a nearly 90-degree clockwise rotation in Miocene.

The Sorachi-Yezo Belt consists of a coherent succession, from the Horokanai Ophiolite through the Sorachi Group to the Yezo Group, and the accretionary complexes of the Idonnapu and Kamuikotan zones (Ueda et al., 2000). The Horokanai Ophiolite and the lower part of the Sorachi Group represent a piece of basaltic oceanic crust (Takashima et al., 2002), while the upper part of the Sorachi Group is represented by subaqueous calcalkaline and alkaline volcano-sedimentary sequences, suggesting an oceanic island arc setting (Girard et al., 1991; Takashima et al., 2002). The Yezo Group conformably overlies the Sorachi Group and comprises very thick sandstone and mudstone sequences. The sandy clastics of this sequence were derived from Cretaceous granitic rocks and Jurassic accretionary complexes of the Oshima Belt, which represents a contemporaneous continental arc setting (Kito et al., 1986). Besides these, serpentinite melanges with high-P and low-T type Kamuikotan metamorphic blocks and other mélangé complexes constitute an axial part and a large-scale anticlinorium of the belt called the Kamuikotan Zone (Niida and Kito, 1986; Nakagawa and Toda, 1987). Therefore, the Yezo Group is distributed in both the eastern and western sides of the axis forming two rows. In the central part of the Sorachi-Yezo Belt, the Yezo Group widely crops out in the eastern and western slopes of the Yubari mountain range whose core is composed of the Sorachi Group and the Yubari-dake serpentinite melanges (Nakagawa and Toda, 1987; Takashima et al., 2004). The group of the west has been well studied in the Mikasa and Oyubari areas as the basement rocks for the Eocene coal measures called the Ishikari Group.
Fig. 2-4 Major geologic units and distribution of the Mesozoic to lower Paleogene systems in Hokkaido (Ando, 2003; Takashima et al., 2004; Ando et al. 2006)

Fig. 2-5 East-westward geologic profile of central Hokkaido. Location of cross section A-A' shown in Fig. 2-4.
2.2. Tectonic evolution of central Hokkaido

The major tectonic history of central Hokkaido is summarized as follows;

(1) During the pre-Jurassic time, old oceanic plate (Izanagi, Kura and Pacific plates) are subducted westward along the Eurasian margin, and a single accretionary complex was formed (Kiminami and Kontani, 1983; Ueda & Miyashita, 2005; Fig. 2-6).

(2) Eastward jump of the ocean trench was occurred and the Oku-Niikappu Remnant Arc was developed during the Late Jurassic to Early Cretaceous (Fig. 2-6).

(3) The Oku-Niikappu Remnant Arc crust, which was formed until the earliest Cretaceous, accreted to the Eurasian continental margin, and the newly formed daughter arc and back-arc basin were formed during the mid-Cretaceous (Ueda & Miyashita, 2005; Fig. 2-6).

(4) The condition of the subduction zone of central Hokkaido changed greatly since the timing of accretion of the Oku-Nikappu Remnant Arc in the mid-Cretaceous. Subduction zone metamorphism in the Kamuikotan zone transformed from a typical blue-schist facies series to a high-pressure-intermediate facies series at this time (Sakakibara & Ohta, 1994; Ueda & Miyashita, 2005; Fig. 2-7). [Stop D1-2: Kamuikotan metamorphic complex]

(5) Late Cretaceous forearc basins were broadly developed and turbidite-dominant Yezo Group was deposited there (Fig. 2-7). [Stop D2-3: Late Cretaceous turbidite]

(6) Prior to the early Paleogene time, the central Hokkaido area was situated in the forearc zone of a trench–arc system at the eastern margin of the Eurasia plate, underneath which the eastern paleo-Okhotsk plate had subducted westward (Takano & Waseda, 2003; Fig. 2-8).

(7) During the early to middle Eocene time, coal-bearing non-marine to littoral sediments were widely deposited in the central and eastern parts of the Hokkaido (Iijima, 1996; Takano & Waseda, 2003; Hasegawa et al., 2009). [Stop D1-1: Bibai Coal Mine]

(8) During the Eocene to Miocene time, an arc system on the eastern Okhotsuk plate (Kuril Outer Arc in Fig. 2-6) collided and obducted onto the western Eurasia plate, and the Sorachi–Yezo Belt was subsequently converted to a foreland setting. The Hidaka Metamorphic Belt was situated along the boundary between these plates. (Takano & Waseda, 2003; Kawakami et al., 2004; Figs. 2-8, 2-9).

(9) Rapid uplift of the Hidaka Metamorphic Belt occurred in the Early Miocene (19-16 Ma) (Arita et al., 2001; Kawakami et al., 2004; Fig. 2-9). Following this event, deep and narrow foredeep basins were formed west of the Hidaka Belt and Hidaka Metamorphic Belt (Kawakami et al., 2004).

(10) After the early development of mountain ranges (i.e. the proto-Hidaka Mountains) during the Early to Middle Miocene, westward thrusting and exhumation of the eastern part of the Hidaka Belt have occurred during the Middle to Late Miocene (Kawakami et al., 2004; Fig. 2-9).
Fig.2-6. Ocean plate stratigraphy and reconstructed subduction history for central to western Hokkaido (Ueda & Miyashita, 2005). Hb, Horobetsugawa complex; Nm, Nemuro Belt; Nz, Naizawa complex; ONC, Oku-Niikappu complex; Ru & To, Hidaka Belt, Rurochi Fm & Tomuraushi area; Sk, ophiolites in Sakhalin.

Fig.2-7. Tectonic regimes in Cretaceous central Hokkaido (Ueda & Miyashita, 2005).
Fig. 2-8. Tectonic history and paleogeographic sketches of the Cretaceous-Paleogene (Kiminami, 1989).

Fig. 2-9. Tectonic history and paleogeographic sketches of the Oligocene-Miocene.
2.3 Geomorphology of Hokkaido

Hokkaido, the northernmost of the four larger Japanese islands is of peculiar interest to geographers because it is different from the rest of Japan, especially in topography. Due to the active tectonic and volcanic activity of island arc system, most of the topography in Japanese island is characterized by steep gradients. In contrast, topography in the Hokkaido is characterized by relatively low gradient hills and mountains with relatively broad lowland plains. It is considered as the result of broad erosion due to the glaciated process (particularly during the glacial periods). The highest mountain in the Hokkaido Island is Asahi-dake (Taisetus Mountain), 2,291 m (7,510 ft) above sea level (Stop point D1-3 to D1-5). Even in the interglacial condition at the present-day, the permafrost layer is distributed in the Taisetus Mountain, and forms the largest periglacial area in Japan. The most extensive plains are the lowstands of the Ishikari, Tokachi, Nemuro, Teshio, and Kushiro (Fig. 2-2). Of these the Ishikari Plain is by far the largest and most important.

The Ishikari River originates from Ishikari-dake of the Taiseus mountains in central Hokkaido (Fig. 2-2). Ishikari River flows westward from Kamikawa basin to Kamuikotan area, then flows to southward into broad Ishikari plain, and finally flows into the Japan Sea. Catchment area is 14,330km² (the second largest catchment area in Japan), and river length is 268km (the third longest river length in Japan). The Ishikari River was previously not flowing into the Japan Sea, but it was flowing southward into the Pacific Sea (River mouth was located around Tomakomai city, southern Hokkaido). Due to the eruption of Shikotsu volcano and broad deposition of Shikotsu pyroclastic flow, the Ishikari River began to flow westward into the Japan Sea (Yanagida, 1994; Koaze et al., 2003). Surrounded by the Pacific Ocean, the Sea of Japan and the Sea of Okhotsk, Hokkaido is home to a variety of magnificent mountains, extensive wetlands, beautiful lakes, marshes, rivers, and forests (Fig. 2-2).

2.4. Volcanism in Hokkaido

Hokkaido has two volcanic zones, along which many volcanoes and hot springs exist. The above tectonic events reflected Neogene volcanism in Hokkaido. Nakagawa et al. (1995), Hirose and Nakagawa (1999) and Hirose et al. (2000) showed spatial and temporal variations in volcanism since ~20 Ma (Fig. 2-10) to discuss relationships between tectonic movement and volcanism. These studies also revealed geochemical features of the volcanic rocks, and concluded that subduction related volcanism has continued since ~12 Ma in west Hokkaido and since ~14 Ma in east Hokkaido. This arc volcanism since the late Miocene has changed the volcanic fields in Hokkaido. Relatively extensive volcanism during the Pliocene converged into three volcanic fields and the isolated Rishiri volcano in the Quaternary. There are no Quaternary volcanoes between these volcanic fields (Fig. 2-10).
The Quaternary volcanoes are distributed in three volcanic fields; Southwest Hokkaido (SWH), Taisetsu-Tokachi-Shikaribetu (TTS) and Akan-Shiretoko (AKS) Quaternary volcanic field (Fig. 2-11). The three fields are distributed on distinct geological province. The central Hokkaido belt (TTS) was developed along the paleo-plate boundary, and that both southwestern and east Hokkaido are regarded as arc trench systems characterized by open back arc basins during Miocene (Nakagawa, 1999).

![Fig. 2-10](image-url)

**Fig. 2-10.** Temporal and spatial change of volcanism (black and hatched areas) since around 20 Ma (Nakagawa et al., 1995; Hirose and Nakagawa, 1999; Hirose et al., 2000).
Fig. 2-11. Distribution of Quaternary volcanic rocks in Hokkaido (modified from Machida and Arai, 1992).

Fig. 2-12. Geologic map of the Hokkaido (Geological Society of Japan).
3. DESCRIPTION OF STOPS
3.1. June 13, 2011 (Day 1)

We will depart from Hokkaido University, and go northeastward along the Ishikar River (Fig. 1-1). We first visit Sanbi Coal Mine Company in Bibai City to observe an excellent exposure of the Middle Eocene coal-bearing fluvial deposits (Stop D1-1). After lunch, we will visit the site of Kamui-kotan high-P/T metamorphosed accretionary complex (Stop D1-2). Then, we will arrive at Souunkyou and observe several view-points of Pleistocene welded pyroclastic rocks (Stop D1-3), Ishikari River catchment in Taisetsu Lake (Stop D1-4), and the headstream point of Ishikari river at the Mikuni pass (Stop D1-5). Finally, we will arrive at Choyo Resort Hotel in Souunkyou (Fig. 1-1).

Stop D1-1 Bibai coal mine (Middle Eocene coal-bearing fluvial deposits)
[Locality] Sambi Coal Mine, Bibai City
[Time] 120 minutes
[Synopsis] Coal-bearing succession of the Bibai Formation in the middle Eocene Ishikari Group exposed markedly in the Sanbi Coal Mine, Bibai City, central Hokkaido (Figs. 3-1, 3-2; Hasegawa et al., 2009). Exploitation of coal field in Hokkaido initiated since 1873 by American geologist Dr. B.S. Lyman (particularly in Yubari area), and the operation of coal mine in Bibai city by Mitsui-Bibai Company was started since 1928. Since 1961, Sanbi Coal Mine Company started their operation, and their production of coals reach about 60,000 ton per year at present (Fig. 3-3). Coals are transported to the thermal power plant in Naie City and Sunagawa City, and they produce about 10% of electric power in Hokkaido.

The Bibai Formation in the Sanbi Coal Mine is composed of alternating beds of sandstone, siltstone, mudstone and coal. Coal beds in this area are developed as 6 major horizons and they are numbered as Coal-bed 1 to 6, in ascending order (Figs. 3-4, 3-5). Coal-beds 1–3, and 6 are intercalated with thick sandstone beds of fluvial channel, indicating the deposition in floodplain environments of meandering river system. Particularly, the fluvial channel sandstone beds above Coal-beds 2 and 3 are characterized by distinctively thick (> 10 m) sandstone beds, suggesting that the braided fluvial system were at least partly developed (Fig. 3-5D; Stop 2). On the other hand, Coal-beds 4–5 are interbedded with siltstone beds of horizontal lamination and ripple cross-lamination, and interbedded with several layer of siderite nodules, indicating the deposition of lower energy floodplain and swampy area (Fig. 3-5B, C; Stop 1). In addition, the sulfur concentrations are significantly high in Coal-beds 4U3 and 4U4 layers (TS > 2%), suggesting the deposition in brackish to estuary environments (Inoue et al., in preparation).

Hokkaido Eocene coals are characterized by high hydrogen content and abundant degradenite, showing strongly oil-prone characteristics. Most of oil and natural gas resources in East Asian mid- to high-latitude are also derived from coal and organic-rich lacustrine sediments of the Eocene age. The extremely warm and humid “greenhouse” climate of the Eocene period
might play an important role for the deposition of these organic-rich sediments on land, although their possible linkage is not clear yet. Coal-bearing succession of the Ishikari Group represents a rare glimpse for evaluating the linkage of source rock deposition and Earth’s climate change during the Eocene “greenhouse” world (Hasegawa et al., 2009).

![Fig. 3-1.](image1)  (left) Distribution of Eocene sedimentary basin and coal-bearing strata, and location of Sanbi Coal Mine in Bibai city. (right) Geologic map of the Ishikari Group, and location of Sanbi Coal Mine.

![Fig. 3-2.](image2)  General lithostratigraphic chart of Ishikari Group (Tanai, 1990; Takano & Waseda, 2003).

![Fig. 3-3.](image3)  (left) Office of the Sanbi Coal Mine. (right) Coal fired power plant in Naie and Sunagawa City.
Fig. 3-4. Outcrop photograph of Stop point 1. Coal-bed 4 to Coal-bed 6 and intercalated siltstone and sandstone beds of the Bibai Formation and overlying Akabira Formation in the Sanbi Coal Mine.

Fig. 3-5. (left) Columnar section of the Bibai Formation in the Sanbi Coal Mine. Coal-beds are numbered
from 1L (1 Lower) to 6U (6 Upper), in ascending order. (right) (A) Outcrop of Coal-bed 5U② and Coal-bed 6L and intercalated horizontal and lenticular channel sandstones.; (B) Outcrop of Coal-bed 5L and underlying siderite nodules.; (C) Outcrop of Coal-bed 4U① and Coal-bed 4U② and intercalated volcanic tuff.; (D) Outcrop of Coal-bed 2 and overlying channel sandstone.

Fig. 3-6. Location map of Stop D1-1 Sanbi Coal Mine
Stop DI-2 Kamui-kotan (high-P/T metamorphosed accretionary complex)

[Locality] Kamui-kotan gorge area, under suspension bridge (N43° 43’ 55’’, E142° 12’ 03’’)  
[Time] 40 minutes

[Synopsis] Protolith sequence, accretionary process, tectono-metamorphism of Kamuikotan high-P/T metamorphosed accretionary complex

The Kamuikotan complex in the Sorachi-Yezo belt, located in central Hokkaido, has been extensively subjected to subduction-related high-pressure and low-temperature metamorphism. The Kamuikotan complex is widely distributed in N-S direction from Sakhalin to southern Hokkaido (Fig. 2-4). The Kamuikotan complex in this exposure consists of basic schist, calcareous schist, siliceous schist, and pelitic schist (Figs. 3-7, 3-8, 3-9). We can observe the original sequence of the ocean crust and pelagic sediments (basaltic pillow lava, basaltic hyaloclastite, volcanic sandstone and mudstone, limestone, chert, and siliceous mudstone, in stratigraphic ascending order) and their accretion process of the Kamuikotan metamorphic rocks (Sakakibara & Ota, 1994; Fig. 3-10). Metabasites in the Kamuikotan complex is considered to be deposited in Panthalassa Sea during the Jurassic time, and underplate subducted and metamorphosed during the Late Cretaceous time (Fig. 2-6).

“Kamuikotan” means “place where god (genie) lives” in Ainu (indigenous people in Hokkaido and northern Japan) language. In Kamuikotan gorge area, all the divergence rivers in Asahikawa basin are joined, and so Ishikari River becomes a swift current in between high mountain of metamorphic rock zone. Due to the swift current of the Ishikari River, there are many Potholes in Kamuikotan metamorphic rocks. According to the Ainu myth, these potholes are assumed to be the footprint of god (genie). Thus, pothole and metamorphic rock in Kamuikotan gorge area are protected as national monument in Asahikawa City, so that sample collection using rock hammer is prohibited in this exposure.

On the basis of petrological and geochronological data, the coherent metamorphic rocks of the Kamuikotan complex are divided into six units as follows: Susunai, Horokanai, Harushinai, Biei, Pankehoronai, and Shizunai (Sakakibara & Ota, 1994). Based on their metamorphic mineral sequences, the six units can be classified into the following three baric types: high-pressure 1 (HP1), high-pressure 2 (HP2), and high-pressure intermediate (HI). The Horokanai and Shizunai units belong to the HP1 type, the Harushinai and Biei units belong to the HP2 type, and the Susunai and Pankehoronai units belong to the HI type. Metabasites of the HP1 type are defined by the association of lawsonite + Na amphibole or epidote + Na amphibole (glaucophane or crossite). The HP2 type is characterized by the assemblage of pumpellyite + Na pyroxene + chlorite, and the representative low-variance assemblages are lawsonite + pumpellyite+ Na pyroxene+ chlorite and pumpellyite+ Na pyroxene + Na amphibole + chlorite. In the HI type, the most common low-variance assemblage is pumpellyite + epidote+ actinolite + chlorite. These results, together with the previously published K-Ar and 40Ar-39Ar ages, Sakakibara & Ota (1994) suggested that the Kamuikotan metamorphic rocks gradually decreased in pressure during the Cretaceous. This
tendency indicates an increase in the Kamuikotan subduction geotherm during Early Cretaceous to early Eocene time. The increase in the paleogeotherm may result from the change of subduction rates and subducting slab ages.

Fig. 3-7. Geologic map with cross section in the Kamuikotan gorge area (Sakakibara et al., 2007).

Fig. 3-8. Outcrop photograph of the Kamuikotan metamorphic complex (Sakakibara et al., 2007).
Fig. 3-9. Overview photograph of the Kamuikotan gorge area.

Fig. 3-10. Reconstructed ocean plate stratigraphy of the Kamuikotan complex (Sakakibara et al., 2007).
Fig. 3-11. Location map of Stop D1-2 Kamuikotan gorge area, under suspension bridge
Stop D1-3 Souunkyou and Taisetsu volcano (Late Pleistocene welded pyroclastic rocks)

[Locality] Obako in Souunkyou
[Time] 30 minutes
[Synopsis] Taisetsu mountain range is generic name of the over 20 mountains of 2000 m height above sea level, which include highest summit Mt. Asahi-dake in Hokkaido (2291 m ASL). Ohachidaira caldera (2 km in diameter) is located at the center of the Taisetsu mountain range (Figs. 3-13, 3-14). Mt. Asahi-dake is located at southwest of the Ohachidaira caldera. Taisetsu volcano ranges 12 km wide in East-West, and 8 km wide in North-South. The pyroclastic flow plateaus are widespread around the foot of the Taisetsu volcano. Souunkyou and Obako are located at northwest of the Taisetsu volcano (Figs. 3-12, 3-13). Thick welded pyroclastic rocks are extensively exposed in Souunkyou area (maximum thickness reaches 200 m).

The Taisetsu volcano locates on northern margin of Taisetsu-Tokachi-Shikaribetu (TTS) Quaternary volcanic field (Figs. 2-3, 2-9). During late Pliocene to early Pleistocene, Tokachi welded tuff, which is composed of more than eight silicic pyroclastic flow deposits, was issued from this area. These tuffs have covered 1200 km² area in the central Hokkaido (Ikeda and Mukoyama, 1983). The latest big caldera-forming eruption took place in 500 ka at the Tokachi-mitsumata caldera located on the Northeastern part of TTS (Ishii et al., 2002). After the numerous caldera-forming eruptions, two volcanic chains began its activity: Nipesotsu-Shikaribetsu and Taisetsu-Tokachi volcano chain.

The Taisetsu volcano consists of two stratovolcanoes: Northern- and Southern-Taisetsu volcano. About 35 ky ago, most explosive eruption occurred at the summit area of Taisetsu volcano to produce plinian fall deposits followed by pyroclastic flow, resulting to form small depression, Ohachidaira caldera (2 km in diameter). Pyroclastic flow ran down along the slope of the volcano, and flowed along the valley at north and south of the volcano. In this valley, thick valley-pond type of welded pyroclastic flow is exposed. Asahidake, one of the summit domes of Taisetsu volcanoes, is still active.

In Obako, we can observe the bottom of the Ohachidaira pyroclastic flow, and can find pumice fall layer (Ohachidaira pumice fall) deposit beneath the flow. Spfa 1 ash layer, which derived from caldera-forming eruption of Shikotsu volcano 200 km far from here, is also recognized in the soil beneath the fall. Here, we will recognize the paleo-valley of the Ishikari River, which had been filled with Ohachidaira pyroclastic flow. Also, we will observe the welded tuff, which contain pumice, scoria and banded pumice.
Fig 3-12. Densely welded pyroclastic flow deposit from Ohachidaira caldera in Obako.

Fig 3-13. Geographic classification of the Taisetsu volcano (Ohachidaira caldera is located at the center).
Fig. 3-14. Location map of Stops D1-3 (Obako), D1-4 (Taisetsu Lake), and D1-5 (Mikuni pass) in Souunkyou area, central Hokkaido.
Stop D1-4 Taisetsu Lake and Dam (view of Ishikari River catchment)
[Locality] Taisetsu Lake and Dam
[Time] 30 minutes
[Synopsis] Lake Taisetsu is a dam lake (rock-fill dam) completed in 1975 (Fig. 3-15). The dam is 86.5 m in height with a reservoir area of 292.0 ha, and collects water from the Ishikari River’s main stream as well as a number of its tributaries. Surrounded by primeval forest, this dam lake offers spectacular views that must be seen to be believed. Although there are several hypothesis about the existence of the glacier in the Taisetsu mountain range, Naruse et al. (1982) suggested that there were perennial glacial in Taisetsu mountain area at around 1500 m above sea level during the glacial period.

Fig 3-15. Overview photograph of Taisetsu dam lake.
Stop D1-5 Mikuni pass (view of Tokachi-Mitumata caldera)

[Locality] Mikuni pass
[Time] 30 minutes

[Synopsis] The headstream of the Ishikari River originates between the Mt. Ishikari-dake (1967 m ASL) and Mt. Mikuni (1541 m ASL) in Taisetsu mountain range. The ridge line between the Mt. Ishikari-dake and Mt. Mikuni is extended to the northeast-southwest direction, and it forms a watershed of the Japan Sea side and the Pacific Ocean side. Mt. Mikuni forms the watershed of the following three rivers; (i) the Ishikari River flowing to Japan Sea; (ii) the Tokachi River flowing to Pacific Ocean; and (iii) the Tokoro River flowing to Okhotsk Sea (Figs. 2-2, 3-14).

At the Mikuni pass, we can see the Tokachi-Mitumata basin surrounded by volcanoes (Fig. 3-16). Although the genesis of the basin had been controversial, the basin is now considered as a large caldera formed by a giant eruption in 0.9 Ma. The eruption produced pumice fall and pyroclastic flow. Total volume can be estimated to be about 100 km³. The mountain behind the basin is Quaternary volcanoes, Nipesotsu volcano group, which started their activity after the caldera formation. Maruyama volcano in the volcano group is active. The latest eruption of the volcano occurred in AD 1898.

Fig 3-16. Overview photograph of Mikuni pass and Tokachi-Mitumata caldera.
Choyo Resort Hotel

**Address:** Souunkyo Onsen, Kamikawa-cho, 078-1795, Hokkaido

**Tel:** +81-1658-5-3911; **Fax:** +81-1658-5-3922;  
**Web:** http://www.choyo-resort.com/fl/english/index.html

**Type of hot spring:** Sulfur spring

**History of Souunkyou Onsen:** discovered in 1900, and operation initiated since 1924
3.2. June 14, 2011 (Day 2)

In the morning, we will depart from Souunkyou, and go southward to Biei and Furano (Fig. 1-1). We will stop to see the periglacial landform in Biei City (Stop D2-1). Then, we will observe the outcrop of the Pleistocene fault and resulted landscape in Furano City (Stop D2-2). In the afternoon, we will visit Sandandaki park and observe Late Cretaceous submarine fan turbidite deposits (Stop D2-3). At last, we will visit Mikasa City Museum and tour the exhibition of Cretaceous ammonoid collections in Hokkaido (Stop D2-4) (Fig. 1-1).

**Stop D2-1 Biei (Periglacial landform)**
[Locality] Northwest Hill Viewing Park in Biei city
[Time] 30 minutes

**Synopsis** Landform of the Biei City is characterized by periglacial landform (Fig. 3-17). Periglacial landforms are formed due to the repeated freezing and thawing of the ground (freeze-thaw action). The term *periglacial* relates to cold-climate processes and landforms. The most important periglacial influence on valleys is frost action, which produces abundant debris by freeze-thaw action on rock and soil. During the coldest periods of the Quaternary, the periglacial zone was enlarged to approximately twice its present extent. Hill slopes became mantled with frost-shattered rubble that moved downslope during cycles of freezing and thawing. The relics of this periglacial activity characterize much of the modern humid-temperate zone.

Periglacial landform in Biei shows gently wavy (rolling) terrains with gentle slope convex surface and dish-shape valley concave part, which is also called as “dell” structure (Fig. 3-17). Similar landforms are also seen in Cape Soya and Wakkanai in northern Hokkaido (Fig. 3-18). Such landform is mainly found in cold regions, but the other region also formed probably during the last glacial periods. Such landforms are also seen in the mountain area between the forest limit and the snow line, which is also called “periglacial area”. In Cape Soya, the terrain is considered to be formed in 20,000 years ago (Fig. 3-18).
Fig 3-17. Overview photographs of the Biei perigracial landform “dell” structure (up), Northwest Hill Viewing Park (left down), and Biei landform and distant prospect of Tokachi mountain range (right down).

Fig 3-18. Aerial photograph of the perigracial landform “dell” structure in Cape Soya.
Fig. 3-19. Location map of Stops D2-1 Northwest Hill Viewing Park in Biei City.
Stop D2-2 Furano (Pleistocene fault and resulted landscape)

[Locality] Goryo fault outcrop and Namakoyama Hill, western Furano basin
[Time] 40 minutes

[Synopsis] Furano basin forms elongated basin of North-South direction (30 km length in N-S and 5 km width in E-W directions, respectively). The Furano thrust system run along the topographic boundary of Furano basin. The western marginal faults of Furano basin are mainly composed of low angle reverse faults dipping to west (Figs. 3-20, 3-21). The geological structure around the seismic line is characterized by Nakafurano-Namakoyama fault and Goryo fault from west to east and fault-related folds. Nakafurano-Namakoyama fault are thrusts dipping to west, and Goryo fault is a thrust dipping to east. It is presumed that Goryo fault is a back thrust associated with Nakafurano-Namakoyama fault. (Ohtsu et al., 2007).

In Goryo Stone Pit outcrop (Fig. 3-22), we can observe cross section of Goryo fault. This outcrop is composed of Tokachi welded pyroclastic rocks and gravel layer dipping to the east at 40-50 degree. The seismic reflection profile reveals that this fault corresponds to the Goryo fault system (Fig. 3-21). Because the top of Tokachi welded tuff is dated at about 1.18Ma ± 0.06Ma, Furano thrust system is considered as active fault system which continuously active at least since 1 Ma, and uplifted the Namakoyama Hill (Tajika et al., 2007). Gravel layer is composed of clast-supported cobbles without floodplain mudstones, suggesting alluvial fan or braided fluvial deposits. Such gravel deposits overlying on Tokachi welded pyroclastic rocks are only confirmed from western margin of the Furano basin. Thus, alluvial fan and fluvial current are thought to be developed only in the western part of the basin (Tajika et al., 2007).

Fig 3-20. Geographic map of the Furano basin with marginal fault system, and Namakoyama Hill
Fig. 3-21. (left) Overview photograph of Namakoyama fault system and resulted landscape. (right) seismic profile of western Furano Basin and reconstructed Namakoyama fault system.

Fig. 3-22. (upper) Photograph of Goryo Stone Pit outcrop. (lower) sketch of the Goryo outcrop.
Fig. 3-23. Location map of Stops D2-2 Namako-yama fault outcrop in Furano city.
Stop D2-3 Sandantaki Park (Late Cretaceous submarine fan turbidite deposits)

[Locality] Sandantaki Park, along the Route No.452 between Furano and Mikasa cities

[Time] 20 minutes

[Synopsis] In Sandantaki Park, light grey colored turbidite sandstone deposits are exposed. The Ashibetsu River flows northward and is falling down on several steps, which are formed by the alternating beds of turbidite sandstone. This turbidite sandstone deposits belong to the Tsukimisawa Member of the Haborokawa Formation in Upper Yezo Group (Takashima et al., 2004; Figs. 3-24, 3-25, 3-26). Although there is shallow channel structure in some part, the Tsukimisawa Member of the Haborokawa Formation is characterized by fine- to medium-grained, felsic volcaniclastic sandstone with parallel lamination structure. Bouma sequence is not recognized from this turbidite sandstone deposits in this section, and so the Tsukimisawa Member is characterized by unique facies of relatively coarse facies compared to the general mudstone dominated facies of the Upper Yezo Group.

Cretaceous to Paleocene sediments filling the Yezo forearc basin are widely distributed over a distance of 1,400 km from south Sakhalin to offshore of north Honshu through the meridian zone of central Hokkaido and have a North–South trend (e.g., Ando, 2003; Takashima et al., 2004; Fig. 3-25). The Yezo Group consists of a very thick sedimentary sequence of mudstones and sandstones with subordinate conglomerates conformably overlying the Sorachi Group, an ocean floor sequence that was formed during the Late Jurassic-Barremian. The Yezo Group is 10,000 m thick in the type section in the Oyubari area (Takashima et al., 2004). It is separated by a disconformity or a gentle angular unconformity from the overlying Middle–Upper Eocene coal-bearing Ishikari Group, the Upper Eocene–Lower Oligocene Poronai Group, or Miocene marine strata.

The Haborogawa Formation is mainly composed of bioturbated mudstone, the upper part is characterized by coarsening upward successions, from mudstone to muddy sandstone and/or sandstone. It is the synchronous shallower-water facies of the Kashima Formation. The lithology and sedimentary cycles of this formation differ between the Tomamae and Mikasa areas. In the Mikasa area the formation forms a single, coarsening-upwards sequence, from bioturbated sandy mudstone to very fine-grained sandstone. On the other hand, the Tsukimi Sandstone Member in the Haborogawa Formation consists mostly of volcaniclastic sandstones with very thin interbedding of dark grey mudstones. Its geological age is considered to be Coniacian to earliest Campanian. The palaeo-depth of this deposit is considered to be outer shelf (Takashima et al., 2004).
Fig. 3-24. Outcrop photographs of the Late Cretaceous turbidite deposits (Tsukimi Sandstone Member in the Haborogawa Formation) in Sandantaki Park.

Fig. 3-25. Schematic diagram of the Yezo Group in the Sorachi-Yezo belt (Takashima et al., 2004).
Fig. 3-26. Correlation of selected lithostratigraphic columns and the lithostratigraphic subdivisions of Upper Yezo Group (Takashima et al., 2004).
Fig 3-27. Location map of Stops D2-3 (Sandantaki park) and D2-4 (Mikasa Museum).
Stop D2-4 Mikasa Museum (Cretaceous ammonoid collections)

[Locality] Mikasa City Museum

[Time] 50 minutes

[Synopsis] Mikasa City Museum, which is established in 1979, exhibits the nature and history of Mikasa City. This museum is famous as “Ammonoid Fossil Museum”. The exhibition hall consists of three sections; (1) Paleontology and Geology: Cretaceous Ammonoid collections taken mainly from Hokkaido; (2) Coal industry and life: History of Coal Mine and their life in Mikasa city; (3) History of Mikasa city: prehistoric remains and relic discovered in Mikasa. Particularly, the Cretaceous Ammonoid collections in this museum are known as one of the foremost collections in Japan (Fig. 3-28). Over 800 collections of the Hokkaido Ammonoids (100 species) are exhibited in Paleontology and Geology section. The heteromorph ammonoid “Nipponites sp.”, which is very unique specimen of Northwest Pacific area, is also exhibited. In addition, there are abundant large-sized ammonoides of over 50 cm diameters (Fig. 3-28). The visitor can touch most of these ammonoid specimens. In addition to ammonoid collections, Cretaceous marine reptile of the Taniwhasaurus mikasaensis (Mosasauridae, Tylosaurinae) and herbivorous dinosaur of the Nodosaurus sp. (Ankylosauridae), and Cretaceous large-sized bivalves of the Inoceramids are also exhibited. Most of these collections are donated by local fossil collectors in Hokkaido. Thus, it is not an exaggeration to say that Mikasa City Museum is supported by such dedicated fossil lovers.

Fig 3-28. Exhibition of the Cretaceous ammonoid collections in Mikasa City Museum.
Key Bibliographical References


References


Reference to this publication should be as follows: