

An aerial photograph of the Toya Caldera and Usu Volcano GeoPark. The image shows a large, dark, jagged volcanic crater rim in the foreground. In the middle ground, there is a prominent, reddish-brown, conical volcano (Usu Volcano) surrounded by dense green forest. To the right, a large, calm blue lake (Lake Toya) is visible, with a small town and some buildings along its shore. The background features rolling green hills and distant mountains under a clear sky.

# Toya Caldera and Usu Volcano GeoPark

Application dossier  
for nomination to the Global Geoparks Network

*The Joint Committee for the promotion of community  
development with the Lake Toya Area Eco Museum*



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## Background and Characteristic of Nominated Geopark Area

The proposed Toya Caldera and Usu Volcano Geopark includes unique sites for active volcanism, several hot springs, and rich natural habitats, which attracts many tourists every year.

One of the distinctive and important features of the proposed Geopark is the accessibility to interesting geological sites in a compacted area. Important geological formations, such as the Toya Caldera (also known as Lake Toya) which was formed 110,000 years ago and the Usu Volcano (also known as Mt. Usu) which was created 10,000 to 20,000 years ago, are easy to get to. The site also has recent relics from the 9 volcanic activities for 350 years (since the Edo period). Thus, the area is suited to learn about the history of coexistence between human and the ever-changing earth.

These natural resources have been utilized for educational purposes to understand earth science and natural disasters. Additionally the site has attracted national and foreign tourists as a geotourism and ecotourism hot-spot. The site has also hosted international events such as the International Workshop on Volcanoes Commemorating the 50th Anniversary of Mt. Showa-Shinzan in 1995 and the G8 Hokkaido Toyako Summit in 2008.

Over the years, the region's multiple municipal governments, local habitants, and scholars have cooperated in disaster mitigation and the effective prior evacuation resulted in no casualties at the 2000 eruption. The site hopes to continue to work with future generations to build a sustainable community, which is able to cohabitate with its geological surroundings.

The Toya Caldera and Usu Volcano region own attractive natural and geological archives, and actively manages these rich heritages as a geotourism site. For an example, the Usu Volcano region highlights the characteristic remains from past volcanic eruptions by connecting these sites with trails and description boards as well as hosting volcanological exploration tours by guides. The proposed Toya Caldera and Usu Volcano Geopark hopes to become a Geopark that lives up to the theme of "coexistence between human and the ever-changing earth."



*The Craters of Usu 2000 eruption at the foot of Mt. Nishiyama. Tourist could be access the craters and experience volcanic activity easily.*

## Overview of Proposed Geopark Area

### 2-1 Fundamental Data

The proposed Toya Caldera and Usu Volcano Geopark is located in Hokkaido, the Northern island of Japan. The site is approximately 1,180km<sup>2</sup> in area and includes parts of the Shikotsu-Toya National Park.

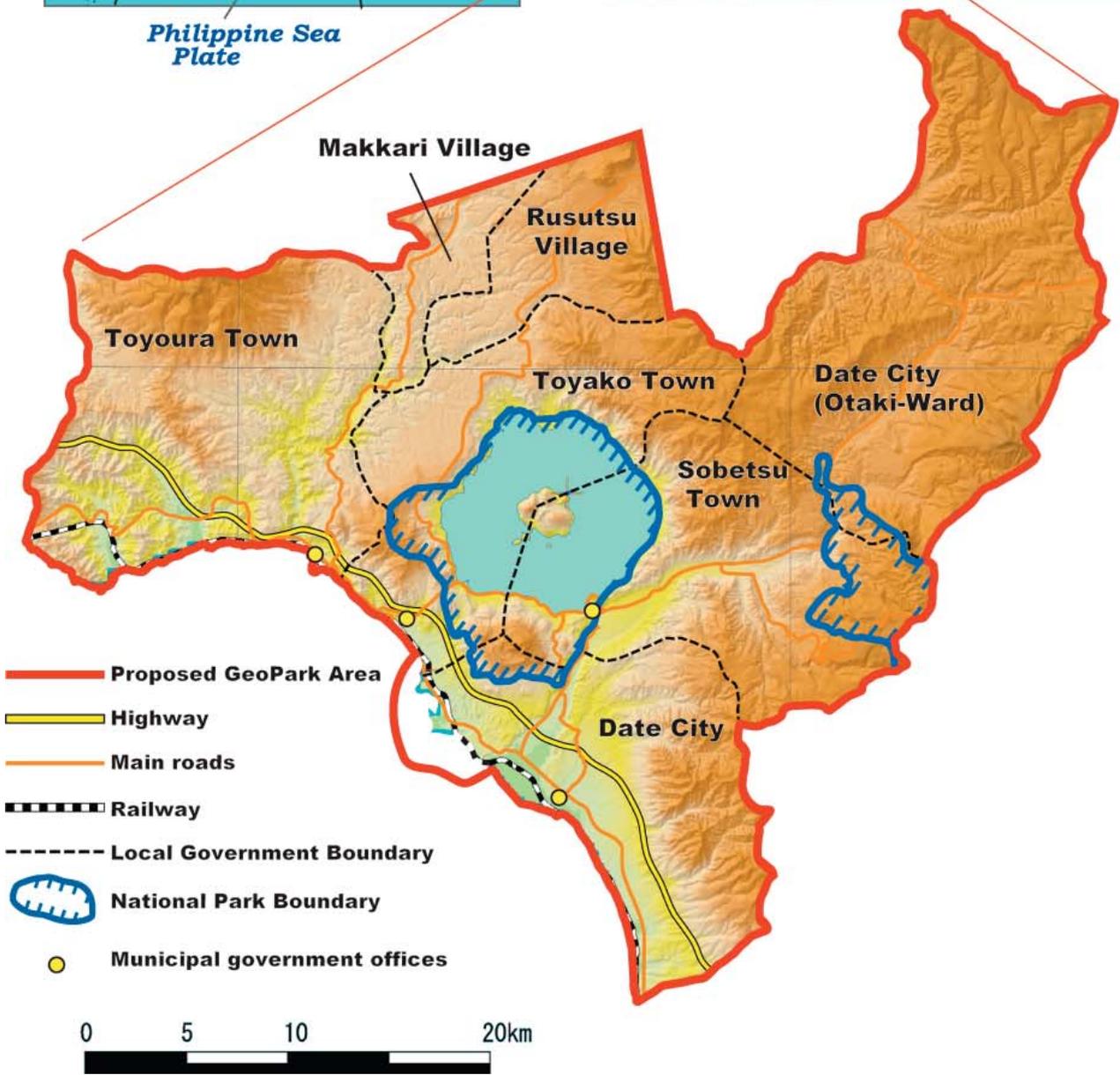
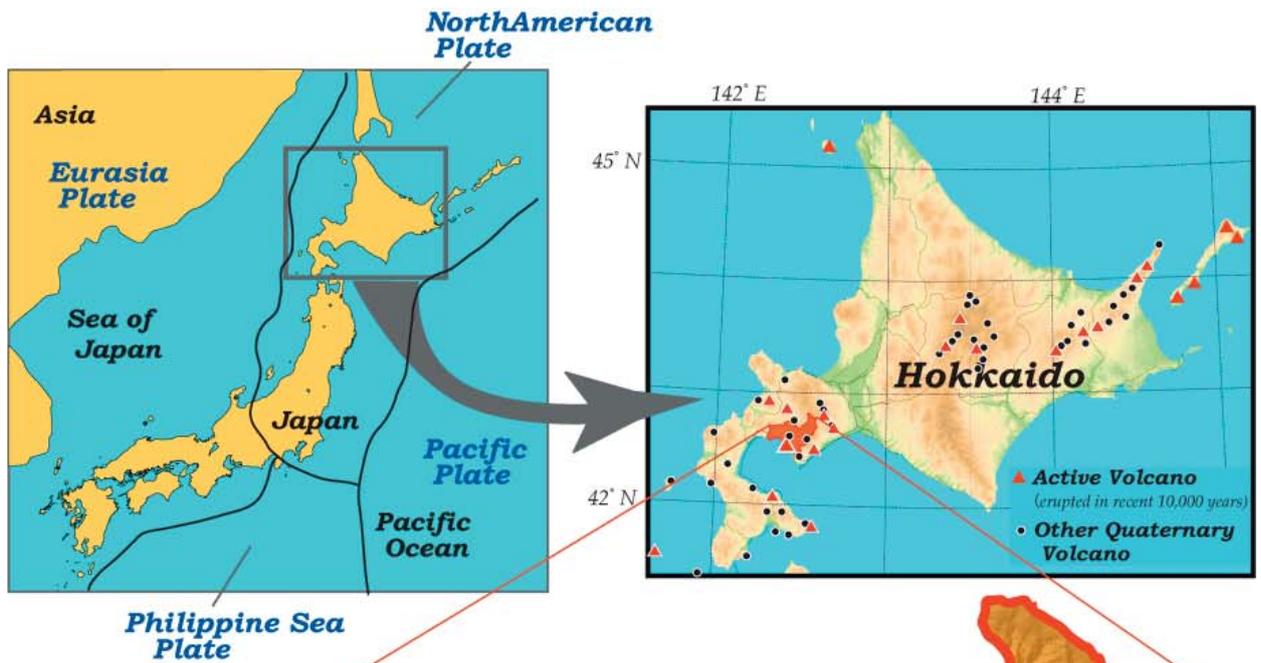
The location is approximately 3.5 hours away from Tokyo, the capital of Japan, utilizing the airplane, car and the railroad. From the New Chitose Airport, the International airport in Hokkaido, the site is approximately 2 hours away by car. The site boasts a well maintained transportation infrastructure, including highways and bus routes, making the location easily accessible from overseas and nationally.

The area is municipally-owned by the prefectural Hokkaido government in conjunction with two general local agencies; Iburi subprefectural office (and its local offices in Date City, Sobetsu Town, Toyako Town, Toyoura Town) and Shiribeshi subprefectural office (and its local offices in Rusutsu Village and Makkari Village).

The climate of the region, according to the Köppen Climate Classification, is classified between “Hot Summer Continental Climates (Dfa)” and “Warm Summer Continental or Hemiboreal Climates (Dwa~Dwb).” The annual mean temperature is 7.8 Celsius, the annual mean precipitation is 932mm, and the annual integrated sunshine is 1,463 hours (Date City). The snow depth during the winter averages between 50cm to 1m, which is mild comparative to other areas in Hokkaido and an unique characteristic of the area.

The total population of the region, including the few ethnic Ainu groups (Hokkaido’s indigenous population), is approximately 59,400 people (according to the national census in October

2005), of which about 59% resides at Date City. The traditional local industries include agriculture, fishery, and livestock business (primary sector of industry), which are well-established, however, the main industry is tourism (tertiary sector of industry). According to the classification of the three-sector hypothesis, the population by industry is the following: Primary sector of industry (15.8%), Secondary sector of industry (16.3%), and Tertiary sector of industry (67.9%). The tourism industry, which is structured around the Toya Caldera and Usu Volcano, is a crucial community industry, and the region has attracted approximately 8,950,000 tourists in 2006 (6% of the total tourism in Hokkaido), and approximately 230,000 foreign lodgers (15% of the total tourism in Hokkaido). The high-volume of foreign tourists is particularly noteworthy. Since the early 20th century, the local community has enjoyed the opportunities to connect with national and international volcanologists, which has helped enrich the knowledge and raise the awareness level in the region. These groundwork activities lead to the occasion to host international events such as the International Workshop on Volcanoes Commemorating the 50th Anniversary of Mt. Showa-Shinzan in 1995 and the G8 Hokkaido Toyako Summit in 2008. The International Workshop on Volcanoes Commemorating the 50th Anniversary of Mt. Showa-Shinzan is especially noteworthy for its community driven integration of researchers with local municipality and citizens, making it an internationally unique scholarly workshop. The area is not only known for its experience in hosting international events, but also in its active management of the site by protecting the natural and geological environment, as well as making the area accessible with trails and guilds for educational and touring purposes.



Locality of Proposed Geopark Area

## 2-2 Natural Environment

The nominated Toya Caldera and Usu Volcano Geopark has an unique natural environment as a result of its varying geological formations and conditions, such as lakes and volcanoes, which is inhabited by a diverse group of fauna and flora. Compared to other parts of Hokkaido, the weather is mild at the in the region, which is classified as a cool temperate zone. The forest landscapes in the Southwestern part of Hokkaido are commonly composed of deciduous forests, with climax communities of *Quercus crispula* and *Acer mono*, or mixed forests (needle-leaved and broad-leaved trees), with additional species of *Picea jezoensis* and *Abies sachalinensis*. The Toya Caldera region, however, is affected by the latitude of the location and the continuous volcanic activities in the area, and lacks the natural coniferous trees, which are common in other parts of Hokkaido. Instead, the site hosts broad-leaved deciduous forests with climax community mostly composed of *Quercus crispula*. Additionally, approximately 70% of forests in Hokkaido are native forests, a proportion which is true for the forests in the region. The progression and distribution of early stage succession species, such as *Reynoutria sachalinense* (a synonym of *Polygonum sachalinense*) grass field and *Populus maximowiczii* forest, are also common at the site; due to the effects of the



“The rich natural environment located around the Toya Lake”

volcanic activities of Usu Volcano over a vast area. Additionally, the underground volcanic movement has helped maintain the diverse plant

species by protecting the area from the intrusion of the common bamboo grass forest floors.

Approximately 600 vascular plant species have been reported in the Toya Caldera region, which is about a third of species found in Hokkaido, and of the 600 species, approximately 100 species are categorized as toll trees. There are also communities of costal plants near Volcano Bay, as well as alpine flora at low elevation region due to the unique volcanic features. Both coastal and alpine plants are valuable vegetation which are decreasing in population, and the region has a distinct environment suitable for cohabitation. Additionally, there are many other species listed in the Red Data Book, which can be observed in the region.

The region’s vast forest is also an important habitat for large mammals, such as *Ursus arctos* and *Cervus nippon yesoensis*. Furthermore, the regions is one of the outstanding habitats for maintaining high biodiversity of avifauna, represented by *Dryocopus martius* registered as a national natural treasure by Environmental Agency of Japan and *Picus canus* of which distribution is restricted in Hokkaido only. Also, the Toya Caldera is populated by species of lake birds, such as *Aix galericulata* and *Mergus merganser*, and the Osaru river estuary is home for species of stream birds such as *Megaceryle lugubris*, as well as sea birds such as *Larus crassirostris* and *Larus schistisagus*. The broad-range of forest and water bird species make the area an ideal observation site. On the other hand, there are concerns regarding the reproduction of feral *Cervus nippon yesoensis*, which escaped from a tourist facility, and the impact of over-populated deer may affect the ecosystems on the Nakajima Island enclosed by Lake Toya.

The Lake Toya is populated by numerous fish species, such as *Hypomesus nipponensis*, *Oncorhynchus masou*, and *Salvelinus leucomaenis leucomaenis*. Aside from smaller

mountain run-offs, the Osaru River is the only river which flows in and out of the lake, making the *Oncorhynchus masou* an unique lake type salmon that does not travel to the ocean and spends it's entire of life between the river and lake.



"*Megaceryle lugubris* at the Osaru river"

## 2-3 Landscape and Geology

### 1. Landscape and land-use

The landscape of the area is composed of a mixture of mountain terrain, plateau and valley.

Most of the mountain terrains, aside from the active Usu Volcano, are created by eroded volcanic edifice from the Neogene to Quaternary Era, and the highest point at the region is Mt. Orofure (1,230.7m), followed by Mt. Nukibetu (994m), Usu Volcano (733m), and Mt. Horomoi (624.8m).

The Northern half of the region composed of a plateau created by pyroclastic flow deposit erupted from Toya Caldera (which will be further discussed later) and the altitude is approximately 200 to 300m of flat land surface that is divided by small-sized rivers.

The valleys formed near the coast and river side, such as along the Osaru River. Most of the valleys are low river terrace and low to middle marine terrace, and there are a few alluvial plains along the river and coastal area.

Although the plateaus are used mostly as fields

and the valleys are commonly used as residential, field, as well as commerce and industry sites, the majority of the mountain terrain is kept as forest land.

The main rivers in the region are Osaru River (length of river channel 43km) and Nukibetu River (length of river channel 36.9km). Other rivers are shorter than 10km.

The important and noteworthy Geosites in proposed Toya Caldera and Usu Volcano Geopark are located around the Lake Toya and Usu Volcano. The Toya Caldera is a circular lake which is approximately 10km in diameter, 84m in lake surface altitude, and 180m in depth at the deepest point. The lake was filled with water in the large caldera, which was created by a large-scale volcanic eruption to generate a pyroclastic flow that took place approximately 110,000 years ago. There are also two post-caldera volcanoes, which were created approximately 50,000 years ago, of which one is located at the center of Toya Caldera called Nakajima Volcano (also known as Nakajima Island) and another located on the southern shore called Usu Volcano.

### 2. Geology

#### Overview of the geological and tectonic settings of Hokkaido

The Toya Caldera and Usu Volcano region is located in Hokkaido, which is located at the boundaries of two continental plates (North American and Eurasian plates) and one oceanic plate (Pacific plate). Thus, Hokkaido is considered a subduction zone (island arc-trench system), with the Eastern half located on the Kurile Arc and the Western half located on the Northeastern Japan Arc. This tectonic setting is presumed to have formed around the Jurassic period. The majority of the geology of Hokkaido is consisted of accretionary prism sediments and island-arc sediments from the Jurassic to Eocene Tertiary period, as well as trapped forearc hemipelagic

sediments and metamorphic rocks. Overlying this is a layer of Post-Palaeogene continental-margin arc and island-arc based subaerial and marine sediments. Additionally, the intense island arc volcanism (explained in more details later), until Miocene period, caused huge pile of volcanic materials.

Subduction Zone volcanism has been continued until middle Miocene period at the Kurile arc and Northeastern Japan Arc. There are 76 Quaternary volcanoes and 29 active volcanoes on and around Hokkaido, most of which are located on the volcanic front, and runs parallel to the Kurile trench ~ Japan trench. These are mainly composed of stratovolcanoes and lava domes formed by andesitic~ rhyolitic magma, as well as large scale caldera volcanoes, such as Toya Caldera and Shikotsu Caldera. These volcanoes are characteristic landscape features of Hokkaido.

### Overview of the regional geology at the proposed Geopark site

The basement geologic formation of the site is rocks from the Pre-Tertiary system, with layers of the following; hydrothermally alternated volcanic formations from the Middle-Miocene to Pliocene Epoch, volcanic formations from the Pliocene Epoch to Middle-Pleistocene, eruption products from the Toya Caldera, and volcanic ejecta from Usu Volcano. More than half of the region is made from volcanic deposits, with some sedimentary formations and plutonic rocks. There are no outcrops of metamorphic rocks.

On the Eastern side of the region, there are also distribution of pyroclastic flow deposits from the eruption of Kuttara Caldera approximately 50,000 to 40,000 years ago and Shikotsu Caldera approximately 41,000 years ago.

The foundation of Usu Volcano is created by the activities of a basaltic~andesitic composite

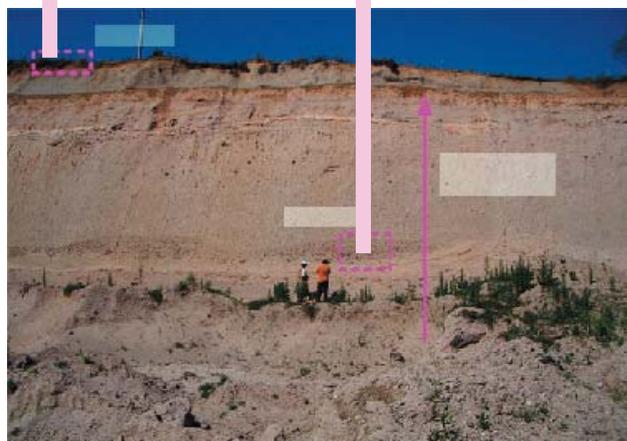
volcano since ~approximately 20,000 years ago and the groups of lava domes and cryptodomes located on the peaks and foot of the mountain.

The current cove with its many small hills and mounds around Usu Bay was created 7,000 to 8,000 years ago by a debris avalanche, as a result of a large schale sector collapse that occurred at the top of Usu Volcano. After ~7,000 years of dormancy, Usu Volcano resumed its volcanic activity in 1663 and since has erupted 9 times during the 350 years. Most of the groups of lava domes and cryptodomes located on the mountain top (O-Usu, Ko-Usu, Mt. Ogari and Mt. Usu Shinzan) and piedmont (Mt. Showa Shinzan, Mt. Konpira, Mt. Higashi Maruyama and Mt. Meiji Shinzan) formed during recorded history, however, the formation of a few of the domes are unknown.

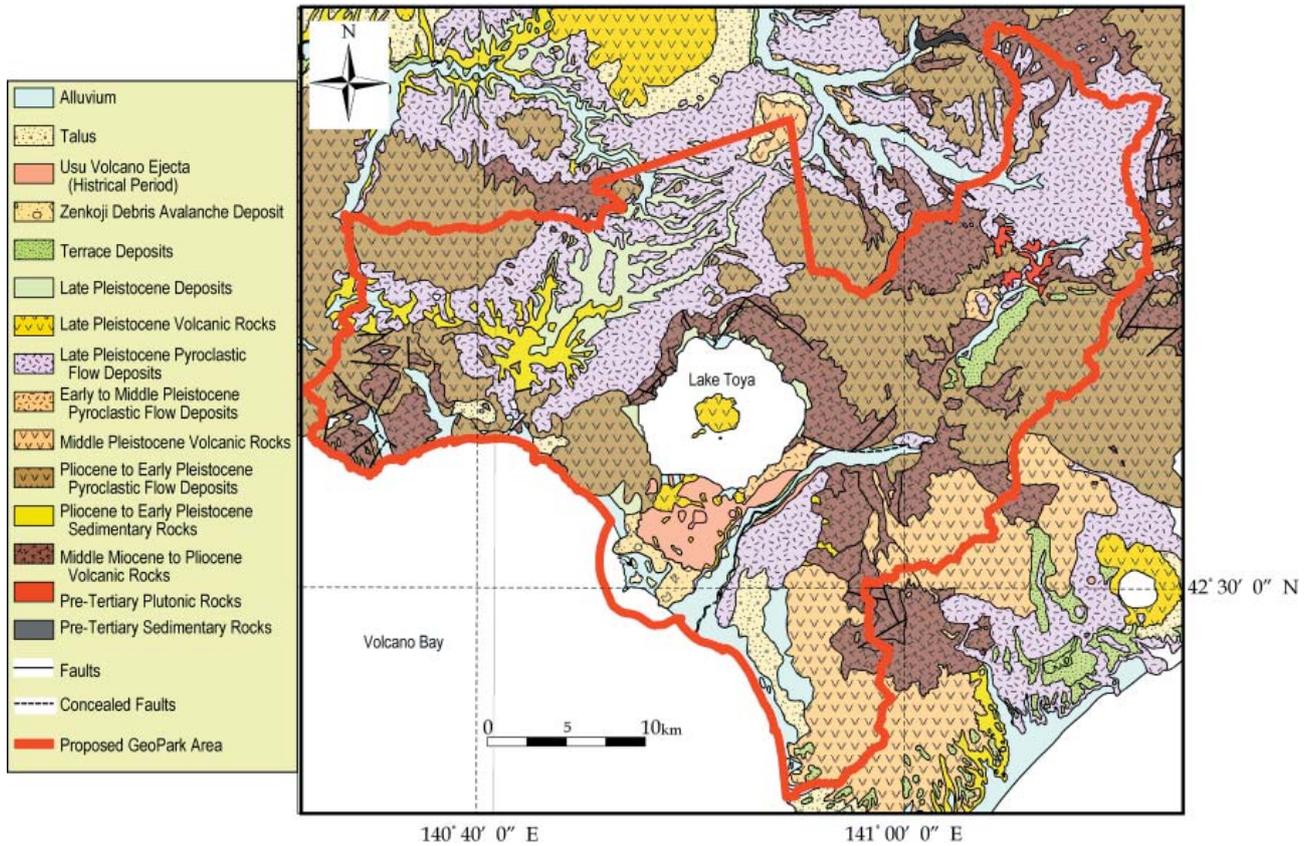


*"Pyroclastic deposits sequence from Kuttara Volcano and Nakajima Island"*

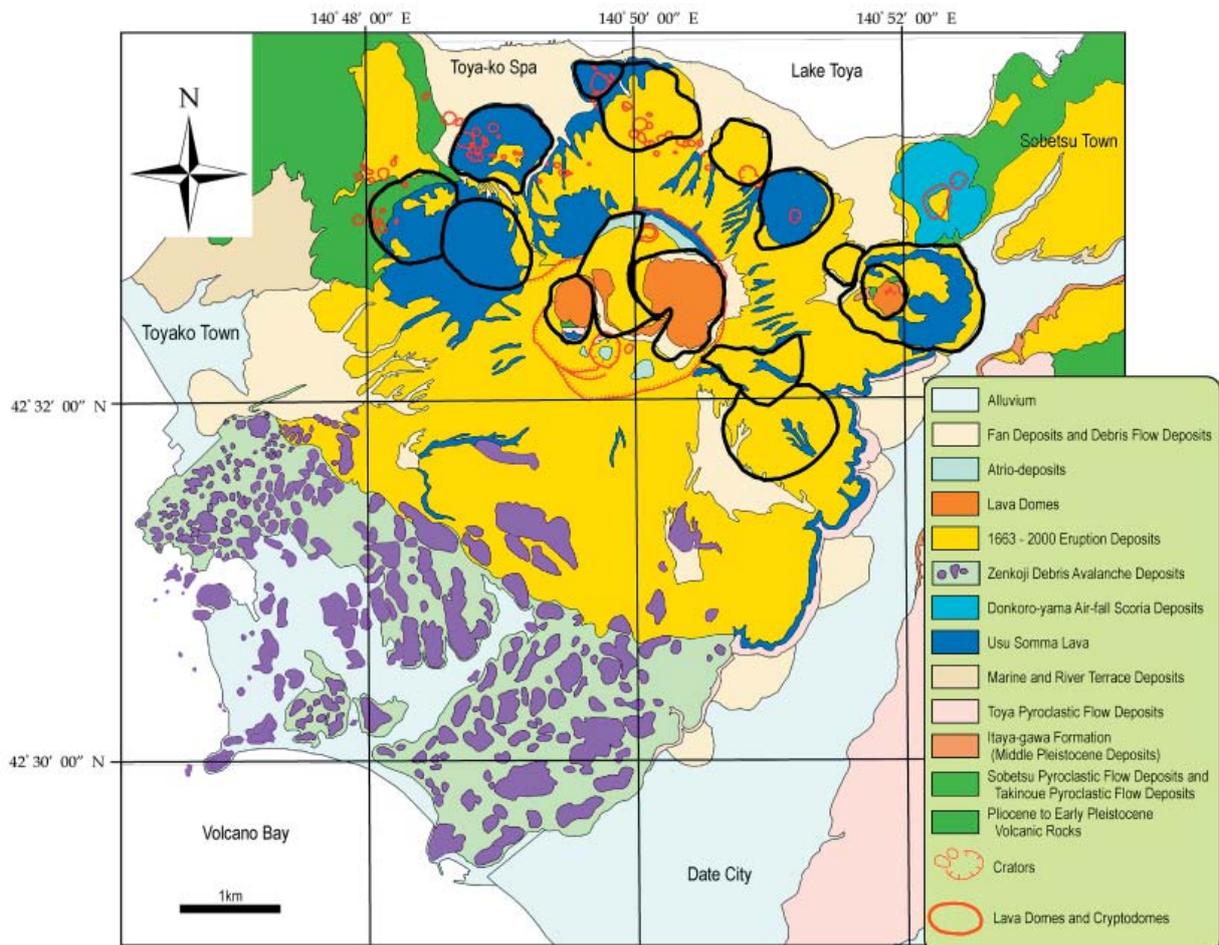
*"Rock fragments trapped inside of pyroclastic flow deposit"*



*"Outcrop of pyroclastic flow deposit"*



Geological map around proposed Geopark Area



Geological map around Usu Volcano

## Geological heritage for the future generations

### 3-1 Ever-changing earth

The Toya Caldera and Usu Volcano region is unique for its active volcano and ever-changing geology. The site has variable geological history, as a result of various volcanic events, such as the huge-scale eruption which formed the collapsed caldera and pyroclastic flow deposit, development and destruction of stratovolcanoes, and periodic eruption with notable ground-deformation in a few decade years after 7,000 years of dormancy. Next eruption has expected in a few decade-years later. These are unique geological artifacts that one can discover about and learn from by visiting these geosites.



*Mt. Shouwa Shinzan Geotour with children*

### 1. Pre-Toya Caldera Era (Neogene Tertiary Miocene Middle Pleistocene)

The oldest geological formations in the region are a mixture of slate, shale, and granodiorite of the Pre-Tertiary System (Jurassic Era). These formations could not be observed on the surface, and can only be seen by geothermal bore-hole over 1,000m underground. By the middle Miocene to Pliocene epoch, volcanism took place in most of the area. Most of the geological formation composed of andesitic and deictic pyroclastics of lava flows, and there are barely any sedimentary formations. The pyroclastic formation near Osaru River (Osarugawa formation) has an intercalation

of welded tuff, which is speculated to be caused by subaerial volcanic activity. On the other hand, there are scattered hyaloclastite in the coastal area near Toyoura Town, as a result of subaqueous volcanic activity.

During the Pliocene epoch to middle Pleistocene, the andesitic composite volcanoes were particularly active, which formed mostly lava flows with minor pyroclastic rocks. There are also discoveries of welded tuff with unidentified origins at the southern shore of Toya Caldera, known as Takinoue pyroclastic flow deposits and Soubetsu pyroclastic flow deposits (named after the nearby town).

### 2. The formation of Toya Caldera and Usu Volcano



*Toya Caldera*

Approximately 110,000 years ago, there was a large scale pyroclastic flow eruption which formed the Toya Caldera. The pyroclastic flow deposit by this event reached as far as the Japan Sea coast, which is approximately 40km away, and the cognimbrite ash (known as Toya tephra) covered whole area of the northern region of Japan, an area approximately 450km in radius. The total amount of volcanic ejecta exceeded 150km<sup>3</sup>, making this one of the largest volcanic eruptions in Japan. As a result of this catastrophic event, the region, except for mountain terrains, was covered with pyroclastic flow, which created a vast plateau around the Toya Caldera. The plateau is currently utilized for agriculture and creates an extensive farmland scenery. Approximately 50,000 years

ago, Nakajima Volcano became active as a post-caldera volcano. Located at the center of the Toya Caldera, the activities of Nakajima Volcano created over 10 lava domes and a tuff cone. Subsequently, approximately 20,000 years ago, Usu Volcano became active. At the early stages, the volcano erupted countless times and ejected basaltic~andesitic lava flows, which resulted in the creation of a stratovolcano named "Usu Summa Lava". Simultaneously, Mt. Donkoroyama scoria cone was formed at the northeastern piedmont of Usu Volcano. Roughly 7,000 to 8,000 years ago, the mountain peak of Usu Volcano collapsed, causing a debris avalanche deposits around the southwestern piedmont, which resulted in the formation of numerous hummocky hills. The current cove with its many uphills and downhills at Toya Bay as well as most of the current geological features of the region were formed by this time. Thereafter, Usu Volcano entered a long 7,000 year dormant period.



*Hummocky hills around the cove of Usu Bay*

### **3. Volcanic activities of historic period**

Usu Volcano abruptly became active in 1663, and thereafter has erupted in a 20 to 60 years cycle during the following years: late 17th century, 1769, 1822, 1853, 1910, 1943-45, 1977-78, 2000. The properties of Usu Volcano's magma has converted to dacitic and rhyolitic compositions. The eruption style has also changed to a more explosive one and takes place typically at two types, one being an explosive eruption (such as plinian, sub-plinian and phreatomagmatic eruption) at the mountain top (1663, late 17th

century, 1769, 1822 , 1853 , 1977-78), and another being a phreatomagmatic and phreatic explosion at the mountain slope or base (1910, 1943-1945, 2000). The characteristic features of both eruptions are the creations of lava domes and cryptodomes, as well as ground deformation (such as ground upheaval or subsidence and creations of faults) at a large area of the piedmont.

The eruption in 1663 was the largest eruption of Usu Volcano during historic period. Precursory earthquakes took place 4 days before, and started as a small-scale eruption at the mountain top which lead to the largest plinian eruption of Usu Volcano. Followed by many phreatic andphreatomagmatic eruption with pyroclastic surge and ash fall, the eruption finished with the formation of Ko-Usu lava dome. Due to the westerlies, pumice falls from the Usu Volcano traveled over 250km reaching the eastern regions. The pyroclastic surge and ash fall dramatically changed the geography of the region in the continued eruption approximately for a month. Total erupted material was 2.8 km<sup>3</sup>, dense rock equivalent (DRE) was 1.12 km<sup>3</sup>, the volcanic explosively index (VEI) was 5, and resulted in five casualties. In the late 17th century, summit eruptions have taken place, wich caused pyroclastic surge and pumice fall to the northwestern foot of the mountain. Total erupted material was 0.001 km<sup>3</sup>, DRE was 0.0004 km<sup>3</sup>, and the volcanic explosively index (VEI) was 2. In 1769, a summit eruption occurred, causing a pyroclastic flow to the southeastern base which devastated a village. The total erupted material was 0.11 km<sup>3</sup>, DRE was 0.04 km<sup>3</sup>, and the volcanic explosively index (VEI) was 4. There are also speculations about the possibility that Ko-Usu lava dome was created as a result of this eruption.

The eruption of Usu Volcano in 1822 resulted in over 100 casualties, which is the largest number of casualties caused by eruption of Usu

Volcano. Precursory earthquakes took place approximately 3 days before, followed by an eruption at the mountain peak. This caused twice eruption of pyroclastic flow and pyroclastic surge as well as pumice fall, all of which reached the mountain foot in all directions. Eventually, after the formation of a cryptodome called Mt. Ogari, the eruption ceased. The total erupted material was 0.30 km<sup>3</sup>, DRE was over 0.13 km<sup>3</sup>, and the volcanic explosivity index (VEI) was estimated to be around 4. There are not many records of the 1853 eruption; however, it is known that the eruption occurred at the mountain top, with ash fall, pumice fall, and pyroclastic flow reaching the northeastern base of the mountain. The transportation route in the area was blocked for a few years due to the event. The total erupted material was 0.47 km<sup>3</sup>, the DRE was over 0.26 km<sup>3</sup>, and the volcanic explosivity index (VEI) was estimated to be around 4. The O-Usu lava dome is thought to have started its formation as a result of this eruption.

After 4 days of precursory earthquakes, phreatic and phreatomagmatic explosions took place at the northern piedmont in 1910, continued for a few months. The total erupted material was 0.055 km<sup>3</sup>, and the volcanic explosivity index (VEI) was estimated to be around 2. Although the explosion was not large in magnitude, the explosion and formation of the cryptodome (Mt. Yosomiyama) was only a few hundred meters away from the village and caused a large infrastructural damage. On the other hand, the Toyako hot spring spa was found soon after the event, which contributed to the population increase of local resident and improved tourism in the region.

The 1943 to 1945 eruption started from the ground uplifting at the eastern piedmont. Half year of after, phreatic and phreatomagmatic explosions started near villages and field at the eastern mountain foot, with intense ground-uplift which continued until September 1945, and resulted in the creation of the lava dome



*Cocktail jet by phreatic (phreatomagmatic) eruptions at the 1910 eruption*

called Mt. Showa Shinzan with Mt. Yaneyama cryptodome. The total erupted material was 0.11 km<sup>3</sup>, the magma supply rate (DRE) was over 0.11 km<sup>3</sup>, and the volcanic explosivity index (VEI) was estimated to be around 1. Because the eruption and ground deformation took place at areas near the local residents, the villages and lifelines have been damaged severely, and there are many records and relics about this eruption.

The eruption in 1977-1978 took place from the summit and the four plinian eruption caused ash fall to the entire region of Hokkaido. The total erupted material was 0.15 km<sup>3</sup>, DRE was over 0.09 km<sup>3</sup>, and the volcanic explosivity index (VEI) was estimated to be around 4. Although the eruption was happened at the summit, there were populated cities at the foot of the mountain, thus, lahar, ash fall and ground deformation caused an immense damage to local citizens.

Most recently, there was an eruption in 2000, which was forecasted by the Japan Meteorological Agency and was covered extensively by the mass media. The start of the eruption was captured by television cameras, which is a rare occasion for volcanic activities worldwide. After 4 days of precursory earthquakes, there was an eruption from the northwest to western piedmont; causing ash fall for the following two months, ground deformation for the following four months, and the creation of the western cryptodome located

at the western foot of the mountain. The total erupted material was 0.27 km<sup>3</sup>, and the volcanic explosivity index (VEI) was estimated to be around 1.

A common problem of all recent eruptions has been the close vicinity of the eruption site and the local population, resulting in the extensive damages to the local communities. However, due to the preparation of the local community, such as the creation of a hazard map as well as evacuation practice activities held by the cooperation of the municipality, citizens and volcanologist, there were no direct casualties.



*The 2000 eruption, which caused severe damage to the surrounding community*

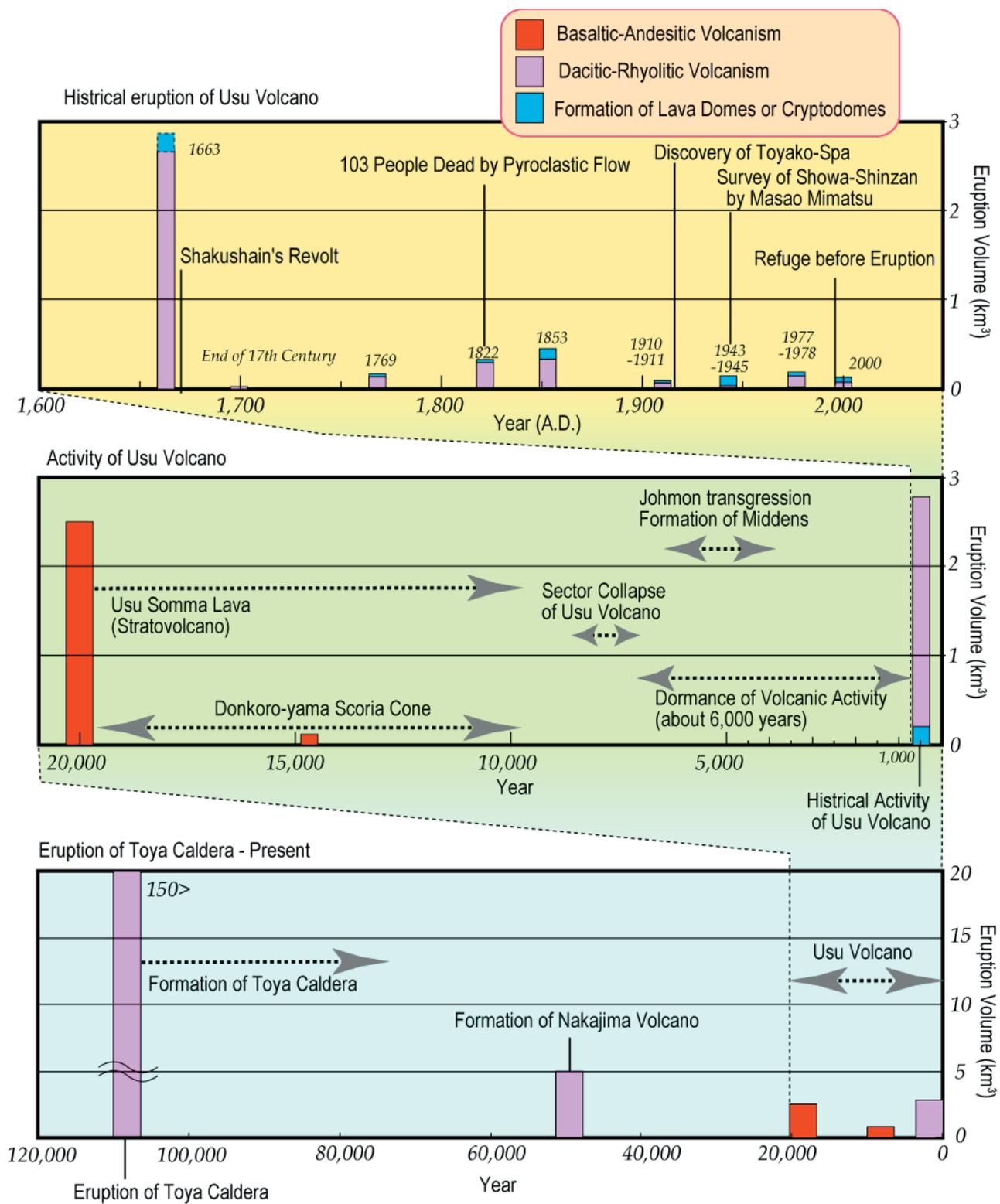
#### **4. The international significance of the geological heritage site**

Usu Volcano is one of the most active volcanos in Japan, and has erupted 9 times in the last 350 years, causing highly viscous magma. The most recent eruption was in 2000, and similar eruption will follow in future.

There are many records of these repeating volcanic activities. For an example, the formation of Mt. Showa Shinzan lava dome and its development is written and known as “Mimatsu Diagram.” This observation record and other valuable documents are accessible to the public at the “Mimatsu Masao Volcano Memorial Museum.”

There are not only written records, but also geological relics, which can be accessed by using trails. There are not many places in the world where there are rich artifacts that can be observed so easily. The scenic site of the Toya Caldera and pyroclastic plateau, formed by the large scale eruption with pyroclastic flow, is a distinct landscape in the region. There are also areas with geological formations where one can see the movements of the magma and its effects on the surface, which is accessible for volcanic sightseeing and an important tourist site. There are also preparations of guided tours and other opportunities for national and foreign tourists to enrich their knowledge.

Aside from expanding volcanic tourism, mitigation of volcanic disasters, such as construction of disaster-prevention facility and continued education cooperation with local citizens, are also crucial. The implementation of these disaster mitigations as well as approaches of cohabitation of man and Earth should be internationally known and shared with others in the same circumstance.



Volcanic activity since late Pleistocene around Toya caldera and Usu Volcano

### 3-2 Cohabitation with the ever-changing volcanoes

#### 1. Effects of volcanoes on natural environment

The Toya Caldera and Usu Volcano region is unique for its variety of volcanically affected natural environment, ranging from recently affected sites to areas where the last volcanic activity took place over 100 years ago. The region has been wholly affected by the volcano, including the coastal habitat and lakes. Additionally, it is rare for such a volcanically active area to be so populated, making this an examination site for cohabitation with nature.

#### Ecological succession on plants

Ecological succession is defined as temporal changes in plant and animal communities after disturbances, such as volcanic eruptions. There is significance to understanding this phenomenon visually; however, opportunities to observe entire succession is rare in the world. In some cases, the chronosequence method is used to understand these changes over time. Chronosequence approach is that the successional sere is inspected using the sequential set of changes in structure and composition of plant communities. Observations made from this method, however, can not be used when the same type of disturbance occur within a narrow area. In the case of the Toya Caldera, nevertheless, there has been several eruptions since 1822 at different locations, making it possible to use this method to observe successional changes over a 200 year period.

The area a few kilometers around Usu Volcano can be made into several different geotourism and ecotourism trails by combining different volcanic relics according to the years of formation and purpose of the tourist. For an example, there could be a forest succession tour starting at the 2000 eruption site to examine the herbaceous vegetation, followed by the 1977-78 eruptions site and its surrounding large perennial plant field

and a young forest of *Populus maximowiczii*, continuing on to the mountain base near Mt. Showa Shinzan and its maturing *Populus maximowiczii* forest, as well as the site around Mt. Yosomi and the matured *Populus maximowiczii* forest, and lastly the eruption location from the 1822 and 1853 explosion and the gradual invasion of *Quercus crispula* at a climax forest. Such a tour is suited to discover about succession and the progression of time by learning hands-on while experiencing the lush natural history.



Recovering forest after the eruption

Additionally, along the riverside, there are characteristic forests of *Cercidiphyllum japonicum* and *Ulmus davidiana* var. *japonica*. Although these scenic and diverse ecosystem structures are placed in a harsh volcanically active location, there are also various understory vegetations. For an example, Japan's largest population of *Trillium smallii*, which are ranked as "Vulnerable" according to the Red Data Book by the Ministry of the Environment of Japan, can be found at the Southern basin of the Usu Volcano. Furthermore, there have been reported on more species that have been endangered and/or thriving in this region. Furthermore, there are observations of adaptive and distinctive plant species of bryophyte and spermatophyte, i.e. *Gnaphalium japonicum*, in areas with active fumarolic gas.

Also, O-Usu lava dome is a single peak located near the coast, where there are established coastal plants, such as *Arabis stelleri* var. *japonica*, *Linaria japonica*, and *Plantago*

*camtschatica*. These plants signify the interesting similarities between plants established on coastal and volcanic-desert habitats. In addition, there are also alpine plants such as *Salix reinii*, *Pseudolysimachion schmidtianum* var. *schmidtianum*, and *Campanula lasiocarpa*, flourishing in areas only 700m in altitude and surviving through multiple eruptions.



Deer at Nakajima Island

### The biological succession of animals

At the early stages of the post-eruption period, there is a decrease in the number of herbivores; however, this has provided a unique opportunity to observe the invasive process of organisms. The area around the 4th volcanic vent, which was created during the 1977 eruption, is currently a wetland environment that is shifting from a reed swamp to a *Salicaceous*. Although it has only been a little over a decade since the eruption, there are reproducing populations of *Hynobius retardatus* and other amphibian species in the region. These amphibians are carnivores, thus, logically species that are below on the food chain must have recovered to a certain level as well. In addition, the deer population in Nakajima Island increased in an explosive manner, which decreased their food resource. To avoid the decline of the population, the deer took a strategical shift from one food resource to another. These harsh conditions bring out some of the unique adaptation by living creatures, making this a great location for research. Additionally, this region is abundant in avifauna, and the population near the mountain top of Usu Volcano has recovered over

time, and as a result, the population of plants which depend on birds for seed dispersal, such as *Elaeagnus umbellate* and *Cerasus sargentii* are recovering as well. These disrupted areas are important academically and educationally to research and learn about successional mechanisms of ecosystem.

In the 1970s, due to the strongly acidic effluent from the sulfur mine poring into the Osaru River, the Toya Lake reached the level of pH of 5 and the ecosystem simplified greatly. As a mitigation response, the influent water was neutralized to stop the further acidification of Toya Lake. The ash fall from the eruption in 2000, also affected the lake by lowering the water turbidity and raising the concentration of phosphate, resulting in an influx of planktons. Fortunately, the ash fall was alkaline and helped bring back the water to a pH of 7 level. Further recovery of the ecosystem is anticipated as the food chain stabilization over time.

### Knowledge from the 1977-78 eruption

The peak of the volcano and the surrounding area affected mainly from the 1977-78 eruptions provide an interesting and crucial research ground to study the organisms' ability to adapt to stressful and disturbed environments. Below are some of the representative research results, which have been published in academic journals. Similar patterns in early successional stages that adapt disturbances can be found and researched at the 2000 volcanic vent sites.

More than 1000 seeds per square meter can survive over a few decades in the former topsoil buried under the thick volcanic deposits.

Typically volcanic succession starts from lichens and mosses, followed by annual herbaceous plants; however, the Usu Volcano region lacks these phases. This is due to the quality and quantity of volcanic deposits (pumice stone and volcanic ash) and the composition of the flora

before the eruption.

At the Usu Volcano, the early succession starts from the recovery of the perennial herbs. This is due to the erosion of volcanic ash fall and the inability of short plants to stabilize firmly to the ground. On the other hand, post-eruption habitats are well-adapted to the post-eruption habitats, due to long-distance seed dispersal by wind and the capability to grow roots to settle in the soil.

Most springtails (Collembola) survive the eruption under the ash fall and the rejuvenation of the species helps recover the soil in the area.

Numerous species of ants and bees inhabit in the diverse regions (bare land, grassland, and broad-leaved woodland) adjacent to the Usu volcano, respective to the habitat preferences that are determined by the dominant plant species in each.

Mammals were thought to be destroyed by the eruption, however, after 20 years from the eruption a species of forest rodent, *Clethrionomys rutocanus bedfordiae*, was found at the *Reynoutria sachalinensis* grassland near the mountain peak. The recovery of the *Clethrionomys rutocanus bedfordiae* population is thought to be a result of the creation of a diverse hierarchical structure like a forest by the predominance of *R. sachalinensis*, a large perennial for, growing up to a few meters in height, and abundant litter accumulation in the grassland. In addition, larger mammals have also been sighted, but in extremely smaller population sizes.

In summary, the Toya Caldera and Usu Volcano area covers a diverse number of species that inhabits the various types of ecosystems from ocean side, high and low land, as well as inland water areas. Thus, the area provides a unique research ground to understand the adaptation of different organisms to volcanic activities.

## 2. The lives and cultures of the ancestors

The culture of Japan is rooted in the hunter-gatherer Jomon culture. After the continuation of the Jomon culture over millions of years, the Honshu, Shikoku and Kyusyu islands of Japan, started to shift to an agricultural culture called Yayoi, which was introduced by the outside world. On the other hand, Hokkaido continued the lifestyle of the Jomon culture, i.e. hunting, fish catching and picking. Today, the old cultures in Hokkaido are distinguished separately by the other Japanese cultures and named “continued Jomon culture (200 B.C. to the 7 Century),” “Satsumon culture (the 8 to 12 Century),” and “Ainu culture (after 13 Century).” Therefore, the Ainu people, who strongly inherited the original culture, are considered the indigenous people of Hokkaido.

“Kaizuka” (also known as shell heap) could be called the symbolic feature for the hunter-gatherer culture. Kaizuka was first created around 6,000 years ago, when the Jomon Kaishin, a time period when the sea-level rose greatly, reached the peak and spread all over Japan from the northern Hokkaido to the southern Okinawa. In Hokkaido, unlike the Honshu area, kaizuka was being built until the beginning of the Modern Age, along with the continued society of hunting and picking.

Kitakogane Shell Heap Ruins, where one can learn Jomon culture (left), and Kamuichashi Historical Ruin Park of Ainu culture (upper right)

In the proposed Geopark area, the Kaizuka ruins are mainly gathered near the Usu Bay. Representative examples of these archives are Irie/Takasago Kaizuka, Wakkaoi Kaizuka, Usu Moshiri Ruins. In addition, the Rebunge kaizuka and Kitakogane Kaizuka are relatively large settlements and considered important villages since it played a role in commerce and rituals,



Kitakogane Kaizuka Park, where one can learn Jomon culture

even though both ruins are located away from the Usu Bay. The region, however, also has several ruins without any trace of kaizuka.

In general, there are numerous ancient remains near this area, which is thought to be a result of the rich natural food supply. For an example, the Volcano Bay provided a rich source of seafood, the hilly terrain near the Usu Volcano was a great hunting site, and the small and big rivers going in and out of the Lake Toya as well as the other rivers from the mountain ranges near by was an ideal resource for the ancient people. The main sources of food for the people during the Jomon Era to the modern Ainu culture were seals and whales.

Although the relationship between volcanoes and ancient people living in the Jomon to continued Jomon culture is unknown, there are no evidences regarding a large scale volcanic eruption. It is in recent times that there are indications of disasters, for an instance, there are accumulations of volcanic ash originated from the Usu Volcano around the newer kaizuka and the scattered Shashi remains. There are also evidences of the eruption of Mt. Komagatake, located at the opposite shore, and damages from tsunami were recognized, as well as signs of volcanic ash from Baitoushan which traveled from



Kamuichashi Historical Ruin Park of Ainu culture

the Korean peninsula. These volcanic eruptions are thought to have effected the lives of people in the area to some degree.

After the medieval times, the culture in Hokkaido is referred at as the Ainu culture. By this time, there are apparent influences from the culture in other parts of Japan (i.e. Honshu). For example, remains of agricultural fields were discovered as the proof for farming. Also, the effect of the Honshu culture can be seen on the accessories and tools. The material culture was rapidly transformed after the Modern Ages by the opening of trade and development by the Honshu Culture. The arrival of people from Honshu to Hokkaido and their activities, such as the establishment of places for commerce and the building of Usu-Zenkokoji temple as one of the Ezo-Sankanji temples, triggered changes in the lifestyle of the Ainu people by necessity.

Although the principles of material culture among the Ainu group changed dramatically by the interaction with Honshu, the spiritual culture of the Ainu people today are no different from their ancestors, and was unaffected by the expansion of Buddhism or Catholicism. The Ainu festival of “Kamuinomi Icharupa” in the present day still bears close resemblance to the ritual and mass, which took place in the Jomon era.

After 7,000 years of dormancy, the Usu volcano

became active in 1663, which greatly affected both the lives of Ainu and mainland Japanese. The 1663 eruption of Usu Volcano and the 1667 eruption of Mt. Tarumae-zan heavily affected the lives of Ainu, due to the damages the volcanoes caused to the ecosystem in Hokkaido. The lives of the hunter-gatherer culture were struck with poverty, which led to an armed uprising. Furthermore, the 1822 eruption caused pyroclastic flow and pyroclastic surge towards the southeastern piedmont, which resulted in 103 casualties out of the 380 residing at the Tokotan settlement. After the disaster, the residents of this settlement were forced to clear out of their land and relocate. The detailed situation of this disaster is known today, due to a record in the diary of a monk from Usu-Zenkoji temple.



*The cenotaph for human sacrifice by the pyroclastic flow (left) and Usu-Zenkoji temple with the record of 1667 eruption (under).*



### 3. The Lives of People at The Present Day

1) The eruption of Mt. Usu in the 20th century and the way for people to coexist with the volcanoes

#### **The 1910 eruption (the era of Meiji 43) and the birth of Mt. Yosomi (Meiji-Shinzan)**

The 1910 eruption is the first eruption in the world in which people were able to take appropriate action for disaster reduction according to the scientific research of precursors of a volcanic eruption. Throughout the eruption, scientists delved into modern and multidisciplinary researches regarding the phenomenon of the eruption, earthquake and ground deformation, which lead to the development in volcanology and the science of eruption prediction, i.e. modeling of volcanic action and eruption prediction.

The eruption began in July 25th, 1910 and continued until August 10th. Although there were no direct casualties caused by the eruption, a civilian, who ignored police regulation, entered into a restricted area and was killed by the hot lahar. Due to the ash fall and hot lahar, the dry fields, buildings and roads were damaged.

This eruption occurred with the remarkably severe predictive phenomenon. The earthquake, which is one of the predictive phenomena of volcanic eruptions, began four days before the eruption, and the maximum earthquake reached M 5.5, resulting in damages to buildings in the Abuta residential area.

The prediction of the volcanic eruption resulted in the evacuation of 15,000 people who lived in a 12km radius from the top of the mountain a day before the eruption. The eruption occurred about 300m away from the residential area during night time, and although there were damages of ash deposit at Konpira shrine, no humans were killed because of the successful preliminary

evacuation.

It was Mr. S. Iida, a chief of Muroran Police Office, who appropriately predicted the eruption and insisted the preliminary evacuation after discussing with the prime minister. As a student at the police school, Iida had attended the classes taught by Professor Fusakichi Omori from Tokyo Imperial University, who was considered a world authority in seismology and volcanology. To persuade people about the importance of prior evacuation, Iida read his notes from these classes out loud, and eventually convinced the people. In addition, the evacuation experience from the eruption of Mt. Tarumaezan the year before was an important training for the residents around Mt. Usu, making this a great example, in which past experience and knowledge promoted disaster reduction.

It is also worth noting that the baseline study had been conducted before the eruption. The Investigation Committees for Disaster Reduction of Earthquakes conducted the local research on Usu Volcano two years before the eruption, and published a 120 page report, 4 months before the eruption. At the same time, the army conducted precise leveling of the surface area and cubic change of the volcano, the Sapporo observatory made observation of earthquake on a steady basis, and the leading-edge-scientists of that time (John Milne, Y. Omori, T. Kato, Tomas Jaggard) made preliminary visiting to Usu volcano, all of which resulted in the culmination of reduction of disaster by prior scientific research.

## The 1943-45 eruptions and the birth of Mt. Showwa-Shinzan

The volcanic activity of Mt. Showa-Shinzan started in December 1943 with an intense earthquake. A half year later, a small-scale phreatic explosion occurred at the eastern foot of the mountain, where the surface of the ground was uplifted. When the eruption was at peak, a small-scale pyroclastic surge also occurred. Due to the multiple volcanic ashes, eruptions, pyroclastic surges and upheaval of ground, the residents at Fukaba village located at the eastern foot of the mountain experienced catastrophic damages, and were forced to clear out of their land. The vigorous eruption frightened a mother, who wrapped the new born child in cloth and into a wooden box in the closet; however, this child was choked to death due to the fine volcano ash that blew into the house. During the four eruptions in the 20th century, this child is the only causality from the direct damage of the eruption of Usu Volcano. The 1943-45 eruption devastated the plow lands, railways and roads and resulted in the desolation of the village.

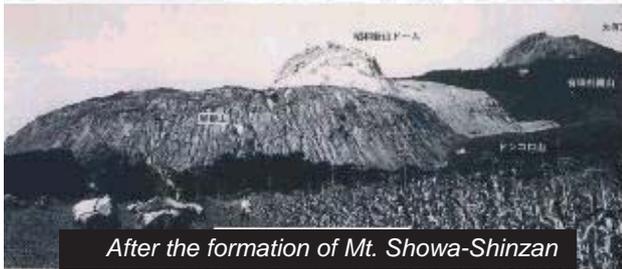
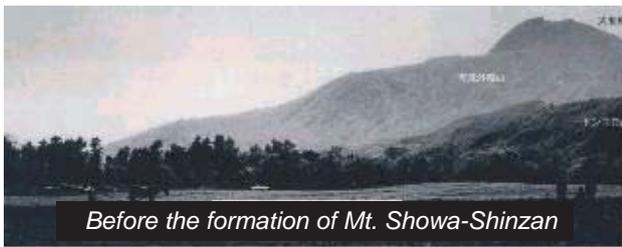
Prof. T. Minakami at Earthquake Research Institute started the leveling and seismic observations of the Usu volcano three months before the initial eruption in June 1944. The observation points were increased right before the eruption, and by utilizing seismic instruments placed at five points, the scientists tried to determine the epicenter, an attempt made for the first time in the world.

The eruption started with a sudden increase of small earthquakes at the uplifting eastern foot of the mountain, which was followed 6 days later with the first explosion. At that time, Mr. M. Mimatsu, the chief of the local post office, acknowledged the massive cracks on the ground, which were radically expanding from the center of the upheaval.



*Statue of M. Mimatsu watching Mt. Showa-Shinzan*

When the Usu Volcano erupted in the Meiji Era (1910), Mimatsu was asked to help measure the volcanic activity of Usu Volcano. He learned the basis of volcanology by observing the scientists researching everyday and constantly hearing them say, “this volcano will erupt again.” When the frequent earthquakes were recoded around Usu Volcano 33 years after the Meiji eruption, Mimatsu immediately contacted the scientists. He continued recording the strength of the earthquakes and sketched the shape of Usu Volcano from the same point, which he reported to the scientists. Professor K. Fukutomi, a physical scientist at the Hokkaido University, provided Mimatsu with a theodolite, which initiated Mimatsu into further observation, and increased the accuracy of the sketched data portrayed by Mimatsu. The vivid formation and change in landscape can be seen by superposing the ridge lines of the continuous sketches into one picture, which creates a visual that shows the upheaval in the wheat field located at the eruption site near the foot of Usu Volcano and the development of the lava dome. These sketches by Mimatsu were highly appraised and named “Mimatsu Diagram” at the International Scientific Volcano Society held in Oslo in 1948. Further, in 1957 Mt. Showa-Shinzan became designated as a “Special Natural Treasure” in Japan.



### **The 1977-1978 eruptions and the birth of Mt. Usu-Shinzan**

The pumiceous explosion, which started in Aug. 7th 1977, was one of the five largest eruptions in the 20th century in Japan, and the elevation of the eruption column reached 12km up into the atmosphere. This eruption was the first challenge for the thriving tourist site, which had grown into a hot-spot with its many attractions of hot springs created by the Meiji eruption, the Shikotsu-Toya National Park and Mt. Showa-Shinzan as a designated Special Natural Treasure. Fortunately, there were great amount of research taking place in the area, including the Japan Meteorological Agency, which started baseline monitoring of Usu Volcano in 1967, as well as the Hokkaido government, which permanently established a Volcano Expert Committee under the Hokkaido Disaster Prevention Council. In addition, the scientists have started the Volcanic Eruption Prediction Plan in 1974, and established Usu Volcano Observatory in Hokkaido University, four months before the eruption.

There were clear signs of predictive phenomenon, such as the earthquake that took place 32 hours of the eruption, the ground cracks, and the expansion of volcanic body right before the eruption. However, because the earthquakes were weak compared to the earthquakes at the previous two eruptions and

the predictive phenomenon dragged on for six months, the tourists were not adequately ready or aware about the possible volcanic disaster. The community's lack of emergency can be noted by the event, which took place amid the precursory earthquakes, where a few ten-thousand tourists attended the firework exhibition reenacting the past eruptions at the open space at Mt. Showa-Shinzan, an area which traps people with no place to evacuate.

The highly explosive pumiceous eruption with dacitic magma continued for one week. The four huge eruption columns rose erratically over 10,000 meters, resulting in the serious damage to infrastructure and transportation at the Toyako hot spring spa area, such as the temporary traffic blocking because of volcanic cinders and ash falls while raining. Fortunately, there were no direct casualties as a result of the eruption hazard. Lahar frequently occurred after the rain, a trend which started after the first eruption. For an example, the fine volcano ash from Ginnuma eruption, which mainly contained clay minerals, settled over the thick pumiceous layers at the mountain slope in a mortar condition. The rainfall, which could not be absorbed into ground, concentrated into the valley line, where an intensive mudflow was created.

The lahar in October 10th, 1978 resulted in two casualties and one person was lost. There were increased provisions for disaster mitigation, such as the sand guarding, as well as massive evacuations of residents after this lahar. After a group of residents moved out from the Konomi-no-sawa area, a debris dam was built in the space, as well as the construction of three artificial rivers at the Toyako hot spring spa area.

This eruption triggered the invention of new monitoring technologies, one after another, and new theories on volcanology were established along with these technologies. This eruption played a key role to start a new scientific

era of understanding volcanic phenomena comprehensively in real time.



The ash column of the 1977 eruption from the top of mountain

### **The 2000 eruption and the formation of a cryptodome**

The Usu Volcano eruption in 1977-1978 left a mark on the history of volcanic observation for the thorough research and records, on the other hand, the eruption in 2000 left a mark in the history of volcano disaster provision. After the catastrophe of the eruption of Nevado del Ruiz in Colombia, South America in 1985, the volcanologists in the world realized that “as long as the volcanic activity and possible disasters are only understood by scientists, the responsibility are also on the scientist.” On the other hand, the consciousness of the residents living at the foot of Usu Volcano changed greatly in the last decade of the 20th century, as a result of the tragic pyroclastic flow caused by the eruption of Unzen Volcano in 1991. Local residents started to take mitigating action, such as taking interest in the volcano hazard map.

It was after the huge tsunami that attacked Okushiri island, caused by the earthquake at the southwestern offshore of Hokkaido, that started

the acceptance of the hazard map, which was rejected by the local community until then. The local government was impacted by the tsunami in Okushiri island, which resulted in roughly 200 causality, and in 1995 when the International Workshops for the 50th Memorial of Mt. Showa-Shinzan Eruption took place, the Usu Volcano hazard map was distributed to every household in the area for the first time.

When the maps were authorized, the awareness of Usu eruption among citizens rose, and a variety of activities which utilized the maps were organized. For an example, volcanology classes and lectures were held by researchers for residents, as well as, a musical, based on the collection of eruption experiences by the local students, was held and played.

Before the first eruption on March 31st 2000, there were observations of premonitory phenomenon for five days. As the days got closer to the eruption date, the magnitude of the earthquake increased, and there were clear signs of crustal movements and land cracks all over the top and base of Usu Volcano. The four day period of premonitory phenomenon was ideal, since it took the same amount of time for the complicated Japanese government to take action. During this period, the government decided to order a massive resident evacuation, which cleared the area with no resident disobeying the instruction. There were about 15,000 residents living at the foot of the mountain, all of whom finished evacuating to other locations by March 31st.

At the 2000 eruption, there were building damages and burial due to the lahar, as well as the deformation of buildings and main roads caused by crustal deformations. Also with this eruption, the magma intruded into the underground, which pushed up the surface and moved the crust of the western foot of the mountain by 70m.



*The road drastically changed in shape due the crustal deformation*

Moreover, the damages of volcanic ash largely affected the social lives of the residents and their local economy. This was an especially damaging eruption, since the eruption site was located near the residents' living area, thus made a tremendous impact to the community. However, there is no doubt that this all-encompassing operation marked an important step in the history of disaster management action at Usu volcano, especially since there were not casualties. The success of the disaster mitigation completely depends on the understanding

and action by local residents, which is only effective once people understand the risks and act accordingly to protect their life. From this point of view, the increased consciousness of disaster mitigation among the government and local residents regarding this eruption should be worth noted, and, meanwhile, this is also a fruitful result of the various activities of government, researchers and private businesses for raising awareness toward Usu volcano among local residents over time.



*Although the eruption occurred very close to the living area, there were no human suffering because of the cooperation of the local government, scientists and the residents.*

## 2) The Response Activities of the Municipal Government towards the Eruption

The Usu Volcano is one of the most active volcano in Japan, yet there is a large local population residing close by, as well as being a popular tourist site, which is a rare phenomenon world-wide. For this reason, the local municipally government has promoted a variety of measure for “community-building in conjunction with disaster mitigation.”

Since the eruption started in August 1977, three people were killed, both dead and lost, due to the heavy ash fall around the area causing lahar in 1978, which had been warned since the beginning of eruption. In addition, the buildings and infrastructure were severely damaged because of the falling pyroclastic material, and crustal disturbance, which had been taking place in the foot of the mountain since the beginning until 1982. To prevent secondary disasters, projects such as the construction projects on Usu volcano as well as erosion and torrent control were started. Here, all construction methods were experimented, sought, checked up, and undertook to find an effective measures in volcanic erosion and torrent control. In areas where crustal alterations were still occurring, construction for erosion and torrent used a highly deformation resistant method. Additionally, soft-structural methods, such as reducing the displacement of earth and sand by expansion of



*The construction for erosion and torrent while crustal change has still been taken place*

willow roots planted along dams and construction roads, were actively adapted, rather than constructing a hard building.

The 1977 eruption was the first eruption after the inauguration of “Coordinating Committee for Predicting Volcano Eruption,” that took place in 1974 under “Plans for Prediction of Volcanic Eruption.” “Integrated Observing Team on Usu Volcano, Coordinating Committee for Prediction of Volcanic Eruption,” which was in charge of monitoring the volcano, held an emergency press briefing for the first time at the Sobetsu town hall. The documents regarding the volcano were released to the press at every briefing and the mass media and residents welcomed this, and as a result, disclosures of documents have become the standard since then.

Since the 1977 eruption, a variety of illuminating projects for disaster reduction have been held by the local municipal governments. In Sobetsu town, with the combined efforts of Hokkaido University, classes and lectures about Usu Volcano are provided at Hokkaido Citizens’ College. Moreover, every year since 1983 the college organized a “local history classes for kids” as a part of a field work study. Both projects are considered to be learning and experiencing classes about Usu Volcano, and through these educational opportunities the local municipality hopes to stimulate and encourage the understanding of volcanoes, and create basic understanding of necessary procedures during eruptions.

In October 1995, during the “International Volcano Workshops of 50th memorial with the birth of Mt. Showa-Shinzan,” the three main cities which installed the council, created “Usu Volcano hazard map,” which was created for the envisioned future eruption. The hazard map was created based on past volcanological data and disaster reports, and was distributed to every household in the region area.



The hazard map distributed to every household

“The Committee of Volcano Disaster Mitigation Conference for Usu Volcano” by Date city, Abuta town (Toyako town today), and Sobetsu town organized an integrated disaster reduction training, which was followed by ongoing information on disaster mitigation trainings for local residents individually by city. One of the reason for the cooperative and responsive evacuation procedures at the 2000 eruption is attributed to the continued public awareness programs, which increased the understanding of Usu volcano and disaster mitigation among local residents. Further, the responsive communication between experts and the local governments assisted the local residents made a complete evacuation before the eruption. In terms of construction based mitigation measures such as a channel was built, which drained mudflow along the channel structure, and without these kinds of measures the mudflow may have spread and caused a larger harm.

Although there were no human casualties in the 2000 eruption, there were many damages to public facilities and the local municipalities agreed

that along with protecting human life, it is also crucial to build a disaster mitigation community to reduce economic loss. The foundation of this idea of community building around disaster mitigation is from the “Usu volcano,” which was written in 1973 by professor Yokoyama and Katsui from Hokkaido University. The report described in detail of the possible damage and the need for disaster mitigation action according to the location of eruption, time periods and type of eruption, as well as the ways to utilize the lands around the volcano. In fact, this report clearly proposed what is now recognized as “disaster mitigation community building.” Unfortunately, the significance of this report was lost in the midst of an economic growth in Japan and the booming tourism around Usu Volcano, the report was considered a recommendation, rather than an emergent measure. The academic valued of the report has not been lost in the last 30 years, and currently this reports is used as a foundation for building disaster mitigating communities. Land used has been reconsidered according to the “Basic Principle for Recovery Planning,” which proposes the relocation of primary schools (which is used for people in need of help during natural disasters) and hospitals based on the hazard map.

After the 2000 eruption, the municipal government realized that the predicted area of reachable pyroclastic flow was changed due to the new deformation of land and it was necessary to inform people about the up-to-date predictions about eruptions at the foot of the volcano, since three out of four eruptions at Usu Volcano were from the foot of the mountain. Therefore, in 2001 the municipal governments around Usu Volcano published a revised “Volcano hazard map for Mt. Usu.” This map is printed in A3 size to be placed on the walls at home, and the additional guidebook is created to provided more details.

Additionally, the Hokkaido Regional Development Bureau established the “Discussion committee on

educational publications of Usu volcano disaster mitigation” with emeritus professor Ui in Hokkaido University as the chairman and with the members of primary and junior-high school teachers in Date city, Abuta and Sobetsu town. The “Educational sub-textbook for Usu volcano disaster mitigation” was created by the committee and distributed to the local students, with the intension to disseminate knowledge on volcano and disaster mitigation.

The municipal governments around the area, with the assistance of the national government and Hokkaido Prefecture, adopted the idea of “Eco-museum concept,” which compares the region to a “museum” and the nature and ruins are the “displays,” as a part of many recovery projects after the 2000 eruption. By visually experiencing the active volcano, enjoying the surrounding rich nature, and discovering ancient archives, the local governments hoped the “museum” would attract tourism for its educational merit of learning about the history of Hokkaido, as well as increase public awareness of disaster mitigation and provide opportunities for community building between local residents.

### 3) The Private Sector Activities and Education

In the area around Usu volcano, there is a long history of continued activities by non-governmental organizations regarding disaster mitigation education. In the last phase of the World War II, the Mt. Showa-Shinzan was born at the south foot of Usu Volcano. While this natural phenomenon was treated as a secret by the government, due to its occurrence during wartime, however, Mr. Masao Mimatsu, a chief of the local post office, believed this was an one in a million opportunity to understand the characteristics of Usu volcano. He, therefore, recorded a detailed note of the whole eruption. The detailed observation records including “Mimatsu Diagram,” the picture of the gradual formation of the volcano, were highly acclaimed as scientific volcano observation by the local

residents. Currently, Mr. S. Mimatsu, a grand son-in-law of Masao, succeeds the will of Masao, and contributes to educational activities for disaster reduction while managing the M. Mimatsu Memorial Museum.



*Curator S. Mimatsu educating children for disaster reduction*

Even though the area boasted such ancestors in the past, recovering from the war damages and the development of a solid economy took precedence over the existence of the disaster, which faded over the years behind the materialism of people who were more interested in the development of the area. In August 1977, without taking any mitigation measures, people were forced to encounter the eruption, which created ash columns that reached stratosphere. The firework display was held for tourists, even though the precursory earthquakes frequently took place, however, the volcanic activities continued for the following five years, which triggered the people to reconsider the current lifestyle and come to terms with the wealth and hardships of living in a volcanically active area. The local community also decided to inherit the idea of constructing “culture of disaster reduction.” Behind this strong force for change is the acknowledgment that people were aware that the only reason this 1977 eruption was not the largest disaster with the largest death toll in Japan, was the product of consecutive blessing.

In November 1977, the municipal government requested scientists to hold a disaster mitigation lecture named "The Eruption of Usu Volcano," as well as building an Usu Volcano observation station with Hokkaido University located in Sobetsu town on April 1977. The lectures named "The consideration of local history- The quest for volcanoes," took place nine times for twenty hours, and the framework of coordination among residents, researchers and governments was built. Many anniversary events of the eruptions such as Mt. Yosomiyama in 1910, Mt. Showa-Shinzan in 1944, and Mt. Usu-Shinzan in 1977-78 were held. Not only were the lectures by the various teachers prosperous, but the climbing session was also popular. In this session, one could climb Usu volcano and Mt. Showa-Shinzan, which were usually banned, and understand the active situation of the volcanoes, an experience which is hard to understand from the foot of the volcano, while also enjoying the attractive sceneries. Among those especially the volcano program "The local history session for children" held by Sobetsu town is one of the effective educational methods for preparing for the next possible eruption. This is because, the eruption of Usu Volcano is predicted once every 20 to 60 years, and the children today are the ones who will experience the disaster and become the backbone for disaster mitigation in the area.

It should be noted that the international volcano workshop was held as the 50th memorial of the birth of Mt. Showa-Shinzan was an event organized by the municipal government, which only has a mere population of 3,500 people. In this workshop, the over 500 scientists and officers working in the field of volcano disaster mitigation, both domestically and internationally, were present. Further, it was a big achievement that the hazard maps, which were resented by the local residents, were smoothly accepted at this workshop. Along with this international workshop, the volcano summit for children also took place. It was also effective in stimulating educational

officials to be interested in the curriculum, apart from the event led by the Ministry of Education, Culture, Sports, Science and Technology, and to understand the roles of school buildings, which are appointed as evacuation sites, as well as learning the ways to protect students with special needs during disasters.

The significance of these measures were verified at the eruption in 2000. The success of a pre-evacuation was the first ever in the history of evacuation of volcanic eruption in Japan, and participated by all residents, which was a lesson learned from multiple different kinds of disasters at different areas, such as the evacuation during Unzen volcano eruption and the tsunami at Hokkaido Nanse-oki. Because the eruption occurred very close to the residential area, though the scale of the eruption was not great, it could have been a tragedy if people did not evacuate. Although traditionally there are negative images around disaster evidences, which were intentionally erased and replaced with a safe image of the area, the community realized that this was an effective way to attract tourists as well as maintaining a high public awareness regarding disaster reduction. Thus, as a part of civilian activity for disaster recovery, local residents became tour guides to transmit as a history teller through activities in "Sobetsu Ecomuseum-Friends Society." In the past, the "hard" constructional enhancement was valued as effective measures for disaster mitigation, but since the 2000 eruption, the significance of "soft" mitigation efforts for disaster reduction are reevaluated and considered important.

#### **4) The Boon by Volcano and Geotourism**

Today, the vast farmland are cultivated and the beautiful scenery of the country side in the Toya pyroclastic flow tableland, which has been created by the pyroclastic eruption forming Toya Caldera 110,000 years ago, can be seen. The soil, combined with volcanic ash and pumice, is good for crops, and moreover, plenty of fruits and

vegetables are harvested by harnessing its warm weather condition in the tableland.



*The pyroclastic flow tableland is cultivated and utilized as vast farmland*

In Konai district of Sobetsu town, vegetables such as tomatoes and ornamental plants were grown in the gardening complex facility by utilizing geothermal heat energy (hot spring). In addition, tremendous seafood is caught in the eruption gulf created by the flow of volcanic debris avalanche from Usu volcano.



Scallops caught in the volcanic debris avalanche are famous across Japan

The Toyako hot spring spa, as one of the boons of Usu volcano, has been created of the upwelling by the raise of magma from the 1910 eruption, and started with the opening of “Ryukokan,” the first hot spring hotel in 1917. This 1910 eruption made 45 explosive craters which had been appeared just between the east side of Mt. Higashi-Maruyama and Mt. Konpira Mt. Nishi-

Maruyama. The eruption also lifted the land in the east side of Mt. Nishi-Maruyama up, and as a result formed a new mountain, which was 250m above sea-level. This mountain is called Mt. Meiji-shinzan or “Yosomiyama,” due to its birth in the year of Meiji 43, and currently paved to be the walking trails after forty years from its birth. From this trail, the recovery of the vegetation 100 years after the eruption and the fumaroles, which has still been active today, can be observed. Further, the walking trails in South Usu Gairin course and the crater groups of Mt. Nishiyama piedmont and Mt. Konpira, both formed by the 2000 eruption, are also maintained. Here, one can see, with their own eyes, the evolving creator basin, the municipal housing buried by the lahar and accumulated volcano ash and the massive rifts. These trails are utilized to learn the horror of volcano activity as well as the significance of coexistence. As it was mentioned before, the municipal governments around Usu volcano has established “Eco-museum promotion discussion council in Lake Toya area,” and been promoting the concept of Eco-museum as the way to recover from the 2000 eruption. There are many resources in the region, including the Lake Toya, the nature of the soil and volcano activity, the Jomon ruins, the Ainu culture, and more recently the coexistence with volcanoes and the hot spring tourism. With these, the municipal governments have been working to promote the ruins in the area to be preserved as an international value.

The Hokkaido Lake Toya G8 Summit was held on July 2008 and to make the leap forward to become an international tourist site, the municipal governments promoted the resources and information regarding the Lake Toya area. To lead the new model of tourism, the governments decided to hold area recovery tours and created opportunities to learn the living and wisdom of the ancestors with the coordination of the private business and local volunteer guides. These

approaches were taken well by the public. In the future, by using a variety of existing tools in the area such as the foot path, the local governments will approach projects regarding enjoyable geotourism for local revitalization, through tour guides and boards to explain the topographically and geographically important sites and feature the geographic ruins.



*The municipal governments conserve the disaster ruins, and utilize them as places for learning fear of volcano activities and coexistence with volcano*

### 3-3 The sites in Lake Toya and Usu volcano Geopark

Geosite Contents 				
Name of Theme Site	Keywords	International/ National Relavance	Use of Site	
<b>Theme: A</b> <i>Volcanic Activities before the Formulation of Toya Caldera</i>				 <b>Miocene - middle Pliocene</b>
<b>Geosite A01</b> Pre-Toya Caldera: Igneous formations	Pre-Tertiary system, Welded tuff, Hyaloclastite	Japan	Education/Tourism/Science	
<b>Geosite A02</b> Sewage from Horobetsu Sulphur Mine	Mine, Water pollution	Japan	Education/Science	
<b>Theme: B</b> <i>Huge Pyroclastic Flow and Formation of caldera</i>				 <b>Approx. 110,000 years ago</b>
<b>Geosite B01</b> Sediments of Toya Pyroclastic Flow and Pyroclastic Flow Plateau	Pyroclastic flow, Pyroclastic flow plateau, Outcrop, Pumice, Volcanic ash	International	Education/Tourism/Science	
<b>Geosite B02</b> Toya Caldera	Caldera, Huge pyroclastic flow eruption	International	Tourism/Science	
<b>Theme: C</b> <i>Formation of Series of Nakajima Lava Domes</i>				 <b>Approx. 50,000 years ago</b>
<b>Geosite C01</b> Nakajima Island	Lava Dome, Tuff cone, Deer, Ecology, Ruins	Japan	Education/Tourism/Science	
<b>Theme: D</b> <i>Usu Stratovolcano</i>				 <b>Approx. 110,000 years ago</b>
<b>Geosite D01</b> Usu Stratovolcano	Stratovolcano, Lava, Andesite, Basalt	Japan	Education/Science	
<b>Geosite D02</b> Mt. Donkoro-yama	Pyroclastic cone, Strombolian eruption	Japan	Science	
<b>Geosite D03</b> Surface landscape of Debris Avalanche Deposit	Sector collapse, Debris avalanche, Hummocky surface	International	Education/Tourism/Science	
<b>Geosite D04</b> Outcrop of Debris Avalanche Deposit	Sector collapse, Debris avalanche, Outcrop	Japan	Education/Science	
<b>Geosite D05</b> Series of Kaizuka (shell heap) Remains	Kaizuka (shell heap) remain, Jomon	International	Education/Tourism/Science	
<b>Geosite D06</b> Lifestyle of Ainu People	Ainu, Chise, Chashi	Japan	Education/Science	
<b>Theme: E</b> <i>Eruption at the Summit in 17-19 Century</i>				 <b>17th-19th century</b>
<b>Geosite E01</b> Cenotaph for Victims in Bunsei Pyroclastic flow	Pyroclastic flow, Abuta-kotan, Cenotaph	Japan	Education	
<b>Geosite E02</b> Usu Gairinzan (Somma) Trail	Pumice, Volcanic Ash, Cinder cone, Pyroclastic flow, Plinian Eruption, Lava dome, Cryptodome	International	Education/Tourism/Science	
<b>Geosite E03</b> Koboro Cave	Enku, Kannon	Japan	Education	
<b>Geosite E04</b> Usu Zenkoji Temple	Debris avalanches, Pyroclastic flow, Documentation recorded by priests, Ishiwari Sakura (Cherry)	Japan	Education/Tourism/Science	
<b>Geosite E05</b> Fauna of Southern Foot of the Mt. Usu	Recovery of plants, Trillium amabile	International	Education/Science	
<b>Theme: F</b> <i>The 1910 Eruption at the Foot of the Mountain and the formation of multiple craters and Mt. Yosomi cryptodome</i>				 <b>The year of 1910</b>
<b>Geosite F01</b> Mt. Yosomi-yama Trail	1910 crater, cryptodome, recovery of plants	Japan	Education/Tourism/Science	
<b>Geosite F02</b> Genta Ana Crater	1910 crater, recovery of plants	Japan	Education/Science	
<b>Geosite F03</b> Mt. Kompira-yama	1910 Crater, Faults	Japan	Education/Science	
<b>Theme: G</b> <i>Formation of Mt. Showa-shinzan Lava dome and crustal alteration during the 1944-45 eruptions</i>				 <b>1943-1945</b>
<b>Geosite G01</b> Mt. Showa-shinzan	Upheaval of the ground, Cryptodome, Lava dome, Recovery of plants	International	Education/Tourism/Science	
<b>Geosite G02</b> Shinzan swamp	Ground deformation, Dammed Lake	Japan	Education/Tourism	
<b>Geosite G03</b> Remains of the former Iburi line Railway Bridge	Ground deformation, Railway remain	Japan	Education/Tourism/Science	

## Geosite Contents

Name of Theme Site	Keywords	International/ National Relevance	Use of Site
<b>Theme: H The 1977-78 Eruptions at the mountain peak and the Ground Deformation</b>			<b>1977-1978</b>
<b>Geosite H01</b> The 1977 Summit Crater	Series of 1977-1978 Craters, Pyroclastic surge, Recovery of plants	International	Education/Tourism/Science
<b>Geosite H02</b> Mt. Usu-Shinzan	Cryptodome	International	Education/Tourism/Science
<b>Geosite H03</b> Northern Somma	Fault, Crater wall	Japan	Education/Science
<b>Geosite H04</b> Fault Displacement at the North-Eastern Foot of the Mountain	Fault, Movement of the crust	Japan	Education/Science
<b>Geosite H05</b> Former Usu Volcanic Observatory of Hokkaido University	Volcanic Observation	Japan	Education/Science
<b>Geosite H06</b> Toyako hot spring spa	Boon and disaster of volcanoes	International	Education/Tourism/Science

Name of Theme Site	Keywords	International/ National Relevance	Use of Site
<b>Theme: I The 2000 Eruption, which Damaged Peoples Daily Activities</b>			<b>2000</b>
<b>Geosite I01</b> Trail at the Foot of Mt. Nishi-yama	Series of craters, Movement of the Earth' s crust, Recovery of plants	International	Education/Tourism/Science
<b>Geosite I02</b> Series of Craters at the Foot of Mt. Nishi-yama	Series of craters	Japan	Education/Science
<b>Geosite I03</b> Ex-National Route 230	Ground deformation	International	Education/Tourism/Science
<b>Geosite I04</b> Izumi Park Town Route	Series of craters, Recovery of plants	Japan	Education/Tourism/Science
<b>Geosite I05</b> Ground Deformation at the Rim of the Lake Toya	Fault, Upheaval	Hokkaido	Education/Tourism
<b>Geosite I06</b> The 2000 Eruption Remnant Park and Trails at the Crater of Mt. Kompira-yama	Craters, Lahar, Recovery of plants	International	Education/Tourism/Science
<b>Geosite I07</b> Precursory Faults at the Northwest Side of the Summit	Faults, Eruption	International	Education/Science
<b>Geosite I08</b> Coastal Vegetation at the Mouth of Osaru River	Rosa rugosa, Calystegia soldanella, Elymus mollis trin., Ixeris repens, Carex kobomugi, Dianthus var longicalycinus, Galium verum L. var. asiaticum Nakai, sea birds, coastal vegetation	Japan	Tourism/Science

## Tourist Information

Name of Theme Site	Keywords	Use of Site
<b>Museum</b>		
<b>01</b> Mimatsu Masao Memorial Hall	Mt. Showa Shinzan, Volcanoes/Disaster education, Mimasu Masao, Mimatsu Diagram	Education/Info. Collecting
<b>02</b> Date City Fire / Disaster Prevention Centre	Volcanoes/ Disaster education, HQ office of response activities on Disasters	Education/Info. Collecting
<b>03</b> Lake Toya Visitor Center / Toya Town Volcanic Science Museum	Environment/Nature education, Volcanoes education, Lake Toya/ Usu Mountain.	Nature/Education/Info. Collecting
<b>04</b> Soubetsu Information Centre "i"	Road Station, Volcanoes/ Disaster education	Education/Info. Collecting
<b>Information</b>		
<b>01</b> Road Station "Shrine of History in Date"	Volcanoes/ Disaster Education, Archives, Environment /	Info. Collecting/Education
<b>02</b> Road Station "Aputa"	Natural Education, Local Libraries	
<b>03</b> Road Station "Toyoura"		
<b>04</b> Road Station "Forest 276 Otaki"		
<b>05</b> Road Station "Lake Toya"		
<b>06</b> Toya Water Station		
<b>07</b> Sobetsu Town Local History Museum		
<b>08</b> Toya Takarada Village-life House		
<b>09</b> Forest Museum		
<b>10</b> Toyako Town Library		

### Geosite B-02 Toya Caldera

**[Level of Importance: Global / Purpose of use: Tourism Science]**



A vast amount of magma was discharged on land caused by the huge pyroclastic flow eruption, which turned into the collapse caldera. By collecting water inside of the caldera over time, it eventually came to be the Lake Toya as it is today. The Lake Toya is the third largest caldera lake in Japan in size, shaping an almost complete circle with 11km in length on the west-east side, and 9km in width from the north-south side. Nakajima Island is one of the most characteristic sights of the lake, and it was formed by the eruptions approx 50,000 years ago.

### Geosite E-02 Usu Gairinzan (Somma) Trail

**[Level of Importance: Japan/ Purpose of use: Education • Science]**

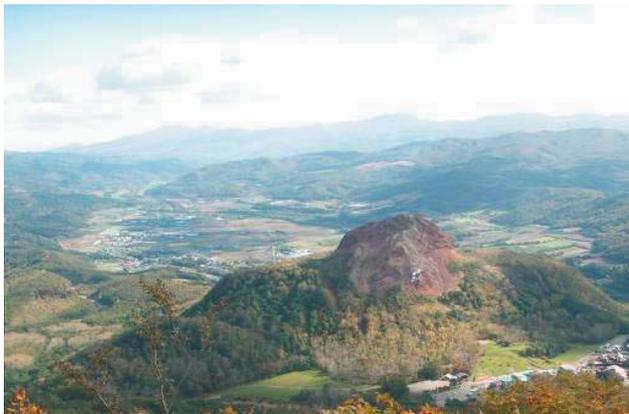


From the Usu Gairinzan trail, visitors can see a series of lava domes and cryptodomes; such as Ko-Usu, which rises up in the crater plain, O-Usu, Mt. Ogari, Mt. Usu-shinzan, as well as Ginnuma crater, which appeared during the 1977-78 eruption.

The Southern ridge of the crater plain on Usu Gairinzan Trail, called “South Gairinzan,” was formed by the deposits around the crater formed by the low-temperature pyroclastic surge, which occurred after the plinian eruption in 1663. These ridges are partially layered, making the formation process complex. On the other hand, the parts referred as Gairinzan were made by the collapses of the stratovolcano approximately 7,000 years ago.

### Geosite G-01 Mt. Showa-Shinzan

**【Level of Importance: global/ purpose of use: Tourism • Science】**



Precursory earthquakes started in December 1943 and in January 1944, the ground of wheat fields, roads and railways started to rise. In April, the upheaval recorded 16 meters high at some areas. From mid-April, the upheaval activity concentrated in areas around the north of the Fukaba village, which was lifted 50 meter high. On 23rd of June, the eruption started at the Western side of the Fukaba village. Soon after, the upheaval of the cryptodome became 250 meter high, currently known as Mt. Yane. In the beginning of December, a triangle lava dome in the middle of a series of craters located at the centre of a cryptodome, which is currently known as Mt. Showa-shinzan, and the height rose to be 407m by September 1945. Mt. Showa-shinzan burnt its underground clay in the middle of its growth, which has turned into a natural red-brown brick. Also there are traces of the original wheat field, such as river rocks, left in the middle of the lava dome.

Even now, some surface are of the Mt. Showa-shinzan reached above 300 degree celsius, thus there are not many flora at this site. However, the summit area displays an unique geological scenery. On the other hand, visitors can observe forests of *Populus maximowiczii* at the mountain base, 60 years after the eruption.

### Geosite I-01 Trail at the foot of Mt. Nishiyama

**【Level of Importance: Global / purpose of use: Education • Tourism • Science】**



The 2000 eruption created over 60 craters and the underground magma lifted the surface of the ground as high as 70m. Some of the craters at the foot of Mt. Nishiyama are still actively discharging vapours 8 years after the eruption. These active craters are connected with trails for local residents and tourists to access and observe the effects of the 2000 eruption. Also, the crater from the 2000 eruption is an ideal location to examine the ecology of an area just after an eruption. Currently, the area is in the process of recovering from a bare land to a perennial land, and there are sightings of *Polygonum Sachalinense*. Additionally, at a series of craters near the foot of Mt. Nishiyama, there are active plumes where there are recovering populations of bryophytes, which are strong to stress. It is also an appropriate place to observe plants, which can be applied at the micro land form.

**Operation and Management of Toya Caldera and Usu Volcano Geopark**

**4-1 Management plan**

**Organizational structure**

The Toya Caldera and Usu Volcano Geopark would be managed by “The Joint Committee for the promotion of community development with the Lake Toya Area Eco Museum (JC)” and “the Steering Committee of the Lake Toya Area Eco Museum (SC),” which are explained below.

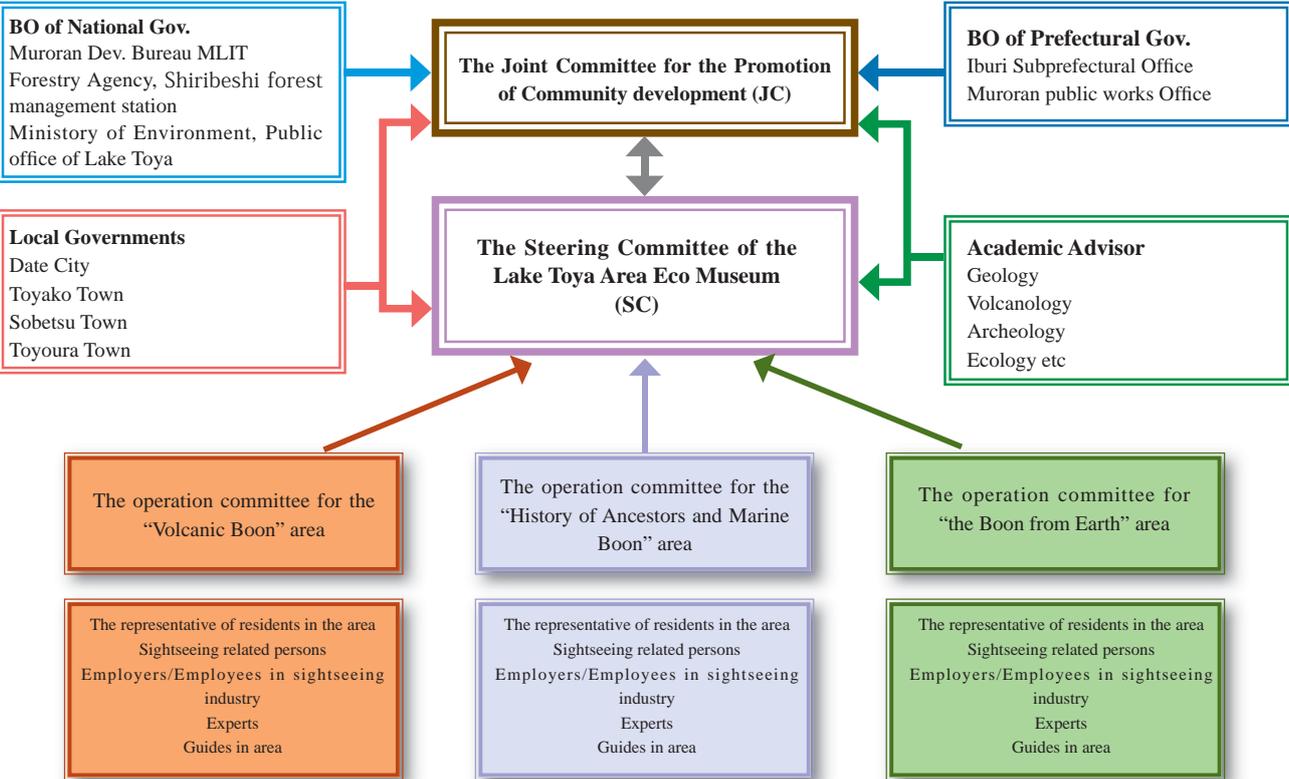
JC has so far identified cultural heritages, such as ruins from the Jomon era, as well as geological and natural heritages, such as Mt. Usu and Lake Toya, as the resource of community. By utilising these resources, JC has worked on sustainable community development.

Furthermore, the JC seeks to pass down these rich resources to the future generations by acknowledging the preciousness and spreading the information to the world. JC believes that these efforts can also contribute to the economic

development of the region.

The JC is consisted of local municipalities, academic advisors, and administrative organisations, i.e. national government, which support local initiatives. The SC is consisted of representatives from local residents, academic advisors, and full-time secretaries. Under the SC, there are Area Management Committees for each of the following 3 themes; “Volcanic boon”, “History of ancestors and marine boon”, and “Boon of the earth and culture.” Each committee has participants from guides of the site as well as academic experts who have deep knowledge on the subject related with the theme.

The Toya Caldera and Usu Volcano Geopark is consisted of many geosites, which are not only geological heritages, but also natural and cultural heritage. The Geopark employs inputs from specialized agencies i.e. on local historical culture research institutions, as well as group of local residents to conserve the diverse heritages of the site.



*Organizational Structure of the Toya Caldera and Usu Volcano Geopark Lake Toya & Mt. Usu Geopark*

**“The Joint Committee for the promotion of community development with the Lake Toya Area Eco Museum (JC)”**

The JC is in charge of drafting operational plans of the Toya Caldera and Usu Volcano Geopark, and organising facility development plans as well as conservation plans based upon inputs of academic advisors.

Date City, Toyoura Town, Sobetsu Town, Toyako Town (Planning, Tourism, Education)

Muroran Development and Construction Department, Usu Reconstructed Road Office, Lake Toya Park Rangers’ Office, Shiribeshi Forest Office, Iburi Subprefectural office of Hokkaido, Muroran Public Works Office

Academic Advisors(Geology, Volcanology, Archaeology, etc.)

**“The Steering Committee of the Lake Toya Area Eco Museum (SC)”**

The SC manages commodity development and service function of the Geopark. Also the SC recommends to the JC on plans of development and conservation.

- Representatives of local residents
- Experts (representative of the Area)
- Full-time employed Secretary of the SC

**Area Management Committee**

- Representatives of local residents
- Experts
- Representatives from tourism sector, managers of the business industry
- Representatives of local civil organisations, geo-guides, eco-guide organisations

Table 4-1 Contents of the works of each function

Function	Contents of the works
A Administration	Budget planning, Administration, Fund raising Publication (Media work, other related promotional strategy, Guide management) Inter-organisational arrangements Administration for integrated media works
B Facility management	Facility management: geosites and trails Conservation strategy development of theme centres Management works for signboards Planning of installments of Guiding sing boards Maintenance of information servers Evaluation of new satellites
C Networking	Strategy development of local Transportation Planning of trail development / routes Maintenance of information servers (webpage)
D Service	Registration and evaluation of qualified guides Strategy development for promotion of guide tours Planning of development of park-designated commodities Sales of commodities Planning and development of guidebooks
E	Training and capacity development of guides Facilitation of Geosite meetings Planning and facilitation of field based learning opportunities Management of permanent / temporal exhibition using educational materials Administration and operation on publication and educational seminars etc.
F Research studies	Research and studies on each theme Information collection and archiving on each theme Networking with research institutions (e.g. universities) Education of guides (workshops, awareness raising)

## Operational Plan

So far, with membership donation from local governments as well as subsidies from the National and Prefectural Government, the JC has conducted various activities such as; periodical clerical work and main base planning of the Geopark management as well as designing of common logo of the park, installing signboards and publishing booklets (fliers) for awareness-raising. In addition, the committee has launched a 3 year plan in 2007, and currently it is promoting projects for facility development (i.e. signboards), fostering guides, and for publicity. In the future, with establishment of SC, which is explained in the former section of this document, JC will share secretary works on operations with other stakeholders, including local residents.

Also, JC has launched the Scientific Advisory Boards on the Toya Caldera and Usu Volcano Geopark, which is consisted with experts of volcanology, ecology, archaeology, tourism studies etc. The board has already achieved to address the geological, natural and cultural value of the Lake Toya & Mt. Usu area as well as the possibility and importance of geo-tourism in the tourism industry. The Geopark will implement continuously recommendation from the Advisory Boards in its operational plans.



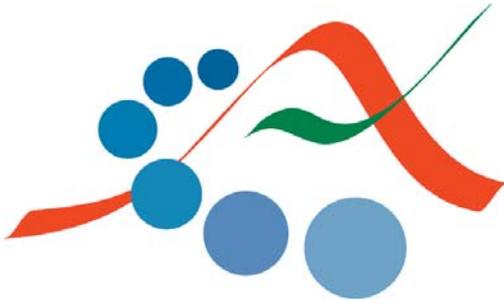
*Operational Meeting with participation of residents, experts, and representatives of the government*

## Development Plans

Development Plans of the Geopark is formulated by the JC with significant consideration on the concept of sustainable development. Every sector, including municipalities, conduct facility development and management based upon the plan. Also, the SC considers strategies to utilise local resources including developing tour-service as well as agricultural commodities. The service and commodities developed by the SC will be tested through needs assessment with analysis and evaluation, and reflected to the Development Plans drafted by the JC.

Some parts of the Toya Caldera and Usu Volcano Geopark are certified as a National Park by the Minister of Environment based upon Natural Park Act, and the Ministry of Environment is in charge of conserving and managing the area. The rest of the area is monitored by multi-ministerial manner with clear distinction of the responsibilities of each jurisdiction; such as, forest management by the Forestry Agency, and facilities against volcanic and related disasters by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). So far, the pleasure boat route around Lake Toya and Mt. Showa Shinzan cable car was launched and there are well-established transportation systems in the Geopark area, besides public transportation,

The mainstream tourism in the area has been short-term group tours with hired bus, but more recently, such tendency have shifted to private based long-term tourism in smaller groups. This change produced a lot of demands for diverse types of tourism; namely, geo-tourism, eco-tourism, and green tourism. The SC recognized these changes immediately, and catered to the needs by enhancing the variation of tour-service; i.e. order-made tour which applies detailed requests from each group, educational tour, etc.



*Logo of the park which represent Volcanoes, Sea, and Lands*

#### **4-2 Information and Environmental Education**

At the Toya Caldera and Usu Volcano Geopark, there is the Usu Volcano Observatory, which is a part of the Hokkaido University Graduate School of Science, is continuing basic research work on prediction of volcanic eruptions. Japan Metrological Agency (JMA) maintains routine monitoring facilities at this volcano. Also, there are a lot of academic papers on Mt. Usu, which is a mountain that is quite crucial as the on-site-based research of Japanese volcanoes. Date City Institute of Funkawan Culture conducts academic survey and research in order to deepen understandings on pre-historic and ancient culture in addition to the natural history of Funka Bay (Volcano-Bay) area. The institute also holds workshops for children, and sends experts to public seminars.

The Geopark area, also conducts, not only academic research, but also environmental and disaster education for local residents. Sobetsu Town Office has provided the children in the community with workshops on local history for 25 years since the 1977 eruption, providing an opportunity to learn and review volcanoes and the local environment. Also, the office provides a tree planting scheme as a part of a primary school programme in order to recover some of the forest that was damaged by the eruption, and a children's camping scheme to learn about the biology at the Lake Toya. For adults, the municipalities provide Mt Usu hiking programme and Mt. Showa-Shinzan hiking programme. In

addition, the JC organises geotours not only for local residents of the town but also for those who lives in the surrounding neighbourhoods. When these tours need to be cancelled due to weather conditions, the organisers alternatively prepare workshop at museums; namely, Mimatsu Masao Memorial Museum or Lake Toya Visitor Center.

Aside from the local government, the local residents have also taken an enthusiastic and large role in activities regarding the local region. There are many local and civil organizations in the area, such as the "Sobetsu Eco-Museum Friendship Association," which aims to disseminate local appeal to tourists by exploring the cohabitation of residents and volcanoes, in addition to, the "Association of Okoshimbe," which conducts on-site guide, arrangements of signboard, and workshops of Kita-Kogane Shell Heap Park. There are also other volunteer associations which provide guide services as well as conserve ancient and valuable remains. In order to contribute to these kinds of educational activities, materials such as the Mt. Usu Guidebook and fliers were published, not only in Japanese but also in English, Chinese and Korean. Also, videos on Mt. Usu were distributed in Japanese and English. At the Sobetsu Information Center "i" and Visitor Center of Ministry of Environment, which are the core-centers of the Geopark, as well as Date City Disaster Prevention Center, which is one of the theme centers, have permanent exhibition on volcanoes, and periodic exhibition on volcanoes and environment, which are renewed constantly.



*Permanent Exhibition on Volcanoes*

In order to ensure the safety of local residents and tourists, a hazard map (“Mt. Usu Volcano Hazard Map”) was created and distributed to all local households as well as accommodation facilities such as hotels. When the mountain showed any sign of intensification in volcanic activities, advisories and warnings are issued by the Japan Meteorological Agency (JMA). Information from JMA is immediately provided to local residents and tourists.



3D hazard map for Mt. Usu

#### 4-3 Geotourism

General information and advice for tourists regarding the Geopark can be obtained at the following facilities, which are divided as “core-center” or “theme-center”;

##### Core-Center

- Sobetsu Information Center “i”
- Lake Toya Visitor Center

##### Theme Center

- Memorial hall for Kitanoumi - Yokozuna grand champion wrestler / Sobetsu Town Local Museum
- Mimatsu Masao Memorial Museum
- Road Station “Forest 276 Otaki”
- Road Station “Lake Toya”
- Toya Water Station
- Toya Takarada Village-life House
- Road Station “Shrine of Date History – Reimei Kan”

- Fire Station/ Disaster Center of Date city
- Road Station “Aputa”
- Road Station “Toyoura”



Mimatsu Masao Memorial Museum

Also the Geopark, is already equipped with well-arranged signboards, arrows, and boards with reference notes to guide visitors. The core centers, which distributes information (i.e. “Sobetsu Information Center “i”), were designed to be barrier-free, thus, accessible to visitors in wheelchairs. In addition, information on local activities are informed at the notice board at the exhibition space and webpage.

Sobetsu Information center “i” also acts as a tourist information center that is accessible by public transportation. The center is opened every day except New Year holiday seasons, and the information desk at the center provides relevant source for visitors via boards (exhibition), video, internet, and special exhibition, which is organized periodically.

Geopark areas are accessible by using public transportation; including ropeway to the summit and pleasure boat route to Nakajima Island. The Geosites have also prepared car parking facilities as well as public toilet facilities.

The booklets, which were published in several languages, have information on public transportation including main routes to get to the geosites. There are also plans to make public transportation and related information available



*Pleasure boat to Nakajima Island*

on the websites as well as linkages to tourist industry associations and timetables of the transportation system.

So far, several organized local geotours has been guided by earth science experts as well as local volunteers. Tours also are created with consideration for alternative routes depending on the weather situation.

The site also has signboards with reference notes not only in Japanese but also in English. Maintenance works of those boards are conducted by the local governments. There are also booklets, fliers, guidebooks, DVD, and website regarding the geosite. The website is designed to distribute information to the public and make access to information easy for users looking for specific information on geosites and communities. The website also links to the website of local governments. As for accessibility of feedbacks to the web managers, such contact information (address, telephone number, and e-mail address) is disclosed on the website.

Each of the trails have a specific topic, for an example; volcano focused trails at Mt Yosomi, Konpira Crater, and Nishiyama Crater, as well as Nakajima Trail, which is focused on fauna and flora, and Usu Zenkoji Temple Trail, which is related to archaeology.

At the Geopark, visitors are statistically counted

using the information collected from the use of ropeway and hotels in the area. The data is categorised depending on the visitors' origin, such as those who are from Hokkaido, outside of Hokkaido, non-nationals etc. By using a questionnaire based survey and model tours created for publicity, the satisfaction and detailed demand regarding tourism is conducted. These data help evaluate and analyse the service and commodities at the site, which were developed by the initiatives of JC and SC.



*Cable car which leads to the Summit of Usu and Mt. Showa Shinzan*

#### **4-4 Further potentials for economic development in the region**

The region is highly acclaimed for its successful response to the volcanic eruption of Mt. Usu in 2000, resulting in zero casualties due to the appropriate coordination and instruction amongst scientific experts and the local community. The eruption, however, severely damaged many public facilities and private houses, as well as greatly affecting the tourist industry and productivity of industries. Also, due to the nation-wide problem of dwindling birthrate and an aging population, it is crucial to maintain the labour populations as well as creating a new industry in the region. The Geopark will contribute to such task by promoting unique community development as well as enriching the tourist industry.

The SC promotes tourism by creating model tour courses and publishing booklets, which covers

a wider region of the Geopark area. Also, the SC is also considering a certification system to license tour guides, which will lead to foster professional tour guides. In addition, the area hopes to increase not only individual visitors but also targeting group educational trips from all over the country (i.e. school trips), thus, increase the profitability of the industry .

In order to promote local agricultural products, there are restaurants and accommodation facilities that provide local foods. Local governments, which are the member of JC, also launched a local store for selling local agricultural products. Some products; namely, apples of Sobetsu Town, pork and strawberries of Toyoura Town, are developed as local-brand products. In order to encourage the brand image with the local industry, the local government provides opportunities every year by launching “food festivals” (a market focusing on promoting local-brand products), such as “Sobetsu Apple Festival” and “Toyoura Pork-Strawberry Festival.” In the future, the JC plans to develop marketing and sales of these locally processed foods as souvenirs.

There are also products that are directly related to the Geopark, such as publications and guidebooks on Mt. Usu and Lake Toya. Visitors can purchase these books at Theme Center and other related shops in the region. Additionally, the local government supports the promotion of local handicraft industry, and the products are exhibited and sold at core centers, i.e. Sobetsu Information Center “i”, where products are show-cases and sold.

#### Backgrounds and Reasons for the proposed Geopark registration

The Toya Caldera and Usu Volcano Geopark is a unique region which has a wealth of characteristic



*The Usuzan (Mt. Usu) Guidebook is a popular souvenir that is published in four different languages.*

## Chapter 5

### Backgrounds and Reasons for the proposed Geopark registration

The Toya Caldera and Usu Volcano Geopark is a unique region which has a wealth of characteristic geological relics in a relatively compact area, starting with the 110,000 year old Toya Caldera to the 10,000 to 20,000 year old Mt. Usu, as well as the recent history of eruptions, currently reaching nine eruptions since 1663. In addition, the uniqueness can be illustrated at the volcanically activities sites which are continuing even now, and the visitors can see the movement first hand. Moreover, visitors can learn the history of cohabitation of the moving earth and human.

So far, by utilising local resources, the region has promoted geo-tourism, and became one of the most prominent tourist destinations in the country.

The purpose of the proposed Geosite is to continue the current activities for local development and conserve the geosite as a learning ground for people to experience the wonders of the active and living Earth, therefore, passing down the knowledge and geological heritage of the area to the next generation.

At the proposed Toya Caldera and Usu Volcano Geopark, there are precious fauna and flora

living in the conserved thick forest and abundant water resources. These fauna and flora have experienced and changed by the volcanic activities in the region, and are the living exhibit of evolution and vigor of nature. It is crucial to conserve these resources and learn from nature, as well as to sustain and hand over the environment to future generations.

Since 2000, the community has continuously promoted the initiatives of ecomuseum with consolidation of local residents, municipalities, administrative agencies, and academic experts. By cooperating with related agencies, the site hopes to conducted initiatives which will help to achieve sustainable community development at this region. We also believe that these efforts will help prepare for the next possible eruption.

The ideology of the Global Geopark Network (GGN), is one of which we, as a community, share deeply. We believe that the affiliation to GGN would be an objective recognition nationally and internationally, which could encourage further participation and engagement of local residents to the active and sustainable management of the region. We have made efforts up to this day, in order to support geological, environmental, and disaster education, as well as progression of geotourism, and sustainable development. We would be honoured to actively participate and extend these efforts as a member of GGN, as well as contributing to the development of Geoparks by disseminating the experience of disaster education and history of living with volcanoes.

