『公益財団法人中島記念国際交流財団助成』（独）日本学生支援機構実施留学生地域交流事業

Guide for Geology

Northern area of Aichi Prefecture, Tokai Nature Trail

Kiso River

Inuyama Castle

Nagoya University of Economics

1. Introduction

The Tokai Nature Trail is a path that runs from Takao in Tokyo to Minoo in Osaka. Its total distance is 1,697 km.

Points of interest along the trail in Aichi Prefecture include Mt. Tobisu and Mt. Horai-ji in the Southeast area, Dando valley and Koran-kei valley in the Central area, Mt. Sanage, Iwaya-do valley, Iruka Lake in the Northern area and Inuyama Castle near the border with Gifu Prefecture (Aichi Prefecture, Department of Environment, 2014). This trail is main portion of the Tokai Nature Trail. Some branch routes also have interesting points. You may need to check for a suitable season to walk along the route, as well as the likely time it will take. Some hiking guide books are available.

This Pamphlet is prepared as an introduction to the geology along the trail from Inuyama Castle to Mt. Sanage through Joko-ji. Walking is useful not only for health but also for learning about nature and history along the trail. You may enjoy the walk along the trail while studying the geologic history.

2. Outline of Geology

The geology of the area can be understood from the geological map on the website of the Geological Survey of Japan (2015). The geology of the trail is briefly described in the following passages:

Mesozoic

The Jurassic accretionary complex of the Mino Belt is distributed from Inuyama Castle to the Joko-ji area through the Utsutsu Pass. The complex is composed of sandstone, mudstone, chert and limestone. These rocks were assembled in Jurassic times. Pre-Jurassic chert and limestone were mixed as blocks in Jurassic sediments.

Late Cretaceous granitic rocks occur around the mountainous area from Mt. Iwasu to Mt. Sanage. They slowly solidified from granitic magma in the crust at the east margin of the Asia Continent. Heat from this magma metamorphosed Jurassic rocks into hornfels. Metamorphic minerals such as cordierite and biotite occur in the Jurassic rocks near the granitic rocks.

Neogene

Neogene strata occur around the mountainous side. The Miocene Mizunami Group consists of marine sandstone, mudstone and conglomerate. These rocks often contain fossils. Pliocene Seto Group overlies the Mizunami Group. The Seto Group consists of non-marine gravel, sand and mud. The lower part of the Seto Group contains potter's clay.

Quaternary

The terrace deposits are seen in flat areas along rivers. The deposits are composed of gravel, sand and mud. Alluvium deposits are distributed in low lands along present rivers. The deposits consist of gravel, sand and mud.

3. Introduction to Geology

Classification of rocks

The rocks on the earth are basically divided into sedimentary rocks, igneous rocks and metamorphic rocks. This is commonly described in basic geological texts.

Sedimentary Rocks

Sedimentary rocks are formed by consolidating sediments deposited in layers (Parker edit, 1994). Sediment is a mass of organic or inorganic solid fragmented materials. Conglomerate consists of gravel set in a fine-grained matrix. Sandstone consists of sand particles and mudstone consists of mud. Chert is a hard, dense, micro- or crypto-crystalline rock composed of microcrystalline quartz. Limestone is composed dominantly of calcium carbonate, principally in the form of calcite. Tuff is consolidated volcanic ash, composed largely of fragments produced directly from volcanic eruption.

Igneous Rocks

Igneous rocks are the rocks that have congealed from a molten mass (magma). They are divided into volcanic rocks and plutonic rocks. Volcanic rocks are finely crystalline or glassy igneous rock resulting from volcanic activity at or near the surface of the earth. Plutonic rocks are formed at considerable depth by crystallization of magma (Parker edit, 1994).

Volcanic rocks are divided into basalt, andesite and rhyolite in order of increasing silica. Plutonic rocks are divided into granite, granodiorite, diorite and gabbro in order of decreasing silica

Metamorphic Rocks

Metamorphic rock is formed from preexisting solid rocks by mineralogical, structural and chemical changes, in response to extreme changes in temperature, pressure, and shearing stress (Parker edit, 1994).

Geologic Age

Geologic age determination is divided into two types; one is relative chronology, the other is radiometric chronology. The relative chronology is geochronology in which the time order is based on superposition or fossils. The radiometric chronology is an absolute-age dating method based on the existing ratio between radioactive parent

elements and their radiometric daughter isotopes (Parker edit, 1994).

Geologic time scale is defined based on the relative age of various geologic periods and the absolute time intervals. It is named Precambrian, Paleozoic, Mesozoic and Cenozoic in order of oldest to youngest.

Accretion Tectonics

During the Mesozoic period Japan was situated along the eastern margin of Asia. From this time onwards, the eastern margin of the Asian continent, and hence of the Japanese Islands has been dominated by oceanic convergent tectonics associated with the formation of accretionary complexes. Mesozoic geological record shows evidence for the accretion of ocean islands, plateaus and ridges (Taira et al., 2016).

Geologic Map

It is a representation of the geologic surface or subsurface features by means of sign and symbols and with an indicated means of orientation; it includes nature and distribution of rock units, the occurrence of structure features, and mineral deposits.

References

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Taira, A., Ohara, Y., Wallis, S.R., Ishiwatari, A. and Iryu, Y. (2016) Geological evolution of Japan: an overview. Geology of Japan (Moreno et al. eds), 1-24, Geological Society, London.

Geological Survey of Japan (2015) Seamless Geological Map of Japan at 1:200,000 in scale.
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Parker, S.N. editor in chief (1994) Dictionary of Geology & Mineralogy. McGraw-Hill, 346 p.

Local Bus Time schedule, in Japanese

Meitetsu Bus http://timetable.meitetsu.co.jp/bus/BusLine.aspx?param=3

Oiden Bus http://michinavitoyota.jp/portal/bus.html?_tf=mv

Community Bus, Toyota City http://www.city.seto.aichi.jp/docs/2010111002703/

4. Geology along the Trail

Inuyama to Zenjino

Inuyama-Yuen Station and Zenjino Station are convenient for visiting this course. Near Inuyama-Yuen Station, chert is largely exposed along the Kiso River. Inuyama Castle is built on chert strata. Cherty rocks are used mainly for the stone walls of Inuyama Castle.

First you follow the road along the Kiso River. Then you will find a route for Jakko-In Temple. Climb this path and then you can reach the ridge way. Along the ridge way, bedded chert is exposed. The color of the rock is variable, white, gray, chocolate brown and black.

After Mt. Tsugao you will find two courses. One is the Ena sub route, the other is the Aichi main route. Take the Aichi route. You will see a pond at the foot of the mountain. Then you will see an outcrop of semi-consolidated sandstone. This is in part of Miocene strata.

After a little walk, you will find Zenjino Station.

Bedded chert along the ridge way

Mt. Doju, to Mt. Miroku through Mt. Otani

You can go to the foot hills of these mountains by bus from Kozoji Station. The bus routes are the Botanical Garden line and Iwaodai line. At the Botanical Garden, you will find some routes toward the mountainous peaks on guide boards. From the bus stop “Hosono” of Iwaodai Town line, you can climb to Mt. Dojyu through the Hosono Camp site.

From the Hosono Camp site, you can easily access Mt. Doju along a mountain path. Rocks exposed along this path are mostly bedded chert.

A ridge way from Mt. Doju is a part of Tokai Nature Trail. Along the trail, you trace Mt. Otani and Mt. Miroku. The out cropped rocks are mostly chert. Sandstone and mudstone are also sometimes cropped out.

A small hut and some benches are equipped around the summit of Mt. Miroku. From the summit, you can see Ise Bay, Nobi Plain, Mt. Ontake and Mt. Ena.

Chert around the summit of Mt. Miroku

From Mt. Miroku, you can go down to the Botanical Garden by following the path. Chert, sandstone and mudstone are exposed. Marble is also exposed at one point. Marble is a metamorphic rock composed of recrystallized calcite.

In summary, cherty rocks are common, and mudstone, sandstone and minor limestone (marble) are also exposed in the area around Mt. Doju, Mt. Otani and Mt. Miroku. These rocks were formed in different geologic ages but they were assembled in middle to late Jurassic time, and are interpreted accretionary complex.

In addition to geological mapping, you may enjoy studying botany in the Botanic Garden. After that return to Kozoji Station by bus from the garden.

Exposure of marble

Mt. Doju and Jokoji

As mentioned above, you can climb up Mt. Doju from the Hosono bus stop. You will follow a ridge way to Jokoji. From Mt. Doju, first go downwards. Along the path, cherty rocks are mainly exposed. Cross the paved road. Then again follow the trail in the mountainous forest. The trail is relatively flat.

Again you will cross a paved road. Sandstone and mudstone are exposed. Tracing a path in forest, you see a light gray rock. It is granite. Its exposure is limited at the surface, but bigger mass of it may exist under the surface.

Near Tamano Yuen, a gravel layer is widely exposed. Rock type of gravel is mostly chert. This layer is named the Seto Group, Pliocene sediments.

At the foot of the mountain, you will find a paved road running to Jokoji Station. In a small café near the station, mineral collections are exhibited.

Gravel near Tamano Yuen

Jokoji to Mt. Yamaboshi

At Jokoji Station, you can cross over the Shonai River. Sandstone, mudstone and chert are cropped out in this river.

Just after the bridge over the Shonai R., you will cross a signal road. Follow the mountain path along a small valley. This path is suitable to practice geological mapping based on foot measuring. Bedded chert, sandstone and mudstone are cropped out.

You can trace the Tokai Nature Trail by following the guide signs. You can see a sign for Mt. Takane, but there is no peak around this "mountain". Through this mountain, the Trail path runs eastwards. At Obora Pass, you cross a paved road. Geological exposure is rare from Mt. Takane to Obora Pass.

Neighboring the Trail, thermally metamorphosed mudstone (pelitic hornfels) can be found. Sometimes the hornfels contains cordierite.

Sandstone and mudstone in Shonai River near Jokoji Station

From Obora Pass the trail runs eastwards. Chert and mudstone are exposed. More eastwards, a gravel layer is exposed. The peak is Mt. Yamaboshi. At Miyakari Pass, we trace northward, leaving the Tokai Nature Trail. Chert and mudstone are exposed. Granite is exposed near the mountainous foot. After that, you can return to Jokoji Station along a paved road.

Mt. Iwasu

Use a bus bound for Kami-Shinano from Owari-Seto Station to access Mt. Iwasu. Walk for a while along a paved road from the Kami-Shinano bus terminal, then find an entrance to the Tokai Nature Trail. Follow the path along valley. Granitic rocks are exposed along the path. Parallel joints in the granitic rocks run with NNE-SSW strike. At the ridge way, you can access the peak of Mt. Iwasu. Around here, weathered granite is exposed.

Tracing the ridge way, you will find two routes of the Tokai Nature Trail. One is toward the Seto Water Fall, the other toward Iwaya-do. Through Iwaya-do, you can trace the downtown area of Seto City.

Weathered granite around Mt. Iwasu

Mt. Sanage

Mt. Sanage is 628.9m high, the highest peak along the Tokai Nature Trail of northern Aichi Prefecture.

Summit of Mt. Sanage

You will find two courses to the summit of Mt. Sanage. One is the north route that runs from Akatsu and Unkoji Temple. For Akatsu, a bus from Owari-Seto Station is available. The other is the south route that runs from Sanage Shrine. For Sanage Shrine, a bus from Kami-Toyota Station is available. If you are using a private car, parking is possible near Sanage Shrine. A long distance walk from north, Akatsu bus stop, to the south, Sanage Shrine, is a one day trip course described as follows.

First, walk from Akatsu bus stop to Unkoji Temple through the camp sites. The Tokai Nature Trail runs from Unkoji Temple. Trace the path following guide boards. Mt. Sanage consists of Late Cretaceous Granite. The granite is formed at considerable depth by crystallization of magma.

Near the summit of Mt. Sanage, you can see some mountains in the distance referring to the guide picture board.

Guide board

The path from the summit of Mt. Sanage to Sanage shrine is basically downhill. The mountain path sometimes crosses paved roads, but useful guide boards help you with your walk. Along the path, some educational boards are placed. For example, a board titled “Weathering of granite” about halfway along the route explains geology of the path.

The watermill was rebuilt for an exhibition. The mill was used for crushing weathered granite. Crushed material is a high quality resource for pottery. This type of water power mill was used before electric power until around 1965.

Reconstructed Watermill

The Sanage Shrine bus stop is located at the foot of the mountain. .

The granite of Mt. Sanage contains orbicular granite. It is exposed along the path separately from the Tokai Nature Trail. That path runs about 1 km west and parallel to the Tokai Nature Trail. It is covered by wire nets for academic protection, and only observation is possible.

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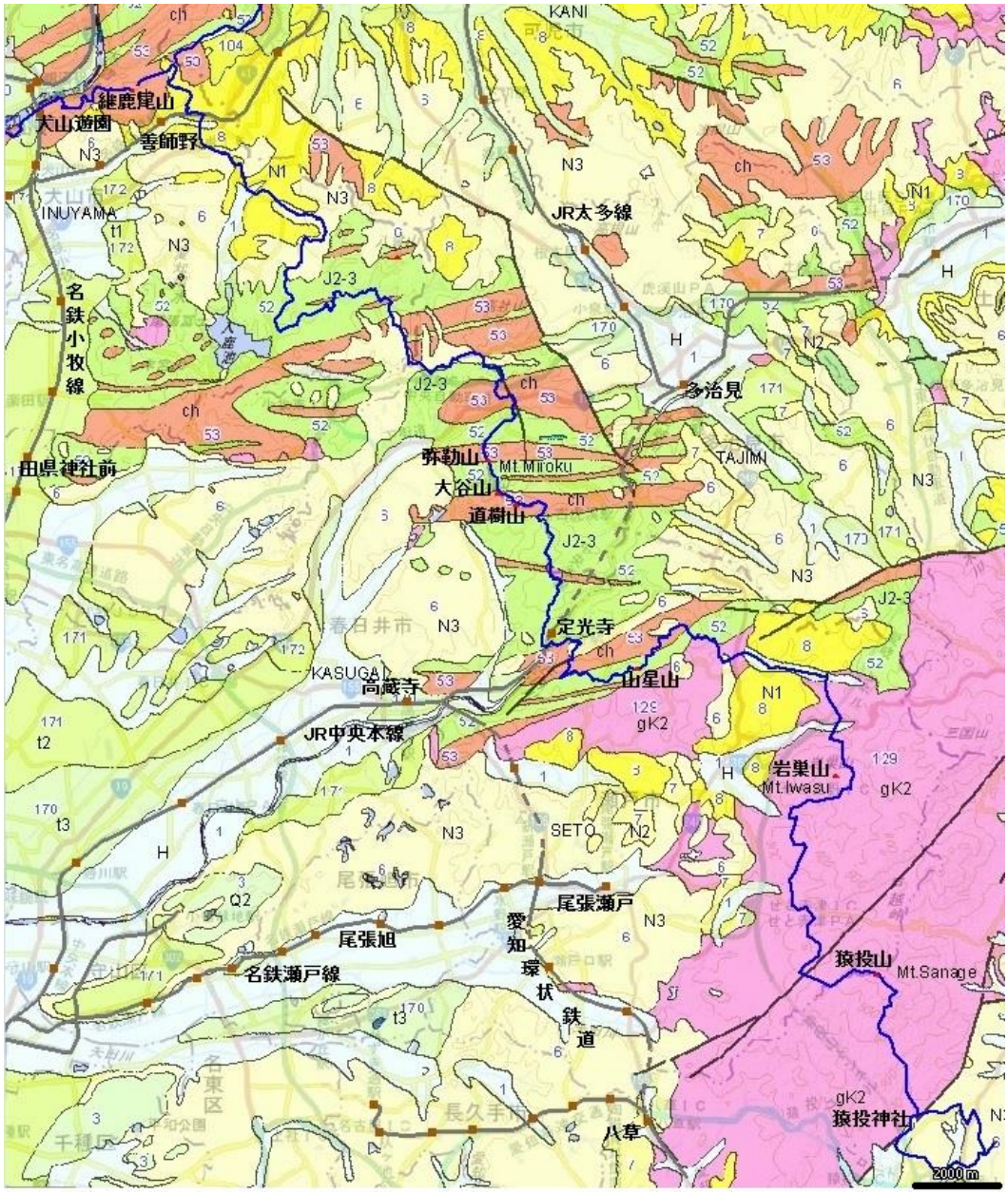

Geologic age			no.	symbol	Geology	Lithology
Cenozoic	Quaternary	Holocene	1	H	Alluvium, Fan deposits	Gravel, sand and mud
			170	t3	Lower terrace deposits	Gravel, sand and mud
		Pleistocene	2	Q3	Mud flow deposits	Rubble and mud
			171	t2	Middle terrace deposits	Gravel, sand and mud
			172	t1	Higher terrace deposits	Gravel, sand and mud
			3	Q2	Karayama and Yagoto Formations	Gravel, sand and mud
	Neogene	Pliocene	6	N3	Seto Group (upper)	Gravel, sand and mud
			7	N2	Seto Group (lower)	Porcelain clay, mud, sand and gravel
		Miocene	8	N1	Mizunami Group (main part)	Sandstone, mudstone and conglomerate
			104	N1	Mizunami Group (Hachiya F.)	Andesite, basalt and volcanic breccia
Mesozoic	Cretaceous	Late Cretaceous	129	gK2	Granitici rocks	Granite and granodiorite
	Jurassic	Middle to Late Jurassi	52	J2-3	Matrix of accretionary complex	Sandstone and mudstone
			53	ch	Blocks of accretionary complex (Triassic to Middle Jurassic)	Chert

Geological map. Based on Geological Survey of Japan (2015).