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Geology around Ulaanbaatar
— Field excursion guide for East Eurasian Geological Seminar 2003 —

Yuhei Takahashi*, Niiden Ichinnorov**, Sereenen Jargalan***, Sodnom Khishigsuren*** and Jargal Lkhamsuren***

* Geological Investigation Center, UB-37, P.O.Box-318, Mongolia

** Paleontological Center, Academy of Sciences, UB-51, P.O.Box-260, Mongolia

*** Mongolian University of Science and Technology, UB-46, P.O.Box-520, Mongolia

1. Introduction

Mongolia is composed of a number of tectonic zones that form the Central Asian Orogenic Belt, which is located between the Siberian Craton in the north and the Tarim and Sino-Korean Cratons in the south. Mongolia is subdivided into a northern domain and a southern domain. The former has been classified as a "Caledonian" orogen and the latter as a "Hercynian" (or "Variscan") orogen. According to Badarch et al. (2002), the term Caledonian and Hercynian are inappropriate as a time indicators for the Central Asian Orogenic Belt. However the basic two-fold subdivision for Mongolia into a northern and southern domain is still applicable.

Around Ulaanbaatar, some representative geologic units in northern domain can be observed. The granitic rocks are also cropped out. In addition, various mineral deposits are distributed around Ulaanbaatar.

This guide was firstly unofficially prepared for the participants in East Eurasian Geological Seminar 2003. However, some geologists are demanding us more copies of this guide because the description in the guide is useful for not only foreign geologists but also Mongolian students who are studying geology. We hope this guide will be also used by the people who are not geologists.

2. Outline of Geology

The area around Ulaanbaatar is geologically included in the northern domain of Badarch et al. (2002). The area can be divided into the following units in younging order; the Haraa Group, Hentey Group, Granitic rocks, Cretaceous lake deposits and Cenozoic sediments (Magic Project, 1998).

The Haraa Group occurs in the west to northwest of Ulaanbaatar. It extends into the Transbaikal region, Russia. It consists of Cambrian-Lower Ordovician (to Silurian?) greenschist facies metamorphosed sandstone, siltstone, argillite, phyllite, schist and minor conglomerate and tuff. Badarch et al. (2002) regarded the Haraa Group as a backarc/forearc basin.

The Hentey Group crops widely around Ulaanbaatar. The Hentey Group is Devonian-Carboniferous turbidite sediments such as sandstone and mudstone. It includes chert layer and small lenses of limestone. For the Henty Group many interpretation has been proposed, for example,

an accretionary wedge, part of the Mongol-Okhotsk oceanic gulf, basin with an Andean type continental margin, and post-orogenic successor basin on Caledonian basement (review of Badarch et al. (2002)).

The granitic rocks intrude into the Haraa Group and Hentey Group. The granitic rocks are divided into early Paleozoic granite to granodiorite, middle to late Paleozoic granite with minor diorite masses and late Triassic to early Jurassic granite. Tungsten mineralization is related with the Triassic to Jurassic granite. Gold mineralization is controlled by a sub-horizontal shallow structural zone related to regional faulting due to granite chilling and uplifting process.

Cretaceous lake deposits are distributed at east of Ulaanbaatar. Coal in the Cretaceous is mined for the power stations in Ulaanbaatar.

Cenozoic sediments are distributed in lowlands. Clay deposits occur in the sediments and are mined for producing brick.

3. Pre-seminar excursion (East of Ulaanbaatar)

Nalayh coal mine:

Nalayh town is situated 35 km southeast of Ulaanbaatar. This area is geologically composed of Cretaceous lake deposit, which is named Zuunbayan Formation. The coal mine is located in the southern part of Khentii mountains province. The Zuunbayan Formation in Nalayh is characterized by shale, clay-shale, coal, coal-bearing mudstone, siltstone, gravelite and conglomerate. Thickness of the Formation is 600 m.

Coal-bearing sequence consists of 9 coal-bearing beddings. Total thickness of the coal layers is 17.67 m. The Coal is mined under ground for a local use.

Baga-nuur coal mine:

Baga-nuur coal deposit is situated at 110 km east of Ulaanbaatar. In this area Cretaceous Zuunbayan Formation is distributed. This Formation is divided into 3 members:
(1) Lower-member consists of shale, sandstone and mudstone. Thickness of the member is 250 m. (2) Middle-member is characterized by mudstone, siltstone, coal, and sandstone. Thickness of it is 280 m. (3) Upper member is composed of coal, coaly mudstone, mudstone and sandstone. Thickness of the member is 100 m.

The Baga-nuur coal deposit is composed of 23 coal-bearing layers. Thickness of each coal-bearing bedding is 0.03 to 4.6 m. Total thickness of coal layers is 17.96 m.

Terelj Park (Hentey Group and Gorkhi Granite):

The Terelj Park is located in about 40 km east of the Ulaanbaatar. Around the ovoo (Mongolian cairn) near the entrance of Terelj Park, the Hentey Group crops. It is composed of sandstone and mudstone with chert beds. Upper Devonian conodont is found from reddish chert in this point (Kurimoto, unpublished).

The granitic pluton, Gorkhi Granite, is well croped out at the Gorkhi in the Terelji Park. Gerel and Lkhamsuren (1999) described this granitic mass and pegmatite bodies as following. The biotite K-Ar age of the Gorkhi Granite is 205-220 Ma. The Gorkhi Granite is divided into porphyritic coarse-grained

biotite granite, equigranular medium-grained granite and porphyritic granite with fine-grained groundmass. About 800 pegmatite bodies occur in the granite. In these pegmatite bodies, quartz crystal up to 7.5 tons was found.

Bus -nuur:

Small lake, named Bus-nuur, is seen along road near Nalayh. Small hill stands within the lake. This lake is topographically considered as pingo remnant, which is periglacial morphology.

4. Post-seminar excursion (Northwest and south of Ulaanbaatar)

Haraa Group:

Along main road from Ulaanbaatar to north area, various Paleozoic strata are exposed southwards younging. According to Tomurtogoo ed. (1999), lower Carboniferous, Silurian, and middle Cambrian to lower Ordovician are distributed from Ulaanbaatar to north in order. Generally schistose and/or weakly metamorphosed rocks have been called Haraa Group (series).

Greenish psammitic schist is well exposed near the marks showing 61 km and 63 km from center of Ulaanbaatar. Laminated coarse-grained sandstone is exposed near the junction to Bornuur town.

Boroo Gold Deposit:

The Boroo gold deposit area is located at about 100 km NNW of Ulaanbaatar and it is underlain by Cambrian-Ordovician deformed shale, siltstone and fine-grained sandstone of the Haraa Group and early Paleozoic Boroo granitic complex. Numerous dacite, rhyolite and aplite dikes intrude both the granitic rocks and meta-sedimentary rocks in the deposit area.

A sub-horizontal shallow northwest dipping structural zone, the Boroo fault, is interpretated be the main control for Au mineralization in the Boroo deposit (Gantsetseg et al., 2003). The Boroo fault was related to regional thrust faulting caused by granite chilling and uplifting process. According to Gantsetseg et al. (2003), this fault would more likely produce detachment faults, rather than thrust faults.

Gold mineralization is divided into two types; gold-sulfide dissemination type and quartz vein type. Cameco is now exploring in this area. According to Cameco (2003), the mineable reserve is approximately 10 Mt of ore with an average grade of approximate 3.6 g/t Au. At full capacity Boroo will produce up to 5.5 tones of Au per year.

Tsagaan Dawaa Tungsten deposit

Tsagaan Dawaa deposit is located north-west 80 km from capital Ulaanbaatar. The deposit area consists of medium to coarse grained biotite bearing porphyritic granite, which is a part of late Triassic to early Jurassic Tohom massiv. The granite is cut by north-west striking dikes of granite-porphyries, aplites, felsite and pegmatites. Tsagaan Dawaa tungsten deposit area is located along the Yoroo gol deep fault zone, therefore the area is cut by northeast striking faults.

Quartz-wolframite veins are distributed at the western and southern part of the fault zone. The

biggest is Vein-1, which locates near the northwest striking vein (see cover photo of this issue). The vein strikes northwest and dipping of it is southwest 15°, with average thickness of 1.23 m and average content of W_2O_3 is 1.65%. Its length on the surface is 80 m. Vein-2 is located at south of Vein-1. Its thickness varies from 0.4 to 1.27 m. Content of W_2O_3 varies in big range and it reaches up to 3.5-4.8%. Vein-3 strikes southeast. Its thickness ranges from 0.1 to 0.5 m, and length is 175m. W_2O_3 content reaches up to 12.6%. Vein-5 is 175 m in length with 0.2-1.1m thickness. W_2O_3 is up to 0.1%.

Greizenization zone locates at the southeast part of the area. It is 25-80 m in length and 0.2-0.6 m in thickness. W_2O_3 reaches up to 3.5%.

Mt. Bogd:

The Bogd uul Granite occurs around Mt. Bogd, south of Ulaanbaatar. This Granite intrudes into Devonian to Carboniferous Hentey Group with discordant boundary. The Bogd uul Granite is mainly biotite granite and rarely contains hornblende. It is divided into porphyritic facies and equigranular facies (coarse-grained and fine- to medium-grained).

Previously age of this granite has been thought as Jurassic based on biotite K-Ar method, but new zircon Pb/Pb age of it shows Triassic (Khishigsuren et al., 2003).

5. Museum of Geology and Mineral Resources of Mongolia

The Museum of Geology and Mineral Resources of Mongolia belongs to School of Geology, Mongolian University of Science and Technology. The museum has three sections; Geological, Mineral Resources and Minerals. The Geological Section display general geological samples in Mongolia; sedimentary rocks, igneous rocks, metamorphic rocks and fossilized fauna and flora. The Mineral Resources Section demonstrates fuel resources, metallic resources and non-metallic resources in Mongolia. The Mineral Section shows all mineral types classified into the following group; nuggets, sulfides, oxides, silicates, carbonates, phosphates, tungstates, sulfates, fluorides and chlorides.

The exhibition of Precious and Colored Stones displays minerals used as gems in jewelry: transparent aquamarine, blue and pink topaz crystals, bright red garnets, multicolored agates, jaspers, chalcedonies, turquoise, fancy flint, nephrite, and others.

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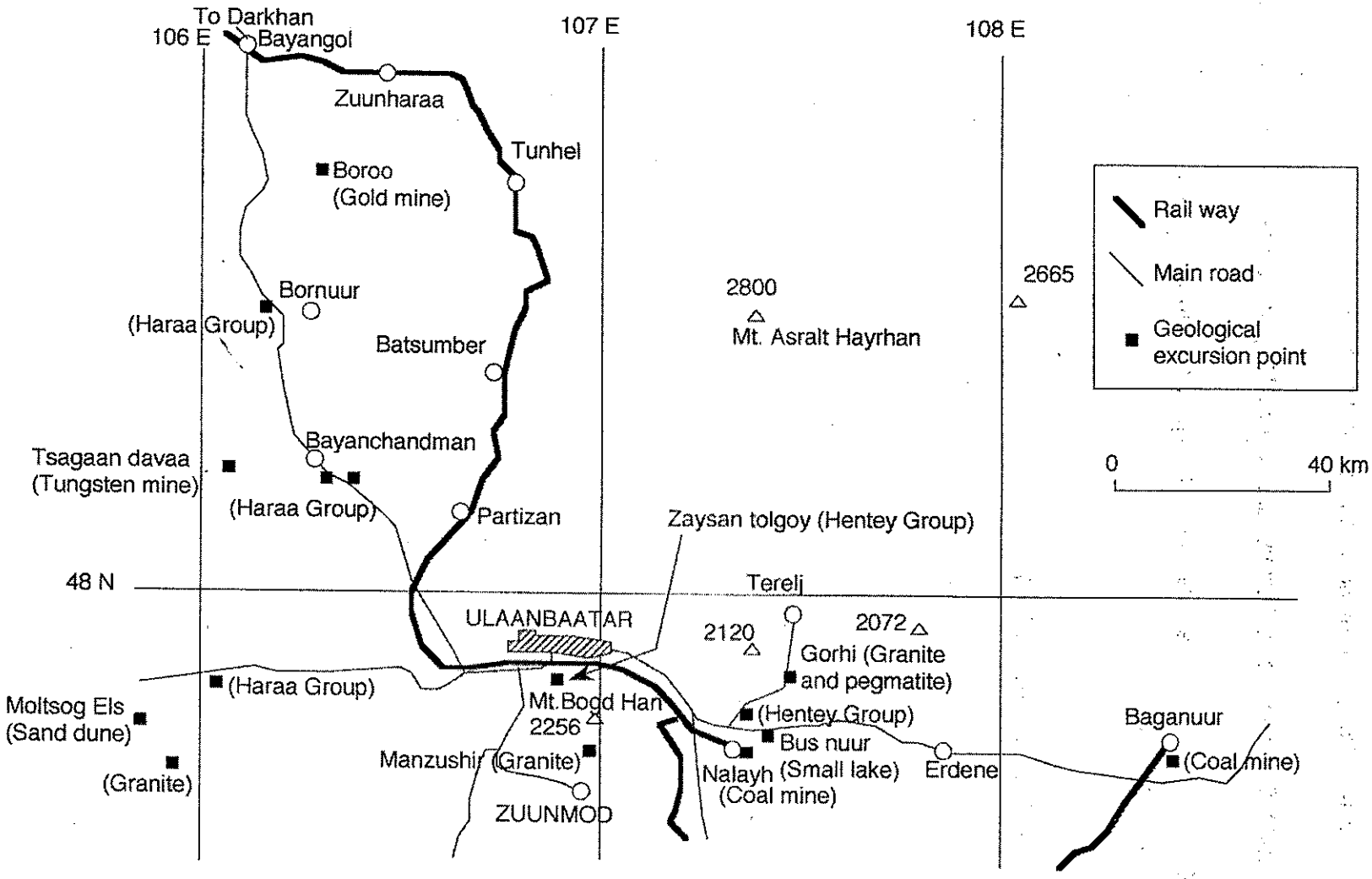

Fig.1 Guide map for geological excursion around Ulaanbaatar