GEOLOGICAL SOCIETY OF HONG KONG NEWSLETTER

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As 'warned' in the last issue, here the report on the geological aspects of the NXJ trip comes. Mr. William Chow, a veteran GSHK secretary and a committee member, has kindly prepared this report. To better illustrate the rich details, maps and photos, we have decided to divide the report to three parts.

Our warmest THANKS to William for his efforts and time! This series of Newsletter will be a perfect Christmas Gift to all of you! MERRY CHRISTMAS AND HAPPY NEW YEAR !

GSHK

A Note on the Geological Excursion to North Xinjiang (3-1)

by William Chow

1. Introduction

The remarkable relief of Xinjiang consists of two basins – the Junggar Basin (准噶爾盆地) and the Tarim Basin (塔里木盆地) divided by three parallel E-W running mountain ranges, from north to south respectively, Altay Mt (阿爾泰山), Tianshan Mt (天山) and Kunlun Mt (昆倫山). This topography is a result of the collision of various plates in the earth's history from the Archean to the present day. Due to the existence of mountains and basins in this driest part of the country, Xinjiang displays a variety of landscapes other than just desert.

In July, GSHK organized an excursion to North Xinjiang. Our 4-wheel drives cruised in a triangular route in the northern part of Xinjiang around the Junggar Basin (Plate 1). For our detailed itinerary please refer to Carina's report. This note describes the geological features observed in the field trip.

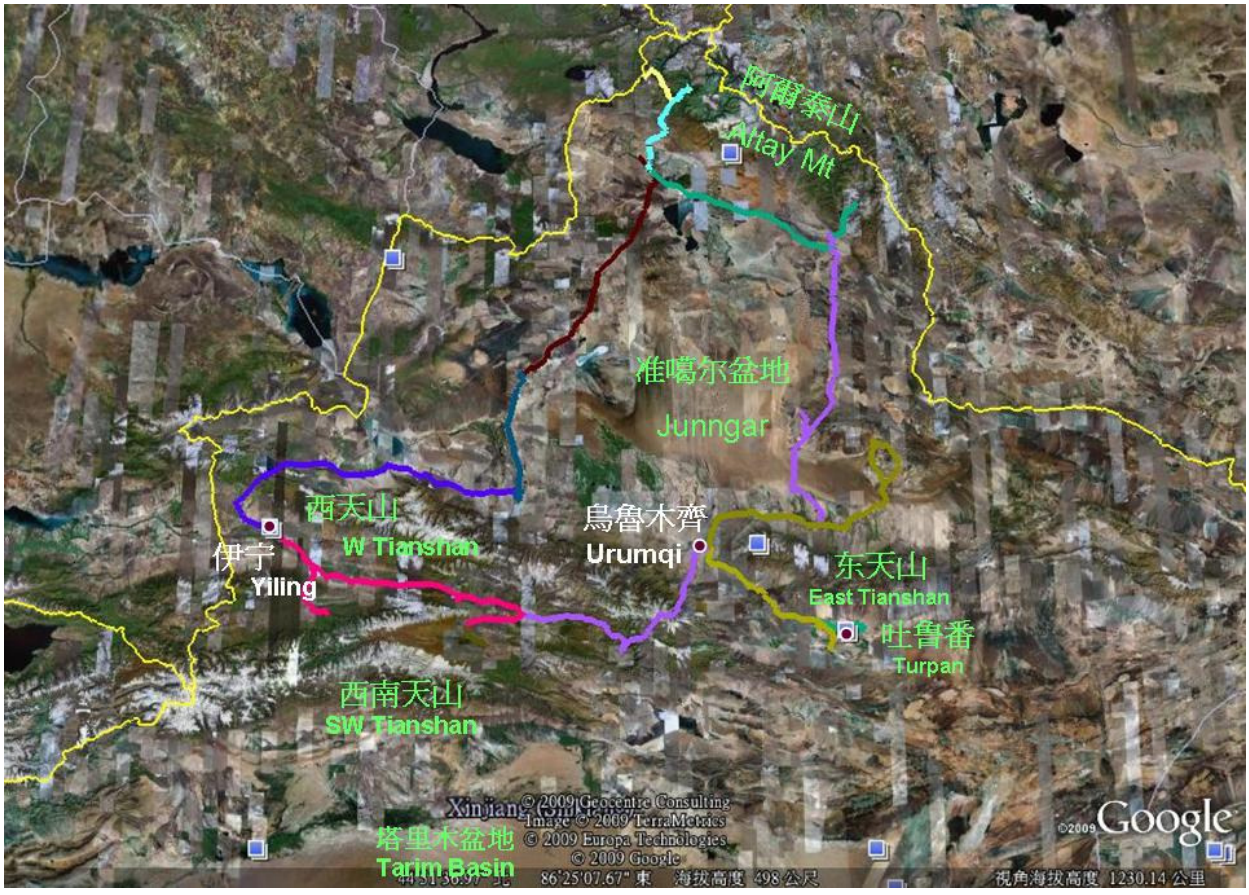

Plate 1 North Xinjiang trip -- colour lines represent our routes

2. Tectonic Structure

At the end of the Proterozoic (800 – 900 Ma), a united paleo-continent was formed from the aggregation of several blocks of archaic landmass which were derived from a primordial continental nucleus. From the Sinian to the Ordovician periods, the paleo-continent broke up and was separated by the Paleo-Asian Ocean.

In the Silurian-Devonian period, the Altay landmass joined with the Siberian plate. To the south, there were the remnant of the Paleo-Asian Ocean and the convergence of the Kazakhstan-Junggar and Tarim blocks. Up to the Permian, the Siberian, Kazakhstan-Junngar and Tarim plates had merged to become the North Asian Continent. At this time the Qiangtang (South China) plate still unconnected as the Tethys Ocean opened up.

The Tethys Ocean disappeared gradually after the Tertiary by the subduction of the north-moving Indian plate into the greater North Asian Continent.

Then the orogenic activity never stopped. There were occurrences of rift depressions and small ocean basins so that sedimentary layers are found in the region.

2.1 Altay Mt

Today, the Irtysh River (額爾齊斯河) marks most of the boundary between the Siberian plate and the Kazakhstan-Junggar plate (Plate 2). North of the river is Altay Mt, the folding continental rim of the Siberian plate.

On the journey to Koktokay, we crossed over the Koktokay-Ertai fault zone (可可托海-二台斷裂). It is a transform fault cutting across Altay Mt. This structural line creates a narrow strip of lowland which controls the flow of the river (Plate 3). Near Koktokay, an underground hydro-electric power station (136 m below surface) was built at Haizikou (海子口) where a lake was formed behind the dam over the Irtysh River. This reservoir just sits on this fault.

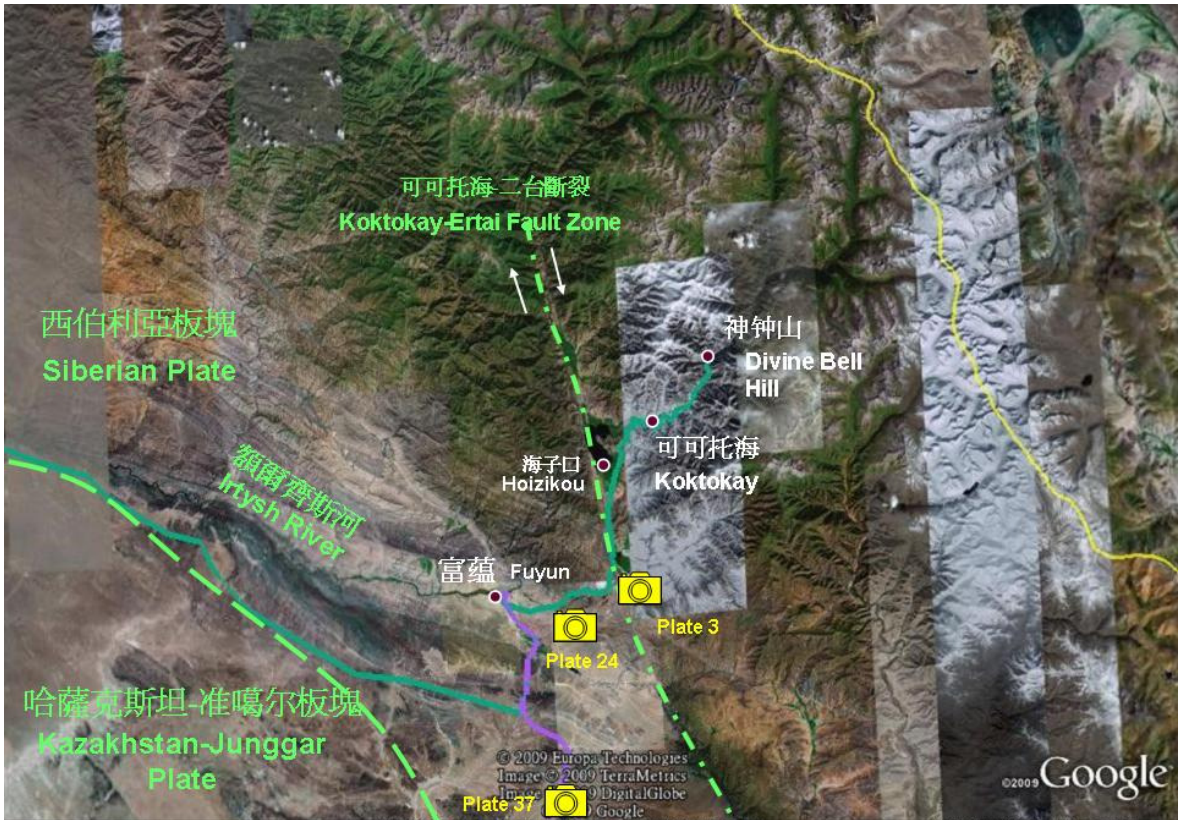

Plate 2 Altay region

Plate 3 A swamp on the left flank of Koktokay-Ertai fault

At the upstream of the Irtysh River, granite is the dominant rock type which was fashioned into magnificent scenery by the force of nature. A Geopark is established now with the landmark at Divine Bell (神钟山) (Plate 4). Sheeting joints developed on granite and mechanical weathering shaped the rocks. The drastic daily temperature changes caused the expansion and contraction of the rock. Once cracks extended, water was trapped and with the solidification of ice at night, cracks were further enlarged. Consequently, lots of debris fell from the rock body by means of disintegration along the sheeting joints. Soil was washed down from the steep slope which exposed the bare rock surface in a bell shape.

Plate 4 The Divine Bell

The orogeny of Altay Mt has not yet ceased. Evidence of uplift is still observed at Hemu Village (禾木村) in the Kanas (喀纳斯) region (Plate 5).

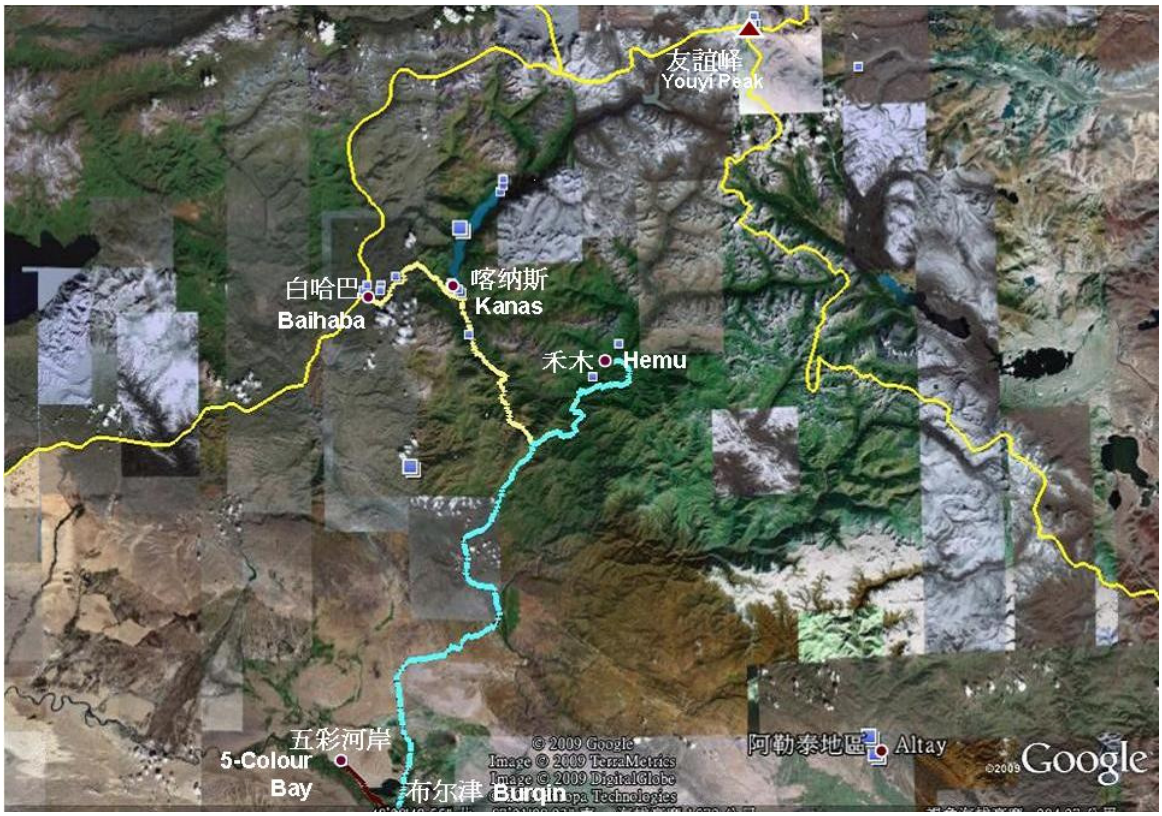

Plate 5 Kanas region

Inhabitants of Hemu Village are Mongolian who settle at the valley of Hemu River southeast of Kanas. They live in wooden huts of Russian style which are built on river terraces at different levels. A river erodes at upstream and deposits at downstream where its energy disperses when flowing along a gentle gradient. In the latter case, huge layers of sediments accumulate at the river bed if the land subsides continuously. Where there is uplift, the river rejuvenates its incision power of downward erosion again. It cuts into the sediments and changes the river channel into terraces. At Hemu, the uplift occurred in different time periods to craft stages of terrace. 7 levels can be identified, as seen in Plate 6. This shows that Altay Mt keeps on rising.

2.2 Tianshan Mt

Geographically, Tianshan Mt segregates Junggar Basin and Tarim Basin. This mountain range is not a single entity. The West Tianshan Mt (west of Urumqi) has a span of about 350km from north to south and consists of distinctive structural elements.

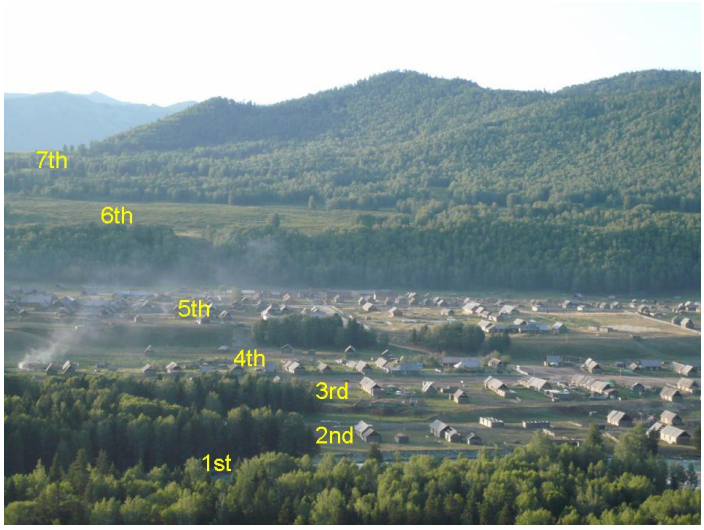

Plate 6 Hemu Village: river terraces at different levels

The major geological units include Borohoro Mt (博羅科努山), Erenhabinga Mt (伊連哈比爾尕山), Yili river valley (伊犁河谷), Narat Mt (那拉提山), Erbeng Mt (艾爾賓山) and Yultuz Basins (尤路都斯盆地) - Dayultuz (greater Yultuz 大尤路都斯) and Xiaoyultuz (lesser Yultuz 小尤路都斯). Several major fault zones traverse these mosaic blocks.

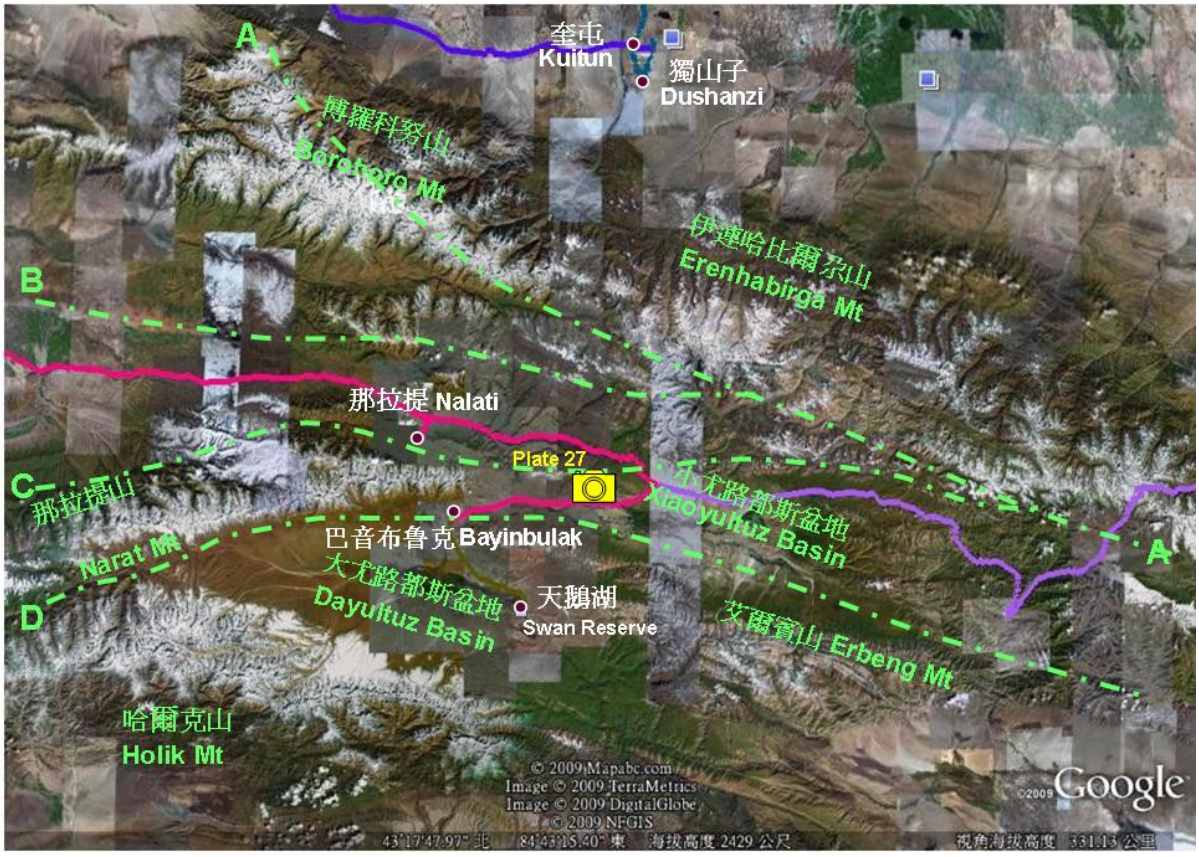

Plate 7 Tectonic structure of West Tianshan M

In Plate 7, the fault zones are represented by letters:

A – Haxilegen Fault Zone (哈希勒根斷裂帶)

B – Borohoro Mt South Rim Fault Zone (博羅科努山南緣斷裂帶)

C – Narat Mt North Rim Fault Zone (那拉提山北緣斷裂帶)

D - Narat Mt South Rim Fault Zone (那拉提山南緣斷裂帶)

Fault A is the suture between the Junggar microplate and the Yili microplate; both are members of the Kazakhstan Plate. The Yili microplate is the Yili Valley enclosed by Faults B and C. The part of Borohoro Mt within Faults A and B is the relic of a Paleozoic island arc. The Yili microplate is separated from the Tarim plate by the Narat suture zone which is confined by Faults C and D. Hence, Fault D, or the Narat Mt South Rim Fault, is the north margin of the Tarim plate subducting into the Kazakhstan plate in the north. On Day 11 of our trip, we departed for Swan Reserve from Bayinbulak (巴音布鲁克). In fact we traveled over two plates – from the Kazakhstan plate to the Tarim plate (Plate 8).

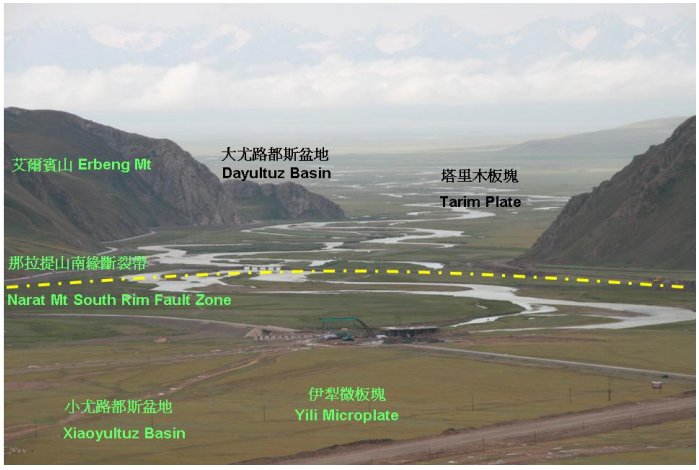

Plate 8 Looking south to Swan Reserve from Bayinbulak

Tianshan Mt is a young fold mountain and some of the structural features can be seen near Turpan (吐魯番) at the barren land of Tuyugou Village (吐峪溝麻扎村) (Plate 9). Plate 10 reveals a plunging fold where the fold axis lies horizontally above the road. Strata were pushed to one side by stress.

Plate 9 Turpan region

Plate 10 Plunging fold

Plate 11 shows a syncline being cut by a canyon and the v-shaped limbs appear at the cliff face.

Plate 11 Syncline

Another interesting feature associated with folding structure is mud volcanoes at Dushanzi (獨山子) (Plate 7). Here, mud volcanoes were not the outcome of igneous activity. They were formed by the discharge of underground water together with mud which built up into dome-shaped mounts (Plate 12). There are oil fields in the surrounding area. It is believed that the gas coming from oil fields acts as a propellant to drive the underground water and mud up to the surface through cracks which developed at the axis of an anticline shown in Plate 13.

Plate 12 Gas, water and mud emanating from cracks

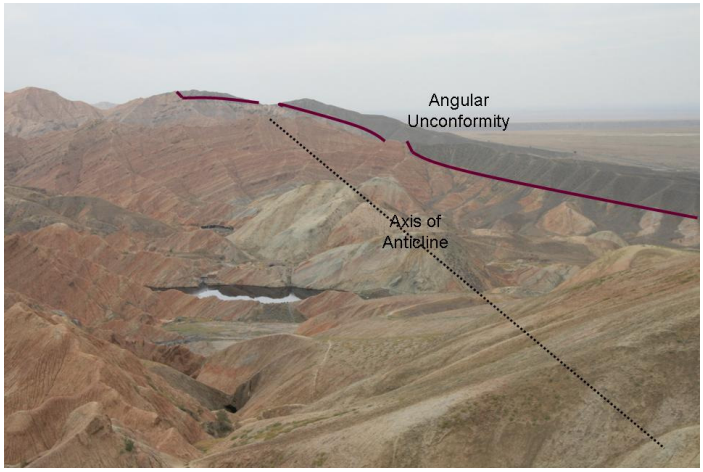

Plate 13 An anticline at Dushanzi

Most of Xinjiang's scenery is structural-controlled. Sayram Lake (賽里木湖) (Plate 14) is a salt lake at

Plate 14 Sayram Lake

the foothills of North Tianshan Mt (Plate 15). We passed by this lake on our way to Yili. It is positioned on a graben which is a depression of land between parallel faults. They are normal faults where the expansion force created room for the subsidence of the block of land. As the land sank, water from melted snow from the adjacent mountains flowed into the low land forming the lake.

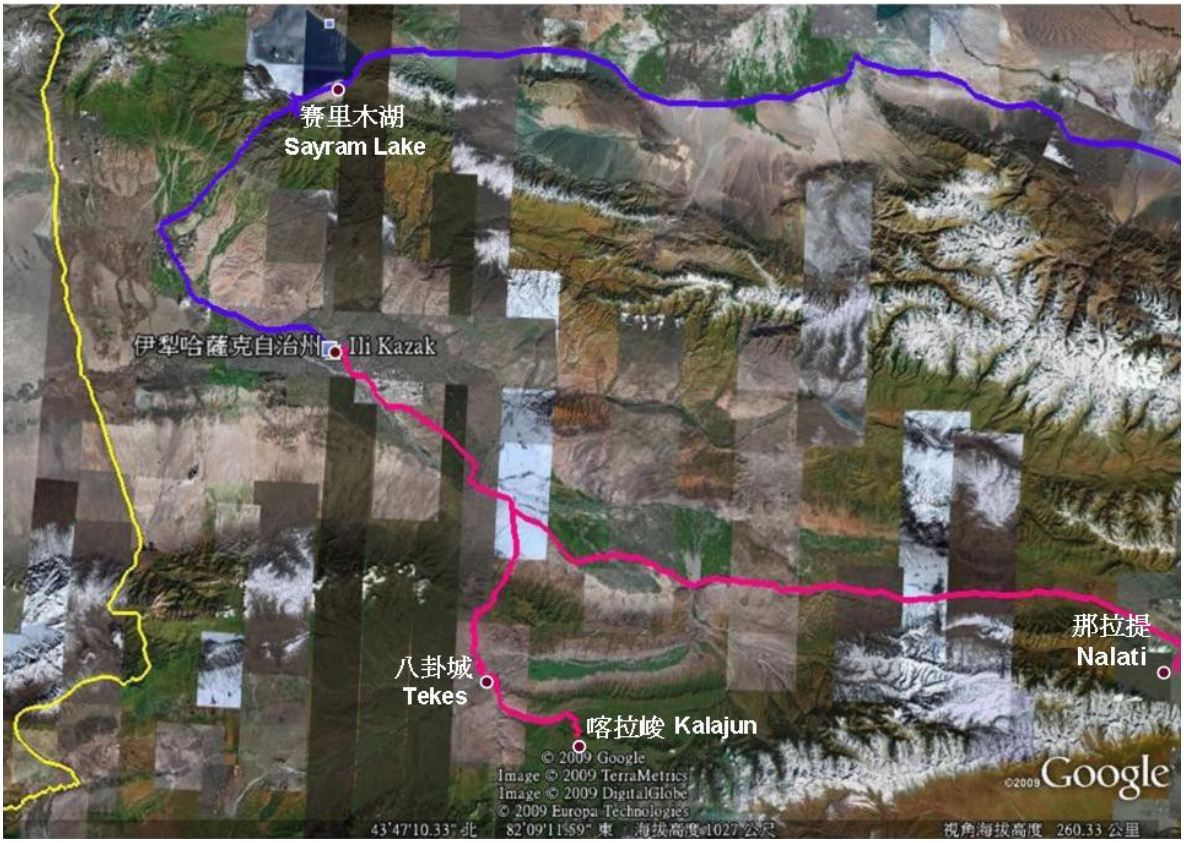

Plate 15 Yili Region

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3. Landforms

Desert is dominant in the arid environment of Xinjiang which is a consequence of the action of wind and water. The Junggar Basin is occupied by the Gurgantunggut Desert (古爾班通古特沙漠) (Plate 16) with semi-mobile sand dunes. Moreover ice has carved the terrain in some areas especially at high mountains.

3.1 Landscape of Aeolian Process

Wind serves as a common agent to erode the desert because of its capability of picking up loose and fine particles and depositing them to distant areas. Deflation is the process of shifting dust and sand particles away from the origin. Subsequently, coarse gravels/ pebbles are left on the ground which is known as desert pavement. We came across this stony desert (Plate 17), or reg, when we went from Shiqian Beach (石錢灘) to Dinosaurs

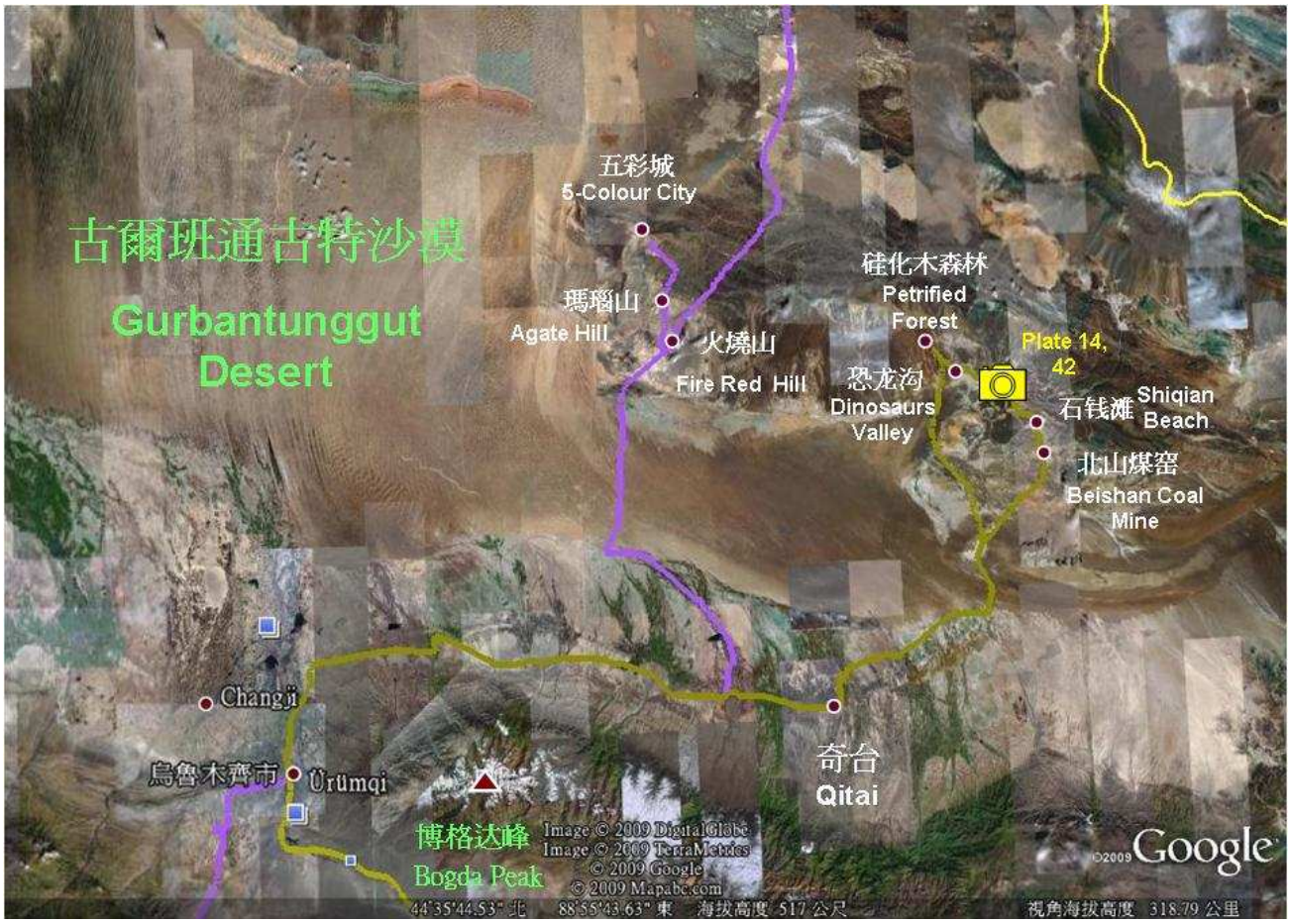

Plate 16 Tunggar Basin and Gurbantunggut Desert

Plate 17 Desert pavement covered with desert varnish

Valley (恐龍溝) (Plate 16). The rock fragments in Plate 17 were shiny and dark in colour. This was because they were coated with iron and manganese oxides having been exposed to sunshine and moisture for long periods of time. We call this feature desert varnish.

Abrasion is the erosive power of wind when driving dust and sand as tools against rock surfaces. The rock is subject to natural sandblasting and is gradually worn down under a sequence of pitting, etching, faceting and polishing. The end-products of these faceted rocks are called ventifacts (Plate 18).

Plate 18 Ventifacts from Burgantunggut Desert

Plate 19 Urho Ghost Town

Abrasion is more effective along joints and lines of weaknesses on rock surfaces in a desert. As this process persists with prevailing wind, aisles will be carved in small hills which become elongated ridges parallel to one another. This is the landscape of yardang. We visited Urho Ghost Town (烏爾禾魔鬼城) (Plate 19) before arriving at Karamay (Plate 20). Urho is a yardang worked out by wind erosion from an old river channel system. It derived its name from the murmurs caused by gales when strong air currents thrust through the opening in the fields of yardang.

When the wind dies down, the carried dust and sand particles will settle down. Sometimes they will build up sand dunes varying in sizes. Along the road from Qitai to Fuyun in the Gurgantunggut Desert, sand sediments formed a very thick layer with undulating surface where sand dunes were hardly identified. However, at the dried Aydingkol Lake (艾丁湖) near Turpan (Plate 9), we saw some small sand dunes with striking shapes (Plate 21). They were elongated with vegetation on one side. The size may be confined by the limited supply of fine particles and silt because most of the lake bed was covered with a hard salt crust. The alignment of dunes indicated the direction of wind and vegetation grew on the leeside.

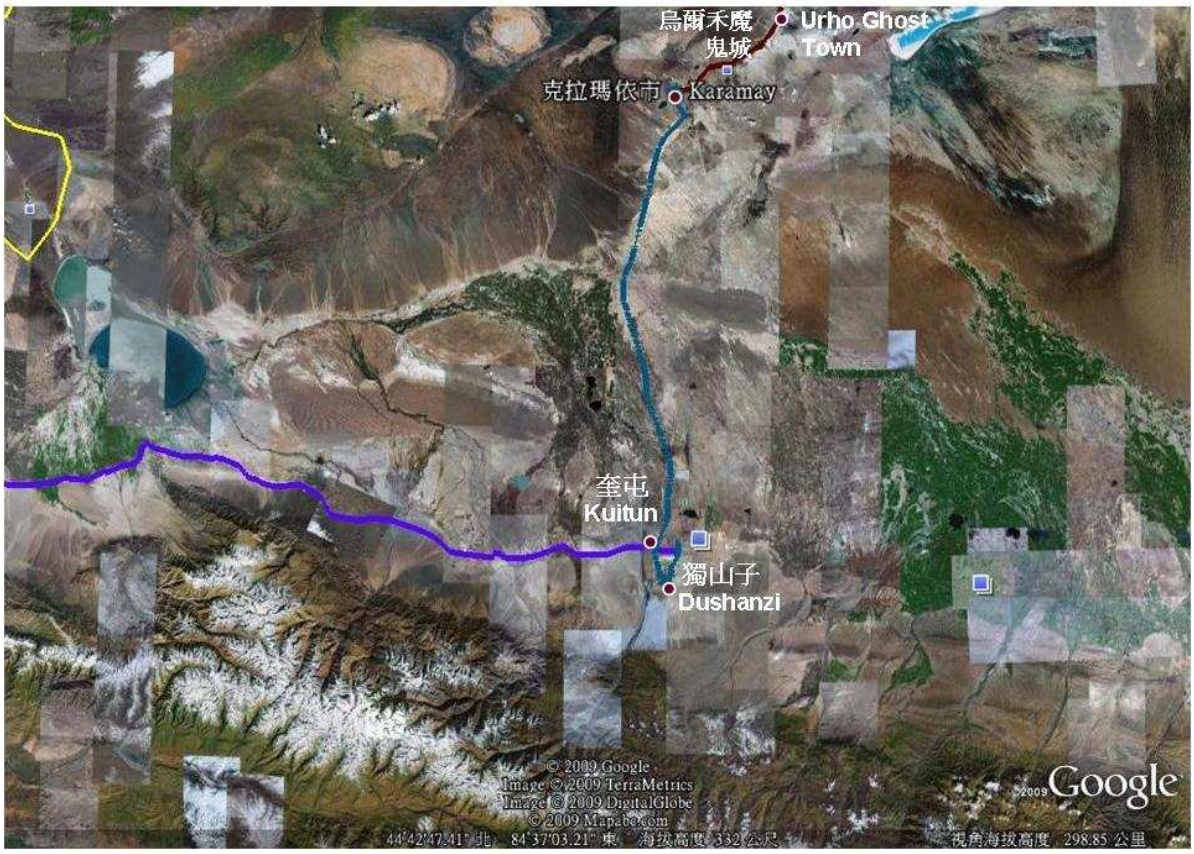

Plate 20 Karamay region

Plate 21 Sand dunes at Aydingkol Lake

Plate 22 Five-colour City

3.2 Landscape of Fluvial Process

Xinjiang has less precipitation than other parts of China. As a common characteristic of a desert, rainfall, when it occurs, is intensive and happens in a brief period that creates rapid surface runoff. This allows water to be an effective agent of erosion, transportation and deposition. Due to the infrequent rainfall, lack of vegetation to preserve ground water, high evaporation and seepage on desert land, most rivers are ephemeral. But their actions significantly change the appearance of the relief.

An astonishing scene of fluvial erosion is found at Five-colour City (五彩城) (Plate 22) which is a canyon at the Qitai area. (Plate 16). The steep slope can last long in arid environment for the mechanical weathering helps to maintain the vertical cliff face. Another similar example is

Five-colour Bay (五彩灣) near Burqin (布尔津) (Plate 5). Located at Irtysh River, small gorges were cut down by ephemeral distributaries that produced a contrasting view against the opposite low lying bank (Plate 23). The latter was drained with the Irtysh River so that vegetation grows on the wet and fertile land.

Plate 23 Five-colour Bay

In other areas, short-lived rivers form different depositional relief. After leaving Fuyun (富蘊) for Koktokay, we encountered the magnificent Atlay Mt (Plate 2). Then we noted a sloping platform stretching out across the foothill (Plate 24).

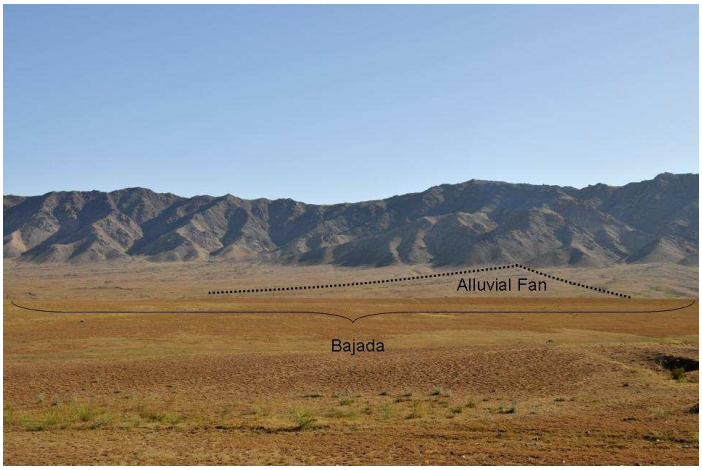

Plate 24 Altay Mt

This was bajada, a collection of sediments washed down from uphill. The ephemeral rivers are usually a result of thunderstorms that leads to large volumes but transient streamflow. They are capable of transporting larger boulders. When the streamflow dissipates, sediment loads are dropped in a short distance along the course of transportation. They often chock the stream channel at the valley mouth. As the stream regains its water from the next storm, it spills outwards, seeking lower routes and brings new loads on top of old sediments. Gradually a fan-shaped mound is built up as an alluvial fan. In large mountain ranges like Altay Mt, alluvial fans created by individual mountain gorges coalesced together to become the bajada.

Normally, drainage systems in deserts seldom terminate at sea. Being restrained by the structure, they flow towards intermontane basins. Before ephemeral rivers disappear, they still carry silt and sand further away from mountain areas and deposit towards playa, the central part of the basin. The fine particles accumulate on a relatively flat floor which is sometimes occupied with water. We drove over a 'mini' playa (Plate 25) near Dinosaur Valley (Plate 6). Death Valley in the US is a classical playa.

Plate 25 Playa

If water is held in playa, it is subject to strong evaporation and turns into saline lakes. Aydingkol Lake (Plate 9) is a salt lake of this kind and now nearly dried up. It is situated at 154.3 metres below sea level. Aydingkol Lake is now the lowest depression in China and the second lowest in the world. Ripple marks (Plate 26) were clearly seen on the dried lake bed.

Plate 26 Aydingkol Lake: ripple marks

3.3 Landscape of Glacial Process

The glaciation process can be seen at mountains. Typical mountain glacier landforms at Erbeng Mt. in Yultuz Basins (Plate 7) are shown in Plate 27.

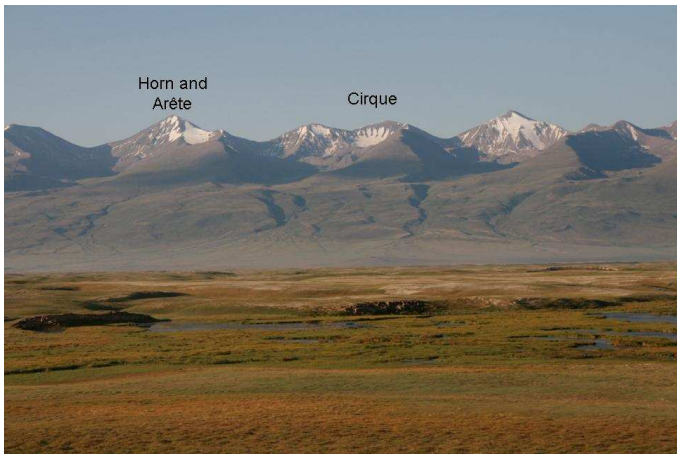

Plate 27 Cirque and arête in West Tianshan Mt

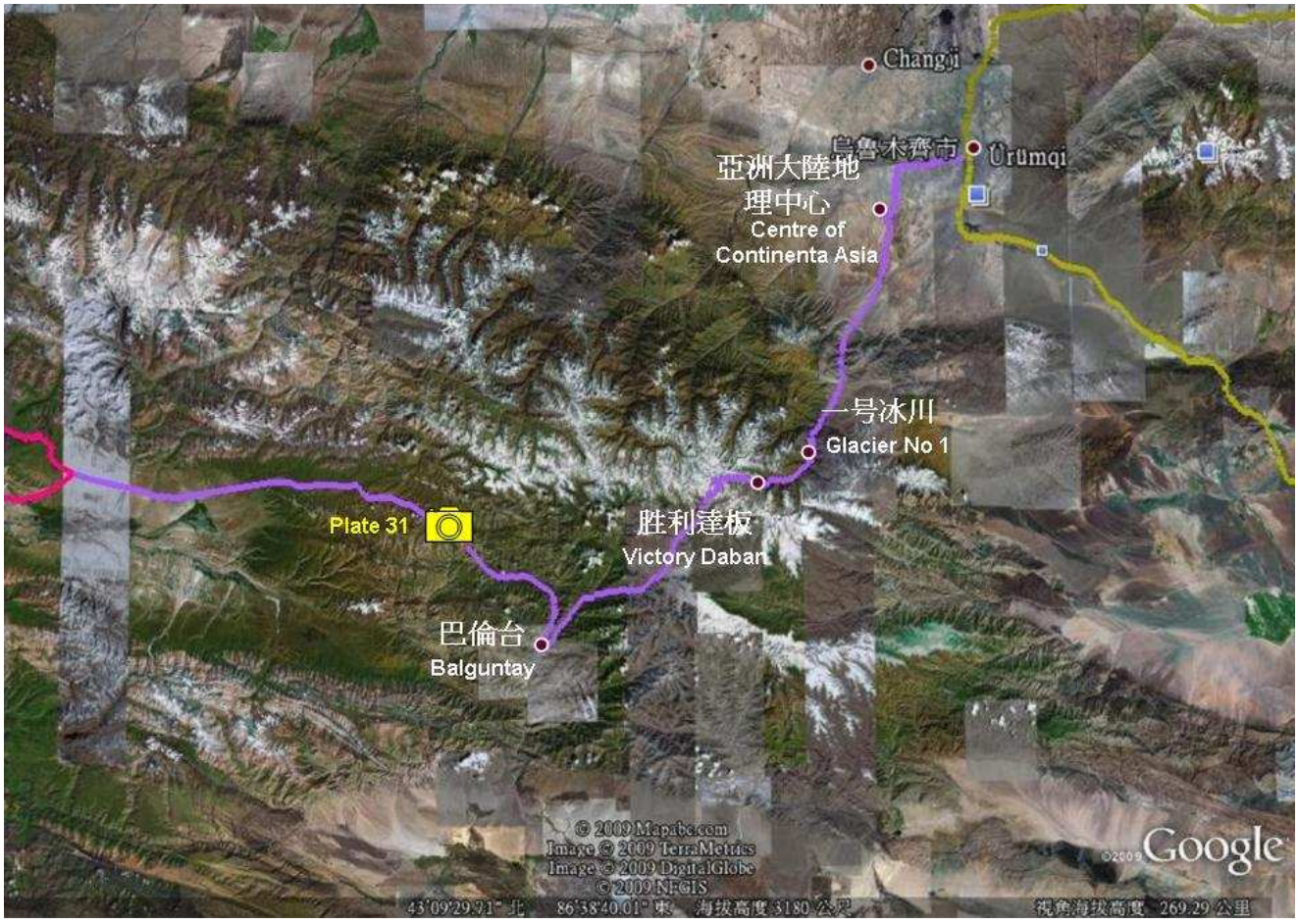

Plate 28 Glacier No 1 at Tianshan Mt

They have nearly vertical walls from which glaciers originate. Neighbouring cirques are divided by narrow ridges known as arête. Several arêtes join to a horn in the form of a sharp peak.

Contemporary glaciers are found at high altitudes of Tianshan Mt. For the easy access from Urumqi, the most visited glacier is the Glacier No 1 (Plate 28) of West Tianshan Mt. At 125 km south of

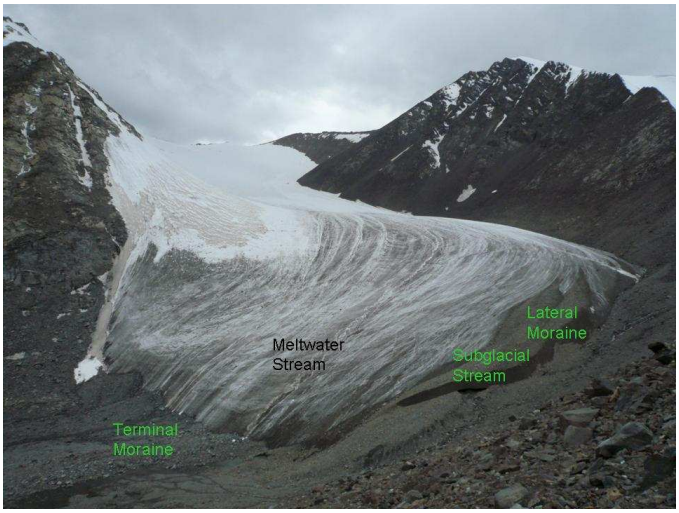

Plate 29 Snout of Glacier No 1

Urumqi, there are more than 150 glaciers in the district. Glacier No 1 is about 500m wide and 2.2 km long and is also the source of Urumqi River. We visited the glacier in the summer when it was retreating. We noted a relatively high volume of runoff from both surface meltwater and subglacial streams (Plate 29).

Apart from the current glaciation, post-glacial landforms of the last Ice Age were also identified at certain areas. The spectacular Kanas Lake (喀纳斯湖) in Altay Mt (Plate 30) is a portion of the Kanas River in a U shape valley. The valley was widened and deepened by valley glacier. The glaciofluvial deposition piled up moraine/till in a section of the glacier tough as a natural dam which now becomes the gorgeous Kanas Lake.

Plate 30 Kanas Lake

Plate 31 below presents another type of glacial depositional features near Balguntay (巴倫台) (Plate 28). Glacial erratics were transported and dumped by a continental ice sheet. Unlike rolling along a river bed, these boulders were moved inside the ice which had little chance of being rounded. They remained as angular fragments embedded in unsorted glacial till.

Plate 31 Glacial erratics

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4. Natural Resources

The tectonic history of Xinjiang started since the Archean. It recorded the earth's movements with the growth and accretion of plates, and the opening and dissipation of ancient oceans. The orogeny and the change in sea levels triggered mineralization as well as the formation of fossil fuels. Affluent natural resources are nature's gift granted to Xinjiang.

4.1 Mineral Resources

Altay means 'gold mountain' in native language, probably explaining why precious metals have been extracted from this area for a long time. Moreover, gemstones like aquamarine and tourmaline are also produced. Koktokay (Plate 2) is the mining centre of Altay Mt. The latter was the Paleozoic active continental margin in the southwest part of the Siberian Plate. Thousands of pegmatite intruded in granite around Koktokay. Most of them contain valuable and rare elements which are essential to modern industries.

Extensive excavation has been operated at Koktokay for beryl (Be), spodumene (Li), lepidolite (Li), tantalite-columbite (Nb-Ta), and pollucite (Cs). The most stunning feature of the area that draws visitors' attention is the No. 3 Mine (Plate 32). It is a large open pit which has been quarried since

Plate 32 Koktokay No. 3 Mine, one of the largest pegmatites in the district

the 1950's. After decades of operation, it ceased production in the early 2000's but re-opened in 2006. Now beryl is mined for beryllium.

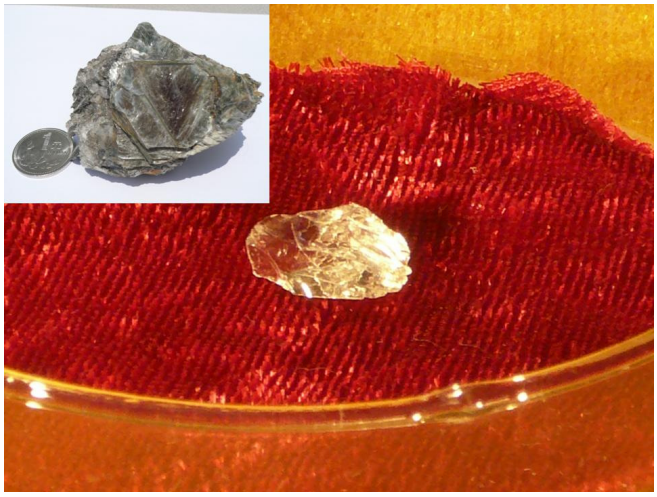

Plate 33 Irtyshite (Insert: muscovite, a common gangue mineral in No. 3 Mine)

Another talking point of the No. 3 Mine is the discovery of Irtyshite (額爾齊斯石) - a name of type

locality. It was once a unique mineral discovered in the earth and was later found in the Irtysh River area in Kazakhstan. Irtyshite is an oxide of Na, Ta and Nb. Details of the mineral are as follows:

- Chemical Composition: $Na_2(Ta, Nb)_4O_{11}$
- Colour: Colourless (Plate 33)
- Lustre: Adamantine
- Streak: WhiteCrystal System: Hexagonal
- Habit: Microscopic crystal
- Hardness: 6.8
- SG: 7.03
- Cleavage: None
- Fracture: Uneven; very brittle

Salt is a common economic mineral in arid regions, a direct result from repaid evaporation. There are many salt lakes and rock salt sites in Xinjiang yielding salt products. Yanhu (鹽湖) (Plate 34),

Plate 34 Yanhu - white salt crust at lake shore

meaning salt lake and close to Urumqi (Plate 9), is a production base for table salt, industrial salts, mirabilite, sulfuric acid and hydrochloric acid. The salt content of this lake is so high that it raises the density of the lake water. It has a state of great buoyancy that resembles the Dead Sea. Recently, a recreation resort has been built to utilize this wonder for tourist attraction.

4.2 Energy Resources

Coal mines are found in many areas in the Junggar Basin. They are not at great depths from the earth's surface. Therefore the opencast method of mining is adopted. We stopped at Beishan Coal Mine (Plate 16) near Qitai. The coal from this mine was found at the Jurassic strata. The operation was not large in scale but was effective because the overburden was not thick. It did not require heavy investment in equipments and machinery (Plate 35). According to local historical publications, this coal mine had been

Plate 35 Open pit of Beishan Coal Mine

operated since the Qing Dynasty. It is estimated to have a total reserve of anthracite up to 62.5 billion tons and the annual production is around 100,000 tons.

Xinjiang has the largest deposit of coal in China. When we traveled in the Junggar Basin, we came across individual opencast coal mines. In fact they were linked to a large coal belt.

Another vital fossil fuel resource in Xinjiang is petroleum. Karamay has been the traditional oil production base of the *New* China. Indeed the first oil well explored in Xianjiang was at Dushanzi (Plate 20) at the foothill of north Tianshan Mt. It

was drilled in the early 1900's (late Qing Dynasty).

The Karamay oil field started to produce crude oil in 1955. Oil was discovered in the region in the early 20th Century. In the 1940s, a local resident earned his living by collecting oil from an 'oil spring' at Heiyoushan (黑油山), meaning Block Oil Hill, 2 km northwest of Karamay (Plate 36). Crude

Plate 36 Oil 'spring' at Black Oil Hill

oil flowed out to the surface along joints and cracks and on mixing with sands (aeolian sediments), it became natural asphalt. This process continued and the 'spring' gained its height to become a small mount that received its name.

Plate 37 Karamay Oil Field

The most prominent view at Karamay which came to sight was the densely spacing pumpjacks (Plate 37). They were relatively small in size. The daily production of each pumpjack was about several tons of oil. Compared with the daily output of several thousands tons produced from one machine in the Tarim oil field, one will note the low efficiency at Karamay. This can be explained by two reasons: the physical characteristics of oil extracted from this region and the geological structure of these oil fields.

Karamay produces heavy crude oil which is viscous in nature. It contains 40% to 60% of hydrocarbons in content and flows slowly. In order to raise yields, engineers employ steam stimulation as a technique to tackle the problem. Steam is injected underground through a pipe system to warm up the oil for the lowering its viscosity.

The oil fields of Karamay exist in the Permian, Triassic and Jurassic strata. They are mainly conglomerates of ancient alluvial fans and river banks. Unlike oil reservoirs in sandstone which have a homogeneous structure, the uneven grain sizes and complicated pore structure of conglomerates hinder the effectiveness of oil extraction.

The contents taken out from oil wells comprise of oil, gases and ground water. They are pumped to a central processing plant for separation. Water is drained back into the ground. Gases are toxic; after being treated, they can generate electricity for Karamay. A portion of the oil output is processed locally at Kuitun (奎屯) and Dushanzi for the production of polymers. The rest is transported to Lanzhou (蘭州) for refining into fuel oil and other by-products. Apart from fossil fuels, renewable energy sources receives much attention now for their potential development in Xinjiang.

Xinjiang enjoys long sunshine duration which

favours the utilization of solar power. Although present technology does not support commercial power generation, solar power for running small home appliances is used by some herdsmen who migrate seasonally for pasture with their tents.

Plate 38 Panels of solar cells (at the bottom of antenna) for a transmission station near Fuyun

Another common application of solar energy is the power supply for telecommunication transmission stations in remote areas (Plate 38). We traveled along desert roads during our trip and our mobile phones were well connected with adequate signals (except intentional blockage).

Compared with solar power, wind power is much more widely used in a large scale. We passed by two windfarms en route. The first one was at Five Colour Bay near Burqin (Plate 5).

Plate 39 Daban Windfarm

The second was Daban Windfarm (達板風力發電站) which was one of stopping points on our way to Turpan (Plate 39). The windfarm was situated at a pass in between East and West Tianshan Mt south of Urumqi. The north-westerly trade wind blows through the pass and causes gale with effective force. This is an ideal location to set up the windfarm.

4.3 Water Resources

Water is the most precious matter in a desert. Local people adopted traditional wisdom when uilding the Karez (坎兒井) to collect snow water for cultivation. A Karez is water tunnel dug manually to transport water from the foothills of Tianshan to farmland (Plate 40).

Plate 40 Series of shafts near Turpan indicates the alignment of Karez that exist underground (Source: Google Earth)

Usually a Karez was constructed at a place where the surface rocks were permeable. If canals were built on land surface, serious seepage would decrease the efficiency of the water supply. So the Karez was burrowed into impervious strata below surface allowing it to convey water with less

wastage. However, modern technology of erecting large reservoirs at upstream and connecting to the main water systems replaced the function of the Karez system. As the natural drainage is now interrupted by dams, water supply to the Karez has decreased, making the Karez insignificant today but is left as a tourist attraction.

5. Paleontological Heritages

Qitai (奇台) National Geopark (Plate 16) covers a wide area with various fascinating fossils spots, namely Petrified Forest, Dinosaur Valley and Shiqian Beach (石錢灘).

Petrified Forest (奇台硅化木森林) gets its fame from being the second largest of its kind in the world (after the Petrified Forest National Park in Arizona, US). Buried beneath the earth's surface, logs of Jurassic sequoia and gingko (Plate 41) were silicified by the underground water which replaced the original cells with silica. The morphology of tree trunks was preserved but the body was made up of cryptocrystalline quartz. Some of them are pretty chalcedony. Agate, a variety of chalcedony, can be found at Agate Hill (Plate 16). At this location, agate fragments spread over the desert but collection of good samples requires patience.

Plate 41 Petrified wood, Qitai

In the vicinity of the Petrified Forest are the Dinosaur Valley and Shiqian Beach. Dinosaur Valley was an important excavation ground for dinosaur fossils of the Upper Jurassic. It is now turned to an exhibition house with 'in situ' fossilized dinosaur bones (Plate 42).

Plate 42 Dinosaur bones at Dinosaurs Valley (Inserts: fossils found at Shiqian Beach)

Shiqian Beach means 'stone coins' beach. The stone coins were mainly cross section pieces of fossilized crinoid stems. They were formed by the weathering from rocks of Upper Carboniferous. Apart from crinoids, there were fossils of marine invertebrates like corals, brachiopods, gastropods, cephalopods, bivalves etc. They indicated the existence of shallow sea in the Junggar Basin at the time of Upper Carboniferous.

In the upper left insert of Plate 41, both longitudinal- sections and cross sections of crinoids are displayed. The two right-most samples are pressed cross section. In the right bottom insert of the same plate, from left to right are pieces of coral, gastropod and another coral.

During our trip, fossilized plant fragments were also noted at Beishan Coal Mine and Five-Colour City.

6. Mirage

Mirage happens as a common phenomenon in a desert. We observed one just before arriving at Dinosaurs Valley of Qitai National Geopark. A mirage is a refraction of light when it passes through two layers of air of different optic densities. The hot ground surface of a desert heats up the air above it. This causes a sheet of air having diverse temperature and humidity

Plate 43 Mirage observed in east Junggar Basin

compared with the level of air above it. Because of the different characteristics of these two layers of air masses, light changes its speed which results in refraction. When this refracted ray reaches our eyes, it gives us unusual images such as the misplacement of objects.

This may lead to our wrong interpretation on what we see. In Plate 43, a lake seemed to appear in front of us. In reality, the 'lake' was just a refracted image of the sky.

Afterword

A field trip is always the best way of studying geology. Although we covered 4700 km in 13 days (excluding the time in Urumqi) in north Xinjiang, it was by no means a comprehensive study of the complex structure and geology of the area. Due to the adverse political atmosphere when we went and the inadequate preparation on field information, some major geological sites were missed during our trip.

This note is compiled with references read after the trip. It is my wish that it would help to enrich our knowledge and make our trip a valuable contribution to the study of Xinjiang geology.

Last but not the least, I would like to thank GSHK for giving me the chance to deliver this report. My grateful thanks are also due to Carina for her meticulous letter-by-letter proof reading of the above content; to Lin Hoi Yung for his assistance in gathering the relevant journals; to Mr PS Nau, Mr KW Lai and Dr Shaw for their on-site lectures during the trip; and also to Mr Ma, our driver who worked in oil company for years, for the sharing of his rich knowledge of the regional geology. Photos of this report are taken out from the Group's collection.

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