

REPORT

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# Tunkhel and Mandal Artisanal Operations

Selenge province, Mongolia

Technical Report

July 2022 / Version 3.0

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## About the Author

The Artisanal Gold Council (AGC) is a charitable non-profit NGO dedicated to improving the opportunities, environment, and health of millions of people involved in artisanal and small-scale gold mining (ASGM) in the developing world. Based in Canada, AGC has worked in over 30 countries and with hundreds of artisanal and small-scale mining communities around the world on topics including but not limited to: community development, poverty reduction, formalization, mining policy, markets and supply chains, public health, environmental management, mining engineering, and human rights.

AGC operates from the principle that improving the global ASGM sector requires direct intervention at the community level. The AGC therefore has a long history of working with mining communities. Lessons learned, and knowledge gained from working with ASGM communities around the world, are embedded in the design of all AGC's teaching and learning materials.

Find out more at: [www.artisanalgold.org](http://www.artisanalgold.org)



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## About This Report

This technical geological assessment report was developed by Jose Luis Barillas-Diaz, MSc, Exploration Geologist of the Artisanal Gold Council (“AGC”), Enkhbayasgalan D., MSc, Geologist of AGC Mongolia, and O. Byambasuren, Technologist Engineer of AGC Mongolia. This report presents the findings from the geological fieldwork conducted in the Tunkhel village area and Mandal soum, Selenge province conducted in May 2022. The objective is to provide an outline of the artisanal exploitable mineral resources for the two small-scale gold mining (“ASGM”) from the planetGOLD Mongolia project in the Selenge Province. This document is designed to serve as the geological basis for the development of practical recommendations and strategies for the efficient mining and processing of the mineral resources using mercury free technology.

This document has been developed for the use and benefit of the planetGOLD Mongolia project activities and to support business planning for the subject communities of small-scale miners.

Disclaimer: This report does meet National Instrument 43-101 standards of disclosure for mineral projects (“NI 43-101”).

*The planetGOLD Mongolia project is working toward eliminating mercury in the artisanal and small-scale gold mining sector by using a bottom-up approach; involving members of the sector directly in the creation, and the implementation of policies and practices, to sustainably improve mining operations and livelihoods. The planetGOLD Mongolia project is funded by the Global Environment Facility; implemented by the NRDC, and the Ministry of Environment and Tourism of Mongolia. The Artisanal Gold Council acts as the executing agency.*

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# Abbreviations/Acronyms

Abbreviation/Acronym	Definition
<b>ASM</b>	Artisanal and Small-Scale Mining
<b>ASGM</b>	Artisanal and Small-Scale Gold Mining
<b>LSM</b>	Large-Scale Mine
<b>MASL</b>	Metres Above Sea Level
<b>MFPS</b>	Mercury-free Processing Systems ("MFPS")
<b>NKGB</b>	North Khentei Gold Belt
<b>QSP</b>	Quartz Sericite Pyrite
<b>SKP</b>	Shijir Khishig Mining Partnership
<b>SLSM</b>	Surleg Mandal Large Scale Mine

## Introduction

‘Tunkhel village’ and ‘Mandal soum’ are two sites selected as part of the planetGOLD Mongolia pilot project—small-scale mercury-free processing systems (“MFPS”) in Mongolia. The project's objective is to increase gold recovery using mercury free systems, and to implement best ASGM practices at the two sites. The Tunkhel operation is an artisanal gold extraction site roughly 18 km west of the village of Tunkhel, in Mandal soum. Mandal is a small-scale mine operation exploiting a polymetallic deposit approximately 93 km north of Tunkhel village. Both projects are located in the southern portion of the province Selenge Aimag. In the immediate vicinity of the two study areas are the world-class gold deposits: Gatsuurt and Boroo (Figure 1). Tunkel is approximately 5 km SE of the Gatsuurt gold mine (currently owned by Boroo Pte. Ltd.) and Mandal is 40 km NE of the Boroo gold mine. The two gold large-scale mines (“LSM”) are separated by approximately 34 km.

The Tunkhel site has been active for more than ten years; employing roughly 180 miners between two ASGM sites:

- ▶ Bor Tolgoi (~10 ha); and,
- ▶ Bulag (5 ha)

Bulag is a more recent operation, that has operated under a federal ASGM license since 2019. The artisanal miners are currently advancing an adit, at this site, that has not yet accessed gold mineralization. At the time of writing; no material was being processed from this access point. A series of vertical artisanal mine shafts, at Bor Tolgoi transect the mineralized zone, targeted by the adit and are actively producing gold bearing material along strike. The majority of vertical mining shafts in the study area are abandoned due to geotechnical issues, and/or losing the mineralized feature. Only six shafts were operational at the Bor Tolgoi site at the time of the site visit in May 2022.

Mandal soum has four artisanal organizations, totaling roughly 150 miners, operating at the Noyot Mountain ASGM site (12.3 ha). Only two of the four organizations, Shijir Khishig mining partnership (SKP) and Duush Mandal NGO, allowed access to their operations during the field visit (May, 2022). In the southern region of Noyot Mountain; Surleg Manal cooperative currently operates a medium-scale mine and is commissioning a new project called the Mandal MTE partnership. The artisanal operations target different levels of the Noyot Mountain mineralized zone.

The purpose of this technical report is to estimate the geological potential, via underground geological mapping and geochemical sampling, of the specified areas to support artisanal mining and processing operations. Further, the report is intended to support a business case for outside investment in the Tunkhel and Mandal artisanal processing and/or mining operations.

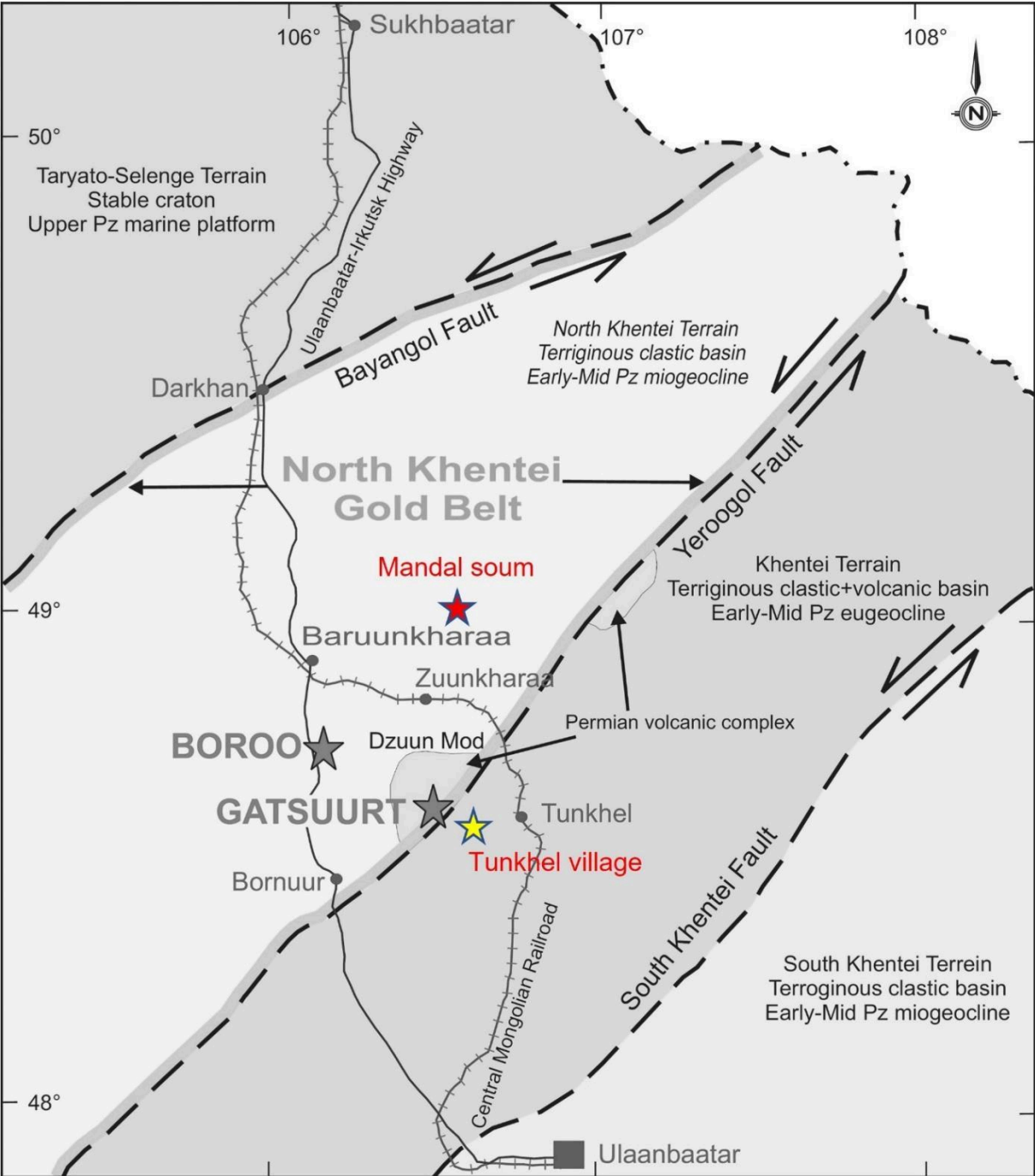


Figure 1: Major tectonic features, LSM gold mines, and the two ASGM selected study areas (Cluer et al., 2005).

Tunkhel and Mandal are located in the North Khentei Gold Belt (“NKGB”). Mandal is in the center of the tectonic feature; whereas, Tunkhel is on the sinistral regional strike-slip Yeroogol fault that

is considered terrane-bounding between the NKGB and Khentei Terrain (“KT”) (Figure 1). The Yeroogol fault borders the Kharaa Terrain along its southeastern margin and the Khentei Terrane in the southeast. In addition, several linear accretionary metallogenic belts are present within the southern part of the region which include gold-quartz vein deposits and occurrences.

Detailed geological mapping, and a geochemical sampling program, for this study, centred on the Tunkhel Site (~51 ha) and the Mandal site (~15 ha). The mapping and sampling program focused principally on the underground operations and mineralogical description of samples from the artisanal shafts.

The sampling program consisted of rock chip samples from surface outcrops, trenches, and underground mines, shaft waste rock, as well as waste core samples from historical exploration programs in Tunkhel and Mandal. The SGS laboratory in Mongolia conducted sample testing consisting of fire assay, aqua regia digest, ICP, and bulk density. A standard QA/QC program was employed to validate the results from the laboratory.

This technical study summarizes and interprets geological, geochemical, and structural data acquired during fieldwork. Estimates of the geological potential for exploitable artisanal resources, of the Tunkhel and Mandal sites, are based on recommended techniques (Erasmus, 2021). This study does not adhere to National Instrument 43-101 “NI 43-101” reporting standards.

## Property Description and Location

Tunkhel is located approximately 110 km north of Mongolia’s capital city of Ulaanbaatar in the Mandal Soum (District) of Selenge Aimag (province), north-central Mongolia. The project is roughly at latitude 48° 35’ 30” N and longitude 106° 36’ 41” E. Tunkhel Bagh (village) is located 19 km to the northeast of the ASGM site; and is an administrative unit of Mandal soum, with a population of approximately 1,400 (2021).

Table 1: Tunkhel and Mandal legal status

Aimag	Soum	Area (ha)	Organization	Status
Selenge	Mandal (Tunkhel)	5.0	Tunkhel Manlai and Tunkhel Tuuchee partnerships	Bulag official ASGM site
Selenge	Mandal (Tunkhel)	>10	Baatar Vangiin Khishig NGO	Bor tolgoi old ASGM site
Selenge	Mandal		SKP (Certified Partnership by Fair-mined Standard)	Noyot ASGM site
Selenge	Mandal	12.3	Surleg Mandal	
Selenge	Mandal		Duush Mandal Khairkhan kholboo	
Selenge	Mandal		Mandal MTE	

Table 2: Geographic and UTM Coordinates of Bulag ASGM land

Corner	Geographic coordinates								UTM 48 N			
	Latitude				Longitude				Latitude	Longitude	East (X)	North (Y)
1	48°	35'	29.1"	N	106°	36'	33.7"	E	48.591	106.609	618670.63	5383287.29
2	48°	35'	32.6"	N	106°	36'	38.6"	E	48.592	106.610	618768.71	5383397.47
3	48°	35'	30.5"	N	106°	36'	54.0"	E	48.592	106.615	619085.50	5383339.29
4	48°	35'	26.4"	N	106°	36'	51.2"	E	48.590	106.614	619030.83	5383211.49
5	48°	35'	27.0"	N	106°	36'	41.7"	E	48.591	106.612	618835.85	5383225.91

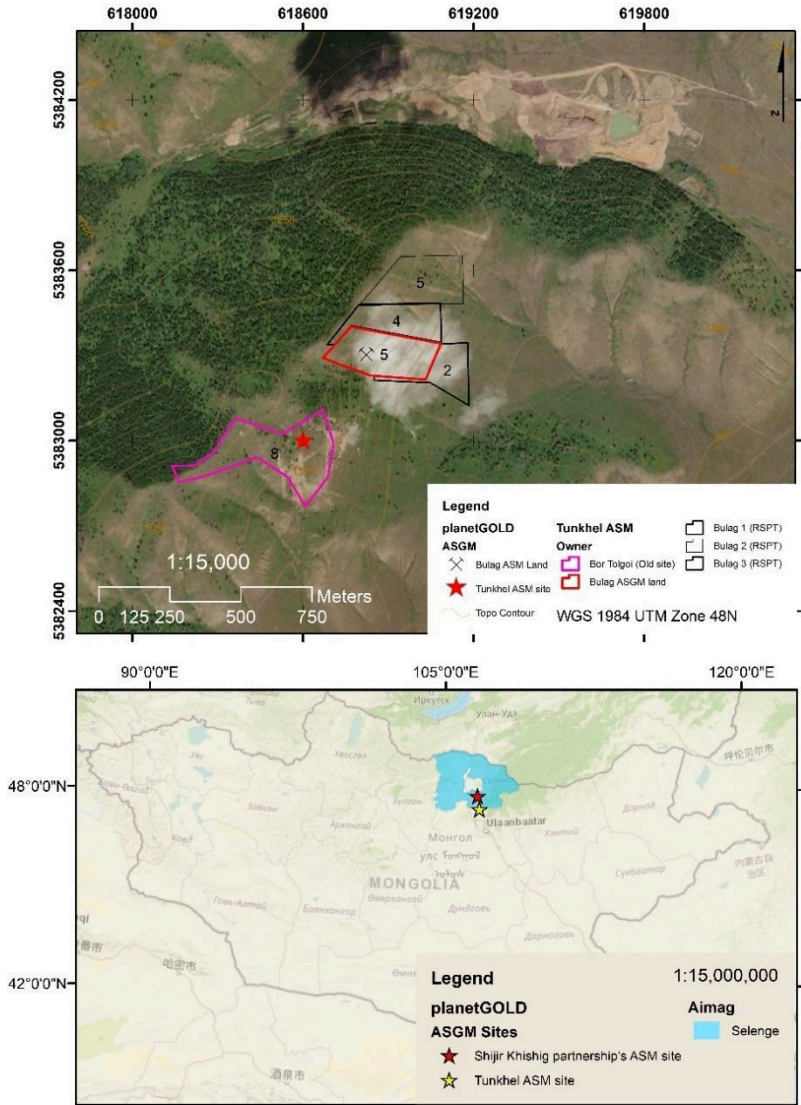


Figure 2 Map showing the Tunkhel location and the mining organizations in the study area

The Mandal study area is in the Noyot Mountain region, located approximately 22 km north of Mandal soum (the capital of Selenge Aimag) and 196 km from Ulaanbaatar city. Mandal is the largest district in Mongolia that is not a provincial capital, and has a reported population of 27,011 (2019).

Table 3 Geographic and UTM Coordinates of the SKP ASM site

Corner	Geographic coordinates						UTM 48 N					
	Latitude			Longitude			Latitude	Longitude	East (X)	North (Y)		
1	49°	0'	13.18"	N	106°	32'	1.73"	E	49.004	106.534	612177	5428996
2	49°	0'	12.11"	N	106°	32'	8.89"	E	49.003	106.536	612323	5428966
3	49°	0'	22.55"	N	106°	32'	8.12"	E	49.006	106.535	612301	5429288
4	49°	0'	20.92"	N	106°	32'	13.78"	E	49.006	106.537	612417	5429240

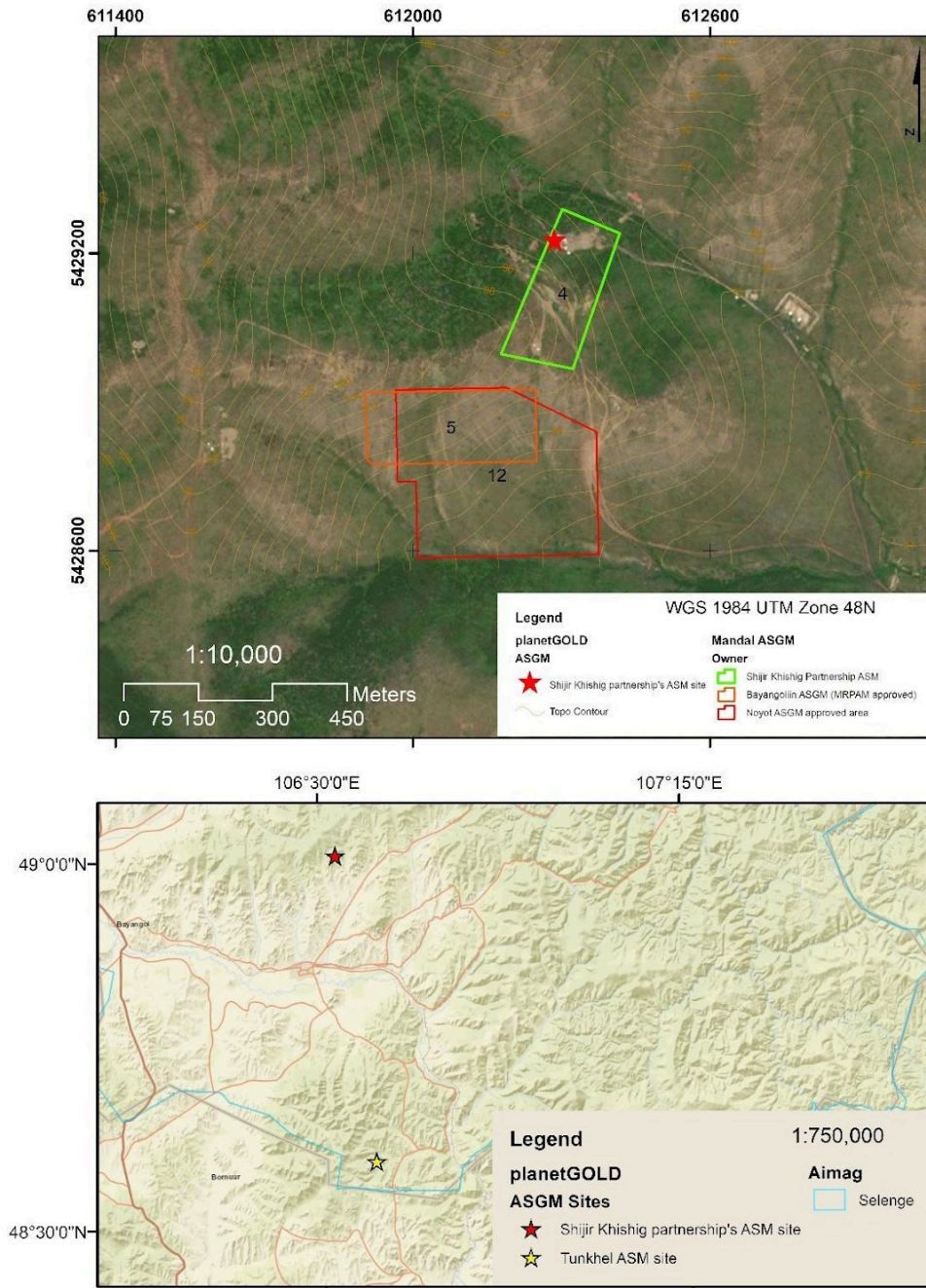


Figure 3 Map showing the Mandal location and the mining organizations in the study area

LSM Surleg Mandal is located approximately 1.2 km SW from the Tunkhel ASGM operation. The industrial scale operation is centred on mining a placer gold deposit (Lode gold); Which recently started underground mining (Figure 2). The Shijir Khishig Partnership ASM claim is located on the northern slope of Noyot Mountain (Figure 3; green polygon). The “Surleg Mandal” SLSM area is depicted by the red polygon on Figure 3.

## **Accessibility, Climate, Local Resources, Infrastructure and Physiography**

### **Accessibility**

The Access to Tunkhel project is partly via the highway connecting Ulaanbaatar to Selenge province center (Sukhbaatar), which takes approximately three hours. There is a two-lane all-weather road through the countryside, that leading to the site which is approximately 10 km from the highway. The same gravel road connects Tunkhel village to Mandal soum (Figure 4) and it takes ~3 hours to drive between sites.

Land transportation is the primary means of moving people, goods, and services from the Ulaanbaatar to Mandal Soum.

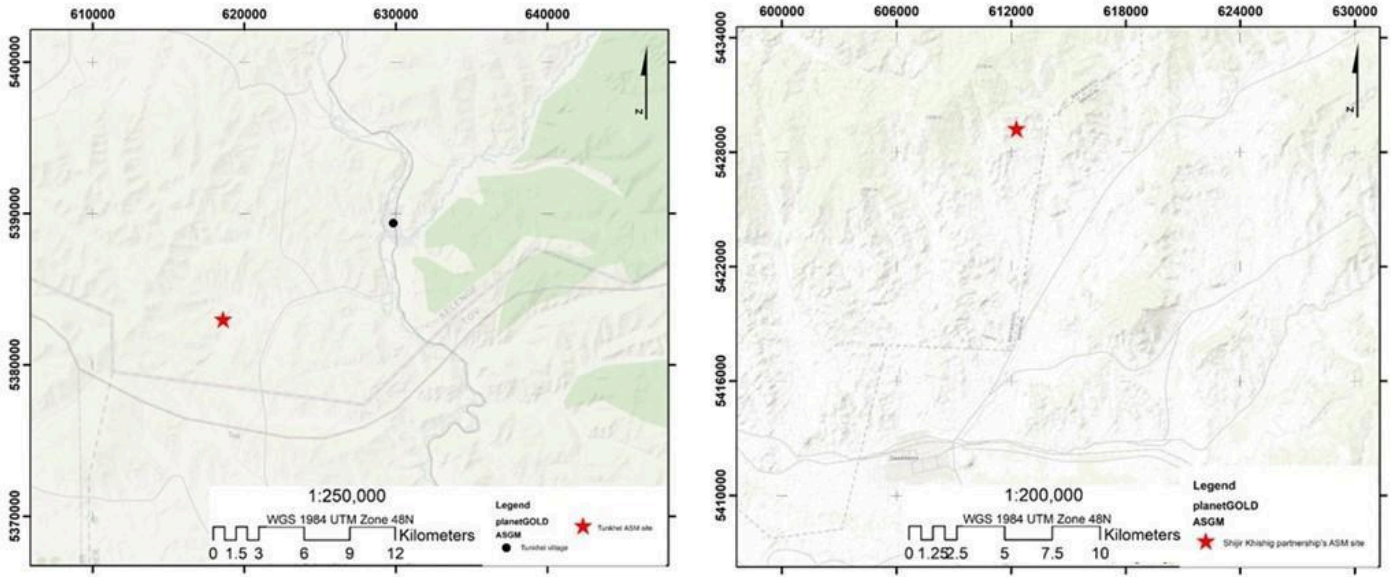


Figure 4 Left, Map with the main roads to access to Tunkhel ASGM; Right, Map with the main roads to access of Mandal soum and Noyot Mandal ASGM

## Climate

The climate in the project area is mid-continental and is therefore temperate to cold. The average annual temperature is approximately 0°C but drops to minus 40°C from December through February. Summer temperatures may exceed 40°C; however, on average the daytime summer temperature is ~20°C.

The area receives about 28 cm of precipitation annually, most of which is rainfall from July through August. Winters are relatively dry, with a moderate amount of snow that may persist on the ground from early November to April due to prevailing low temperatures. Although the climate may present some challenges to heavy equipment operation, the Boroo Gold Mine and Mill have demonstrated the ability to operate effectively year-round (Figure 5).

Field exploration is the most efficient from March through November, although drilling operations can continue throughout the year.

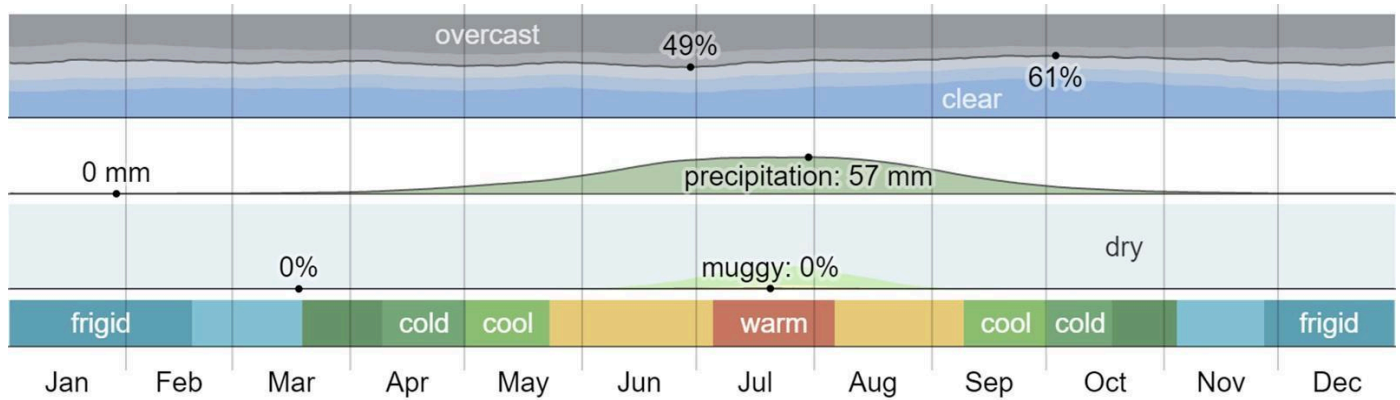


Figure 5: Chart of the yearly average weather in Mandal soum

## Local Resources

Tunkhel village has a working-age population of 1,400 people, of which 250 have permanent jobs, and about 650 are categorized as unemployed. Many of the villagers started gold mining during times of economic hardship. Apart from the traditional rural livelihoods of herding and agriculture, the leading employers are timber operations near the village. Timber operations offer seasonal work twice yearly and employ approximately 300 to 400 people. Hard rock ASGM operations began informally in Tunkhel around 2007 at the Bulag mining site. The site is currently recognized as a formal artisanal and small-scale mining operation and is fully permitted.

Mandal is the largest soum in Mongolia with a population of 27,011 as of 2019. That same year, the working age population totaled 16,717 people which made up 62% of the total force in Selenge province. The soum is 484,373 ha the majority of which is prime agricultural and crop land. The region accounts for 21% of the total vegetable production for the province (SASD, 2020). Artisanal gold mining has become one of the primary sources of income in this community and the soum Governor's Office (KII, 2020) has committed to actively supporting and organizing the sector. According to the Governor's Office, there is one large-scale mining license and about 1,000 artisanal gold miners based in Mandal soum.

Approximately 70% of the soum is timbered and supports forestry-based enterprises. The forested area surrounding the Tunkhel Village has been declared a protected natural reserve where mining is prohibited. However, the reserve continues to be subject to timber harvesting.

## **Infrastructure**

The Tunkhel and Mandal study areas are sparsely populated and are inhabited by mainly nomadic herdsman living in small camps and villages. Skilled labour, replacement parts and other support services are generally sourced in Ulaanbaatar (the capital city).

Ulaanbaatar has a population of over 1,300,000 inhabitants (as per 2013 census) consisting of roughly half of the country's entire populace. The city is also Mongolia's central hub for road, rail, and international air services.

The Mandal soum farming community is the largest settlement near the two project areas with approximately 14,000 inhabitants (as of 2004) lies ~30 km north of the project area. Basic medical services, fuel and unskilled labour can be sourced from this community.

### *Water Supply*

Abundant water is available throughout the year at both subject sites. The Tunkhel operations source water from a well downhill of the mine site that was sunk by Boroo Gold for the benefit of the herder community. This well is the central water source for mine operations.

The Mandal and Surleg operations retrieve water from historical mine workings. At the time of the site visit, underground mining at Surleg ceased due to mine flooding.

### *Power Supply*

National grid power is unavailable at the artisanal mining sites. Both areas source power via medium-scale diesel-gasoline generators (gensets).

### *Communication*

Mandal soum and Tunkhel village have internet, telephone, and mail services. However, wireless phone coverage is intermittent at both sites. Cell reception is generally limited to topographical highs at both locations.

### *Mining Companies*

There are a handful of industrial (historical and operational) in the vicinity of the ASGM operations:

- ▶ Balchzhi placer gold mine (unknown ownership):

- ▶ Gatsuurt Gold mine (OZD Asia Pte. Ltd.);
- ▶ Boroo Gold Mine (Boroo Pte. Ltd.); and,
- ▶ Sharyn Gol Mine Mongolia (Sharyn Gol Joint Stock Company).

## **Physiography**

Mongolia is made up of a diverse set of landforms. Travelling from north to south, the country is categorized by the presence of four major terrains: mountain forest steppe, mountain steppe, as well as semi-desert and desert in the extreme south. North-central Mongolia includes at least two major landscape types of upland steppe: “Boroogol terrain” and “Dzuun Mod”.

The Boroogol terrain is typified by gentle relief and moderately steep, rolling hills covered by grasslands with small discontinuous forests on north-facing slopes. The average elevation is 1,200 metres above sea-level (“MASL”). Streams are moderately or poorly developed and the higher order streams, in large part, are ephemeral. Loess (windblown silt) soil dominates the top of the soil profile source?.

The “Dzuun Mod” terrain in the project area consists of rolling to steep mountains with moderately forested northern and eastern facing slopes generally devoid of bedrock outcrop. The forest cover typically consists of birch, pine, and larch species. The dryer south and west-facing slopes are grass-covered and very steep with 15% to 20% of the slopes having exposed rock outcrop (Figure 6).

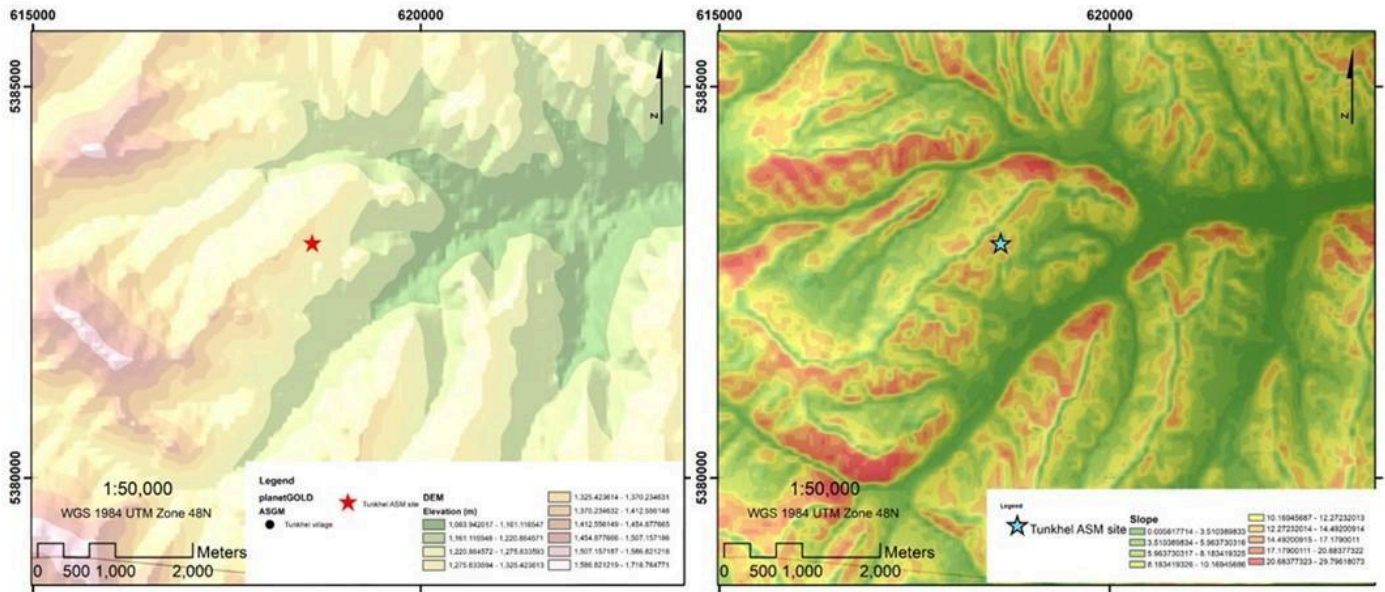


Figure 6 Elevation and Slope map of Tunkhel ASGM

The average elevation of the study area is 1,300 MASL. Major river valleys are just under 1,000 MASL; whereas the highest mountains are less than 2,500 MASL. Podzol soils dominate the region and streams are moderate to well developed. Solifluction is common and evident as “contour” lines on grassy slopes in both the Dzuun Mod and Boroogol terrains. Tunkhel has an elevation of ~1318 MASL with a slope 10° to 15° towards the east. The geomorphology at the Tunkhel ASGM site consists of an elongated mountain ridge-top, trending NE-SW with gentle slopes on both sides of the rise. At Mandal, the elevation averages ~1224 MASL and the slope >20° towards the east. The slopes surrounding Noyot Mountain are moderately steep and the mountain has a semicircular geo-form due to the underlying intrusive body that forms it.

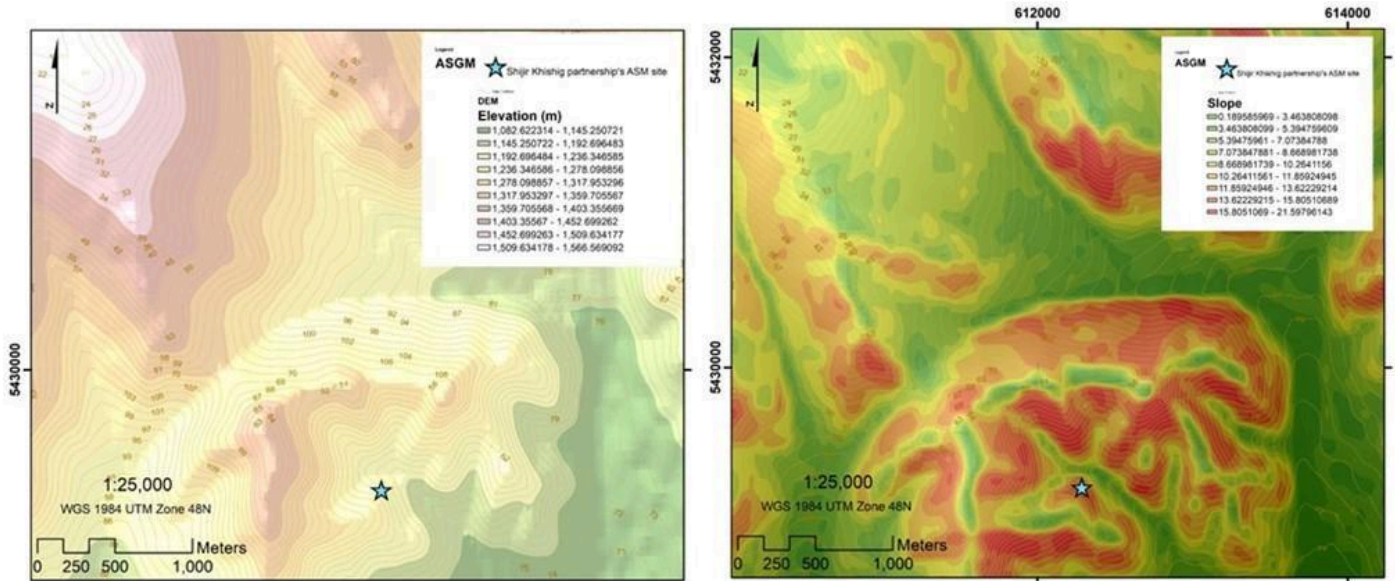


Figure 7 Elevation and slope map of Mandal ASGM

## History

### Tunkhel

The history of ASGM Exploration in the Tunkhel ASGM region spans several intervals from the 1970s through to today. Mining in the area evolved from an initial gold placer discovery to hard rock mining with the discovery of load gold. This led to the development of the world-class Gatsuurt and Boroo deposits consisting of more than 3Moz of gold. That said, most of the historical exploration as well as the initial discoveries in Tunkhel have been through the work of artisanal miners.

Pan concentrates collected during a Mongolian government mapping program in 1970 detected gold in samples along a length of 1.5 km in the Gatsuurt Valley. Trenches and shallow pits were also sampled; however, no further follow-up work was carried out due to mercury being the exploration focus of the campaign. In 1989, a series of drill holes were advanced in parallel fence patterns with a cable-tool rig. Low gold concentrations were detected in the holes located in the lower part of the Gatsuurt Valley. Despite these indicators, the Gatsuurt placer deposit was not discovered until 1991 as the result of a detailed geological exploration program in the Zuun Mod (Noyon) district. The initial gold placer resource at that time was estimated at 2.5Mt of contained gold (or ~80koz). As a result of this significant gold discovery, two ASGM operations were

organized to the north and south of Tunkhel for the extraction of placer gold.

In 1998, alluvium was sampled for gold as part of a broad exploration program in an attempt to trace the bedrock gold source for the placer deposit. Detailed mapping of the Gatsuurt placer deposit as well as region soil sampling were conducted. The survey uncovered strong gold and arsenic soil anomalies on the south slope of what turned out to be the Central Zone and the Main Zone of the Gatsuurt deposit (Figure 8). The soil sampling program also identified several gold anomalies along the northeast extension of the future Central Zone. As a result of the success of the soil sampling campaign, the number of individual artisanal gold miners ("Ninjas") and small-scale miners (NGOs, partnerships, and cooperatives) increased almost exponentially reaching a peak of more than 2000 miners (personal conversations with Centerra Gold management - 2019).

In the vicinity of the Tunkhel ASGM operation, six drill holes collars were located from a historical drilling program likely dating from the 90s.

In 2019, Bulag was permitted for ASGM exploitation. The cooperative excavated exploration trenches and later advanced a mine adit. At the time of the site visit, this adit had a total length of 76 m at an inclination of 9°. Also in 2019, an Induced Polarization ("IP") geophysical study was conducted by SOD SORTOO LLC (Appendix A) at the Tunkhel site.

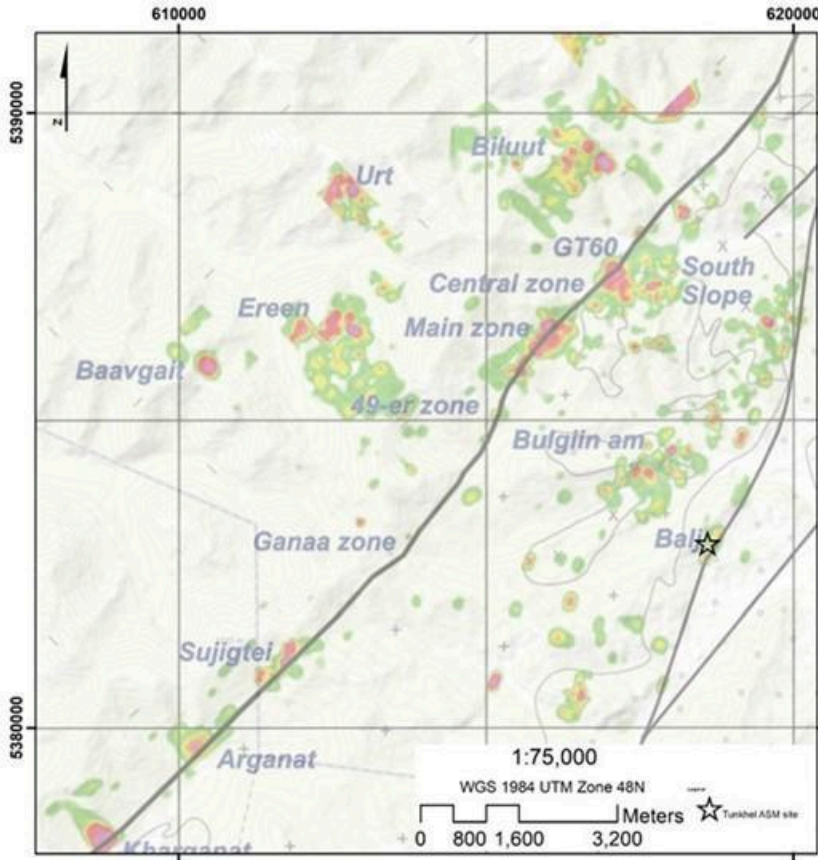


Figure 8 The Regional Au geochemical soil anomalies map conducted by Centerra in 2017



Figure 9 Bulag ASGM Main Mining Tunnel

## **Mandal**

Geological exploration of the Noyot mineralized zone was conducted over several intervals dating from the 1990s to the present day. In the Mandal ASGM region, the first geological work was conducted by Chinese companies which developed a mine tunnel. Currently this tunnel is inside the SKP operational area in Mandal. The main tunnel has a length of 20 m with 230° azimuth and a dip of -35°. The length measured during this study was 140m. This is the oldest mine working in the Mandal study area.

At the top of the Noyot Mountain, in the NGO Duush Mandal zone, there is intermittent illegal mining by artisanal miners. Lower down the mountain, on the southern slope, the Surleg Mandal Cooperative has a formal ASGM exploitation permit. This cooperative has been relatively successful and is the fastest growing small-scale operation in the region (Figures 10 and 11) and is semi-mechanized.

Several large-scale, conventional exploration programs have worked this area. Rock core samples from previous exploration programs were identified during fieldwork (Figure 12) and a geophysical campaign was in progress in the western portion of Noyot Mountain.

Access to the Surleg operation was not granted during the site visit, and no information on the mine was found in the public domain.

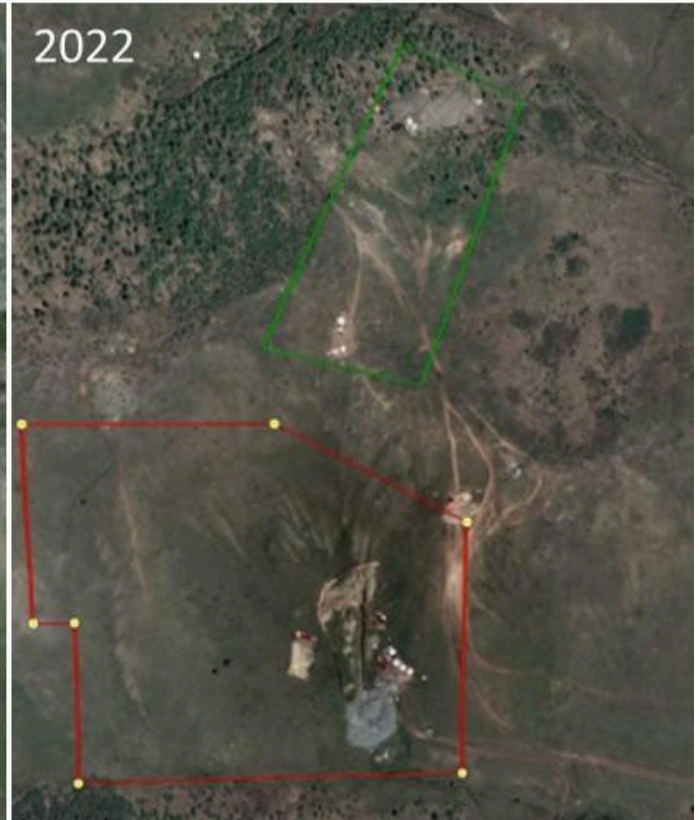


Figure 10 Historical mining activities in the Noyot Mountain. The red polygon represents the Surleg ASGM and the green polygon the SKP. In less than 18 years, mining activity has increased substantially in the area. The growth of the Surleg Mandal SLSM is evident



Figure 11 Surleg Mandal SLSM located at the south of the Noyot Mountain in the Mandal ASM



Figure 12 Drill Core samples historical exploration program(s) NW-W Noyol Mountain

## Geological Setting and Mineralization

### Regional Geology

#### *Tectonic Setting*

Mongolia occupies a central part of the Asian continent, and an interior portion of the Eurasian Plate. Major tectonic events occurred during the Paleozoic and early Mesozoic when exotic terranes and micro-plates were repeatedly accreted to the ancient core of the Siberian plate (Cluer et al. 2005; Khishgee et al. 2014). The age of the terranes in Mongolia thus decreases southward, with the northern Tuva Terrane consisting mostly of Proterozoic and Lower Paleozoic rocks while the Southern Terrane contains an important component of Permian to Jurassic intrusives. A major Caledonian event cratonized northern Mongolia, while a subsequent Hercynian event affected central and southern Mongolia. Post-Permian intrusions were of anorogenic alkalic affinity, and Mesozoic volcanics were extruded in response to extensional relaxation (Cluer et al. 2005; Khishgee et al. 2014).

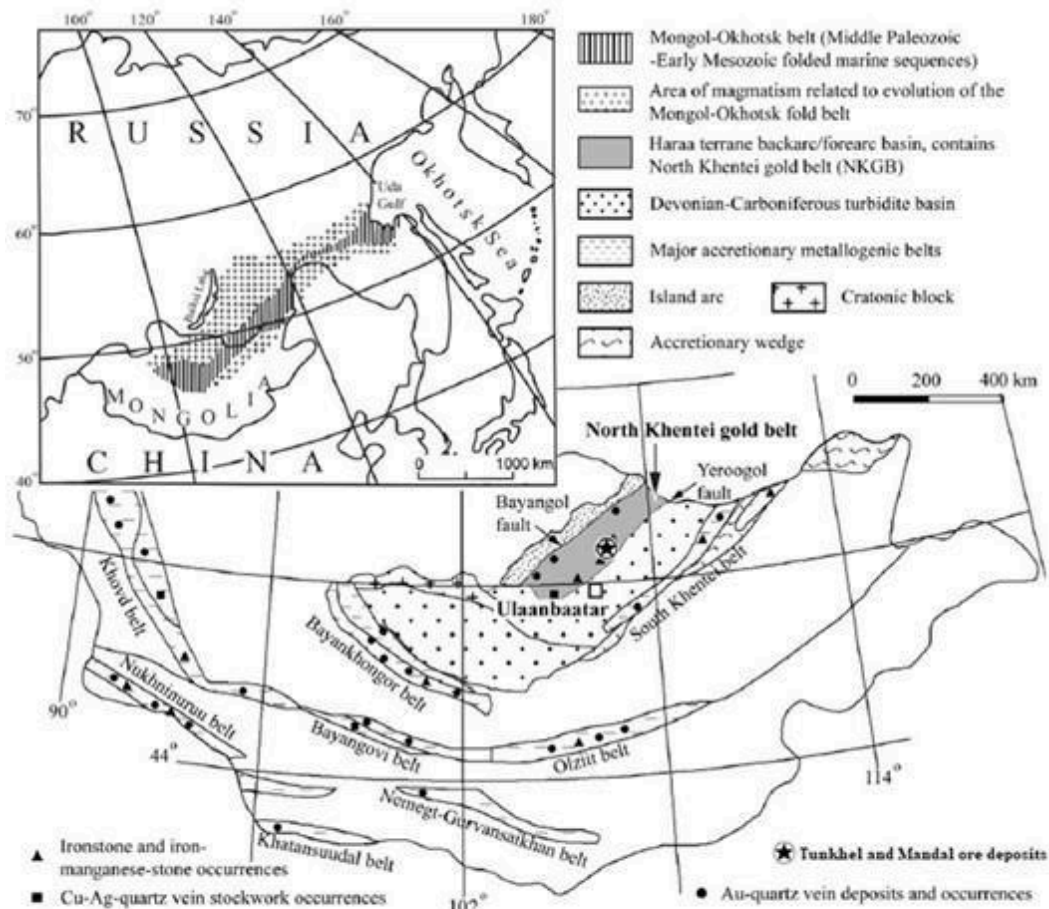


Figure 13 Tectonic setting of the North Khentei gold belt (NKGB). Modified from Badarch et al. (2002).

The structural setting of north-central Mongolia is dominated by several north-easterly striking strike-slip faults of a regional extent; that are considered terrane-bounding in nature, and may have tens of kilometers of cumulative sinistral displacement (Cluer et al., 2005). The Tunkhel deposit is likely controlled by one of these - the Balj Fault. The Noyot Mountain gold deposits are interpreted to be located near a second-order, northwesterly striking sympathetic structure (shear zone). In this region, NW-trending faults and fracture zones intersect the Yeroogol fault, and these intersections are considered to have been favorable for gold mineralization (Cluer et al., 2005).

The Tunkel and Noyot-Mandal mineralized zones are situated in the North Khentei gold belt (“NKGB”) (Fig. 1) which is one of the most productive gold provinces in Mongolia. The NKGB has a long history of gold production from placer and lode deposits, and both yield significant gold reserves (Dejidmaa, 1996). The source lode gold deposits have been discovered immediately adjacent to gold placer deposits along faults, or shear zones, and ore bodies occur as linear or vein styles. Examples of such deposits include the Gatsuurt, Boroo, Ulaanbulag, Baavgait, Ereen, Sujigtei, Tsagaanchuluut and Urt deposits. These deposits have been recognized as

intrusion-related vein-type gold mineralization (Dejidmaa, 1996).

In recent studies, the lode gold deposits in the NKGB have been classified as mesothermal or orogenic types (Kotlyar et al., 1999; Hendry et al., 2006; Goldfarb et al., 2013), and  $^{40}\text{Ar}$ – $^{39}\text{Ar}$  dating of hydrothermal minerals formed by wall rock alteration indicate that the ore mineralization occurred in the early Mesozoic (Khishgee et al., 2014).

Gold mineralization of the lode deposits in the NKGB (Figure 13) is characterized by the following: (i) disseminated and stockwork low sulfide-Au type broadly distributed in host rocks; (ii) quartz veins and veinlets with low-sulfide and high Au contents; and/or, (iii) strongly silicified and breccia with low-moderate sulfide and high Au contents. The volumes of these ore deposit types vary within individual lode deposits (Dejidmaa, 1996; Kotlyar et al., 1999, Khishgee et al. 2014).

## **Project Geology & Mineralization**

### *Tunkhel*

The Tunkhel mineralized zone is underlain by middle Cambrian Kharaa rocks, the medium-upper Ordovician intrusive unit, and lower Devonian intrusive and sub-intrusive rocks. The basement consists of early Permian Zuunmod volcanics and the early Paleozoic Boroogol granitoid complex is in fault contact with the meta-sedimentary rocks of the late Proterozoic to early Paleozoic Kharaa Formation (Hendry et al., 2006). The Balj fault structurally controls the Tunkhel zone and two placer gold deposits bound the northern and southern extents of the zone (Figure 14).

Tunkhel is hosted by a schist altered by contact metamorphism (facies include hornfels, migmatite, biotite-amphibole-feldspar gneiss). The crystalline schist is interbedded with in-equigranular sandstone and thin aleurolite layers. The Balj fault and parallel faults subdivide the ore body. In the southwest region, the old ASGM workings are in the hanging wall of the fault; whereas, the Bulag mine is in the footwall. These two zones initially formed as a single deposit and were subsequently displaced by post-mineralization sinistral movement along the Balj fault. The metasedimentary rocks from Kharaa were intruded by medium to upper Ordovician felsic rocks. The first phase of the intrusion (I) was a medium to coarse grained granodiorite, plagiogranite, granite and porphyritic granite. The second phase (II) consisted of a medium grained biotite leucogranite. The Tunkhel schist and metasedimentary rocks were intruded by Lower Devonian granitic rock. Based on the available literature this intrusive body had three phases, but only one phase (III) was observed during the field investigation. Where observed, the composition of the

rock is alkalic leucogranite, aplitic granite, pegmatite, quartz veins, vein like bodies (Figure 16).

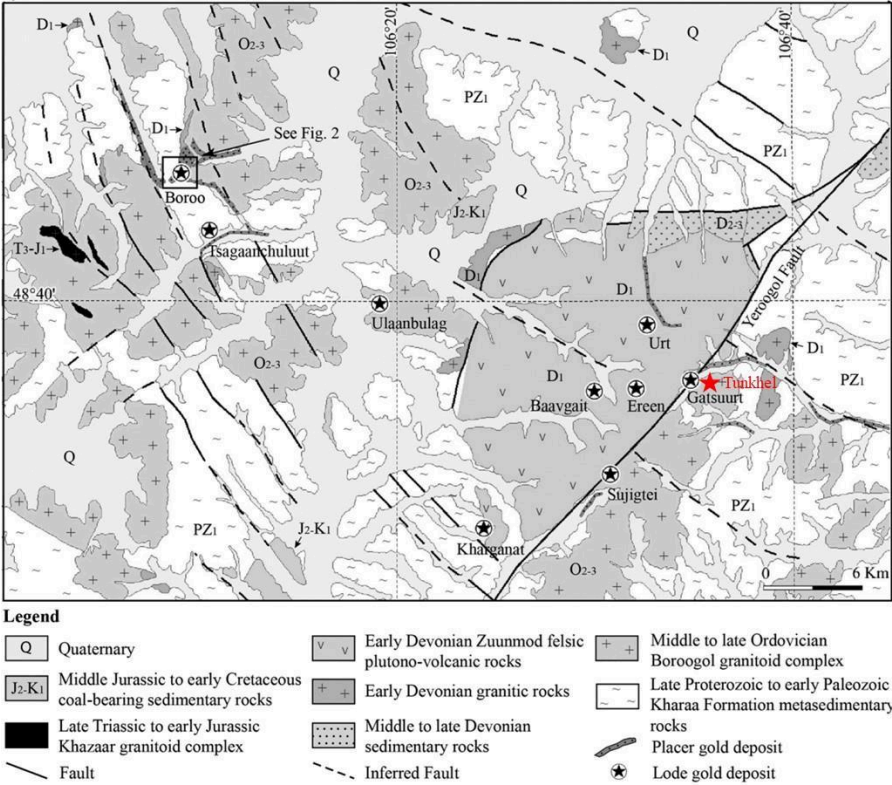


Figure 14 The geotectonic setting of the NKGB and Tunkhel

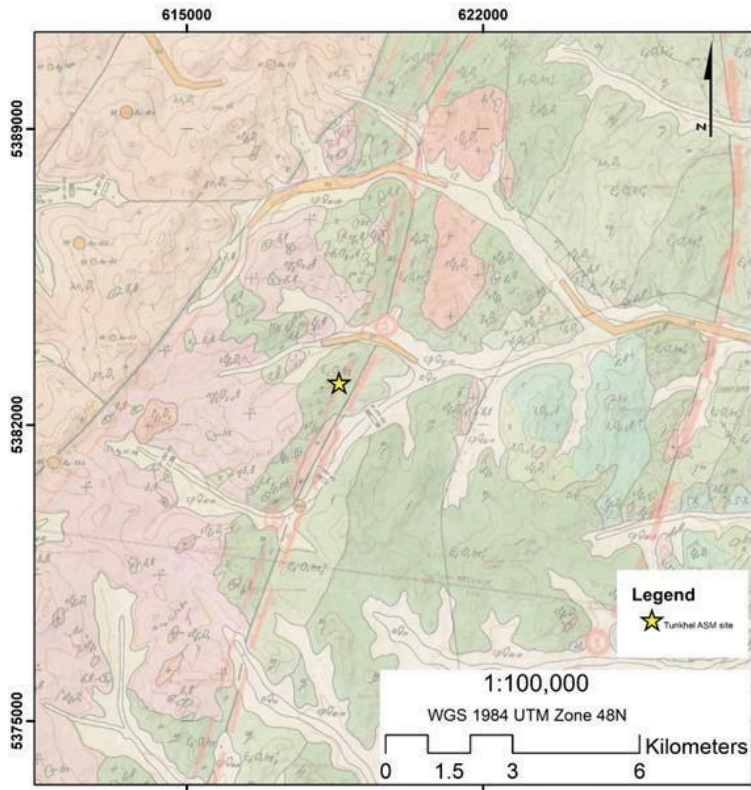


Figure 15 Geological Map of the Tunkhel region (See Figure 17 for the Legend)

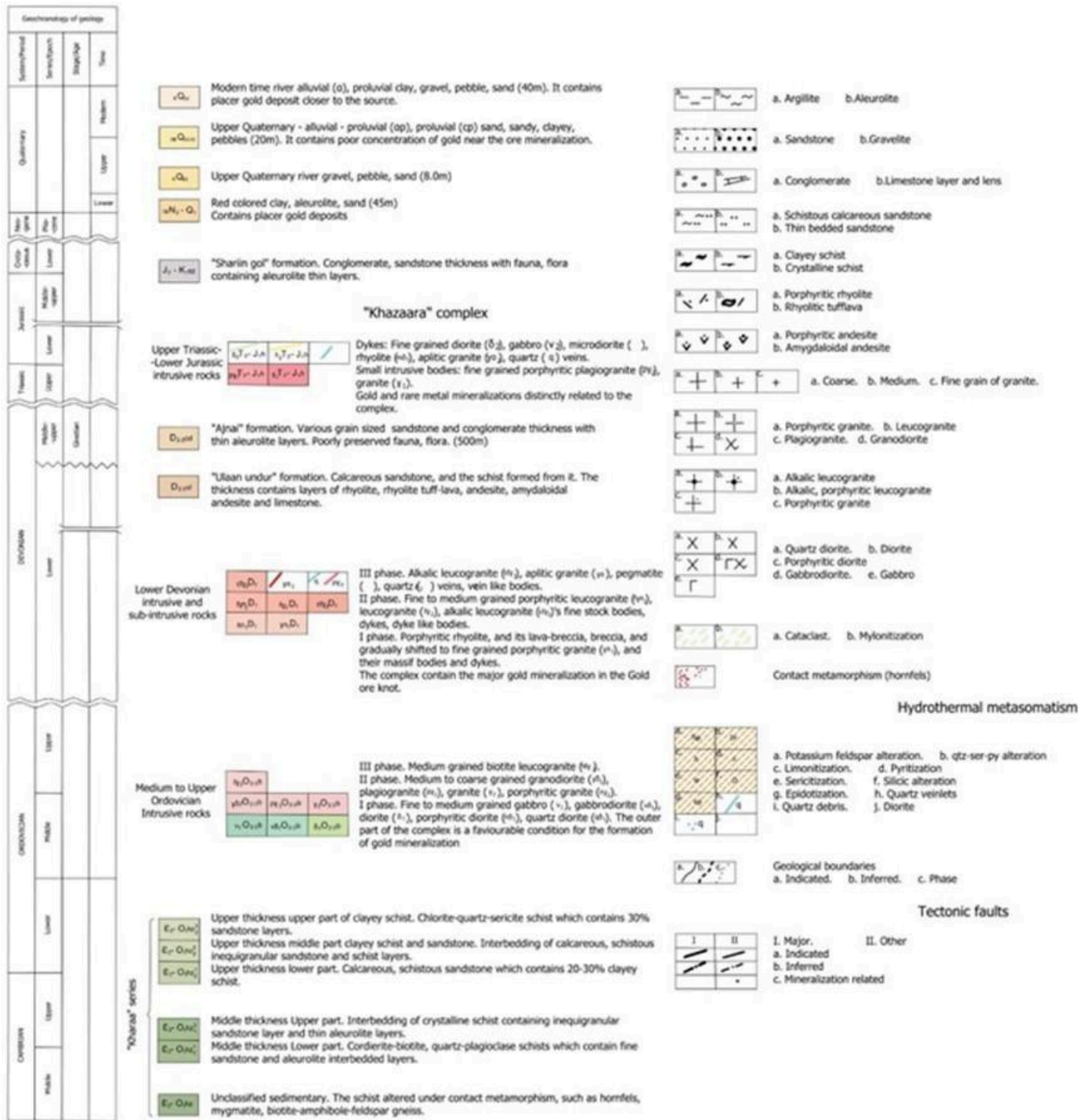


Figure 16 Geological-Stratigraphy column from Tunkhel

## *Mandal*

The Noyot mineralized zone is hosted by the Boroo complex of the middle-upper Ordovician intrusive. This intrusive rock is thought to be a secondary phase (II) of the granitic complex and consists of grey colored, medium to coarse grained porphyritic granite and granodiorite (Figure 17, 18). The system appears to be controlled by a NW-SE fault complex.

The geology of the Mandal area is dominated by the folded Kharaa metasediments consisting of a sequence of flysch sediments composed of siltstone, sandstone, and greywacke. These rocks are of regional extent and are interpreted to be of Lower Paleozoic age. Early Paleozoic age (~520 to 450 Ma) intrusive rocks of the Boroo Complex have intruded these sediments. In the study area, the Boroo complex consists of leucocratic granite and granodiorite which underlie the southern portion of the Noyot Mountain (Figure 18).

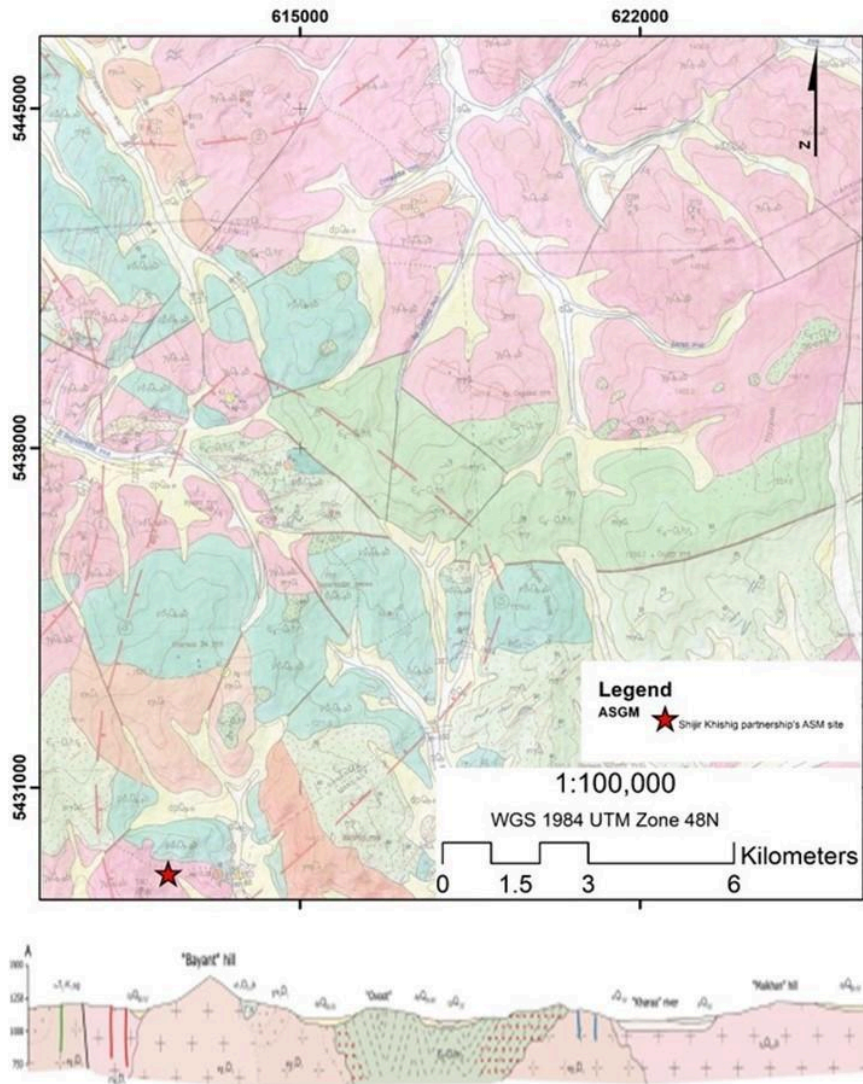


Figure 17 Geological map of the Noyot ore deposit with a schematic representative cross section from the Mandal study area

## STRATIGRAPHIC COLUMN

Scale: 1:25000

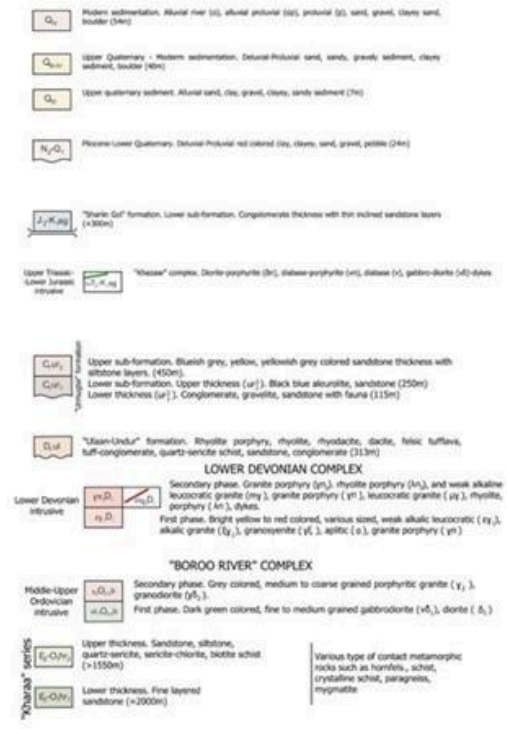
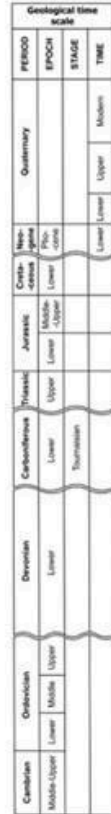
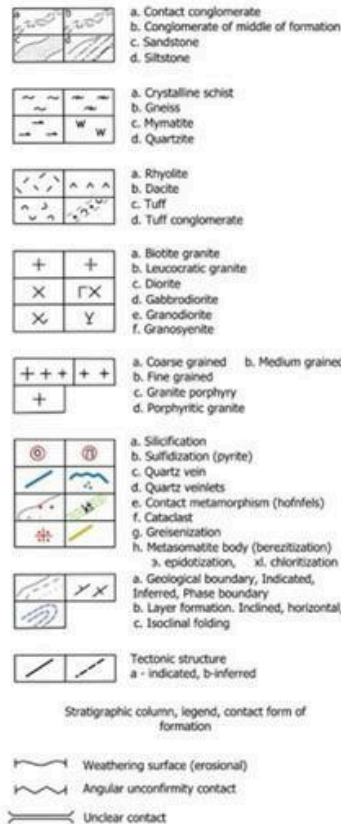
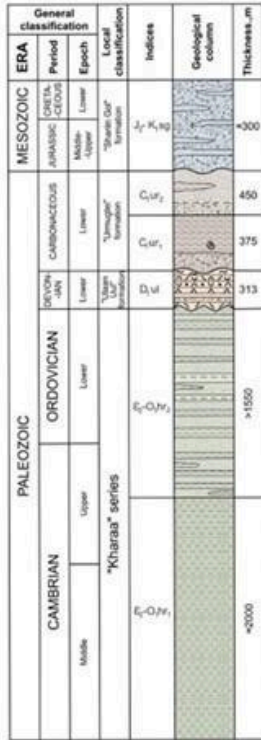


Figure 18 Geological-stratigraphic column from Noyot ore deposit

# Deposit Types

## Tunkhel

The Tunkhel mineralized zone consists of orogenic gold with low-sulphide quartz gold (Böhlke, 1982; Groves et al., 1998; Drew, 2003). Several deposits and other bedrock gold occurrences in the North Khentei belt are orogenic type occurrences (Khishgee et al., 2014) including Boroo, Ulaanbulag, Baavgait, Ereen, Sujigtei, Tsagaanchuluut, and Urt (Kotlyar et al., 1999; Hendry et al., 2006; Goldfarb et al., 2013). Locally, these occurrences consist of quartz veins with relatively coarse gold and overall low-sulphide content, as well as the presence of disseminated fine gold in nearby highly sulphidized rock (Figure 19).

Orogenic gold deposits are often closely associated with economically important gold placers, and this relationship is also observed in the Tunkhel deposit area. The main type of mineralization in Tunkhel is quartz-native gold veinlets; as well as black silica, or pervasive quartz silica, with high grade oxidation. The highest gold grades are associated with disseminated sulphides (Figure 20).

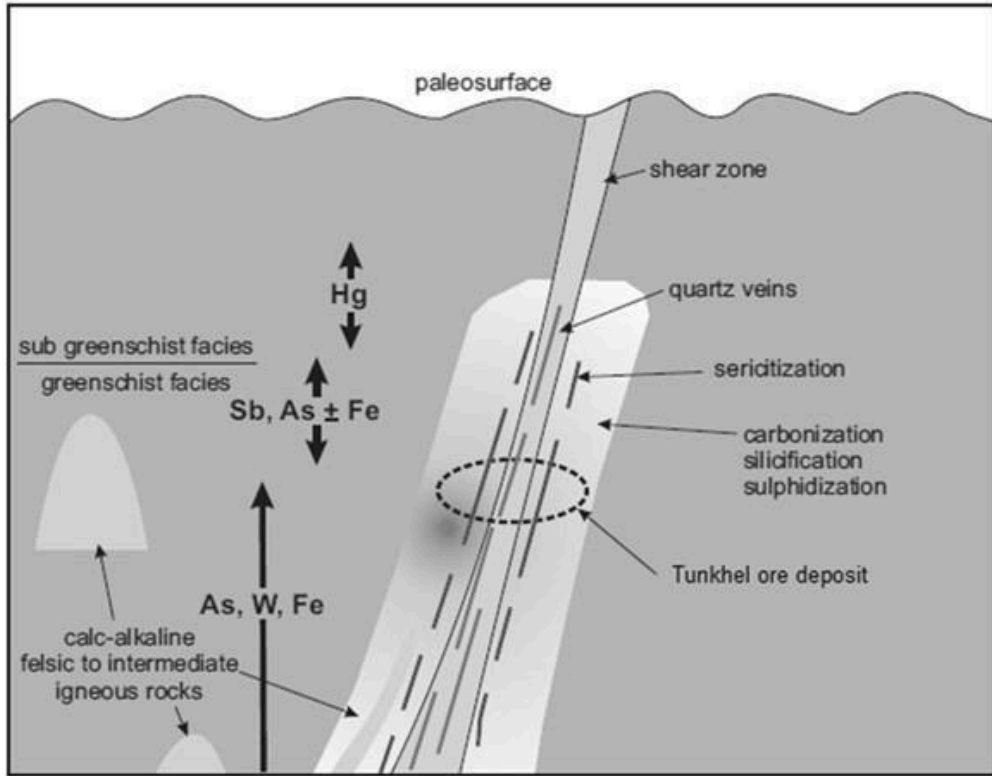


Figure 19 Schematic Geologic Model of an Orogenic Low Sulphide Gold Quartz Vein System (Goldfarb et al., 1995)

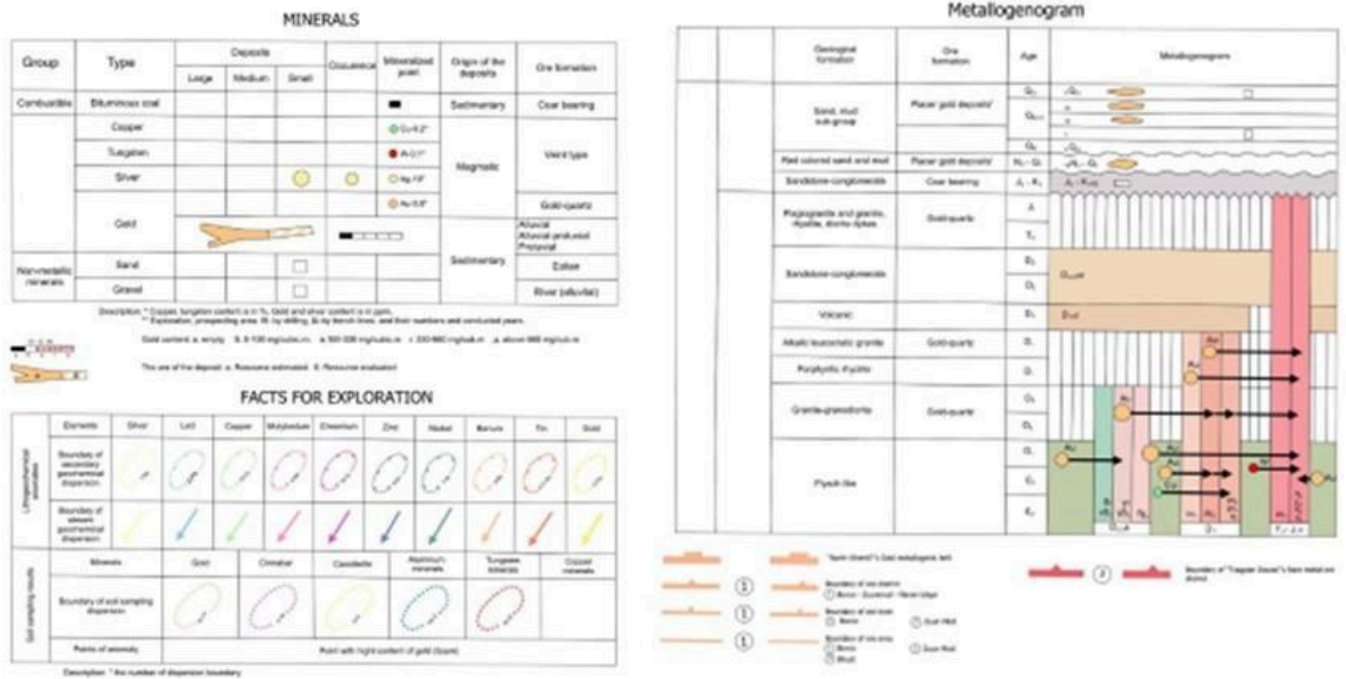


Figure 20 Minerals and Methanogenesis from Tunkhel

## **Mandal**

The Noyot mineralized zone is a low silica gold polymetallic sulphide system, associated with a zone of quartz-sericite-pyrite (QSP) alteration, in the areas sub-parallel to the Noyot fault. The mineralized zone is intrusion-related; and is hosted by a Cambrian-Ordovician sequence of highly deformed shales, siltstones, and fine sandstones (of the Kharaa metasedimentary series) as well as the Paleozoic granitoids of the Boroo Complex.

The bulk of the mineable gold mineralization at Mandal is hosted in a, strongly quartz-sericite altered and sulphidized, nearly flat lying zone controlled by the Noyot fault. The fault has been traced for 1.2 km and is thought to be a thrust fault; that dips at an angle of 55° NE with an azimuth of 290° NW. The fault cuts across the intrusive contact between meta sediments and granitic rocks in the north; but is entirely contained within the metasediments in the south.

Two main types of mineralization have been noted at Noyot. The first type consists of gold-sulphide zones, that hosts the largest proportion of gold mineralization. This type of mineralization is structurally controlled by the Noyot Fault. It is strongly altered and made up by quartz-sericite sulphidized zones, that occur in thin, irregular veinlets (less often in breccia zones) disseminated within pervasive alteration. The intensity of the sulphide mineralization depends on the primary host rock; and the intensity of alteration is generally stronger in the metasediments than the granites. The main sulphide minerals are pyrite, arsenopyrite, chalcopyrite, and tetrahedrite; as well as galena and gold associated with this mineralization, that is relatively fine-grained. The second type of mineralization consists of gold-quartz veins. The quartz veins are white and massive, and the associated gold is commonly fine-grained. The thickness of quartz veins varies from a few centimeters up to 3 m, and appear to be fracture infill veins/veinlets mostly in metasediments. The veins also occasionally carry sulphides with visible gold.

## **Geological Field Program**

Exploration of both project sites included geological mapping (surface and underground); rock chip sampling of the veins, waste rock, and surface outcrops for geochemical data analysis. Spatial data references UTM WGS84 48 N.

Regional geological mapping in Tunkhel covered an area of 51 ha and detailed geological mapping

was conducted over 29 ha with underground mapping focused on the Bulag main tunnel (inclined at 9° with a total length of 74 m). In the case of Mandal, regional mapping covered 21 ha with detailed mapping focused on 6 ha in the immediate vicinity of mine workings. The underground geological survey was conducted along the 140 m length of the SKP mine tunnel. The first section of the tunnel is 67 m long at an azimuth of 230 m and inclined 35°. After this first section, the mine workings branches into several tunnels in different directions. The sampling program was focused on the tunnel following the trend of the main mineralized structure (150° azimuth and inclined at ~10°).

The sampling program was conducted in three stages:

- ▶ The first stage focused on collecting samples during regional geological mapping for a total of 16 rock-chip samples.
- ▶ The second stage focused on prospecting operational shafts, and rock chip sampling of waste rock as well as mineralized veins at the bottom of the shaft.
- ▶ The third stage examined underground mining operations at both sites.

The geochemical program for the both sites totalled 165 samples, including standards, blanks, and duplicates. The samples were shipped to the SGS laboratory at the facility in Ulaanbaatar for analysis. The program consisted of 94 samples at Tunkhel and 63 samples at Mandal and the samples were shipped in four batches.

Several analytical methods were used for this program: 49 element ICP-MS (21 samples), IC40A acid digestions (four samples); fire assay and aqua regia digest with ICP-OES ppb finish for low grade gold samples (51 samples); and, fire assay and aqua regia digest with by AAS ppm finish for high grade gold samples (93 samples). Further, bulk density testing was conducted on 43 samples and mercury detection testing on six samples.

A standard QA/QC program was employed to confirm the validity of the geochemical testing. One in ten of the samples analysed were QA/QC samples (standards, blanks or duplicates). The standards and blank samples used were produced by OREAS (described in further detail below).

## **Geological Mapping**

The geological observations described in this report are from the surface mapping of the outcrops at the Tunkhel and Mandal ASGM sites; as well as an underground geological survey at the Bulag

and SKP operations, respectively.

The geological field mapping encompassed lithology, mineralogy, mineralization, and alteration, as well as structure. Enkhbayasgalan D., MSc Geologist performed thin sections for the petrography analysis.

### *Tunkhel*

The geological survey at Tunkhel was conducted from SW to NE; generally following the trace of the Balj fault, and abandoned shafts along mineralized trend of the study area. Thirty-nine vertical shafts are located along this trend running parallel to the Balj fault which runs SW to NE. The fault runs ~1.7 km in the Tunkhel ASGM region and strikes ~40°NE with a dip >70°.



Figure 21 Vertical shafts looking to the NE showing the lineation of the artisanal operations

The mineralized gold zones are generally controlled by fracture sets and/or by thrust faults. At Tunkhel, the main area currently being mined consists of rock with fine-grained free gold, and gangue minerals consisting of quartz, sericite, dickite, and carbonate minerals. The host rocks are silicified, sericitized, argillized and oxidized. Gold deposition is interpreted to have occurred at lower temperatures, via hydrothermal fluids, related to major tectonic features.

In the southeastern region of the property, outcrops from the Ordovician-Devonian granitic intrusive are in contact with the schist and metasedimentary rocks; and the green schist in this

area has amphibolite-hornfels facies. Typically, the schists are medium- to coarse-grained. The intrusive is a coarse grained to medium grained granite with a porphyritic texture (especially the crowded coarse quartz crystals). Some feldspar minerals are altered to sericite with pale greenish grey colored clay minerals creating a mottled texture. The granite does not contain visible sulfides; but some outcrops exhibit hematite oxidation enrichment. Four samples of intrusive granite were obtained for ICP analysis which showed that the intrusion has an affinity with alkalic leucogranite. The intrusive body borders the crest of the hill and has an elongated shape striking NE-SW bounded by the Balj fault along the eastern extent (Figure 22).



Figure 22 Outcrop of the medium-coarse grained granite modified by a fault plane with slickensides and oxides

The material mined from the Bort Tolgoi (historical ASGM) shafts dominantly consists of quartz fragments with sericite alteration. In some vein rock chips, it is possible to observe fine-grained free gold hosted in milky and massive quartz; however, most of the gold is bound to oxide sulfides (iron oxide) and disseminated, invisible to the naked eye (Figure 23).



Figure 23 Artisanal vertical shaft at Bor Tolgoi. Left, “Ninja” miner next to the shaft. Right, ore material from the shaft

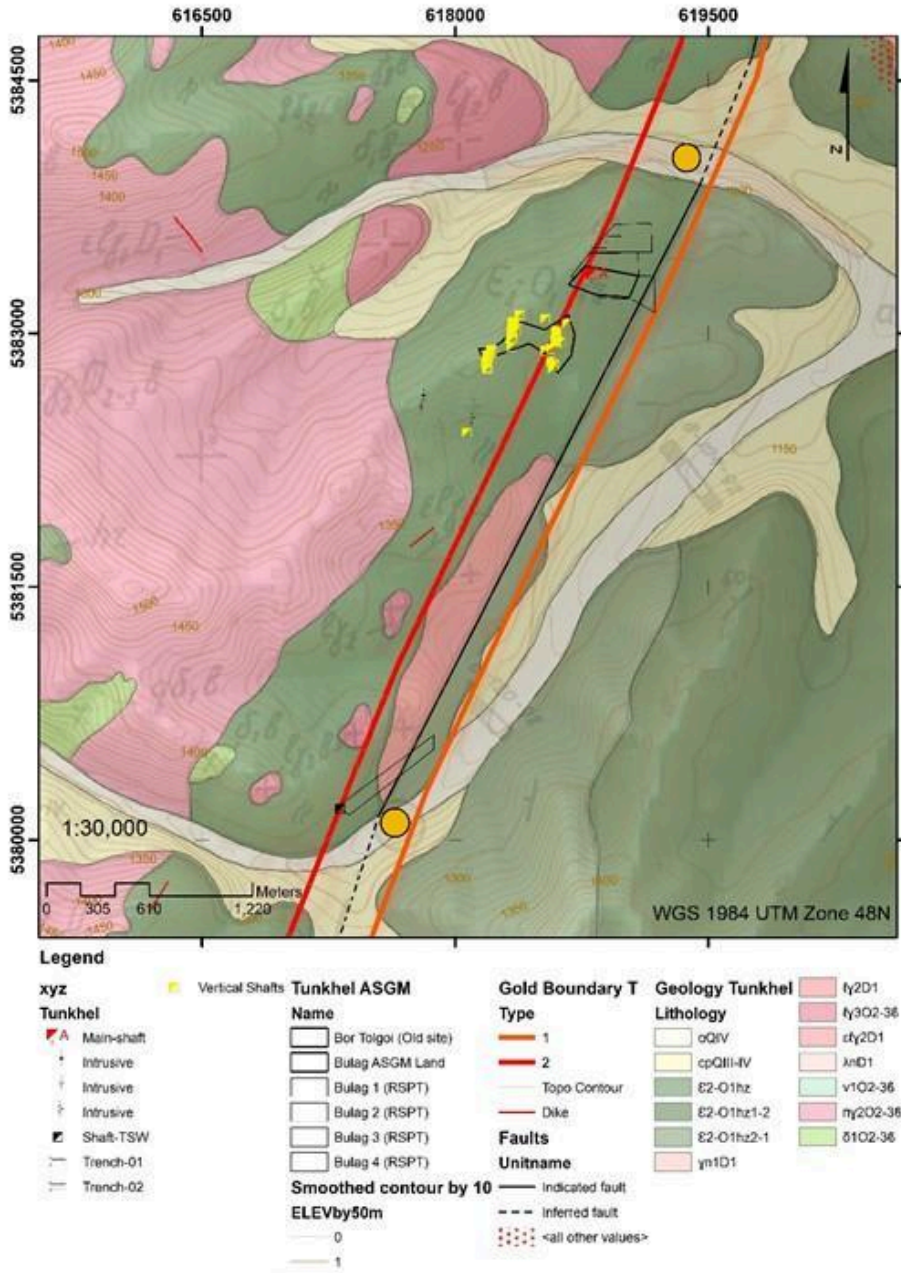


Figure 24 Geological map of Tunkhel with location of the vertical shafts in yellow. The orange points are the placer ore deposits NE and SW of Tunkhel. The red lines bound the mineralized gold zone

At the Bulag ASGM site two trenches are located in the northeast portion (“Bulag 2”). The trenches exhibit oxide-quartz-sericite-cinnabar subtype localized occurrences along the Bajl regional fault. The main trench shows a fault zone with oxide alteration and cinnabar (Hg) manifestation. Cinnabar is typical of orogenic deposits and is regularly observed in the trace of faults. The cover

consisted of an intrusive rock with phaneritic texture; rich in potassium feldspar with some amphiboles.



Figure 25 Bulag ASGM Trench-01 containing a vein, metasedimentary host rock, oxidation, and cinnabar oxide

Table 4 Tunkhel Trench UTM Coordinates

Name	X	Y	Z
Trench-01	618849.1	5383494	1308.489
Trench-02	618940.2	5383563	1309.797

The Bulag ASGM site currently hosts an operating mine adit. The total length of the adit is 76 m with an average height of 2 m. The coordinates of the Tunkhel mine main access point are 618842 E, 5383342 N.

The locations of the other tunnels on the property are listed on Table 5 below:

Table 5 Tunkhel mine Survey

Survey of the Bulag mine in Tunkhel ASGM			
Tunnel ID	Length	Azimuth	Di p
1	8	325	-5
2	9.3	340	-8
3	20	345	-9

4	20	345	-9
5	7	350	-9
6	11.3	340	-9

The host rock is intensely altered by oxides, sericite, and fine quartz veining. The metasedimentary rock is observed to be an intense green colour, is strongly silicified in some portions of the mine, and is highly intensely sheared (Figure 26, 27).



Figure 26 Left, Dikes of K composition light pink color. Right, Vein of Qtz-Ser+FeOx hosted in the metasedimentary rocks

Despite the substantial alteration and high frequency of quartz veinlets - no sulfides or disseminated gold were observed. The mine appears to be cutting through the upper cap of the deposit oxidation layer. Geochemical testing shows no indication of strong mineralization; therefore, it is possible that the mineralized body is at depth, or has been displaced by regional fault action.



Figure 27 Tunkhel metasedimentary rocks sheared by sinistral fault action; Hydrothermal fluids used these faults as a channel for mineralization emplacement



Figure 28 Placer Gold deposit located at the NE extent of the Tunkhel ASGM claim

The Tunkhel field work concluded with the inspection of an area located 3.5 km SW of the Tunkhel ASGM operation (Figure 24, Bulag 4). An abandoned shaft was in the southern part of this area; and the majority of the site is covered by Quaternary material, with an abandoned placer mine (Figure 24). The bedrock outcrops located at higher elevations are composed of coarse-grained granitic bodies with no visible mineralization.



Figure 29 Abandoned Placer artisanal gold mine located at the SW of the Tunkhel ASGM

### *Mandal*

As previously noted, the Mandal ASGM and NGO Duush cooperatives are currently exploiting gold mineralization at Noyot mountain. The geological fieldwork, focused on geological mapping, and sampling in the vicinity of (and within) the mine workings. The surface geology in the vicinity of the Mandal ASGM mine site is a medium-coarse grained porphyritic granite and granodiorite body. This is likely the secondary phase of the Boroo Complex. At the NGO Duush Mandal site, the rock consists of sedimentary and metasedimentary units with evidence of alteration. Samples from the workings at this site consist of metasediments, that were partially silicified, with high content of vein quartz. Some samples presented copper carbonates (Malachite) and strong limonite oxidation. The metasediments have undergone deformation and are altered. The evidence of a structural control for mineralization by a fault system (shear zone) at Noyot increases with depth.

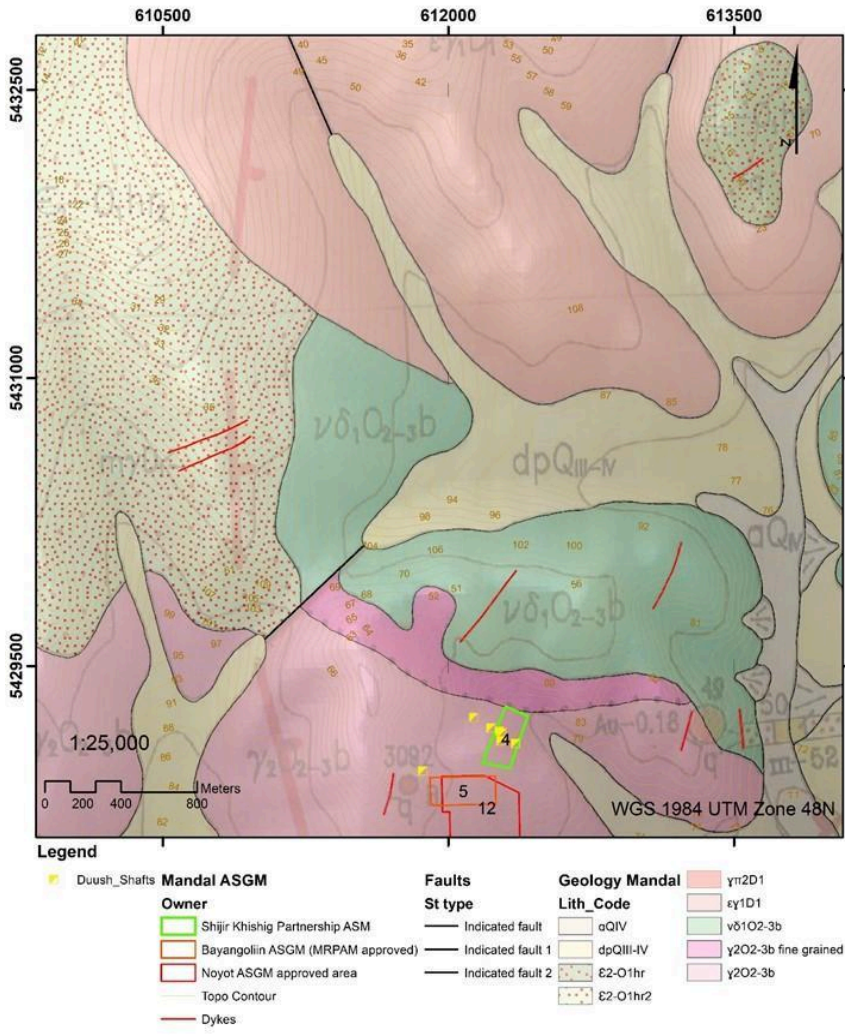


Figure 30 Geological Map of Mandal. In yellow shows the artisanal shafts from Duush NGO

Unlike Tunkhel, the vertical shafts at Mandal do not demonstrate a surface trend. The mine shaft sites are in the upper part of Noyot Mountain, descend vertically, and intersect SKP mine workings at depth. Underground development follows gold mineralization. Mining moves in different directions depending on conditions and access points.



Figure 31 Vertical shafts from Duush NGO in the uphill of the Noyot Mountain

The mineralization being mined at this location; generally, consists of gold bound with pyrite and chalcopyrite, within quartz veins with limonite boxwork common. The first phase of the SKP fieldwork focused on sampling the waste rock from the mine.

The waste rock is rich in sulfides, oxides and milky quartz veins, hosted in granodiorite (Figure 32), green schist and highly silicified metasediments. Sericite-quartz alteration is pervasive throughout the material.



Figure 32 Waste rock disposal from the SKP

The second part of the SKP fieldwork was a survey of the mine and sampling of mineralized

structures.

Table 6 Survey of the main SKP tunnel - Mandal ASGM

SKP Survey in Mandal			
Tunnel ID	Length	Azimuth	Inclination (°)
1	20	230	-35
2	20	230	-33
3	20	235	-30
4	7	240	-30
5	3	250	0
6	20	250	5
7	8	245	8
8	23.5	150	10
9	19.5	150	5
10	12	140	0
11	6	170	-20

The total depth of the main tunnel of the SKP mine is ~159 m. The extent and workings of the mine are complex; as artisanal miners work at multiple levels following mineralization. Some of the shafts are vertical, or have an inclination  $>45^\circ$ ; which makes tunnel mapping, measurements and surveys challenging.



Figure 33 First section of the SKP mine Tunnel - NW intrusive granodiorite

The NW wall of the main access point consists of granodiorite with the first section of the tunnel (Table 6, from 1 to 4) intersecting medium-coarse granodiorite. The second section crosses a fault contact between granodiorite and the metasedimentary rocks (at ~103 m).



Figure 34 Fault contact between the granodiorite and the metasediments

The final section of the tunnel opens into a vault >7 m high which is actively being mined following a mineralized trend (azimuth of 150°). This area contains a concentration of quartz veins with polymetallic sulfides controlled by the Noyot fault (140° strike with 80° dip towards NE). The main veins are lightly oxidized with pyrite, chalcopyrite, galena, and sphalerite with high grades of Cu, Zn and Pb.



Figure 35 Mineralized vein with a strike of 140° controlled by the Noyot fault

# Sampling

## Sample Preparation, Analyses and Security

The geochemical sampling program was carried out in four stages at the Bulag (Tunkhel) and the SKP (Mandal) mines: surface outcrops, waste rock from operating shafts and mines, mineralized veins from artisanal shafts, and underground mineralized veins.

For the current study, a total of 4 batches totalling 165 samples were processed by the SGS Mongolia Laboratory with the QA/QC program consisting of 14 samples. The QA/QC program included the testing of six standards, three high grade (OREAS 245) and three medium grade (OREAS 239). The program also included four duplicates from the sample types and four pulp blanks (OREAS 24d). Thirteen samples from 14 satisfied the 1SD parameter with sample C00274527 testing out of range of the 1SD. Based on the result, two anterior and posterior samples were discarded.

The QC-Mine tool used for the QA/QC analysis.

Table 7 QA/QC Analysis of the standards and pulp blanks used in the MRA

Sample ID	Type	QA/QC	Method	Au (Certified Value)	Au (SGS result)	1SD (OREAS)	1SD
C00274665	Blank	OREAS 24d	FAA505	<1 PPB	<0.01 ppm	IND	0.000
C00274518	Standard	OREAS 239	FAI313	3.55 ppm	3560 ppb	0.086	0.000
C00274527	Blank	OREAS 24d	FAI313	<1 ppb	5 ppb	IND	2.828
C00274600	Standard	OREAS 245	FAI313	25.73 ppm	>10000 ppb	0.546	0.000
C00274634	Blank	OREAS 24d	FAA505	<1 PPB	<0.01 ppb	IND	0.000
C00274640	Standard	OREAS 245	FAA505	25.73 ppm	25.9 ppm	0.546	0.120
C00274655	Standard	OREAS 239	FAA505	3.55 ppm	3.56 ppm	0.086	0.007
C00274548	Standard	OREAS 245	FAA505	25.73 ppm	25.9 ppm	0.546	0.120
C00274569	Blank	OREAS 24d	FAA505	<1 PPB	<0.01 ppm	IND	0.000
C00274575	Standard	OREAS 239	FAA505	3.55 ppm	3.57 ppm	0.086	0.014

### *Tunkhel*

Based on historical work conducted by the AGC during site selection, systematic sampling during the field assessment, and our knowledge of ASGM mining techniques; we consider a gold grade of 28.8 gpt representative of the exploitable artisanal resource geological potential; with a bulk

density of 2.64. The average ore grade in the LSM ore deposits that surround Tunkhel is 5 g/mt .

Table 8 Ore samples from the active vertical mine shafts in Tunkhel

Sample	X	Y	Project	Location	Au (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)
C00274501	618322.0	5382967.9	Tunkhel	Shaft-15	38.7	196	257	161
C00274581	618565.7	5382911.5	Tunkhel	Shaft-35	68.8	67	134	52
C00274595	618565.7	5382911.5	Tunkhel	Shaft-35	15.4	40	28	75

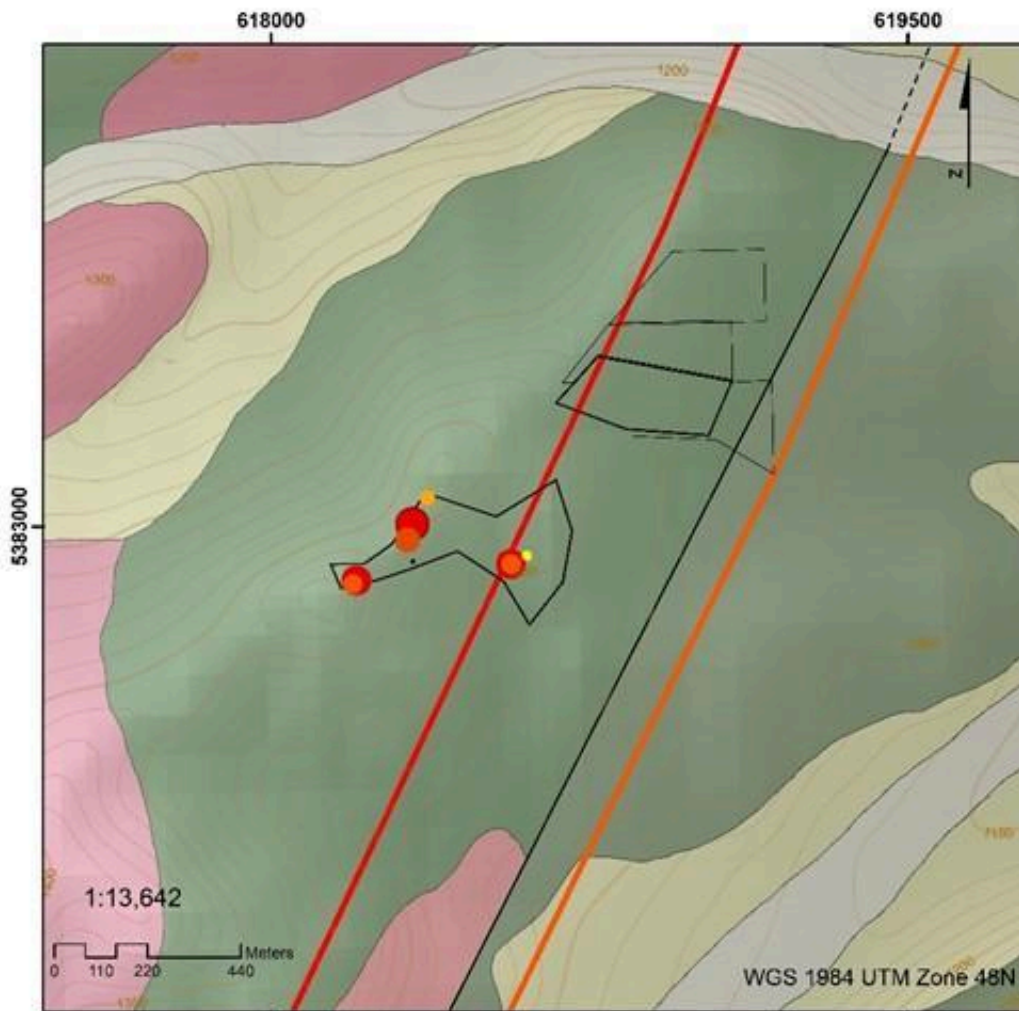
The gold grade of these types of artisanal resource zones are very high due to the selective nature of artisanal mining techniques, and the low rock volumes extracted.

In the mineralized areas accessed by Shaft-15, gold presented from fine to medium-grained within quartz veining; with some areas strongly oxidized.

The Bulag ASGM has not yet reached an economic artisanal resource, and a gold- grade cannot yet be estimated. However, sampling and geological field work suggest this area is highly prospective.

Table 9 ICP-MS results from the Bulag ASGM (Tunkhel)

SAMPLE_ID	X	ICP-MS		Location	Au (ppm)
		Y			
C00274528	618841.6	5383341.6		ASGM Bulag	<0.01
C00274529	618841.6	5383341.6		ASGM Bulag	0.02
C00274530	618841.6	5383341.6		ASGM Bulag	0.01
C00274531	618841.6	5383341.6		ASGM Bulag	<0.01
C00274532	618841.6	5383341.6		ASGM Bulag	<0.01
C00274533	618841.6	5383341.6		ASGM Bulag	0.01

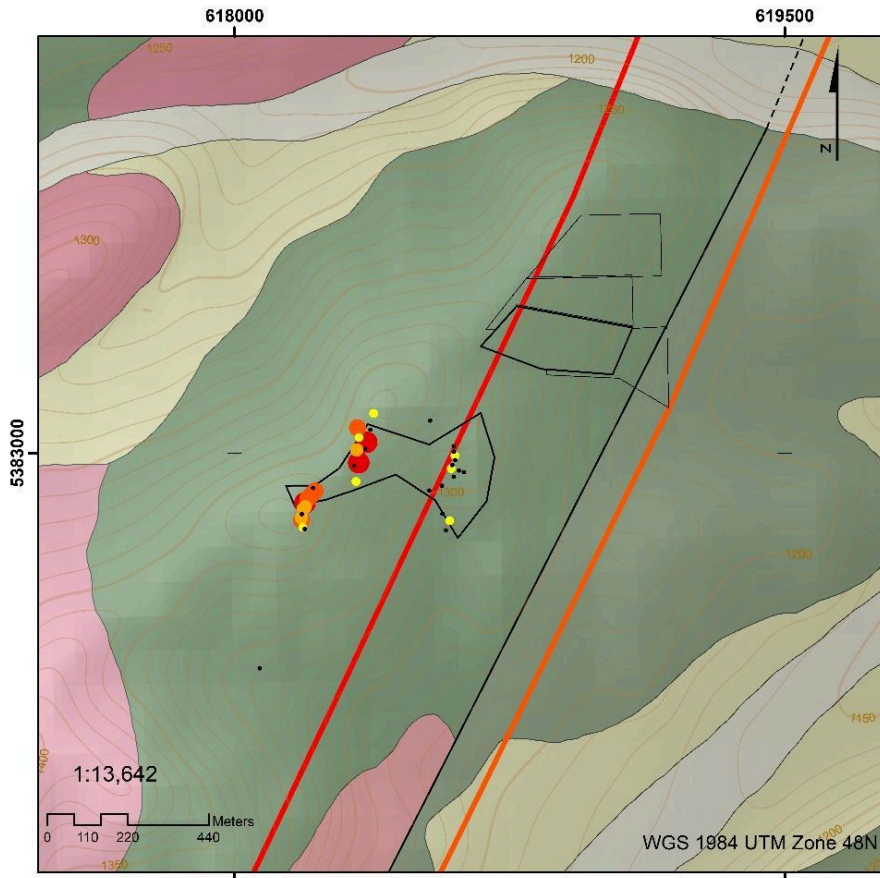


### Legend

<b>Au</b>	— Dike	<b>Geology Tunkhel</b>	ty2D1
• 0.330000	<b>Faults</b>	Lithology	ty3O2-36
• 0.330001 - 6.140000	<b>Unitname</b>	□ αQIV	εty2D1
• 6.140001 - 11.500000	— Indicated fault	□ cpQIII-IV	λnD1
• 11.500001 - 15.400000	- - - - Inferred fault	■ ε2-O1hz	v1O2-36
• 15.400001 - 38.700000	□□□□ <all other values>	■ ε2-O1hz1-2	ny2O2-36
• 38.700001 - 71.200000		■ ε2-O1hz2-1	δ1O2-36
• 71.200001 - 153.000000		□ γn1D1	

Figure 36 Map showing the geochemical anomalies from vertical mine shafts mineralized material samples (Tunkhel ASGM)

The map on Figure 36 shows a concentration of gold geochemical anomalies in the area of the historical Tunkhel site; which match the trends of the presumed structural controls of the mineralization. These anomalies suggest that the mineralized bodies may be shallow and hosted in the fault hanging wall.



**Legend**

<b>Au_ppm_</b>	— Dike	<b>Geology Tunkhel</b>	□ tγ2D1
• 0.010000 - 0.250000	<b>Faults</b>	□ Lithology	□ tγ3O2-36
• 0.250001 - 0.620000	<b>Unitname</b>	□ αQIV	□ εtγ2D1
• 0.620001 - 1.130000	— Indicated fault	□ cpQIII-IV	□ λnD1
• 1.130001 - 3.620000	- - - - Inferred fault	□ ε2-O1hz	□ v1O2-36
• 3.620001 - 7.160000	••••• <all other values>	□ ε2-O1hz1-2	□ nγ2O2-36
		□ ε2-O1hz2-1	□ δ1O2-36
		□ γn1D1	

Figure 37 Geochemical gold anomalies from vertical mine shaft waste rock samples

The waste rock, despite having lower gold values, maintains the same pattern of spatial distribution as the anomalies west of the fault. This information supports the Bulag Operation’s exploration effort. Suggesting that tunnelling should be redirected to the west to intercept the mineralized zone.

Samples were collected in Trench-1 at Bulag, analyzed for mercury, and were found to have anomalous values. Sample C00274589 (618849.0644 E; 5383493.588 N) returned a value of 691 ppb Au and 32 ppb Hg.

*Mandal*

Based on the field program, sample values and our knowledge of artisanal mining practices; a value of 16 gpt gold with an average rock bulk density of 2.65 is considered representative of the exploitable artisanal resource’s geological potential at the Mandal ASGM site. These values are based on sampling at both the SKP mine and the Duush NGO site.

Table 10 Duush NGO area geochemical samples results (Mandal)

SAMPLE_ID	X	Y	Au (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)
C00274647	612223.1	5429176.6	19.1	132	>5000	379
C00274648	612223.1	5429176.6	2.24	87	1625	1340
C00274652	612269.1	5429159.7	5.44	45	544	211
C00274653	612280.9	5429151.7	12.7	109	1010	388
C00274654	612280.9	5429151.7	8.06	98	1019	342
C00274656	612275.0	5429109.2	37.3	175	3482	255
C00274657	612275.0	5429109.2	35.1	150	3286	251
C00274658	612275.0	5429109.2	43.8	228	2663	321
AGC-MN-12	612230.5	15429190.6	27.2	NA	NA	NA
AGC-MN-13	612231.0	15429168.4	13.1	NA	NA	NA

The previous values of gold in Mandal are from the SKP and Duush NGO. The values reported for Duush are 27.7 gpt and 13.1 gpt gold from Shafts 2 and 4, respectively. In the case of SKP, the mineralized vein sample returned 45.2 gpt gold.

At the Duush NGO site; host rock is a green metasedimentary unit with hematite, silica, and quartz veinlets. Based on the sampling conducted, this area generally carries high gold-grades. The miners tend to focus on extracting mineralized material along the trace of the main shear (orientated NW-SE). The highest sample value from the SKP mine returned 35.6 ppm gold; that was taken from the central mineralized vein striking 140° (C00274611 at a length of 142 m). Grade values tended to decrease substantially with increasing distance from the main producing area. The samples averaged 5.65 gpt gold in aggregate from the SKP mine.

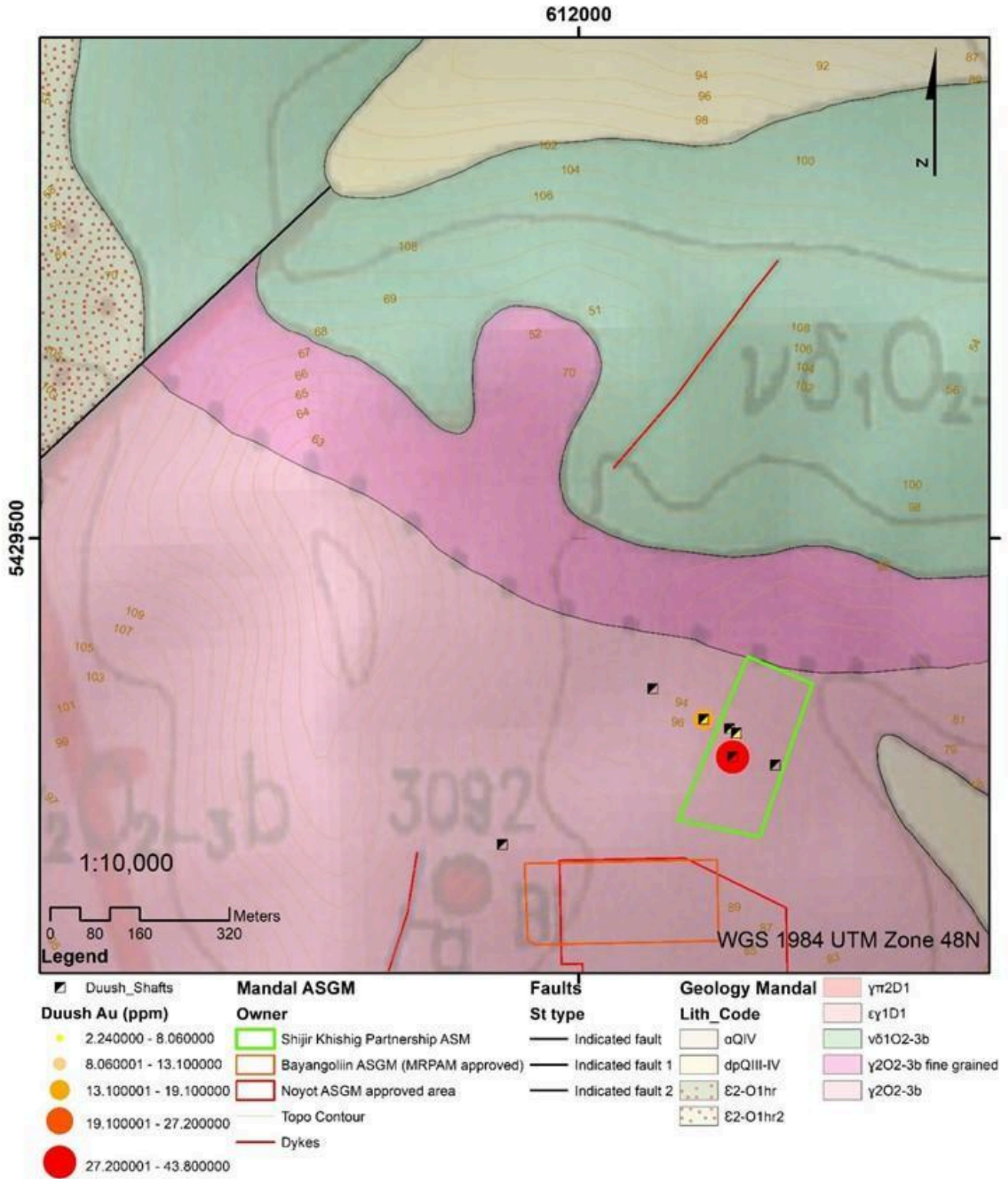


Figure 38 Geochemical gold anomalies from vertical mine shaft mineralized zone samples

## Exploitable Artisanal Resource Estimates

The project Contextual Study produced by the AGC in 2021 delineated the daily ore extraction from Tunkhel and Mandal study areas.

Table 11 Average annual ore extraction in both study areas

Location	Partnerships	Avg. Daily extraction, by partnership (kg/day)	Avg. daily extraction by region (tpd)	Working days (days/year)	Avg. annual extraction (t/year)
Tunkhel	14	225	3.2	142	447
Mandal	16	283	4.5	128	580

This study evaluates the mineral geological potential, in the context of artisanal mining, for Tunkel and Mandal. This is based on 1:50,000-scale geological mapping; integrated geochemical and geophysical data, and economic geology models.

Given budget and resource limitations, only the geological potential for resources exploitable by artisanal mining techniques was estimated. Geological potential in this context refers to material that can be accessed and processed by artisanal miners; for which an ore quantity and grade can be reasonably estimated based on geological interpretation, with limited sampling. *This estimate is not a defined resource or reserve as per National Instrument 41-101 guidelines.* The estimate is the opinion of a qualified exploration geologist, based on geological interpretation, and with limited sampling. Gathered through appropriate techniques; from locations such as outcrops, trenches, and mineshafts.

The table below (Table 12) shows the resulting estimates for both ASGM sites.

Table 12 Artisanal Exploitable Gold Resources for Tunkhel and Mandal

	Metric Tons	Au (gpt)	Ounces
Tunkhel Exploitable Artisanal Resource	28,000	28.8	25,900
Mandal Exploitable Artisanal Resource	74,000	16.7	39,700

It should be noted that the estimate assumes consistent average grades and thicknesses through the mineralized zone. It also assumes that there are no geotechnical, or groundwater issues, and that the material can be mined without excess dilution.

Spatial autocorrelation analysis methodology was used to estimate the exploitable artisanal resources. Spatial grade variability can differ significantly across deposit types and within zones of the same deposit.

The Tunkhel exploitable tonnage was calculated using a rock density of 2.64 for the mineralized body with a variant range of 0.5 to 2.3 m thickness; frequency of veins of 0.75 to 2.75 m, and an ore grade of 28.8 gpt, with a mineralized area of approximately 2600 m<sup>2</sup>. In the case of Mandal, a density of 2.65 was used for the mineralized veins with a thickness between 1.2 to 4.5 m and a frequency of vein of 2 m. The average ore grade used for the study was 16.7 gpt and the mineralized area was estimated as ~3100 m<sup>2</sup>.

## Interpretation and Conclusions

The Tunkhel and Mandal mineralized zones are in the tectonic setting of the NKGB. The Tunkhel ore deposit is identified as an orogenic deposit with low-sulfide quartz gold. However, the Noyot gold deposit (Mandal) is a low silica gold polymetallic sulfide system associated with a zone of quartz-sericite-pyrite (QSP) alteration sub-parallel to the Noyot fault.

The Tunkhel ASGM operation is bounded by operating placer gold mines to the north as well as Gatsuurt, a world-class orogenic deposit. The Balj fault controls the Tunkhel zone with a SW to NE orientation. Gold emplacement occurs along this structure within its zone of influence. The gold grade is high in discrete areas, and ranges from >40.0 gpt to 6 gpt, in the historical artisanal mine shafts. The artisanal resource is currently being exploited by two ASGM partnerships, that access the zone via a horizontal mine shaft at the Bulag ASGM site.

The historical Bortolgoi artisanal mine was operated by artisanal miners from the Baatar vangiin Khishig NGO. The recently organized Tunkhel Bulag ASGM partnership is formalized, and is fully permitted for mining operations. The Bulag miners have standard personal protective equipment (PPE) and are well equipped for mining. However, the Bulag operation is still in the exploration phase, and their access points have not yet intersected economic material. The areas surveyed and sampled during the current field study confirmed this view but the results suggest the area is prospective for gold.

The Mandal ASGM community is actively mining the Noyot Mountain mineralized zone. The miners have a good understanding of the nature of gold mineralization and the controlling structure; therefore, exploration efforts have been very successful historically. The presence of several artisanal mining groups such as Duush NGO, and other ASGM groups, reflects the high interest in the area, and mining success to date. However, the ASGM groups do not mine in a coordinated way; this increases the risk of serious accidents, and of gold zone sterilization.

Furthermore, the lack of planning results in inefficient extraction, and duplication of mine development infrastructure.

## **Recommendations**

Sample collection and geological mapping efforts were hindered by mine infrastructure safety issues. An engineered underground support program should be implemented for workforce safety. Further, standard protocols for underground blasting should be followed, that have properly designed ventilation systems. Once these programs are in place, then a more thorough underground geological study should be conducted.

A surface magnetic survey should be conducted to better define regional geological trends. Depending on the budget; Induced Polarization surveys could be carried out to determine areas of high resistivity and high sulphides. These surveys would help guide mining activities, and exploit the gold resource in a more organized, and efficient manner.

A mine planning committee should be established at both ASGM sites to ensure efficient access, increase safety and improve exploration efforts through better communication and coordination between cooperatives.

## **Statement of General Conditions**

### **Standard of Care**

This report has been prepared in accordance with generally accepted geological practices in estimating geological potential for artisanal gold exploitable resources. No other warranty, expressed or implied, is made.

### **Complete Report**

All records, documents, files and data (electronic or otherwise), generated as part of this assignment are a part of this report. To properly understand the recommendations and opinions of this report, reference must be made to the entire report as described above.

## **Basis of This Report**

This report has been prepared for the specific site and purpose that were described herein. The applicability of any of the findings, recommendations, or opinions expressed in the report are only valid to the extent that there has been no material alteration to any of the said descriptions provided to AGC and the exploration geologist.

## **Use of This Report**

Any use which a third party makes of this report, or any portion of this report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from the use of this report.

## **Independent Judgement**

The information, interpretations and conclusions in this report are based on our interpretation of the site conditions based on a limited field investigation and limited sampling programme. We cannot accept responsibility for independent conclusions, interpretations and/or decisions made by or others who may come into possession of this report (or any part thereof) which may be based on information contained in this report.

## **Interpretation of Evidence**

This report was based on information and evidence obtained during the field investigation as well as our experience in the artisanal gold mining industry. Our opinions were formed on the evidence provided and observed.

## **Geological Potential**

The geological mining potential reported in this study is only valid for the purposes for which it was prepared - artisanal gold mining. It is essential to understand that the geological potential estimate of an exploitable artisanal resource is based upon a given set of geochemical and geological parameters which have demonstrated their technical and economic viability at a stated

point in time. Technical and economic parameters critical to the recommendations/conclusions in this report may change with markets and mining operations. Therefore, conclusions should be used with caution and accommodate current conditions.



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## ARTISANAL GOLD COUNCIL

The Artisanal Gold Council (AGC) is a charitable organization dedicated to improving the opportunities, environment, and the health of the millions of people involved in artisanal and small-scale gold mining in the developing world. The AGC has a core team of technical and administrative staff based in Victoria, British Columbia, Canada, and operates in over 20 countries in Asia, South America, and Africa.

The AGC envision a formalized, environmentally sound, and socially responsible ASGM sector that supplies responsible Artisanal Gold™ to markets attracting socially responsible investors and buyers and encouraging ethical consumer behaviours. Working directly with ASGM communities and local experts to develop integrated and practical solutions that address the unique circumstances that exist in different locations around the world, the AGC aims to improve the ASGM sector through awareness, training, education, and capacity-building. The diversity of the AGC's and our grass-roots approach allow us to effectively bridge field work with national and international policy.

The AGC partners with diverse local, national, and international governments, international development agencies and funders around the world in various collaborative arrangements. As a financial advocacy service provider to the Global Knowledge Management and Exchange of Child Project Results Through Networking and Outreach Activities for the GEF GOLD Program (the planetGOLD global project), the AGC leads education, outreach and advocacy to the financial services and investment sector with a goal to educate financial service providers and investors about the changing landscape of financial and investment opportunities in the ASGM and advocate for more direct engagement resulting in increased financial flows to the ASGM. The AGC is also the executing agency for the planetGOLD child projects in Mongolia, the Philippines and Burkina Faso.



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