

Mongolia

“Land of Blue Skys”

**Impressions From Two Summer
Field Seasons, 2011-12**



Author: Douglas Hutchison

Brisbane-based consultant exploration geologist

**Worked in Mongolia in northern summers of 2011-12 as
technical consultant (advising Mongolian field teams)**

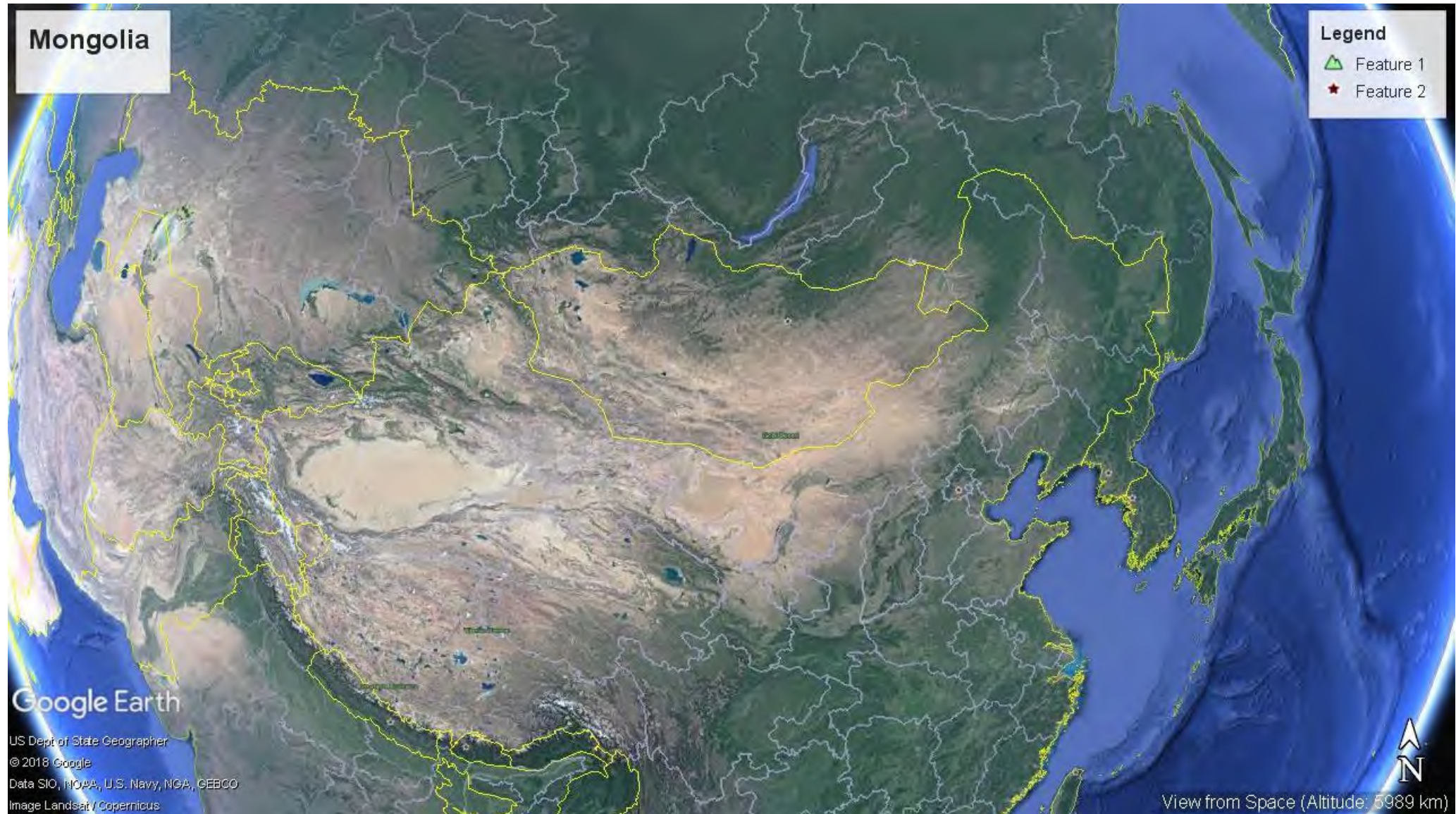
for

**Connect Resource Services
(Brisbane-based private company)**

Strategic Location – Buffer Between China & Russia



Google Earth Image (showing desert areas)



Mongolia - History Snapshot

- 1206:** Founding of Mongol Empire under Chinggis Khaan
Reached fullest extent under Kublai Khan (conquest of China)
- 1367:** Break up of Mongol Empire
- 1367-1691:** Period of disintegration, disunity & in-fighting
- 1691-1921:** Under control of China (Manchu Empire)
- 1922-1992:** Mongolian Peoples Republic - under control of USSR
- 1946:** Adopted Russian script
- 1992:** Founding of independent modern Mongolia

Mongol Empire – Largest in History (Land)

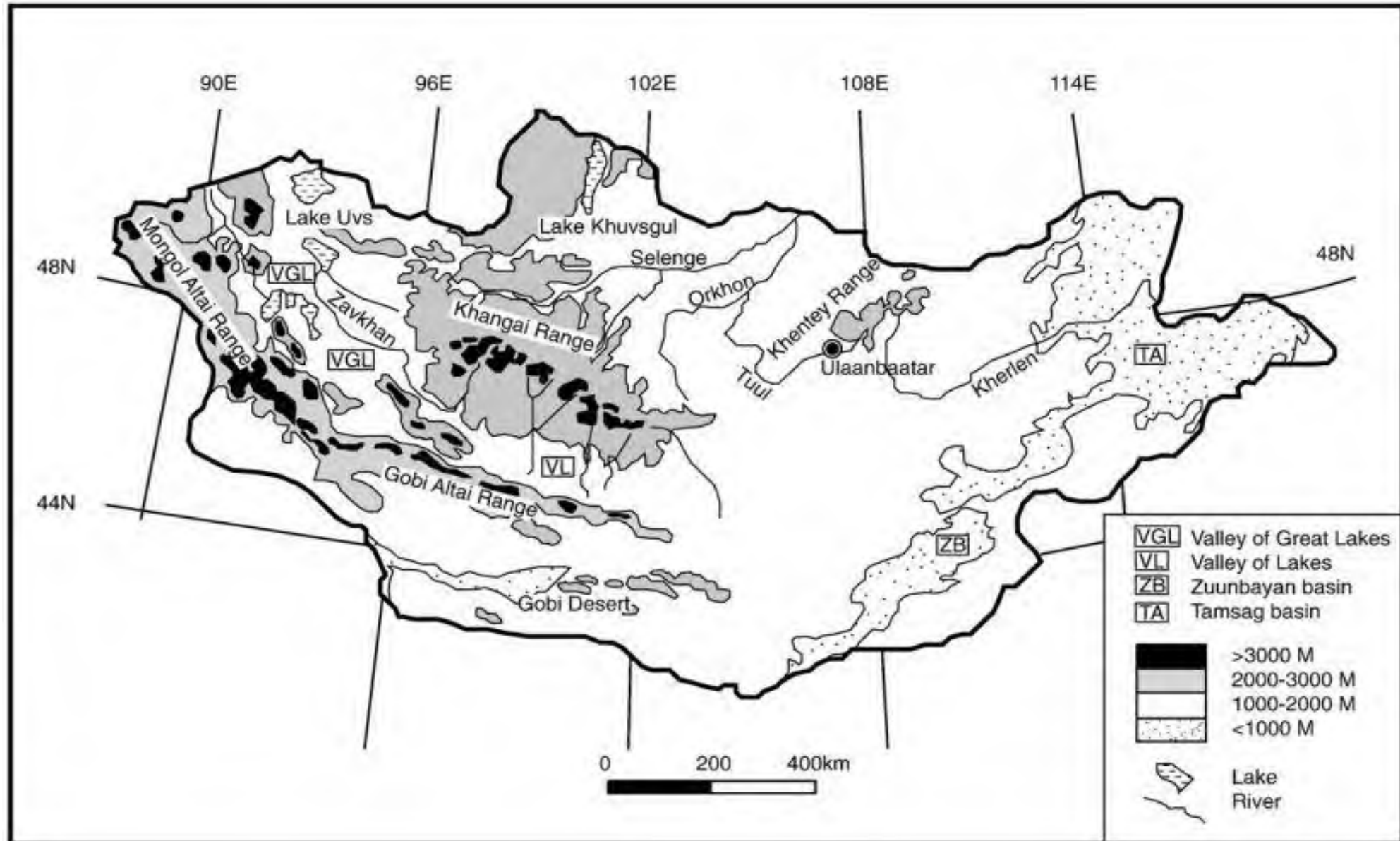


Terrain and Work Areas

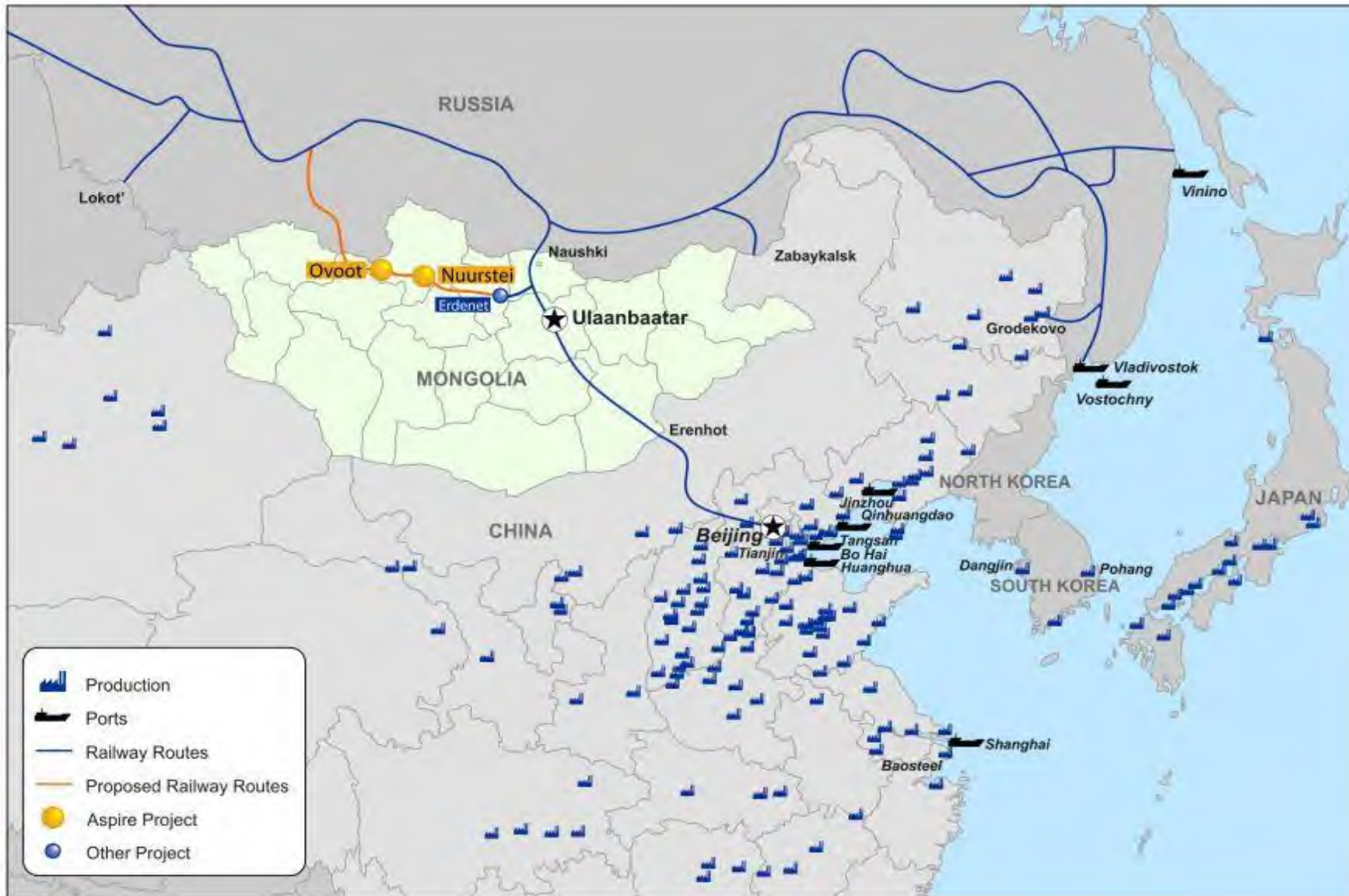
Highest Point - 4,374m Lowest Point - 518m Average - 1,580m



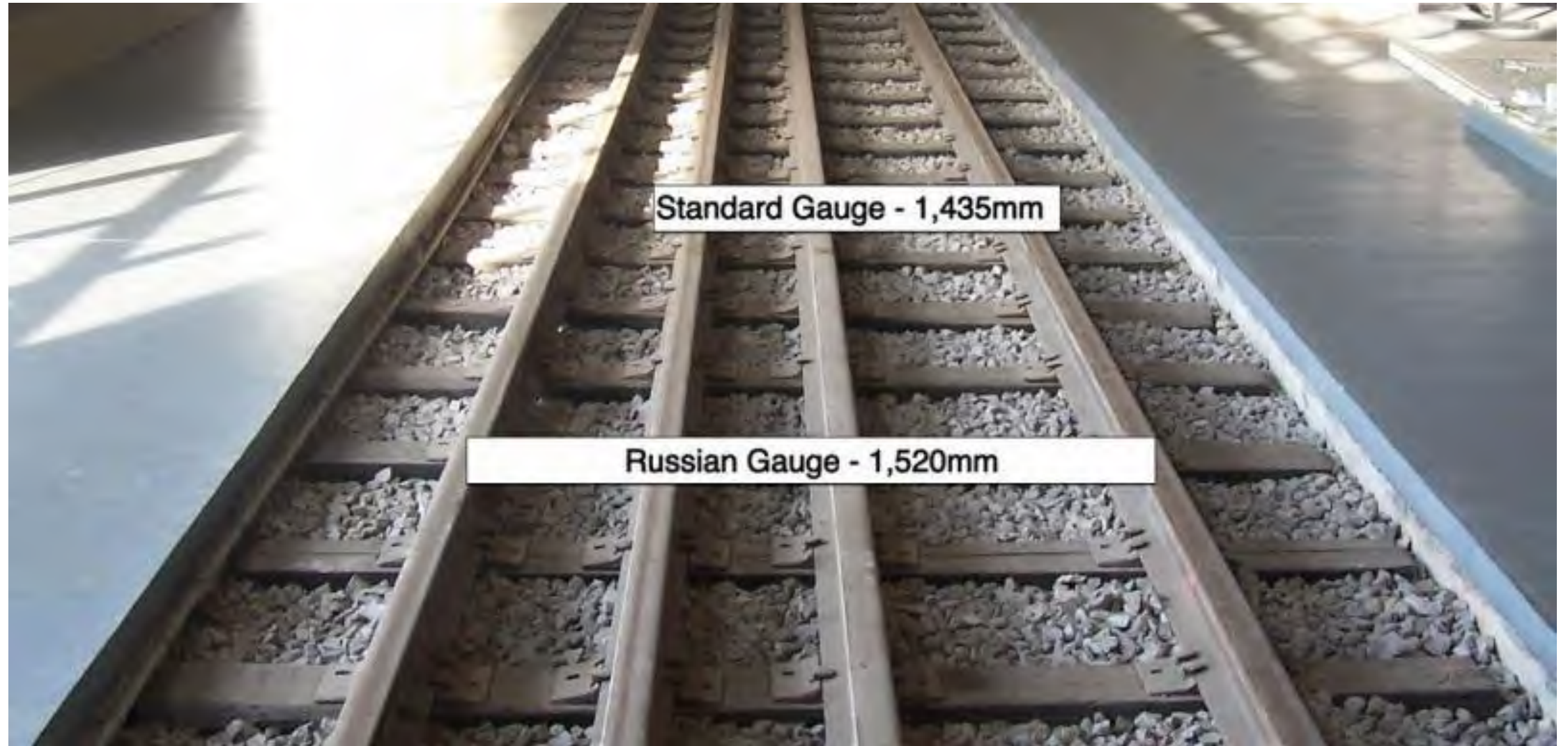
Simplified Topography



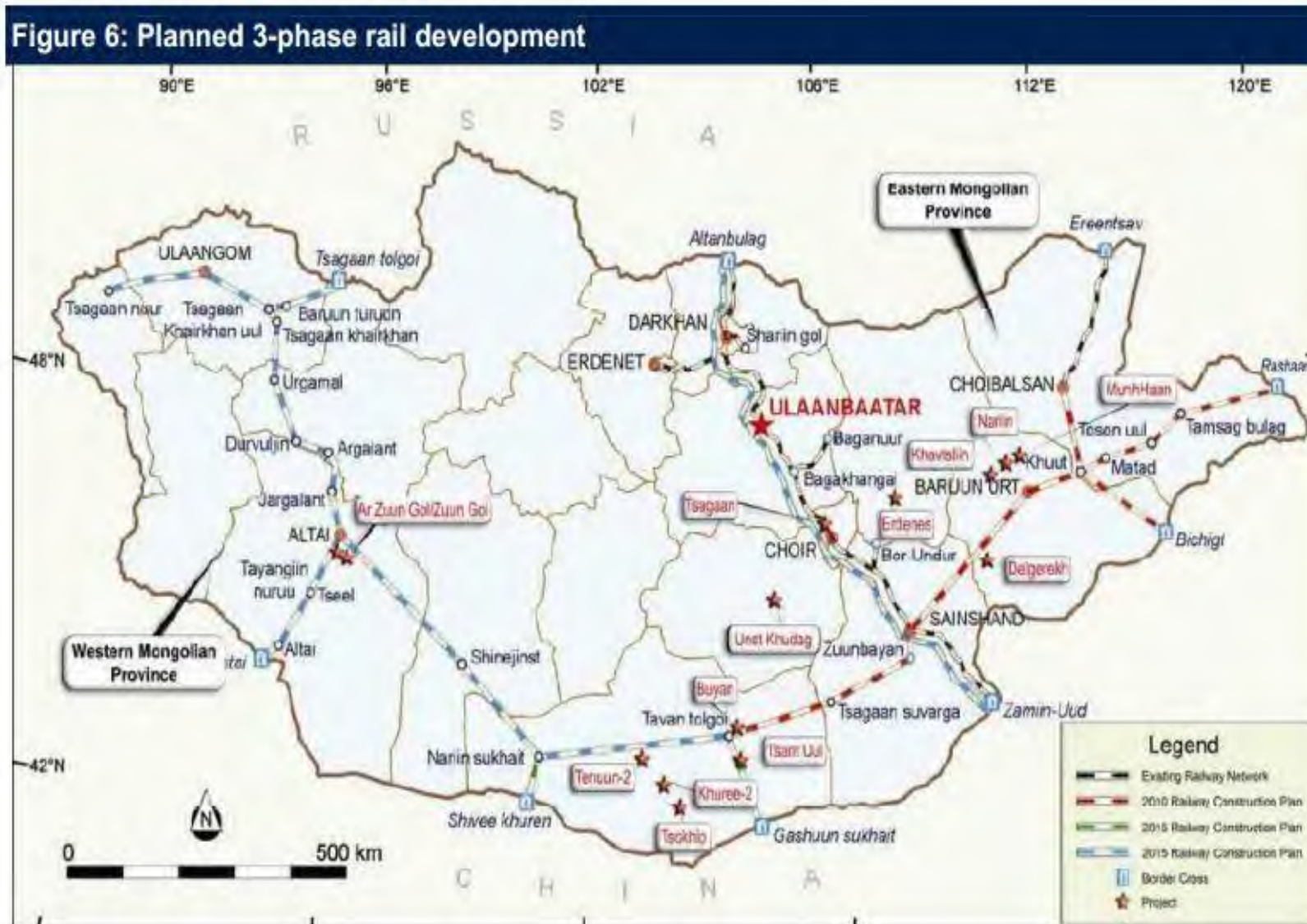
Infrastructure - Rail Links



Railway Uses Standard Russian Gauge



Planned New Railways



Infrastructure - Roads (and Work Areas)



One of Two Main E-W Roads - 2012



New Roads Under Construction - 2012

(Photo taken near Altai, SW Mongolia)



Mongolian Road Train

(Most trucks are from Russia)



Country Snapshot

Area:	1.564 million km² (QLD - 1.727 m km²)
Population:	3.076 million (2 per km²)
Capital City:	Ulaan Baater (population 1.1m approx.)
Government:	Parliamentary Democracy
Language:	Mongolian (90%), Turkic, Russian
Religion:	Tibetan Buddhist (~90%), Muslim (3%), Christian (2%)
Currency:	Tugrik (2,567 to USD; 1,100 to AUD in 2012!)
Doing Business Ranking:	62nd
Crime:	7.2 homicides/100,000 (2015) (Aust 1/100,000-2014)

Economy Snapshot (2017)

GDP:	US\$13 billion (137th in world)
GDP per Capita:	US\$3,900 (Australia – US\$56,135)
GDP Growth:	5.1%
Inflation Rate:	4.2%
Exports:	US\$6.2 billion (80% minerals)
Imports:	US\$4.3 billion
Reserves:	US\$3.0 billion
External debt:	230% of GDP

China is main market. Vulnerable to commodity price swings & Chinese economy. Lower Chinese demand for coal is a large downside risk.

Ulaan Baater (UB) - Construction boom in 2011-12



UB – Central Square & Parliament Building



Mongolian Writing - Adopted Russian Script in 1946



UB - Typical Russian-style Buildings



Chinggis Khaan – Images or Statues Everywhere!



Chinggis Khaan Statue (Metal Construction)



UB - Piped Steam for Heating from Power Station



UB - Most Mongolians are Buddhist

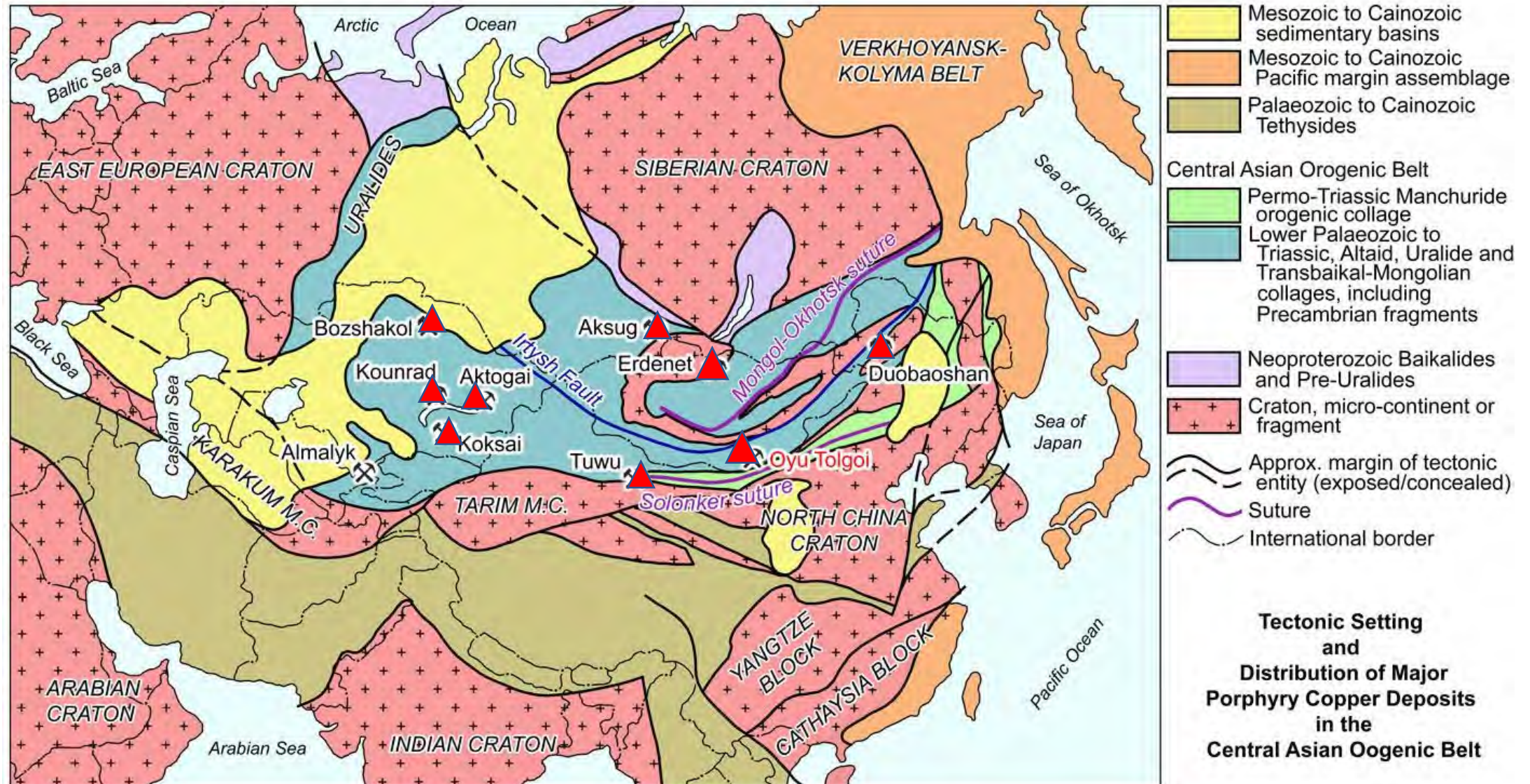


Tectonic Setting

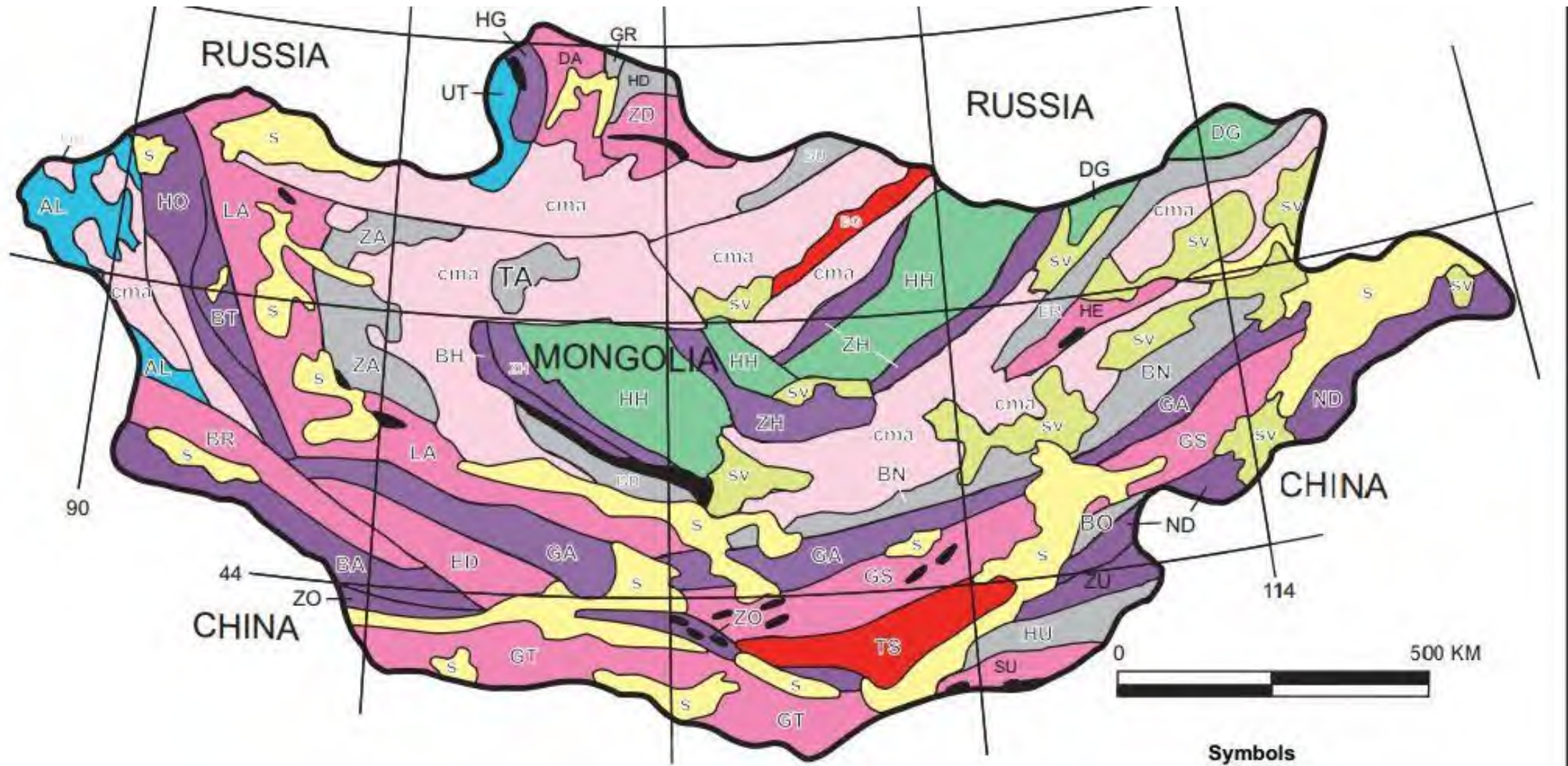
Part of Central Asia Orogenic Belt (CAOB) - crunched between Siberian Craton and North China Craton from 1000Ma to 250Ma. VERY complicated geology!



CAOB - Highly Mineralized

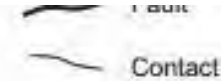


Geological Terranes – Very Complex



Geological Terranes - Reference

EXPLANATION		
Tectonic Environments		Terranes
Archean and Proterozoic Terranes		
	Cratonal	AL Altay terrane (Passive continental margin)
Early and Middle Paleozoic Terranes		BA Baruunhuuray terrane (Accretionary wedge)
	Passive continental margin	BD Baidrag terrane (Cratonal)
	Continental margin arc	BG Bayangol terrane (Continental margin arc)
	Island arc	BH Bayanhongor terrane ((Accretionary wedge)
	Turbidite basin	BO Bargyn ovoo terrane (Cratonal)
	Accretionary Wedge	BN Buyant terrane (Cratonal)
	Ophiolite and oceanic crustal rocks	BR Baaran terrane (Island arc)
Middle Paleozoic to Cenozoic Overlap Assemblages		BT Baatar Hayrhan terrane (Accretionary wedge)
	Devonian and Carboniferous continental margin arc	BU Buteel terrane(Cratonal)
	Cretaceous and Cenozoic sedimentary and volcanic rocks	DA Darhad terrane (Island arc)
	Cenozoic overlap sedimentary rocks	DG Dochgol terrane (Turbidite basin)
		ED Edren terrane (Island arc)
		ER Ereen Davaa terrane (Cratonal)
		GA Govi Altay terrane (Accretionary wedge)
		GR Gargan terrane(Cratonal)
		GS Gurbansaihan terrane(Island arc)
		GT Govi Tien Shan terrane (Island arc)
		HA Harhorin terrane (Accretionary wedge)
		HE Herlen terrane (Island arc)
		HG Hug terrane (Accretionary wedge)
		HH Hangay Hentey terrane (Turbidite basin)
		HO Hovd terrane (Accretionary wedge)
		HU Hutag terrane (Cratonal)
		LA Lake terrane (Island arc)



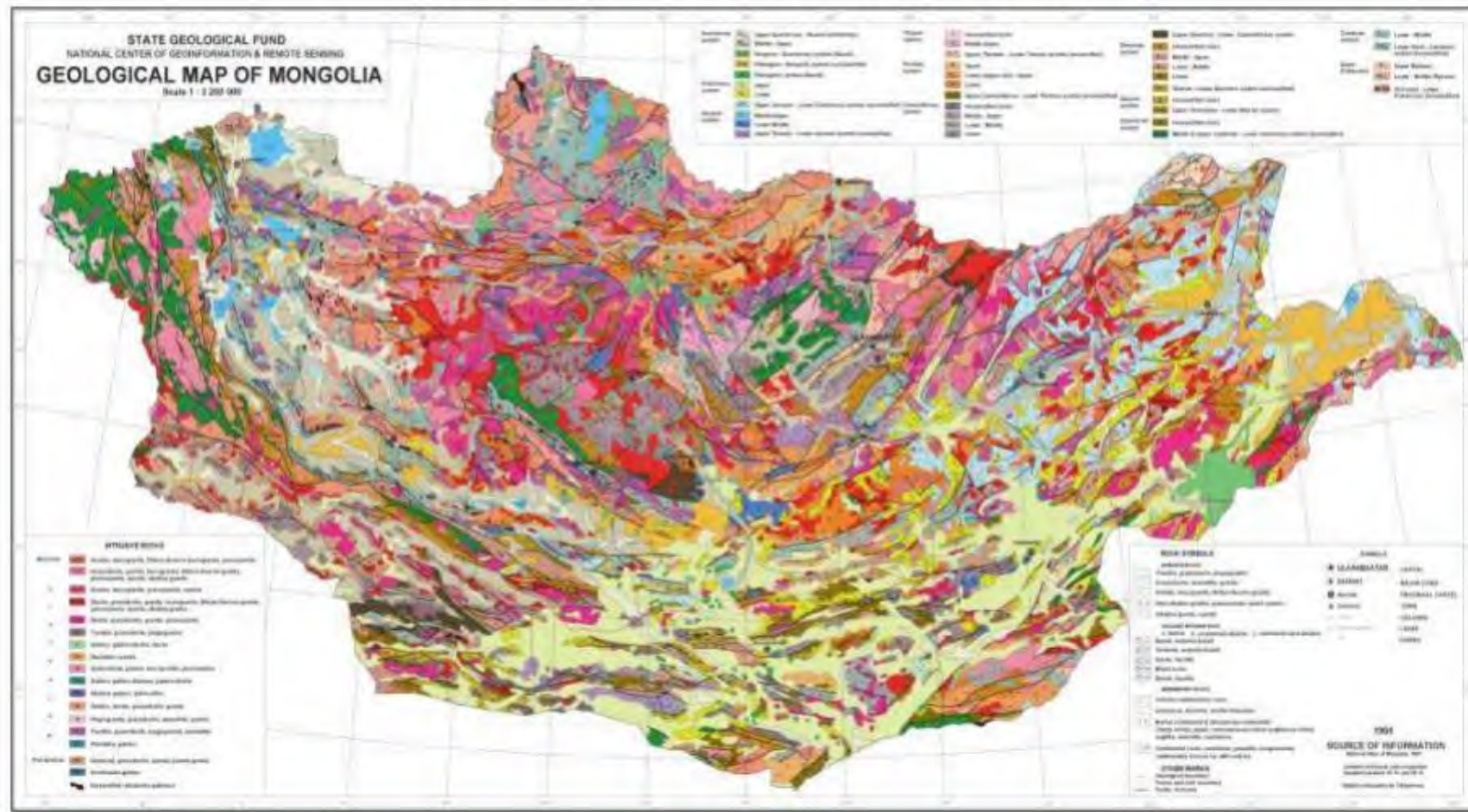
Regional Geology Map

100% 1:200,000 scale mapping; ~40% 1:50,000 scale mapping

All 200k mapping by Russians; all maps & reports in Russian or Mongolian

~60% 1:200,000 scale aeromagnetics; some gravity and multi-spectral coverage

GEOLOGICAL MAP OF MONGOLIA

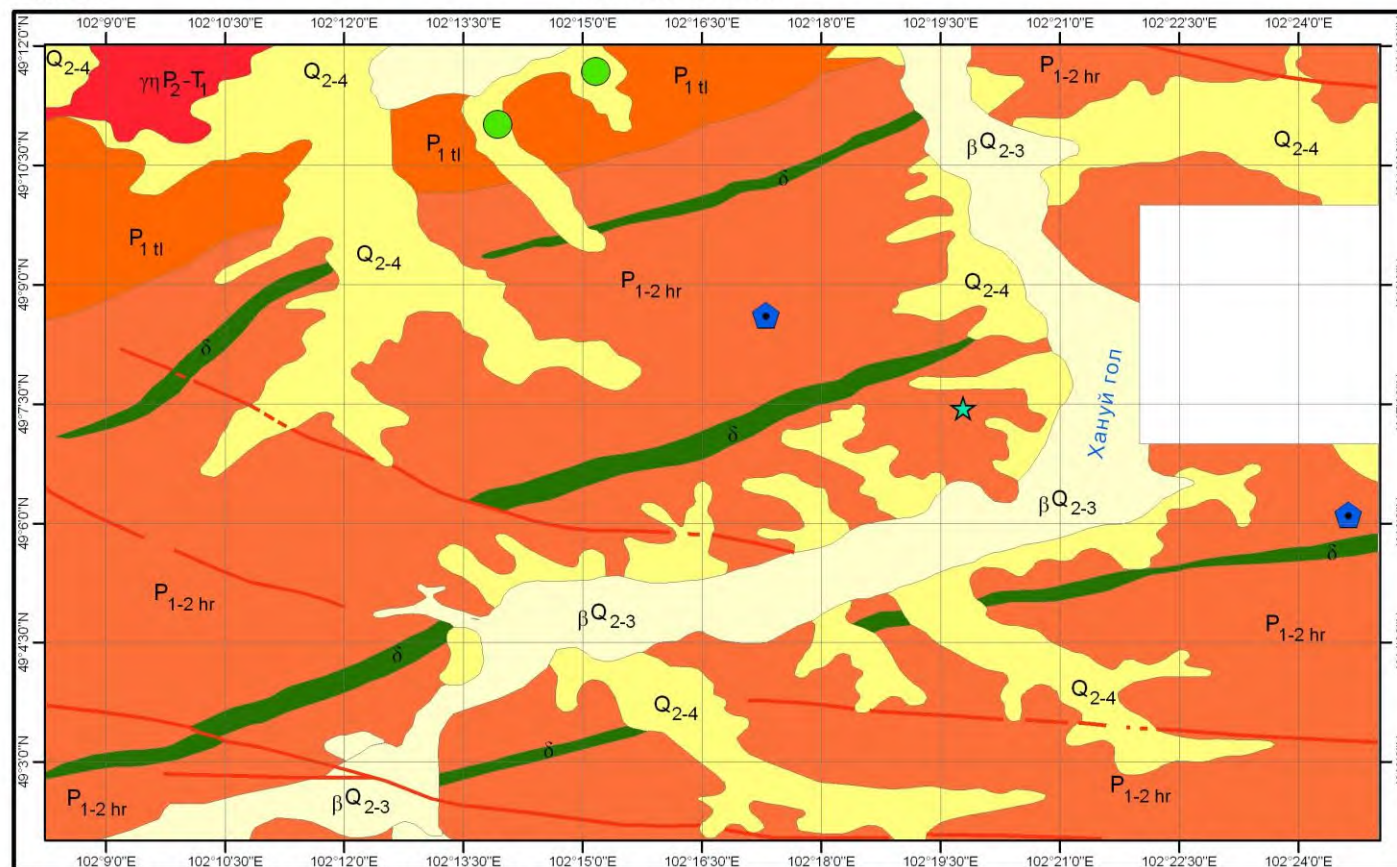


Example of Geology Map

"Далайн молор"ХХК-ны Булган аймгийн Баян-Агт сумын нутагт орших 13988Х лицензийн дугаартай "Бэрх гозгор" эрэл хайгуулын талбайн геологи ашигт малтмалын зураг

2008 он

Масштаб 1:150000



Таних тэмдэг

- Дөрөвдөгч систем**
- Q₂₋₄** Дунд дөрөвдөгч орчин үеийн хурдас:Делюви-пролювийн хайрга дайрга, элс, элсэнцэр.
 - βQ₂₋₃** Дунд-дээд дөрөвдөгчийн базальт
- Пермийн систем**
- P_{2tl}** Тулбур формац: Базальтууд, трахибазальт, трахиандезит, афирийн буйлс маягийн,буйлсэн чулуурхаг, кристалжсан туф, туф алевролиты туфууд.
 - P_{1-2hr}** Харган формац: Туф бөсөлжин, туф элсэн чулуу, туф алевролит, ховороор базальтийн хэмхдэс агуулсан алевролитууд.
- Пермийн интрузив**
- γP_{2-T1}** Сэлэнгэ комплекс: Боржин нь жижиг дунд ширхэгтэй биотит агуулсан, роговикжсон, шүлтлэгжсэн. Мөн гибрид, боржиндиорит, диорит, сиенит диорит.

Микродиорит, диорит порпирит.

Хагарал

Цагаан тугалга

пиритжилт

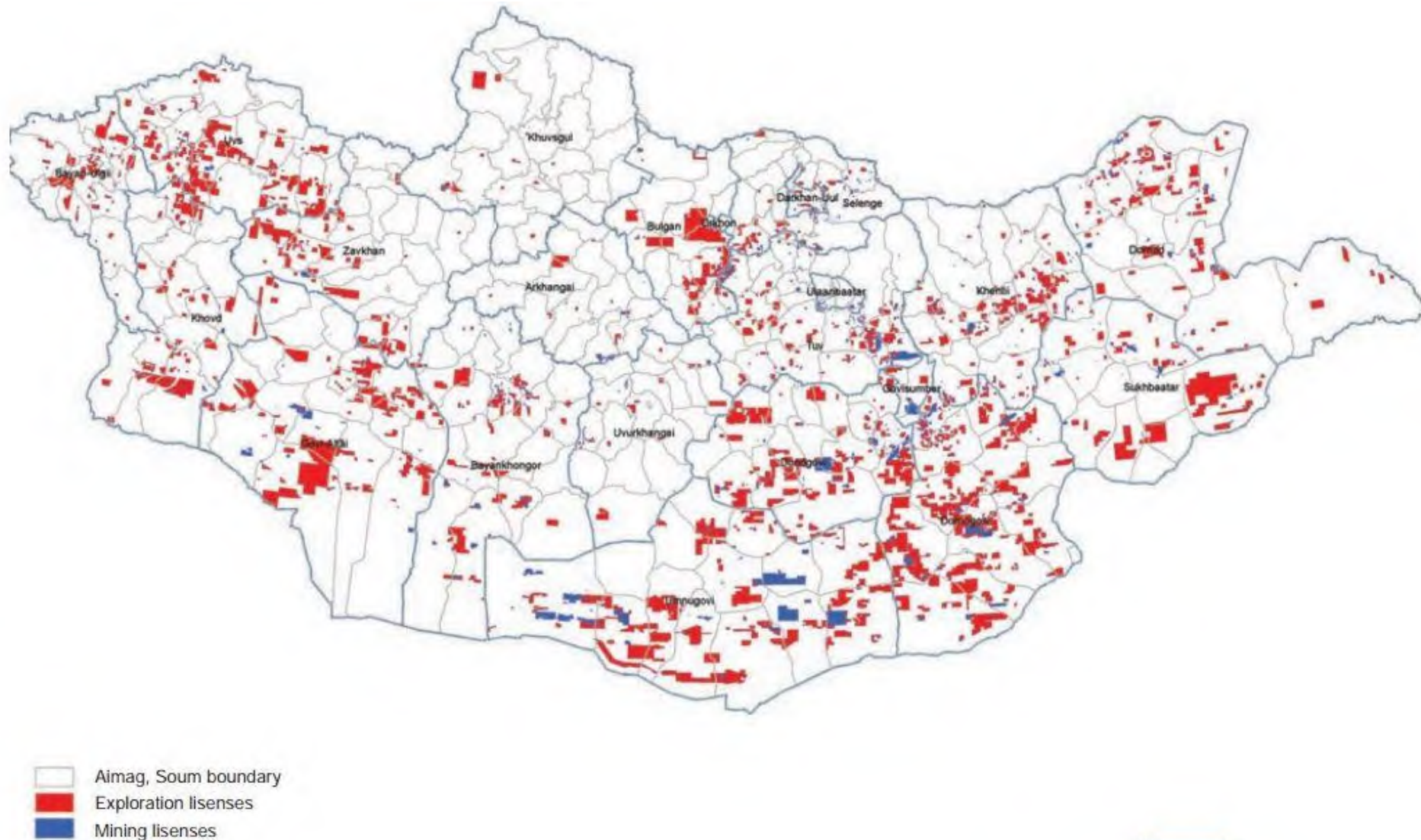
Цахиурлаг чулуулаг (халцедон)

Зурсан: Б. Хүрэлбаатар

Зургийг : ARC GIS 9.2 программ дээр зурав.

Орхон-Сэлэнгийн бассейн 1:200000-ны масштабтай зураглал.
Ж. Даваасүрэн, В. А. Новиков нарын зохиосон зургаас татав.

~2700 Exploration Licences in 2016



Mining Industry - Snapshot (2016)

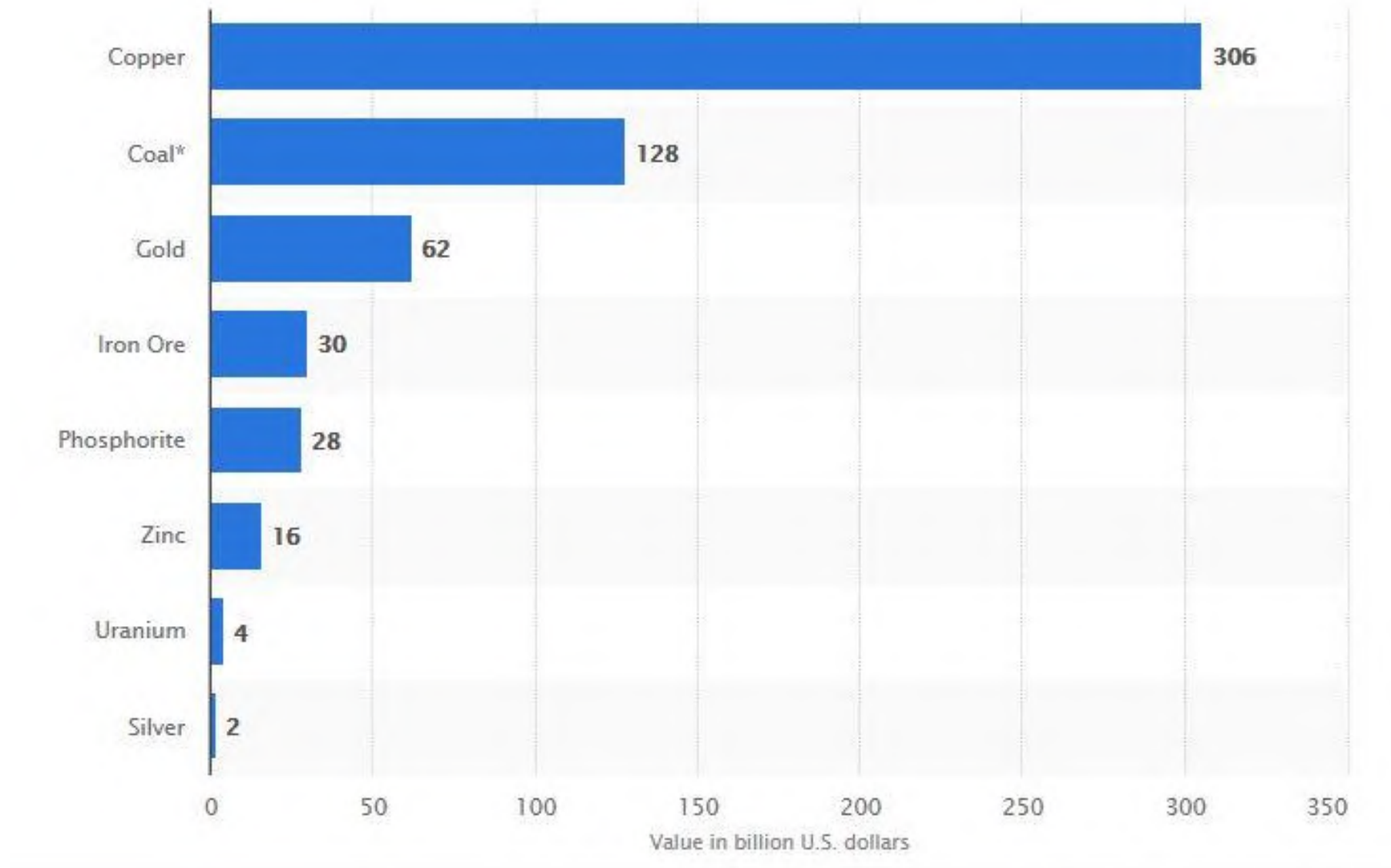
- 18% of GDP, 68% of industrial output, 81% of export earnings; employs 40,000 people
- 1130 mineral deposits and 7668 mineral occurrences; 80 different commodities
- RESERVES:
 - - 3290 t of proven gold reserves
 - - 60.7 Mt of proven copper reserves
 - - 1.7 Bt of proven iron ore reserves
 - - 26.8 Bt of proven coal reserves (in top ten countries for coal reserves)
- Untapped mineral wealth valued at \$1.3 trillion (?global estimate)

Mineral Production – 2016

(Also significant fluorspar producer)

Commodity	Production
Gold - hard rock & placer Oyu Tolgoi (in Cu conc)	597,000 oz (18.5 t) 27,350 oz (848 kg)
Copper Conc – Erdenet Oyu Tolgoi	657,000 t 904,000 t
Iron	180,000 t
Coal	34 Mt (25Mt exported)
Petroleum (oil)	8.25m barrels (~500,000 vehicles)
Tungsten, molybdenum, zinc & tin	

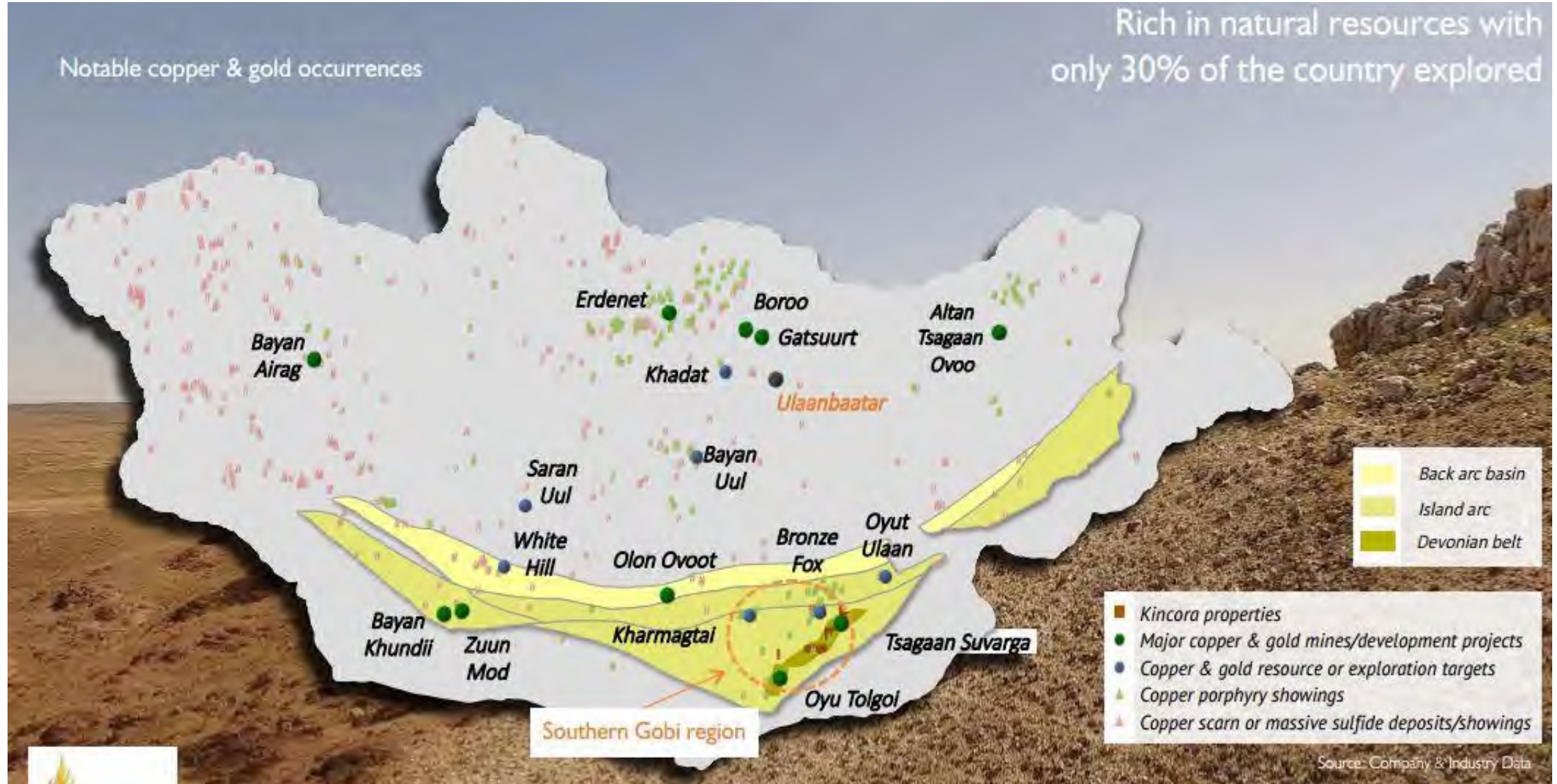
Mining Industry - Resource Value US\$Bn (2017)



Strategic Mining Projects

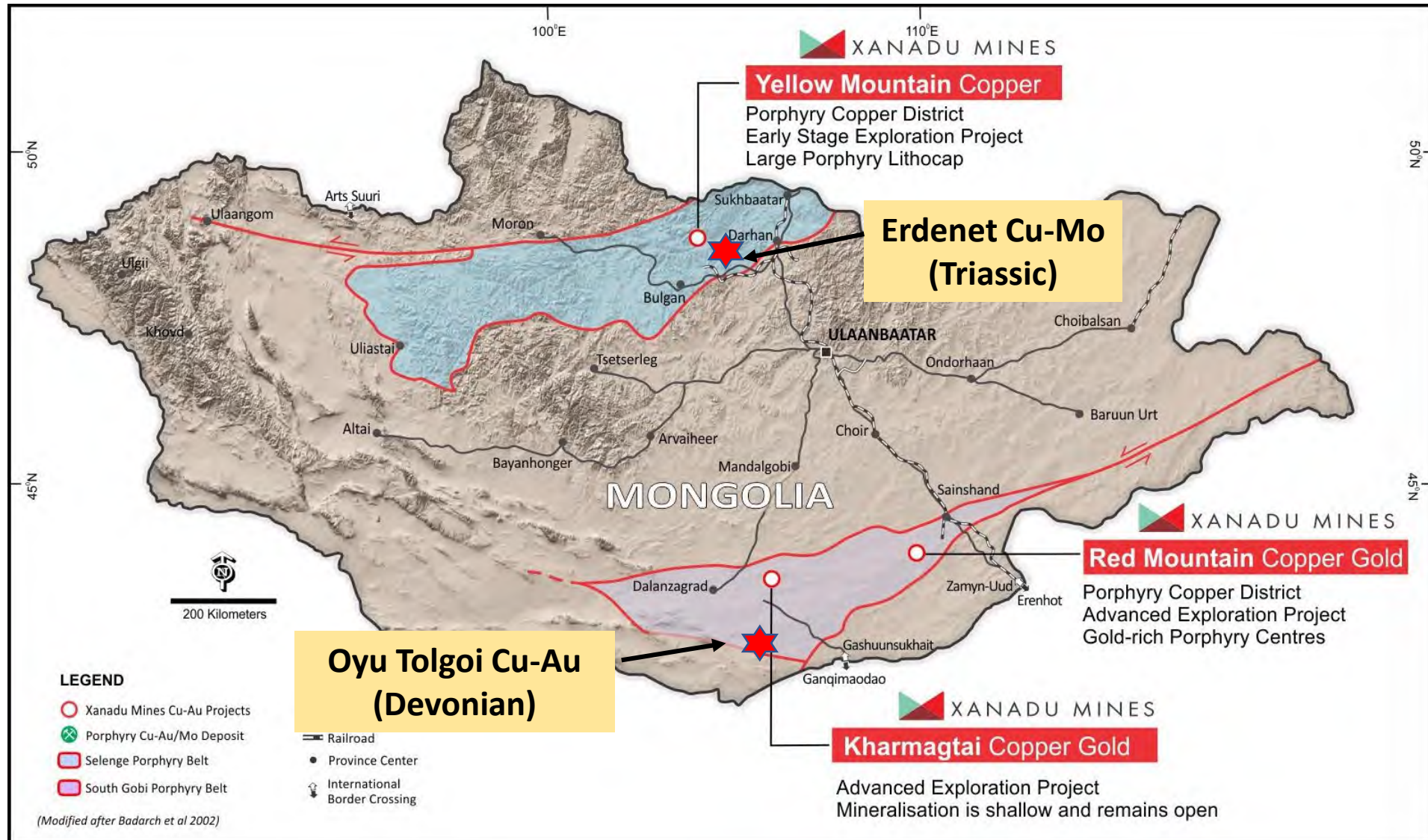


Copper Deposits



Oyu Tolgoi and Erdenet - Location

(Two Main Copper Belts – Under Explored)



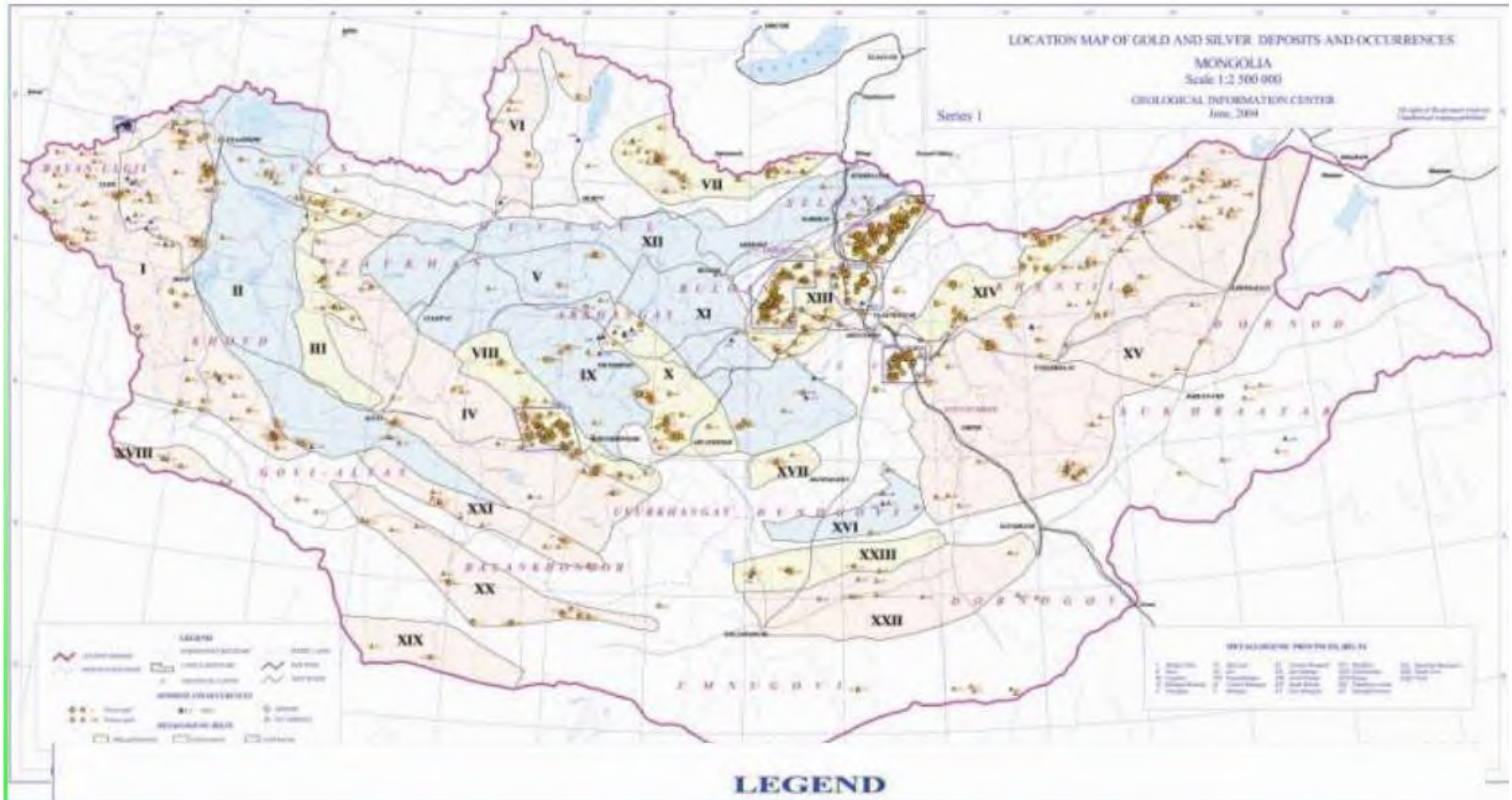
Oyu Tolgoi and Erdenet - Resources

Oyu Tolgoi: 1.45 Bn tonnes at 0.86% Cu & 0.30g/t Au
12.5 Mt copper and 10Moz gold
12km long cluster of 7 Cu-Au deposits, containing
>42 Mt copper and 1850t gold

2018 Production forecast: 125-155,000t copper &
240-280oz gold

Erdenet: 2.37 Bn tonnes at 0.38% Cu & 0.013 ppm Mo
9 Mt copper

Gold Deposits – Many Small Mines



Part of Tian Shan Gold Belt

The Prolific Tian Shan Gold Belt – Giant Deposits

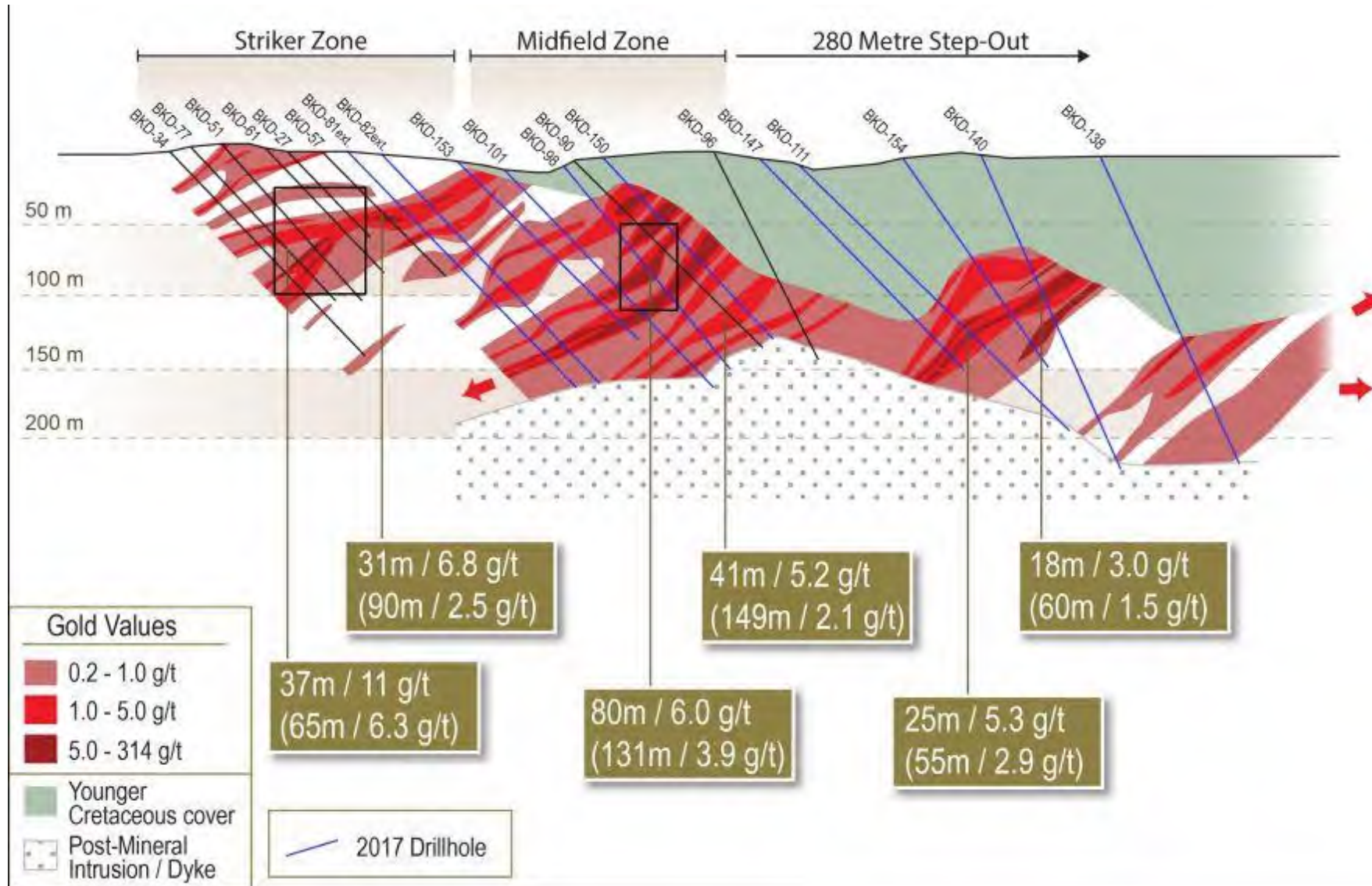
Limited Exploration through Southwestern Mongolia



South Mongolia – Resource Rich



Bayan Khundii Gold Project (Erdene Resources)



Significant Production from Ninja (illegal) Gold Miners

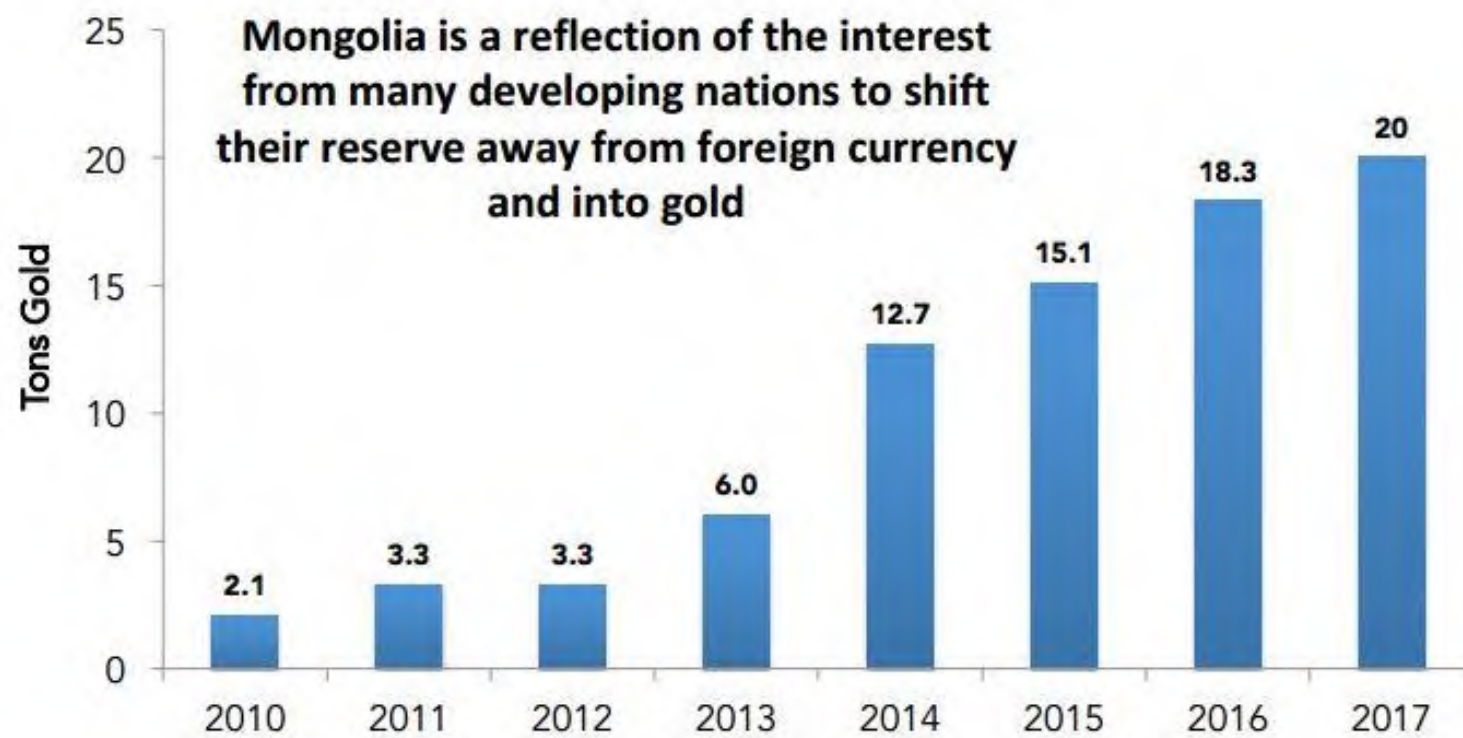


Ninja Miners

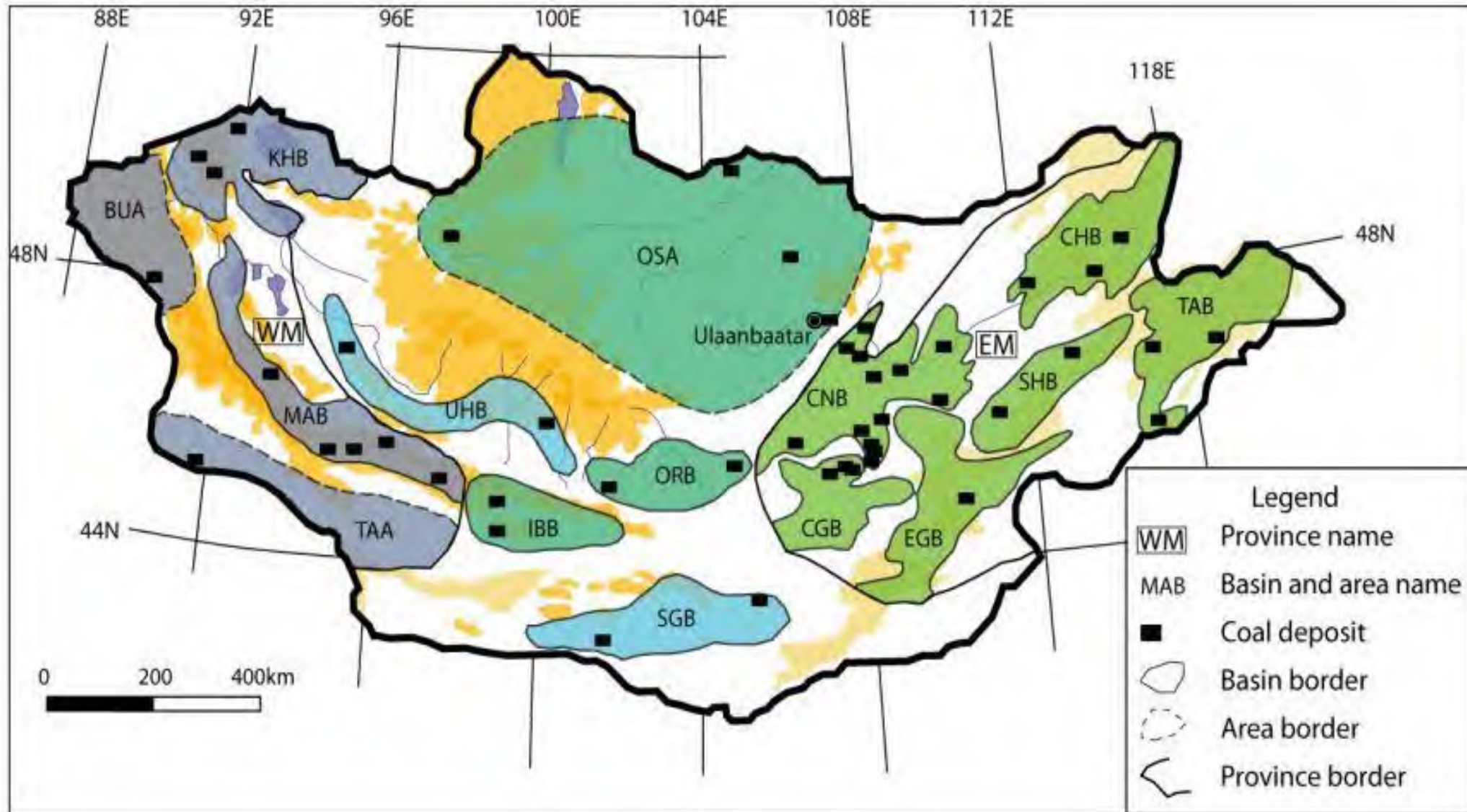


Central Bank Gold Purchases

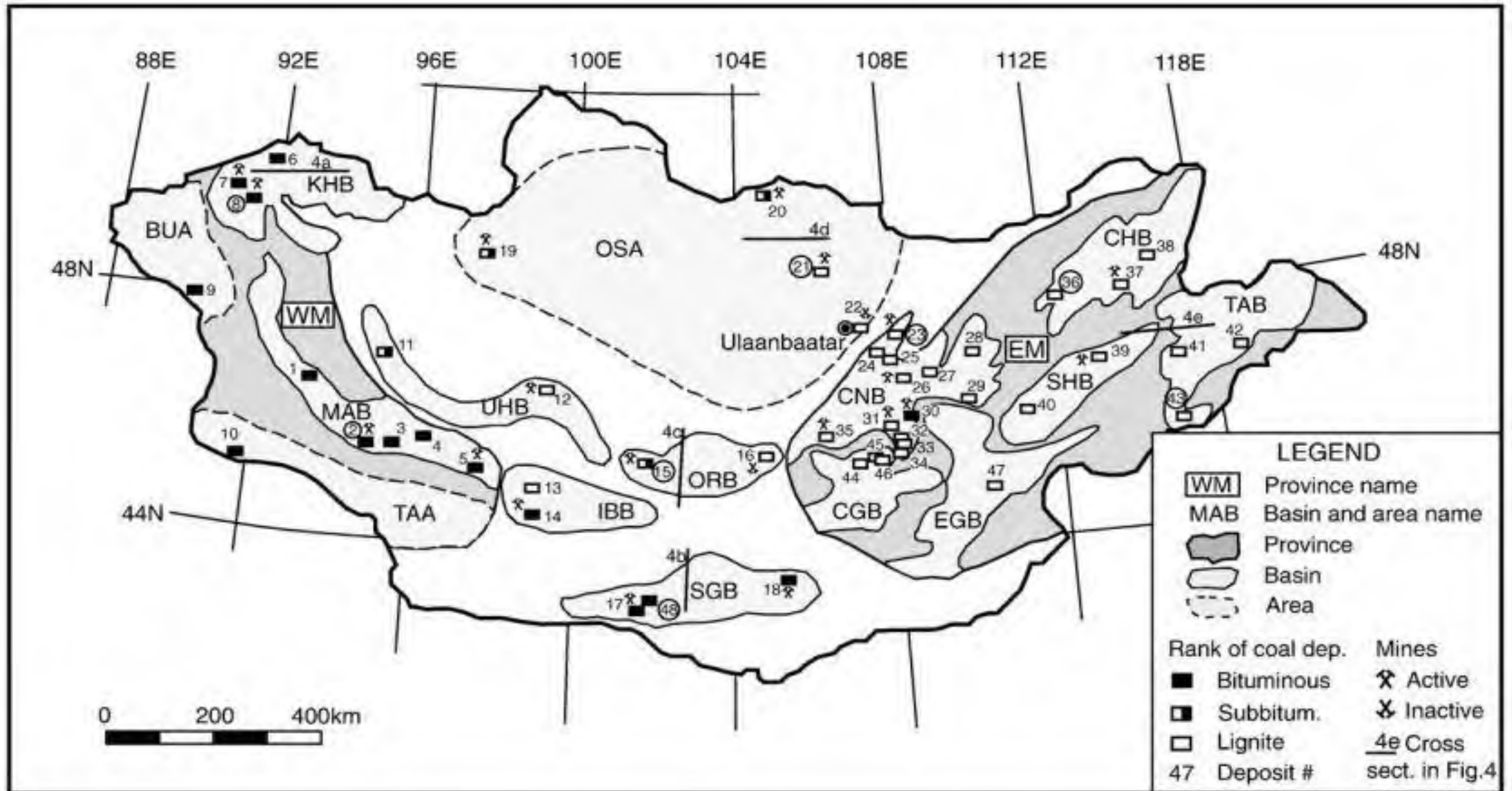
Gold Purchases by Bank of Mongolia from 2010 to 2017



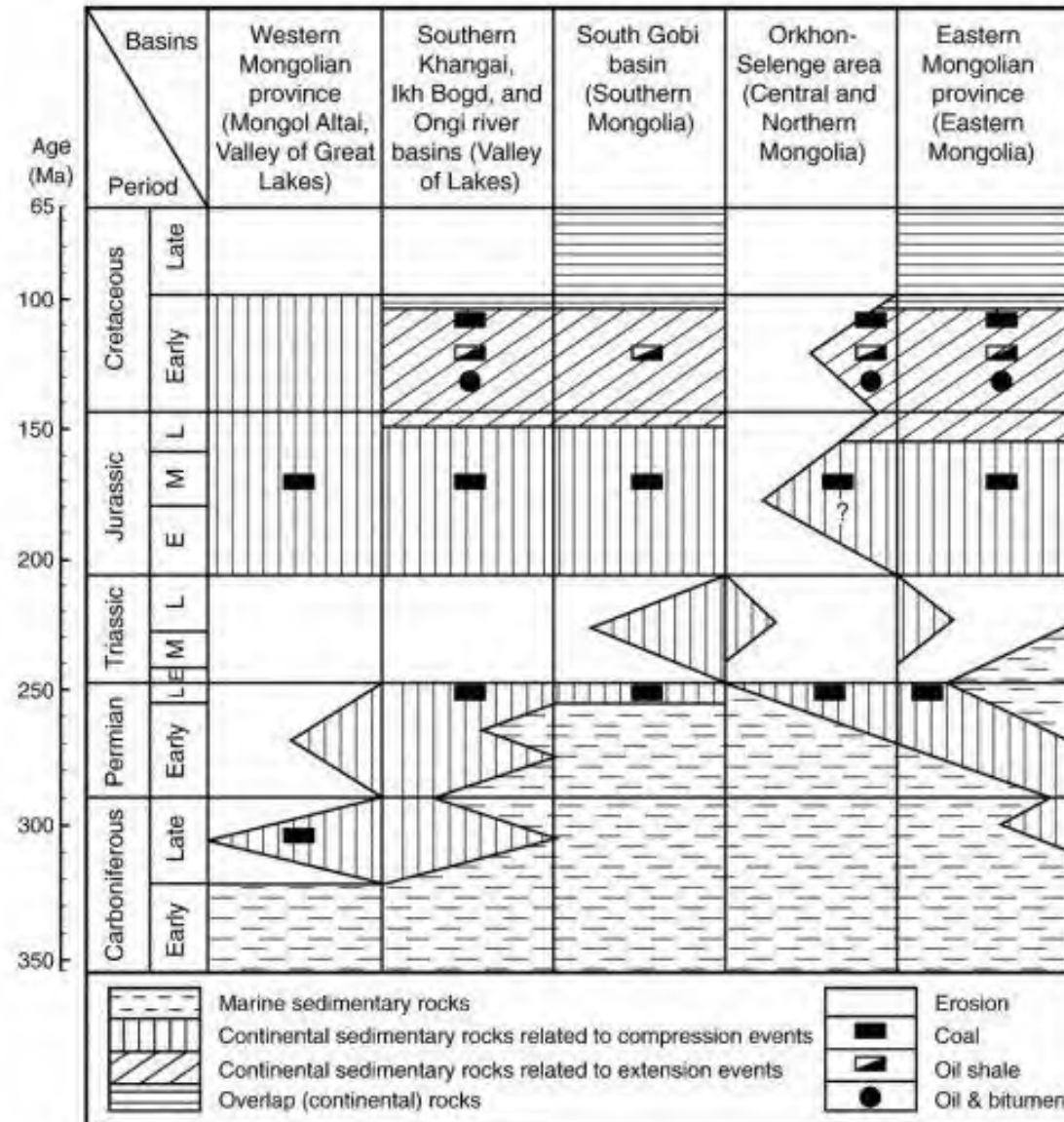
Coal Basins & Deposits



Coal-Bearing Basins



Coal-Bearing Strata



Top Four Coal Producers - 2016

In 2016: 10 operating mines & 8 projects under feasibility or scoping studies

Deposit	Production
Tavan Tolgoi	20 Mt
Ukhaa Khudag	10 Mt
Ovoot Tolgoi	7 Mt
Khushuut	6 Mt

Coal Exports To China are by Truck (until railway is upgraded)

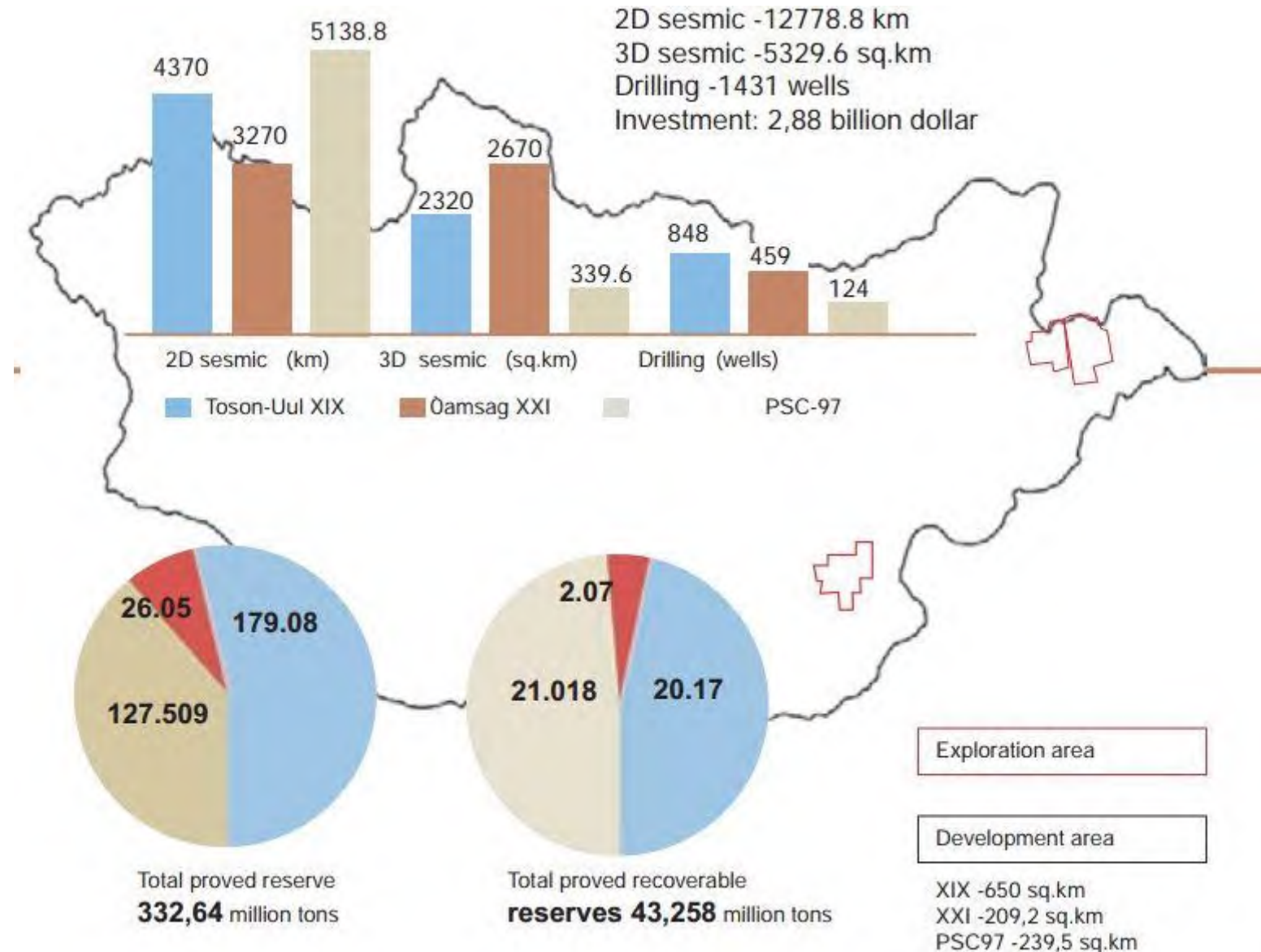


Petroleum Exploration Permits (2016)

Figure 29. Petroleum exploration work



Petroleum Reserves



Landscape - North Mongolia



Ovoo - Roadside Buddhist Shrine



Ovoo - (Walking around 3 times clockwise as mark of respect)



Olgii - Western Mongolia

(Few trees or gardens in Mongolia)



The New and the Old - Olgii Airport

(EZ airline modelled on Rex Aviation in Australia)



The Old and the New

Main Street of Tsengel – Westernmost Town in Mongolia



The Old and the New – Main Street of Altai (Olgii Province)



Road Side Cafe - Central Mongolia



Village Mosque - Kazakhs of W. Mongolia are Muslim



Roadside Meat Mart



Selling Airag - Fermented Mare's Milk (Alcoholic) (Olgii)



Town of Buyant - Altai Mountains

(Most of my fieldwork was in Altai Mountains)



Altai Mountains – W Mongolia (typical Mongolian scene)



Altai Mountains – Glaciated Terrain



Glaciated Terrain - U-shaped Valley



Glacier-smoothed Outcrop



Horses - Integral Part of Mongolian Culture



Typical Field Camp – Govi Altai

(Doors face south away from worst weather)



Erecting a Ger - 1



Erecting a Ger - 2 (Felt Insulation)



Erecting a Ger - 3



My Sleeping Ger – Altai Mtns



Interior Of My Sleeping Ger



Tonight's Dinner - 1

(Local herd animals supplied our meat)



Tonight's Dinner - 2



Mongolian Colleagues - 1 (Govi Altai)



Mongolian Colleagues - 2 (Altai Mtns)

(My young interpreter at left, my Kazakh driver at right)



Student Geologists - 2 Universities Teach Geology

(Students are required to work in industry during summer)



Fieldwork – Altai Mountains



Fieldwork – Gobi Desert



Great Exposure

(Unconformity - Devonian volcanics on Ordovician metasediments)



Great Exposure - Sagsai Fault (along side of valley)



Drilling – Altai Mountains

(Australian drilling company)



Trenching Alteration Zones - Altai Mountains



Auger Soil Sampling – Mid Autumn

(last week of fieldwork before winter shut down)



Bogged in the Moraine

(4wd Russian “Kombi” van – simple but rugged & practical)



Local People - Nomadic Herders

(Idyllic location for summer camp)



Drying Cow Dung for Fuel (No wood in most of Mongolia)



Drying Meat Strips - Mongolian jerky

(Need to have enough food & fuel to survive the harsh winter)



Winter Quarters (Temp commonly drops to -30 deg C) (Up to 80% of herd may die in a harsh winter – sometimes 100%!)



Kazakh Herder – W. Mongolia

(Two humped Bactrian camels are common in most of Mongolia)



Yaks – Hairy Cattle (Losing their winter coats)



Lifestyle Based on Herd Animals

(Mixed sheep & goat...and cattle/yak herds)



Milking Sheep and Goats for Food



Milking the Horses

(Mare's milk is used to make airag – a fermented alcoholic drink)



Kazakh Herder Family – with trained eagle



Interior of Kazakh Ger – Stove for Cooking & Heating



Hospitality to All Visitors is Integral to Culture



A Very Typical Ger (SW Mongolia)

(The guard dogs are all vicious and rabid)



Camels are the Beasts of Burden



Herder Family Being Moved by Russian Truck (The animals walk)



Main Wrestling Stadium – UB

(Wrestling is the national sport – same status as cricket in Australia)



Wrestlers are National Celebrities

(Photographed at annual Naadam Festival – 2012)

