GOLD METALLOGENY OF MONGOLIA

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INTRODUCTION

Mongolia regards as one of new frontiers in Central Asian Mobile Belt for discovering lode gold deposits. During last 30 years there has been extensive exploration for placer gold deposits by mongolian government, but lode gold deposits of Mongolia has been explorated badly.

Nowdays there are a few lode gold deposits and few hundreds occurrences discovered by Geological Mapping at scale 1:200 000 and 1:50 000 , but some of them were known of ancient time. Substantial studies of lode gold deposits and occurrences and of the gold resources potential of Mongolia have been conducted by mongolian, russian, cerman and bulgarian geologists during last 30 years.

This report provides characterictics of main types, metallogenic epoches and natural space distribution of lode gold mineralization of Mongolia.

PREVIOUS METALLOGENIC STUDIES

Main informations of lode gold mineralization of Mongolia have been published by Marinov N.A. (1963), Dornfeld G., Kraft M. (1964), Borzakovskii Yu. A. et.al. (1971), Kraft M., Taubert P. et. al. (1974), Tsypukov Yu. p., Lombo D. (1975), Blagonravov B.A., Shabalovskii A.E. (1977), Blagonravov B.A., Tsypukov Yu.P. (1977), Poznyak B.O., Dejidmaa G. (1977), Gottesman V. (1978), Tsherbakov Yu.G., Roslyakov N.A. et.al. (1979), Blagonravov B.A., Byambaa J., Podkolzin V.M. (1980), Tsherbakov Yu.G., Dejidmaa G. (1984), Blagonravov B.A., Blagonravova L.A. et.al. (1984), Tsherbakov Yu.G., Dejidmaa G., Kalinin Yu.A. (1986), Dejidmaa G. (1980, 1985), Alkin V.S., Kunytsyn V.V. et.al. (1989), Blumen B.A. et.al. (1989), Bolotova N.Ya., Dejidmaa G. et. al. (1990), Bokulev A.A. (1991), Blumen B.A. (1991), Dejidmaa G., Eideliman L.E. et.al. (1993), Mironov Yu.B., Trofhimov N.S. (1993), Mironov Yu. B., Soloviev N.S. (1993), Richard H. Sillitoe et. al. (1996)

CLASSIFICATION OF LODE GOLD DEPOSITS AND OCCURRENCES

Lode gold deposits and occurrences of Mongolia in this report are classified into 6 groupes, few classes and several types (tab. 1).

Groupes are presented by Acrhaean, Phanerozoic mesothermal, Epithermal, Intrision related, Gold in ancient seafloor hydrothermal systems and Ancient placer deposits and occurrences according to Foster R.P. (1993)

1. There are few Archaean to Early Proterozoic metamorphic terranes in the territory of Mongolia which belong to parts of Granitoid-Creenstone belt (fig. 1). The Baidrag terrane of them is more potential for discovery of Archaean-Early Proterozoic lode gold deposits. There have been discovered few silicate-oxide iron and gold-sulphide-quartz replacement occurrences. The Kharaat uul gold occurrence is presented by pyritized, silicificated replacement in gneisses of gneiss-amphibolite formation. Host gneisses are pyritized, silicificated, sericitized, chloritized and cut by

quartz-pytite veining oxidized intensively from surface. The grade of gold varies from 0.3 to 10 g/t on surface and the occurrence is the primary source of a gold placer deposit of the area.

2. Phanerozoic mesothermal gold deposits and occurrences are distributed widely in ancient tectonically active continental slopes of Upper Proterozoic and Early Paleozoic (O - D) (fig. 2, 4). They are presented by turbidite-hosted (black and green shales) mesothermal vein and disseminated veining classes. The vein class is presented by lower sulphide gold-quartz type and the disseminated veinning - by high sulfide type. There are few occurrences of gold-quartz type of Upper Proterozoic and disseminated sulphide-quartz veinning type of Vend-Early Cambrian in Baidrag-Burdyn gol district. Deposit (Olon ovoot) and occurrences of Devonjan age of the group are distributed widely in southern part of Mongolia in Devonian continental active slope. Devonian deposits and occurrences have a space relationship with concordant dykes, sills of diabase, gabbro and diorites.

3. Epithermal gold occurrences in volcanic terranes are distributed in southern and eastern parts of the territory of Mongolia in Eastern Mongolian Upper Mesozoic (fig. 7) and Southern Mongolian Upper Paleozoic (fig. 5) volcano-plutonic belts. According to their predominant rock-alteration and mineral-composition assemblages the epithermal group subdivides into adularia-sericite and alunite-kaolinite classes. The adularia-sericite class relates to volcanic environments and mostly distributes in Eastern Mongolian riftogenic volcanic belt (in volcanic rocks, in grabens and on a frame of grabens). Known occurrences of the class are presented by lower sulphide epithermal quartz veins and disseminated replacement types. The alunite - sericite class relates to porphyry magmatism and has genetical and space relationship with porphyry copper, copper - molybdenum deposits and occurrences formed in volcano-plutonic belt of active continental margin of Andian type. Known occurrences of the class are presented by high sulphide quartz veins, breccia types. Host volcanic and volcano - terrigenic formations are alterated widely and there are wide developed hypergene alunite and kaolinite.

4. Intrusion related gold deposits and occurrences are distributed widely in the territory of Mongolia. According to Sillitoe R.H. (1993) the groupe subdivides into 4 classes and several types (see tab. 1).

4.1. The intrusion hosted/disseminated class has space and genetical relationship with porphyry magmatism related deposits. To the class we belong the gold-copper porphyry, gold-bearing copper-molybdenum porphyry stockworks and gold-sulphide-magnetite-quartz vein and breccia types (fig. 3,4,5,6). Gold-porphyry type is new in Mongolia and we think that some gold occurrences in granite-porphyry dykes of Zamar-Ugtaaltsaidam district belong to the type. Known occurrences of last type has a space and genetical relations with copper - porphyry occurrences.

4.2. Skarn deposits and occurences are distributed widely and are presented by gold - copper and gold - copper - iron types. The skarn class deposits and occurrences formed in Early Paleozoic (fig. 3), Upper Paleozoic to Early Mesozoic (fig. 6)and Upper Mesozoic (fig. 7) metallogenic epoches in active continental margins. Mineral composition of the classe is more compilicated.

4.3. The class of stokwork, disseminated and replacement in noncarbonate rocks are wide distributed in ancient active continental margins and subdivides into two types. The gold - sheelite stockwork type (fig. 4) has a space and genetical relation with tungsten and molybdenum deposits and is distributed in tungsten - molybdenum - gold bearing districts. The gold - sulphide - quartz veining/replacement type (fig. 3, 4) are distributed in gold districts in space and genetical relation with vein class . This type is more potential for discovering of bulk mineable deposit, but it was studied badly. The Olgii - Sagsai, Burgastain gol, Eroo gol, Baljiin gol districts are more potential for discovering of the type gold deposits.

Tab.1 Main group, class and types of lode gold deposits and occurrences of Mongolia

GROUP	CLASS	TYPE	DEPOSITS, OCCURRENCES / AGE / / DISTRICTS /
1	2	3	4
Archaean-Early Proterozoic in Granitoid-Creenstone terrane	Disseminated replacement	Gold - sulphide /pyrite/ - quartz veinning	Kharaat uul / PR1 / /Baidrag - Burdyn gol /
Phanerozoic mesothermal in continental slope of tectonicaly active continental margin	Vein	Cold-quartz-vein	Daltyn khondii, Khoit I,II / R / / Baidrag - Burdyn gol /, Olon ovoot / D/ / Mandal ovoo /, Bayangovi ./ D / /Bayangovi-Bayanleg / Khan uul / V - E1 / / Tuin - Taatsyn gol / Daltyn khondii / R / /Baidrag - Burdyn gol /
	Disseminated replacement	Cold-sulphide-quartz veinning	
Epithermal in volcanic terranes	Alunite - kaolinite /High sulphide /	Gold-sulphide-quartz vein, breccia, ledges /replacement	Shuteen / C / /Mandakh - Shuteen /, Ikh Shankhai / C / /Ikh Shankhai/
	Adularia - sericite /Lower sulphide /	Gold-/silver/-quartz vein and replacement	Tsagaan / K1 / /Onon - Berkh /, Ugtam / K1 / /Turgen gol / Bulgan group / K1 / / Bulgan/
Intrusion related in active continental margin	Intrusion hosted stockwork/disseminated	Gold - copper-porphyry	Kharmagtai , Ovoot khyar, Ukhaa khudag / C / /Kharmagtai / Khadat / MZ1 / /Zamar - Ugtaaltsaidam /
		Gold bearing copper-molybdenum porphyry	Avdar tolgoi / MZ2 / /Dochiin gol /, Tsagaan suvarga / D / / Tsagaan suvarga /
		Gold - porphyry?	Ulaangozgor, Erdenetsog ovoo / MZ1 / /Zamar - Ugtaaltsaidam/
		Gold-sulphide-magnetite-quartz breccia	Tsakhir khudag / P / /Govi-Altai / Kharmagtai / C / / Kharmagtai /
	Skarn in carbonate rocks	Gold - copper skarn	Khokh bulgiin khondii / P / /Baidrag - Burdyn gol / Tsakhir khudag / P / / Govi - Altai /
		Gold - copper - iron skarn	Teshig I, II, III /MZ1 / /Teshig /, Erdenetolgoi / MZ2 / /Dochiin gol/
	Stockwork, disseminated and replacement in noncarbonate rocks	Gold - sheelite stockwork	Mushgui, Khalgat, Zeeriin gol, Dund salaa / D / /Dungerekh-Tsagaan gol /
		Gold-sulphide-quartz veinning and replacement	Khomol / MZ / / Baljiin gol /, Buural gol / MZ 1/ / Eroo gol / Sagsai / D / /Olgii - Sagsai /, Gozgor, Khagshir bulag, Talyn salaa / D / / Burgastain gol /

1	2	3	4
	Vein	Gold-lower sulphide-quartz	Tsagaanchuluut, Boroo 7 / MZ 1/ /Boroo - Zuun mod / Tsagaan tsakhir uul / P / /Baidrag - Burdyn gol / Bumbat, Nariin gol / PZ1 / / Zaamar - Ugtaaltsaidam/
		Gold - sulphide - quartz	Narantolgoi, Suzigt / MZ1 / /Boroo - Zuun mod / Tsagaan tolgoi / O / / Altankhokhii - Tsagaan tolgoi /
		Gold-sulphide-quartz vein and wall rock alteration type	Boroo, Tsagaangozgor, Bayantsagaan / MZ 1/ /Boroo-Zuun mod /
		Au - Ag - Pb - Zn - quartz vein and wall rock alteration type	Bayan uul / MZ2 / / Tsav /, Tarvagatai / MZ2 / / Azargyn gol
		Au - Ag - Cu - quartz	Nomint, Soeo-Under / MZ2 / / Dochiin gol /, Ereen group / MZ1 / / Teshig/
		Au - As - quartz	Zaagiin khondii, Tsagaan khondii , Ilturuut / MZ2 / / Dochiin gol /
		Au - Ag - As - Sb - quartz vein and wall rock alteration type	Ovor khooloi, Bor-Under, Burgast / MZ2 / / Dochiin gol /
		Au - Ag - As - Sb - Te - quartz vein and wall rock alteration type	Urliin ovoo, Dagai, Kharguit / MZ2 / / Dornot /
		Gold-magnetite-hematite-quartz vein and stocwork	Delberekh bulag group / MZ2 / / Narsyn khondlon /
Gold in ancient seafloor hydrothermal systems	Volcanogenic sulphides	Gold rich copper massive sulphides	Borts uul / V-E1 / / Khirgis nuur /, Naran davaa /V-E1/ /Govi - Altai /
	Metalliferous sediments	Gold rich silicate-oxide iron formation	Bayan-Airag, Shuvuu uul / R / /Urgamal-Zavkhanmandal /
		Gold-bearing silicate formation / quartzite /	Bayan-Airag, Shuvuu, Zun shuvuu, Burkheer kyar uul / R / / Urgamal - Zavkhan mandal /
		Gold-sulphide-quartz veinning	Bayan-Airag, Zuun shuvuu uul / R / /Urgamal-Zavkhanmandal/
Ancient placer		Gold-bearing conglomerates	Sharyn gol / K1 / / Eroo gol / Uyanga field / J / / Uyanga - Taragt / Bayan - under / P / / Delgerkhaan /

4.4. The vein classe of gold deposits and occurrences is distributed widely (fig. 2, 3, 4, 6. 7) and is well studied than others. Most of gold deposits of Mongolia belong to the class or the class is traditional in Mongolia. The size of known deposits varies from few ten kilogramms to few ten tonns. The mineral composition of the classe varies in wide arrange, so we subdivide the class into several types by its mineral assemblages. Wall rock alterations are developed very widely in some deposits and occurrences forming bulk mineable deposits (The Boroo deposit of Boro - Zuun mod district). The mineral composition of the classe become more complex from older to younger metallogenic epoches. Forexample, arsenic, antimony, tellurium, lead, zinc, silver, copper and thier minerals become to play more role in composition of Mesozoic, specially in Upper Mesozoic deposits and occurrences.

5. Known gold-bearing and gold deposits and occurrences developed in ancient seafloor hydrothermal systems are discovered in western part of Mongolia in Upper Proterozoic to Early Cambrian " Lake " structure - formation zone (fig. 3). The group subdivides into two classes: volcanogenic gold rich massive sulphides and metalliferous sediments. The gold rich massive and disseminated sulphide deposits and occurrences distributed in Khirgis nuur and Govi - Altai districts belong to copper sulphide type. The class of metalliferous sediments are presented by gold rich silicate - oxide iron , silicate formations and disseminated sulfide and gold - sulphide - quartz - veinning types. Known occurrences of these types are discovered in Urgamal - Zavkhanmandal district.

6. The group of ancient gold placers is new in Mongolia and they are also bad studied . Known occurrences of the group are a primary source of several gold placer deposits. Gold-bearing conglomerates of Permian, Jurassic and Cretaceous age belong to the group.

GOLD-BEARING METALLOGENIC EPOCHES

Known lode gold and gold-bearing deposits and occurrences of Mongolia formed in Archaean to Early Proterozoic, Upper Proterozoic, Early Paleozoic, Middle Paleozoic, Upper Paleozoic, Upper Paleozoic to Early Mesozoic and Upper Mesozoic metallogenic epoches(see fig. 1,2,3,4,5,6,7). Main chatacterictics of them are shown in the table 2.

SPACE DISTRIBUTION

There are 55 gold-bearing districts in the territory of Mongolia (fig. 8). Main characterictics of them are shown in the table 3. Mostly on the territory of gold-bearing dicrticts are distributed deposits and occurrences of gold and other mineral resources related spatialy and geneticaly and of one metallogenic epoch. But there are some more complicate districts, which has gold deposits and occurrences of two or more metalogenic epoches. For last we belong the Baidrag - Burdyn gol and Tuin - Taatsyn gold distrists of Bayankhongor metallogenic zone. The situation depends from tectonic-structure position of the zone. The zone consists from Archaean to Early Proterozoic metamorphic, Upper Proterozoic turbidite, Early Cambrian sea floor and turbidite, Middle Cambrian to Ordovician turbidite narrow structure - formation zones had own mineral resources and gold mineralization. These zones are activized tectonicaly and magmaticaly in Upper Paleozoic to Early Mesozoic epoche and on. all of them are distributed Upper Paleozoic to Early Mesozoic gold deposits and occurrences.

Tab.2. Metallogenic evolution and Geodinamic situation of Gold Mineralization in the territory of Mongolia

Metallogenic epoch	Geodinamic situation	Genetical types of Gold oreformation	Main mypes of deposits	Goldbearing areas
1	2	3	4	5
Upper Proterozoic	Seafloor	Sediment -rift environments with auriferous hydrotermal precipitates	Silicate formation horizonts with low-grade gold & copper	Urgamal-Zavkhanmandal
			Silicate-oxide iron formations	Urgamal-Zavkhanmandal
			Disseminated or massive sulphides in schists	Urgamal-Zavkhanmandal
	Active continental margin	Intrusion-related /Basite-granitoide pluton/	Gold-quartz vein & stockworks	Urgamal-Zavkhanmandal. Khugiin-gol
		Metamorphic mezothermal	Gold-quartz veins & dis-seminated sulphide-quartz	Baidrag-Burdyn gol
Early Paleozoic	Island arc	Intrusion-related /Porphyric intrusions/	Gold-copper & copper-gold porphyry	Govi-Almai / Beger /
		Volcanogenic massive sulphides	Massive sulphides / copper-kolchedan /	Khirgis nur / Borts uul / Govi-Altai /Naran davaa/
	Active continental margin	Intrusion-related /Basite-granitoide pluton/	Gold-copper skarn	Khirgis nur. Urgamal-Zavkhan-mandal. Buutsagaan
			Gold-quartz vein & stockworks	Khirgis nur. Ero gol. Zamar
		Metamorphic mesother-mal	Gold-quartz vein & stock-work	Tuin-Tatsyn gol

Table 2: continued

1	2	3	4	5
Upper Paleozoic	Island arc	Intrusion-related /Porphyric-intrusions/	Gold-bearing copper-molybdenum porphyry	Tsagantsuvarga
	Active continental margin of Andian type / C - P / / in volcano-plutonic terranes /	Intrusion-related /Porphyric-intrusions/	Copper-gold porphyry	Mandakh, Kharmagtai, Baidrag-Burdyn gol.
			Copper-gold skarn	Govi-Altai, Baidrag-Burdyn gol
			Breccia-hosted	Govi-Altai, Kharmagtai
			Gold-/magnetite-hematite/-quartz vein	Kharmagtai
			Epithermal alunite-kaolinite type	Mandakh /Shuteen/, Ikh-Shankhai
	Active continental margin of Andian /in the nothern jart of Southern Mongolia/ and Californian type / western part of Mongolia/ / D - C /	Intrusion-related /Basite-granitiode pluton/	Gold-quartz vein	Mandal ovoo, Tsogt ovoo, Bayanleg-Bayangovi
			Gold-sulphide-quartz vein	Altantsogts, Alman Khokhii-Tsagan tolgoi, Shar khooloi
			Stockwork, disseminated gold-sheelite-quartz	Dungerekh-Tsagan gol, Olgii-Sagsai
			Replacements in non-carbonite rocks	Burgastain gol, Olgii-Sagsai
			Copper-gold skarn	Burgastain gol
			Gold-lead-zinc stockwork	Mongol Altai /Dulan khar uul/
		Metamorphic mesothermal	Gold-quartz vein	Uench-Bodonch
Upper Paleozoic to Early Mesozoic / PZ3 -MZ1 /	Active continental margin of Pacific Ocean type	Intrusion-related /Basite-granitoide pluton and stocks, dykes/	Gold-quartz veins	Boro-Zunmod, Ero gol, Tuin gol-Tatsyn gol, Uyanga-Taragt, Baljiin gol
			Gold-sulphide-quartz vein	Boro-Zunmod / Narantolgoi, Sujigt/, Teshig /Ereen/

1	2	3	4	5
			Copper-magnetite-gold-skarn Intrusion hosted replacement & stockwork	Teshig /Teshig 1,2,3/ Boro-Zunmod /Boro. Tsagangoz-gor/
		Intrusion-related /Porphyric intrusion/	Copper-gold porphyry	Ugtaltsaidam / Khadat/
			Gold-porphyry?	Ugtaltsaidam /Ulan gozgor/
			Gold-quartz vein	Ugtaltsaidam /Erdenetsog ovoo/
		Sediment hosted	Gold-conglomerate	Uyanga-Taragt, Delgerkhan
Upper Mesozoic / J 3 - K1 /	Active continental margin /continental riftogenic volcano-plutonic belt/	Intrusion-related / Basite-granitoide /	Au-Ag-Pb-Zn-quartz vein	Tsav, Dochiin gol
			Breccia hosted Au-Ag-Pb-Zn	Dornot /Ulaan, Mukhar/
			Au-Ag-W-Mo-Cu-bearing stovwork/disseminated	Dochiin gol /Avdar tolgoi/
			Au-Fe2O3-Fe3O4-quartz vein and stockwork	Narsyn khondlon /Delbèrekh bulag/
			Au-Sb-As -quartz vein & replacement	Dochiin gol /Bor ondor, Ovor kholoi, Burgast/
			Au-As -quartz-vein	Dochiin gol /Zagiin khondii, Tsagaan khondii/
			Au-Te-quartz vein & replacement	Dornot / Urliin ovoo, Kharguit, Dagai /
			Au-Ag-W-Fe-Cu-skarn	Dochiin gol /Erdenetolgoi/
		Volcanic-related epither-mal	Au-Ag-vein & replacement disseminated / adularia-sericite type/	Onon-Berkh, Turgen gol, Baljiin gol, Bulgan
		Sediment hosted	Gold-conglomerate	Ero gol, Zamar

CONCLUSION

Hard rock gold exploration in Mongolia is at a lower level and known gold occurrences of several genetic groups and types of several metallogenic epoches are numerous and widespread, that shows yet there is potential.

ABBREVIATIONS

Standart chemical symbols: for example, Au - gold, Ag - silver, Cu - copper, Pb - lead, Zn - zinc, W - tungsten, Mo - molybdenum, Be - beryllium, Sb - antimony, Hg - mercury, Ba - barium, Fe -iron, Sn - tin, As - arsenic, F - fluorine, U - uranium, Te - tellurium, Ni - nickel, PGE - platinum-group elements.

Geologic Time: PR 1 - Early Proterozoic, R - Upper Proterozoic , V-E1 - Vendian to Early Cambrian, PZ1 - Early Paleozoic, O - Ordovician, S - Silurian, D - Devonian, C - Carboniferous, P - Permian, PZ3 - Upper Paleozoic, MZ - Mesozoic, MZ1 - Early Mesozoic, MZ2 - Upper Mesozoic, J - Jurassic, K1 - Early Cretaceous

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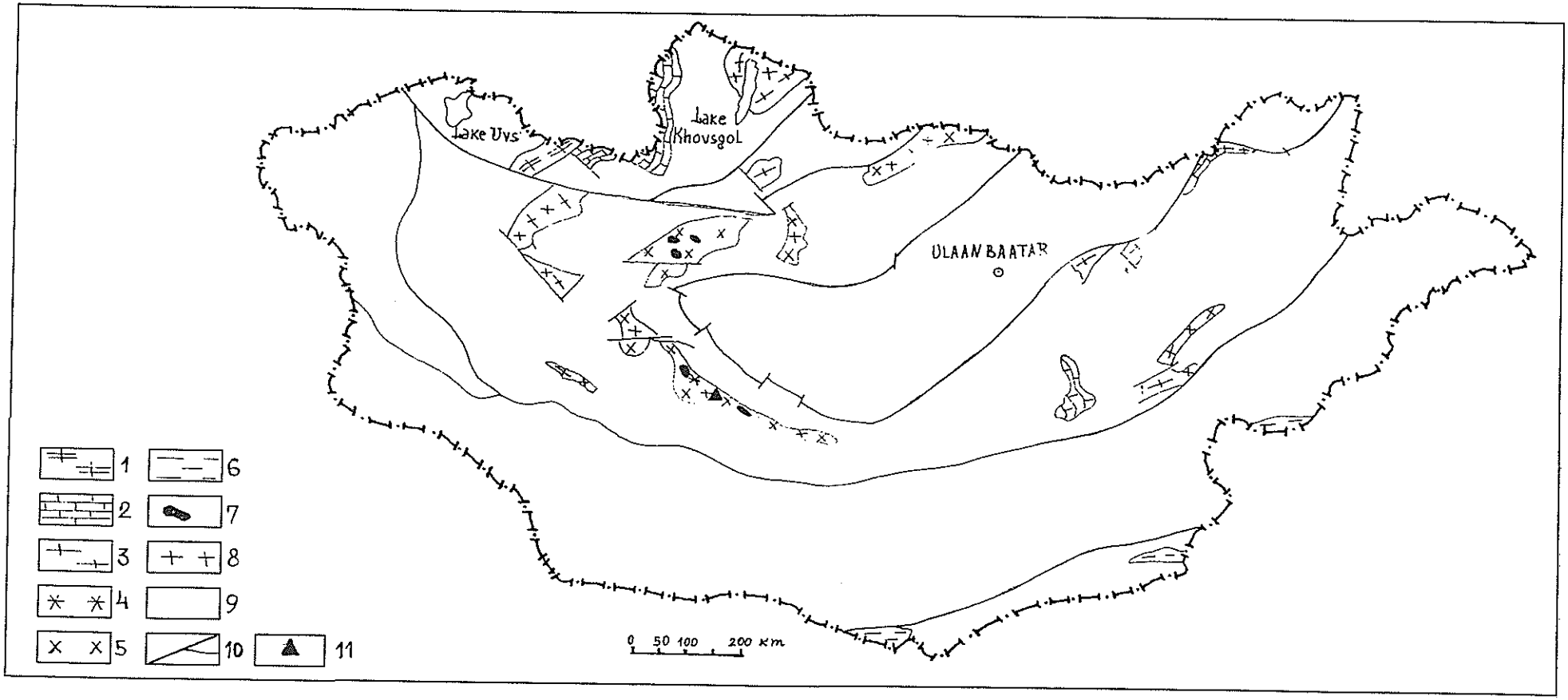

FIG. 1. SCHEME OF DISTRIBUTION OF ARCHEAN TO EARLY PROTEROZOIC STRUCTURES AND GOLD MINERALIZATION IN MONGOLIA

1 - 7 - Archean to Early Proterozoic structures and consisting them formations: 1 - Eclogite - gneisses, 2 - Quartzite - marbles, 3 - Granite - gneisses, 4 - Tonalite - gneisses, 5 - Gneiss - amphibolites, 6 -Gneiss - crystalline schists, 7 - Gabbro - anorthosites, 8 - Granitoides, 9 - Post Archean to Early Proterozoic structures, 10 - Main faults, 11 - Gold occurrences

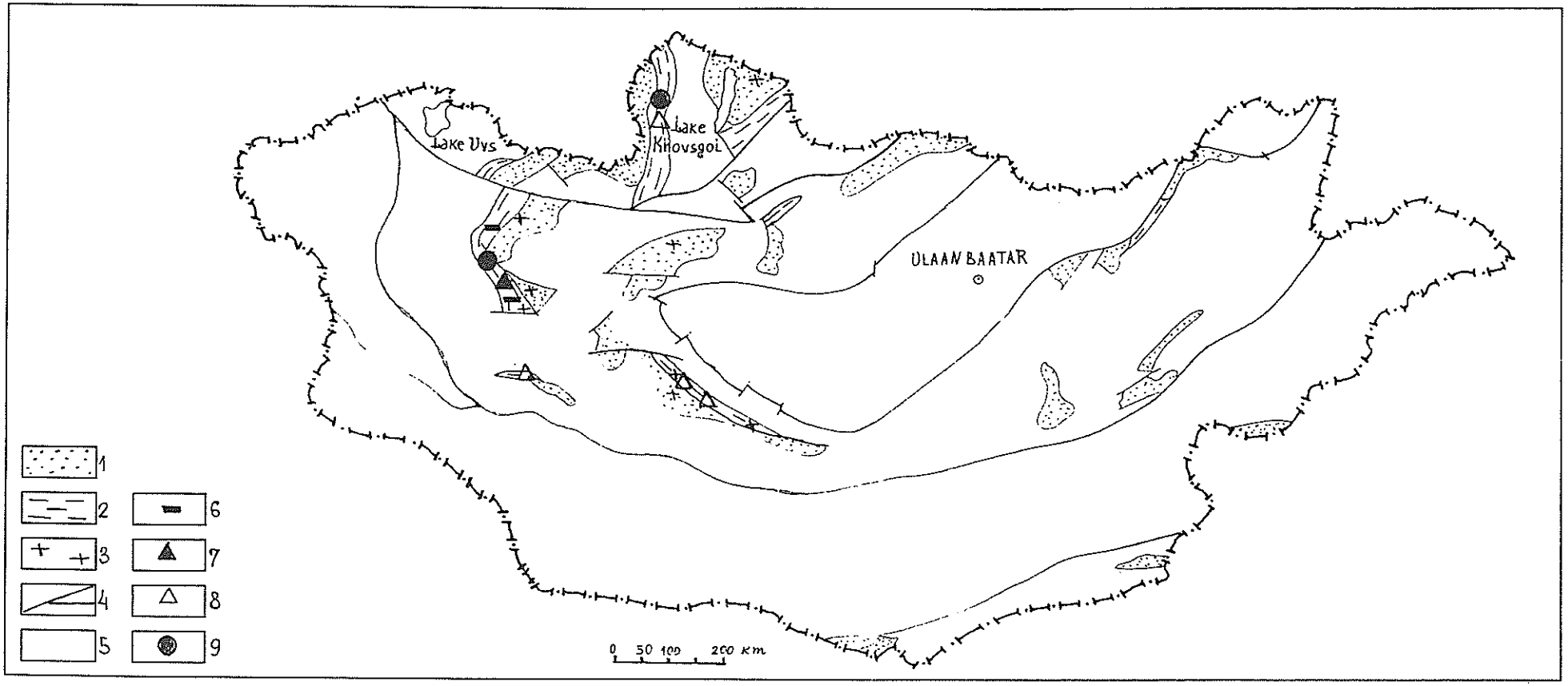

FIG. 2. SCHEME OF DISTRIBUTION OF UPPER PROTEROZOIC (Early to Middle Rephean) STRUCTURES AND GOLD MINERALIZATION

1 - Archean to Early Proterozoic metamorphic basement, 2 - Upper Proterozoic submarine fan turbidite basins formed on ocean crust, 3 - Upper Proterozoic gabbro-plagiogranite -granite intrusions, 4 - Main faults, 5 - Post Upper Proterozoic structures, 6 - 9 - Gold occurrences: 6 - Gold-bearing iron oxide and iron-manganese oxide formation, 7 - Disseminated gold-silicate - oxide type, 8 - Disseminated gold-sulphide-quartz veinlets and gold-quartz subordinite mesothermal veins, 9 - Gold-quartz and gold-sulphide-quartz veins and stockwork related to intrusion.

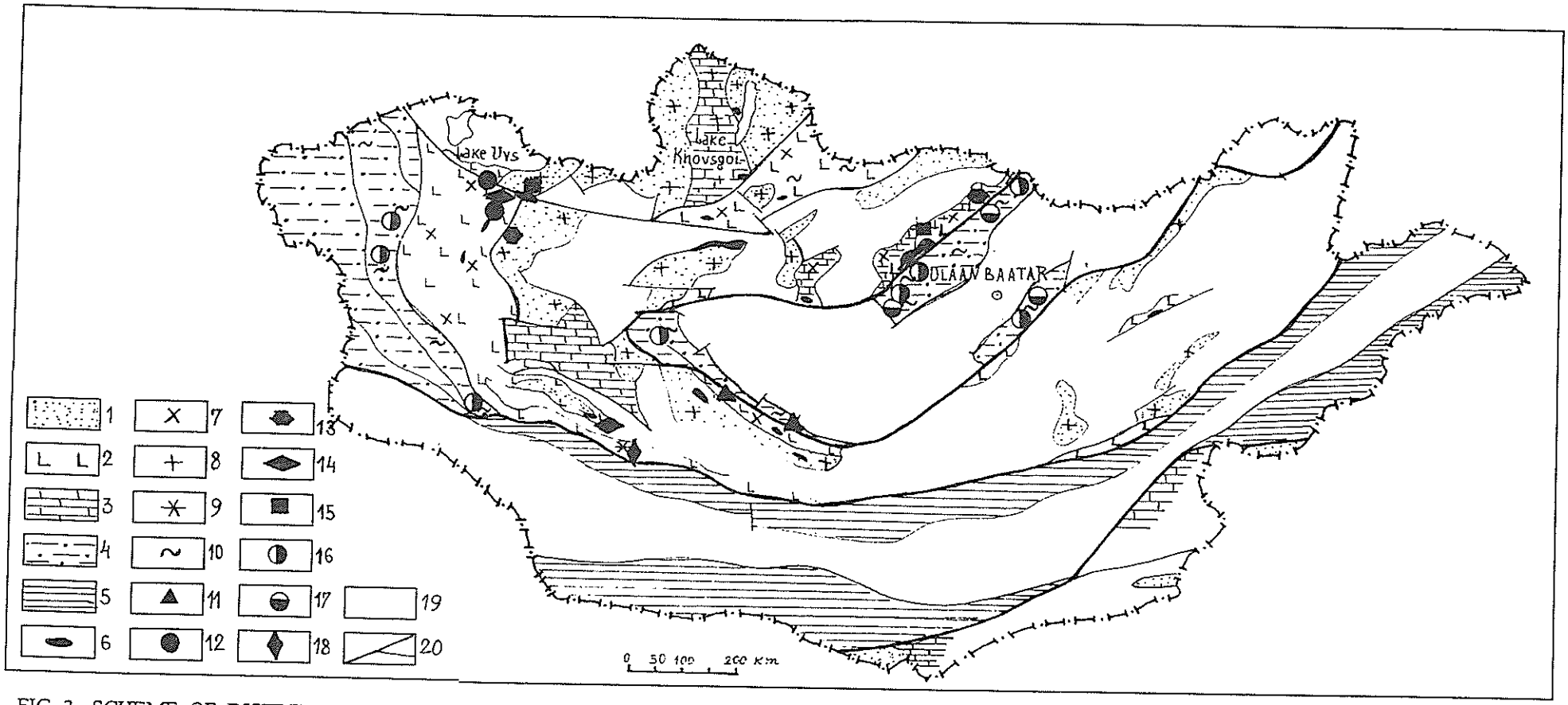

FIG. 3. SCHEME OF DISTRIBUTION OF EARLY PALEOZOIC (R3 -V - E -O - S) STRUCTURES AND GOLD AND GOLD-BEARING DEPOSITS AND OCCURRENCES IN MONGOLIA (Early Paleozoic structures are shown after Byamba J., 1993).

1 -Archean to Proterozoic metamorphic basement. 2 - 3 - Upper Riphean to Early Cambrian structures formed: 2 - on ocean crust, 3 - on continental crust; 4 - Middle Cambrian to Ordovician structures formed on transitional crust; 5 - Early Paleozoic srtuctures formed on continental crust; 6 - 9 - Cambrian intrusive rocks: 6 - Gabbroides, 7 - Gabbbro-plagiogranite-granites, 8 - Diorite-granodiorite-granites, 9 - Porphyry intrusions; 10 - Ordovician and Silurian intrusions; 11 - 15 -Cambrian gold and gold-bearing deposits and occurrences: 11 -Disseminated gold-sulphide-quartz subordinite veinlets, 12 -Gold-sulphide-quartz veins, 13 - Gold-copper skarns, 14 - Gold-bearing copper massive and disseminated sulphides in basalt, 15 -Gold-bearing sulphides in gabbro; 16 - 17 - Ordovician and Silurian gold deposits and occurrences: 16 - Gold-quartz and gold-sulphide-quartz veins, 17 -Disseminated replacement type in noncarbonite rocks; 18 -Porphyry gold-copper, 19 -Post Early Paleozoic structures, 19 - Faults.

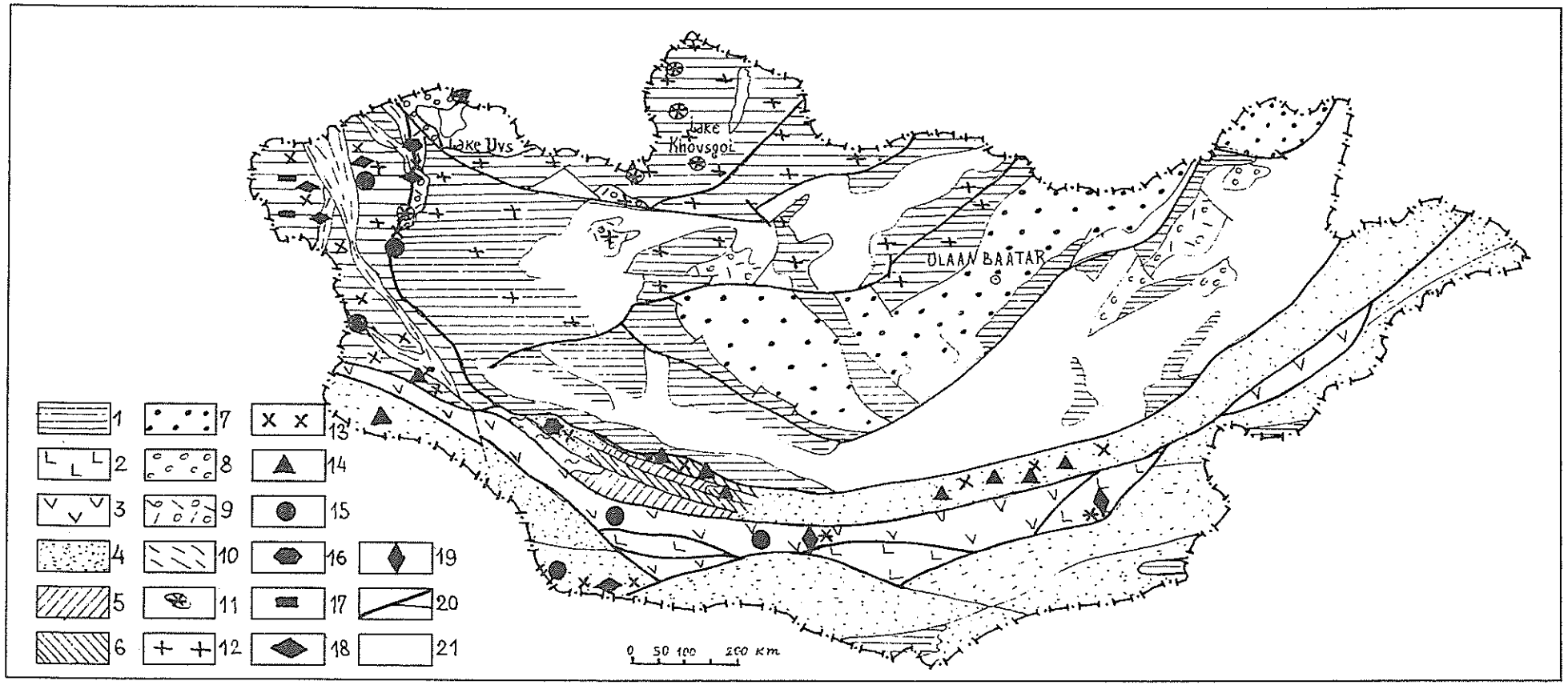

FIG. 4. SCHEME OF DISTRIBUTION OF MIDDLE PALEOZOIC (S - D - C) STRUCTURES AND GOLD AND GOLD-BEARING DEPOSITS AND OCCURRENCES IN MONGOLIA (Hercynian structures are shown after Byamba J., 1993).

1 - Precambrian and Caledonian folded structures. 2 - 6 - Early Hercynian structures of Southern Mongolian Hercynian folded belt: 2 - Island arcs formed on ocean crust. 3 - Island arcs formed on continental crust, 4 - Continental sholts and slopes, 5 - 6 - Backarc basins and uplifts of Andian type island arc: 5 - Uplifts with terrigeny-carbonite-volcanic rocks, 6 - Basins with terrigeny-volcanic rocks; 7 - 10 - Hercynian structures of Northern Mogolian folded belt: 7 - Interplate sea basins, 8 - Continental terrigenic basins, 9 - Continental terrigeny-volcanic basins, 10 - Riftogenic structures; 11 - 13 -Intrusive formations: 11 - Alkaline intrusions, 12 - Subalkaline granitoide intrusions, 13 - Gabbro-plagiogranite-granite intrusions; 14 - 19 - Gold deposits and occurrences: 14 - Subordinite mesothermal gold-quartz veins, 15 - Gold-sulphide-quartz veins, 16 - Gold - copper skarns, 17 - Gold-sulphide-sheelite-quartz veins and stocworks, 18 - Disseminated replacement type in noncarbonite rocks, 19 - Porphyry molybdenum - copper; 20 - Main faults, 21 - Post Hercynian structures.

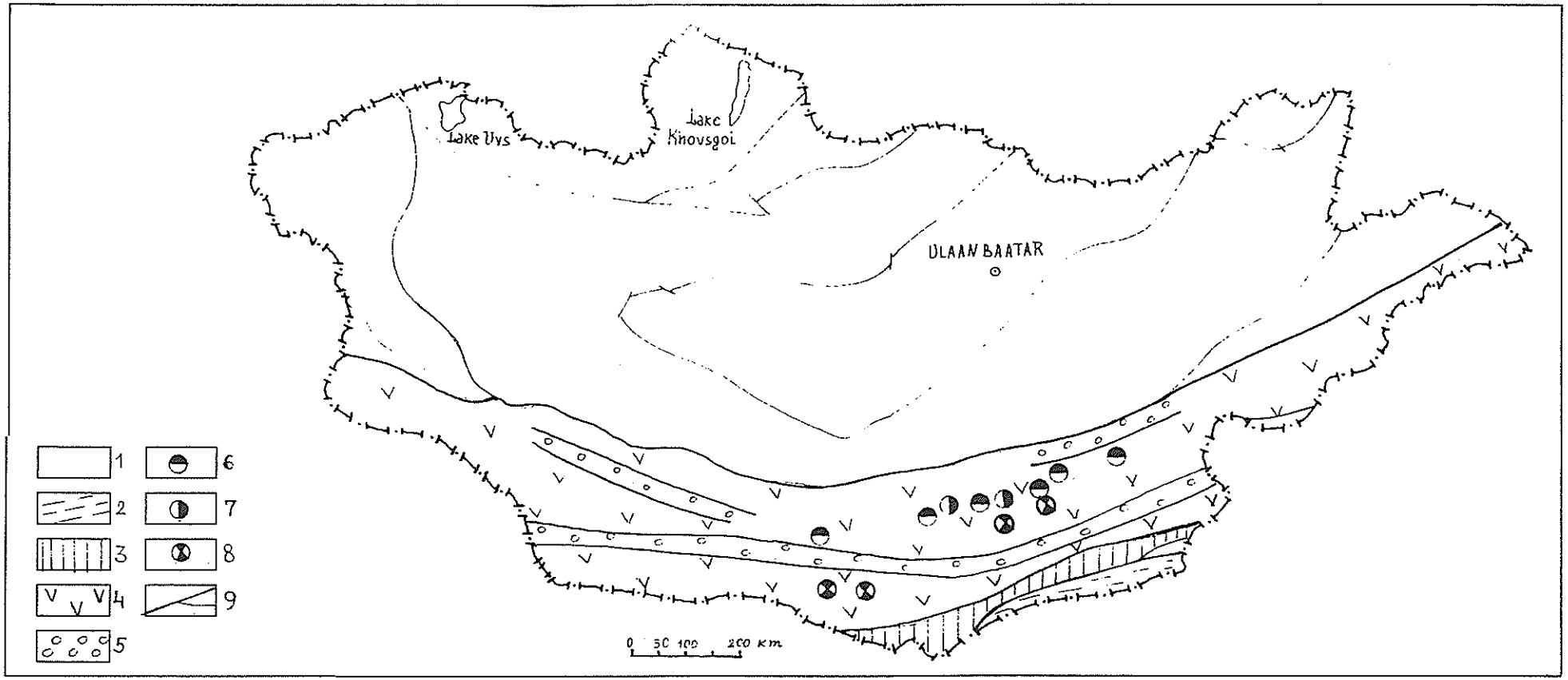

FIG.5. SCHEME OF DISTRIBUTION OF UPPER HERCYNIAN STRUCTURES AND GOLD AND GOLD-BEARING DEPOSITS AND OCCURRENCES IN MONGOLIA (Upper Hercynian strustures are shown after Byamba J., 1993).

1 - Pre-Upper Hercynian structures, 2 - 5 - Upper Hercynian structures: 2 - Ocean riftogenic zone, 3 - Continental slope, 4 - Continental margin volcano-plutonic arc, 5 - Continental riftogenic zones; 6 - 8 - Gold and gold-bearing deposits and occurrences: 6 - Porphyry gold-copper, 7 - Gold-hematite-magnetite-quartz-veins, 8 - Epithermal high sulphide alunite - kaolinite type, 9 - Main faults.

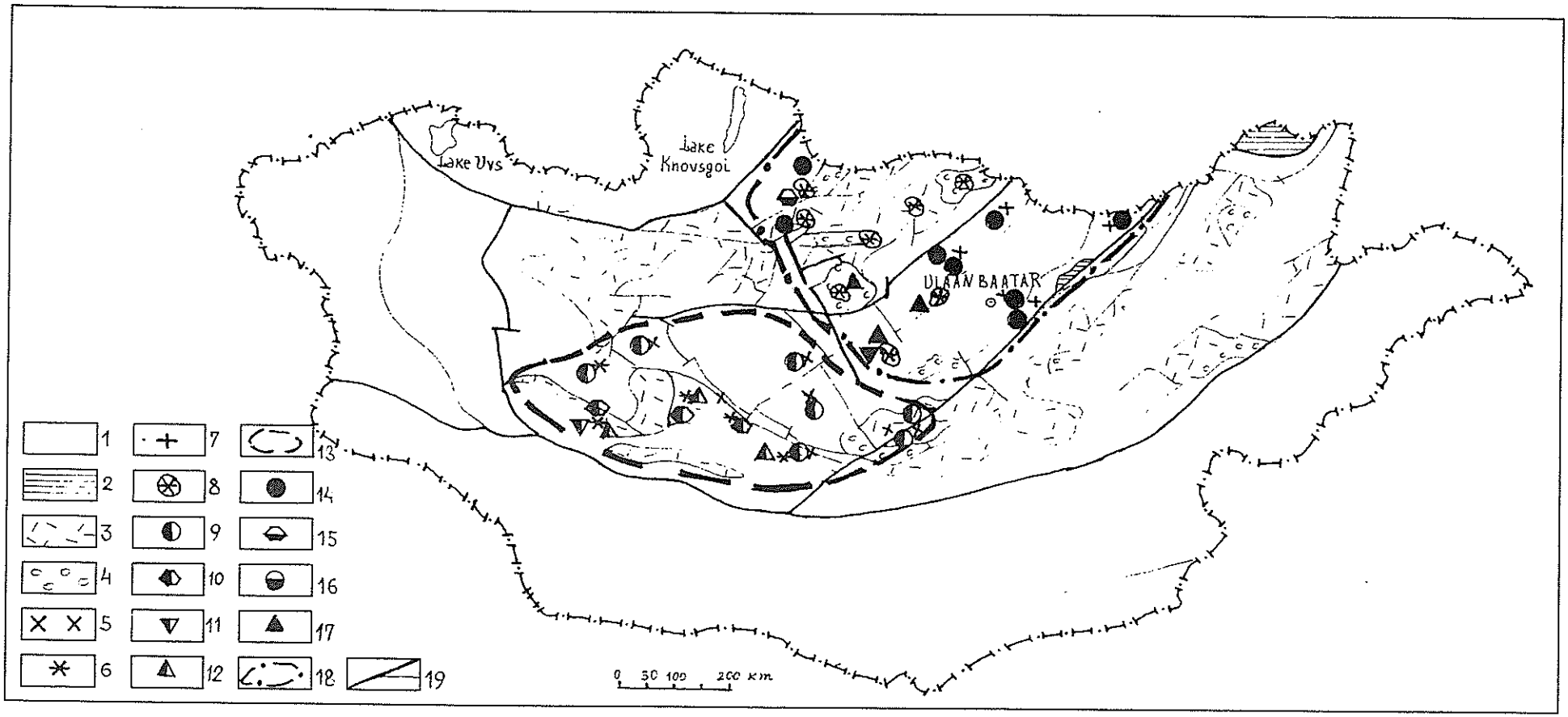

FIG.6. SCHEME OF DISTRIBUTION OF UPPER PALEOZOIC TO EARLY MESOZOIC ACTIVE CONTINENTAL MARGIN STRUCTURES AND GOLD AND GOLDBEARING DEPOSITS AND OCCURRENCES IN MONGOLIA

1 - Caledonian and Hercynian folded structures. 2 - 3 -Permian to Early Triassic structures: 2 - Interplate sea basins. 3 - Continental riftogenic structures. 4 -Middle Triassic to Early Jurassic terrigenic and terrigeny-volcanic basins. 5 - Upper Paleozoic pre-batolite small intrusions and dykes. 6 - Upper Paleozoic subalkaline latite and porphyry intrusions. 7 - Early Mesozoic pre-batolite small intrusions and dykes. 8 - Early Mesozoic subalkaline latite and porphyry intrusions. 9 - 12 - Upper Paleozoic gold and gold bearing deposits and occurrences: 9 - Gold-quartz and gold-sulphide-quartz veins. 10 - Gold-copper skarns. 11 - Breccia-hosted gold. 12 - Gold-bearing copper porphyry. 13 - Area of distribution of Upper Paleozoic gold mineralization. 14 - 17 - Early Mesozoic gold and gold-bearing deposits and occurrences: 14 - Gold - quartz and gold-sulphide-quartz veins. 15 - Gold-iron-copper skarns. 16 - Gold-hematite-magnetite-quartz veins. 17 - Gold-bearing porphyry copper. 18 -Area of distribution of Early Mesozoic gold mineralization. 19 - Main faults.

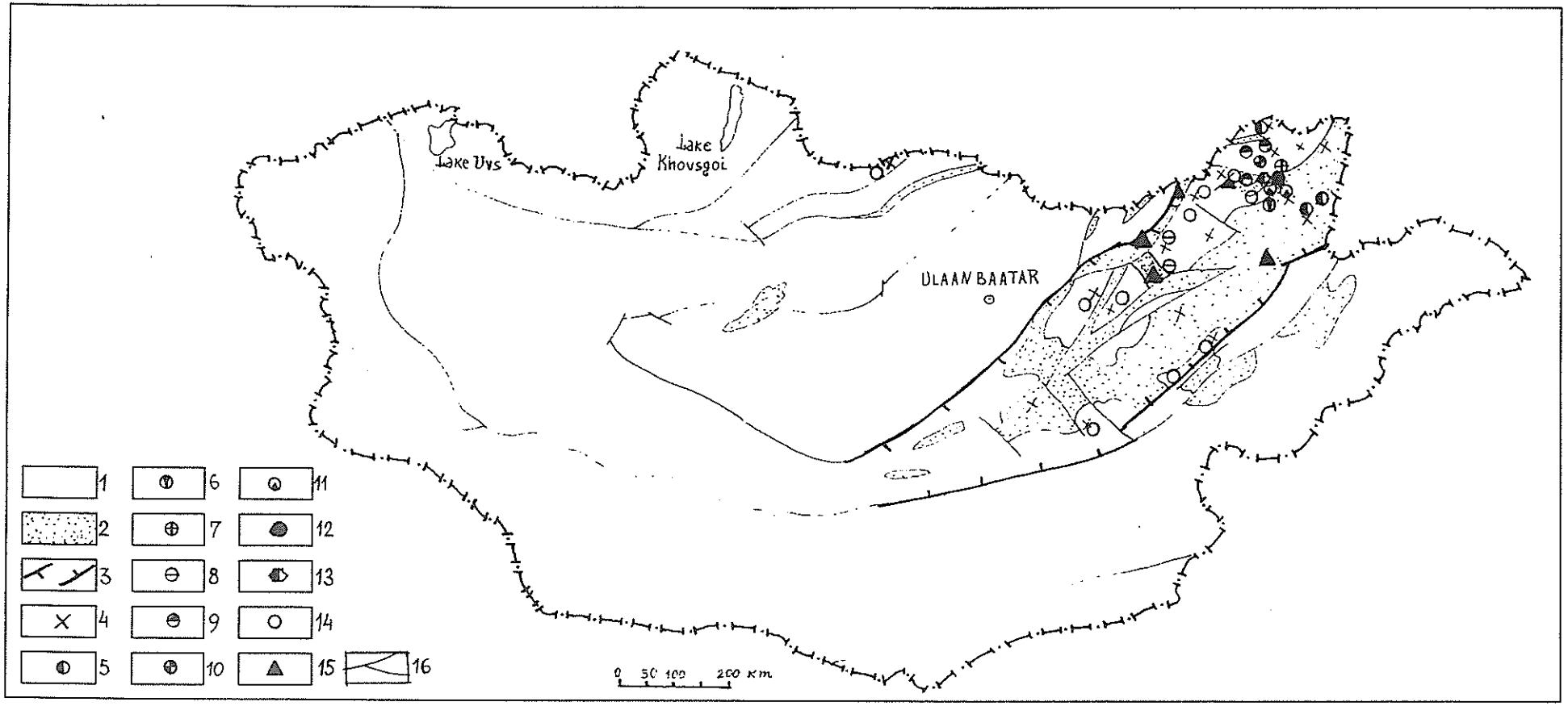

Fig.7. SCHEME OF DISTRIBUTION OF UPPER MESOZOIC CONTINENTAL RIFTOGENIC STRUCTURES AND GOLD AND GOLDBEARING DEPOSITS AND OCCURRENCES IN MONGOLIA

1 - Pre-Upper Mesozoic structures, 2 - Upper Mesozoic volcanic structures, 3 - Area of distribution of gold and goldbearing deposits and occurrences, 4 - Subalkaline latite and porphyry intrusions. 5 - 13- Gold and goldbearing deposits and occurrences related to subalkaline intrusions: 5 - gold-silver-lead-zinc-quartz-veins, 6 - Breccia - hosted gold-silver-lead-zinc, 7 - Gold-silver-tungsten-molybdenum-copper-quartz stockworks, 8 - Gold-hematite-magnetite-quartz veins and stockworks, 9 - Gold-silver-antimony-arsenic-quartz veins and stockworks, 10 - Gold-arsenic-quartz veins, 11 - Gold-tellurium-quartz veins and stockworks, 12 - Gold-silver-copper-quartz veins, 13 - Gold-silver-copper-tungesten skarns, 14 - Gold-tungesten-(molibdenum)-quartz veins and stockworks, 15 - Epithermal gold-quartz veins and replacement disseminated types related to volcanic rocks, 16 - Main faults

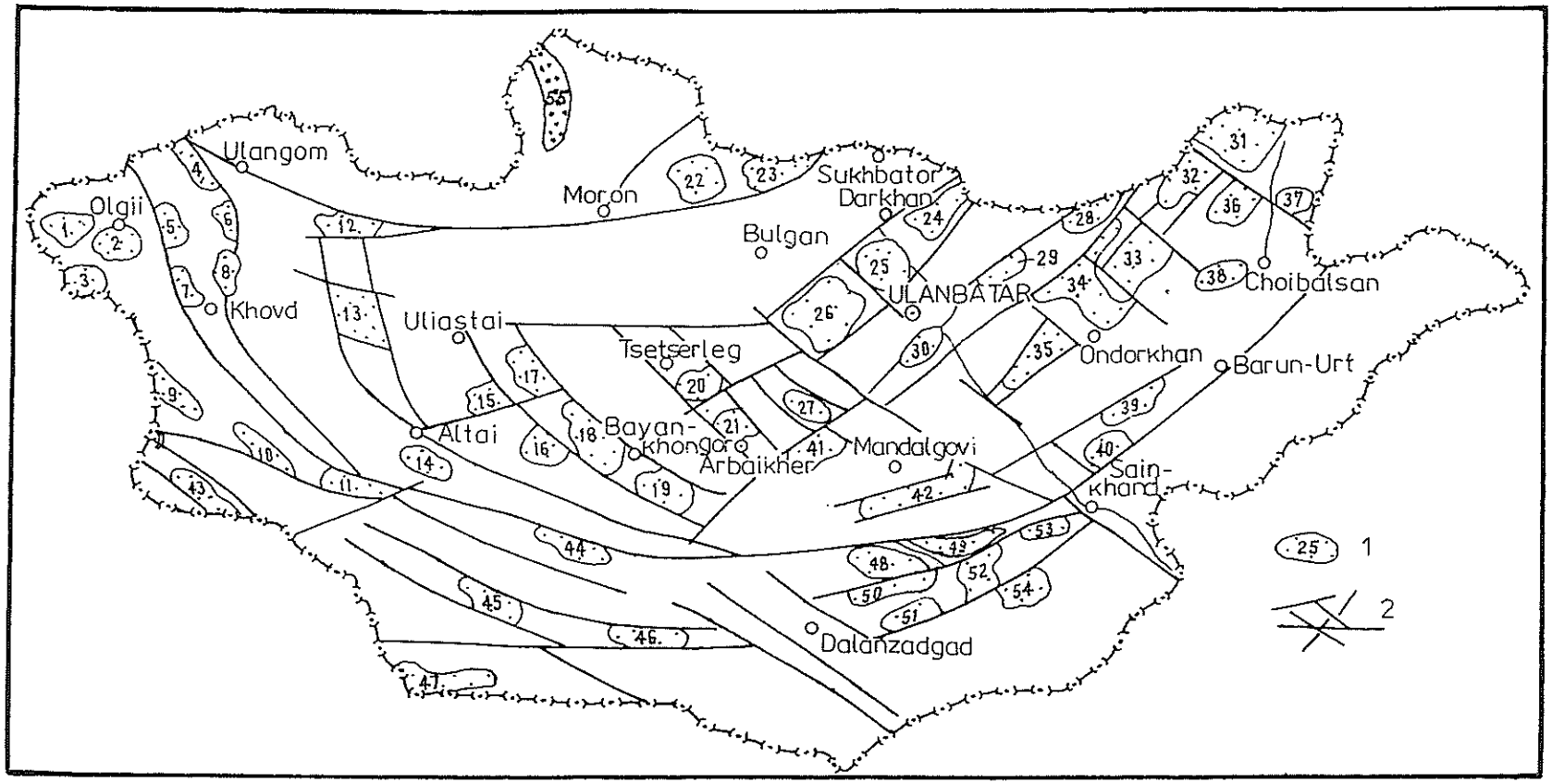

Fig.8 Schema of distribution of goldbearing areas of Mongolia (G. Dejidma)

1-Goldbeuring areas; 2-Main deep and regional faults of Mongolia;

P. S. Name and metallogenic specialization of goldbearing areas are shown in the table 3

Tab.3 GOLD-BEARING DISTRICTS OF MONGOLIA AND THEIR METALLOGENIC SPECIALIZATIONS

Number of districts on the fig.1	Name of districts	Metallogenic specialization	Types of gold mineralization	Deposits and occurrences
0	1	2	3	4
1	Dungerekh - Tsagaan salaa	W, Mo, Be, Au, Sb	Sheelite-gold-quartz veins and stockworks	Mushgui, Khalgat, Zeeriin gol, Dund salaa
2	Olgii - Sagsai	Au, W, Mo, Hg, Ba	Sheelite-gold-quartz veins and stockworks Gold - quartz-veins Stockwork, disseminated & replacement types in non-carbonate rocks	Nariin nuur Dert tolgoi Sagsai
3	Khurimt	Au	Gold placers	Khuiten gol, Elt, Songino uul
4	Uureg nuur	Au, Ag, Fe, Cu	Gold placers	Iljignii gol
5	Altantsogts	Au	Gold-sulphide-quartz veins & replacement complex type	Yamaat, Khoo, Khavtsal, Emeelt, Ovgor
6	Burgastain gol	Au, Cu, Fe, Ba, Pb, Zn	Gold - skarn Stockwork, disseminated & replacement types in non - carbonate rocks Gold placers	Elochka, Khagarlyn, Cenretal, Khagshir bulag Gozgor, Khagshir bulag, Talyn salaa Burgastain gol, Shuluun bulag, Talyn salaa
7	Khovd	Au	Gold - quartz - veins Gold - sulphide - quartz veins	Khovd Shunshigt uul
8	Altan khokhii - Tsagaan tolgoi	Au, Cu	Gold - sulphide - quartz veins	Tsagaan tolgoi
9	Upper Bulgan	Au	Gold - quartz veins Gold placers	Unnamed occurrences Khuurai sair
10	Uench - Bodonch	Au	Mesothermal gold - quartz veins Gold placers	Unnamed occurrences Uench
11	Shar khooloi	Au	Gold - sulphide - quartz veins Gold placers	Shar khooloi I, II Shar khooloi
12	Khirgis nuur	Cu, Au, W	Gold-bearing massive sulphide / copper / Gold - sulphide - quartz veins & stockworks Gold - skarn	Borts uul Morit uul, Khirgis Bayankhairkhan

Table 3: continued

0	1	2	3	4
13	Urgamal - Zavkhanmandal	Au. Cu. Fe. Mn. Pb. Zn	Gold - skarn Gold - quartz veins & stockworks Gold-bearing massive sulphides / copper / Gold-bearing silicate -oxide iron formation Gold-bearing silicate /quartzite / formation Gold placers	Erdenekhairkhan Eastern Shuvuu uul. Airag uul Bayan- Airag Bayan-Airag . Shuvuu uul Burkheer khar uul, Shuvuun uul Shuvuun uul
14	Govi - Altai	Au. Cu, Fe. Cr. PGE	Gold-bearing massive sulphides / copper / Gold - skarn Gold - breccia / Breccia - hosted/ Gold-bearing porphyry copper	Naran davaa Tsakir khudag ore field Tsakhir khudag ore field Tsakhir khudag ore field
15	Unegt	Au. Ag	Gold - quartz veins	Unegt
16	Buutsagaan	Au. Cu. Fe	Gold - copper - iron skarn	Buutsagaan
17	Galuut - Gurvan bulag	Au, Sb. Hg, W	Gold - quartz veins	Gurvanbulag
18	Baidrag - Burdyn gol	Au, Cu. Fe	Gold - quartz veins Gold - sulphide - quartz veins Mesothermal gold - quartz veins Mesothermal gold-sulphide disseminated type in black shale Gold-sulphide type in Lower Proterozoic rocks Gold - skarn Gold - breccia / Breccia hosted / Gold-bearing porphyry copper Gold placers	Tsagaan Tsakhir uul Bombogor North I. II. Northern Bombogor Daltyn khondii Kharaat uul Khokh bulgiin khondii Saran uul Saran uul Dovont. Baidrag et. al. placer fields
19	Tuin - Taatsyn gol	Au. W	Gold - quartz veins Mesothermal gold - quartz veins. linestockworks Gold placers	Taatsyn gol Khan uul Taatsyn gol
20	Battsengel	Au	Gold - quartz veins Gold placers	Sodot field Sodot
21	Uyanga - Taragt	Au	Gold - quatrz veins Gold-bearing Jurassic congloberates Gold placers	Uyanga field Uyanga field Ultiin gol
22	Teshig	Au, Cu, Fe. W, Mo	Gold - sulphide - quartz veins Gold - copper - iron skarn	Ereen / Tavt /. Khushuut. Khureet Teshig I. II. III
23	Azargyn gol / Tarvagatai /	Au, W. Mo, Ag. Pb, Zn, Cr. PGE	Gold-sulphide-quartz veins and disseminated & replacement complex type Gold - chromite placer	Tarvagatai Tsagaan bulag

0	1	2	3	4
24	Eroo gol	Au	Gold - quartz veins Stockworks, disseminated and replacement types in non-carbonate rocks Gold placers Gold-bearing conglomerates / Lower Cretaceous /	Nariin Khargant Buural gol, Gozon shar, Baga Olont Khuder gol, Tolgoit, Bugant, Khargant, Ulent, Tsamkhag, Khuiten, Sharyn gol groups Sharyn gol, Tolgoit, Tsamkhag groups
25	Boroo - Zuun mod	Au	Gold - quartz veins Gold - sulphide - quartz veins Gold - quartz veins and disseminated /replacement complex type Gold placers	Tsagaanchuluut, Boroo 7, Biluut et. al. Natantolgoi, Sujigt Boroo, Tsagaangozgor, Bayantsagaan Ikh Tashir, Nergui, Nariin khondii
26	Zaamar - Ugtaaltsaidam	Au, Cu	Gold - quartz vein Porphyry gold - copper Porphyry gold ? Gold - bearing conglomerates / Lower Cretaceous/ Gold placers	Bumbat, Nariin gol fields Khadat Erdenetsog -Ovoo, Ulaangozgor Conglomerates in Zamar field Tuul, Bayangol, Toson, Ar-Naimgan, Khailaast et. al.
27	Delgerkhaan	Au, Cu	Gold-bearing porphyry copper Gold - quartz veins Gold-bearing conglomerates / Upper Permian / Gold placers	Bayan uul Unegt ovoo Bayan Ondriin field Kharzat
28	Baljiin gol	Au	Gold - quartz veins Stockworks, disseminated and replacement types in non-carbonate rocks Epithermal gold-quartz veins Gold placers	Aguuts, Jargalant Khomol Tenuun gol Khomol, Galgatai et. al.
29	Terelj	Au	Gold placers	Altan suudal
30	Baruun Urt	Au	Gold placers Gold - quartz veins Gold - sulphide-quartz veins	Baruun Urt Unnamed occurrences Agit
31	Dochiin gol	Pb, Zn, Ag, W, Mo, Sn, Cu, Sb, As, Au, Hg, Fe	Gold - antimony - quartz veins and replacement complex type Gold - arsnic - quartz veins and replacement complex type Gold-bearing silver-lead-zink-quartz veins Gold-bearing porphyry copper-molybdenum Gold-copper-iron skarn Gold-sulphide /copper/-quartz veins	Ovor khooloi, Bor - Ondor Zaagiin khondii, Tsagaan khondii Baitsyn ovoo, Chonon Avdar tolgoi Erdene tolgoi Nomint, Soeo Ondor

Table 3: continued

0	1	2	3	4
32	Turgen gol	Au. Ag, Hg, W. Mo	Gold-quartz veins and replacement complex type Epithermal gold-silver-quartz veins Gold placers	Tsagaanchuluut khudag I. Tsagaanchuluut khooloi Tsagaanchuluut khudag II Tsagaanchuluut khudag, Tsagaanchuluut khooloi. Gun Ondoriin khooloi. Arshaant. Ovoljoo
33	Narsyn khondlon	Sn. Pb. Zn. An. Ag, Fe. F	Gold-/magnetite-hematite/- quartz veins. stockwork Gold-magnetite-chlorite-actinolite replacements Gold placers	Delberekh bulag Western Delberekh bulag Salkhit
34	Onon - Berkh	Au. Ag, F. Sn, W, Hg, Sb	Gold-sulphide-quartz veins and replacement in carbonate rocks / complex type/ Epithermal gold-silver -quartz veins	Khokh tolgoi Bayanzurkh. Tsagaan
35	Kherlen	W. Mo. Ag, Pb, Zn. Sn. Au	Gold-quartz veins Gold-sulphide-quartz veins Gold placers	Ulaan Ondor Khoer Zotlig, Bulgiin
36	Dornot	Ag. Pb. Zn. U. Mo. Au, Te	Gold-bearing silver-lead-zinc- breccia Gold-tellurium-quartz veins and replacement complex type Gold-quartz veins Gold placers	Ulaan. Mukhar Dagai, Urliin ovoo, Khatguit Modon, Butan Mukhar khaviin khooloi
37	Tsav	Ag, Pb, Zn. Au. Mo	Gold-bearing silver-lead-zinc-quartz veins	Tsav, Bayan uul, Altan tolgoi
38	Bulgan	Au. Ag	Epithermal gold-quartz veins and disseminated replacement complex type	Group occurrences of Bulgan
39	Buyant	Au. W. Mo. Pb. Zn	Gold - quartz veins	Buyant. Oortsog
40	Altan shiree - Delgerekh	An. Cu, Fe, W	Gold -/magnetite-hematite/-quartz veins Gold-copper-iron skarn	Monkh khoer chuluu, Omno baga chuluu Chandmani uul
41	Erdenedalai	Au	Gold-quartz veins	Sharga ovoo. Tsagaan ovoo
42	Middle Govi	Au. Ag, W. Mo. Sn	Gold - quartz veins Gold-sheelite-quartz veins and stockworks	Salkhit uul Morit uul. Talyn uul
43	Baitag	Au. Ag, Pb. Zn, Sb	Gold - quartz veins Gold-antimony - quartz veins Gold-bearing silver-lead-zinc replacement type	Khaltar uul I, II Olon bulag Nukhnii nuruu
44	Bayanleg - Bayangovi	Au. Cu, W	Gold-quartz veins Gold-copper-iron skarn	Bayangovi, Oortsog Erdene, Shirt
45	Edergenii nuruu	Au	Gold - quartz veins Gold placers	Khadat gunii khudag Khushuut, Khar uul, Khur uul

0	1	2	3	4
46	Nemegt	Au. Cu, Ni. PGE	Gold - quartz veins Gold placers	Unnamed occurrences Toromkhon, Zostyn sair. Alag shandyn sair, Khuren bosgyn sair
47	Talyn meltes - Khatan suudal	Au	Gold- sulphide-quartz veins and disseminated replacement complex type	Talyn meltes. Khatan suudal
48	Mandal Ovoo	Au	Gold - quartz veins and replacement complex type	Olon Ovoot
49	Tsogt Ovoo	Au	Gold - quartz veins	Dayangar. Khoit Kharmagtai. Ukhaa khudag
50	Kharmagtai	Au. Cu, Fe	Porphyry gold - copper Gold-/magnetite-hematite/-quartz veins	Kharmagmai. Ukhaa khudag, Ovoot khyar Unnamed occurrences
51	Ikh Shankhai	Cu. Au. Ag	Epithermal high sulfide gold -quartz vein /alunite-kaolinite type /	Ikh Shankhai
52	Mandakh - Shuteen	Cu, Au. Ag	Gold-bearing porphyry copper Epithermal high sulfide gold - quartz vein / alunite - kaolinite type /	Khongoot, Narin khudag Shuteen
53	Saikhandulaan	Cu. Au. Ag	Gold-bearing porphyry copper	Ovuut
54	Tsagaan suvarga	Cu. Mo. Au. Ag	Gold-bearing porphyry molibdeniucopper	Tsagaan suvarga
55	Khugiin gol	Au. Pb. Zn	Gold - quartz veins and stockworks	Unnamed occurrences