EXPLANATORY NOTES
FOR
THE MINERAL DEPOSIT DATA
OF
MINERAL RESOURCES MAP OF EAST ASIA

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Geological Survey of Japan, AIST

Masaharu KAMITANI*, Kimio OKUMURA*, Yoji TERAOKA*,
Sumiko MIYANO and Yasusi WATANABE***

* Institute for Geo-Resources and Environment, GSJ. AIST
** Geoinformation Center, GSJ. AIST

The mineral resources map of East Asia shows land area deposits of main metallic mineral and non-metallic mineral resources, except for construction materials. Uranium is included, although its principal utilization is for nuclear energy. About 3,000 mineral deposits are shown on the map regardless of their status of exploration and exploitation. In Japan and South Korea, many metallic mineral deposits have been exhausted during a couple of the last decades. The map does not, therefore, necessarily represent the present resources picture. In general, mineral deposits of economic size and grade are figured, but some low-grade occurrences have also been plotted on the map in order to indicate a resource potential.

The background geology of the Mineral Resources Map including the correlation diagram for map units (Fig. 1) was adopted from the Geological Map of East Asia (Teraoka and Okumura, 2003). The legend of the mineral resources map conforms

fundamentally to that of the Circum-Pacific mineral resources map (Guild, 1981; Kamitani et al., 1999).

The commodity symbols show the metal or mineral content of the deposits by colored geometric shapes with some modification. The colors, insofar as possible, indicate metals or minerals of similar type. For example, copper and associated metals are orange, precious metals are yellow, lead-zinc and associated metals are blue, and tungsten-tin and associated metals are red. The five shapes and ten colors indicated on the map's legend provide fifty combinations.

Three sizes of symbols(Fig. 2) denote the relative importance of the mineral deposits. Limits between the three sizes categories for each commodity are mostly in terms of metric tons of the substances contained before exploitation. Some deposits shown as the smallest symbols on this map correspond to mineral occurrences, but they are included because they may help identify and estimate prospective areas broadly favorable for exploration planning of specific metals and minerals.

Eleven deposit types including undifferentiated deposit shown on the map are as follows.

Magmatic and irregular massive deposits: Podiform chromite, nickel-copper, carbonatite, magnetite and magnetite-ilmenite deposits. *Skarn and contact-metasomatic deposits:* Stratified, usually carbonate, rocks intruded by intermediate to acid igneous rocks. They are associated with a hydrothermal stage of mineralization. *Hydrothermal vein and fissure-filling deposits:* Crosscutting, epithermal to hypothermal deposits in any type of host rock. The major dimensions are transverse to stratification in sedimentary or volcanic hosts. *Pegmatite and greisen deposits:* Crosscutting, pegmatitic and greisenized lode deposits in any type of host rocks and closely related to acidic intrusive. *Porphyry deposits including stockwork and disseminated deposits:* Irregular disseminated deposits in or associated with acidic to intermediate intrusive rocks. Some deposits have been described as stockworks and/or disseminated deposits. *Stratabound deposits including volcanogenic sedimentary and sedimentary exhalative deposits:* Deposits of generally limited horizontal extent occur at more or less the same horizon in stratified rocks. It may be partly concordant or partly discordant with the enclosing rocks. Some deposits are stratiform with wide lateral extent and syngenetic with enclosing rocks. Examples are iron formation and sedimentary and exhalative copper, lead and zinc deposits. Most massive sulfide deposits belong to this category. *Sedimentary deposits including sandstone-hosted deposits:* Deposits rigorously confined to one or more layers in sedimentary rocks. Evaporite and phosphorite deposits are usually syngenetic with enclosing rocks. *Metamorphic deposits:* Deposits formed by regional metamorphism like most graphite deposits.

Residual deposits: Deposits formed by surficial chemical concentration. These deposits include laterite, bauxite, uraniferous calcrete and some manganese oxide deposits. The criterion is that supergene processes were responsible for producing ore grade materials. *Placer deposits:* Deposits formed by a surficial mechanical concentration. Examples are alluvial and beach placer deposits, such as gold, ilmenite, monazite and diamond.

Mineral deposit numbers are given only for large-size deposits on the Mineral Resources Map, and all the deposit data including small and medium-size of deposits can be obtained from the data sheet of "Mineral deposit data of East Asia".

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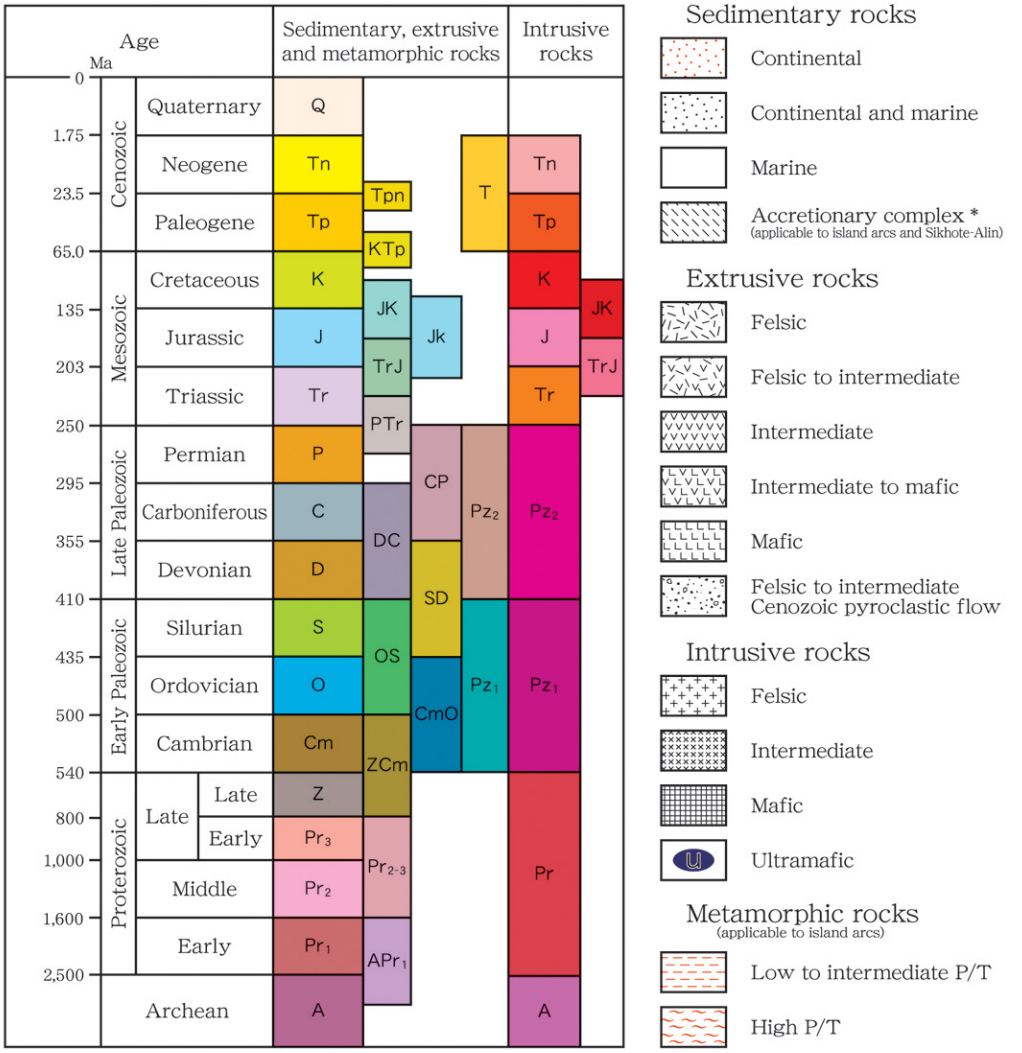
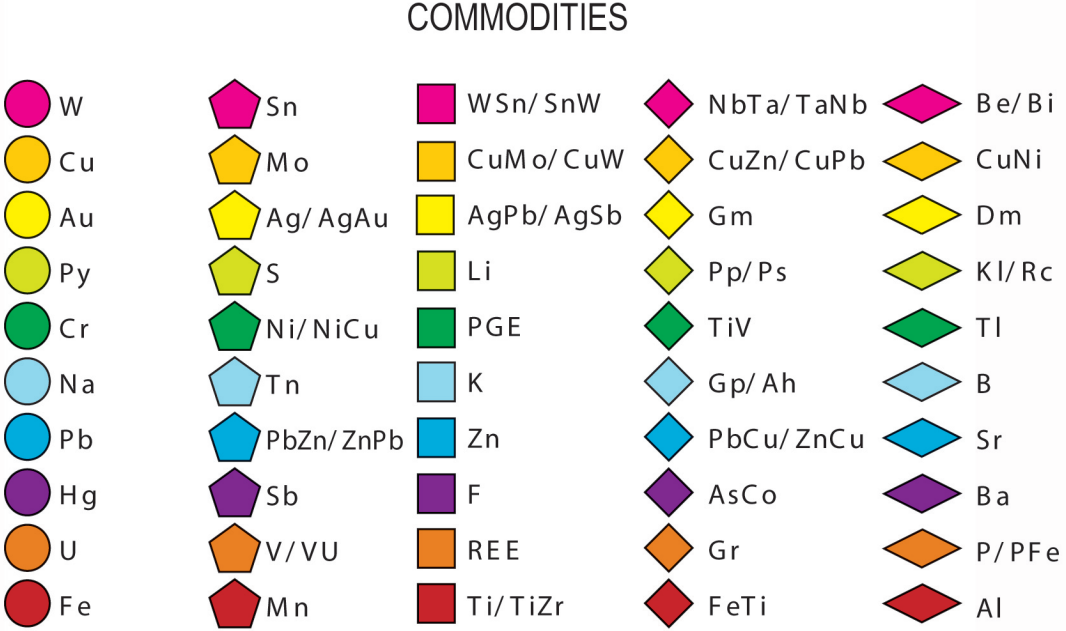


* Age of terrigenous clastic sediments is shown in case of accretionary complex which includes blocks of older rocks such as basalt, limestone and chert of oceanic origin.

Background geology after TERAOKA, Y. and OKUMURA, K. (2003) Geological Map of East Asia. Geological Survey of Japan.

iFigure 1 Correlation diagram for base map



Abbreviations; Ah: anhydrite, Dm: diamond, Gm: gemstones, Gp: gypsum, Gr: graphite, Kl: kaolin, PGE: platinum group elements, Pp: pyrophyllite, Ps: pottery stones, Py: pyrite, Rc: refractory clay, REE: rare earth elements, Tl: talc, Tn: thenardite

Figure 2 Commodity symbols

Table 1 Abbreviation used in Mineral deposit data sheet

Commodity	Deposit type and shape	Geologic age
Ag: silver	Alv: alluvial	A: Archean
Al: aluminum	Bed: bedded	C: Carboniferous
An: anhydrite	Cnt: contact-metasomatic	Cm: Cambrian
As: arsenic	Crb: carbonatite	D: Devonian
Au: gold	Dis: disseminated	J: Jurassic
B: boron	Evp: evaporite	K: Cretaceous
Ba: barium	Exh: exhalative	KTp: Cretaceous-Paleogene
Be: beryllium	Ffill: fissure-filling	Mz: Mesozoic
Bi: bismuth	Grs: greisen	Mz1: Early Mesozoic
Cd: cadmium	Hyd: hydrothermal	Mz2: Late Mesozoic
Co: cobalt	Irg: irregular	O: Ordovician
Cr: chromium	Lnt: lenticular	P: Permian
Cu: copper	Lyr: layered	Pcm: Precambrian
Dm: diamond	Mas: massive	Pr: Proterozoic,
F: fluorite	Mgm: magmatic	Pz1: Early Paleozoic
Fe: iron	Mtm: metamorphic	Pz2: Late Paleozoic
Ga: gallium	Pgm: pegmatite	Q: Quaternary
Gm: gemstones	Pdf: podiform	S: Silurian
Gp: gypsum	Plc: placer	T: Tertiary
Gr: graphite	Prp: porphyry	Tn: Neogene
Hg: mercury	Rpl: replacement	TnQ: Neogene-Quaternary
I: iodine	Sed: sedimentary	Tp: Paleogene
In: indium	Sht: sheet	Tr: Triassic
K: potassium	Skn: skarn	U: Unclassified
Kl: kaolin	Str: stratabound	
Li: lithium	Stw: stockwork	
Mg: magnesium	Tl: talc	
Mn: manganese	U: undifferenciated	
Mo: molybdenum	Vn: vein	
Na: sodium salt	Vol: volcanogenic	
Nb: niobium	Wth-Res: weathering-residual	
Ni: nickel		
P: phosphate		
PGM: platinum group elements		

Pp: pyrophyllite Ps: pottery stone Py: pyrite Pb: lead REE: rare earth elements S: sulfur Sb: antimony Sn: tin Sr: strontium Ta: tantalum Ti: titanium Tl: talc Tn: thenardite U: uranium V: vanadium W: tungsten Zn: zinc Zr: zircon		

Table 2　Deposit size used in Mineral deposit data sheet

Size limits are shown in metric tons of metals or minerals except for diamond and precious gems in carats. Past production and/or reserves totaled.

Size / Commodity	Large >	Medium >	Small
Aluminum (bauxite) (Al_2O_3)	100,000,000	1,000,000	
Antimony (Sb)	500,000	10,000	
Arsenic (As)	1,000,000	10,000	
Barite ($BaSO_4$)	5,000,000	50,000	
Beryllium (BeO)	1,000	10	
Boron (B_2O_3)	10,000,000	100,000	
Chromium (Cr_2O_3)	1,000,000	10,000	
Cobalt (Co)	20,000	1,000	
Copper (Cu)	1,000,000	50,000	
Diamond (Dm)	20,000	1,000	
Fluorite (CaF_2)	5,000,000	100,000	
Gold (Au)	200	10	
Graphite (fixed C.)（Gr）	1,000,000	10,000	
Gypsum-anhydrite ($CaSO_4$)	100,000,000	5,000,000	
Iron (ore) (Fe)	100,000,000	5,000,000	
Kaolin/Refractory clay (ore)	50,000,000	1,000,000	
Lead (Pb)	1,000,000	100,000	
Lithium (Li_2O)	100,000	10,000	
Manganese (ore:≧40%Mn)	10,000,000	100,000	
Mercury (Hg)	20,000	1,000	
Molybdenum (Mo)	500,000	25,000	
Nickel (Ni)	500,000	25,000	
Niobium-Tantalum [$(Nb,Ta)_2O_5$]	100,000	1,000	
Phosphate (P_2O_5)	200,000,000	1,000,000	
Platinum group elements (PGE)	200	10	
Potassium (KCl or K_2O)	10,000,000	1,000,000	
Precious gems (Gm)	20,000	1,000	
Pyrite (FeS_2)	20,000,000	200,000	
Pyrophyllite/Pottery stone (ore)	50,000,000	1,000,000	

Rare earth with Yttrium (RE_2O_3)	5,000,000	50,000
Silver (Ag)	10,000	500
Sodium (NaCl)	100,000,000	1,000,000
Strontium (Sr)	1,000,000	10,000
Sulfur (S)	100,000,000	1,000,000
Talc (ore)	10,000,000	1,000,000
Thenardite (Na_2SO_4)	100,000,000	1,000,000
Tin (Sn)	100,000	5,000
Titanium (TiO_2)	10,000,000	1,000,000
Tungsten (W)	50,000	1,000
Uranium (U)	50,000	1,000
Vanadium (V)	10,000	500
Zinc (Zn)	1,000,000	100,000

Table 3 Abbreviation of minerals used in Mineral deposit data sheet

The following abbreviation of minerals are used for the mineral deposit data sheet.

acn: acanthite
alb: alabandite
all: allanite
aln: alunite
amb: amblygonite
anh: anhydrite
ank: ankerite
ant anataze
apt: apatite
apy: arsenopyrite
arg: argentite
ars: arsenic
aut: autunite
azr: azurite

bar: barite
bhm: boehmite
bon: bornite
brn: braunite
brt: berthierite
bry: beryl
bis: bismuthinite
bul: boulangerite
bun: bournonite

cal: calcite
cam: camsellite
cas: cassiterite
cbl: chrysoberyl
cbn: cubanite
cbt: cobaltite
cer: cerussite
cff: coffinite
chc: chalcocite
chg: chlorargyrite
chl: chlorite
chm: chromite
cll: collophanite
cls: celestite
cnb: cinnabar
col: columbite
cor: corundum
cov: covelline
cp: chalcopyrite
crhc: calciorhodochrosite
crn: carnotite
cup: cuprite

dat: datolite
dgn: digenite
dic: dickite
dlm: dolomite
dm: diamond
dnb: danburite
dsp: diaspore

elc: electrum
emr: emerald
eng: enargite

f-c: fixed carbon
fl: fluorite
frg: fergusonite
fsp: feldspar

gal: galena
gbs: gibbsite
gld, gold
grn: garnierite
grp: graphite
gth, goethite
gyp: gypsum
hal: halite
hem: hematite
hll: halloysite
hmc: hydromica
hsm: hausmannite
hss: hessite

ill: illite
ilm: ilmenite
igl, ignition loss

jms: jamesonite
jrs: jarosite

kfs: potassium feldspar
kln: kaolinite
kmb: kimbelite

ldp: ludwigite,
lim: limonite
lnn: linnaeite
lpd: lepidolite
luz: luzonite

mal: malachite,
mcr: microlite
mcy: mercury

mic: mica
mgt: magnetite
mlb: molybdenite
Mn-ox: manganese oxide
mnz: monazite
mrb mirabilite
mrc: marcasite
mrg: miargyrite
mrm: marmatite
msc: muscovite
mty: metatyuyamunite

nbis: native bismuth
ncc: niccolite
ncp: native copper
nmn: naumannite
noc: nocerite
nph; nepheline
ntll: native tellurium
ntr: niter

orp: orpiment
ort: orthite

par: paricite
pbl: pitchblende
pet: petalite
phal: polyhalite
phn: phenacite
plb: polybasite
pnt: pentlandite
pph, pyrophyllite
prs: proustite
psl: psilomelane
ptb: pitchblend
py: pyrite
pyc: pyrochlore
pyg: pyrargyrite
pyl: pyrolusite
pyr: pyrrhotite

qz: quartz

rhc: rhodochrosite
rhd: rhodonite
rlg: realgar
rub: ruby
rut: rutile

sch: scheelite
ser: sericite
sid: siderite
slf: sulfur
slt: rock salt
slv: silver
smt: smithonite
spc: specularite
spd: spodumene
sph: sphalerite
spp: sapphire
stb: stibnite
stn: stannite
stp: stephanite
str: strontianite
syl: sylvine
szb: szeibelyte

tan: tantalite
tll: tellurite
ten: tennantite
tet: tetrahedrite
thn: thenardite
tlc: talc
tmgt: titaniferous magnetite
top: topaz
tph: tephroite
trm: tremolite
trn: trona
tum: tourmaline

uph: uranophane
urn: uraninite

vilm: vanadiferous ilmenite
vll: valleriite

wit: witherite
wlf: wolframite

xnt: xenotime

zir: zircon
znc: zincite
znk: zinkenite

References

1. General

Guild, P. W. (1981) Preliminary metallogenic map of North America; a numerical listing of deposits. U.S. Geological Survey Circular, 858－A, 93p.

Kamitani, M., Piper, D. Z., Swint-Iki, T. R., Fan, P-F., Kanehira, K., Ishihara, S., Shimazaki, Y., Radkevich, K., Palfreyman, W. D., Sudo, S., McCoy, F., Manheim, F. T., Lane-Bostwick, C. M., Sullivan, L. G., Mizuno, A. and Luepke, G. (1999) Mineral-Resources Map of the Circum-Pacific Region, scale 1:10,000,000, with explanatory note, 29p., Northwest Quadrant. Circum-Pacific Council for Energy and Mineral Resources, U.S. Geological Survey.

Teraoka, Y. and Okumura, K. (2003) Geological Map of East Asia, scale 1 : 3,000,000, with tectonic division and columnar sections. Geological Survey of Japan, AIST.

2. China

Ai, X. (chief ed.) (1996) The discovery history of mineral deposits of Shandong Province, China. Geol. Pub. House, Beijing, 305p. (in Chinese with English summary) .

Cao, Y. (chief ed.) (1996) The discovery history of mineral deposits of Tibetian Autonomous Region, China. Geol. Pub. House, Beijing, 76p. (in Chinese and English).

Chen, D. (chief ed.) (1996) The discovery history of mineral deposits of Jiangxi Province, China. Geol. Pub. House, Beijing, 245p. (in Chinese with English summary).

Chen, H. and Li, J. (chief eds.) (1996) The discovery history of mineral deposits of Jilin Province, China. Geol. Pub. House, Beijing, 137p. (in Chinese with English summary).

Cun, G., Chen, J., Zhang, F., Li, Q., Li, S., Dong, J. and Mu, T. (1992) Gold Deposits of China. Institute of Gold Deposits, Beijing, 218p. (in Chinese).

Dong, H. (chief ed.) (1996) The discovery history of mineral deposits of Hunan Province, China. Geol. Pub. House, Beijing, 281p. (in Chinese with English summary).

Feng, D. (chief ed.) (1996) The discovery history of mineral deposits of Qinghai Province, China. Geol. Pub. House, Beijing, 233p. (in Chinese with English summary).

Hart, C. J. R., Goldfarb, R. J., Qiu, Y., Snee, L., Miller, L. D. and Miller, M. L. (2002) Gold deposits of the northern margin of the North China craton: multiple late

Paleozoic-Mesozoic mineralization events. Mineralium Deposita, vol. 32, p. 326－351.

Hou, Z., Ma, H., Zhang, Y., Wang, M., Pan, G. and Tang, R. (2003) The Himalayan Yulong porphyry copper belt: product of large-scale strike-slip faulting in eastern Tibet. Economic Geology, vol. 98, p. 125－145.

Huang, D., Wu, C. and Huang, D. (1988) REE geochemistry and mineralization characteristics of the Zudong and Guanxi granites, Jiangxi Province. Acta Geologica Sinica, no. 4, p. 311－328 (in Chinese with English abstract).

Jiang, S.（chief ed.）(1996) The discovery history of mineral deposits of Beijing Municipality, China. Geol. Pub. House, Beijing, 139p. (in Chinese with English summary).

Kang, B. (chief ed.) (1996) The discovery history of mineral deposits of Heilongjiang Province, China. Geol. Pub. House, Beijing, 165p. (in Chinese with English summary).

Li, H. (chief ed.) (1996) The discovery history of mineral deposits of Hebei Province, China. Geol. Pub. House, Beijing, 167p. (in Chinese with English summary).

Li, J. (chief ed.) (1996) The discovery history of mineral deposits of Fujian Province, China. Geol. Pub. House, Beijing, 137p. (in Chinese with English summary).

Li, J. (chief ed.) (1996) The discovery history of mineral deposits of Hubei Province, China. Geol. Pub. House, Beijing, 177p. (in Chinese with English summary).

Liu, S. (chief ed.) (1996) The discovery history of mineral deposits of Shaanxi Province, China. Geol. Pub. House, Beijing, 122p. (in Chinese with English summary).

Liu, Y. (chief ed.) (1996) The discovery history of mineral deposits of Liaoning Province, China. Geol. Pub. House, Beijing, 191p. (in Chinese with English summary).

Lu, Z. (chief ed.) (1996) The discovery history of mineral deposits of Inner Mongolian Autonomous Region, China. Geol. Pub. House, Beijing, 279p. (in Chinese with English summary).

Luo, J., Yang, Y., Zhao, Z. and Yang, J. (1994) Evolution of Tethys in western Yunnan and mineralization for main metal deposits. Ministry of Geology and Mineral Resources, China, Geological Memoirs, series 4, no. 45, 340p. (in Chinese with English abstract).

Luo, M. (chief ed.) (1996) The discovery history of mineral deposits of Henan Province, China. Geol. Pub. House, Beijing, 213p. (in Chinese with English summary).

Mao, J., Goldferb, R. J., Zhang, Z., Xu, W., Qiu, Y. and Deng, J. (2002) Gold deposits

in the Xiaoqinling-Xiong'ershan region, Qinling Mountains, central China. Mineralium Deposita, vol. 37, p. 306－325.

Metals Economics Group (MEG) (1995) China: Emerging Mineral Opportunities. MEG, Canada, 218p.

Tang, Z. (chief ed.) (1996) The discovery history of mineral deposits of Gansu Province, China. Geol. Pub. House, Beijing, 188p. (in Chinese with English summary).

Wang, F. (chief ed.) (1995) The discovery history of mineral deposits of Shanxi Province, China. Geol. Pub. House, Beijing, 253p. (in Chinese with English summary).

Wang, S. (chief ed.) (1996) The discovery history of mineral deposits of Ningxia Hui Autonomous Region, China. Geol. Pub. House, Beijing, 112p. (in Chinese).

Wei, J. and Tan, L. (chief eds.) (2001) Taiwan non-metallic economic minerals. Taiwan economic minerals, vol. 2, Central Geological Survey of Taiwan, 224p. (in Chinese).

Wu, C., Bai, G. and Huang, D. (1992) Characteristics and significance of HREE rich granitoids of the Nanling Mountain area. Bull. Chinese Academy Geological Sci., vol. 25, p. 43－58 (in Chinese with English abstract).

Wu, D. (chief ed.) (1996) The discovery history of mineral deposits of Guizhou Province, China. Geol. Pub. House, Beijing, 289p. (in Chinese with English summary).

Wu, G. (chief ed.) (1996) The discovery history of mineral deposits of Guangdong Province, China. Geol. Pub. House, Beijing, 400p. (in Chinese with English summary).

Yao, P. (chief ed.) (1993) Records of China's iron ore deposits. Ministry of Metallic Industry, China, Metallurgic Industry Press, 662p. (in Chinese).

Zeng, R., Li, W., Zhang, W., Qin, X., Guo, F., Tao, D. and Pu, X. (1988) The mercury deposits in China. Chendu Institute of Geology and Mineral Resources, China, 254p. (in Chinese with English abstract).

Zhai, Y. (chief ed.) (1996) The discovery history of mineral deposits of Guangxi Zhuang Autonomous Region, China. Geol. Pub. House, Beijing, 257p. (in Chinese with English summary).

Zhang, Y. (chief ed.) (1996) The discovery history of mineral deposits of Yunnan Province, China. Geol. Pub. House, Beijing, 217p. (in Chinese with English summary).

Zhang, Y. (chief ed.) (1996) The discovery history of mineral deposits of Sichuan Province, China. Geol. Pub. House, Beijing, 223p. (in Chinese with English

summary).

Zhang, Z. (chief ed.) (1996) The discovery history of mineral deposits of Xinjiang Uygur Autonomous Region, China. Geol. Pub. House, Beijing, 181p. (in Chinese with English summary).

Zhou, T., Goldfarb, R. J. and Phillips, G. (2002) Tectonics and distribution of gold deposits in China—an overview. Mineralium Deposita, vol. 37, p. 249—282.

Zhou, Z. (chief ed.) (1996) The discovery history of mineral deposits of Anhui Province, China. Geol. Pub. House, Beijing, 173p. (in Chinese with English summary).

Zhu, A. (chief ed.) (1996) The discovery history of mineral deposits of Zhejiang Province, China. Geol. Pub. House, Beijing, 165p. (in Chinese with English summary).

Zhu, G. (chief ed.) (1996) The discovery history of mineral deposits of Jiangsu Province, China. Geol. Pub. House, Beijing, 155p. (in Chinese with English summary).

Zhu, X. (chief ed.) (1999) Mining information of China, vol. 2, Metallic mineral deposits. Chinese Mining Association, Science Press, Beijing, 665p. (in Chinese).

3. Japan

Banba, T. (1957) Chromite deposits of Hokkaido I: Chromite deposits of the Hidaka-Iburia district. GSJ Report, no. 176, 60p. (in Japanese with English abstract).

Geological Survey of Japan (GSJ) (1980) Mines summary report, vol. 1, Northeast Japan. GSJ Report, no. 260, 310p.

Geological Survey of Japan (GSJ) (1980) Mines summary report, vol. 2, Southwest Japan. GSJ Report, no. 260, 266p.

Ishihara, S. (1971) Major molybdenum deposits and related granitic rocks in Japan. GSJ Report, no. 239, 178p. (in Japanese with English abstract).

Ishizuka, O. and Imai, A. (1998) “Brown ore” from the Fukazawa kuroko deposits, Northeast Japan: Its characteristics and formation process. Resource Geology, v. 48, no. 2, p. 53—73.

Kikuchi, Y., Matsugi, M. and Goto, T. (1982) Geological assessment of the Sakoshi-Odomari gold mine, Hyogo Prefecture. Mining Geology, v. 32, p. 361—368 (in Japanese with English abstract).

Kinosita, K.(1961) Mineral deposits of Japan. no. 9, Kyushu, Asakurashoten, 605p. (in Japanese).

Marumo, K. and Sawai, O. (1986) K—Ar ages of some vein-type and kuroko-type

deposits in the southwestern Hokkaido, Japan. Mining Geology, v. 36, p. 21－26 (in Japanese with English abstract).

Mining Association of Japan (MAJ) (1965) Mineral deposits of Japan; kuroko, skarn and kieslager deposits. MAJ, 581p. (in Japanese).

Mining Association of Japan (MAJ) (1968) Mineral deposits of Japan; vein, manganese, sulfur and uranium deposits. MAJ, 941p. (in Japanese).

Mining and Materials Processing Institute of Japan (MMPIJ) (1989) Gold mines of Japan (Nihon Kinzanshi), 1, Kyushu. MMPIJ, 144p. (in Japanese).

Mining and Materials Processing Institute of Japan (MMPIJ) (1990) Gold mines of Japan (Nihon Kinzanshi), 2, Hokkaido. MMPIJ, 154p. (in Japanese).

Mining and Materials Processing Institute of Japan (MMPIJ) (1992) Gold mines of Japan (Nihon Kinzanshi), 3, Tohoku. MMPIJ, 222p. (in Japanese).

Mining and Materials Processing Institute of Japan (MMPIJ) (1994) Gold mines of Japan (Nihon Kinzanshi), 4, Kanto and Chubu. MMPIJ, 144p. (in Japanese).

Mining and Materials Processing Institute of Japan (MMPIJ) (1994) Gold mines of Japan (Nihon Kinzanshi), 5, Kinki-Chugoku-Shikoku. MMPIJ, 93p. (in Japanese).

Narita, E., Yajima, J., Ota, E., Watanabe, Y., Hasaka, T., Hasaka, H. and Sudo, S. (1996 a) Mineral resources map of Hokkaido (eastern part), scale 1:500,000. Geological Survey of Japan.

Narita, E., Yajima, J., Ota, E., Watanabe, Y., Hasaka, T., Hasaka, H. and Sudo, S. (1996b) Mineral resources map of Hokkaido (western part), scale 1:500,000. Geological Survey of Japan.

Nikko Metal Co. Ltd. (2005) Metal production of Toyoha mine, Hokkaido, during from 1951 to 2003. Nikkan Sangyou Shinbun, Tokyo, Japan (in Japanese).

Nokleberg, W., Bounaeva, T. V., Miller, R. J., Seminskiy, Z. V. and Diggles, M. F. (eds.) (2003) Significant metalliferous and selected non-metalliferous lode deposits, and selected placer districts for Northeast Asia. U. S. Geological Survey, Open-File Report 03－220 (CD-ROM).

Power Reactor and Nuclear Fuel Development Corporation (PR & NFDC) (1994) Uranium resources of Japan. PR & NFDC, 391p. (in Japanese).

Saito, M., Banba, T., Sawa, T., Narita, E., Igarashi, T., Yamada, K. and Sato, H. (1967) Metallic and non-metallic ore deposits of Hokkaido. Geological Survey of Japan, 575p. (in Japanese).

Sudo, S. (1998) Mineral resources map of Kanto－Koshin'etsu, scale 1:500,000. Geological Survey of Japan.

Sudo, S. and Igarashi, T. (1997) Mineral resources map of Tohoku, scale 1:500,000.

Geological Survey of Japan.
Sudo, S. and Komura, R. (2000) Mineral resources map of Chubu－Kinki, scale 1:500,000. Geological Survey of Japan.
Sudo, S. and Murao, S. (2004) Mineral resources map of Chugoku and Shikoku, scale 1:500,000. Geological Survey of Japan.
Sudo, S. and Ogasawara, M. (2005) Mineral resources map of Nansei Shoto, scale 1:500,000. Geological Survey of Japan.
Sudo, S., Watanabe, Y. and Komura, K. (2003) Mineral resources map of Kyushu, scale 1:500,000. Geological Survey of Japan.
Suyari, K., Iwasaki, M. and Suzuki, T. (eds.) (1991) Regional Geology of Japan. 8, Shikoku, Kyoritsu Shuppan Co. Ltd., 267p. (in Japanese).
Yamada, R., Nishitani, Y., Tanimura, S. and Konishi, N. (1988) Recent development and geologic characteristics of the Nurukawa kuroko deposits. Mining Geology, vol. 38, p. 309－324 (in Japanese with English abstract).
Yoneda, T. (1987) Barite ores and compositional variations in tetrahedrite-tennantite of the Minamishiraoi mine, Hokkaido, Japan. Mining Geology, v. 37, p. 323－326 (in Japanese with English abstract).
Yoshimura, T. (1969) Supplement to Manganese ore deposits of Japan. Part Ⅱ, Manganese mines of Japan. Science Report, Faculty of Science, Kyushu Univ., Special issue, no. 2, 1,004p. (in Japanese with English abstract).

4. Mongolia

Economic and Social Commission for Asia and the Pacific (ESCAP) (1999) Geology and mineral resources of Mongolia. Atlas of Mineral Resources of the ESCAP Region, ESCAP, United Nations, vol. 14, 192p.
Geological Information Center (GIC) (2003a) Brief information on mineral commodities of Mongolia, Au, Ag (Location map series 1). Mineral Resources Authority of Mongolia, Ulaanbaatar, 38p.
Geological Information Center (GIC) (2003b) Brief information on mineral commodities of Mongolia, Cu (Location map series 2). Mineral Resources Authority of Mongolia, Ulaanbaatar, 38p.
Geological Information Center (GIC) (2003c) Brief information on mineral commodities of Mongolia, Base metals (Pb, Zn, Ni, Co, Al) (Location map series 4). Mineral Resources Authority of Mongolia, Ulaanbaatar, 10p.
Geological Information Center (GIC) (2003d) Brief information on mineral commodities of Mongolia, Sn, W, Be, Ta, Nb, Li (Location map series 5). Mineral Resources Authority of Mongolia, Ulaanbaatar, 12p.

Jargalsaihan, D., Kazmer, M., Baras, Z. and Sanjaadorj, D. (1996) Guide to the geology and mineral resources of Mongolia. Geological Exploration, Consulting and Services Co. Ltd., Ulaanbaatar, 329p.

Khashgerel, B. E., Rye, R. O., Hedenquist, J. W. and Kavalieris, I. (2006) Geology and reconnaissance stable isotope study of the Oyu Tolgoi porphyry Cu-Au system, South Gobi, Mongolia. Economic Geology, vol. 101, p. 503－22.

Metal Mining Agency of Japan (MMAJ) (2003) Overseas mining information. MMAJ, vol. 33, p. 15－29 (in Japanese).

Watanabe, Y. and Stein, H. J. (2000) Re-Os ages for the Erdenet and Tsagaan Suvarga porphyry Cu－Mo deposits, Mongolia, and tectonic implications. Economic Geology, vol. 95, p. 1537－1542.

5. North Korea

Kim, S. E. and Hwang, D. H. (1983) Metallogenic map of Korea, scale 1: 1,000,000, with explanatory text. 52p., Korea Institute of Energy and Resources.

Takashima, K. and Kishimoto, H. (1987) Unsan mine and its surrounding gold deposits in North Korea. Chishitu News, no. 398, p. 28－41 (in Japanese).

6. Russian Far East

Nokleberg, W. J., Bundtzen, T. K., Dawson, K. M., Eremin, R. A., Goryachev, N. A., Koch, R. D., Ratkin, V. V., Rozenblum, I. S., Shpikerman, V. I., Frolov, Y. F., Gorodinsky, M. E., Melnikov, V. D., Ognyanov, N. V., Petrachenko, E. D., Pozdeev, A. I., Ross, K. V., Wood, D. H., Khanchuck, A. I., Kovbas, L. I., Nekrasov, I. Y. and Sidrov, A. A. (1996) Significant metalliferous and selected non-metalliferous lode deposits and placer districts for the Russian Far East, Alaska, and the Canadian Cordillera. U. S. Geological Survey, Open-file Report 96-513-A, p. 1－39.

Sato, K., Lavrik, N. I. and Vrublevsky, A. A. (1993) Geology and mineral deposits in Sikhote-Alin. Chishitsu News, no. 468, p. 16－26 (in Japanese).

7. South Korea

Economic and Social Commission for Asia and the Pacific (ESCAP) (1987) Republic of South Korea. Atlas of mineral resources of the ESCAP Region, ESCAP, United Nations, vol. 3, 51p.

Kim, J. H. (1982) Geology and mineral resources of Korea. Yonsei Univ., South Korea, 523p. (in Korean).

Kim, S. E. and Hwang, D. H. (1983) Metallogenic Map of Korea, scale 1:1,000,000,

with explanatory text. Korea Institute of Energy and Resources, 52p.

Koh, S. M. (2004) Metallic mineral deposits of South Korea. Korea Institute of Geosciences and Mineral Resources (Unpublished).

Nokleberg, W., Bounaeva, T. V., Miller, R. J., Seminskiy, Z. V. and Diggles, M. F. (eds.) (2003) Significant metalliferous and selected non-metalliferous lode deposits, and selected placer districts for Northeast Asia. U. S. Geological Survey, Open-File Report 03－220 (CD-ROM).

8. Viet Nam

Do, H. D. (1992) Gold deposits of Vietnam. *in* Epithermal gold in Asia and the Pacific, mineral concentrations and hydrocarbon accumulations in the ESCAP Region. ESCAP, United Nations, vol. 6, p. 206－222.

Economic and Social Commissions of Asia and the Pacific Region (ESCAP) (1990) Viet Nam. Atlas of mineral resources of the ESCAP Region, ESCAP, United Nations, vol. 6, 124p.

Fontaine, H. and Workman, D. R. (1978) Review of the geology and mineral resources of Kampuchea, Laos and Vietnam. Third regional conference on geology and mineral resources of Southeast Asia, Bangkok, p. 541－774.

Geological Survey of Viet Nam (GSV) (1991) Metallogenic Map of Viet Nam, Scale 1:1,000,000. Ha Noi.

Phan, V. Q., Vu, N. H., Nguyen, N. H. and Nguyen, V. T. (1991) Some characteristics of gold formation in terms of the evolution process of Viet Nam earth crust. Proceedings of the Southeast Asia Gold Symposium, 1991 (Seagold' 91) , Viet Nam, p. 17－24.

Roskill Information Services (1999) The economics of nickel. 9th edition, Roskill Information Services Ltd., London, 260p.