DESCRIPTION OF MAP UNITS
NORTHEAST ASIA GEODYNAMICS MAP

OVERLAP ASSEMBLAGES
(Arranged alphabetically by map symbol)

ad Adycha intermountain sedimentary basin (Miocene and Pliocene) (Yakutia)

Basin forms a discontinuous chain along the foot of southwestern slope of Chersky Range in the Yana and Adycha Rivers basins. Contain Miocene and Pliocene sandstone, pebble gravel conglomerate, claystone, and minor boulder gravel conglomerate that range up to 400 m thick.

REFERENCES: Grinenko and others, 1998.

ag Agul (Rybinsk) molasse basin (Middle Devonian to Early Carboniferous) (Eastern Sayan)

Consists of Middle Devonian through Early Carboniferous aerial and lacustrine sand-silt-mudstone, conglomerate, marl, and limestone with fauna and flora. Tuff, tuffite, and tuffaceous rock occur in Early Carboniferous sedimentary rocks. Ranges up to 2,000 m thick in southwestern margin of basin. Unconformably overlaps Early Devonian rocks of South Siberian volcanic-plutonic belt and Precambrian and early Paleozoic rocks of the Siberian Platform and surrounding fold belts.

REFERENCES: Yanov, 1956; Graizer, Borovskaya, 1964.

ags Argun sedimentary basin (Early Paleozoic) (Northeastern China)

Occurs east of the Argun River in a discontinuously exposed, northeast-trending belt and consists of Cambrian and Ordovician marine, terrigenous detrital, and carbonate rocks. Cambrian units are composed of of feldspar-quartz sandstone, siltstone, shale and limestone and contain abundant *Afaciacyathus sp., Bensocyathus sp., Robustocyathus yavorskii, Archaeocyathus yavorskii(Vologalin), Ethomophyllum hinganense Gu,o* and other fossils. Ordovicain units consist of feldspar-quartz sandstone, siltstone, fine-grained sandstone and phylitic siltstone, and interlayered metamorphosed muddy siltstone and fine-grained sandstone with brachiopods, corals, and trilobites. Total thickness ranges up to 4,370 m. Basin unconformably overlies the Argunsky metamorphic terrane.

References: Bureau of Geology and mineral Resources of Inner Mongolia Aut. Reg., 1991

ajb Asia-Japan backarc basin on extended continental crust (late Tertiary and Quaternary) (Offshore areas between Eastern Asia continent and Japan)

Consists of deep backarc basins between Japan and Eastern Asia continent. Depth of water is about 3,000 m, shallower than for backarc basins over oceanic crust. Geophysical survey shows relatively thin continental crust, more than 10 km. Extended continental crust is interpreted for basins. A backarc basin with similar structure occurs southwest of Kyushu Island, Japan as the northern extension of Okinawa trough.

References: Tamaki and others., 1992; Wakita and others., 1992; Inoue and Honza, 1983.

ajc Asia-Japan continental shelf (late Tertiary and Quaternary) (Offshore areas between Eastern Asia continent and Japan)

Occurs adjacent to Eastern Asian continent, Japanese Islands and other islands. Typical water depth ranges from 100 m to 200 m.

References: Wakita and others, 1992.

ajr Asia-Japan backarc basin on rifted continental crust (late Tertiary and Quaternary) (Offshore areas between Eastern Asia continent and Japan)

Occurs between Japan and Eastern Asia and includes Yamato Bank, Kita Yamato Bank, Korea Plateau, Oki Bank, Sado Ridge, and Okushiri Ridge in areas west of north Hokkaido Island, west of northern Honshu Island, and east of Korean Peninsula. Basins contain thick sequences of sedimentary rocks in grabens bounded by normal faults. Tectonic inversion from extension to compression at the western margin of the backarc basin to the west of northern Honshu formed thrust movement along the previous normal faults. Active thrusts characterize the unit that is interpreted as a plate boundary between Eastern Asia continent and Japanese Islands.

References: Tamaki and others, 1992; Okamura, 2000.

Akitkan volcanic-plutonic belt (Paleoproterozoic) (Transbaikalia)

akv Volcanic-rich part

akp Plutonic part

Extends to northeast for over 400 km and ranges up to 50 km wide along the border of the North Asian Craton. Consists of Paleoproterozoic poorly deformed subalkaline, intermediate siliceous lava with a minor amount of basalt porphyry and subaerial sedimentary and volcanic sedimentary rocks (Akitkan). Contains two volcanic complexes: (1) trachyte, trachyandesite and dacite porphyry, lesser andesite porphyry, felsitic and quartz porphyry, sedimentary rocks, and tuff (Domugdinsky and Chaisky complexes); and (2) trachyrhyolite and rhyolite associated with thick sequences of pyroclastic rocks (Khibelensky complex). A Rb-Sr isotopic age for volcanic rocks is 1620±20 Ma. Also occurring are coeval subvolcanic and hypabyssal intrusions of diorite, granodiorite, and granite and rapakivi-like granitoids of the Primorsky complex with a Rb-Sr isotopic age of 1690±40 Ma, and a U-Pb isotopic age 1690± 30 Ma.

REFERENCES: Brandt and others, 1978; Bibikova and others, 1981; Bukharov, 1987.

Altai volcanic-plutonic belt (Devonian and Early Carboniferous) (Gorny Altai, Salair, Mongolia, Northwest China)

alv Volcanic part

alp Plutonic part

In Gorny Altai and Salair regions, consists of Devonian and Early Carboniferous sedimentary, volcanic, and intrusive rocks. Major sequences are as follow. (1) A sequence of Early-Devonian (pre-Emsian) marine carbonate-terrigenous sedimentary rocks to the west, and coastal-marine and non-marine molasse-to the east. Start and duration of volcanic activity was of unequal duration in different parts of the belt. Volcanic units composed of mafic and intermediate volcanic rocks in lower part of the ection and mainly siliceous volcanic rocks in upper part. Overlying the Altai and Anui-Chuya terranes, the volcanic rocks are calc-alkaline (Ergol, Kumir, and Korgon suites in Altai terrane; Ongudai and Kuratin suites in the Anui-Chuya terrane). Volcanic rocks overlying the Uimen-Lebed terrane are subalkaline (Nyrnin and Sagan suites).

Coeval plutonic rocks consists of hypabyssal and mesoabyssal massifs. Intruding the Anui-Chuya and Terekta terranes are coarse-grained porphyric subalkaline granite and alkaline granite with rybekite a U-Pb zircon isotopic age of 381±5 Ma. calc-alkaline quartz diorite and granodiorite, and calc-alkaline, subalkaline, and alkaline granite (Topolnin complex). Intruding the Uimen-Lebed terrane, are coarse- and medium-grained porphyritic biotite and two-mica granite and leucogranite (Turochak complex) and granosyenite and subalkaline granite (Kyzyltash complex). Granitoids of the Kyzyltash complex intrude Middle Devonian siliceous effusive rocks of the Sagan suite. Intruding the Altai terrane are gabbrodiorite, diorite, quartz diorite, granodiorite, and granite (Rakhmanov complex) that are alumina-saturated and are transitional between I- and S-types. Plutonic rocks of Ust-Belov complex are calk-alkaline, have a Rb-Sr isotopic age of 369±13 Ma, and intrude the Anui-Chuya, Charysh, Talitsk, Salair, and Ulus-Cherga terranes. Coarse-grained porphyritic granodiorite are are dominant along with quartz diorite, diorite, and melanogranite. Intruding the Talitsk and Zasurin terranes is the Borovlyan complex composed of mica melanogranite (with rare cordierite) and granodiorite, and minor granite and leucogranite, and with a U-Pb isotopic age of 362-372 Ma. In Anui-Chuya and Charysh terranes, the Borovlyan complex is mainly coarse-grained leucogranite.

The Altai volcanic-plutonic belt is interpreted as forming along an active continental margin in an oblique subduction zone environment in which lithospheric blocks (terranes) migrated along the margin of continental plate. Volcanism occurred in interblock zones, and intrusive magmatism occurred mainly in inner parts of the blocks.

REFERENCES: Gutak, 1987; Yolkin and others, 1994; Titov and others, 1997; Vladimirov and others, 1997; Berzin, 1998.

In northwest China, crops out along a major northwest-striking ridge in the Altai area. Consists mainly of Devonian gneissic plagioclase granite that includes early-stage discordant intrusive, anatectic-replacement, and facies, late-stage metasomatic facies. Plagioclase granite of anatectic-replacement facies exhibits a Rb-Sr isochron age of 377±18Ma. Unit also contains Carboniferous biotite-two mica granite that intrudes Carboniferous strata and exhibits a K-Ar isotopic age of 330 Ma, a concordant $^{207}Pb/^{206}Pb$ age of 279.4 Ma, and an internal Rb-Sr isochron age of 290 Ma. The intrusions are low-alkalic, Al super-saturated, and calc-alkalic. The granites intrude a Middle Devonian and Early Carboniferous terrestrial detrital-volcanic sedimentation basin.

References: Bureau of Geology and mineral Resources of Xinjiang, Uygur Aut. Reg., 1992; Chen Zefu, 1997.

als Alashan plutonic belt (Silurian) (Northwestern China)

Occurs in the Archean and Paleoproterozoic Alashan terrane of Sino-Korean Craton and strikes mainly east-west. Composed mainly of gneissic granite and addamellite that form stocks and a minor batholith. Granitic rocks are calc-alkalic, S-type, and are interpreted as forming from melting of continental crust. Isotopic ages of most plutonic rocks are of Middle and Late Silurian.

REFERENCES: Bureau of Geology and Mineral Resources of Inner Mongolia Aut.Reg., 1991; Cheng Yuqi and others, 1994.

am Altai-Mongolia intermontane basin (Paleogene, Neogene, and Quaternary) (Altai-Sayan region)

Consists of various basins are filled by continental molasse and local glacial deposits. Basin formation occurred during Neogene and Quaternary orogeny.

REFERENCES: Devyatkin, 1965; Bogachkin, 1981.

an Anabar anorthositic belt (Archean) (Yakutia)

Consists of anorthosite, gabbro-anortthosite, and monzodiorite (Anabar complex) that occur in the Kotuikan, Magan, and Billyakh melange zones of the Anabar shield. The largest Central pluton has an area of about 800 km^2; total area of all the plutons is about 2,000 km^2. Central parts of large plutons composed of homogeneous anorthosite, whereas the margin parts consist of gabbro-anorthosite, mangerite, and monzodiorite with gneissoid structures. A Sm-Nd isochron isotopic age of monzodiorite crystallization is 2.2 Ga.

REFERENCES: Rosen, 1994.

Altai-Sayan back-arc basin (Altay-Sayan Region). Consists of the Biya-Katun (asbk), Mrass-Bateni (asmb), Kiya (aski), and Kizhikhem (askz) units.

asbk Altai-Sayan back-arc basin (Biya-Katun unit) (Late Neoproterozoic and Cambrian) (eastern Gorny Altai)

Extends along a complicated north-south striking strike-slip zone from the Kuznetsk Alatau to the north to southeastern Gorny Altai to the south. Occurs in several smaller tectonic blocks, lenses, and sheets. Mainly composed of a eastern part of Vendian and Early Cambrian shallow-water siliceous-carbonate sequence (Baratal suite). Unit locally underlain by basalt with subordinate siliceous shale and carbonate rocks. Unit interpreted as forming in a volcanic island on oceanic crust.

The western part of the Katun terrane consists of early Early Cambrian carbonate rocks, basalt, siliceous shale, and fine-grained clastic rocks formed in a relatively deep-water back-arc basins with volcanic zones. Carbon-rich sedimentary rock and thin flows of tholeiitic and alkaline basalt and picrobasalt (Eskongin suite) fill the basins. High- and low-Ti tholeiitic and alkaline basalt with subordinate sedimentary rocks (Manzherok suite) comprise the uplifts. The late Early Cambrian units of massive limestone, sandstone, siltstone, marl, and sparse volcanic rocks (Shashkunar, Cheposh, and Barangol suites) with archaeocyata, trilobites, and brachipods, and is overlain by basalt and tuff in large volcanic fields (Ust-Syoma suite).

The younger Biya-Katun unit occurs in small grabens or tectonic lenses and consists of Early Ordovician (Tremadoc) motley molasse that is locally overlain by Devonian active continental margin deposits. Also occuring are Middle Paloeozoic alkaline and subalkaline granite.

REFERENCES: Romanenko, 1978; Avrov, 1980; Volkov, 1986; Kungurtsev, 1991; Repina and Terleev, 1991; Buslov and others, 1993; Gibsher and others, 1997.

aski Altai-Sayan back-arc basin (Kiya unit) (Late Neoproterozoic and Cambrian) (northern Kuznetsk Alatau)

Consists of two packages of tectonic sheets thrusted to the south-southwest. Ophiolite sheets of the Tersa terrane occur between these two packages.

The lower (southern) package consists of: (1) a lower unit of metabasalt, and subordinate carbonaceous-siliceous shale, metaterrigenous rocks, and carbonate rocks; (2) Late Riphean and Vendian limestone and dolomite interlayered with siliceous rock, siliceous shale, sand-siltstone and mafic volcanic rock (Kabyrzin, Zapadnosibirskaya and Belkin suites): (3) fossiliferous Early Cambrian shale-carbonate deposits (Ust-Kundat and Usin suites). Local imbricated ophiolites also occur.

The upper (northeastern) package overlaps the lower package and (or) is thrust over the imbricated ophiolites, and is composed of: (1) Late Riphean and Vendian siliceous-clay-carbonate sequences with interlayered sheets of Vendian or Vendian and Early Cambrian(?) subalkaline basalt, tuff, tuff-breccia, brecciated lava, and interlayered mudstone, and siliceous and carbonate sedimentary rock (Kamzass and Ust-Anzass suites): (2) Early Cambrian carbonate deposits (Ust-Kundat and Usin suites): (3) a Middle Cambrian sedimentary-volcanic sequence (Berikul suite) composed of andesite, andesite basalt, tuff, tuff-breccia, lava and volcaniclastic-sedimentary rocks ranging from siltstone to conglomerate.

Also occurring is the Kiya unit that contains: (1) Late Precambrian and Early Cambrian submarine-landslide sedimentary rocks with carbonaceous material, and subalkaline basalt possibly formed in extensional zones in a back-arc basin; and (2) Middle Cambrian volcanic rocks and associated clastic formed in the final stage of back-arc basin evolution. The Kiya unit is intruded by large granitic massifs that intruded after imbricate thrust. To the north are overlapping are Devonian, Mesozoic, and Cenozoic deposits.

REFERENCES: Khomentovskii, 1960; Repina and others, 1964; Gintsinger and others, 1969; Gintsinger, 1979; Alabin, 1983; Grigor'yev, 1988.

askm Altai-Sayan back-arc basin, Kizhikhem unit) (Late Neoproterozoic) (southwestern Eastern Sayan)

Occurs in a large strike-slip fault zone, between the Derba terrane (Riphean passive continental margin) and Vendian-Cambrian island-arc terranes. Consists of southwest thrusting tectonic lenses and sheets. Composed of Late Riphean sedimentary sequences and Vendian and Cambrian island arc rocks. Metamorphosed from greenschist to amphibolite facies. Ranges up to several thousand meters thick.

Unit composed of relatively deep-water volcanic-carbonate-terrigenous-shale assemblages (Kuvai, Ashkasok, Lysan, Chatyrlyg, and Urman suites). Some sections dominated by fine-

grained clastic black shale with sparse interlayers of andesite to mafic volcanic rocks and limestone. Others sections are dominated by volcanic rocks with interlayered carbonaceous sandstone, siltstone, limestone, chert, and shale. Local sections are dominated by carbonate-terrigenous deposits with turbidites associated with volcanic rocks and conglomerate. The carbonate-terrigenous sections are probably relatively younger than volcanic-shale sections.

Carbonate and terrigenous-carbonate deposits compose tectonic lenses up to tens km long. Examples are a section of: (1) the Sarlyk suite composed carbonate rocks, carbonate-terrigenous rocks interlayered volcanic interlayers; and (2) the Taguldin suite composed of metaterrigenous rocks in a lower part, and limestone and dolomite with algae in the upper part. Conglomerate lenses and packages, ranging up to 1,000 m thick, with carbonate clasts, occur throughout the section. The conglomerates appear to occur along carbonate uplifts.

The Kizhikhem unit consists of Vendian-Cambrian motley limestone about 500 m that that occurs in tectonic wedges and sheets.

The unit contains small lens-like, and sill-like bodies of titaniferous gabbro and serpentinized pyroxenite that are associated with volcanic rock and shale sections that contain high-Ti mafic volcanic rocks. Also occurring are early Paleozoic collisional granites related to strike-slip faulting, and early Paleozoic layered titaniferous pyroxenite-gabbro massifs related to local back-arc extension zones, and Early Devonian subalkaline granite related to rifting.

REFERENCES: Khomentovskii and others, 1960; Shelkovnikov, 1962; Predtechenskiy, 1967; Zamaraev, 1975; Tarnovskiy, 1979; Altukhov, 1986.

asmb Altai-Sayan back-arc basin (Mrassu-Bateni unit) (Late Neoproterozoic and Cambrian) (Gornaya Shoriya, Kuznetsk Alatau, Eastern Sayan)

Occurs in large, imbricated tectonic sheets and lenses thrust southward with unclear stratigraphy. Described below is a general stratigraphic succession. Sedimentary and volcanic rocks at the base of the section only occur in northwestern part of unit. Base of section (Beloiyusskaya, Koltas or Tashelgin suites) consists of mainly greenschist and siliceous volcanic and pyroclastic rocks that are succeeded by volcanic rocks, siliceous rock, marble, metasandstone, gravelstone, and conglomerate with carbnaceous sedimentary rocks. Two younger units occur.

(1) The first unit consists of Late Riphean, Vendian, and Early Cambrian sedimentary and volcanic rocks. Extensive shallow-water limestone (Kabyrzin, Poluden, Goldzhin, Bidzhin, Belkin, Karchit, Tunguzhul, Usin, Uyarsk, and other suites) and dolomite (Zapadnosibirskaya, Tarzhul and Martyukhin suites) occur along with local, less abundant siliceous shale. Vendian and Early Cambrian units are rich in P2O5 and Mn and locally host small phosphorite and Mn deposits. Vendian and Early Cambrian polymictic sandstone and graywacke, siltstone, and siliceous shale (Tamalyk, Tuzukhsin, Mrass and other suites) also occur. The Riphean-Cambrian sedimentary units consist of massive and thick-bedded carbonate rocks with algae (Precambrian) and archaeocyata (Early Cambrian) containing bioherms, and thin-bedded and carbon-rich units in basins. Also occurring are calcarenite and calcilutite. Deposition along a slope is indicated by submarine landslide folds, sedimentary breccia, and other structures. Also occurring are Late Riphean and, possibly, Vendian Early Cambrian volcanic rocks composed mainly of siliceous volcanic rock, tuff, and volcaniclastic rocks (Riphean Poluden, Goldzhin and Mrass suites). Locally occurring are subalkaline volcanic rock and mafic tuff in units up to 1,500-2,000 m thick (Loshchenkov, Kulbyurstyug, Kamzass, and other suites).

(2) The second unit ranges from several hundred to first thousand meters thick and consists of Early and Middle Cambrian sedimentary and volcanic rocks, including carbonate rock, shale, and siliceous shale with interlayered polymictic conglomerate (Usin suite, Karasuk, Mazass, Ulutag, Efremkin, Blagodat, Sladky Koren, Eldakh, and other suites). Other units include sandstone, mafic to siliceousvolcanic rocks, tuff, tuff-breccia, and tuffaceous conglomerate (Azyrtal, Kuten-Buluk, Bateni, Tolchein and, possibly, Amar suites). Also occurring are volcaniclastic rocks as tectonic sheets with Precambrian units. Early and Middle Cambrian volcanic rocks in uplifts and

associated basinal sedimentary deposits (Bateni and Tolchein suites) occur with tectono-gravitational for the uplifts that contain tuff and coarse-grained clastic volcaniclastic rock (Berikul suite). Also occurring are batholiths of the Tannuola plutonic belt.

Overlap assemblage is unconformity overlapped by Devonian and Carboniferous continental volcanic and sedimentary units, and is intruded by Early Devonian subalkaline granite of the South Siberian volcanic-plutonic belt.

REFERENCES: Nemirovskaya, 1961; Yaroshevich, 1962;Repina and others, 1964; Musatov and Predtechenskiy, 1967; Amgaian, 1971; Bondareva, 1978; Lyubalinskaya, 1978; Gintsinger, 1979; Koptev, 1983; Alabin, 1983; Suvorova, 1983; Grigor'yev, 1988; Kheraskova and Gavrilova, 1996.

ay Alashan-Yinshan plutonic belt (Triassic) (Northern China)

Occurs in a northeast to east-west-trending Triassic batholith belt that trends from northeast to east-west. Consists mainly of calc-alkalic granite and monzonite that are interpreted as derived from melted continental rocks. Some granite is alkali and forms small intrusions that occur along east-west-trending deep fault zones.

REFERENCES: Bureau of Geology and mineral Resources of Inner Mongolia Aut.Reg., 1991; Cheng Yuqi and others, 1994.

ayp Alashan-Yinshan plutonic belt (Proterozoic) (Northern China)

Belt trends northeast to east-west and contains early and late stages. Early felsic stage consists of variably-sized intrusions associated with gneissic structures. Main rock types are syntectic plagioclase granite, granite, and granodiorite that are calc-alkali and are interpreted as derived from transitional continental crust. Isotopic age is about 1,400 Ma. The late stage is complicated and consists of a granite and granodiorite batholith, and minor mafic rocks, such as gabbro and diorite that contain irregular inclusions of ultramafic rocks such as buchnerite. Rocks are calc-alkalic and and are interpreted as remelted continental rocks. Isotopic age is about 1,000 Ma.

REFERENCES: Bureau of Geology and mineral Resources of Inner Mongolia Aut.Reg., 1991; Cheng Yuqi and others, 1994.

az Amur-Zeya sedimentary basin (Late Jurassic to Quaternary) (Southern Russian Far East)

Occurs in a 90 to 230 km wide basin that extends northeast for 390 km. Forms northeastern extension of the Sunlao basin in China. Consists of: (1) Late Jurassic (Tihonian) siltstone, mudstone, and andesite tuff; (2) Early Cretaceous (Berriasian and Valanginian) sandstone, siltstone, mudstone, and andesite; (3) Early Cretaceous (Hauterivian and Barremian) sandstone, siltstone, and mudstone; (4) Early Cretaceous (Barremian and Albian) andesite and mudstone; (5) Late Cretaceous (Turonian and Campanian) mudstone, siltstone, and sandstone; and (6) Late Cretaceous and Cenozoic sandstone, mudstone, and brown coal ranging from 2,000 to 5,000 m thick. Mesozoic units range from 1,500 to 4,300 m thick.

REFERENCES: Oil and gas content of the Far Southeast and adjacent territories, 1998; Volk and Gaponenko, 1981; Kos’ko, 1984; 1988; Volk and others, 1984; Fujita and Cook, 1990.

ba Biya sedimentary basin (Cambrian and Ordovician) (northeastern Gorny Altai) (Altai)

Consists of shallow-water marine molasse ranging from 5,000 to 6,000 m thick that contains trilobites, brachipods, and corals. Unconformably overlies Uimen-Lebed terrane. Composed of following units. (1) Middle and Late Cambrian gray and red conglomerate, polymictic mudstone, and limestone (Tandoshin, Ynyrgin, Bolsheishin, and Kulbich siutes). (2) Locally unconformably overlying Ordovician sandstone, siltstone, and mudstone with lesser conglomerate, and limestone (Choi, Ishpin, Tuloi, Gurjanov, Chebor, and other suites) with local breaks and unconformities, the largest during the Early and Middle Ordovician. Basin deposits are unconformly overlain by Devonian sedimemntary and volcanic units formed along an active continental margin, and intruded by middle and late Paleozoic granite. Basin interpreted as a fragment of a mobile shelf formed along a transform continental margin.

REFERENCES: Belousov, Sennikov, 1960; Gintsinger and others, 1969; Sennikov, 1977; Avrov, 1980; Grigor'yev, 1988.

bh Bohai sedimentary basin (Cenozoic) (Northeastern China)

Consists of following units: (1) early Tertiary argillite intercalated with sandstone, glutenite, dolostone, and dolomitic limestone; (2) early Tertiary argillite intercalated with sandstone, marl, dolostone, oil shale, and bioclastic limestone; (3) early Tertiary argillite, sandstone, basalt, and tuff; (4) late Tertiary sandstone, gravel-sandstone, and argillite; (2) late Tertiary interlayered sandstone, glutenite, and argillite; and (5) Quaternary interlayered clay and fine sand layers featuring river-lake sedimentation and minor marine sedimentation. Maximum thickness of the basin is about 10,000 m.

REFERENCES: Wang Shanshu, 1990; Qiu Zhongjian and Gong Zaisheng, 1999.

bi Billyahk plutonic belt (Paleoproterozoic) (Yakutia)

Consists of granite and granodiorite of Billyakh complex (pluton) comprising an area 1,000 km^2. Occurs in melange zones of the Anabar shield. Granite and granodiorite exhibit a porphyroblastic to massive to gneissoid textures. Porphyroblastic granodiorite exhibits a K-Ar isotopic age of 1.80 to 1.81 Ga A U-Pb zircon isotopic age for a biotite granite in the Kotuikan melange zone is 1.87 to 1.84 Ga.

REFERENCES: Krylov and others, 1963, Stepanov 1974.

bk Baikal sedimentary-volcanic rift belt (Oligocene through Quaternary) (Transbaikalia)

Belt strikes northeast direction for over 1,500 km from Lake Khubsugul, Mongolia to the western border of the Aldan shield, and forms an intricately branching system of basins filled with Cenozoic sedimentary rocks. Largest basins the Baikal, Tunka, Barguzin, Upper Angara, Tsypinsky, Tsypikansky, Muya, Chara, Udokan and Tokka basins. In most basins, sedimentary rocks are divided into two sequences. (1) A lower Oligocene and Early Pliocene sequence of sandstone, siltstone and mudstone with layers of limestone, marl, and diatomite. Thickness varies from 2,000 to 5,000 m. (2) A Middle and Late Pliocene and Quaternary upper sequence of conglomerate, and pebble, and gravel sedimentary rock. Occurring in the central parts of large basins are thin clastic sedimentary rocks including sandstone, siltstone and mudstone. Thickness of the upper sequence is about 1,000 m. Also occurring are limited moderate alkaline-olivine-basalt formation. Locally occurring are trachybasalt, basanite, hawaiite, and trachyte that form flows that extend to basin margins.

REFERENCES: Logachev, 1967; Stupak, 1987; Rasskazov, 1993.

bl Belokurikha plutonic belt (Late Permian through Early Jurassic) (Altai, Mongolia, Northwestern China)

Belt extends from Salair to Gorny to Rudny Altai regions and into Mongolia and northwestern China. Consists of two areas of granitoid magmatism; (1) plutons in Salair, Rudny Altai, and Gorny Altai areas that vary widely in geochemical composition, but have similar isotopic ages of 240 to 245 Ma; and (2) plutonis in southern Gorny Altai area that consist of abundant Late Triassic and Early Jurassic REE massifs.

In the northern part of Gorny Altai area, granitoid massifs comprise a composite batholith and consist mainly coarse-grained porphyric biotite granite and younger, small stocks of medium-grained biotite granite, dike-like bodies of two-mica and muscovite leucogranite, and aplite and pegmatite veins (Belokurikha complex). These units consist of peraluminous potassic granite with decreased calcium and mafic components, typical REE and peraluminous composition. Units exhibit U-Pb zircon isotopic ages of 232$\pm$4.7 Ma, and a Rb-Sr whole rock and mineral isochron age of 243.5$\pm$2.1 Ma. Coarse-granined granite, medium-grained syenite, two pyroxene syenite, and quartz syenite form the Aya complex that intrudes the Belokurikha terrane. These granitic rocks are potassium-rich subalkaline granitoids with U-Pb zircon and Rb-Sr whole rock isotopic ages of 246 to 244 Ma.

The large granitic massifs of Sinukha-Tigirek complex intrude the Gorny and Rudny Altai areas and consist of: coarse-grained granite and leucogranite (main phase); granodiorite and monzodiorite (early phase); fine-grained granite and aplite (late phase). The granitic rocks are calc-alkaline series with potassium dominant over alkalis, exhibit several features of within-plate subalkaline rocks. The units exhibit U-Pb zircon isotopic age of 251$\pm$4.7 Ma

and a Rb-Sr whole rock age of 243.5±2.1 Ma (Late Permian and Early Triassic). In the southern Gorny Altai and within the Altai terrane are REE granitic massifs of the Chindagatui-Kalgutin complex that comprise a composite batholith composed mostly of medium- and coarse-grained porphyritic granite, and younger phases of muscovite and muscovite-tourmaline leucogranite and aplite that occur small stocks and dikes. The early stagerocks are REE and peraluminous type with potassium dominant over alkalies. The late stage rocks are have high concentrations of Li, Cs, and P. The U-Pb zircon and Rb-Sr isotopic age isotopic 183 to 204 Ma.

The belt is interpreted as intruding in a transpression geodynamic environment during postcollisional compression. The belt formed after major Early Carboniferous and Middle Carboniferous accretion of large continental blocks.

REFERENCES: Vladimirov and others, 1996, 1997; Kruk and others, 1998; Obolenskiy and others, 1999.

bo Bogdarin molasse basin (Ordovician? and Devonian?) (Transbaikalia)

Occurs in scattered small fragments in the Baikal Mountains, Vitim lowland: right bank of Bogdarin River (Bogdarin suite), Kholoy-Vitim interfluve (Istashinsky suite), and Yambuy river basin (Yambuy suite). Consist mainly of inferred Ordovician(?) and Devonian(?) variegated terrigenous sedimentary rocks including conglomerate, sandstone (polymictic, arkose and quartz sandstone), siltstone, mudstone, and marl. Locally occurring are wave-tidal structures and ripples. Some areas contain scarce thin interlayered siliceous tuff. Sedimentary rocks are intermontane depression molasse. Unconformably overlay Eravna terrane, and Vendian, Cambrian, and Ordovician overlap assemblages. Intruded and contact metamorphosed by undated granitoids, and deformed into northeast-striking sheared folds. The variegated molasse sedimentary rocks of the basin occurredare interpreted as forming in isolated intermontane depressions after accretion of underlying to the Siberian Platform.

REFERENCES: Belichenko and others, 1961, 1962; Belichenko, 1969, 1977; Butov, 1996.

bt Balyktakh volcanic field (Early Cretaceous) (Yakutia)

Unconformably overlies Kotel'nyi terrane and consists of Aptian-Albian terrigenous coal-bearing rock. Upper part also contains rhyolite flows and tuff that range from up to 35 to 60 m thick (Balyktakh volcanic field) and Cenomanian siltstone, mudstone, and sandstone with a crust of weathering at the base (a few meters). Sparese late Mesozoic, north-west striking diabase dikes, up to several tens of meters thick, intrude Early Cretaceous units.

REFERENCES: Dorofeev and others, 1999.

bu Bureya sedimentary basin (Early Jurassic to Early Cretaceous) (Southern Russian Far East)

Consists chiefly of Jurassic and Cretaceous shallow-marine and nonmarine sandstone, siltstone, and shale. Early and Middle Jurassic units are mainly marine, and late Middle Jurassic (Callovian) units grade into to nonmarine deposition. Interlayered coal deposits occur in Late Jurassic and Early Cretaceous section, and interlayered felsic tuff occurs throughout Jurassic section. Units are weakly to nondeformed in the western part of basin, but are folded and faulted in the eastern part. Basin unconformably overlies Turan and Malokhingansk terranes of the Bureya superterrane.

REFERENCE: Krasny and others, 1966; Kozlovsky, 1988.

bug Bulgugsa granite (Late Cretaceous) (Korea)

Consists of plutonic rocks varying from tonalite and granodiorite to adamellitic granite to granite porphyry. Biotite and hornblende adamelite granite are most common. The Jindong granite of the southern part of the Kyongsan Basin may be the oldest plutonic rocks of the Bulgugsa granite and vary from granodiorite to hornblende granite and biotite granite to granite porphyry. A similar trend occurs in the Bulgugsa granite but the youngest member of the series, the Masan granite, are more highly differentiated and vary from tonalite to admellite to micrographic granite porphyry. The Masan granite occurs in the southeastern part of the Kyongsang Basin, is finer grained, has a higher quartz and potassic feldspar content, and lower biotite content than the other plutonic rock series of the Bulgugsa granite. Many of Koreas epigenetic lode mineral deposits are hosted in the Bulgugsa granite.

REFERENCES: Lee, 1987, 1988.

bv Barguzin-Vitim granitoid belt (Late Carboniferous) (Transbaikalia)

Forms a huge granitoid body of irregular shape extending northeast for over 800-850 km and ranges up to 300 km wide. Occurs in central part of Baikal Mountains. Contains initial and major stages. Initial stage consists of monzonite, quartz monzonite, granodiorite, synplutonic basalt bodies, aplite-basalt dikes, melanocratic nodules, and schlieren. The granitoids of the main stage comprise allochthonous and autochthonous groups: The allochthonous group, mainly granite and rare granodiorite is highly homogeneous with sharp contacts with host rocks that are weakly metamorphosed. The autochthonous group is metamorphosed to amphibolite facies and exhibits gradational contacts of migmatite. The southern part of batholith hosts the Zazinsky complex of granite and quartz syenite. The belt also contains alkaline basalt, nepheline, alkaline syenite, andalkaline granite K-Ar, Rb-Sr, and U-Pb isotopic analyses of belt plutons yield ages of 320 to 290 Ma.

REFERENCES: Kozubova and others, 1980; Bukharov and others, 1992; Litvinovsky and others, 1992; Neimark and others, 1993; Yarmolyuk and others, 1997.

bw Beitianshan-Waizunger sedimentary basin (Carboniferous through Permian) (Northwestern China)

Occurs in sparse, northwest-trending outcrops and consists of Carboniferous marine and terrestrial detrital rocks, volcanic rocks, and Permian continental volcanic and detrital rocks. Carboniferous strata consist of siltstone, calcareous sandstone, tuffaceous silstone, fine-grained sandstone, dacite, tuffaceous conglomerate, sandstone and siltstone. The terrestrial detrital rocks contain brachiopods, pelecypods, and plant fossils. The Permian units consist of terrestrial volcanic rocks, intermediate-mafic volcanic rocks intercalated with detrital rocks, coal layers, sandstone, siltstone, tuff, oil shale, mudstone and marl. Units contain abundant *Angaroparieiam*, *Noeggerathiopsis*, and other plant fossils.

REFERENCES: Bureau of Geology and mineral Resources of Xinjiang, Uygur Aut.Reg., 1992; Cheng Yuqi, 1994, and Chen Zefu, 1997.

ca Central Asian plateau basalt belt (Neogene and Quaternary) (Russia, Mongolia, China, Korea)

In Russian Southeast, consists chiefly of thick flows of olivine tholeite, alkaline basalt and basalt andesite that form flood basalt, and subvolcanic plutons of picrite, bisanite, hawaite, and trachyte. The volcanic rocks are typical interplate geochemical series with high content of noncoherent elements, REE and HFSE inclusive, high LREE/HREE, Ni/Co and low Ti/Ni. Enrichment of LILE, and Ba and Sr indicates participation of mantle matter that was metasomantically metamorphosed durion previous subduction.

REFERENCES: Zou and Armastrong, 1982; Tatsumoto and others, 1992; Fedorchuk and Filatova, 1993; Ionov and others, 1995; Yarmolyuk and Kovalenko, 1995; Martynov, 1999.

In Northern China, consists of Cenozoic basalt that widely overlies middle of Sino-Korea Craton and other Paleozoic terranes to the north. Cenozoic basalts are mainly alkali basalt with minor tholeiite. The alkali basalt containing the inclusion of ultramafic rocks (mainly spinel lherzolite), is intensely alkaline, strongly enriched in LILE and LREE, exhibits a low ratio of TiO_2/Al_2O_3 in early stage units. The Cenozoic basalts in the middle of the Sino-Korea Craton comprise an area of about 3,000 km^2. In this area, the Hannuoba basalt consists of early-stage alkaline basalt and basanite and late-stage tholeiite and formed in two major periods, 24 to 18 Ma and 16 to 13 Ma. Total thickness ranges up to 100 to 300 m. In the Changbai Montain, near the boundary between China and the Korean Peninsula, crops out over an area of 15,000 km^2 and consists mainly of alkaline basalt (alkali olivine basalt, tholeiite and quartz-trachyte), and minor tholeiite of Paleocene to Recent age. The basalt in Dalainuoer region in Northern China crops out over an area of 10,000 km^2 and consists mainly of alkali basalt that contains ultramafic inclusion includions. Isotope age ranges from of 11.4 to 0.47 Ma (Miocene through middle Pleistocene).

REFERENCES: Cheng Yuqi, and others, 1994; Liu Jiaqi, 1999.

cc Chokhchur-Chekurdakh granite belt (Cretaceous) (Yakutia)

Belts contains granitoids a suite of diorite, granodiorite, and granite, and suite of granite and leucogranite locally found in the south part. Both suites are intruded by dikes of rholite, rhyodacite, and dacite porphyry and comagmatic subvolcanoes and volcanoes. The youngest units are shosholite-latite-trachyrhyolite dikes.

The suite of diorite, granodiorite, and granite occurs in stock-shaped plutons in which granodiorite prevails, and have ^{40}Ar-^{39}Ar isotopic age of 105-109 Ma, and a K-Ar isotopic age of 90-115 Ma. The granitoids are highly mafic, low water-content, and formation from a high-temperature melt. The rocks have a normal or slightly high total alkalinity that increases both north south, are close to I-type, with deviations to S- and A-types in the southern part of the belt. The granitoids are of within-plate origin according to Y/Nb and Rb/(Y+Nb) ratios. The southern part of the belt contains small plutons of subalkaline biotite granite and dikes of aplite and leucogranite.

The following lithologies are most prevalent: alkali feldspar lencogranite, granite porphyry, and rhyolite, rhyodacite, trachyrhyolite, and trachyrhyodacite porphyry. These lithologies occur in small stocks and subvolcanic bodies with numerous apophyses and and are locally associated with several volcanoes in the southern part of the belt (Pavel-Chokhchur pluton and Chyrpunya paleovolcano) and have K-Ar isotopic ages of 94-78 Ma. The vent of the Churpunya paleovolcano with associated large Sn deposit consists of granite and granodiorite-porphyry is similar to other plutons of the granite-lencogranite association that comprise a high-K, late orogenic or anorogenic magmatic series with compositions close to calc-alkaline phemasite granite rocks, with REE alkaline granite. REE trends exhibit enrichment in Ce-group elements and a distinct Eu minimum that is characteristic for S-type granite. The Chokhchur-Chekurdakh granite belt is superposed on the Late Jurassic Svyatoy Nos magmatic arc.

REFERENCES: Trunilina and others, 1996; Trunilina and others, 1999; Layer and others, 2001; Trunilina, in press.

chs Chosun sedimentary basin (Cambrian and Ordovician) (Korea)

Basin occurs in southern Korea and consists of Cambrian and Ordovician rocks of the Chosun supergroup that locally contains fauna with Hwangho or Yangstse affinities. Basin contains two major sequences, the Yeongweol and sequences Duwibong. The Yeongweol sequence contains Chiangnan fauna, that was deposited in axis of the elongate Ogcheon basin, and is separated by major faults from the Duwibong sequence that locally contains horizons with Hwangho faunas, and was deposited in extensive shelf seas along the margin of the Ogcheon basin that sporadically was linked to the Pyeonnam and Yangstse basins. Main stratigraphic units of the Yeongweol and Duwibong sequences are as follows. Yeongweol sequence: Kurang Formation, Sambangsan Formation, Machari Formation, Wagok Formation, Mungog Formation, and Yeongheung Formation. Duwibong sequence: Jangsan Quartzite, Myobong Slate, Sesong Slate, Hwajeol Formation, Dongjeom Quartzite, Dumugol Formation, Maggol Limestone, Jikunsan Shale, and Duwibong Limestone.

REFERENCES: Lee, 1987.

Chara-Uchur rift system (Paleoproterozoic) (Yakutia)

Consists of a Paleoproterozoic rift system that extends latitudinally across the Aldan-Stanovoy shield and overlaps the Early Precambrian West Aldan, Central Aldan, Uchur and Batomga terranes. Rift system includes, from west to east, the Udokan, Uguy, and Ulkan basins and small alkali-ultramafic, mafic, and carbonatite plutons that are too small to depict on map.

cuk Udokan basin (Paleoproterozoic) (Yakutia)

Occurs on the southwestern margin of the Aldan-Stanovoy shield and consists of clastic sedimentary and minor carbonate rocks that range up to 10,000 m thick and that are intruded by granite with a isotopic age of 2,200 to 1,800 Ma. Unit is folded and regionally metamorphosed up to amphibolite faceis.

REFERENCES: Bogdanov and Apol'sky, 1988.

cug Uguy basin (Paleoproterozoic) (Yakutia)

Occurs north and northeast of the Udokan basin and consists of red and grey carbonate, volcanogenic, and clastic sedimentary rockd that correlate with the upper part of the Udokan basin. Locally deformed into several overturned synclines.

REFERENCES: Davydov, 1986.

cul Ulkan basin (Paleoproterozoic) (Yakutia)

Occurs on the southeastern margin of the AldanStanovoy shield and consists of flat-laying alkali basalt, rhyolite, red conglomerate, and sandstone and ranges up to 5,500 m thick Unit intruded by alkali granite with a K-Ar isotopic age of 1850 Ma.

REFERENCES: Gamaleya and Zabrodin, 1967.

Czs Cenozoic undivided sedimentary rocks (Paleogene, Neogene, and Quaternary) (All areas)

Consists of undivided Cenozoic sedimentary rocks.

db Daebo granite belt (Early to Late Jurassic) (Korea)

Crops out over 16% of Korea and consists of several granitic batholiths in several northeast striking belts. Consists of granite, granodiorite, and subordinate tonalite and gabbro. Locally grades into muscovite granodiorite, and two-mica granite. Along the Ogcheon terrane margin, grantic rocks are metamorphosed and deformed into schistose granite or biotite gneiss. Isotopic age ranges from 148 to 194 Ma.

REFERENCES: Won, 1987; Kang and others, 1995; Jin, 1995.

dms Damaoqi sedimentary basin (Cenozoic) (North-central China)

Overlaps Yinshan terrane of Sino-Korean Craton and consists mainly of Pliocene sedimentary strata of mudstone and marl that are intercalated with fine-grained sandstone and basalt. Thickness is greater than 100 m.

REFERENCES: Bureau of Geology and mineral Resources of Inner Mongolia Aut. Reg., 1991; Li Weiguo, 1996.

dr Dzhakhtardakh volcanic field (Cretaceous) (Yakutia)

Occurs within the Selennyakh block of the Omulevka terrane and consists of Cretaceous volcanic and sedimentary rocks that unconformably overlie complexly-deformed Devonian sedimentary rocks. The volcanic rocks consist of subhorizontal and slightly-inclined flows and sheets of varying composition and thickness are are associated with comagmatic intrusions. The volcanic and sedimentary rocks are grouped into the Dzhakhtardakh unit subdivided into five subunits of which the lower three are Early Cretaceous, and the upper two are Late Cretaceous. The first (lower) subunit is 150 m thick and consists of pyroxene-biotite dacite and rhyodacite grading upward into trachyanndesite basalt, to hyalobasalt and two-pyroxene blister basalt (up to 100 m thick) with quartz latite and trachyte inclusions. Trachyandesite basalt exhibits a K-Ar isotopic age of 131 Ma and quartz latite exhibits a Rb-Sr isotopic age of 123 Ma. The second subunit is 140 to 170 thick and contains at a 40-m-thick biotite-sanidine quartz latite overlain by kaolinized and silicified trachyrhyolite and trachydacite (about 15 m thick). The Rb-Sr isotopic age of quartz latite is 116 Ma. Upwards area bed of trachyrhyolite clast lava (35 m thick), alternating quartz latite, kaolonized trachydacite, trachyrhyolite, and rare thin andesite basalt. The third subunit is about 220 to 270 m thick, and varies from siltstone, polymictic and volcanomictic sandstone to conglomerate, gravelstone, and cobble round-stone. Pebbles are composed of oolitic and organogenic limestone, calcareous sandstone and siltstone, and quartz-siderite-kaolite schist. Rare pebbles off albite-sanidine granite and granite porphyry also occur. Siltstone, sandstone, and mudstone contain carbonified Aptian and Albian flora. Volcanic rocks constitute less than 15 percent of the sequence, including thin pyroxene-amphibole trachyrhyolite sheets at the base, and trachyte, trachybasalt, and basalt sheets at the top. Trachyandesite basalt exhibits a K-Ar isotopic age of 112 Ma, and quartz and olivine-two pyroxene latite from the middle of the sequence exhibits a K-Ar isotopic age of 104 and 94 Ma. The unit contains a lower and middle Albian flora. The third subunit is intruded by monzonite of

the Great and Minor Dzhakhtardakh plutons. The Late Cretaceous volcanic and sedimentary rocks of the fourth and fifth subunits of the Dzhakhtardakh unit unconformably overlie the Early Cretaceous sedimentary rocks. The fourth subunit is 260 to 290 m thick, and consists of sheets (15 to 65 m thick) of olivine-two pyroxene-biotite and two-pyroxene-biotite trachybasalt, trachyandesite basalt, trachyandesite, and quartz latite. Two-pyroxene-biotite latite from the upper part of the sequence exhibits a K-Ar isotopic age of 92 Ma, and blister basalt and trachybasalt exhibits K-Ar isotopic ages of 102 and 108 Ma, respectively. The fifth subunit contains two horizontal sheets of alkali olivine-two-pyroxene basalt trachybasalt (10 m thick) and biotite-pyroxene trachyte-crachychyolite (up to 65 m thick). A K-Ar isotopic age for the alkali basalt is 93 Ma. The fifth subunit is intruded by alkali grante and granite porphyry of the Khara-Sis pluton.

REFERENCES: Trunilina and others, 1996, 1999.

dxs Daxingaling sedimentary overlap assemblage (Carboniferous through Permian) (Northeastern China)

Occurs in Daxinganling Mountains, trends northeast, and is sparsely exposed, and mostly covered by Jurassic volcanic rocks. Consists mainly of the Carboniferous marine, terrigenous detrital and carbonate rocks, Early Permian marine carbonate rocks, and Late Permian continental sedimentary and volcanic rocks. The Carboniferous strata are mainly lithic sandstone, mudstone, siltstone, quartz sandstone, limestone, and tuff with brachiopods, corals, and cephalopods. The Permian strata consist of sandstone, siltstone, limestone, andesitic porphyry and rhyolite porphyry and intercalated pyroclastic rock with corals, brachiopods, and plant fossils. Stratigraphic thickness ranges up to 10,812 m.

REFERENCES: Bureau of Geology and mineral Resources of Inner Mongolia Aut.Reg., 1991; Wang Quan, 1991.

dz Dzugdzur anorthositic belt (Paleoproterozoic) (Yakutia)

Occurs in southern part of the Tyrkanda tectonic melange zone and consists of several large anorthositic plutons (Dzugdzur, Kun, Maniensky). Similar plutons occur in the Chogar terrane. Belt also includes gabbro, gabbro-norite and ultramafic rocks. Anorthosite is mainly in tectonic contact with the surrounding units. The isotopic age of anorthosite is 1.7 Ga.

REFERENCES: Lennikov, 1968; Sukhanov and others, 1990.

ea Eurasia oceanic basin (Late Cretaceous through Present) (Arctic ocean)

Consists entirely of Cenozoic deposits with a synoceanic cover ranging from 1.5 to 8 km thick. Three structural stages are recognized and concist of variously oriented submarine fans. Thickness of sedimentary formation in each of structural stage varies from a few hundreds of meters to 2,000 to 4, 000 m. Seismic wave velocities in the sand-clay turbidite complexes increase with the depth of sedimentary rocks, from 1.75 km/sec in upper part to 4.1-4.5 km/sec in the lower part. Seismostratigraphic analysis of the synoceanic cover reveals sill-type intrusives. Surface of oceanic basement exhibits a complex contrasting relief. Basins contains Nansen and Amundsen basins that are separated by Gakkel Ridge rift. Structural units are almost indistinct because of being ubiquitously buried under very thick sedimentary rocks. The Gakkel Ridge rift zone is 55 to 60 km wide. The Nansen basin varies from 120 km width in the north to 25 to 30 km in the south. Near the rift zone, the sedimentary cover is thick and depth of basement is greater. The spreading rate for the southwest Gakkel Ridge, south of 80° N, was slower than the whole of the Eurasia basin, indicating that the Nansen basin formed more slowly than the Amundsen basin. The structure of the sedimentary formation over the Gakkel Ridge and the nature of faults indicate continuous, slow spreading north of 78° N. Slow spreading and high sedimentation velocities resulted in burial of Gakkel Ridge, formation of synsedimentary antiforms above the rift shoulders and synforms in the rift valley. Thickness of the sedimentary cover above the oceanic rift shoulders vary from 2,000 to 5,000 m, increasing southward, whereas in the rift valley thickness reaches 6,000 m. The tectonic activity of the Gakkel Ridge lessens in the same direction.

REFERENCES: Bogdanov and others, 1998.

ed Erduosi sedimentary basin (Triassic through Cretaceous) (North-central China)

Forms an intraplate basin containing Late Triassic and Cretaceous continental strata. Consists of: (1) Late Triassic sandstone, siltstone, mudstone, shale and coal; (2) Jurassic mudstone, sandstone, siltstone, shale and coal seams (J); (3) Cretaceous conglomerate, sandstone, and mudstone. Basin overlain by Cenozoic river and lake sedimentary rocks and loess.

REFERENCES: Cheng Yuqi and others, 1994; Tian Zaiyi and others, 1997.

ej East Jlin plutonic belt (Silurian) (Northeast China)

Consists chiefly of quartz diorite, granodiorite, and monzonitic granite. U-Pb isotopic ages are 502, 400 to 516, 320, Ma, K-Ar isotopic age is 408 Ma, Pb-Pb isotopic age is 400 Ma, and Rb-Sr isotopic ages are 524 Ma and 445 Ma. Belt extends trends east-west direction for about 550 km, to north of Sino-Korean Craton.

REFERENCES: Bureau of Geology and Mineral Resources of Jilin Province, 1989; Zhang Hairi and others, 1991; Zhao Chunjin and others, 1996.

el Erlian sedimentary basin (Jurassic through Quaternary) (North-central China)

Rift basin consisting mainly made up of the Cretaceous sandstone and shale of lake facies. The tectonic framework as the graben and borst in mutual substitution controls the formation of the basin. The thickness of Jurassic volcanic rocks and the deposits of Cenozoic alluvial and flood sand, gravel is very thin and the thickness of the graben is up to 4 km.

REFERENCES: Bureau of Geology and Mineral Resources of Inner Mongolian Aut.Reg. (Inner Mongolian GMRB), 1991; Tian Zaiyi others, 1997.

es East Sikhote-Alin volcanic-plutonic belt (Late Cretaceous through Miocene) (Southern Russian Far East)

es Volcanic part

esp Plutonic part

Consists chiefly of five major units: (1) Early Cenomanian rhyolite and dacite; (2) Cenomanian basalt and andesite; (3) thick Turonian to Santonian ignimbrite sequences; (4) Maastrichtian basalt and andesite; and (5) Maastrichtian to Danian rhyolite. Also occurring are Paleogene to Miocene high-titanium calc-alkalic basalt and andesite. Contains coeval, mainly intermediate-composition granitic plutons. For paleomagnetic determinations, two localities from the Primorye region yield grade low-quality results for of Late Cretaceous volcanic rocks indicating southerly displacements with respect to the Siberian Platform of 14°±10° and 9°±11°. The East-Sikhote-Alin belt is correlated with the Okhotsk-Chukotka volcanic-plutonic belt on strike to the north in Russian Northeast. Belt overlain by Miocene to Quaternary high-titanium tholeiitic and alkalic basalt.

REFERENCE: Nevolina and Sokarev, 1986; Nazarenko and Bazhanov, 1987.

et East Tuva back-arc basin (Late Neoproterozoic and Cambrian) (Eastern Tuva and southeastern Eastern Sayan)

Consists of the Kharal and Ailyg sedimentary-volcanic assemblage that occur fault-separated units.

The Kharal sedimentary-volcanic assemblage to the west and northwest and consists of two units: (1) The Late Riphean(?) terrigenous-volcanic unit (Kharal series) is composed of sandstone, siltstone, carbonaceous shale, mafic and siliceous volcanic rock and tuff, interlayered limestone and jasperoid with lgae fossils, and iron-bearing quartzite ranging from 6,000 to 7,000 m thick. Volcanic varieties are unevenly distributed locally form (up to 2,000 to 3,500 km thick) lens-like bodies grading laterally into terrigenous rocks. Metamorphosed from greenschist to lower amphibolite facies. (2) The Vendian(?) terrigenous unit (Okhem suite) consists of siltstone, sandstone, volcaniclastic rock, tuff and minor algae-bearing. A conglomerate horizon with the pebbles of underlying rock and granite occurs at the base of the unit. These relations indicate the terrigenous-volcanic unit formed prior to the initiation of a Vendian and Cambrian island arc, whereas the terriogenous unit formed near a volcanic arc and was

the source of clastic and tuffaceous material. In the east, Kharal assemblage contains Cambrian and Ordovician granitoids (Tannuola complex) that are interpreted as forming in a transpression orogenic setting.

The Ailyg type sedimentary-volcanic assemblage occurs in nappes and sheets adjacent to, overlying the Tuva-Mongolian superterrane. Consists of siliceous-carbonaceous and carbonaceous units and black shale, and lesser basalt and andesite, and sparse ultramafic and gabbro bodies. Carbonate rocks are widely distributed with a total thickness of over 2,500 to 3,000 m.

In East Tuva and southeastern Eastern Sayan the Vendian-Early Cambrian carbonate deposits (Sarygchazin and Syannyg suites) with archaeocyata and trilobites occur in tectonic sheets in the upper part of the section, and locally are overlain by Middle and Late Cambrian terrigenous and shale units (Kyzyldag and Mangatgol suites). Near the Tuva-Mongolian superterrane margin, the carbonate rocks (Ulanergin suite) contain dolomite and calc-dolomite with microphytholites and sponge spicules.

The back-arc basin and adjacent terranes are intruded by variable age granitic bodies. The largest are Late Cambrian and Ordovician orogenic plutons of the Tannuola complex, sparse, rift-related, middle Paleozoic subalkaline granite, and small bodies of within-plate late Paleozoic and Early Mesozoic REE granite. The back-arc basin and Vendian and Early Cambrian island-arc units are interpreted as forming in an early Paleozoic complex imbricate-thrust zone associated with rapid sinistral strike-slip faulting and southward thrusting.

REFERENCES: Abramov and others, 1972; Zaikov, 1976; Zaikova, 1978;Belichenko and others, 1986; Butov and others, 1979; Sugorakova, 1987; Dobretsov, Ignatovich, 1989; Gibsher, Terleev, 1989, 1992.

fh Fenhe sedimentary basin(Cenozoic) (Northern China)

Consists of Pliocene and Quaternary sedimentary rocks. Pliocene units are: (1) conglomerate intercalated with mudstone; (2) mudstone, shale and sandstone; (3) interlayered mudstone and sandstone; and (4) mudstone intercalated with sandstone, marl, and shale. Older sedimentary rocks are either alluvial and diluvial facies whereas the younger sedimentary rocks are lacustrine. Quaternary sedimentary rocks consist mainly of: (1) mudstone intercalated with sandstone and shale; (2) interlayered mudstone and sandstone; and (3) clay and fine sand. The Quaternary sedimentary rocks formed in rivers and lakes. The maximum thickness of the basin is 3,800 m.

REFERENCES: Bureau of Geology and Mineral Resources of Shanxi Province, 1989; Wang Nailiang, 1996.

ga Gazimur sedimentary basin (Late Neoproterozoic through Early Ordovician) (Transbaikalia)

Occur in several isolated outcrops overlapping northeast Argunsky terrane. Largest area forms an extended band about 150 km long and ranging from 20-25 km wide. Consists of five suites. (1) The basal Vendian(?) Tsagan-Olysky suite consists of coarse-grained quartz sandstone, gravelstone, conglomerate, quartz shale. Clast composition indicates sedimentation in deep washout associated with Riphean intrusive and sedimentary formations. (2) The Early Cambrian Bystrinsky suite mainly composed of coarse-layered and interlayered massive dolomite and bedded limestone, with minor interlayered clay, carbonaceous-clay, calcareous-siliceous rocks with stromatolites, catagraphies, archaeocyates, trilobites, brachypods, and bivalves. (3) The Middle Cambrian Altachinsky suite composed of intercalated sandstone, siltstone, carbonaceous shale, limestone, dolomite, and marl. (4) The early Late Cambrian Kultuminsky suite composed of dolomite and limestone that are suceeded by quartzite, sandstone, siltstone and gravelstone. And (5) concordantly overlapping Early Ordovician(?) Bogdatsky suite composed of a monotonous thin, intercalated siltstone, argillite, and polymictic and quartz sandstone with rare interbedded carbonate rocks. The total thickness of sedimentary rocks in the basin is estimated to be 5,000-7,000 m.

REFERENCES: Rutshtein and Chaban, 1997; Stetsjuk, 1977.

Gobi-Khankaisk-Daxing'anling volcanic-plutonic belt (Permian) (Mongolia, Transbaikalia, Northeastern China)

ghv Volcanic part

ghp Plutonic part

In Northeastern China, Daxing'an plutonic belt occurs in the Dayangshu and Jiliuhe belts. The Permian Dayangshu belt extends northeast for 500 km on the eastern side of Daxinganling Mountains and consists mainly of

an adamellite and granite batholith a K-Ar isotopic age of 270 to 320 Ma. The belt is dominantly calc-alkalic and A-type granite and is interpreted as forming during collision.

The Jiliuhe belt consists chiefly of granodiorite, monzonite granite, quartz diorite, quartz monzonite diorite, synogranite and akali-feldspar granite with a K-Ar isotopic age of 244 Ma and a U-Pb zircon isotopic age of 241 Ma. The belt occurs over the most of the southeastern Xiaoxinginling Mountains, strikes north-south for about 800 km and ranges from 200 to 500 km wide.

REFERENCES: Li Zitong and others, 1988; Bureau of Geology and Mineral Resources of Jilin Province GMRB, 1989; Bureau of Geology and Mineral Resources of Inner Mongolian Aut.Reg. (Inner Mongolian GMRB), 1991; Zhang Hairi and others, 1991; Bureau of Geology and Mineral Resources of Heilongjiang Province (GMRB), 1993; Xu Wenliang 1994; Zhao Chunjin and others, 1996.

In Transbaikalia region, belt consist the Gazimu and Undinsky granitoid complexes that intrude the Argunsky terrane. (1) The granitoids of the Gazimur complex comprise massifs with an area of 2,000 km^2. The first phase of the complex consists of quartz diorite grading into granodiorite; the second phase consists of local banded to gneissic granodiorite; the third phase consists of massive to gneissic biotite and two-mica granite. (2) The granitoids of the Undinsky complex occur in large massifs with an area of about 1,000 km^2. The first phase of the complex consists of gabbro-diorite, diorite, and quartz diorite; the second phase consists of amphibolie-biotite graniodiorite, biotite granite, and leucogranite. The Undinsky complex is calc-alkaline series or locally weakly alkaline. The Rb-Sr isotope age of the second (main phase) of Undinsky granite is 246±1 Ma. A K-Ar isotope age of the third phase of Undinsky granite is 233 to 252 Ma. The granitoids are interpreted as forming in a Permian subduction zone dipping under the Argunsky terrane.

Two interpretations exisit for structural relationships of the two complexes. (1) The granitoids of the Gazimur Complex are older than the Undinsky Complex, with the Gazimur granite being early Paleozoic, whereas the Undinsky complex is Late Carboniferous. Or (2) the Gazimur Complex is a marginal facies of the Undinsky Complex.

REFERENCES: Kozlov, 1972; Rutshtein and Chaban, 1997; Efremov and others, 1998.

Volcanic-sedimentary part occurs between Central Mongolian volcanic-plutonic belt and Onon terrane in eastern Mongolia and consist of: (1) Middle and Late Carboniferous sandstone, siltstone, minor limestone with brachipods and bryozoans; (2) Early Permian basalt, andesite, dacite, rhyolite, tuff, conglomerate, sandstone with plant fossils; and (3) unconformably overlying, widespread, gently-dipping Late Permian sandstone and siltstone with plant fossils, local lenses of limestone with brachiopods. Unit ranges up to 6,000 m thick. In the northern and central part of belt, the Early Permian volcanic and sedimentary rocks gradationally overlies Middle and Late Carboniferous sedimentary rocks; in southern part, the Early Permian rocks unconformably overlies Late Riphean strata. The volcanic-sedimentary part is interpreted as a forearc basin that formed along the northern edge of Central Mongolian volcanic-plutonic belt.

REFERENCES: Mossakovsky and Tomurtogoo, 1976; Kovalenko and others, 1995; Parfenov and others, 1999.

gl Great Lakes sedimentary basin (Jurassic and Cretaceous) (Mongolia)

Occurs in Great lakes basin in western Mongolia and Jurassic and Cretaceous non-marine sedimentary rocks. Complete section at Dariv contains five formations: Lower to Middle Jurassic Jargalant formation; Upper Jurassic Dariv formation; Upper Jurassic-Lower Cretaceous Ikhes Nuur formation; Lower Cretaceous Gurvan Ereen formation; and Lower Cretaceous Zereg formation. The Jargalant formation consists of cobble-boulder conglomerate, coarse-grained sandstone with interbedded siltstone and coarse-grained sandstone, and local sandstone interbedded with siltstone, mudstone, and coal. Uppermost section consists of upward-fining sequences of coarse- to medium-grained sandstone, siltstone, mudstone, and coal. Formation unconformably overlies Paleozoic Lake terrane and contains pre-Callovian ostracods and abundant plant material. The disconformable Dariv formation consists of an upward-fining sequence that grades from medium and coarse cross-bedded sandstone at the base to red siltstone and mudstone in the upper part. Dinosaur fossils (*Mamenchisaurus sp.*) occur at eleven horizons. The Ikhes Nuur formation consists of interbedded conglomerate and coarse-grained sandstone with phyllopods and charophytes. The Gurvan Ereen formation consists mainly of fine-grained gray shale, siltstone with

local centimeter scale interbedded sandstone and siltstone with fish, phyllopods, ostracods, mollusks, insects, and a small ornithischian dinosaur. The Zereg formation consists mainly of gray or yellow siltstone and mudstone with spordic cross-bedded, rippled sandstone.

The Great Lake basin is characterized by coarse stream-dominated alluvial, debris flow, braided fluvial, and meandering fluvial facies deposits that typically display upward fining trend, and formed in humid invironments. The Upper Jurassic and Cretaceous sedimentary rocks are coarse-grained alluvial and braided fluvial deposits, in which coarse-grained sedimentary rocks grade abruptly to fine-grained oxic lacustrine or playa facies. Sedimentary style suggests a change to less humid or seasonally-wet climate. Sedimentary style, linear orientation of Mesozoic outcroppings, axial paleocurrent indicator, isotopic provenance results, and regional tectonic setting suggest deposition in a foredeep of extensive, underfilled, contractile foreland basin.

REFERENCES: Devyatkin, 1970; Khosbayar, 1973; Devyatkin and others, 1975; Graham and others, 1997.

Hasan-Amurian volcanic-plutonic belt (Paleocene to early Miocene) (Korea and Russian Southeast)

ha Volcanic part

hap Plutonic part

Occurs in multiple grabens that extend from northeast to sublatitudinally, and chiefly consists of Paleocene and Eocene subalkaline rhyolite and subalkaline granite plutons, and Paleocene and Eocene bimodal volcanic rocks mainly basalt, Oligocene and Early Eocene bimodal volcanic rocks, mainly basalt, and Miocene basalt and andesite. Basalt is characterized by high Ti/V, Ni/Co, LREE/HREE or LILE/HFSE and $^{87}Sr/^{86}Sr$ ratios. Belt interpreted as forming over a slab-window that occurred under continental transform margin.

REFERENCES: Varnavsky, Martynov, 1983; Popov, 1986; Sedykh and Rybalko, 1988; Khanchuk and Ivanov, 1999; Popov and Grebennikov, 2001.

hb Huvsgol-Bokson sedimentary overlap assemblage (Late Neoproterozoic through Middle Cambrian) (Mongolia, Eastern Sayan)

Occurs in the eastern East Sayan region, extends south into Mongolia, and overlaps the Dibinsky, Gargansky, Ilchir, and Hugeisnky terranes. Consists of Bokson series and correlative units that comprise a sedimentary cover for a Vendian and Cambrian passive continental margin. Major units, from bottom to top, are the Khutensky, Khuzhitaisky, Mangatgolsky Zabitsky, Njurgatinsky, and Tabin-zurtinsky suites. The lower two suites consist of dolomite and are divided by a bauxite horizon with Ediakarksy-type medusoids, stromatolites, microphytollites, onkolites, archaeocyates, and Cambrian algae. The overlying suites consist of limestone with late Aldan, Lena, and Amginsky archaeocyates and trilobites. The uppermost Mangatgolsky suite consists of inferred Middle Cambrian and Ordovician shale and greywacke with minor carbonate and siliceous rocks. The lower boundary of the Bokson series is complicated by tectonic gravitational structures and contains Vendian basal sandstone, conglomerate and shale that overlap the Riphean ophiolite of the Ilchir terrane.

REFERENCES: Zhabin, 1971; Boos, 1991; Khain and Fedotova, 1995; Butov, 1996.

In northwestern Mongolia, occurs in Huvsgol and Zavhan basins. The Zavhan basin contains the Tsagaan Olom and Bayangol formations. The Tsagaan Olom formation sharply unconformably overlies Late Riphean rhyolite and tuff of the Zavhan formation. The Tsagaan Olom formation consists of: (1) Sturtian siliciclastic rocks and diamictite; (2) limestone with phosphatic horizons and Nemakit-Daldynian shelly fossils. The Bayangol formation consists of interbedded Tomotian argillite, siltstone, sandstone and massive limestone. The Hovsgol basin contains the Hovsgol group that includes the Arasan, Dood Nuur, Harmay, and Hesen formations that consist of dolomite, limestone, phosphorite, quartz sandstone, siltstone, slate, and chert with total thickness ranging up to 4,500 m.

REFERENCES: Dergunov and others, 1980; Ilyin, 1982; Byamba, 1996; Khomentovsy and Gibsher, 1996; Lindsay and others, 1996.

hg Hangay plutonic belt (Late Carboniferous and Early Permian) (Mongolia)

Occurs chiefly in Hangay and Hentiy plateau of Central Mongolia and consists of several large- to medium-size multiphase plutons that form the Hangay and Sharusgol complexes. Plutons composed of granodiorite, tonalite,

plagioclase granite, and minor gabbrodiorite, diorite, quartz diorite, and plagioclasic leucogranite with K-Ar isotopic ages ranging from 295 to 260 Ma, and 300 to 263 Ma in the Hangay and Hentiy Mountain Ranges, respectively. A U-Pb zircon isotopic age for this granite is 250 to 255 Ma with initial $^{87}Sr/^{86}Sr$ value of 0.7051 to 0.7058. A negative εNd(T) value exists, and a Nd model age ranges from 1290 to 2154 Ma, suggesting the involvement of older crust. Granitic rocks exhibits S-type characteristics, and are calc-alkaline with moderate K composition.

REFERENCES: Geology MPR, 1973; Pavlenko, 1974; Fedorova,1977; Budnikov and others, 2000.

hh Huanghai sedimentary basin (Mesozoic and Cenozoic) (China)

Consists of the Northern and Southern Yellow Sea Basins. The Northern Yellow Sea Basin consists of Mesozoic and early Tertiary, continental sedimentary rocks, and younger, late Tertiary and Quaternary, alternating marine and continental sedimentary rocks. The Northern Yellow Sea Basin is poorly known. The thickness of the Mesozoic and Cenozoic deposits in the subsiding (thickest) parts of the combined basins ranges up to 5,000 to 6,000 m.

REFERENCES: Wang Shanshu, 1990; Qiu Zhongjian and Gong zaisheng, 1999.

hi Hiroshima granitic plutonic belt (Cretaceous and Paleogene) (Japan)

Occur throughout the Japanese Islands especially in the inner part of southwestern Japan and northeast Japan. Unit named for widely-distributed Cretaceous granite in the Hiroshima Prefecture. Consists mainly of coarse-grained, white granite that intrudes Akiyoshi-Maizuru, Mino-Chichibu, Sangun-Hidagaien-Kurosegawa, and Hida terranes.

REFERENCES: Shibata and Ishihara, 1979.

hlt Hailar-Tamsag sedimentary basin (Late Jurassic and Cretaceous) (Eastern Mongolia and Northeastern China)

Consists of Late Jurassic continental volcanic rocks, Early Cretaceous lake sedimentary rocks, and Late Cretaceous and Cenozoic stream sedimentary rocks. Overlaps Paleozoic basement. A seismic profile shows a graben structure for the northwestern and southeastern parts of the basin, with an uplift occurring in the central part. Basin ranges to 3 to 5 km deep. Basin formed during subsidence related to Late Jurassic and Early Cretaceous rifting.

REFERENCES: Li Sitian, 1990; Zhang Dequang, 1992; Zhang Xiaodong, 1992; Liu Li, and others, 1994.

hn Hongiesa granite (Proterozoic) (Korea)

Consists chiefly of alkalic granite and granodiorite that intrude the Pre-Cambrian Geonggi and Yeongnam terranes. Isotopic are of biotite granite with isotopic ages ranging from 880 to 875 Ma.

REFERENCES: Geology of Korea, 1987, 1988.

hr Kharinsk granitic assemblage (Triassic) (Russian Southeast)

Consists chiefly of S- and A-type biotite granite with rare amphibole, with local quartz diorite and granodiorite, possibly with xenoliths restites of metamorphic rocks. Granites are calc-alkaline but locally are subalkakine. Rb, Nb, and Y geochemistry suggest collisional or interplate origin. Granites are overlapped by the Upper Triassic deposits and exhibit K-Ar isotopic ages of 242 to 245 Ma and 220 to 225 Ma. Contains Sn-REE greisen and pegmatite.

REFERENCES: Popeko, 1980; Martynuyk and others 1990; Gonevchuk and others, 1995, 1996.

hs Hyesan granite (Permian to Triassic) (Korea)

Consists of stocks and batholiths that intrude the Machollyong, Rangnim, Imjingang, and Yeongnam terranes. Consists chiefly of granite and lesser gabbro, diorite, and granodiorite with isotopic ages of 297 to177 Ma.

REFERENCES: Geology of Korea, 1993.

ht Hutuo rift basin (Paleoproterozoic) (Northern China)

Consists, from lower to upper, of: (1) Humeta formation composed of conglomerate, quartzite, feldspathic quartzite, phyllite, stromatolite-bearing dolomite; (2) phyllite, dolomite, sandy slate, and quartzite intercalated with metabasalt; (3) metaconglomerate, phyllite, plagioclase quartzite, and quartzite others. A U-Pb zircon isotopic age for the metabasalt is 2,366 Ma. Some authors interpret that the Huto basin is a Paleoproterozoic (2400-1900 Ma) rift; however, other authors interpret the Hutuo basin as a foreland basin.

REFERENCES: Cheng Yuqi and others, 1994; Zhai Mingguo and others, 2000.

hx Hexizoulang sedimentary basin (Jurassic through Cenozoic) (Northwestern China)

Forms a rift basin filled mainly by Jurassic fluviolacustrine terrigenous deposits with local Triassic strata that crop out in a small intermountainous basin and consist mainly of red coarse intermountainous and piedmont river clastic rocks with florra fossils and lanellibranchiata. Younger Cretaceous and Cenozoic strata are thin and mainly stream deposits. Thickness of basin ranges up to 2,000 m.

REFERENCES: Bureau of Geology and Mineral Resources of of Gansu Province, 1991; Tian Zaiyi etc, 1997.

ib Izu-Bonin volcanic belt (Miocene through Quaternary) (Western Pacific Ocean)

Consists of a volcanic arc composed chiefly of basalt to rhyolite, associated volcaniclastic rocks, and intercalated hemipelagic mudstone. Forms an overlap assemblage for Izu-Bonin island arc terrane. Belt exhibits a P wave velocity of 2-4 km/s based on offshore seismic survey with a thickness of 0.5 to 2 km. Several small volcanic islands (too small to depict on map) with outcrops Izu-Bonin terrane occur in eastern part of Izu-Bonin volcanic belt. A backarc depression occurs along rear of the volcanic front and extends parallel to arc. Rifts structures occur in backarc side of volcanic front. Width of the rift zone ranges from 50 to 150 km. Distinct back arc rifts with widths of about 30 km occur in backarc side of the volcanic front. The thickness of volcanic belt is thicker in rift grabens.

REFERENCES: Morita and others, 2000; Taira and others, 1998.

jb Japan basin (Neogene and Quaternary) (west of Hokkaido Island)

Consists of a backarc basin with basement of oceanic crust that ranges from 8 to 9 km thick according to geophysical investigations. Basin exhibits a funnel shape that opens to the east. Maximum width is 350 km and length is about 600 km. Water depth of the basin ranges form 3,500 to 3,700 m. Basin exhibits a smooth and flat sea floor formed by deposition of distal turbidites derived from surrounding landmasses including the Japanese islands. Thickness of the sedimentary rocks is about 600 m. Sedimentary rocks are mainly calcareous claystone, chert, siliceous claystone, diatom claystone, claystone, and silty claystone. Age of the sedimentary rocks ranges from middle Miocene to Quaternary. Basin interpreted as forming during backarc spreading.

REFERENCES: Tamaki, 1988; Tamaki and others, 1992.

jh Jihei volcanic and plutonic belt (Mesozoic) (Northeast China)

Belt trends north-south. Volcanic rocks consist mainly of: (1) Early Triassic andesite; (2) Late Triassic rhyolite dacite and volcanoclastic rocks; (3) Early Jurassic basalt, andesite, and volcanoclastic rocks; (4) Middle Jurassic andesite, trachyte, dacite, and volcanoclastic rocks; (5) Late Jurassic rhyolite and pyroclastic rocks; and (6) Early Cretaceous andesite, rhyolite, and volcanoclastic rocks. The igneous rocks are mainly calc-alkaline and locally are alkaline. The plutonic rocks are mainly monzonite granite, granite, and and minor granodiorite, alkali-feldspar granite, and other alkali rocks.

REFERENCES: Li Zitong and others, 1988; Cheng Yuqi and others, 1994.

ji Jihei plutonic belt (Permian) (Northeastern China)

Consists chiefly of granodiorite, monzonitic granite, quartz diorite, quartz monzonite, diorite, syenite, and akali-feldspar granite. K-Ar isotopic age is 244 Ma, and U-Pb isotopic age is 241 Ma. Belt occurs mainly in southeastern Xiaoxing'anling Mountains, is about 800 km long, 200 to 500 km wide, and strikes north-south.

REFERENCES: Li Zitong and others, 1988; Bureau of Geology and Mineral Resources of Jilin Province, 1989; Zhang Hairi and others, 1991; Bureau of Geology and Mineral Resources of Heilongjiang Province, 1993; Zhao Chunjin and others, 1996.

jifb Japan and Izu-Bonin forearc basins (Paleogene through Quaternary) (Western Pacific Ocean)

Occurs along the three trench systems, Japan and Izu-Bonin trenches and Nankai trough. Consists of mainly clastic sedimentary rocks. Along Japan trench unit consists mainly of the Cretaceous through Quaternary sedimentary rocks. Unit along Izu-Bonin trench consists mainly of Paleogene through Quaternary sedimentary rocks. Serpentine diapirs occur along eastern margin of the forearc region adjacent to Izu-Bonin arc. Typical forearc basin occurs along the Naknai trough and contains Miocene through Quaternary sedimentary rocks.

REFERENCES: Wakita and others, 1992.

jl Jilin-Liaoning-East Shandong volcanic-plutonic belt (Late Jurassic and Cretaceous) (Northeastern China)

Belt trends north-northeast. Volcanic rocks consist of:: (1) Middle Jurassic andesite and pyroclastic rocks; (2) Early Cretaceous andesite, dacite and pyroclastic rocks; and (3) Late Cretaceous andesite and trachyte. Volcanic rocks are calc-alkali and locally alkaline. Plutonic rocks consist mainly of calc-alkali monzonite and lesser granite, potassic granite and granodiorite, and minor intermediate and mafic rocks, such as diabase and quartz diorite, that form small, widely-distributed intrusions. Granite exhibits K-Ar isotopic ages of 142 to 164 Ma and 112 Ma. Most granites intruded in Early Jurassic and the Early Cretaceous. Late Cretaceous intrusive rocks are mainly granite and plagioclase granite. Some studies suggest part of granites are Proterozoic.

REFERENCES: Yao Fengliang and others,1990; Li Jingqian and others, 1992; Cheng Yuqi and others, 1994; Yang Zhongfang and others, 1998.

jn Japan Cenozoic sedimentary basin (Paleogene and Neogene) (Japan)

Consists of Neogene sedimentary basins that form two major groups, one group adjacent to the sea west of Japan, and the other adjacent to the Pacific Ocean. Basins adjacent to sea west of Japan consist mainly of volcaniclastic rocks, and marine and non-marine sedimentary rocks that were deposited in back arc and intra-arc basins. Basins adjacent to Pacific Ocean formed in a fore-arc setting and most are smaller than those adjacent to the sea west of Japan. The basins at Joban (Tohoku), Chikuho (Kyushu), Ishikari (Hokkaido) areas include coal. Basins overlie all of terranes in Japan. Neogene granitic rocks are included in this unit.

REFERENCES: Kano and others, 1991.

jq Japan Quaternary sedimentary basins (Quaternary) (Japan)

Scattered throughout Japanese Islands and unconformably overlie pre-Quaternary basement rock. Basins contain mainly alluvial deposits with minor lacustrine sedimentary rocks. The largest is the Kanto Basin that underlies Tokyo forms from sediment from the major Ara-kawa, Tone-gawa, and Edo-gawa Rivers. Basins overlie all terranes in Japan.

REFERENCES: Japan Association of Quaternary Research, 1987.

js Jasong volcanic belt (Jurassic) (Korea)

Consists chiefly of Jurassic andesite and related tuff. Lower part of belt consists of tuffaceous and terrigenous sedimentary rocks that range from 300 to 400 m thick. Middle part of belt consists of mainly lava that ranges form

300 to 400 to 800 to 1200 m thick. Volcanic sequence evolved from andesite and andesite-dacite to predominantly siliceous rocks. Basalt and andesite-basalt are predominant in central part of belt. Upper part of belt consists of tuffs and sedimentary rocks composed of interlayered tuff sandstone, and gravelit. Basalts composed of plagioclase, olivine, Ti-poor augite, and rare amphibole and ore minerals. Andesitess composed mainly of plagioclase with rare amphibole and pyroxene. Rocks are characterized by low K_2O/Na_2O values (0.5-0.7), enrichment in light lanthanites, and mildly negative Eu anomaly (Eu/Eu* = 0.15 – 0.30).

REFERENCES: Geology of Korea, 1993; Filatova, 1995.

jsb Japan sedimentary basin (Mesozoic) (Japan)

Consists of Triassic through Cretaceous sedimentary rocks in western and central Japan. Consist of sandstone, conglomerate, and mudstone, with local coal that formed in marine, brackish, and non-marine conditions. Units unconformably overlie Paleozoic metamorphic and sedimentary rocks in various terranes.

REFERENCES: Kimura, 1980.

jv Japan volcanic belt (Quaternary) (Japan)

Consists of extensive Quaternary volcanic rocks formed during subduction of Pacific and Philippine Sea Plates. Volcanic rocks are mainly calc-alkaline basalt and andesite. Belt includes 83 active volcanoes and overlies all Japan terranes. Belt occurs mainly in four areas in Japan, Hokkaido, eastern Honshu, Izu penunsula, and Kyushu and backarc side of the southwestern Japan. Volcanos in first three areas are formed by subduction of Pacific Plate whereas those in the Kyushu and backarc side of southwestern Japan formed by subduction of the Philippine Sea Plate. Areal extent of volcanic rocks is largest along the volcanic front.

REFERENCES: Editorial Committee for the Occurrence of Cenozoic Volcanic Rocks in Japan, 2000.

ka Kan collisional granitic belt (Neoproterozoic) (Yenisey Ridge)

Occurs in the southern part of Yenisey Ridge and form a massif with an area of about 2,000 km^2. Consists mainly of calc-alkaline porphyry-like plagioclase-microcline biotite granite with lesser adamellite, diorite, and gabbro-diorite. Geodynamic environment for belt is not clear, and no reliable isotopic or geochemical age data exist. Belt intrudes Paleoproterozoic(?) units of Yenisey and Kuzeev terranes. Correlated with Tataka-Ayakhta granite that occurs north of the Angara River.

REFERENCES: Datsenko, 1984; Kuznetsov, 1988.

kb Kalba-Narym plutonic belt (Late Carboniferous through Early Triassic) (Kalba-Narym area)

Extends along the southwestern boundary of the Irtysh shear-zone consists mainly of granitoid plutons in the Kalba-Narym batholith. Consists of Kalguta, Kalba, and Monastyr complexes. (1) Kalguta complex consists of small massifs of two-feldspar biotite-garnet granodiorite and granite (with rare relict clino- and orthopyroxene), and dikes of granite-porphyry and granodiorite-porphyry. Granitoids are alumina-saturated and alkaline, with REE compositions intermediate between S- and I-type granite. (2) Younger Kalba complex consists of large massifs of coarse-grained porphyritic biotite and biotite-muscovite granite and rare granodiorite, with late phases of fine-grained biotite and two-mica granite and leucogranite, two-mica and muscovite aplite-like granite and aplite, leucocratic pegmatoid granite, and pegmatite. The complex is peraluminous and alkaline. U-Pb and Ar-Ar isotopic ages for the complex ranges from 280 to 292 Ma (Late Carboniferous and Early Permian. And (3) younger Monastyr complex consists of of coarse-grained biotite granite, medium- and fine-grained biotite, and two-mica leucogranite, aplite, and pegmatite. Complex is peraluminous and alkaline with low concentrations of mafic components and calcium. REE composition is typical for peraluminous REE granite. A U-Pb isotopic age is 230 to 240 Ma. The Monastyr complex is similar to granitoids of the Belokurikha belt in age and composition. Belt is interpreted as forming during collision of Kazakhstanian and Siberian continents.

REFERENCES: Scherba and others, 1971; Dyachkov, 1972; Kuzebny, 1975; Grigor'yev, 1988; Vladimirov and others, 1996; Travin and others, 1998.

kbu Khanka-Bureya granitic belt (Ordovician and Silurian) (Russian Southeast)

Consists chiefly of granite and lesser granodiorite and monzonite that intruded immediately after intense deformation and regional metamorphism associated with amalgamation of the Voznesenka, Spassk, Nakhimovka, Kabarga, Matveevka, MaloKhingan, Bureya, and Mamyn terranes. Belt forms major intrusives along eastern margin of the Khanka superterrane (Grodekovo, Grigorevka, and Shmakovka plutons) and southeastern Bureya superterrane of similar age and composition. Ordovician medium-grained, occasionally pophyritic biotite- and tourmaline- leucogranite mainly forms small (areas of 8-12 km^2) sheet- and stocklike intrusions with steeply dipping contacts and other smaller intrusions. Rb–Sr and Sm-Nd isotopic age of granite intruding the Voznesenka terrane is 450 Ma. The Silurian granites form multi-phase bodies, mainly diorite to granite, with biotite granite, locally with predominant hornblende. Both in Primorye and Khabarovsk regions, the late phase granites contains tourmaline, and are potassic, high-alumina, calc-alkaline, and S type that locally grades into A-type. Nb, Y, and Rb geochemistry of the Grodekovo pluton with a Rb-Sr isotopic age of 411 Ma, Rb-Sr, is interpreted as forming in an island arc, whereas the Grigorevka granite with a Rb-Sr isotopic age of 396 Ma is interpreted as having an interplate origin. Belt contains Sn and REE lode mineral deposits.

REFERENCES: Nedashkovsky, 1980; Rub and Rub, 1982; Nazarenko and Bazhanov, 1987; Martynyuk and others, 1990; Zonenshain and others, 1990; Ryazansteva and others, 1994; Belyatsky and others, 1999; Khanchuk, 2000.

kd Kodar granitic belt (Paleoproterozoic) (Yakutia)

Occurs in the southern and western parts of the West Aldan granite-greenstone terrane and consists of several Na-K lopolite-like plutons. Granodiorite and quartz diorite form the lower parts of the lopolite and intrude and contact metamorphose the Late Archean and Paleoproterozoic overlap assemblages of the Udokan series. Isotopic age is is 1.9 to 1.8 Ga. Emplacement of granitoids of the complex occurred in three phases. First phase consists of granodiorite and biotite-amphibole and biotite granite, the second phase consists of of biotite and two-mica granite, and the the third phase consists of diorite porphyry, granite porphyry, and quartz porphyry. First phase rocks are most widespread and have massive or trachytoid textures.

REFERENCES: Fedorovskiy, 1972; Rublev and others, 1981.

kh Khmelev back-arc basin (Devonian and Carboniferous) (Southwestern Salair, Altai)

Forms part of a middle Paleozoic back-arc basin that overlaps the Vendian and early Paleozoic Salair and Alambai terranes. Composed mainly of marine Devonian and Early Carboniferous deposits. Local Ordovician and Silurian shelf and continental slope deposits that apparently occur in the inner areas of the basin, are overlain by Devonian rocks along a tectonically-imbricated northeastern flank that is thrust over the Salair terrane. To the southwest basin is overlapped by Mesozoic and Cenozoic deposits of the Biya-Barnaul basin.

Devonian and Early Carboniferous units range up to 5,000 m thick and consists of three sequences. (1) Bauxite-bearing, Early Devonian and Eifelian units containing red terrigenous rocks at the base that unconformabl overlie early Paleozoic rocks. (2) A Givetian gray, terrigenous flysch sequence composed of conglomerate interbedded with sandstone at the base, and local pyroclastic rocks; and (3) phosphate-bearing Late Devonian and Early Carboniferous calcareous shale with limestone beds more than 200 m thick, and sandstone interbedded with coarse-grained clastic conglomerate. Unit (2) correlates with Givetian active continental margin volcanic units in northern Gorny Altai, northeastern Salair, Bugotak-Mitrofanov uplift of the Kolyvan-Tom basin. The eastern part of the basin intruded by small bodies of Permian (?) granite.

REFERENCES: Matveevskaya, 1969; Surkov, 1988; Yolkin and others, 1994.

khs Khemchik-Sistigkhem basin (Middle Cambrian through Devonian) (Tuva)

Consists of Middle Cambrian through Silurian shallow-water marine molasse deposits. (1) In the northeast, the lower part of the section consists of Middle and Late Cambrian Irgitkhem, Onchan and Chapshyn suites that range up to 3,000 m thick The Irgitkhem suite is correlated with Early Cambrian sedimentary and volcanic unit of the Khamsara island-arc terrane and is composed of variably sized conglomerate cemented by tuff with an olistostrome horizon of limestone olistoliths with Early and Cambrian trilobites. The Onchan suite contains mostly siltstone and

mudstone and lesser calcareous clastite in the upper part with Late Cambrian trilobites, The Chapshyn suite consists of several gradational intervals of conglomerate, sandstone, and siltstone. (2) The Middle Cambrian Akdurug and Karabulun suites occur in central part of basin in tectonic sheets and wedges within Ordovician and Silurian deposits. Suites consist of conglomerate, sedimentary breccia, and silty-mudstone with olistostromes of limestone olistoliths with Early Cambrian archaeocyates. The fine-grained clastic matrix contains Middle Cambrian Amgaian trilobites and Late Cambrian(?) coarse-grained pebble and boulder conglomerate. (3) The unconformably overlying Ordovician-Silurian units contain a diverse marine fauna, range from 4 to 4.5 km thick, and typically contain local unconformities. Most complete sections occur along the northeast and southwest flanks of the basin and are mainly motley gravel and sanddy siltstone that is locally cross-bedded. Also occurring is conglomerate with well-rounded pebbles and boulders (Shemushdag, Malinov, and Sistigkhem series). Olistostrome-like strata occur in the lower part of the Ordovician section, and calcareous rocks and limestone occur in the upper part of the Ordovician section. And (4) the Silurian, Chergak, and Atchol suites consist of gray and motley sandy mudstone and interbedded carbonate rocks that are locally overlain by Early Devonbian motley continental molasse with flora remnants. Basin locally intruded by several small bodies of granite and gabbro of the South Siberian volcanic-plutonic belt, and by the Torgalyk unit of middle and late Paleozoic gabbro sills and dikes that occur along local extension zones. Basin interpreted as a fragment of the mobile dissected shelf of a transform margin.

REFERENCES: Zonenshain, 1963; Geology of the USSR, 1966; Chuchko and others, 1969; Alexandrov, 1979; Berzin, 1979.

klr Kalar anorthosite belt (Paleoproterozoic) (Yakutia)

Occurs in the Kalar tectonic melange zone and consists of two large plutons that are composed mainly of anorthosite (with labradorite, andesine, oligoclase). Also occurring are lesser gabbro-anorthosite with Ti-Fe lenses, with rare pyroxene, hornblende, and garnet. An isotopic age for the anorthosite is 1.9 Ga.

REFERENCES: Fedorovskiy, 1972; Glukhovskiy and others, 1993.

kni Konino-Nimelen sedimentary basin (Neogene and Quaternary) (Russian Southeast)

Consists chiefly of Neogene and Quaternary conglomerate, sandstone, and shale ranging up to 1,200 m thick.

REFERENCES: Varnavsky and others, 1988.

ko Khingan-Okhotsk volcanic-plutonic belt (Cretaceous) (Northern part of Russian Southeast)

ko Volcanic part

kog Plutonic part

Consists of following two main sequences. (1) Barremian to Cenomanian calc-alkalic andesite and tholeiitic minor basalt, with coeval gabbro, diorite, and granodiorite; and (2) a Late Cretaceous (mainly pre-Senonian) suite of K-rich felsic volcanic rocks, tuff, ignimbrite, and coeval subvolcanic intrusive and granitic rocks. Belt overlies Turan and Malokhingask terranes of Bureya superterrane, and Badzhal and Ulban terranes. Belt is interpreted as a magmatic arc tectonically paired to the Early Cretaceous accretionary-wedge and subduction-zone complexes of the Khabarovsk, Amur River, and Kiselevka-Manoma terranes.

REFERENCES: Sukhov, 1975; Scheglov, 1984; Natal'in, 1991, 1993.

kr Kara granitic belt (collisional and postcollisional) (Late Carboniferous and Early Permian) (Taimyr Peninsula)

Consist of autochthonous, para-autochthonous, and allochthonous units. Autochthonous and paraautochthonous granite form small (raning up to tens of km across) bodies that intrude flysch deposits of Kara terrane that is metamorphosed to amphibolite facies. Allochthonous (discordant) granite intrude both metamorphosed flysch of Kara terrane and sedimentary, volcanic and sedimentary units of Chelyuskin and Fadeev terranes on the Chelyuskin Peninsula. Autochthonous granite is a potassium-sodium series and consists of porphyroblastic biotite, and biotite-amphibolite calc-alkaline, and subalkaline varieties. The allochthonous granite varies from porphyritic biotite granite, biotite-amphibole granodiorite and quartz diorite, to amphibole-biotite granosyenite, quartz syenite, diorite

and monzonite. Kara granites are S- and S-I types. A U-Pb zircon isotopic age for autochthonous granite is 300 to 306 Ma for and 260 to 270 Ma for allochthonous granite. Belt interpreted as forming during collisional post-collision events during accretion of Kara paleocontinent to North Asian Craton in the late Paleozoic.

REFERENCES: Makhlaev and Korobova, 1972; Zabiyaka and others, 1986; Proskurnin, 1991; Vernikovsky and others, 1995; 1998.

ks Kuznetsk-Sayan plutonic belt (Early Silurian to Early Devonian) (Kuznetsk Alatau, West Sayan, Tuva, Altai)

Consists of gabbro to granitic complexes of calc-alkaline, plumasitic, subalkaline and latitic composition. Calk-alkaline plutons form large, elongated massifs that intrude turbidite and overlapping shelf sedimentary rocks of the West Sayan, Dzhebash, Amil, Teletsk, and Borus accretionary terranes. Main units are Bolsheporozh diorite-granodiorite-granite and Bichebalyk gabbro-gabbronorite complexes. In Kuznetsk Alatau region, main calk-alkaline granitoids are the Telbes monzodiorite-granodiorite-melanogranite and Bolsherechensk diorite-gabbronorite complexes that intrude Early and Middle Cambrian formations of the Telbes-Kitat island-arc terrane, and Late Cambrian and Early Ordovician formations of the Taidon molasse(?) basin. Plumasitic granitoids only intrude the West-Sayan, Dzhebash, Amil, Teletsk, and Borus terranes and occur in the Dzhoy granodiorite-granite-leucogranite complex that is associated with calc-alkaline granitoids of the Bolsheporozh complex. Subalkaline plutons mainly intude the northern part of Kuznetsk Alatau and Gornaya Shoriya regions, and rarely in the West Sayan and Tuva regions and form the Patyn syenite-gabbro, Kistal granosyenite-granite-leucogranite, Chebulin alkaline granite-subalkaline granite, Karadat alkaline syenite, Sutkhol subalkaline granite-leucogranite, and Kukshin gabbro-monzodiorite-granosyenite-leucogranite. K-Ar and U-Pb isotopic ages for the belt range from Early Silurian to Early Devonian. Belt interpreted as collisional magmatic complex formed along a middle Paleozoic transform continental margin.

REFERENCES: Dovgal, Shirokih, 1980; Gordienko, 1987; Zaltsman and others, 1996; Vladimirov and others, 1999.

ksh Kara Sea shelf sedimentary cover (Cambrian thorugh Permian) (Kara Sea)

Unit consists of Paleozoic terrigenous-carbonate rocks that overlies the Kara terrane. Unit crops out in the Arctic Ocean the islands of North Land Archipelago and other islands of Arctic Ocean to the north-northwest of the Taimyr Peninsula. Unit consists of: (1) Neoproterozoic flysch; (2) Cambrian flysch with trilobites, and carbonate nodules and lens; (3) unconformably overlying Ordovician through Devonian shallow-water, lagoon, and coastal deposits, locally with a basal conglomerate; (4) rift-related, alkaline and subalkaline volcanic rocks and intrusive rocks that occur in, or intrude the Ordovician terrigenous and carbonate units. Also occurring are small granite bodies that are similar in composition to postcollisional (Permian) granites from the North Taimyr region. Locally occurring are Carboniferous and Permian continental and coastal terrigenous sedimentary rocks that occur in sparse isolated outcrops.

REFERENCES: Makar'ev and others, 1981; Lazarenko, 1982; Khapilin, 1982; Markovsky and Smirnova, 1982; Proskurnin, 1995; Bogdanov and others, 1998

kt Kolyvan-Tom back-arc basin (Devonian to Permian) (Kalyvan-Tom area)

Occurs in western Siberia and consists of eastern and western tectonic sheets that are southeastward over the Vendian and Early Cambrian terranes. Oldest rocks occur in front of the western package in theBugotak-Mirofanov anticlinorium, and the youngest deposits occur in the rear of the eastern package in the Gorlov-Zarubin trough. Tectonic lenses in the Bugotak-Mitrofanov anticlinorium consist of unfossiliferous volcanic and sedimentary rocks similar to Cambrian deposits of the Salair island-arc terrane. The basin contains the following Devonian and early Carboniferous marine deposits, and Middle Carboniferous-Permian continental deposits.

(1) Emsian-Early Givetian units consist of gray sandy siltstone and shale with organic limestone and conglomerate. (2) Early Givetian deposits consist of motley conglomerate and sandstone interbedded with limestone to the southeast and sedimentary-volcanic rocks in theBugotak-Mitrofanov anticlinorium to the northwest. Volcanic rocks are mainly basalt and andesite basalt with subordinate rhyolite, dacite, mafic to siliceous tuff, and subvolcanic equivalents. (3) Late Givetian and Early Carboniferous units consist of Late Givetian and Late Devonian motley

conglomerate-sand-shale molasse-like assemblage with limestone that is overlapped by Tournaisian-Visean shallow-water limestone, marly shale, and sandstone. (4) Franian consist of sparse andesite, andesite-basalt porphyry, and tuff. To the northwest is a thick section of Late Givetian and Early Carboniferous sandstone, siltstone, and mudstone flysch (about 8,000 m thick) with local thin limestone beds that formed in a deepwater basin. Thickness of Tournaisian-Visean deposits ranges from 500 to 800 m to the southeast to 4,000 to 5,000 m to the northwest. (5) Unconformably overlying Early Carboniferous and Permian units consist of conglomerate, overlying shallow-water marine sedimentary rocks (Serpukhovian and Namurian series), and sandstone, siltstone, and shale with coal that range up to 2,000 m thick. Units are interpreted as forming during collision. The units of the Kolyvan-Tom zone are intruded by Early Permian orogenic plutons with K-Ar biotite and hornblende isotopic and Rb-Sr isotopic ages of 245 to 265 Ma, and Triassic orogenic plutons with a K-Ar isotopic age of 236 Ma and a Rb-Sr isotopic age of 230 Ma.

REFERENCES: Matveevskaya, 1969; Grigor'yev, 1988; Surkov, 1988; Kungurtsev and others, 1998.

ktb Khungari-Tatibi granitic belt (Mid-Cretaceous) (Russian Southeast)

Consists of Early Cretaceous granitoid plutons that occur between the middle branch of Hungari River to the north and the Sea of Japan to the south along the Central Sikhote-Alin fault. Northern part of the belt consists of large batholith intrusions, including the high aluminiferous Hungari granite. Isotopic ages are a Ar-Ar biotite isotopic age for the Gobil pluton of 107±1 Ma, and a Rb-Sr isotopic age for granite from the Shivki pluton of 127±5 Ma, and a Rb-Sr isotopic age of 123±0.8 Ma for the Lermontovka pluton. The belt also includes the Sinegorsk intrusive complex that consists of high aluminiferous gabbro, quartz monzonite, and biotite granite that intrude the Khanka terrane. In the Central Sikhote-Alin area, the belt consists of multi-phase granitoid plutons composed of diorite, quartz diorite, monzonite, granomonzonite, granodiorite, biotite-hornblende granite, granite porphyry, leucocratic granite, and aplite. Rb-Sr isochron isotopic ages for the Tatibi granitoid complex in this area range from 128 to 98 Ma. A K-Ar isotopic age for the Berezovka granitoid pluton is 120 Ma, and a Rb-Sr isochron age for the Novogorka pluton is 116 Ma.

REFERENCES: Izokh and others, 1967; Martynyuk, 1990; Gerasimov and others, 1994; Levashov, 1991; Natal'in, 1994; Simanenko and others, 1997; Khetchikov, 1998.

kul Kular granite belt (Late Mesozoic) (Yakutia)

Belt extends north-eastern 125 km, consists of Oyun-Yuryakh, Tarbagannakh, Kerekh, Kyuchyuss, Tirekhtyakh and Solur biotite granite plutons, and intrudes Early Permian and Triassic sedimentary rocks of the northern Kular-Nera terrane. Belt consists of small adamellite stocks and dikes of granite. A K-Ar isotopic age for granite is 156 to 113 Ma and for adamellite is 116-76 Ma, respectively. ^{40}Ar-^{39}Ar isotopic studies indicate closure of the K-Ar system of biotite of the granite plutons occurred at 102.7 to 102.9 Ma. Geodynamic origin of the belt is not clear.

REFERENCES: Trunilina, 1970; Layer and others, 2001.

ky Kyongsang sedimentary basin (Early Cretaceous) (Korea)

The Kyongsang sedimentary basin occurs in a north-northeast-trending semi-graben that contains: (1) the middle Early Cretaceous Shindong Group (2,000 to 3,000 m thick) composed of sandstone, shale, conglomerate, and marl; (2) the late Early Cretaceous Hayang Group (1,000 to 5,000 m thick), that is underlain by the Shindong Group in the western Kyongsang Basin, composed of shale, sandstone, and minor marl and conglomerate, and local volcanic rock; and (3) the. Yuchon Group (2,000 to 3,000 m thick) composed of volcanic and associated sedimentary rocks. In Kyongju-Yuchon area, the Yuchon Group is divided into the lower Chusasan andesite sub-group and the upper Unmunsa rhyolite subgroup (Kim, S.W., 1982) with a local intervening unconformity.

REFERENCES: Yamanari, 1924; Chang, 1975; Kim, 1982; Lee and Chang, 1987; Lee, 1999.

kz Kuznetsk orogenic basin (Devonian to Early Triassic) (Kuznetsk area)

Consists of three major units. (1) Devonian and Early Carboniferous orogenic units occur along the basin periphery. Devonian volcanic rocks occur in two belts of different ages, the Salair and Telbes-Barzass belts.

Devonian units are transgressively overlain by shelf deposits consisting of shallow-water carbonate and calcareous sandstone and mudstone with Tournaisian and Visean marine fauna. Also occurring is tuff and tuffaceous units that for which eruptive centers are missing. (2) Overlying the orogenic unit is a Early Carboniferous sedimentary sequence (about 7,000 to 8,000 m thick), and a Middle Carboniferous through Permian continental sand-clay sequence with numerous coal beds, and subordinate tuff-sand-siltstone and andesite pyroclastics in the upper part of the section in the Balakhon and Kolchugin series. And (3) in the central part the basin is conformably overlying Early Triassic sandstone, siltstone, tuff, lava, basalt flows, and basalt dikes that comprise the Maltsev series.

A cross section for the Kuznetsk basin is asymmetrical with the thickest sections occurring in the southwestern and western areas. Closer to the Salair and Kolyvan-Tom zone, units are folded and cut by longitudinal reverse faults and thrusts. To the east the basin thickness decreases and the basin is less deformed. Basin interpreted as forming during an Early and Middle Carboniferous orogeny, with sedimentation continuting up into the Early Triassic.

REFERENCES: Matveevskaya, 1969; Grigor'yev, 1988; Surkov, 1988; Yolkin and others, 1994.

Ia Laptev Sea continental slope (Late Cretaceous through Oligocene) (Arctic ocean)

Occurs along continental slope of the Laptev Sea between 116^{O} and 127^{O} E and is underlain Precambrian rocks of North Asian Craton. Consists of Late Cretaceous and Cenozoic sedimentary rocks ranging from 1.5 to 8 km thick. Two structural stages are identified, a Late Cretaceous and Early Paleocene rift complex and a Cenozoic abyssal complex. (1) The rift complex exhibits seismic wave velocities of 3.15 to 4.0 km/sec with a maximum thickness of 2 to 3 km and probably is sandstone and mudstone with a subcontinental genesis. The sedimentary units fill interblock grabens in the basement underlying the slope, and a marginal depression along the junction between continental and oceanic crust. And (2) the abyssal complex consists of variably-orientedmarine beds with a thickness of 1.5 to 6 km. The seismic wave velocity for a sandstone-mudstone turbidite formation increases with depth from 1.75 km/sec in the upper part of the section to 3.2 to 3.5 km/sec in the lower part. The basement exhibits a block structure that is similar to an Atlantic-type passive continental margin. The subsidence of Precambrian blocks forming the continental basement towards the Eurasia basin is controlled by a complex system of listric faults. The northern segments of the continental slope formed in the Late Cretaceous and Early Paleocene, whereas the extreme southern part of the continental formed during the Late Paleocene and Early Oligocene. The width of continental slope from the modern edge of the Laptev Shelf to the continental-ocean boundary varies from 120 to 130 km in the north, to 60 to 100 in the south.

REFERENCES: Bogdanov and others, 1998.

Ib Lower Borzja fore-arc basin (Early Carboniferous through Early Triassic) (Transbaikalia)

Overlies the west-northwest boundary of the Argunsky terrane. Eastern boundary of basin is overthrust by Early Jurassic Upper Borzja basin filled with marine molasse. Western boundary is interpreted as an overthrust along which the sedimentary rocks of the Onon terrane are thrust over the Lower Borzja basin.

Consist of the Early Carboniferous Urtuy suite rocks and Late Permian-Early Triassic Borzja. (1) The Urtuy suite consists of tuffaceous sandstone, tuffaceous siltstone, arkose, and greywacke with interbedded jasperoid, siliceous rocks, and limestone lenses. Local lenses of limestone and fragments reef limestone contain abundant Visean bryozoans, tabulate corals, trilobites, brachiopods. The sedimentary rocks vary along strike. Fragments of organic limestone form olistoliths with ayounger matrix. The sedimentary rocks of the suite are interpreted as a subduction melange between a forearc basin and a deep-water trench. The maximum thickness of sedimentary rocks ranges up to 2,500 to 3,000 m. And (2) the Borzja series contains four Late Permian and Early Triassic subseries with a total thickness ranging from 4,000 to 7,000 m. The first subseries (Late Permian) unconformably overly the Urtuy suite and consist of coarse-grained clastic terrigenous rocks that grade upward into rhythmicaly intercalated sandstone and siltstone. The second (Late Permian) subseries consists very fine-grained clastic rocks with gradational layering and abundant bedded subalkaline siliceous tuff. The third subseries (Late Permian) exhibits a lower saturation with variable-composition tuffaceous rocks. The occurrence of tuffaceous rocks in the sedimentary rocks coincides with the time of intrusion of subduction-related granitoids of the Undinsky complex that forms part of the Gobi-Khankaisk-Daxinanling belt. The upper fourth subseries (Late Permian and Early Triassic) is similar to the second subseries. Late Permian age id defined by abundant brachyopods, bivalves, *Crinoidea*, bryozoans, gastropods, and conularia. The uppermost part of the unit may be Late Triassic.

REFERENCES: Kotlyar and Popeko, 1974; Popeko, 1996; Rutshtein and Chaban, 1997.

lch Lenivaya-Chelyuskin sedimentary assemblage (Vendian thorugh Carboniferous) (Taimyr Peninsula)

Consists of Vendian through Carboniferous terrigenous and carbonate rocks that unconformably overlap Late Precambrian sedimentary and volcanic rocks that form part of an island-arc. Consists mainly of quartz sandstone, gritstone, and conglomerate with interlayered, finely-banded limestone with subordinate interlayered sandstone and dolomite predominate in the low part of section. The Vendian part of the unit is about 185 to 200 m thick. Concordantly overlying are mudstone, siltstone, and black graptolite shale with interlayered limestone and dolomite that ranges from from Cambrian to Middle Devonian, and in the western part of Taimyr to Early Carboniferous. Total thickness ranges up to 1,000 to 2500 m.

REFERENCES: Solov'eva and others, 1978; Kaban'kov, Sobolevskaya, 1981; Zabiyaka and others, 1986.

ldp Liaodong plutonic belt (Triassic) (Northeast China)

Occurs in the center of the Archean Jilin-Liaoning-East Shandong terrane, Sino-Korean Craton, and extends over an area of 7,400 km^2. Consists mainly of adamellite plutons that form discontinuous batholiths and stocks. Plutonic rocks interpreted as drived from melted continental crust. A Rb-Sr isochron age for the belt is 216 Ma.

REFERENCES: Lin Jingqian, 1992; Cheng Yuqi and others, 1994.

lg Lugyngol volcanic and sedimentary basin (Permian) (Southeastern Mongolia)

Consists of two major units. (1) Early to Late Permian calk-alkalic andesite, dacite, rhyolite, conglomerate, sandstone, siltstone with plant fossils, and minor limestone with brachiopods and bryozoans. The turbidite formed in an outer fan and basin plain settings. And (2) widely distributed Late Permian flysch sedimentary rocks (Lugyngol and Harnuden formations) that unconformably overlie Late Riphean to Devonian rocks. Rock lithologies composed of interbedded sandstone, siltstone, argillite, conglomerate, and minor limestone with brachiopods, fusulinids, bryzoans. Lithologies form high density turbidite, up to 5 km thick. Provinence data from Lugyngol formation suggested derived from an undissected volcanic arc field. Unit intruded by Late Permian and Triassic alkalic and REE granite.

REFERENCES: Pavlova and others, 1991; Ruzhentsev and others, 1992; Amory, 1996.

ll Lower Lena graben sedimentary rocks (Paleocene through Early Eocene) (Yakutia)

Sedimentary rocks deposited in various grabens (Sogo, Kengdei, Kunga and Kieng) that occur near the Lena River delta and stike sublongitudinally. The sedimentary rocks of grabens unconformably overlap the Paleozoic and Mesozoic rocks of the northwestern part of the Verkhoyansk fold and thrust belt. Lower part of unit consists of late Paleocene sedimentary rocks including mudstone, aleurite with lenses of sandstone, conglomerate, and brown coal (Sogo suite, about 150 m thick). Upper part of the section consists of early Eocene sedimentary rocks including mudstone, aleurite, sandstone, lignite, sandy loam, and gravel (Kengdei suite, about 600 m thick, and Emgend'ya suite, greater than 136 m thick). Unit overlain by Quaternary sedimentary rocks that are greater than 50 m thick. Grabens related to extension associated with opening of the Eurasia Ocean basin in the Arctic ocean.

REFERENCES: Grinenko and others, 1989, 1998.

loa Lower Amur overlap assemblage (Late early and early Late Cretaceous) (Russian Southeast)

Extends from lower reaches of Amur River to mouth of Usurri River. Consists of three retrogressive marine suites (middle Albian to early Turonian). At base of assemblage are conglomerate and related rock of Sitoginskaya Suite that contains coarse-grained proximal turbidite. Total thickness of suite is 1,500 m. Middle to late Albian age indicated by Inoceramus, ammonite, and auceline fossils (Resolutions, 1979). Overlying is Silasinskaya Suite that consists mainly of siltstone, volcaniclastic rock, silicified tuff, and tuffaceous sandstone with thickness of 900 m. Late Albian to Cenomanian age based on Inoceramus. Overlying is Utiskaya Suite consisting mainly of volcaniclastic rock, andesite, and related tuff. Thickness about 1,000 m. Age of late Cennomanian to Turonian

based on Inocermas. Unconformably overlying are Aptian to early Cenomanian Assikaevskoya and Strel'nikovskaya Suites that contain offshore terrigenous sedimentary and volcaniclastic rock. Thickness is about 4,000 m.

Assemblage is characterized by abundant ammonites and mollusks, and by flora in lower part. Assemblage is deformed into simple folds, and is cut by northeast-striking faults. Abundant volcaniclastic rock indicates assemblage formed in a back-arc basin that formed west of the coeval Kema volcanic arc. Assemblage is overlapped by volcanic rock of the East Sikhote-Alin volcanic-plutonic belt.

REFERENCES: Resolutions, 1979.

ly Laiyang volcanic -sedimentary basin (Cretaceous) (Northeastern China)

Consists of the following sequence of volcanic and sedimentary rock. (1). The Laiyang Group occurs in the lower part of the sequence and consists mainly of sandstone and mudstone, and intercalated siltstone and shale. Conglomerate occurs at the base. (2) The Qingshan Group occurs in the middle part of the sequence and consists andesite and dacite. And (3) the Wangshi Group occurs in the upper part of the sequence and consists mainly of sandstone, siltstone, and mudstone with intercalated conglomerate is in the lower and middle parts of the group. The thickness of the sedimentary strata in the basin ranges up to 5,000 m.

REFERENCES: Cheng Yuqi and others, 1994; Zhang Zengqi and Liu Mingwe, 1996; Tian Zaiyi, 1997.

ma Mana sedimentary basin (Late Neoproterozoic through Middle Cambrian) (Northwestern Eastern Sayan)

Consists of Late Riphean to Middle Cambrian (Amgaian) clastic and carbonate rocks in two tectonic units, the inner Zherzhul and outer Solbin units that are thrust west-southwest over the Riphean Kuvai terrane.

The Zherzhul unit consists of four assemblages. (1) Late Riphean limestone and microphytolith-bearing dolomite interbedded with submarine landslide conglomerate and polymictic sandstone and mudstone (Angaloi suite) that range up to 700 m thick. The assemblage occurs in a large strike-slip fault zone that later evolved into an imbricate thrust fault. (2) Vendian terrigenous rocks (Zhistyk suite), and terrigenous and carbonate flysch (Anastasjin suite) that ranges over 1500 m thick. Conglomerate locally contains well-rounded pebbles of variable composition. These two suites are overlain by olistostrome-like horizon composed of breccia, sandstone, and mudstone, late Riphean limestone and dolomite, flysch. (3) Early and Middle Cambrian limestone, dolomite, and marl that formed at variable depth (Ungut, Zherzhul, Siner and Shakhmatov suites) with algae, microphytolites, Hyolithes, brachipods, archaeocyata, and trilobites. And (4) a lens-like, fault-bounded body that extends for over 15 km long, and thyat occurs in the middle part of the basin between the Vendian flysch and Early-Middle Cambrian deposits. The fault-bounded body consists of of Early Cambrian dolomite and limestone with abundant archaeocyata and trilobites (Murtuk reef).

The Solbin unit contains Late Riphean rocks (Angaloi suite) and overlaps the Riphean Kuvai terrane or the older (Archean and Paleoproterozoic) metamorphic rocks of the Arzybei block. The lower part of the unit contains dolomite with microphytolites, clastic rocks with fragments of volcanic, carbonate, quartzite, siliceous intrusive, and metamorphic rocks. Upward, the shallow-water Angul suite consists of Vendian conglomerate, motley quartz and arkose sandy gravelstone. The uppermost of the suite is green silty mudstone. Overlying are Cambrian carbonate rocks with abundant clastic material. Unconformly overlying are Late Cambrian and Early Ordovician red and motley continental molasse (Badzhei, Narva and Glukharin suites) that formed in fault-bounded troughs and grabens along the northeastern margin of the Mana basin. The lower part of the molasse unit contains unsorted coarse-boulder clastics with fragments of Early and Middle Cambrian limestone and dolomite. Upwards are sandy siltstone. Coarse-grained clastic rocks (Kichen suite) occur outside the southeastern Mana basin within the East Sayan Main Fault. Theya are interpreted as forming during large-scale strike-slip displacement along a transform continental margin. The northern Mana basin sequences are overlapped by Devonian volcanic and sedimentary rocks, and are intruded by granite of rift-origin South Siberian volcanic-plutonic belt. The Mana sedimentary basin is interpreted as forming in a back-arc environment.

REFERENCES: Berzin, 1967; Khomentovskii and others, 1978; Khomentovskii, Gibsher, 1980.

mb Main granite belt (Late Jurassic) (Yakutia)

Extends 1,100 km along the boundary of the In'yaly-Debin synclinorium and the Kolyma-Omolon superterrane. Consists of large linear plutons (with areas from several hundered to 2,000 km^2) composed of amphibole-biotite and two mica granite and granodiorite with ^{40}Ar-^{39}Ar isotopic ages of 143 to 138 Ma (P. Layer, unpublished data, 1999). Belt interpreted as forming during collision of the Kolyma-Omolon superterrane and the North Asia Craton (Parfenov, 1984, 1991, 1994).

REFERENCES: Parfenov, 1984, 1991, 1994.

mch Myongchon sedimentary basin (Cenozoic) (Korea)

Consists chiefly of Paleogene and Niogene nonmarine clastic rocks ranging up to 1.500 m thick with local Oligocene basalt and tuff.

REFERENCES: Geology of Korea, 1993.

mn Minusa molasse basin (Middle Devonian through Early Permian) (Kuznetsk Alatau, Eastern Sayan)

Unconformably overlaps Early Devonian rocks of the South Siberian volcanic-plutonic belt. Lowest part of the basin represents a short-lived Givetian marine transgressve unit of red coarse-grained clastic deposits in the lower part (Early Givetian) and gray terrigenous and carbonate sedimentary rocks with marine fauna fossils in the upper part. Basin continued evolved into a continental environment in the Permian. Late Devonian and Permian units range up to 9 km thick and consist of motley sandy-silty mudstone, conglomerate, marl, and lagunal-lacustrine limestone with fauna and flora. Also occurring are Early Carboniferous (Tuornasian and Visean) rhyodacite tuff, and local Middle Carboniferous and Early Permian coal-bearing sedimentary rocks.

REFERENCES: Luchitsky, 1960; Shneider and Zubkus, 1962;Mossakovsky, 1963.

mr Moma rift sedimentary basin (Miocene and Pliocene) (Yakutia)

Consists of Moma, Upper Selennyakh, Uyandina,and Irgichan subbasins.

(1) The Moma basin is adjacent to the Chersky and Moma Ranges, is bounded by high-angle listric normal faults, extends for about 1,200 km, and contains segments striking north-northwest and northwest. The width of the basin varies significantly from a few tens to 100 km. The cross section shape grades from trapezoidal to slightly concave. The most widespread surface unit is Quaternary glacial drift, and Pliocene alluvial deposits that overlie Paleozoic and Mesozoic rocks. In the Moma River valley is the Balagan-Tas volcano with a cone composed of alkali basalt with a ^{40}Ar-^{39}Ar isotopic age of 300 Ma. The Moma basin extends along the axial part of an arched uplift and formed in a Pliocene rift.

(2) The Upper Selennyakh basin is the northwestern continuation of the Moma basin and occurs between the Chersky Range termination and the Selennyakh Range. The basin ranges up to 200 m thick, is somewhat older than the Moma basin, and contains Miocene and Pliocene rocks (sand and pebble gravel) overlain by Middle Pleistocene glacial deposits.

And (3) the Uyandina and Irgichan basins occur on the northwestern termination of the Chersky and Moma Ranges system. The basins contain Oligocene, Miocene, and Early Pliocene rocks that are generally similar to coeval deposits of the Upper Selennyakh basin. The Late Miocene and Early Pliocene sedimentation rate increased sharply to 4 to $6x10^{-2}$ mm/yr as compared to 1.5 to $2.0x10^{-2}$ mm/yr for older times. Late-Miocene and Early Pliocene rocks are coarse-grained and predominating pebble gravel. Occurrence of carbonate rock pebbles and cross-bedding uplift are interpreted as forming from uplift of the Selennyakh Range. The Uyandina and Irgichan basins are interpreted as pull-apart basins that formed along the terminations of strike-slip faults.

REFERENCES: Layer and others, 1993; Paech and others, 1998.

Mongol-Transbaikalia volcanic-plutonic belt (Late Triassic through Early Cretaceous) (Mongolia)

mtv Volcanic part

mtp Plutonic part

Extends for over 3,000 km from the Hangay Mountains to the Pacific Ocean. Volcanic part consists of early Mesozoic volcanic rocks that occur in separate areas mainly filling basins, up to 4,000 to 5,000 m thick surrounding the plutonic part, and in association with shallow plutons in the margins of the Khentey uplift. Volcanic rocks consist of trachyandesite, dacite, and trachyrhyolite flows, stocks, necks, extrusive domes. Volcanic rocks range from calc-alkaline to subalkaline and Na-enriched. Also occurring are bimodal basalt-trachyrhyolite-comendite suites including olivine basalt. Alkaline trachyrhyolite and comendite comprise volcanic-plutonic complexes in association with alkaline granite, consisting of riebeckite granite and quartz syenite that occurs in stocks.

Plutonic part occurs mainly in Hentiy uplift in large grandiorite batholiths (Baga Khentey, Erendavaa, Yuroogol). Sparse, highly-alkaline gabbro-granite occur along a deep northwest-trending fault. Along the margins of the Hentiy uplift are shallow plutons composed of granite, leucogranite, and Li-F granite. K-Ar isotopic ages range from 220 to 180 Ma, and a Rb-Sr isotopic age is 229 Ma. To the east, the pluotnic belt age varies to Late Jurassic and Early Cretaceous. Most of the older Early Mesozoic intrusions (about 90%) are granitoids, and gabbro constitutes only 2.5% of the belt. Granitoids in internal part of belt consist of calc-alkaline granodiorie-granite with minor quartz diorite and are I-type. Shallow plutons occur in external part. Major plutons are porphyritic biotite granite, two-mica granite, and K-feldspar granite, and lesser highly-evolved peraluminous, alkali granite are that is close to S-type. Li-F granite ranges from leucogranite to microcline-albite or amazonite-albite granite with Li-mica.Granitoids have initial Sr ratios of 0.705 to 0.708, indicating partial derivation from juvenile source. The belt is interpreted as forming during a continent-continent collision.

REFERENCES: Rare metal granitoids, 1971; Tectonics MPR, 1974; Zonenshain and others, 1976; 1983; Koval and others, 1984; Koval and Gerel, 1986; Gerel, 1995; Kovalenko and others, 1995.

nb Northern granite belt (Early Cretaceous) (Yakutia)

Extends 700 km in latitudinal direction along northern margin the Kolyma-Omolon superterrane. Consists of large, elongated plutons composed of quartz diorite, monzodiorite, and biotite granite, as well as amphybole-biotite granodiorite, biotite granite, and two-mica granite. Belt exhibits ^{40}Ar-^{39}Ar isotopic age of 138 to 120 Ma (P. Layer, unpublished data, 1999). Belt interpreted as forming during subduction of oceanic crust duirng a closure of a small oceanic basin.

REFERENCES: Bakharev and others, 1988; Trunilina and others, 1996; Parfenov and others, 1999a.

nc North China sedimentary basin (Cenozoic) (southeast part of Northeastern China)

Consists of Tertiary sedimentary rocks. Early Tertiary terrigenous sedimentary assemblage consists of: (1) mudstone, siltstone intercalated with sandy conglomerae, and oil shale; (2) mudstone, siltstone intercalated with sandstone, shale and oil shale, coal, limestone and basalt; and (3) interbedded mudstone and sandstone. Late Tertiary sedimentary rocks consist of: (1) sandstone, mudstone intercalated with conglomeratic sandstone and conglomerate; and (2) interbedded mudstone and sandstone. Basin is overlaid by the Quaternary alluvium, proluvial lake mudstone, marine sedimentary rocks, and terrigenous sediments.

REFERENCES: Cheng Yuqi and others, 1994; Tian Zaiyi and others, 1997.

nm North marginal plutonic belt of North China Platform (Carboniferous and Permian) (Northeastern China)

Belt strikes east-west along the northern margin of the North China Platform and consists of a huge batholith composed mainly of calc-alkalic granodiorite, adamellite, and granite. Isotopic ages for granitoids in the belt range from Late Carbonifreous through Permian. Most of the plutonic rocks in the belt are interpreted as derived from melted continental crust.

REFERENCES: Bureau of Geology and Mineral Resources of Jilin, 1989; Bureau of Geology and Mineral Resources of Inner Mongolia, 1991.

no Noyon foreland basin (Middle Triassic through Early Jurassic) (Mongolia)

Occurs in Noyon syncline and other scattered outcrops in southern Mongolia. Consists of: (1) Middle and Late Triassic conglomerate, sandstone, siltstone with plant fossils, up to 2,500 m thick; and (2) Early Jurassic(?) organic-rich siltstone, dolomitic oil shale about 10,00 m thick. Lower part of section is interpreted as a braided and meandering fluvial and alluvial lake facies, and upper part is iinterpreted as poorly oxygenated lacustrine facies. The Noyon basin overlie the Atasbogd and Zoolen terranes of southern Mongolia and is interpreted as syntectonic foreland basin.

REFERENCES: Mossakovsky and Tomurtogoo, 1976; Tomurtogoo and Badarch, 1986; Hendrix and others, 1996.

np North Tarimu plutonic belt (Permian) (Northwest China)

Consists of Permian post-orogenic intrusions, mainly alkalic, A-type syenite-granite. In Waizhunger area, the intrusions form small batholiths and stocks along with coeval Early Permian continental volcanic rocks. Youngest strata intruded by the plutons are the Lower Permian. A K-Ar amphibole isotopic age for quartz monzonite is 265.2 Ma. K-Ar isotopic ages for syenite-granite porphyry and quartz monzonite porphyry are 254.8 Ma and 238.3 Ma, respectively. In the North Tianshan area, the intrusions are mainly Na-rich, calc-alkalic syenite-granite, alkalic granite, quartz monzonite.

REFERENCES: Bureau of Geology and Mineral Resources of Xinjiang, Uygur;1992; Chen Zefu, 1997.

nr Nohi rhyolite volcanic belt (Cretaceous) (Japan)

Occurs along inner (Japan Sea) side of the Median Tectonic Line (MTL) in the southwestwern Japan. Related to Hiroshima Granitic belt. Nohi belt consists mainly of rhyolite and rhyodacite tuff and lava, with minor lacustine deposits in the lower part. Some rhyolite and rhyodacite tuff are welded. Unconformably overlies Jurassic and Permian accretionary complexes, and Akiyoshi-Maizuru, Mino-Chichibu, Sangun-Hidagaien-Kurosegawa, and Hida terranes.

REFERENCES: Koido, 1991.

ns North-Sakhalin sedimentary basin (Oligocene through Quaternary) (Russian Southeast)

Occurs in the north of Sakhalin Island and extends for 700 km and varies from 100 to 150 km wide. Chiefly consists of Oligocene and to Quaternary continental, literal-marine, and marine clastic rocks ranging up to 14,900 m thick. Miocene marine clastic rocks range up to 11,000 m thick and contain oil deposits.

REFERENCES: Geology of the USSR, Sakhalin Island, 1970; Oil and gas content, 1998.

nw Northern, Eastern, and Western Siberia sedimentary basins (Mesozoic and Cenozoic) (Western and Eastern Siberia)

The North Siberia basin forms northern part of the unit and is subdivided into the Enisei-Khatanga and Lena-Anabar basins. (1) The Enisei-Khatanga basin is about 900 km long and 370 km wide and occurs between the Tunguska basin to the south and the Taimyr fold system to the north. The western boundary of the Enisey-Khatanga basin is definedas a right-lateral strike-slip fault. The basin has a linear, almost symmetrical structure, and geophysical studies revealed a number of troughs depressions, and ridges that continue into the West Siberian basin. The central part of the basin is a large trough. The basin contains Jurassic and Cretaceous deposits more than 7,000 m thick that unconformably overlying Triassic and Permian rocks. Jurassic rocks include mudstone and siltstone with ammonites, pelecypods, and belemmites, and an upper part composed of sandstone and gravelstone with local intraformational erosion. The Tithonian rocks in the southern part of the basin unconformably overlie Early Oxfordian and Callovian deposits. The Early Cretaceous sedimentary rocks are subdivided into marine Valanginian and Early Hauterivian mudstone and siltstone with ammonites and foraminifera, and overlying Barremian and Albian coal-bearing continental sequences. And (2) the Lena-Anabar basin occurs along the coast of the Laptev Sea, extends for 550 km, ranges up to120-140 km wide, displays an asymmetric structure, with a shorter northern limb and a much steeper southern limb. The basin contains Jurassic and Early Cretaceous (early Valanginian) marine

sedimentary rocks and Late Valanginian and Albian continental coal-bearing rocks. The Jurassic rocks transgressively overlie the Triassic, Permian, and Neoproterozoic deposits. The thickness of the Jurassic deposits in the northern basin ranges from 980 to1,160 m, and decreases to 180 to 530 m to the south. The Early Cretaceous sedimentary rocks are 2,900 m thick to the north, decrease to 850 m to the south.

References: Markov, 1970; Surkov and others, 1998;Yapaskurt, 1992.

The East Siberia sedimentary basin forms the northeastern part of the unit on the eastern flank of Siberian Platform. The Jurassic rocks transgressively overlie Triassic and late Paleozoic units. The Triassic and Early and Middle Jurassic rocks range up to 700 m thick, and consist mainly of shallow-marine sandstone and mudstone that grade on the northwest and southwest margins of the Vilyui basin into continental sandstone and conglomerate up to 200 m thick. The Late Jurassic and Cretaceous deposits occur in the marginal Verkhoyansk foreland basin adjacent to the front of the Verkhoyansk fold and thrust belt, and merge with the Vilyui basin. The Late Jurassic and Early Cretaceous deposits are mainly continental sandstone, sandstone, siltstone, claystone, and coal. A maximum thickness (up to 4,500 m) occurs near the front of the Verkhoyansk fold and thrust belt, and sharply decreases to several hundred meters toward the platform. At the base of the section are shallow littoral-marine deposits. Gradation from marine sedimentary rocks into continental units occurred in most of the basin in the Late Jurassic, and in the north of the basin in the early Early Cretaceous. The marginal Verkhoyansk foreland basin contains mainly lake-alluvial plain facies that towards the platform grade into river alluvium facies and northerly, along the foreland basin trend, into coastal alluvial plain and near-shore shallow water facies. The Late Cretaceous deposits range up to 1,000 m thick, and consist of continental coarse-grained sandstone and kaolin claystone with interbedded brown coal, lignite, and conglomerate. Most of the sedimentary rocks formed in the marginal Verkhoyansk foreland basin in the Late Jurassic and Early Cretaceous with source areas of the Siberian Platform, and south of the platform in the Aldan-Stanovoy shield area. At the time of deposition, no mountains existed in the area of the present-day Verkhoyansk fold and thrust belt. The present-day mountains first appeared in the Late Cretaceous. Thermal sinking of the eastern part of the Siberian Platform, that involved the flanks of the sedimentary basins, began in Middle Carboniferous time continued through the Mesozoic.

REFERENCES: Markov, 1970; Yapaskurt, 1992; Surkov and others, 1998.

The West Siberian sedimentary basin forms the southwestern part of the unit and occurs between the East-European and North Asia Cratons. The basement of the basin is collage of terranes of different ages (Proterozoic to middle Paleozoic) that were accreted during late Paleozoic collisions. Prior to formation of the West-Siberian basin, Permian(?) and Early Triassic submeridional rifts were filled with continental terrigenous clay-rich sedimentary rocks with interbedded volcanic rocks, and local layered mafic intrusions. The lower part of the basin consists of Early and Middle Jurassic sedimentary rocks with local abundant coal. To the south towards the Sayan-Altay region are small grabens and marginal fault troughs. On the southwestern margin of the North Asian Craton, the Early and Middle Jurassic sedimentary rocks consist of foredeep basins with widespread coal deposits. To the north the basin widens and continental sedimentary rocks grade into coastal-marine rocks that are assumed to continue to the north of the basin and are underlain by Late Triassic coastal-marine sedimentary rocks.

The main part of the Western Siberian basin consists of Late Jurassic through Cenozoic sedimentary rocks that consist of marine facies rocks in the internal part of the bains that grade into continental sedimentary rocks to the north and to the basin margins. The younger Cenozoic units consist of non-marine sedimentary rocks that overlie the entire area of Western Siberia, except for the northern coastal zone. The total thickness of Mesozoic and Cenozoic sedimentary rocks varies from the edge to the center with a thickness of about 4,000 m. Maximum values occur over rift structures. The northern basin, near the marginal Arctics Sea, the thickness ranges up to 7,000 to 1,000 m. The Western Siberia basin contains one of the largest oil and-gas Provinces of the World. The largest reserves of hydrocarbons occur the Mesozoic sedimentary rocks in a rift system.

REFERENCES: Surkov and Zhero, 1981; Surkov, 1986; Yanshin and Borukaev, 1988.

In the area southeast of the Siberian platform, the West Siberian sedimentary basin occurs in piedmont depressions, and extends northwest for over 500 km along the base of East Sayan Mountains, and ranges up to about 100 km wide direction. The basal part of the basin consists of coarse-grained clastic rocks that discordantly overlie Riphean, Vendian, and Cambrian sedimentary rocks of the Siberian Platform. The main, Jurassic sedimentary rocks in the basin occur in various facies: Irkutsky, Dabatsky, Bolsherechensky, and Baikalsky, and consist of conglomerate, sandstone, and siltstone and along stike grade into argillite. Coal occurs locally. The Early

and Middle Jurassic Irkutsk basin contains abundant fossil pollen, plants, insects, and mollusks. The main part of the Irkutsk basin, along the base of Eastern Sayan Mountains, contains horizontally-bedded Jurassic sedimentary rocks that range from 150 to 200 m thick. The basement of the basin subsides to southwest where the thickness of Jurassic sedimentary rocks increases to 600 to 700 m. Local folds occur close to the Angarsky overthrust where the Jurassic sedimentary rocks overlapp Archean rocks.

REFERENCES: Florensov, 1960.

ob Okhota sedimentary basin (Late Eocene through Miocene) (Russian Far East)

Occurs along the coast of the Sea of Okhotsk and unconformably overlies the Okhotsk terrane and the late Mesozoic rocks of the Uda and Okhotsk-Chukotka volcanic-plutonic belts. Consists of: (1) Late Eocene volcanic rocks (greater than 100 m thick) and Early Oligocene basalt (greater than 20 m thick) with a isotopic age of 34 Ma; and (2) Miocene sedimentary rocks consisting of sand, clay, lignite, and conglomerate (Marekan suite) (greater than 800 m thick). Basin conformably overlain by Quaternary sedimentary rocks (greater than 100 m thick).

REFERENCES: Grinenko and others, 1998.

obg Obong Group (Cenozoic) (Korea)

Consists of a sequence of Paleocene to Eocene sedimentary rock that is about 40 m thick. Occurs in northeastern part of north Korean Peninsula along downstream part of Tuman River. Group is divided into the Kumsaengdong and Songsang coal-bearing Formations and Obong Basalt, from older to younger. The Kumsaendong Formation is about 20 m thick and is composed of tuff, tuffaceous sandstone, shale, and coal. Spore and pollen are mainly gymnosperm pollen, such as Picea, Pinus, Tsuga, Lariz, and Cedrus. The Songsang coal-bearing Formation consists mainly of sandstone, coal sandstone, shale, and lignite. Pollen from the formation include Juglans, Carya, Cyclocarya, Pterocaya, Engelharditia, Proteaceage, and Moraceae. The Obong Basalt consists of basalt and alkali tuff.

REFERENCE: Lee, 1987.

oc Okhotsk-Chukotka volcanic-plutonic belt (late Early Cretaceous and Late Cretaceous) (Yakutia)

oc Volcanic part
ocp Plutonic part

The Okhotsk-Chukotka volcanic-plutonic belt consists of Albian and Late Cretaceous, gently dipping basalt, andesite-basalt, andesite, dacite, rhyolite, and tuff, and rare nonmarine clastic rocks including conglomerate, grit, and sandstone at the base. Also occurring are locally widespread silicic volcanic rocks, mainly ignimbrite. The belt overlaps the southeastern part of the Aldan-Stanovoy shield, Okhotsk terrane, and adjacent margin of the Verkhoyansk fold and thrust belt. Volcanic rocks have Ar-Ar isotopic ages of 74 to 88 Ma and associated granitic rocks have isotopic ages of 84 to 104 Ma.

REFERENCES: Bakharev, 1976; Belyi, 1977, 1978; Zagruzina, 1977; Parfenov, 1984; Filatova, 1988; Lane and others, 1998; Lebedev and others, 1989.

ok Okinsky sedimentary basin (Ordovician through Devonian) (Eastern Sayan)

Occurs in southeastern part of Eastern Sayan region, overlaps Shutkhulai and Hug terranes, and forms a discontinuous, sublatitudinal fault-bounded trough. Overlying the Hugeinsky terrane are the sedimentary rocks of the Okinsky basin for which the structure is not clear. The volume, stratigraphic position, and lithologies of the two lower sequences are unknown because of lack of reliable data. The basin in a monocline that dips south-southeast.

The composition of the upper flyshoid sequence that comprise the Oka basin is a relatively homogeneous: sequence of massive structure quartz-chlorite-sericite shale, polymictic sandstone with interbeds and lenses bearing small pebble conglomerate, coarse-grained clastic sandstone, and limestone. A few horizons are thin layered, indicating quiet sedimentation. Fossils include chitinozoans, bryopzoans, graptolites, and diverse algae

REFERENCES: Roschektaev and others, 1983; Katjukha and Rogachev, 1989; Butov, 1996.

pb Pacific Ocean basin (Cretaceous through Quaternary) (Pacific Ocean)

Occurs east and southeast of Japan and overlies Pacific plate. Contains several hundreds meters of sedimentary rocks, mainly thin clastic sedimentary rocks, variable mixtures of volcanic ash, siliceous microfossils, chert, and calcarous chalk. Oceanic crust underlying basin in the map area interpreted as forming in Early Cretaceous and contains northeast-trending magnetic anomaly lineations from M5 to M15. The age of oceanic crust youngs towards northwest. The depth of the ocean floor ranges from 5,000 to 6,000 m.

REFERENCES: Wakita and others, 1992; Nakanishi, 1993.

Post-amalgamation assemblage of the Kolyma-Omolon superterrane (Yakutia)

Post-amalgamation assemblage of the Kolyma-Omolon superterrane includes the Uyandina-Yasachnaya volcanic belt (unit pku) and the Ilin'-Tas back arc basin (unit pki).

pku Uyandina-Yasachnaya volcanic belt (Late Jurassic) (Yakutia)

Extends for 1,000 km and ranges up to 150 km wide overlying the Omulevka terrane and the southern margin of the Kolyma-Omolon superterrane. Consists of a 3,500 m thick assemblage of andesite, basalt, dacite, rhyolite lava, and tuff, and shallow marine sandstone, siltstone, conglomerate, and gravelite with a Late Jurassic fauna. Belt is interpreted as forming above a subduction zone that was located along the southern margin of the belt and was dipped northeastward. Al;ternatively, the subduction zone may have dipped southwest, under the northern margin of the belt.

REFERENCES: Zonenshain and others, 1990; Parfenov, 1984, 1991, 1994; Ged'ko, 1988; Stavsky and others, 1994.

pki Ilin'-Tas back arc basin (Late Jurassic) (Yakutia)

Occurs northeast of the Uyandina-Yasachnaya volcanic belt and consists of folded Kimmeridgian and Volgian units that unconformably overlie strongly-deformed late Paleozoic rocks in the Arga-Tas terrane. Units are: (1) conglomerate (up to 650 m thick), (2) alkali basalt (400-500 m thick), (3) conglomerate, sandstone, and siltstone (up to 800 m thick), and (4) shallow marine and continental black shale (up to 8000 m thick). The Ilin'-Tas basin may be a forearc basin of the Uyandina-Yasachnaya magmatic arc.

REFERENCES: Baranova, 1980; Danilov and Stavskiy, 1984; Parfenov, 1984, 1991, 1994; Terekhov and Dylevsky, 1988; Zonenshain and others, 1990**.**

pl Primorsk lowland and Laptev sea shelf sedimentary cover (Pliocene through Holocene) (Yakutia)

The Primorsk coastal lowlands, of which the Yana-Indigirka region is the largest, extending for about 1,000 km, extend along the coast in a latitudinal direction and slope gently seaward. Absolute elevations of the southern margins that face the continent and along inner uplift slopes range from 100 to 120 m and decrease to 0 to 30 m northward. Along the coastline is a thermal abrasion scarp with a height of a few to several tens of meters. The scarp is made of an ice complex that is destroyed during strong storms and retreats as much as several tens of meters. The icy deposits consist of aleurite with ice lenses and veins and with late Paleolithic mammal bones. The thickness of the ice complex is 60 to 70 m. The rock ice content increases northward direction with a volume of dozens of times higher than the mineral mass, typical of an Arctic-type ice complex. Widely developed are thermokarst lakes that consist of isometric depressions with diameters of several hundred m to ten km. The lakes are interpreted as forming during degradation of ice complex during Holocene climatic warming. Evidence of other cryogenic processes also occurs on lowlands surfaces and include polygonal ground, boolgoonyakhs, and baydjerakhs. Intensive thawing of frozen ground and denudation exposes bones, skin scraps, and, rare mummified, Late Paleolithic animals. The reasons for massive death of the animals at the Pleistocene-Holocene time boundary is unclear. Near Tiksi, at the boundary between the lowland and mountainous region, are oriented lakes excavated in the country rocks (Permian and Carboniferous aleurite and sandstone), crest-like ridges up to several tens of meters

high, linear ridges with a height of a few meters that are similar to drumlins, and trough-like valleys that were probably produced by a Pleistocene shelf glacier advancing onto the coast.

REFERENCES: Grosvald and Spector, 1993.

pn Pyeongang sedimentary basin (Carboniferrous to Triassic) (Korea)

The sedimentary basin disconformably overlies the Cambrian and Ordovician Chosun Sequence and is unconformably overlain by the Jurassic Daedong System. Basin is divided into Hongjeom, Sadong, Gobangsan, and Nogam Series of the Pyeongan Group. Deposited started in a shallow-water marine basin with subsequent non-marine conditions and coal depositon, and finaly, non-marine, shallow water environment deposition. In the Ogcheon Basin, the basin ranges up to 4,000 m thick. Coal units range up to100 to 200 m thick.

REFERENCES: Kodaira, 1924; Kawasaki, 1926; Lee, 1987.

pp Popigay astrobleme (Late Eocene) (Yakutia)

Occurs on the northern margin of the Anabar shield (Siberian Platform) and forms a round depression 80 km in diameter with a floor that is 200 to 300 m lower than the surrounding plateau. The depression consists of impactite composed of varying amounts of glass thatchemically corresponds to andesite and dacite, and rock and mineral fragments; explosive allogenic breccias (that fell after the explosion within or beyond the limits of the crater), and authigenic breccias (material from the crater bottom that underwent high-grade shock metamorphism (with local melting and formation of pseudotachylite). The units range up to 2,000 m thick The impactites are classified as massive lava-like tagamite, and glassy and clastic suevite. The tagamite and impact glasses exhibit ^{40}Ar-^{39}Ar isotopic ages of 35.7±0.2 Ma.

REFERENCES: Masaitis and others, 1975, 1998.

psm Pacific Ocean seamounts (Cretaceous) (East of Japan)

Consists chiefly of Cretaceous alkaline basalt and overlying sedimentary rocks that form seamounts that stand 1,000 to 4,000 m above the Pacific Ocean floor that is typically 6,000 m deep. Typical diameter of seamounts is about 30 km. Sedimentary rocks are mainly Cretaceous reef limestone with minor younger pelagic sedimentary rocks.

REFERENCES: Wakita and others, 1992; Winterer and others, 1993.

sa Sayan collisional granitic belt (Paleoproterozoic?) (Altai)

Intrudes early Precambrian gneiss, schist, and amphibolite OF Birusa and Tumanshet terraneS, extends northwest for 300 km and ranges up to 30 to 50 km wide, and forms small massifs with areas of up to several tens of km^2. Overlapped by terrigenous-carbonate deposits of Karagas and Oselok units. Belt consists of biotite, two-mica, and muscovite granite, and normal and subalkaline leucogranite. Latter exhibit increased alumina (Al_2O_3 = 14-15.5%) and increased K (K_2O:Na_2O = 1.2-2). Only poorly-reliable Pb-Pb isotopic ages of 1700 to1770 Ma exist. Belt interpreted as forming during collision.

REFERENCES: Brintsev, 1994.

sab South Aldan sedimentary basin (Jurassic) (Yakutia)

Occurs in the southern part of the Aldan-Stanovoy shield and includes the Chulman basin (240×80 km area), the Tokko basin (150×60 km area), and 20 smaller basins along an 120 km-wide, latitudinal band. Basins contain mainly Jurassic terrigenous coal-bearing limnic rocks, and lesser Neocomian units. Basin exhibits an asymmetric structure with greater depth to basement to the south, close to bounding faults thickness up to 4,000 m according to geophysical data. The Early to Middle Jurassic strata range up to 1,000 m thick and occur throughout the basins. Jurassic units in the southern parts of the basins are intensively deformed. The most extensively-studied Chulman basin contains anticlines and synclinesup to several kilometers wide with limbs dipping at 40 to 70º. The folds are complicated by numerous subparallel reverse faults that dip south. The northern part of the large basins contain Jurassic rocks that dip gently (0-2º) south. Sedimentation occurred within a single piedmont basin with several

smaller basins separated by transverse uplifts. Clastic material was supplied from the Stanovoy uplift to the south. Basins are bounded to the south by steep and gentle thrusts along which the Early Precambrian rocks overthrust the Jurassic units. The amount of horizontal displacement on the South-Chulman thrust, that bounds the south Chulman basin, is about 15 km according to geophysical data. The basin is interpreted as a back-arc basin for an active continental margin located on the southern margin of the Aldan-Stanovoy shield. The tectonically linked magmatic belt was the Stanovoy granite belt.

REFERENCES: Ishina, 1961; Pavlov and Parfenov, 1973; Syundyukov and others, 1979; Zhelinsky, 1980; Parfenov, 1984.

sal South Altai back-arc basin (Middle Devonian through Early Carboniferous) (Southwestern Altai)

Consists of a fragment of a back-arc basin composed mainly of terrigenous and tuff-terrigenous deposits with a concealed basement. To the southwest the basin the Rudny Altay island-arc terrane. The visible base of the sedimentary sequence consists of rhythmically interbedded Late Givetian (Late Devonian) volcanomictic sandstone, siltstone, siliceous shale, and tuff. A belt of diabase and gabbro-diabase dikes, sills and larger linear mafic bodies, that intrude the northeastern margin of the basin, is related to a Late Devonian extension in a back-arc basin. The Devonian deposits are overlain by thick Early Carboniferous flysch with sparse fauna. Although the southwestern margin of the basin is cut by numerous faults, a relation to a magmatic arc is vaguely indicated by upward-coarsing sedimentary rocks and pyroclastic rocks and lava. Middle and Late Carboniferous coal-bearing continental molasse occurs locally.

REFERENCES: Nekhoroshev, 1958; Matveevskaya, 1969; Rotarash and others, 1982; Berzin and Kungrtsev, 1996.

sb Subgan granite belt (Paleoproterozoic) (Yakutia)

Occurs in the Amga tectonic melange zone and consists of several plutons of Na-K granite and pegmatite veins. Major lithologies are biotite and mica granite that intrudes Late Archean and Paleoproterozoic metamorphic rocks. The isotopic age of granite is 2.0 to1.9 Ga.

REFERENCES: Beryozkin, 1977.

Selenga sedimentary-volcanic plutonic belt (Permian through Jurassic) (Transbaikalia, Mongolia)
sev Volcanic part
sep Plutonic part

In Mongolia, unit forms an elongate, northeast-trending extending for about 1,000 km belt. Consists chiefly of large volcanic fields and granite plutons that occur between the northern Hangay and Hentiy Mountains and southern Hubsgol area. Volcanic rocksare composed mainly of Permian rhyolite, trachyrhyolite, dacite, trachydacite, andesite basalt, trachybasalt, and andesite flows, and pyroclastic rocks, and local non-marine sedimintary rocks with plant fossils. The volcanic rocks rangefrom calc-alkalic to subalkalic; however in the western and northern segments, the latest Permian volcanic rocks are bimodal and alkalic. For the alkalic volcanic rocks K_2O predominates or Na_2O and K_2O are roughly equal. Volcanic rocks range from 4,000 to 10,000 m thick in central part of Orhon-Selenge basin. Locally are Middle and Late Triassic conglomerate, sandstone, siltstone with plant fossils (Abzag Formation), and depositionally overlying Jurassic basalt, andesite, tuff, minor conglomerate (Mogod Formation). Plutonic rocks are chiefly Permian granodiorite, granite, granosyenite, and subordinate monzonite, diorite, and gabbrodiorite and Late Triassic to Jurassic REE granite and leucogranite. Plutonic massifs of subalkalic granite and alkalic granite occur in the western part of the belt. In the central part of the Orhon-Selenge basin is the well-known Erdenet porphyry Cu-Mo deposit that is hosted in granodiorite, granite and gabbro-diorite. K-Ar and Rb-Sr isotopic ages range from 260 to 220 Ma. However, Ar-Ar isotopic age on mica from the Erdenet deposit is 207 Ma. The widespread calc-alkalic magmatism in the belt is interpreted as a widespread continental-margin arc related to subduction of Mongol-Okhotsk plate beneath southern Siberia.

REFERENCES: Kepezhinskas and Luchitsky, 1974; Mossakovsky and Tomurtogoo, 1976; Continental volcanism., 1983; Yarmolyuk and Kovalenko, 1983; Orolmaa, 1986; Yarmolyuk and others, 1990; Gavrilova and

others, 1991; Sotnikov and others, 1994; Kovalenko and others, 1995; Lamb and Cox, 1998; Parfenov, and other, 1999; Takahashi and others, 1999.

In the Transbaikalia region, belt forms one of the largest late Paleozoic and Early Mesozoic units of Central Asia. Extends for over 2,000 km from central Mongolia to the northeast through Transbaikalia, and into the Aldan-Stanovoy highland, with a width ranging from 250 to 300 km. Belt overlies Zavhan, Dzhida, Khamardaban-Olkhon, Orkhon-Ikatsky, Eravna, Khangay-Dauria, and West-Stanovoy terranes. Belt composed of Late Carboniferous, Permian and Early Triassic volcanic rocks composed of: (1) subalkaline bimodal basalt and rhyolite with trachyte and comendite, (2) subalkaline basalt and andesite; (3) subalkaline andesite, dacite, and rhyolite, and (4) subalkaline rhyolite. Isotope K-Ar isotopic age of volcanic rocks of the Kuytun series (trachyrhyodacite, rhyodacite, dacite, trachyandesite, trachyandesite-basalt, trachyrhyolite, rhyolite) is 255 to 265 Ma. Plutonic formations in the belt consist primarily of alkaline monzonite, granosyenite, and quartz syenite, subalkaline monospar syenite, alkaline syenite, and subalkaline and alkaline granite. Also locally occurring are alkaline granitoids, including diorite, granodiorite, and granite. The subalkaline and alkaline granitoids, typical of Selenga belt, have the following isotope ages: K-Ar age of 235 to 260 Ma at Bichursky; Rb-Sr age of 232$\pm$7 Ma at Nerchugansky; Rb-Sr age of 280$\pm$18 Ma to 257$\pm$8 Ma at Nizhnya Selenga; Rb-Sr age of 287$\pm$4 Ma at Kudunsky; and Rb-Sr from 265$\pm$1 Ma to 221$\pm$1 Ma at Kunaley. Belt is interpreted asforming along a late Paleozoic and Early Mesozoic transform continental-margin setting associated with oblique subduction of oceanic crust of the Mongol-Okhotsk paleoocean under the southern margin of the Siberian continent.

REFERENCES: Litvinovsky and Zanvilevich, 1976; Vartanova and others, 1976; Shergina and others, 1979; Gordienko, 1987; Litvinovsky and others, 1990; Parfenov and others, 1996, 1999; Rutshtein and Chaban, 1997; Litvinovsky and others, 1999.

sg Sinegorsk volcanic-plutonic assemblage (Devonian and Mississippian) (Russian Southeast)

Consists chiefly of Devonian and Mississippian bimodal volcanic rocks with mainly rhyolite (95% of volcanic rocks), and shallow-water and continental clastic rocks and tuff. Locally occurring are subvolcanic alkaline gabbro and granite intrusions that are interpreted as forming during breakup of Gondwanaland.

REFERENCES: Levashov, 1991; Khanchuk and others, 1996.

sgg Shangganhe sedimentary basin (Cenozoic) (Northern China)

Consists of Pliocene and Quaternary sedimentary rocks. The Pliocene units are: (1) silty clay and basal gravel; (2) interlayered clayey silt, silty clay, and grit. The Quaternary sedimentary rocks are mainly clayey silt and grit with loess usually at the top. Total thickness of the section is 100 m.

REFERENCES: Bureau of Geology and Mineral Resources of Shanxi Province, 1989; Wang Nailiang, 1996.

shb Shikoku back arc basin (Neogene and Quaternary) (Offshore area south of Japan)

Contains several hundreds meters of Miocene to Quaternary sedimentary consisting of hemipelagic mudstone, claystone, ash, and nannofossil chalk. Depth of water in the basin is about 4,500 m. Basin overlies 8-km-thick oceanic crust according to geophysical investigations. Basin and underlying oceanic crust interpreted as forming during backarc spreading.

REFERENCES: Wakita and others, 1992; Inoue and Honza, 1983.

sj Sanjiang sedimentary basin and Yishu graben (Mesozoic and Cenozoic) (Northeastern China)

Consists chiefly of (1) Late Jurassic marine siltstone, sandstone, and mudstone, and continental mudstone, siltstone, sandstone, and conglomerate with abundant coal; (2) Early Cretaceous volcanic breccia, tuff, and sandstone; and (3) Tertiary mudstone, siltstone, sandstone, and conglomerate with abundent coal. Stratigraphic section is about 5,000 m thick. The basin covers an area of over 30,000 km^2 and is interpreted as a rift basin. Eocene and Oligocene strata occur mainly in Yishu graben and consist of coal-bearing beds of Shulan Group and Shuiquliu

Formation, and in the eastern part consists of coal and kerogenite of the Huadian and Meihe Formations. Also occurring is Pliocene plateau basalt.

REFERENCES: Compilation Group of Prospecting and Discovery of Oil and Gas in China, 1992; Bureau of Geology and Mineral Resources of Heilongjiang Province, 1993; Compilation group of Oil Geology of Daqing Oil Field, 1993; Wangyouqin and others, 1997.

sk South Sakhalin sedimentary basin (Cenozoic) (Russian Southeast)

Occurs in southern Sakhalin island and adjacent Terpeniya and Aniwa Bays. Consists chiefly of Paleocene and Eocene continental coal-bearing clastic rocks up to 1,300 m thick, and Oligocene to Quaternary literal-marine and marine clastic rocks up to 6,000 m thick. Miocene marine deposits are interpreted as forming during opening of Sea of Japan.

REFERENCES: Geology of the USSR, Sakhalin Island, 1970; Oil and gas content, 1998**.**

skc Sino-Korea platform sedimentary cover (Proterozoic through Triassic) (China)

Consists of a major overlap sedimentary assemblage deposited on Archean and Proterozoic Sino-Korea Craton. The platform sedimentary cover consists of the following major units.

(1) The Paleoproterozoic and Mesoproterozoic Changcheng sequence (1800-1400 Ma) consists of: (a)quartz sandstone intercalated with conglomerate and shale; (b) shale mainly with ferrous sandstone at the bottom; (c) dolostone intercalated with shale and sandstone; (d) quartz sandstone intercalated with siltstone, dolostone and intermediate and mafic volcanic rock; and (e) mainly dolostone and dolomitic limestone with sparse Mn-bearing shale and dolostone at the base. Maximum thickness ranges up to 4270 m.

(2) The Mesoproterozoic Jixian sequence (1400-1,000 Ma) consists of: (a) dolostone; (b) mainly dolostone intercalated with dolomitic sandstone; (c) shale intercalated with dolostone and sandstone; and (d) Mn-bearing dolostone, shale, and limestone. Maximum thickness ranges up to 4511 m.

(3) The Neoproterozoic Qingbaikou sequence (1,000-800 Ma) consists of: (a) siltstone intercalated with fine-grained sandstone and marl; (b) conglomerate and sandstone intercalated with shale; and (c) dolomitic and muddy limestone. Maximum thickness ranges up to 600 m.

(4) The Neoproterozoic Sinian sequence (<800 Ma) occurs in southern Liaoning and southern Jilin Provinces and consists of two series. The lower series consists of: (a) quartz sandstone intercalated with siltstone and shale; (b) shale, sandstone, and limestone; (c) limestone; and (d) dolostone intercalated with quartz sandstone. Thickness ranges up to 3,000 m. The upper series consists of: (a) mainly limestone intercalated with sandstone at the top; (b) marl; (c) sandstone and shale intercalated with limestone; and (d) sandstone intercalated with shale in the lower part and limestone in the upper part. Thickness ranges up to 1800 m. All the Proterozoic strata formed in coastal and shallow marine facies of clastic rocks and carbonates and form several sedimentary cycles.

(5) The Early Cambrian sequence crops out on the eastern part of the platform and consists mainly of: (a) siltstone and sandstone intercalated with several phosphorite layers; (b) limestone; (c) limestone intercalated with shale, marl, and gypsum in the lower part; and (d)) shale intercalated with limestone, marl, dolostone, and gypsum. Thickness ranges up to 300 to 560 m.

(6) The Middle Cambrian sequence consists of a lower and upper series. The lower series consists of: (a) shale intercalated with limestone; (b) shale intercalated with limestone, sandstone, and siltstone; and (c) limestone, locally intercalated with shale. Thickness ranges up to 132-367 m. The upper series is 150 to 220 m thick and consists of limestone and intercalated shale.

(7) The Early Ordovician sequence consists of two series. The lower series consists of: (a) limestone and dolomitic limestone intercalated with shale; (b) shale and dolostone; (c) dolomitic limestone and marl; and (d) dolomitic limestone and limestone. Thickness ranges up to 330 to1100 m. The upper series is mainly limestone and ranges from 55 to 203 m thick.

(8) Late Carboniferous and Permian units consist of continental and marine facies clastic rocks and coal-bearing clastic units. Continental rocks are dominate. The Late Carboniferous units consists of: (a) shale and sandstone intercalated with limestone, and coal, and iron beds and bauxite layers at the bottom; and (b) sandstone, siltstone, and shale, intercalated with limestone, coal, and bauxite. Thickness ranges up to 190 to 600 m. The Early Permian consists of in ascending order 1) siltstone, shale intercalated with marine limestone, bauxite and coal layers. Quartz sandstone is present at the bottom; 2) sandstone, shale intercalated with bauxite and coal layers. The upper series of the system in ascending order consists of: 1) mudstone, shale, siltstone intercalated with sandstone; 2) mudstone intercalated with sandstone. The thickness of the Permian is totaled to 326-1146m.

And (9) Triassic units consist of to clastic river and lake units with thickness ranging up to 1604 to 2615 m. The Early Triassic units are: (a) sandstone intercalated with siltstone, shale, and mudstone; and (b) mudstone and siltstone. The Middle Triassic units consists of: (a) fine-grained sandstone intercalated with oil shale and siltstone; and (b) fine-grained sandstone and silty mudstone intercalated with shale. The Late Triassic units are sandstone and mudstone awithcoal layers in the upper part.

REFERENCES: Bureau of Geology and Mineral Resources of Hebei Province, Beijing and Tianjing, 1989; Bureau of Geology and Mineral Resources of Shanxi Province, 1989; Cheng Yuqi and others, 1994; Tian Zhaiqi and others, 1997.

sl Sedimentary basin of Laptev Sea shelf (Early Cretaceous through Present) (Yakutia)

Forms a 10 km thick sedimentary rocks of Aptian to Cenozoic age. According to recent seismic data in the base of sedimentary cover there are a number of rift basins extending longitudinally and northwesterly throughout the shelf (Drachev and others, 1998). Formation of the basin is assumed to be related to large-scale crustal extension that predated the Eurasia basin opening in the Cenozoic.

The shelf is very shallow and has a level surface. Over most of the shelf area depth to bottom does not exceed 30 m, and at a distance of tens of kilometers from the shore the water depth is 20-10 m, sometimes even as shallow as a few meters. The level surface of the Laptev shelf odscures buried river valleys and old shorelines. The buried valley of the Lena river is traced from the western side of its present-day delta - the Olenek Channel - toward the shelf edge in a sublongitudinal direction. The buried valley of the Yana river is also traceable. The greatest depths are observed near the edge of the continental slope - 150-170 m in the Laptev Sea.

Subaquatic permafrost is found to exist on the bottom of the sea. It occurs only near the shores at a depth of several tens of centimeters to several meters from the bottom surface. The subaquatic permafrost is a relict (pre-Holocene) formation and has a discontinuous distribution. It is related to Late Pleistocene (Grimaldian) regression when the eastern sector of the Arctic represented a land of subsurface and, locally, surface glaciation.

On the coasts of the Laptev Sea there are deltas of large Siberian rivers such as Lena and Yana. In spite of a large catchment area of the Lena river ($2418x10^3$ km^2) its solid discharge is insignificant ($11.3x10^6$ t/yr) yielding to that of the relatilvely small Indigirka river (catchment area $360x10^3$ km^2, solid discharge - $16.7x10^6$t/yr). The small discharge and the young (post-glacial) age of the present-day Lena delta may explain its small area and a low thickness (few tens of meters) of its sedimentary rocks. The Lena delta existing at the time of the Grimaldian regression did not coincide with the present one. It was located on the continental slope where there were, probably, deltas of other rivers such as Yana. This delta acquired their present-day position after the post-glacial transgression that quickly changed the denudation base of the whole of the Arctic basin.

The basins of the Laptev and East Siberian Seas are separated by the New Siberian Islands. Some of them are characterized by plain relief (e.g. New Siberia Island, Faddeevskiy Island, Minor Lyakhov Island), while others (e.g., Great Lyakhov Island, Kotel'nyi Island) are uplands. In the plains, cover icy loams are widespread representing an ice complex of the arctic type.

The highest elevations are registered in Kotel'nyi Island (374 m) and Great Lyakhov Island (311 m). The straits between the islands represent sublatitudinal troughs variably compensated for by Cenozoic sedimentary rocks.

The shelf structure comprises several deep rifts and highly uplifted basement blocks forming a rift system. The sedimentary cover of the rifts is underlain by a heterogeneous folded basement, that consolidated in the Mesozoic, and includes up to five seismic stratigraphic units (complexes), presumably of Late Cretaceous-Quaternary age and corresponding to different rifting phases. Their total thickness ranges from 3-4 to 8-12 km in the rifts and does not

exceed 1.0-1.5 km in the horsts. The entire rift system is overlain by a continuous horizontal cover of upper Pliocene-Quaternary sedimentary rocks, that records the general subsidence of the shelf under the conditions of decelerated rifting. The latter event is related to the latest reorganization in the motion of the Eurasian and North American plates occurring approximately 3 Ma ago. The thinning of the rift sedimentary cover and the gradual simplification of its internal structure in the east direction are interpreted as the result of rift migration. The existence of the Laptev Sea rift system is explained by the fact that, during the last 60-70 Ma, this region was a segment of a boundary zone between the North American and Eurasian plates in the Arctic.

REFERENCES: Lastochkin, 1977; Lastochkin and Fedorov, 1978; Drachev and others, 1998; Drachev and others, 1998; Drachev, 2000.

slj East Shandong-East Liaoning-East Jilin rift basin (Paleoproterozoic) (Northeastern China)

Basin contains two assemblages of metamorphic rocks: (1) fine-grained biotite, hornblende, or diopside gneiss, leucogneiss intercalated with fine-grained graphite-biotite gneiss, Al-rich gneiss and schist, plagioclase amphibolite, marble, and Ca-Mg-sillicate rocks (South Liaohe, Jian, and Jingshan Groups); and (2) phyllite, muscovite-biotite schist, fine-grained leucogneiss, and dolomitic marble (North Liaohe and Fenzishan Groups). Two assemblages are represent coeval, different facies. A Rb-Sr isotopic age of B-bearing rocks of the South Liaohe Group is about 2,060 to 2,167 Ma. The basin is interpreted by some authors as a Paleoproterozoic (2000-1800 Ma) rift. However, other authors interpret the basin as foreland basin for an island arc.

REFERENCES: Cheng Yuqi and others, 1994; Lu Liangzhao and others, 1998; Zhai Mingguo and others, 2000.

smb Seamounts in Japan back-arc basin (Neogene and Quaternary) (Offshore area northwest of Japan)

Consist chiefly of alkaline basalt with thin sediment covers. Seamounts were formed by post-spreading igneous activity in the back arc basin behind (west of) the Japanese island arc. Formed in Miocene and rise from 1,000 to 3,000 m high above ocean floor. Typical size of the seamounts is about 10 to 20 km diameter. Numerous small seamounts occur in the Yamato basin. The Bogorov seamount, a large seamount located in the Japan basin south of the Russian Southeast, may have Cretaceous basement.

REFERENCES: Gunibidenko, 1979; Tamaki, 1988; Wakita and others, 1992.

sms Seamounts in Shikoku back-arc basin (Neogene and Quaternary) (Offshore area south of Japan)

Consist of basaltic rocks with thin sediment covers. Seamounts comprise the Kinan seamounts chain in the center of the back-arc basin and rise 1,000 to 3,000 m high above ocean floor. Typical size of the seamounts is about 30 km diameter, with a maximum size of 80 km long. The back-arc basin is located behind the Izu-Ogasawara (Bonin) island arc. Seamounts are interpreted as forming in middle Miocene (around 15 Ma) during post-spreading igneous activity.

REFERENCES: Wakita and others, 1992.

South Mongolian volcanic-plutonic belt (Middle Carboniferous through Late Triassic) (Mongolia)

smv Volcanic part

smp Plutonic part

Occurs in southern Mongolia and overlies Zoolen, Gobi Altay, and other terranes. Consists of Middle Carboniferous through Permian volcanic, volcaniclastic, and intrusive rocks. Middle and Late Carboniferous sequence consists chiefly of calc-alkalic basalt, andesite, basaltic andesite, dacite, and rhyolite, and interbedded tuff and tuffaceous sandstone up to 3.5 km thick. Permian sequence is mainly a bimodal complex of subalkalic to alkalic basalt, trachyrhyolite, comendite, pantellerite, minor trachyandesite, trachydacite, and trachyte. Intrusive rocks are Middle and Late Carboniferous granodiorite, granite, and leucogranite K-Ar isotopic ages of 249 to 340 Ma. A Rb-Sr isochron isotopic age for peralkaline granite from the Hanbogd pluton is 282 Ma, and an age for nepheline-syenite from the Luugyin Gol massif is 244 to 222 Ma. The Middle and Late Carboniferous granitoids are mainly

calc-alkaline and S- and I-type. Permian plutonic rocks are chiefly I- and A-type. Belt interpreted as a continental margin arc formed during Permian continental rifting.

REFERENCES: Pavlenko and others, 1974; Yarmolyuk,.1978, 1983; Vladykin and others, 1981; Kovalenko and others, 1995; Munkhtsengel and others, 1999.

sn Svyatoi Nos volcanic belt (Late Jurassic) (Yakutia)

Consists of Late Jurassic volcanic and sedimentary rocks on Svyatoy Nos peninsula that are surrounded by Cenozoic sedimentary rocks of the Primorsk lowlands. Basement of arc is unknown. The volcanic and sedimentary rocks contain the Oxfordian and Kimmeridgian fauna and consist of interbedded tuffaceous and sedimentary rocks, tuff, and basalt and andesite flows. Igneous rocks form a low-alkaline calcareous magmatic series. K-Ar isotopic ages are 157 to 148 Ma for basalt. Also occurring are rare dikes of diabase, diorite, and andesite porphyry.

REFERENCES: Trunilina, in press.

snw Sangwon sedimentary basin (Paleproterozoic) (Korea)

The Sangwon Basin is excellently exposed in the Pyeongnam basin and is up to several thousand meters thick. The basin is subdivided into the Chikyon, Sadang-u, and Kuhyon series, and isoverlain locally by the mainly disconformable Chosun Supergroup. A glauconite isotopic age from quartzite near the Amnok River is 853 Ma (Kim, 1964). This basin is divided into three faces in which the upper and lower faces chiefly are detrital rocks, and middle facies is mainly carbonate rocks. The Chikyon series is composed mainly of chlorite schist, muscovite schist, calcareous chlorite schist, and lesser quartz-biotite schist, phyllite, quartzite, and marble. Thickness ranges from 300 to 2,000 m. The Sadang-u Series conformably overlies the Chikyon series, and is overlain by the Kuhyon Series or the Chosun Supergroup and is composed mainly of dolomite and limestone with locally intercalated chlorite schist, phyllite, and quartzite. Locally occurring is stromatolite limestone with *Collenia*. Dolomites near Cholwonand Kimhwa contains Mn deposits. Thickness of the series ranges up to 1,600 to 1,800 m. The Kuhyon series unconformably overlies the Sadang-u Series and consists of pebble-bearing phyllite, coal-bearing phyllite, and black slate. Average thickness is about 800 m.

REFERENCES: Lee and Na, 1987; Geology of Korea, 1993.

sol Songliao sedimentary basin (Jurassic through early Tertiary) (Northeastern China)

Consists chiefly of (1) Middle and Late Jurassic sandstone, conglomerate, and intermediate to felsic volcanic rock with coal; and (2) Cretaceous and Tertiary mudstone, siltstone, sandstone, and conglomerate with coal and oil shale. The basin is about 350 km wide, 750 km long, strikes northeast, and covers an area of about 260,000 km^2 in. The basin ranges generally from 1 to 5 km deep, is locally is 10 km deep, and is the largest Mesozoic and Cenozoic sedimentary basin in China. The basin formed in three three stages, fault subsidence (Late Jurassic and Early Cretaceous), downwarping (Cretaceous), and shringkage (Late Cretaceous and early Tertiary). The basin is interpreted as forming during rifting.

REFERENCES: Zhu Xia, 1986; Guan Shichong and others, 1991; Compilation Group of Prospecting and Discovery of Oil and Gas in China, 1992; Liu Zhaojun and others, 1992; Compilation Group of Oil Geology of Daqing oil field, 1993; Liu Delai and others, 1996; Sun Jiapeng and others, 1997.

ss South Siberian volcanic-plutonic belt (Early Devonian) (Eastern Altai-Sayan)
ss Volcanic part
ssp Plutonic part

Unconformably overlaps Archean-Proterozoic rocks of the North Asian Craton to the north, to Ordovician and Silurian shelf deposits to the south. The largest volcanic basins are at Minusa, Tuva, and Agul (Rybinsk). Consists mainly of bimodal mafic and siliceous volcanic rocks with rare andesitic rocks. High alkali volcanic rocks occur locally. In the northern part of the belt are olivine basalt, trachibasalt, essexite, phonolite, alkaline trachite, trachiandesite, and trachirhyolite. Less alkaline volcanic rocks with Na dominating over K occur in the southern part of the belt. Volcanic rocks are interbedded with continental motley and red coarse-grained clastic deposits with flora. Middle Emsian gray carbonate-terrigenous marine sedimentary rocks occur in the southern Minusa and

southwestern Tuva basin, and lagoon-continental deposits occur in the northern Minusa basin. Sedimentary and volcanic deposits range up to 3,000 or more m. Local dolerite sills and dikes occur and are interpreted as forming during extension.

Intrusive rocks vary from subalkaline to alkaline gabbro to granite that intrude Early Devonian sedimentary and volcanic rocks and older terranes. The Goryachegorsk gabbro-syenite complex in the northern Kuznetsk Alatau, and thye Gornaya Shoriya and Sangilen alkaline syenite complexes in southern Tuva, and the Saibar alkaline-syenite and syenite complex in Eastern Sayan are mainly alkaline gabbroids and syenite that form small massifs. Gabbros and syenites locally contain nepheline. The most abundant subalkaline and alkaline granitoids form large intrusive massifs and small plutons in linear zones. Subalkaline and alkaline assemblages occur in the Shumikha and Ognit syenite-granite and Brensk granosyenite-granite-leucogranite complexes. Latite subalkaline granitoids form sparse, small massifs in the southeastern Eastern Sayan (Buedzhul and Kordov-Kanzybin gabbro-monzonite-syenogranite complexes).

Belt is interpreted as forming during Early Devonian rifting during transition from a continental-margin transform margin to a convergent margin. Rift-related magmatism ceased at the Early to Middle Devonian boundary and was succeeded by deformation with development of a pre-Givetian unconformity and occurrence of strike-slip faulting with simultaneous formation of sedimentary molasse basins over areas with thinned continental crust.

REFERENCES: Klitin, 1960; Luchinsky, 1960; Rik, 1961; Shneider and Zubkus, 1962; Mossakovsky, 1963; Leontjev and others, 1981; Teleshev, 1981; Yashina, 1982; Gordienko, 1987; Smagin and others, 1997; Zonenshain and others, 1990; Berzin and Kungurstev, 1996.

st Stanovoy granite belt (Jurassic and Early Cretaceous) (Yakutia)

Consists of multiphase, fractured, older plutons of gabbro, diorite, and younger plutons of granodiorite, granite, and granosyenite. Epizonal granodiorite batholiths are most common. The belt occurs along the southern margin of the Aldan-Stanovoy shield of the Siberian Platform and extends west into the eastern Transbaikalia region. Belt generally occurs parallel to Mesozoic Mongol-Okhotsk fold system and transects various older tectonic structures of the early Precambrian Stanovoy fold system. The granitoids are calc-alkaline with pronounced dominance of Na_2O over K_2O. The age of granitoids in the western part of the belt ranges from Triassic toNeocomian and youngs eastward to Late Jurassic and Neocomian. K-Ar isotopic ages for entire belt range mainly from 70 to 140 Ma, and locally extend to 200 Ma. The granite belt is the western continuatipn of the Uda volcanic arc to the east that consists manly of andesite in Triassic, Jurassic, and Neocomian Dzhelon Formation. Local early Mesozoic volcanic rocks occur in Upper Primorye and are also widespread in Transbaikalia. Fragments of siliceous and intermediate volcanic rock in Middle Jurassic sandstones of South Aldan basin, derived from the Stanovoy uplift, indicate early Mesozoic volcanic rock that was coeval with the granite belt.

REFERENCES: Ishina, 1961; Zabolotskiy, 1978; Molchanova, 1981; Zhelinskiy, 1980; Parfenov, 1984.

sv South Verkhoyansk granite belt (Late Jurassic) (Yakutia)

Extends longitudinally along the central part of the South Verkhoyansk synclinorium and related to the South Verkhoyansk greenschist metamorphic belt. Consists of following variable-age magmatic units, including batholiths, relatively small granitoid plutons, and dikes. (1) Oldest unit is a Late Jurassic gabbro and diorite unit that consists of fractured intrusions and dikes of pyroxene and pyroxene-amphibole gabbro-diorite and amphibole diorite. Unit and host Carboniferous and Permian terrigenous rocks are regionally metamorphosed. (2) Younger diorite porphyry occurs as thin (from 5 cm to 5 m thick) dikes that strike northwest deep steeply. Dikes occur in gentle fractures in swarms in sandstone, quickly wedge out, have irregular shape, are strongly altered, and exhibit K-Ar isotopic ages of 143 to 157 Ma. In the central part of the belt are granite porphyry dikes form northeast and sublongitudinal striking swarms that extend up to 30 km, are conformable with folds, and are cut of younger granodiorite porphyry dikes. A K-Ar isotopic age of the granite porphyry dike is 143 Ma. The diorite porphyry and granite porphyry dikes are regionally metamorphosed. (3) Younger, large batholithic plutons (with sizes of up to 900 km^2) (Uemlyakh, Tarbagannakh, and others), and small granitoid intrusions (Dzhelindsha, Dybinsk, and others), occur mostly in the central part of the belt. The batholithic plutons are concentrically zoned, have an external zone of amphibole-biotite quartz diorite and granodiorite, an intermediate zone of granodiorite and adamellite, and a central zone of amphibole-biotite granite. The plutons exhibit planar flow structures typical of mesozone intrusions. (4) Small (with sizes of up to 25 km^2) intrusions of the Dzhelindzha type occur in the central

part of the belt, consist of quartz diorite and granodiorite, are high-K calc-alkaline series, subaluminous, highly ferruginous, weakly oxidized, and have high-Ca content. Associated are numerous plutons of diorite and quartz diorite, granodiorite porphyry, and granite porphyry, and aplitic plagiogranite dikes with mainly northwest and sublatitudinal strike. On the northern side of the belt are small (with areas of up to 7 km^2) intrusions of hornblende-biotite granitoids (Dybinsk and others). The Dybinsk intrusion is mainly granodiorite with subordinate adamellite and granite. In contrast to the batholithic granitoids, these units are more alkaline, high-K, aluminous and less Ca-rich. K-Ar isotopic ages are 140 Ma for the early generation of plagioclase from the granodiorite of the Tarbagannakh pluton that is consistent with a Rb-Sr isotope age of 140 to 141 Ma for the granidiorite. ^{40}Ar-^{39}Ar isotopic agesfor biotite, hornblende, and K-spar from the Uemlyakh granodiorite pluton are 123.3, 123.7, and 114.4 Ma, respectively. A similar ^{40}Ar-^{39}Ar age of 123.3 Ma occurs for biotite, and a similar K-Ar age of 135 to 141 Ma occurs for the Dybinsk intrusion. (5) In South Verkhoyansk region are several small mid-Cretaceous granitoid plutons. The Kurum pluton (with a size of 7 km^2) occurs near the northeast edge of the Nezhdaninka Au deposit and has a Rb-Sr isotopic age of 122 to 124 Ma, and a ^{40}Ar-^{39}Ar biotite isotopic age of 93 to 99 Ma. The pluton consists mainly of amphibole-biotite granodiorite along with common dikes and veins of leucocratic biotite granite, aplitic granite, aplite, and pegmatite. Lamprophyre dikes of the Nezhdaninka ore field have K-Ar isotopic ages of 94 Ma. (6) The Gel'dinsk group of stocks (with areas of up to 1 km^2) occurs near the southwestern edge of the Nezhdaninka ore field and consist of diorite and quartz diorite that are metaluminous, highly ferruginous, weakly oxidized, and Ca rich. A Rb-Sr isochron isotopic age for the diorite is 100 ± 15 Ma. Biotite ^{40}Ar-^{39}Ar and Rb-Sr isotopic ages are 93 to 96 Ma, and 94 Ma, respectively. (7) The Darlerchan (with a size of 15 km^2) and Kutep (with a size of 600 km^2) plutons occur in the central part of the South Verkhoyansk synclinorium. Both putons exhibit concentric structure with coarse-grained granite forming the external zone and medium- and fine-grained granite forming central zone. A K-Ar isotopic age for granite from the Kutep pluton is 119 to 96 Ma, and a biotite ^{40}Ar-^{39}Ar isotopic age for the Darlerchan leucogranite is 107 Ma. (8) The Supsk (Upper Khandyga) pluton (with a size of 4 km^2) occurs in the northern part of the South Verkhoyansk synclinorium and ranges from melanocratic syenodiorite and quartz diorite in the marginal part of the synclinorium to biotite-horublende granodiorite in the center. K-Ar quartz isotopic ages for diorite and syenodiorite are 137 to 142 Ma and 143 Ma, respectively. A ^{40}Ar-^{39}Ar biotite isotopic age for the quartz diorite is 93 Ma. (9) The youngest igneous unit in the South Verkhoyansk belt consists of lamprophyre and diorite dikes. The lamprophyres consist of camptonite, vogesite, odinite, and kersatite. The dikes cut all the granitoid plutons including the Kutep and Darlerchan granite and leucogranite. The granitoids of the South Verkhoyansk belt are interpreted as a Late Jurassic through mid-Cretaceous subduction-related magmatic arc that may represent a rear zone of the Uda continental-marginal magmatic arc.

REFERENCES: Indolev, 1965, 1979; Grinberg and others, 1970; Nenashev and Zaitsev, 1980; Simanovich and Andriyanov, 1994; Parfenov, 1984; Bakharev, 1999; Layer and others, 2001.

sy South Yakutian subalkaline and alkaline igneous belt (Early Jurassic through Early Cretaceous) (Yakutia)

Occurs on the northen part of the Aldan-Stanovoy shield and consists of highly variable calc-alkaline granitoids, subalkaline and alkaline-potassium rocks, dunite, and kimberlite, and occurs in stocks, dikes, sills, ring intrusions, and calderas that form clusters in a general latitudinal striking belt of long duration. The early stage consists of magmatic rock pebbles in Early Jurassic conglomerate, and Jurassic vitroclactic tuff and tuffaceous sandstone. Intrusive rocks cut Late Jurassic sedimentary rocks. The Mesozoic magmatic rocks vary in composition along strike. In the Sutam and Gonam regions, close to the granodiorite batholith of the Stanovoy uplift, are calc-alkaline granodiorite, alkaline rocks are minor and increase away from the margin of the shield. In the Tyrkanda and Khatymi regions, are syenite and increasing quantity and diversity of alkaline rocks. The largest amount of nepheline and leucite alkaline rock occur in the Upper Amga and Central Aldan regions that are far from the Stanovoy Range.

REFERENCES: Minkin, 1960; Bidzhiev and Minaeva, 1961; Maksimov, 1975; Lutz, 1980.

ta Tatarka-Ayakhta collisional granitic belt (Neoproterozoic) (Yenisey Ridge)

Belt consists of a series of massifs ranging in size from 200 to 1200 km^2, mainly in Central Angara and West Angara terranes. Some massifs intrude volcanogenic-sedimentary complexes of the Poputninsk terrane. Generally the massifs are discordant, as for the Sukhopit and Tungusik plutons, and are surrounded by contact-metamorphic halos. Some large massifs are conformable with major folds. Rock types are biotite subalkaline granite, and less-abundant amphibole-biotite quartz syenite, and normal granite and leucogranite. Belt formed in both syn- and post-

collisional events. Belt is an indicator for paleogeodynamic reconstruction of the tectonic origin of Neoproterozoic Yenisey Ridge. Most likely, the belt formed during collision of Central Angara terrane with the Siberian Craton. Older U-Pb zircon isotopic age for belt is 850±50 Ma. New U-Pb ages range from 750 to 760 Ma.

REFERENCE: Volobuev and others, 1980; Datsenko, 1984; Vernikovskaya and others, 2002.

tb Transverse granite belts (Early Cretaceous) (Yakutia)

Consists of several belts of granitic rocks that extend up to a few hundred km and radiate outwards from the southwestern bend of the Kolyma-Omolon superterrane. The belts taper out to the southwest and north and consists of fracture-related plutons and dikes swarms composed mainly of diorite, granodiorite, and granite. ^{40}Ar-^{39}Ar isotopic ages are 132 to 124 Ma (P. Layer, unpublished data, 1999). The belts crosscut, at high angle, older folds and faults of the Verkhoyansk fold and thrust belt.

REFERENCES: Trunilina and others, 1985.

tbr Tyrma-Bureinsk granitic assemblage (Permian) (Russian Southeast)

Consists chiefly of hornblendite granodiorite and occurs mainly in the eastern Bureya pluton. Assemblage covers and area of 2,000 to 3,000 m^2 and strikes northeast. Assemblage composed of gabbro to predominant granite that formed in four stages: (a) gabbro and diorite; (b) biotite-hornblende granodiorite and granite, and rare quartz diorite; (c) biotitic granite; and (d) leucogranite. Assemblage is mainly high-alumina and calc-alkaline. In most rocks Na is dominant over K. For leucogranite, total K_2O+Na_2O content exceeds 8% and K is dominant over Na. In the Niman River basin, the assemblage intrudes the Early and Middle Devonian units.

REFERENCES: Romashkin, 1975; Popeko and others, 1980; Martynyuk, 1983; Martynyuk and others, 1990.

td Taidon graben (Middle Cambrian through Early Ordovician) (Northwestern Kuznetsk Alatau) (Altai)

Consists of following units: (1) A basal unit of Middle Cambrian (Mayaian) and Late Cambrian red and gray conglomerate, graywacke, siltstone, shale, and limestone (Bolshekitat and Chernoosipovskaya suites) that range up to 1,300 m thick with local andesite and basalt volcanoclastic rocks. And (2) a 4 to 4.5 km thick unit of Late Cambrian and Early Ordovician conglomerate, sandstone, and siltstone with subordinate limestone (Kitat, Taimen, and Alzas suites). Local mafic and siliceous volcanic rocks in the Early Ordovician part of the section are interpreted as tectonic sheets. Trilobites occur at all stratigraphic levels. The Cambrian and Ordovician units are intruded by middle Paleozoic orogenic granite. The Taidon graben formed in a fragment of a mobile shelf adjacent to Vendian and Cambrian island arcs, and is separated from the island-arc by large strike-slip faults.

REFERENCES: Alabin, 1983; Grigor'yev, 1988; Berzin and Kungurtsev, 1996.

Tes volcanic-plutonic belt (Devonian through Late Triassic?) (Mongolia)

te Volcanic part

tep Plutonic part

Consists of numerous large plutons and scattered volcanic rocks that extends east-west for at least 500 km across all of terranes of northern Mongolia. Plutonic rocks consist of biotite leucogranite, granosyenite, and lesser quartz syenite, and syenite with K-Ar isotopic ages ranging from 347 to 220 Ma. Many plutons contains three phases: (1) coarse-grained biotite leucogranite, and granosyenite; (2) biotite granite porphyry; (3) fine-grained leucogranite, alaskite, and aplite. Plutonic rocks are calc-alkaline, REE enriched, and rare metal enriched (W, Mo, Be, Sn). and oversaturated in Al, Si, and exhibit a predominance of K2O over N2O. Plutonic rocks area similar to the Daban and Zaza intrusive complexes of Transbaikalia area, Russia. Associated volcanic rocks locally consist of andesite, dacite, rhyolite, tuff, and volcaniclastic sedimentary rocks brachiopods.

REFERENCES: Geology MPR, 1973; Yashina, 1975; Gordienko, 1987; Kovalenko and others, 1995.

tg Tamirgol sedimentary basin (Permian) (Mongolia)

Consists of Permian volcanic and continental clastic rocks exposed in scattered areas of central part Hangay Mountains. Lowermost part consists of Early Permian rhyolite and dacite brecccia, tuff, minor siltstone, and ranges up to 200 m thick. Upper part consists of interbedded Late Permian sandstone, siltstone, and conglomerate with abundant plant fossils ranging up to 600-700 m thick.

REFERENCES: Geology MPR, 1973; Durante, 1976; Zaitsev and others, 1969.

tk Tas-Kystabyt magmatic belt (Jurassic) (Yakutia)

Consists of a discontinuous chain of granitoids that extend for 300 km north-northwest in the southeastern part of the Verkhoyansk-Kolyma orogenic region. Also includes the large Taryn subvolcano. The belt obliquely cuts the Adycha-Taryn fault zone with no significant displacement, and stitches the Verkhoyansk fold and thrust belt to the Kular-Nera terrane. Variable age magmatic rocks occur in the belt. Belt consists mainly of basalt flows, dikes, sills, and subalkaline diabase and gabbro-diabase stocks that intrude Early Jurassic and rare Middle Jurassic terrigenous rocks. Basalts are subalkaline, medium K content, calc-alkaline, and low-K tholeiitic series. Basalts are not part of magmatic belt, but are interpreted as forming during extension related to formation of the Verkhoyansk passive continental margin. The major units are as follows. (1) Oldest unit of diorite that forms large xenoliths in the endocontact zones of the younger Nel'Kan and Kapriznyy granitoid plutons. Rb-Sr and K-Ar isochron isotopic ages for diorite in the Nel'kan pluton are 177±23 Ma and 172±6 Ma, respectively. A Rb-Sr model isotopic age is 167 Ma, a ^{40}Ar-^{39}Ar amphibole isotopic age for diorite from the Kapriznyy plyton is 161.8 Ma. (2) Nearly coeval Late Jurassic and Early Neocomian granodiorite-granite and adamdelite-granite plutons intrude the northern part of the belt. (3) Granodiorite-granite plutons (Ergelyakh, Kurdat, Yakut, Symyr) occur along the western margin of the belt. The largest (with a size of 30 km^2), and the mostly eroded Ergelyakh pluton are composed of granodiorite (42%), adamellite (20%), granite (38%), and dikes and veins of aplitic granite, and aplite. A ^{40}Ar-^{39}Ar biotite isotopic age for granodiorite from the Ergelyakh intrusion is 142.9 Ma, is 143.2 Ma for adamellite from the Yakut intrusion, and is 141.2 Ma for granite of the Kurdat intrusion. The large Nel'kan adamellite-granite pluton (with a size of 1,200 km^2) occurs in the northern part of the belt and consists of mainly biotite adamellite grading into granodiorite in the endocontact zone. Granite forms irregular bodies in the center of the pluton along with common dikes and veins of aplitic granite, aplite, and pegmatite. Rb-Sr and ^{40}Ar-^{39}Ar rock and mineral isotopic age range from 152 to141 Ma. (4) A suite of rhyolite, dacite, and diorite-granodiorite complexes occur on the southeastern margin of the belt. The rhyolite complex consists of a sedimentary-volcanic succession (ranging from 700 to 850 m thick), and also as 250 m thick lenses along the eastern exocontact zone of the Taryn subvolcano. The lower parts of the suite consist of mudstone, siltstone, and tuffaceous sandstone with Neocomian flora. (5) Overlying units of dacite of the Taryn subvolcano units, volcanic and sedimentary rocks with a Callovian-Kimmeridgian fauna, and younger Valanginian-Hauterivian volcanic and sedimentary rocks with a K-Ar isotopic age of 137 to 134 Ma. These relations indicate a Berriasian and early Valanginian age for the lower suite. The dacite complex comprising the Taryn subvolcano covers an area of about 1,500 km in area in the axial part of the belt. The subvolcano extends for almost 100 km in a north-northwest direction forming a giant oval basin with steep west and eastern edges, and a flat bottom complicated by a central dome. The hosting Late Triassic and Early and Middle Jurassic sedimentary rocks are cut by faults and plunge beneath the subvolcano faults. The host rocks are deformed into a large low-angle graben-syncline. ^{40}Ar-^{39}Ar isotopic ages for the dacite are 134 to 138 Ma, and an initial Sr isotope ratio is 0.7100 to 0.7110. (6) The Bulgunyakh diorite-granodiorite complex forms a dike-shaped intrusion in the southwest part of the belt and the Trud, and in the Kapriznyy, Odonkan, Arya-Salin, and Chingankan plutons to the east. The Odokan pluton intrudes dacite of the Taryn subvolcano. Rb-Sr biotite isotopic ages for granodiorite from the Odokan oluton are 146, 144, 141, 125, and 124 Ma. The diorite-granodiorite-granite complex at the southern end of the belt has isotoic ages of 141 to 134 Ma. (7) Granite-lencogranite plutons (Levoindigirka, Ust'-Nera, and Ebir-Khaya) occur in the northern part of the belt. and consist of biotite and two mica granite that forms dikes and veins of leucogranite, aptite, and pegmatite. A ^{40}Ar-^{39}Ar isotopic muscovite age is114.9 Ma and a biotite age is 102 Ma. Granitoids of the Churukta stock (with a size of 3 km^2) on the western margin of the belt consist of granodiorite with rare veins of aplitic granite and aplite. Rb-Sr biotite and K-Ar whole rock)isotopic ages are 100 to104 Ma. (8) The youngest ganitoids in the belt are the Semonanian Byryllyelakh and the Turonian and Early Senonian Kuranakh-Salin plutons. The Byryllyelakh pluton occurs on the western margin of the belt and consists of adamellite with dikes and veins of aplitic granite and aplite. Rb-Sr and K-Ar isotopic ages are 96 to 91 Ma. The Kuranakh-Salin pluton (with a size of 130 km^2) occurs in the southern part of the belt and consists mainly of granodiorite-perphyry and lesser adamelite-porphyry. Biotite K-Ar and ^{40}Ar-^{39}Ar isotopic ages are 91 and 86.1 Ma,

respectively. The origin of the Tas-Kystabyt magmatic belt is well understood. The belt probably may be a branch of the Uda continental-marginal magmatic belt.

REFERENCES: Rudich, 1959; Popov and Kuznetsov, 1987; Shkodzinskiy and others, 1992; Mishin, 1994; Bakharev and others, 1997; Kotlyar and others, 2000; Layer and others, 2001.

tkn Tyrkanda granite belt (Paleoproterozoic or older) (Yakutia)

Belt occurs in the northern, sublongitudinal part of the Tyrkanda tectonic melange zone. Granitoid plutons occur mainly along the western and eastern boundaries of the zone, extend for 600 km, and range up to 10 km wide. Consists mianly of amphibole and biotite gneiss, granite gneiss, gneissic granite, charnokite gneiss derived from siliceous and intermediate magmatic rocks, incuding subalkaline and normal granite, quartz syenite, monzodiorite, and quartz diorite. The isotopic age of charnokite intruding the crystalline rock of the Tyrkanda tectonic melange zone is 1.9 Ga.

REFERENCES: Dook and others, 1986.

tl Telmen plutonic belt (Middle Cambrian through Early Ordovician) (Mongolia)

Forms numerous large batholiths and small massifs in northern and central Mongolia and consists chiefly of granodiorite, biotite granite, plagiogranite, tonalite, and gabbro with K-Ar isotopic ages ranging from 547 to 491 Ma. The plutons usually consists of two phases: (1) diorite, gabbro-diorite, and gabbro, and rare pyroxenite, hornblendite; and (2) granodiorite, plagiogranite, adamelite, tonalite, quartz diorite, and granite. Units are calc-alkaline with a predominance of Na over K. Belt is interpreted as the product of melting or contamination of continental crust during widespread Paleozoic accretion of terranes.

REFERENCES: Geology MPR, v. 2, 1973; Pavlov, 1975; Kovalenko and others, 1975; Gordienko, 1987.

tm Tumangang granite (Late Permian through Late Triassic) (Korea)

Intrudes the Tumangang and Kwanmo terranes and consists of Late Permian fdiorite, granodiorite, biotite and two-mica granite, and granite porphyry. ormations Isotopic ages of biotite and granite range from 265 to 280 Ma. Overlapping are Middle and Late Triassic conglomerate.

REFERENCES: Geology of Korea, 1993.

tn Tannuola plutonic belt (Cambrian and Ordovician) (Eastern Altai-Sayan) (Altai)

Consists of calc-alkaline, subalkaline, and latite granitoids. K-Ar, U-Pb, Rb-Sr and Sm-Nd isotopic ages vary from Middle Cambrian to Ordovician with the main magmatic stage in the Ordovician. Calc-alkaline granitoids are most abundant and widespread and generally form large massifs and batholiths in Kozhukhov, North Sayan, Kizir-Kazyr, Khamsara, Ondum, Tannuola, Ulugo island-arc terranes, Altai-Eastern Sayan and East Tuva basins, Derba and Sangilen passive continental margin terranes, and Tomsk metamorphic terrane. Most widespread granitoid are the Martaiga and Olkhov gabbro-diorite-granodiorite and Tannuola diorite-tonalite-granodiorite complexes, and the less extensive Sadrin diorite-granodiorite, Teba gabbrodiorite-granite-leucogranite, Tadzhila gabbro-diorite, and Bugulma granite complexes. Latite granitoids form small massifs, that occur mainly in back-arc basins and rarely in island-arc terranes. Subalkaline and alkaline granitoids (Tigertysh granite, Shalym gabbro-syenite, Kazyr syenite-gabbro complexes) form large batholiths in the Altai and Eastern Sayan back arc basins, and smaller plutons in the Kizir-Kazyr island arc terrane and Mana sedimentary basin. Belt interpreted as forming along a continental transform margin.

REFERENCES: Distanova, 1987; Gordienko, 1987; Lebedev and others, 1993; Zaltsman and others, 1996; Kazakov and others, 1999; Regional…, 1999; Vladimirov and others, 1999.

to Torom sedimentary basin (Late Triassic through Early Cretaceous) (Russian Southeast)

Overlaps the Galam terrane and consists of Jurassic (Piensbachian, Toaarcian, and Aalean; Oxfordian and Kimmeridgian), and Early Cretaceous coastal-marine and continental clastic deposits. Stratigraphical hiatuses occur

at the Triassic and Jurassic boundary, and in the Jurassic and Early Cretaceous (Hauterivian and Albian). Sedimentary rocks range up to 4,000 m thick.

REFERENCES: Fedorchuk and Filatova, 1966; Martynov, 1983; Varnavsky and others, 1988; Popov, 1986.

tr Taraka collisional granitic belt (Paleoproterozoic) (Yenisey Ridge)

Belt forms an elongated northwest-trending massif with dimensions of about 100 km long and up to 10-20 km wide. Belt occurs in the eastern part of the Angara-Kan block. To the west, the massif forms merges with gneiss of Atamanov terrane with a gradation from granite to granulite along a zone of migmatite gneiss. To the east, the massif is overlapped by the Late Riphean to Vendian terrigenous and carbonate sedimentary rock, and to the south, by Devonian sedimentary rock. Most part of the massif consists of porphyritic biotite-microcline granite. The western endocontact zone consists of low-alkali garnet-biotite granite, gneiss-granite, and hybrid gneissic granodiorite with garnet and cordierite. Granitic rocks are calc-alkaline with oversaturated alumina and are interpreted as forming during late Paleoproterozoic collision. U-Pb zircon and monazite isotopic ages range from 1780-1850 Ma. The Taraka granitoids formed from progressive melting of granulite-gneiss strata along with an intense supply of LREE, U, Th, K, Rb, Zr, and Hf during enlargement of magma chamber, particularly during formation of porphyritic subalkalic granite. Judging from the abundance of migmatite, the presence of restite cordierite and garnet, and a high Rb/Sr ratio (2 to 4.5), the autochthonous, low-alkali granitoids are S-type.The porphyritic sodium-potassic and, particularly, subalkalic granite is very similar to A-granites, though with higher contents of Rb, Ba, Th, and Ti, and lower contents of Yb and Y compared with their average composition.

REFERENCES: Geochronology, 1973; Makhlaev and Zabiyaka, 1976; Datsenko, 1984; Volobuev and others, 1980; Whalen and others, 1987; Nozhkin and others, 1991; Nozhkin and others, 2003.

Trans-Baikalian-Daxinganling sedimentary-volcanic-plutonic belt (Middle Jurassic through Early Cretaceous) (Transbaikalia, Mongolia, Northeastern China)

trbs Sedimentary part
trbp Plutonic part
trbv Volcanic part

In Northeastern China, belt extends northeast-southwest for about 1,300 km, ranges up to 500 km wide, and forms main part of Daxinganling Mountains. Belt composed mainly of calc-alkalic basalt trachyandesite, trachydacite, dacite and local alkalic and subalkalic intrusives. Belt interpreted as forming strike-slip and extension of an inner plate.

REFERENCES: Bureau of Geology and Mineral Resources of Inner Mongolian Aut.Reg. (Inner Mongolian GMRB), 1991; Bureau of Geology and Mineral Resources of Heilongjiang Province, 1991; Xu Wenliang, 1994.

In the Transbaikalia region, belt extends over 1,400 km and ranges up to 630 km wide and forms a major Mesozoic unit in Central Asia. Units of the belt overlaps the Orkhon-Ikatsky, Eravna, West Stanovoy, Hangay-Dauria, Onon, Kamensky, and Argunsky terranes northern Mongolia, western and eastern Transbaikalia, and northeastern China. The volcanic and sedimentary formations of the belt fill numerous northeast-striking rift depressions. Volcanic rocks are subdivided into two widespread series: (1) Middle and Late Jurassic shoshonite and latite; and (3) Late Jurassic and Early Cretaceous rift trachybasalt, trachyrhyolite, and comendite. Volcanism occurred in pulses and six volcanic stages, ranging from Late Jurassic to Late Cretaceous, are based on numerous isotope K-Ar determinations. The terrigenous sedimentary rocks in Cretaceous basins often contain brown coal beds. Cordilleran-type metamorphic core complexes formed synchronously with rift depressions in the Ikatsky, Eravna, and Priargunsky terranes

Intrusive units of the belt form several complexes: (1) The Kyrinsky complex contains large calc-alkaline plutons of biotite-, biotite-amphibole diorite, granodiorite, granite, leucogranite with K-Ar isotope ages of 180 to 150 Ma; (2) the Sokhondinsky complex contains small calc-alkaline subvolcanic bodies of dacite and rhyolite with K-Ar isotope ages of 175 to 160 Ma; (3) the Asakan-Shumilovsky complex contains biotite- and biotite-amphibole-granite, and leucogranite with a Rb-Sr isotope age of 185±1 Ma; (4) the Kharalginsky complex contains alkaline biotite leucogranite, syenite-porphyry, leucogranite, and alaskite with K-Ar isotope ages 170 to 140 Ma; (5) the Shakhtaminsky complex contains subalkaline diorite, quartz monzodiorite, biotite-amphibole granodiorite, granite, and granosyenite with Ar-Ar isotope ages of 151 to 159 Ma; (6) the Amanansky complex contains subalkaline

granodiorite, quartz syenite, quartz monzonite, granite with Rb-Sr isotope ages of 186±23 Ma and 193±6 Ma; (7) the Amudzhika-Sreetensky complex contains subalkaline gabbro, quartz monzonite, subalkaline quartz diorite, granodiorite, quartz syenite, and granite with K-Ar isotope ages of 164 to 139 Ma; (8) the Akatuevsky complex contains alkaline gabbro, monzonite, and syenite-porphyry with K-Ar isotopic ages of 185 to 153 Ma; (9) the Kukulbey complex contains siliceous and ultra-siliceous biotite-, biotite-muscovite granite and alaskite, Li-F REE granite, and ongonite with Rb-Sr isotope ages of 142 to 143 Ma and K-Ar isotope ages of 145 to 133 Ma; (10) the Konduysky complex contains biotite- and biotite-amphibole granite, and leucogranite with K-Ar isotope ages of 122 to120 Ma; and (11) the Dotulursky complex contains alkaline granite with K-Ar isotope ages 149 to 140 Ma.

REFERENCES: Alexandrov, Rublev, 1983; Tauson and others, 1984; Antipin, 1992; Gavrikova and others, 1992; Kazimirovsky, 1994; Ivanov and others, 1995; Kozlov and others, 1996; Rutshtein and Chaban, 1997; Sklyarov and others, 1997; Sotnikov and others, 1998; Kovalenko and others, 1999;

In southeastern Mongolia, belt consists of Late Jurassic and Cretaceous volcanic and sedimentary rocks. Sedimentary rocks consist chiefly of conglomerate, coarse sandstone, siltstone, and paper shale, and contain minor interbedded basalt flows and ash tuff. Tamsag and Zuunbayan basins contains thick Early Creatceous lacustrine siltstone and mudstone with oil. In northeastern Mongolia, belt consists of subalkaline basalt and basalt andesite, trachyte, trachyandesite, minor dacite, and rhyolite with coeval shallow felsic intrusions with K-Ar ages for basalt ranging from 156 to 105 Ma with initial Sr isotope ratios ranging from 0.70605 to 0.7059.

REFERENCES: Enkhtuvshin, 1995; Traynor and Sladen, 1995; Munkhtsengel and Iizumi, 1999.

Tungus plateau basalt, sills, dikes, and intrusions (Permian and Triassic) (Siberia)

tuv Volcanic-rich part

tup Plutonic-rich part

Consists mainly of massive basalt flows that formed on the North Asian Craton at the Permian-Triassic boundary. Named the Siberian traps and are most widespread in the Tunguska basin with a total thickness of the lava sheets and tuff ranging up to 3,000 m. In the eastern part of the platform are widespread intrusive traps consisting of extensive belts of sills and rare dikes that intruded major fault zones on the eastern margin of the Tunguska basin, and on the southwestern and northeastern slopes of the Anabar shield.

Magmatism began with the emplacement of sills and dikes followed by intrusion and volcanism with eruption of large volumes of lava, diatreme formation, and deposition of a tuffaceous-sedimentary unit. On the eastern margin of the Tunguska basin, multiple hypabyssal sills intruded and extend for tens to hundreds of kilometers to the east of the magma feeders. Thickness of sills range up to 500 m near the magma feeders, and decreases to 10 to 15 m towards flow fronts. Sparse dikes are magma feeders. Multiple sills in the Paleozoic units, with a total thickness of a few hundred meters, are known from drilling on the Tunguska basin margin. Intrusive bodies are classified into undifferentiated and weakly differentiated diabase; olivine diabase; and gabbro-diabase; differentiated troctolite gabbro to diabase to granophyre intrusions; intrusive bodies with anorthositic differentiation trend composed of diabase, olivine gabbro-diabase, and anorthosite gabbro-diabase; intrusions of magnesian gabbro-diabase with sparse sulfide and native metals; and diabase and gabbro-diabase differentiated to picrodiabase and plagioclase; and intrusive subalkaline diabase. Most widespread are undifferentiated and weakly differentiated intrusions. The principal rocks are diabase and gabbro-diabase.

Intrusions with an anorthositic differentiation comprise a special group of intrusions. Anorthosite is interpretedas forming during stoppage of the melt due to a change from extension to compression. The Permian-Early Triassic traps are dominated by tholeiitic basalt with petrochemical and geochemical features defined by the initial magma-generation processes. Compared to the rift zone basalt, the tholeiitic basalt is characterized by lower TiO_2 and P_2O_5, and higher Ni and Cr, and depletion in Vi, Sr, Ba, and B.

Age of trap magmatism is late Permian and early Triassic. Hundreds of K-Ar isotopic ages yield a wide range of ages from 270 to 220 Ma. ^{40}Ar-^{39}Ar isotopic ages indicate formation of the thick lava sheet in the intensely-studied Noril'sk region in the time interval from 248.3±1.7 to 246.9±2.5 Ma. Similar $^{40}Ar^{39}$-Ar isotopic ages occur for other regions of the Tunguska basin. Special geochronologic investigation of the Siberian traps involving dating of their zircons and paleomagnetic studies indicate that trap magmatism occurred at the Permian-Triassic time boundary and continued for less than 1 Ma. This type of magmatism is best interpreted as forming in a mantle plume originating at the core-mantle boundary with no relation to lithosphere structures. The eruption of the Siberian traps was among

the largest surficial volcanic eruptions throughout the Phanerozoic history of the Earth. The total volume of the igneous material is estimated at 2.10^6-$3.10^6 km^3$.

REFERENCES: Oleinikov and Tomshin, 1976; Oleinikov, 1979, 1984; Oleinikov and Savvinov, 1980; Oleinikov and Tomshin, 1991; Renne and Basu, 1991; Campbell and others, 1992; Basu and others, 1995; Dalrymple and others, 1995; White and Mckenzie, 1995; Venkatesan and others, 1997; Al'mukhamedov and others, 1999.

tv Tuva molasse basin (Middle Devonian through Late Carboniferous) (Tuva)

Basin unconformably overlaps Early Devonian rocks of the South Siberian volcanic-plutonic belt and contains Middle Devonian through Carboniferous continental grey and motley terrigenoius rocks, rare mudstone, marl, and limestone. Givetian lagunal-lacustrine and shallow marine deposits with fauna and flora opccur in the lower part of the unit. Tuff and tuffaceous rocks occur in the Early Carboniferous part of the unit. In the inner part of the basin, the layered Devonian and Carboniferous range up to about 10,000 km thick. Along the basin margins there are angular unconformities and transgressive contacts in the Middle Devonian, Late Devonian, and Early Carboniferous units.

REFERENCES: Klitin, 1960; Alexandrov, 1979; Buslov and others, 1993.

ua Upper Angara carbonate sedimentary basin (Late Neoproterozoic thorugh Middle Cambrian) (northern Transbaikalia)

Basin formed on the Early Cambrian and Riphean complexes and is preserved in erosional fragments. Basin contains, from older to younger, conglomerate, gravelstone and sandstone with interbedded siltstone with one unit of subalkaline high-Ti basalt and tuff with a thickness of 30 to 40 to 850 m. A basal horizon is succeeded by transitional sandstone and siltstone sequence ranging up to 700 m thick and is overlain by a carbonate sequence that is 3,000 m thick and contains Early and Middle Cambrian archaeocyatheans, trilobites, and brachiopods. The basal terrigenous sequence contains Vendian micro-fossils. The basin is deformed into various types of folds.

REFERENCES: Yazmir and others, 1975; Bulgatov and others, 1990; Stanevich and others, 1992.

ub Upper Borzja marine molasse basin (Early Jurassic) (Transbaikalia)

Basin unconformably overlies the pre-Jurassic formations of the Argunsky terrane, is U-shaped with the convex part facing east. Basin contains several concordant suites of sedimentary rockswith a total maximum thickness of 9,000 m. (1) The Igakisky suite contains black aleurolite and argillite with minor sandstone with a Plinsbakh fauna. (2) The Akatuy suite contains conglomerate with the lenses of and interbedded sandstone, siltstone and argillite. (3) The Onon-Borzja suite contains alternating sandstone, argillite, aleurolite, and rare conglomerate Toarsky fauna. And (4) the Kalgansky suite contains sedimentary rocks of coastal facies: sandstone with interbedded argillite with Toarsky marine fauna.

REFERENCES: Okuneva, 1973; Rutshtein and Chaban, 1997.

ubn Uboynaya granite- syenite belt (anorogenic) (Early Triassic) (Taimyr Peninsula)

Belt contains small plutons (with diameters of a few tens of km) of subalkaline and alkaline granite, granosyenite, syenite, and alkaline syenite that intrude the Precambrian Kara terrane, and also Paleozoic terrigenous-carbonate and Early Triassic volcanic and sedimentary and volcanic deposits mainly in the northwestern Taimyr Peninsula. The granitoids are A-type that formed in continental rift zones or are within-plate granitoids. U-Pb and Ar-Ar isotopic ages range from 241 to 249 Ma. Granitoids intruded immediately after extrusion of trap basalt.

REFERENCES: Ravich and Chaika, 1959; Bezzubtsev and others, 1986; Vernikovsky and others, in press.

ud Uda volcanic-plutonic belt (Late Jurassic and Early Cretaceous) (Yakutia)

Belt consists chiefly of basalt, andesite-basalt, andesite, and tuff and interlayered sandstone, siltstone, conglomerate, and coal with Jurassic and Early Cretaceous fauna and flora. Belt overlaps southeastern part of

Aldan-Stanovoy shield, Okhotsk terrane, and adjacent margin of the Verkhoyansk fold and thrust belt. Volcanic rocks have K-Ar isotopic ages of 118 to 176 Ma and, associated granitic rocks have K-Ar isotopic ages of of 150 to 190 Ma.

REFERENCES: Lebedev and others, 1989; Zmievsky and others, 1990.

uds Uda sedimentary basin (Late Jurassic and Cretaceous) (Russian Southeast)

Consists chiefly of Late Triassic and Jurassic clastic rocks ranging up to 4,000 m thick, and Cretaceous non-marine clastic rocks ranging up to 2,500 m thick. Basin occurs at the collision zone between the North Asian Craton and Mongol-Okhotsk orogenic belt. Northeastern basin overlies volcanic rocks of the Late Jurassic and Early Cretaceous Uda-Murgal island arc, and is interpreted as a peripheral post-collisional foreland basin. The southern flank of the basin adjacent to the Mongol-Okhotsk orogenic belt appears is more highly deformed as compared to the gentle northern flank adjacent to the North Asian Craton. The basin contains chiefly; (1) Late Jurassic coastal marine clastic sedimentary rocks (about 3,000 m thick) deposits deposited in a residual basin along the northern margin of the Mongol-Okhotsk orogene; (2) Early Cretaceous (Berriasian and Barremian), sedimentary rocks (700 m), mainly continental sandstone, conglomerate, and gritstone with abundant pebbles derived from Precambrian rocks; and (3) middle Aptian continental clastic sedimentary rocks (about 500 m or thicker); and (4) younger volcanic rocks in the eastern part of the basin. Total stratigraphic thickness ranges up to greater than 4,000 m.

REFERENCES: Lishnevsky and Zemlyanov, 1972; Parfenov, 1983; Oil content…, 1998; Oil and gas content …, 1998; Kirillova, 2000, 2001, in press.

ul Ulkan plutonic belt (Paleoproterozoic) (Yakutia)

Consists of Ulkan and South Uchur plutons with the total area of 2,700 km^2 and several small plutons that intrude volcanogenic and sedimentary rocks of the Ulkan series. Belt has an isotope age of 1.7 to 1.8 Ga and consists of two suites. (1) a first suite composed of syenite, quartz syenite diorite, granosyenite, rapakivi granites, and subalkaline leucogranite; and (2) a seond suite composed of alkali granite and pegmatite. The isotope age of granite and hornblende syenite is 1.7 to 1.72 Ga. Rapakivi-granite comprises most of the magmatic rocks. Syenite and other rocks of the first phase occur mainly in the western part of the Ulkan pluton.

REFERENCES: Tugarinov and others, 1965; Neimark and others, 1992.

Umlekam-Ogodzhin volcanic-plutonic belt (Cretaceous) (Northwestern Russian Southeast)

uo Volcanic part
uog Plutonic part

Consists chiefly of: (1) Early Cretaceous sandstone, conglomerate, and mudstone with sparse flora and freshwater fauna; (2) Early Cretaceous calc-alkalic andesite, dacite, and tuff with K-Ar ages of 112 to 135 Ma; and (3) Late Cretaceous alkalic basalt and rhyolite. Intruded by coeval Early Cretaceous granite, granodiorite, diorite, and monzodiorite. Some granitic plutons are probably Late Jurassic, or older because their detritus was shed into the Early Cretaceous part of section. Belt deposited on Gonzha terrane, and on Mamyn and Turan terranes of Bureya superterrane after collision of these terranes with the Tukuringra-Dzhagdinsk terrane.

REFERENCES: Volsky, 1983; Kozlovsky and others, 1988.

ur Urmogtey sedimenary basin (Early and Middle Carboniferous) (Northern Mongolia)

Occurs in scattered outcrops and consists of Early and Middle Carboniferous conglomerate, sandstone, siltstone with brachiopods, bryozoans, and crinoids. Overlies Orhon and Baydrag terranes.

REFERENCES: Geology MPR, v.1, 1973, Mossakovsky and Tomurtogoo, 1976.

us Ussuri sedimentary assemblage (Early Cretaceous through Quaternary) (Russian Southeast)

Consists of Cretaceous sedimentary rocks in small Cretaceous basins and Cenozoic coal-bearing deposits in small fault basins (Dunhua-Mishashan, Alchansky, and Arsen'ev). Consists mainly of: (1) early and middle Albian

alternating continental and coastal marine rocks ranging up to about 2,000 m thick; (2) middle to late Albian sedimentary rocks and subaerial volcanic rocks, particularly in the eastern part of the basin, and ranging up to about 2400 m thick; (3) Cenomanian alluvial plain sedimentary rocks that formed in an arid climate with a thickness of about 400 m; and (4) Cenozoic continental lacustrine-alluvial and coal depositsthat are about 800 m were deposit in the grabens and half-grabens.

REFERENCES: Varansky and others, 1988; Khanchuk and others, 1996; Kirillova, 2000, 2001; Amel'chenko and others, 2001.

ut Ust-Taimyr sedimentary assemblage. (Late Jurassic and Early Cretaceous) (Taimyr Peninsula)

Consists of sedimentary rocks in the Ust-Taimyr basin formed in the area of the Nizhnyaya Taimyra River and the Chelyuskin Peninsula. Basin occurs in poor outcrops of various fragments and is overlapped by Quaternary sedimentary rocks. Basin unconformably overlaps Precambrian and Paleozoic units and contains mainly Late Jurassic sandstone with abundant fauna, and local coal-bearing gray and chocolate mudstone, and Early Cretaceous fine-grained sandstone with coal and muddy limestone seams. Individual coal seams ranges from 2 to 4 m thick, coal-bearing series ranges from 60 to 80 m thick.

REFERENCES: Bezzubtsev and others, 1986.

vch Vorogovka-Chapa basin (Late Neoproterozoic through Cambrian?) (Yenisey Ridge)

Unit consists of a set of basins in the western, northwestern, northeastern, and eastern parts of the Yenisey Ridge region that transgressively overlie the Sukhopit, Tungusik, more rarely Teya units. Basins generally contain a lower unit of fragmental, poorly bedded violet and brown conglomerate, greywacke and sandstone with interlayered gray sandstone, siltstone, and mudstone. The upper unit contains limestone, dolomite, and mudstone. Greatest thickness occurs in the northwestern Yenisey Ridge in outcrops overlying Late Riphean ophiolite and island-arc units. Olistostromes occur in this area. K-Ar glauconite isotopic ages from samples in this area are 700, 650, and 635 Ma and oncolite ages are Late Riphean and Vendian.

REFERENCES: Khomentovsky and others, 1972; Volobuev and others, 1976. Postel’nikov, 1980.

Vladivostok sedimentary and magmatic assemblage (Permian) (Russian Southeast)

vl Sedimentary part

vlp Plutonic part

Consists chiefly of marine and nonmarine clastic rocks, limestone, tuff, basalt, and andesite. The basalt contain up to 2% of TiO_2. Sedimentary rocks range from deep-sea turbidite deposits to shallow-sea and nonmarine deposits. Volcanic and sedimentary rocks are intruded by Permian granite and gabbro. Assemblage is interptreted as a rift unit formed in a marginal sea adjacent to the Laolin-Grodekov island arc terrane.

REFERENCES: Levashov, 1991; Khanchuk and others, 1996; Khanchuk, 2000.

vor Voronin trough sedimentary basin (Mesozoic through Cenozoic) (Kara Sea)

Occurs within the Kara plate to the west of North Land Archipelago. Seismic data indicate a maximum thickness of 12 to 15 km, decreasing to 4 to 2 km above uplifts. Basin contains two-members. (1) Lower member, from island exposures, is Riphean through Late Paleozoic and consists of carbonate, evaporite, and terrigenous rocks with interlayered igneous rocks with a total thickness 7,000 to 9,000 km. (2) Upper member is 2,000 to 3,000 m thick and consists of Triassic through Cenozoic deposits. The Cenozoic deposits form a cover with a maximum thickness of 1,000 m. Basin interpreted as a riftogenic trough.

REFERENCES: Bogdanov and others, 1998.

vz Verkhnezeya sedimentary basin (Cenozoic) (Russian Southeast)

Consists of upper Miocene, Pliocene, and Quaternary sandstone, siltstone, mudstone, and pebble conglomerate, with local upper Miocene coal seams. Total thickness of sequence ranges up to 500 m.

REFERENCES: Putintsev, 1992.

wsa West Sakhalin sedimentary basin (Paleocene through Quaternary) (Russian Southeast)

Consists chiefly of Paleocene to Quaternary marine and non-marine sandstone, mudstone, conglomerate, and coal ranging from 4,200 m to 6,000 m thick. Miocene sedimentary rocks in basin are related to opening of Sea of Japan.

REFERENCES: Geology of the USSR, Sakhalin Island, 1970; Oil and gas content, 1998.

xa Xinjiang Altai plutonic belt (Silurian) (Northwestern China)

Belt occurs in the Altai Mountains of Xinjiang, China. Belt consists mainly of gneissic gabbro, tonalite, and plagioclase granite. Intermediate and mafic plutonic rocks are interpreted as syntectonic and mantle-derived whereas granite is interpreted as forming from remelting of continental crust during anatexis. A Rb-Sr isochron age for granite is 408 Ma.

REFERENCES: Bureau of Geology and Mineral Resources of Xinjiang, Uygur Aut. Region, 1992; Cheng Yuqi, 1994; Chen Zefu, 1997.

yc Yucheon volcanic belt (Late Cretaceous) (Korea)

Consists chiefly of the Late Cretaceous intermediate and locally felsic continental-margin arc volcanic rocks. Occurs as an elongate chain of marginal continental volcanic belts that extend along the eastern Asian margin and occupy the southern Korean Peninsula. K-Ar ages of volcanic rocks range from 79 to 75 Ma. Younger volcanic rocks occur in southern part of basin. Consists of following units. (1) The Hakpong Formation is composed of basalt lava and agglomerate tuff that is underlain and overlain by tuffaceous argillite. (2) The Chaeyaksan Formation consists of basalt and andesite ranges from 200 to 500 m thick. The unit grades upward to mafic volcanic conglomerate and agglomerate tuff. (3) The Chunsasan Formation composed of andesite and the Unmunska Formation composed of dacite and rhyolite. Total thickness of volcanic formations in the basin ranges up to 2,000 m. Characteristic of the Late Cretaceous volcanism is a evolution from andesite to siliceous rocks and predominance of siliceous over the mafic extrisoves. Late Cretaceous volcanic units are high-K and calc-alkaline. Mafic volcanic rocks are enriched in LREE with respect to HREE and exhibit a minor Eu anomaly. The basalts in the lower units are characterized by high Sr and low Mg contents.

REFERENCES: Chang, 1975; Min and others, 1982; Chang, 1987; Geology of Korea, 1988; Won and others, 1991; Kim and Lee, 1993; Hwang and Kim, 1994; Poucle and others, 1995; Sung and others, 1997; Kim and others, 1998; Yun, 1998; Lee, 1999.

yj Yanji-Jixi-Raohe overlap sedimentary assemblage (Mesozoic and Cenozoic) (Northeast China)

Occurs mainly in Yanji-Jixi-Raohe region and consist of following units. (1) Middle and Late Triassic marine sedimentary rocks in Dajiahe, Dalingqiao, and Nanshuangyashan Formation, and overlhing marine molasse of Yongfuqiao Datushan Formation; (2) volcanic rocks of Late Triassic Daxinggou Group; (3) Early Jurassic paralic deposits of Kaibei Group; (4) late Middle Jurassic and Early Cretaceous Longzaogou Group of paralic coal beds, including the Peide, Nandatashan, Qihulinhe, Hongxingchenzi, Caoyang, Shuguang and Donganzhen Formations; (4) Late Jurassic and Early Cretaceous continental coal-bearing Jixi Group that includes the Didao, Chengzihe, and Muling Formations; (5) middle Early and Late Cretaceous Yanji Group that includes the kerogenite-bearing Dalazi Formation; (6) coal-bearing Eocene-Oligocene fault-basin deposits of the Hunchun Formation; (7) middle Pleistocene Tumenzi Formation; and (8) Pliocene Cuangdishan basalt. Nandatashan Formation consists of Middle Jurrassic volcanic rock and Caoyang Formation consists of Late Jurassic and Early Cretaceous volcanic rock.

REFERENCES: Bureau of Geology and Mineral Resources of Heilongjiang Province , 1993; Wang Youqin and others, 1997.

Yanliao volcanic-sedimentary basin and plutonic belt (Jurassic through Cretaceous) (Northeastern China)

yl Volcanic-sedimentary basin

ylp Plutonic belt

Consists of volcanic and sedimentary basins and plutonic rocks in the northern part of the West Liaoning-Hebei-Shanxi granulite-orthogneiss terrane, Sino-Korean Craton. The lower part of the Early Jurassic suite consists of basalt, andesite, and andesite pyroclastic rocks, intercalated with conglomerate and sandstone. The upper part of the Early Jurassic suite consists of of shale, sandstone intercalated with conglomerate and coal layers. The lower part of the Middle Jurassic suite consists mainly of conglomerate, sandstone and intercalated tuffaceous sandstone and intermediate to felsic volcanic rock with local dominant tuffaceous sandstone. The upper part of the Middle Jurassic suite consists mainly of andesite and pyroclasitc rocks, and intercalated conglomerate, sandstone and shale. The lower part of the Late Jurassic suite consists of conglomerate, tuffceous sandstone, siltstone and shale, and the upper part of the Late Jurassic suite consists mainly of andesite, rhyolite, and pyroclastic rocks, and intercalated tuffceous sandstone. The lower part of the Early Cretaceous suite consists mainly of andesite, rhyolite, and pyroclastic rocks, and intercalated tuffceous sandstone, conglomerate, and shale. The middle part of the Early Cretaceous suite is mainly siltstone, shale, sandstone, and intercalated conglomerate and coal layers. The upper part of the Early Cretaceous suite consists mainly of conglomerate, sandstone, and mudstone, and intercalated coal layers. The Late Cretaceous suite consists mainly of conglomerate and intercalated sandstone and mudstone. Total sedimentary thickness ranges up to 20,000 m.

REFERENCES: Bureau of Geology and Mineral Resources of Hebei Province, Beijing and Tianjing, 1989; Cheng Yuqi and others, 1994; Tian Zaiyi and others, 1997.

Plutonic part of belt occurs at the northern part of the West Liaoning-Hebei-Shanxi granulite-orthogneiss terrane, Sino-Korean Craton and strikes east-west. Felsic rocks are very common in the belt. The early, Jurassic stage consists of calci-alkalic, hybyssal monzonite and granite batholiths and stocks that are derived from syntectonic crust and mantle. Rb-Sr isotopic age is 185 Ma and K-Ar isotopic ages are 191 Ma and 161 Ma. The late, Cretaceous stage consists of hypabyssal granite porphyry.

REFERENCES: Bureau of Geology and Mineral Resources of Hebei Province, Beijing and Tianjing, 1989; Cheng Yuqi and others, 1994.

yn Yonil Group (Cenozoic) (Korea)

Unit and correlative strata occur in Ulsan, Pohang, Younghae, and Pukpyong areas in south Korea. Strata are mainly marine, except for the exclusively non-marine Yangbuk Group. The Yonil Group in the Pohang area is the thickest and contains the most complete section of middle and late Miocene deposits in Korea. The Yonil Group is divided into the Soam Conglomerate, and Songhakdong, Taegok, Idong, and Pohang Formations from older to younger. The Soam Conglomerate consists mainly of conglomerate with intercalated sandstone and thin shell beds. The overlying formations consists of marine mudstone, siltstone and sandstone, and contain abundant fossils, including foraminera, diatoms, silicoflagellates, radiolarian, dinoflagellate, nannonfossils, and mollusks.

REFERENCES: Lee, 1987.

yss Yinshan volcanic-dedimentary basin(Jurassic through Cretaceous) (North-central China)

Consists of a series of volcanic and sedimentary basins overlapping Yinshan terrane, Sino-Korean Craton and consists of: (1) Early Jurassic conglomerate, sandstone, and shale, intercalated with mudstone and marl and with coal layers in the lower part; (2) Middle Jurassic conglomerate and sandstone intercalated with siltstone and shale; and (3) Early Cretaceous basalt and andesite intercalated with siltstone in the lower part, and conglomerate, sandstone, siltstone, and mudstone in the middle part and intermediate-mafic-felsic volcanic rocks intercalated with glutenite and marl. Total thickness is about 3,000 m.

REFERENCES: Bureau of Geology and Mineral Resources of Inner Mongolia Autonomous Region, 1991; Cheng Yuqi and others, 1994; Li Weiguo, 1996; Tian Zaiyi and others, 1997.

zbl Zhangbei-Bayan Obo-Langshan metasedimentary and metavolcanic rocks

(Mesoproterozoic) (North-central China)

Consists of following greenschist facies Mesoproterozoic rocks: (1) metaconglomerate, quartzite, stromatolite marble, phyllite, slate, mica schist, actinolite schist, and minor metamorphosed intermediate and siliceous volcanic rock (Chaertai Group); and (2) phyllite, slate, quartzite, meta-sandstone, and marble (Banyan Obo Group). U-Pb zircon age is 1,500-1,600 Ma.

REFERENCES: Dong Shenbao and others, 1986; Cheng Yuqi and others, 1994.

zg Zhangguangcailing plutonic belt (Silurian through Ordovician) (Northeastern China)

Belt occurs in Zhangguangcailing and Taipingling Mountains, extends about 400 km, ranges up to 200 km wide, and strikes north-south. Consists chiefly of granodiorite, monzonite, quartz diorite, quartz monzonite diorite, syenogranite, and K-feldspar granite. K-Ar isotopic age is 500 Ma, and Rb-Sr isotopic ages are 456, 434, and 375 Ma. Tectonic environment is probably synorogenic.

REFERENCES: Li Zitong and others, 1988; Zhang Hairi and others, 1991; Zhang Xingzhou, 1992; Heilongjiang GMRB, 1993; Jilin GMRB, 1989; Zhao Chunjin and others, 1996.

zh Zag-Haraa turbidite basin (Middle Cambrian through Early Ordovician) (Transbaikalia, Mongolia)

Occurs in central and northern parts of Hangay and Hentiy uplands in two blocks. Eastern block occurs between Orhon and Hangay-Dauria terranes and consists of: (1) Middle Cambrian through Early Ordovician sandstone, siltstone and graywacke that are metamorphosed to greenschist facies, andare intruded by granite and granodiorite with K-Ar isotopic age of 420 Ma; (2) overlying Devonian andesite, rhyolite, tuff, sandstone, siltstone, and argillite with brachiopods; and (3) Early Carboniferous shallow-marine sedimentary rocks. The western block (Zag zone) consists of: (1) Middle Cambrian through Early Ordovician pelitic and psammitic schist intruded by Ordovician granite; and (2) overlying Late Ordovician(?) conglomerate and sandstone.

REFERENCES: Geology MPR, 1973; Voznesenskaya and others, 1995; Kotlyar and others, 1998.

zhs Zhangguangcailing sedimentary overlap assemblage (Paleozoic) (Northeast China)

Consists of: (1) Early and Middle Devonian carbonate, terrigenous and felsic volcanic rocks (Fuxingtun, Hongchuan, and Heilonggou Formations); (2) Devonian sandstone, conglomerate siltstone, siliceous lava, siliceous tuff, andesite tuff and flows (Heitai, Laotudingzi, and Qilikashan Formations); (3) Early Carboniferous tuff, flows, and graywacke (Beixing Formation); (4) Late Carboniferous tuff, lava, sandstone siltstone, and flows (Tangjiatun and Yangmugang Formations); and (5) Early Permian sandstone, siltstone, and limestone (Tumenling and Yuquan Formations).

REFERENCES: Guo Shengzhe and others, 1992; Bureau of Geology and Mineral Resources of Heilongjiang Province , 1993; Wangyouqin and others, 1997.

zr Zyryanka sedimentary basin (Late Jurassic through Cenozoic) (Yakutia)

Extends for 450 km along the northeastern foothills of Moma Range and contains an asymmetric structure. The deepest, southwestern edge has Cenozoic deposits with a thickness of 2,500 m, and contains imbricate thrusts that cut Late Jurassic and Cretaceous deposits. The Cenozoic deposits with a basal conglomerate overlie the Cretaceous rocks with local scour consist of alluvial, lake-alluvial, and bog sandstone, conglomerate, aleurolite, and mudstone with coal. Neogene deposits consist of widespread conglomerate, and volcanic rocks of various composition. Late Miocene-Early Pliocene deposits consist of conglomerate and abundant sandstone and phyllite derived from Late Jurassic units. Paleogene deposits consist of conglomerate contain with abundant volcanic rocks with clasts of Triassic slate, granite, and phyllite. Orientation of cross bedding is similar to the Paleogene and Neogene deposits, clastic material was derived from south and south-east. Paleogene and most of the Miocene deposits form parts of a single arched uplift. Imbricate thrusts formed along the southwestern edge of the basin in the late Miocene and early Pliocene along with uplift of the Moma Range. leading to deposition of a thick conglomerate derived from the Moma Range.

REFERENCES: Gaiduk and others, 1990, 1993; Paech and others, 1998; Gaiduk and Prokopiev, 1999.

zs Zhangguangcailiang sedimentary overlap assemblage (Mesozoic) (Northeast China)

Consists of sedimentary rocks in fault basin and in a volcanic belt. Shuangyang fault basin consists of Late Triassic Dajianggang Formation, Early Jurassic Banshidingzi Formation, Middle Jurassic Taiyangling Formation, and Late Jurassic and Early Cretaceous volcanic rock intercalated with coal-bearing strata of Deren, Jiuda, Anmin, and Shahezi and Yingchen Formations. Main units of volcanic belt are Early Jurassic Yuxingtun and Nanloushan Formations, and Late Jurassic and Early Cretaceous volcanic rock and coal-bearing sedimentary rocks of Maoershan, Banzifang, and Taoqihe Formations.

REFERENCES: Bureau of Geology and Mineral Resources of Heilongjiang Province, 1993; Wangyouqin and others, 1997.

CRATON AND CRATON MARGIN

North Asian Craton and Craton Margin (Eastern Siberia)

North Asia Craton and Craton Margin forms stable, rigid, cratonal core of northern Asia. Units include the North Asia Craton (Siberian Platform) (unit NSC) that forms the central and largest part of the craton, and the Verkhoyansk fold and thrust belt (unit NSV), South-Taimyr fold belt (unit NAT), East Angara fold and thrust belt (unit NSE), and Patom-Baikal fold and thrust belt(unit NSP) that occur on the eastern, northern, western, and southwestern margins of the craton, respectively.

REFERENCE: Kosygin and others, 1964.

NAC North Asian Craton (Archean through Mesozoic) (Siberian Platform)

Consists of Archean and Proterozoic metamorphic basement, and non-deformed, flat-laying platform cover consisting of Late Precambrian, Paleozoic, and Mesozoic sedimentary and volcanic rocks. Locally ranges up to 14,000 m thick. Metamorphic basement exposed in the Aldan-Stanovoy and Anabar shields located near southern and northern craton margins, respectively. Along southwestern margin of the craton craton is a narrow band of basement rocks named the Near-Sayan Uplift. Within the Aldan-Stanovoy and Anabar shields and the Near-Sayan Uplift are several terranes made composed of Early Precambrian crystalline rocks of varying composition and structural style.

The crystalline basement of the Aldan-Stanovoy and Anabar shields and the Near-Sayan Uplift is overlapped by flat-laying Riphean (1600-650 Ma) non-marine and shallow-marine clastic and carbonate rocks that range up to 1500 m thick. Previously these Riphean deposits were interpreted as the oldest sedimentary units of the Siberian Platform; however, recent drilling and geochronological data reveal Late Precambrian orogenic belts with isotopic ages of 1,400 to 1,100 Ma in the basement beneath the sedimentary cover. These data indicate that the Riphean non-marine and shallow-marine clastic and carbonate rocks represent a post-amalgamation assemblage formed after amalgamation of older Early Precambrian terranes into larger continental blocks.

Several structures stages are recognized for the platform cover: (1) Vendian and early Paleozoic; (2) middle Paleozoic; (3) late Paleozoic; and (4) Mesozoic. Each stage is characterized by a unique structural style and unique suite of sedimentary and magmatic rocks. The stages, as summarized below, are separated from each other by surface of regional discontiniuties and unconformities related to major tectonic events.

(1) The Vendian and early Paleozoic structural stage consists of Vendian, Cambrian, Ordovician, Silurian, and Early Devonian limestone, dolomite, marl, shale, siltstone, and sandstone. The absence of the Vendian and early Paleozoic on the Aldan and Anabar shields is interpreted as the result of uplift and erosion. The Vendian was marked by onset of major marine transgression onto the Siberian continent that cumulated in the Early and Middle Cambrian. During the Late Cambrian, Ordovician, and Silurian, a regression occurred that ended in uplift and erosion of the eastern Siberian Platform in the Early Devonian. Early Devonian rocks are absent on most of the eastern Siberian Platform and occur only in the Tunguska basin and the Verkhoyansk fold and thrust belt where

they conformably overlie older Siberian deposits. The Early Devonian was the period of general uplift and erosion in the eastern Siberian Platform followed by subsequent major rifting.

(2) The middle Paleozoic structural stage contains units formed during major rifting processes of the eastern of the Siberian Platform. These units consist of Middle to Late Devonian and Early Carboniferous red sandstone, dolomite, conglomerate, gypsum, and rock salt. These units occur in linear grabens (aulacogens) that originate near the front of the Verkhoyansk fold and thrust belt and die out toward the inner parts of the platform. The aulacogens are associated with fault-bounded horsts and extensive belts of basalt dikes and sills that are mapped for hundreds of km. Associated are kimberite fields, basalt diatremes, alkali-ultramafic plutons, and carbonatite. The middle Paleozoic aulacogens are failures branches of triple-rift systems for which the main branches are interpreted as occurring beneath the Verkhoyansk fold and thrust belt. Middle Paleozoic rocks do not occur beyond the limits of the aulacogens in the eastern platform because: (1) sedimentation mainly occurred within the limits of the actively downsinking aulacogens; and (2) deep erosion of the adjoning parts of the platform. In the central sector of the Verkhoyansk fold and thrust belt, about twenty gypsum-anhydrite diapirs occur in the Carboniferous and Permian terrigenous rock units. The diapirs contain limestone fragments with Devonian fauna and basalt, suggesting that a Devonian sedimentary units with evaporite deposits are widely distributed at the base of the Verkhoyansk fold and thrust belt.

(3) The late Paleozoic structural stage consists of Middle and Late Carboniferous and Permian terrigenous continental coal-bearing and marine-littoral deposits. During this period was was the formation of the Vilyui basin and an extensive linear subsidence zone on the eastern and northern margins of the platform graded into a passive continental margin to the east the later became the Verkhoyansk fold and thrust belt. The Vilyui basin and the subsidence zone form the single Vilyui sedimentary basin and are interpreted as forming during crustal thermal sinking in response to heating and thinning during Devonian and Early Carboniferous rifting.

Massive basalt lava flows, the Siberian traps, formed on the Siberian Platform at the Permian-Triassic boundary and are most widespread within the Tunguska basin that occurs on the northwestern side of the platform. The lava sheets and tuffs range up to 3,000 m thick, and along the periphery of the Tunguska basin are widespread intrusive traps consisting extensive of belts of sills and rare dikes that occur along major fault zones. K-Ar isotopic ages (hundreds of determinations) exhibit a wide range of ages: from 280 to 210 Ma (Early Permian through the Late Triassic). Similar ^{40}Ar-^{39}Ar isotopic ages occur for the thick lava sheet in the intensely-studied Noril'sk region and range from 248.3±1.7 to 246.9±2.5 Ma. Similar ^{40}Ar-^{39}Ar isotopic isotopic ages occur for other regions of the Tunguska basin. Specialized geochronologic studies of the Siberian traps involving on zircons and paleomagnetic studies also indicate that trap magmatism occurred at the Permian-Triassic boundary and extended for less than 1 Ma. This magmatism is interpreted as forming from a mantle plume originating at the core-mantle boundary.

(4) The Mesozoic structural stage is interpreted as related to thermal sinking of the eastern part of the Siberian Platform that began in the Middle Carboniferous and continued through the Mesozoic. The thermal sinking involved the flanks of the sedimentary basins. The Triassic and Early and Middle Jurassic rocks range up to 700 m thick and consist mainly of shallow-marine sandstone and shale grading on the northwest and southwest margins of the Vilyui basin into continental sandstone and conglomerate ranging up to 200 m thick. Jurassic sedimentary rocks transgressively overlie and seal Triassic and late Paleozoic deposits. Late Jurassic and Cretaceous deposits occur in the Near-Verkhoyansk foreland basin adjacent to the frontal Verkhoyansk fold and thrust belt that merges with the Vilyui basin. The Late Jurassic and Early Cretaceous deposits consist mainly of continental sandstone, siltstone, shale, and coal. A maximum thickness of 4,500 m occurs near the frontal Verkhoyansk fold and thrust belt, and sharply decreases to several hundred meters towards the platform. At the base of the section are shallow littoral-marine deposits. Late Jurassic marine sedimentary rocks grade into early Early Cretaceous continental units in most of the northern basin. The Near-Verkhoyansk foreland basin contains mainly lake and alluvial plain units that grade towards the platform into the river-bed alluvium facies, and northerly, along the foredeep trend, into coastal alluvial plain and near-shore shallow water facies. Late Cretaceous deposits range up to 1,000 m thick and consist of continental coarse-grained sandstone, and kaolin mudstone with interbedded brown coal, lignite, and conglomerate.

REFERENCES: Sborshchikov and Natapov, 1969; Gusev and others, 1985; Malich and others, 1987; Gaiduk, 1988; Renne and Basu, 1991; Campbell and others, 1992; Yapaskurt, 1992; Basu and others, 1995; Dalrimple and others, 1995; White and McKenzie, 1995; Surkov and Korobeinikov, 1997; Venkatesan and others, 1997; Al'mukhamedov and others, 1999.

NAE North Asian Craton Margin (East Angara fold and thrust belt) (Late Neoproterozoic

through Cambrian) (Yenisey Ridge)

Occurs in the eastern Yenisey Ridge to the east of Central Angara terrane. Extends northwestern for 500 km. Consists of Late Riphean terrigenous-carbonate sedimentary rocks (sandstone, siltstone, mudstone with interlayered dolomite and limestone) that are metamorphosed up to greenschist facies. Sedimentary rocks deformed into monoclines, box-like folds, and flexures. Zones of intense linear contortion occur along faults. No Neoproterozoic magmatic units are recognized. Unconformably overlapped by Late Riphean and Vendian molasse and Vendian and Cambrian dolomite andlimestone.

REFERENCES: Khomentovsky and others, 1972; Kornev and others, 1974; Postel'nikov, 1980.

NAP North Asian Craton Margin (Patom-Baikal fold and thrust belt) (Mesoproterozoic and Neoproterozoic) (Transbaikalia)

Overlies the southern margin of the North Asian Craton and consists of a basin, ranging from 8,000 to 10,000 m thick, composed carbonate and terrigenous sedimentary rocks of the Teptorginsky, Balaganakh, Dalnetaiginsky and Bodaibo series. Units were discordantly overly subsiding passive margin of the pre-Riphean basement of the North Asian Craton, discontinuously overlie Vendian and Cambrian sedimentary rocks, and contain Riphean stromatolites, microphytolites and micro-fossils. Metapelite of the Balanakh and Delnetaiginsky series exhibit Pb-Pb isochron ages of 1602, 1562 and 1414 Ma. Marble of the Imnyakh suite capping the Dalnetaiginsky series exhibits a Pb-Pb isochron age of 864. Detritus in the Angarsky and Dogaldynsky suites of the Bodaibo series (uppermost of the Patom basin) suggests derivation from ophiolite and island arc complexes of the Bakal-Muya terrane during accretion to the craton. Coeval with granitoid magmatism was intrusion of granite porphyry and granodiorite-porphyry stocks (Yazovsky complex) with an U-Pb zircon isotopic age 730 Ma.

Patom basin units exhibit kyanite-sillimanite regional metamorphism, or chlorite-sericite-biotite-garnet subfacies of greenschist facies, or staurolite-chloritoid, staurolite-kyanite-biotite-staurolite subfacies. The metamorphic depressions are alternated with chlorite-sericite zone and thermal anticlines. The centers of the latter expose syn-metamorphic granite and rocks of kyanite-biotite-staurolite subfacies of metamorphism. A Rb-Sr isochron isotopic metamorphic age is 799 Ma. Tectonic structure of the Patom basin is a large, nappe snf folded arc system concave to the north. The southern part of the Patom basin, where sublatitudinal, with alternating narrow and ridge-like uplifts and wide basins exhibits a peculiar folded pattern. Formation of the nappe and folded arc occurred in the Phanerozoic at about 509 and 420 Ma and was accompanied by reequilibration of primary Sr-isotope systematics in previously metamorphosed rocks, and by intrusion of: (1) early Paleozoic(?) dikes and minor of gabbro bodies (Dodykhtinsky complex); (2) granite batholiths and pegmatite veins with U-Pb zircon isotopic ages of 350 to 300 Ma; (3) dikes of lamprophyres of Kadali-Butuinsky complex with a Sm-Nd whole rock and mineral isotopic age of 312 Ma; (4) younger intrusion of dikes and stocks of granite-porphyry (Aglan-Yansky and Oporogsky complexes); (5) minor bodies of nepheline syenite (Synnyrsky complex); and (6) sills and dikes of diabase and gabbro-diabase (Zharovsky complex). Isotope ages of granite porphyry, nepheline syenite, and diabase are not available.

REFERENCES: Korikovsky and Fedorovsky, 1980; Dolnik and others, 1990; Neimark, Ovchinnikova and others, 1990; Neimark and others, 1990; Sharov and others, 1991; Ivanov and others, 1992, 1995; Vinogradov and others, 1996; Fefelov and others, 2000.

NAV North Asian Craton Margin (Verkhoyansk fold and thrust belt) (Carboniferous through Middle Jurassic) (Yakutia)

Extends for 2,000 km along the eastern margin of the North Asian Craton and consists chiefly of a thick wedge of cratonal margin deposits ranging up to 20, 000 m thick. Major units are Carboniferous, Permian, Triassic, and Early and Middle Jurassic clastic rocks, and marine-littoral, deltaic, and shelf sedimentary rocks deposited on margin of the North Asian Craton. Major units grade successively eastward into turbidite deposits and deep-water black shale. Also occurring are: (1) local Middle to Late Devonian and Tournaisian, rift-related deposits similar to those on Siberian Platform; and (2) local Early Triassic and Early Jurassic alkalic basalt flows, and basalt dikes and sills. Northern and southern parts of fold and thrust belt contain thick, Neoproterozoic and early Paleozoic shallow-marine carbonate and clastic deposits that are finer-grained and thicker to east. Sedimentary rocks of the fold belt are apparently tectonically detached from crystalline basement of craton, with fold belt separated from the Siberian Platform by a Late Cretaceous, west-verging thrust belt.

REFERENCES: Bulgakova and others, 1969; Natapov, 1984; Parfenov, 1984, 1985, 1987; Prokopiev, 1989; Parfenov and Prokopiev, 1993; Prokopiev, 1998.

North Asian Craton Margin (South-Taimyr fold belt) (Ordovician through Triassic) (Taimyr Peninsula)

NATT	Dominantly clastic rocks
NATC	Dominantly carbonate rocks
NATB	Dominantly plateau basalt

Consists chiefly of a thick wedge of craton margin deposits, and deep basin deposits that range up to 20,000 m thick. Composed chiefly of Ordovician through Jurassic clastic rocks, shallow-marine terrigenous and carbonate rocks, and mafic volcanic and volcanoclastic rocks. Northern part of fold belt consists mainly of Ordovician through Middle Carboniferous carbonate rocks ranging up to 6,000 m thick. Southern part of fold belt generally consists of the Middle Carboniferous through Permian shallow-marine terrigenous deposits, ranging up to 7000 m thick, and Late Permian and Triassic mafic volcanic and volcanic clastic rocks ranging up to 4,000 to 5,000 m thick. The Late Carboniferous and Permian sedimentary rocks contain extensive sills and dikes of the Early Triassic trap subalkaline and alkaline diabase. Sedimentary rocks are extensively faulted with the intensity of fauting reducing to the south. Fold belt is separated from the Siberian Platform by Mesozoic and Cenozoic Yenisey-Khatanga Trough.

REFERENCES: Pogrebitsky, 1971; Khain, 1979; Bezzubtsev and others, 1986; Uflyand and others, 1991; Vernikovsky, 1996; Inger and others, 1999.

South China (Yangzi) Craton (Korea and China)

SCG Gyenggi terrane (Granulite-paragneiss) (Mesoproterozoic and Neoproterozoic and older) (Korea)

Consists of the following units: (1) paragneiss, banded, porphyroblastic garnet-bearing, migmatic, and granitic, with intercalations of biotite chlorite shale, crystalline limestone, and quartzite (Geongggi complex and Seosan group); (2) Mesoproterozoic slightly metamorphosed sedimentary rocks including chlorite slate, phyllite, and biotite-chlorite schist (Yeoncheon Group); and (3) Neoproterozoic Taean Group of biotite phyllite-slate, sericite-quartz phyllite, and chlorite phyllite. All three units rocks are intuded by the Jurassic Daebu granite. Terrane is overlain by several small Cretaceous pull-apart basins filled with terrigenous rocks (Sindong and Hayang Groups) and the volcanic rocks (Yucheon Group) that occur along northeast striking strike-slip fault zones.

REFERENCES: Geology of Korea, 1993.

SCJ Jiaonan Ultra-High Pressure (UHP) terrane (Metamorphic) (Paleoproterozoic) (Northeastern China)

Terrane is bounded by the Tanlu fault zone to the west, and the Wulian-Rongcheng fault zone to the north and northwest. Terrane is a part of the Sulu collision belt that is the eastern continuation of the Dabei collision belt between the Sino-Korea Craton and the Yangtz Craton. Terrane is displaced to the north by up to several hundred kilometers along the Tanlu fault. The terrane is a displaced block derived from the northern margin of the Yangtzi plate. Terrane consists mainly of the Paleoproterozoic Jiaonian Group that consists of: (1) biotite plagioclase gneiss intercalated with amphibolite(Dashangou Formation); (2) biotite monzontic gneiss intercalated with biotite schist (Zhenjiagou Formation); (3) biotite granulite and leptynite (Qiuguanzhuang Formation); (4) mica schist and granulite intercalated with marble, quartzite and felsic volcanic rock (Yujiagou Formation). Metamorphic grade is lower amphibolite facies along with local eclogite facies metamorphism. Diorite intrudes the upper part sequence and has a U-Pb zircon isotopic age of 1855 Ma. Most authors interpret the ultra-high pressure metamorphic and collisional belt as occurring between the Sino-Korea Craton and the Yangtzi Craton and formed in Triassic (200-230 Ma).

REFERENCES: Cao, 1990; Cao and others, 1990; Liou and others, 1996; Fuyua Wu, 1998, Yao and others, 2000.

Sino-Korean Craton (China and Korea)

SKA Alashan terrane (Granulite-paragneiss) (Paleoproterozoic) (Northwestern China)

Consists of Paleoproterozoic carbonate-paragneiss-schist-phyllite and sparse Archean metamorphic rocks including hornblende gneiss and intercalated granulite, plagioclase amphibolite, diopside marble, and magnetite quartzite. The main rocks are mica-quartz schist, fine-grained biotite gneiss, marble, and quarzite metamorphosed at middle and low pressure greenschist facies and ampibolite facies during progressive metamorphism belt. A Rb-Sr whole rock isochron isotopic metamorphic age is 1,927 Ma. Oldest overlying rocks are low metamorphic-grade Mesoproterozoic terrigenous and carbonate rocks.

REFERENCES: Dong Shenbao and others, 1986; Cheng Yuqi and others, 1994.

SKE Erduosi terrane (Granulite-paragneiss) (Archean) (North-central China)

Consists mainly of Archean metamorphic rocks that are exposed only at terrane periphery; most of terrane covered by younger rocks.

In the Xuanhua-Huaian area in eastern part of terrane, consists of tonalite, trondhjemite, and granodiorite mostly metamorphosed to granulite facies, including supracrustal hypersthene amphibolite granulite, hypersthene plagioclase gneiss and intercalated biotite plagioclase gneiss and magnetite quartzite with a metamorphic age of the granulite of about 2,500 Ma. Khondalite occurs in the Jining area of the terrane and consists mainly of sillimanite and garnet-bearing potassic feldspar gneiss and felsic rocks that are intercalated with sparse granulite, marble, calcsilicate rocks, and graphite gniess. S type, potassic feldspar granite comprises up to 50% of the section and is interpreted as the remelting of supracrustal rocks at depth. The northern part of the terrane in the Daqingshan and Wulashan areas is similar to the eastern part of the terrane. The western part of terrane in the Qianlishan and Helanshan areas is dominanted by khondalite. The khondalite series exhibit U-Pb isochron ages of 1,800-2,000 Ma (Paleoproterozoic). The oldest overlapped assemblages are Paleo amd Mesoproterozoic metamorphosed fragmental rocks-carbonate rocks formed in a Paleo and middle Mesoproterozoic rift environment.

REFERENCES: Jin Wei and others, 1991; Wu Changhua and others, 1994; Lu Liangzhao and others, 1996; Wu Jiashan and others, 1998.

SKJ Jilin-Liaoning-East Shandong terrane (Tonalite-trondhjemite-gneiss) (Archean) (Northeastern China)

Consists mainly of granitoid gneiss of the tonalite-trondhjemite-granodiorite series with an isotopic age of greater than 2,900 Ma and Late Archean potassic granite.A U-Pb zircon age of the granitoid mylonite derived trondhjemite at Anshan, Liaoning Province, is 3,804 Ma showing relics of Early Archean granitoid continental crust in the terrane. Metamorphic supracrustal rocks occur in the granitoid gneiss as variable size relics. In the northern Liaoning and southern Jilin Provinces at the northern part of the terrane, supracrustal rocks consist of two-pyroxene granulite, amphibolite, biotite plagioclase gneiss, biotite leptynite, chlorite schist, and phyllite intercalated with large amounts of magnetite quartzite. In southern Liaoning Province in the central part of the terrane, relics of the metamorphic supracrustal rocks consist of biotite diopside plagioclase gneiss, biotite leptynite, magnetite quartzite, and amphibolite that are metamorphosed to amphibolite facies with a metamorphic age of about 2,600 Ma. In eastern in of the Shandong Peninsula in the southern part of the terrane, the granitoid gneiss formed during the Late Archean and comprises most of the region, and supracrustal rocks consist of biotite leptynite, plagioclase gneiss and leptite and intercalated amphibolite and local amphibole two-pyroxene granulite. A U-Pb zircon isotopic age for the gneiss is 2,500 to 2,600 Ma. The oldest overlap assemblages is the

Paleoproterozoic volcanic rocks, fragmental rocks and metamorphosed carbonate sedimentary rocks that occur in the Paleoproterozoic Rift).

REFERENCES: Liu D.Y., 1992; Cheng Yuqi, 1994; Shen Baofeng and others, 1994; Wu Jiashan and others, 1998.

SKL West Liaoning-Hebei-Shanxi terrane (Granulite-orthogneiss) (Archean) (Northern China

Consists mainly of varous assemblages of Archean metamorphic rocks in different areas, and is probably a composed terrane.

In the Northern Hebei and Western Liaoning Provinces, the northern part of the terrane consists mainly of deformed and metamorphosed felsic gneiss (derived from intermediate and siliceous intrusions) and various granitoids. Felsic gneiss derived from multiple intrusive episodes of a tonalite and trondhjemite-granodiorite complex. Isotopic ages range mostly from 2,500 to 2,600 Ma and rarely up to 2,900 Ma. Granites include hypersthene granite and monzonite and potassic granite, have isotopic ages of 2,400 to 2,500 Ma, and are the products of anatectic melting of the felsic gneiss and supracrustal rocks. Minor supracrustal rocks in the area consists mainly of: (1) interlayered sillimanite garnet biotite plagioclase gneiss, fine-grained garnet biotite gneiss, and fine-grained, felsic, garnet-rich gneiss occasionally with graphite flakes; (2) an assemblage of amphibole-biotite granulite- and plagioclase gneiss locally intercalated withmagnetite quartzite; and (3) stratiform garnet- and pyroxene-amphibolite and intermediate to mafic granulite and sparse lensoidal ultramafic rocks. The isotopic ages range from 2,400 to 2,600 Ma. The highest metamorphic degree of the metamorphic complexes is up to granulite facies and it is concluded that the metamorphic temperature and pressure are up to 800° C and 0.8 Gpa respectively. In the Qian An area are some relics of Early Archean crust in the Late Archean Granite that are composed of metamorphosed supracrustal rocks such as amphibolite, chrome-mica or garnet- and sillimanite quartzite, and banded iron formation, and gray gneiss. A maximum U-Pb zircon age for chrome-mica quartzite is 3,722 to 3,630 Ma.

In the Taihang Mountain area, thecentral-southern part of the terrane, the major units are metamorphosed sedimentary, volcanogenic, and mafic volcanic rocks with minor metamorphosed plutons. The common units are mafic granulite, amphibolite, felsic gneiss, leptynite, leptite, and marble that are metamorphosed at granulite facies.

The western parts of the terrane in the Wutai Mountain and Luliang Mountain areas consists of granite-greenstone belts, tonalite-trondhjemite-granodiorite, and monzotite. The greenstone belts consist of: (1) biotite leptynite, amphibolite, and metamorphosed ultramafic rocks; (2) chlorite schist, chlorite-albite schist and feldspar quartzite; and (3) quartzite and phyllite. The isotopic age of the granite intruding the assemblages is 2,500 to 2,600 Ma.

In the Hengshan area, the northwestern part of the terrane contains supracrustal rocks consisting mainly of garnet two-pyroxene granulite, amphibolite, amphibole leptynite, and biotite plagioclase gneiss. The felsic gneiss is derived from tonalite-trondhjemite-granodiorite. The units are metamorphosed at amphibolite to granulite facies. The oldest overlapp assemblages are slightly metamorphosed Paleoproterozoic cataclastic rocks and carbonates of the Hutuo Group formed in a Paleoproterozoic rift.

REFERENCES: Dong Shengbao and others, 1986; Wu Jiashan and others, 1991, 1998; Liu, D.Y. and others, 1990; Bai Jin and others, 1993; Cheng Yuqi and others, 1994.

SKM Machollyong terrane (Granulite-paragneiss) (Archean to Paleoproterozoic) (Korea)

Consists of Archean and Proterozoic rocks: (1) Archean porphyroblastic gneiss; (2) Machollyong Supergroup containing Proterozoic schist, gneiss, and marble; and (3) the Sangwon Group containing Neoproterozoic conglomerate, sandstone, shale, limestone, and quartzite. Units intruded by Riwon Complex granite, the Late Permian-Triassic Hyesan Complex granite, and the

Jurassic Daebu granite, and are overlapped by Jurassic epicontinental volcanitic and terrigenous rocks of the Jason Group. Overlap Tertiary rocks are epicontinental terrigenous deposits and volcanic rocks of the Ch'ilbosan and Myongchong Groups.

REFERENCES: Geology of Korea, 1993.

SKR Rangnim terrane (Granulite-paragneiss) (Archean) (Korea)

Consists of gneiss, migmatite, and metamorphic granite of the Nangnim Supergroup, with lesser granulite, gneiss, schist, and amphibolite, and metamorphosed ultramafic extrusive rocks. Unconformably overthrust are Neoproterozoic (Sinian), slightly metamorphosed deposits of the Sangwon Supergroup including the Chik'yon Series composed of chlorite-, muscovite-, and calcite-chlorite schist, phyllite, quartzite, and marble; the Sadang-u Series composed of limestone and dolomite with intercalated chlorite schist, phyllite, and quartzite; and the Kuhyon Series composed of pebble phyllite, coal-beraring phyllite, and black slate.

Overlap assemblages are the early Paleozoic Chonsun Supergroup, and the late Paleozoic and early Mesozoic Pyeongang Group. The Chosun Supergroup consists of Early and Middle Cambrian Yangdok Group composed of basal quarzite conglomerate and shale with limestone interlayer; the Middle-Late Cambrian Ch'osan Group composed of shale with limestone layers; the Ordovician Mandal Group composed of limestone and dolomitic limestone; and the Silurian Hoedongri Formation composed of limestone, dolomitic limestone, siltstone, and mudstone. Unconformably overlying is the Pyeongang Group that consists of the Late Carboniferous Hongjin Series composed of purple and dark shale and limestone, the Late Carboniferous and Early Permian Sadong Series composed of shale, sandstone, anthracite coal beds, and limestone, the Late Permian Kobansan Series composed of sandstone, shale, and coal beds, and the Triassic Taejawon Series composed of red, yellow, and dark green shale and sandstone. All older units are unconformably overlain by Middle and Late Jurassic terrigenous conglomerate, sandstone, and shale of the Taedong Supergroup and Early Permian conglomerate, shale, sandstone, and intermediate and siliceous volcanic rocks of the Taebo Group. Intruding the terrane are the Late Permian and granite of the Triassic Hyesan complex, and the Jurassic Daebo and Late Cretaceous Bulgugsa granites.

REFERENCES: Geology of Korea, 1993.

SKYE Yeongnam terrane (Granulite-paragneiss) (Late Archean to Paleoproterozoic) (Korea)

Consists of: (1) gneiss and schist of the Sabaegsan Complex that is composed of metapelitic rocks, para- and orthgneiss; (2) the Sanch'ong Complex that is composed of metamorphosed gabbro, diorite, syenite, anorthosite, and gneiss; and (3) gneiss and schist of the Honam Complex that is composed of granitic gneiss, paragneiss, and metasedimentary rocks. Units metamorphosed to amphibolite facies and intruded by synkinematic Hongiesa granite with a K-Ar biotite isotopic age of 880 Ma. Units unconformably overlain by nonmetamorphosed sedimentary rocks of the early Paleozoic Chosun Supergroup, and late Paleozoic Pyeonngang Group. The Chonsun Supergroup consists of the Early and Middle Cambrian Yangdok Series that is composed of conglamerate, quartzite, slate, and rare limestone. The Middle Cambrian through Ordovician Great Limestone Series is composed of limestone, shale, and quartzite. The Pyeongang Supergroup consists of rare continental and shallow-marine coal-bearing terrigenous rocks of Carboniferous, Permian, and Early Triassic age, including conglomerate, sandstone, slate, and mudstone. The lower Pyeongang Group contains several limestone beds. Intusive rocks are the Jurassic Daebu granite interpreted as forming along an active continental margin. Overlap units consist of: (1) Early Cretaceous terrigenous epicontinental deposits of the Sindong and Hayang Groups that formed in pull-apart basins along a transform continental margin; and (2) Late Cretaceous volcanic rocks of the Yuchon Group and Bulgugsa granite.

REFERENCES: Geology of Korea, 1993.

SKYS Yinshan terrane (Granite-greenstone belt) (Archean) (North-central China)

Consists of: (1) plagioclase amphibolite, amphibolite, and hornblende schist intercalated with biotite-albite schist and magnetic quartzite; (2) albite-biotite schist intercalated with plagioclase amphibolite, metatuffaceous sedimentary; (3) hornblende-albite schist intercalated with metavolcanic terrigenous and terrigenous sedimentary rocks metamorphosed to chlorite schist with lower amphibolite facies metamorphism. Granitic rocks include mainly tonalite and K-feldspar granite. A U-Pb zircon isotopic age for tonalite is 2,450 to 2,470 Ma. The oldest overlapping assemblages are terrigenous-carbonate metasedimentary units of a Paleoproterozoic rift and a Mesoproterozoic rift.

REFERENCES: Li Shuxun and others, 1987;Cheng Yuqi and others, 1994; Zhang Yixia and others, 1994.

TECTONIC MELANGE ZONES

am Amga tectonic melange zone (Yakutia)

The Amga tectonic melange zone separates the Central Aldan superterrane from the West Aldan and Tynda composite terranes to the west and south of it, respectively, truncates the Kalar tectonic melange zone, forms an arch, extends for 650 km, ranges from a few kilometers to 150 km wide. The zone consists of thrust and strike-slip faults and synchronous folds that strike parallel to the length of the zone. The zone contains rock assemblages of significantly different composition, age, and metamorphic grade. Most widespread are orthogneiss and subordinate tonalite-trondhjemite gneiss. Also present are paragneiss, fragments of greenstone belts of Archean and Paleoproterozoic age, and differentiated plutons of gabbro, diorite, and plagiogranite.

The orthogneiss consists of granitic gneiss and gneissic granite metamorphosed at transitional amphibolite to granulite facies, and tonalite-trondhjemite gneiss and migmatite metamorphosed at amphibolite facies. The isotopic age of granitic gneiss is 2.4 to 2.5 Ga and for associated pegmatoid gneissic granite is 2.2 Ga. Tonalite-trondhjemite gneiss and migmatite, that are widespread in the West Aldan composite terrane, have an isotopic age of 2.8 Ga. In the western zone, boudins of altered eclogite with a model Nd isotopic age of 2.4 Ga occur, and exhibit regressive amphibolite facies metamorphism with an isotopic age of 1.9 Ga. Zircons from migmatite leucosomes exhibit a similar age.

Granulite facies paragneiss complex occurs in the Chuga, Amedichi, and Fedorov Groups. The Chuga Group, with no analogues in adjacent terranes, consists of garnet-biotite gneiss, plagiogneiss, quartzite, carbonate rocks, and biotite, biotite-amphibole, amphibole and diopside-amphibole plagiogneiss and schist with a peak metamorphic grade of moderate-pressure, low-temperature granulite facies. Sm-Nd isotoic data indicate an age of 2.3 to 2.4 Ga for the source rocks for garnet-biotite and garnet-cordierite-biotite plagiogneiss and migmatite that are derived from metagraywacke.

The Amedichi Group occurs in the central part of the zone and consists of quartzite and high-alumina gneiss, lenses of calc-silicate rocks and calciphyres, and rare bodies of mafic schist. Protoliths of the high-alumina gneiss and migmatite were derived from the rocks with ages of 3.6 to 3.3 Ga and were metamorphosed at moderate-pressure, high-temperature granulite facies. The lithology and metamorphism of the group are similar to those of the Kulumkan Group in the Central Aldan superterrane/ The Fedorov Group occurs in the eastern zone and is analogous to the Fedorov Formation in the Central Aldan superterrane. The paragneisse comprising this group exhibit diaphthoresis at amphibolite and greenschist facies.

Near the western margin of the zone are fragments of Archean greenstone belts. The largest is the Subgan belt (with dimensions of25 km by 5 km) that consists of metabasalt with an isotopic age of 2.9 Ga, and metapelite. The belt is regionally metamorphosed at low-grade amphibolite facies (andalusite-sillimanite zone). The isotopic age of synmetamorphic granite and pegmatite from the sillimanite zone is about 2.0 Ga. Progressive metamorphism of the Subgan greenstone belt suceeded by isofacial diaphthoresis and structural transformation of granite-gneiss, gneiss-granite and the rocks of the Chuga Group that frame the belt. The Subgan belt was probably metamorphosed from about 2.15 to 1.9 Ga. Paleoproterozoic greenstone belts have been tentatively established based on preliminary isotopic data, comprise small tectonic slabs in the central part of the zone, and consist of metavolcanic rocks,

metapelite, and metapsammite. The grade of metamorphism varies from greenshist to low-grade amphibolite facies that occurred from about 2.0 to 1.9 Ga.

Stitch assemblages include granite and pegmatite with isotopic ages of 2.0 to 1.9 Ga, and coeval gabbro, diorite, and plagiogranite (Ungra complex) metamorphosed at amphibolite facies.

REFERENCES: Beryozkin, 1977; Dook and others, 1986; Sal'nikova, 1993; Smelov and Beryozkin, 1993; Kovach and others, 1995b; Smelov, 1996.

bl Billyakh tectonic melange zone (Yakutia)

The Billyakh tectonic melange zone occurs in the eastern Anabar shield, separates the Daldyn and Khapchan terranes, and extends for 250 km and ranges from 5 to 12 km wide. The zone is defined by a well-defined gravity low, in which marginal mylonite sutures exhibit an intense positive magnetic anomaly. The magnetic signature of the interior part of the zone is highly differentiated and with alternating signs, whereas to the west, near the Khapchan terrane area, magnetic signature is subdued. The zone dips steeply east, flattens at depth according to geophysical data, and consists of closely-spaced fault systems bounding blocks of variable diaphthorite and migmatite. The main rock types are biotite-amphibole paragneiss with garnet and graphite that is retrograded amphibolite facies, often with well-preserved bands and boundins of non-retrograded rocks. Occurring locally are carbonate and calc-silicate rocks. Low-grade, amhibolite facies diapthotite forms lenses along mylonitization zones and consist of epidote-clinopyroxene and andradite-clinopyroxene schist. In the central part of the zone is the Billyakh pluton composed of of porphyroblastic granodiorite and granite. In the northeastern Anabar shield, the Billyakh tectonic melange zone is adjacent to a band of diaphthorite and mylonite named the Saltakh diaphthoresis zone that contains lithology and structure similar to other parts of the Billyakh zone. The Saltakh zone includes several diorite-tonalite plutons. The structure of the Billyakh zone generally consists of alternating mylonitize and cataclastic zones with strike-slip and reverse movements, and by lenses and small blocks with well-defined linear folds with steeply-dipping hinges and axial surfaces.

REFERENCES: Lutz and Oxman, 1990.

kl Kalar tectonic melange zone (Yakutia)

The Kalar tectonic melange zone occurs between the West Aldan granite-greenstone composite terrane and the Tynda tonalite-trondhjemite-gneiss composite terrane to the south. The zone extends latitudinally for 650 km and ranges from 50 to 150 km wide. The zone structure consists of widely-developed, deep-seated thrusts and strike-slip faults, and companion folds. The zone contains a large number of tectonic slabs wuth rocks differing in composition, age, and metamorphism, including the granulite of the Khani-Kurul'ta, Zverev, and Iengra blocks, tonalite-trondhjemite orthogneiss, Archean and Paleoproterozoic greenstone belts, anorthosite, and granite.

Granulite in the Khani-Kurul'ta block consists of enderbite-, charnockite-, and granite-gneiss, hypersthene, two-pyroxene, two-pyroxene-amphibole plagiogneiss with lenses and bands of garnet-biotite and garnet-hypersthene gneiss, garnet-biotite, garnet-cordierite, and garnet-sillimanite gneiss with lenses of calc-silicate rocks and magnetite quartzite. Grade of metamorphism increases from east to west to moderate- and high-pressure granulite facies. The protolith of the garnet-hypersthene plagiogneiss has an isotopic age of 3.0 Ga, and a Sm-Nd isochrone isotopic age for garnet-pyroxene schist is 3.1±0.018 Ga (Jahn and others, 1990). Paragneiss is intruded by a pluton of metagabbro, metadiorite, and metagabbroanorthosite prismatic magmatic zircon with an isotopic age 3.0 to 3.15 Ga, and isometric metamorphic zircon with an isotopic age of 2.96 to 3.15 Ga. These relations suggests almost emplacement and metamorphism of intrusive rocks.

Granulite in the Zverev block consists of diorite-gneiss, enderbite-gneiss, and amphibolite with lenses and bands of paragneiss with peak metamorphism of high-pressure granulite facies. A two-pyroxene schist has an isotopic age of 3.0±0.10 Ga, metagabbro has an age of 2.90±0.09 Ga, and enderbite has an age of 2.7 Ga.

Paragneiss of the Iengra block exhibits Paleoproterozoic metamorphism. Zircon from quartzite and amphibolite a Pb-Pb isotopic age of 2.38 to 1.8 Ga. The orthogneiss complex is metamorphosed to amphibolite facies,is tectonically juxtaposed against the granulite blocks, and consists of Late Archean biotite plagiogneiss derived from tonalite-trondhjemite. Pb-Pb zircon isotopic ages are 2.8 to 2.5 Ga, and are close to the ages of tonalite-trondhjemite gneiss from the West Aldan and Tynda composite terranes.

The Kalar belt is metamorphosed to low grade amphibolite facies and is interpreted as an Archean greenstone belt. The Chulman belt contains Paleoproterozoic greenstone with a model Nd isotopic age for low-grade amphibolite facies amphibole-plagioclase schist of 2.1 Ga. Anorthosite in the Kalar pluton occurs separate tectonic slabs and has an isotopic age of 1.9 Ga.

Stitching assemblages in the the Kalar tectonic melange zone include various types of pegmatite and a layered gabbro-ultramafic pluton with an isotopic age of 1.9 to 1.8 Ga.

REFERENCES: Fedorovskiy, 1972; Beryozkin, 1977; Bushmin and others, 1983; Dook and others, 1986; Rudnik, 1989; Jahn and others, 1990; Kovach and others, 1995b.

kt Kotuykan tectonic melange zone (Yakutia)

The Kotuykan tectonic melange zone extends northwest across the central part of the Anabar shield, and separates the Daldyn enderbite-gneiss terrane to the east from the Magan tonalite-trondhjemite terrane to the west. The Kotuykan zone forms linear structure curved westward. Magnetic and gravity anomalies for the zone extend more than 150 km to the middle reaches of the Great Kuonamka and Kotuykan Rivers. The melange zone consists of two bands: (1) a western band, named the Lamuik diaphthoresis zone; and (2) an eastern band named the Kotuykan-Monkhool diaphthoresis zone. Between the bands are small blocks and wedges of both the Magan and Daldyn terranes. The Kotuykan melange zone is truncated by the major Anabar fault. Adjacent to the southern part of the Kotuykan zone is a narrow wedge of diaphthorite named the Kharapsk diaphthoresis zone. Boundaries between the zone and granulite facies rocks are consist of left-lateral strike-slip and reverse faults that form steep southeast dipping mylonite zones. The Kotuykan melange zone exhibits a lens-block structure that is the result of abundant mylonite and cataclasite along the fault zones.

The zone consists mainly of amphibolite facies diaphthorite composed of biotite, biotite-amphibole, and amphibole gneiss and schist with local garnet. Occurring locally are quartzite and high-alumina gneiss. The units are metamorphosed to high-temperature amphibolite grade. Low-grade amphibolite and greenschist facies diaphthorite, in an en-echelon arrangement, occurs in the Aly-Yuryakh and Monkhoolo Rivers interfluve. Progressively metamorphosed rock assemblages occur in the diaphthoritic zone and contain a characteristic parageneses. These rocks are fine-grained, contain no relics of primary high-temperature minerals, and do not contain reaction relations. Garnets exhibit a progressive metamorphic zoning, with spessartine and grossular increasing from rim to core.

Magmatic units in the Kotuykan zone are giant plutons of anorthosite, monzodiorite, and gabbro-anorthosite (northern and central parts of zone), porphyroblastic granodiorite, alaskite, biotite granite, and two-mica granite and pegmatite (central and southern parts of zone). A Sm-Nd mineral isochron isotopic age for monzodiorite is 2.2 Ga (ε Nd=-6.1) and is interpreted as the crystallization age. Monazite from syntectonic migmatite exhibits a U-Pb discordant zircon isotopic age of 2.0 to 1.9 Ga, and genetically related uraninite exhibits a Pb-Pb isotopic age of 2.0 to 1.9 Ga. The youngest unit in the Kotuykan melange zone is biotite granite with a discordant U-Pb zircon isotopic age of 1.9 to 1.8 Ga.

REFERENCES: Stepanov, 1974; Perchuk and Ryabchikov, 1976; Oxman, 1989; Lutz and Oxman, 1990; Rosen and others, 1994.

mg Magan tectonic melange zone (Yakutia)

The Magan tectonic melange zone occurs in the western part of the Anabar shield, is bounded by bands of mylonite and cataclasite ranging up to 2 km wide. The structure of the zone is defined by systems of closely-spaced, subparallel strike-slip and reverse faults containing bands of mylonite and strongly-foliated rocks. The northern Magan zone contains mainly amphibolite facies diaphthorite consisting of intensively migmatized and granitized biotite and biotite-amphibole gneiss, with lenses of pink and red granite, and lesser carbonate and high-alumina rocks. Also occurring are granulite facies lenses with weak development of diaphthorite. The northwest Magan zone contains the Kraevoy pluton containing porphyroblastic granitoids, and in the interfluve of the Minor and Great Magana rivers are anorthosite plutons.

REFERENCES: Rosen and others, 1994.

tr Tyrkanda tectonic melange zone (Yakutia)

The Tyrkanda tectonic melange zone occurs between the East Aldan superterrane and the Central Aldan superterrane and The ynda composite terrane to the west and south, respectively. The zone is arched, extends for 1,650 km, and ranges from 50 to 200 km wide. The zone contains tectonic slabs of various types of paragneiss and anorthosite that are bounded by narrow blastomylonite zones, Abundant granite bodies occur in the sublongitudinal part of the zone. The largest are the Idjek and Kholbolokh slabs that dip gently eastward direction.

The Idjek tectonic slab consists of hypersthene, hypershene-diopside, and hypersthene-diopside-amphibole plagiogneiss with bands and lenses of two-pyroxene-hornblende schist and calc-silicate and diopside schist. Locally occurring are lenses of garnet-biotite and garnet-hypersthene-biotite plagiogneiss and gneiss. The unit is metamorphosed to high-pressure granulite facies with a Nd model isotopic age for garnet-biotite plagiogneiss of 2.4 Ga.

The Kholbolokh tectonic slab consists of garnet-biotite plagiogneiss with bands of calc-silicate rock, quartzite, sillimanite and cordierite gneiss, and hypersthene, diopside, and two-pyroxene plagiogneiss with bands of calc-silicate rock, schist, and garnet-biotite gneiss metamorphosed to high-pressure granulite facies. A Sm-Nd isotopic age for biotite-hypersthene, garnet-biotite, and garnet-biotite-sillimanite gneiss indicate protoliths were derived from the rocks as old as 2.35 to 2.2 Ga.

Stitching magmatic rocks are the Ust'-Idjek pluton charnockite that intrudes paragneiss of the Idjek tectonic slab and contain xenoliths of garnet-biotite gneiss of the Seim Group in the Sutam terrane. A U-Pb isochrone isotopic age for magmatic zircon from charnockite is 1.9 Ga. Anorthosite in the Tyrkanda zone has a similar age.

The Idjek and Kholbolokh tectonic slabs contain rocks similar to the East Aldan superterrane. The Tyrkanda tectonic melange zone is interpreted as a deep thrust zone along which the East Aldan superterrane is overthrust the Central Aldan superterrane.

The tectonic melange zones of the Aldan-Stanovoy shield were welded at about 2.1 to 1.8 Ga, along with composite terranes and superterranes into a single continental block. The welding consisted of repeated deformation and high-temperature metamorphism up to granulite facies in the Central Aldan and East Aldan superterranes, as well as by repeated deformation and regional low-grade amphibolite and greenschist facies of metamorphism in the West Aldan composite terrane.

REFERENCES: Dook and others, 1986; Smelov, 1996; Rudnik, 1989; Stogniy and others, 1996.