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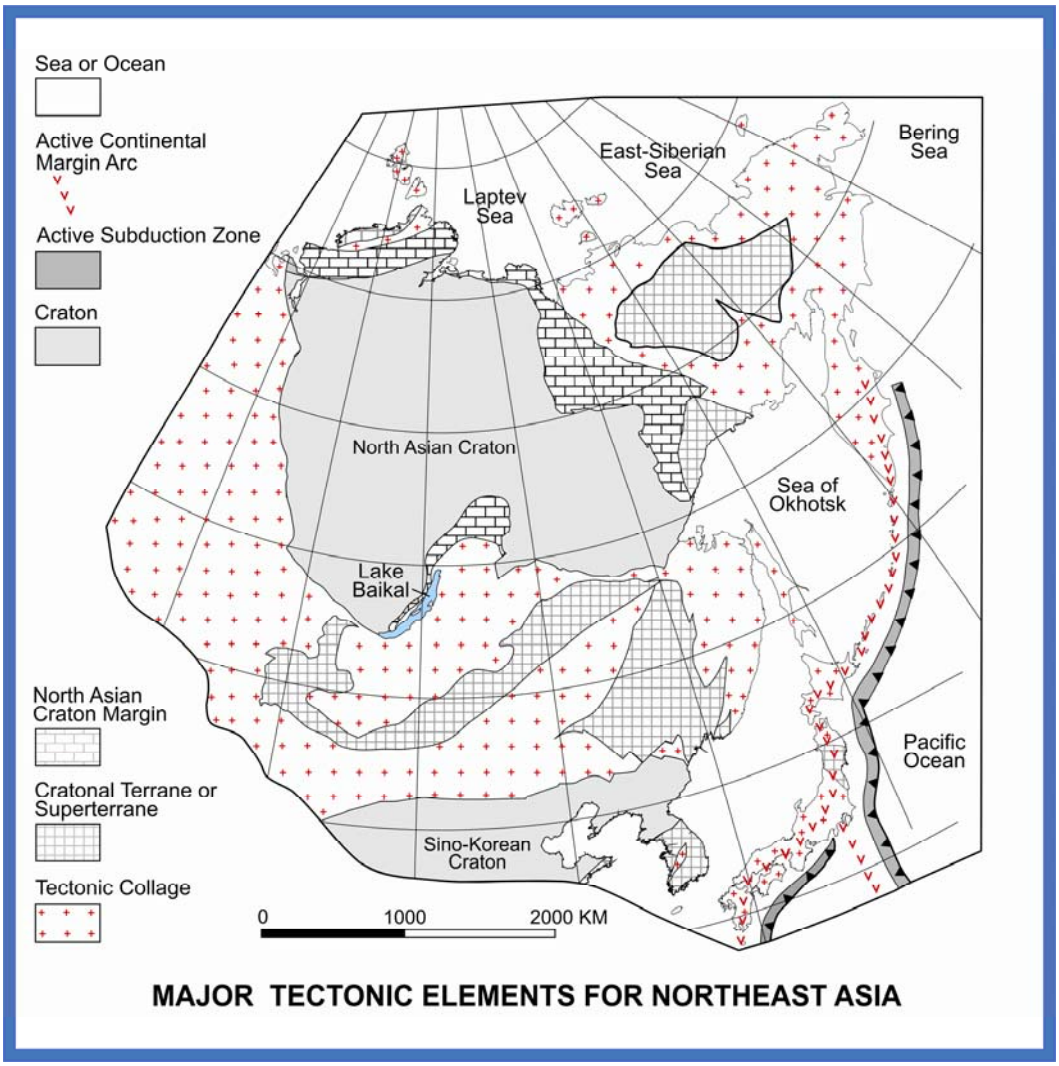
Appendix B – Description of Map Units for Northeast Asia Summary Geodynamics Map



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U.S. Department of the Interior
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Prepared in collaboration with Russian Academy of Sciences, Mongolian Academy of Sciences, Korean Institute of Geosciences and Mineral Resources, Geological Survey of Japan/AIST, and Jilin University

Appendix B – Description of Map Units for Northeast Asia Summary Geodynamics Map

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Appendix B – Description of Map Units for Northeast Asia Summary Geodynamics Map

Introduction

The major map units on the Northeast Asia Summary Geodynamics Map are cratons, craton margins, cratonal terranes, superterranes, tectonic collages (Archean to Proterozoic, Vendian to Cretaceous, Late Cretaceous and Cenozoic), overlapping continental-margin arcs (Devonian to early Tertiary), transform continental-margin arcs (Devonian to Early Cretaceous), active arcs (Miocene through Present), and active subduction zones (Miocene through Present). Units are listed in order of map unit abbreviations within each major unit. The map units are described in Greninger and others (1999), Nokleberg and others (1994, 1997c, 2000, 2004), and Naumova (2006).

Cratons

NAC - North Asian Craton (Archean and Proterozoic). Consists of Archean and Proterozoic metamorphic basement, and non-deformed, flat-laying platform cover consisting of Late Precambrian, Paleozoic, and Mesozoic sedimentary and volcanic rock. Cover 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 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. Four sequences comprise the platform cover: (1) Neoproterozoic; (2) Vendian and early Paleozoic; (3) middle Paleozoic; (4) late Paleozoic; and (5) Mesozoic. Each stage is characterized by a unique structural style and unique suite of sedimentary and magmatic rocks. The sequences are separated from each other by regional discontinuities and unconformities that are related to major tectonic events.

SKC - Sino-Korean Craton (Archean and Proterozoic). Consists of several major terranes and younger overlap units in northern China and northern Korean Peninsula. The Archean and Proterozoic metamorphic basement is composed of various major terranes and first overlap units: (1) Paleoproterozoic Alashan granulite-paragneiss terrane in northwestern China; (2) Archean Erduosi Granulite-paragneiss terrane in north-central China; (3) Archean Yinshan granite-greenstone terrane and first overlapped Zhangbei-Bayan Obo-Langshan metasedimentary and metavolcanic rocks (Paleo-Mesoproterozoic) in north-central China;

(4) Archean Jilin-Liaoning-East Shandong tonalite-trondhjemite-gneiss terrane and overlapped, metamorphosed and deformed rocks of East Shandong-East Liaoning-East Jilin rift or foreland basin (Paleoproterozoic) in northeastern China; (5) Archean West Liaoning-Hebei-Shanxi granulite-orthogneiss terrane and overlapped, metamorphosed and deformed rocks of Hutuo rift basin (Paleoproterozoic) in northern China; (6) Archean to Paleoproterozoic Machollyong granulite-paragneiss terrane in northern Korean Peninsula; and (7) Archean Rangnim granulite-paragneiss terrane in northern Korean Peninsula. Overlap units are extensive Proterozoic and Paleozoic continental-margin sedimentary rock and lesser volcanic rock; and extensive Mesozoic and Cenozoic marine and terrigenous sedimentary rock units, and volcanic and plutonic arc rock units.

Craton Margins

BP - Baikal-Patom Craton Margin (Riphean to Cambrian and older basement). Consists of a fault-bounded basin containing Riphean carbonate and terrigenous sedimentary rock, and younger Vendian and Cambrian sedimentary rock that discordantly overly a fragment of pre-Riphean basement of the North Asian Craton. Local detritus suggests derivation from ophiolite and island arc complexes of the Bakal-Muya terrane during accretion to the craton. Local greenschist and amphibolite facies regional metamorphism with isotopic ages of about 800 Ma.

EA - East Angara Craton Margin (Riphean and older basement). Consists of late Riphean terrigenous-carbonate sedimentary rock (sandstone, siltstone, mudstone with interlayered dolomite and limestone) that overlie a fragment of the North Asian Craton. Metamorphosed up to greenschist facies. Unconformably overlapped by late Riphean and Vendian molasse and Vendian and Cambrian dolomite and limestone.

ST - South Taimyr Craton Margin (Ordovician to Jurassic). Consists chiefly of a thick wedge of craton margin deposits and deep basin deposits ranging up to 20,000 m thick. Composed chiefly of Ordovician to Jurassic clastic rock, shallow-marine terrigenous and carbonate rock, and mafic volcanic and volcaniclastic rock. Late Carboniferous and Permian sedimentary rocks contain extensive sills and dikes of the Early Triassic trap subalkaline and alkaline diabase. The terrane is interpreted as a tectonically detached from crystalline basement of the North Asian Craton that was subsequently accreted back onto the craton.

VR - Verkhoyansk (North Asian) Craton Margin (Devonian to Jurassic). 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 rock, and marine-littoral, deltaic, and shelf sedimentary rock deposited on the Verkhoyansk passive continental 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 Early Carboniferous, rift-related deposits similar to those on Siberian Platform; and (2) local Early Triassic and Early Jurassic alkalic basalt flows, dikes, and sills. Northern and southern parts of craton margin contain thick, Neoproterozoic and early Paleozoic shallow-marine carbonate and clastic deposits that are finer-grained and thicker to east. The terrane is interpreted as tectonically detached from passive continental margin and crystalline basement of the North Asian Craton.

Cratonal Terranes

GY - Gyenggi-Yeongnam (combined) cratonal terrane (Archean and Proterozoic). Consists of two major parts: (1) Mesoproterozoic and Neoproterozoic and older Gyenggi granulite-paragneiss terrane in southern Korean Peninsula; and (2) Late Archean to Paleoproterozoic Yeongnam granulite-paragneiss terrane in southern Korean Peninsula. Locally overlain by extensive Paleozoic continental margin sedimentary rock and lesser volcanic rock; and extensive Mesozoic and Cenozoic marine and terriginous sedimentary rock units, and volcanic and plutonic arc units. The terrane is interpreted as a displaced fragment of the Sino-Korean Craton, or possibly a fragment of the South China (Yangzi) Craton.

JA - Jiaonan cratonal terrane (Proterozoic). Consists a Paleoproterozoic major high pressure terrane that is a displaced fragment of the South China (Yangtzi) Craton. Locally overlain by extensive Paleozoic continental margin sedimentary rock and lesser volcanic rock; and extensive Mesozoic and Cenozoic marine and terriginous sedimentary rock units, and volcanic and plutonic arc units.

OH - Okhotsk cratonal terrane (Archean, Proterozoic, and early and middle Paleozoic). Consists chiefly of large blocks of Archean to Paleoproterozoic gneiss and schist with a U-Pb zircon age of 3.7 Ga. Overlain by: (1) gently-dipping, shallow-marine Middle and Neoproterozoic clastic and carbonate rock; (2) Early Cambrian limestone, marl, and sandstone; (3) Early Ordovician conglomerate, limestone, marl, and sandstone; and (4) unconformably overlying Middle Devonian limestone, sandstone, shale, and conglomerate, and Late Devonian rhyolite, ignimbrite, andesite, dacite, and tuff that are interlayered with nonmarine sandstone, siltstone, and conglomerate.
Overlying units are Carboniferous to Late Jurassic nonmarine and rare marine clastic rock. The terrane is interpreted as a fragment of the North Asian Craton and Craton margin that was rifted in the Late Devonian or Early Carboniferous and accreted to the Eastern Asia continental margin in the Late Jurassic.

Superterranes

AR - Argun-Idermeg superterrane (Proterozoic to Cambrian; Timing of accretion - Late Neoproterozoic to Cambrian). Consists of: (1) Paleoproterozoic to late Paleozoic Argunsky metamorphosed passive continental margin terrane (AR) (Eastern Mongolia, Northeastern China, Transbaikalia); and (2) Proterozoic to Cambrian Idermeg metamorphosed passive continental margin terrane (ID) (Eastern Mongolia).

BJ - Bureya-Jiamusi supterterrane (Proterozoic to Permian; Timing of accretion – Early Paleozoic). Consists of an early Paleozoic collage fragments of the following metamorphic, continental-margin arc, subduction zone, passive continental-margin and island arc terranes: (1) Neoproterozoic to Triassic Bureya terrane (BU) (Southern Russian Far East); (2) Neoproterozoic and older and Early Cambrian Jiamusi terrane (JI) (Northeastern China); (3) Proterozoic Matveevka terrane (MT) (Southern Russian Far East); (4) Proterozoic Nakhimovka terrane (NK) (Southern Russian Far East); (5) Silurian to Permian(?) South Kitakami metamorphosed island arc terrane (SK) (northern Honshu Island, Japan); and (6) Late Carboniferous and Permian Laoyeling-Grodekov island arc terrane (LG) (Northeastern China, southern Russian Far East); (7) Cambrian through Permian passive continental-margin Voznesenka terrane (Southern Russian Far East); (8) Cambrian(?) and Ordovician(?) Sergeevka island arc terrane (SG) (Southern Russian Far East); (9) Neoproterozoic through Devonian Zhangguangcailing continental-margin arc terrane (ZN) (Northeastern China); (10) Ordovician and Silurian Heilongjiang subduction zone, type B terrane (HE) (Northeastern China); (11) Archean through Middle Triassic Urmi passive continental margin terrane (UR) (Northeast China, southern Russian Far East); and (12) Late Carboniferous and Permian Tumangang island arc terrane (TB) (Korea).

These terranes are derived from a series of late Precambrian volcanic units, and late Precambrian to Ordovician shallow marine clastic and carbonate rock. Local amphibolite and granulite facies metamorphism of Early and Middle Ordovician age (480 to 500 Ma). Units intruded by Cambrian and Ordovician granitoids and unconformably overlain by Devonian rock.

The superterrane is interpreted as a fragment of Gondwana that was accreted to the Sino-Korean craton in the Late Permian and accreted to the North Asian Craton in the Late Jurassic during closure of the Mongol-Okhotsk ocean. The superterrane may be a fragment of the Yenisey-Transbaikal orogenic belt that also contains early Paleozoic granulite facies metamorphism and Cambrian and Ordovician granitoids.

KR - Kara superterrane (Proterozoic to Ordovician; Timing of accretion – Early Paleozoic(?). Consists of Late Neoproterozoic to Ordovician Kara continental-margin turbidite terrane (KR) (northern part of Taimyr Peninsula). The terrane contains mainly Late Riphean turbidite units metamorphosed up to amphibolite facies. Uppermost turbidites contain Cambrian and Early Ordovician fauna. Turbidites are unconformably overlain by Ordovician-Devonian littoral-marine and continental sedimentary rock. The superterrane accreted to North Asian Craton with genesis of Middle Permian two-mica and biotite-amphibole granite and granodiorite (with U-Pb, Rb-Sr, and incremental Argon isotopic ages of 264 to 252 Ma. Granitoids comprise an extensive belt that obliquely cuts the superterrane and the margin of the late Riphean Circum-Siberian collage. The superterrane is interpreted as a rift fragment of the North Asian Craton that was reaccreted in the Jurassic.

KOM - Kolyma-Omolon superterrane (Archean to Jurassic; Timing of accretion – Late Jurassic). Consists of a collage of cratonal, passive continental-margin, island arc, ophiolite terranes. Major terranes are: Alazeya (island arc), Aluchin (subduction zone), Argatass (turbidite), Beryozovka (turbidite), Kenkel'da (subduction zone), Khetachan (island arc), Munilkan (oceanic), including various small ophiolite fragments (Garbyn'ya, Indigirka, Kybytygas, Munilkan, Uyandina, Uvyazka), Nagondzha (turbidite), Oloy (island arc), Omolon (cratonal), Omulevka (continental margin), Prikolyma (continental margin), Uyandina (island arc), and Yarkvaam (island arc). The superterrane formed during accretion of terranes of cratonal, continental (Omulevka, Prikolyma, and Omolon terranes), and oceanic affinity to the Alazeya island arc. Obduction of oceanic crust and formation of small ophiolite fragments of the Munilkan terrane were associated with this process.

The superterrane is unconformably overlain by the Late Jurassic Uyandina-Yasachnaya superterrane marginal arc (uy) under which the Oimyakon ocean basin was subducted during migration of superterrane towards the North Asia (Verkhoyansk) Craton Margin. The superterrane was accreted to the northeast Verkhoyansk (North Asian) Craton Margin in the Late Jurassic to Early Cretaceous. The accretion resulted in formation of collisional granites of the Main (mb) (Late Jurassic) and Northern (nb) (Early Cretaceous) granite belts (Yakutia).

TM - Tuva-Mongolia superterrane (Late Riphean and older; Timing of accretion – Late Neoproterozoic). Consists many of fragments of the: (1) Archean and Paleoproterozoic Gargan cratonal terrane (GG) (North Huvsgol, Mongolia, Eastern Sayan); (2) Proterozoic Sangilen passive continental-margin terrane (SA) (Southwest Siberia, Mongolia); (3) Neoproterozoic and older Baydrag cratonal terrane (BY) (Northwest Mongolia); and (4) Late Archean(?) and Paleoproterozoic(?) Muya metamorphic terrane (MS) (Transbaikalia). The superterrane also includes the various terranes of the Baikal-Muya island arc system (Baikal-Muya, Barguzin, Dibinsky, Hug, Ilchir, Kuvai, Olokit-Delunuran, and Sarkhoy terranes) that were amalgamated to form the Tuva-Mongolian microcontinent. The superterrane is unconformably overlain by Vendian and Cambrian sedimentary and volcanic rock.

Tectonic Collages Accreted Between North Asian and Sino-Korean Cratons (Proterozoic to Early Mesozoic Accretions

AB - Atasbogd collage (Ordovician to Permian; Timing of accretion – Late Carboniferous or Early Permian). Consists of: (1) Ordovician to Permian Waizunger-Baaran terrane; (2) Devonian to Carboniferous Beitianshan-Atasbogd terrane; and (3) Paleoproterozoic to Permian Tsagaan Uul-Guoershan continental-margin arc terrane; The collage is interpreted as a southwest continuation (present-day coordinates) of the South Mongolia-Khingan island arc. Units in collage are unconformably overlain by Permian volcanogenic and coal-bearing units. The collages comprising the arcs were accreted to the southern margin of the Siberian continent in the Late Carboniferous or Early Permian (320 to 300 Ma).

AL - Altai collage (AL) (Vendian to Ordovician; Timing of accretion – Late Silurian). Consists of Vendian to Early Ordovician Salair island arc and various fragments of arc-related turbidite, and subduction zone terranes, metamorphic terranes derived from arc-related units, and thick Cambrian and Ordovician overlap turbidite units formed on continental slope and rise, and fragments of originally-adjacent oceanic terranes are the major units in the collage.

The collage is interpreted as an island arc system that near the southwest margin (present-day coordinates) of the North Asian Craton and Margin and previously-accreted terranes. These units occur in the Gorny Altai, West Sayan, Central and Northwestern Mongolia, and adjacent regions of northern China.

The Salair island arc (Vendian-Early Ordovician) is preserved in various fragments in southwestern Siberia in the: (1) Early Cambrian to Early Ordovician Salair island arc terrane; (2) the Cambrian Ulus-Cherga island arc terrane; and (3) Early and Middle Cambrian Sugash terrane. The tectonically-linked subduction zone and oceanic crust units are the: (1) Vendian and Early Cambrian Alambai subduction zone terrane; and (2) Late Neoproterozoic to Early Cambrian Baratal subduction zone terrane.

The arc is also preserved in various fragments in the following metamorphic (arc-related) terranes: Middle Silurian and older Angurep terrane; Late Permian and older Belokurikha terrane; and Mesoproterozoic and Neoproterozoic Qinghe-Tsel terrane.

The arc is also preserved in various fragments of the following continental-margin turbidite terranes: Early to Late Paleozoic Anui-Chuya terrane; Precambrian and Cambrian to Devonian Altai terrane; Cambrian to Devonian Charysh terrane; Late Neoproterozoic to Devonian West Sayan terrane; and Neoproterozoic through Silurian Hovd terrane.

The arc is tectonically linked to various fragments in the following subduction zone terranes: Early Paleozoic or older Kaitanak terrane; Middle Devonian or older Maralikha terrane; Late Neoproterozoic through Early Cambrian Terekta terrane; and Late Neoproterozoic to Early Cambrian Baratal terrane.

The arc is also tectonically linked to various fragments of the following oceanic terranes: Late Neoproterozoic and Early Cambrian Mogen-Buren terrane; Late Cambrian and Early Ordovician Zasurin terrane; and Late Neoproterozoic and Early Cambrian Saratan terrane.

The timing of the accretion of the collage to the Siberian continent is constrained by an angular unconformity at the base of the Upper Silurian or Devonian units and by orogenic granitoid magmatism of Early Devonian or older (pre-Emsian) age (about 435-415 Ma).

CS - Circum-Siberia collage (Proterozoic; Timing of accretion - Neoproterozoic). The collage consists of Baikal-Muya island arc, the Near Yenisey Ridge island arc, the Zavhan continental-margin arc, Central and West Angara passive continental-margin terranes, all of Neoproterozoic age, and small fragments of cratonal and metamorphic terranes of Archean and Proterozoic age.

The collage is interpreted as three separate Neoproterozoic island arc systems that formed south (present-day coordinates) of the North Asian Craton and Margin and previously accreted terranes. The collage unconformably overlain by Vendian and Cambrian sedimentary rock units, similar to coeval rocks of the Siberian platform, but much thicker and containing more marine units. Accretion of the collage to the North Asian Craton and Craton Margin occurred in the late Neoproterozoic.

Baikal-Muya island arc (Neoproterozoic). Preserved in various fragments in the: (1) Paleoproterozoic to Early Cambrian Hamar-Davaa metamorphic terrane (metamorphosed forearc prism); (2) Neoproterozoic Baikal-Muya island arc terrane; (3) Late Neoproterozoic Barguzin metamorphic terrane (metamorphosed forearc prism); and (4) Late Neoproterozoic Sarkhoy island arc terrane. The tectonically-linked subduction zone or subduction zone units are the: (1) Paleoproterozoic to Neoproterozoic Olokit-Delunuran subduction zone terrane; (2) Neoproterozoic Hug subduction zone terrane; and (3) Neoproterozoic Kuvai subduction zone terrane.

Near Yenisey Ridge island arc (Neoproterozoic). Preserved in various fragments in the: (1) Neoproterozoic Isakov island arc terrane; (2) Late Neoproterozoic Predivinsk island arc terrane; and (3) Neoproterozoic Chelyuskin island arc terrane.

Zavhan continental-margin arc (Neoproterozoic). Preserved in various fragments in northern Mongolia in the: (1) Late Neoproterozoic Zavhan continental-margin arc terrane; and (2) Neoproterozoic Tasuul oceanic terrane.

Cratonal and Metamorphic terranes (Archean and Proterozoic). Consist mainly of relatively small (tens of kilometers wide) fragments preserved in the: (1) Archean and Paleoproterozoic Gargan cratonal terrane; (2) Late Archean(?) and Paleoproterozoic(?) Muya metamorphic terrane; and (3) Paleoproterozoic Kan cratonal terrane. The terranes are interpreted as fragments of the North Asian Craton and that were rifted away during the breakup of the Rodinia supercontinent. These cratonal and metamorphic terranes formed a tectonic backstop for the accretion of the Neoproterozoic island arcs in the Circum-Siberia collage.

MO - Mongol-Okhotsk collage (Devonian to Late Jurassic; Timing of accretion – Late Paleozoic to Early Mesozoic). Consists mainly of middle to late Paleozoic and early Mesozoic Selenga, Hangay, and Uda-Murgal and Stanovoy continental-margin arcs composed of continental-margin igneous overlap assemblages, continental-margin turbidite terranes, and tectonically-linked outboard subduction zone terranes. The arcs overlap the southern margin of the North Asian Craton and Margin and previously-accreted terranes.

The major continental-margin arc overlap units in the collage are the: (1) Permian to Jurassic Selenga sedimentary-volcanic plutonic belt; (2) Late Carboniferous and Early Permian Hangay plutonic belt; and (3) Jurassic and Early Cretaceous Uda-Murgal and Stanovoy granite belts; (4) Devonian to Triassic Lan continental-margin turbidite terrane; and (2) Late Triassic to Middle Jurassic Ulban continental-margin turbidite terrane.

Tectonically linked to the arc are the following subduction zone terranes: (1) Cambrian to Early Carboniferous Galam terrane (GL); (2) Silurian to Permian Tukuringra-Dzhagdy terrane; (3) Silurian to Late Carboniferous Hangay-Dauria terrane; and (4) Paleozoic Ononsky terrane.

The collage is interpreted as forming during long-lived closure of Mongol-Okhotsk Ocean with oblique subduction of terranes beneath the southern North Asian Craton Margin and previously-accreted terranes. Closure and accretion extend from the Permian to the Late Jurassic (140 to 90 Ma). After closure of the Mongol-Okhotsk Ocean, left-lateral slip continued along the Mongol-Okhotsk fault that bounded the former ocean along and resulted in formation of Trans-Baikalian-Daxinganling bimodal igneous belt.

Solon collage (SL) (Carboniferous to Permian; Timing of accretion - Late Paleozoic to Early Mesozoic). Consists of following subduction zone terranes: (1) Carboniferous and Early Permian North Margin terrane; (2) Late Carboniferous to Permian Solon terrane; (3) Devonian Imjingang terrane; (4) Paleozoic Ogcheon terrane; and (5) Silurian through Permian Sangun-Hidagaien-Kurosegawa terrane. The terranes of the collage are interpreted as fragments of Solon Ocean plate. The terranes locally contain sedimentary units with mixed Tethyan and Boreal fossils.

The subduction zone terranes were derived from underthrusting of the northern part of the Solon Ocean plate to form a continental-margin arc on the South Mongolia-Khingan collage and Argun-Idermeg superterrane (Amur microcontinent composed of Agun and Idermeg passive continental margin terranes).

The arcs are: (1) South Mongolian arc composed of Middle Carboniferous to Late Triassic South Mongolian volcanic-plutonic belt; (2) Lugyngol arc composed of Permian Lugyngol volcanic and sedimentary basin; (3) Gobi-Khankaisk-Daxing'anling arc composed of Permian Gobi-Khankaisk-Daxing'anling volcanic-plutonic belt; and (4) Jihei arc composed of Permian Jihei plutonic belt.

Various subduction zone terranes were derived from underthrusting of the southern part of Solon Ocean plate and are tectonically linked to the North Margin continental-margin arc that formed on the Sino-Korean Craton. The arc is composed of the Carboniferous and Permian North Marginal Plutonic Belt of North China Platform.
The various terranes in the Solon collage were accreted to continental margins in the Permian to Triassic (290 to 203 Ma).

SM - South Mongolia-Khingan collage (Ordovician to Carboniferous; Timing of accretion – Late Carboniferous or Early Permian). Major unit in collage is the South Mongolia-Khingan arc and tectonically-linked subduction zone terranes.

Collage consists mainly of extensive local Ordovician, Silurian, Devonian, and Mississippian island arc and turbidite terranes and tectonically-linked subduction zone terranes. Preserved in various fragments in the: (1) Neoproterozoic through Early Carboniferous Nora-Sukhotin-Duobaoshan island arc terrane; (2) Devonian to Carboniferous Beitianshan-Atasbogd terrane; (3) Cambrian to Middle Devonian Dongwuzhumuqin-Nuhetdavaa terrane; (4) Middle Ordovician to Early Carboniferous Mandalovoo-Onor terrane; (5) Silurian to Early Carboniferous Gurvansayhan terrane; (6) Devonian and Early Carboniferous Edren terrane; (7) Cambrian to Devonian Govi Altai turbidite terrane; (8) Ordovician to Devonian Bayanleg subduction zone terrane; and (9) Devonian to Permian Hegenshan terrane. The tectonically-linked subduction zone terranes are: (1) Ordovician(?) and Devonian Zoolen terrane; and (2) Devonian Mandan terrane.

The South Mongolia-Khingan island arc was separated from the North Asian Craton by a large back-arc basin now represented in fragments contained in the: (1) Ordovician to Devonian Bayanleg subduction zone terrane; and (2) Devonian Mandah subduction zone terrane. The collages comprising the arcs were accreted to the southern margin of the Siberian continent in the Late Carboniferous or Early Permian (320 to 300 Ma).

WD - Wundurmiao collage (Mesoproterozoic to Silurian; Timing of accretion – Late Silurian). Consists of: (1) Late Ordovician to Silurian Laoling island arc terrane; (2) Mesoproterozoic to Middle Ordovician Wundurmiao subduction zone terrane; and (3) Neoproterozoic Seluohe subduction zone terrane. The collage is interpreted as an Laoling island arc system that formed near Sino-Korean Craton that was widely separated from North Asian Craton in the early Paleozoic. The collage intruded by granodiorite with a U-Pb age of 466 Ma and unconformably overlain by Silurian clastic rock. The collage was accreted to Sino-Korean Craton in the Late Silurian (435-415 Ma) along a transform continental margin.

The timing of the accretion of the collage to the Siberian continent is constrained by an angular unconformity at the base of the Upper Silurian or Devonian units and by orogenic granitoid magmatism of Early Devonian or older (pre-Emsian) age (about 435-415 Ma).

WS - West Siberian collage (Ordovician to Carboniferous Timing of accretion – Late Carboniferous or Early Permian). Preserved in various fragments in southwestern Siberia. Consists of the: (1) Late Silurian to Early Carboniferous Rudny Altai island arc terrane; and (2) the tectonically-linked Ordovician to Early Carboniferous Kalba-Narim subduction zone terrane. The collage is a northwest continuation (present-day coordinates) of the South Mongolia-Khingan island arc. The collage extends under Cenozoic and Mesozoic cover of southwestern Siberia.

YT - Yenisey-Transbaikal collage (Vendian to Devonian; Timing of accretion – Vendian to Early Ordovician). Consists of Vendian to Middle Cambrian Kuznetsk-Tannuola, Dzhida-Lake island arc terranes, tectonically-linked back-arc basins, and tectonically eroded subduction zone terranes. The collage is interpreted as a linear array of Vendian and Cambrian island arc systems that formed south (present-day coordinates of the North Asian Craton and Margin and previously accreted terranes. The eastern part of the collage also includes the West Stanovoy metamorphosed terrane that may be a displaced fragment of the North Asian Craton or of another craton.

The collage is unconformably overlain by Ordovician-Silurian flysch and molasse and also contains local Early Ordovician metamorphic and granitoid complexes. Accretion of the collage to the Siberian continent is interpreted as forming in the Late Cambrian to Early Ordovician (500 to 460 Ma) during counter-clockwise rotation of the Siberian continent that resulted in collision and duplexing of island arcs, and closure of the back-arc basins. As a result, most of the island arcs and tectonically-linked subduction zones ceased activity in the Middle Cambrian. In the Late Cambrian and Early Ordovician, collisional granitoid batholiths were emplaced and along with high-temperature metamorphic belts.

Kuznetsk-Tannuola island arc (Vendian to Middle Devonian). Preserved in various fragments in southern Siberia and Mongolia in the: (1) the Neoproterozoic to Devonian Telbes-Kitat island-arc terrane; (2) Late Neoproterozoic and Cambrian Kozhukhov island arc terrane; (3) Late Neoproterozoic and Early Cambrian Kanim island arc terrane; (4) Cambrian to Ordovician Uimen-Lebed island arc terrane; (5) Early Cambrian Kurai island arc terrane; (6) Neoproterozoic to Devonian Ulgey Island arc terrane; (7) Neoproterozoic to Early Cambrian North Sayan island arc terrane; (8) Cambrian Kizir-Kazir island arc terrane; (9) Cambrian Khamsara island arc terrane; (10) Early Cambrian Ulugo island arc terrane; (11) Late Neoproterozoic to Ordovician Ondum island arc terrane; (12) Cambrian and older(?) Tannuola island arc terrane; and (13) late Riphean to Middle Cambrian Minusinsk-Tuva back-arc basin.

The tectonically-linked subduction zone and oceanic crust units are the: (1) Late Neoproterozoic Teletsk subduction zone terrane; (2) Late Neoproterozoic and Early Cambrian Dzhebash subduction zone terrane; (3) Vendian and Early Cambrian subduction zone Amil terrane; (4) Early Cambrian Borus subduction zone terrane; and (5) Late Neoproterozoic and Early Cambrian Kurtushiba subduction zone terrane. Blueschist facies units occur in the Borus and Kurtushiba terranes.

Behind the Kuznetsk-Tannuola island arc were the Minusa and Tuva back-arc molasse basins that consist of the Altai-Sayan and East Tuva back-arc basins. The units in the Altai-Sayan back-arc basin are the: (1) Late Neoproterozoic and Cambrian Biya-Katun unit; (2) Late Neoproterozoic and Cambrian Kiya unit; and (3) Late Neoproterozoic Kizhikhem unit. The East Tuva back-arc basin is Late Neoproterozoic and Cambrian age. The Minusa and Tuva back-arc molasse basins were formed over the Kuznetsk-Tannuola island-arc terranes and represent superposed structures related to the formation of Hercynian ocean basins.

Dzhida-Lake island arc (Vendian to Middle Cambrian). Preserved in various fragments in southern Siberia and Mongolia in the: (1) Late Neoproterozoic and Cambrian Lake island arc terrane; (2) Late Neoproterozoic and Early Cambrian Eravna island arc terrane; (3) Late Neoproterozoic to Silurian Orhon-Ikatsky arc terrane; and (4) Late Neoproterozoic and Early Cambrian Dzhida island arc terrane.

Behind the Dzhida-Lake island arc was the Transbaikal back arc basin that consists of the: (1) the Ikatsky part of the Late Neoproterozoic to Silurian Orhon-Ikatsky continental-margin arc terrane; (2) part of the Paleoproterozoic through Early Cambrian Hamar-Davaa metamorphic terrane; and (3) part of the Late Neoproterozoic Barguzin metamorphic terrane.

West Stanovoy metamorphosed continental margin terrane (Archean through Neoproterozoic). Occurs at the eastern end of the collage in Transbaikalia and northern Mongolia and consists of Early to Late Archean Nikitkinsky, and Paleoproterozoic schist, gneiss, quartzite-aluminous and carbonate subcomplexes that are intruded by Late Archean Paleoproterozoic granitoid and lesser mafic plutonic rocks complexes. The terrane is metamorphosed from greenschist to upper amphibolite to granulite facies and may be a displaced fragment of the North Asian Craton or of another craton.

Tectonic Collages Accreted onto Eastern Margin North Asian and Sino-Korean Cratons (Mesozoic and Cenozoic Accretions

BD - Badzhal collage (Triassic to Early Cretaceous; Timing of accretion – Late Cretaceous). Consists of subduction zone terranes composed of mainly Triassic and Jurassic turbidite with fragments of Pennsylvanian and Permian limestone and chert containing Tethyan fauna, Late Triassic and Jurassic chert, and small basalt lenses. Preserved in fragments of the following terranes in the northern Russian Southeast: (1) Triassic to Middle Jurassic Badzhal subduction zone terrane; and (2) Middle Triassic through Middle Jurassic Nadanhada subduction zone terrane.

The subduction zone terranes were subducted beneath Siberian continental margin and previously-accreted terranes and thereby resulting in formation the Umlekan continental-margin arc that is composed of the Cretaceous Umlekan-Ogodzhin volcanic-plutonic belt. The collage was amalgamated and accreted to the Siberian continental margin during subsequent strike-slip emplacement of outboard terranes in the Early Cretaceous. The collage is unconformably overlain by the Late Albian and Late Cretaceous Okhotsk-Chukotka volcanic-plutonic belt that forms a major continental-margin arc.

CH - Chukotka collage (Paleozoic to Triassic; Timing of accretion – Late Jurassic to Early Cretaceous). Consists of passive continental-margin terranes that formed along the long-lived Neoproterozoic to early Mesozoic North American Continental Margin. Major units are Paleozoic to Triassic continental shelf and slope sedimentary rock, Early Jurassic flysch, and unconformably overlying, flat-lying Late Jurassic and Early Cretaceous sedimentary overlap units. The collage consists of various passive continental margin terranes that originally formed along the North American Craton Margin. The collage is interpreted as forming during rifting of the North American Craton Margin in the Late Jurassic and Early Cretaceous and accretion of terranes to northern the North Asian Craton Margin in the Late Cretaceous.

EP - East Kamchatka Peninsula collage (mainly Paleocene; Timing of accretion – Pliocene). Consists of Coniacian-Paleocene island arc formations with ophiolite fragments that are preserved mainly in the: (1) Late Cretaceous to Paleocene Kronotskiy island arc terrane; and (2) mainly Cretaceous and Paleocene Kamchatskiy Mys oceanic terrane. The collage is interpreted as a short-lived island arc and adjacent oceanic crust that were accreted to the Eastern Asia continental margin during closure of inboard ocean in the Pliocene. The collage unconformably overlain by flat-lying Quaternary volcanic units.

ES - East Sakhalin collage (Late Cretaceous to early Tertiary; Timing of accretion – Early Tertiary). Consists of Late Cretaceous to middle Eocene island arc and tectonically-linked subduction zone terranes in fragments in the: (1) Late Cretaceous Terpeniy island arc terrane; (2) Late Cretaceous to middle Eocene Tokoro-Nemuro island arc terrane; (3) Late Jurassic through Late Cretaceous Shmidt island arc terrane; (4) Early Cretaceous to Miocene Shimanto subduction zone terrane; and (5) probable subduction zone terranes delineated by linear positive magnetic anomalies to the east of Sakhalin Island. Accretion of the island arc to the Eastern Asia continental margin occurred during closure of an inboard ocean and resulted in formation of collision-related granitoids at about 40 Ma.

HS - Honshu-Sikhote-Alin collage (Jurassic and Early Cretaceous; Timing of accretion - Cretaceous). Consists of fragments of subduction zone, continental-margin turbidite (flysch), and island arc terranes. Preserved in fragments in the (1) Permian to Early Cretaceous Mino Tamba Chichibu subduction zone terrane; (2) Carboniferous and Permian Akiyoshi-Maizuru subduction zone terrane containing fragments of sedimentary units with Tethyan fossils; (3) Cretaceous Sambagawa metamorphic terrane; (4) late Early Cretaceous Kema island arc terrane; (5) Late Jurassic through Early Cretaceous Taukha subduction zone terrane; (6) Late Permian through Middle Jurassic Samarka subduction zone terrane; (7) Early Paleozoic (?) Khor island arc terrane; (8) Jurassic and Early Cretaceous Kiselyovka-Manoma subduction zone terrane; and (9) Late Jurassic and Early Cretaceous Zhuravlevsk-Amur River continental-margin turbidite terrane. The Zhuravlevsk-Amur River continental-margin turbidite terrane and companion island arc terranes are interpreted as forming along a Late Jurassic and Early Cretaceous continental-margin transform fault along which the older subduction zone Mino Tamba Chichibu and Akiyoshi-Maizuru subduction zone terranes were emplaced. The collage is interpreted as forming along a transform continental margin.The collage is unconformably overlain by Late Albian and younger flat-lying volcanic units of the East Sikhote-Alin volcanic-plutonic belt and its continuation onto Honshu Island.

KOR - Koryak collage (Late Triassic to Cretaceous; Timing of accretion – Late Cretaceous). Consists of a Late Jurassic and Early Cretaceous island arc and tectonically-linked subduction zone terranes that are preserved in fragments in the: (1) Late Jurassic to mid-Cretaceous Mainitskiy island arc terrane; (2) Late Jurassic to Paleocene Alkatvaam subduction zone terrane; (3) Paleozoic Zolotogorskiy passive continental margin terrane; and (4) Upper Paleozoic-Early Cretaceous Ekonay subduction zone terrane.

OK - Olyutorka-Kamchatka collage (Late Cretaceous and Paleocene; Timing of accretion – Early Cenozoic). Consists of island arc and tectonically-linked subduction zone terranes in fragments in the: (1) Late Early Cretaceous to Paleocene Olyutorka-Kamchatka island arc terrane; (2) Late Cretaceous Iruneiskiy island arc terrane; and (3) Late Cretaceous to Oligocene Vetlovskiy subduction zone terrane. The collage is unconformably overlain by Late Eocene, Oligocene, and Miocene sedimentary units. The collage was accreted to the Eastern Asia continental margin during closure of inboard ocean.

PA - Penzhina-Anadyr collage (Late Jurassic to Early Cretaceous; Timing of accretion – Late Cretaceous). Consists of Late Jurassic-Neocomian subduction zone terranes and a tectonically-linked island arc terrane that rim the eastern Kolyma-Omolon superterrane and Verkhoyansk-Kolyma collage. Preserved in fragments of the: (1) Ordovician to Middle Jurassic Penzhina Anadyr subduction zone terrane that includes fragments of Devonian ophiolite; (2) Middle and Late Jurassic Talovskiy subduction zone terrane; (3) the Late Triassic to Early Cretaceous Kony-Murgal arc terrane; (4) Triassic Velmay subduction zone terrane; and (5) West Pekulney island arc terrane. The subduction zone terranes were subducted beneath margin of Siberian continent margin and previously-accreted terranes to form the Uda-Murgal continental-margin arc and offshore extension into the Kony-Murgal island arc. The collage was formed in the Senomanian-Campanian following the closure of the outboard Mongol-Okhotsk Ocean. The collage is interpreted as the Uda-Murgal continental-margin and island arc and and tectonically-linked subduction zone terranes. The collage is unconformably overlain by the Late Albian and Late Cretaceous Okhotsk-Chukotka volcanic-plutonic belt (oc) that forms a major continental-margin arc.

SA - South Anyui collage (Permian to Early Jurassic; Timing of accretion – Late Cretaceous). Consists of Late Jurassic to Neocomian subduction zone terranes, and island and continental-margin arc terranes that rim the northeastern Kolyma-Omolon superterrane and Verkhoyansk-Kolyma collage. Preserved in fragments of the: (1) mainly Late Jurassic-Early Cretaceous South Anyui subduction-zone terrane; (2) Triassic and Early Jurassic Velmay subduction-zone terrane; (3) Late Jurassic and Early Cretaceous Oloy and Late Jurassic Svyatov Nos volcanic belts along the northeast margin of the Kolyma-Omolon superterrane;
(4) and Late Jurassic and Early Cretaceous Nutesyn continental-margin arc terrane that formed on the margin of the Chukotka collage during the closure of the South Anyui Ocean; (5) Permian and Triassic Shalaurov subduction zone terrane. The collage is interpreted as the Oloy island arc and tectonically-linked subduction zone terranes. The collage was accreted onto the Siberian continent margin during closure of the South Anyui Ocean in the early Late Cretaceous. The collage is unconformably overlain by the Late Albian and Late Cretaceous Okhotsk-Chukotka volcanic-plutonic belt (oc) that forms a major continental-margin arc.

The collage is unconformably overlain by Maastrichtian and Eocene and Oligocene sedimentary and volcaniclastic rock. The accretion of collage to the Russian Northeast continental margin occurred during closure of the inboard ocean and was followed by formation of Okhotsk-Chukotka continental-margin arc and tectonically-linked outboard subduction zone.

SH - Sakhalin-Hokkaido collage (Cretaceous; Timing of accretion – Eocene). Consists of Late Cretaceous flysch terranes of Sakhalin and Hokkaido Islands, and tectonically-linked subduction zone terranes to the east that contain fragments of ophiolite, glaucophane schist, Late Jurassic and Early Cretaceous limestone with Tethyan reef corals and island arc terrane. Preserved in fragments in the: (1) Middle Triassic to early Late Cretaceous Aniva subduction zone terrane; (2) Jurassic to Paleogene Sosunay-Langeri subduction zone terrane; (3) Early Cretaceous to Miocene Shimanto subduction zone terrane; (4) Late Cretaceous through Paleogene Nabilsky subduction zone terrane; and (5) Late Jurassic through Late Cretaceous Kamyshovy island arc terrane. The terranes were subducted beneath Eastern Asia continental margin resulting in formation of the East-Sikhote-Alin continental-margin arc composed of the: (1) Late Cretaceous to Miocene East Sikhote-Alin volcanic-plutonic belt; and (2) Early Cretaceous West Sakhalin turbidite basin terrane. The collage is interpreted as a continental-margin fore-arc basin and tectonically-linked subduction zone terranes associated with the East Sikhote-Alin continental-margin arc. Accretion of the collage to the Russian Southeast continental margin occurred during closure of the inboard ocean and was followed by formation of outboard modern-day continental-margin arcs in Russian Northeast, Kurile Islands, and Japan and tectonically-linked outboard subduction zone.

VK - Verkhoyansk-Kolyma collage (Late Paleozoic to Early Jurassic; Timing of accretion – Late Jurassic to early Early Cretaceous). Consists of: (1) Permian, Triassic, and Early Jurassic Kular-Nera passive continental margin terrane (KN) that formed between the North Asian Craton Margin and the Kolyma-Omolon superterrane to the east in the Russian Northeast; The rocks of the terrane are distal formations of the Verkhoyansk passive continental margin; (2) Mid-Late Jurassic Polousny-Debin subduction zone terrane; (3) Carboniferous to Jurassic Viliga passive continental-margin terrane; (4) Debin ophiolite terrane; and (5) Late Neoproterozoic through Late Triassic Kotel'nyi passive continental margin terrane. Part of Kular-Nera terrane was subducted beneath the Kolyma-Omolon superterrane in the Late Jurassic resulting in formation of Late Jurassic Uyandina-Yasachnaya island arc along the southern margin of the Kolyma-Omolon superterrane. Ophiolite terranes (Garbyn’ya, Indigirka, Kybytygas, Munilkan, and Uyhandina) derived from the collapsing ocean basin were obducted onto the superterrane. The Polousny-Debin subduction zone formed during subduction of the Oimyakon oceanic crust beneath the southern margin of the Kolyma-Omolon superterrane. Consists of a deformed passive continental margin, accreted ophiolites, and subduction zone and is interpreted as forming during accretion of outboard Kolyma-Omolon superterrane.

WK - West Kamchatka collage (Mid-Cretaceous to early Tertiary; Timing of accretion – Early Cenozoic). Consists of late Paleozoic to Cretaceous subduction zone terranes in the Russian Northeast in the: (1) Jurassic and Cretaceous West Kamchatka subduction zone terrane; (2) Late Jurassic and Cretaceous Yanranay subduction zone terrane; and (3) Jurassic Ekonay subduction zone terrane.

The collage is tectonically linked to Okhotsk-Chukotka continental-margin arc (mid Cretaceous to early Tertiary, 96-50 Ma) that consists of the: (1) mid Cretaceous to early Tertiary Okhotsk-Chukotka volcanic-plutonic belt; and (2) Albian and Late Cretaceous Penzhina sedimentary basin. The collage was accreted to the Eastern Asian continental margin during outboard accretion of the Olyutoka-Kamchatka island arc.

Overlapping Continental-Margin Arcs - Devonian to Early Tertiary

at – Altay arc (Devonian and early Carboniferous, 381 to 290 Ma). Occurs in southwestern Siberia, northwestern Mongolia, and western northern China and consists of an extensive suite of mafic and intermediate, and local siliceous volcanic rock, mafic and intermediate intrusive rock, and associated sedimentary rock. Stratified units deposited under continental to marine conditions. Igneous rocks range from calc-alkaline to subalkaline to alkaline. The arc is interpreted as forming along an active continental margin in an oblique subduction zone environment.

ea - East Sikhote-Alin arc (Late Cretaceous to early Tertiary, 96 to 55 Ma). Occurs along the margin of southern Russian Far East and consists of Late Cretaceous and early Tertiary volcanic and plutonic rocks in the East Sikhote-Alin and West Sakhalin turbidite-basin terranes. The arc is interpreted as forming during subduction of the Ancestral Pacific Ocean plate with formation of the older part of the Hidaka subduction zone, the younger part of the Aniva subduction-zone terrane, and the Nabilsky, and Tokoro subduction-zone terranes.

gh - Gobi-Khankaisk-Daxing'anling arc (Permian, 295 to 250 Ma). Occurs in northern China, Mongolia, and Transbaikal Region and consists of Gobi-Khankaisk-Daxing’anling volcanic-plutonic belt that overlies and intrudes the Argun-Idermeg superterrane, South Mongolian collage, and Solon Collage. Volcanic and related sedimentary units composed of basalt, andesite, dacite, rhyolite, tuff, sandstone, siltstone, conglomerate, sandstone, and minor limestone.

Granitoid units are composed of adamellite, granite, granodiorite, monzonite granite, quartz monzonite, quartz diorite, gneissic granite, and two-mica granite. The arc is interpreted as forming during subduction of the northern part of Solon Ocean plate under the southern margin (present-day coordinates) of the Argun-Idermeg superterrane.

ha - Hangay arc (Late Carboniferous to Early Permian, 320 to 272 Ma). Occurs in central Mongolia and consists of large- to medium-size multiphase composed of granodiorite, tonalite, plagioclase granite, and minor gabbrodiorite, diorite, quartz diorite, and plagioclase leucogranite. Intrudes Yenisey-Transbaikal collage and Mongol-Okhotsk collage. The arc is interpreted as forming during subduction of the northern part of Mongol-Okhotsk Ocean plate under the North Asian Craton Margin and previously-accreted terranes.

ji - Jihei arc (Permian, 295-250 Ma). Occurs in eastern China and consists of granodiorite, monzonite, quartz diorite, quartz monzonite, diorite, syenite, and alkali-feldspar granite. Unit intrudes Bureya-Jiamusi supterterrane and South Mongolia-Khingan collage. The arc is interpreted as forming during subduction of the northern part of Solon Ocean plate under the southern margin (present-day coordinates) of the Bureya-Jiamusi supterterrane and adjacent units.

ko - Khingan-Okhotsk arc (Early and mid-Cretaceous). Occurs in the Russian Southeast and consists of the Khingan-Okhotsk volcanic-plutonic belt that contains K-rich felsic volcanic rocks and coeval subvolcanic to plutonic granitioids. The arc was tectonically paired to the Early Cretaceous Zhuravlevsk-Amur River and Kiselevka-Manoma subduction-zone terranes, part of the Honshu-Sikhote-Alin collage.

lg - Lugyngol arc (Permian, 295 to 250 Ma). Occurs in southeastern Mongolia and consists of Lugyngol volcanic and sedimentary basin composed of calk-alkalic andesite, dacite, rhyolite, conglomerate, sandstone, siltstone, and extensive flysch. Unit overlies and intrudes the South Mongolian collage and Solon collage. The arc is interpreted as forming during subduction of the northern part of Solon Ocean plate under the southern margin (present-day coordinates) of the Argun-Idermeg superterrane.

ma - Main granite belt (Late Jurassic, 144 to 134 Ma). Occurs along adjacent margins of the North Asian Craton Margin and Kolyma-Omolon superterrane. Consists of Main amphibole-biotite granite, two mica granite, and granodiorite. The granite belt is interpreted as forming during and immediately after collision of the Kolyma-Omolon superterrane onto the North-Asian Craton Margin.

nb – Northern granite belt (Early Cretaceous, 138 to 120 Ma). Occurs along northwestern margin of 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 interpreted as forming during subduction of oceanic crust during a closure of a small oceanic basin during late stage of accretion of Kolyma-Omolon superterrane.

nm - North Margin arc (Late Carboniferous to Permian, 320 to 272 Ma). Occurs in northern China and consists of North marginal plutonic belt composed of calc-alkalic granodiorite, quartz monzonite, and granite. Unit intrudes northeastern margin (present-day coordinates) of Sino-Korean Craton. The arc is interpreted as forming during subduction of the southern part of Solon Ocean plate under the northeastern margin (present-day coordinates) of Sino-Korean Craton.

nr - Norovlin arc (Devonian to Early Carboniferous). Occurs in northern Mongolia and the Transbaikal region and consists of a continental-margin arc formed on the Argun-Idermeg superterrane (Amur microcontinent - Argunsky and Idermeg passive continental margin terranes). The arc preserved in Early to Middle Devonian calc-alkaline volcanic rock and in Middle to Late Devonian volcaniclastic rock, chert, and mudstone, and coeval granitoids that overlie or intrude superterrane and in Devonian to Early Carboniferous volcanic-sedimentary rock fragments in the Ononsky subduction zone terrane. The arc is interpreted as forming during subduction of the Mongol-Okhotsk Ocean plate beneath northern margin (present-day coordinates) of Argun-Idemeg superterrane (Amur microcontinent).

oc - Okhotsk-Chukotka arc (Late Cretaceous to early Tertiary, 96 to 53 Ma). Occurs along the margin of central and northern Russian Far East and consists of mid- and Late Cretaceous and early Tertiary volcanic and plutonic units in the Okhotsk-Chukotka volcanic-plutonic belt (oc) and the Penzhina sedimentary basin. The arc is interpreted as forming during subduction of the Ancestral Pacific Ocean plate with formation of West Kamchatka, Ekonay, and Yanranay subduction zone terranes.

ol - Oloy arc (Late Jurassic, 154 to 135 Ma). Occurs along the margin of the Kolyma-Omkolon superterrane and consists of Late Jurassic-Neocomian Oloy volcanic belt, Late Jurassic Svyatov Nos volcanic belt, and the Indigirka-Oloy sedimentary-volcanic-plutonic assemblage. The arc is interpreted as an island arc that formed on the Kolyma-Omolon superterrane during subduction of the South Anyui Ocean plate beneath superterrane and formation of South Anyui subduction-zone terrane.

se - Selenga arc (Permian to Jurassic, 295 to 135 Ma). Occurs in Mongolia and southern Transbaikal regions and consists of large volcanic fields and granite plutons. Volcanic rock composed of rhyolite, trachyrhyolite, dacite, trachydacite, andesite basalt, trachybasalt, and andesite flows, and pyroclastic rocks, and local non-marine sedimentary rocks. Granite plutons composed of granodiorite, granite, granosyenite, and subordinate monzonite, diorite, and gabbrodiorite, REE granite, and leucogranite. Unit overlies and intrudes Yenisey-Transbaikal collage and Tuva-Mongolia superterrane. The arc is interpreted as forming during oblique subduction of the Mongol-Okhotsk Ocean plate under the North Asian Craton Margin and previously-accreted terranes.

sm - South Mongolian arc (Middle Carboniferous through Triassic, 320 to 203 Ma). Occurs in southern Mongolia and consists of South Mongolian volcanic-plutonic belt composed of calc-alkalic basalt, andesite, basaltic andesite, dacite, and rhyolite, and interbedded tuff and tuffaceous sandstone, granodiorite, granite, and leucogranite. Unit overlies and intrudes South Mongolian collage and Atasbogd collage. The arc is interpreted as forming during subduction of northern part of Solon ocean under the Argun-Idermeg superterrane.

sv - South Verkhoyansk granite belt (Late Jurassic to mid-Cretaceous, 157 to 93 Ma). Occurs in central Russian Far east. Extends longitudinally along the central part of the South Verkhoyansk synclinorium in the Verkoyansk (North Asian) Craton Margin. Occurs in batholiths, smaller granitoid plutons, and dikes. Compositions include amphibole-biotite quartz diorite and granodiorite, adamellite, amphibole-biotite granite, local melanocratic syenodiorite, and local dikes of plagiogranite and granite aplite, leucocratic biotite granite, and pegmatite lamprophyre. Granitoids are mainly high-K calc-alkaline series, subaluminous, and highly ferruginous. Granite belt is interpreted as forming during the accretion of the outboard Okhotsk terrane.

tv - Transverse granite belt (Early Cretaceous, 134 to 124 Ma). 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. The belts crosscut, at high angle, older folds and faults of the Verkhoyansk (North Asian) Craton Margin. Belt is interpreted as forming during late stage of accretion of Kolyma-Omolon superterrane.

uo - Umlekan-Ogodzhin arc (Jurassic and Cretaceous, 135 to 65 Ma). Occurs along the margin of the Kolyma-Omolon superterrane and consists of Umlekan-Ogodzhin volcanic-plutonic belt and coeval Late Jurassic and Early Cretaceous granitic plutons. Tectonically linked to a Badzhal and Nadanhada subduction-zone terranes, part of the Badzhal collage.

us - Uda-Murgal and Stanovoy arcs (Jurassic to Early Cretaceous, 203 to 96 Ma). Occurs in central part of Russian Far East and consists of Late Jurassic and Early Cretaceous, and lesser Late Triassic to Middle Jurassic igneous-rock preserved in the Uda volcanic-plutonic belt, the Uniya-Bom turbidite-basin terrane, the Umlekan-Ogodzhin volcanic-plutonic belt, the Upper Amur sedimentary assemblage, and the Stanovoy granite belt. The arc intrudes and overlies southern margin of the North Asian Craton. The arc is interpreted as forming during subduction of the Mongol-Okhotsk Ocean plate and formation of the Tukuringra-Dzhagdi subduction-zone, Galam subduction zone, and Ulban subduction zone terranes.

uy - Uyandina-Yasachnaya arc (Late Jurassic to Early Cretaceous, 154 to 120 Ma). Occurs along the southern margin of the Kolyma-Omkolon superterrane and consists of the Uyandina-Yasachnaya volcanic belt, Zyryanka sedimentary basin, the small Ainakhkurgen, Umkuveem, and Upper Penzhina basins, and the North Omolon basin that form part of the Indigirka-Oloy sedimentary-volcanic-plutonic assemblage. The arc is interpreted as forming during subduction the Oimyakon Ocean plate between the North Asian Craton Margin and the Kolyma-Omolon superterrane. Remnants of oceanic crust preserved in small obducted ophiolites along the margin of superterrane.

Transpressional Arcs - Devonian to Early Cretaceous

mt - Mongol-Transbaikal arc (Late Triassic to Early Cretaceous, 230 to 96 Ma). Occurs in northern Mongolia and southern Transbaikal regions. Preserved in the Late Triassic to Early Cretaceous Mongol-Transbaikal region volcanic-plutonic belt (mt) that consists of volcanic rocks in separate major basins and composed of trachyandesite, dacite, and trachyrhyolite flows, stocks, necks, and extrusive domes. The Mongol-Transbaikal arc also includes coeval granite plutons composed of grandiorite, alkaline gabbro-granite, granite, leucogranite, and Li-F granite. The arc is interpreted as forming during strike-slip faulting and rifting along the Mongol-Okhotsk fault during and after the final closure of the Mongol-Okhotsk Ocean. The arc is also referred to as North Gobi arc.

ss - South Siberian arc (Early Devonian, 415 to 400 Ma). Occurs in Eastern Altai-Sayan region and consists of South Siberian volcanic-plutonic belt. Volcanic rocks composed of bimodal mafic and siliceous volcanic rock including andesite, olivine basalt, trachybasalt, essexite, phonolite, alkaline trachite, trachyandesite, and trachyrhyolite. Plutonic rocks composed of subalkaline to alkaline gabbro to granite, alkaline-syenite, granosyenite, leucogranite, and latite-bearing subalkaline gabbro, monzonite, and syenogranite. The arc is interpreted as forming along southern margin of the North Asian Craton and Craton Margin during Early Devonian rifting that successively evolved into a continental-margin transpressive-fault margin and into a convergent margin.

tr - Trans-Baikal-Daxinganling arc (Middle Jurassic through Early Cretaceous, 175 to 96 Ma). Occurs in Transbaikal region, Mongolia, Northeastern China and consists of Trans-Baikalian-Daxinganling sedimentary-volcanic-plutonic belt. Volcanic rocks composed of shoshonite, latite, trachyte, trachyandesite, trachybasalt, trachyrhyolite, shoshonite, latite subalkaline basalt, and basalt andesite. Plutonic rocks composed of large calc-alkaline to subalkaline plutons of granite, leucogranite, quartz syenite, quartz monzonite, granodiorite, and biotite-amphibole diorite, and small calc-alkaline subvolcanic bodies of dacite and rhyolite. The arc is interpreted as forming during strike-slip faulting and rifting along the Mongol-Okhotsk fault during, and after the final closure of the Mongol-Okhotsk Ocean.

Active Continental-Margin Arcs - Miocene to Present

ib - Izu-Bonin arc (Miocene through Present, 20 to 0 Ma). Occurs south of southern Japan and consists of a volcanic arc composed chiefly of basalt to rhyolite, associated volcaniclastic rocks, and intercalated hemipelagic mudstone. The arc is interpreted as forming from subduction of the Philippine Sea Plate with formation of Nankai subduction zone.

ja - Japan arc (Miocene through Present, 23 to 0 Ma). Occurs along the Japan Islands and consists of extensive Quaternary volcanic rock formed during subduction of the Pacific and Philippine Sea Plates. Also contains associated volcanogenic forearc and back arc sedimentary basins. Volcanic rocks are mainly calc-alkaline basalt and andesite. Belt includes 83 active volcanoes and overlies all Japan terranes. The arc is interpreted as forming during subduction of the Pacific Ocean and Philippine Sea Plates with formaton of Japan Trench and Nankai subduction zones.

kk - Kuril-Kamchatka arc (Miocene through Present, 11 to 0 Ma). Occurs along Kamchatka Peninsula and Kuril Islands and consists of the Pliocene to Quaternary Central Kamchatka volcanic belt, central Kamchatka volcanic and sedimentary basin, and the East Kamchatka volcanic belt. The arc is interpreted as forming during subduction of the Pacific Ocean Plate with formation of Japan Trench subduction zone.

Active Subduction Zones - Miocene to Present

JT - Japan Trench subduction zone (Miocene through Present; Timing of accretion – 23 to 0 Ma). Consists of late Tertiary and Quaternary Japan and Kuril-Kamchatka trench subduction zone terranes. Tectonically linked to the: (1) Miocene to Present Japan arc (ja); (2) Miocene to Present Kuril-Kamchatka arc; and (3) Paleogene through Quaternary Japan and Izu-Bonin forearc basins. The subduction is interpreted as forming during active underthrusting of the western PacificOcean Plate beneath the Eastern Asia continental margin.

NN - Nankai subduction zone (Miocene through Present; Timing of accretion – 23 to 0 Ma). Consists of the Miocene through Quaternary Nankai subduction zone terrane. Tectonically linked to the: Miocene to Present Japan arc; (2) Miocene to Present Izu-Bonin volcanic belt; (3) Paleocene Kyushu-Palau island arc terrane; and (4) Miocene through Quaternary Izu-Bonin island arc terrane. The subduction is interpreted as forming during active underthrusting of a fragment of the Pacific Ocean Plate.

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