Metallogenesis and Tectonics of Northeast Asia
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Appendix B

Description of Map Units for Northeast Asia Summary Geodynamics Map

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Introduction

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

Cratons

NAC North Asian craton (Archean and Proterozoic)—Consists of Archean and Proterozoic metamorphic basement and nondeformed, flat-laying platform cover of late Precambrian thourgh Mesozoic sedimentary and volcanic rocks, locally as much as 14,000 m thick. Metamorphic basement is exposed in the Aldan-Stanovoy and Anabar shields near the southern and northern cratonal margins, respectively, and in a narrow band of basement rocks named the Near-Sayan uplift along the southwestern cratonal margin. Within these two shields and uplift are several terranes composed of early Precambrian crystalline rocks that vary in composition and structural style. The platform cover consists of Neoproterozoic, Vendian and early Paleozoic, middle Paleozoic, late Paleozoic, and Mesozoic sequences; each is characterized by a unique structural style and a unique suite of sedimentary and magmatic rocks, and each are separated from the others by regional discontinuities and unconformities 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 the northern part of the Korean Peninsula. Archean and Proterozoic metamorphic basement composes various major terranes and first-overlapped units: (1) the Paleoproterozoic Alashan granulite-paragneiss terrane in northwestern China, (2) the Archean Erduosi granulite-paragneiss terrane in north-central China, (3) the Archean Yinshan granite-greenstone terrane and first overlapped Proterozoic and Mesoproterozoic rift-related Zhangbei-Bayan Obo-Langshan metasedimentary and metavolcanic rocks in north-central China, (4) the Archean Jilin-Liaoning-East Shandong tonalite-trondhjemite-gneiss terrane and Paleoproterozoic overlapped, metamorphosed and deformed rocks of East Shandong-East Liaoning-East Jilin rift or foreland basin in northeastern China, (5) the Archean West Liaoning-Hebei-Shanxi granulite-orthogneiss terrane and overlapped, Paleoproterozoic metamorphosed and deformed rocks of Hutuo rift basin in northern China, (6) the Archean and Paleoproterozoic Machollyong granulite-paragneiss terrane in the northern part of the Korean Peninsula. Overlap units consist of extensive Proterozoic

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and Paleozoic continental-margin sedimentary rocks and lesser volcanic rocks; extensive Mesozoic and Cenozoic marine and terrigenous sedimentary rocks, and volcanic and plutonic arcarc-related rocks.

Craton Margins

BP Baikal-Patom cratonal margin (Riphean through Cambrian and older basement)—Consists of a fault-bounded basin containing Riphean carbonaceous and terrigenous sedimentary rocks, and Vendian and Cambrian sedimentary rocks 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 is isotopically dated at about 800 Ma.

EA East Angara cratonal margin (Riphean and older basement)—Consists of late Riphean terrigenous carbonaceous sedimentary rocks (sandstone, siltstone, and 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 cratonal margin (Ordovician through Jurassic)—Consists chiefly of a thick wedge of cratonal margin and deep-basin deposits as much as 20,000 m thick. Composed chiefly of Ordovician through Jurassic clastic rocks, shallow-marine terrigenous and carbonaceous rocks, and mafic volcanic and volcaniclastic rocks. Late Carboniferous and Permian sedimentary rocks contain extensive sills and dikes of Early Triassic trapp subalkaline and alkaline diabase. 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) cratonal margin (Devonian through Jurassic)—Consists chiefly of a thick (maximum 20 km) wedge of cratonal margin deposits, mainly Carboniferous, Permian, Triassic, and Early and Middle Jurassic clastic rocks, and littoral-marine, deltaic, and shelf sedimentary rocks deposited on the Verkhoyansk passive continental margin of the North Asian craton, grading successively eastward into turbidite deposits and deep-water black shale. Includes (1) local Middle through Late Devonian and Early Carboniferous rift-related deposits similar to those on the Siberian platform, and (2) local Early Triassic through Early Jurassic alkalic basalt flows, dikes, and sills. The northern and southern parts of the cratonal margin contain Neoproterozoic and early Paleozoic thick shallow-marine carbonaceous and clastic deposits that fine and thicken eastward. Interpreted as tectonically detached from passive continental-margin and crystalline basement of the North Asian craton.

Cratonal Terranes

GY Gyenggi-Yeongnam cratonal terrane (Archean and Proterozoic)—Consists of two major parts: (1) the Mesoproterozoic, Neoproterozoic, and older Gyenggi granulite-paragneiss terrane in the southern part of the Korean Peninsula, and (2) the Late Archean and Paleoproterozoic Yeongnam granulite-paragneiss terrane in the southern part of the Korean Peninsula Peninsula. Locally overlain by extensive Paleozoic continental-margin sedimentary and lesser volcanic rocks, and extensive Mesozoic and Cenozoic marine and terriginous sedimentary rocks, and volcanic and plutonic arc-related rocks. 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 metamorphic terrane, locally overlain by extensive Paleozoic continental-margin sedimentary and lesser volcanic rocks, extensive Mesozoic and Cenozoic marine and terriginous sedimentary rocks, and volcanic and plutonic arc-related rocks. Interpreted as a displaced fragment of the South China (Yangtzi) Craton.

OH Okhotsk cratonal terrane (Archean, Proterozoic, and early and middle Paleozoic)—Consists chiefly of large blocks of Archean and Paleoproterozoic gneiss and schist with a U-Pb zircon age of 3.7 Ga, overlain by (1) gently dipping shallow-marine Mesoproterozoic and Neoproterozoic clastic and carbonaceous rocks, (2) Early Cambrian limestone, marl, and sandstone, (3) Early Ordovician conglomerate, limestone, marl, and sandstone, (4) unconformable 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, and (5) Carboniferous through Late Jurassic nonmarine and rare marine clastic rocks. Interpreted as a fragment of the North Asian craton and cratonal margin that was rifted in the Late Devonian or Early Carboniferous and accreted to the East Asian continental margin in the Late Jurassic.

Superterranes

AI Argun-Idermeg superterrane (Proterozoic through Cambrian; timing of accretion - late Neoproterozoic through Cambrian)—Consists of (1) the Paleoproterozoic through late Paleozoic Argunsky metamorphosed passive-continental-margin terrane (AR) (eastern Mongolia, northeastern China, Transbaikalia), and (2) the Proterozoic through Cambrian Idermeg metamorphosed passive-continental-margin terrane (ID) (eastern Mongolia).

BJ Bureya-Jiamusi superterrane (Proterozoic through Permian; timing of accretion, early Paleozoic)—Consists of an early Paleozoic tectonic collage of the following metamorphic, continental-margin-arc, subduction-zone,

passive-continental-margin and island-arc terranes: (1) the Neoproterozoic through Triassic Bureya terrane (southern Russian Far East), (2) the Neoproterozoic and older and Early Cambrian Jiamusi terrane (northeastern China), (3) the Proterozoic Matveevka terrane (southern Russian Far East), (4) the Proterozoic Nakhimovka terrane (southern Russian Far East), (5) the Silurian through Permian(?) South Kitakami metamorphosed island-arc terrane (northern Honshu Island, Japan), and (6) the Late Carboniferous and Permian Laoyeling-Grodekov island-arc terrane (northeastern China, southern Russian Far East), (7) the Cambrian through Permian passive-continental-margin Voznesenka terrane (southern Russian Far East), (8) the Cambrian(?) and Ordovician(?) Sergeevka island-arc terrane (southern Russian Far East), (9) the Neoproterozoic through Devonian Zhangguangcailing continental-margin-arc terrane (northeastern China), (10) the Ordovician and Silurian Heilongjiang subduction zone, type B terrane (northeastern China), (11) the Archean through Middle Triassic Urmi passive-continental-margin terrane (northeastern China, southern Russian Far East), and (12) the Late Carboniferous and Permian Tumangang island-arc terrane (Korean Peninsula), all derived from a sequence of late Precambrian volcanic units, and late Precambrian through Ordovician shallow-marine clastic and carbonaceous rocks, locally metamorphosed tp amphibolite and granulite facies metamorphism dated at Early and Middle Ordovician (480 to 500 Ma). Intruded by Cambrian and Ordovician granitoids and unconformably overlain by Devonian rocks. 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, possibly a fragment of the Yenisey-Transbaikal orogenic belt that also contains early Paleozoic granulite facies metamorphic rocks and Cambrian and Ordovician granitoids.

KR Kara superterrane (Proterozoic through Ordovician; timing of accretion, early Paleozoic(?)—Consists of the late Neoproterozoic through Ordovician Kara continental-margin turbidite terrane (northern part of the Taimyr Peninsula), containing mainly late Riphean turbidites metamorphosed to amphibolite facies. Uppermost turbidites contain Cambrian and Early Ordovician fauna. Turbidites are unconformably overlain by Ordovician through Devonian littoral-marine and continental sedimentary rocks. Accreted to the North Asian craton with the genesis of Middle Permian two-mica and biotite-amphibole granite and granodiorite (with U-Pb, Rb-Sr, and incremental Ar isotopic ages of 252-264 Ma. Granitoids compose an extensive belt that obliquely cuts the superterrane and the margin of the late Riphean Circum-Siberian tectonic collage. Interpreted as a rift fragment of the North Asian craton that was reaccreted in the Jurassic.

KOM Kolyma-Omolon superterrane (Archean through Jurassic; timing of accretion, Late Jurassic)—Consists of a tectonic collage of cratonal, passive-continental-margin, island-arc, and ophiolite terranes, mainly the 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). Interpreted as having formed during accretion of terranes of cratonal, continental (Omulevka, Prikolyma, Omolon), and oceanic affinity to the Alazeya island arc, in association with obduction of oceanic crust and formation of small ophiolite fragments of the Munilkan terrane. Unconformably overlain by the Late Jurassic Uyandina-Yasachnaya superterrane marginal arc (uy), under which the Oimyakon Ocean basin was subducted during migration toward the North Asia (Verkhoyansk) cratonal margin. Accreted to the northeast Verkhoyansk (North Asian) cratonal margin in the Late Jurassic and Early Cretaceous, resulting 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: (1) the Archean and Paleoproterozoic Gargan cratonal terrane (North Huvsgol, Mongolia, eastern Sayan), (2) the Proterozoic Sangilen passive-continental-margin terrane (southwestern Siberia, Mongolia), (3) the Neoproterozoic and older Baydrag cratonal terrane (northwestern Mongolia), and (4) the Late Archean(?) and Paleoproterozoic(?) Muya metamorphic terrane (Transbaikalia). Includes various terranes of the Baikal-Muya island-arc system (Baikal-Muya, Barguzin, Dibinsky, Hug, Ilchir, Kuvai, Olokit-Delunuran, and Sarkhoy) that were amalgamated to form the Tuva-Mongolian microcontinent. Unconformably overlain by Vendian and Cambrian sedimentary and volcanic rocks.

Tectonic Collages Accreted between the North Asian and Sino-Korean Cratons (Proterozoic through Early Mesozoic)

AB Atasbogd collage (Ordovician through Permian; timing of accretion, Late Carboniferous or Early Permian)—Consists of (1) the Ordovician through Permian Waizunger-Baaran terrane, (2) the Devonian and Carboniferous Beitianshan-Atasbogd terrane, and (3) the Paleoproterozoic through Permian Tsagaan Uul-Guoershan continental-margin-arc terrane. Unconformably overlain by Permian volcanogenic and coal-bearing rocks. Accreted to the southern margin of the Siberian continent in the Late Carboniferous or Early

Permian (320 to 300 Ma). Interpreted as a southwestward continuation (present-day coordinates) of the South Mongolia-Khingan island arc.

AL Altai collage (Vendian through Ordovician; timing of accretion, Late Silurian)—Consists of the Vendian through Early Ordovician Salair island arc and fragments of arc-related turbidite and subduction-zone terranes, metamorphic terranes derived from arc-related rocks, and thick Cambrian and Ordovician overlap turbidites formed on the continental slope and rise, and fragments of originally adjacent oceanic terranes (Gorny Altai, West Sayan, Central and Northwestern Mongolia, and adjacent regions of northern China). Interpreted as an island-arc system that near the southwest margin (present-day coordinates) of the North Asian craton and cratonal margin and previously accreted terranes. The Salair island arc (Vendian through Early Ordovician) is preserved in fragments in southwestern Siberia in: (1) the Early Cambrian through Early Ordovician Salair island-arc terrane, (2) the Cambrian Ulus-Cherga island-arc terrane, and (3) the Early and Middle Cambrian Sugash terrane. Tectonically linked subduction-zone and oceanic-crustal rocks are the Vendian and Early Cambrian Alambai subduction-zone terrane and the late Neoproterozoic and Early Cambrian Baratal subduction-zone terrane. The arc is also preserved in fragments in the Middle Silurian and older Angurep, the Late Permian and older Belokurikha, and Mesoproterozoic and Neoproterozoic Qinghe-Tsel metamorphic (arc-related) terranes. The arc is also preserved the Early to Late Paleozoic Anui-Chuya terrane; the Precambrian and Cambrian through Devonian Altai terrane; the Cambrian through Devonian Charysh terrane; the late Neoproterozoic through Devonian West Sayan terrane, and the Neoproterozoic through Silurian Hovd continental-margin turbidite terranes. The arc is also tectonically linked to the Early Paleozoic or older Kaitanak, Middle Devonian or older Maralikha, late Neoproterozoic through Early Cambrian Terekta, and late Neoproterozoic through Early Cambrian Baratal subduction-zone terranes. The arc is also tectonically linked to the late Neoproterozoic and Early Cambrian Mogen-Buren terrane, the Late Cambrian and Early Ordovician Zasurin terrane, and the late Neoproterozoic and Early Cambrian Saratan oceanic terranes. Timing of the accretion to the Siberian Continent is constrained by an angular unconformity at the base of the Upper Silurian or Devonian rocks and by orogenic granitoid magmatism of Early Devonian or older (pre-Emsian) age (435-415 Ma).

CS Circum-Siberia collage (Proterozoic; timing of accretion - Neoproterozoic)—Consists of the 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. Interpreted as three separate Neoproterozoic island-arc systems that formed south (present-day coordinates) of the North Asian craton and cratonal margin and previously accreted terranes. Unconformably overlain by Vendian and Cambrian sedimentary rocks, similar to coeval rocks of the Siberian platform but much thicker and containing more marine rocks. Accretion of the collage to the North Asian craton and cratonal margin occurred in the late Neoproterozoic. The Baikal-Muya island arc is preserved in fragments in the Paleoproterozoic through Early Cambrian Hamar-Davaa metamorphic terrane (metamorphosed forearc prism), the Neoproterozoic Baikal-Muya island-arc terrane, the late Neoproterozoic Barguzin metamorphic terrane (metamorphosed forearc prism), and (4) the late Neoproterozoic Sarkhoy island-arc terrane. Tectonically-linked subduction-zone terranes are the Paleoproterozoic through Neoproterozoic Olokit-Delunuran, the Neoproterozoic Hug, and the Neoproterozoic Kuvai. The Near Yenisey Ridge island arc is preserved in fragments in (1) the Neoproterozoic Isakov, the late Neoproterozoic Predivinsk, and the Neoproterozoic Chelyuskin island-arc terranes. The Zavhan continental-margin arc is preserved in fragments in northern Mongolia in the late Neoproterozoic Zavhan continental-margin-arc, and the Neoproterozoic Tasuul oceanic terranes. Cratonal and metamorphic terranes consist mainly of relatively small (tens of kilometers wide) fragments preserved in the Archean and Paleoproterozoic Gargan cratonal terrane, the Late Archean(?) and the Paleoproterozoic(?) Muya metamorphic terrane, and the Paleoproterozoic Kan cratonal terrane which 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 Neoproterozoic island arcs to the Circum-Siberia collage.

MO Mongol-Okhotsk collage (Devonian through Late Jurassic; timing of accretion, late Paleozoic and early Mesozoic)—Consists mainly of the middle to late Paleozoic and early Mesozoic Selenga, Hangay, 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 North Asian craton and cratonal margin and previously accreted terranes. Major continental-margin-arc overlap rocks are (1) the Permian through Jurassic Selenga sedimentary-volcanic plutonic belt, (2) the Late Carboniferous and Early Permian Hangay plutonic belt, (3) the Jurassic and Early Cretaceous Uda-Murgal and Stanovoy granite belts, (4) the Devonian through Triassic Lan continental-margin turbidite terrane, and (5) the Late Triassic through Middle Jurassic Ulban continental-margin turbidite terrane. Tectonically linked to the arc are the Cambrian through Early Carboniferous Galam, the Silurian through Permian Tukuringra-Dzhagdy, the Silurian through Late Carboniferous Hangay-Dauria, and the Paleozoic Ononsky subduction-zone terranes.

Interpreted as having formed during long-lived closure of the Mongol-Okhotsk Ocean with the oblique; closure and accretion extend from the Permian through the Late Jurassic (140-90 Ma). After closure of the Mongol-Okhotsk Ocean, continuing left-lateral slip along the Mongol-Okhotsk Fault that bounded the former ocean resulted in formation of the Trans-Baikalian-Daxinganling bimodal igneous belt.

SL Solon collage (Carboniferous to Permian; timing of accretion - Late Paleozoic and Early Mesozoic)—Consists of the: (1) the Carboniferous and Early Permian North Margin, (2) the Late Carboniferous to Permian Solon, (3) the Devonian Imjingang, (4) the Paleozoic Ogcheon, and (5) the Silurian through Permian Sangun-Hidagaien-Kurosegawa subduction-zone terranes interpreted as fragments of the Solon Ocean plate. The terranes locally contain sedimentary rocks with mixed Tethyan and Boreal fossils. Some subduction-zone terranes were derived from underthrusting of the northern part of the Solon Ocean plate to form a composite continental-margin arc on the South Mongolia-Khingan collage and the Argun-Idermeg superterrane (Amur microcontinent composedm Carboniferous through Late Triassic South Mongolian volcanic-plutonic belt, (2) the Lugyngol arc, composed of Permian Lugyngol volcanic and sedimentary basin, (3) the Gobi-Khankaisk-Daxing'anling arc, composed of Permian Gobi-Khankaisk-Daxing'anling volcanic-plutonic belt, and (4) the Jihei arc, composed of Permian Jihei plutonic belt. Other subduction-zone terranes were derived from underthrusting of the southern part of the Solon Ocean plate and are tectonically linked to the North Margin continental-margin arc that formed on the Sino-Korean craton and is composed of the Carboniferous and Permian North Marginal plutonic belt of the North China platform. The various terranes were accreted to continental margins in the Permian and Triassic (290-203 Ma).

SM South Mongolia-Khingan collage (Ordovician through Carboniferous; timing of accretion, Late Carboniferous or Early Permian)—Consists mostly of the South Mongolia-Khingan island arc. Collage mainly composed of extensive local Ordovician, Silurian, Devonian, and Mississippian island-arc and turbidite terranes and tectonically linked subduction-zone terranes. Preserved in fragments in (1) the Neoproterozoic through Early Carboniferous Nora-Sukhotin-Duobaoshan island-arc terrane, the Devonian through Carboniferous Beitianshan-Atasbogd terrane, the Cambrian through Middle Devonian Dongwuzhumuqin-Nuhetdavaa terrane, the Middle Ordovician through Early Carboniferous Mandalovoo-Onor terrane, the Silurian through Early Carboniferous Gurvansayhan terrane, (6) the Devonian and Early Carboniferous Edren terrane, (7) the Cambrian through Devonian Govi Altai turbidite terrane, (8) the Ordovician through Devonian Bayanleg subduction-zone terrane, and (8) the Devonian through Permian Hegenshan terrane. Tectonically linked subduction-zone terranes are the Ordovician(?) and Devonian Zoolen, and the Devonian Mandan. The South Mongolia-Khingan island arc was separated from the North Asian craton by a large backarc basin now represented by fragments in the Ordovician through Devonian Bayanleg subduction-zone terrane and the Devonian Mandah subduction-zone terrane. The collages composing the arcs were accreted to the southern margin of the Siberian continent in the Late Carboniferous or Early Permian (320-300 Ma).

WD Wundurmiao collage (Mesoproterozoic through Silurian; timing of accretion, Late Silurian)—Consists of (1) the Late Ordovician and Silurian Laoling island-arc terrane, (2) the Mesoproterozoic through Middle Ordovician Wundurmiao subduction-zone terrane, and (3) the Neoproterozoic Seluohe subduction-zone terrane. Interpreted as having formed in the Laoling island-arc system that formed near Sino-Korean craton that was widely separated from the North Asian craton in the early Paleozoic. Intruded by granodiorite with a U-Pb age of 466 Ma and unconformably overlain by Silurian clastic rocks. Accreted to Sino-Korean craton in the Late Silurian (435-415 Ma) along a transform continental margin. Timing of accretion of the collage to the Siberian Continent is constrained by an angular unconformity at the base of the Upper Silurian or Devonian rocks and by orogenic granitoid magmatism of Early Devonian or older (pre-Emsian) age (about 435-415 Ma).

WS West Siberian collage (Ordovician through Carboniferous; timing of accretion, Late Carboniferous or Early Permian)—Consists of the Late Silurian through Early Carboniferous Rudny Altai island-arc terrane and the tectonically linked Ordovician through Early Carboniferous Kalba-Narim subduction-zone terrane. Preserved in fragments in southwestern Siberia. Interpreted as a northwest continuation (present-day coordinates) of the South Mongolia-Khingan island arc where it extends under Cenozoic and Mesozoic cover of southwestern Siberia.

YT Yenisey-Transbaikal collage (Vendian through Devonian; timing of accretion, Vendian through Early Ordovician)—Consists of Vendian through Middle Cambrian Kuznetsk-Tannuola, Dzhida-Lake island-arc terranes, tectonically linked backarc basins, and tectonically eroded subduction-zone terranes. Interpreted as a linear array of Vendian and Cambrian island-arc systems that formed south (present-day coordinates) of the North Asian craton and cratonal margin and previously accreted terranes. Eastern part includes the West Stanovoy metamorphosed terrane, which may be a displaced fragment of the North Asian craton or another Unconformably overlain by Ordovician and Silurian flysch and molasse and contains local Early Ordovician metamorphic and granitoid complexes. Interpreted as having been accreted to the Siberian Continent in the Late Cambrian and Early Ordovician (500-460 Ma) during counterclockwise rotation of the Siberian continent that resulted in collision and duplexing of island arcs and closure of backarc 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 along with high-temperature metamorphic belts. The Kuznetsk-Tannuola island arc is preserved in fragments in southern Siberia and Mongolia in: (1) the Neoproterozoic through Devonian Telbes-Kitat island-arc terrane, (2) the late Neoproterozoic and Cambrian Kozhukhov island-arc terrane, (3) the late Neoproterozoic and Early Cambrian Kanim island-arc terrane, (4) the Cambrian and Ordovician Uimen-Lebed island-arc terrane, (5) the Early Cambrian Kurai island-arc terrane, (6) the Neoproterozoic through Devonian Ulgey Island arc terrane, (7) the Neoproterozoic through Early Cambrian North Sayan island-arc terrane, (8) the Cambrian Kizir-Kazir island-arc terrane, (9) the Cambrian Khamsara island-arc terrane, (10) the Early Cambrian Ulugo island-arc terrane, (11) the late Neoproterozoic through Ordovician Ondum island-arc terrane, (12) the Cambrian and older(?) Tannuola island-arc terrane, and (13) the late Riphean through Middle Cambrian Minusinsk-Tuva backarc basin. The tectonically linked subduction zone and oceanic-crustal rocks are: (1) the late Neoproterozoic Teletsk subduction-zone terrane, (2) the late Neoproterozoic and Early Cambrian Dzhebash subduction-zone terrane, (3) the Vendian and Early Cambrian Amil subduction-zone terrane, (4) the Early Cambrian Borus subduction-zone terrane, and (5) the late Neoproterozoic and Early Cambrian Kurtushiba subduction-zone terrane. Blueschist-facies rocks occur in the Borus and Kurtushiba subduction-zone terranes. Behind the Kuznetsk-Tannuola island arc were the Minusa and Tuva backarc molasse basins, consisting of the Altai-Sayan and East Tuva backarc basins. Units in the Altai-Sayan backarc basin are (1) the late Neoproterozoic and Cambrian Biya-Katun unit, (2) the late Neoproterozoic and Cambrian Kiya unit, and (3) the late Neoproterozoic Kizhikhem unit. The East Tuva backarc basin is late Neoproterozoic and Cambrian. The Minusa and Tuva backarc molasse basins, which formed over the Kuznetsk-Tannuola island-arc terranes, represent superposed structures related to the formation of Hercynian ocean basins. The Dzhida-Lake island arc is preserved in fragments in southern Siberia and Mongolia in (1) the late Neoproterozoic and Cambrian Lake island-arc terrane, (2) the late Neoproterozoic and Early Cambrian Eravna island-arc terrane, (3) the late Neoproterozoic through Silurian Orhon-Ikatsky island-arc terrane, and (4) the late Neoproterozoic and Early Cambrian Dzhida island-arc terrane. Behind the Dzhida-Lake island arc was the Transbaikal backarc basin, consisting of (1) the Ikatsky part of the late Neoproterozoic through 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.

The West Stanovoy metamorphosed continental-margin terrane, which occurs at the east end of the collage in Transbaikalia and northern Mongolia, consists of the Early to Late Archean Nikitkinsky, and Paleoproterozoic schist, gneiss, quartzite-aluminous and carbonaceous subcomplexes, which are intruded by late Archean and Paleoproterozoic granitoid and lesser mafic plutonic rocks. The terrane, which is metamorphosed from greenschist to upper amphibolite to granulite facies, may be a displaced fragment of the North Asian craton or another craton.

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

BD Badzhal collage (Triassic through 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 in the northern Russian Southeast in the Triassic through Middle Jurassic Badzhal and the Middle Triassic through Middle Jurassic Nadanhada subduction-zone terranes, which were subducted beneath the Siberian continental margin and previously accreted terranes, resulting in formation of the Umlekan continental-margin arc 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. Unconformably overlain by the late Albian and Late Cretaceous Okhotsk-Chukotka volcanic-plutonic belt, which forms a major continental-margin arc.

CH Chukotka collage (Paleozoic through Triassic; timing of accretion, Late Jurassic and Early Cretaceous)—Consists of passive-continental-margin terranes that originally formed along the long-lived Neoproterozoic through early Mesozoic North American continental margin. Major units are Paleozoic and Triassic continental shelf and slope sedimentary rocks, Early Jurassic flysch, and unconformably overlying, flat-lying Late Jurassic and Early Cretaceous sedimentary overlap rocks. Interpreted as having formed during rifting of the North American continental margin in the Late Jurassic and Early Cretaceous and accretion of terranes to the northern North Asian cratonal margin in the Late Cretaceous.

EP East Kamchatka Peninsula collage (mainly Paleocene; timing of accretion, Pliocene)—Consists of Coniacian through Paleocene island-arc rocks with ophiolite fragments, which are unconformably overlain by flat-lying Quaternary volcanic rocks. Preserved mainly in the Late

Cretaceous to Paleocene Kronotskiy island-arc terrane and the mainly Cretaceous and Paleocene Kamchatskiy Mys oceanic terrane. Interpreted as a short-lived island arc and adjacent oceanic crust that were accreted to the East Asian continental margin during closure of an inboard ocean in the Pliocene.

ES East Sakhalin collage (Late Cretaceous to early Tertiary; timing of accretion, Early Tertiary)—Consists of Late Cretaceous through middle Eocene island-arc and tectonically linked subduction-zone terranes preserved in fragments in (1) the Late Cretaceous Terpeniy island-arc terrane, (2) the Late Cretaceous to middle Eocene Tokoro-Nemuro island-arc terrane, (3) the Late Jurassic through Late Cretaceous Shmidt island-arc terrane, (4) the Early Cretaceous through Miocene Shimanto subduction-zone terrane, and (5) probable subduction-zone terranes delineated by linear positive magnetic anomalies to the east of Sakhalin Island. Accretion to the East Asian continental margin occurred during closure of an inboard ocean and resulted in the 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 (1) the Permian through Early Cretaceous Mino Tamba Chichibu subduction-zone terrane, (2) the Carboniferous and Permian Akiyoshi-Maizuru subduction-zone terrane containing fragments of sedimentary rocks with Tethyan fossils, (3) the Cretaceous Sambagawa metamorphic terrane, (4) the late Early Cretaceous Kema island-arc terrane, (5) the Late Jurassic through Early Cretaceous Taukha subduction-zone terrane, (6) the Late Permian through Middle Jurassic Samarka subduction-zone terrane, (7) the early Paleozoic (?) Khor island-arc terrane, (8) the Jurassic and Early Cretaceous Kiselyovka-Manoma subduction-zone terrane, and (9) the 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 having formed 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. Unconformably overlain by late Albian and younger flat-lying volcanic rocks of the East Sikhote-Alin volcanic-plutonic belt and its continuation onto Honshu Island. Interpreted as having formed along a transform continental margin.

KOR Koryak collage (Late Triassic through 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: (1) the Late Jurassic through mid-Cretaceous Mainitskiy island-arc terrane, (2) the Late Jurassic through Paleocene Alkatvaam subduction-zone terrane, (3) the Paleozoic Zolotogorskiy passive-continental-margin terrane, and (4) the 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. Preserved in fragments in: (1) the Late Early Cretaceous and Paleocene Olyutorka-Kamchatka island-arc terrane, (2) the Late Cretaceous Iruneiskiy island-arc terrane, and (3) the Late Cretaceous through Oligocene Vetlovskiy subduction-zone terrane. Unconformably overlain by late Eocene, Oligocene, and Miocene sedimentary rocks. Interpreted as having been accreted to the East Asia continental margin during closure of an inboard ocean.

PA Penzhina-Anadyr collage (Late Jurassic and 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: (1) the Ordovician through Middle Jurassic Penzhina Anadyr subduction-zone terrane that includes fragments of Devonian ophiolite, (2) the Middle and Late Jurassic Talovskiy subduction-zone terrane, (3) the Late Triassic through Early Cretaceous Kony-Murgal arc terrane, (4) the Triassic Velmay subduction-zone terrane, and (5) the West Pekulney island-arc terrane. Interpreted as the Uda-Murgal continental-margin and island arc and tectonically linked subduction-zone terrane, which formed in the Senomanian-Campanian following the closure of the outboard Mongol-Okhotsk Ocean. Unconformably overlain by the Late Albian and Late Cretaceous Okhotsk-Chukotka volcanic-plutonic belt that forms a major continental-margin arc.

SA South Anyui collage (Permian through Early Jurassic; timing of accretion, Late Cretaceous)—Consists of Late Jurassic through Neocomian subduction-zone terranes, and island and continental-margin-arc terranes that rim the northeastern Kolyma-Omolon superterrane and the Verkhoyansk-Kolyma collage. Preserved in fragments in (1) the mainly Late Jurassic-Early Cretaceous South Anyui subduction-zone terrane, (2) the Triassic and Early Jurassic Velmay subduction-zone terrane, (3) the Late Jurassic and Early Cretaceous Oloy and Late Jurassic Svyatov Nos volcanic belts along the northeastern margin of the Kolyma-Omolon superterrane, (4) the 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, and (5) the Permian and Triassic Shalaurov subduction-zone terrane. Interpreted as the Oloy island-arc and tectonically linked subduction-zone terranes. Unconformably overlain by the Late Albian and Late Cretaceous Okhotsk-Chukotka volcanic-plutonic belt (oc) that forms a major continental-margin arc. Interpreted as having accreted to the Russian Northeast continental margin during closure of the inboard South Anyui Ocean

and was succeeded by formation of the Okhotsk-Chukotka continental-margin arc.

SH Sakhalin-Hokkaido collage (Cretaceous; timing of accretion, Eocene)—Consists of the 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: (1) the Middle Triassic through early Late Cretaceous Aniva subduction-zone terrane, (2) the Jurassic through Paleogene Sosunay-Langeri subduction-zone terrane, (3) the Early Cretaceous through Miocene Shimanto subduction-zone terrane, (4) the Late Cretaceous and Paleogene Nabilsky subduction-zone terrane, and (5) the Late Jurassic through Late Cretaceous Kamyshovy island-arc terrane. The terranes were subducted beneath the East Asian continental margin resulting in formation of the East-Sikhote-Alin continental-margin arc composed of (1) the Late Cretaceous to Miocene East Sikhote-Alin volcanic-plutonic belt, and (2) the Early Cretaceous West Sakhalin turbidite basin terrane. Interpreted as a continental-margin forearc basin and tectonically-linked subduction-zone terranes associated with the East Sikhote-Alin continental-margin arc that were accreted to the Russian Southeast continental margin during closure of an inboard ocean, followed by the formation of outboard modern-day continental-margin arcs in the Russian Northeast, Kurile Islands, and Japan and tectonically-linked outboard subduction zone.

VK Verkhoyansk-Kolyma collage (Late Paleozoic through Early Jurassic; timing of accretion, Late Jurassic and early Early Cretaceous)—Consists of (1) the Permian through Early Jurassic Kular-Nera passive-continental-margin terrane (KN) that formed between the North Asian cratonal margin and the Kolyma-Omolon superterrane to the east in the Russian Northeast as distal formations of the Verkhoyansk passive continental margin, (2) the Middle and-Late Jurassic Polousny-Debin subduction-zone terrane, (3) the Carboniferous through Jurassic Viliga passive-continental-margin terrane, (4) the Debin ophiolite terrane, and (5) the late Neoproterozoic through Late Triassic Kotel'nyi passive-continental-margin terrane. Part of the Kular-Nera terrane, which was subducted beneath the Kolyma-Omolon superterrane in the Late Jurassic, resulting in formation of the 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 terrane formed during the subduction of the Oimyakon oceanic crust beneath the southern margin of the Kolyma-Omolon superterrane. Interpreted as having formed during accretion of the outboard Kolyma-Omolon superterrane.

WK West Kamchatka collage (Mid-Cretaceous to early Tertiary; timing of accretion, Early Cenozoic)—Consists of (1) the Jurassic and Cretaceous West Kamchatka, (2) the Late Jurassic and Cretaceous Yanranay, and (3) the Jurassic Ekonay subduction-zone terranes in the Russian Northeast. Tectonically linked to the Okhotsk-Chukotka continental-margin arc (mid Cretaceous to early Tertiary, 96-50 Ma) that consists of the mid Cretaceous to early Tertiary Okhotsk-Chukotka volcanic-plutonic belt and the Albian and Late Cretaceous Penzhina sedimentary basin. Interpreted as having been accreted to the East Asian continental margin during outboard accretion of the Olyutoka-Kamchatka island arc.

Granite Belts and Overlapping Continental-Margin Arcs (Devonian through Early Tertiary)

at Altay continental-margin arc (Devonian and early Carboniferous, 381-290 Ma)—Occurs in southwestern Siberia, northwestern Mongolia, and northwestern China, where it consists of an extensive suite of mafic and intermediate-composition, and locally siliceous volcanic rocks, mafic and intermediate-composition intrusive rocks, and associated sedimentary rocks. Deposited under continental to marine conditions. Igneous rocks range from calc-alkaline through subalkaline to alkaline in composition. Interpreted as having formed along an active continental margin in an oblique-subduction-zone environment.

ea East Sikhote-Alin continental-margin arc (Late Cretaceous and early Tertiary, 96-55 Ma)—Occurs along the margin of southern Russian Far East, where it consists of Late Cretaceous and early Tertiary volcanic and plutonic rocks in the East Sikhote-Alin and West Sakhalin turbidite-basin terranes. Interpreted as having formed 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 continental-margin arc (Permian, 295-250 Ma)—Occurs in northern China, Mongolia, and the Transbaikal region where it consists of the Gobi-Khankaisk-Daxing'anling volcanic-plutonic belt that overlies and intrudes the Argun-Idermeg superterrane and the South Mongolian and Solon collages. Volcanic and related sedimentary rocks are composed of basalt, andesite, dacite, rhyolite, tuff, sandstone, siltstone, conglomerate, sandstone, and minor limestone. Granitoid rocks are composed of adamellite, granite, granodiorite, monzonite granite, quartz monzonite, quartz diorite, gneissic granite, and two-mica granite. Interpreted as having formed during subduction of the northern part of the Solon Ocean plate under the southern margin (present-day coordinates) of the Argun-Idermeg superterrane.

ha Hangay continental-margin arc (Late Carboniferous and Early Permian, 320-272 Ma)—Occurs in central Mongolia, where it consists of large to medium-size multiphase rocks

composed of granodiorite, tonalite, plagioclase granite, and minor gabbrodiorite, diorite, quartz diorite, and plagioclase leucogranite. Intrudes the Yenisey-Transbaikal and Mongol-Okhotsk collages. Interpreted as having formed during subduction of the northern part of Mongol-Okhotsk Ocean plate under the North Asian cratonal margin and previously accreted terranes.

ji Jihei continental-margin arc (Permian, 295-250 Ma)— Occurs in eastern China, where it consists of granodiorite, monzonite, quartz diorite, quartz monzonite, diorite, syenite, and alkali-feldspar granite. Intrudes the Bureya-Jiamusi superterrane and the South Mongolia-Khingan collage. Interpreted as having formed during subduction of the northern part of the Solon Ocean plate under the southern margin (present-day coordinates) of the Bureya-Jiamusi supterterrane and adjacent rocks.

ko Khingan-Okhotsk continental-margin arc (Early Cretaceous and mid-Cretaceous)—Occurs in the Russian Southeast, where it consists of the Khingan-Okhotsk volcanic-plutonic belt that contains K-rich felsic volcanic rocks and coeval subvolcanic through plutonic granitoids. Tectonically paired with the Early Cretaceous Zhuravlevsk-Amur River and Kiselevka-Manoma subduction-zone terranes (parts of the Honshu-Sikhote-Alin collage).

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

ma Main granite belt (Late Jurassic, 144-134 Ma)—Occurs along adjacent sections of the North Asian cratonal margin and the Kolyma-Omolon superterrane, where it consists of Main amphibole-biotite granite, two-mica granite, and granodiorite. Interpreted as having formed during and immediately after collision of the Kolyma-Omolon superterrane with the North-Asian cratonal margin.

nb – Northern granite belt (Early Cretaceous, 138-120 Ma)— Occurs along the northwestern margin of the Kolyma-Omolon superterrane, where it consists of large, elongate plutons composed of quartz diorite, monzodiorite, and biotite granite, as well as amphibole-biotite granodiorite, biotite granite, and two-mica granite. Interpreted as having formed with subduction of oceanic crust during closure of a small oceanic basin in the late stage of accretion of the Kolyma-Omolon superterrane.

nm North Margin continental-margin arc (Late Carboniferous and Permian, 320-272 Ma)—Occurs in northern China, where it consists of the North marginal plutonic belt composed of calc-alkalic granodiorite, quartz monzonite, and granite. Intrudes northeastern margin (present-day coordinates) of the Sino-Korean Craton. Interpreted as having formed during subduction of the southern part of the Solon Ocean plate under the northeastern margin (present-day coordinates) of the Sino-Korean craton.

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

oc Okhotsk-Chukotka continental-margin arc (Late Cretaceous and early Tertiary, 96-53 Ma)—Occurs along the margin of the central and northern Russian Far East, where it consists of mid- and Late Cretaceous through early Tertiary volcanic and plutonic rocks in the Okhotsk-Chukotka volcanic-plutonic belt and the Penzhina sedimentary basin. Interpreted as having formed with subduction of the West Kamchatka, Ekonay, and Yanranay terranes during subduction of the ancestral Pacific Ocean plate

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

se Selenga continental-margin arc (Permian through Jurassic, 295-135 Ma)—Occurs in Mongolia and the southern Transbaikal regions, where it consists of large volcanic fields and granite plutons. Volcanic rocks composed of rhyolite, trachyrhyolite, dacite, trachydacite, andesite basalt, trachybasalt, andesite flows, pyroclastic rocks, and local nonmarine sedimentary rocks. Granite plutons are composed of granodiorite, granite, granosyenite, and subordinate monzonite, diorite, and gabbrodiorite, REE granite, and leucogranite. Overlies and intrudes the Yenisey-Transbaikal collage and the Tuva-Mongolia superterrane. Interpreted as having formed during oblique subduction of the Mongol-Okhotsk Ocean plate under the North Asian cratonal margin and previously-accreted terranes.

sm South Mongolian continental-margin arc (Mid-Carboniferous through Triassic, 320-203 Ma)—Occurs in southern Mongolia, where it consists of the South Mongolian volcanic-plutonic belt composed of calc-alkalic basalt, andesite, basaltic andesite, dacite, rhyolite, and interbedded tuff and tuffaceous sandstone, granodiorite, granite, and leucogranite. Overlies and intrudes the South

Mongolian and the Atasbogd collages. Interpreted as having formed during subduction of the northern part of the Solon ocean under the Argun-Idermeg superterrane.

ss South Siberian volcanic-plutonic belt (Early Devonian)—Occurs in southern Siberia and the southern Transbaikal regions, where it consists of bimodal mafic and siliceous volcanic rocks with rare andesite, continental, red coarse-grained clastic rocks, diabase dikes and sills, and subalkaline to alkaline gabbro and granite, which occur in large intrusive massifs and small plutons in linear zones. Sedimentary and volcanic rocks range as far as 3,000 m or greater. Interpreted as having formed during rifting associated with a transition from a continental-margin transform margin to a convergent margin.

sv South Verkhoyansk granite belt (Late Jurassic through mid-Cretaceous, 157-93 Ma)—Occurs in the central Russian Far East, where it extends longitudinally along the central part of the South Verkhoyansk synclinorium on n the Verkoyansk (North Asian) cratonal margin. Occurs in batholiths, smaller granitoid plutons, and dikes composed of amphibole-biotite quartz diorite and granodiorite, adamellite, amphibole-biotite granite, and local melanocratic syenodiorite and locally in dikes of plagiogranite and granite aplite, leucocratic biotite granite, and Interpreted as having formed during the accretion of the outboard Okhotsk terrane.

tv Transverse granite belt (Early Cretaceous, 134-124 Ma)—Consists of several belts of granitic rocks that extend as far as a few hundred km and radiate outward from the southwestern bend in the Kolyma-Omolon superterrane. The belts taper out to the southwest and north and consist of fracture-related plutons and dikes swarms composed mainly of diorite, granodiorite, and granite. The belts crosscut, at a high angle, older folds and faults of the Verkhoyansk (North Asian) cratonal margin. Interpreted as having formed during the late stage of accretion of Kolyma-Omolon superterrane.

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

us Uda-Murgal and Stanovoy continental-margin arcs (Jurassic and Early Cretaceous, 203-96 Ma)—Occur in the central Russian Far East, where they consist of Late Jurassic and Early Cretaceous and lesser Late Triassic through Middle Jurassic igneous rocks 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. Intrude and overlie the southern margin of the North Asian craton. Interpreted as having formed during subduction of the Mongol-Okhotsk Ocean plate with formation of the Tukuringra-Dzhagd, Galam, and Ulban subduction-zone terranes.

uy Uyandina-Yasachnaya arc (Late Jurassic and Early Cretaceous, 154-120 Ma)—Occurs along the southern margin of the Kolyma-Omkolon superterrane and consists of the Uyandina-Yasachnaya volcanic belt, the Zyryanka sedimentary basin, the small Ainakhkurgen, Umkuveem, and Upper Penzhina basins, and the North Omolon basin, all parts of the Indigirka-Oloy sedimentary-volcanic-plutonic assemblage. Interpreted as having formed during subduction the Oimyakon Ocean plate between the North Asian cratonal margin and the Kolyma-Omolon superterrane, along the margin of which remnants of oceanic crust are preserved in small obducted ophiolites.

Plume-Related Igneous Province (Permian-Triassic Boundary)

tp Tungus Plateau (trapp) basalt, sills, dikes, and intrusions (Permian and Triassic)—Occurs in western part of eastern Siberia, where it consists of large volumes of basalt lava, tuffaceous-sedimentary rocks, sills and dikes, diatremes, diabase; gabbro, troctolite gabbro, anorthosite, and granophyre intrusions. Principal rocks intrusive rocks are diabase and gabbro-diabase. Geochronologic andpaleomagnetic studies indicate that trapp magmatism occurred at the Permian-Triassic boundary for a period of less than 1 Ma. Eruption of the Siberian trapps was among the largest surficial volcanic eruptions in the Phanerozoic history of the Earth Interpreted as forming in a mantle plume originating at the core-mantle boundary with no relation to lithosphere structures.

Transpressional Arcs (Devonian to Early Cretaceous)

mt Mongol-Transbaikal transpressional arc (Late Triassic through Early Cretaceous, 230-96 Ma)—Occurs in northern Mongolia and the southern Transbaikal region. Preserved in the Late Triassic through Early Cretaceous Mongol-Transbaikal volcanic-plutonic belt (mt) that consists of volcanic rocks in separate major basins, composed of trachyandesite, dacite, and trachyrhyolite flows, stocks, necks, and extrusive domes. Includes coeval granite plutons composed of grandiorite, alkaline gabbro-granite, granite, leucogranite, and Li-F granite. Interpreted as having formed with strike-slip faulting and rifting along the Mongol-Okhotsk Fault during and after closure of the Mongol-Okhotsk Ocean. Also referred to as the North Gobi arc.

ss South Siberian transpressional arc (Early Devonian, 415-400 Ma)—Occurs in the eastern Altai-Sayan region, where it consists of the South Siberian volcanic-plutonic belt. Volcanic rocks are composed of bimodal mafic and siliceous volcanic rocks, including andesite, olivine basalt, trachybasalt, essexite, phonolite, alkaline trachite,

trachyandesite, and trachyrhyolite; plutonic rocks are composed of subalkaline to alkaline gabbro to granite, alkaline-syenite, granosyenite, leucogranite, and latite-bearing subalkaline gabbro, monzonite, and syenogranite. Interpreted as having formed along southern margin of the North Asian craton and cratonal margin during Early Devonian rifting that successively evolved into a continental-margin transpressive-fault margin and into a convergent margin.

tr Trans-Baikal-Daxinganling transpressional arc (Middle Jurassic through Early Cretaceous, 175-96 Ma)—Occurs in the Transbaikal region, Mongolia, and northeastern China, where it consists of the Trans-Baikalian-Daxinganling sedimentary-volcanic-plutonic belt. Volcanic rocks are composed of shoshonite, latite, trachyte, trachyandesite, trachybasalt, trachyrhyolite, shoshonite, latite subalkaline basalt, and basalt andesite; plutonic rocks are 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. Interpreted as having formed during strike-slip faulting and rifting along the Mongol-Okhotsk Fault during, and after closure of the Mongol-Okhotsk Ocean.

Active Continental-Margin Arcs (Miocene to Present)

ib Izu-Bonin continental-margin arc (Miocene through Holocene, 20-0 Ma)—Occurs south of southern Japan, where it consists of a volcanic arc composed chiefly of basalt to rhyolite, associated volcaniclastic rocks, and intercalated hemipelagic mudstone. Interpreted as having formed from subduction of the Philippine Sea plate during formation of Nankai subduction zone.

ja Japan continental-margin arc (Miocene through Holocene, 23-0 Ma)—Occurs along the Japan Islands, where it consists of extensive Quaternary volcanic rocks formed during subduction of the Pacific and Philippine Sea plates. Also contains associated volcanogenic forearc and backarc sedimentary basins. Volcanic rocks are mainly calc-alkaline basalt and andesite. Belt includes 83 active volcanoes and overlies all Japan terranes. Interpreted as having formed during subduction of the Pacific Ocean and Philippine Sea plates with formation of the Japan Trench and Nankai subduction zones.

kk Kuril-Kamchatka continental-margin arc (Miocene Holocene Present, 11-0 Ma)—Occurs along the Kamchatka Peninsula and Kuril Islands, where it consists of the Pliocene to Quaternary Central Kamchatka volcanic belt, the Central Kamchatka volcanic and sedimentary basin, and the East Kamchatka volcanic belt. Interpreted as having formed during subduction of the Pacific Ocean Plate during formation of the Japan Trench subduction zone.

Active Subduction Zones (Miocene to Present)

JT Japan Trench subduction zone (Miocene through Holocene; timing of accretion, 23-0 Ma)—Consists of the late Tertiary and Quaternary Japan and Kuril-Kamchatka Trench subduction-zone terranes. Tectonically linked to (1) the Miocene to Present Japan arc (ja), (2) the Miocene to Holocene Kuril-Kamchatka arc, and (3) the Paleogene through Quaternary Japan and Izu-Bonin forearc basins. Interpreted as having formed during active underthrusting of part of the western PacificOcean plate beneath the East Asian continental margin.

NN Nankai subduction zone (Miocene through Holocene; timing of accretion, 23-0 Ma)—Consists of (1) the Miocene through Quaternary Nankai subduction-zone terrane. Tectonically linked to (1) the Miocene to Holocene Japan arc, (2) the Miocene to Holocene Izu-Bonin volcanic belt, (3) the Paleocene Kyushu-Palau island-arc terrane, and (4) the Miocene through Quaternary Izu-Bonin island-arc terrane. Interpreted as having formed during active underthrusting of a fragment of the Pacific Ocean plate.

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