COMPARATIVE TECTONICS AND METALLOGENY OF NORTHEASTERN RUSSIA AND ALASKA

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ABSTRACT

Northeastern Russia and Alaska have a specific simultaneously interoceanic and intercratonal position in the Earth's structure, similar to the tectonic areas of Central America or Southeastern Asia. This region has been confined to one of a few "gapings" of the Pacific mobile Belt presumably since the Riphean-Early Paleozoic, and that during the entire regional history, the constructional tectonic processes occurred to close this gap. The concept, that holds that most of the structural constituents or terranes of the region have a marginal sea, but not an oceanic origin, is based on the different dates (paleontological, petrogeochemical) including comparative metallogenic analysis.

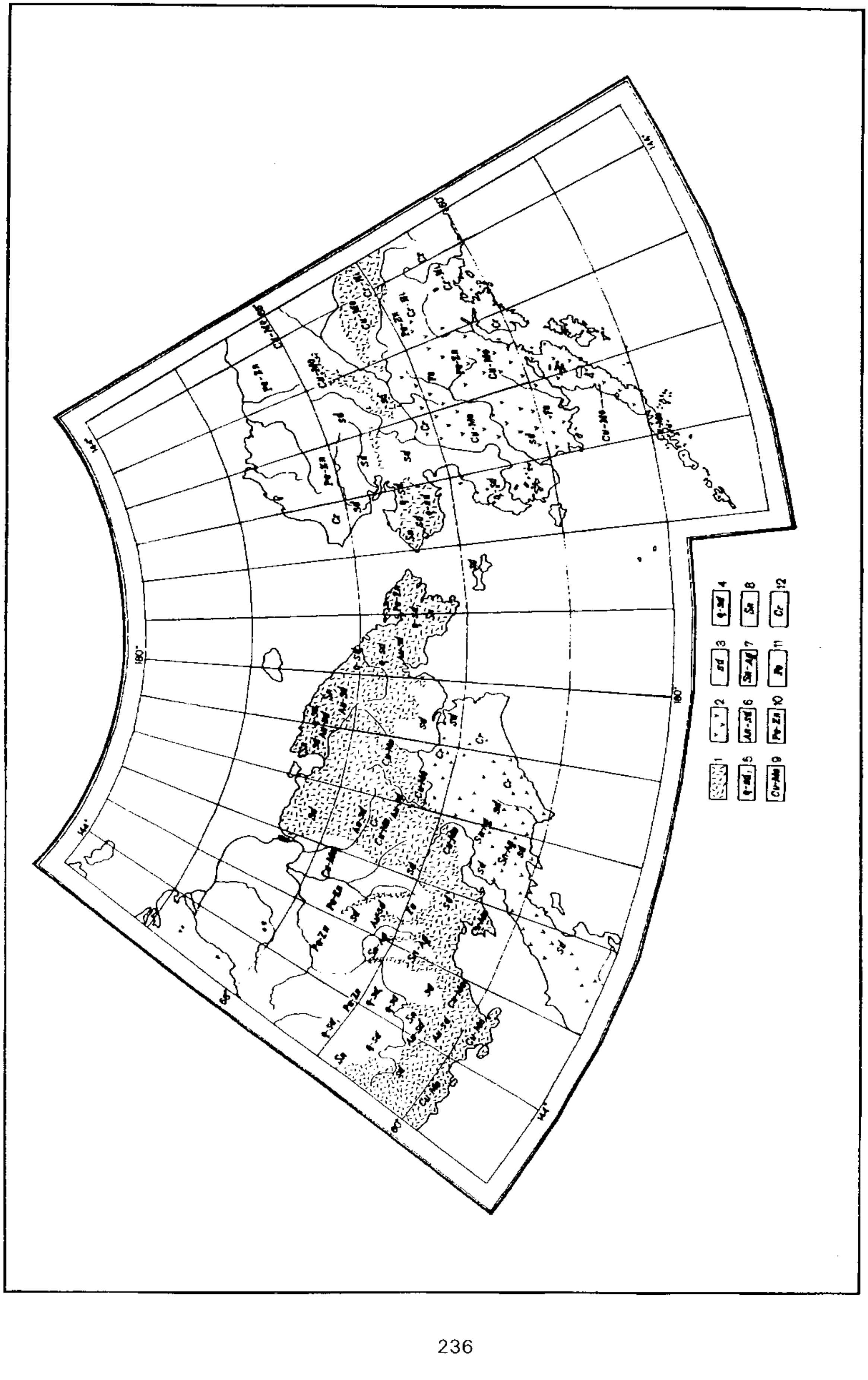
In accordance with the latter, gold and tin deposits are more wide-spread in Northeastern Russia than in Alaska, due primarily to the formation of numerous deposits within major terranes of turbidite marginal sea basins and its passive continental margins during the collisional, accretionary and post-accretionary stages of their development. In Alaska, the same type terranes are less abundant in gold occurrences, whereas, stratiform lead-zinc and Kuroko massive sulphide deposits are wide-spread there. Porphyry copper-molybdenum deposits occur in most terranes in Alaska and also within island arc terranes in Northeastern Russia. In general, the Alaska terranes are more similar by their metallogeny to the Alazea-Oloj and Koryak-Kamchatka terranes than to the Kolyma-Chukchi terrane group. The terranes of Koryakiya and most Alaska are dominated by mineral deposit assemblages of the mantle line of mineralization.

The described similarities and differences are concealed to a great extent due to the convergence of non-principal assemblages during the post-accretionary mettalogenic development.

Northeastern Russia and Alaska have a specific interoceanic and intercontinental (intercratonal) position in the Earth's structure (Chekhov, 1987, 1989). Like other modern active tectonic areas, including Central America and Southeastern Asia, this region has been confined to one of few gaps of the Pacific mobile Belt, presumably since the Riphean-Early Paleozoic. Constructional tectonic processes occurred to close this gap, as supported by (Chekhov, 1990) and also by newly obtained data.

Finding Cambrian-Ordovician faunas of the North American type in the Penzhine Range and Taigonos Peninsula and archaeocyathean and trilobite of the Siberian affinity in Alaska (Zhuravlev, 1992) testify that, during the Phanerozoic, Northeastern Russia and Alaska were relatively close to each other and represented a system of different-type marginal sea basins similar to those found in Southeastern Asia. It seems, that these marginal sea basins occurred along a peculiar kind of continental bridge that developed between the Siberian and North American cratons in the Preriphean. Their active tectonic margins, i.e. island arc systems faced both the Prearctic Ocean to the north, as is best evident from the Canadian Arctic, and the Prepacific or Panthalassa to the south. According to the existing tectonic viewpoint, the regional terrane mosaic can, in this case, be understood as resulting not only from the accretion of heterogeneous and alien fragments of subducting oceanic plates and their inclusion into the accretionary prism, but primarily due to the tectonic approach and matching of different portions of suprasubduction zones including island arcs, back-arc, fore-arc and interarc basins and other elements belonging to both Arctic and Pacific marginal seas (Chekhov, 1989). Thus, the concept, that most of the structural constituents or terranes in Northeastern Russia and Alaska have a marginal sea but not an oceanic origin, is based on correlations and comparisons of micro- and macropaleontologic, and paleofloral data from active areas of the Southeastern Asia type, which are structurally similar. This approach is substantiated by petrologic and petrogeochemical studies and isotopic dating of magmatic rocks, testifying, in particular, to wide-spread volcanics of boninite series and tholeitic lavas displaying the marginal sea and island arc properties in this area (Gelman et al., 1988).

It is important, that the "marginal sea" approach promote the regional tectonics. For instance, the Chukchi-Alaska paradox, that the Chaun-Chukotka area and the Brooks Range were immediately adjacent to each other in the past, but now are much different by their infilling formations and complexes and even their structure styles. Whereas, the Yukon-Koyukuk depression and the Alazeya-Oloi system of Mesozoids are isolated and remote from each other, but display many similarities. It is clear, that in the first case, there are marginal sea



← Metallogenic map of basic and principal mineral assemblages and post-accretionary deposits for the Russian Northeast and Mainland Alaska (Metallogenesis of..., 1993)
1 - Northeastern Asia Mz post-accretionary metallogenic belt and its continuation at the Mainland Alaska (marginal sea tectonic genesis); 2 - Kz post-accretionary metallogenic belt (oceanic genesis). *Mineral deposit assemblages named by accordingly with names of basic or principal assemblages*: 3 - undifferentiated sulphide disseminated and massive ore deposit (sd); 4 - quartz-sulphide disseminated ore with gold-quartz ore assemblage (q-sd); 5 - quartz-sulphide with tungsten and tin ore assemblages (q-sd_1); 6 - gold-sulphide disseminated ores (Au-sd); 7 - complementary silver-sulphide and tin-porphyry (Sn-Ag); 8 - tin-(silver)-porphyry (Sn); 9 - copper-(molybden)-porphyry (Cu-Mo); 10 - plumbum-zinc stratiform (Pb-Zn); 11 - ferrum- ore (Fe); 12 - chromite and platinum metal zoned mafic-ultramafic (Cr).

basins differing in the degree of the substratum granite alteration, which became close in space during collisional processes, whereas in the second case, there are rift structures featuring the same mechanism of spreading (Chekhov, 1990, 1992).

Another problem for discussion with regard to the Northeastern Asia tectonics is the position of paleoboundaries between the Eurasia and North America plates. There are three variants including the boundaries lying meridionally from the Lena River mouth to Sakhalin(1), approximately along the eastern side of the Inyali-Debin synclinorium (2) and along the South-Anyui rift(3), but none of them is generally adopted. If the regional paleostructure is understood as a mosaic of microplates, which reciprocally changed position during their developmental history, then, it becomes clear, that the like boundary couldn't possibly exist as a single well-defined suture. This is clearly exemplified by the modern regional tectonics of Southeastern Asia and Central America.

In our opinion, the Koni-Tanyurer island arc system of the interior Okhotsk-Chukchi volcanic Belt is such a boundary structure of the first order, i.e., of the interplate suture rank. Recently, more data have been obtained evidencing that, during Riphean to Early Paleozoic, this interior area of the Okhotsk-Chukchi volcanic Belt served as a well-defined boundary separating the structure elements of the Arctic (Boreal) and Pacific tectonic and paleobiogeographic affinities.

From the modern plate tectonics viewpoint, the complicated folded systems in Northeastern Russia and Alaska are understood as resulting from the processes of subduction, accretion and collision of blocks or terranes having a different tectonic origin. The concept of mosaic of tectono-stratigraphic terranes is used as a tectonic basis for metallogenic modelling and mineral assemblage studies. Such an approach encourages a certain new understanding of the regional metallogenic history.

The established system of mineral deposits is based on their relations to different tectono-stratigraphic terranes and the resulting differences in their composition, origin and tectonic position. In addition, all mineral deposits can also be classified in terms of the time of terrane accretion. Mineral deposits are divided into three groups according to the three major crust formation stages within the continent-to-ocean transition zone, as follows: 1) pre-accretionary mineral deposits, which formed prior to other deposits of any tectono-stratigraphic terrane; consequently, these deposits are primary or basic ones with references to the subsequent metallogenic history (Sidorov, 1987, 1992); 2) syn-accretionary mineral deposits, which formed when terranes or plates underwent collisions associated with magmatic and metamorphic processes and intense tectonic deformations; and 3) post-accretionary mineral deposits, which formed last under the conditions of subaerial continental marginal volcanoplutonic belts (magmatic arcs) overlying different terranes. The same approach is used to discriminate between metallogenic belts, which consist of approximately co-eval and genetically interrelated mineral deposits, with the involvement of tectonic environments under which these deposits formed. Each regional metallogenic zoning is a result of a complicated interaction in time and space of pre-, syn- and post-accretionary mineralizing processes including the simultaneous occurrence of different accretion stages within different mineralization zones. In other words, the distribution of metallogenic belts greatly reflects the mosaic of terranes.

The comparison of mineral assemblages of terranes in Northeastern Russia and Alaska and the post-accretionary metallogenic belts and the locations of basic mineral assemblages are shown on the Figure.

The comparison of basic or principal assemblages and their mineral deposit assemblages in Northeastern Russia and Alaska is hampered by the lack of data on metalliferous zones of sulphidization depicted on the scheme as the principal assemblages, i.e. Sd undifferentiated sulphide and q-Sd quartz-sulphide, tungsten-tin assemblages. These principal assemblages are the most wide-spread and most of the quartz-gold, tin, tungsten and other lode deposits are related to them. The formation of quartz veins and stringers began in the pre-accretionary period simultaneously with hydrothermal-sedimentary activity and proceeded during the collisional, accretionary and post-accretionary developmental stages of terranes. It is difficult to determine the time of formation of quartz veins due to their high convergent character and also because they could intensely form during any the developmental stages of terranes. The metalliferous and non-metalliferous properties of these quartz veins are closely related to the occurrences of principal assemblages, which were earlier understood as altered host rocks or disseminated mineralization zones.

The bedrock sources of major placers in Northeastern Russia are mostly related to a very simple quartz-sulphide (gold-quartz-sulphide) ore deposit assemblage with the principal assemblage consisting of zones of pyrite or pyrrhotine alterations with brecciform spotted and veinlet silicification. These pre-accretionary occurrences are present in terranes of turbidite basins of continental block passive margins and marginal seas. They are not usually of commercial interest despite large zones of disseminated gold mineralization. The sources of placers are abundant gold-quartz veins and stringers which formed during the collisional, accretionary and post-accretionary developmental stages of terranes. Commercial gold deposits are also sometimes related to them, and tin and tungsten placer sources formed at the same.

The formation of major gold deposits including the Natalka, Nezhdanin and Maiskoe deposits was inherited since the pre-accretionary developmental stage of the terranes, and acquired the commercial vein-veinlet-disseminated character during the collisional and accretionary stages, as exemplified by the Natalka deposit, and especially at the beginning of the post-accretion of the Northeastern Asia metallogenic belt. Most of the tin and tin-silver deposits are also inherited and related to post-accretionary and, not as often, to accretionary granitoids. In Chukotka, the accretionary and post-accretionary granite-forming processes were continuous.

In Alaska, the similar conditions, under which the mineral deposits formed, are characteristic of terranes of passive and replaced continental margins, e.g. the Nome area. The majority of other terranes feature other conditions of mineralization corresponding to those of the Koryak and Northern Kamchatka terranes. Nevertheless, the post-accretionary metallogeny of Alaska is similar to the post-accretionary metallogenic belt of Northeastern Asia, which consequently, could be continued on to the American continent. But this similarity is not directly related to pre-accretionary mineralization and results from a convergence of hydrothermal occurrences which formed under different geologic environments and had different ore sources.

The principal assemblages and ore deposit assemblages of terranes of the oceanic crust, island arcs and continental rifts are similar, with some differences between. The differences include wide-spread massive sulphide and copper-porphyry deposits in Alaska that can be explained by the fact that this terrane type is better known and examined in Alaska. The occurrence of major tin-silver and tin (tin-porphyry) deposits in rift structures in Northeastern Russia is due both to the continental crust of a greater thickness here and a high-rejuvenated character of hydrothermal processes (Sidorov, 1991).

Thus, gold and tin deposits are more wide-spread in Northeastern Russia than in Alaska, primarily due to the formation of numerous deposits within major terranes of turbidite marginal sea basins and the passive continental margins during the collisional, accretionary and post-accretionary stages of their development. In Alaska, the same type terranes are less abundant in gold occurrences, whereas stratiform lead-zinc and Kuroko massive sulphide deposits are wide-spread there. Porphyry copper-molybdenum deposits occur in most terranes in Alaska and also within island arc terranes in Northeastern Russia. In general, the Alaska terranes are more similar by their metallogeny to the Alazea-Oloj and Koryak-Kamchatka terranes than to the Kolyma-Chukchi terrane group.

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On the basis of the concept of the Early Precambrian three lines of mineralization inherited by Phanerozoic metallogeny (Sidorov, 1992) a supposition is possible that the formation of the principal disseminated sulphide assemblages hosted by Phanerozoic layers was primarily related to the Precambrian iron formation metamorphism, the tin-uranium-polymetallic deposit assemblages were related to the rejuvenation of uranium-polymetallic deposit, and the other deposit assemblages were related to the mantle copper-nickel and chromite mineralization line or could also result from different combinations of these three lines of the Early Precambrian mineralization.

If our concept is true, then, the iron formations associated with uranium-polymetallic assemblages were predominant in the Kolymian and Chukchi terranes in Northeastern Russia during the Early Precambrian, which makes them different from most terranes in Alaska. Judging from the occurrence of sulphide or tin-uranium-polymetallic deposit assemblages (see the Figure) the same or similar conditions under which the mineralization proceeded during the Precambrian were characteristic just of some terranes in Western Alaska. The terranes of Koryakiya and most Alaska are dominated by mineral deposit assemblages of the mantle line of mineralization.

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