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Regional forecasting of sandstone type uranium deposits

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1. Introduction

The Neogene-Quaternary collision of the African, Arabian and Indian plates from the south and the Mesozoic-Cenozoic subduction of the Pacific plate from the east led to the formation of large orogenic belts in the regional parts of the Eurasian plate. Each of them is characterized by its metallogenic peculiarities. The analysis of spatial distribution of endogenous and exogenous uranium deposits within the limits of separate orogenic areas creates preconditions for exposure peculiarities of metallogenic zonation in every large geological block. It allows to plan in them the place sandstone deposits of uranium in different under the terms of the formation sedimentary basins. Leading ore localizing factor –the groundwater and interlayer oxidation zones controlling uranium mineralization were established for all objects of sandstone type. United source of uranium – domestic the recharge areas of adjacent mountain structures were proposed for overwhelming number of deposits. The metallogeny of uranium was most fully studied within the limits of the Alpine-Himalayan tectonic belt.

1. The metallogeny of uranium of the Alpine-Himalayan belt

A number of major segments allocated spanning orogenic regions and adjacent to suborogenic sections of activated platform.

2.1. The Mediterranean segment. The subduction of the African plate on the western end of the Eurasian continent began at the end of Miocene in the Pliocene. The Mediterranean segment is subdivided into orogenic and suborogenic regions. The orogenic area from 300 to 700 km is located in the extreme south of folded belt. Typically, a foreland zone is situated within the orogeny boundary. It is characterized by thrusts, over-thrust sheets, and is frequently capped with red-colored molasses at the frontier. In this given segment the notion of suborogen is seen as the slightly activated part of the Western-European platform. The French Massif Central and the Bohemian Massif are included in it. The Metallogenic sequence was quite clearly outlined within the limits of the segment. Here the Permian uranium ore epoch was widely displayed –that is the time of origin of stratiform deposits of uranium of Bikhor type on the large area. Its genesis is still widely debated today. Small, seldom middle deposits (Pb, Zn, As, CaF2 and others) were formed in the Mesozoic-Cenozoic period (elementary stage of subduction). They are not infrequently conjugated with small granitoid intrusions. Small sandstone deposits (Grezio and others) were later revealed in the depressions of the French Massif Central within the limits of suborogen. The deposits Gamr and Königstein tightly connected with effusions of the Bohemian Massif in the regional part of suborogen completed metallogenic evolution of the European section of the West-European platform conditioned by subduction of the African plate. In general, the Mediterranean segment presents a full metallogenic picture. It was created as a result of subduction of the African plate under the southwestern part of the Eurasian continent.

2.2. The Arabian segment. The subduction of the Arabian plate at the southern part of the Eurasian plate determined the formation of the 500 km wide orogenic belt spanning the territories of Iran, Turkey and Caucasus. We divide it into three sectors –Anatolian, Caucasian and Kopet Dagh. The Oligocene dates the beginning of intensive orogenesis. The first point of analysis within this segment is area development at product regions of volcanic activity. The second is the influence of a long, narrow trough of land on the region's metallogeny;

once situation during the early Miocene period at the current location of the Caucasian ridge. The last appeared in place of the trough in late Miocene, at the time of the young volcanoes (Elbrus, Kazbek). The third and final peculiarity of the Caucasian region is high oil content.

As a result, the following incomplete metallogenic series was loomed. 1) Large accumulations of hydrocarbons within the limits of the Persian Gulf, Iran, Iraq and the North-Caspian depression. 2) Orogen, endogenous deposits of Cu, Mo, Co, Au, Mn and others, and hydrothermal uranium deposits (Byk, Beshtau) located on the external front are localized. 3) The area of suborogen in the Ciscaucasia with titanium-zirconium placers and accumulations of hydrocarbons (the North-Caucasian basin), and at the eastern slope of the Stavropol arch weakly developed groundwater oxidation zones (Balkovskoe) were discovered in the young sediment of Paleo-Don.

2.3. The Indian segment is the most uranium productive in the extended belt Tethys. In orogenesis intensity the Indian segment has surpassed all such processes in the World. The collision of the Indian plate converted at a distance of over 1500 km into the depths the Eurasian plate and differentiated the orogenic area along the vertical by horsts till +9000 m and grabens till -5000 m. It is divided into the Pamir and the Himalayan sectors. They differ in structural peculiarities and scale of ore content.

Three types of metallogenic zones controlling roll-type deposits of uranium were marked in the Pamirs sector. With all the uniqueness of each zone's type, they have in common the confinedness of the largest and unique deposits –giants to suborogen, where they gravitate to areas most remote from orogen. Obviously, that collision model of development of this region is only answering to existing geodynamic situation of the region. The Pamir "wedge" is the result of the drawn out collision between the Indian plate coming on the Eurasian plate. All deposits-giants of roll-type are located within the limits of the suborogenic (activated) part adjacent to the Turan platform and the southern edge of Kazakh "shield". We have shown that the main conveyer of roll-type uranium deposits-giants in the area of transit were initially only surface and ground, and only later interlayer waters originating in the North and the Median Tien-Shan at the zone of the maximum collisional stress. The tight spatial and paragenetic connection of the influent flow of uranium waters, forming uranium deposit-giant roll-types with the most actively advanced site on the Indian plate –the Pamir "wedge". The most productive metallogenic zones originate at supposed sites of mantle uranium accumulation at whose closure deposits-giants are situated.

The Himalayan sector is characterized by a more complicated geological structure in comparison with Pamir. One of the unsolved problems of the Himalayan sector is the reason for such a small uranium content. The absence of large deposits of uranium within the limits of the Himalayan sector is explained by intensive promotion to the northeast of the orogenic area border during the N-Q period. This exacerbated frequent recharge area fluctuations, active migration of hydrocarbons, and an absence of regional stable centers of unloading. This hampered the broad development of ore-forming interlayer oxidation zones. It should be noted, that industrial deposits of uranium in the area of hinterland were revealed only in the northern edge of the Indian subcontinent. Here the preconditions were created for the formation in the Neogene-Quaternary sedimentary basins of the groundwater and interlayer oxidation zones and the uranium ore.

1. The metallogeny of uranium of the Pacific belt

The high metallogenic potential of the Pacific ore belt meridional is determined by the Mesozoic-Neozoic subduction of the Pacific plate. This process affected the tectonic blocks of the Eurasia continent to depths from 500 to 1500 km. It should be noted, that insignificant deposits of uranium (Ningyo-Toge, Tono and others) in the small graben tectonic structures accomplished with coarse-grain bed and lake sediments of the Cretaceous and the Miocene-Pliocene age were discovered within the limits of the Japanese islands and the south of Korean peninsula. The ores were formed by ground waters.

We emphasize, that the eastern part of the Eurasia plate has undergone significant changes in the course of subduction. Within the limits of the activated part, the areas with the mode of intracontinental rifting and passive margin are escaped. Endogenous deposits of calderas connected with volcano-tectonic structures of the Mesozoic age. On the external part of the belt sandstone type uranium deposits of the Cenozoic age are located. in tight spatial connection with young covers of basalt predominate on the external (the western) front of uranium ore belt in the same districts. These covers fix the western border manifestation of subduction in the east of the Eurasia continent and confirm the western meridional border of the Baikal-South-China uranium ore belt. The above model allows supposing tight spatial connection abyssal geodynamical processes in the Mesozoic-Cenozoic era with the accommodation of uranium deposits. Distinct separation of metals in the diametrical section of belt is outlined. In it's internal part uranium is conjugated with Au (caldera Aldan), Mo, Pb-Zn and CaF2 (caldera Streltsovskaya), with Pb, Zn, W, Mo, Au, CaF2 (caldera Dornod) and with Mo, Ti, CaF2 (caldera Xiangshan). The uranium is often separate from other metals on the external front of uranium ore belt. This is evidently explained by its high mobility.

To the west, basalt magmatism was intensively displayed in the area of damping in the passive margin of the continental block. The uranium is often separated from other metals on the external front. This is apparently explained via its high mobility. Toward the west, basalt magmatism was intensively manifested in the field of

attenuation of the passive margin of continental block. Sandstone type uranium deposits in the Transbaikalia (Vitim district), in Mongolia (ore manifestation Sul and others) and on the western end of the South-China platform (Yunnan) are spatially closely connected with it. All these objects are covered with the Quaternary basalts. The infiltration deposits of uranium out of touch with young volcanism were revealed within the limits of cover of the Sino-Korean craton in the Ordos basin and Erlian depression of China. Perhaps, even the greater part of them were discovered within the limits of these structures were formed from domestic sources of alimentation.

The subduction process of the Pacific plate is owed to a full set of natural metallogenic zones spanning from the deep rear of the subduction zone along its external damped front.

1. Conclusion

The marginal part of the Eurasian continent was divided into a number of segments, each of which is characterized with its own metallogenic specialization caused by the processes collision and subduction. The sandstone type uranium deposits were on the external fading collision front and were located within the limits of area of suborogen in three structures –the Mediterranean and the Indian segments, and the Pacific belt. Different metallogenic specialization and the scale of manifestation of hydrogenic ore process within the limits of the Pacific belt and the Indian segment of the Alpine-Himalayan belt, the formation of which is caused by the similar the Mesozoic-Cenozoic global geodynamical processes, are determined by a number of reasons. The uranium on the external front of fading geodynamic processes (within the limits of suborogen) turned out in different structural, lithological and hydrogeological environments. Within the limits of the Baikal-South-China belt it was localized in the restricted by area paleo-valley basins and depressions. The deposits are often spatially and in age are mated with covers of young basalts. Large endogenic deposits of uranium in the local structural blocks (calderas) are localized in the rear parts of the belt. The scales of objects of sandstone type within the limits of the Baikal-South-China of uranium ore belt do not exceed average.

The deposits of uranium within the limits of the Indian segment (The Pamir sector) are localized in the vast basins of suborogen type and major extensive paleo-valley in the artesian basins with running mode. It is characterized by a weak expression of young volcanic activity in the district and insignificant on scales endogenic uranium deposits in the rear parts of province (mountain Tien Shan). Considering the south framing of the Eurasian continent (area of collision of the Indian plate), we distinctly see the basic similarity in the position of infiltration uranium deposits of the Tien Shan megaprovince and the Baikal-South-China uranium ore belt –component part of the Pacific metallogenic belt. They gravitate towards area of attenuation of geodynamical processes in both cases. The endogenous uranium objects take places near the area of contact of collision plates. Their sizes both endogenous and exogenous are noticeably different in the south and the east of the Eurasian plate. The scale of infiltration deposits of the Tien Shan megaprovince is on the order more deposits of the Baikal-South-China belt. This is due to the wide areas of transit and many-tier geochemical barriers, favorable for localization of uranium from the oxygen-containing uranium-bearing waters, moving through the Cretaceous and the Paleogene deposits of Turan plate and major basins of the South Kazakhstan. However, endogenous uranium deposits of the Tien Shan are significantly inferior in scale to major uranium objects of the Mesozoic age of the Pacific ore belt.

The reasons of such phenomena require further study. Given the material is evidence about tight spatial relation of part of infiltration uranium deposits with endogenous deposits of uranium confined to volcanogenic-tectonic structures. Moreover, those and others types of uranium objects are confined into a single ore metallogenic zoning. The last is entirely due to global geodynamical processes occurring in the crust and mantle in the marginal parts of the Eurasian plate.

Country or International Organization

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