The Post-Magmatic Genesis of Sperrylite from some Gold Placers in South Part of Krasnoyarsk Region (Russia)

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Krasnoyarsk Region has been one of the main gold-mining provinces of Russia from the last century and up to nowadays. While placer deposits being mining they have marked constantly platinum-group minerals with gold in common. In the main, they were "platinum" (Fe-Pt compounds) and "osmiridium" (Os-Ir-Ru alloys). Receiving and studying heavy concentrates from placer deposits, we have discovered, that practically all of them contained sperrylites somehow, independently of the region, or another PGM presence or absence. One has discovered the mineral in placers of the following rivers and creeks: Coloromo, Krasavitza, Garevka, Lombancha, Danilovsky, Bolshaya Kuzeyeva (Yenisey Ridge), Karagan, Levaya Zhaima, Mana, Bolshaya Sinachaga (Eastern Sayan), Rudnaya, Zolotaya, Bolchoy Khaylyk (Western Sayan), Beika (Kuznetsky Alatau) and some others. The picked out sperrylite is presented, mainly by diversely rounded nodule fragments and more rarely, by separate crystals and its aggregates. As a rule, the biggest crystals (0,1-0,5mm) are less rolled than smaller ones (less than 0,1mm). There are smoothed forms among them mainly. The studied sperrylite crystals have different crystallographic forms. More often we can find hexahedrons among them (Karagan River), sometimes we find octahedrons, cube-and-tetrahedron combinations, cube-and-octahedron ones (Coloromo River) and some others. One marks cube-and-trigon-trioctahedron and cube-and-didodecahedron combinations in isolated cases.

The chemical compositions of sperrylites were determined by the X-ray microanalyser "Camebax-Micro" at UIGGM (Novosibirsk) (Table).

The Table analysis indicates the presence of two groups of the minerals. Their compositions differ from each other. So the placer sperrylites from rivers – Mana, Bolshaya Sinachaga, Levaya Zhaima (Eastern Sayan), Coloromo, Garevka, Krasavitza, Danilovsky, Bolshaya Kuzeyeva (Yeniseisky Ridge) – have antimony and sulphur admixtures, but they have no practically PGE unpurities, except small Rh contents. On the other hand, the placers sperrylites from rivers – Karagan (Eastern Sayan), Rudnaya, Bolshoy Khaylyk, Zolotaya (Western Sayan) are characterized by the Ir, Ru, Rh unpurities presence. It witnesses for absolutely another native sources. For the comparison, they show the composition of the sperrylites from original rocks in some ultramafic-mafic massifs of Eastern Sayan.

The majority of the investigated sperrylitic grains from placers contains itself inclusions of different ore- and rock-forming minerals. One can and should use the mineral compositions for solving the problem on supposed native sources for PGM. Quartz, pyroxenes, micas, common potash feldspars, plagioclases, garnets, talc and some others were identified by the composition among the analyzed mineral inclusions. Besides that, one can find pyrrhotite, ilmenite, rutile and chalcopyrites among the inclusions. Quartz, micas, garnets (spessartite in particular), ilmenite and rutile are the most common inclusions for the first group sperriylites, which are distinguished by the higher compositions purity. The inclusions of orthopyroxenes, talc, olivine and some others are characteristic for the second group of sperrylites. While studying the minerals in reflected light, one has found out that some of their nodules were substituted by platinum from the edges to the center (placers of rivers: Coloromo, Danilovsky, Karagan, Bolshaya Kuzeyeva), up to the formation of perfect platinum pseudo-morphs by the sperrulite (Figure).

A chemical composition of the platinum, originating by the sperrylite, inherits admixtures of the elements, which has been present in the substituted sperrylites in higher quantities. For example, the higher As and Sb contents are marked in the platinum composition from the placer of Coloromo River and they are characteristic for the sperrylite out of the same placer. And on the whole, the native platinum by sperrylite, compared with the magmatic platinum, is characterized by a higher assay (a composition purity), by the iron admixture absence and, evidently, it should be considered as independent mineral species.

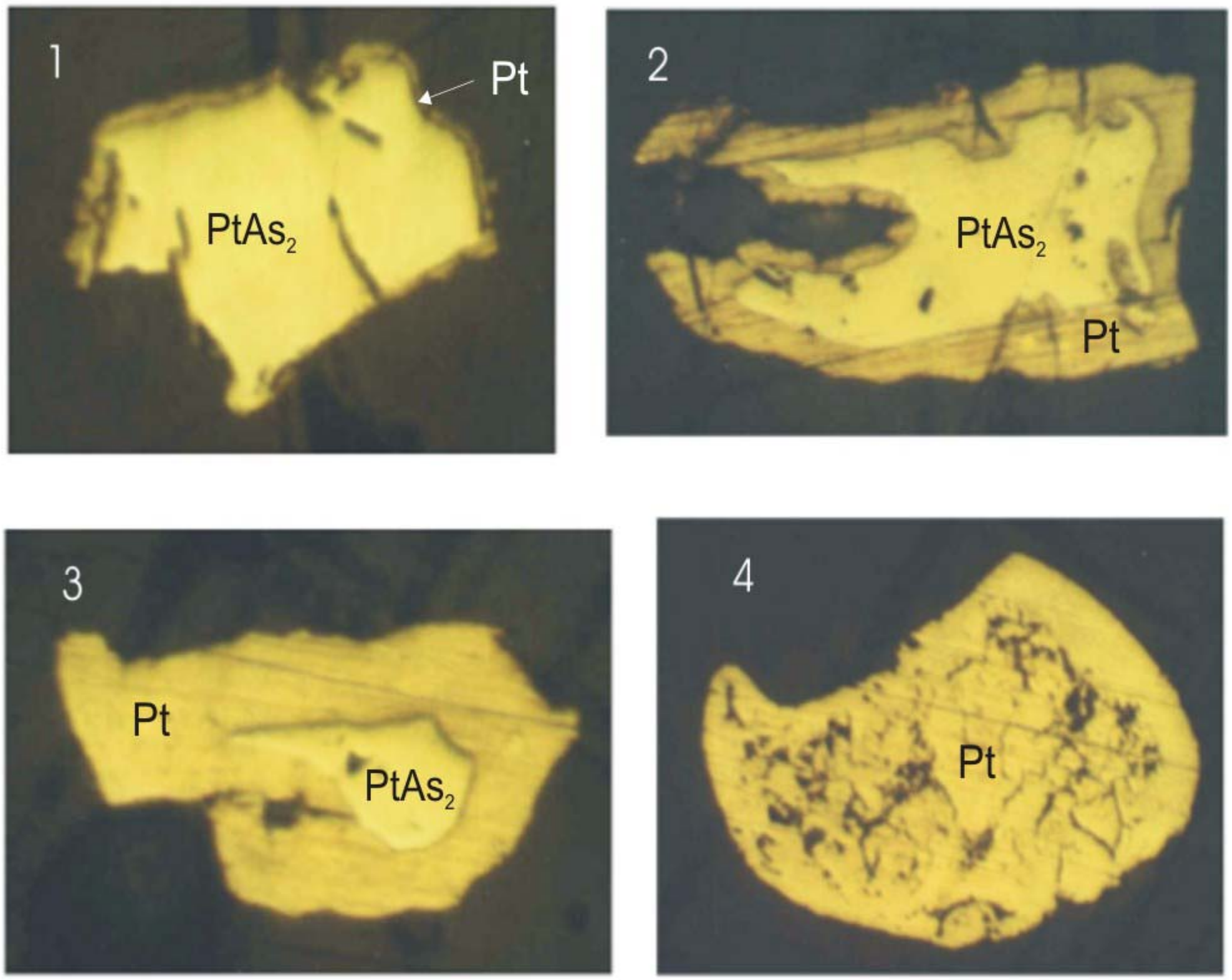

Figure 1. *Stages of replacement of sperrylite (white) by native platinum (gray). 400x.*

Sperrylite presence in the most parts of gold-bearing placers in the south of Krasnoyarsk Region parallel to the absence of any basic and ultrabasic rocks in the nourishment areas of some placers make us suppose, that there are another original sources for this mineral some how. In our opinion, gold ore deposits and hydrothermal type manifestations can be these untraditional sources. This supposition is based on the next two moments. Firstly, in the last years literature there appeared to be the data on direct finds of sperrylites in gold ore deposits (Laverov et.al., 1997). Secondly, they have experimental works concerning sperrylitic synthesis under hydrothermal conditions (Evstigneeva et. al., 1996; Tihomirova et. al., 2000). It witnesses about the possibility of the mineral origin under nature conditions, jointly or separately from gold while gold ore deposits forming. The sperrylite, born in a hydrothermal process, has some specific features allowing to distinguish it from the primary-magmatic analogue associated genetically with the crystallization, of a stratiform basic-ultrabasic magma or formed at platinum minerals substituting of alpinotypic ultramafites. In the first turn, we should attribute its chemical composition to such characteristic sings of a hydrothermal sperrylite. The chemical composition differs from the others by the absence of another PGE admixtures, iridium, osmium and ruthenium especially; they are typical representatives of a hightemperatured paragenesis. As a rule, one marks higher contents the elements only with chalcophile properties (as Sb, for example) in the composition of hydrothermal sperrylite.

Considerably greater variety of crystallomorphologic forms, unlike the mineral, accompanying different platinum-metallic parageneses of traditional industrialgenetic types, is the other sign of the sperrylite, originated under postmagmatic conditions. Accordingly to the published data, cubic habit sperrylites are characteristic for nickel-copper deposits of the Norilsk type; octahedronic forms are prevailing among the sperrylites from circular alkaline-ultrabasic massifs of Konder and Inagly types, among the sperrylites from alpinotypic ultrabasites, among the sperrylites from nickel-copper deposits of Cambalda type (Australia), associated with a basalt-komatiitic formation. Unlike this one marks different forms among the sperrylites of a hydrothermal genesis: cubes, octahedrons, cube-and-tetrahedron combinations, cube-and-octahedron combinations, cube-and-diplaid combinations and some others.

After all, rock-forming minerals inclusions of a typical hydrothermal parageneses with average and low temperatures for the crystallization are characteristic sings for the sperrylites from hydrothermal deposits, unlike the inclusions of chrome-spinellids, ortho-puroxenes, olivines and the others, inherent to PGM from mafit-ultramafitic associations.

Table. Chemical compositions of sperrylite from some gold placers and intrusive massifes of the south of Krasnoyarsk region.

Amounts of analysis	Limits of contents, (wt.%)							Placer deposits
	Pt	Ir	As	Ru	Rh	Sb	S	
Yenisey Ridge								
3	56,29-56,76	0,00	43,13-43,37	0,00	0,00	0,07-0,38	0,02-0,03	Krasavitza
15	55,79-56,58	0,00	42,84-43,51	0,00	0,00	0,00-0,30	0,01-0,06	Koloromo
10	56,09-56,78	0,00	43,14-44,12	0,00	0,00	0,00-0,16	0,00-0,09	Garevka
8	56,23-57,24	0,00	42,39-43,84	0,00	0,06-0,16	0,00-0,19	0,00-0,05	Danilovsky
12	55,49-56,84	0,00	42,78-43,61	0,00	0,00	0,00-0,18	0,00-0,44	Bolshaya Kuzeyeva
Eastern Sayan								
14	56,21-57,29	0,00	42,70-43,57	0,00	0,00	0,00-0,16	0,01-0,05	Mana
3	56,57-56,93	0,00	43,28-44,43	0,00	0,06-0,13	0,00-0,05	0,00	Bolshaya Sinachaga
12	56,20-57,28	0,00	43,44-44,22	0,00	0,00	0,00-0,09	0,04-0,19	Kuvai
4	56,41-56,97	0,00	42,91-43,30	0,00	0,00	0,00-0,25	0,08-0,27	Levaya Zaima
38	55,50-57,04	0,00-1,11	42,18-46,14	0,00-0,05	0,00	0,00-0,27	0,02-0,46	Karagan
Western Sayans								
39	55,49-57,01	0,00-0,90	41,52-43,68	0,00	0,00-0,07	0,00-0,15	0,01-0,11	Rudnaya
2	53,25-54,57	0,89-1,66	43,43-44,01	0,03-0,11	1,19-1,59	0,00	0,96-1,36	Bolshoy Khaylyk
Intrusive massifes of Eastern Sayan								
18	54,09-56,61	0,00-2,16	42,37-43,73	0,00-0,05	0,00	0,00-0,28	0,07-0,39	Massif Kingash
29	53,06-56,76	0,00-2,62	40,64-43,78	0,00-0,06	0,00-0,09	0,00-1,08	0,02-0,46	Massif Kuskanak
2	55,18-55,77	0,29-0,91	43,93-43,95	0,00	0,23-0,42	-	0,58-0,80	Romanovsky massif
C_{lim}	0,146	0,132	0,048	0,038	0,036	0,038	0,012	

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