PGM types and trends from Novoseltsi placers, Bourgas district, Bulgaria

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Wide variety of PGM [1,3,7] including the type locality of vasilite $(Pd,Cu)_{16}(S,Se)_7$ [1] occur amongst the Middle Eocene gravels, sands and clays around the Novosetsi (Konstantinovo) village in the Eastern Srednogorie of Bulgaria (Fig.1).

Mineral composition

The PGM obtained from the heavy mineral concentrates include:

1) ***Fe-bearing platinum and isoferroplatinum Pt_3Fe;***
2) ***Os-rich (Os-Ir-Pt) alloys and Cu-Sn-Zn alloys;***
3) ***Sulphides: PtS, (Pt,Pd)S, (Pd,Ni)S, RhAsS, RuS_2, OsS_2, $(Cu,Pt.Ir)S_2$,$(Rh,Ir,Pt)_{1.77}S_3$ and $(Pd,Cu)_{16}(S,Se)_7$ [1,3,7];***
4) ***Tellurides: Pd_9Te_4.***

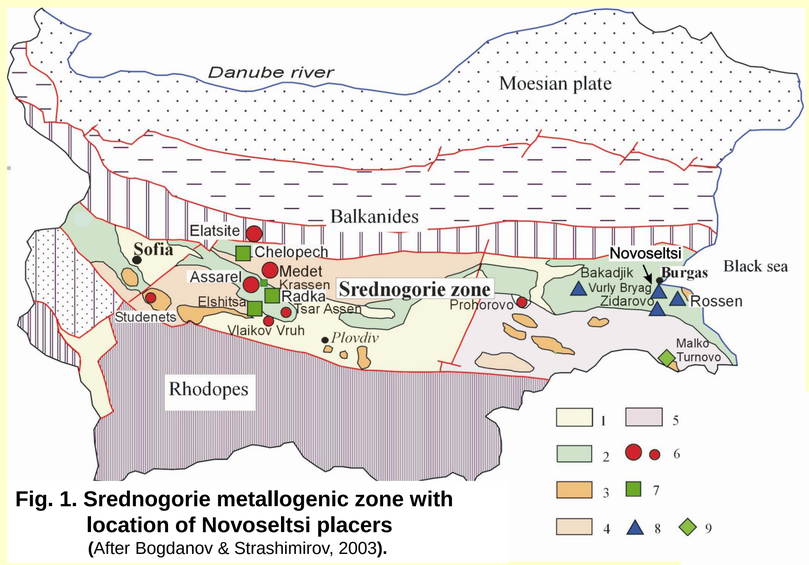

Fig. 1. Srednogorie metallogenic zone with location of Novoseltsi placers (After Bogdanov & Strashimirov, 2003**).**

Other minerals found in the polished sections are:

5) **Cu-Sn-Zn alloys ($Cu_{0.83\text{-}0.88}Sn_{0.03\text{-}0.12}Zn_{0.05\text{-}0.10}$) and,**
6) **Gold displaying zoned pattern of electrum rich core ($Au_{0.61}Ag_{0.39}$) and rim almost devoid of Ag ($Au_{0.99}Ag_{0.01}$) as a result of leaching during the transport. Some of the gold grains are closely associated with the Os and Pt dominant grains (Fig. 2b) suggesting common source.**

Morphology and grain size

The individual grains of the studied PGM are subhedral to anhedral and from about 10μm to 2-3 mm in size (Fig. 2). Some grains have euhedral shapes and others have round shapes (Fig .2a), suggestive of melt droplets.

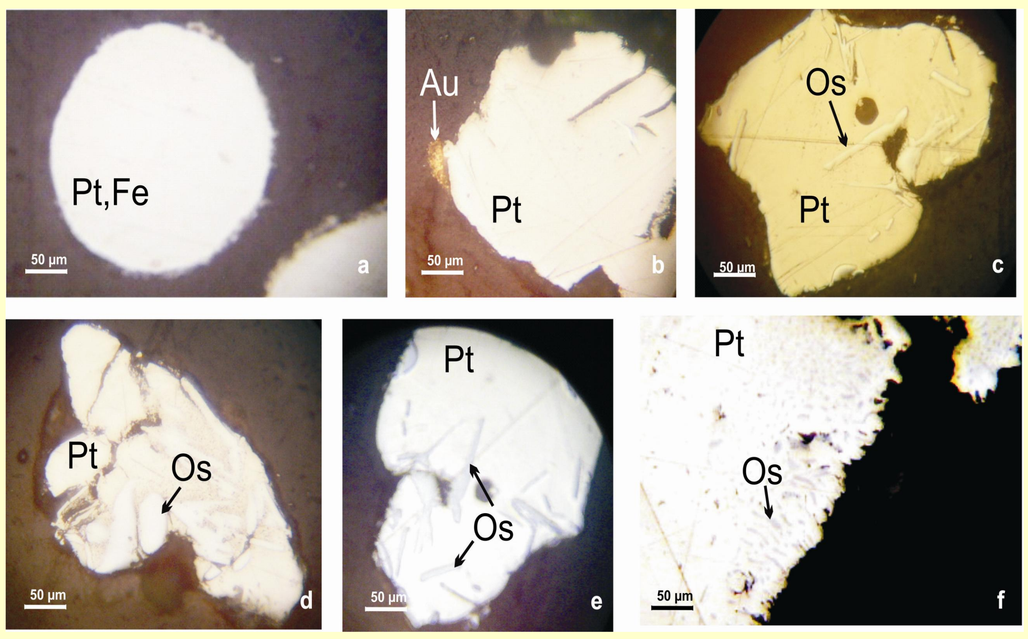

Fig. 2. Morphology and grain size of Pt and Os-rich alloys in reflected-light microphotographs.

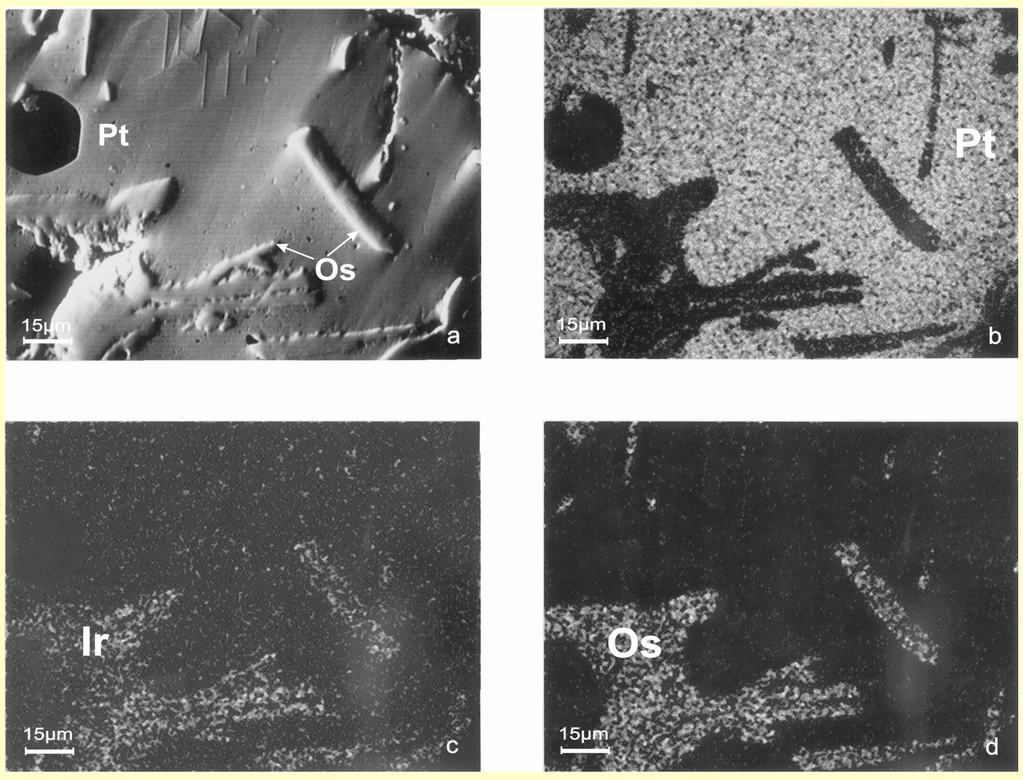

Fig.3. Pt, Ir and Os distribution and associations (EPMA).

Os-dominant minerals are most abundant varieties associated with Fe-bearing platinum which also occur as homogeneous and separate grains and laths (Fig. 2 and 3).

Chemical composition

Most of the examined grains consist mainly of Pt (62.33-81.85 at%) and Fe (11.96-24.73 at%) accompanied by varying amounts of other PGE such as Pd (0.30-19.49 at%), Rh (1.44-4.38 at%), Ir (0.27-6.18 at%) and Os (0.10-2.19at%),(Fig. 3 - 6).

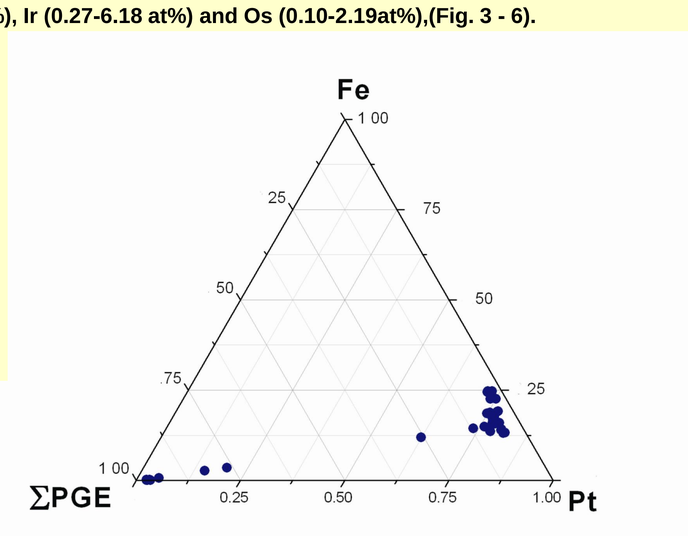

Fig. 4. Compositional data for Fe-bearing platinum (at%) in the system Pt-Fe-ΣPGE.

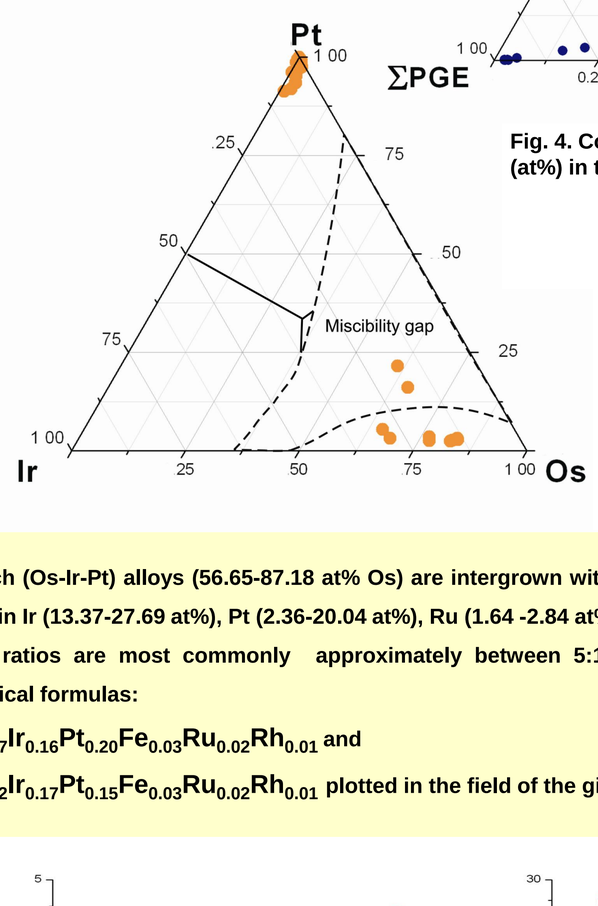

Fig. 5. Compositional data for Pt and Os -rich alloys (at%) in the system Pt-Ir-Os the miscibility gap is drawn according to Harris & Cabri(1991).

Os-rich (Os-Ir-Pt) alloys (56.65-87.18 at% Os) are intergrown with Fe-bearing platinum (Fig. 2 an 3) and contain Ir (13.37-27.69 at%), Pt (2.36-20.04 at%), Ru (1.64 -2.84 at%) and Rh (0.39 -1.12at%), (Fig. 5 and 6). Os:Ir ratios are most commonly approximately between 5:1 and 2:1 with two compositions with empirical formulas:

$Os_{0.57}Ir_{0.16}Pt_{0.20}Fe_{0.03}Ru_{0.02}Rh_{0.01}$ and

$Os_{0.62}Ir_{0.17}Pt_{0.15}Fe_{0.03}Ru_{0.02}Rh_{0.01}$ plotted in the field of the given immiscibility gap [3,5], (Fig. 5).

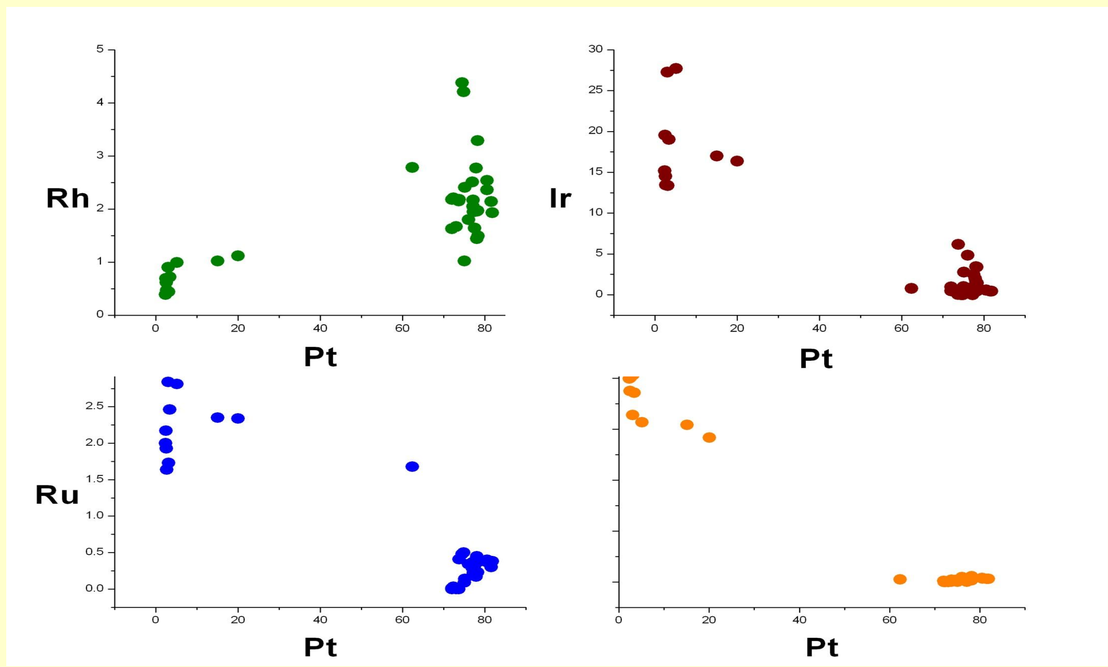

Fig. 6. Relations between Pt, Rh, Ru, Ir and Os concentrations.

Conclusions:

- **Os and Pt dominant alloys represent the main magmatic trend.**
- **The close association of the Pt-Fe alloys and Os-dominant alloys suggests a common origin.**
- **Next, abundant and characteristic for Novosetsi placers is the sulphide trend with exsolution-related domains and blebs of laurite, erlichmanite, braggite, vysotskite, hollingworthite, vasilite, indicating for rise of fS_2 with increasing role of Pd, Ni, Cu and As in addition to Se and Te with decreasing temperature.**
- **The Pt x 100/(Pt+Ir+Os) ratio [4] seems to be extremely high (>98) supporting the conclusion that possible source for the PGM are relics of non-ophiolitic pyroxene bearing hidden, or eroded mafic intrusions affected by post magmatic alterations.**

References

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