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PLATINUM GROUP MINERALS FROM THE YUBDO MAFIC-ULTRAMAFIC ROCKS, WESTERN ETHIOPIA

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The Yubdo platinum deposit is located in Western Ethiopia 520 km from Addis Ababa. Platinum has been mined from the Yubdo area since ancient times. MURDOCK [1] suggested that platinum grains of Yubdo were used to decorate objects in Egypt in the 7th century B C. The period of greatest mining activity in the area, involving British and Italian companies, falls in the years between 1926 and 1941. An estimated 2700 kg of platinum has been extracted from the deposit during its mining history and the annual production reached its peak of 233 kg in 1933. After the mine closures in 1941, several attempts were made to study the elluvial-alluvial platinum deposits and other mafic-ultramafic intrusions in the area. In 1972 the Nippon mining Co. estimated 12,060 kg of platinum reserves in the weathered lateritic deposit with an average platinum content of 0.336 g/t of ore on the basis of the investigations of sample material taken from 29 pits. Placer platinum and gold workings are common in the Yubdo area along the Alfe and Birbir rivers in addition to the known elluvial-alluvial lateritic placer deposits on top of the birbirite and dunitic rocks belonging to the ultramafic body. The presence of sperrylite in the dunite and birbirite rocks of Yubdo as well as the growth of the Pt-Fe nuggets under surfacial conditions have been reported by AUGUSTITHIS [2]. CABRI ET AL. [3] studied the Pt-Fe alloys and identified several PGM inclusions with sulphides, arsenides and oxides.

The 9 km long and 4–5 km wide ultramafic intrusion of Yubdo strikes NNE-SSW and is crossed by the Birbir river in the eastern and southern part of the intrusion. The mafic-ultramafic rocks are underlain by Precambrian basement rocks of sedimentary origin consisting mainly of gneisses, quartzites, mica schists, amphibolites and chlorite schists. Acidic intrusive rocks include syntectonic granodiorites, hybrid granites, quartz-diorite and diorite porphyries which intrude the ultramafic rocks.

The central part of the ultramafic body is dominated by a serpentinised dunite with a cumulate texture and a forsterite content of 81–84 mol.%. Due to the serpentinisation, the olivine grains are commonly rimmed by talc, serpentine, carbonate and opaque minerals. Peridotites rich in amphibole and olivine are found with intercalated dunite and pyroxenite at the east and southern parts of the ultramafic body. Apart from common hornblende, the altered parts contain cummingtonite. The olivine grains are serpentinised at the margins and the opaque minerals consist mainly of chromite and martitised magnetite, where the latter occurs as interstitial single and intergranular grains within olivine. Pyroxenites are found at the outer rim of the ultramafic body and consist of diopsidic pyroxenes.The alteration products are serpentine, amphibole and chlorite. Birbirite, which is found at the top of the dunite and pyroxenites in the center of the ultramafic body, consists of diffuse iron oxides located around the margins of olivine grains.

Several Pt-Fe primary grains were identified enclosed in chromite phases and along alteration zones Pt-Fe alloys found in serpentinised zones have variable sizes and shapes. Some are elongate and relatively large (ca. 20–30 μm) compared to the rounded small grains in the chromites. The most abundant platinum-group minerals (PGM) have intermediate compositions between $Pt_{1.6}Fe$ and $Pt_{3.1}Fe$ with some grains of tulameenite. The PGM in altered rocks have relatively higher values of Pt (69–72 at. %), Cu (1.48–4.97 at. %), Pd (1.39–154 at. %) and lower Fe contents compared to those found in the core of chromite grains .

The nuggets in the pan concentrates have a composition close to Pt_3Fe and some are tulameenite (Pt_2FeCu). Fe content of the Pt_3Fe varies between 23–30 at % and has up to 3.66 at % Cu. Tulameenite grains have more than 32 at. % Fe and up to 16 at. % Cu. Most of the grains have Rh contents between 0–2.09 at % , Pd 0–1.46 at % and Ir 0–2.99 at %. Ru values are very low, generally < 0.5 at %. The average Rh and Ir values in the Pt-Fe nuggets are slightly higher compared to Ru, Os and Pd. PGM occurring as inclusions within the Pt-Fe nuggets consist of alloys, sulphides, sulpharsenides, sulphantimonides, antimonides and telluro-antimonides. They vary widely in shape from laths of osmium-rich phases to equidimensional crystals of laurite. Os-Ir alloys are the most abundant PGM found as inclusions in the Pt-Fe nuggets. The compositions of the Os-Ir alloys are relatively homogeneous with 82–95 at. % Os and 1.18–4.92 at. % Ir. PGM-Sulphide inclusions in the Pt-Fe nuggets include: rhodian-pentlandite ($Rh\text{-}(Fe,Ni)_9S_8$), kashinite ($(Ir,Rh)_2S_3$), prassoite ($Rh_{17}S_{15}$), laurite ($(Ru,Os)S_2$ and an unidentified Rh-Fe-Ni-S phase. Irarsite (IrAsS), platarsite (PtAsS), hollingworthite (RhAsS), genkinite ($(Pt,Pd)_4Sb_3$) , iridium-rhodium sulphantimonide (Ir,Rh)SbS and an unidentified RhSbS phase were also identified in the placer nuggets as inclusions forming euhedral crystals. Possible new PGM from Yubdo are antimonides ($(Rh,Pt,Pd)Sb_2$, (Rh,Pt)Sb, and $(Rh,Pt)Sb_2$)); sulpharsenide (Ru,Rh,Pt)AsS), and tellurides ((Rh,Ir,Pt)SbBiTe, (Pt,Pd,Rh)(SbAsTe)). In addition placer nuggets of native gold (76.10–94.03 at. % Au) and electrum (46.10 at. % Au) are found associated with the Pt-Fe nuggets. The embayed and sculptured surfaces of the platinum-iron nuggets and their intimate association with fine grained iron oxides in the cavities of the nuggets documented from Yubdo are also features of gold grains considered to have grown in a lateritic environment indicating that the processes of formation of gold in laterites are likely to be paralleled by comparable development of platinum-group minerals (PGM). Based on the investigation made one can conclude that 1) the occurrence of droplets of PGM in chromites from bore hole ultramafic samples at depth suggests a magmatic origin; and 2) a remobilization and transport of the Pt-Fe alloys have taken place from a possible dunitic source and concentrated them in the laterites.

PGE analyses of 130 mafic-ultramafic samples from Yubdo indicate enrichment of Pt, Rh and Pd (PPGE) than Ir, Ru, and Os (IPGE). The absence of Os and Rh in the core analyses and their abundance in the inclusion phases might suggest introduction of these elements with hydrothermal fluids during the serpentinisation and lateritisation stage.

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References

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