

RAMAN SPECTROSCOPY APPLIED TO RARE AND TINY PHASES: EXAMPLE FROM THE STUDY OF PLATINUM GROUP MINERALS (PGM).

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Raman spectroscopy is a non destructive and structurally sensitive technique that can be easily used to identify small mineral phases less than 10 microns in size. Some years ago, Raman spectroscopy was applied for the first time, to identify grains of natural platinum group minerals (PGM) [1]. However only 6 Raman spectra were published for the following natural PGM: cooperite (Pt,Pd,Ni)S, sperrylite (PtAs₂), platarsite (PtAsS), moncheite (Pt,Pd)(Te,Bi)₂, braggite (Pt,Pd,Ni)S and potarite (PdHg). Therefore, in this contribution we present the preliminary Raman results obtained on a great variety of PGM.

The PGM are the carriers of the platinum-group elements (PGE): osmium (Os), iridium (Ir), ruthenium (Ru), rhodium (Rh), platinum (Pt) and palladium (Pd). Recently, the PGE have gained tremendous importance due to their application in many modern and advanced technologies. However, with a concentration of about 10⁻⁶ to 10⁻⁷ % in the earth crust, the PGE are numbered among the ultra-trace elements. PGM occur naturally, as alloys, native elements or combinations with other elements, mainly S, As, Te, Bi, Sb, Se and O. Also the PGM are rare, representing only less than the 3% of the approved minerals by the Commission on New Minerals and Mineral Names of the International Mineralogical Association (IMA). According to the literature data updated to 1997 [2], only 96 phases containing the PGE has major components, have been approved, whereas more than 500 PGM are still waiting for a clear identification, in particular for crystallographic characterization to the degree required for acceptance as new mineral species. From 1997 to the present days, only 25 new PGM have been discovered. The main reason for the significant lack of in sufficient identification of PGM is their mode of occurrence, i.e. as minute inclusions, prevents characterization using structural data. Optical and electron microscopy, electron microprobe analysis are the most used techniques for chemical and physical identification of PGM. However, PGM are notoriously difficult to identify during petrographic investigation owing to their small sizes and the similarity of the optical properties of many minerals. Furthermore, where the PGM are only a few microns in size, the electron microprobe generally provides only semi-quantitative analyses due interferences from surrounding minerals. Therefore, there is a need of an innovative and complementary methodology able to provide mineralogical information which is difficult

and sometimes impossible to obtain from other widely used techniques. As a consequence, Raman spectroscopy is suggested as the best candidate to solve this technical problem, as previously proposed by [1]. Our results of Raman spectroscopy applied on selected PGM, such as sulphides, arsenides, sulpharsenides revealed that all the analyzed grains display a very well-defined and characteristic spectrum, as typical for the compounds characterized by the presence of covalent bonding. On the contrary, the Raman spectra of a number of alloys and native elements show no discernible scattering bands suggesting that the possible bonds present in these PGM are metallic or ionic. Few PGM, classified as possible Ru bearing oxides, show a broad and weakly scattered spectrum over the range of about 100–800 cm⁻¹. The collected data also demonstrated that Raman is sensitive on the compositional variation, particularly in the PGM characterized by a solid solution substitution such as laurite (ideally RuS₂)-erlichmanite (ideally OsS₂) series. These results confirm that Raman spectroscopy can be considered an innovative and complementary technique with a huge potential to better characterized and identify rare and tiny phases such as PGM. The two main disadvantages of the Raman spectroscopy applied to the investigation of PGM are: 1) some PGM, such native elements and alloys, are not sensitive to this technique and 2) it does not provide a chemical composition of the investigated minerals. Therefore, it is intended to apply the Raman spectroscopy to a great number of different PGM, already chemically characterized by electron microprobe, with the target to create a future and accessible data base of Raman spectra of a great number of different PGM.

References:

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