CAN RAMAN SPECTROSCOPY REPLACE MICROPROBE IN OC CHEMICAL CLASSIFICATION?

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Introduction: The classification of the hundreds of ordinary chondrites returned from Antarctic expeditions is an expensive and time-consuming process. The classification of ordinary chondrites is generally based on two steps [1]: (a) measurement of the Fe content in olivine and low-Ca pyroxene for identifying the chemical group (H, L, or LL) and (b) petrographic observations for determining the petrologic type (from 3 to 6). Chemical analyses are commonly performed with electron microprobe or quantitative energy-dispersive x-ray spectroscopy with scanning electron microscopy, by comparison with standards. The Fe content is estimated by the calculated mineral formula and expressed as fayalite (Fa) and ferrosilite (Fs) component for olivine and pyroxene respectively. These analytical techniques require specific sample preparation and special operation condition. We show here that the use of Raman spectroscopy for the chemical classification of ordinary chondrites, following the already existing calibrations [2][3], preliminary improved with new data [4], might be an alternative.

Methods: Raman spectra on selected grains were measured with a confocal Raman microscope LabRAM HR Evolution (HORIBA Scientific), with a solid-state laser corresponding to green light (532nm). Spectra were processed with MatLab and specific scripts were used for quickly identifying the characteristic peaks. The composition of the selected grains was checked with electron microprobe. Data from the online database Rruff [5] and newly collected measurements from Type 3 ordinary chondrites of the collection of Royal Belgian Institute of Natural Science were used. Type 3 meteorites were selected for providing a wide range of olivine and pyroxene composition. The obtained calibration was blind tested on other ordinary chondrites of different chemical group and petrologic type. Results were compared with independent classification performed at the NIPR with the traditional technique.

Results: The existing correlation between the Raman shift of selected peaks of olivine and pyroxene and the corresponding Fa and Fs content respectively was calibrated in the common range covered by ordinary chondrites. Possible causes of error are associated to the occurrence of shocked olivine and to the complexity of the pyroxene spectrum. However, a statistically meaningful number of analyses dramatically reduce the possibilities of mistakes. The use of Raman spectroscopy for the chemical classification of ordinary chondrites seems a reliable, easy and convenient method, although for problematic samples (in the case of difficult interpretation) the use of microprobe is still recommended.

References: [1] Weisberg M.K. 2003. In Meteorites and the Early Solar System II, D. S. Lauretta and H. Y. McSween Jr. (eds.), Univ. of Arizona Press, Tucson, 943 pp., p.19-52. [2] Wang A. et al. 2004. *Journal of Raman Spectroscopy* 35:504-514. [3] Kuebler K.E. et al. 2006. *Geochimica et Cosmochimica Acta* 70:6201-6222. [4] Pittarello L. et al. 2013. Abstract. 4th Symposium on Polar Science, Tachikawa, Japan. [5] Downs R.T. 2006. Abstract#O03-13. 19th General Meeting of the international Mineralogical Association, Kobe, Japan.