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Progress Towards micrometer-3D Analysis Using a femtosecond-LA-ICP-TOF-MS System

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If an image is worth a thousand words, a 3D images should be worth a million. The aim of this project is to open the door to LA-ICP-MS analysis of more complex 3D features such as devitrified melt inclusions, mineral inclusions and U-Pb dating. A novel approach for fully quantitative 3D analysis using a femtosecond laser ablation system (Applied Spectra) coupled to an ICP-TOF-MS (TOFWERK) will be presented by example of a glassy melt inclusion (MI) from Hawaiian olivine. The target MI was about 140x85x85µm in size and embedded at about 60-120µm below the surface. The 3D analysis was achieved by analysing a successive series of twenty-height (28) 2D maps in decreasing size, forming at the end, a crater of about 500x800µm wide and 130µm depth, comparable in shape to an open-pit mine (Fig. 1). The beam size used was reduced from 20µm to 10µm for the first 22 top layers, and further reduced to 5µm when approaching the target melt inclusion. Major and trace elements from each of the 28 maps were converted to quantitative analysis using the new "3D Trace Elements" data reduction scheme recently released for IOLITE software [1], which combine multiple calibration material and appropriate normalization [2]. The data were then tabulated to EXCEL charts, converted to X-Y-Z-coordinate, and merged into a single file using a in-house Python script. LeapFrog software (SEEQUENT), a visual software commonly used in geological mining industry, was used to produce 3D images of the ablated pit and MI (Fig. 1). Measured major and trace element concentration in the melt inclusion are in good agreement with expected concentration from the literature [3] (Fig.2).

[1] Paton, C., Hellstrom, J., Paul, B., Woodhead, J., & Hergt, J. (2011). *JAAS*, *26*(12), 2508-2518.

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[3] Norman, M. D., Garcia, M. O., Kamenetsky, V. S., & Nielsen, R. L. (2002). *Chemical Geology*, *183*(1-4), 143-168.

Fig.1) 3D image of the melt inclusion generated in LeapFrog software

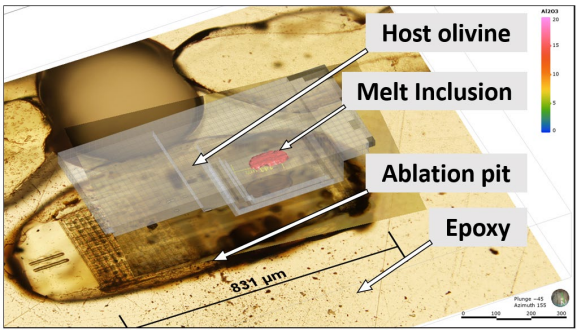

Fig.2) Comparison of the melt inclusion measured concentration with Norman *et al.* (2002)