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Capabilities of a space-born laser mass spectrometer for detection of planetary microsized-fossils

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In this contribution we will discuss the recent progress made in the development of a miniature laser ablation/ionisation mass spectrometer combined with a microscope-camera system for the investigation of micro-sized objects including e.g., ancient microfossil life forms. The instrument suit offers 3D optical diagnostics combined with 3D chemical analysis capabilities. The 3D optical imaging is conducted by the image stacking method with the lateral and vertical resolution down to a few micrometre allowing identification of micro-sized grains and putative fossils by means of the morphological and textural details. Supported by the 3D-optical identification of the objects in the host rocks, precise laser beam positioning and focusing can be achieved and following chemical analyses using the mass spectrometer. The performance of the instrument suit is tested on the micro-sized objects identified in rocks within the carbonate (aragonite, calcite) veins and in silica chert. The 3D-chemical analysis is achieved by combining the lateral chemical imaging and a depth profiling method. The latter analysis involves a layer-by-layer chemical measurements. This is in particularly important when highly heterogeneous materials are investigated allowing the identification of grains and layering within sample subsurface. High level of the micro-sized object material isolation from the host material can be achieved this way, providing a typical ablation layer thickness of 10 to 100 nanometres with a lateral resolution of the laser spot size of about 10 micrometres. This method has also the advantages in the quantitative isotope analyses of highly heterogeneous or layered samples offering possibilities to isolate elements/isotopes embedded in isolating layers and improving the signal-to-noise ratio and the measurements sensitivity. We demonstrate the application of this method to the quantitative measurements of isotopes in micro-sized objects and discuss currently obtained performance figures.

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