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The ROBOMINERS “advanced mineralogical segment”: an in-stream, in slurry analytical module designed for robotic ore exploration and production

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The Horizon 2020 ROBOMINERS project (Grant No. 820971), is developing concepts and prototypes for a bio-inspired, modular and reconfigurable robot-miner for small and difficult to access deposits. This covers both underexplored or currently flooded mines not accessible anymore for conventional mining techniques; or places that have formerly been explored, but whose exploitation was considered non-economic due to the small size of the mineralization or its accessibility.

As part of the sensors payload of the miner, a modular segment of the robot will contain sophisticated geochemical/mineralogical sensors capable of characterising the slurry produced by the drilling process in real-time and interpreting the data as mining diagnostics and navigation parameters for the progression of the miner. This segment will perform in-stream analyses of the drilling slurry using sampling inlet-outlet ports. The sensing techniques currently considered for this segment are LIBS (Laser-induced breakdown spectroscopy), EDXRF (Energy dispersive X-Ray fluorescence), LINF (Laser-induced native fluorescence), Terahertz imagery and time-resolved Raman.

This study presents the first laboratory-scale prototype of this segment, and tests on slurry analogues (bentonite/baryte/salt mixtures of sphalerite ore) with a high-repetition LIBS analyser (1064nm 20 KHz laser, 200-850nm spectrometer, co-axial light collection). As a proof of concept for high-pressure operation, the plasma sparks are created inside the opaque liquid medium using a synchronized argon gas dispenser in front of the laser window. This innovative setup was successfully tested in this study under a pressure range of 1 to 10 bar and a superficial gas velocity range of 50 to 100 mm/s. The next steps in the study is to increase the slurry pressure to simulate deep borehole operation and couple LIBS with a complementary analyser like EDXRF.