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DETERMINATION OF SPECTRA CHARACTERISTICS OF LATERITE DRILL-CORE FOR "ON LINE-ON SITE" REAL-TIME AUTOMATED MINERALOGY DETECTION

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ABSTRACT

Within the framework of responsible mining, a SOLSA project (www.solsa-mining.eu) to develop an in-situ tool allowing a quick mineralogical identification of site drill cores has been recently launched. Its objective is to develop new or improved highly-efficient and cost-effective, sustainable exploration technologies. It combines and integrates non-destructive sensors: X-ray fluorescence, X-ray diffraction, infra-red and Raman spectroscopy and 3D imaging. The challenge is to address mixtures of hard and soft rocks, as encountered in a lateritic environment.

This paper focuses on the determination of spectral characteristics of laterite drill-cores in the visible to short wave infrared spectral range. One of the most important prerequisites is to study the influence of the surface roughness effect on infra-red spectroscopy analyses. For this purpose, four different rock samples: breccia, sandstones, granite and peridotite, each at five surface states have been considered: as-drilled, as-sawn, polished at 6 µm, polished at 0.25 µm and crushed to powder. The reflectance spectra have been acquired with an ASD Fieldspec 3® spectroradiometer with a contact probe at a sampling surface of 1.76 cm^2, allowing a spectral analysis at wavelengths from 350 up to 2500 nm.

The powder spectrum of breccia presents a higher reflectance than the four other spectra from the same material but weak absorption features. The as-sawn sample presents the higher absorption depth, followed by as-drilled sample and the two polished samples (figure 1). At wavelength 2219 nanometers, a peak of absorption is present. The presence of clay minerals is assumed like illite/sericite with more or less smectite, due to the relatively deep water absorption around wavelength 1900 nanometers.

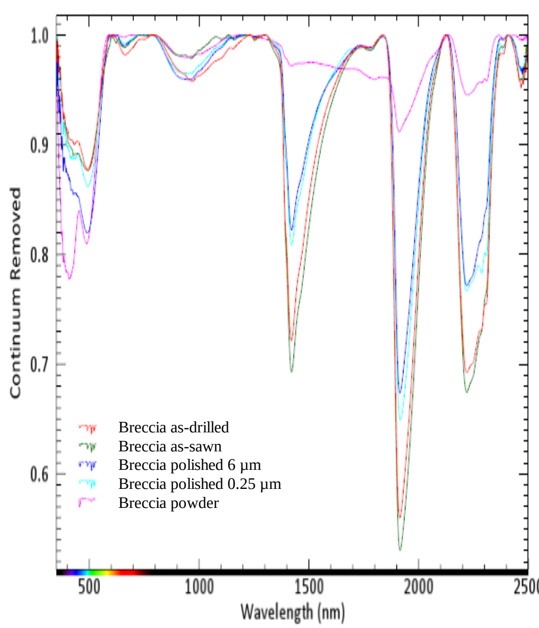

Figure 1: Spectra of Breccia

On sandstone, the polishing decreases the intensity of the reflectance (figure 2), but increases the peak of absorption (figure 3). The powder has a higher reflectance than the four other spectra (figure 2).

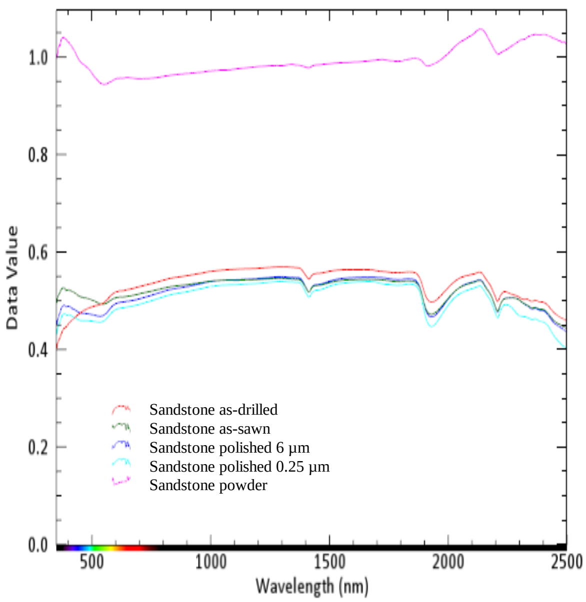

Figure 2: Spectra of Sandstone – Intensity of the reflectance.

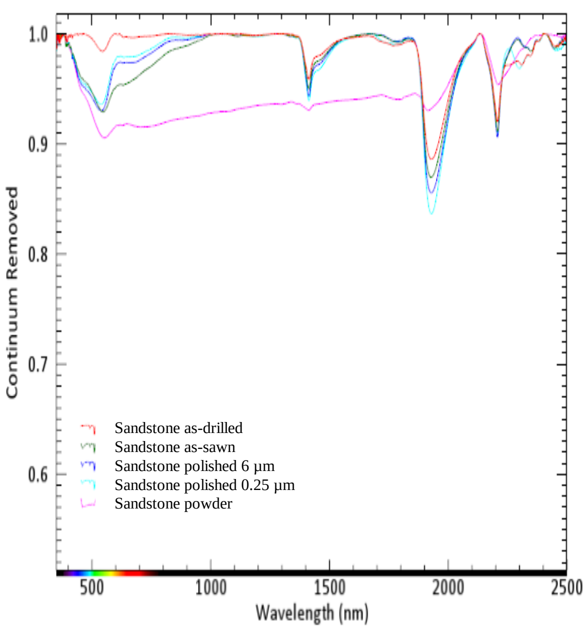

Figure 3: Spectra of Sandstone – Intensity of absorption peaks.

The narrow absorption peak at wavelength 2207 nanometers, also assumes the presence of clay minerals like illite/sericite with more or less smectite, due to the relatively deep water absorption around wavelength 1900 nanometers.

Granite samples show heterogeneity. The two polished samples contain more dark minerals than as-drilled and as-sawn samples (figure 4).

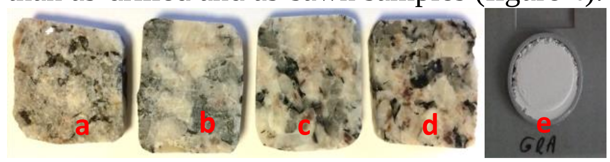

Figure 4: Granite samples – a: as-drilled; b: as-sawn; c: polished at 6 µm; d: polished at 0.25 µm; e: crushed to powder.

Powder appears white with very weak absorption features. For the characteristic features of absorption, at wavelengths 2200 nanometers, 2346 nanometers and 2434 nanometers, the as-sawn sample presents the strongest absorption features and the as-drilled sample the weakest, the two polished samples being in between (figure 5).

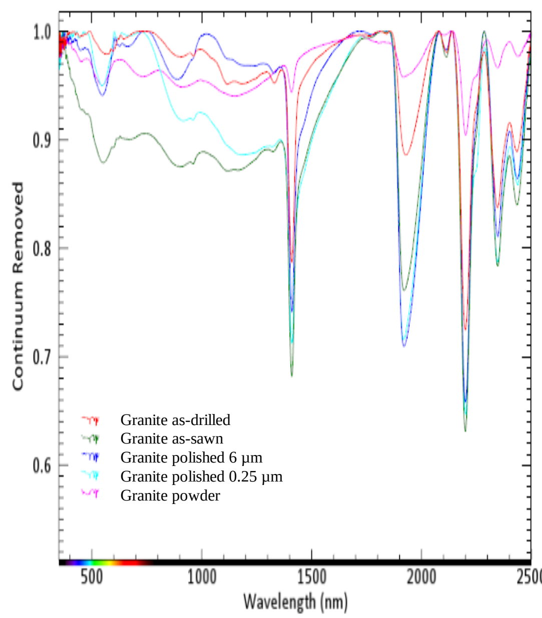

Figure 5: Spectra of Granite

The spectra of the four peridodite samples present a weak reflectance, while, the powder, almost white, reaches a very higher reflectance (figure 6 and 7).

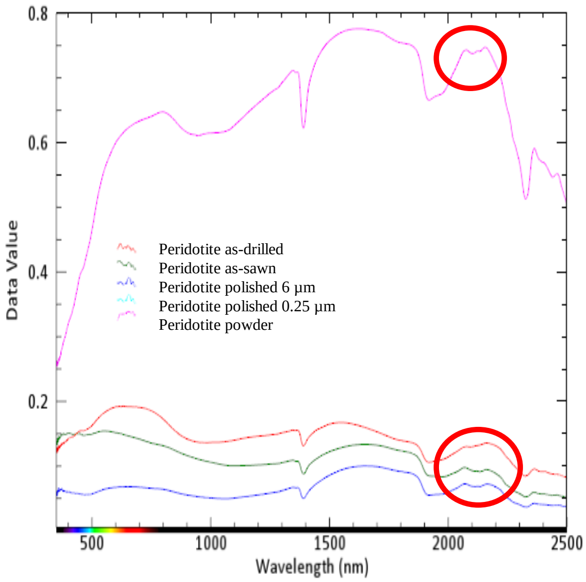

Figure 6: Spectra of Peridotite – Intensity of the reflectance. In red circles, characteristic absorption features of serpentinite.

Figure 7: Peridotite samples – a: as-drilled; b: as-sawn; c: polished at 6 µm; d: polished at 0.25 µm; e: crushed to powder.

Polished samples (the two spectra are combined) present the deepest peaks of absorption (figure 8). As-drilled and as-sawn samples respectively present lower absorptions. The features at wavelength 2324 nanometers could be show the presence of saponite.

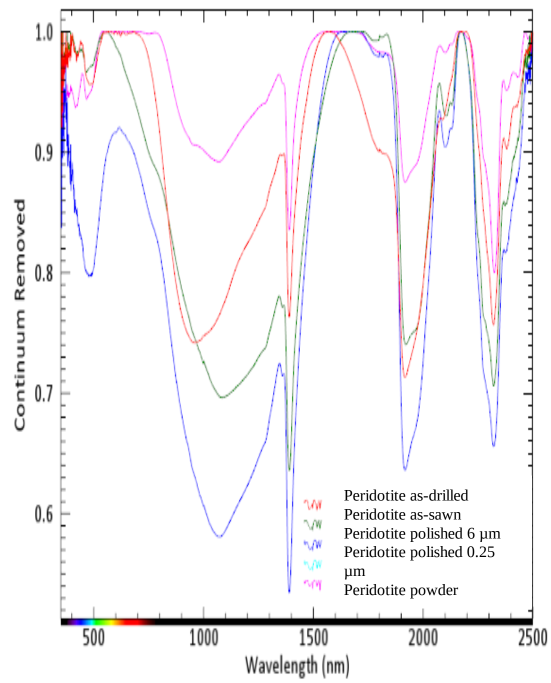

Figure 8: Spectra of Peridotite

The crushed to powder for the four samples has a relatively high intensity of reflectance but the intensity of the absorption peaks is weak.

As-drilled samples for sandstone and granite give weak absorption peaks.

The result of this part of the tests shows that the roughness of sample has an influence on intensity of the absorption peaks. As-sawn and polished samples give the best results, but they are not the most economical and easiest to implement for the "on-line-on site" real-time automated mineralogy detection. During the operation on-site, for economic reasons and for saving time, the tests carried out on this study show that as-drilled samples make it possible to obtain exploitable spectra.

The second prerequisite is to try to obtain characteristic spectra of the minerals present in a lateritic environment. A lateritic drill-core, covering all the alteration profile levels, from the peridotite at the bottom to the red laterite at the top has been chosen. Gradually all the minerals have been identified, from serpentine (figure 6) to smectite (figures 1, 2, 3, 5).

At this stage of the project, a spectral library containing all the characteristic minerals of a lateritic environment is built.

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Index Terms— *laterite, hyperspectral, roughness*