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Title:

Characterization by XCT of cements SD-1 Utrillas M1 and M2

Summary:

Two samples were measured by XCT (pre- and post- CO_2 injection). The acquired volumes have been provided to CIEMAT for their evaluation. The different phases are visible in XCT experiments and the differences from the two states are going to be evaluated by CIEMAT

Keywords:

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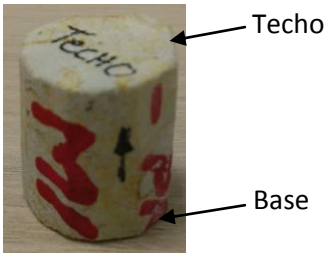
1 Introduction

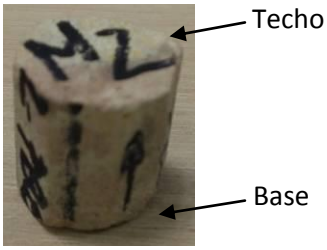
This report summarizes the results of X-ray computed tomography for microstructure characterization. The samples were measured in the as-received state, i.e. no sample preparation was necessary.

The samples were named as follows:

1) SD-1 Utrillas M1 Pre CO_2 35.4m : The picture shows the indications on the sample and were measured in this position.



2) SD-1 Utrillas M2 Post CO_2 35.4m: The picture shows the indications on the sample and were measured in this position



The files delivered to TUDOR together with this report are:

1) This report: "Report_Tomography_Cements_v01.pdf"

2) Two tomographic volumes and the raw data:

"SD-1_Utrillas_M1_vol1850x1890x1680_BH7.0_z1680base.raw"
"SD-1_Utrillas_M2_vol1952x1814x1680_BH7.5_z1680base.raw"

3) The raw data of both measurements:

4) Samples were returned to CIEMAT

2 Results

2.1 X-Ray Computed Tomography measurements

Tomographic inspection was performed on samples SD-1_utrillas_M1 and SD-1_utrillas_M2. The tomograms were acquired at 115 kV and 110 μAmp using a Cu filter of 0.1mm thick. The exposure time was set to 750 msec. In total, 1500 radiographies were acquired for each tomogram. The pixel size was set to 8.95 μm.

The reconstructed volumes can be visualized using different sofwares, like ImageJ (freeware software) or VGStudio max (commercial software). The full dataset for each sample are provided in raw data files. For instance, Figure 1 shows a cross section of both specimens SD-1_utrillas_M1 and SD-1_utrillas_M2.

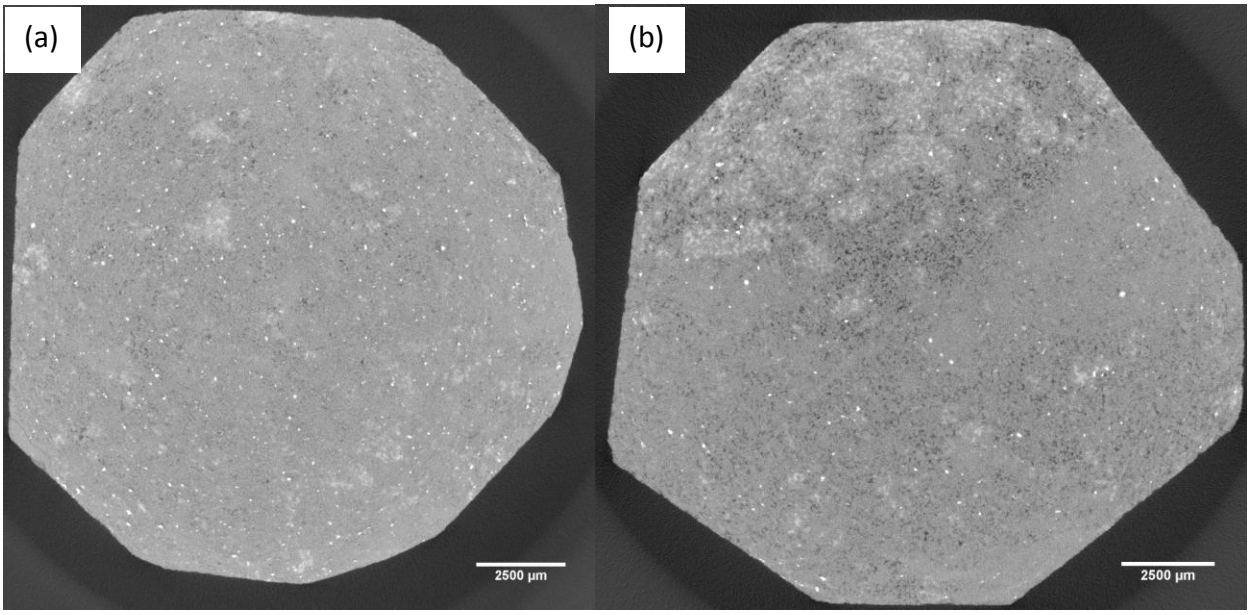


Figure 1. (a) Cross section SD-1_utrillas_M1. (b) Cross section SD-1_utrillas_M2.

The raw data files can be opened using the ImageJ freeware software. All the information required to generate the reconstructed volumes is included in the filename. For example, the name of the file that corresponds to sample SD-1_Utrillas_M1 is:

SD-1_Utrillas_M1_vol1850x1890x1680_BH7.0_z1680base.raw

Where:

- The numbers “1850x1890x1680” indicate the dimensions in “x”, “y” and “z” respectively.
- The volumes were saved in an 8bit format

- "z1680base" indicates that the last slice of the volume (1680 in this case) is close to the end that was named as "base".

Figure 2 shows a screenshot of the ImageJ software:

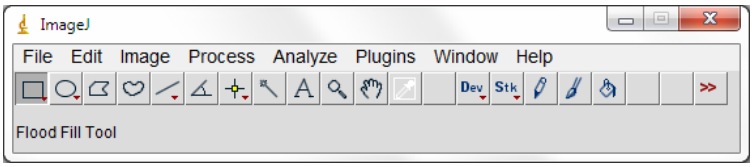


Figure 2. Screenshot of the ImageJ software.

Please note that due to the large size of the files (approximately 5.6 GB each file), you probably need to check the memory & threads variable of ImageJ under Edit\options. Please refer to the ImageJ webpage (http://rsbweb.nih.gov/ij/) for more information.

In order to open the file, go to file, import, raw…The following window will pop up and, for the example, the parameters to be filled are:

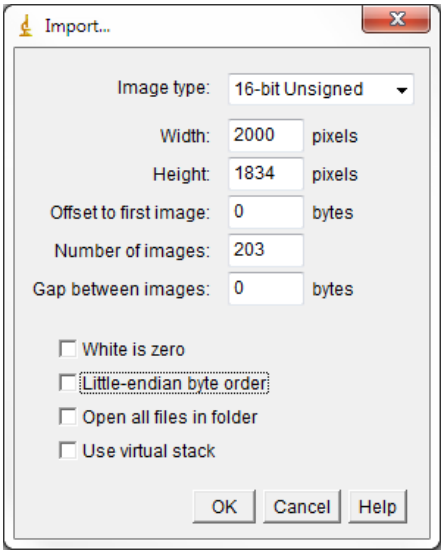


Figure 3. Screenshot of the ImageJ software

3 Conclusions

- The microstructure of both samples could be revealed by X-ray tomography. The quantitative analysis and the usefulness of this measurements will be determine by CIEMAT.

- Higher resolution (up to approximately 2 μm) can be achieved, however in smaller sample volumes (diameter of 4mm maximum). These measurements could provide a better insight of the smaller features in the specimens. In this case it is important to evaluate if such small volume is representative enough.