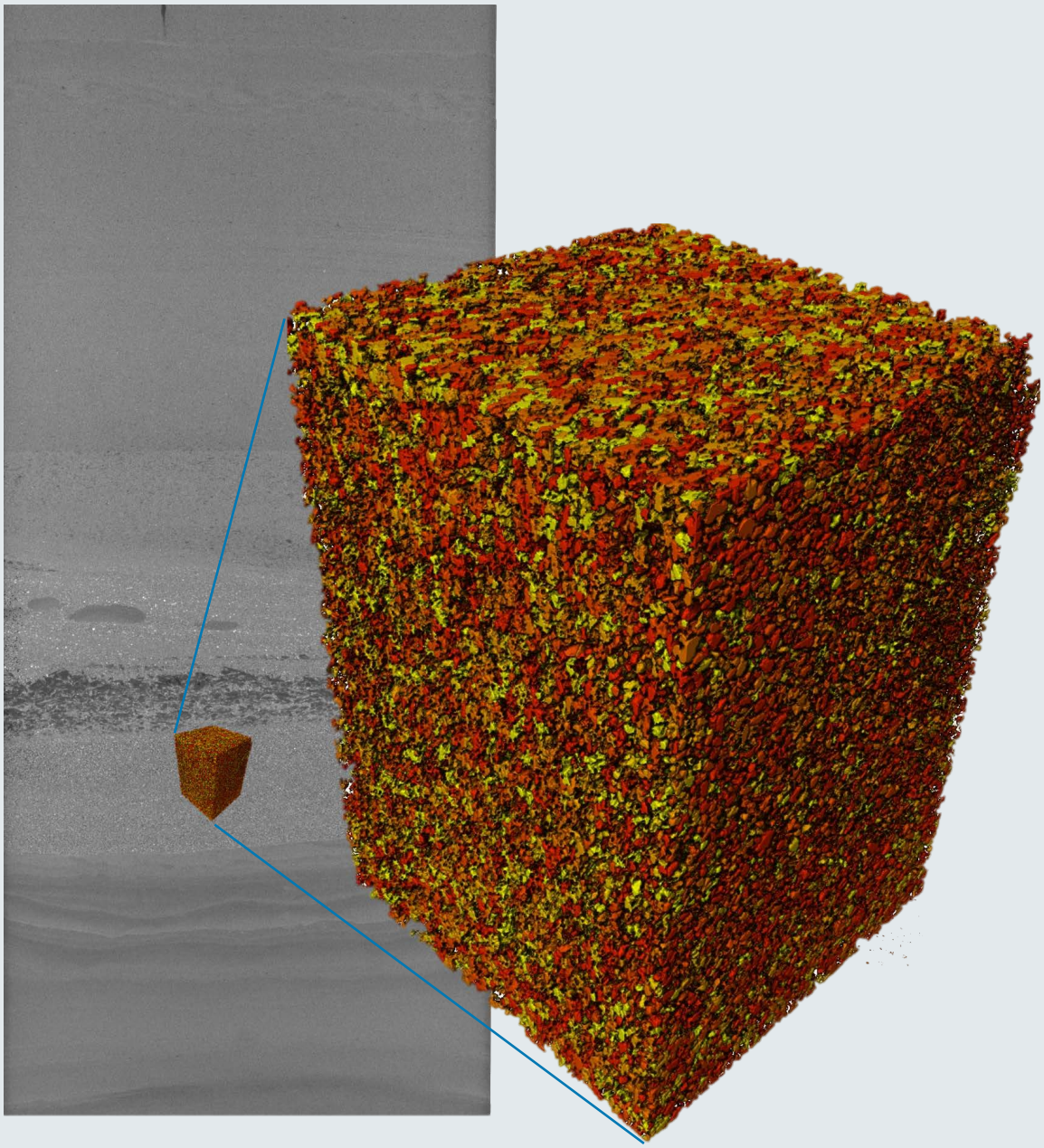
TURBIDITE SEDIMENT CORE

Non-destructive evaluation of grain size distribution



TESCAN CoreTOM

Application example Sediment Core

RCMG

Lacustrine turbidites are a reliable record of seismic activity. When a turbidity current moves downslope a typical sedimentary sequence is created afterwards, including a fine to coarse grained sand fraction at the bottom (if the current has enough energy) towards a layer of fine grains of silt or clay towards the top. The characterization of those turbidites on different locations is essential to reconstruct the complete impact of past earthquakes.

When sedimentary structures are present in cores, it is possible to reconstruct the orientation and flow direction with CT. However, if such sedimentary structures are not present, grain fabric and size analysis can reveal important information. The resolution of medical CT is not sufficient to analyze grain sizes, thus there is a high demand for sediment core analysis to evaluate grain size in a non-destructive way.

Sample

A one-meter high sediment core was mounted on the rotational stage of the TESCAN CoreTOM. The sample represents a turbidite section. The sample was sourced from a lake in Alaska to investigate the paleoseismic activity in the region. For this sample, it is important to understand the complete section in high resolution.

System

The TESCAN CoreTOM combines in a single instrument the typical field-of-view of a medical CT scanner, with high-resolution imaging performance. The integrated workflows are ideal for multi-resolution imaging going from the core to the grain or pore scale. The core is placed in a vertical position and calibrated within the coordinate system of the instrument afterwards.

▶ **Figure 1:** One-meter high sediment core mounted in the TESCAN CoreTOM. Because of the extended vertical travel of the source and detector it is possible to scan complete cores up to 1 m in high resolution.

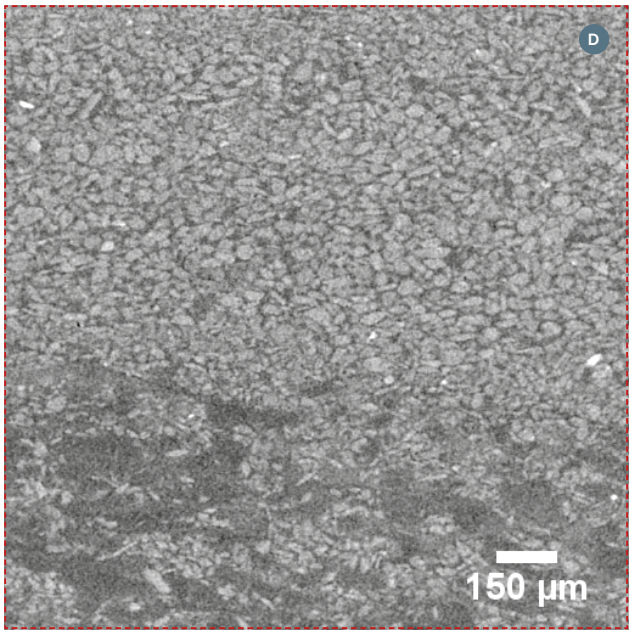
Overview image and VOI selection

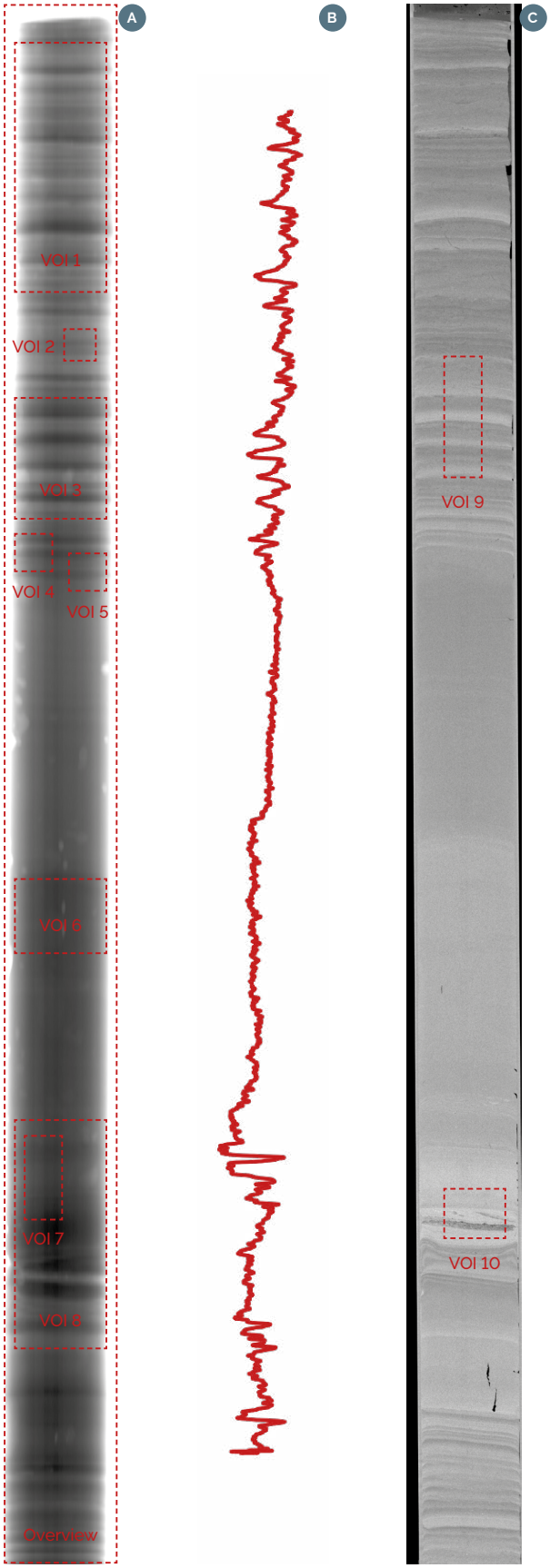
A single-acquisition script can be prepared in Aquila, based on the information provided from a fast overview of the complete core. The fast overview can be a single radiograph of the complete length or an actual full reconstruction.

Because of the unique coordinate system, volumes of interest (VOI's) can be drawn directly on the radiographs or reconstructed volume. For each VOI, a different parameter set ((tube) accelerating voltage, exposure, etc.) can be stored.

By drawing the VOI's, a complete script can be built that automatically inspects the complete core according to a multi-scale and multi-resolution procedure.

▶ **Figure 2:** A Overview radiograph from the complete core. This can be used to select regions for volume of interest (VOI) scans. B Line profile from the acquisition software to fine tune the position of the VOI's. C Vertical slice through the reconstructed volume. Also, on this image can be used to select VOI's. D Reconstructed slice of a certain VOI scan 10.



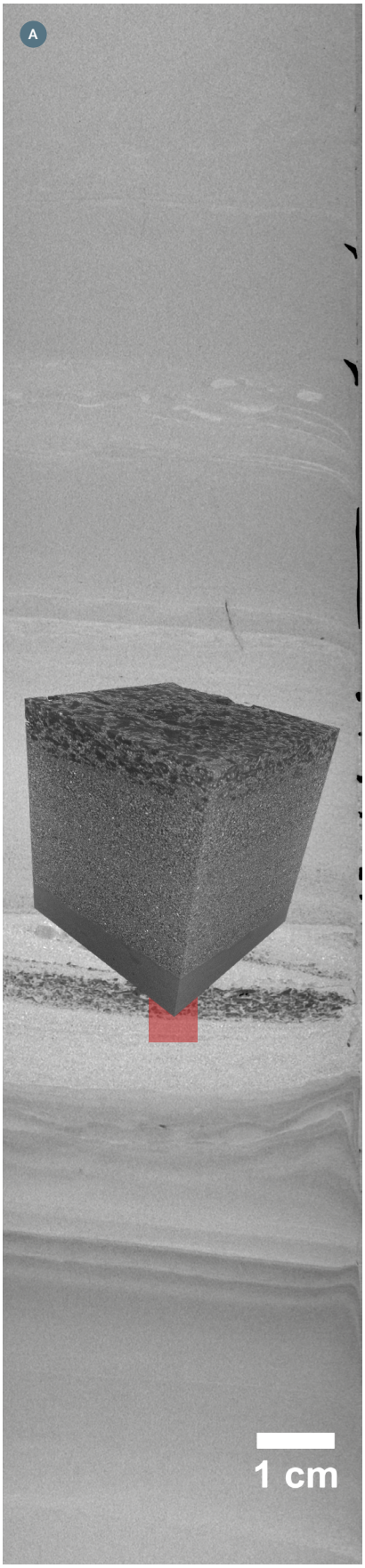


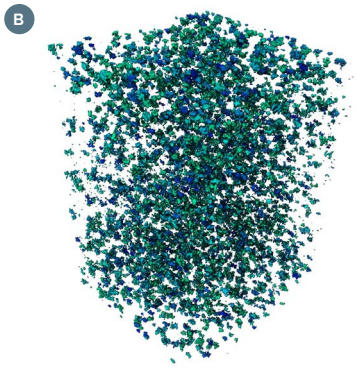
Results

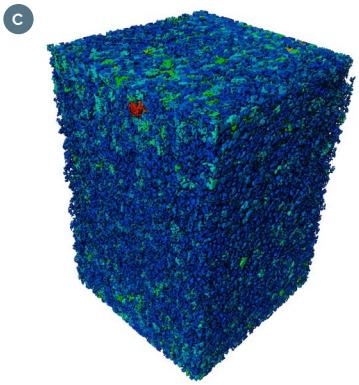
For the high resolution VOI's, it is possible to extract the grain size distribution. Because of the coordinates of each grain can be calculated, it is possible to back project their coordinates in the complete overview scan.

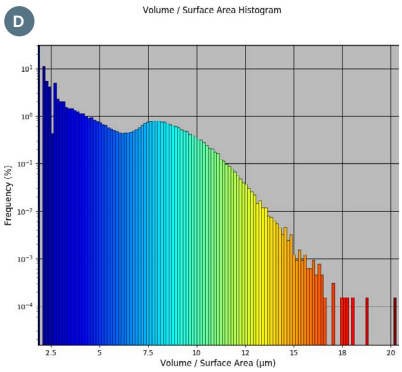
Once the grains are segmented, several analyses can be performed on the volume such as 3D orientation of the grains, grain size distribution, variation in function of height, etc.

Thanks to the coordinate system of the TESCAN CoreTOM, the results can afterwards be linked to other regions or even the complete overview scan. In case of the turbidite section, the fining upwards of the grains was analyzed and compared to other regions.





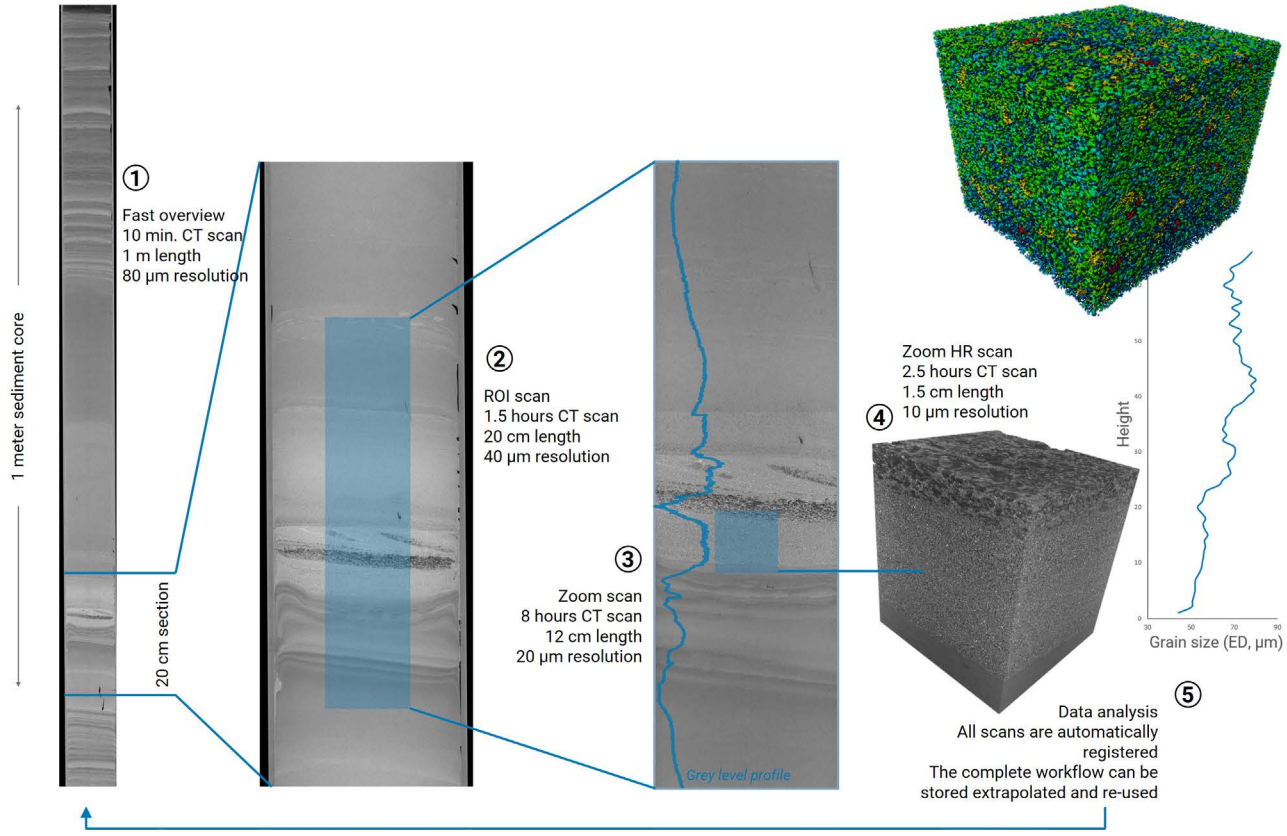




▶ **Figure 3:** A Cross-section through the 40 µm scan with indication of the VOI scanned with 10 µm resolution; B Grains showing an orientation with Phi> 90°; C Grain size distribution with small grains (in blue), and large grains (in red); D Volume/surface area histogram for all the grains.

Conclusions

- It is possible to scan a complete core of 1 m in less than 10 minutes by a stacked and merged acquisition. A resolution of 80 µm on the full core was obtained.
- Based on the overview scan, different volume of interests can be defined of a higher resolution acquisition. Afterwards, all scans are registered in the overview scan by using the coordinate system of the TESCAN CoreTOM.
- Grain size analysis of the coarse fraction (> 10 µm) becomes possible in a completely non-destructive way.



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