LOW-FREQUENCY ELASTIC PROPERTIES OF A POLYMINERALIC CARBONATE: LABORATORY MEASUREMENT AND DIGITAL ROCK PHYSICS

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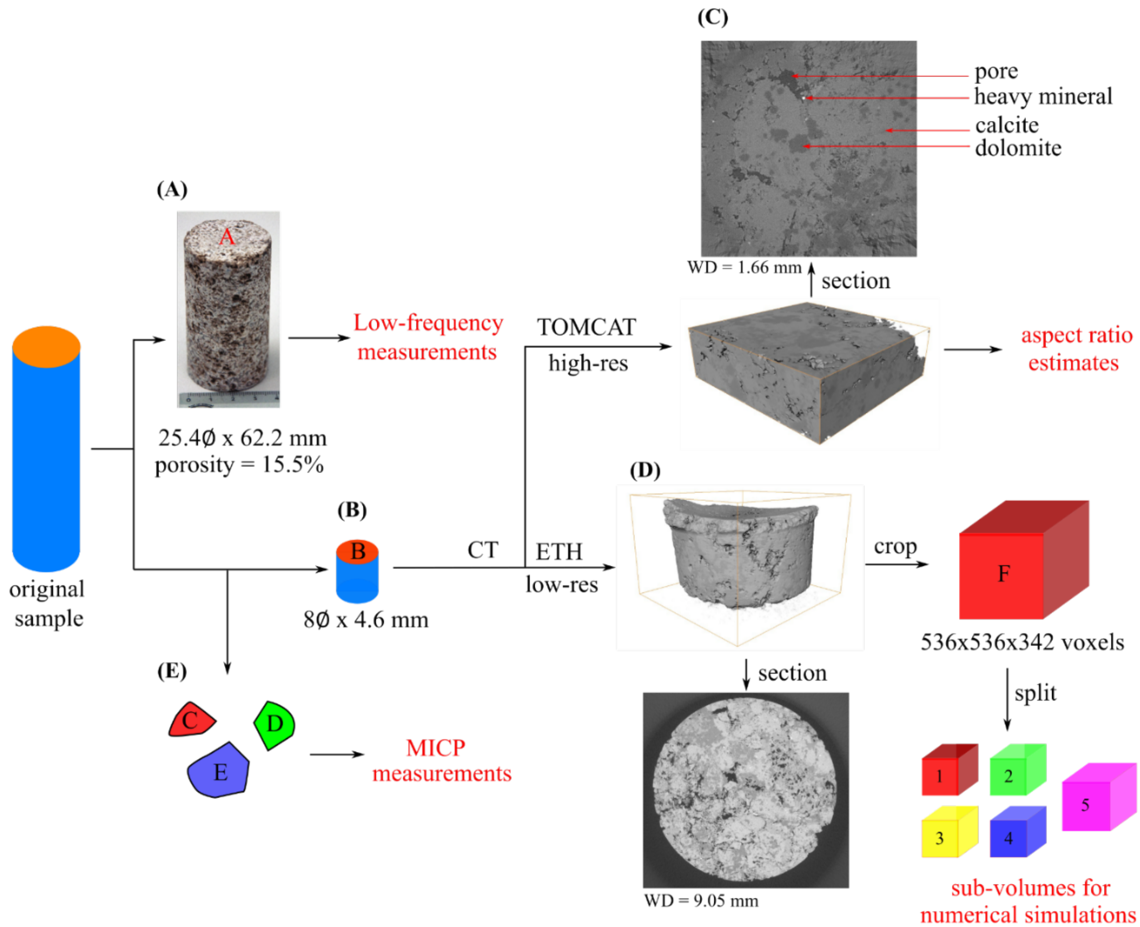
ABSTRACT

We demonstrate that the static elastic properties of a carbonate sample, comprised of dolomite and calcite, could be accurately predicted by Digital Rock Physics (DRP), a non-invasive testing method for simulating laboratory measurements. We present a state-of-the-art algorithm that uses X-ray Computed Tomography (CT) imagery to compute the elastic properties of a lacustrine rudstone sample. The high-resolution CT-images provide a digital sample that is used for analyzing microstructures and performing quasi-static compression numerical simulations. Here, we present the modified Segmentation-Less method withOut Targets method: a combination of segmentation-based and segmentation-less DRP. This new method assigns the spatial distribution of elastic properties of the sample based on homogenization theory and overcomes the monomineralic limitation of the previous work, allowing the algorithm to be used on polymineralic rocks. The method starts by partitioning CT-images of the sample into smaller sub-images, each of which contains only two phases: a mineral (calcite or dolomite) and air. Then, each sub-image is converted into elastic property arrays. Finally, the elastic property arrays from the sub-images are combined and fed into a finite element algorithm to compute the effective elastic properties of the sample. We compared the numerical results to the laboratory measurements of low-frequency elastic properties. We find that the Young's moduli of both the dry and the fully saturated sample fall within 10% of the laboratory measurements. Our analysis also shows that segmentation-based DRP should be used cautiously to compute elastic properties of carbonate rocks similar to our sample.



Sample descriptions and workflow of the process. The original sample was cut into sample A for the low-frequency measurement. The remaining part of the sample was used for CT-scan (sample B) and MICP measurement (sample C, D, E). Sample B was scanned at two facilities: TOMCAT and ETH. The TOMCAT scan provided high-resolution images in which we use for estimating aspect ratio of pore spaces. The ETH scan, whose resolution was lower, covered more area of the sample and was used for numerical simulations. The ruler in the sample A figure is in centimeters and WD represents the width of the image.