

14090: SfM-MVS digital models applied to rock surface roughness

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INTRODUCTION

The mechanical behavior of rock masses is mostly controlled by discontinuities and therefore their parameters must be carefully described and quantified whenever possible. Although discontinuities are treated as planes when an appropriate study scale is used (International Society for Rock Mechanics 1978), they are actually surfaces that present roughness (Riquelme et al. 2018). Both asperities and large-scale undulations plays an important role on controlling rock slope failure and, depending on the mode of origin of the discontinuity, may present anisotropy, such as slickensides or sedimentary structures.

This work proposes the application of two 3D digital models of rock surfaces generated through the SfM-MVS workflow to obtain surface parameters such as the surface roughness coefficient.

METHODS

Two study sites were selected for imaging 3D model generation and roughness analysis. The first site (Model 1) is a fault surface in a limestone quarry, located in Santana do Parnaíba city, São Paulo state, Brazil. A total of 53 images were acquired using a DSLR Nikon D200 equipped with 28 mm Nikkor lens. For georeferencing, a COCLA compass was used to mark dip direction on the surface using a permanent marker. Random points were also drawn on the surface and the distance measurement between them was made using a measuring tape (Figure 1A).

The second site (Model 2) is a granite block located at Clock's Square, University of São Paulo. The model was generated using 78 images acquired with a Nikon D5300 equipped with AF-P 18-55 mm lens (fixed in 55 mm). For orientation and scaling, both the camera geotag and a wooden plate with a north arrow and point at local coordinates were used (Figure 1B).

To compare the results obtained with the digital models, a 15 cm Barton comb profilometer was used to measure 6 profiles along two sections of the block on site 2 (Figure 2).

The 3D models were generated using Agisoft PhotoScan Professional (Agisoft 2018), and no pre-processing or image treatment was applied for both models. CloudCompare (CloudCompare 2018) was used to generate profiles along the 3D surfaces.

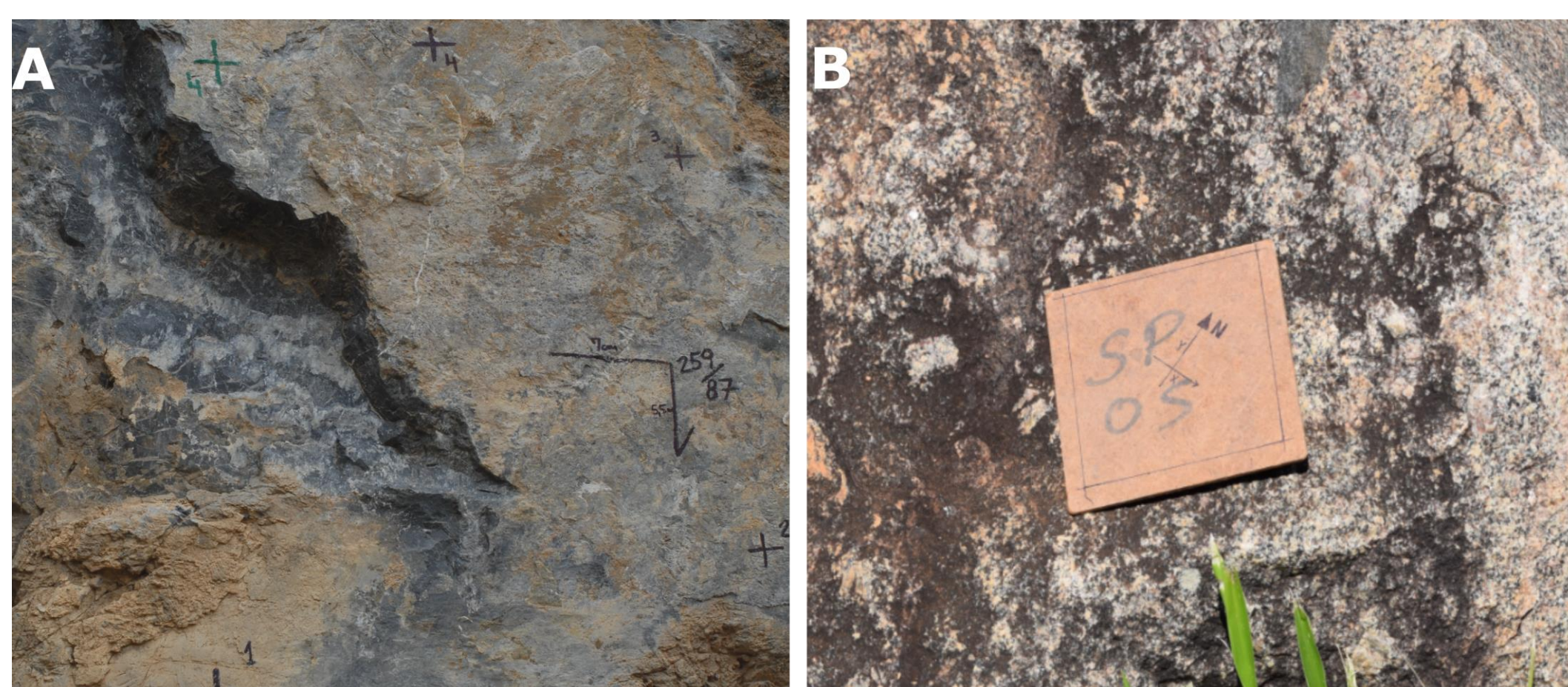


Figure 1. (A) Points and dip direction indication on fault plane for orientation and scaling of Model 1. (B) Wooden plate used as reference plane for orientation and scaling of Model 2.

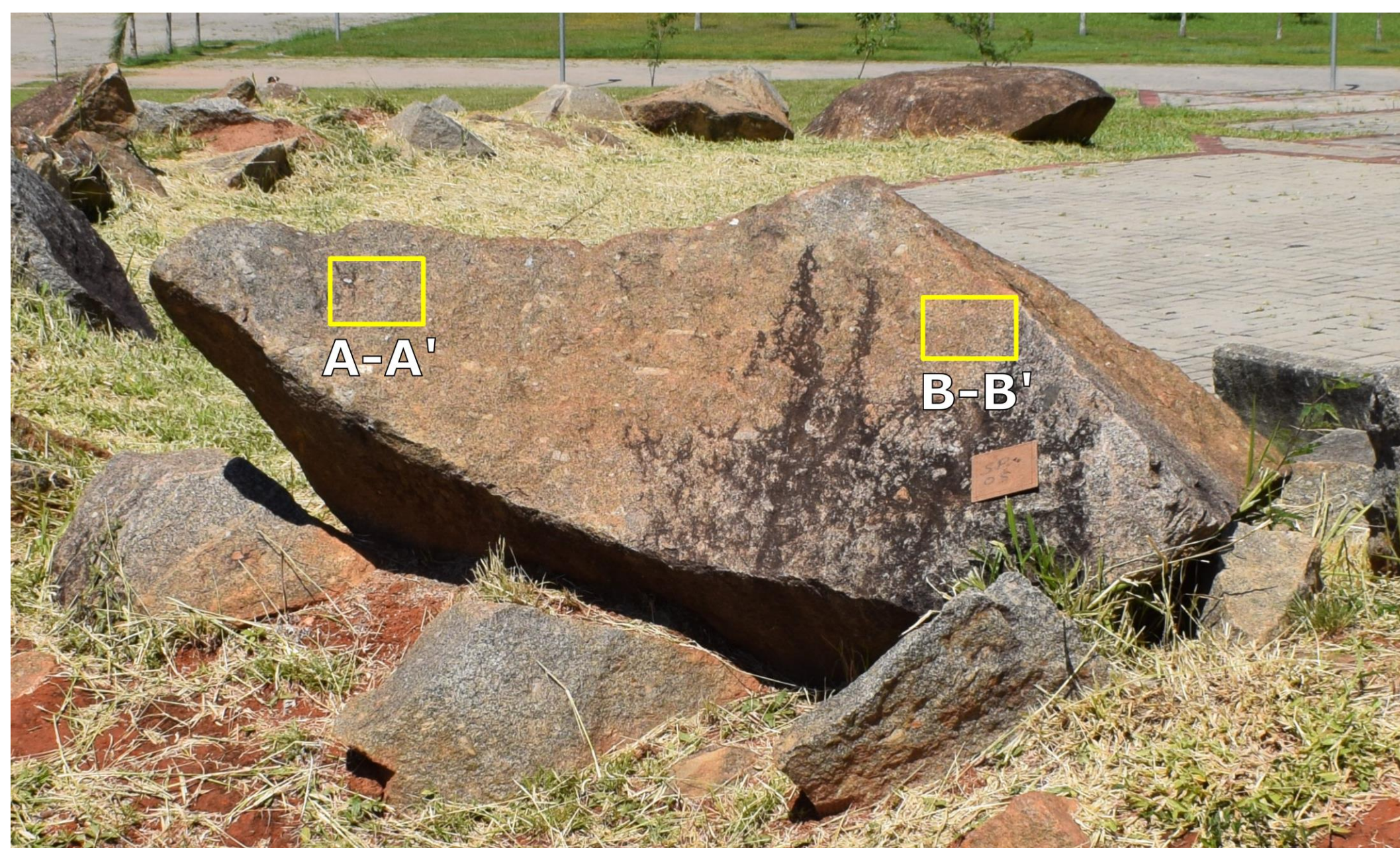


Figure 2. Location of profiles on site 2.

RESULTS

Model 1 comprises a 5.6 m² surface, represented by a mesh of 429,669 vertices and 856,179 faces. Model 2 is a mesh of 10,015,645 vertices and 19,999,999 faces that represents the whole granite block. Because of its high detail level, the model presented visualization problems, and therefore

one of its faces was segmented to perform the analysis.

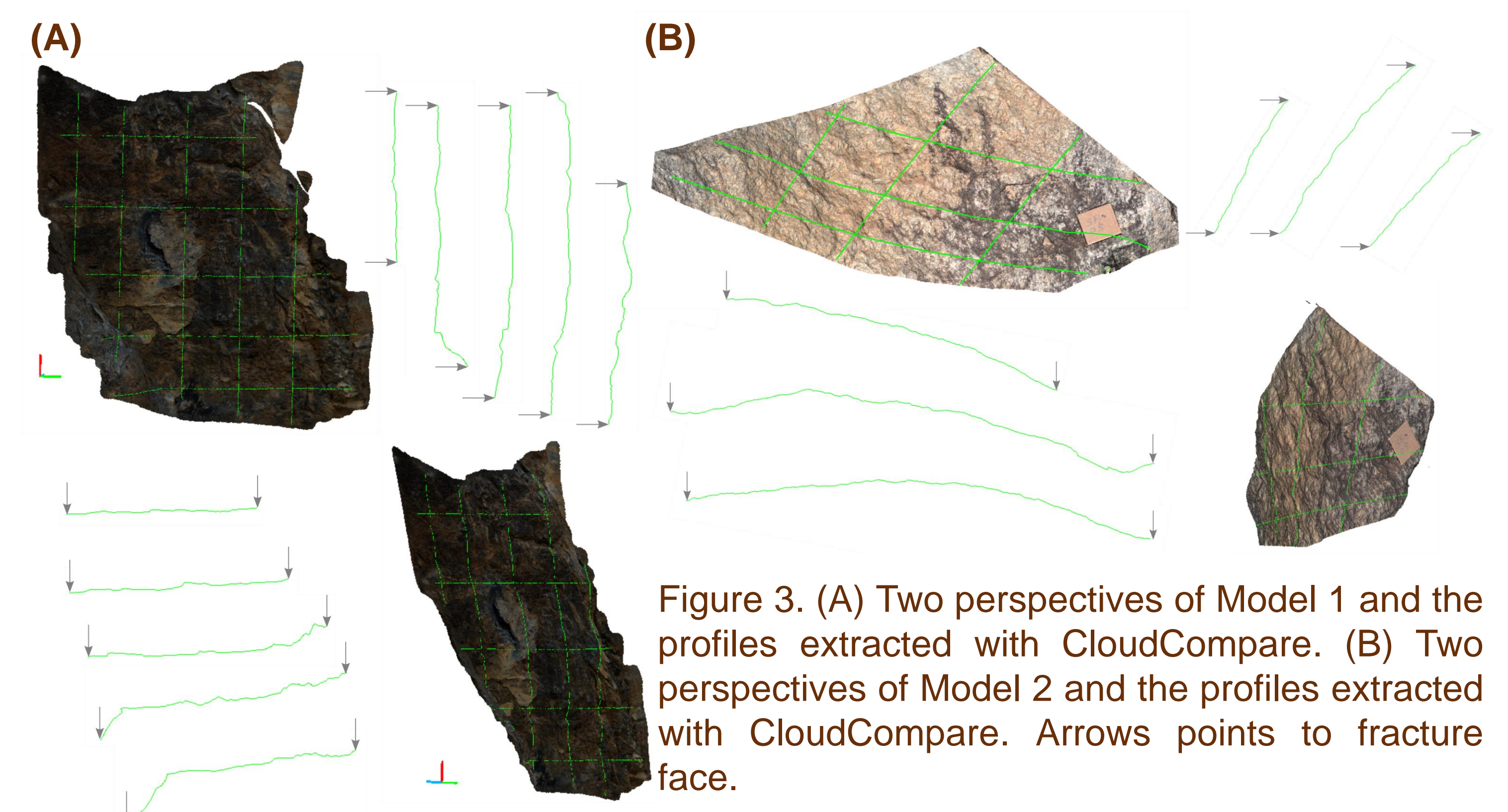


Figure 3. (A) Two perspectives of Model 1 and the profiles extracted with CloudCompare. (B) Two perspectives of Model 2 and the profiles extracted with CloudCompare. Arrows points to fracture face.

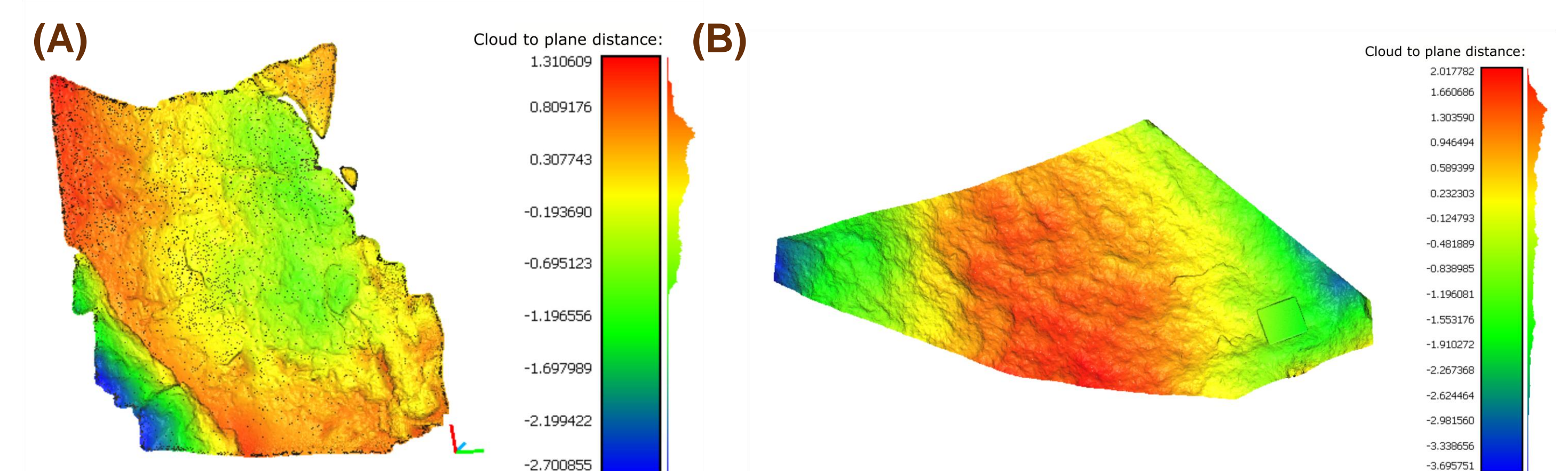


Figure 4. Model 1 (A) and Model 2 (B) cloud to plane distance, calculated with CloudCompare.

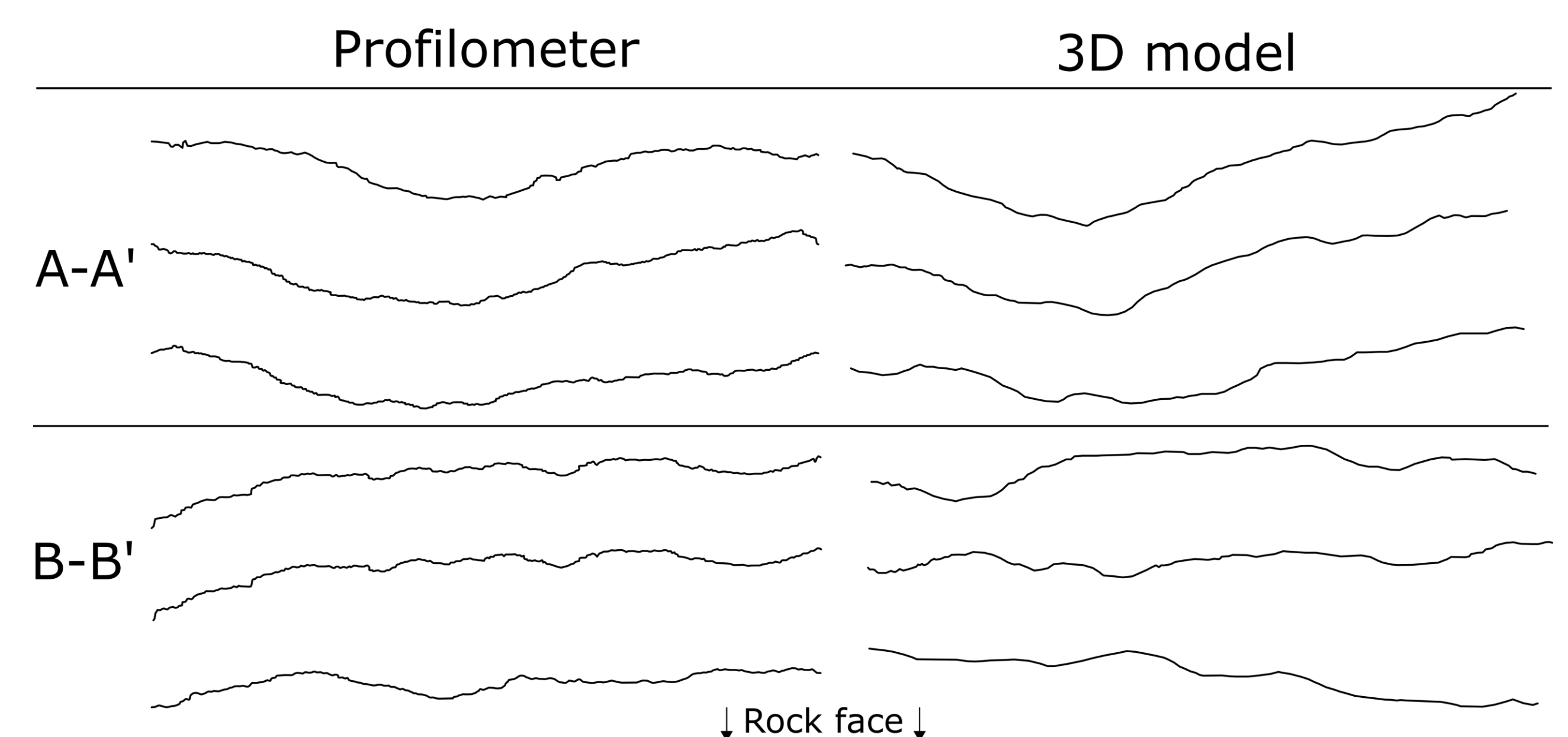


Figure 5. Comparison between A-A' and B-B' profiles obtained on site with Barton comb profilometer and on Model 2 using CloudCompare.

CONCLUSION

The work has demonstrated that the application of a 3D model generated with SfM-MVS workflow for rock roughness analysis is feasible, low cost, and provides a detailed and consistent model that can find future applications. It is important to emphasize that it is not always possible to access the surface of a fracture to perform such analysis, but it can be an important tool to aid in geomechanical classifications and stability analyzes, as well as numerical simulations.

REFERENCES

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