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Reports and More

From Point Clouds to CAD Objects: Workflow manual accompanying the case study of the Sabereebi Cave Monastery, Georgia

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Geotechnical stability models of the Sabereebi Cave Monastery

For the underground Sabereebi Cave Monastery a comprehensive analysis of static stability was conducted (Domej et al., 2022a; reprints: Domej et al., 2022b, 2022c; Pluta & Domej, 2021). Caverns, chapels, and churches were carved into a five-layered sequence of weak sedimentary rock—all of which bear a considerable failure potential (Fig. 1a–b, Fig. 2a–d).

Based on point cloud data from drone photogrammetry as well as from laser scanners acquired in- and outside the caves, a 3D geometry was established which was then used for static elasto-plastic stability models (Fig. 3).

Besides the goal of assessing various geomechanical scenarios through numerical modelling, the case also led to the development of a pilot scheme of numerical model compilation for very large structures without compromising on morphological details, which are most critical for stress concentration and failure.

Workflow manual accompanying the case study

As a matter of custom, the main article (Domej et al., 2022a) does not contain details on the model compilation, hence, the phase of processing point clouds of the caves and the slope into high-resolution CAD objects which – as composite – constitute the base for the numerical model.

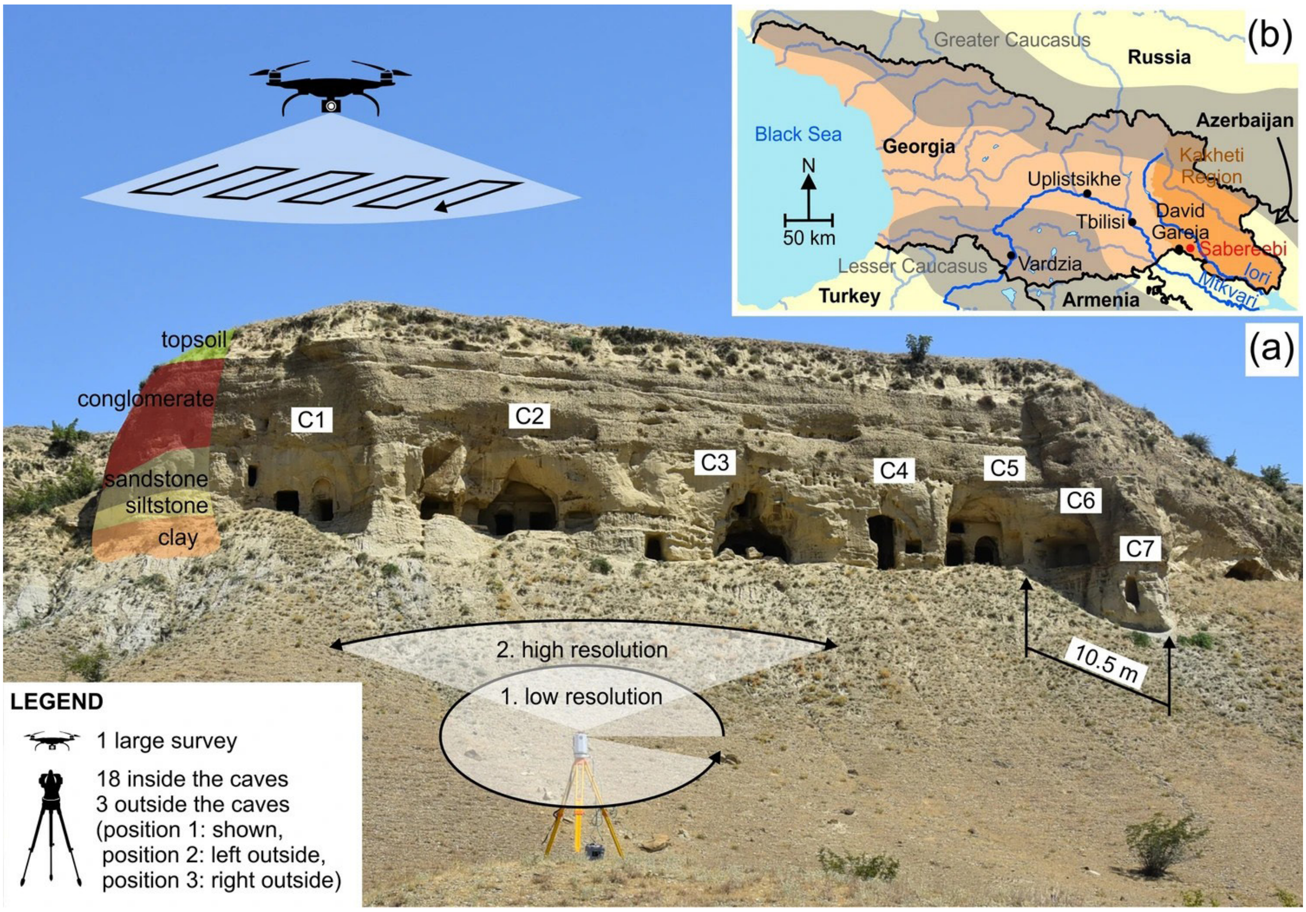

Fig. 1. The Sabereebi Cave Monastery (**a**) in the Kakheti Region of Eastern Georgia (**b**). The representation of the map of Georgia does not reflect political views of the authors nor of the institutions they are/were affiliated to (Domej et al., 2022a).

However, since the transformation of a point cloud into a CAD object is not trivial, we have provided a step-by-step workflow manual for the employed software chain, whose only purpose is to share an efficient procedure. It is designed for a point cloud recorded by a laser scanner inside one of the caves resembling a church with several niches and passages to the outside of the hill slope (Figs. 4 and 5). Following our procedure is, therefore, recommended only for similar projects.

The workflow manual was initially made available at ResearchGate with the former affiliations of the authors:

Domej G., Pluta K., 2020. From Point Clouds to CAD Objects: Overview on a case study. Workflow description for open source use, ver. 1, 21 p. http://dx.doi.org/10.13140/RG.2.2.11452.67208

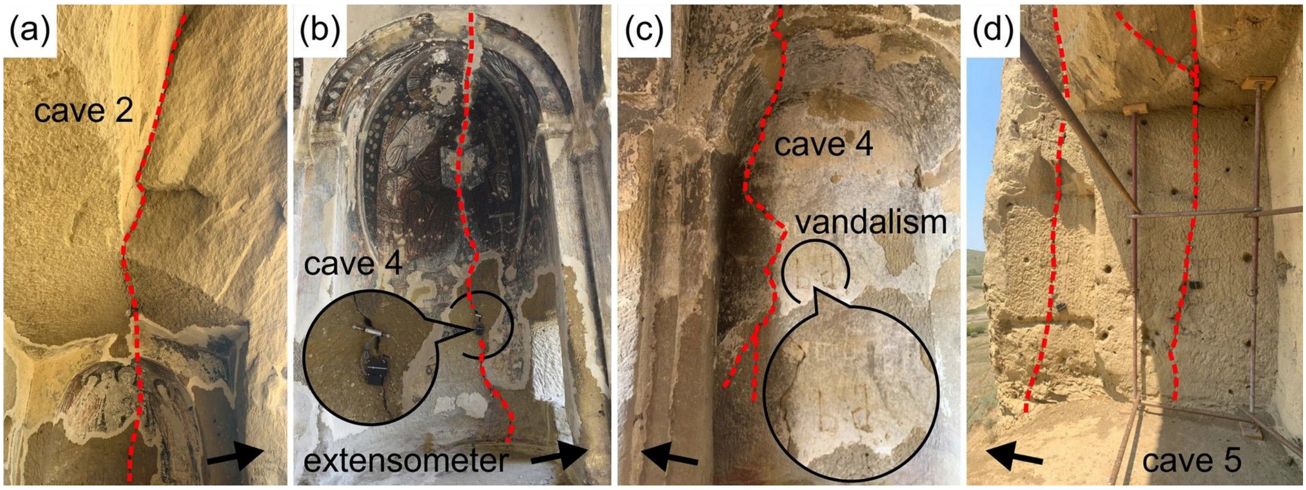

Fig. 2. Fractures at the entrances and in cave 2 (**a**), in cave 4 through a religious fresco monitored by an extensometer (**b**), in cave 4 next to traces of vandalism (**c**), and in cave 5 (**d**). The black arrow points outwards (Domej et al., 2022a).

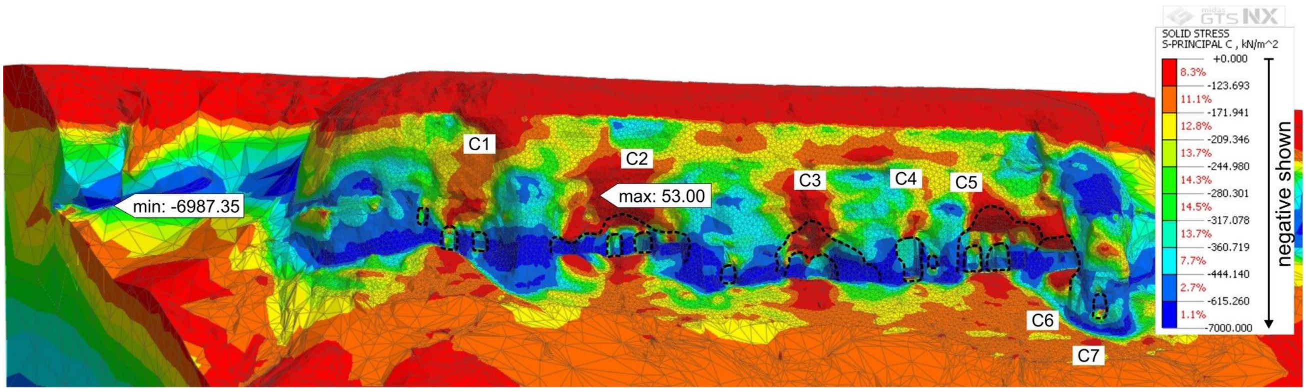

Fig. 3. Zones of compressive stress affecting cave walls, floors, and pillars in particular. Color coding is auto-scaled (Domej et al., 2022a).

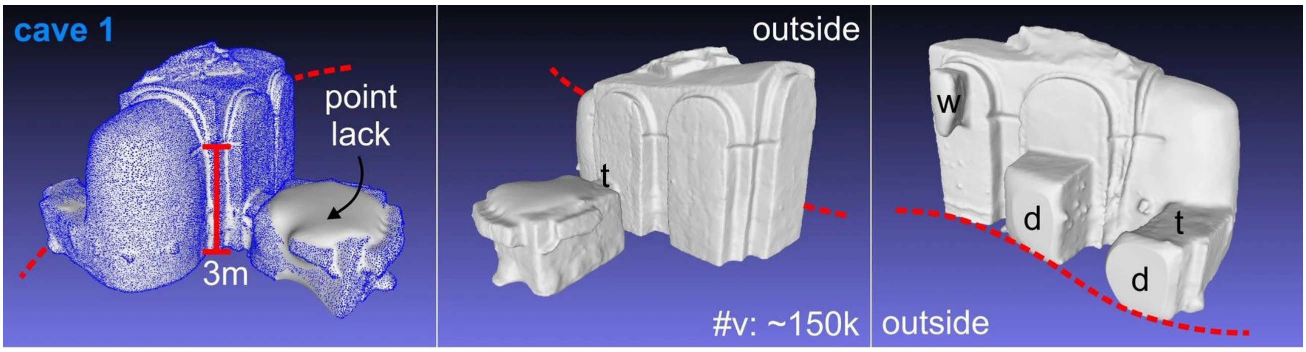

Fig. 4. Envelopes for cave 1 derived from point clouds. The approximate numbers of vertices (per point) for the creation of mesh envelopes are given in thousands. Abbreviations are as follows: d – doors, t – tunnel, and w – window (Domej et al., 2022a).

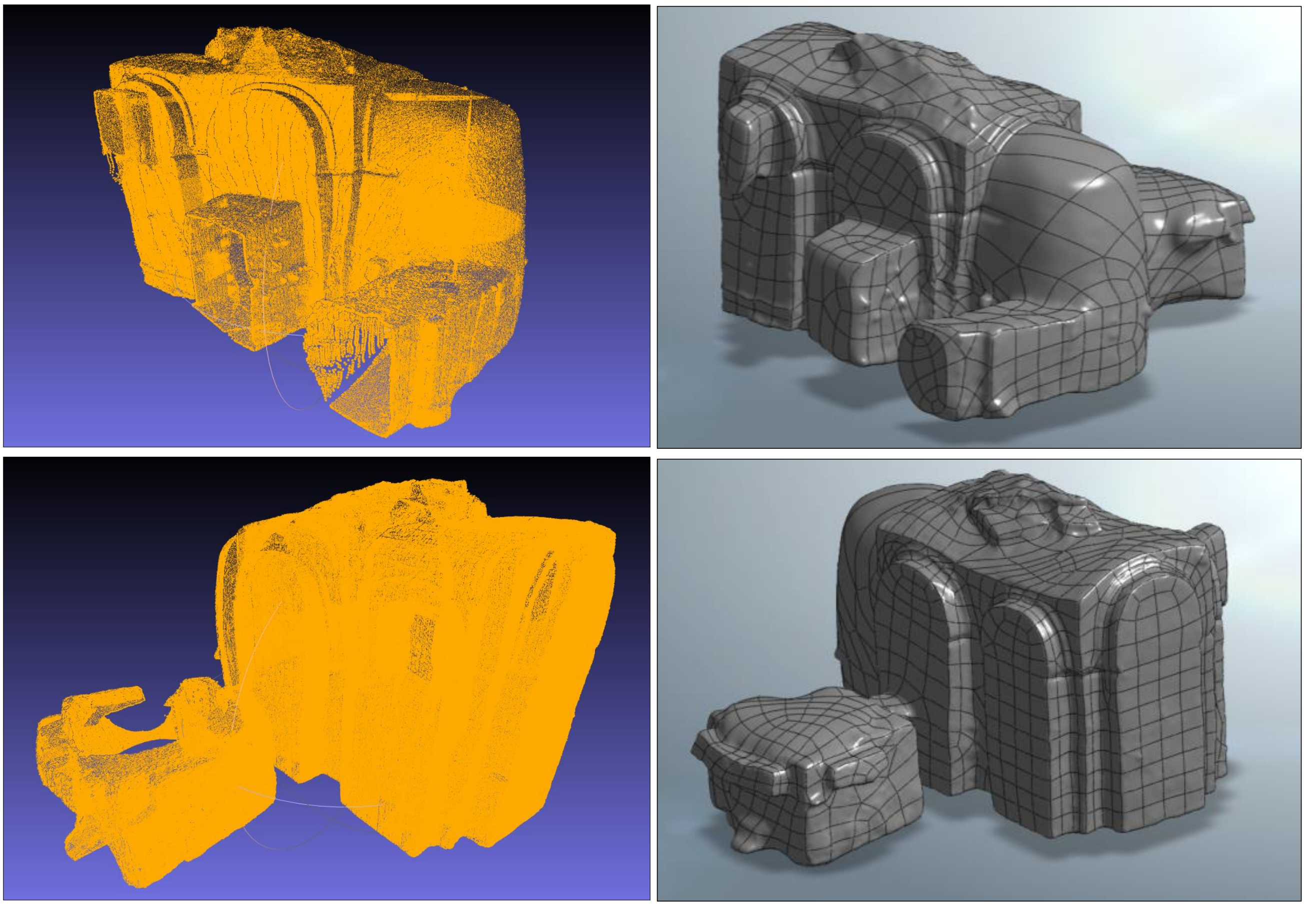

Fig. 5. Cave structure from the front and the back side as point cloud and NURBS (Non-Uniform Rational Basis Splines (Domej & Pluta, 2020).

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The presented workflow was created independently; it is not part of a funded project.

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