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# ABSTRACT BOOK

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## Geosciences and the Challenges of the 21<sup>st</sup> Century



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## Safeguarding the Sacred Stone: 3D surveying of Rock-Hewn Heritage in Georgia (South Caucasus)

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In the framework of a collaborative research project between the University of Siena – Centre of Geotechnologies, Italy, and the Iliia State University (Tbilisi, Georgia) an integrated geomatics fieldwork was carried out at seven major rock-cut heritage sites across Georgia. The oldest monastery, Uplistsikhe (Shida Kartli Region), is dated back to the 1<sup>st</sup> millennium BC; it was originally a pagan rock-hewn city, later transformed into a Christian centre (4<sup>th</sup>–10<sup>th</sup> century). The origin of the sites of Dodos Rqa (Kakheti Region), Natlismtsemeli (Kvemo Kartli Region) and Shiomgvime (Mtskheta-Mtianeti Region) is linked to a Mesopotamian group of Christian monks, namely “13 Assyrian Fathers”, whose aim was the monastic life consolidation in Georgia (6<sup>th</sup> century). Vanis Kvabebi (Samtskhe-Javakheti Region) and Sabereebi (Kvemo Kartli Region) were created from the 8<sup>th</sup> to the 10<sup>th</sup> centuries, during the Medieval monastic expansion. The biggest monastery complex, Vardzia (Samtskhe-Javakheti Region), was constructed from the 12<sup>th</sup> to the 13<sup>th</sup> centuries (Golden Age of Georgia).

The primary objective of the study was to generate a comprehensive and scalable database of 3D point clouds aimed at supporting long-term monitoring and geotechnical-geomorphological analyses of these culturally and geologically important sites.

The survey approach combined Terrestrial Laser Scanning (TLS) acquisitions, using a Trimble™ TX8 scanner, and digital photogrammetry. For nadiral and oblique aerial imagery data acquisition, a DJI™ Mavic 2 Pro Unmanned Aerial System (UAS) was used.

The integration of TLS and UAS datasets was conducted through Structure-from-Motion (SfM) and point cloud registration workflows, allowing the production of high-resolution, georeferenced 3D models. The data processing and analysis was carried out using Agisoft Metashape™ and Trimble RealWorks™ software. In addition, the TLS point clouds were coloured by using a Nikon D7100 camera equipped with a fisheye lens.

These models serve as geospatial and architectural documentation, digital preservation, virtual access and as reference baseline for diachronic analysis and morphological monitoring aimed at highlighting cultural heritage resilience in the face of environmental and anthropogenic pressures.

Moreover, condition of mural paintings and surfaces as well as structural slope stability may be assessed and related remediation works established.

This multi-scale geospatial documentation effort lays the groundwork for long-term rock-cut heritage sites conservation strategies and supports their recognition within international frameworks such as the UNESCO World Heritage List. Only Vardzia has been listed since 2007 in the UNESCO Tentative List.