



Petra documentation project using Laser Scanning



The **Zamani** research group in the Geomatics Division at the University of Cape Town has completed the third phase of the documentation of the UNESCO World Heritage site of Petra in Jordan. For more on the Zamani project visit www.zamani-project.org

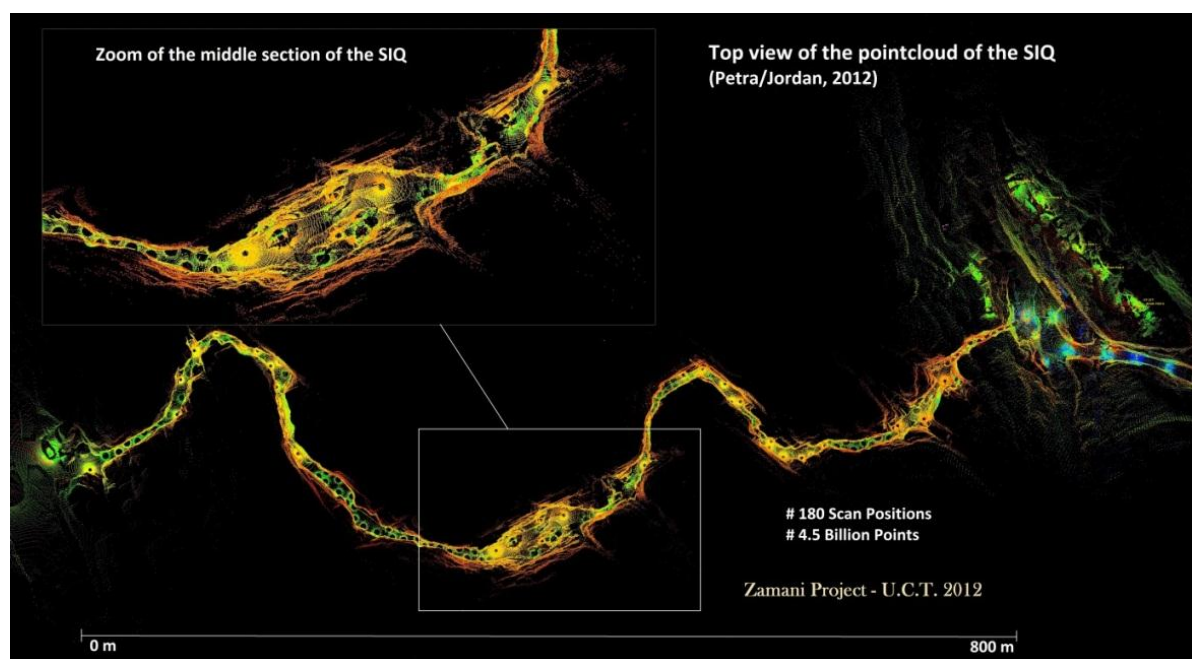
Petra is an Arabian city in the country of Jordan carved out of the sand-stone mountains in Wadi Araba. It was established over 2000 years ago and was the capital of the Nabataeans. The tombs and structures are now in danger of erosion due to earthquakes, floods and natural weathering and are thus in need of monitoring and documentation.

The laser scanning survey of Petra is part of the Siq Stability project, which is a "Funds In Trust" project of the Italian Ministry of Foreign Affairs for UNESCO. It is managed by the UNESCO Amman Office and has as main partners Italian geological experts from ISPRA (Italian Institute for Environmental Protection and Research - Geological Survey of Italy), the Zamani Research Group (University of Cape Town), as well as geologists and a surveyor from the Petra National Trust. It is undertaken in cooperation with the Department of Antiquities of Jordan (DOA) and the Petra Development and Tourism Region Authority (PDTRA).

The main objectives of the project are the development of a:

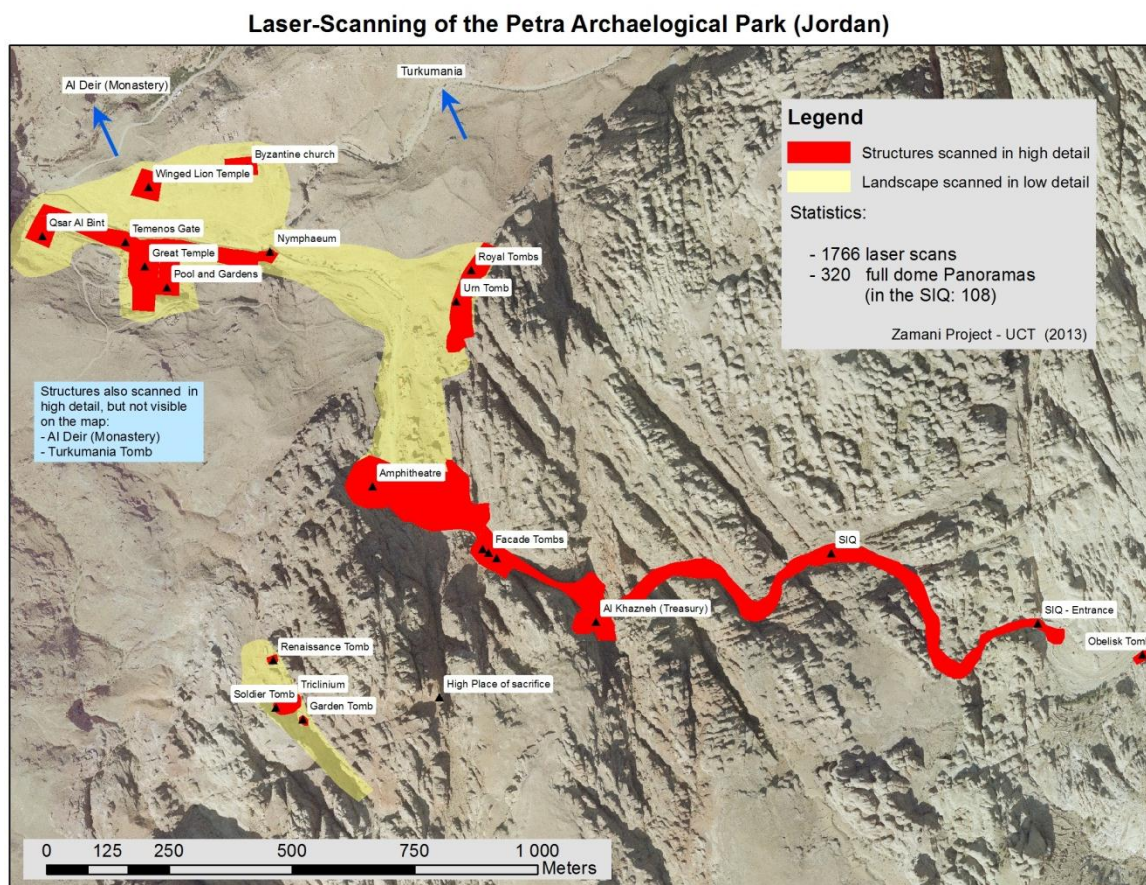
- Monitoring system aimed at detecting potential unstable rocks and at-risk areas.
- Guidelines for implementation of sustainable landslide mitigation strategies and for management of the Petra area.
- A GIS platform for storage, analysis and management of data relevant for the Petra Archaeological Park area.
- A 3D computer model of the Siq and the major structures and landscape of the site.
- A virtual tour of Petra.

The Zamani group is primarily responsible for the 3D modelling of the Siq, i.e. access route to the site based on terrestrial laser scanning and aerial photography, the creation of a comprehensive site GIS and database, a Virtual tour, and 3D documentation of the important tombs and structures.



Layout of the point cloud of the Siq representing about 30% of the full Petra point cloud.

The Zamani team has completed 1766 scans of Petra, produced 320 panoramas and acquired more than 3000 additional digital images. The resulting point cloud is comprised of some 12 billion surface points. The point cloud includes scans of the rock walls of the Siq, which is the narrow access canyon to the site, the outside and inside of some 30 major structures in the two principal wadis of Petra, including the famous Treasury, Monastery, the Royal Tombs, the Soldier Tomb, the Garden Tomb, the Renaissance Tomb, the Amphitheater, Qasr al Bint and the Great Temple. All structures were fully scanned in very high detail (less than 1cm point interval) inside and outside and in some cases included underground tunnels. Also scanned were the general mountain terrain and much of the landscape surrounding the site.



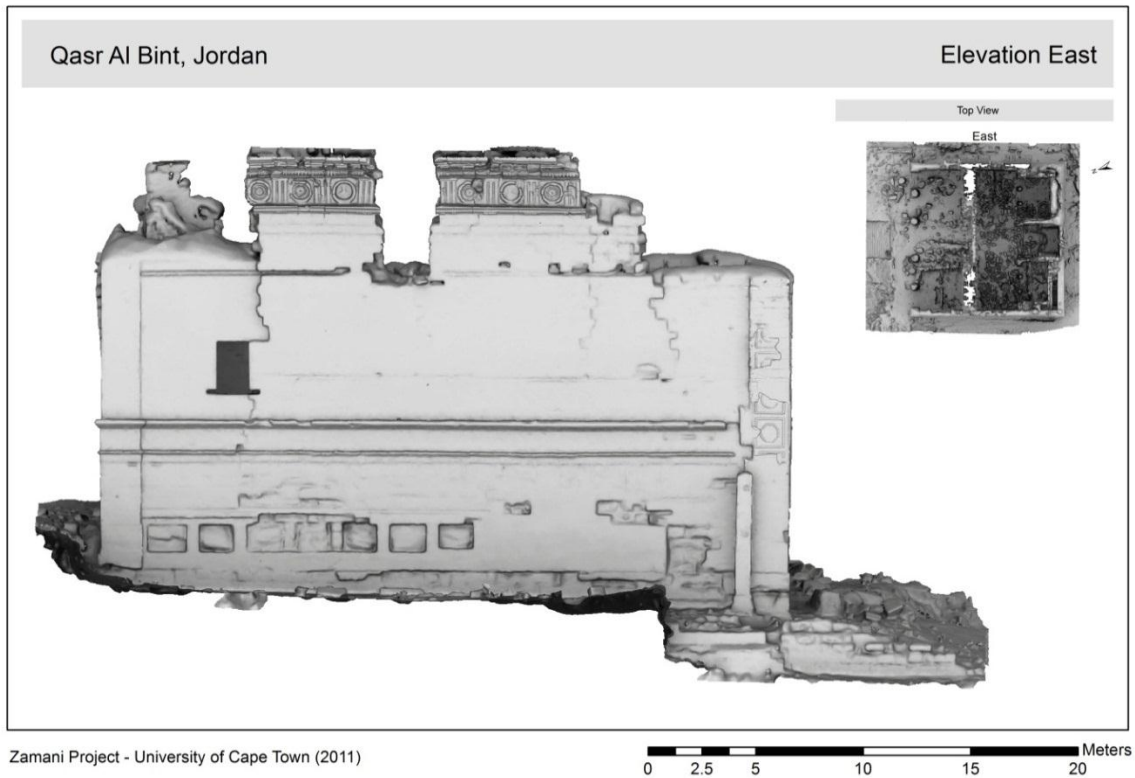
As the Zamani team works generally on fragile sites with difficult-to-access structures it is the team's policy to operate without the use of targets for registration and to rely on surface based registration methods instead. Especially in Petra, the use of targets would have been highly impractical because of the narrow and high rockwalls of the Siq which made GPS or conventional surveys extremely difficult if not impossible. The resulting, fully registered and geo-referenced point cloud combines all models and the landscape and stretches over a distance of 3 km. Comparing the point cloud to a network of GPS points by 3-parameter similarity transformation, i.e. without a scale factor, showed discrepancies between corresponding points in the point cloud and GPS positions of an average of 5 cm with a maximum of 14 cm for one of the points. The high accuracy of the result exceeded all expectations and certainly reflects extremely well on terrestrial laser scanning as a documentation tool not only for manmade structures but also for landscapes.



Textured 3D model of the Royal Tombs (from left: Palace Tomb, Corinthian Tomb and Silk Tomb). Link to watch animation <http://youtu.be/s3zXkb-xkc>

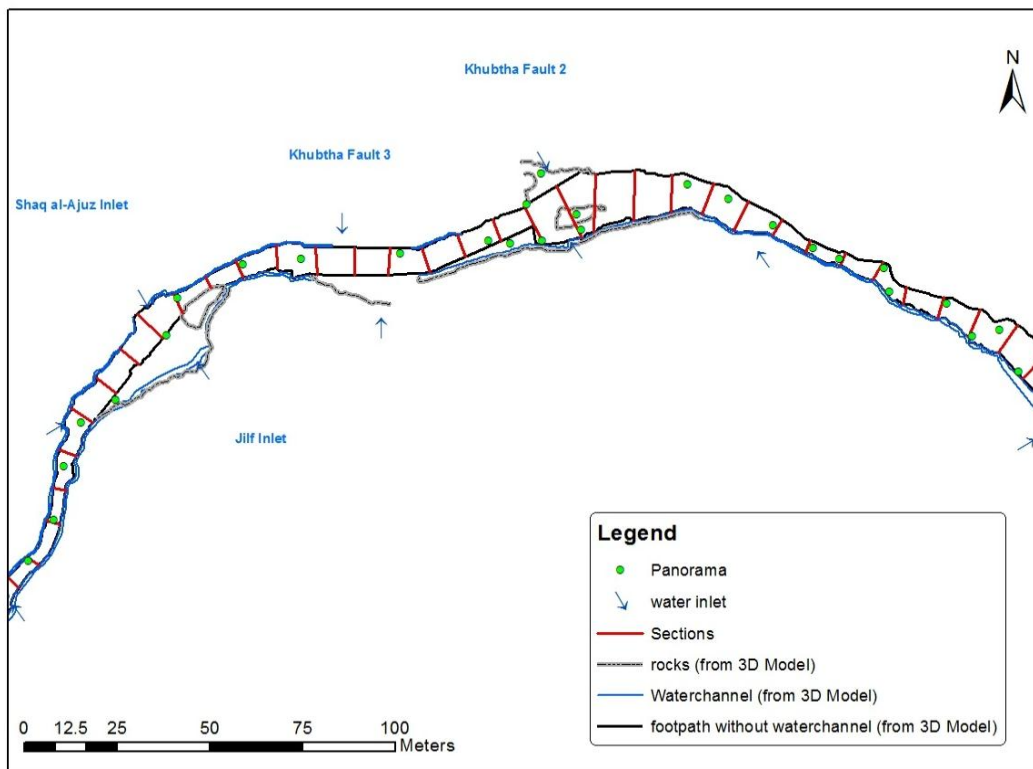


Front view of the untextured Qasr Al Bint 3D Model. Link to watch animation <http://youtu.be/94Ss-EXrc5A>



Elevation of the Qasr Al Bint derived from Laser scan model

GIS of the SIQ (middle part)



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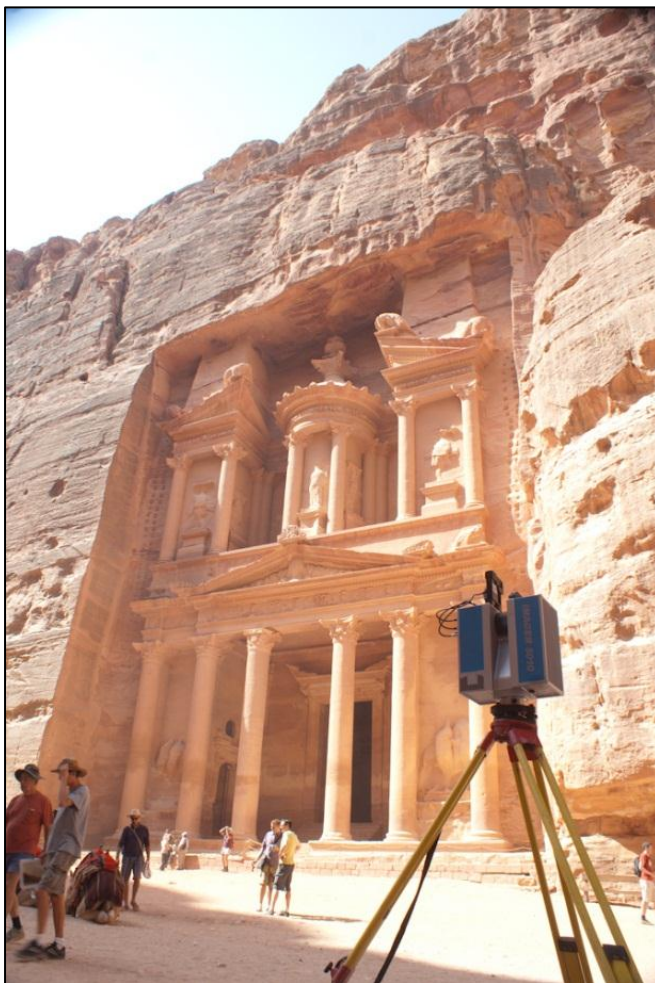
Scanning the Great Temple with a Z+F scanner



GPS survey and scanning on top of the Siq



The Zamani Team and two members of the DOA in the Siq with a Leica (left) and Trimble (right) laser scanner



Scanner in front of Al-Khazneh (the Treasury)



State-of-the-art technology and age-old transport in front of the Urn tomb



Imager Jones in front of Al-Deir (the Monastery)



Transporting scanning equipment to the Monastery



360 degree Panorama of the Urn Tomb