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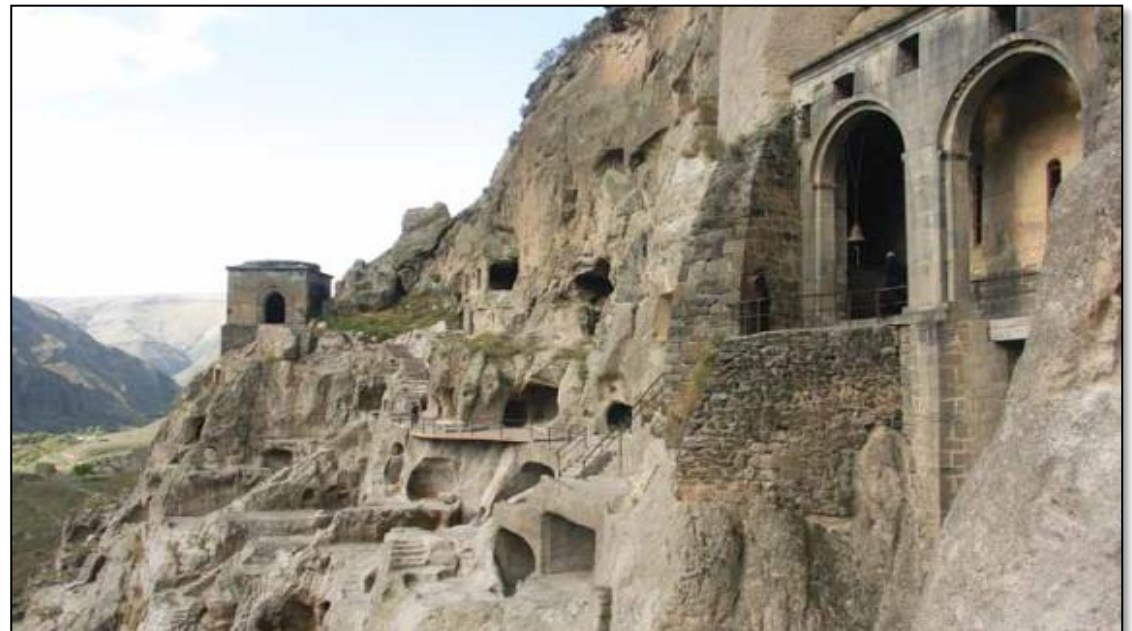
UNIVERSITÀ
DEGLI STUDI
FIRENZE

- UNESCO Chair on the Prevention and Sustainable Management of Geo-Hydrological Hazards,
- University of Florence, Italy

Applying InfraRed Thermography (IRT) for the protection and conservation of rupestrian CH sites affected by slope instabilities

Frodella W., Spizzichino D., Gigli G., Elashvili
M., Margottini C., Casagli N.

Vardzia rock cut city (IX-XII sec.)



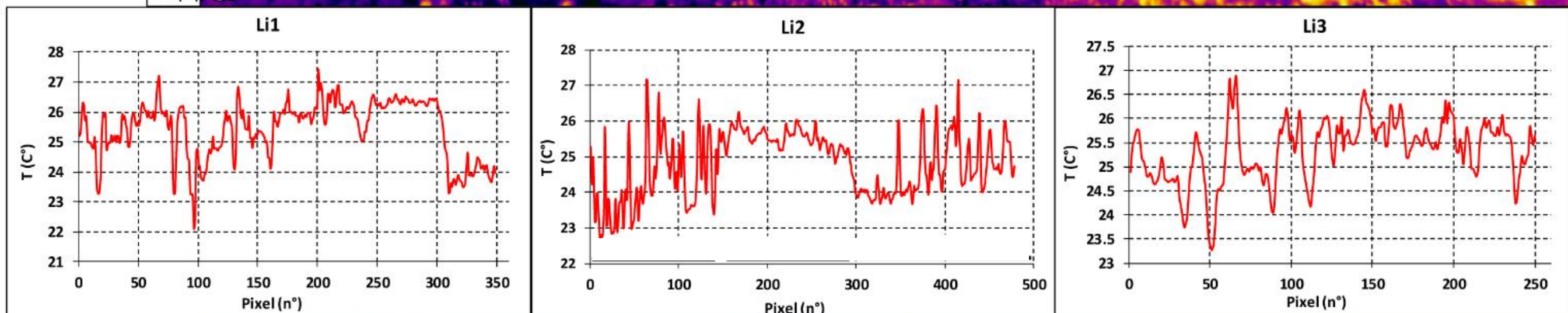
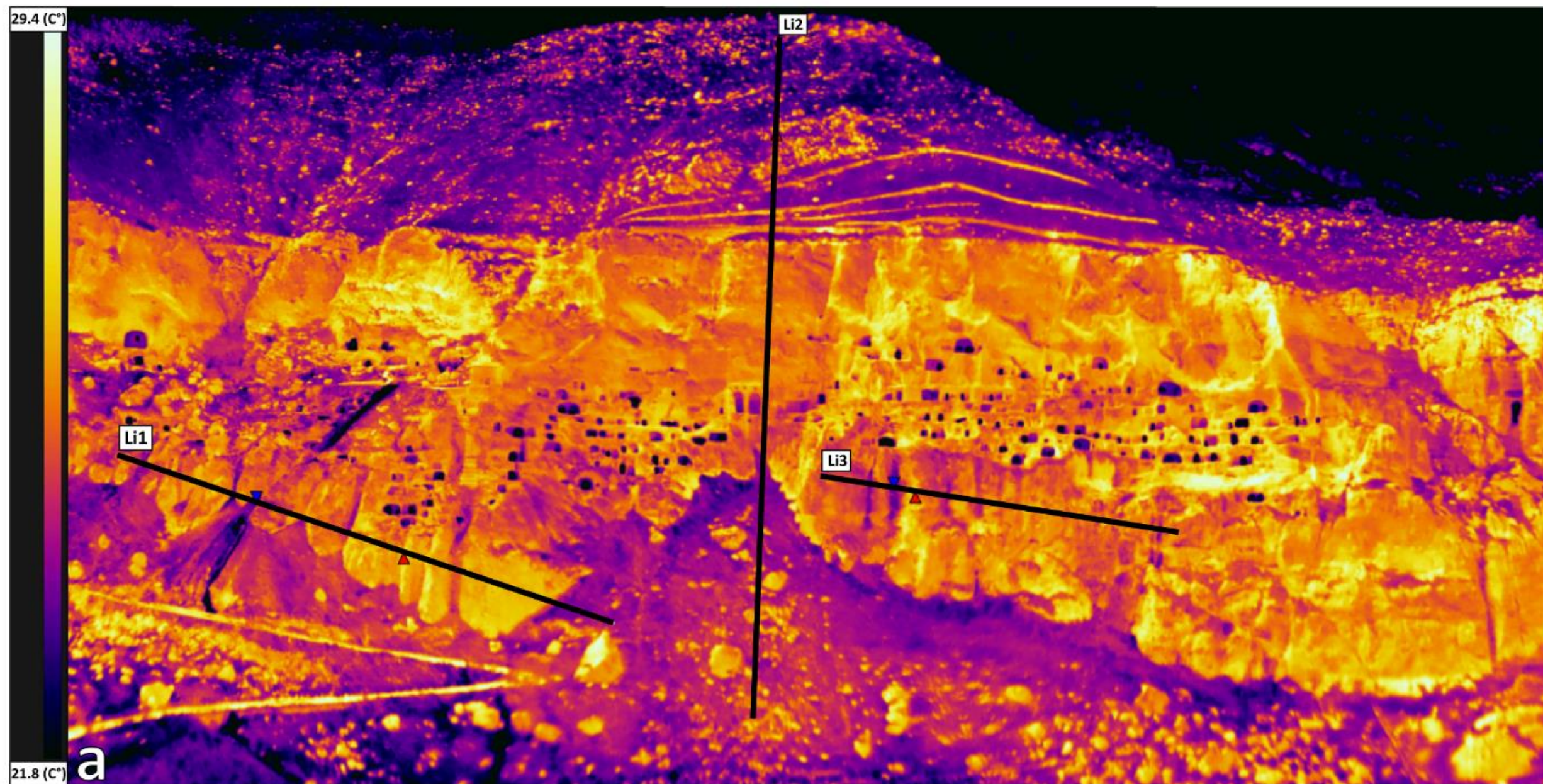
UNESCO Tentative list since 2007 whc.unesco.org/en/tentativelists/5236

Conservation problems

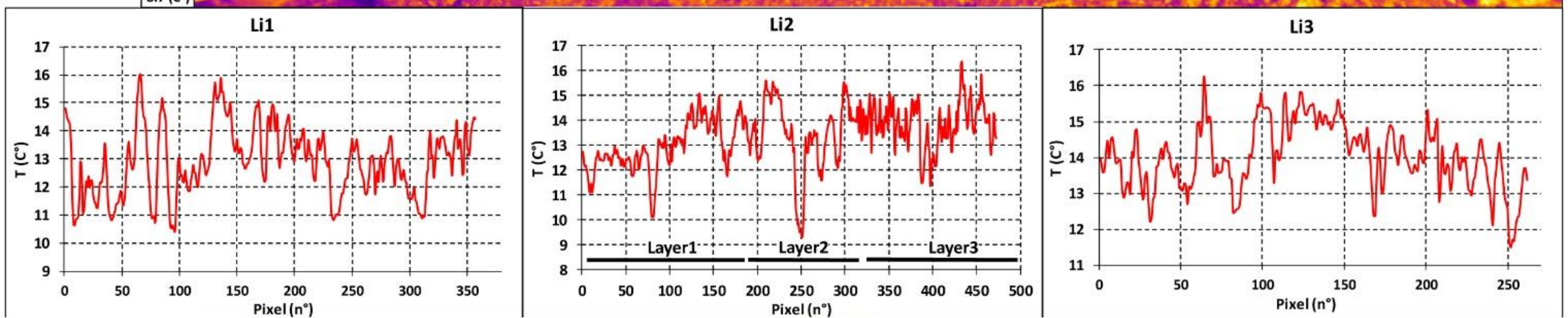
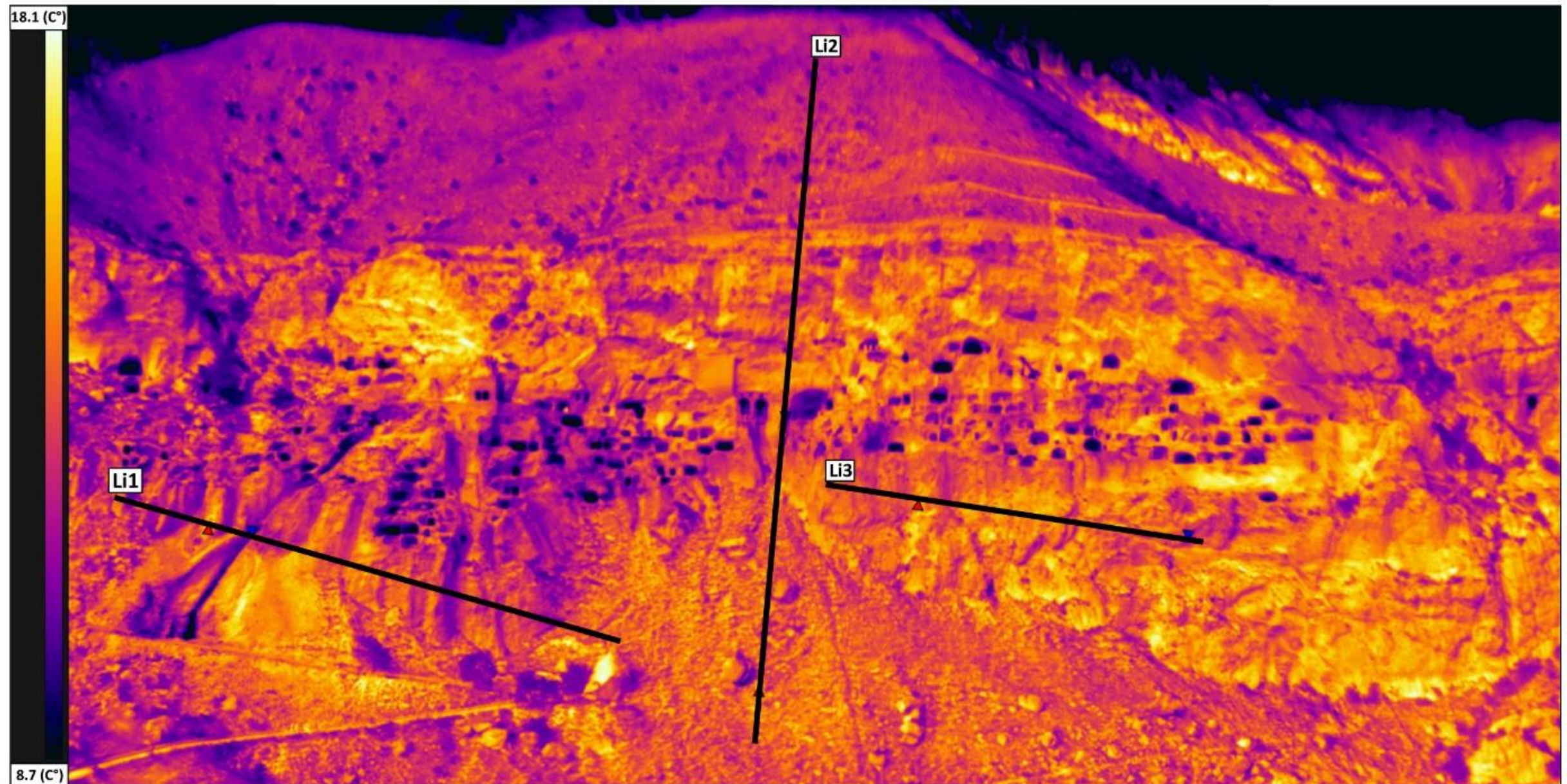


- Moisture causes weathering and degradation of the tuff slope, reducing wall strength, causing the widening of the joints and loosening of the rock mass
- Moisture is therefore recognized as one of the most important factors contributing both to the degradation and instability processes acting in the site of Vardzia

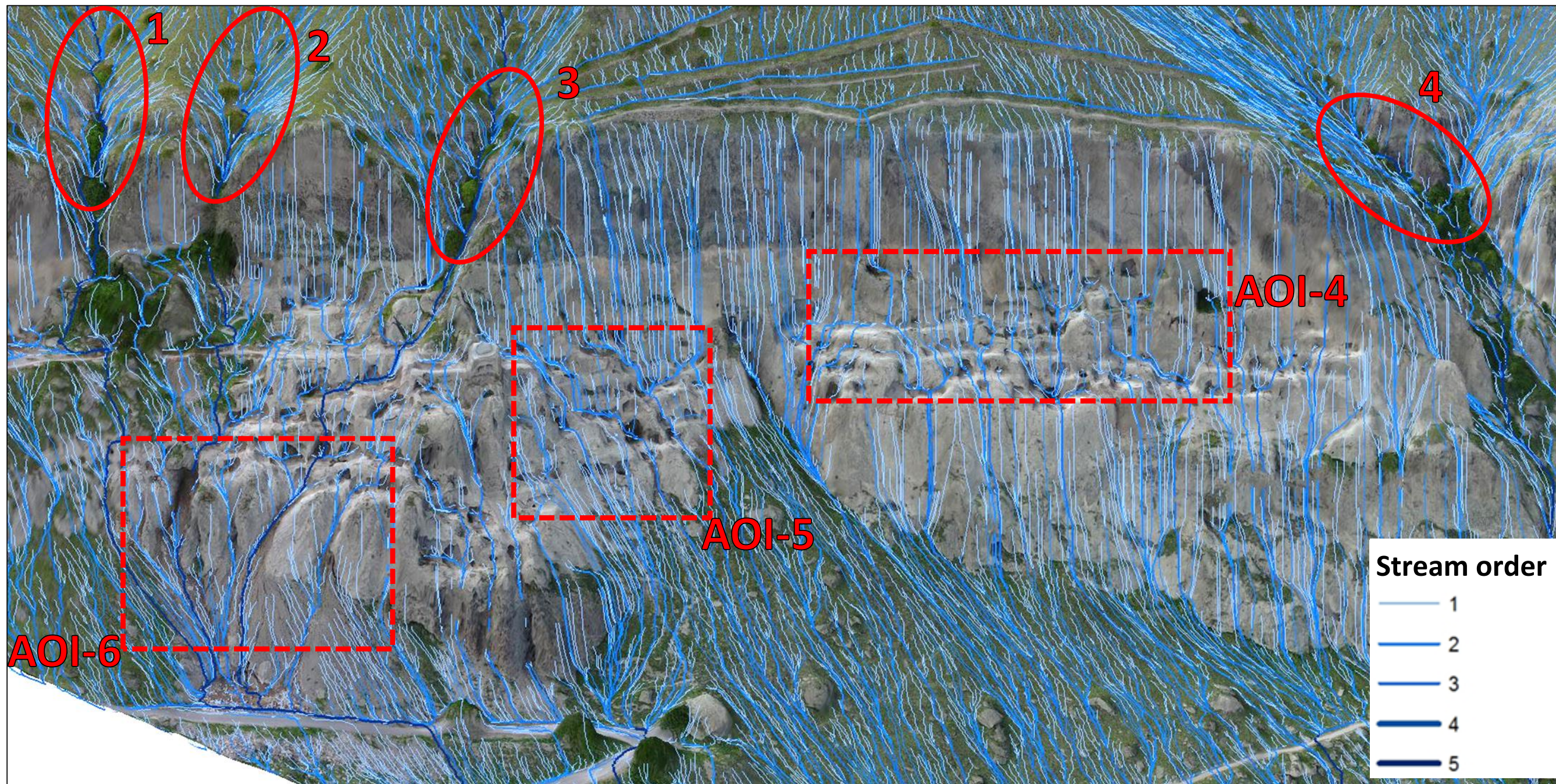
Infrared Thermographic surveys (July 2017)



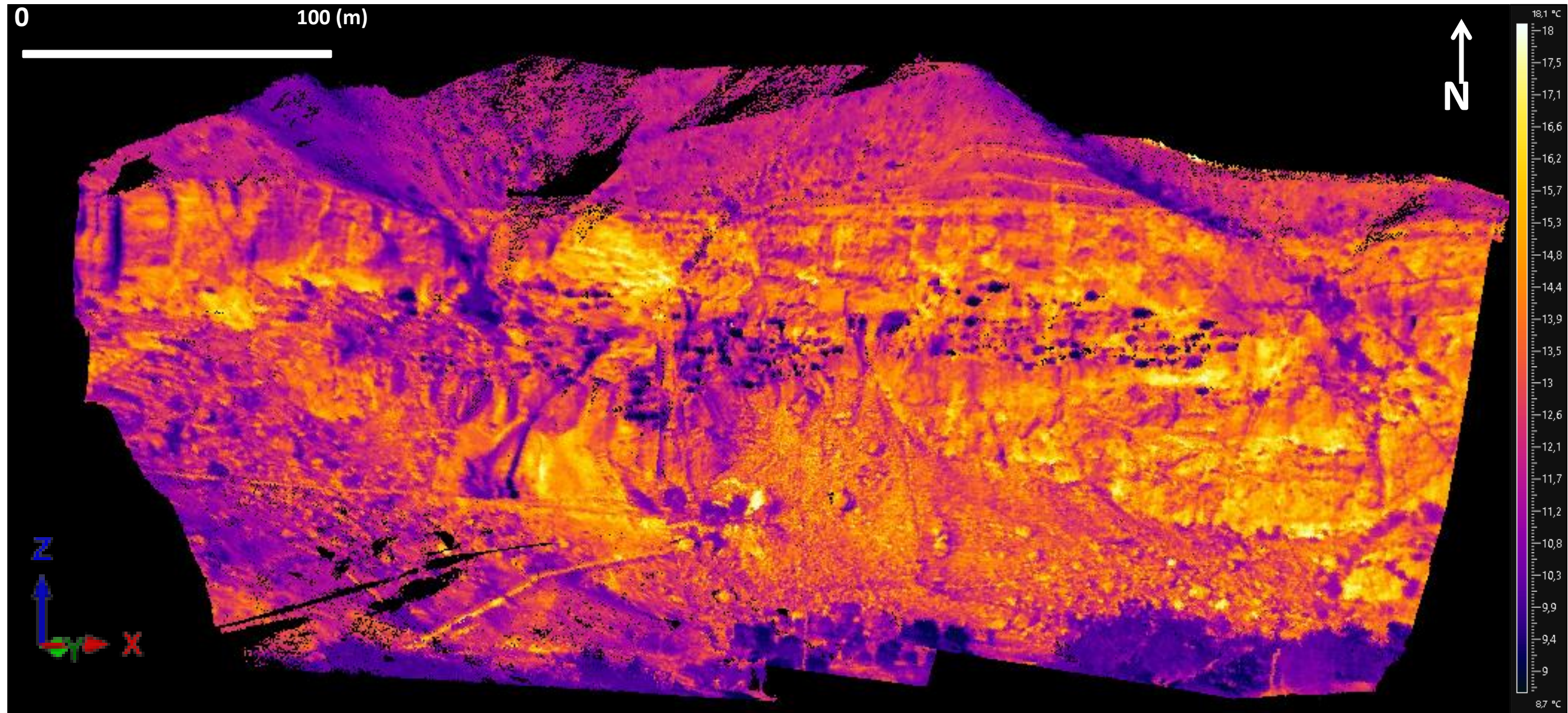
November 2016 IRT surveys



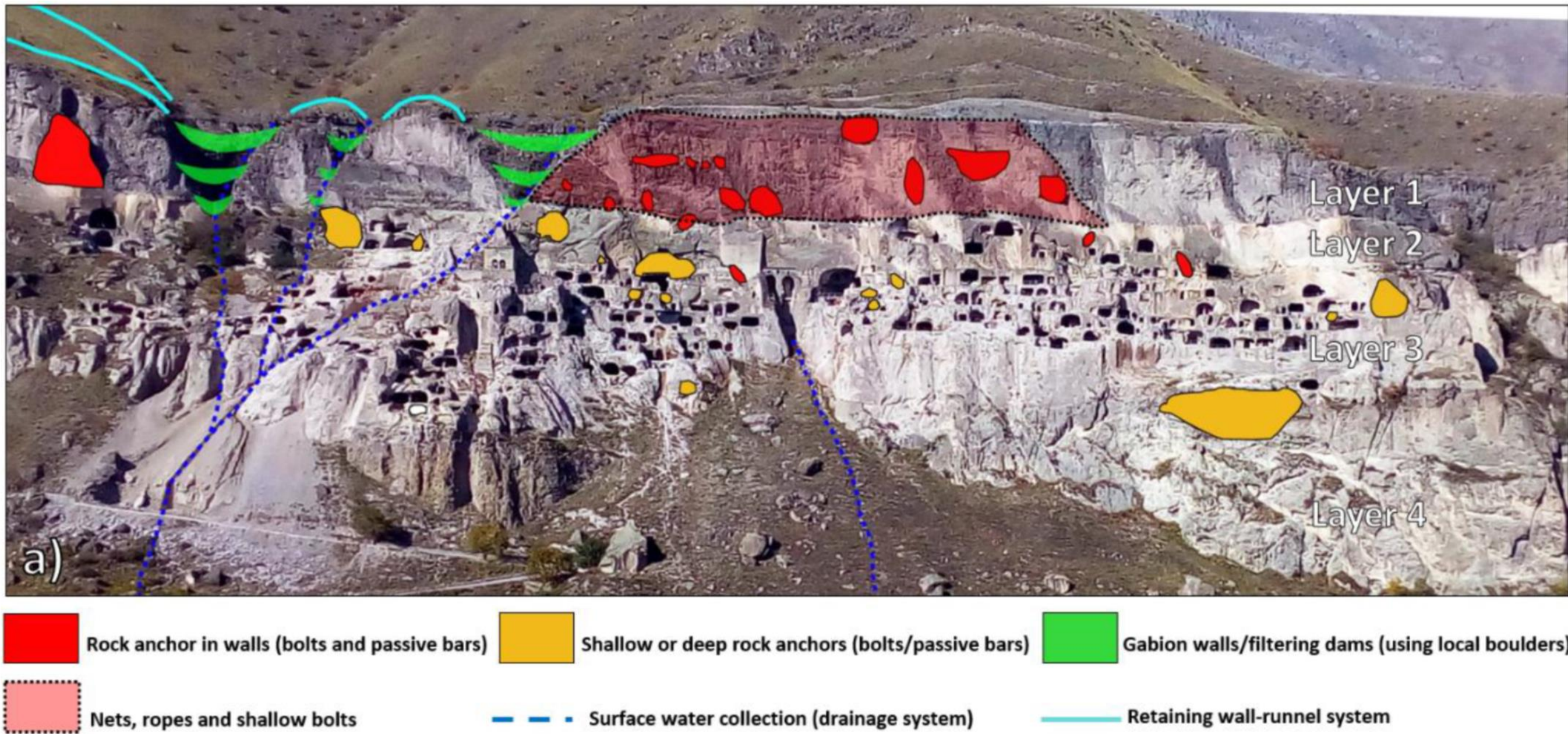
Hydromodelling of drainage network on UAV-DP 3D surface



Data fusion: IRT 3D map



IRT contribution for sustainable mitigation measures



(a) Contribution to the General Master Plan of the proposed mitigation measures for the whole Vardzia Monastery: system of surface water collection and runnel-retaining walls built along the monastery slope rock wall upper sector, sectors characterized by instability on the rock cliff with related anchor type,

Concluding remarks

- IRT can lead to the detection of potentially hazardous features in rupestrian TCH sites (discontinuities and open fractures, scarps, seepage and moisture zones, drainage network, potentially unstable ledge-niche systems)
- IRT is a versatile technique for 2D and 3D slope mapping technique to be used for quick surveying and analysis in the context of TCH conservation strategy
- IRT alone is insufficient for a complete slope characterization, but it can be used as an easy-low cost complementary technique in combination with Digital Photogrammetry (DP) or TLS for TCH mapping and monitoring activities
- A skilled thermal camera operator is strongly recommended for correct image acquisition, elaboration and interpretation

Acknowledgements



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References

Frodella, W., Elashvili, M., Spizzichino, D., Gigli, G., Adikashvili, L., Vacheishvili, N., Kirkitadze, G., Akaki Nadaraia, A., Margottini, C., Casagli, N. (2020). Combining InfraRed Thermography and UAV Digital Photogrammetry for the Protection and Conservation of Rupestrian Cultural Heritage Sites in Georgia: A Methodological Application. *Remote Sensing*, 12(5), 892.

Spizzichino D., Boldini D., Frodella W., Elashvili M., Margottini C. (2017) Landslide risk analysis and mitigation for the ancient rock-cut city of Vardzia (Georgia). Proceedings of 2017 IPL Symposium, UNESCO, Paris, 1-8