THE LONGEST LAVA TUBE IN THE LEVANT: THE 20.5 KM LONG SHIHAN-HARAN SYSTEM, SYRIA

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Abstract

Google Earth, topographic maps and verification from a small surveyed pyroduct segment (Ariqa Cave, Tawk et al. 2009) are used to infer the trace of the longest lava tube system in the Levant, without visiting the studied site. The studied system includes segments of intact pyroduct caves, collapsed segments and lava channels. The system is within the recent lava flows of Tell Shihan, Al-Lajāʾ, Harrat Ash-Shaam, southern Syria. The lava tube carried late Quaternary lava from the base of Tell Shihan volcano westward.

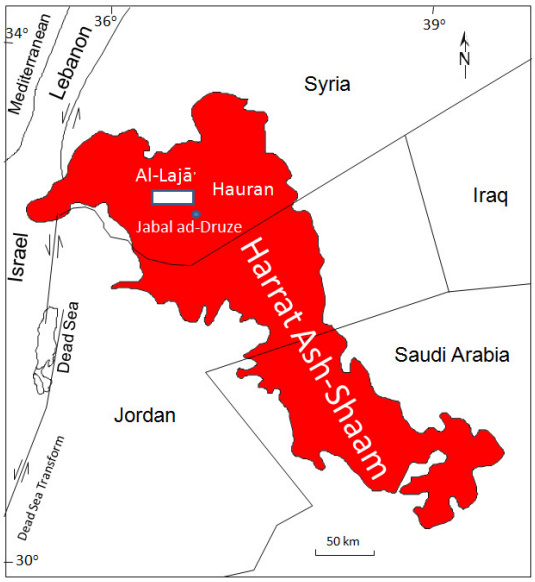

Figure 1. *The study area (rectangle) in Al-Lajāʾ, Haura n, SW Syria.*

Introduction

It is well known that where a lava tube (pyroduct) is close to the surface, sections of its roof may erode or collapse, creating a puka or skylight holes, as well as elongated unroofed caves. The continuous nature of such partially collapsed lava tubes and/or lava channels are often identified by remote sensing as 'dashed lines' of intact lava tube segments and channels, collectively referred to here as a 'lava tube system'. The ability of the human brain to detect patterns, such as alignments or continuous broken undulating lines, can be used for detecting traces of lava tube systems from above.
The intuitive and easy-to-use Google Earth has rapidly emerged as a global medium with increasing potential for lava tube prospection, outflanking other types of orbital imagery and remote-sensing sources. Google Earth imagery has improved dramatically, especially for the Middle East. Its high resolution SPOT Images are useful for detecting lava tubes in hardly-studied regions. The suggested reconstruction should be validated by future expeditions, as should be the case in planetary lava tubes.

Geographic setting

The largest volcanic region of the Levant is Harrat Ash-Shaam, covering some 40,000 km^2 (15,000 sq mi) in Syria, Jordan, Saudi Arabia, and Israel (Fig. 1). Several lava tubes are known in its northeastern area, the Hauran (e.g. Kempe et al., 2006; Frumkin et al., 2008). Tawk et al. (2009) reported a 562 m long lava tube, named Ariqa Cave (Fig. 2), in a Syrian village carrying the same name, NE of Jabal ad-Druze, the highest (summit elevation: 1785m) portion of the Hauran (Fig. 1). Using Google Earth, this cave is shown here to be a small segment of the longest lava tube system in the Middle East, >20 km long. This region of Harrat Ash-Shaam is called Al-Lajāʾ, (Arabic: "Refuge"), and is typically covered by rough Holocene basalt, with limited human access.

Figure 2. *Ariqa Cave (Tawk et al., 2009), central Shihan-Haran system. Photo courtesy Fadi Nader.*

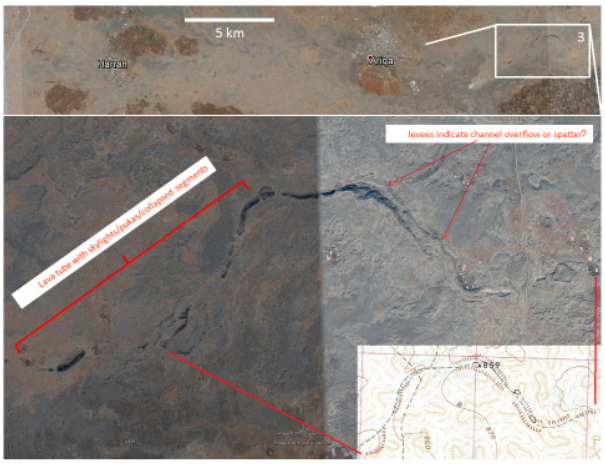

Figure 3. *Eastern portion of Shihan-Haran lava tube system, segmented lava tube trough is evident on Google Earth imagery and topographic map. Inferred levees indicate channel overflow or spatter (?).*

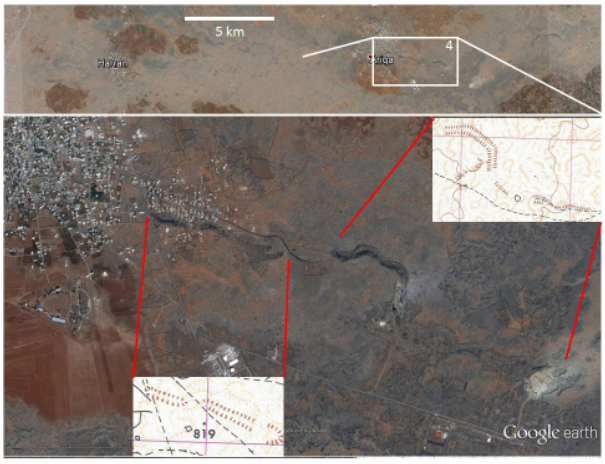

Figure 4. *East-central Shihan-Haran system, with Ariqa village (left).*

Results and discussion

The lava tube system is identified by its remotely sensed collapsed segments, forming an elongated line of troughs. These troughs are either unroofed lava tubes, or open lava channels, inferred by apparent lava levees (Fig. 3). The relief of the channels is emphasized by the typical shade of its southern wall (Figures 3-6). In addition, the channel/collapsed segments act as sediment traps, which become natural 'flowerpots' supporting denser vegetation, compared with the surrounding rocky lava. Some topographic troughs of the lava tube system are large enough to be indicated on 1:50,000 topographic maps. A corroboration for the existence of an uncollapsed lava tube segment is given by the 562 m surveyed cave (Tawk et al., 2009). Topographic maps, based on photogrammetry, show clear trenches, which are segments of collapsed lave tubes/channels. In addition to Ariqa Cave, two unexplored lava tube caves are indicated on topographic maps east of Ariqa village: Meg'arat Hamid and Meg'arat a-Shatab. Several segments of the lava tube system are observed on Google Earth imagery but not on topographic maps (Fig. 7). All these attributes are aligned along the inferred trace of the long lava tube system.

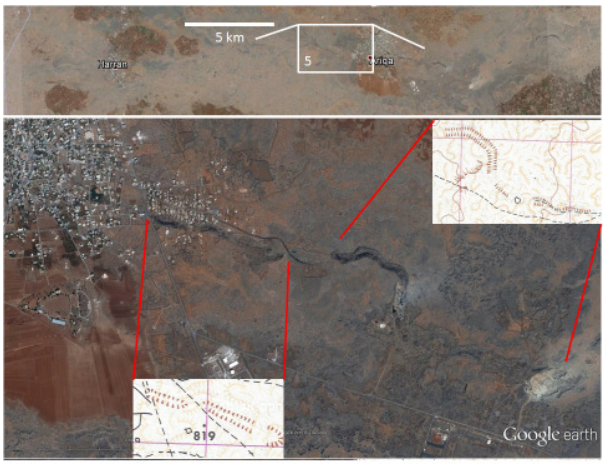

Figure 5. *Central Shihan-Haran system. Ariqa cave map is projected (after Tawk et al. 2009) in Ariqa village (right).*

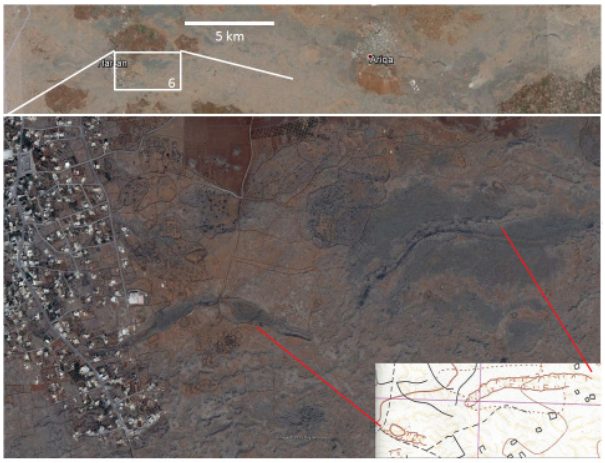

Figure 6. *West-central Shihan-Haran system, with Haran village (left).*

Conclusion

The lava tube segments are compiled and reconstructed from the remote sensing, topographic maps and cave survey data (Fig. 8). The inferred system is 20.5 km long, descending westward from 890 to 650 masl, with

a mean gradient of 1.2% (Fig. 9). It spans most length of the β_5Q_4 pahoehoe lava field that flowed westward from Tel Shihan region (Ponikarov 1963, 1967; Razvalyaev, 1966), shedding light on the lava emplacement mechanism.

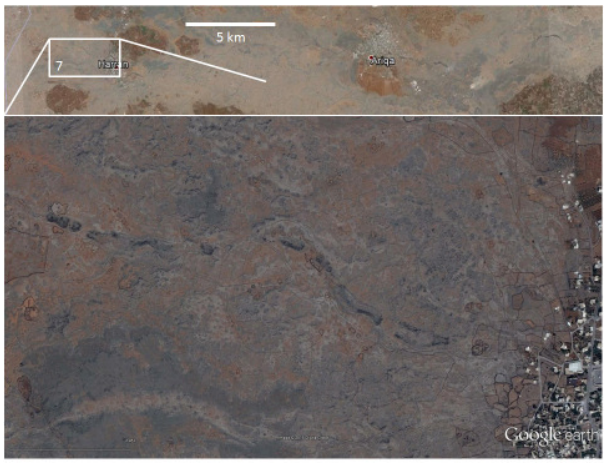

Figure 7. *Western part of Shihan-Haran system, with Haran village (right). The lava tube trough is observed on Google Earth imagery (from village center to NNW) but not on topographic maps, indicating shallow relief.*

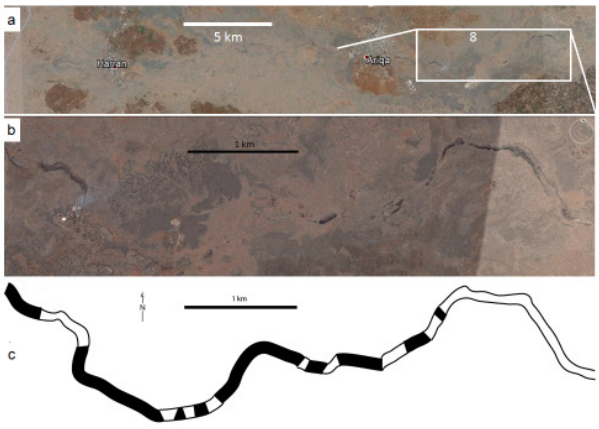

Figure 8. *Example of lava tube trace reconstruction. (a)Location on Google Earth imagery of the lava flow. (b) Enlarged Google Earth imagery of the segment of Shihan-Haran system. (c) Schematic map reconstruction. Inferred uncollapsed tubes in black, and channel/collapsed segments in white. Width is exaggerated.*

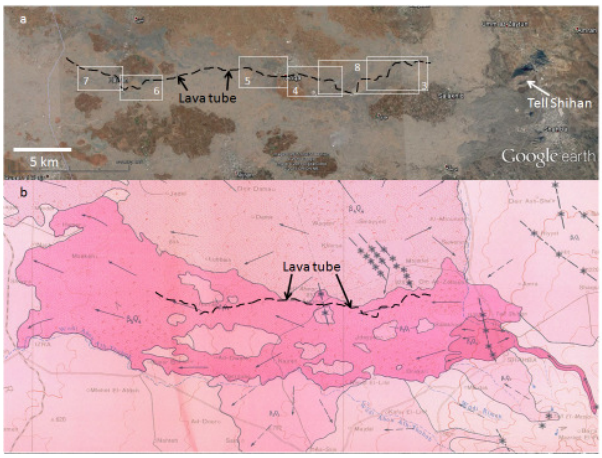

Figure 9. *The β_5Q_4 pahoehoe lava that flowed westward from Tel Shihan region (right) along the 20.5 km long Shihan-Haran system. Black dashed line indicates the reconstructed lava tube. (a) On Google Earth imagery. (b) On geological map (after* Ponikarov 1963, 1967; Razvalyaev 1966).

Acknowledgements

William Halliday invoked the idea to look for this lava tube. Fadi Nader has kindly allowed to use his photograph from inside Ariqa Cave.

References

Dubertret L, Dunand M. 1954-1955. Les gisements ossiferes de Khirbet El-Umbachi et de Hebariye (Safa). Annuel Archeologique de Syrie IV-V: 59-76.

Frumkin A, Bar-Matthews M, Vaks A. 2008. Paleoenvironment of Jawa basalt plateau, Jordan, inferred from calcite speleothems from a lava tube, Quaternary Research, 70: 358-367.

Kempe S, Al-Malabeh A, Frehat M, Henschel H-V. 2006. State of Lava Cave Research in Jordan. Association for Mexican Cave Studies *Bulletin 19*.

Léveillé RJ, Saugata D. 2010. Lava tubes and basaltic caves as astrobiological targets on Earth and Mars: a review. Planetary and Space Science 58(4): 592-598.

Ponikarov VP. 1966. The geology of Syria: Geological Map of Syria and Explanatory Notes, scale 1:200 000. Ministry of Industry, Syrian Arab Republic.

Ponikarov VP. 1967. The geology of Syria: Geological Map of Syria and Explanatory Notes, scale 1:500 000.

Part I: Stratigraphy, Igneous Rocks and Tectonics. Ministry of Industry, Syrian Arab Republic.

Razvalyaev AV. 1966. The geological map of Syria, 1:200,000, sheets1-37-VII, 1-36-XII, explanatory notes. Ministry of Industry, Syrian Arab Republic, Damascus.

Tawk JW, Nader FH, Karkabi S, Jad W. 2009. As-Suwayda lava caves (southern Syria): speleological study combining geology and history. In: White WB, editor. Proceedings of the 15th International Congress of Speleology. International Union of Speleology, July 19-26; Kerrville, Texas, p. 724-729.

Haruyama J, Hioki K, Shirao M, Morota T, Hiesinger H, van der Bogert CH, Pieters CM. 2009. Possible lunar lava tube skylight observed by SELENE cameras. Geophysical Research Letters, 36 (21).