Kanton Zürich
Baudirektion
ARE, Archäologie und Denkmalpflege

Spurensuche im Wald

Einsatz der LiDAR-Daten in der Kantonsarchäologie Zürich

Ulla Wingenfelder



Swiss LiDAR Day, 10.11.2026

Archäologische Sensation

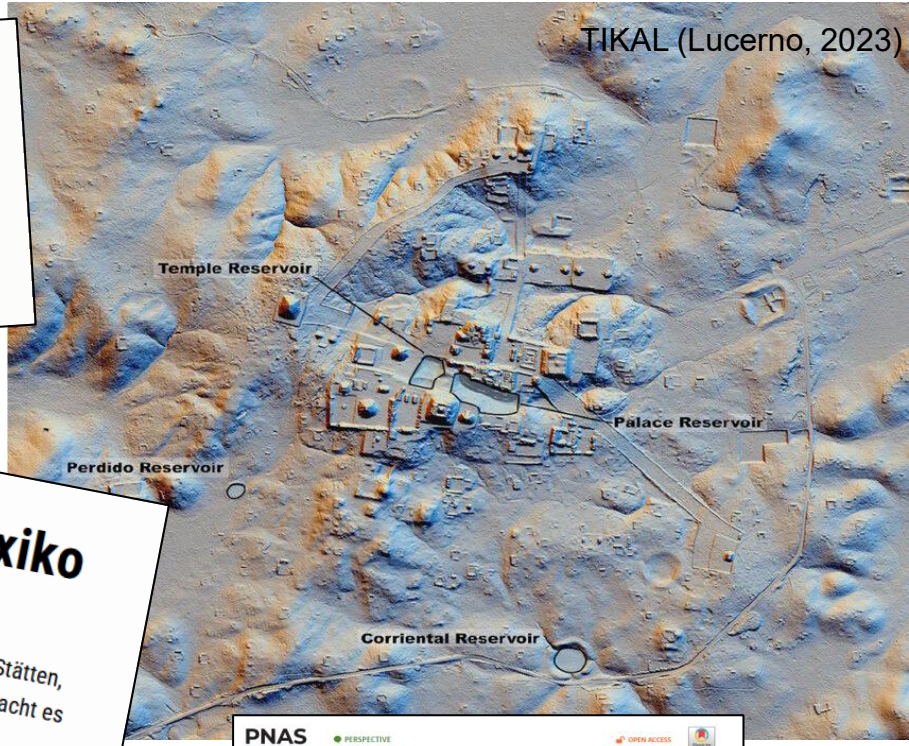
Zufallsfund im mexikanischen Dschungel: Ruinen einer Maya-Stadt

Eine US-Universität hat in Mexiko einen überraschenden Fund gemacht: Eine Stadt, von der man bisher nichts wusste.

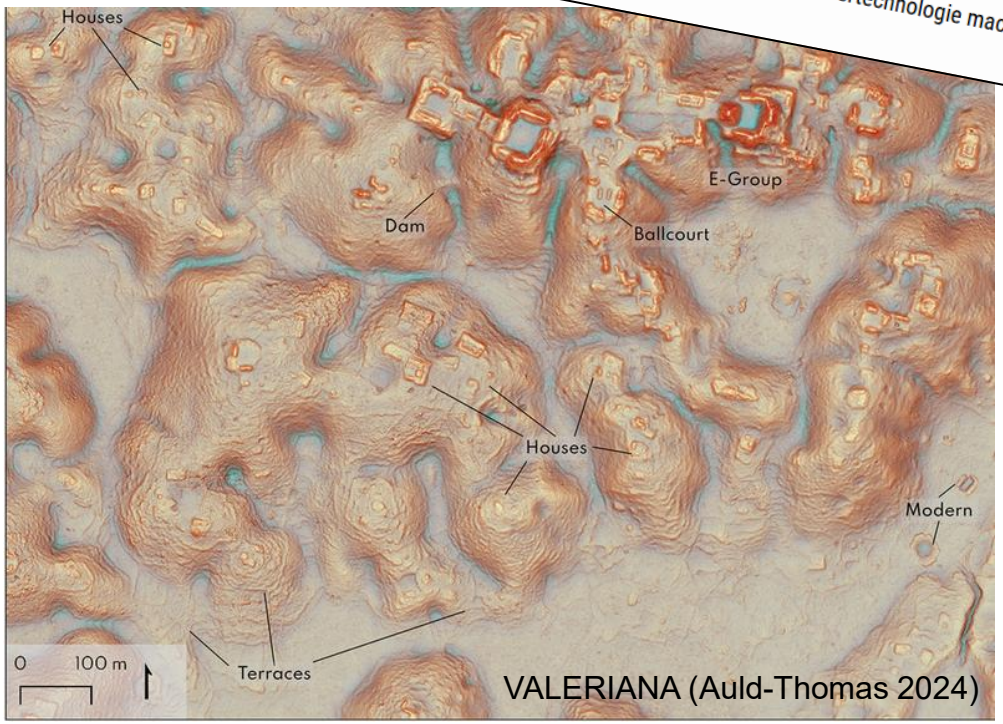
LIDAR-SCANS

Hunderte Mayastätten in Mexiko entdeckt

Unter dem dichten Wald Mexikos schlummern hunderte archäologische Stätten, die Archäologen nun auf Scans entdeckt haben. Eine Lasertechnologie macht es möglich.



TIKAL (Lucerno, 2023)



VALERIANA (Auld-Thomas 2024)



PNAS · PERSPECTIVE · OPEN ACCESS

Ancient Maya reservoirs, constructed wetlands, and future water needs

Lisa J. Lucero[a,1]

Edited by Linda Manzanilla, Universidad Nacional Autónoma de México, Mexico City, Mexico; received May 28, 2023; accepted August 22, 2023

The Classic Maya (c. 250 to 900 CE) in the tropical southern lowlands of Central America dealt with water scarcity during annual dry seasons and periods of climate instability via sophisticated urban reservoir systems they relied on for over a thousand years. Surface water is limited because typically rain percolates through the karstic terrain. I posit that Maya reservoirs functioned as do constructed wetlands (CWs) at present. Still-water systems like CWs and Maya reservoirs can become stagnant and nonpotable due to the build-up of nutrients that promote algal growth. Stagnant waters also serve as breeding grounds for mosquitoes that spread endemic diseases. CWs keep water clean via certain aquatic plants since all plants uptake nutrients (e.g., nitrogen, phosphorus) and decomposing plant matter supports microbial biofilms that break down nutrients. CWs also support diverse zooplankton that prey on pathogens and bacteria that assist to denitrify water. CWs do not require the use of chemicals or fossil fuels and after the initial labor-intensive output become self-cleaning and self-sufficient with some maintenance. I posit that the Maya used a diverse array of aquatic plants and other biota to keep water clean in the same manner as do CWs, which I demonstrate using evidence from excavations and settlement maps, sediment cores and current wetlands, and the iconographic and hieroglyphic records. The next step is to combine what we know about ancient Maya reservoirs in conjunction with what is currently known about CWs to better address future water needs.

Maya reservoirs | constructed wetlands | potable water

Ancient rainfall-dependent tropical societies dealt with water scarcity during annual dry seasons and unexpected periods of climate instability by harvesting rainwater via sophisticated reservoir systems as seen at the Khmer capital of Angkor in Cambodia (9th to 16th CE century), the Sinhalese capital of Anuradhapura in Sri Lanka (4th BCE to 11th CE century), and major Maya cities in Central America (3rd to 10th CE century) (1). The question is, how did people in the past maintain water quality? For the ancestral Maya, I posit that their reservoirs functioned as constructed wetlands (CWs) (e.g., free water surface) (2, pp. 5 to 6, 3) that "use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality" (https://www.epa.gov/wetlands/constructed-wetlands). If this were the case, they can serve as archetypes for natural, sustainable water systems to address future water needs.

The hundreds of ancient Maya cities in the interior southern lowlands in southeastern Mexico, northern Guatemala, Belize, and western Honduras (Fig. 1) all have water management features, especially reservoirs, on which the Maya relied for over a thousand years until c. 900 CE. While I focus on southern lowland urban reservoirs, I include examples from the northern lowlands for comparative purposes (Mexican states of Yucatán and most of Campeche and Quintana Roo). As Table 1 shows, in general, the southern lowlands have higher elevations, better agricultural soils, a deeper and less accessible water table, and higher annual rainfall (4, 5, Table 2.1, 6, figure 2, 7, pp. 23 to 25, 8–11). Their regional differences resulted in distinctive, albeit intersecting, histories (12). The Maya abandoned cities in the southern lowlands by 900 CE while several cities in the northern lowlands witnessed an influx of people and a florescence (e.g., Chichén Itzá) that lasted centuries (some until the arrival of the Spanish in 1511) (13, 14). Vital for Maya in both regions was the need to capture rainfall, especially to provide clean drinking water that lasted through the long dry season.

Understanding how reservoirs supplied potable water for millions of Maya in the Classic period (c. 250 to 900 CE) is crucial because still-water systems, like Maya reservoirs and CWs, if not maintained correctly, can become stagnant and nonpotable due to the build-up of nutrients like nitrogen and phosphorus that promote algal growth (eutrophication) (15). At present, stagnant waters serve as prime breeding grounds for mosquitoes that spread malaria, yellow fever, West Nile virus, and dengue (16). Prior to the arrival of the Spanish in the late 15th century, mosquitoes in the Americas did not carry diseases (17, pp. 145 to 146).* In the tropics, seasonal temperature changes are not extreme enough to kill off most pests. Clean drinking water has always been a concern in the hot and humid tropics where c. 43% of the world's current population resides (18, p. 13). The tropical belt covers c. 40% of the earth's surface and will likely expand due to global climate change (19). People need to drink more water (2 to 3 L per day) than those living in temperate areas (20, p. 1).

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Author contributions: L.J.L. designed research; performed research; and wrote the paper.

The author declares no competing interest.

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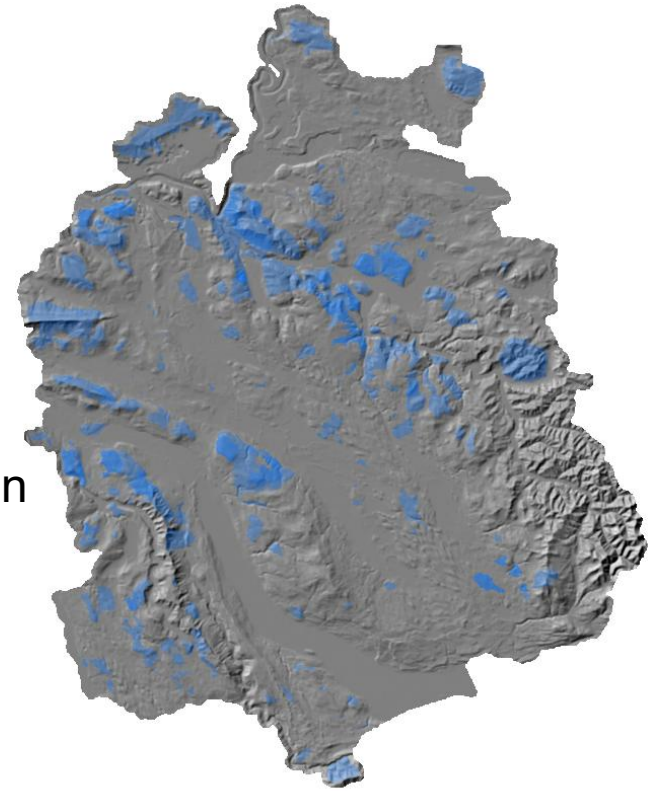
[1]Email: ljlucero@illinois.edu.

Published October 9, 2023.

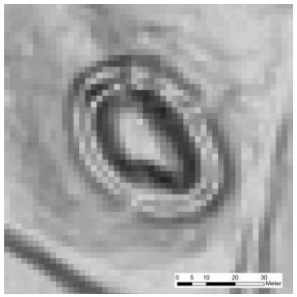
*Native Americans, however, depending on where they lived, still suffered from amoebic dysentery, chagas, leishmaniasis, treponemiasis, tuberculosis, pertussis, giardia, rabies, tularemia, herpes, hepatitis, and poliomyelitis (88, 89).

LiDAR in der Kantonsarchäologie Zürich

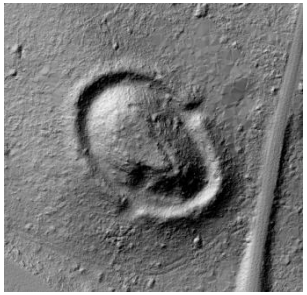
- seit 2008: projektbezogene Anwendung
- 2014: erste flächendeckende LiDAR-Daten im Kanton Zürich verfügbar
- Seit 2015: Intensivierung LiDAR-Auswertungen (bessere Verfügbarkeit und Auflösung)
  - Erarbeitung einer Kartiersystematik und Testen verschiedener Visualisierungstechniken
  - Inzwischen über 100 Kartierprojekte



LiDAR-Projekte
bis Ende 2025



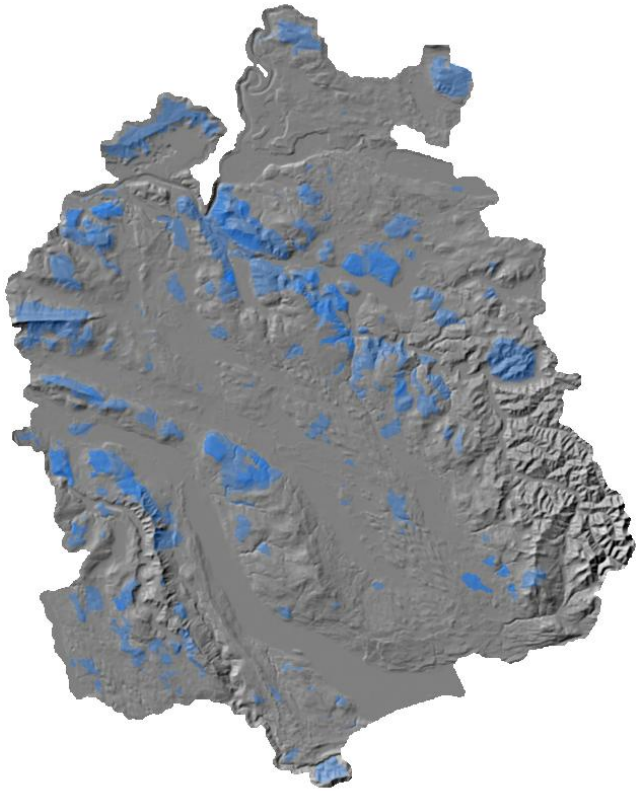
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ZH 2022

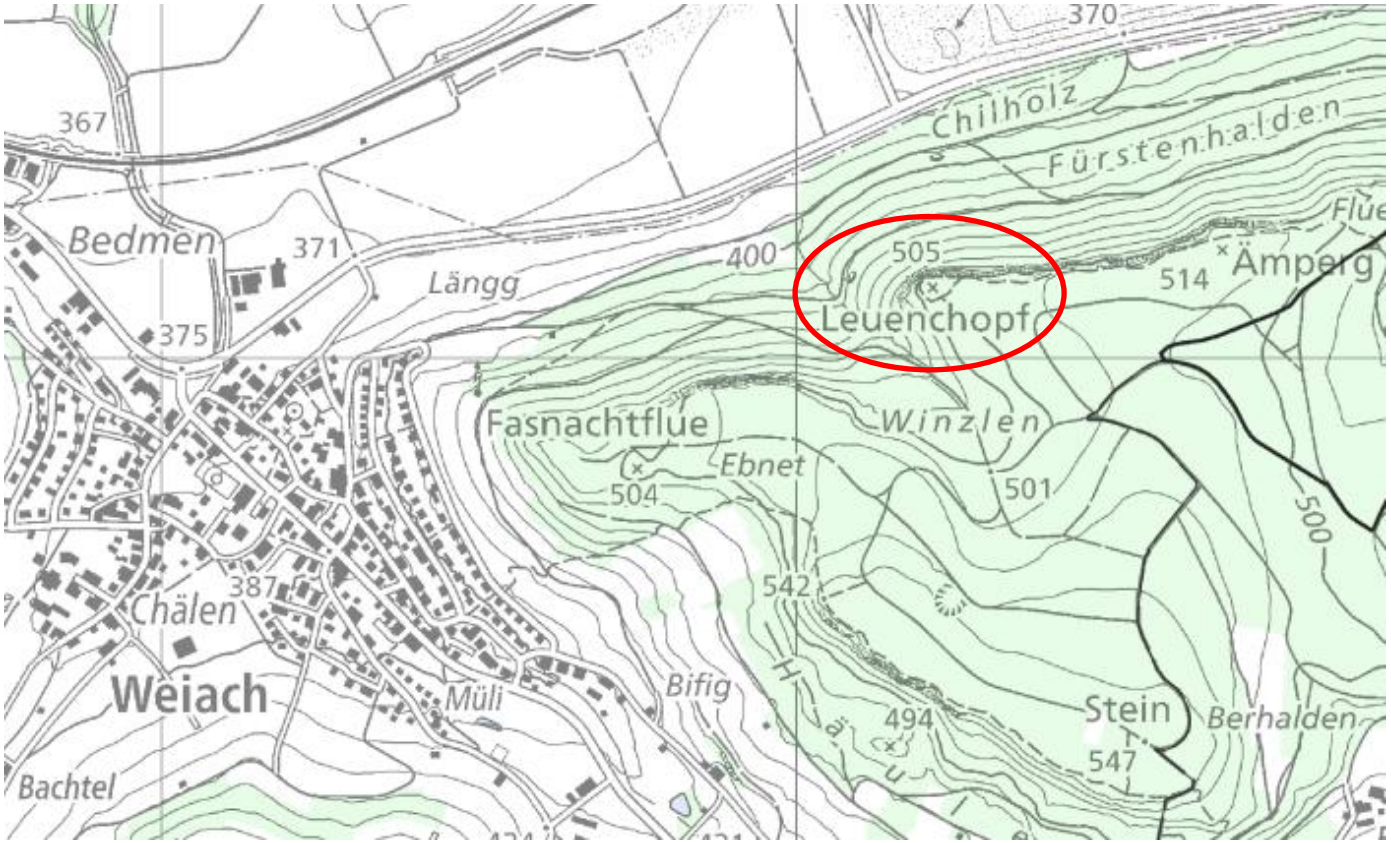
LiDAR in der Kantonsarchäologie Zürich

- **Projektbezogene Prospektion**
  (z.B. im Umfeld von Funden durch ehrenamtliche Detektorgänger
- **Dokumentation/ Fundstelleninventarisierung**
  (z.B. Überprüfung der Perimeter archäologischer Zonen)
- **Schutz/ Prävention**
  (z.B. Identifikation bisher unbekannter Fundstellen, Schutz vor unbeabsichtigter Zerstörung



LiDAR-Projekte
bis Ende 2025

«Rohdaten» und Visualisierungen

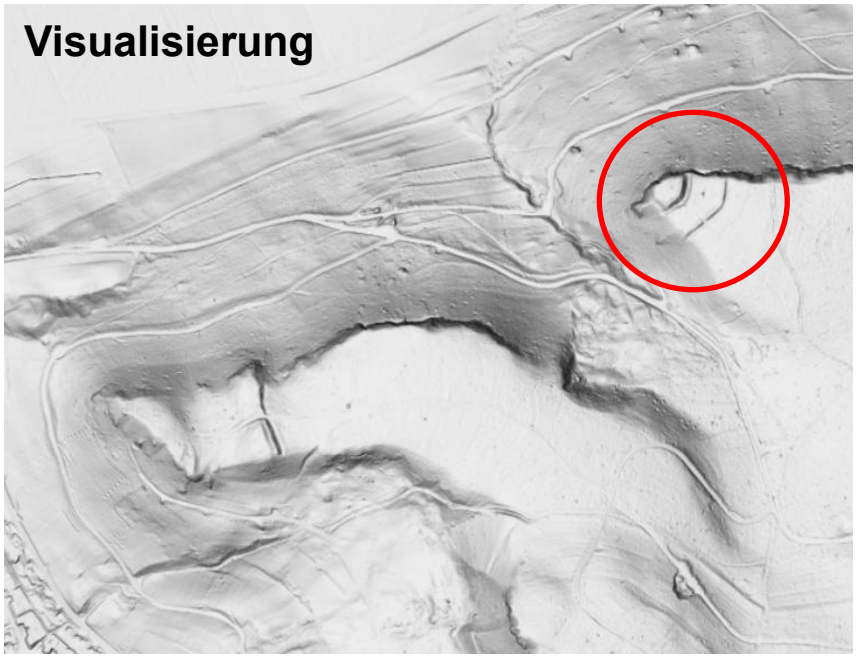


«Leuenkopf» bei Weiach ZH

«Rohdaten» und Visualisierungen

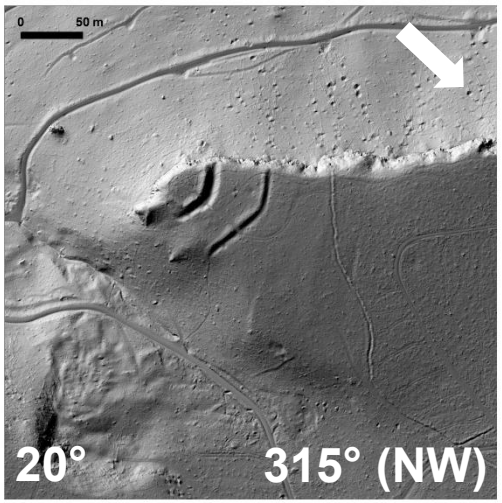


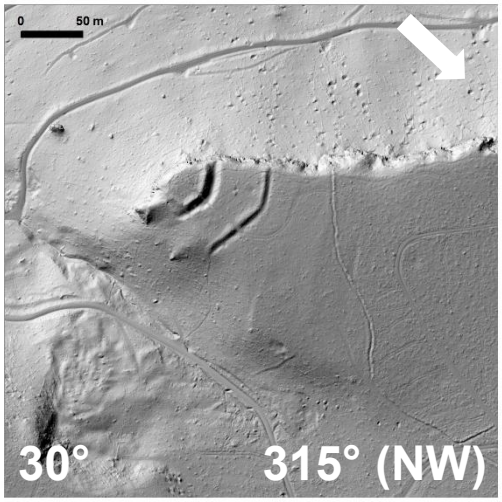
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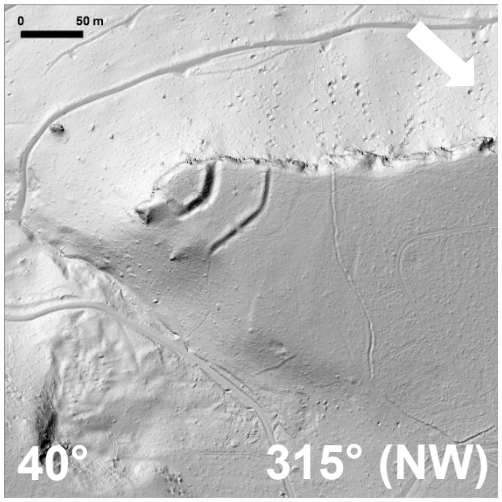


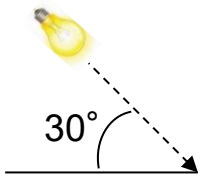
Multidirektionales Relief / Multihillshade

Visualisierungen: Hillshades



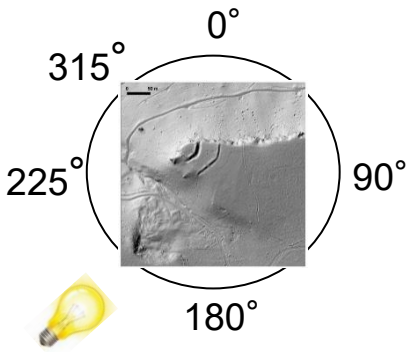




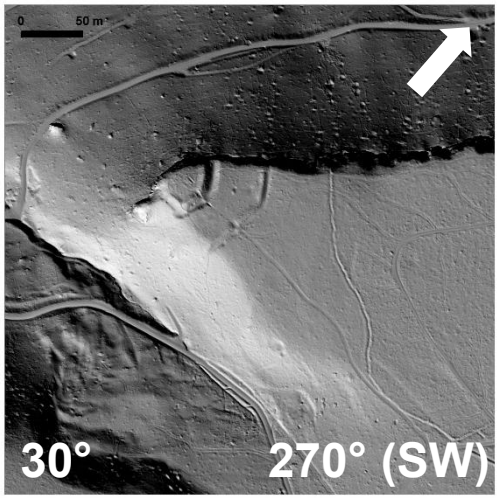


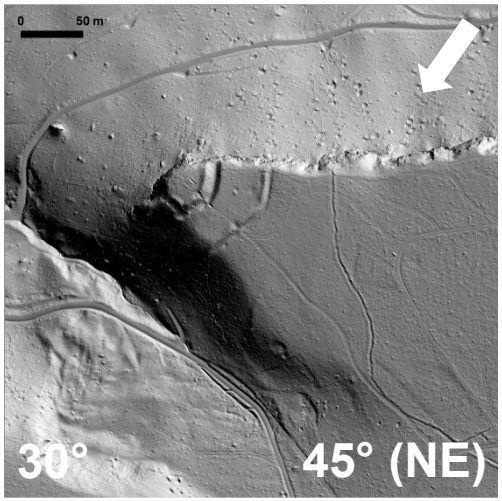
Verschiedene
Einfallswinkel

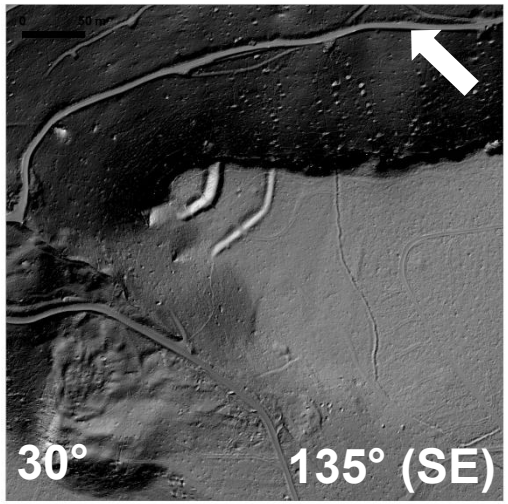
Visualisierungen: Hillshades



Verschiedene
Einfallsrichtungen

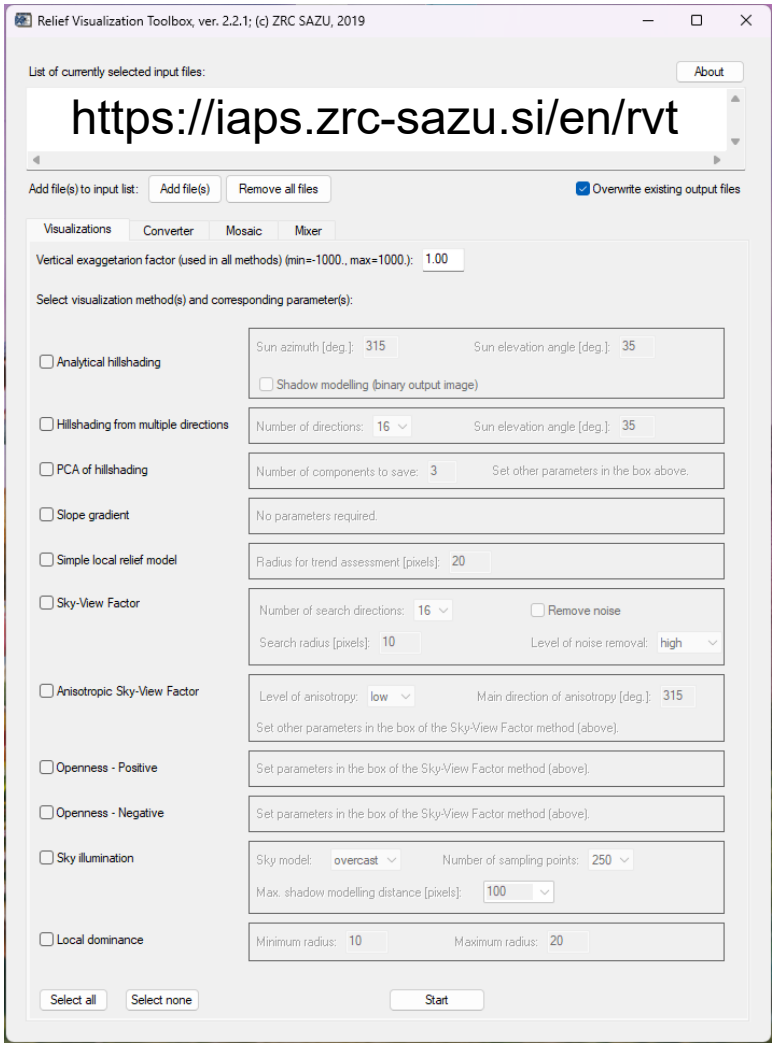






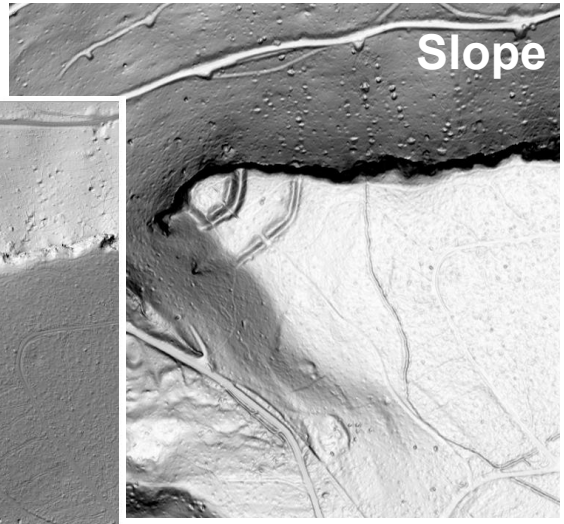
Weitere Visualisierungen

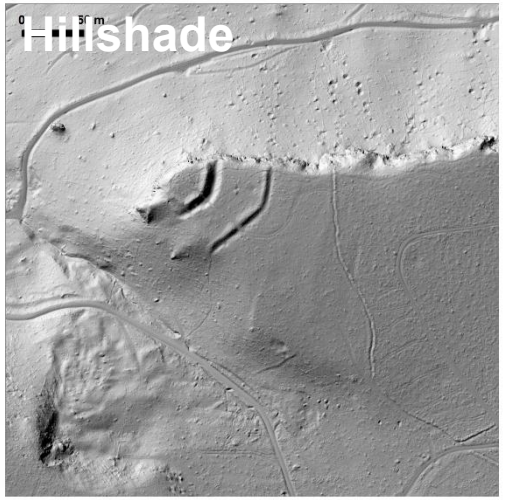


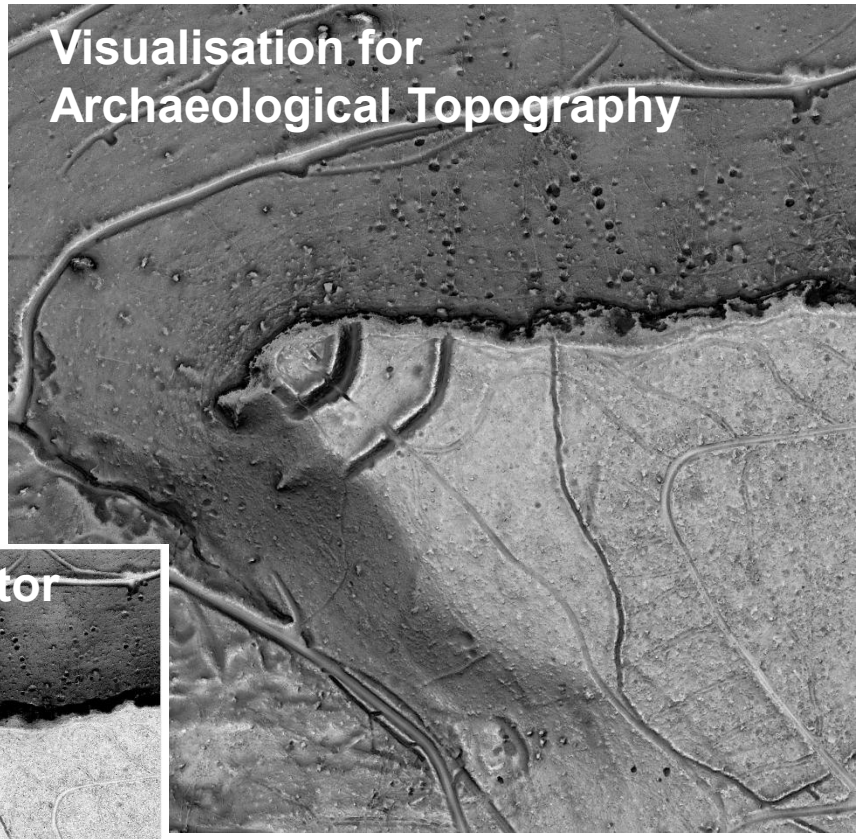


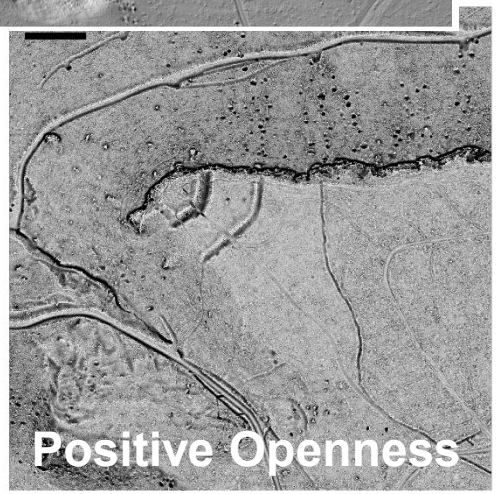
Software-Tool zur Visualisierung von Raster-Höhendaten

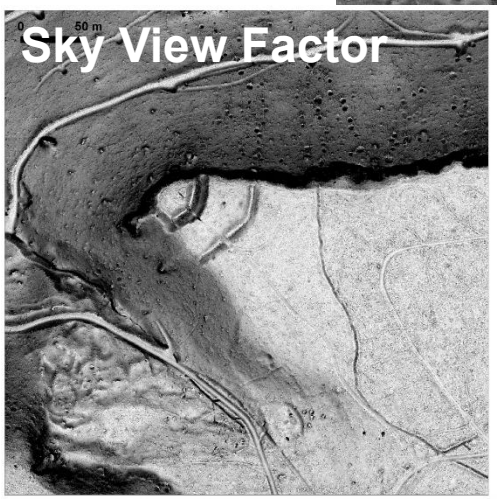
Weitere Visualisierungen





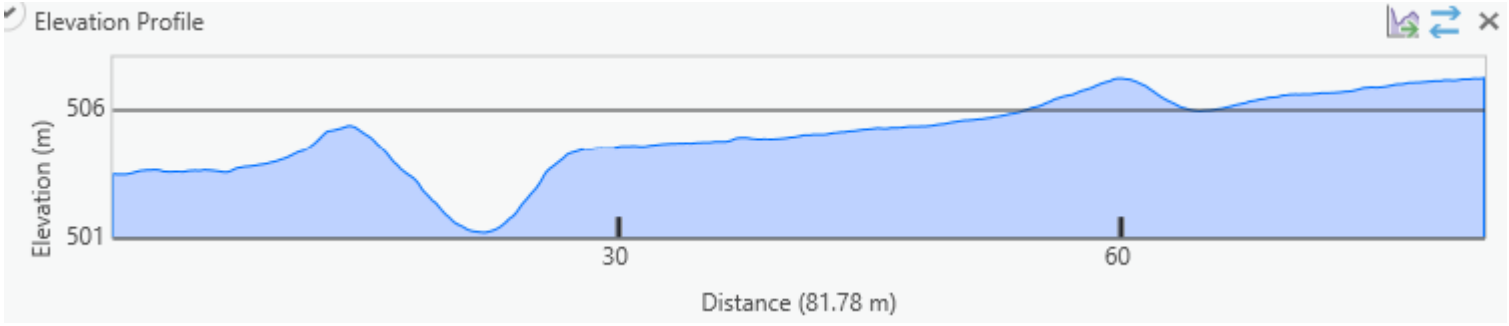






Profil





Interpretation der Strukturen

Wild-Karte ZH



Zehntenpläne

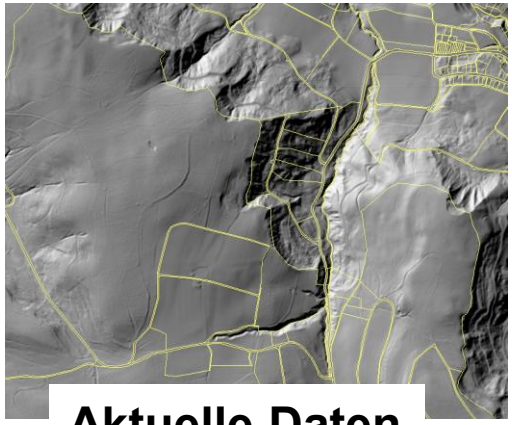


Historische Karten

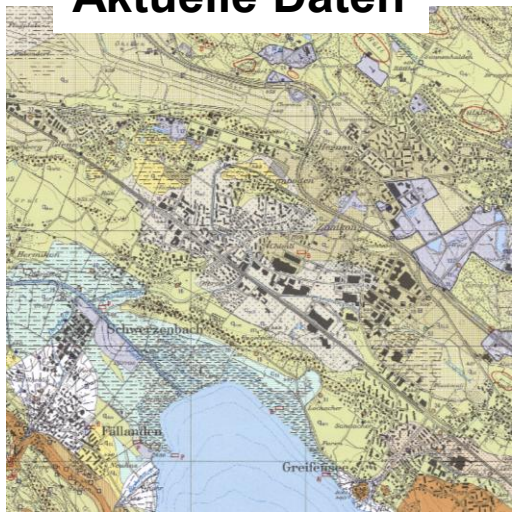


Wald-Pläne

Aktuelle Grenzen



Aktuelle Daten



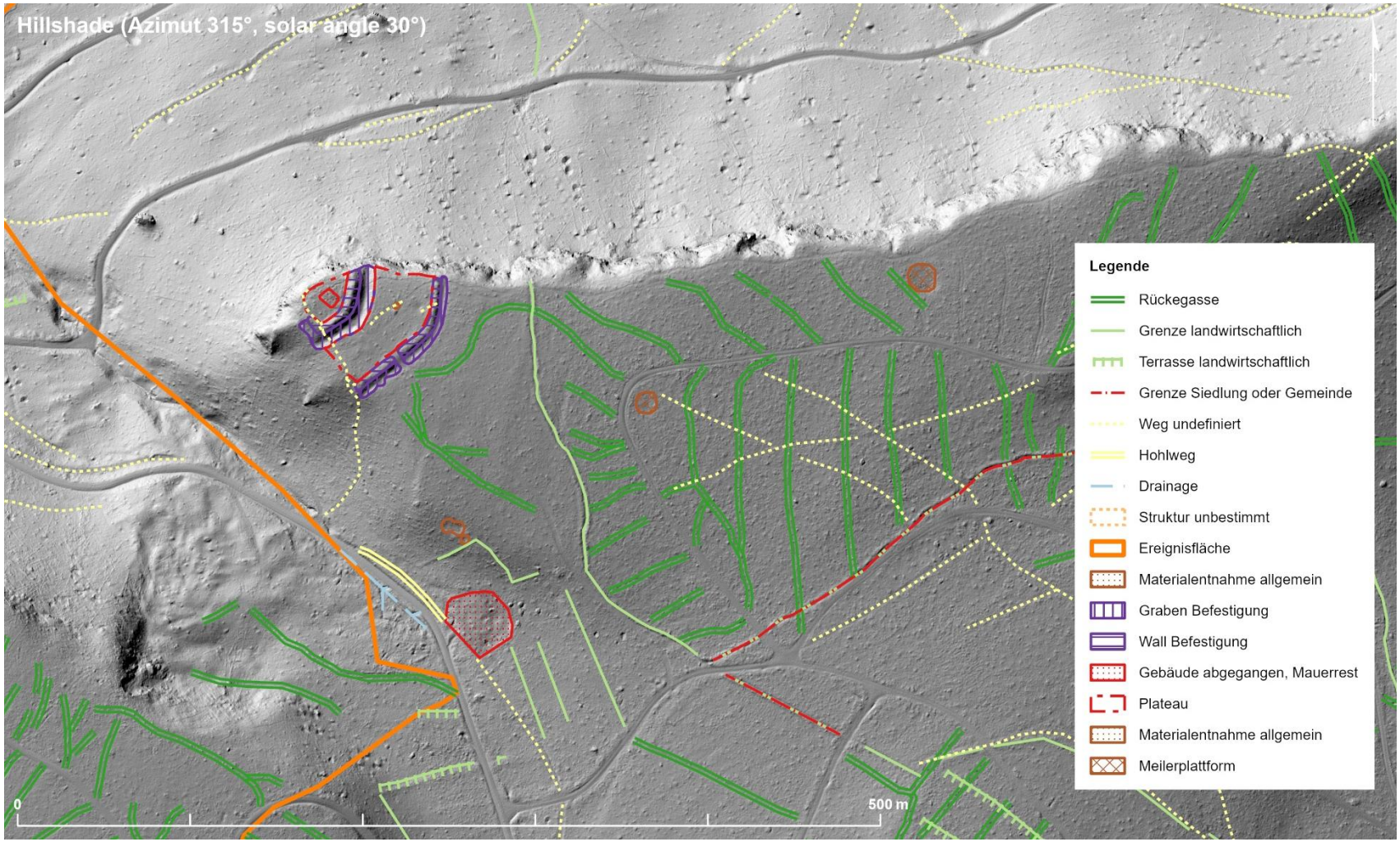
Geologie

map.geo.admin.ch, maps.zh.ch, Staatsarchiv Kt. ZH

Kartierung der Strukturen



Kartierung der Strukturen



«Ground truth»

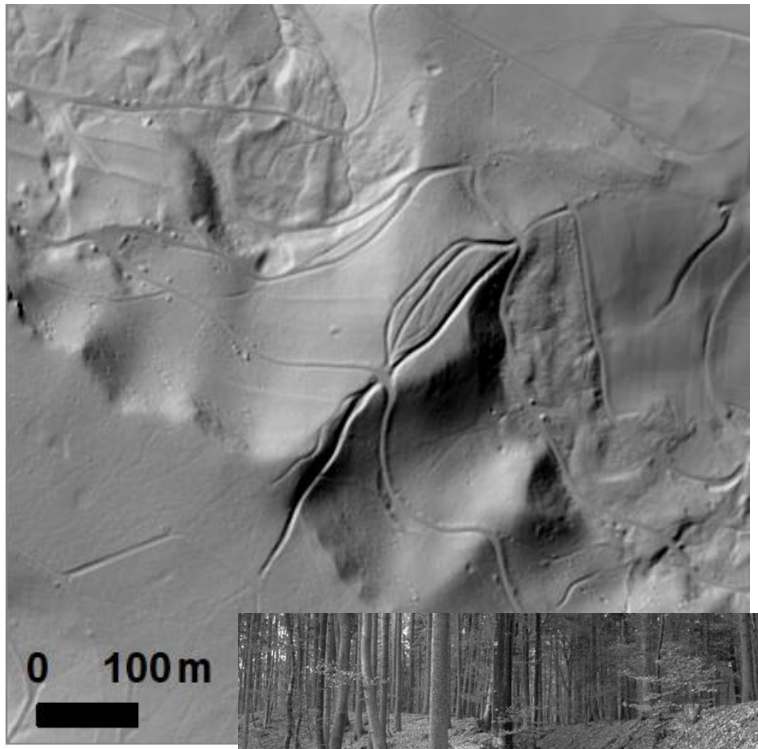
Ausgewählte Strukturen werden «vor Ort» im Gelände überprüft und fotografisch dokumentiert.



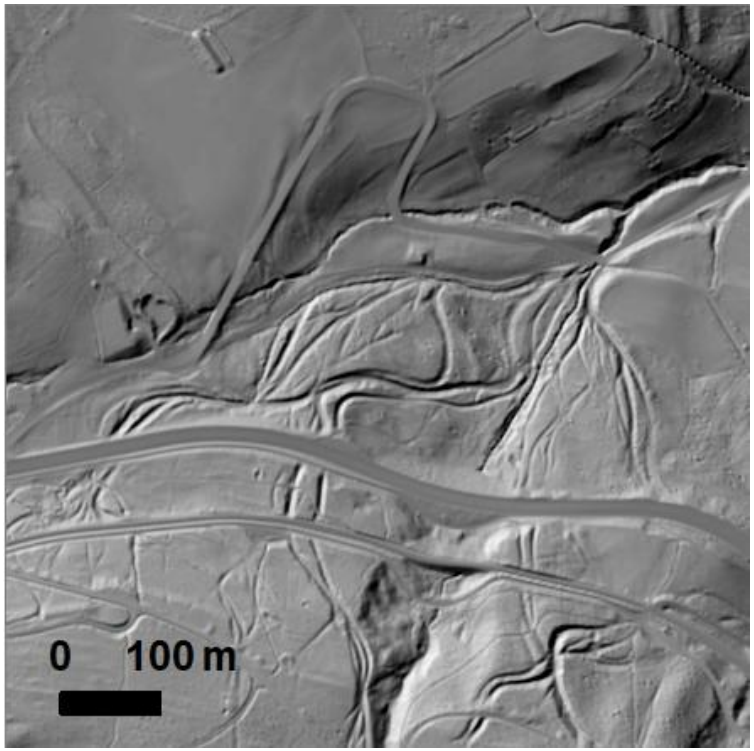


Spuren im Wald...

Stadlerberg



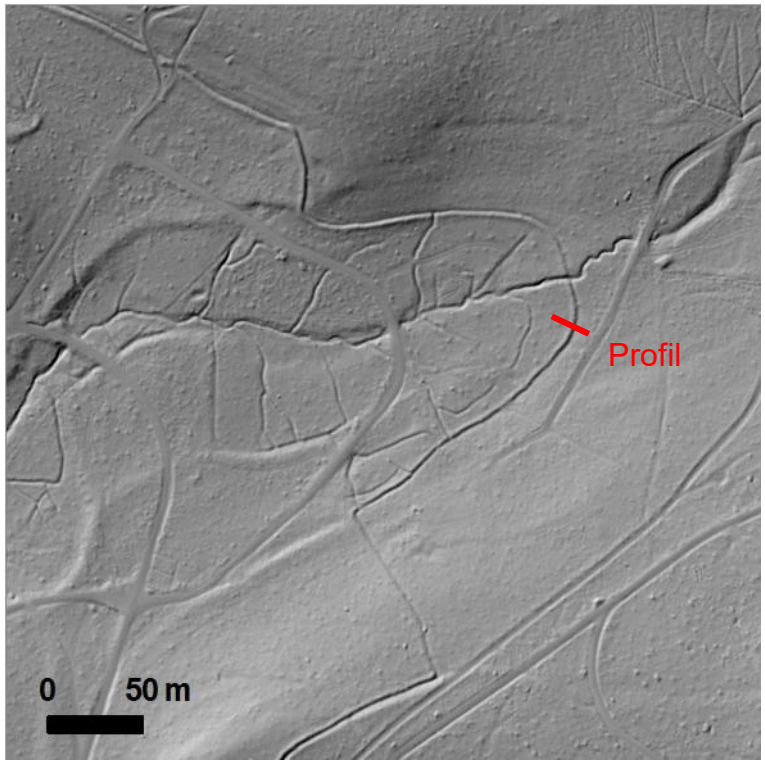
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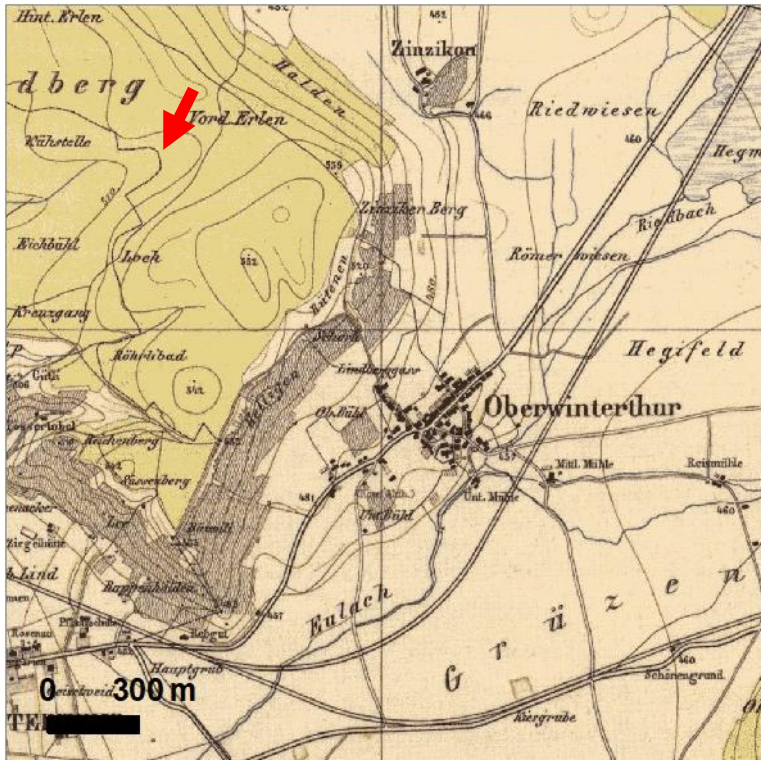
Hohlwege

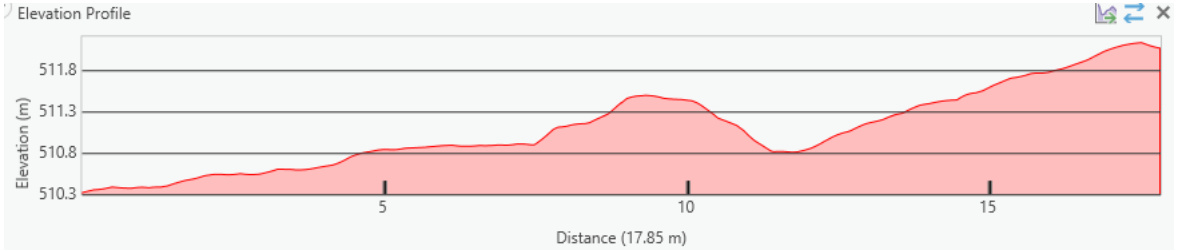
Spuren im Wald...

Winterthur



Wild-Karte 1850

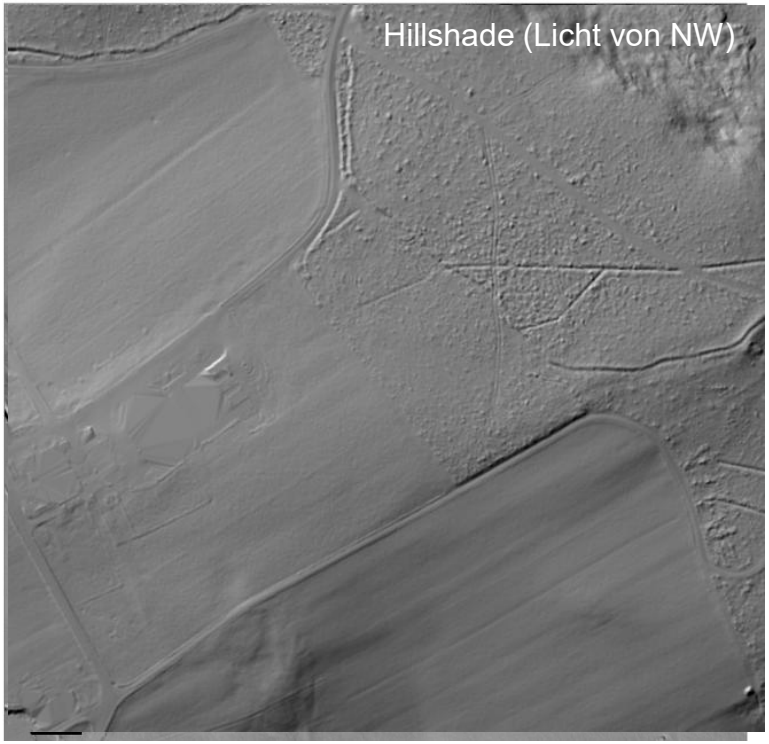




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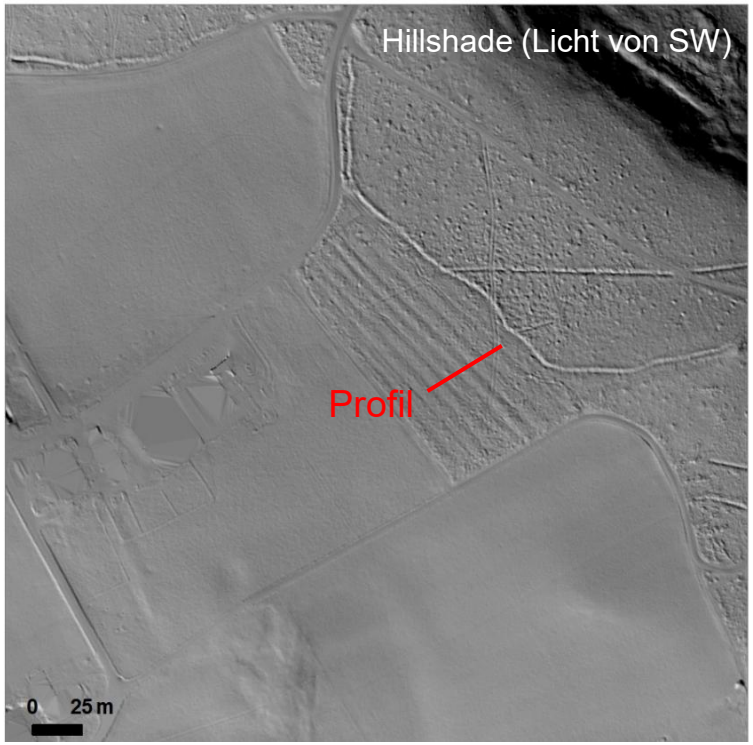
Spuren im Wald...

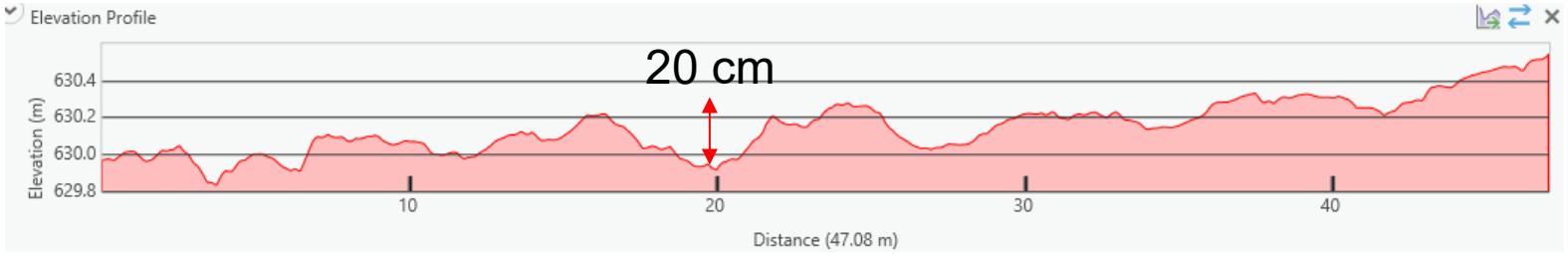
Aesch



Spuren im Wald...

Aesch

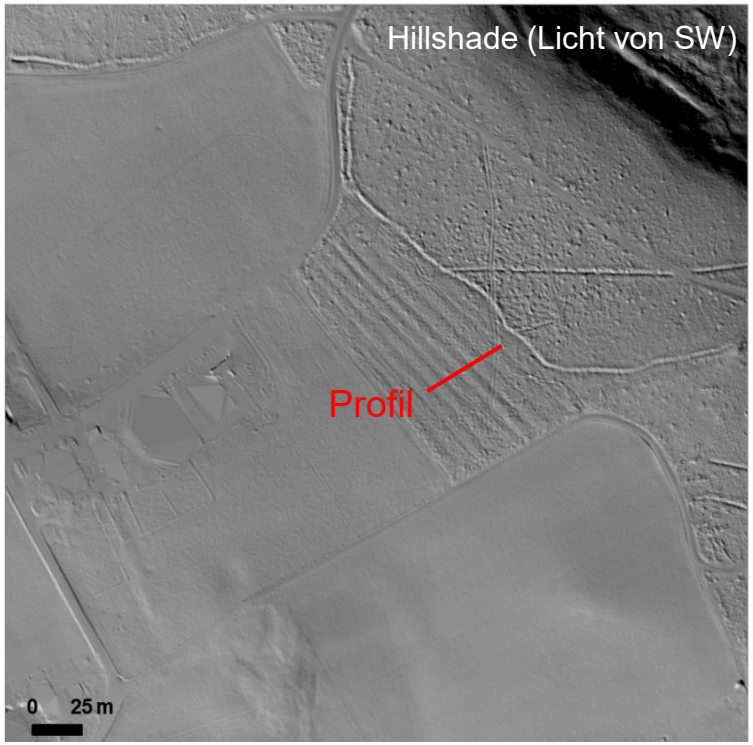




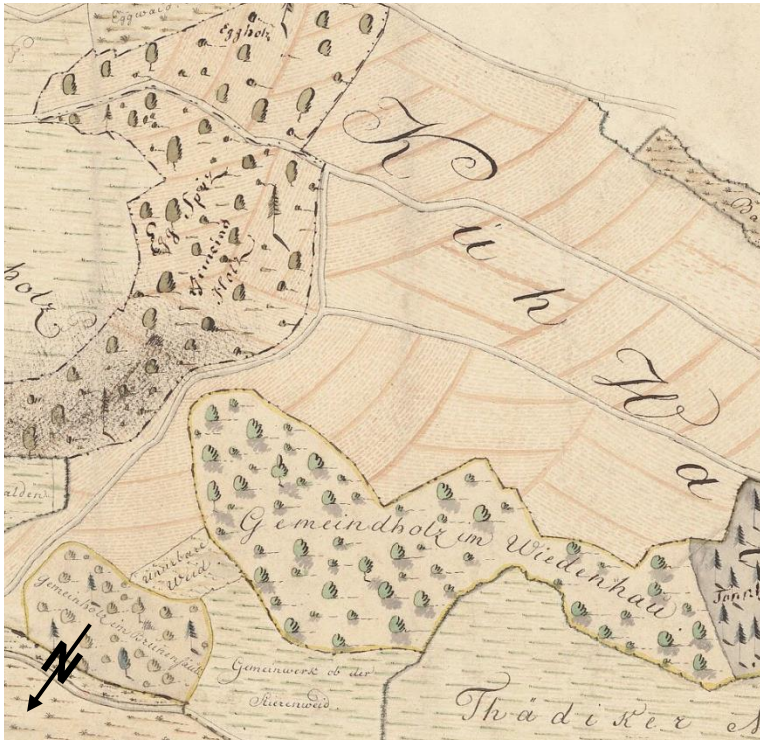
Wölbacker

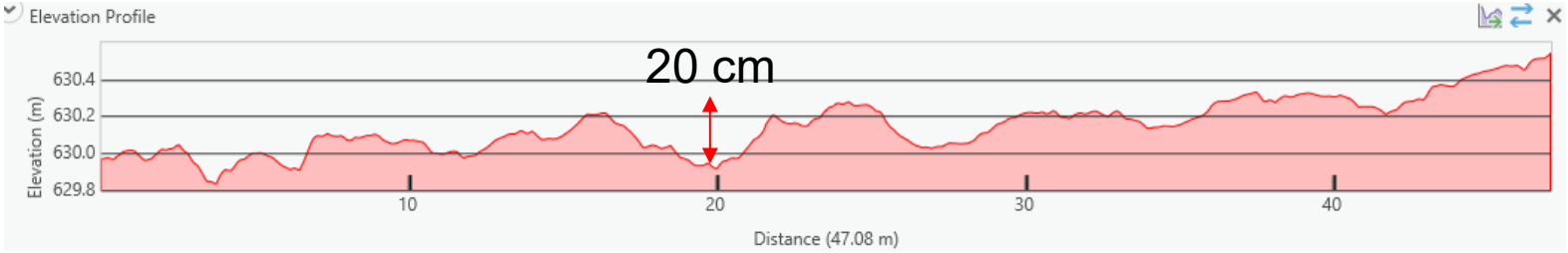
Spuren im Wald...

Aesch



Zehntenplan von 1800 (StAZH Plan Q2)

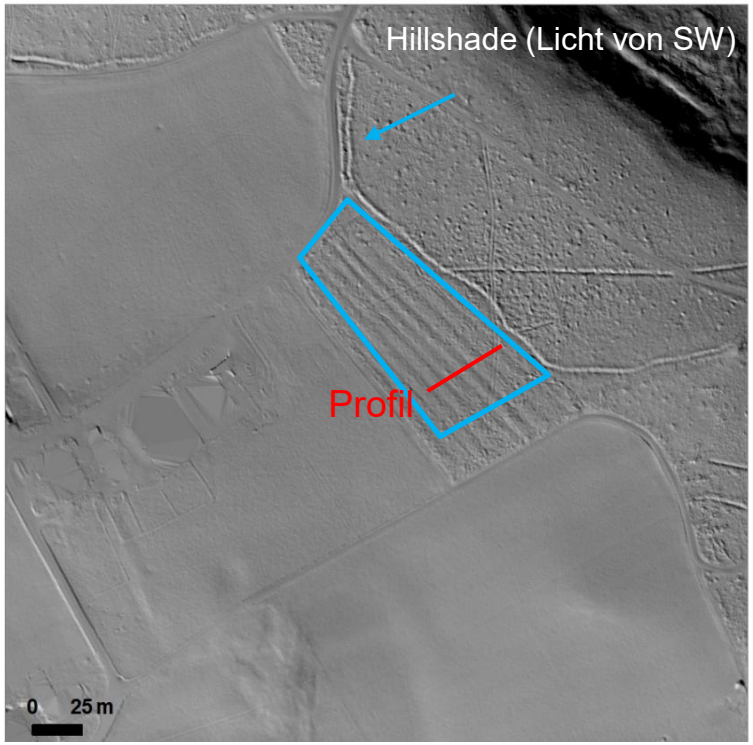




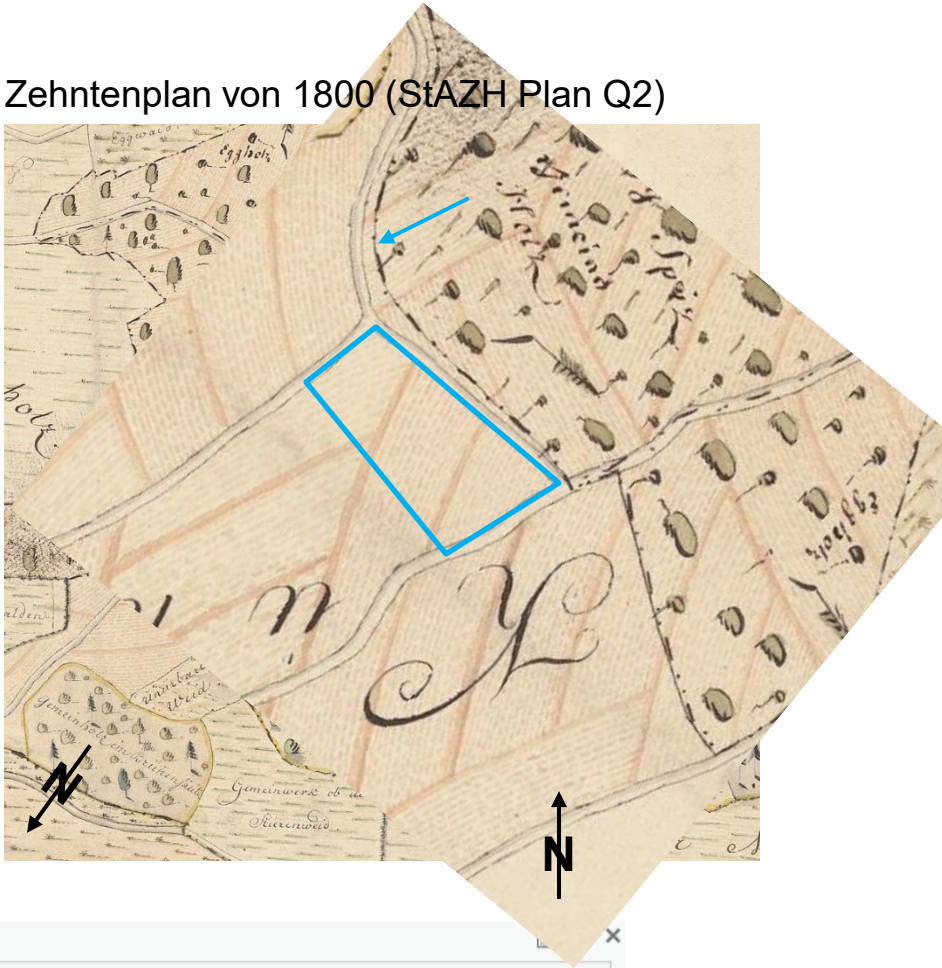
Wölbacker

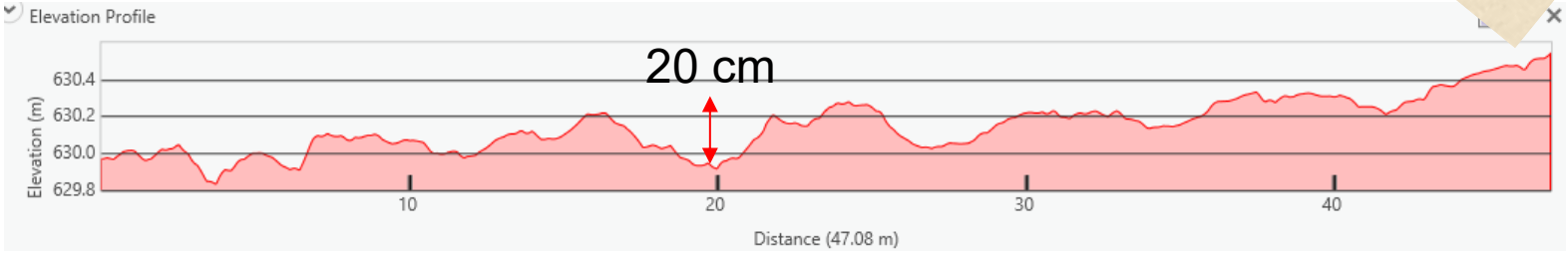
Spuren im Wald...

Aesch



Zehntenplan von 1800 (StAZH Plan Q2)

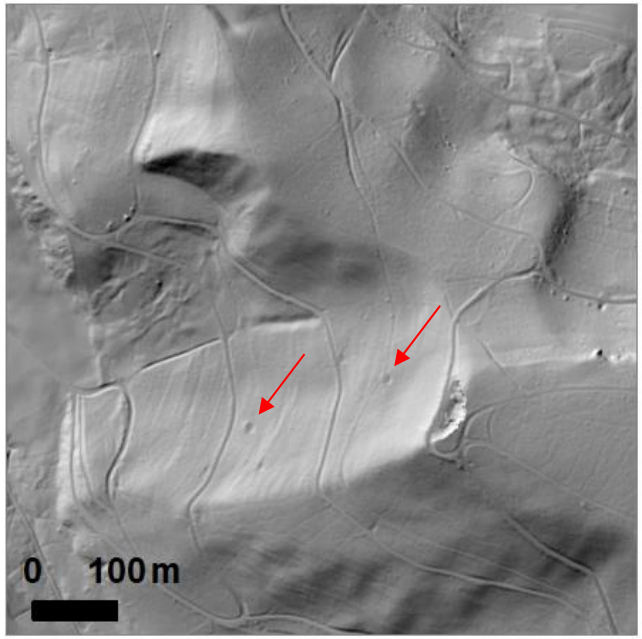




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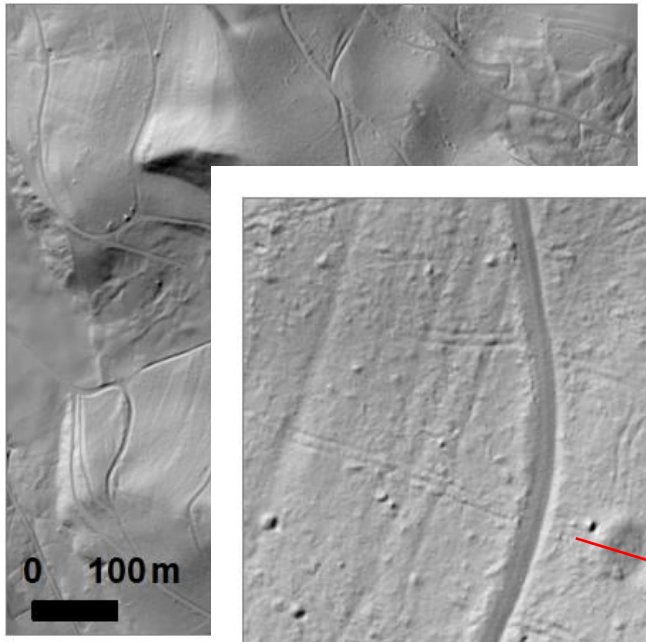
Spuren im Wald...

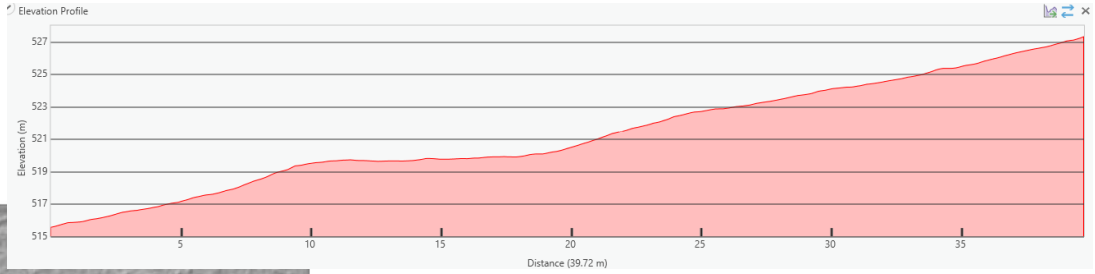
Stadlerberg

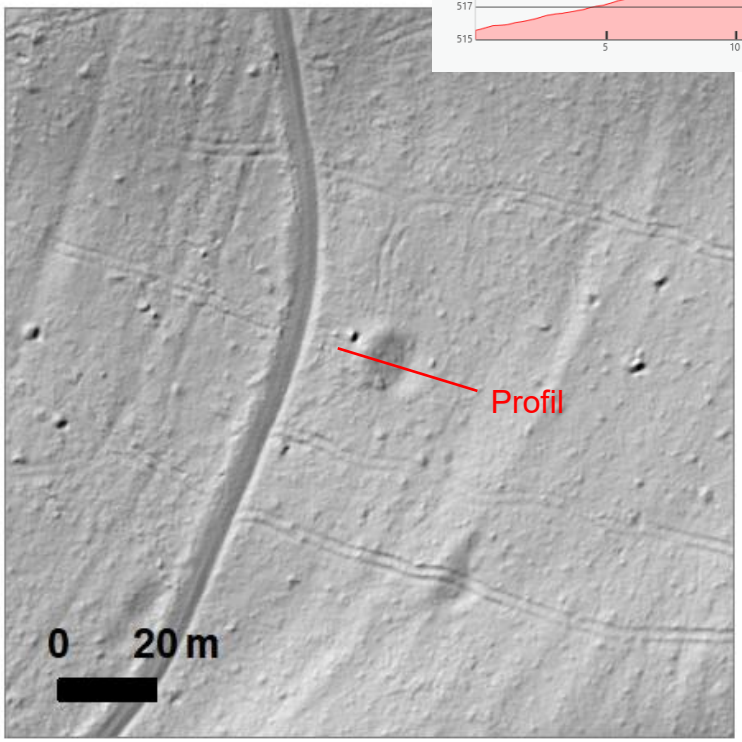


Spuren im Wald...

Stadlerberg

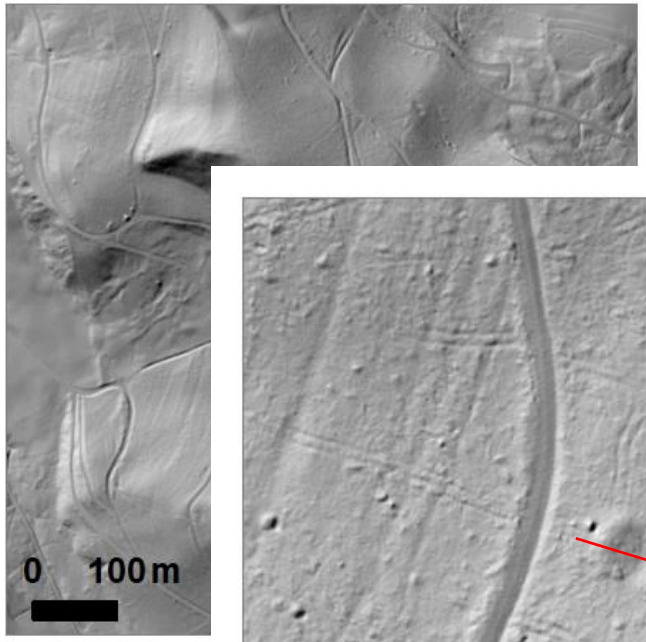


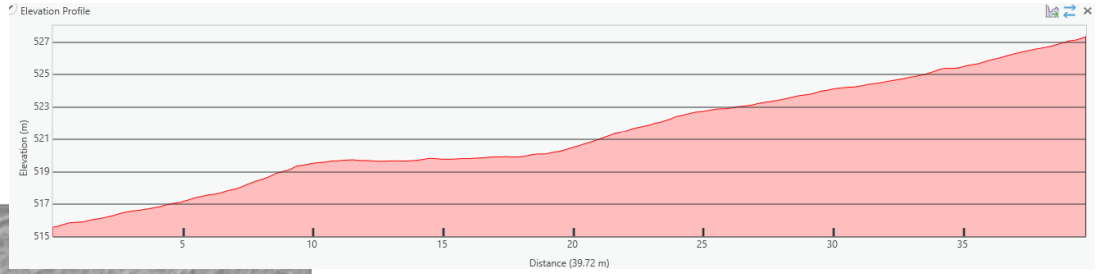


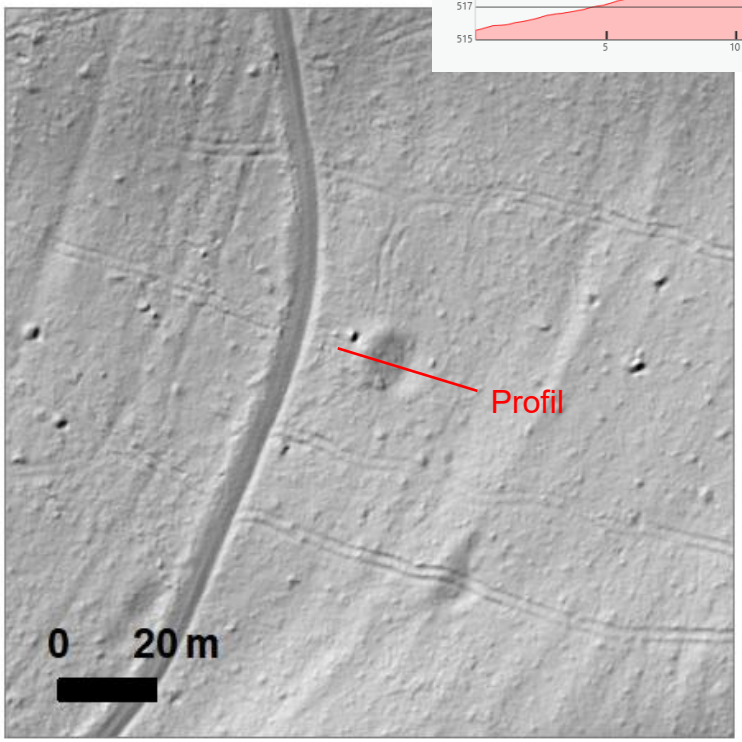


Spuren im Wald...

Stadlerberg







Meilerplattform



Spuren im Wald…

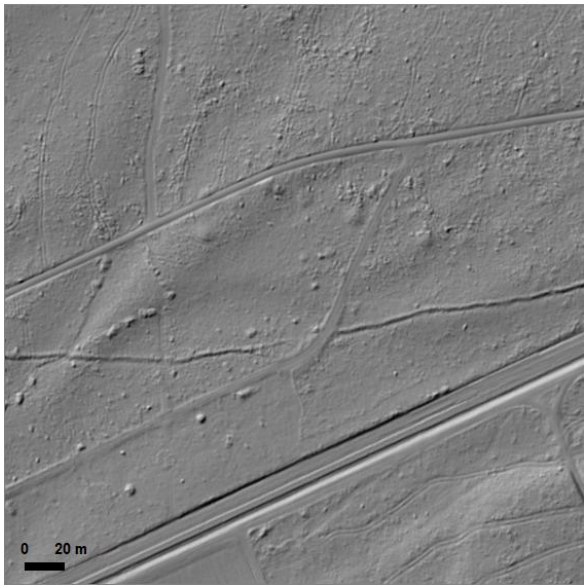


Spuren im Wald...

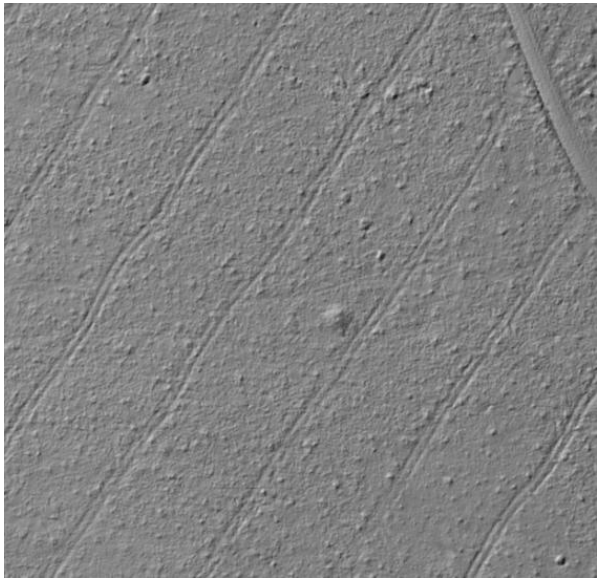
Trüllikon/ Ossingen



Weiach



Oberweningen



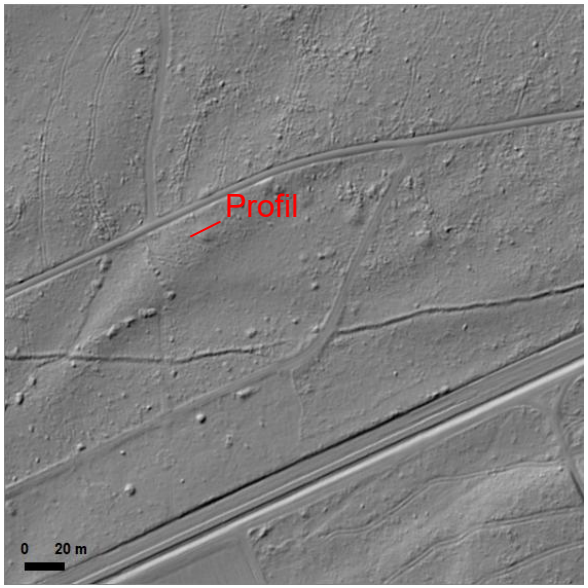
Grabhügel

Spuren im Wald...

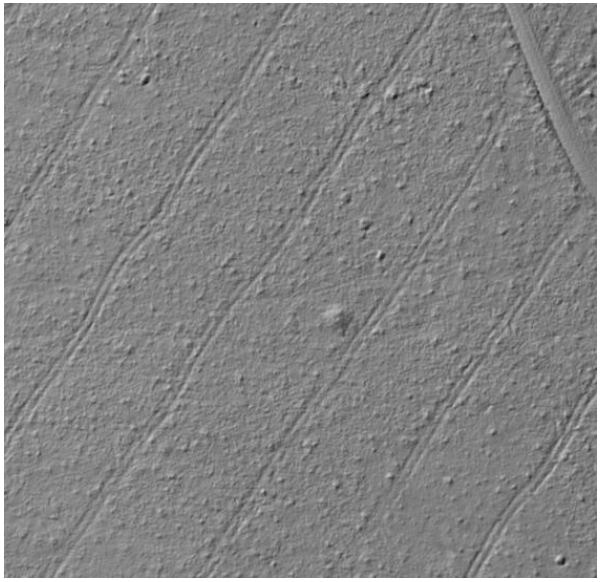
Trüllikon/ Ossingen

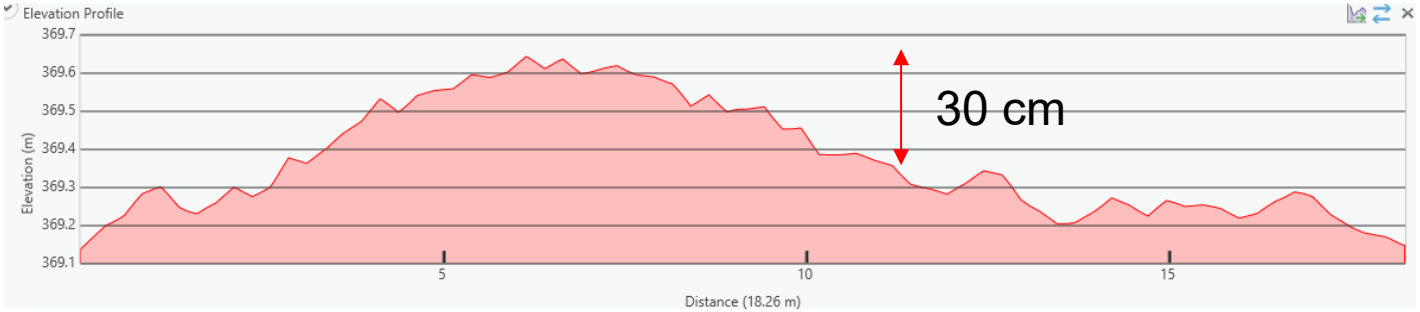


Weiach



Oberweningen





Grabhügel

Baudirektion
Archäologie und Denkmalpflege

Spuren im Wald...



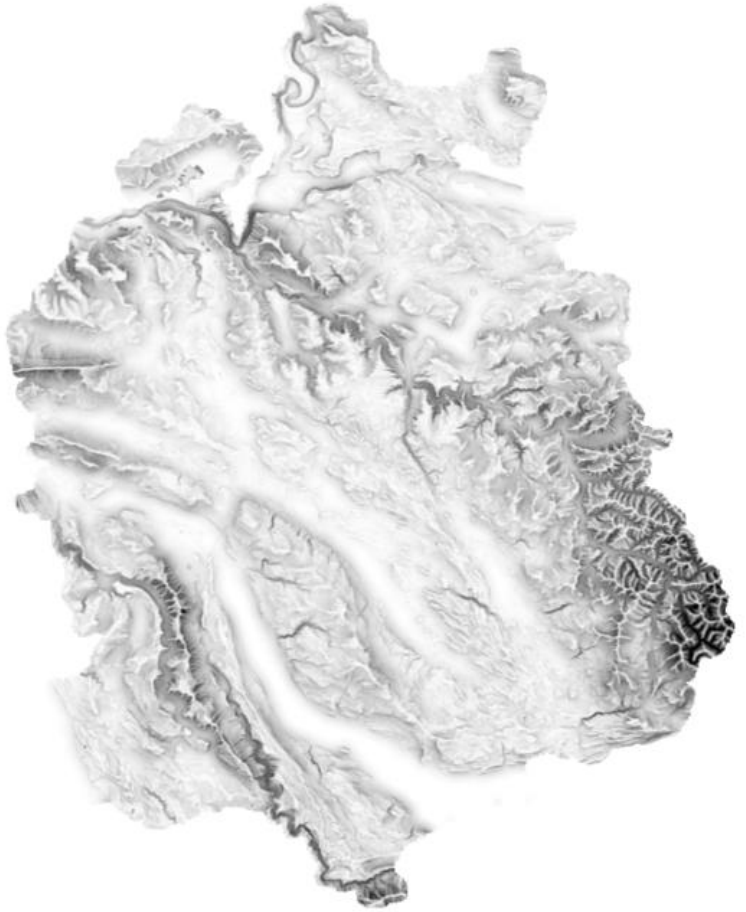
Fazit

Ideale Anwendungsbereiche für LiDAR-Daten

- Bereiche, wo grossflächige Begehungen nicht möglich sind
- flache und/oder flächige Strukturen, die im Gelände kaum sichtbar sind

Aber….

- LiDAR liefert keine konkrete Datierung
- LiDAR zeigt nur oberflächlich erhaltene Strukturen
- Interpretation (auch) abhängig von (Seh-)Erfahrung des Kartierenden



Baudirektion
Archäologie und Denkmalpflege

Vielen Dank für Ihre Aufmerksamkeit!



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Archäologie und Denkmalpflege