SAGA
The Soil Science & Archaeo-Geophysics Alliance

Workshop 1

(Prague, 30/Sep - 01/Oct 2019)

HUMAN-ROCK INTERACTION AND THE BURIAL PRACTICE IN THE NECROPOLIS OF THE EARLY ROMAN ERA JERUSALEM

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Topic 4 (Developing Experimental/Monitoring projects

Aim & Objectives

1. To examine the human-environment interaction in relation to the lithological units and rock hardness

2. To examine the diverse methods by which ancient masons solved various lithological defects encountered during excavation.

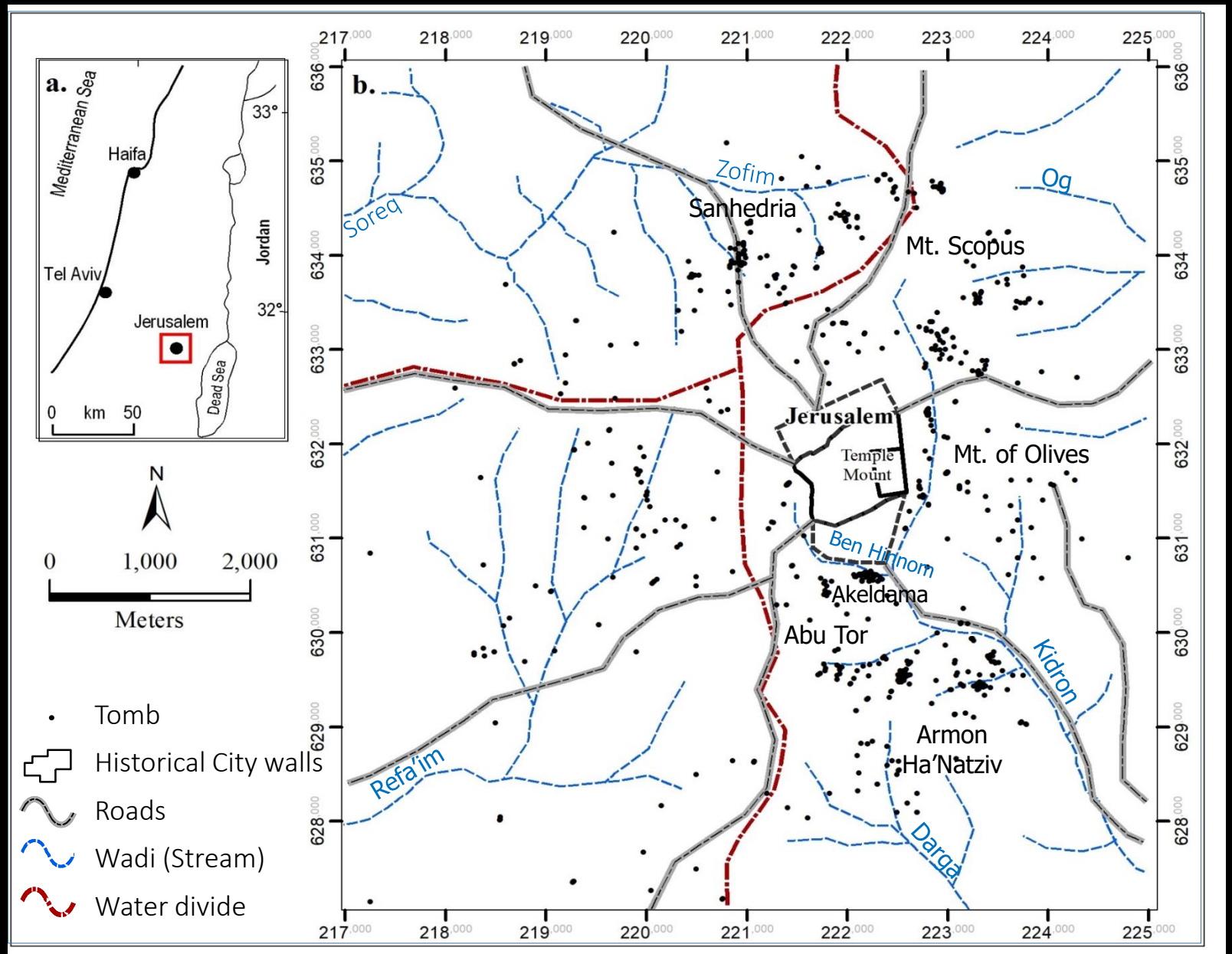
Time and location:

Jerusalem at the end of the Second Temple period (516 BCE to 70 CE)

Drawn by Vladislav Kipnis

The necropolis of ancient Jerusalem was **10 times the size** of the inhabited portion of the city, forming a ring approximately 3–5 km wide around the city walls and dividing the built-up city from the villages on the other side.

Tombs plotted over schematic physical map



During the last 150 years, various archaeological excavations and surveys revealed approximately **900 rock-cut tombs in the extensive necropolis** surrounding the city, dated to the last 150 years before the destruction of the city by the Romans in 70 CE.

The tombs, arranged in **clusters**, were cut into the slopes and cliff walls of the valleys surrounding the city and extending up to the city walls.

Burial customs in the Early Roman period

Tombs of the Sanhedrin, Jerusalem

Jews used to bury their deads in caves or in **ROCK CUT TOMBS,** sometimes with decorated facades and multiple burial chambers. Each tomb typically belonged to a single family.

A '***double burial***': first, the corpse was placed supine on a bench, niche or pit cut into the rock, within the family tomb. After the flesh had decayed, the bones were transferred from the primary to the secondary burial site within the same rock-cut tomb.

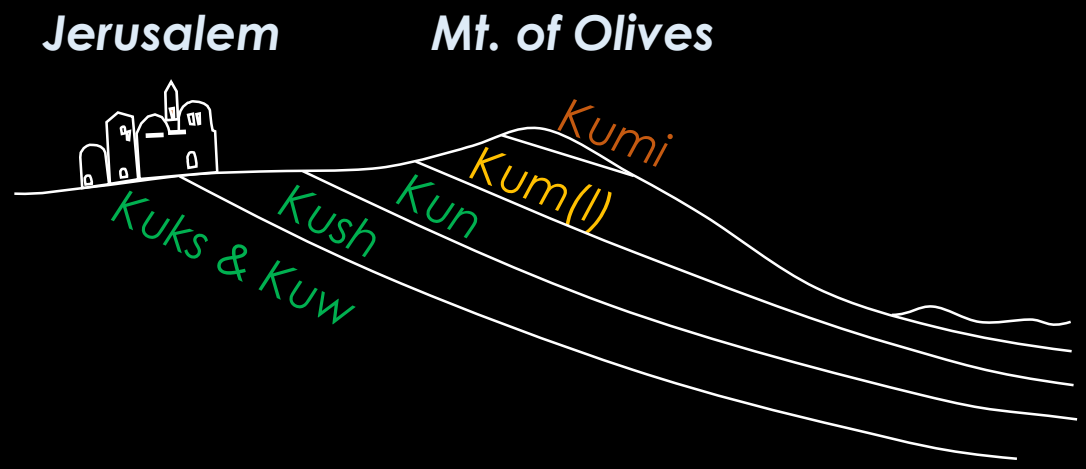
The bones were placed in a ***koch*** or in an **ossuary** (small, covered boxes, sometimes ornamented with carved or incised designs)

Study area: lithology

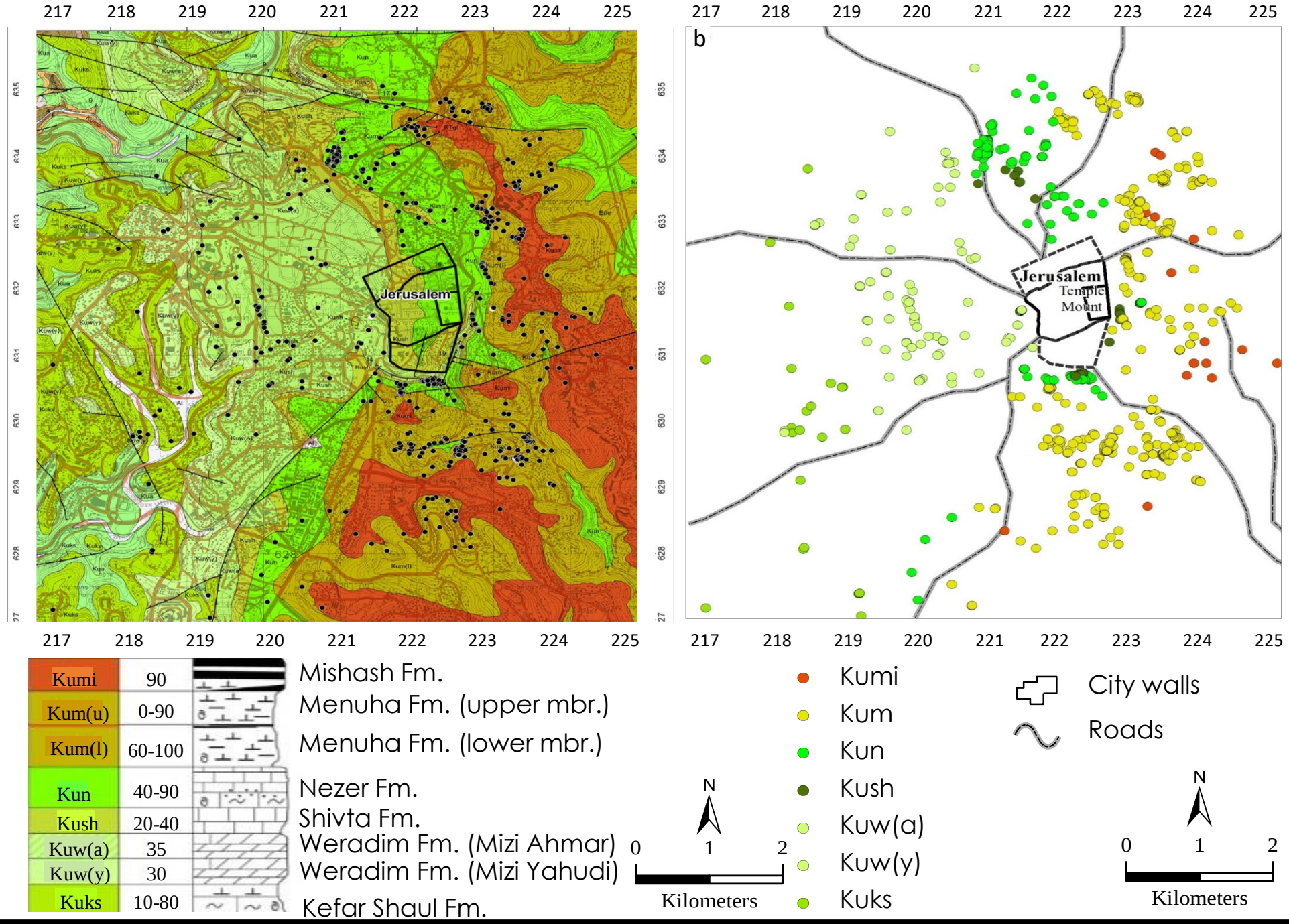
Most of the exposed sequence forming the mountainous backbone of Israel was deposited during the late Cretaceous to the Eocene (125-35 My), on a huge carbonate platform of the Tethys Sea. The succession is composed of a thick (1000 m) sequence of hard, karstic, limestone and dolomite, interbedded with chalk and marls.

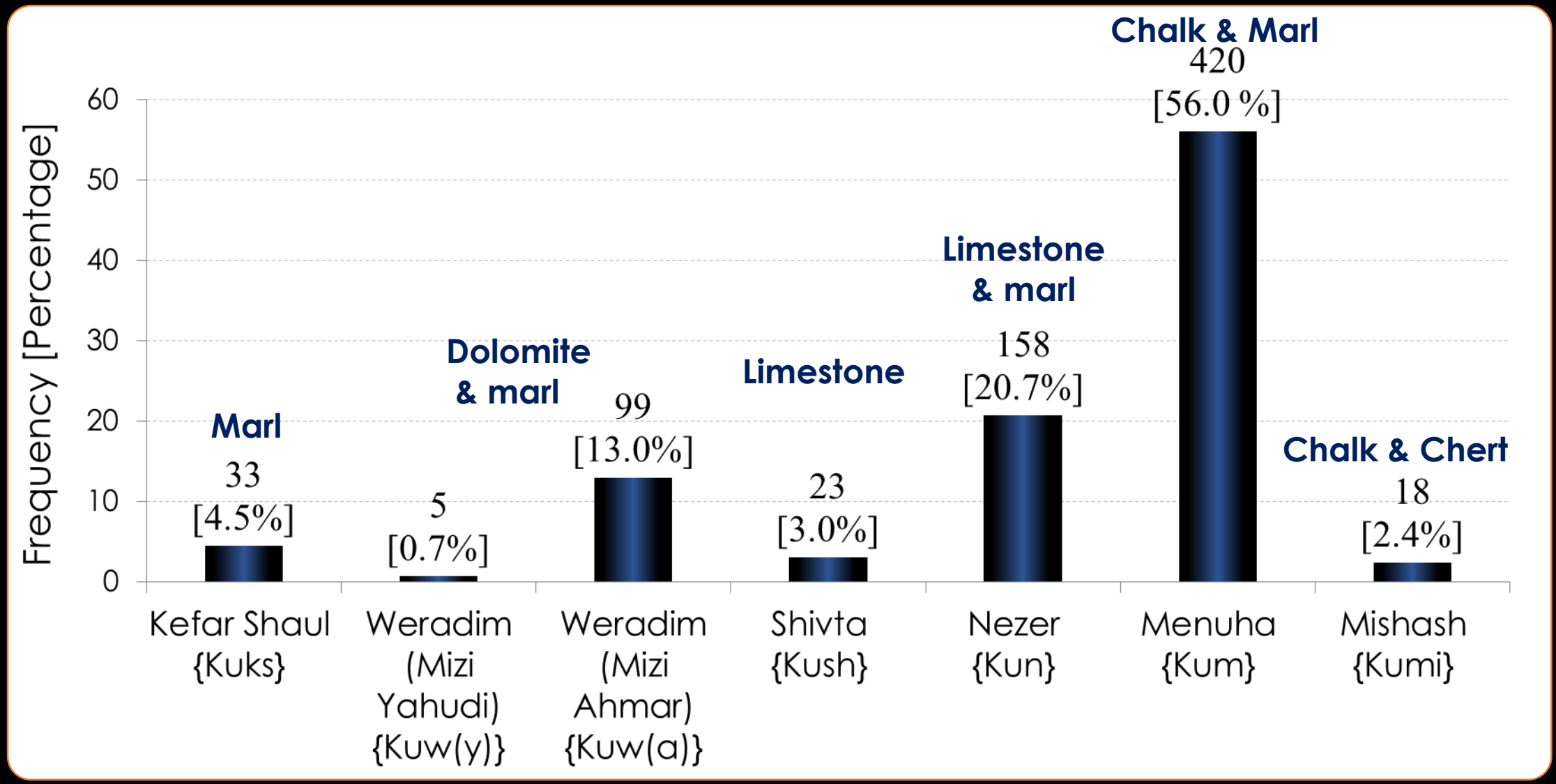
Cenomanian (100-94 My): mostly hard *limestone and dolomite*
Turonian (94-90 My): moderately hard *limestone*
Senonian (90-66 My): soft *chalk, marl* and thin banks of brown flint.

This distribution of rocks is the result of the geological structure: The layers dip at a gradually increasing rate towards the east, representing the eastern flank of the *Judean anticline*.



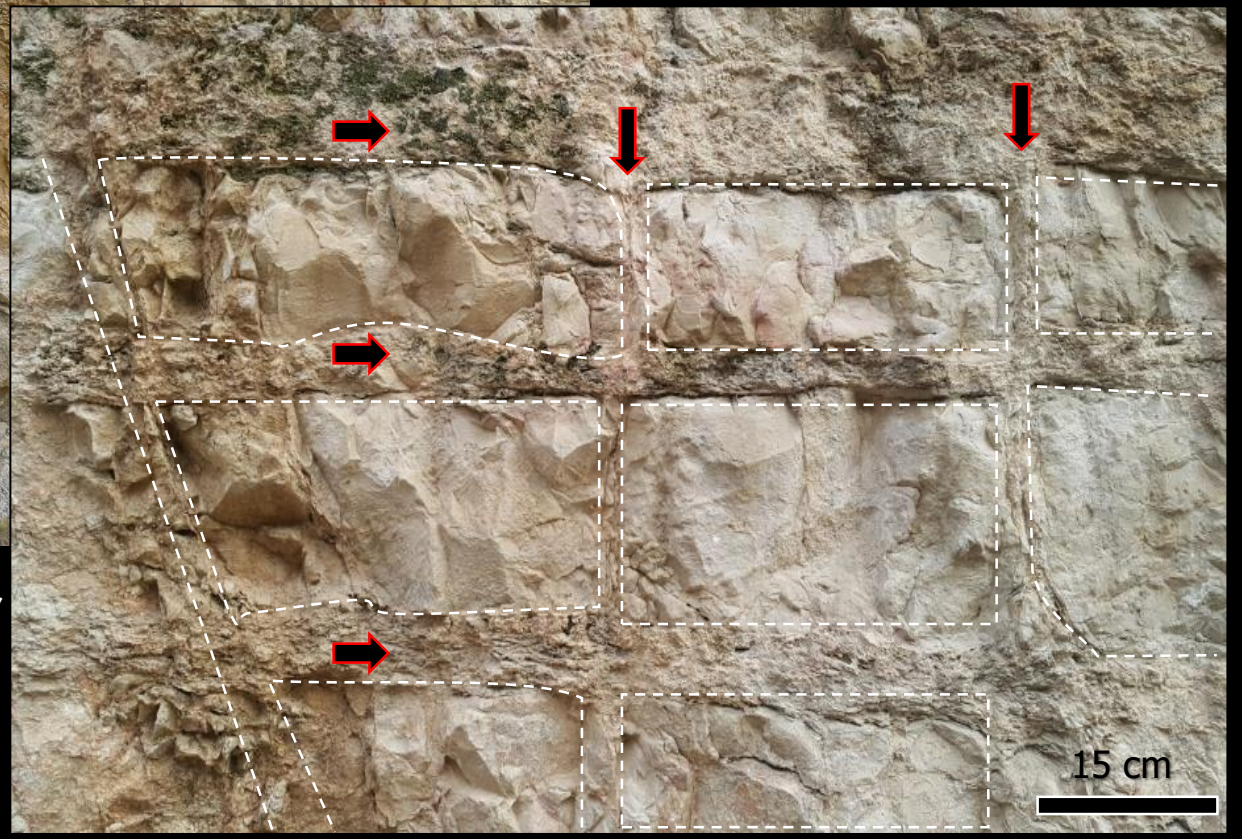
(Geological map modified from Sneh and Avni 2011).





Distribution of tombs by geological formation.
More than half of the tombs are hewn in chalk and marl units (Menuha fms).

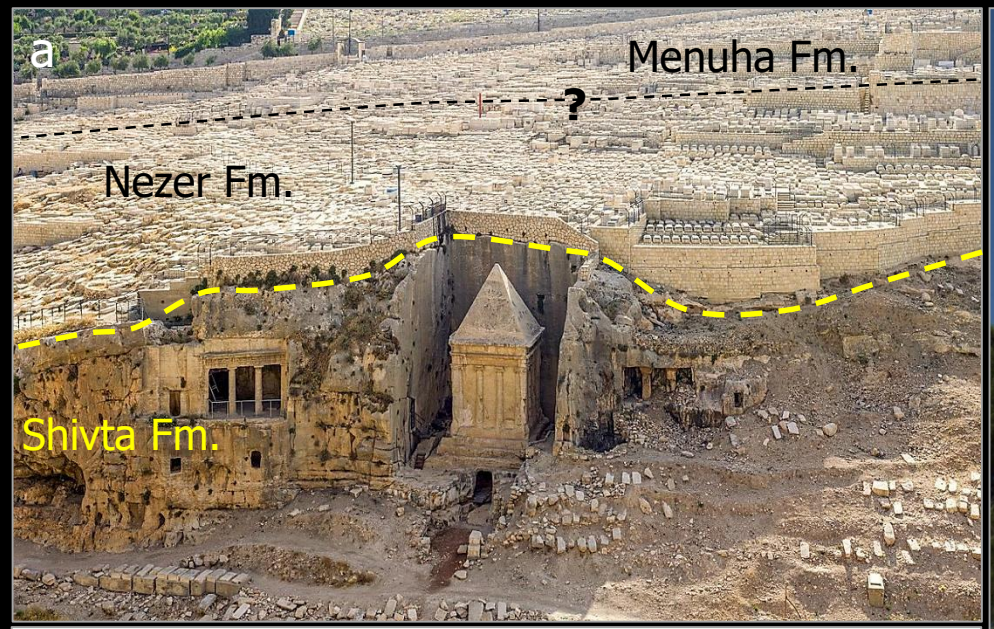
Jason Tomb; Dolomite interbedded with argillaceous material contents.



Quarrying was carried out from the outside inwards, i.e., from the cave entrance towards the inner chambers. When possible, square blocks were removed from the chambers: channels were cut into the edges of the blocks, which were then detached from the bedrock

Tomb of Zechariah; The massive limestone Shivta formaton

Rock-cut tombs into **Shivta formation**: Benei Hezir, Zechariah, Akeldama (Ben Hinom) and Absalom.
The modern Jewish cemetery of Mt. of Olives extends within the overlying softer **Nezer and Menuha** fms



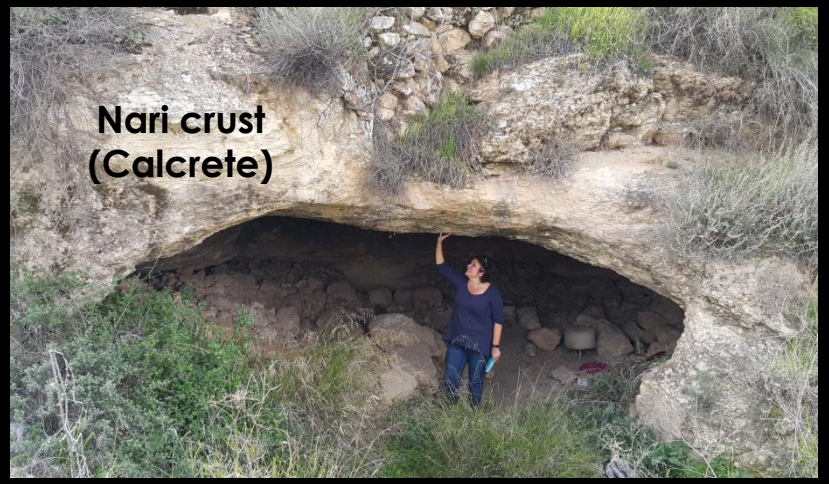
Akeldama (Ben Hinom) rock-cut tombs, carved into the massive, hard limestone of the **Shivta Fm**.

Netzer Fm (Turonian): The courtyard and vestibule of Umm el-Amad tomb, Irregular top and rockfall evidence of the vestibule roof layer. Bottom: Sanhedrin and Eshkolot courtyards with rock cut decorations

Rock-cut tombs into chalk and marl of the **Menuha Fm.**

Mechanical and biogenic weathering

Kokhim and ossuaries hewn in chalk

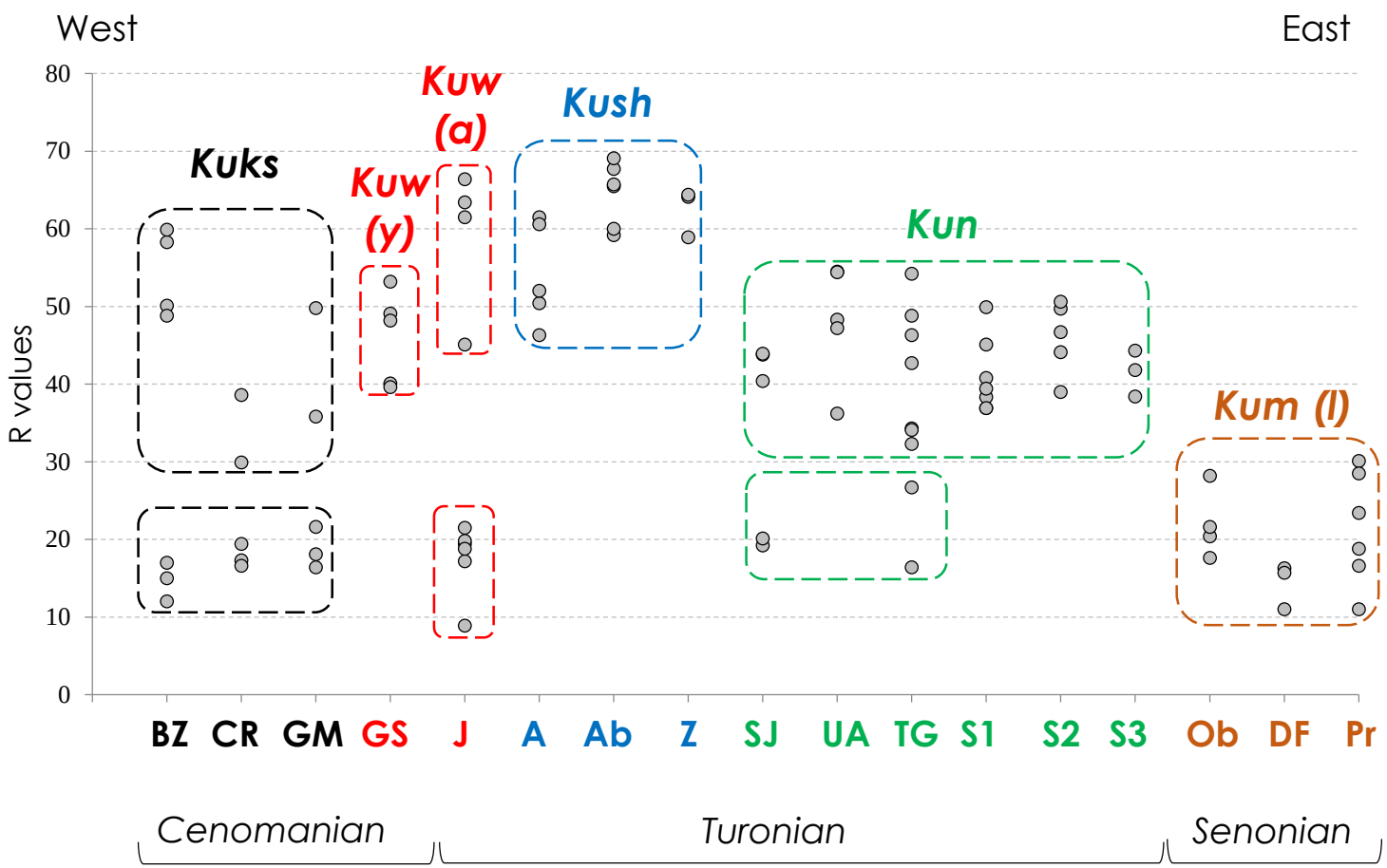


Destruction and collapse of loose material from beneath stable calcrete layers;

Destruction of a rock-cut tomb system during infrastructure constructions, Jabel Muqaber area

My. Scopus Observatory carved in the soft Menuha chalk;
The soft bedrock obliged the introduction and combination of ashlars, to obtain the desired structure

The Schmidt hammer values obtained for 17 tombs in five geological formations.



BZ-Bet Zafafa
CR-Costa Rica street
GM-Givat Mordechai
GS-Gan Sacher
J-Jason
A-Akeldama
Ab-Absalom
Z-Zechariah
SJ-Simeon the Just
UA-Umm el Amed
TG-Tomb of the Grapes
S1-Sanhedrin 1
S2-Sanhedrin 2
S3-Sanhedrin 3
Ob- Mt. Scopus observatory
DF-Dominus Flevit
Pr-Prophets

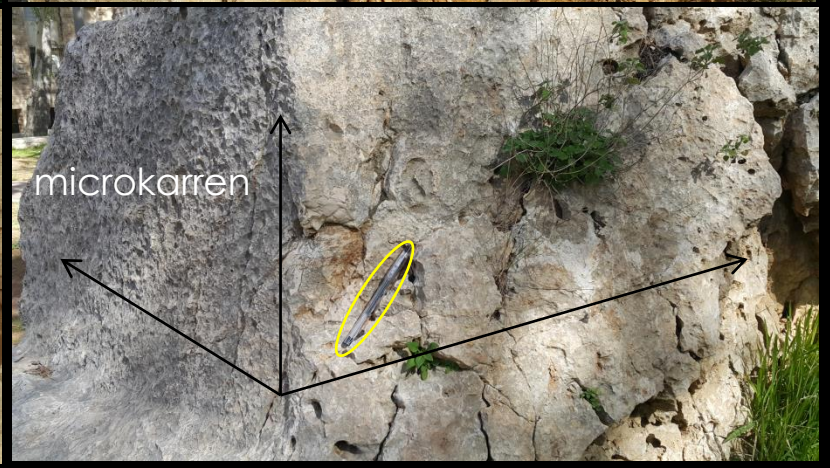
(Kuks=Kefar Shaul Fm., Kuw(y)=Weradim Fm. (Mizi Yahudi), Kuw(a)=Weradim Fm. (Mizi Ahmar), Kush=Shivta Fm., Kun=Nezer Fm., Kum= Menuha Fm. , Kumi=Mishash Fm.

Typical rock decay features in various formations

Close and diffuse **vertical fractures** and brecciated structures in Nezer limestone at Simeon the Just tomb

Vertical fractures and brecciated structures in Nezer limestone at Sanhedrin -2 tomb

Dissolution along **perpendicular fissures** on the ceiling of the vestibular at Sanhedrin-1 tomb



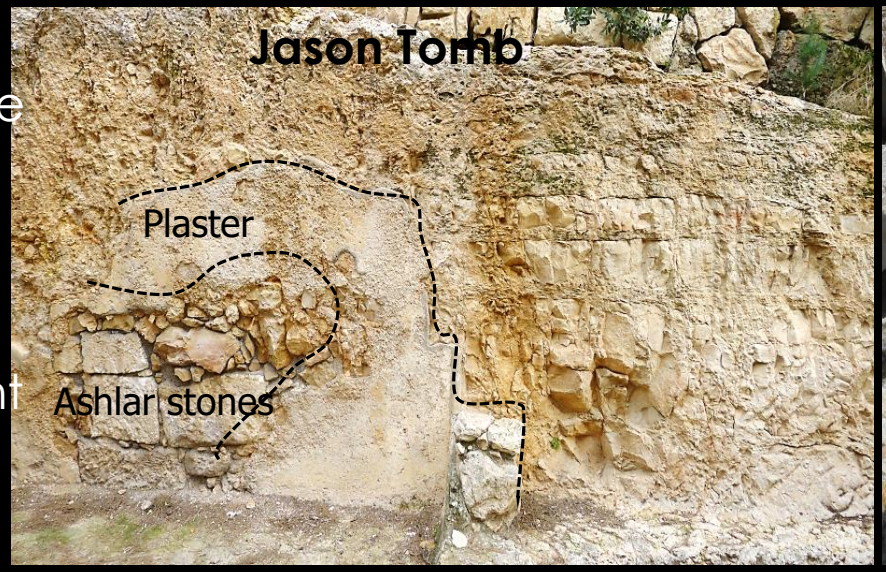
Microkarren structures in a carved limestone block of the Nezer limestone Fm::

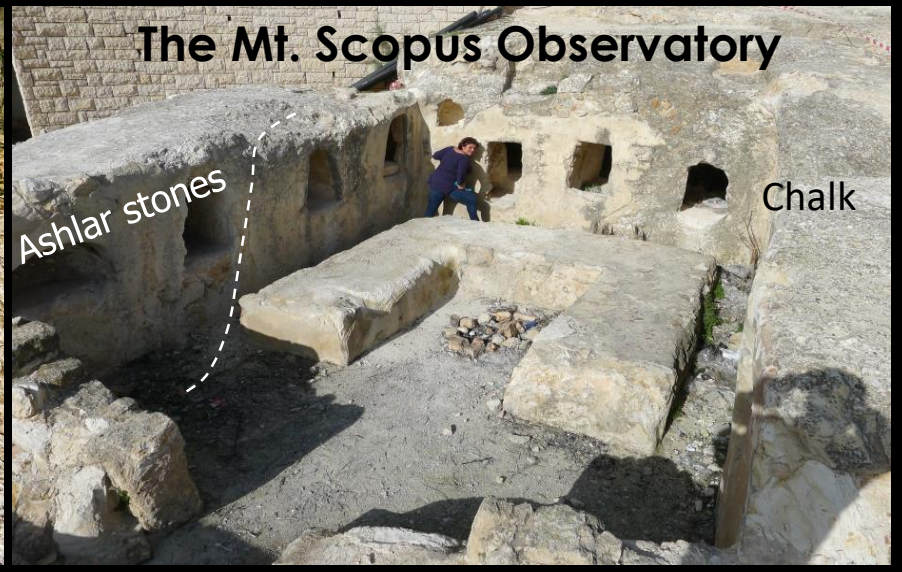
Differential erosion of chalk in Menuha Fm

Roots penetrating bedding planes and enlarging crevices in Nezer limestone Fm. at Akeldama site.

Handling major rock defects

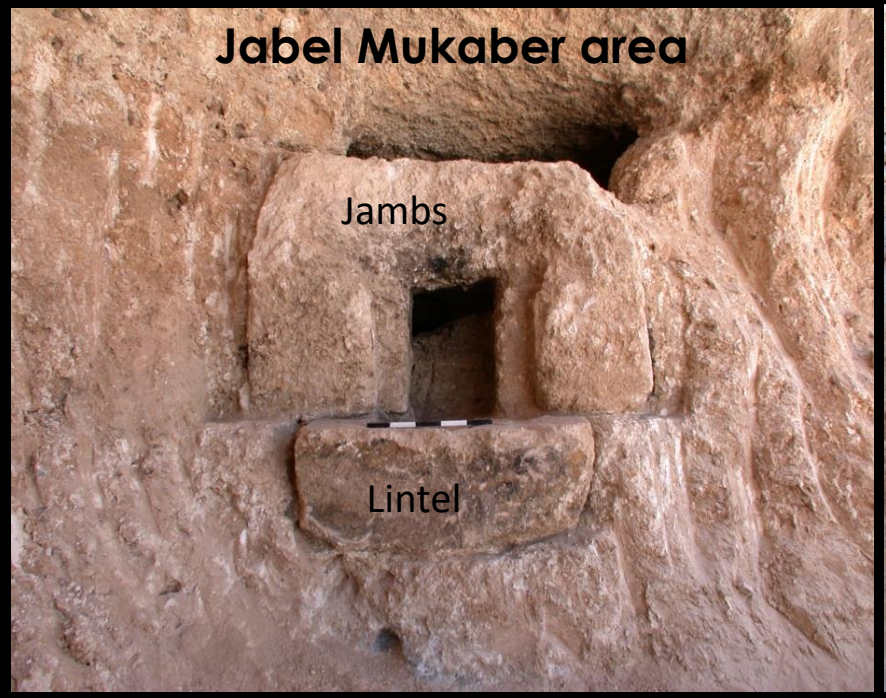
Major defects endangering the stability of the rock-cut chamber, required accomplishment with ashlar stones

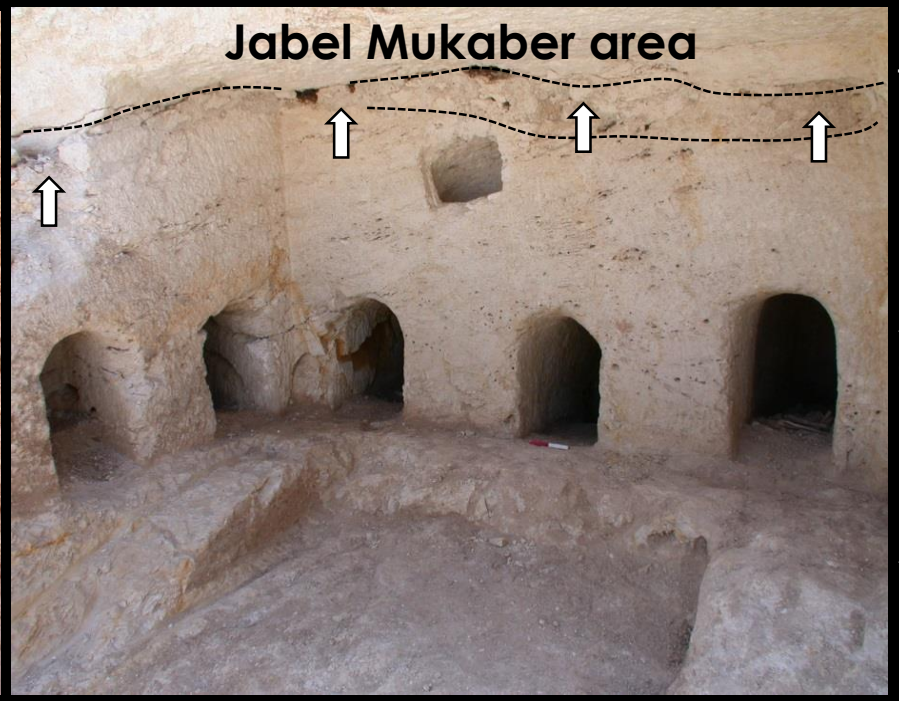




The soft bedrock obliged the introduction and combination of ashlars, to obtain the desired structure.

A π-shaped element was chiseled to create the jambs and the lintel on a wide opening that was cut to discard rock defects.





The contact between the calcrete and the chalk provides a stable ceiling for the tomb chamber. The defects were sealed with a mixture of plaster and small stones.

Epikarst solution pits within the **Shivta massive limestone**, apparently interfered the hewing process which was abandoned or reallocated.

CONCLUSIONS

- The substrate played a crucial role in the establishment of the city and the residents' living conditions i.e the presence or absence of caves in certain areas can be explained by the lithology.
- Approx 80% of the necropolis was hewn in the soft(er) units: Kefar Shaul, Netzer, Menuha/ Mishash
- Socioeconomic status: excavating in the hard limestone of Shivta Formation required high effort and funding and therefore the tombs number is limited (3%).
- In some cases, owners of estates located in soft lithologies granted burial rights to additional families, as proved by the large number of tombs and the clusters of burial systems in the Menuha Formation
- Rock surfaces are mostly decayed by chemical dissolution, enhanced by structural fissures in the rock. Condensation-corrosion and excess moisture were observed on the ceilings of some structures, along with bio-erosion.
- Two types of defects are common in the local rock: (1) Major defects, endangering the stability of the rock-cut chamber that require complementary building with ashlar stones, and (2) Superficial defects that required only aesthetic solutions.

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Lithology and the distribution of Early Roman-era tombs in Jerusalem's necropolis

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Article information

Abstract

If one sells a place to his neighbor to make a grave for himself; …, he makes the middle of the (burial) cave four cubits [wide] by six [cubits] long, and opens into it eight graves: three on one side and three on the other [on the two sides of the length of the cave], and two opposite [the entrance of the cave], each grave four cubits long, six cubits wide, and seven cubits high… . Rabi Shimon says: He makes the middle of the grave six cubits by eight, and opens into it thirteen graves: four on one side and four on the other, three opposite, one to the right of the entrance and one to the left. And a courtyard is made before the cave, six by six, large enough to contain the litter and its buriers; and two caves are opened into it, one on each side. R. Shimon says: Four, on its four sides. Rabbi Shimon ben Gamliel says: All according to the hardness of the rock.
[Mishna Bava Batra, 6/8)

Bava Batra ("The Last Gate") is part of Judaism's oral law between the fourth and eleventh centuries in Lower Mesopotamia.