

## The 2022 Campaign on the Palaeolithic of the Zarqa Valley

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### Abstract

New surveys in August-September 2022 in the upper Zarqa Valley have increased the number of stratified archaeological sites from Early and Middle Pleistocene colluvial/alluvial units. The main results are: 1) the extension of the archaeological-bearing Dawqara Formation (Early Pleistocene) to the northern margin of the Zarqa Governorate, with the recovery of new artefacts, 2) the discovery of rodent teeth remains in an archaeological outcrop of Dawqara Formation 3) the discovery of three new stratified middle Acheulean sites, with minimal disturbance and favourable conditions for future excavations. Within the Dawqara and Birayn Formations the occurrence of several palaeosols indicates recurrent pedogenic phases in the Zarqa Valley and provided new material for palaeoenvironmental characterization of the archaeological sites. Conservation requirements and threats to the sites are also discussed with regard to the whole archaeological heritage of the oldest prehistory of Levant.

**Keywords:** Lower Palaeolithic, Stratigraphy, Taphonomy, Pleistocene, Zarqa Valley, Jordan

### INTRODUCTION

Lower and pre-Acheulean lithic industries in southwestern Asia are mostly known from a few stratified sites, as 'Ubeidiya, with an estimated age of 1.4 Ma (Bar-Yosef and Goren-Inbar 1993), Ain Fil, the lowest archaeological layer of which has a maximum age of 1.8 Ma (Le Tensorer et al. 2015), Yiron, with an unconfirmed age of 2.4 Ma (Ronen 1991) and many surface collections (Le Tensorer and Muhesen 2021; Petraglia 2003; Shoaee et al. 2021; Whalen and Fritz 2004), although dating the latter by geochronological methods is difficult. The vast majority of these sites did not preserve hominin fossil remains and east of the Jordan Valley, Pleistocene mammalian bones are almost absent. Since 1984, the Upper Zarqa Valley has emerged as a core region for the study of the oldest cultures of the Levant (Besançon et al. 1984; Baubron et al. 1985; Copeland and Hours 1988). Research in the valley was later resumed by a joint Italo-Jordan mission focusing on Palaeolithic cultures between 1996 and 1999 (Caneva et al. 2001; Kafafi et al. 1997; Palumbo et al. 1996; 2002, Parenti et al. 1997); and again with four Italo-Brazilian campaigns between 2013 and 2016 (Scardia et al. 2019; Parenti et al. 2024). In this paper we present the results of a new campaign from 2022 supported financially by Brazilian institutions and focusing on the Plio-Pleistocene stratigraphic units and the palaeoenvironmental history of the valley.

### The Survey

The 2022 campaign was carried out between August 11th and September 7th by an international team composed of Fabio Parenti and Simone Belarmino (Federal University of Paraná, Brazil), Giancarlo Scardia

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and João Carlos Cerqueira (São Paulo State University, Brazil), Martine Faure (Lyon University, France) and Sevket Sen (National Museum of Natural History, Paris, France). A synopsis of previous work and the main achievements in the area was presented at the 15th International Conference on the History and Archaeology of Jordan, held in Irbid in August 2022. The 2022 survey had the following goals: 1) to extend the geological map of Quaternary formations; 2) to survey new outcrops for Lower Palaeolithic artifacts; 3) to study the taphonomy of the lower part of Site 334; 4) to collect samples for microbotanical analysis; 5) to identify outcrops favourable to micromammals recovery and; 6) to test photogrammetry as a quick method for recording selected sites. The whole palaeolithic outcrops from Upper Zarqa valley are listed in Table 1:

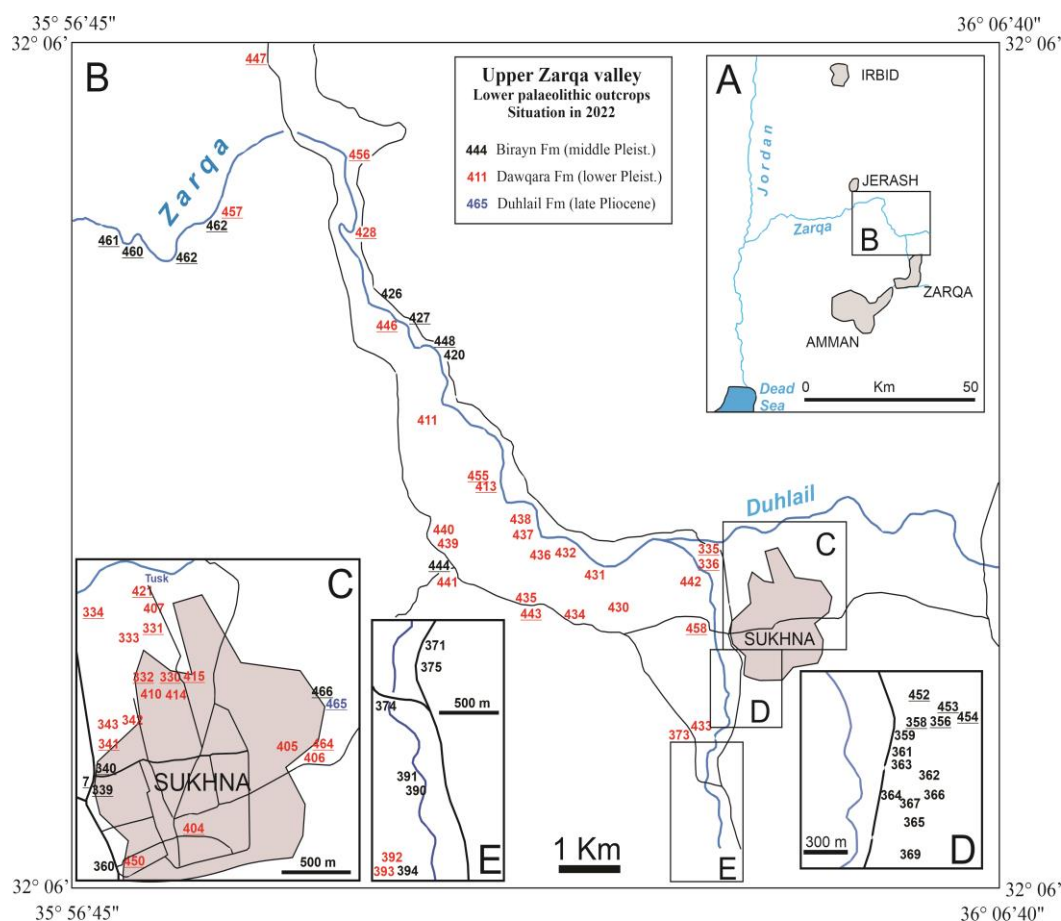
**Table 1: Palaeolithic sites of the Upper Zarqa Valley. Shaded in grey are the sites where preliminary studies were conducted in 2022, including sampling, recovering of artifacts, and photogrammetry.**

Some sites have no coordinates because of the records having been lost, and their age has been determined on a typological basis in the 1996-1999 campaigns (Caneva et al. 2001).

| Site      | Lat. N        | Lon. E        | Units         | Artefacts | Survey | Origin      |
|-----------|---------------|---------------|---------------|-----------|--------|-------------|
| 7         | 32°08'06.9"   | 36°03'44.9"   | Birayn        | 78        | 1996   | Road cut    |
| 330       | 32°08'31.2"   | 36°04'08.3"   | Dawqara       | 1532      | 1996   | Agriculture |
| 331       | 32°08'45.0"   | 36°04'00.1"   | Dawqara       | 34        | 1996   | Agriculture |
| 332       | 32°08'31.6"   | 36°03'58.2"   | Dawqara       | 18        | 1996   | Agriculture |
| 333       | 32°08'41.2"   | 36°03'56.3"   | Dawqara       | 2         | 1996   | Agriculture |
| 334 lower | 32°08'46.7"   | 36°03'47.1"   | Dawqara       | 116       | 1996   | Agriculture |
| 334 upper | 32°08'46.2"   | 36°03'46.6"   | Dawqara       |           | 1996   | Agriculture |
| 334 top   | 32°08'44.9"   | 36°03'51.5"   | Dawqara       |           | 1996   | Agriculture |
| 335       | 32°08'48.0"   | 36°03'41.2"   | ?             | 10        | 1996   | Pipe-line   |
| 336       | 32°08'48.0"   | 36°03'41.2"   | ?             | 4         | 1996   | Pipe-line   |
| 337       | 32°08'52.8"   | 36°03'34.1"   | ?             | 0         | 1996   | Agriculture |
| 338       | 32°08'52.0"   | 36°03'35.4"   | Sukhne        | 0         | 1996   | Agriculture |
| 339       | 32°08'06.0"   | 36°03'45.5"   | Birayn        | 21        | 1996   | Road cut    |
| 340       | 32°08'09.6"   | 36°03'46.5"   | Birayn        | 0         | 1996   | Road cut    |
| 341       | 32°08'18.6"   | 36°03'50.2"   | Dawqara       | 17        | 1996   | Agriculture |
| 342       | 32°08'21.3"   | 36°03'54.2"   | Dawqara       | 28        | 1996   | Agriculture |
| 343       | 32°08'20.8"   | 36°03'52.3"   | Dawqara       | 19        | 1996   | Agriculture |
| 344       | Lost position | Lost position | Dawqara       | 3         | 1996   | Undeterm.   |
| 346       | Lost position | Lost position | Dawqara       | 7         | 1996   | Undeterm.   |
| 348       | Lost position | Lost position | Dawqara       | 2         | 1996   | Undeterm.   |
| 349       | Lost position | Lost position | Dawqara       | 0         | 1996   | Undeterm.   |
| 350       | Lost position | Lost position | Birayn        | 5         | 1996   | Undeterm.   |
| 351       | Lost position | Lost position | Kirbat-Shamra | 72        | 1996   | Undeterm.   |
| 355       | 32°07'43.9"   | 36°03'56.3"   | Birayn        | 1         | 1996   | Building    |
| 356       | 32°07'43.9"   | 36°03'56.3"   | ?             | 37        | 1996   | Agriculture |
| 357       | 32°07'41.6"   | 36°03'54.9"   | Birayn        | 4         | 1996   | Agriculture |
| 358       | 32°07'42.2"   | 36°03'57.0"   | ?             | 1         | 1996   | Agriculture |
| 359       | 32°07'41.0"   | 36°03'54.2"   | Birayn        | 73        | 1996   | Road cut    |
| 360       | 32°07'55.2"   | 36°03'49.1"   | Kirbat-Shamra | 121       | 1996   | Road cut    |
| 361       | 32°07'33.7"   | 36°03'54.1"   | Birayn        | 48        | 1996   | Road cut    |
| 362       | 32°07'32.5"   | 36°03'58.4"   | Birayn        | 39        | 1996   | Building    |
| 363       | 32°07'31.4"   | 36°03'55.4"   | Birayn        | 6         | 1996   | Building    |
| 364       | 32°07'28.2"   | 36°03'55.5"   | Birayn        | 1         | 1996   | Agriculture |
| 365       | 32°07'24.9"   | 36°03'58.8"   | Birayn        | 1         | 1996   | Road cut    |
| 366       | 32°07'28.5"   | 36°03'58.9"   | Birayn        | 3         | 1996   | Road cut    |
| 367       | 32°07'29.1"   | 36°03'57.6"   | Birayn        | 1         | 1996   | Building    |
| 368       | 32°07'21.5"   | 36°03'57.9"   | Birayn        | 1         | 1996   | Agriculture |
| 369       | 32°07'18.5"   | 36°03'58.0"   | Birayn        | 1         | 1996   | Road cut    |
| 370       | 32°07'14.2"   | 36°03'49.3"   | Birayn        | 9         | 1996   | Agriculture |
| 371       | 32°07'02.1"   | 36°03'40.5"   | Birayn        | 18        | 1996   | Road cut    |

| Site | Lat. N        | Lon. E        | Units         | Artefacts | Survey | Origin      |
|------|---------------|---------------|---------------|-----------|--------|-------------|
| 372  | Lost position | Lost position | ?             | 0         | 1996   | Road cut    |
| 373  | 32°07'08.37"  | 36°03'22.34"  | Dawqara       | 0         | 1996   | Road cut    |
| 374  | 32°06'46.2"   | 36°03'27.9"   | Sukhne        | 0         | 1996   | Erosion     |
| 375  | 32°06'55.9"   | 36°03'38.0"   | Birayn        | 35        | 1996   | Road cut    |
| 376  | Lost position | Lost position | Kirbat-Shamra | 21        | 1996   | Undeterm.   |
| 390  | 32°06'24.0"   | 36°03'37.4"   | Kirbat-Shamra | 5         | 1996   | Agriculture |
| 391  | 32°06'26.9"   | 36°03'35.2"   | Birayn        | 4         | 1996   | Agriculture |
| 392  | 32°06'08.2"   | 36°03'28.6"   | Dawqara       | 1         | 1996   | Road cut    |
| 393  | 32°06'00.5"   | 36°03'31.4"   | Dawqara       | 8         | 1996   | Erosion     |
| 394  | 32°06'05.1"   | 36°03'34.23"  | ?             | 0         | 1996   | Erosion     |
| 404  | 32°07'56.4"   | 36°04'11.8"   | Dawqara       | 4         | 1996   | Other       |
| 405  | 32°08'13.8"   | 36°04'39.1"   | Dawqara       | 9         | 1996   | Erosion     |
| 406  | 32°08'14.3"   | 36°04'50.6"   | Dawqara       | 15        | 1996   | Erosion     |
| 407  | 32°08'46.2"   | 36°04'02.1"   | Dawqara       | 3         | 1996   | Agriculture |
| 409  | 32°08'29.8"   | 36°03'59.5"   | Dawqara       | 2         | 1996   | Agriculture |
| 410  | 32°08'28.7"   | 36°04'01.3"   | Dawqara       | 3         |        | Agriculture |
| 411  | 32°09'48.8"   | 36°00'39.7"   | Dawqara       | 2         |        | Agriculture |
| 413  | 32°09'18.0"   | 36°01'14.7"   | Dawqara       | 1         |        | Agriculture |
| 414  | 32°08'29.4"   | 36°04'07.9"   | Dawqara       | 628       |        | Other       |
| 415  | 32°08'29.1"   | 36°04'13.0"   | Dawqara       | 140       | 1997   | Other       |
| 415' | 32°08'28.57"  | 36°04'13.1"   | Dawqara       |           | 2022   | Building    |
| 420  | 32°10'21.2"   | 36°00'46.8"   | Birayn        |           | 1999   | Undeterm.   |
| 421  | 32°08'50.5"   | 36°03'58.0"   | Dawqara       |           | 2013   | Agriculture |
| 427  | 32°10'44.4"   | 36°00'22.6"   | Birayn        |           | 2015   | Road cut    |
| 427' | 32°10'43.76"  | 36°00'21.39"  | Birayn        |           | 2022   | Quarry      |
| 428  | 32°11'28.28"  | 35°59'51.61"  | Dawqara       |           | 2015   | Road cut    |
| 429  | 32°08'43.1"   | 36°03'03.6"   |               |           |        | Road cut    |
| 430  | 32°08'16.7"   | 36°02'28.1"   | Dawqara       |           |        | Building    |
| 431  | 32°08'32.1"   | 36°02'16.2"   | Dawqara       |           |        | Building    |
| 432  | 32°08'42.8"   | 36°01'56.1"   | Dawqara       |           |        | Building    |
| 433  | 32°07'10.3"   | 36°03'22.7"   | Dawqara       |           |        | Road cut    |
| 434  | 32°08'10.0"   | 36°02'02.8"   | Dawqara       |           |        | Road cut    |
| 435  | 32°08'19.2"   | 36°01'36.5"   | Dawqara       |           |        | Road cut    |
| 436  | 32°08'43.0"   | 36°01'46.3"   | Dawqara       |           |        | Undeterm.   |
| 437  | 32°08'51.9"   | 36°01'33.4"   | Dawqara       |           |        | Agriculture |
| 438  | 32°08'57.9"   | 36°01'30.1"   | Dawqara       |           |        | Agriculture |
| 439  | 32°08'45.7"   | 36°00'42.7"   | Dawqara       | 2         |        | Road cut    |
| 440  | 32°08'53.7"   | 36°00'33.5"   | Dawqara       |           |        | Erosion     |
| 441  | 32°08'34.7"   | 36°00'48.2"   | Dawqara       |           |        | Industry    |
| 442  | 32°08'29.0"   | 36°03'11.2"   | Dawqara       |           |        | Road cut    |
| 443  | 32°8'18"      | 36°8'38.41"   | Birayn        | 7         | 2022   | Road cut    |
| 444  | 32°8'36.4"    | 36°0'41.54"   | Birayn        | 4         | 2022   | Agriculture |
| 445  | 32°10'42"     | 36°4'00"      | Birayn        | 19        | 2022   | Road cut    |
| 446  | 32°10'42"     | 36°4'00.85"   | Birayn        | 3         | 2022   | Agriculture |
| 447  | 32°12'51.62"  | 35°58'51.62"  | Dawqara       |           | 2022   | Road cut    |
| 448  | 32°10' 28.84" | 35°57'23"     | Birayn        | 5         | 2022   | Road cut    |
| 450  | 32°7'47.19"   | 35°57'17.39"  | Birayn        | 4         | 2022   | Building    |
| 451  | 32°8'32.76"   | 35°57'57.18"  | Birayn        | 12        | 2022   | Agriculture |
| 452  | 32°7'45.22"   | 35°4'49.74"   | Birayn        | 9         | 2022   | Agriculture |
| 453  | 32°7'42"      | 36°4'13.0"    | Dawqara       | 12        | 2022   | Agriculture |
| 454  | 32°7'42.12"   | 36°1'38.69"   | Dawqara       |           | 2022   | Building    |
| 455  | 32°9'20"      | 36°3'54.70"   | Dawqara       | 3         | 2022   | Agriculture |
| 456  | 32°12'07.98"  | 36°1'12"      | Dawqara       | 1         | 2022   | Industry    |

| Site | Lat. N       | Lon. E       | Units   | Artefacts | Survey | Origin      |
|------|--------------|--------------|---------|-----------|--------|-------------|
| 457  | 32°11'37.30" | 35°59'52.49" | Dawqara | 5         | 2022   | Erosion     |
| 458  | 32°8'11.15"  | 35°58'26.84" | Dawqara | 1         | 2022   | Road cut    |
| 459  | 32°8'11.15"  | 36°3'28.45"  | Dawqara | 17        | 2022   | Erosion     |
| 460  | 32°11'20.74" | 35°3'42.10"  | Dawqara |           | 2022   | Quarry      |
| 461  | 32°11'22.68" | 35°4'49.84"  | Dawqara | 4         | 2022   | Road cut    |
| 462  | 32°11'18.69" | 36°0'06"     | Dhulayl |           | 2022   | Agriculture |
| 463  | 32°08'48.86" | 36°3'22.29"  | Dhulayl | 1         | 2022   | Pipe-line   |
| 464  | 32°8'16.86"  | 35°4'52.34"  | Dhulayl |           | 2022   | Erosion     |
| 465  | 32°8'25.57"  | 36°0'06"     | Sukhne  | 5         | 2022   | Erosion     |
| 466  | 32°8'27.16"  | 36°3'28.45"  | Sukhne  | 2         | 2022   | Erosion     |
| 467  | 32°8'3.02"   | 35°4'49.63"  | Sukhne  | 1         | 2022   | Erosion     |



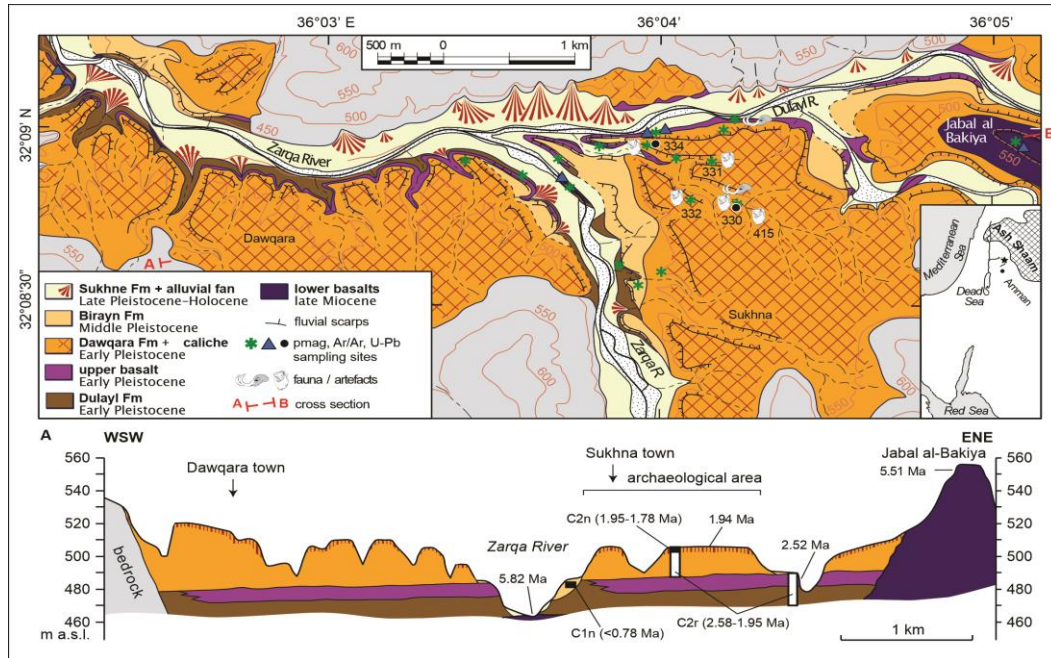
**Fig. 1. The position of Lower Palaeolithic outcrops of the Upper Zarqa Valley. Attribution to the stratigraphic units is proposed. The sites surveyed in 2022 are underlined. Elevations are omitted; for a complete topography, refer to Jordan Survey Map N. 461 and 342, at 1:50,000 scale.**

### Stratigraphy and Chronology

Giancarlo Scardia and João Carlos Cerqueira carried out the geological survey and sampling in the valley, from the bridge on the Zarqa River North of Sukhne to ca. 2 km SE of the bridge on the Zarqa River to Jerash (Fig. 1). Six main units have been recognized within the Zarqa Valley by Baubron et al. (1985) and later reviewed by Scardia et al. (2019), from the oldest to the younger: the Lower Basalt, the Dulayl Formation (Fm), the Upper Basalt the Dawqara Fm, the Birayn Fm, and the Sukhne Fm. Excluding the Lower Basalt, which pertains to a previous cycle of valley infilling, the other units form three well defined fluvial terraces,

informally defined as high, middle and low, respectively. The high terrace is sustained, from the base to the top, by the Dulayl Fm, the Upper Basalt flow, and the Dawqara Fm, unconformably lying on the Lower Basalt. The middle terrace is composed by the Birayn Fm and the low one by the Sukhne Fm.

Based on  $^{40}\text{Ar}/^{39}\text{Ar}$  and U-Pb geochronologic dating, paleomagnetism and archaeological content, Scardia et al. (2019) proposed a regional chronostratigraphic framework of units exposed in the Zarqa Valley, Fig. 2:



**Fig. 2. Geology of the Upper Zarqa valley. The paleolithic artifacts are in the Dawqara and Birayn Fm. Modified from Scardia et al. 2019.**

The Lower Basalt flows took place during Late Miocene (5.80–5.51 Ma) within an already formed valley, reaching the highest aggradation surface at 560 m a.s.l., documented by the Jabal al-Bakiya mesa. After a deep erosion phase, of about 90 m, the Dulayl Formation was deposited on the Lower Basalt starting at since the Gauss-Matuyama geomagnetic reversal at ca. 2.59 Ma (Pliocene–Pleistocene boundary; (Scardia et al., 2019) and consists of fluvial conglomerates and siltstones. Above is the Upper Basalt (2.52 Ma), a cliff-forming lava flow with prismatic jointing and, locally, pillow structure, overlaid by the Dawqara Fm., the Oldowan tools-bearing stratigraphic unit. The Dawqara Fm. consists of dominant braidplain gravels with local swamp and alluvial fan sediments. At the top of this sequence, there is a widespread occurrence of a 1.5 m-thick caliche dated to 1.98 Ma (Early Pleistocene).

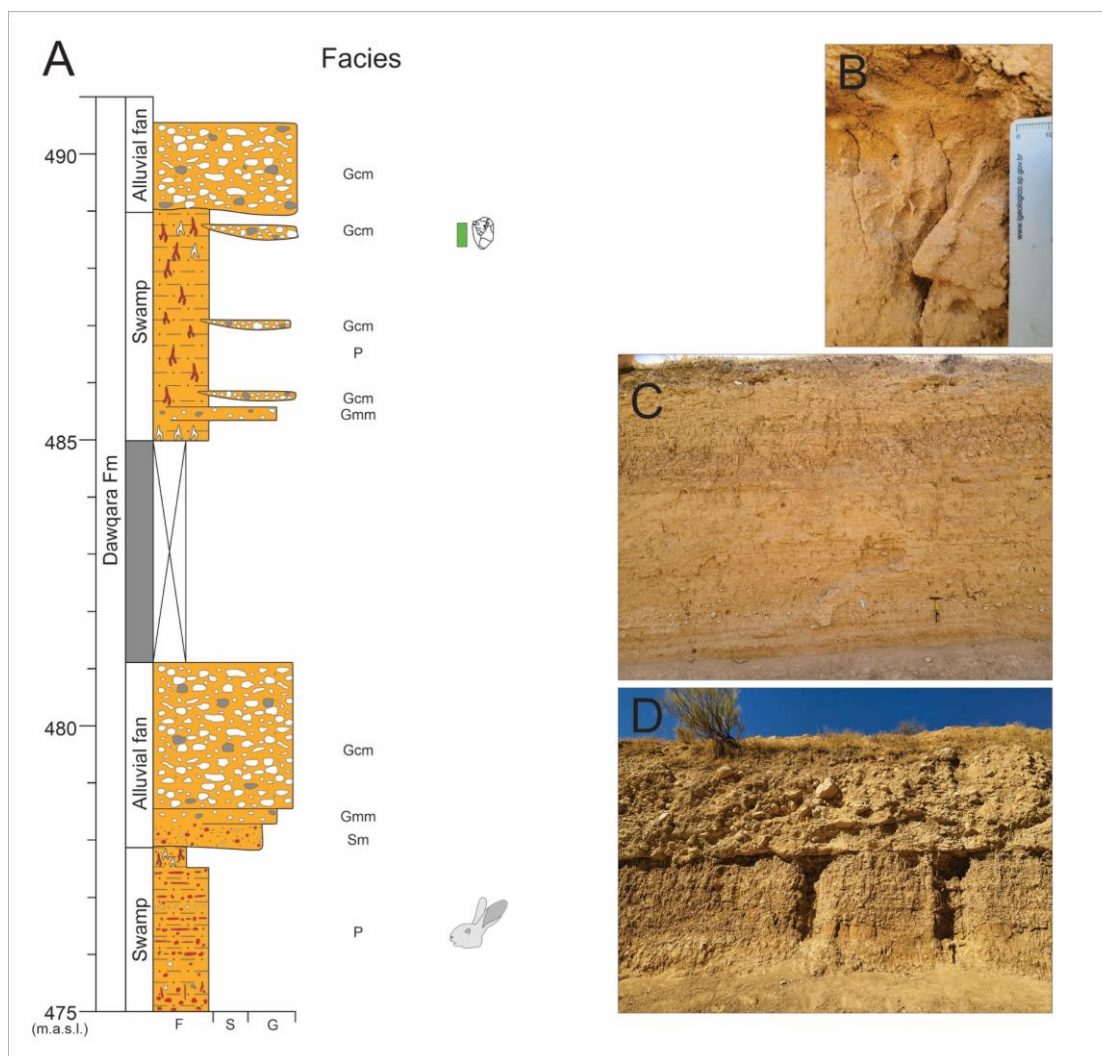
The Dawqara Fm was apparently followed by a long period of erosion (ca. 1 million years) after which the Birayn Formation (Middle Pleistocene?) evidences a takeover in the erosion, which lowered the base level ca. 40 m carving the high terrace deposits and subsequent aggradation, deposited forming the middle terrace, which includes fluvial and slope deposits, both containing Acheulean artifacts, and locally, caliche and gypsum filaments. Lastly, the Sukhne Formation (Late Pleistocene–Holocene) consists of the most recent incision-aggradation phase in the valley with fluvial and slope deposits bearing Epipalaeolithic artifacts and Neolithic to Bronze Age pottery.

In each terrace, a predominance of coarse-grained facies is observed, indicating high-energy gravel bed rivers (Gt, Gp, Gcm, and Gh; facies codes from Miall, 2006), with restricted floodplains (or swamps), represented by fine-grained facies (Fl, Fsm, and Fm). Slope deposits are identified by thick packages of Gcm and Gmm, which are more frequent in the middle and low terraces. Palaeosols (Fr, K, and P) usually cap the high terrace, but are also locally found in the middle terraces.

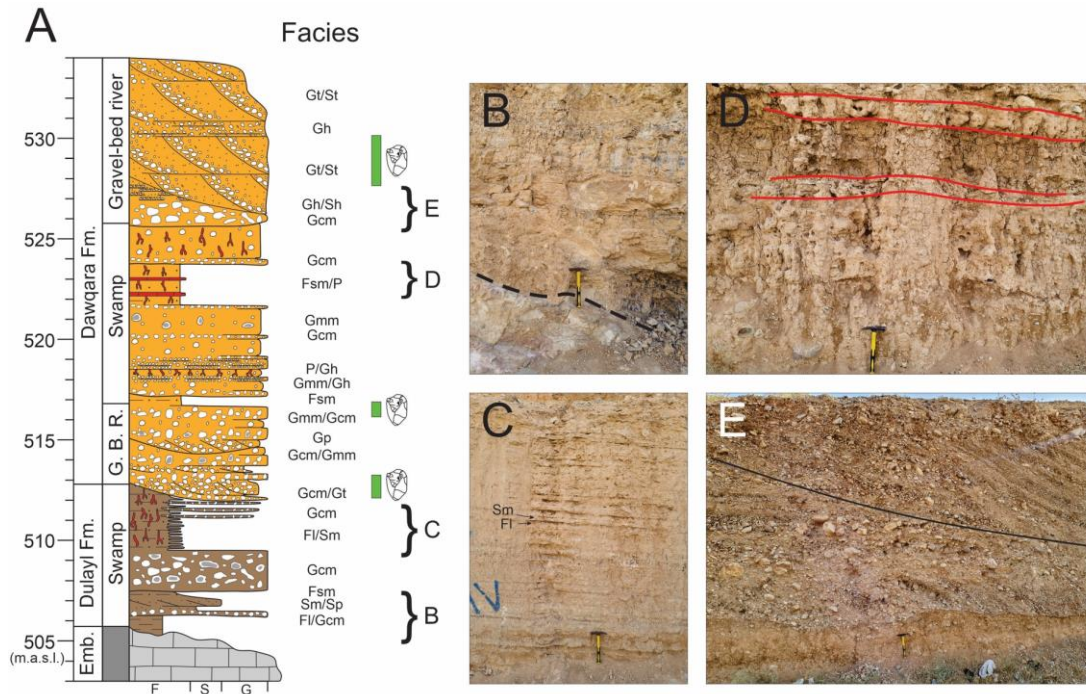
In general, the facies analysis itself does not allow the high, medium and low terraces to be differentiated. These are best classified by: (1) their relative topographical position; (2) the presence of the Upper Basalt; (3) the maturity of cement (which tends to get stronger from younger to older units); (4) the type of lithic industry; and (5) the occurrence of slope deposit facies in the middle and low terraces.

Within the fine-grained sediments of Dawqara Fm at Sites 413 (Fig. 3) and 458 (Fig. 4) widespread

pedogenic features have been observed, including rhizoliths, calcic nodules and cement precipitation within the matrix. Based on the classification of Alonso-Zarza and Wright (2010), the degree of caliche development is ascribed to stages II or III caliche (ca)



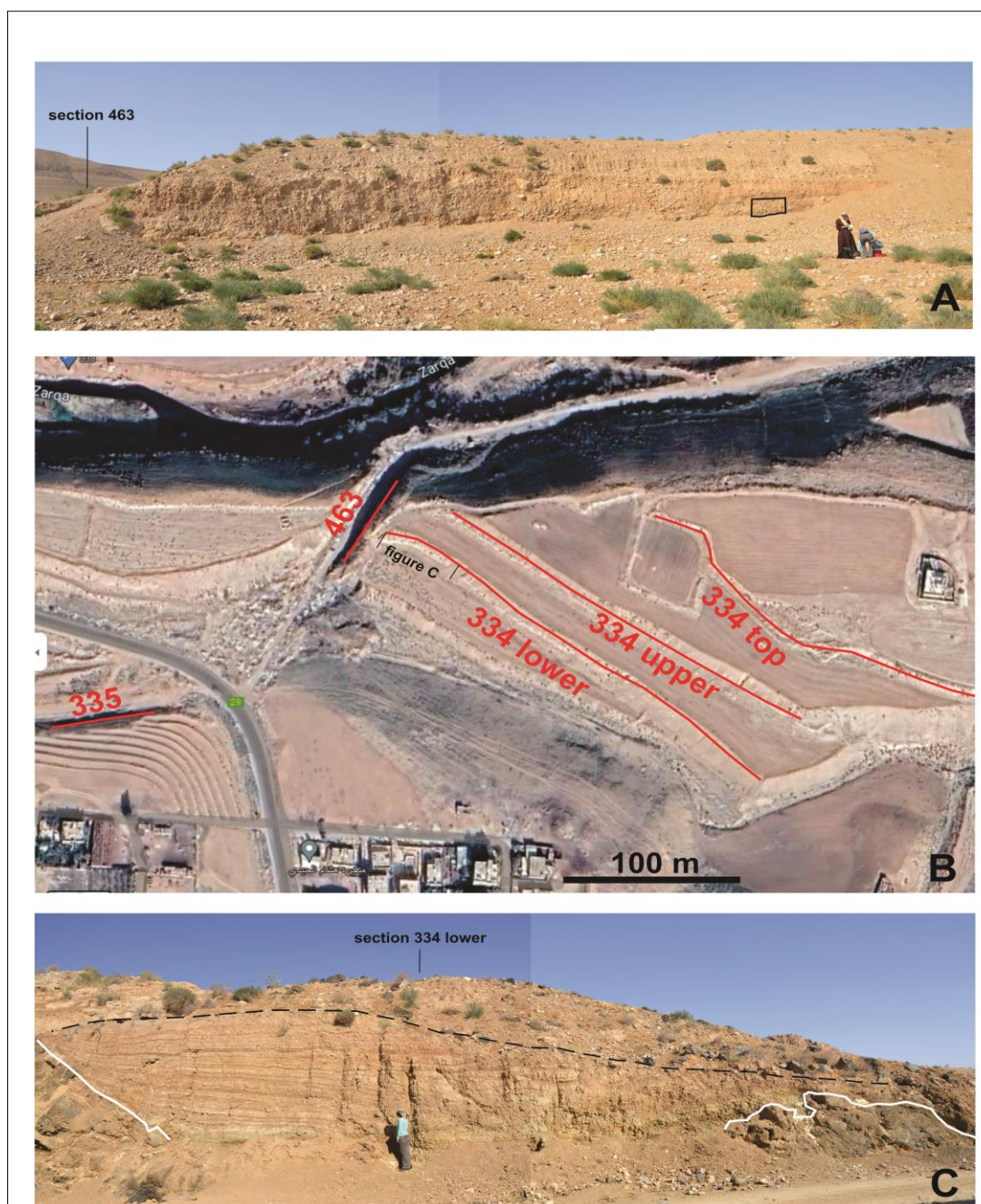
**Fig. 3. Stratigraphic survey of Site 413. A) Stratigraphic section of Site 413; artifacts were found at ca. 489 m a.s.l. and teeth remains of small mammals were found at ca. 476 m a.s.l. B) Picture of small rhizoconcretions observed in paleosols at ca. 488 m. C) Outcrop of stratigraphic interval 485–489 m. D) Outcrop of the lower part of Site 413 (475–480 m). Abbreviations: F = fines; S = sand; G = gravel; Ffacies codes from Miall (2006).**



**Fig. 4. Stratigraphic survey of Site 458. A) Stratigraphic section: green bars indicate the position of lithic artifacts, red layers and root-like shapes indicate carbonate horizons and rhizoconcretions, respectively. The position of pictures B, C, D, and E is indicated. B) Contact between Paleogene carbonate bedrock and the Dulayl Fm (dashed line). C) Picture of the rhythmite-like succession; light-coloured sediments are sandstones (Sm) and dark-coloured mudstone (Fl). D) Stage III calcrete (red lines) within the Dawqara Fm. E) Third-order bounding surface (black line) and fluvial gravel facies Gh and Gt with fining upward. Abbreviations: F = fines; S = sand; G = gravel; facies codes from Miall (2006).**

#### Archaeology of Dawqara and Birayn Formations

The first archaeological goal of the 2022 campaign was the inspection of the lowermost part of the Dawqara Fm, i.e., Site 334 Lower<sub>1</sub> and other possibly correlated outcrops. This was due to the uncertain taphonomic situation of the lithic assemblage from 334 lower, which was mainly attributed to fluvial action (Parenti et al. 2024). In this outcrop we collected a sample of 300 clasts in a 2 m<sup>2</sup>-wide area in order to compare the granulometry and morphology of the artifacts with the background lithology of the encasing sediment (Fig. 5, A). During this operation we recovered ten more artifacts from the site, now totalling 116 (Figs. 6-8).



**Fig. 5. Sites 334 and 463. A)** Western part of Site 334 lower, looking north, August 18, 2022. The sampling area for taphonomy is highlighted in black. The talus on the right (behind the two ladies) is the result of 2015 excavations. The bulk of the lithic assemblage was recovered in 2015 from this portion of the outcrop (Parenti et al. 2024). **B)** Position of 334 and 463 sites from Google Earth; on the top, the Dulayl river is erroneously named Zarqa. **C)** Site 463, looking East. This site was disturbed in 2019 during the addition of capacity to the water-pipeline. An extraordinary sequence of fine-grained sediments, just above the Upper Basalt documents the existence of small ponds in the concavities of the flow, visible on the left. The western sector of Site 334 Lower is just 15 m behind this outcrop, to the SE (this figure, C). The basalt boulders in the upper right have been reworked by agricultural activities; the white line indicates the top of the upper basalt and the dashed line separates *in situ* from reworked sediments.

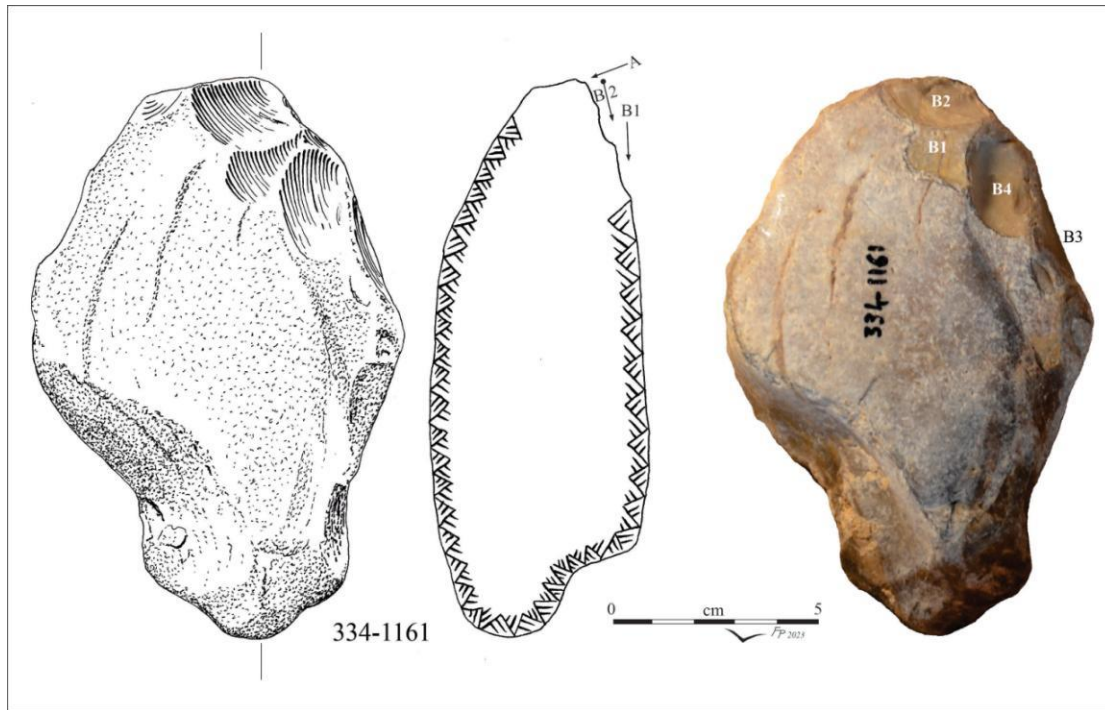


Fig. 6. Core or chopper on flat chert cobble from Site 334 Lower, weight 751 g, very abraded. Two series of flakes (A, B) have been struck on distal end, with double patina.

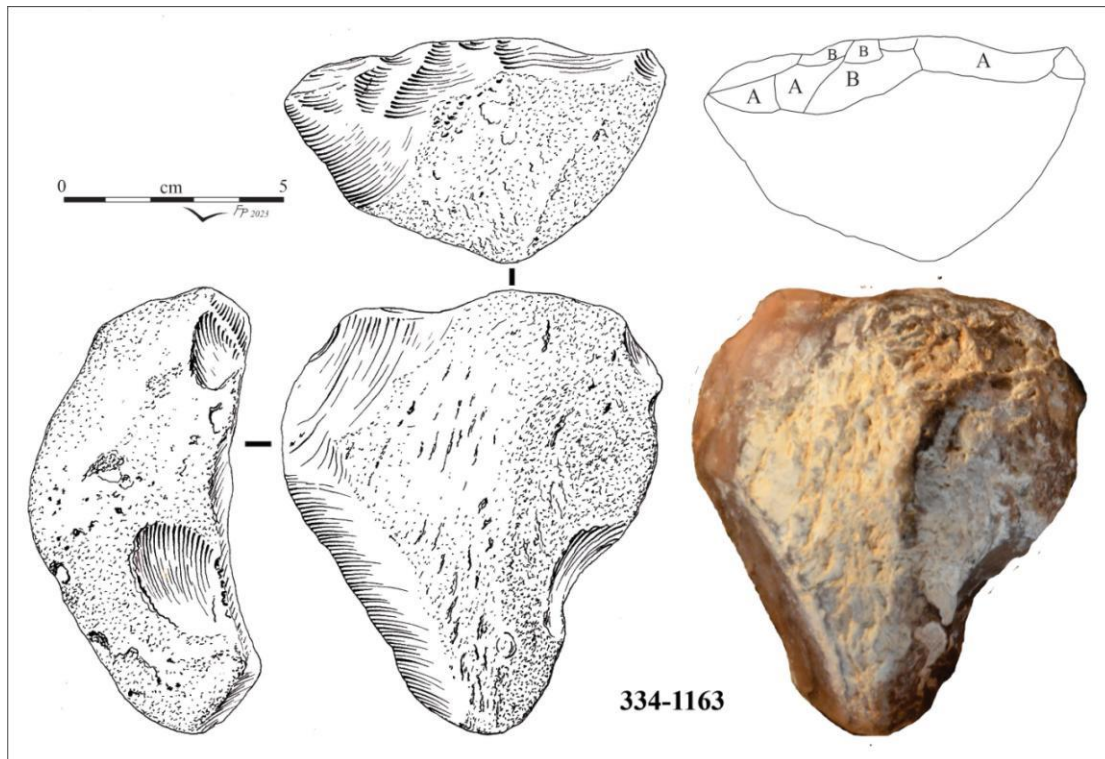
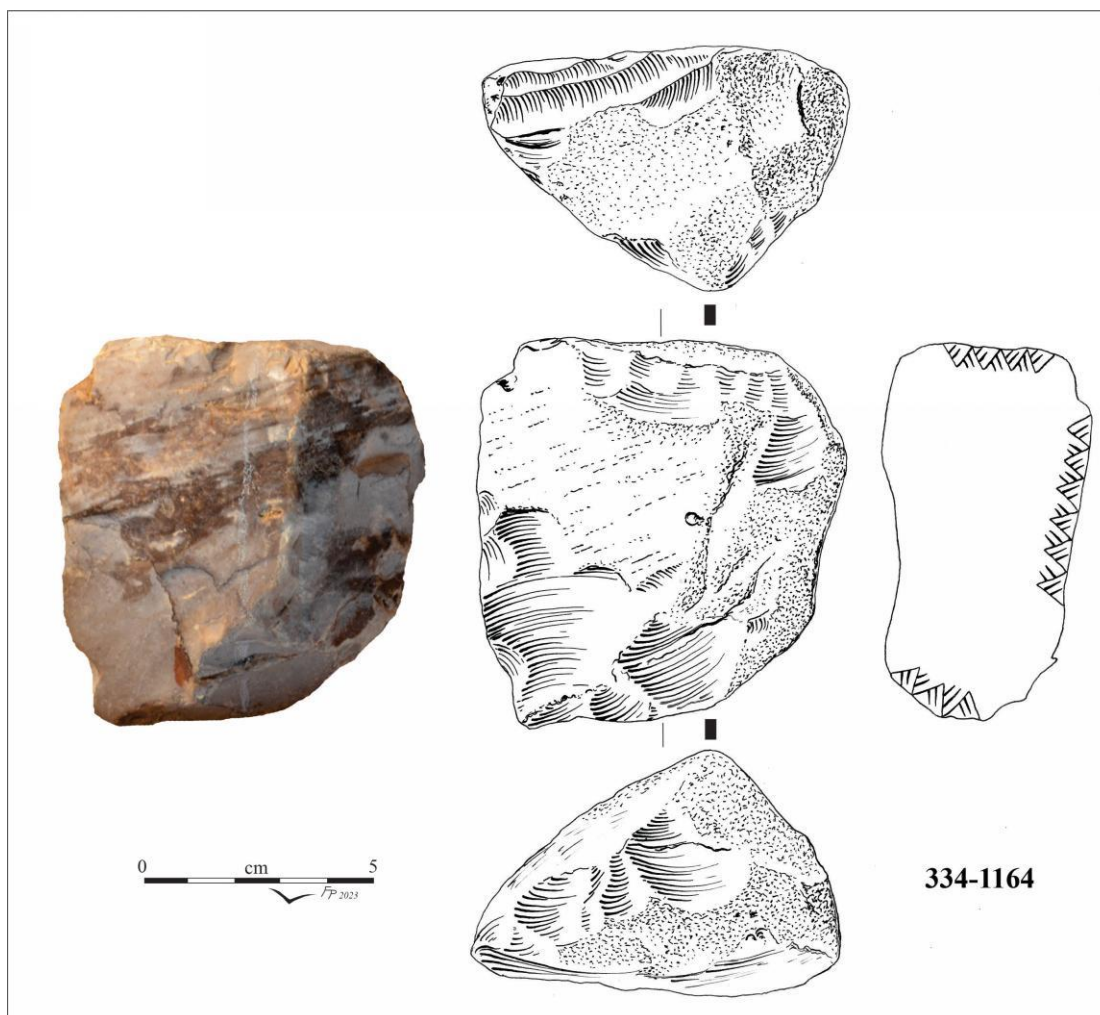


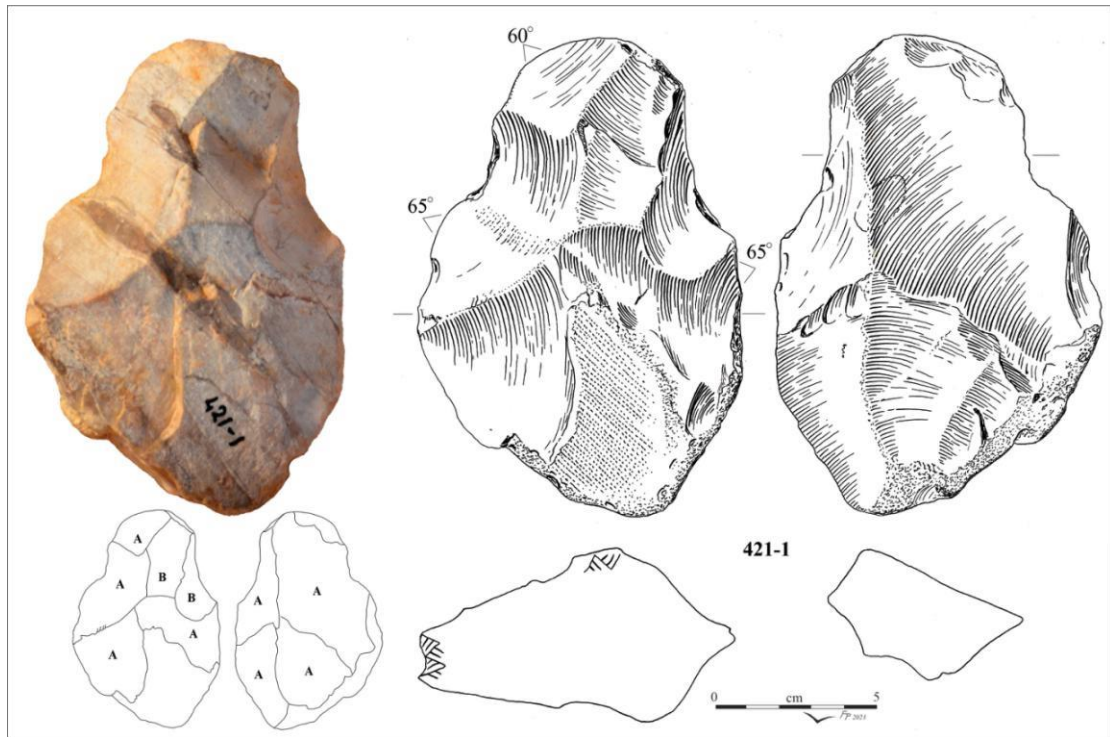
Fig. 7. End-scraper on thick and very abraded chert flake, weight 445 g, from Site 334 Lower. The distal end has been retouched in two different episodes (A, B).



**Fig. 8. Massive and worn chert flake, retouched at both ends from Site 334 Lower; cortical butt, weight 421 g.**

About 15 m NW of the Site 334 Lower we recorded a very clear sequence of laminated silty-clay in the widened cut of the pre-existing water-pipe: [Site 463](#), Fig. 5, C. This site points to wet episodes immediately following the Upper Basalt flow and its lowermost portion has been sampled for palynology.

Other previously recorded sites, both from the Dawqara or Birayn Fms, were reinspected in 2022, recovering more *in situ* artifacts, namely: 331, 332, 335, 336, 341, 356, 358, 404, 413, 421 (Fig. 9), 428, 453 and 454.



**Fig. 9. Rough and very worn handaxe, on flat chert cobble, with cortical bottom, from Site 421; it has been trimmed by two series of scars (A, B); 852 g. Although the outcrop had been reported since 2013, this is the first among seven artifacts recovered in 2022.**

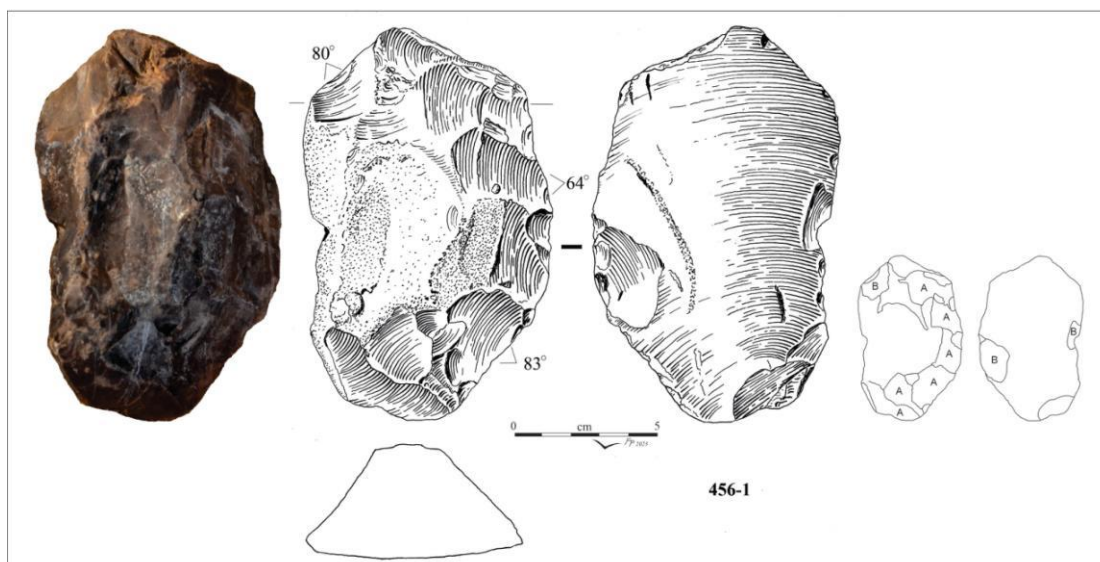
Several unknown outcrops were also surveyed in the 2022 campaign: 456, 457, 458 (Dawqara Fm) and 460, 461, 462, 466 (Birayn Fm).

Some sites deserved special attention due to their archaeological content and the paleoenvironmental potential, from north to south (Fig. 1 and Table 1):

Site 456 (Fig. 1, B), a very thick (about 8 m) sequence of coarse-grained sediments of the Dawqara Fm above the Upper Basalt on the right bank of the Zarqa River and along the road from Zarqa to Jerash. The outcrop is L-shaped and, at the bottom of its eastern margin, we collected five artifacts, among them a large and retouched flint flake with a pronounced bulb and a massive unifacial core. The outcrop is about 200 m long, but, due to its vertical extension, its inspection is impossible above human height (Fig. 10).



**Fig. 10.** Site 456: A) view from SW; B) detail from Google Earth image; C) Eastern side, at the bottom of which the 5 artifacts were recovered.



**Fig. 11.** Thick scraper on chert massive flake, partially bifacial, from Site 456. Double patina, as

**visible thanks to the two series of scars (A, B).**

Site 457 (Fig. 1, B) is a thin exposure of fluvial sediments tentatively ascribed to the Dawqara Fm immediately and above an eroded basalt flow (Fig. 12), in which we recovered a giant bifacial core (29 cm, 6221 g) obtained from an ellipsoidal chert nodule.

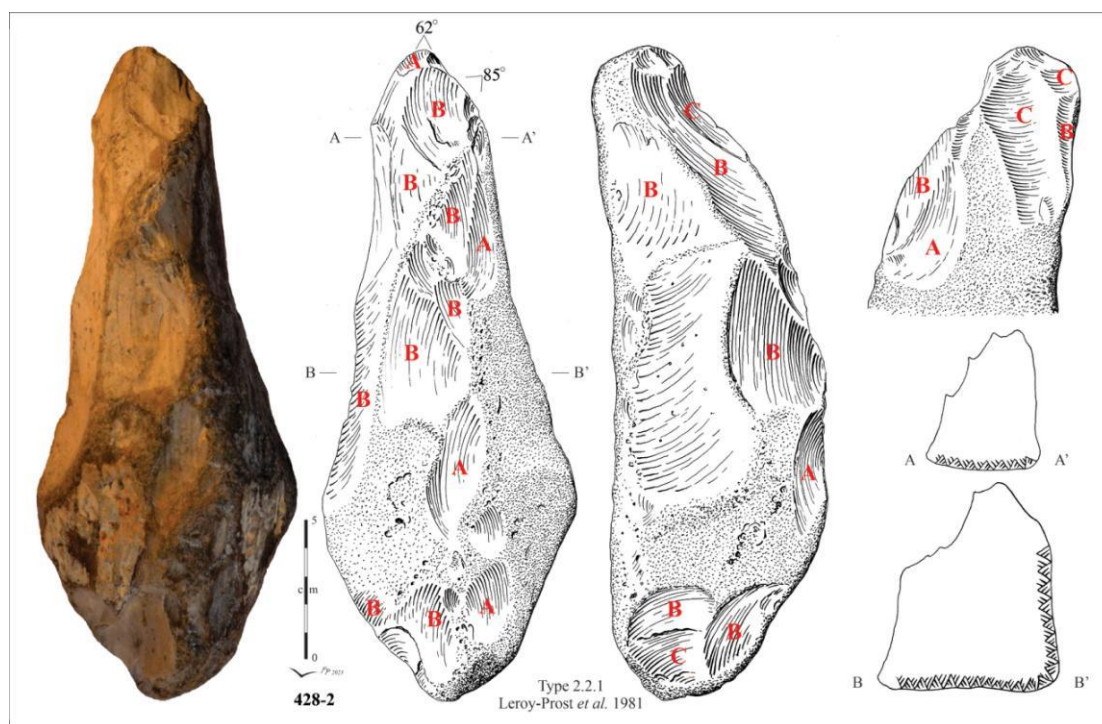


**Fig. 12: Site 457, looking East, Dawqara Fm?. Note the erosion of the basalt layer. The white ellipse points to the giant core recovered *in situ*.**

Site 428 (Fig. 1, B), first recorded in 2015, is a sequence of coarse-grained sediment with a silt layer at the bottom, directly overlaying the upper basalt (Fig. 13). Two trihedral picks are noteworthy among the eight very abraded recovered artifacts (Fig. 14).



**Fig. 13:** Site 428, looking NE, Dawqara Fm. The site is divided in two outcrops, both overlying the upper basalt (UB). In the eastern side a globular core was recovered in 2015 and, in 2022, more artifacts were localized at its bottom close to the top of the road (white point).



**Fig. 14:** Very worn trihedral pick on chert cobble, from Site 428. Three series of scars are in

**evidence (A-C). The proximal end has been summarily flaked; 1565 g.**

**Site 427'** (Fig. 1, B) is the westernmost remaining portion of a terrace formed by the Birayn Fm. It has been plotted in 2015 as Site 427, when fresh Acheulean artifacts in a paleosoil were discovered, exposed by the excavation of the entrance of a private property. In 2022 we examined the corresponding layer on the western side of the road, exposed – and destroyed – by the heavy machinery excavation for a quarry (Fig. 15). We recovered there one fresh Acheulean handaxe and four chert flakes.



**Fig. 15. Site 427', Birayn Fm, looking west, on the western side of the road. Site 427 is behind the photographer, the Zarqa River behind the site. Acheulean layer in white.**

**Site 413** (Fig. 1, B) is a huge outcrop on the left bank of the Zarqa River; it is composed of four steps, comprising the totality of Dawqara Fm. It was first examined in 1997, when a unifacial core on flint cobble was found in the exposed section of the second step from the top (Fig. 16). In 2022 its relevance was heightened due to the finding of a microconglomerate lens with microfossils in the third step from the top. A giant (226 cm, 4329 g) bifacial unplanned core with 8 scars was recovered in the nearby site, 455, correlated to the second step of Site 413.

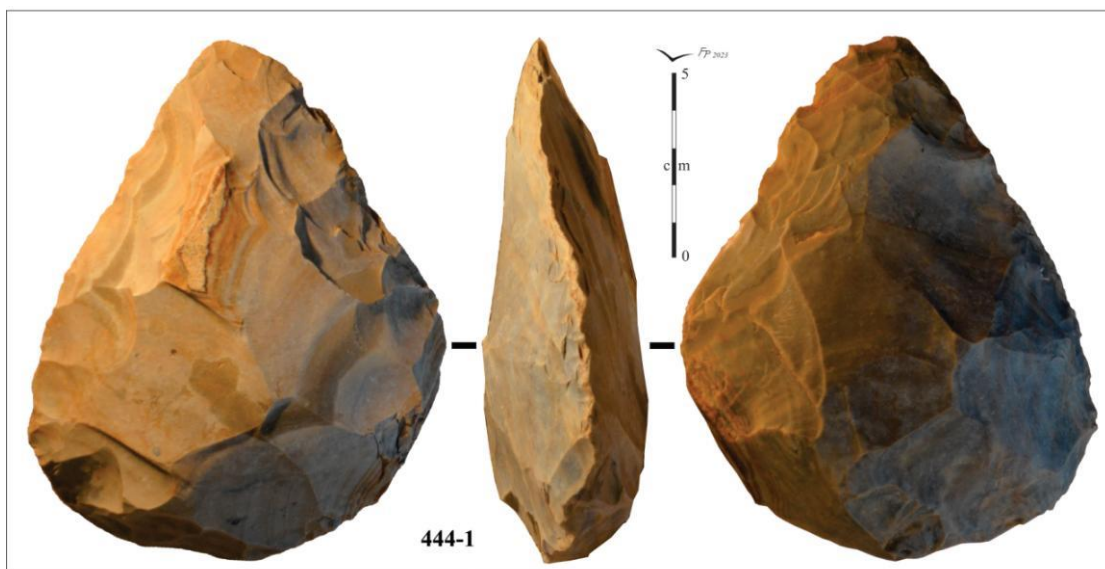


**Fig. 16. Site 413, looking South, Dawqara Fm. The fossiliferous microconglomerate layer is highlighted in white. The portion A is unexplored for fossils, B has been successfully sampled in 2022.**

**Site 444** (Fig. 1, B) was first recorded in 2022 and is a 300 m-wide and 2 m-high outcrop on the northern side of the road to Amman, just north (and below) of Site 441 (Fig. 16). It has been recently cut for agricultural purposes and it is easily accessible from the road. The top is hardened by *caliche* crust. During two careful inspections we recovered in the sandy layer seven artifacts, among them a cordiform handaxe with a large unabraded flake aside, leading to a firm attribution to the Birayn Fm (Fig. 18).



**Fig. 17. Site 444 (Birayn Fm), looking south, 441 (Dawqara Fm) on the background. Simone Belarmino pointing to the *in situ* handaxe (fig. 18).**



**Fig. 18. Cordiform handaxe on chert flake with cortical butt, from Site 444 (Fig. 16), 665 g.**

Site 332 (Fig. 1C) is one of the highest outcrops of the Dawqara Fm, a 2 m-high agricultural cut of the uppermost stratigraphic level, covered by *caliche* crust. Its relevance is due to the discovery of some very fresh artifacts in the fine-grained sediment, which makes this one of the few ideal areas for a large surface archaeological excavation. The site is 250 m west of Site 330, i.e., the richest archaeological and paleontological site of the Dawqara Fm (Parenti et al. 1997, Caneva et al. 2001).

Site 415' (Fig. 1, C): in 2022 we ascertained that Site 415 – discovered and examined in 1997 and having the highest density of artifacts / m<sup>3</sup> (Caneva et al. 2001) – had been obliterated by the construction of a new house (Fig. 19). However, a cut allowed the recording of a site at a right angle with the previous Site 415, which is relevant for the paleotopography and stratigraphy of the whole Dawqara Fm. This site is also very close (120 m) to the main Site 330.

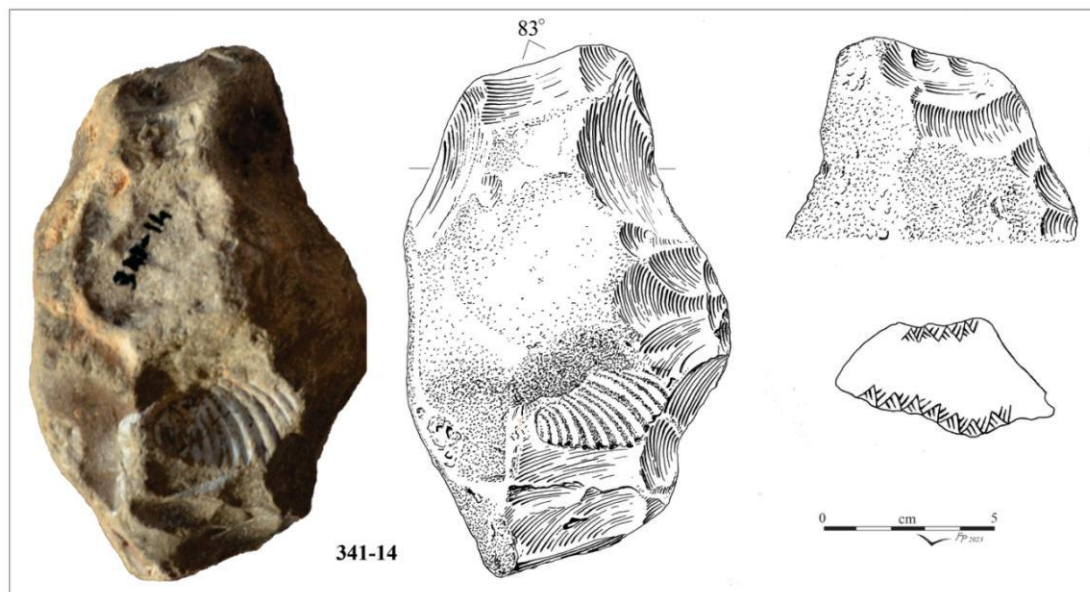


**Fig. 19. Site 415', looking NE, upper Dawqara Fm. It is at south of Site 415, now destroyed by the house. The black lines separate the uppermost reworked sediment from the underlying Dawqara Fm. This site is correlated to the master Site 330.**

Site 341, (Fig. 1, C): first recorded in 1996, it is a 120 m-long and 5 m high outcrop of coarse sediment with some silt lenses at the bottom of Dawqara Fm. In 2022 we recovered more than 15 artifacts at its bottom, two of which in fine-grained sediment (Figs. 20, 21).



**Fig. 20. Site 341, looking SE, lower Dawqara Fm. Agriculturally reworked material above the dotted line.**



**Fig. 21. Rough and worn proto-handaxe from Site 341, partially bifacially trimmed on a Cenomanian chert cobble, 762 g. On the upper face is clearly visible a fossil of cf. *Alectryonia* (family Ostreidae), as determined by Didier Merle (*Museum National d'Histoire Naturelle, Paris*).**

Site 458, (Fig. 1, B) first recorded in 2022, is a 300 m long and curved outcrop, in two steps, with an average height of 5 m and running along the south-western side of the road from Sukhne to Dawqara. The outcrop comprises about 30 m of fluvial sediments with a cross-bedded stratigraphy, encompassing the whole thickness of the Dawqara Fm (Fig. 22). We recovered 17 very worn artifacts, noteworthy among these are a small trihedral pick (Fig. 23), a proto-biface on cobble and a core-scraper on a massive flint flake (Fig. 24).



**Fig. 22. Site 458, looking SE, Dawqara Fm. The town of Sukhne is on the background.**

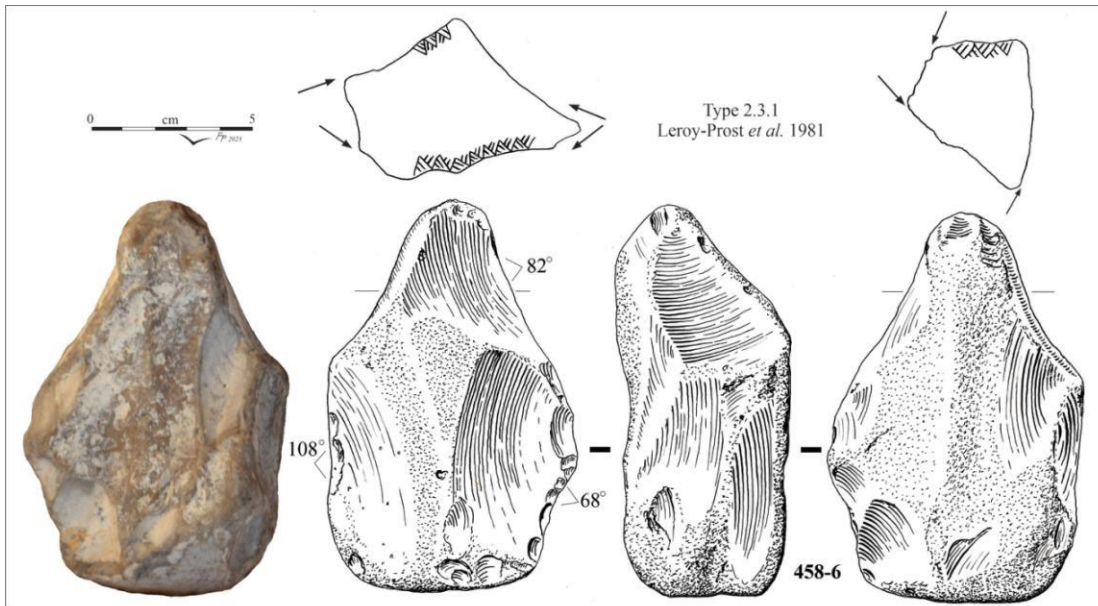


Fig. 23. Small and worn trihedral pick from Site 458, 521 g.

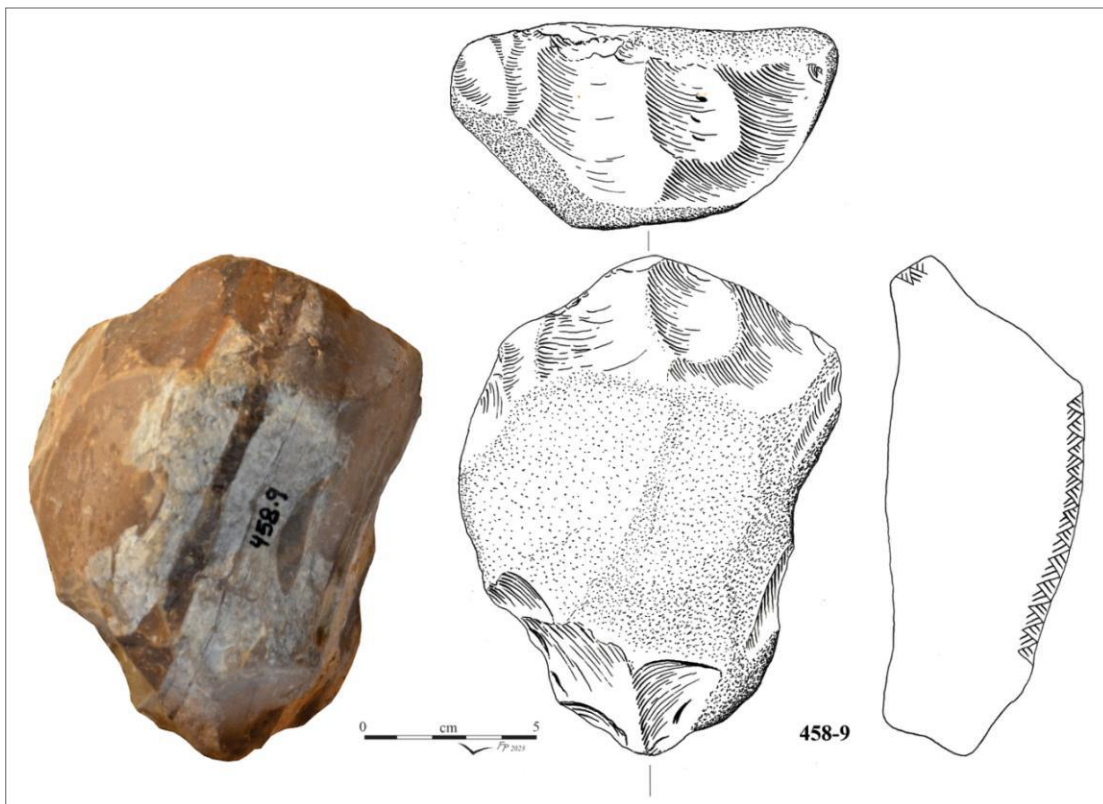
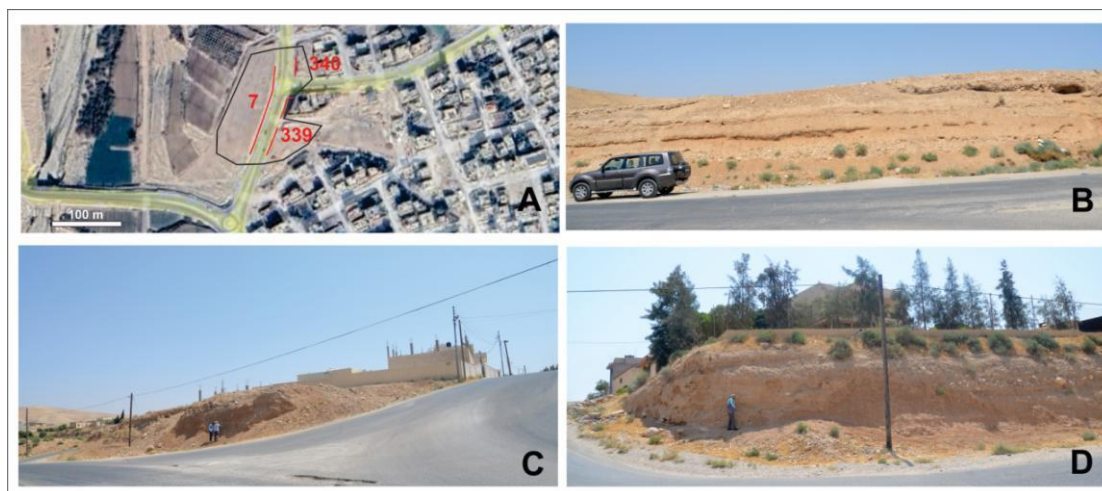


Fig. 24. Core-end scraper on massive chert flake, from Site 458; 1069 g.

Sites 7, 339 and 340, (Fig. 1, C): recorded in 1996, these three contiguous outcrops expose the remains of a huge lower paleolithic site, split by the crossroads leading to Sukhne (Fig. 25). On the top of Site 7 is the Early Bronze age site of Tell Sukhne North (Chesson et al. 1995). In 2022 we collected an additional 8 artifacts in Site 7 and 339. Site 339 produced a rodent tooth and bone fragments in 1997 and Site 7 was sampled for paleomagnetism in 2013, giving a normal polarity (Scardia et al. 2019). The whole assemblage

of the three outcrops totalizes 80 artifacts, 5 of them being handaxes and 24 retouched pieces. Because of this and of its stratigraphic position, we provisionally attribute this site to the Acheulean.



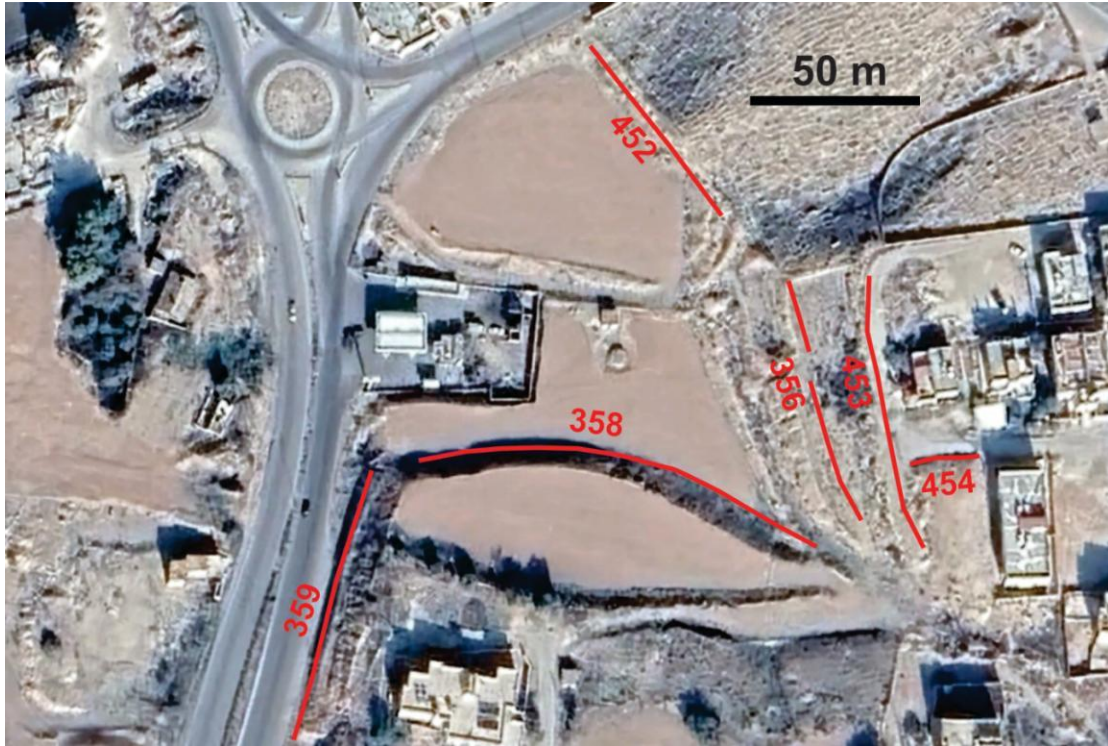
**Fig. 25. Acheulean site at the western entrance of Sukhne. A) Position of Sections 7, 339, 340, Birayn Fm. The black polygon indicates the possible extension of the remaining Acheulean site. B) Section 7, looking W, with the Bronze age site of Tell Sukhne North on the top right. C) Section 339, looking NE; D) Section 340, looking East. The person is pointing to the archaeological layer.**

Site 466, (Fig. 1, C): is a small cavity carved in the coarse fluvial sediment above a gully running S-N, which is (now) the eastern limit of the town of Sukhne (Fig. 26). In an exposed lens of sand, few meters below the top of Dawqara Fm, 9 Acheulean artifacts were recovered, among which, an ovate flint handaxe and a heavy-duty scraper are of note. The artifacts were covered by a blackish patina of Mn and lichens.



**Fig. 26. Site 466, looking west. The Acheulean layer is highlighted.**

Sites 356, 358, 453, 454, (Fig. 1, D): a dense concentration of outcrops around the gas station at the entrance of Sukhne (Fig. 27). An unabraded late Acheulean industry has been recovered *in situ* at Sites 356, 453 and 454. In Site 358, below, however, we collected two massive choppers and one undetermined flake; the stratigraphical position of the outcrop is still uncertain between the Dawqara and Birayn Fm. The chronostratigraphy of the entire sector will be revised in the next campaigns.



**Fig. 27. Sites around the gas station of Sukhne. The scale bar is on the Sukhne Islamic cemetery.**

In order to improve the recording technique of the outcrops, the Sites 330, 334, 415' and 458 have been photographed in close view and photogrammetric reconstruction is under way.

#### Microfossil Remains

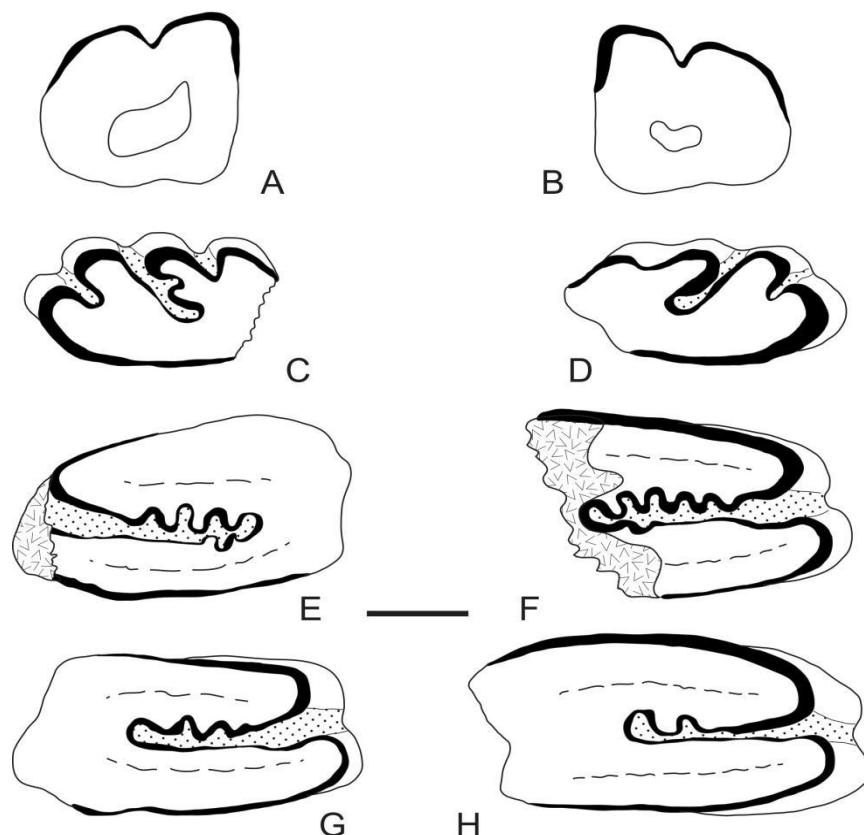
The Dawqara Fm is not rich in vertebrate fossils. Since 1996 the only outcrop yielding fossil bones is Site 330, with *Elephas meridionalis*, *Equus tabeti* and a bovid (Parenti et al. 1997). In 2022, we initiated a systematic small mammalian research in the Early Pleistocene deposits. Only one site yielded identifiable remains of small mammals (Site 413, Figs. 1B, 16), while in another (Site 428, Figs. 1B, 13) we only found unidentifiable bone fragments.

The remains from Site 413 (Fig. 28) consist of two teeth of a murid rodent and a dozen teeth of a lagomorph. The murid is represented by two lower molars (m1 and m3), both indicating a large-sized rat that can be identified as *Arvicanthis* sp. The Early Pleistocene locality of 'Ubeidiya in Israel also yielded four teeth similar in size and morphology to that of Zarqa (Tchernov, 1986).

This genus is well known in Pliocene and Pleistocene localities of south-western Asia, southeast Europe and North and East Africa. Its extant species inhabit Africa in a variety of environments from dry woodland to the more densely wooded depressions with ponds or rivers.

The remains of rabbits are more abundant at Site 413 and consist of isolated teeth (2 upper incisors, five P2s, two P3s, three P4s or M1s, one M2, one M3 and five fragments of lower cheek teeth), representing a medium-sized leporid. The deep grooves on the P2 and wrinkled enamel along the anterior wall of flexa on the upper cheek teeth exclude any comparison with the rabbit genera *Oryctolagus* and *Hypolagus*. The best comparison can be done with species of *Lepus* and *Trischizolagus*. The latter genus is well represented in Europe with several species between about 6.5 and 3.0 Ma (Čermák and Wagner 2013.) and also in Northwest Africa between ca. 3 and 1 Ma (Sen and Geraads, 2023.). All species of *Trischizolagus* have an elongated

upper incisor with a round anterior face. The second upper premolar (P2) has flexa much less deep than that of Site 413. On the other hand, the upper molariform teeth of this genus are quite similar.



**Fig. 28. Upper teeth of Leporidae gen. and sp. indet. from Site 413, in occlusal view. A. left upper incisor, B. right upper incisor, C. left second premolar (P2), D. right P2, E. left P4, F. fragment of right P3, G. right M1 and H. right M2. Scale bar 1 mm.**

Hares (genus *Lepus*) are well dispersed all around the Old World. In the Middle East two extant species share territories: *Lepus capensis* in the southern and *L. europaeus* in the northern regions. The shape of the upper incisors and P2s from Site 413 recall that of these species. However, the size of all teeth in these species is 1/3 larger than that of Site 413, and all *Lepus* species have strongly wrinkled enamel all around the flexa of upper molariform teeth, while the same teeth have enamel wrinkled on the anterior border of flexa on the Site 413 specimens.

It is premature to attribute the leporid of Site 413 to any of these genera. We must remember that the systematics of fossil Leporidae are mainly based on the morphology of the teeth, in particular on the occlusal pattern of the lower third premolar (p3). This tooth is missing in our sample. On the other hand, the lack of comparative material from fossil sites in the Middle East does not facilitate the comparison process. Indeed, fossil lagomorphs are poorly documented in the Middle East. Tchernov (1986) reported on *Hypolagus brachygnathus* from 'Ubeidiya, a well-known Pleistocene leporid in Europe. Bar-El and Tchernov (2000) mentioned the occurrence of the extant Cape hare *Lepus capensis* in nine southern Levantine prehistoric sites (Middle-Late Pleistocene), without, however, any illustrations or measurements allowing comparison to our specimens.

### Conservation and Threats

The numerous outcrops of the Zarqa Valley have different origins (Table 1): more than one third (36) is agricultural, especially positioned at short distances from the river channel, due to the lack of arable land and the weak power of pumping equipment available to local farmers. The number of this kind of outcrop was increasing in 2022, owing to the demand for nursery plantations, mainly of olive trees. Road cuttings in the area have risen to 30 and are increasing because of growing automotive traffic into the expanding northern

Zarqa suburbs. Outcrops created by erosion (13) – which can be violent in arid environments – are also relevant, but usually not very high or steep. Private buildings are also an important source of cuts (10), but these are often difficult to inspect as they require owner permission. Almost vertical cuts are visible along the pipe-lines (3) – as in the case of the astonishing Site 463, Fig. 5C. All sites are in some measure “moving”, albeit at different rates: agriculture and roads being the fastest. These two categories differ in terms of their ownership and – consequently – their access: cuts along main roads are of public domain, but private properties (agriculture and buildings) can constitute a severe obstacle to inspection. In some cases, their disappearance in the short term is announced by the owner himself, as was the case for Site 456 (Fig. 10). Obviously, in such a fast-evolving landscape, constant checking by the DOA officials is necessary, but it would be partially useless without the capillary education of local communities on the value and potential of prehistoric, non-monumental heritage sites.

## CONCLUSIONS

The main results of 2022 campaign are: 1) extension of the geological map of Quaternary formations to the north, which allowed for point 2), the increase of the total area covered by the Dawqara Fm; 3) the geo-archaeological and taphonomic analysis of Site 334 Lower, the main outcrop of the oldest unit of Dawqara Fm; 4) the renewed exploration of other sites possibly related to the same period (335, 336, 341); 5) the discovery of a new and promising fossiliferous locality (Site 413); 6) the discovery of three more Acheulean stratified sites (444, 427', 466) and; 7) the recording of a thick site comprising the totality of Dawqara Fm (458). Finally, it is worth noting the wide repercussion that the age of the sites of Zarqa Valley achieved in 2022, as documented by the visit which His Royal Highness Prince Assam Bin Talal kindly gave us on August 28 (Fig. 29).



**Fig. 29. Visit of HRH Hassam Bin Talal at Site 341, on August 28, 2022. 1) Tareq Nasser Judeh, grandson of HRH Prince al Hasan; 2) Valeria Romare, vice-ambassador of the Italian Republic; 3) Prof. Fadi Bala'awi, head of the Department of Antiquity of Jordan (DoA); 4) Private guard 5) Aktham Oweidi, Director of Excavations and Surveys of DoA; 6) Ghassan Al-Deir, general directorate of DoA; 7) Elham Omar Ahmad Aljabali, DoA representative; 8) Hamid Hadeed, office staff of the director general; 9) Simone Belarmino, archaeologist, Brazil; 10) Fabio Parenti, archaeologist, director of the survey; 11) HRH Hasan Bin Talal; 12) Akram Ootom, director of Zarqa Antiquities' Directorate.**

The survey has strengthened the importance of the upper Zarqa Valley as the cradle of the oldest human

peopling in the Levant, itself the land bridge for the first hominin expansion outside Africa in the Lower Pleistocene.

#### **ACKNOWLEDGEMENTS**

We thank all the personnel of the Department of Antiquities of Jordan for his kind assistance and constant help in the field campaign. The Italian and the Brazilian embassies in Jordan for diplomatic support; the *Coordenadoria de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES, Brazil) for funding the F. Parenti's mission and the São Paulo Research Foundation (FAPESP, Brazil) for funding G. Scardia (2022/05689-6) and J.C. Cerqueira (2021/10300-8); the two anonymous reviewers for their useful suggestions; a special thanks to Mr. Emilio Cabasino, who kindly supported our activities in Amman and to Alan Cannell who revised the English text.

## مسوحات عام 2022 للعصور الحجرية القديمة في وادي الزرقاء / الأردن

فابيو بارينتي<sup>1</sup>، جيانكارلو سكارديا<sup>2</sup>، جواو كارلوس سيركويرا<sup>2</sup>، سيمون بيلارمينو<sup>3</sup>، مارتين فور<sup>4</sup>، سيفكيت سين<sup>5</sup>

### ملخص

كشفت المسوحات الأثرية الجديدة التي جرت في أعالي وادي الزرقاء في الفترة بين شهري تموز وأيلول من عام 2022م عن مواقع جديدة تعود لزمّن البلايستوسين المُبكر والمتوسط؛ حيث توجد فيها تراكمات وترسبات نهريّة/بحريّة جيولوجيّة قديمة. وقد خلصت النتائج إلى الآتي:

1. امتداد المواقع الأثرية التي تعود إلى تشكيل دوقرة الجيولوجي (البلايستوسين المُبكر) إلى المنطقة الشماليّة من محافظة الزرقاء.

2. اكتشاف سِنٍّ أحد القوارض في طبقة تشكيل دوقرة الجيولوجي.

3. تسجيل ثلاثة مواقع آشولية متوسطة جديدة فيها تسلسل طبقات؛ مما يشير إلى أنّها تصلح لإجراء أعمال تنقيب جيولوجي/أثري بها في المستقبل.

يشير الظهور المتكرّر لبقايا الترب القديمة (Paleosols) في تشكيل تكوينات دوقرة (البلايستوسين المُبكر) وتكوينات بيرين (البلايستوسين المتوسط) الجيولوجي إلى إمكانية الحصول على بقايا أثرية جديدة؛ مما يساعد على وضع تسلسل منطقي للتطوّرات البيئيّة القديمة التي حصلت في منطقة أعالي وادي الزرقاء. وبناءً عليه، فإننا نطالب بالمحافظة على هذه المنطقة من العبث والتدمير، آخذين بعين النّظر أنّها تُمثّل أقدم منطقة تعود لفترات العصور الحجرية في بلاد الشام.

**الكلمات الدالة:** العصر الحجري القديم الأدنى، علم الطبقات الأثرية، عمليات التحلّل، عصر البلايستوسين، وادي الزرقاء، الأردن.

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تاريخ استلام البحث 2023/5/22، وتاريخ قبوله للنشر 2023/9/17.

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