Chapter 1
Introduction: Azokh Cave and the Transcaucasian Corridor

Yolanda Fernández-Jalvo, Tania King, Levon Yepiskoposyan, and Peter Andrews

Abstract Azokh Cave (also known as Azikh or Azykh) contains Pleistocene and Holocene stratified sediment infill. The site was discovered by M. Huseinov (also named Guseinov by other authors) who led the previous phase of excavations. The geographic location of the site is at an important migratory route between Africa and Eurasia. The site has yielded Middle Pleistocene hominin remains (a mandible fragment) recovered in the 1960s during a previous phase of excavation work, together with Acheulean (Mode 2) stone tools and contemporaneous fauna. An important characteristic of the Azokh 1 cave site is a continuous sedimentary record along a 7 m section, ranging in age from Middle Pleistocene (MIS 9-8) to Late Pleistocene (Mousterian industry/Mode 3, MIS 5), and to Holocene periods at the top of the series. This detailed record documents three species of *Homo*: ancestors of Neanderthals, *Homo neanderthalensis* and *Homo sapiens*. In addition, two new fossiliferous sites, Azokh 2 and Azokh 5 (which are currently being explored), constitute a potential new source of information, especially about the Middle to Late Paleolithic transition and Holocene periods in the area. Plans for preservation and protection of the whole site are currently in progress.

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Резюме Пещера получила свое название от деревни Азох, расположенной в двухстах метрах от нее в долине. Это карстовый комплекс Южного Кавказа с узкими коридорами и входами, заканчивающимися более широкими камерами, в которых в настоящее время обитает большая популяция летучих мышей.

Карст имеет сложное происхождение, и седиментные наполнения содержат информацию о различных стадиях развития пещеры и ее экологии. Некоторые входы пещеры богаты ископаемыми организмами, указывая тем самым, что эти пространства в прошлом – от среднего плейстоцена до голоцена – были заселены людьми и различными формами животных. Главный и самый большой вход, известный в литературе как Азых, был обнаружен в 1960 г. М.Гусейновым, который до 1980 г. возглавлял раскопки стоянки. Ископаемые организмы в двух новых входах и соединениях последних с внутренними камерами, как и остатки отложений в задней части главного входа, в настоящее время исследуются международной экспедицией, с 2002 г. проводящей здесь раскопки.

Стоянка расположена на естественной магистрали через Кавказ, по которой ранние гоминиды и животные могли мигрировать из Африки в Европу и Азию. Азохская пещера была поочередно заселена тремя видами гоминид – *Homo heidelbergensis*, *Homo neanderthalensis* и *Homo sapiens*, ископаемые останки которых, хотя и разрозненные, найдены здесь.

Среди видов животных наиболее богато представлен гигантский пещерный медведь, здесь обнаружены и другие травоядные и плотоядные формы. Каменные орудия, встречающиеся вместе с ископаемыми костями животных, со следами разрезов указывают на активную деятельность людей на данной стоянке. Непрерывный слой плейстоценовых отложений содержит сведения о переходе от среднего к позднему плейстоцену, которые могут быть ключевыми для понимания происхождения неандертальцев и их предков. Ископаемая фауна и культурные свидетельства предоставляют информацию

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о поведении человека и животных и их социальных стратегиях. Обнаруженные остатки флоры и фауны в этих отложениях характеризуют экосистемы и климат в эпоху плейстоцена.

К сожалению, поверхностный слой подразделения II подвержен сильной эрозии, и находки эпохи голоцена появляются в прямом контакте с плейстоценовыми отложениями. Таким образом, если в действительности и существовали материальные свидетельства о переходном периоде средний–поздний палеолит (т.е. *H. neanderthalensis* – *H. sapiens*), то во входе *Азох 1* они были размыты. К счастью, недавно открытые и все еще находящиеся в стадии предварительного исследования входы *Азох 2* и *Азох 5* имеют достаточно толстый слой седиментов для возможной регистрации временнóго пробела последних 100 тыс. лет.

В книге представлены результаты исследования, которые главным образом основаны на коллекции фаунальных, ботанических и культурных образцов, собранных за 2002–2009 гг. Данная глава описывает историю раскопок и иных форм исследований в пещере в течение начальных восьми полевых сезонов.

Keywords Azykh, Azikh • Human evolution • Pleistocene • Paleofaunas and paleobotany • Stone tools

Introduction

Azokh Cave is located in Nagorno-Karabakh, within the Lesser Caucasus (39º 37.15′ N; 46º 59.32′ E Fig. 1.1). It is an important site for the understanding of human evolution in its archeological, paleontological, environmental and ecological context. The site takes its name from the nearby village, situated in a valley 200 m from the cave (Fig. 1.1b), but it is also known in the literature as Azykh or Azikh. This area was a natural corridor and refuge between Africa and Eurasia during the Pleistocene (Fig. 1.2), indicated by the number of Pleistocene sites in the region (Grün et al. 1999; Gabunia et al. 2000; Lioubine 2002; Fernández-Jalvo et al. 2004, 2010; Tushabramishvili et al. 2007; Doronichev 2008; Mosar et al. 2010).

This chapter includes an introduction to the sites, their location, and the relevance of Azokh Caves to studies of the Middle to Late Pleistocene of the Caucasus. The history of the archaeological expeditions and excavations at Azokh from first discovery to the present are briefly described, and the renewed investigations (2002–2009) at Azokh Cave are described in detail. Two new sites (Azokh 2 and Azokh 5, Fig. 1.3a) have been discovered and provide an additional interest to the previously known site (hereinafter referred to as Azokh 1). Finally, the content of each chapter in the volume is briefly described together with the main findings.

Azokh Cave is significant for several reasons. The site is situated on the migration route through the Caucasus that early hominins and fauna may have followed during passage from Africa into Europe and Asia. Secondly, the caves of Azokh were occupied by three species of hominin for which fossil remains are known. Early research delineated ten stratigraphic "units", numbered X–I from oldest to youngest. Our analysis has identified these units, except for the bed-rock, Unit X, that we have not recognized (see below). In 1968 the first hominin fossil was discovered in Unit V during the Huseinov excavations. This specimen is a small fragment of mandible assessed by Kasimova (2001) as a Middle Pleistocene hominin with affinities closest to the Ehringsdorf sample. We consider this specimen to be *Homo heidelbergensis* (Fernández-Jalvo et al. 2010; King et al. 2016). The current

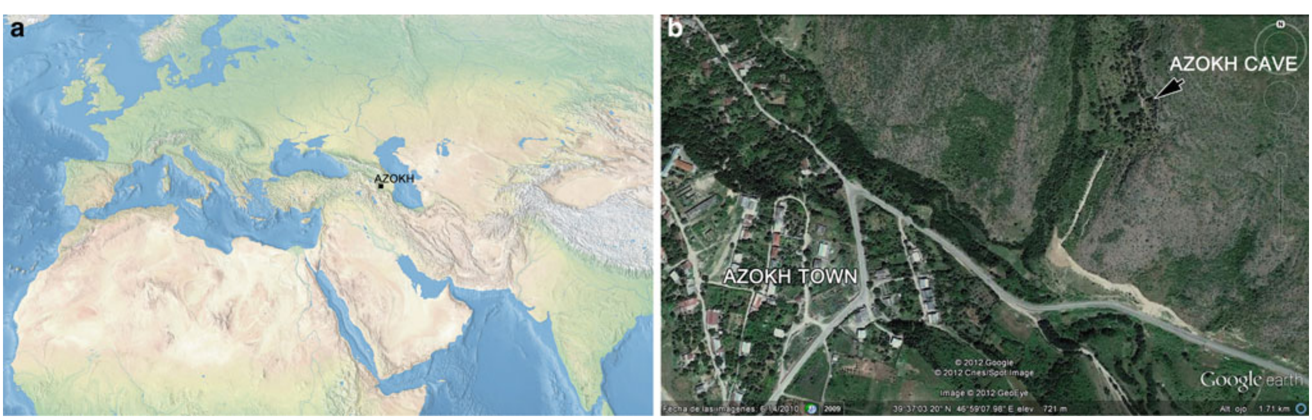

Fig. 1.1 **a** Location of Azokh in Eurasia. **b** Satellite view of the Azokh Cave site (from Google Earth), named from the closest town nearby. The site is located 200 m up on the hill

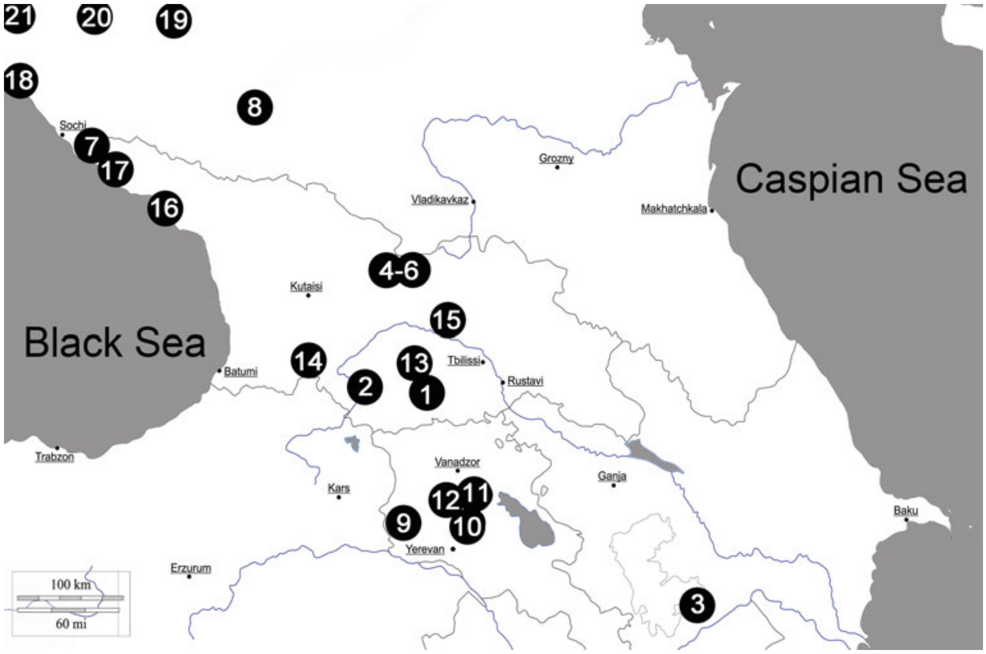

Fig. 1.2 Location of Azokh Cave (3), and pre-Acheulean and Acheulean sites described by Lioubine (2002). 1: Dmanisi; 2: Mont Amniranis; 3: Azokh; 4: Koudaro I; 5: Koudaro II; 6: Tsona; 7: Akhchtyr Cave; 8: Treugolnaya Cave; 9: Satani-Dar, Erkar-Blour, Aregouni-Blour, etc.; 10: Arzni; 11: Djraber; 12: Atiss; 13: Tchikiani; 14: Perssati; 15: Lache-Balta, Kaleti, Tigva, Gorisstavi, etc.; 16: Yachtoukh, Gvard, Otap, etc.; 17: Bogoss; 18: Cap de Kadoch; 19: Abadzekhaya, Chakhanskaja, etc.; 20: Ignatenkov koutok; 21: Abin (from Fernández-Jalvo et al. 2010)

research team has recovered a *Homo neanderthalensis* tooth from Unit II of Azokh 1, and teeth and postcrania of *Homo sapiens* from Azokh 2 and Azokh 5 (King et al. 2016). The main chamber of Azokh 1 Cave has a continuous sedimentary sequence that documents the time span of the first two of these Pleistocene human species.

Recent paleontological and genetic results (Krause et al. 2010; Reich et al. 2010) at Denisova, Siberia, raise questions about the diagnosis of *Homo heidelbergensis* and whether it was the potential ancestor of *Homo neanderthalensis* or *H. sapiens* (Stringer 2012). In this respect, Azokh cave sediments contain a detailed and nearly continuous record that includes the cultural remains of different technologies (from Acheulean to Mousterian-Levallois), in association with hominin fossils. Contemporaneous sites located in the Northern Caucasus (e.g., Mezmaiskaya, Tsona, Djruchula, Kudaro I, Kudaro III, and the slightly older Treugol'naya) have limited records of this transition affected by time averaging events (Liubin et al. 1985; Lioubine 2002; Tushabramishvili et al. 2007; Doronichev 2008; Zeinalov 2010). However, all these sites together provide a complete context of the Middle–Late Pleistocene interval along the Trans-Caucasian corridor.

Another important period in human evolution is the transition between Middle and Late Paleolithic, the cultural transition from *Homo neanderthalensis* to *Homo sapiens*. Unfortunately, the sedimentary sequence at Azokh 1 has an erosional disconformity at the top of Unit II, so that Holocene periods (Unit I) are in direct contact with Middle Paleolithic sediments. No record of the Middle–Late Paleolithic transition is, therefore, recorded in Azokh 1, although it was present in the past, as shown by scattered finds of typical Late Paleolithic stone tools at the bottom of Unit I sediments. The transition may be present at two adjacent cave entrances, named Azokh 2 and Azokh 5, which open into the same underground cave sequence, and which contain enough sediment thickness to potentially record such a transition in place and undisturbed (Domínguez-Alonso et al. 2016; Murray et al. 2016).

The top of the sedimentary sequences of Azokh caves (Azokh 1, Azokh 2 and Azokh 5) provides evidence that the cave was inhabited by humans during Holocene times. A collection of ceramics from Azokh 2 dated to the 8th century AD (1265 ± 23 years BP, see Appendix radiocarbon) has been recovered during the recent excavations. All *in situ* fragments are associated with hearths and domestic

Fig. 1.3 **a** Panoramic view of the localities of Azokh cave sites, Azokh 1 (The main cave passageway dug by Huseinov's team), Azokh 2 (formerly named 'Azokh North') and Azokh 5. **b** View of the trench dug by Huseinov's team near the mouth of the cave, leaving exposed Units IX to VII. The white arrow points to the 'pedestal' a landmark of the cave. The black arrow points to the Unit VI at the base of the pedestal. **c** View of Azokh 1 cave taken from the Uppermost Platform. The green line on the cave wall indicates the original sediment height removed between 1960 and 1980 (the white arrow indicates the 'pedestal' as landmark)

animal remains. The ceramics were made on pottery wheels belonging to a tradition that can be linked to the Iberian Peninsula, where this style persisted to the 12th century. In both this area and Iberian regions we find similar techniques and decorative motifs, such as green-manganese decoration. This tradition originated in Baghdad with a clear Byzantine influence, and it is based on the applications of copper oxide to achieve the green color and manganese oxide for purple, both set against a white luster-glazed background. It is certainly of great interest to recognize how this modern human civilization spread its culture, behaviors and art across different geographic areas becoming successfully adapted to the necessities of different populations. An international team of specialists (J. Gómez, B. Márquez, H. Simonyan, T. Sanz) is currently investigating these ceramics, and they provided these preliminary results.

The current excavations have concentrated on the deep parts of the cave entrance in Azokh 1. They have revealed evidence of seasonal occupations of the site, as well as social living and survival strategies of both hominins and fauna, particularly cave bears. The faunal and botanical remains recovered from Azokh provide information on the past ecosystems and environments, i.e. the context in which these hominins (both extinct and modern species) evolved, as well as the cultural techniques they developed.

History of Excavations at Azokh Caves

Excavations 1960–1988

Excavations were initiated by Mammadali Huseinov (National Academy of Sciences of the Azerbaijan SSR), who discovered the site in 1960 (see Mustafayev 1996; Lioubine 2002; Doronichev and Golovanova 2010). Early excavations at the site (1962 to 1974) led by Huseinov focused on the main entrance of the Azokh 1 passageway, when the cave sediments reached to within 3 m of the roof (Lioubine 2002). In 1968, Huseinov discovered a human mandibular fragment from Unit V that he named as ‘Azikh anthropos’ or ‘Palaeoanthropus azykhensis’.

Huseinov (1965, 1974) differentiated 10 stratigraphic layers, but paleogeographers Velichko and colleagues distinguished 17 horizons (see references and descriptions in Lioubine 2002). Units distinguished by Huseinov (Velichko’s horizons in brackets) are as follows:

- Layer I (Horizon 1) Humus Medieval-Chalcolithic/Copper Age.
- Layer II light yellow silts with angular clasts of almost no thickness at the central part of the entrance gallery (∼Horizon 1) with some Mousterian flint/chert.
- Layer III originally described as grey silts with angular clasts (horizons 2–3) and limestone blocks covering a large surface (Mousterian). The description of this layer was further distinguished by Huseinov and divided into three horizons: (1) crumbly dark grey silt, having manganese-staining at the bottom and containing Mousterian tools. (2) grey silt with mixed clasts at the anterior part of the circular hall containing limestone plaques 1.5 × 0.6 × 0.12 cm and Mousterian tools. (3) light grey silt and yellow silts at the bottom, without clasts, containing late Acheulean or early Mousterian tools.
- Layer IV (Horizon 4) dark brown silts with angular limestone plaques, sterile in archaeology and large mammals.
- Layer V yellow silty unit containing different horizons of diverse colors (Horizons 6–11) Acheulean (Horizon 10 yielded the human mandible).
- Layer VI yellow-grey sandy silt containing rounded clasts (Horizon 12).
- Layers VII–X, 4–4.5 m of grey-bluish clayey silt (Horizons 13–17), with ‘Kuruchai pebble culture’.

Layers VII to X sediments are exposed today in a trench at the entrance to the Azokh 1 passageway (Fig. 1.3b). Pebbles found in Layers X, IX and VII were considered to document an ancient Paleolithic industry, named by Huseinov the *Kuruchai pebble culture*, “… as the Azikh Cave is located in the Kuruchai River basin. The only other known civilization equivalent to Kuruchai Culture dates back 1.5 million years to the Olduvai Gorge in Tanzania. Huseinov believed the Kuruchai Culture dated from between 1.5 million years to 730,000 years ago” (Mustafayev 1996, p. 26). The pebble culture described by Huseinov, however, has been challenged by several authors (e.g., Lioubine 2002; Doronichev 2008; Doronichev and Golovanova 2010 and references therein) who dispute the likelihood of human manufacture of the stones from the lowermost layers, and this issue is still under debate. Huseinov (1985) also mentions that the Matuyama-Brunhes paleomagnetic reversal is located in Layer VIII, suggesting an Early Pleistocene age for the very basal part of the stratigraphy. Huseinov (1974) also described several hearths from Layers VI, V, and III and a series of pits that were encircled with cave wall blocks that the author stated were made by prehistoric humans.

After 1975, a multi-disciplinary Russian-Azerbaijani collaboration took place. This collaboration among different specialists resulted in a more complete description of the lithology and sedimentology of the site. These workers measured sections from the edge of the cave to deeper in the cave entrance. They also described the faunal and lithic remains that had been found. The volume of sediment excavated was extensive, with about 70% of the intact sediments extending as far back as 35–40 m from the cave entrance opening, being removed (Fig. 1.3c). Excavations focused on the trench at the edge of the cave entrance (Layers VII–X), as most of the upper units (Layers I to VI) had already been excavated. Unfortunately, the information and descriptions of excavation procedures and finds before 1975 have either been lost or were too schematic, causing difficulties in interpreting these investigations as described by Lioubine (2002), and Kasimova (2001) expressed uncertainty about where the hominin mandible had been found within the sequence of Layer V (now known as Unit V). Originally it was stated that it had been recovered from the third horizon of Layer V, suggesting an age of about 250 ka (Lioubine 2002), but in 1985 the mandible was referred to the fifth horizon of layer V. Kasimova (2001, p. 44) concluded: "We may change archaeological age if we have some reason to do it, but it is inadmissible to change a horizon where osseous remains of fossil man were found". Lioubine (2002) describes the partial damage of the mandible and the uncertainty about its exact location as a result of the absence of early records. Despite this, however, Huseinov's extensive work has provided a large collection of both fossils and stone tools, as well as the direct evidence of Middle Pleistocene hominins.

Excavations 2002–2009

An initial survey of the site was carried out in 1999 and 2001 by a team of researchers (P. Andrews, P. Ditchfield, Y. Fernández-Jalvo, R. Jrbashyan, S. Karapetyan, T. King, N. Moloney, Y. Sayadyan, and L. Yepiskoposyan, as well as local students) who also briefly investigated other localities in Armenia and Nagorno-Karabakh (see King et al. 2003 and Fernández-Jalvo et al. 2004, as well as the Preface to this volume).

Following the initial survey work, we started excavations at Azokh Cave in 2002. Eight field seasons were conducted during 2002 and 2009 by an international research team. When the Azokh cave project was resumed in 2002, about 970 m^3 (approximately) of intact sediment situated at the rear of the Azokh 1 entrance chamber remained from the previous excavations (Fig. 1.3c). Almost no sediments remained along the sides of the cave walls, but fortunately the top limits of Huseinov's levels I, II, III and IV were visible on the limestone cave walls, allowing confirmation of the contacts between units and correlation of the sediments at the back of the cave with those described by Huseinov.

Excavations conducted between 2002 and 2009 have yielded around 9000 specimens, including 1879 large mammal fossils and 387 lithic artifacts, plus several hundreds each of amphibians, squamate reptiles, bats, rodents, insectivores and lagomorphs. Detailed sampling was undertaken every 20 cm for starch, phytolith and pollen from sections of Azokh 1 and Azokh 5, and samples were also taken during excavation. Several samples were also taken for DNA testing, collagen analyses, dating and for histological and diagenetic studies as part of pre- and post-doctoral research projects. All these studies have furnished material for the multidisciplinary investigation that is described in this volume. The researchers involved in this work include 35 authors representing eight countries (Armenia, UK, Spain, Ireland, France, Germany, Australia and South Africa). The progress of these investigations has been presented at several congresses (INQUA, 2003 and 2007; Quaternary Research Association meeting, 2005; Spanish Society of Paleontology, 2008; Hominins-Carnivores co-evolution 2008 and 2011; Workshop on Site Formation and Post-depositional Processes in Archaeology, 2010; 8th International Meeting of the French Association of Quaternary Studies (AFEQ), 2012; Irish Geological Research Meeting & Lithosphere Workshop, 2012).

Previous publications by the team (King et al. 2003; Fernández-Jalvo et al. 2004, 2009, 2010) named the sedimentological strata as Beds, but the latest publication by Murray et al. (2010) named them as Units, and this nomenclature has been followed here. Fernández-Jalvo et al. (2010) and Murray et al. (2010) mentioned preliminary dating results provided as personal communications by the different laboratories, and these have been refined here (see the Appendix).

Field Seasons

2002 (23rd August–19th September)

When we resumed excavations after a nearly 15-year hiatus, it was necessary to clear the vegetation and large limestone blocks that had collapsed from the cliff overhanging the entrance (Fig. 1.4a, b). These blocks were broken up by our field assistants and used to make steps to facilitate access to the trench dug by Huseinov's team (Fig. 1.4c). A rope was also attached to the cave wall to provide safe passage into the cave. For practical reasons, and for future reference, we described the sediments as platforms of various heights produced by tourist visitors and previous excavations before we started our work at the site, and before the stratigraphy could be definitively set. These platforms were named the Lower, Middle, Upper and Uppermost Platforms (Fig. 1.4d). This nomenclature has been used and referred to in the excavation and fossil labels (e.g., Van der Made et al. 2016).

Fig. 1.4 **a** View of the site in 1999. **b** View of the site in 2002 after removal of the vegetation and limestone blocks that prevented access to the cave. **c** View of the steps made with broken limestone blocks fallen from the vertical cliff. **d** View of the site before site preparation (Dr. Yepiskoposyan on the left and Dr. Safaryan on the right) and three visitors that came with us to the cave. The Lower and Middle Platforms are excavation surfaces left by previous excavators. The Middle Platform was covered by a cone of collapsed sediments (note the broken white line contours the side of the cone, the asterisk points to the reference mark on the section, see Fig. 1.5d). The Upper and Uppermost Platforms were made by visitors

The Lower Platform is the level at which the cave could be accessed from the outside and corresponds to the bottom of Unit V and Unit VI. The Middle Platform is the level of *in situ* sediment covered by collapsed sediments from the section (Unit Vm[1]). The Upper Platform forms the top part of Unit V and the base of Unit IV near the wall (Vu[1]), and the Uppermost Platform is located at the first ledge of the section situated at mid Unit II, both of them formed as a result of visitors passing through the cave entrance in order to see the bat colonies in the cave interior.

Platforms	Digging units	Stratigraphic units
Uppermost	I, II & III	I, II & III
Upper Platform	Vu	IV/Va
Middle Platform	Vm	Vb
Lower Platform		VI

An aerial grid was installed by anchoring bolts to the walls of the cave, forming a permanent reference for the terrestrial grid. It is oriented along the long axis of the cave (Fig. 1.5a, b), and the origin of the Y axis was fixed outside the cave (Fig. 1.5c), on the edge of the limestone bedrock. The excavations on the Middle Platform (Unit Vm) could not be extended laterally to the other side of the cave (lines H and I) in 2002, as we needed to have access to the platforms above. Thus, 2 m were left for access to the top of the sequence and to evacuate sediments using a ladder (Fig. 1.5d).

A laser pointer was fixed to the Middle platform at a fixed point (7.20 m) below the permanent datum (point 0 above the top of the sedimentary sequence). The aerial grid and heights measured using the laser pointer provide three dimensional reference spatial coordinates for each find. Secondary height datum points were fixed for the different platforms. Overburden was removed and dry sieved outside the cave (Fig. 1.6a) and finds (stone tools and fossils) from these disturbed sediments were collected, identified and labeled. A lighting system was installed, powered from a generator placed outside the cave entrance.

[1]The contact between Units IV and V did not become apparent for several years because it was obscured by debris, and the upper part of Unit V was initially identified as Unit IV. What was formerly called Unit V is now labelled Vm, the middle part of Unit V, and what was formerly part of Unit IV is now labelled Unit Vu, the upper part of Unit V An ESR date of 205 ± 16 ka has been calculated for the general area of the contact between the top of Unit V and the base of Unit IV.

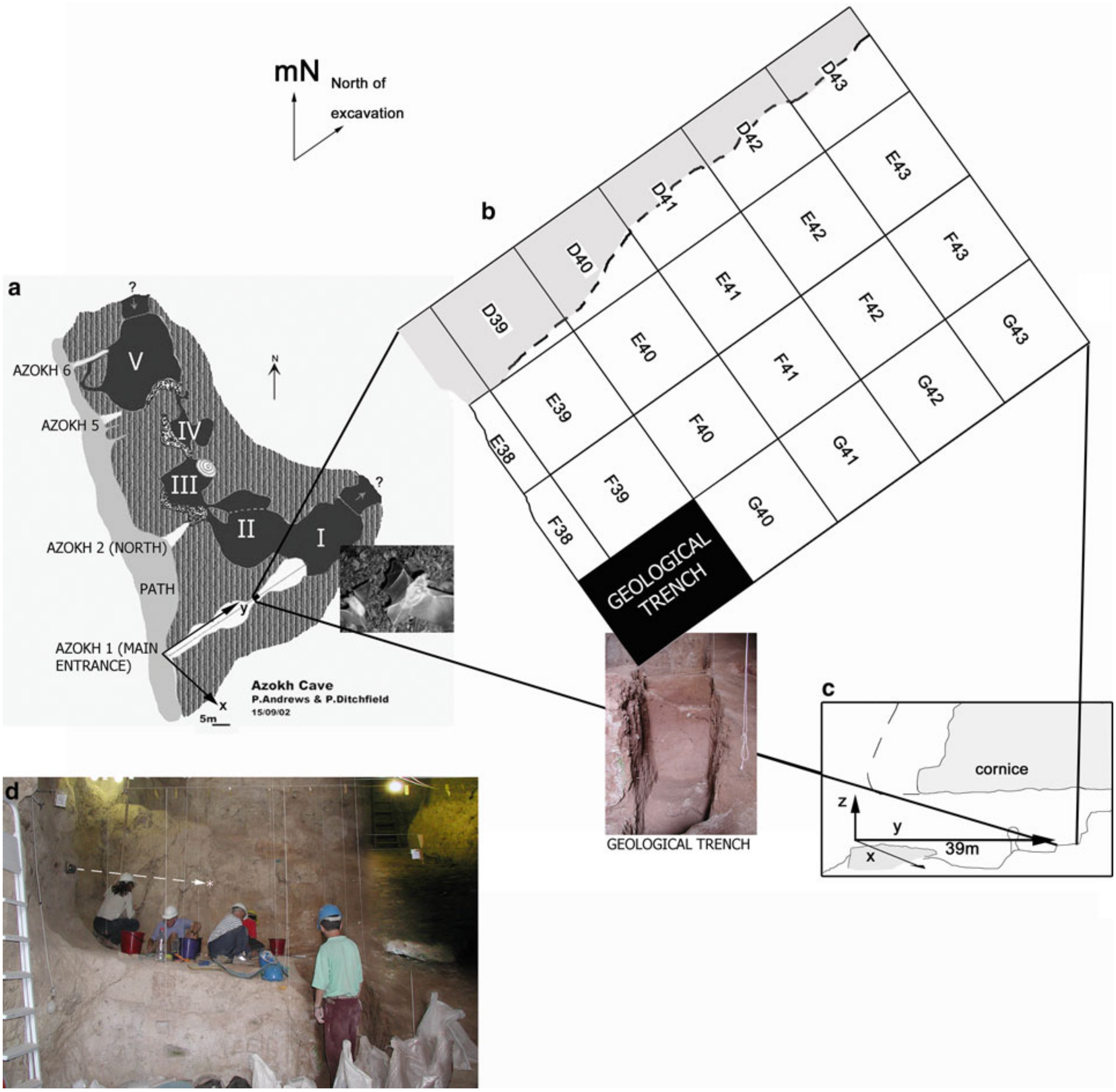

Fig. 1.5 **a** Former topography by P. Andrews and P. Ditchfield in 2002. The dark grey cavities are inner chambers inhabited by bats named as chambers I to V, the white cavities are entrance passageways to the cave system named as Azokh 1 to 6. **b** Initial aerial grid in the Middle Platform. The shaded squares (line D) are the edges of the cave walls. The small inset shows the geological trench already made in 2002 on the front of the Middle Platform. **c** The aerial grid was fixed 39 m from the cave entrance, above the present day cornice, so as to coordinate potential finds below the cornice as it was in the past (broken line). **d** View of the excavations during 2002 in the Middle Platform (Unit Vm). Note the broken white arrow goes from the laser pointer to the reference mark (asterisk) on the sediment section shown in Fig. 1.4d for vertical measurements (height). Note the right side maintains the cone of collapsed sediments to give access to the platforms above and to evacuate sediments using a ladder

Excavations of the Middle Platform (Unit Vm) started on the 1st of September, 2002. A geological trench was made on the front of the Middle Platform (Fig. 1.5b in black) as a stratigraphic reference column for the disturbed and *in-situ* sediments. Huseinov's layers were identified, described and measured. After ten days, the excavation was moved to the Upper Platform, a narrow passageway, and the laser pointer was fixed 4.90 m below the datum (Fig. 1.6d). Good deposits of sediment were found that were softer and richer in fossil content and the rest of the season was focused on this part of the excavation.

The topography of the entire cave system was measured and mapped (Fig. 1.5a). The trench aimed to locate the top of Unit VI, but no clear evidence of this unit was found, probably because it thins out towards this area of excavation. Sediment in the Middle Platform was cemented and finds

Fig. 1.6 2002 season. **a** Dry sieving outside the cave. **b** Wet sieving at the riverside, in the valley. **c** Azokh 2 clearing the collapsed modern cone and view of the test trench dug at the entrance. **d** Fixing the laser pointer and preparation of the excavation in Upper Platform (pathway made by visitors)

were limited, although remarkable (e.g., bear canines, chert, and flint scrapers, and quartz and obsidian stone tools). Obsidian is an exotic raw material, so finding it from this early period might indicate trading with other groups in the vicinity, or collection during seasonal movements. Sediment recovered from the trench excavation as well as from excavations was labeled and wet sieved at the riverside, down in the valley (Fig. 1.6b). Field surveys of areas near Azokh were also carried out in order to search for comparative sites.

Just a few meters to the north from Azokh 1 Cave, Azokh 2 (originally named Azokh North) was discovered at a similar height as the main entrance and with a great thickness of sediments (Figs. 1.3a and 1.6c). The cave floor was covered by a thick layer of disturbed and mixed sediments. These sediments were dry sieved, and remains from Holocene ages appear mixed. All this mixed sediment was thought to be the result of collapse from a potential upper gallery. A trench was dug in the entrance to try to correlate the sediments with those of the interior of the cave system and Azokh 1 (Fig. 1.6c).

On the 16th of September, 2002, the team was invited to visit Azokh school by the headmaster, Ilias Poghosyan, and we gave a presentation to pupils and teachers about our work at the cave, focusing on the significance of Azokh Cave in the context of human evolution, with reference to recent discoveries of hominin fossils, cultural remains and fossil animals found in Georgia, Europe (Spain and UK) and in Africa (Fig. 1.7).

The participants in the 2002 season were P. Andrews, P. Ditchfield, Y. Fernández-Jalvo, T. King, A. Melkonyan,

Fig. 1.7 Picture taken by Y. Fernández-Jalvo at the Azokh school with part of the excavation team and the school pupils and teachers (on the right hand first row, the Head Master (dark blue shirt), Tania King (with a bouquet of flowers) and Peter Andrews (behind T. King), on the left hand, Levon Yepiskoposyan). M. Nieto at the very back of the group in the middle-left part of the picture

N. Moloney, M. Nieto, V. Safarian and L. Yepiskoposyan. Our local Field Assistants from the Azokh village were: A. Balasanyan, G. Balasanyan, H. Boghosian, A. Gervorkian, and A. Ohanyan.

2003 (4th–31st August)

Excavations resumed on the Middle Platform (Fig. 1.8a). In order to establish the limits between stratigraphic units, as well as to confirm lithic and fossil content richness, a test trench of roughly 2 × 2 m was made on the Uppermost Platform at the side of the sediment section next to the wall (square D46 and annexes). The aerial grid was extended to the top part of the sequence and the laser pointer fixed 2.15 m below the datum (Fig. 1.8b). The top of the Upper Platform (Unit I) was not yet prepared for excavation as this unit contained a manure hearth, and the excavation's methodology had to be slightly different. A stratigraphic test trench was started from mid Unit II. Simultaneous excavations of the test trench and the Middle Platform (Unit Vm) were carried out. During excavations in the test trench, we observed that the vertical section had deep cracks running through it, and blocks of sediment were at risk of collapsing. A two-day rescue excavation was carried out to recover all fossils from the front section that was in danger of collapsing, and especially to make safe the excavation of the Middle Platform (Unit Vm). Fossils and lithics found during the rescue excavation were spatially coordinated and sediments were sieved in the river.

By the end of the season, the test trench reached the bottom of Unit III. Abundant fossils (mainly cave bear, *Ursus spelaeus*) and stone tools (of obsidian and chert) were recovered indicating a rich archeo-paleontological content. The sediment of Unit Vm was harder and less rich than that of the test trench (Units II and III). Nonetheless, Unit Vm also yielded important fossils (more ungulates than cave bears) and stone tools (also of obsidian).

Work in Azokh 2 continued, led by the team geologist and two other team members, together with most of our field assistants. Clearing of the overburden covering the sediment of Azokh 2 was extended deeper in the cave, and a second trench (Fig. 1.8c) was made to confirm the tilts of these units. An aerial grid was installed in this small chamber in preparation for its excavation. When clearing the sediment at the back of Azokh 2, a massive accumulation of large blocks was found (Fig. 1.8d). The instability of these blocks posed a safety problem for excavation at the site, forcing us to stop work in Azokh 2 and look for means of stabilizing the blocks. The survey of the inner galleries at the other end of the Azokh 2 chamber (done in 2002) showed there to be even bigger boulders, part of a gravitational cone extending down into Azokh 2 and blocking the connection between the

Fig. 1.8 2003 season. **a** View of the excavations on the Middle Platform and the Uppermost test trench. **b** Excavations in the Uppermost test trench, Dr. Safaryan taking coordinates. **c** View of the test trenches in Azokh 2: the one outside (1) was made in 2002, the one further into the interior (2) was made during the 2003 season (the white arrow points to the cone of stones that was blocked with sacks). **d** View of the cone of blocks at the back of Azokh 2. **e** View of the boulders from the interior of the galleries (with Dr. Safaryan). **f** Sampling fossils and sediment for DNA by Colin Smith

cave entrance and the inner galleries (Fig. 1.8e). These large blocks derive from a vertical shaft about 18 m above Azokh 2, seven meters of which are occupied by the boulder choke.

The test trenches dug in Azokh 1 and Azokh 2 revealed that the beds sloped down from the interior of the cave outwards towards the entrance, indicating the inner karstic system as the sediment source. This inclination was also confirmed for Unit Vm, as well as at Units II and III in Azokh 1.

A further test pit was dug deeper into the floor of the trench in Azokh 1 to find Layer X (bedrock). The floor of the trench is a very hard irregular crust of cemented silty clay and a conglomerate with chert, flint, and possibly jasper, all well rounded. Thickness of this conglomeratic unit could not be estimated as the unit is too hard and cannot be dug with normal tools (the tips of two pick axes were completely bent when trying to break the crust). We were not able to confirm the presence of the bedrock at the floor of the trench at that point. During the 2003 season, we took several samples for collagen and DNA analyses (Fig. 1.8f), as well as for dating.

The participants of the 2003 season were L. Asryan, R. Campos, Y. Fernández-Jalvo, T. King, A. Melkonyan, N. Moloney, J. Murray, M. Nieto, C. Smith, V. Safarian, and L. Yepiskoposyan. Our local field assistants from the Azokh village were:

K. Arakelian, A. Azatkhanian, E. Balasanyan, G. Balasanyan, H. Balasanyan, M. Balasanyan, and A. Gevorkian.

2004 (28th July–6th August)

Early in 2004 one of our field assistants drew our attention to fossils in the sediments outside another entrance to the cave. This entrance was mapped in 2002 and identified as a possible connection with the inner galleries of the cave, but access was too narrow (Fig. 1.9a), and it could not be investigated. In 2004 we explored this entrance further and about 3 m in from the opening we discovered an untouched 4-m section, with fossils visible in the section (Fig. 1.9b). We could not estimate the extent of the sediments beneath the 4-m section, but we established that there is a direct connection with one of the biggest chambers of the inner cave (see Fig. 1.5a) and we subsequently named the cave entrance Azokh 5.

To investigate Azokh 2, we invited Mr. Seyran Hayrabetyan, a mining engineer from Drambon Mine Company near Stepanakert, to visit Azokh in order to discuss with us and advise how we might make the site safe for long term excavations. Mr Hayrabetyan suggested a structure of treated wood to contain the boulders, a proposal that supported other advice we had received from engineers based in Spain. He further proposed that preparation for engineering work for this structure should take place in 2005. In the meantime, he advised us to remove 2 m of sediment and unstable boulders from the rear of the cave. Mr. Hayrabetyan also installed an interim wooden safety structure. As part of the

Fig. 1.9 2004 season. **a** Access to Azokh 5 when it was first discovered. **b** View of the section facing the new entrance of Azokh 5 (with Dr. John Murray). At the back of the section (asterisk) there is direct access to the interior of the cave. See Figs. 1.11d, f and 1.14c. **c** Return of the 2002 fossils and 2003 stone tools. Dr. Fernández Jalvo (left), Dr. Balayan, Director, Artsakh State Museum of Country and History (middle) and Dr. Yepiskoposyan (right) on the return of the fossils

survey work a 1 × 2 m trench was excavated outside Azokh 2 in order to determine the degree of extension of the fossiliferous sediments and their association with the cave walls.

Fossils from the 2002 season were prepared for return to the Artskakh State Museum of Country and History (Fig. 1.9c). These fossils had been conserved and prepared for exhibitions and analyzed by specialists. Albums of photographs of these fossils were also given to the director of the museum, Dr. Melanya Balayan. After the 2004 excavation season in Azokh, the team conducted a survey with Armenian archaeologists in the Aragats region of Armenia for a week.

The participants of the 2004 season were L. Asryan, V. Bessa-Correia, P. Domínguez-Alonso Y. Fernández-Jalvo, T. King, A. Melkonyan, N. Moloney, J. Murray, V. Safarian, and L. Yepiskoposyan. Our local field assistants from the Azokh village were: K. Arakelian, S. Arakian, A. Arzumian, M. Balasanyan, A.Boghosian, Z. Boghosian, A. Gevorkian, A. Minassian, and A. Ohanyan.

2005 (26th July–12th August)

The Middle Platform (Unit Vm) of Azokh 1 was excavated for the whole of the 2005 season. In addition, excavation of Unit II started on the 2nd of August. Stone tools recovered from Unit II showed traits of Levallois technique. Several of our most experienced and skilled field assistants were given training in excavation techniques and were included in the excavation team under the supervision of one of the team members (Fig. 1.10a). This training was focused on excavations in Unit Vm, and the results were very satisfactory.

Fig. 1.10 2005 season. **a** Supervision by Dr. T. King of a field assistant on excavation procedures. **b** View of the excavation area at the Uppermost Platform (Unit II) by senior and experienced team members. **c** and **d** Three dimensional topographic mapping in the interior of the cave system and at the exterior, respectively

Excavations in Unit II, with a more complicated process of fossil recovery, were only carried out by expert team members (Fig. 1.10b). Other field assistants were assigned to help in the geological survey and with the wet sieving team at the river.

We investigated the back of Azokh 2 to determine how the cone of boulders blocking the connection between Azokh 2 and the interior of the cave might be removed manually from the vertical shaft above Azokh 2. We found that this would involve a great deal of manpower and more equipment than we had available, and we therefore postponed activity in the site except for replacing the wooden safety structure that was placed as a safety measure at the end of 2004 by a structure of iron bars weighted down with stones.

In Azokh 5, the main aim for this year was to continue stratigraphic exploration of this exposed section and to assess requirements for excavation in 2006.

Three-dimensional mapping of the cave system was completed this season. Geologists Drs Alonso Dominguez and Murray with two local field assistants from Azokh Village, M. Ohanyan and Z. Assyrian, undertook this work, both inside (Fig. 1.10c) and outside the cave (Fig. 1.10d), in order to determine cave formation processes. Masks and gloves were worn to protect against pathogens carried by the large colony of bats that inhabit the cave. Topographic investigations were made in the interior chambers of Azokh cave as well as outside it, in order to understand the source of sediments.

The participants of the 2005 season were: L. Asryan, P. Domínguez-Alonso, Y. Fernández-Jalvo, T. King, A. Melkonyan, N. Moloney, E. Mkrtichyan, J. Murray, and L. Yepiskoposyan. Our local field assistants from the Azokh village were: R. Abrahamian, A. Arzumian, Z. Assyrian, A. Gevorkian, M. Hayrabetian, A. Minassian, M. Ohanyan, G. Petrossian, and M. Zacharian.

2006 (30th July–23rd August)

The primary aim in 2006 was to excavate the "*fumier*" – a manure hearth from Unit I of Azokh 1. Azokh village elders told us that their ancestors had taken refuge in the cave, together with livestock, during periods of Russian, Turkish, and Persian conflicts since the XVIII century. Unfortunately, animals burrowing into the sediments had disturbed much of the unit, and some of these burrows also affected the top of Unit II (bw in Fig. 1.11a). The thickness of this hearth was about 40 cm and extended over 12 m^2. Ceramics, bones and remains of vegetation and excrement were recovered from this hearth and mapped. Human chewing marks were observed on bones recovered from this Unit (Fernández-Jalvo and Andrews 2011). The location of the hearth, in the entrance of the interior part of the cave system, might have had the purpose of deterring the incursion of animals and bats into the human occupation area.

The aerial grid system was extended to the very rear of the cave passageway, reaching 52 m from the cave entrance, and a laser pointer was fixed at 60 cm below the permanent datum as a reference for the depth (Z) coordinates. An aerial rope and pulley system was installed for the removal of excavated sediment from the Uppermost Platform of the sedimentary sequence (Fig. 1.11b).

Once the *fumier* was excavated, the excavation continued into Unit II. Its contact with Unit I is erosive (Fig. 1.11c, black arrow). The top of Unit II sediment has a crumbly appearance, and fossils are extremely damaged (Fig. 1.11c). Studies of temperature, humidity and pH were also carried out by the geologists, and detailed sampling every 20 cm for starch and pollen was carried out in sections in Azokh 1 and Azokh 5 (K. Hardy).

Excavation of the Azokh 5 passageway started that year in order to obtain a detailed stratigraphic log (Fig. 1.11d). Safety and feasibility for excavation were evaluated. The contact between soil and sediments containing fossils was found, photographed and mapped (Fig. 1.11e). Excavations of the fossiliferous sediments were carried on at the front of the sediment cone, and trenches were dug at the entrance and in the interior of Azokh 5, which showed that the sediments at the entrance of the cave passageway were formed as a wide gravitational cone. The sedimentary cone was formed by a mixture of sediment from several units at the top of the series, which had collapsed, probably several thousand years ago, blocking the present entrance from the passageway.

Inside the cave the vertical section of sediment was exposed (Fig. 1.11d), and we excavated a test pit to evaluate the fossil and artifact content of these deposits and to determine the characteristics of the units exposed in the section. Isolated teeth of *Homo sapiens* were found in the mixed cone at the entrance, and we located further isolated human teeth *in situ* in Unit A. Samples for radiocarbon dating were taken from Unit A (top of the series), and from Unit B for ESR dating. The thickness of fossiliferous sediments below unit E

Fig. 1.11 2006 season. **a** General view of Unit I and top of Unit II at the beginning of the 2006 season showing the uneven surface of Unit I and the extensive animal burrowing. The white arrow points to the manure hearth (fumier) before excavation in Unit I and the black arrow shows the erosional contact with Unit II (bw = modern burrows). **b** Sediment evacuation system using a pulley to reach the outside of the cave where sediment is processed. **c** View of Unit I at the end of the 2006 season; remains of the fumier reach the connection to the inner galleries (white arrow). Note the circle marking a large block of partially buried limestone that was taken as a reference mark (also shown in Fig. 1.11a). **d** Azokh 5 section and the stratigraphic layers (A to E) distinguished in the 4 m long section. Note the asterisk indicating the top of the section and connection with chamber V (see Fig. 1.11d). **e** Entrance to Azokh 5, clearance of the modern soil at the most distal trench (buckets) and small test pit (broken line) on the cone of collapsed and mixed sediments. **f** View of chamber V, in the inner cave system inhabited by bats. Note the asterisk indicating the connection with the 4 m long section in Azokh 5 (see Figs. 1.11d and 1.14c) covered by a large plastic sheet to prevent air currents that may disturb the bats

and their extent into the internal chamber V (Fig. 1.11f) were unknown at this time. Geophysical analyses of the cave were planned for the following season.

The participants of the 2006 season were: E. Allué, L. Asryan, I. Cáceres, P. Domínguez-Alonso, Y. Fernández-Jalvo, K. Hardy, H. Hayrabetyan, S. Hayrabetyan (our local engineer collaborator), T. King, D. Marin-Monfort, E. Mkrtichyan, N. Moloney, J. Murray, T. Sanz Martín, and L. Yepiskoposyan. Local Field Assistants from Azokh village were: A. Arzumanian, T. Assyrian, S. Avanessyan,

K. Azatkhanyan, A. Balasanyan, A. Bagdasaryan, Z. Boghosian, V. Dalakyan, A. Gevorkian, M. Hayrabetian, H. Martirossyan, and M. Zacharian.

2007 (9th July–4th August)

Geophysical analysis of the cave system of Azokh was carried out during the 2007 field season (Fig. 1.12a). This method is based on the different electrical conductivity/resistivity properties provided by empty cavities, sediments and rock. Unfortunately, the boulder collapse at the rear of Azokh 2 hampered any geophysical investigation there. The results of this geotechnical study provided further information on sediment thickness in Azokh 1 and 5, as well as the exact location of the bedrock, inner and upper galleries and connections that are blocked today (Domínguez-Alonso et al. 2016). Furthermore, total station equipment supplied this year by the Drambon Mine Company provided fixed coordinates for the topographic data measured the previous year and enabled us to reconstruct the three-dimensional

Fig. 1.12 2007 season. **a** Geophysical work outside the cave by Dr. Aracil (left) and Dr. Porres (right). **b** Total station operated by a Drambon Mine Company operator. **c** View of excavations in Azokh 1 taken at the end of 2007 season. Note the burrows made by modern animals (filled with sand sacs to prevent their collapse) affect the Holocene sediments of Unit I and the very top of Unit II (Middle Paleolithic). The small inset (bottom left) shows cleared sections of the fumier and sediments below for sedimentological study. The asterisk indicates the location of an end-scraping at the immediate limit between Unit I and Unit II (broken line). **d** Section of Azokh 5, the vertical white lines demarcate the 2 m^2 dug in the section during the 2007 season. **e** Excavations at Azokh 2. **f** Wet screening by the river

topography of the cave system (Fig. 1.12b). In addition, further work concentrating on Units I and II of the Azokh 1 stratigraphic series was carried out. The section was cleaned, and samples taken to analyze the geochemical and sedimentological traits of each unit.

Several expeditions to nearby valleys, aided by GPS and satellite pictures, were carried out in order to map outcrops of different rock types (limestone, volcanic rocks and sediments and tuffs). This was the first phase of work in preparing a regional geological map since there was currently no such map of the area. This was a long-term project that required further expeditions in order to map the entire area. Several samples were taken to date volcanic outcrops interbedded in the limestone that form the Azokh karstic system.

The excavations of Azokh 1 continued the systematic excavation of the top of the series in Unit I (Fig. 1.12c). Excavations focused on removing the remains of this unit beneath the large hearth (*fumier*) that was excavated the previous season. Our initial aim at that time was to preserve the lateral side of Unit I (Fig. 1.12c, section on right hand) and remains of the hearth (Fig. 1.12c, small inset) as reference sections for future studies.

Below the hearth, Unit I appeared poor in bone content and artifacts, probably because this was a distal part of the human occupation. Furthermore, as mentioned above, this unit was intensively burrowed by modern animals, and several erosive layers were also distinguished. These burrows, which were still in use and increased in size and number each year, facilitated the introduction of modern objects into underlying sediments, such as wire, paper and even labels and masks used by the excavation team during the previous season. Furthermore, remains from Unit II (such as Levallois stone tools and cave bear [*Ursus spelaeus*] fossils) were also introduced into Unit I by these burrowers. The sediments of Unit I compared with Unit II were found to have different directions and inclinations. Unit II sediments in the central squares contained poorly preserved large mammal fossils and a sparse microvertebrate fossil content. Fossils contained within the squares close to the cave walls were better preserved (see Marin-Monfort et al. 2016). A laser pointer was fixed at 1.60 m below the datum on the 29th of July 2007 to take coordinates from the middle part of Unit II.

In order to test the archaeological and paleontological richness of the Azokh 5 passageway, excavation work was concentrated on a 2 × 1 m test trench at the exposed section. The test trench produced limited remains, some charcoal and a few fossils (Fig. 1.12d), which is possibly due to the fact that these sediments are at the distal part originally attached to the walls of the cave infilling. The complexity of the site needed careful work and excavations were carried out from the top of the sequence in the large inner gallery (chamber V), rather than continuing work on the section.

Work in Azokh 2 continued in 2007. During preparation of the excavation area, a trench was extended between the two test pits made in 2002 and 2003 respectively. The 2 m^2 excavation was extended laterally to the southern side to obtain further information (Fig. 1.12e). These sediments yielded remains of butchered animals (mainly cow) and artefacts of different ages. In spite of the bad preservation of bone that lead to the low abundance of small vertebrates from the central squares of the excavation of Unit II in Azokh 1, the processing of the excavated sediments was difficult this season due to the large volume of material produced by the simultaneous excavation of Azokh 1 Unit I, Azokh 2 Units 1 and 2, and Azokh 5 Units A to E. An efficient but careful procedure was developed in order to effectively process these excavated sediments (Fig. 1.12f).

The participants of the 2007 season were: E. Allué, P. Andrews, L. Asryan, I. Cáceres, R. Campos, P. Domínguez-Alonso, Y. Fernández-Jalvo., H. Hayrabetyan, S. Hixson Andrews, N. Moloney, J. Murray, D. Marin-Monfort, M. Nieto, A. Pinto, and T. Sanz Martín. Specialists collaborators were: S. Hayrabetyan, E. Aracil, and J. Porres. Local field assistants from Azokh village were: T. Assyrian, K. Azatkhanyan, A. Arzumanian, S. Avanessyan, A. Bagdasaryan, A. Balasanyan, G. Balasanyan, M. Balasanyan, Z. Boghosian, V. Dalakyan, A. Gevorkian, M. Hayrabetian, H. Martirossyan, M. Ohanyan, and M. Zacharian.

2008 (8th July–14th August)

Geological work during the 2008 season was focused on the Azokh 1 sedimentary sequence, providing information on the formation of the cave and the nature of the different deposits recorded in the cave of Azokh 1. A trench was dug from the Lower platform of the cave to make a connection between the geological trench opened by the present excavation team in 2002 and the trench at the entrance opened by Huseinov's team. These trenches exposed the bedrock below the Lower Platform and confirmed the distinct topography of the bedrock (Fig. 1.13a) indicated the previous year by the geophysical work (Fig. 1.13b). Geological results also indicated that the Azokh 5 sequence contained up to 10 m of continuous sedimentation, 4 m of which were exposed in the entrance section. This finding greatly increased the potential of this new site, and excavation was started in the top units. There were, however, difficulties in installing an aerial grid (see Fig. 1.5a) above the section discovered from the Azokh 5 entrance (the connection between these two areas is marked by an asterisk in Fig. 1.11d, f) because of the high chert content of the limestone.

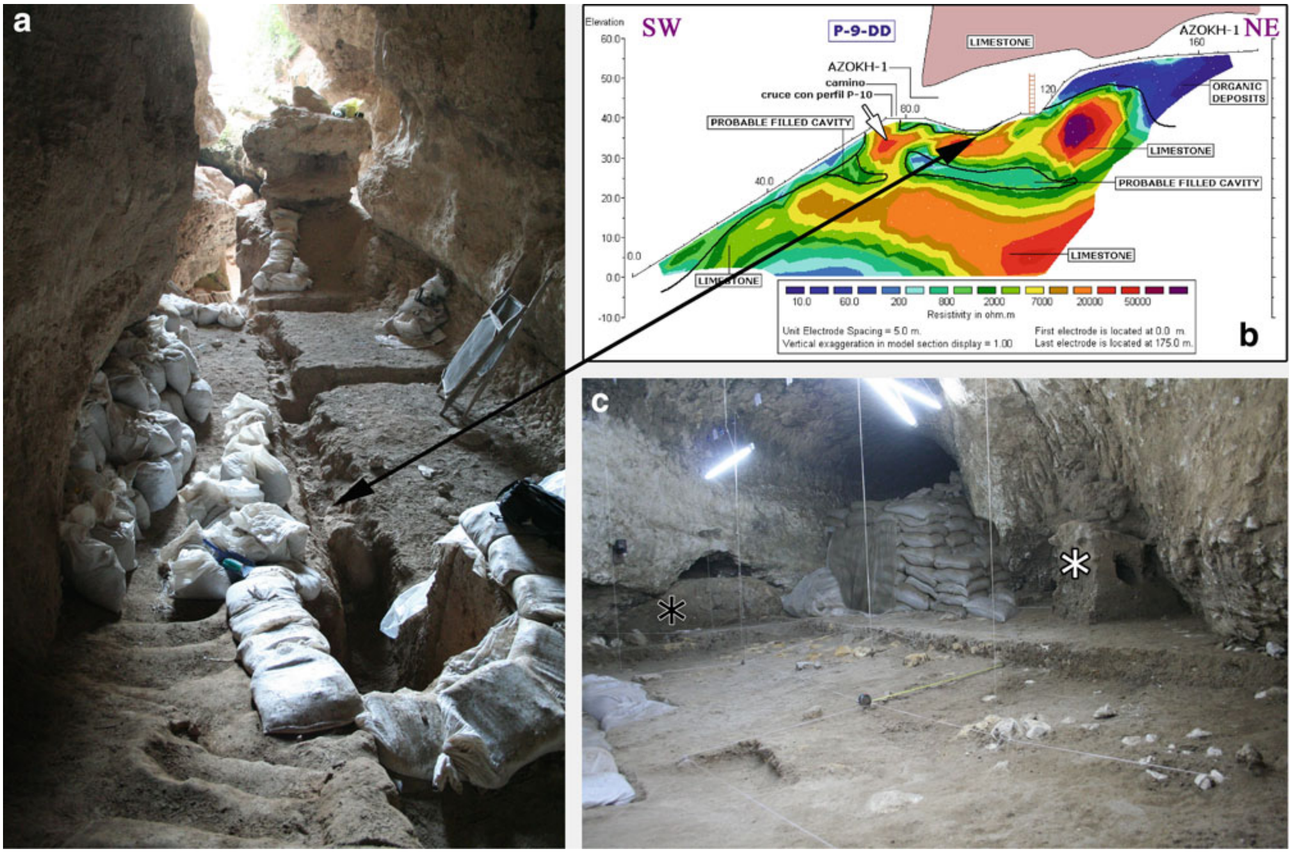

Fig. 1.13 2008 season. **a** View of the trench dug during the 2008 season in Azokh 1 Lower Platform connecting the trench dug by Huseinov's excavation team in the 1970s (on the left of the 'pedestal') and the geological trench dug by us in 2002 (see Fig. 1.5b) uncovering the limestone bedrock. **b** Electrical tomography of Azokh 1 showing the irregular topography of the bedrock underneath the Lower Platform (double head arrow relates the tomography and the uncovered bedrock). **c** View of the extended excavation surface of Unit I and top of Unit II (see text). In addition to the reference section of the 'fumier' (here covered by sacks) two more areas were left as reference sections, a small one encased in an irregularity of the cave wall (black asterisk) and a section next to the fumier (white asterisk) burrowed by modern animals; note the latest section was not exposed in Fig. 1.12c

Excavations in Azokh 1 completed the work in Unit I (Fig. 1.13c). The lateral section, which was left as a reference section, was intensively burrowed and there was a high risk of collapse. Extending the excavation area also allowed us to better interpret sedimentation processes in the cave. The broadening of the excavation area also provided further information about the behavior and social strategies of humans during the occupations of the cave in the past.

The large hearth–*fumier* uncovered in 2006 and sediments below will be left as a reference section for future studies and for guided visits to the cave. This reference section is situated at the connection between the entrance chamber and the interior gallery, inhabited today by bats (Fig. 1.13c) and considered to be the best for archaeological purposes. At the end of each excavation season, the section is covered and protected and has so far survived intact. However, the location of the section on the pathway used by visitors accessing the cave interior puts it at risk of damage and endangers its preservation. Therefore, it was apparent that restricting access through this passage was necessary to ensure the section preserved in the long-term. This would also be of benefit for the large bat colonies inhabiting the interior galleries, since they have been subject to disturbances by large number of unsupervised visitors using fire torches. This suggestion was reinforced by a report written on the protection of bat communities by one of our research team, which discussed the negative impact of such visits on the bat colonies (Sevilla 2008).

We continued excavating the test pit on the Uppermost Platform (Units II and III) that was started in 2003. Further excavation of this test pit from Unit IV to the contact with Unit V was aimed at coming to a better understanding of the stratigraphy and sediments, as well as the fossil and lithic content of these units. Unfortunately, the unstable nature of the remaining sections of sediment exposed made work unsafe, and Unit IV has yet to be excavated. Only a small portion of this unit (smaller than 1 m^2) could be dug in 2008. We can confirm the presence of large mammal fossils and artifacts in Unit IV, but further studies and especially broader extension of the excavation are needed.

Excavation in Azokh 2 continued during the 2008 season.

The participants of the 2008 season were: E. Allué, L. Asryan,, I. Cáceres Y. Fernández-Jalvo, H. Hayrabetyan, L. Hovsepyan, T. King, N. Moloney, D. Marin-Monfort, J. Murray, T. Sanz Martín, S. Turner, and L.Yepiskoposyan. Local field assistants were: Z. Asryan, K. Avagyan, M. Avagyan, A. Azumanyan, A. Balasanyan, M. Balasanyan, A. Gevorkyan, A. Hairbetyan, A. Ohanjanyan, M. Ohanyan, and E. Zakharyan.

2009 (17th July–12th August)

Before starting the excavations, part of the team gave a presentation at the National Assembly in Stepanakert on the research at Azokh caves carried out by our team. The Head of the National Assembly, the Minister of Culture, the Head and other members of the Department of Tourism, as well as the Director of the Artsakh State Museum of History and Country Study, relevant academic members of the State University of Artsakh and colleagues from the archeological project at Tigranakert, all attended this meeting. Local

Fig. 1.14 2009 season. **a** Scaffolding installation in Azokh 1 and view of the excavation area in Unit Vm excavating the lateral side that could not be reached before. **b** View of the extended excavation in Azokh 1 Unit II on the edge of the section. **c** View of the extended excavation area in chamber V above Azokh 5 (the asterisk marks the connection with Azokh 5 section, see Fig. 1.11d, f). **d** View of the small chamber discovered at the basal (entrance trench) of Azokh 1 (underneath the steps built in 2002, compare with Fig. 1.4c) white arrow in Fig. 1.13b. **e** View of the interior of the small chamber with stalactites, stalagmites and 'dog tooth' formation

authorities also attended the presentation from Azokh, including the past and present mayors of the village, and the headmaster of the school. Several specialists from our team made the presentation in English, with simultaneous translation into Armenian by two members of the team. After the talk, several questions from the audience gave rise to interesting exchanges of information and support for the continuation of our project at Azokh. Several of the academics and authorities that attended the presentation also visited the site, some for the first time.

Excavations in Azokh 1 were focused on extending the excavations of Unit Vm and Unit II (Fig. 1.14a, b). In previous years we had left the areas lateral to the Unit V excavation surface covered by overburden to facilitate access to the excavation area at the top of the sequence using a ladder. In 2009 the ladder was removed and replaced by scaffolding, donated by Base Metals Ltd, a local mining company. The scaffolding allowed us to extend the excavation of Unit Vm to squares H and I (Fig. 1.14a). The augmented collections from Units II and Vm are to provide material for two doctoral theses and a master thesis by three students in our team. A second aim was to start systematic excavation of the deposits of Azokh 5. The excavation proceeded from the top of the series, which dates from the Iron Age and yielded a collection of ceramics. Given the difficulties of this cave chamber for installing an aerial grid, we used a total station (Fig. 1.14c). The total station was also used in Azokh 1 to coordinate some geological samples, as well as finds that appeared during the clearing of sections at different points near the cave entrance.

Geological and geomorphological investigations of the cave deposits continued. The studies required detailed sampling to accomplish investigations on the sedimentology and geochemical traits of the sediments. A second study of electrical tomography (made by Análisis y Gestión del Subsuelo S.L. specialists) was also carried out that season (Fig. 1.14d), with the aim of increasing information about the extent and depth of the sediments in the interior of the cave (especially chamber V which connects to Azokh 5 see Fig. 1.5a). Further investigations of the trench adjacent to the cave entrance made by the previous excavation team (lead by Huseinov) led to the discovery of a small chamber at the entrance to Azokh 1 (Fig. 1.14e). There are no sediments present, but samples for dating were taken from a speleothem in the interior of the chamber. This chamber has delicate 'dog tooth' calcite crystals and copious development of speleothems, both stalactites and stalagmites (Fig. 1.14f). 'Dog tooth' formation indicates that the chamber was partially immersed in calcareous water, allowing crystals to grow. The previous excavation team did not refer to this small cave, and there was no evidence of anthropic activity there. However, the cave was originally sealed by a stalagmite flow crust and isolated from the trench, but only a small piece of this crust remained *in situ*, most having been broken. A sample taken from this part of the cave yielded an age of 1.19 ± 0.08 Ma (see Appendix, uranium–lead).

During this season gates were installed in all the cave entrances to protect the excavation areas from visitors to the site during the year. The Government of Nagorno-Karabakh facilitated this, and at the same time, the Government employed a guardian and official guide at the site, who conducts visits to the cave. In addition, from this time onwards visitors wishing to visit the interior of the cave inhabited by the bat colonies must obtain written permission from the relevant government department. The gates were designed according to the guidelines of the International Group of Chiroptera specialists in order to prevent disturbance to the bats that inhabit the interior of the cave during their daily transit in and out of the cave. These gates do not completely prevent all unauthorized or unsupervised visits to the cave, but rather convey to visitors that this site is important and must be protected.

The participants in the 2009 season were: E. Allué, M.C. Arriaza, L. Asryan, S. Bañuls, I. Cáceres, P. Domínguez-Alonso, V. Faundez, Y. Fernández-Jalvo, N. Ghambaryan, H. Hayrabetyan, L. Hovanisyan, L. Hovsepyan, A. Mardiyan, D. Marin-Monfort, N. Moloney, J. Murray, T. Sanz Martín, and L.Yepiskoposyan, Specialist Collaborators: J. Porres and M. Miranda. Local field assistants were: T. Asryan, A. Arzumanian, S. Avanesyan, K. Azatkhanyan, A. Bagdasaryan, A. Balasanyan, G. Balasanyan, M. Balasanyan, Z. Boghosian, V. Dalakyan, A. Gevorkian, M. Hayrabetian, H. Martirosyan and M. Zacharian.

Correlating Huseinov's Layers to Our Units

Units distinguished in the current excavations may not correspond in detail with layers distinguished by Huseinov, but it can be assumed that the original stratigraphy has been identified in general terms. There are some descriptions that are imprecise or that are at odds with our observations. Layer X, for instance, has been described to be either the bedrock or a unit that we have not identified. Lioubine (2002, p. 25) refers to this unit as follows: "Nous remarquerons que la couche archéologique X est considérée par les géologues comme située plus bas dans le profil et comme étant la roche-mère altérée (Gadziev et al. 1973, p. 13), à l'intérieur de laquelle 'des découvertes n'ont pas été réalisées' (Suleimanov 1979, p. 45). Cependant, Guseinov y voit 'le stade initial de l'occupation de la grotte' et décrit 16 outils lithiques apparemment trouvés là (Guseinov 1985: 14)." If Layer X is the bedrock, it would be unusual to recover stone tools from it. If it was a layer at the base of the series, it would have been very thin and heterogeneous. We have not yet resolved this issue.

Sediments in the trench (Units IX to VI) have been distinguished by Murray et al. (2010, 2016) as a separate sequence (Sequence 1) that is distinct from fossiliferous Units V to I containing lithics and evidence of human presence (Sequence 2). Original descriptions by Huseinov and colleagues stated that this trench produced 186 tools assigned to the Oldowan technique (Mode 1) (Mustafayev 1996), although the human manufacture of these stones is still under debate. We have not found fossils or lithics in the sediments of Sequence 1 so far except for Unit VI, that yielded some fossils. Murray et al. (2016) suggest that either the limited sediments left in the trench by previous excavations may explain the lack of fossils, or this may reflect that the cave was not open to the outside when it was deposited (Murray et al. 2010). However, only traces of sediments from Unit IX to VII remain, and the only trace of Unit VI is in irregularities of the cave walls and at the base of the 'pedestal' (see Fig. 1.3b black arrow, and Murray et al. 2016)..

In the course of digging the connecting trench from the middle platform to the cave entrance trench, we found that bedrock outcropped at the level of what we called the Lower Platform (Fig. 1.13a). This discovery definitively indicates two episodes during deposition of the cave sediment, with Sequence 1 (Units IX to VII) restricted to the trench at the entrance. The outcropping bedrock indicates correlation between the base of Unit VI and the base of Unit V (Murray et al. 2010). Unit VIc was laid down by water, probably a small river, and the fact that it wedges out towards the interior of the cave means that it cannot be readily identified at the base of the Middle Platform. This may suggest that it was produced by water flowing into the cave from the exterior (Murray et al. 2010). Before the Unit VI event, the cave was probably below the water table (Fig. 1.15).

There is a variation in the sedimentation pattern within the cave in Unit VI and after deposition of sediments in the trench, and it may represent the opening of the cave that allowed animals and humans to enter and occupy it (Murray et al. 2010). The small valley in front of the cave formed when the cave was opening. The flooding indicated by Unit VIc may then represent the moment at which the small river valley was at the same height as the cave. As the base level of the valley lowered through erosion (Fig. 1.15), the cave would become free of flooding, and animals and humans would be able to enter and occupy the cave.

Unit V extends towards the back of the cave from the bedrock to what we named the Upper Platform. The contact between Unit V and Unit IV is diffuse and irregular, and it is difficult to distinguish the contact precisely (Fig. 1.16). Geological studies in this part of the section have shown that Unit V extends above the surface of the Upper Platform, and fossils found here were labeled as belonging to Vu (V upper, which corresponds to the top of the stratigraphic Unit Va described by Murray et al. (2010, 2016). Recently we have confirmed that Unit Vu may contain fossils from the base of Unit IV, especially from squares near the wall where the

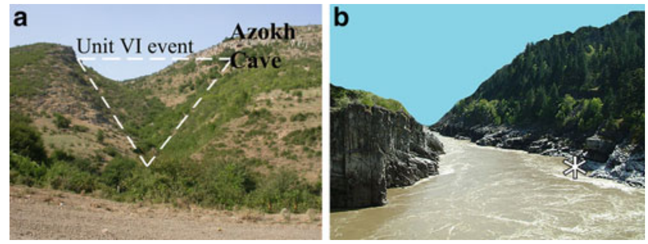

Fig. 1.15 **a** View of the small valley in front of the Azokh caves. The "Unit VI event" indicates the height of the paleo-river when Unit VI was accumulating in Azokh Cave. **b** Possible reconstruction of the landscape before the "Unit VI event" (the asterisk points to the hypothetical emplacement of Azokh Cave)

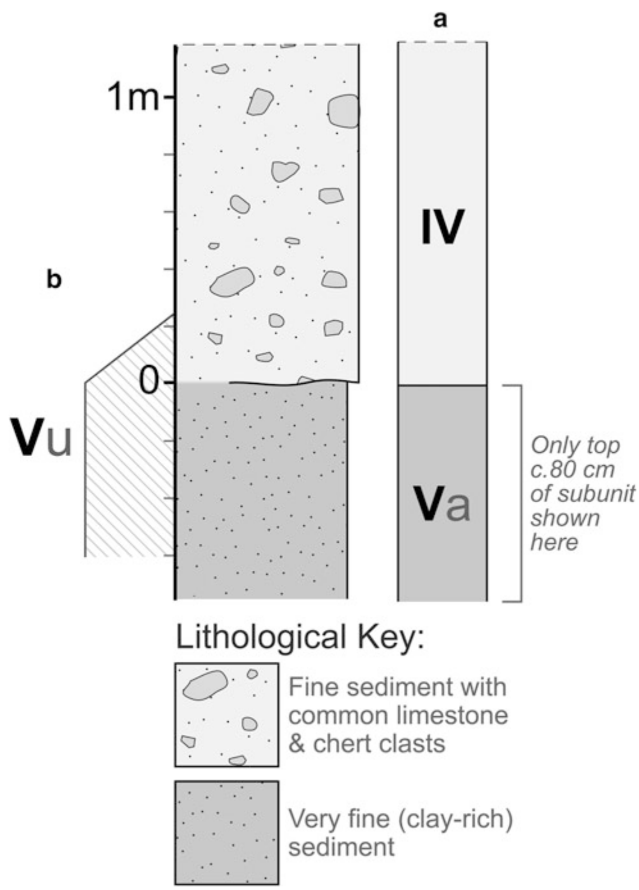

Fig. 1.16 Detailed view of the stratigraphic contact between Units V and IV in Azokh 1. **a** Lithostratigraphic unit terminology employed by Murray et al. (2010, 2016) for this part of the succession; **b** Terminology for richly fossiliferous interval recovered from Upper Platform (mentioned in Chaps. 4 and 6–15 in this volume). Note that Unit Vu may include the base of Unit IV in the transitional zone close to the cave wall where the limit between IV and V was difficult to distinguish precisely

contact between Units IV and V is at a different level. Excavations of Unit IV in the future will solve the current problem, and we have still to distinguish the Unit IV–V contact near the wall. We have assigned Unit Vm (V middle) to fossils and lithics recovered from the Middle Platform (surface left by previous excavations), which corresponds to the middle part of the stratigraphic Unit Vb described by Murray et al. (2010, 2016).

According to Huseinov, only microfauna was recovered from Layer IV (Lioubine 2002), and the lack of large mammals and stone tools from Huseinov's excavations suggested that humans abandoned the cave during this period (Mustafayev 1996). We can, however, confirm the presence of large mammal fossils and artifacts in Unit IV, although further studies and especially proper excavation are needed.

Currently, excavations in Unit I and Unit II have been almost completed over a wide area, although the remaining part of Unit I did not extend over more than 18 m^2. Unit II extends at present to roughly 40 m^2. The contact of Units I and II is a disconformity indicating that sediments deposited during the Late Pleistocene were removed by erosion. The contact shows laminar sediments in some parts of Unit I (Fig. 1.11a black arrow), and this may suggest that the erosion was produced by floodwater.

Chapters of This Book

The following fourteen chapters have been devoted to different aspects of research on the Azokh caves, plus an Appendix documenting the dating of the sediments and fossils using different methods. They are briefly summarized below.

Chapter 2: *Stratigraphy and Sedimentology of Azokh Caves, South Caucasus* Murray et al. (2016).

The stratigraphic sequences of Azokh 2 and Azokh 5 are described fully here for the first time, together with a detailed description of Azokh 1. The sedimentary sequence of Azokh 1 is broadly divisible into nine units that are divided between two geographically isolated sequences. The lowermost sequence or Sequence 1 (Unit IX to Unit VI) is predominantly non-fossiliferous but becomes both fossiliferous and calcareous at the very top, which displays evidence of fluvial deposition Unit VI. The upper sequence or Sequence 2 (Units V to I) is richly fossiliferous and has yielded many different species of mammals (macro and micro) and evidence for human occupation. The Azokh 2 sedimentary sequence is at least 1.65 m in depth, although the base has not been reached, and a boulder collapse in the rear of the chamber has hampered comprehensive investigation efforts. The connection of Azokh 5 with the largest cave hall of the Azokh karstic system has revealed at least 4.5 m of cave-filling sediment, which is divisible into five stratigraphic units (A–E), but the sequence continues about six more meters in depth.

Chapter 3: *Geology and Geomorphology of Azokh Caves* Domínguez-Alonso et al. (2016).

The geomorphology of the currently accessible portions of the karstic cave network at Azokh, and data relating to the surface topography of the internal cave fill, document the pattern of karst formation and speleological processes. Analytical methods include electrical tomography, total station coordinates and topographic measurements of the interior and exterior of the caves. The most interesting result from electrical resistivity (tomography) is the thickness of sedimentary sequences in Azokh 1 and Azokh 5 (up to 10 m). These geophysical studies indicate the presence of a small blind chamber at the cave entrance of Azokh 1, as well as the irregular bedrock topography at the passage (lower platform) to the rear of the cave chamber of Azokh 1.

Chapter 4: *Lithic Assemblages Recovered from Azokh 1* Asryan et al. (2016).

Descriptions of the lithics recovered in the stratigraphic units and their significance in the Middle–Late Pleistocene of the Caucasus concentrate particularly on those from Middle Paleolithic contexts. Artifacts are predominantly made from local raw materials. Levallois technology is well represented in core preparation and a range of blank types (flakes, points and blades). Retouch of Levallois and non-Levallois pieces is generally non-invasive but also includes some examples of basal thinning. The Middle Paleolithic assemblage presented here is consistent with the lithic traditions evident in other areas of the Lesser Caucasus. In contrast to previous excavations, the lithic assemblage of Azokh 1 is not abundant from these excavations, probably as result of the location of the excavation at the rear of the cave. Evidence of knapping in this part of the cave has not been observed. Further microwear investigations of these lithics, field work to localize obsidian, hornfels and siliceous raw material sources, as well as experimental work (e.g., trampling, corrosion) to explain post-depositional modifications of these tools, are in progress.

Chapter 5: *Azokh Cave Hominin Remains* King et al. (2016).

The hominin remains discovered from the three different passageways connecting the outside with the internal chambers are described in this chapter. A fragment of Middle Pleistocene hominin mandible was found in Azokh 1 by the previous excavation team in the 1960s and named as "Palaeoanthropus"; this specimen is described based on a replica. It is tentatively assigned to *Homo heidelbergensis*. In 2010 a complete permanent first upper left molar tooth was found at the top of the series in Azokh 1 in deposits dating to 100 ka. A preliminary description and metric analysis of the tooth assigns the specimen to *Homo neanderthalensis*. In 2007 an incomplete partial skeleton and two teeth, thought to belong to the same individual, were found in Azokh 2. Human teeth and a phalanx have been found in Azokh 5. Dental description is detailed in this chapter.

Chapter 6: *The New Material of Large Mammals from Azokh and Comments on the Older Collections.* Van der Made et al. (2016).

All fossiliferous units have large mammal taxa that in mid-latitude Europe are considered to be "interglacial" elements, while there are no clear "glacial" elements, which suggests warm temperate conditions despite the altitude of the cave. Situated just south of the Lesser Caucasus mountains, the area is by definition Asian, though it might be more useful to consider this area part of western Eurasia. Many "typically European" species range far into Asia, as did Neanderthals. The most abundant large mammal species in the Azokh I sequence are the cave bear *Ursus spelaeus*, several species of cervids and bovids (*Cervus elaphus*, *Dama¸ Capra aegagrus*), together with tortoise, lagomorphs, rodents, reptiles and amphibians, all of which are ubiquitous at all levels. Large felids (*Panthera pardus*), canids (*Canis lupus, Vulpes vulpes*) and bison are present in Unit II; rhino (*Stephanorhinus*) and badger are known from Unit Vu, wolf, jackal and hyaena (*Crocuta crocuta*), *Megaloceros* and roe deer are present in Unit V, and wild pigs (*Sus scrofa*) have been identified at most units so far. An interesting aspect of the study area is its geographical and biogeographical position as they relate to inter-continental faunal movements. Most species present are common in western Eurasia.

Chapter 7: *Rodents, Lagomorphs and Insectivores from Azokh Cave* Parfitt (2016).

Small mammals are abundant in Azokh 1. The rodent assemblages are dominated throughout by arvicoline rodents indicative of dry steppes and semi-deserts. Several regionally extinct arid-adapted or montane taxa are also well represented throughout the sequence. Unit Vu has yielded the earliest Caucasian record of rat (*Rattus* sp.), a genus previously thought to have been a relatively recent (late Holocene) introduction. The small mammal fauna shows broad similarities to those from semi-desert and steppe regions to the south, implying dispersals from southwestern Asia; there appear to be only tenuous links with the Pleistocene small mammals north of the Caucasus. The striking difference in environmental reconstruction between the small and large mammals is interpreted as due to taphonomic bias.

Chapter 8: *Bats from Azokh Caves* Sevilla (2016).

Azokh Cave is one of the most important shelters for living colonies of bats in the Caucasus. Over 70,000 bats have been recorded in the cave during the winter, consisting mainly of colonies of the Lesser Mouse-eared bat (*Myotis blythii*) and Mehely's Horseshoe bat (*Rhinolophus mehelyi*). These numbers increase during the summer, as Schreiber's Long-Fingered bats (*Miniopterus schreibersii*) breed in the cave, forming large nursery colonies. Four other species occur either as smaller colonies or roosting singly, mainly occupying rock crevices. The abundant bat fossils preserved in the sediments of the cave show that the three main species found today in Azokh Cave have been using this same shelter for the past 300 kyr. However, their relative abundances vary from one layer to another, with variations in the rarer species also being observed. Since the sediments excavated at Azokh Cave were formed during a time interval with major climatic changes, an excellent example of how environmental changes in the past may have caused changes in the bat populations of a cave is provided by the long stratigraphic sequence in Azokh 1.

Chapter 9: *Amphibians and Squamate Reptiles from Azokh 1* Blain (2016).

Lower vertebrate fossils from Azokh cave include three anuran species, at least five lizards and seven species of snakes. Some of them are characteristic of high altitudes in the Caucasus today, while other taxa have greater similarities with the fossil and extant herpetofauna of the Irano-Turanian or Mediterranean biogeographical provinces. No mid Asian desert taxa have been found. Through the Azokh 1 chronological sequence, the evolution of the paleoherpetofaunal assemblages suggest a progressive increase in aridity between Unit Vu (late Middle Pleistocene) and Units II and I (Late Pleistocene to Holocene periods), with replacement of meadow-steppe environments by an arid mountain steppe environment.

Chapter 10: *Taphonomy and Site Formation of Azokh 1* Marin-Monfort et al. (2016).

The taphonomic study reported here is based on the large mammal assemblage recovered from Azokh 1. We have been able to distinguish the sources of the large mammal fauna recovered from Azokh 1, the interactions between cave bears and humans, the extent to which bat guano influenced fossil preservation, and the role of humans and bears in the accumulation/dispersal of the fossils. The extensive guano deposits in the cave have heavily damaged these fossils and produced geochemical changes. The taphonomic sequence of events that gave rise to the site formation of Azokh 1 is described here. Small mammal taphonomy is described in Chap. 15.

Chapter 11: *Bone Diagenesis at Azokh Caves* Smith et al. (2016).

Bone diagenesis processes transform the organic and mineral phases of bone during decay and fossilization. In order to understand how these processes have affected the skeletal material recovered from Azokh caves (and in particular to assess the organic preservation of the bones), "diagenetic parameters" of skeletal material from Holocene, Late Pleistocene and Middle Pleistocene deposits from Azokh caves have been measured. These indicate that the bone organic content from the Pleistocene layers of Azokh is poorly preserved, and many bones show evidence of extensive infilling of the pores with secondary minerals. This type of preservation has not previously been described in archaeological material.

Chapter 12: *Coprolites, Paleogenomics and Bone Content Analysis* Bennett et al. (2016).

Coprolites from fossil sites and present day scats/excrements are signs of the activity of carnivores and herbivores present at the site or nearby environment. Unit II from Azokh 1 yielded two complete undamaged coprolites. Taphonomic, geochemical and biometric indications were not conclusive about the identity or source of the coprolites. Targeted mitochondrial DNA analyses performed on one of the coprolites yielded mitochondrial sequences identical to those of modern brown hyena (*Hyaena brunnea*). However, this finding was not supported by further investigation using next-generation high throughput sequencing. The most parsimonious interpretation of the results of the genetic analyses is that the highly sensitive PCR assay reveals contamination of the coprolite with minute amounts of modern brown hyena DNA presumably originating from brown hyena scats sampled recently in the same laboratory.

Chapter 13: *Paleoenvironmental Context of Coprolites and Plant Microfossils from Unit II, Azokh 1* Scott et al. (2016).

No pollen was found in the sediments of Azokh 1, probably due both to oxidation from persistent humidity changes in the cave and to increasing scarcity of pollen with distance from the cave opening. One possible source, however, is from the complete and undamaged coprolites recovered from Unit II. These coprolites contained rare diatoms and pollen, which indicate proximity to water; and numerous phytoliths were found. The phytoliths in the coprolites were compared with those in associated deposits in the cave and modern soils, both in order to interpret the past environment in the area and to build up a complete spectrum of the vegetation in the area.

Chapter 14: *Charcoal Remains from Azokh 1: Preliminary Results* Allué (2016).

Charcoal from fires in the caves is well preserved in the upper sedimentary units of Azokh 1. The taxonomic study of the charcoal has identified some of the wood used as firewood by the human groups occupying the caves. Changes in taxonomic composition can be related both to human activities in the caves and to availability of plants in the surrounding region. The plants identified indicate that deciduous woodland was the predominant vegetation type in the vicinity of the caves. There is no indication of vegetation or climatic change up through the sedimentary sequence.

Chapter 15: *Paleoecology of Azokh 1* Andrews et al. (2016).

Paleoecological interpretations obtained from data on the fauna and flora provide evidence on past environments. Plant data from charcoal and phytoliths indicate the presence of local and regional woodland vegetation; small mammal, amphibian and reptile species richness patterns indicate the presence of arid environments; large mammals and bats indicate warm temperate conditions and woodland again. The contrast between these different lines of evidence are attributed to taphonomic processes, for the small vertebrates are shown to be the result of predator accumulations, and the identity of the predators suggest that they preferentially hunted in open environments some distance from the cave. Large mammals and plants are more proximal to the cave and indicate local conditions. The conclusion is that woodland was present on the mountain slope adjacent to the cave, with arid areas on the lower slopes away from the cave, which is exactly what is present in the area today in the Azokh region.

Chapter 16: *Appendix: Dating Methods Applied to Azokh Cave Sites.* Introduction: Fernández-Jalvo; Radiocarbon: Ditchfield; Electron Spin Resonance: Grün, Lees & Aubert; Amino acid racemization: Torres, Ortiz & Díaz Bautista; Uranium Lead: Pickering (2016).

Racemization combined with ESR and U/Th series dating shows an age of around 300 ka for Unit V from which a human mandible fragment was found in the 1980s. An ESR date of 205 ± 16 ka has been calculated for the area of the contact between the top of Unit V and the base of Unit IV. U–Pb dating has been applied to a speleothem sample brought from the small cave at the entrance to Azokh 1 'Lowermost Level' giving an age of 1.19 ± 0.08 Ma. This is currently the oldest age for any material from the Azokh Cave Complex and gives a minimum age for the formation of the cave itself. Other methods of dating have been tried, but some such as thermoluminiscence (TL), cosmogenic or optically stimulated luminescence (OSL) could not be carried out because sediments currently under excavation are too deep inside the cave and derived from within the cave. Bat guano has caused diagenetic alteration of fossil bones that affected radiocarbon dating of the actual fossils, and the influence of diagenesis on samples is discussed in the chapters on bone diagenesis and taphonomy. Radiometric methods for the top of the sequence have provided dates of ~2300 years BP (384 calBC) for middle Unit A of Azokh 5, and 1265 ± 23 years BP (8^{th} century) for the Unit 2 of the Azokh 2 sequence. Dates from the top of Azokh 1 are too young and results are not isotopically reliable.

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