

AZÉ 1-4 (SAÔNE-ET-LOIRE, BURGUNDY, FRANCE): ITS POSITION IN THE FILLING UP OF THE CAVE AND THE CONDITIONS UNDER WHICH IT WAS PUT IN PLACE

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Abstract: From 1985 to 1987, work done to remove obstructions in the Grotte Préhistorique d'Azé (the Azé Prehistoric Cave) led to the discovery of the paleontological deposit, Azé 1-4. This deposit is situated upstream from the Azé 1-3 deposit studied by A Argant. Since 2005, a sedimentological study has been carried out in order to position Azé 1-4 in the chronology of the sedimentation process which filled in the Grotte Préhistorique d'Azé. A number of cross sections of sediment were prepared between Azé 1-3 and Azé 1-4 as well as further upstream in the same zone as Azé 1-4. The layer of sediment which characterises the Azé 1-4 deposit was located in all these cross sections and analyses were carried out on the different sediments found at each of these locations. This work has enabled us to position Azé 1-4 in the sedimentation process which filled up the cave, to explain the conditions which brought this about, and to put forward a dating of the deposit.

Key words: Azé, bear, paleontology, Burgundy, Pleistocene, sedimentology.

INTRODUCTION

The Grotte Préhistorique d'Azé (Azé 1) is situated in the Saône-et-Loire department of Burgundy in France. (Fig. 1)

The entrance to this cave has been known for a long time and researches were first carried out at the end of the 19th century. In the 1950s, R. Dravet and R. Morel (Bonnefoy, 2002) carried out numerous works in the first 60 meters of gallery (Guillot, 2005). At the beginning of the 60s, M. Bonnefoy joined R. Morel in this activity. Together they broke through the stalagmitic floor which closed off the cave 60 metres from its entrance, thus providing access to the rest of the cave which was however almost completely filled with sediment. Between 1964 and 1970, Jean Combier brought to light the prehistoric and paleontological deposits of Azé 1-1 (Fig. 2) in the Salle d'Entrée (Entrance Room).

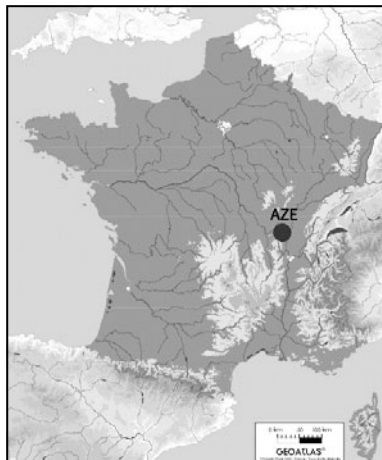


Fig. 1. Geographic location of Azé.

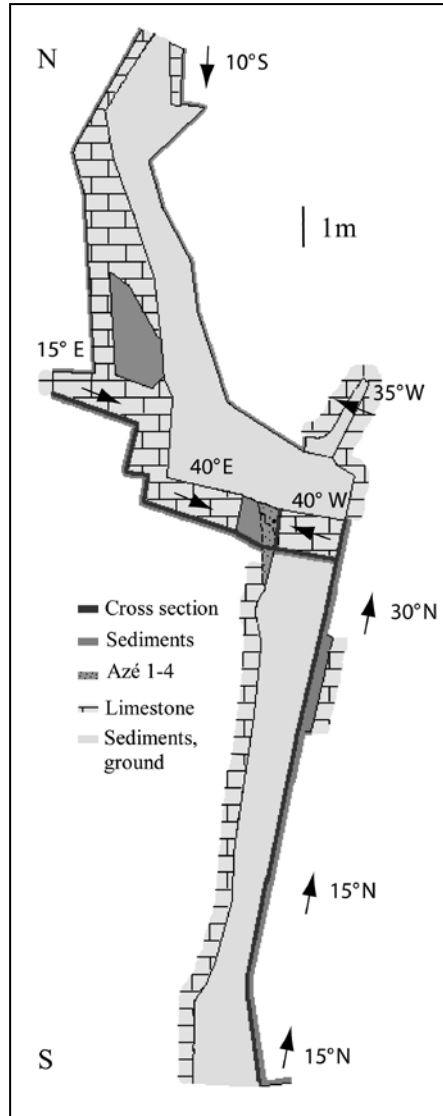
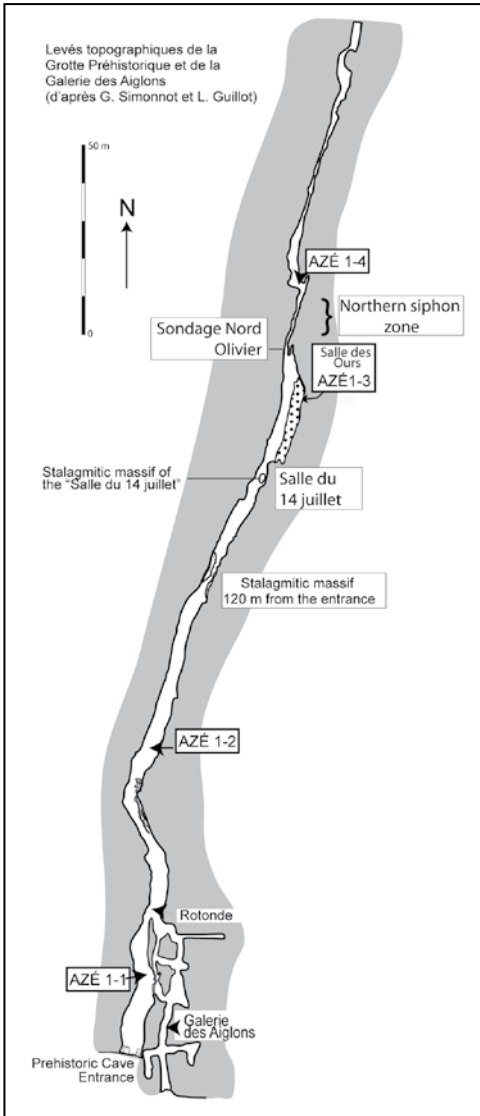


Fig. 2. Position of the different paleontological deposits at Azé (topographic plans: L. Guillot and G. Simonnot, computer processing: J. Argant).

Fig. 3. Detailed plan of the Baïonnette. Positions of the cross sections studied and the slopes of the sandy layers of Azé 1-4 (topographic plans: B. Aubouef and L. Barriquand, computer processing: B. Aubouef).

In 1978, A. and J. Argant carried out a salvage excavation immediately to the north of the stalagmitic floor 60 meters from the entrance, as a result of which the Azé 1-2 deposit became known. In 1974, R. Morel and M. Bonnefoy discovered the Salle des Ours (Bear Cave) 200 meters from the cave entrance. From 1982 to 1985, A. and J. Argant excavated part of the Salle des Ours and discovered the paleontological deposit, Azé 1-3 (Argant, 1991). From 1985 to 1987, obstructions in the cave beyond the Salle des Ours were removed. A former siphon was partly cleared and a change in the direction of the gallery, in the form of a bayonet, was discovered (Fig. 2 and 3).



Fig. 4a. View of Azé 1-4 today (Photograph: L. Barriquand).



Fig. 4b. View of Azé 1-4 today (Photograph: L. Barriquand).

At this location, a large number of bear bones had accumulated. This is the Azé 1-4 deposit (Fig. 4a and 4b).

Some of the bones found in the passage at this time have been removed without any systematic written or photographic records being made. Another group of bones, situated under a limestone ledge, has been kept in place and the rest of the deposit is still buried in sediment.

THE AZÉ 1-4 DEPOSIT

Description

The size of the Azé 1-4 deposit is not well-known because part of it has been removed by the developers of the cave and because towards the north it is still covered by sediment. The deposit seems to be an accumulation of bones in the bottom of a siphon in a layer of sand whose characteristics are already well-known. It is no more than a metre wide and its known length is about 2 metres. The fossiliferous layer slopes steeply north at about 40°. The bones are mixed with a large number of rather flat limestone stones coming from

the rock surrounding the cave. A large number of bones are fractured and no anatomical connection is visible. The bones are oriented north-south. Also associated with the deposit are a number of limestone blocks which have become detached from the surrounding rock.

Position within the sedimentary filling of the Grotte Préhistorique

Several cross sections of the sediment in this section of the cave have been carried out (Fig. 3). These cross sections have made it possible to position the Azé 1-4 deposit (Fig. 4a and 4b) in the sedimentary filling of the Grotte Préhistorique (Fig. 5, 6 and 7).

The deposits of sediment linked to Azé 1-4 took place when the cave was already partially filled. At least 32 sedimentary deposits predate Azé 1-4. These deposits make up 2.4 m of the sediment in the Baïonnette (Bayonet). The depth of the substratum under the Azé 1-4 deposit is not known. After the formation of Azé 1-4, further sedimentation occurred, almost completely filling the karst. At least 19 deposits occurred after Azé 1-4. They make up 2.3 m of the sediments in the Baïonnette.

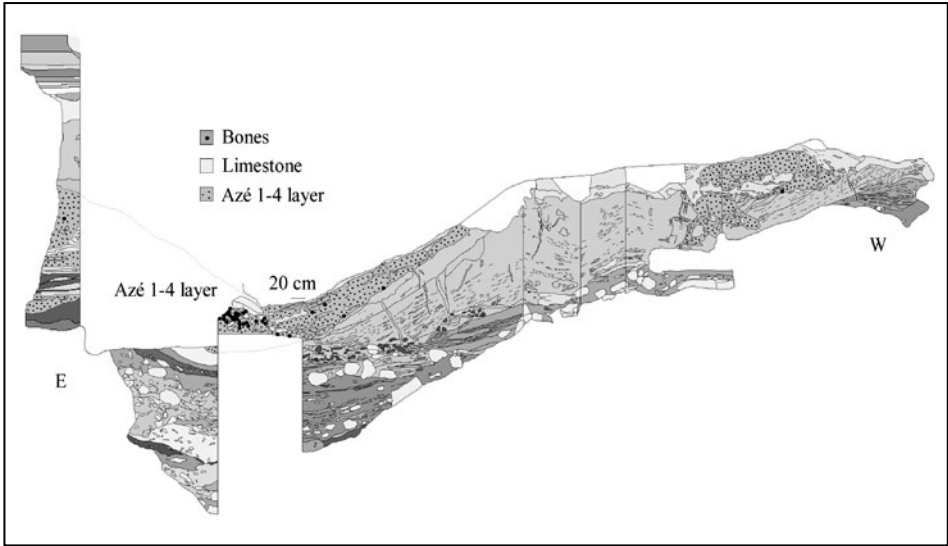


Fig. 5. East-west cross section of the sediments in the Baïonnette (plans: B. Auboeuf, J. and L. Barriquand, L. Guillot, C. Lenoble and C. Nykiel, computer processing: L Barriquand).

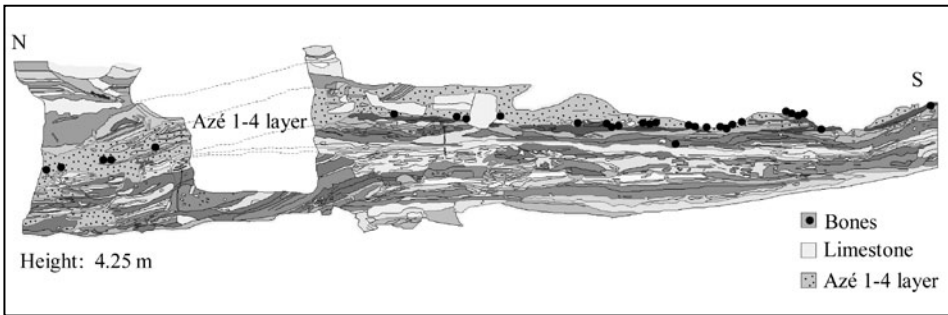


Fig. 6. North-south cross section, east side of the Baïonnette, showing the fossiliferous layer corresponding to Azé 1-4 upstream of Azé 1-4 (plans: J. and L. Barriquand, L. Guillot, and C. Nykiel, computer processing: L. Barriquand).

Granulometric analyses have been carried out on the sediments taken from the Salle des Ours and the Baïonnette (Fig. 8).

The sediments of Azé 1-4 consist of a mixture of fine and coarse sands. They are made up of 70 to 80 % sands, 15 to 25 % silts and clays, and only 2 to 9 % gravels. They mark a transition between the earlier and later sediments which surround them.

The sedimentary deposits which predate Azé 1-4 correspond to the alternation of coarse sediments (several layers are made up of 60 to 80 % gravels) and of fine sediments (several layers are made up of 90 to 95 % clays and silts). These deposits were not laid down in a continuous or uniform manner. In addition, the granulometric variations imply very different flow rates of the stream. The gallery has therefore been subject to periods of heavy flooding when large amounts of gravel were transported, but also very gentle flow rates favouring the settling of silts and clays. Some periods of drying out have also occurred between different sedimentary layers.

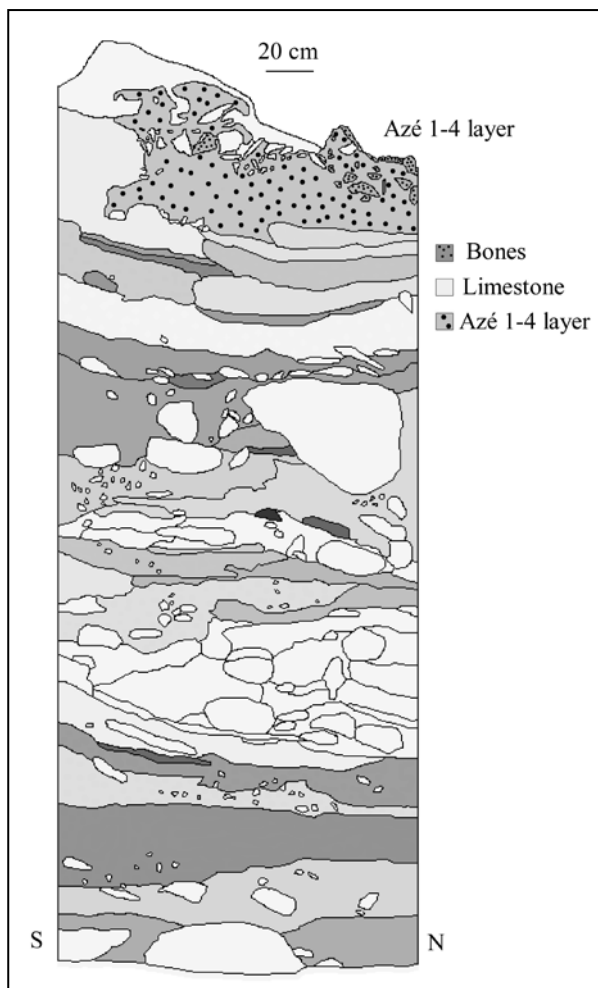


Fig. 7. North-south cross section, east side of the Baïonnette and the Azé 1-4 deposit, showing sedimentary filling prior to Azé 1-4 (plans: J. and L. Barriquand, computer processing: L. Barriquand).

Conditions leading to the formation of the Azé 1-4 deposit

The Azé 1-4 deposit consists of an accumulation of a large number of bones. However when we examine the cross sections situated upstream and downstream from this deposit, we notice that some bones are present (in lower numbers) both in the sandy layer corresponding to Azé 1-4, and at the junction of this layer of sediment and the one below. Azé 1-4 therefore does not represent an isolated group of bones but marks a level of occupation by bears in the cave. In the layers of sediment prior to Azé 1-4, we have noted the presence of some bones, but only in the layers of sediment which immediately precede the Azé 1-4 deposit. In the layers which come after the deposit we have not noted the presence of bones.

The observation of the slopes that characterise the sediments upstream and downstream of Azé 1-4 demonstrate that we are close to a point of drainage in the cave system. Upstream, the sediments slope towards the south, whereas downstream the slope is towards

The sedimentary deposits which occurred after Azé 1-4 correspond to alternations of sands (several layers consist of 60 to 90 % sands) and of even finer sediments. Only two samples, coming from the same layer, reveal coarse components, but these are attributable to cryoclastic phenomena. On the east side of the Baïonnette, these fine sediments are made up predominantly of silts (60 to 80 %), whereas in the west part of the Baïonnette, the fine sediments situated above the Azé 1-4 layer are made up of a mix of silts (55 %) and clays (44 %) and the sands are missing. This lateral change implies a very different functioning between the western and eastern parts of the passage after the Azé 1-4 deposits were put in place. There again, the deposits were not continuous and the presence of mud cracks indicate that the cavity experienced periods of drying out.

The granulometric analysis of the sediments show that the sediments of Azé 1-4 are very similar to the sediments collected by A and J Argant during their excavation of Azé 1-3.

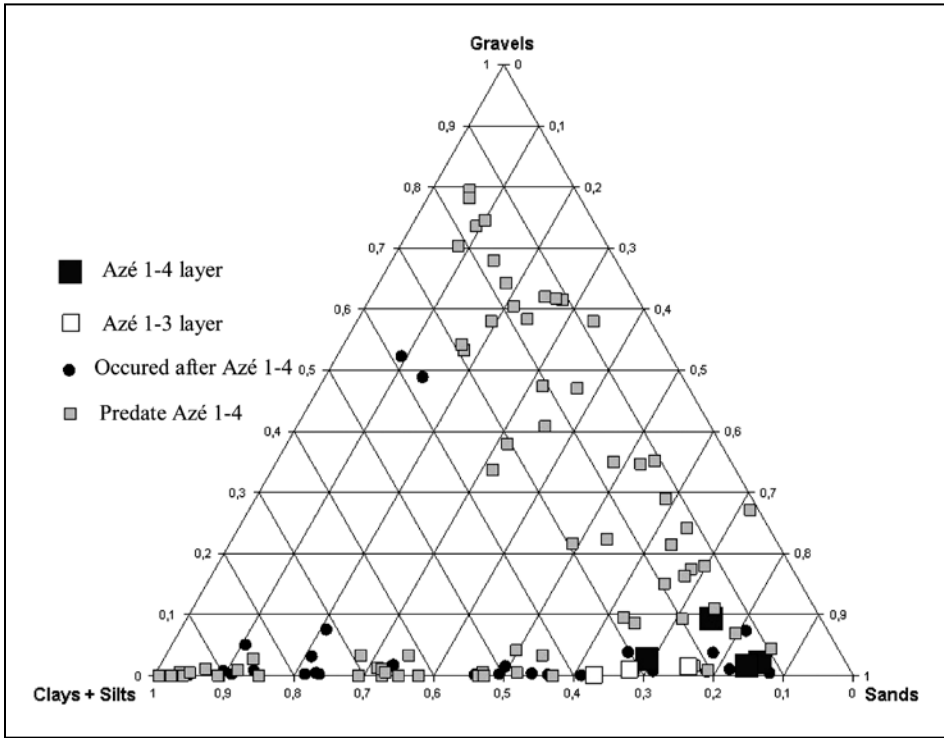


Fig. 8. Ternary granulometric diagram of the sediments in the Azé 1-4 layer and of sediments collected during the excavation of Azé 1-3 by A. and J. Argant.

the north. From east to west in the Baïonnette, the sediments are in the form of a V. The low point of this V lies directly beneath the lowest part of the cavity roof. The bones have the same slopes as the sediments in which they are found. The large bones are systematically oriented N - S.

Just above the southern part of the east cross section, work done to remove obstructions has revealed the existence of a bear skeleton in anatomical connection (backbone and ribs in connection associated with a skull, not so far excavated). The position of this skeleton and the geometry of the cavity at this point strongly suggest that it could only have come from the south, i.e. the direction opposite to the direction in which the underground river flows.

We believe these observations support the conclusion that the Azé 1-4 deposit was formed in a similar manner to that of Azé 1-3 (Argant and Barriquand et al., 2007). Water entered the prehistoric cave in an occasional manner. At these times, the Salle des Ours and the siphon were totally or partially submerged. At the end of these periods of flooding, the water drained out via a low point in the vicinity of Azé 1-4. As a result, bones were drawn towards the north, in a direction opposite to the normal flow of water in the cave system, where they settled into the sediments sloping north towards to the outlet. Certain characteristics of the cave wall such as abrupt changes of direction led to the accumulation of bones at these points.

Dating Azé 1-4

To this day, no absolute means of dating Azé 1-4 exists. The biochronology of bears, the only means of dating Azé 1-4 with certainty, has not yet been carried out.

The layers of filling prior to Azé 1-4 do not provide any means of dating. However a series of Uranium-Thorium datings (Barriquand et al., 2006) has been conducted on the stalagmitic floor which developed between the Salle du 14 Juillet and the Salle des Ours. These tests indicate that this floor formed between 190,000 years ago (isotopic stages 6 – 7) and 110,000 years ago (isotopic stage 5). At isotopic stage 5, access to the Salle des Ours was therefore closed off.

In direct relation to Azé 1-4, we have previously seen that a skeleton in connection was found in this sedimentary layer, 15 metres down stream of Azé 1-4. This indicates to us that the presence of bears in the cave was contemporaneous with the formation of the Azé 1-4 deposits. All this leads us to think that the deposits of Azé 1-3 and Azé 1-4 were put in place during the same phase (similarity of the sediments, of the conditions under which they were put in place, and of the layers themselves). Alain Argant (Argant, 1991) has used biochronology to date the bears of the Azé 1-3 deposit to the late middle Pleistocene (end of isotopic stage 6). This suggests to us that Azé 1-4 also dates to isotopic stage 6.

CONCLUSIONS

Azé 1-4 consists of an accumulation of bones. This is a result of a drainage of bones by water which having flowed into the Salle des Ours then flowed out, in a direction opposite to the prevailing current in the cave system, through a low point in the cavity. This deposit is not an isolated one for this fossiliferous layer can be found upstream and downstream from Azé 1-4. This study shows us that the Azé 1-4 and Azé 1-3 deposits are characterised by strong similarities, both with respect to the features of the sediments of which they are composed and the conditions under which they were put in place. It is no longer possible today to establish in situ direct links between the sediments of the two deposits but we are able to say that Azé 1-3 and Azé 1-4 were formed during the same phase of functioning of the cavity and certainly at the time of isotopic stage 6. The presence of a skeleton in anatomical connection between Azé 1-3 and Azé 1-4 (in the same layer as Azé 1-4) allows us to affirm that bears were still coming into the cave when the sediments were put in place.

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**AZÉ 1-4 (SAÔNE-ET-LOIRE, BOURGOGNE, FRANCE) : SA POSITION DANS
LE REMPLISSAGE SÉDIMENTAIRE DE LA GROTTTE ET LES CONDITIONS SOUS
LESQUELLES IL S'EST MIS EN PLACE.**

Résumé

De 1985 à 1987, les travaux de désobstruction dans la Grotte Préhistorique d'Azé permirent de découvrir le gisement Paléontologique d'Azé 1-4. Celui-ci est situé en amont du gisement d'Azé 1-3 étudié par A. Argant. Depuis 2005, une étude sédimentologique a été menée afin de situer Azé 1-4 dans l'histoire des remplissages qui ont colmaté la Grotte Préhistorique d'Azé. Des coupes sédimentaires ont été dressées entre Azé 1-3 et Azé 1-4 ainsi qu'en amont et au niveau d'Azé 1-4. Le niveau sédimentaire correspondant à Azé 1-4 a été repéré dans toutes ces coupes et des analyses ont été effectuées sur les différents sédiments qui constituent le remplissage. Ces travaux permettent aujourd'hui de positionner Azé 1-4 dans le remplissage de la Grotte, d'expliquer les conditions qui ont entraîné leur mise en place et d'avancer une datation du gisement.

**AZÉ 1-4 (SAÔNE-ET-LOIRE, BURGUNDSCO, FRANCÚZSKO):
POZÍCIA JEJ VÝPLNE A PODMIENKY, ZA KTORÝCH BOLA USADENÁ**

Zhrnutie

Práce na odstraňovaní závalu v jaskyni Préhistorické d'Azé (Prehistorická jaskyňa d'Azé), prebiehajúce v rokoch 1985 až 1987, viedli k objaveniu paleontologického náleziska Azé 1-4. Nálezisko je situované v smere proti prúdu od lokality Azé 1-3, preskúmaného A. Argantom. Od roku 2005 sa realizuje sedimentologická štúdia s cieľom zaradenia vrstiev Azé 1-4 v chronológii procesu sedimentácie v Prehistorickej jaskyni d'Azé. Medzi Azé 1-3 a Azé 1-4 a rovnako aj ďalej proti prúdu v tej istej zóne ako Azé 1-4 sa urobilo niekoľko priečnych rezov sedimentmi. Vrstva sedimentu charakteristická pre nálezisko Azé 1-4 sa našla vo všetkých týchto rezoch a analýzy sa realizovali v rôznych sedimentoch nájdených v každom z nich. Táto štúdia nám dáva možnosť zaradiť Azé 1-4 v chronológii sedimentov, ktoré sa ukladali v jaskyni, vysvetliť pomery, za akých sa to udialo, a posunúť vpred datovanie náleziska.