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OBSERVATIONS ON SPELEOGENESIS AND TAPHONOMY OF HOMINID BONE ACCUMULATIONS IN "CUEVA MAYOR" SIERRA DE ATAPUERCA, SPAIN

By

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Key words: Sima de los Huesos, Atapuerca, cave formation, hominid, taphonomy.

Abstract

Sima de los Huesos (SH) is a Middle-Pleistocene site inside the cave of Cueva Mayor where the oldest hominids of Spain have been found in great numbers. In essence, SH is a talus cone at the bottom of a shaft at the deepest part of the cave. The stratigraphic sequence of various layers in the cone is described here in detail. The most striking sediments are those of clays and sands that have been correlated with warm and cold periods respectively. The presence of scalloping on a cave wall and a rock fall at a place near the top of the shaft shows that there may have been a paleoentrance at this point through which the hominds entered the cave. From this original entrance the river waters would have flowed into the cave during the phreatic phase of the formation of the cave that would have been followed by the vadose phase and the human occupation. All evidence taken together i.e. the dating studies, the stratigraphy, the taphonomy and the speleogenesis suggest an age of about 140-250Ka BP for the Atapuerca hominids, an age that coincides with the interglacial period of marine oxygen-isotope episode 7. The presence of the hominid bones deep into the shaft appears to have been due to a perimortem mortuary practice, similar to that of ancient Greeks for unwanted individuals, and constitutes the earliest evidence of a mortuary practice in humans. The paper includes observations made in Cueva Mayor in the years 1989, 1990 and 1991.

Περίληψη

Το σπήλαιο Cueva Mayor, Νότια των Πυρηναίων, είναι φημισμένο γιατί σε αυτό βρέθηκαν οι παλαιότεροι ανθρωπίδες της Ισπανίας (Arsuaga *et al.* 1993). Περισσότερα από 1600 οστά έχουν βρεθεί που ανήκουν στον αρχαϊκό *Homo sapiens* και τα οποία περιλαμβάνουν περί τα δεκα ανθρώπινα κρανία. Στην παρούσα εργασία γινεται επανεκτίμηση της στρωματογραφίας, της σπηλαιογένεσης, της ταφονομίας και των ραδιοχρονολογήσεων του σπηλαίου και αποδίδεται μια ηλικία ανάμεσα στα 140 και 250 χιλιάδες χρόνια πριν από σήμερα για τους ανθρωπίδες αυτούς. Η ηλικία αυτή αντιστοιχεί στη Μεσοπαγετώδη περίοδο 7, σύμφωνα με τις θαλάσσιες θερμοκρασίες από τα ισότοπα οξυγόνου. Το κτενιωτόν (scalloping) του τοιχώματος και η κατάρρευση της οροφής σε ένα σημείο του σπηλαίου πάνω από το βάραθρο όπου βρέθηκαν τα οστά, δείχνει ότι εκεί πρέπει να υπήρχε η αρχική είσοδος του σπηλαίου. Από αυτή την είσοδο πρέπει να έμπαιναν στο σπήλαιο οι ανθρωπίδες. Η παρουσία των ανθρώπινων οστών στον κώνο των ιζημάτων του βαράθρου φαίνεται να είναι ένα ταφικό έθιμο των ανθρωπίδων αυτών που απαλλάσσονταν από τα ετοιμοθάνατα ή πεθαμένα ατομα με το να τα πετούν στο βάραθρο αυτό. Αυτή είναι και η

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παλαιότερη μαρτυρία ταφικού εθίμου, πιο παλιά ακόμα και από αυτή των Νεάντερταλ. Όσον αφορά τις αρκούδες του είδους *Ursus deningeri* φαινεται οτι έπεσαν από μόνες τους στο βάραθρο - εξαιτίας ατυχήματος -όπως έχει συμβεί και σε άλλα σπήλαια.

Intoduction

Sierra de Atapuerca is situated in Northern Spain about 14 Km to the East of the city of Burgos and consists of Cretaceous rocks in which an extensive karstic system has been developed. Cueva Mayor (fig. 1), one of the caves of this karstic system, is formed inside a small hill. To the south of the hill runs the Arlanzón river. Deep inside the Gueva Mayor, at a distance of more than 500m from its entrance, is the *Sima de los Huesos* (SH) site (fig. 2) that lies at the bottom of a 13 m deep shaft. Most of the animal fossils found in SH belong to *Ursus deningeri*, a Middle Pleistocene ancestor of the cave bear, but there are also a few bones belonging to *Panthera leo cf. fossilis, Lynx pardina spelaea, Felis silvestris, Vulpes vulpes, canis lupus, Martes sp.* and a small mustelid (Arsuaga *et al., in press).* The site, however, is famous for its hominids: more than 1600 fossil human bones have been found so far belonging to at least 32 individuals including about ten skulls. They fit well within the archaic *Homo sapiens* group and appear to document an early stage of Neanderthal evolution (Arsuaga *et al.* 1993). The Atapuerca human assemblage is the most complete collection of Middle Pleistocene humans ever discovered from one site. No herbivore bones or stone artifacts have ever been found in SH.

Stratigraphy

Aguirre (1994) has put forward the hypothesis that the thirty two or so bodies were lying in the mud and they were transported to SH by a mud flow from another chamber of the cave. This hypothesis is no longer tenable because: a) there is no such a connection of SH with another chamber and there has never been any in the past b) no trampling marks on the bones were observed: even nearly complete skulls have been found in SH. Cranium 5 presents some grooves on the occipital and the two parietals but these are probably due to rubbing against the bedrock caused by movements produced by the weight of the overlying sediments (Arsuaga pers. comm.). Indeed, there is a convex bulging of the sediments (layers 9 & 11) at the end of SH apparently due to the weight of the overlying talus cone (fig. 2). Some of the human bones were in the past half buried in the clay as evidenced by the presence of a stalagmitic paleolevel line and a dark bone staining on some skulls. Similar lines and stainings on skulls from other caves have already been described by Bartsiokas et al (1982) c) some of the red clays have been deposited in small cavities on the wall of the shaft and in roof chimneys (ceiling cavities) of the cave, evidence of their exokarst origin and finally d) the deposits in SH are a classical case of *talus cone* meaning that they fell from the mouth of the shaft forming a cone of rubble with an inclined slope (fig. 2). Talus cones with more or less inclined slopes are classically formed at the bottom of shafts and they are usually made up of infalling rock fragments, bones, earth and mud (Ford & Cullingford 1976) as in this case. Some of the infalling items have been deposited in concavities of the shaft wall of SH.

The stratigraphic observations reported here were made during the excavation campaings of 1989, 1990 and 1991 when the talus cone was still largely unaffected by the excavations. 1989 was the year when the first hominid bones were found *in situ* in SH. According to my observations, the SH talus cone consists of the following undisturbed layers from top to bottom (fig. 2):

1) A brown mud. It may correspond to the SRM layer described as dark clays with bat guano by Arsuaga *et al.* (1993).

2) A speleothem that covers in two bands the slope of the talus cone half way up its height either side of the cave wall. It is in essence a flowstone from the walls of the cave. It is not clear whether it corresponds to the CR layer described as a continuous stalagmitic floor by Arsuaga *et al.* (1993) which is still unreliably dated at 300Ka (Arsuaga pers. comm. in Nov. 1996).

3) A yellow clay.

4) Blocks of stones.

5) Black clay (bat guano) and a few pieces of charcoal in one place.
6) White marls described by Arsuaga *et al.* (1993 & *in press*) but not observed by A.B. since they were found after 1991. They might correspond to the white marls that are found at the top of the shaft inside the cave and on the hill ground outside the cave immediately above the SH site where the original entrance of the cave (fig. 2) may have been (see below).
7) A stalagmitic crust covering of bear bone assemblage that was formed by some stalactites hunging over it. It corresponds to the speleothem CVP described by Arsuaga *et al.* (1993). Differing parts of this speleothem have been dated from 70Ka by J. Bischoff using uranium series dating (Arsuaga *et al.* 1993) to 119-143Ka (sample 141) by R. Grun using ESR (Aguirre 1994). Apparently, CVP has directly covered the bear bone breccia (No 8), which was free of the overlying sediments (No 1-6) being at the periphery of the talus cone.
8) Bone "breccia" with mainly fossil bear bones dated at 105-126Ka by R. Grun using ESR on tooth enamel (samples 168b & 168c, Aguirre 1994) and at least 200Ka by Bicshoff *et al* (in press) using U-series dating and ESR on bone which is not the best material for applying these methods on. There appears to be a paradox between the dates given for layers 7 & 8 since bear teeth cannot be younger than the enclosing speleothem. This can be explained if we take into account that there may well have been bears keeping falling down from the shaft *after* the initial deposition of speleothem No 7, since the two events are in essence unrelated and lasted for a long time. The age range of 105-200Ka given for the bear bones corresponds to the biochronology of *U. deningeri* i.e. before the terminal Middle Pleistocene (Arsuaga *et al, in press*). Thus, there is neither confusion in the dates given for the various deposits in SH nor inversion of the deposits as discussed by Aguirre (1994).
Some recent bones found in SH and mentioned by Arsuaga *et al.* (*in press*) belong to animals that may have recently entered the cave from the present day entrance of Cueva Mayor. This entrance seems to have been opened by a rock fall much later than the beginning of the Upper Palaeolithic (i.e. after 40 Ka ago) and before the Bronze Age according to archaeological evidence discussed by Arsuaga *et al.* (in press). These recent bones may have been mixed intrusively with the layers of SH.
9) Red clays with human bones which are dated at about 320Ka by non-destructive gamma ray spectrometry (sample ATA-75, Aguirre 1994) but the method is still experimental and usualy produces an overestimation of ages. Bicshoff *et al* (in press) gave a date of at least 200Ka by U-series dating and ESR on bone which is not the best material for applying these methods on especially when bone histology has not been preserved due to recrystallization of bone apatite as in this case of the Atapuerca bones. At the interface between the 8 and 9 layer there is a mixing of human with bear bones (Arsuaga *et al.* 1993).
10) A speleothem stuck on the cave wall described also by Aguirre (1994) as samples 117 & 121 and dated at about 360 Ka. It is not attached to either 9 or 11 layers and therefore has no stratigraphic relation whatsoever with them as suggested by Aguirre (1994).
11) Sandy silt without bones described as sterile laminated silts and sands by Arsuaga *et al.* (1993). Layers 9, 10, and 11 end up on the bed rock (cave wall).
From the above stratigraphy and the dated speleothems and bones, it is clear that the bear and human bones should have an age between the minimum given for bears i.e. 105Ka B.P. and the maximum given for humans i.e. 320Ka BP, the human bones being somewhat older than the bear ones with a time overlap between the two. This time span for the two species contains the interglacial period of the oxygen-isotope episode 7 and intercuts the interglacials of episodes 5 and 9 of the marine paleotemperature curve. If we take into account the interglacial character of the red clays containing the human bones, then the age of the hominids is narrowed to between 140 and 250Ka i.e. the age range of oxygen-isotope 7 and not that of the episode 11 as suggested by Aguirre (1994). Indeed, in other caves, red clays have been associated with warm (and interglacial) periods and coarse sands with cold periods (see e.g. Butzer 1965, Sweeting 1973 and Bogli 1980). Therefore, the sands of layer No 11 probably correspond to a cold period, perhaps that of the oxygen-isotope episode 8.

Speleogenesis and Taphonomy

In the southern part of *Sala de los Cíclopes*, a big chamber just before SH (fig. 2), there is a similar sequence of clays and sands from top to bottom (fig. 3): a) Red clay I, b) Calcareous Sand I, c) Red clay II and d) Calcareous Sand II. In sand II there is a coarsening upwards (fig. 4). This is perhaps due to the fact that when water velocities increase, the deposits coarsen upwards, terminated abruptly owing to a log of boulders or cobbles jammed into the roof (see e.g. Ford & Cullingford 1976). Therefore, there is evidence that in Cueva Mayor, the red clays and the sands are allochthonous deposits corresponding to a warm period (apparently interglacial) and a cold period respectively. The massive amounts of red clays and sands in Sala de los Cíclopes are evidence of the existence of a nearby paleoentrance. The red clays may be the result of iron-rich terra rosa soils washed in from the surface (see e.g. Ford & Cullingford 1976) by surface streams or a river bringing in surface materials. The remnant of this river may be the Arlazón river. This deposition of clays and sands could have taken place in Cueva Mayor after the original phreatic episode of the cave and before the vadose phase had begun (see analogous cases in Bretz 1942). At the moment, it is not clear to which clays and sands of SH the clays and sands of Sala de los Cíclopes correspond if they do at all (one might speculate that they correrspond to Red Clay I and Sand I respectively).

One important speleogenetic feature in caves is *scalloping*. This feature has also been observed on a wall near the top of the shaft of SH in Cueva Mayor (fig. 2 & 5). Scallops can be defined as dissolutional concave hollows in packed patterns common on walls, floors, and ceilings in the vadose zone of caves. They are steeper at the upstream end, indicative of the water flow towards the opposite end (Bretz 1942), as the scallop length moves downstream (Curl 1974). Apart from indicating direction, scallops are also important indicators of the velocity of paleoflow. Scallop length is inversely proportional to water velocity of the ground water (Ford & Cullingford 1976). As can be observed from fig. 5, the direction of the flow cannot be easily discerned but the small size of the scallops (about 1 inch) indicates a strong water current once flowing from this narrow passage. Usually, scallops have a length of 0.5-20cm but they can reach a length of 2m (as they do in other parts of Cueva Mayor).

Interestingly, opposite the scalloped wall there is a rock fall (always near the top of the shaft) forming a small talus cone as evidenced from stones mixed with a white marl. The same marls can be found outside the cave on the ground surface above the rock fall. Apparently, there was once a paleoentrance near the top of the shaft of SH in the place where the white marls are found today (as marked in fig. 2). This paleoentrance can be regarded as the original entrance of Cueva Mayor. Today, the thickness of the cave roof above the point of collapse is about 12 m.

From the original entrance, the river waters probably flowed in with force as evidenced from the small size of scallops on the walls at this place. This would have taken place when the forerunner of Arlanzón river was flowing at a higher level so that the entire cave lay beneath the water table. This scalloping was formed before the deposition of sands and red clays in the cave. The water that passed from the original entrance was chiefly responsible for the opening of the cave passages and the shaft in Cueva Mayor during the phreatic phase of speleogenesis.

After this initial phase of cave formation, the outside river waters appear to have started a periodic infilling with sands and red clays until a valley downcutting caused the then Arlanzón river to fall to a lower level.

As a consequence, the vadose phase of the cave started to dominate, thus allowing the hominds to enter the cave from its original entrance (paleoentrance). The accumulation of their bones in SH seems to have been due to a perimortem mortuary practice of these hominids who used the shaft as a convenient means for disposing of already dead individuals or ones about to die, by throwing them into the shaft. This is the earliest evidence of a mortuary practice in humans and it is even older than that used in Neanderthal burials. Interestingly, this practice seems to be very similar to an ancient Greek perimortem mortuary practice described by many ancient Greek writers (for a review, see Themelis 1982). The ancient Spartans, for instance, used *Kaiadas*, a famous shaft, as *apothetes*, i.e. as a dumping site for disposing of enemies and diseased or convicted individuals, thus producing similar bone accumulations to that of SH. The opening of the cave during that

time is also evidenced by the presence of bat guano and bear bones in the sediments of the cave floor in Sala de los Cíclopes. The bears, though, seem to have entered the cave at a later period than humans did and fall into the shaft of SH by accident i.e. the shaft was a natural trap for the bears as cave shafts have been in other cases e.g. the Austrian caves (see e.g. Kurten 1969).

Conclusions

The original entrance of Gueva Mayor may well have been near the top of the shaft that leads to Sima de los Huesos (SH) as evidenced by the rock fall of the cave roof and the wall scalloping at this point as well as the presence of the white marls both inside and outside the cave in the area of collapse (fig. 2). The influx of river waters from this entrance seems to have been chiefly responsible for the cave formation (phreatic phase). When the vadose phase started to dominate, sands and red clays were deposited alternately, apparently corresponding to cold and warm periods respectively. The re-assessed evidence suggests that the hominid bones found in the red clay of SH have been deposited in such a warm period (interglacial) between 140 and 250Ka B.P. or the oxygen-isotope episode 7. It seems that the presence of the human bones in the deep shaft is the result of a perimortem mortuary practice by the hominids and it constitutes the earliest evidence of such practice in humans. On the other hand, the presence of bear bones in SH seems to have been by accident as it is the case for other caves. All the deposits in SH have formed a talus cone at the base of the shaft.

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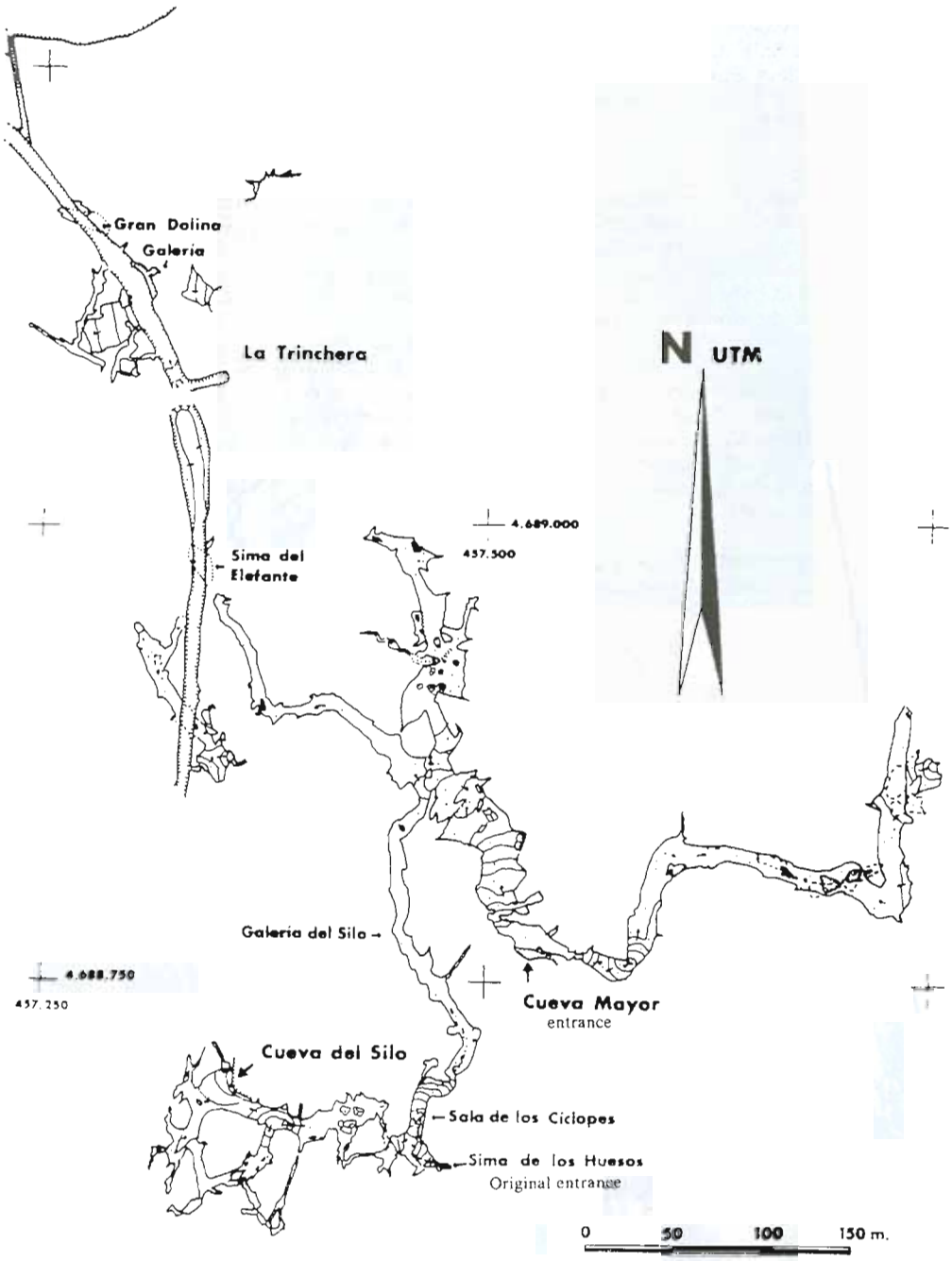

G. E. Edelweiss

Fig. 1 The plan of Cueva Mayor (Ibeas de Juarros, Atapuerca, Burgos, Spain). Note the position of the present day entrance and the suggested original entrance.

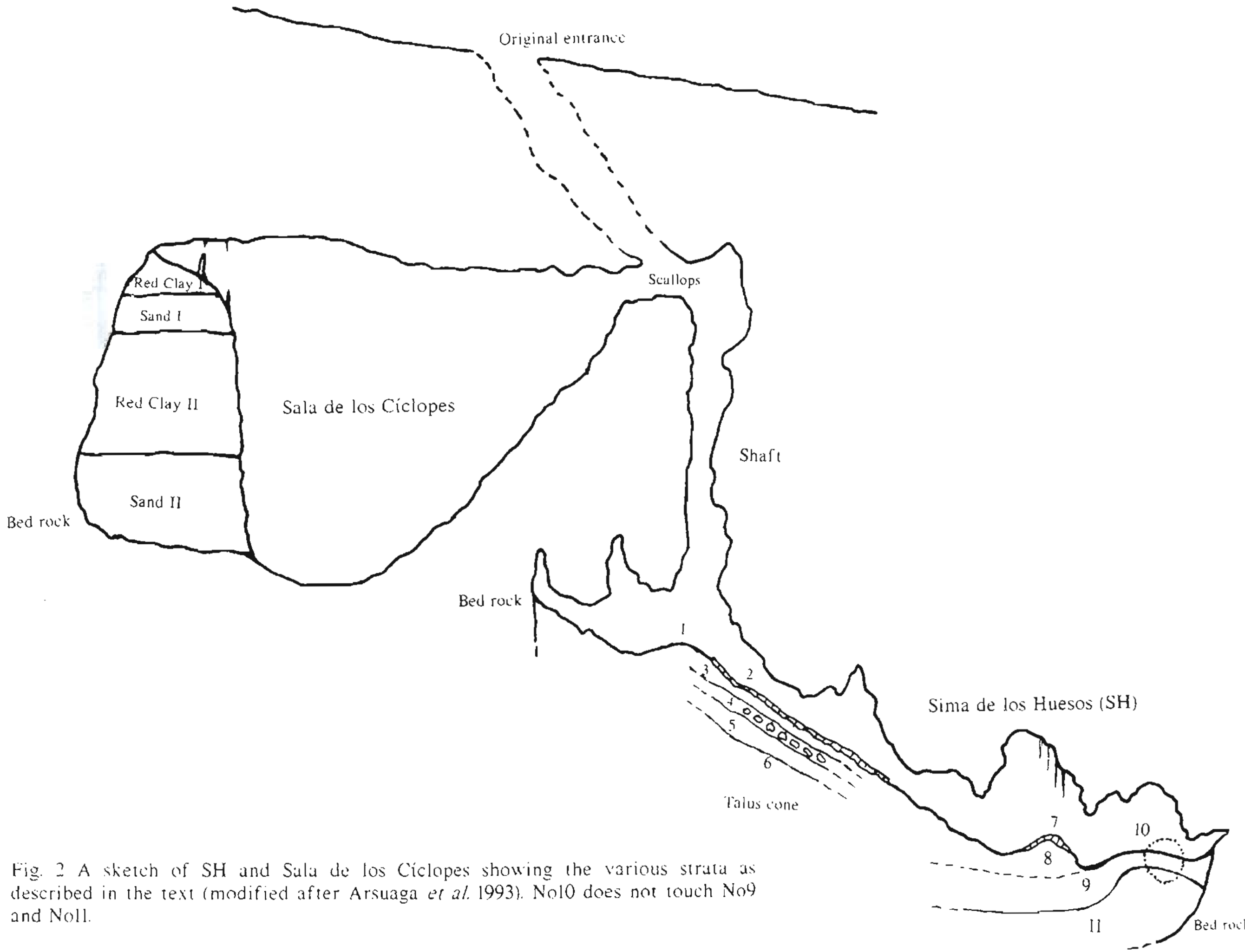

Fig. 2 A sketch of SH and Sala de los Cíclopes showing the various strata as described in the text (modified after Arsuaga *et al.* 1993). No10 does not touch No9 and No11.

Fig. 4 The transition from the sands (bottom) to the red clay (top) in Tubo de los vientos. A coarsening upwards can be observed in the sands just above the fine lamination.

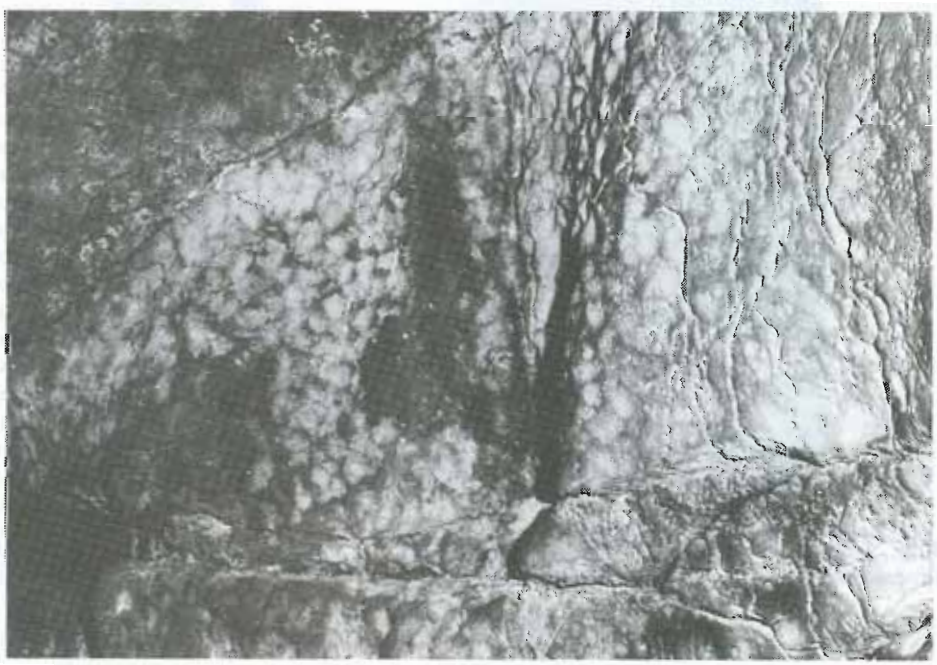

Fig. 5 Scalloping on the wall on the top of the shaft of SH. The average size of scallops in 1 inch.

Fig. 3 The stratigraphy in Sala de los Ciclopes. From top to bottom we have the limestone ceiling, Red Clay I, Calcareous Sand I, Red Clay II and Calcareous Sand II.