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FIFTEEN YEARS ALONG THE "DEVIL'S TRAILS": NEW DATA AND PERSPECTIVES

Adolfo Panarello [1], Maria Rita Palombo [2], Italo Biddittu [3], Paolo Mietto [4]

[1] Dipartimento di Scienze Umane, Sociali e della Salute, Università Studi Cassino e Lazio Meridionale, Cassino (FR), Italy
[2] Dipartimento di Scienze della Terra, Sapienza Università di Roma, IGAG_CNR, Roma, Italy
[3] Istituto Italiano di Paleontologia Umana, Convitto Nazionale Regina Margherita, Anagni (FR), Italy
[4] Dipartimento di Geoscienze, Università degli Studi di Padova, Padova, Italy

Corresponding author: A. Panarello <panarello@unicas.it>

ABSTRACT: On March 2003, the discovery of human fossil footprints on the volcanic ashes of the north eastern slope of Roccamonfina volcano was announced to the world. They were dated to through $^{40}Ar/^{39}Ar$ to 349±3 ka. For this reason they are still among the oldest ichnological issues known up to now. Furthermore, they are, more specifically, among the rarest ichnological evidence left by Middle-Pleistocene man. These fossil footprints are not randomly located but, on the contrary, they are patterned to form at least two trackways (called "Trackway A" and "Trackway B") whose general shapes have not found comparisons in the world so far. Both trackways branch off from another unique fossil structure, which is the oldest human fossil pathway identified so far. All directly collectable data from these structures has been analysed and published in a series of reports. Although the high antiquity of the footprints has been for a long time the leitmotiv and the most attractive element for the media and scientists, its true paleontological power must be seen in its capacity to provide significant clues about the everyday behaviour and the environmental context of *Homo heidelbergensis* during the Middle Pleistocene and whose remains have been found on very few sites of the same age. Unfortunately, despite the worldwide media clamour and the great attention of the scientific world, despite the publication of many reports, the geosite is still not adequately protected and promoted and is at risk of losing a significant part of its paleontological and touristic potential. Nevertheless, scientific research, in spite of great difficulties, goes on.
Here we report about the state of what has already been done by scientists and what still needs to be done, pointing out that no more time can be wasted to preserve one of the most important and ancient human ichnosites ever discovered.

Keywords: Roccamonfina, Devil's Trails, Ciampate del diavolo, fossil footprints, hominids, paleofauna, *Homo heidelbergensis*

1. INTRODUCTION

The "Ciampate del diavolo" palaeontological site (N41°19.954' - E14°01.488') (Fig. 1) lies on the north-eastern slope of the Roccamonfina volcano. Before its discovery, on August 4th, 2001, only a legend existed telling the story of an uncanny walker who had left his footprints on the still burning lava after trampling on it. Another local historian supposed that they might have been left by some ancient Italic people (Iulianis, 1986). Indeed, local people, probably due to their lack of scientific knowledge, thought that only a supernatural being could have walked on the burning lava without burning itself. Actually, the ground is not made up of lava but of tuff and this was the first remarkable evidence, which was noted by the discoverers (Adolfo Panarello and Marco De Angelis). As it is well known, tuff is the result of the consolidation of a pyroclastic chaotic deposit. Anyway, although not completely convinced, local people accepted this explanation and passed it down from generation to generation, up until 2001. Previously some local scholars had tried to find a scientific explanation of those "strange" footprints, but none of them succeeded (Panarello, 2005).

On March 13th, 2003, after all the necessary surveys, tests and studies, the scientific team led by Paolo Mietto (University of Padua) announced to the world the discovery of what were the oldest fossil footprints attributable to some exemplars of the genus *Homo* so far. They were preserved on a Brown Leucitic Tuff (BLT) formation, which was preliminarily dated between 385 and 325 ka (Mietto et al., 2003). During the first surveys, carried out during the two preceding years, at least 46 footprints and at least one handprint had been detected. They were organized in at least two trackways (called "Trackway A" and "Trackway B") and associated with fossil prints of other human body anatomical parts and with a still unspecified number of animal footprints. Most of this was published in the first official reports by Avanzini et al. (2008).

After some fieldwork, from 2005 to 2010, within the main palaeontological site, located near the village of "Foresta" (municipality of Tora e Piccilli, Caserta province, Central Italy) many other signs were detected and they are still under study. In addition to other possible animal footprints, an astonishing structure was also found, which resembled paths left in the snow by walkers moving casually. This structure was partially altered during quarrying activities in historical times, but preserved enough details to be objectively studied. Actually, two doctoral works have permitted a rigorous and comprehensive detection and interpretation of the whole geology of the site (Santello, 2010), in addition to the morphology and structural evolution of each of the ich-

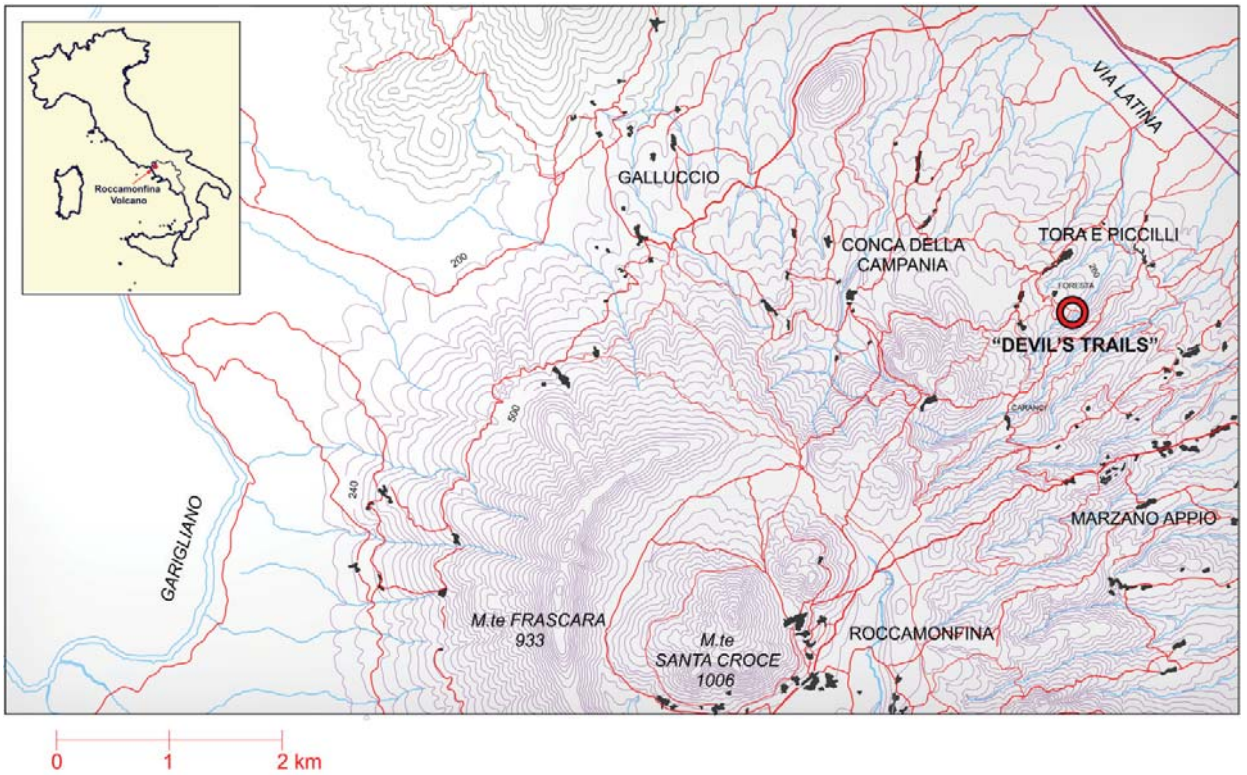

Fig. 1 - Location of the “Devil's Trails” (“Ciampate del Diavolo”) paleontological site (Roccamonfina volcano area, central Italy).

nites and pseudo-ichnites (Panarello, 2016a) found during the field work carried out by the research team led by Paolo Mietto (University of Padua). Recently, an official report about the aforementioned structure, which was thought to be a fossil prehistoric path, has been published: it is actually a middle-Pleistocene pathway from which at least two trackways of human fossil footprints branch off (Panarello et al., 2017b).

Over the past two years, specific research has started on palaeoanthropological, palaeozoological and palaeo-biomedical aspects.

The ichnosite of "Foresta" is, in truth, exceptional because it allows to observe and to study on the same site the following aspects:

- it is possible to carry on a detailed geological, stratigraphical and radiometrical analysis of the substrate;
- there are a great number of human and animal fossil footprints, which are preserved on a very steep slope (up to 80%);
- human footprints are organized in gait patterns that cannot be compared to similar ones anywhere else so far;
- human footprints are associated with fossil prints of other human body anatomical parts (calves, possible gluteus, etc.), which have not been found elsewhere up to now;
- there is at least one human handprint, which is located in the open air and not in a cultural context;
- there is the oldest fossil pathway known up to now in the world; it preserves within its length (over 50m) both human and animal fossil footprints oriented in different directions;
- there are fossil footprints of palaeofauna;

Finally, the "Ciampate del diavolo" ("Devil's Trails") paleontological site is one the oldest ichnosites of the world and certainly one the most precious for the study of the behaviour and the body structure of European Middle-Pleistocene, likely *Homo heidelbergensis* as suggested by the presence of remains of this species in the region, i.e. the Ceprano skull (Ascenzi et al., 1996, 2000; Manzi et al., 2000, 2010, 2016; Di Vincenzo et al., 2017).

In this paper we report on the state of the studies to file what has been done during last fifteen years and what must still be done in a scientific perspective and, especially, in the view of the preservation and promotion of this quite unique site (not started as yet), which must be considered as one of the most important in the entire world.

2. A UNIQUE SITE IN THE WORLD

2.1 State of the art

At present, the unearthed surface, made up of Brown Leucitic Tuff (BLT) is about 2000 square meters wide. So far, 8 stratigraphic units have been surveyed. They are numbered from LS01 to LS08 and are related to pyroclastic flows of variable magnitude, composition and dating. The trampled level is LS07. It is separated from LS08 by an interstructure formed of thin, variable granular materials that facilitated the preservation of

Fig. 2 - A zone (red rounded), near Trackway A, in which mud-crack are preserved on the original prehistoric surface.

fossil footprints during the following pyroclastic flow which put in place LS08 geological unit (Santello, 2010; Panarello, 2016a, 2016b) (Fig. 2). Various dating of LS07 are available. The first of them, at 385-325 ka, was carried out using the K/Ar method (Luhr & Giannetti, 1987; Appleton, 1972; Giannetti, 1979a, 1979b; Radicati of Brozolo et al. 1988; Ballini et al., 1989a, 1989b, 1990; Cole et al., 1992; De Rita & Giordano, 1996). A more punctual dating at 345 ± 6 ka was provided by Scaillet et al. (2008) through $^{40}Ar/^{39}Ar$ method. The last and most accurate radiometric $^{40}Ar/^{39}Ar$ dating, which was carried out on both LS07 and on LS08 layers, was done by Lisa Santello together with the scientific team led by Paolo Mietto. It provided a dating at 349 ± 3 ka (Santello, 2010: 68-69). The possibility of having a dating for both the trampled layer and for what sealed it, enables scientists to precisely establish the chronological extremes of footprints within a very narrow range, which is slightly younger than the Termination IV (337 ka) and which is correlated with late MIS 10. This fact is not common to all the other ichnosites of hominids known in the world up to now and this must be considered as another reason for the uniqueness of the "Devil's Trails" site. Moreover, between LS07 and LS08, no palaeosoils have been found suggesting that not much time passed between the pyroclastic flows, which put these geological units in place.

From a taphonomic point of view, the lithification of the layer LS07, which allowed the fossilization of the footprints, is due to a zeolitization process (Mietto et al., 2003), which was preceded by a quite common cooling and drying process of the surface. This is well documented by the presence of mud cracks flanking fossil footprints in many places (Fig. 2). The trampled surface was also protected by a sort of protective debris blanket, which was created by the fallout materials before the following pyroclastic flow took place. Finally, the exploration and analysis of other BLT deposits which are distant from the "Devil's Trails" site and which are located on the eastern and southern sides of the volcano, also allowed the clarification that the zeolitization of the pyroclastic deposit did not occur homogeneously. So that inconsistent levels alternate with others, which have a lithic consistence, and this inhomogeneity has favoured the preservation of fossil footprints and has also provided the chance to see them again after their re-exposure caused both by natural and anthropic agents.

The human fossil footprints are aligned to form two different trackways (called "Trackway A" and "Trackway B") (Figs. 3, 4), both descending the slope and both generally oriented toward south-east. The very singular shapes of these trackways show evident attempts to manage the steep incline, which sometimes appear successful and sometimes do not. The "Trackway A", in fact, has a "Z"-shaped pattern because the trackmaker was smart at judging the steep and slippery slope and in choosing the best route to safely descend it. On the contrary, trackmaker B chose a difficult route; therefore, he slipped and fell. During his attempt to regain balance, he left the print of his left hand and of other parts of his body on the still soft and already moderately cooled substrate (Avanzini et al., 2008).

No other hominid ichnosite has an incline comparable to that of the "Devil's Trails" site. In some zones, this

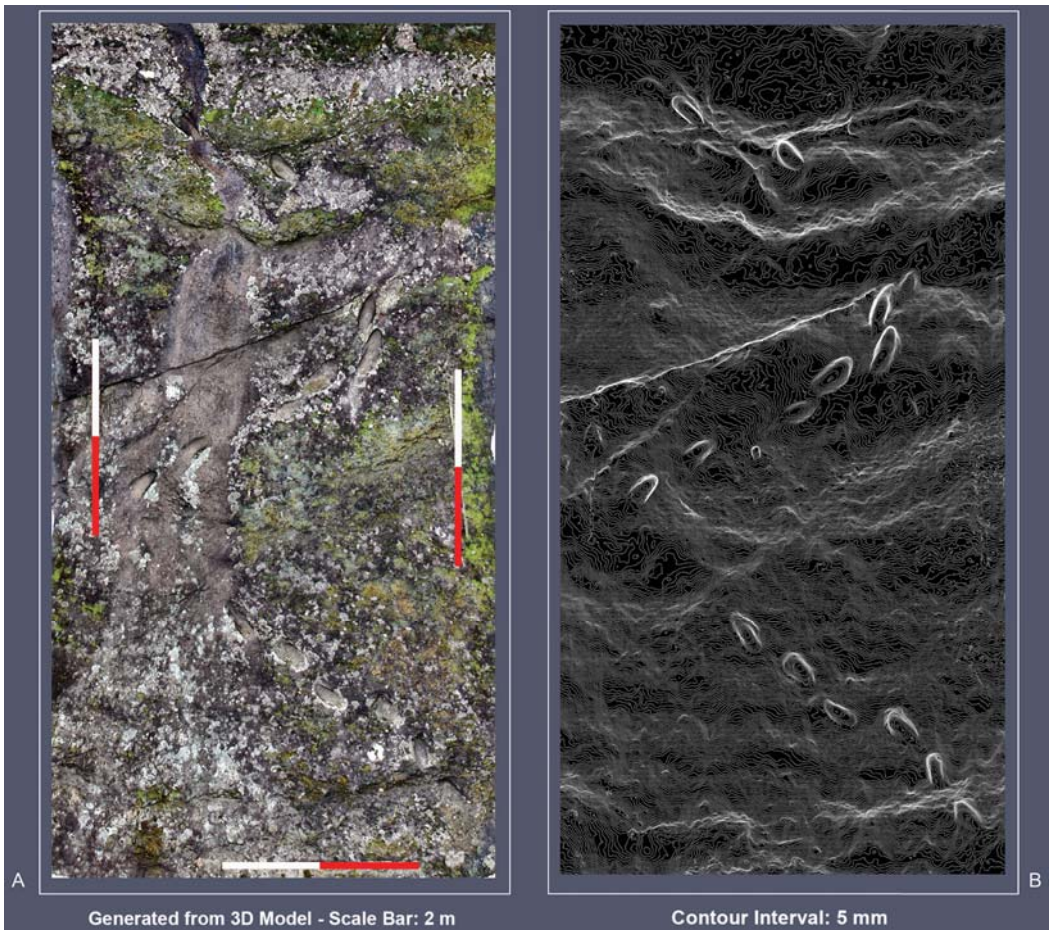

Fig. 3 - Trackway A, southern view: 3D generated zenital image, scale bar 2 m (A); contour lines 5 mm (B).

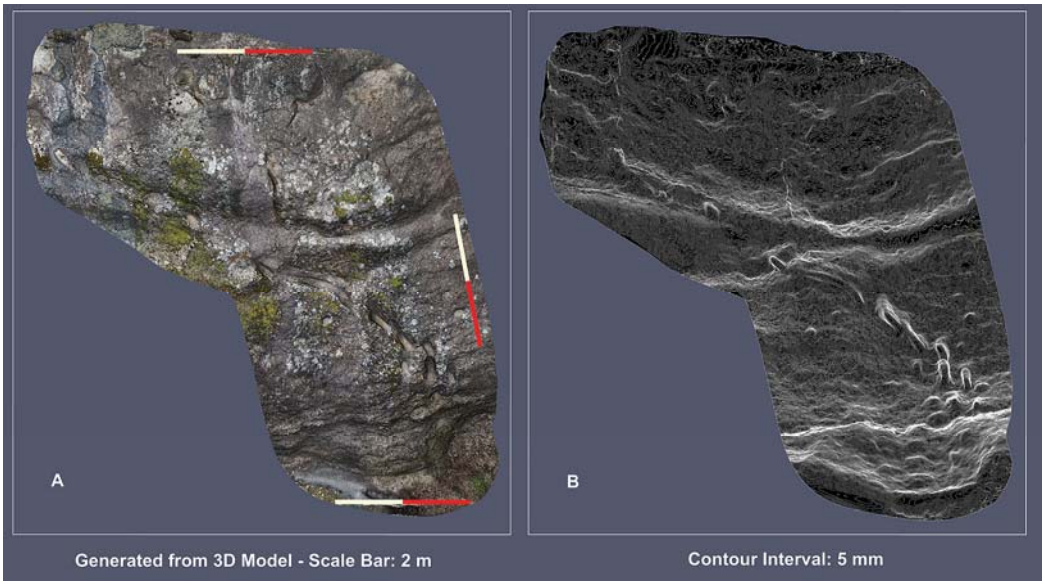

Fig. 4 - Trackway B, southern view: 3D generated zenital image, scale bar 2 m (A); contour lines 5 mm (B).

incline exceeds 30° and this means that the two trackmakers had to use good judgement to maintain balance during their risky downhill slope descent. This allows us to infer, through the study of gait patterns, that the trackmakers had the same pelvis structure as ours, that they were habitual bipeds and that they were fully able to make conscious and developed behavioural choices. Actually all the footprints belonging to both "Trackway A" and "Trackway B" clearly point out evident step crossings and other foot adjustments to manage natural constraints or to test the ground in search of more stable support and balance during walking. Moreover, the left hand of trackmaker B is cleverly used to regain lost balance by touching the upward sidewall flanking the long slippery slope (Avanzini et al., 2008).

Similar evidence is not known elsewhere in the world nor other findings of handprints are known which can be safely considered completely free from cultural claims and which are located in a subaerial environment like that of the "Devil's Trails" site. Finally, in the distal part of Trackway B, the deep prints of calves and of other possible hands and of a possible gluteus are clearly visible. This recent evidence is still under study.

The most recent and detailed photogrammetric surveys and the 3D models (Fig. 5) created by scientists permitted to confirm the actuality of all the footprints (46, at least) of both Trackway A and B. On the contrary, they have highlighted that some stratigraphical problems about Trackway C still occur. So this trackway has been put under study (Panarello et al., 2016; Panarello and Mietto, 2017) once again.

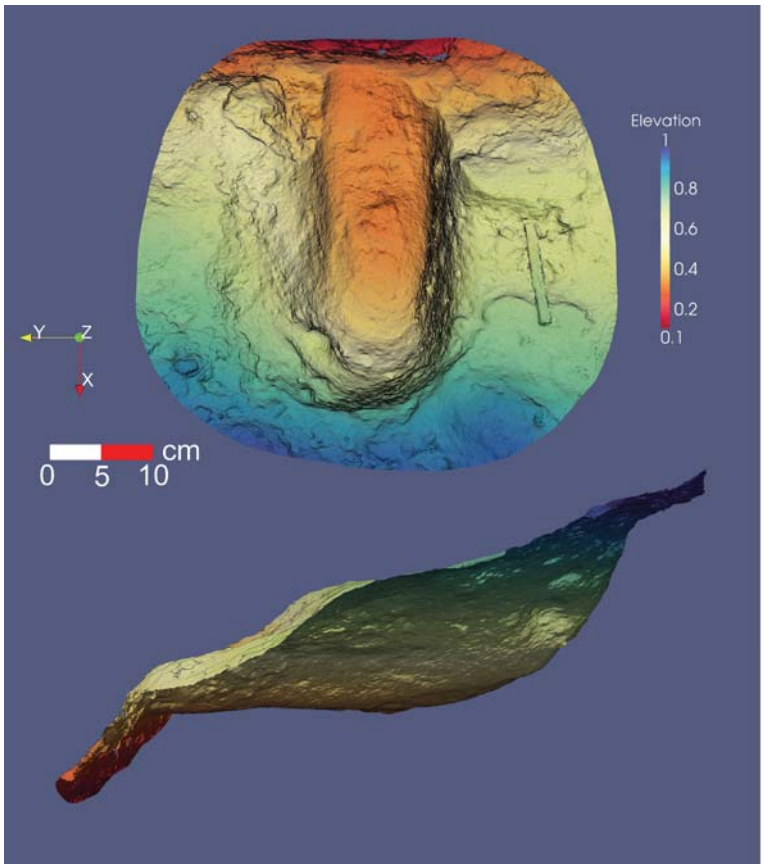

Fig. 5 - Trackway A: 3D generated depth map (zenital and transversal images) of the human fossil footprint called A25 (right foot); contour lines: 1 mm; scale bar: 10 cm.

At least four more human footprints were found in the western end of the site. They are still under study and will be published as soon as their analysis is complete. Other partially altered human and animal footprints have been found within the space of the prehistoric pathway that dominates the tuff slope and from which the two Trackways A and B branch off. Studies about this prehistoric route, already noticed in 2005, has recently been completed: it proved to be, actually, the oldest human fossil pathway ever discovered so far. To date it is not comparable to other similar elements anywhere in the world both for antiquity and for the duration of the settling dynamics it suggests (Panarello, 2016a, 2016b; Panarello et al., 2017).

The footprints of Foresta, the so-called "Devil's Trails" (or "Ciampate del diavolo") are among the oldest human fossil footprints ever discovered outside Africa. In Africa, only the footprints of Laetoli (Leakey and Hay, 1979; Meldrum et al., 2011; Deino, 2011; Masao et al., 2017), those of Ileret (Bennett et al., 2009), and those of Koobi-Fora (Behrensmeyer & Laporte, 1981; Bennett et al., 2009) are certainly older, as well as in Europe those of Happisburg (Norfolk, UK) (Ashton et al., 2014). Recent data suggest that also the single footprint found of Terra Amata (France) could be older (de Lumley et al., 2011). Many other ichnosites of hominins are known all over the world (Lockley et al., 2008; Bennett & Morse, 2014; Panarello, 2016b) and some of them are very interesting, i.e. that of Willandra Lakes, Southeastern Australia (Webb et al., 2006; Webb, 2007), but none of them has the same antiquity of the aforementioned sites. The Sapienza University of Rome recently announced the discovery of new ancient hominid ichnosite, dated to about 800 ka, in Eritrea (https://www.uniroma1.it/it/node/26082

2.2. New Data

Contemporaneously with the study of human footprints, new lines of research have been developing over the last couple of years aimed at providing a new radiometric chronological constraint (Panarello et al., 2017b) to the site, and to investigate the environmental context. Specifically, archaeological surveys were performed to provide further evidence of the presence of *Homo heidelbergensis* inside and around the Roccamonfina volcanic area. Furthermore, since 2016 new analysis of the palaeosurface has begun to detect vertebrate footprints

Fig. 6 - The stone biface from Ceppagna (after Pigorini, 1876).

useful to giving some clues about the palaeofauna living in the same area and frequenting the site of "Devil's trails" paleontological site.

Finally, a first analysis about the sex and the body mass of human trackmakers has been started, awaiting more in-depth physical study.

3. TRACKMAKER'S IDENTITIES: NEW RESEARCH FOR NEW CLUES

3.1. Archaeological investigations

Since the second half of the nineteenth century there is known evidence of an ancient human presence in northern Campania and in Molise, which is documented by lithic tools, generically attributed to the "stone age" (Nicolucci, 1871). The first citation about the finding of a classic Acheulean biface tool in situ was given in 1876 by Luigi Pigorini (Pigorini, 1876). Although mistakenly doubting about its belonging to a generic "periodo archeolitico" ("archaeolytic period = lower Palaeolithic") he described one of the most classic Italian biface stone tool with quite unusual dimensions (mm 233 x 105 x 75; Fig. 6), which had been found «*alla profondità di quasi sei metri tra uno strato di argilla e uno di ghiaia, cavandosi le fondamenta di una casa colonica presso il villaggio di Ceppagna*» ("at a depth of about six meters between a layer of clay and a gravel, breaking the foundations of a farmhouse in the village of Ceppagna") (Pigorini, 1876), a small village lying only 17 km far from the "Devil's Trails" paleontological site.

For this reason, a systematic exploration of the palaeontological site and its surroundings has been started in 2014, in search for evidence able to confirm the first belief that trackmakers could have been some *Homo heidelbergensis* individuals and thus specifying also their cultural identity.

Researches carried out up to now have enabled us to identify some artifacts/implements scattered on the soil surface that, at the moment, cannot be attributed to any precise chronological phases.

On the contrary, some more interesting data may be provided by one basalt artifact which was found right inside the "Devil's Trails" palaeontological site, in the matrix, called α, between the LS07 and LS08 geological layers, i.e. between the trampled surface (LS07) and its sealing layer (LS08) (Santello, 2010) (Fig. 7, Fig. 8).

This lithic tool was accidentally uncovered by quarrymen who enlarged, in historical times, the original prehistoric surface which has recently been interpreted as a walking space located upward of the trackways A and B of human fossil footprints (Panarello, 2016a; Panarello et al., 2017b), but it had not been noted before the most recent field works by Paolo Mietto's scientific team during the years 2013-2015. The

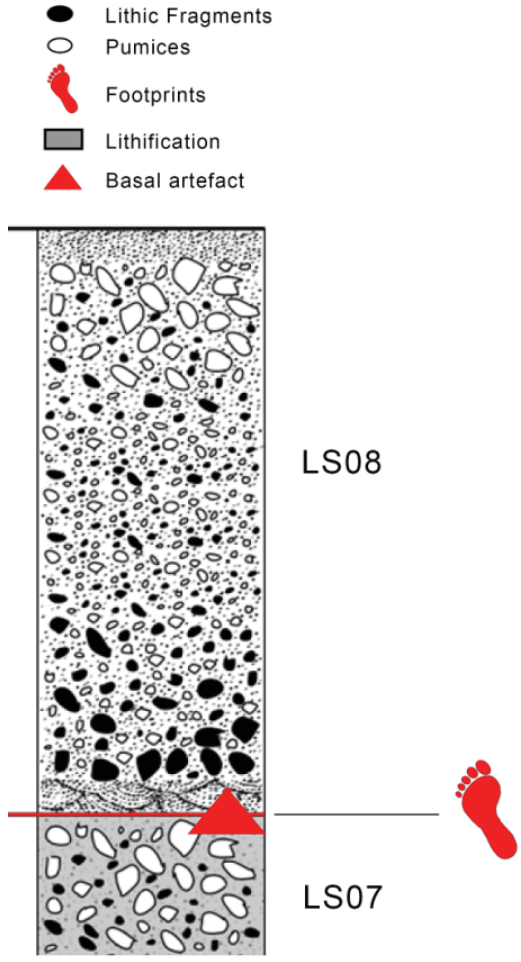

Fig. 7 - Detail of the position, in geological stratigraphy, in which the basalt core has been found (reworking after Santello, 2010).

Fig. 8 - "Devil's Trails" paleontological site detail photos of the lithic core from "Devil's Trails" paleontological site at the moment of its finding.Scale Bar: 10 cm.

same artifact was left in situ up to June 2016, when it was extracted with the maximum care in order to register its exact stratigraphic location. The entire surface of the lithic tool preserves an altered two-colour patina. The weathered part, which has been exposed to the light and rain, has acquired a dark colour (dark grey hue 5y 4/1) and a slight lustration whereas the side that was embedded in the LS07 sediments has a lighter colour (grey hue 5y 5/1) and a homogeneous patina with some traces of the sediments forming the layer. Fresh fractures are not recognizable.

The artifact, which can be classified between the cores, has concave surfaces for multidirectional removals. One of its sides (Fig. 9) has the negative of 3 removals from a single percussion plane while one comes from the opposite plane. Its lower face has centripetal removals on which the impact point is not clearly distinguishable (Fig. 10). Its section is flat convex. Its maximum measurable dimensions are mm 52 x 45.50 x 42. Its weight is 94 gr.

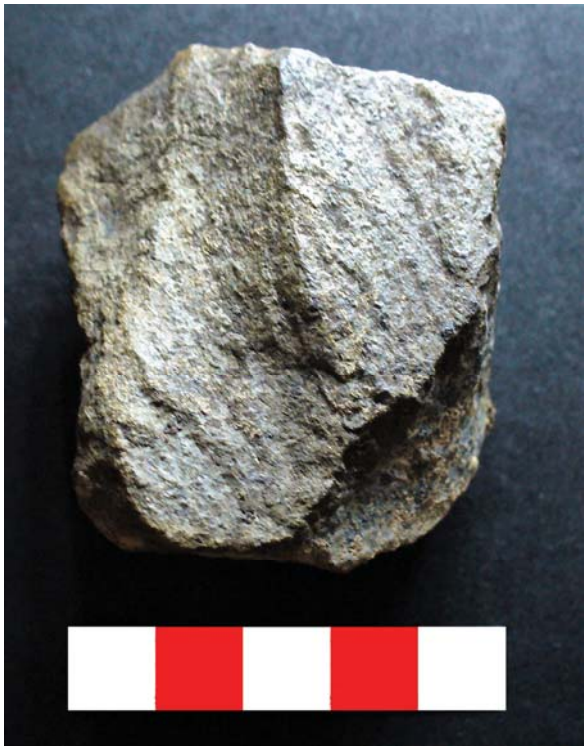

Fig. 9 - The exposed side of the lithic core found between geological layers LS07 and LS08 (Scale Bar: 5 cm).

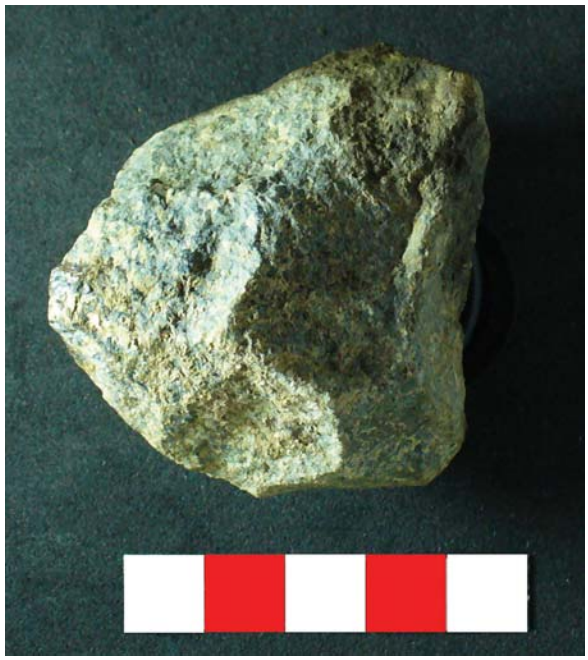

Fig. 10 - The buried side of the lithic core found between geological layers LS07 and LS08 (Scale Bar: 5 cm).

Fig. 11 - Zenital photo of the space between the original position of the lithic core and the footprints of the middle sized ruminant artiodactyl.

The use of basalt and hard materials of volcanic origin for the manufacture of similar tools is already known from the most ancient phases of Palaeolithic technology in Africa in the Olduvai Gorge (Leakey 1971) and at Melka Kunturé (Chavaillon & Berthelet, 2004; Chavaillon & Piperno, 2004); in Eurasia at Dmanisi (Celiberti et al., 2004; de Lumley et al., 2005); in Europe at Bois-de-Riquet in southern France (Bourguignon et al., 2015).

A direct comparison with some known evidence from Central Italy can be made with the stone tools from two Palaeolithic sites located in the Frosinone province, i.e. Fontana Ranuccio in Anagni and Pofi-Cava Pompi.

At Fontana Ranuccio there is a level of pedogenized tufite with solifluction and ferritic crust containing abundant fossil fauna and lithic tools which have been dated at the lower Palaeolithic and attributed to the Acheulean facies (Ascenzi et al., 1993). K-Ar dating made on leucite crystals indicated for this site an age of 458 ka (Biddittu et al., 1979). At the Fontana Ranuccio site remains of fauna are associated with lithic and bone industries: small and medium-sized flint tools are associ-

ated with more rare basalt ones, medium-sized basalt and flint bifaces, numerous artefacts derived from bones of mammals with a particular choice on the use of *Palaeoloxodon antiquus* diaphysis. At the same site four human molars have been found: they show morphological characteristics and chronology matching those of *Homo heidelbergensis* (Ascenzi et al. 1993).

At the site of Pofi - Cava Pompi, during the extraction of "pozzolana" in the 1960s (Fedele et al., 1962), human fossil ulna and tibia remains were found. They are associated with fossil fauna and rare lithic tools made up of flint and basalt. Despite the absence of bifaces, the site of Cava Pompi show several similarities with that of Fontana Ranuccio because of the presence of small-sized flakes and bowls, and because of the use of basalt and animal bones for the manufacture of medium-sized artifacts (Passarello and Palmieri, 1968; Biddittu and Segre, 1978).

The finding of the basalt tool inside the "Devil's Trails" site on the same surface where human fossil footprints are preserved adds an important element which will certainly help to elaborate new hypotheses and to make new assumptions about the possible contemporaneity of the scatter of the precious tool along the prehistoric frequented pathways and about the possible significance of its typological aspect (the existence of a core also implies the presence of a hammerstone). Another interesting feature is the position and distance of the core (1,0534 m) compared to the herbivorous footprints described in this work (Fig. 11).

It is, therefore, evident that more careful studies are necessary about the discovered stone tool with special attention to the micro-traces preserved on its surface. It is also necessary to go on investigating about the location of the finding paying maximum attention to the erosive processes of the layer LS07, in order to try to find other tools and generically cultural evidence strictly related to the trampled layer with the possible demonstration that human presence within the palaeontological site is exclusively proven by the well-known fossil footprints.

3.2. Looking for vertebrate footprints

The detection and identification of vertebrate footprints on the Foresta palaeosurface is challenging due to the characteristics of the pyroclastic flow they are impressed on, and the alteration undergone by the top of the volcanoclastic deposit during its prolonged exposure to weathering agents (Fig. 12). The features of footprints left by a trackmaker, indeed, strictly relate to the typology of the substratum (e.g. granulometry, water content, degree of cohesion, inclination of the impressed surface) that affect depth and shape of tracks, as well as to gait, body mass, gender, and age of trackmakers (see e.g. inter alios Allen, 1997; Bromley, 2001; Milàn, 2007; Manning, 2004; Milàn & Bromley, 2006, 2008; Fanelli et al., 2007; Marty et al., 2009; Morse et al., 2013; Platt & Hasiotis, 2014). Most Quaternary vertebrate footprints and trackways have been reported from aeolian or coastal sandy deposits, some from swampy, muddy fluvio-lacustrine environments (see inter alios Flor, 1989; Lea, 1996; Allen, 1997; Quintana et al., 2001; Fornos et al., 2002; Lucas et al., 2002; Morgan et al., 2002; Scott, 2005; Hunt and Lucas, 2007; Lucas, 2007; Milàn et al., 2007, 2015; Noe-Nygaard et al., 2007; Oishi et al., 2002; Bromley et al., 2 009; Kim et al., 2009; Neto-de-Carvalho, 2010; Buynevich et al., 2011; Aramayo et al., 2015) while tracks associated with volcanic deposits were mainly preserved in volcanic ash, rarely in volcanoclastic sediments (see e.g. Johnson, 1937; Lucas & Schultz, 2007; Meldrum et al., 2011).

The best preserved mammal footprints found to date at the Foresta site have been detected on the subhorizontal surface, used as a route-way by *Homo heidelbergensis,* bordering the pyroclastic flow slope (Fig. 13). They belong to a middle sized ruminant artiodactyl (ichno-order Artiodactipedida sensu Vialov, 1966), as is clearly indicated by the elongated and wedge shape of the concave hyporelief of two hooves (medial digit III hoof and lateral digit IV hoof), which are mirror images of each other, and show a convex, parabolic external outline, with a broader caudal part and angular distal edge, while the internal one is slightly concave.

The ichnotaxonomy and trackmaker identification of artiodactyl tracks, especially those of ruminants, is however difficult because of a basic similar morphology of the foot among different taxa and the large variation in shape of footprints impressed by the same trackmaker in relation to the gait (causing the clouts to flex differently and spread apart) age and gender (affecting size and shape) (see e.g. Cervipeda and Pecoripeda ichnotaxa). The identification issues increase in the case of Foresta footprints due to the presence of only two footprints, which are not placed in succession but side by side, nearly parallel to each other (the right better defined than the left), and show some intriguing features. Both footprints show weakly convex clout walls, and markedly convergent hoof tips. Subunguinus spaces are not visible, while callus pad impressions are hardly detectable on the right footprint, where the impressions of dewclaws, the small vestigial nails for digits two and five, are visible behind the tracks of the third and fourth digit, while dewclaw impressions are not well-defined in the left footprint. A narrow interdigital space is present in the right footprint, while in the left one the impression of third and fourth digits are superimposed, as the third would slide on the fourth. The size of footprints (length and breadth of about 5 and 3 cm respectively) may be consistent with that of either roe deer or chamois. The size may be consistent too with footprints of fallow deer females of young red deer individuals, though the latter usually show a more convex clout walls. The most intriguing features are, however, the presence of the dewclaw impressions combined with the footprint position, and the lack of divergence shown by lateral and medial hooves. Dewclaw impressions may be present when deer slowly walk on a soft substrate, or by jumping roe deer and chamois. In the first case, however, impressions of left and right manus/pes alternate, while footprints left by a jumping roe deer they are not side by side, and impressions of third and fourth digit significantly diverge from each other. The hint feet of chamois, during racing and jumping, touch the ground side by side and in front of the forelegs, but the hooves diverge considerably and dewclaws leave their footprint distant from the third and fourth digit impressions. More data is

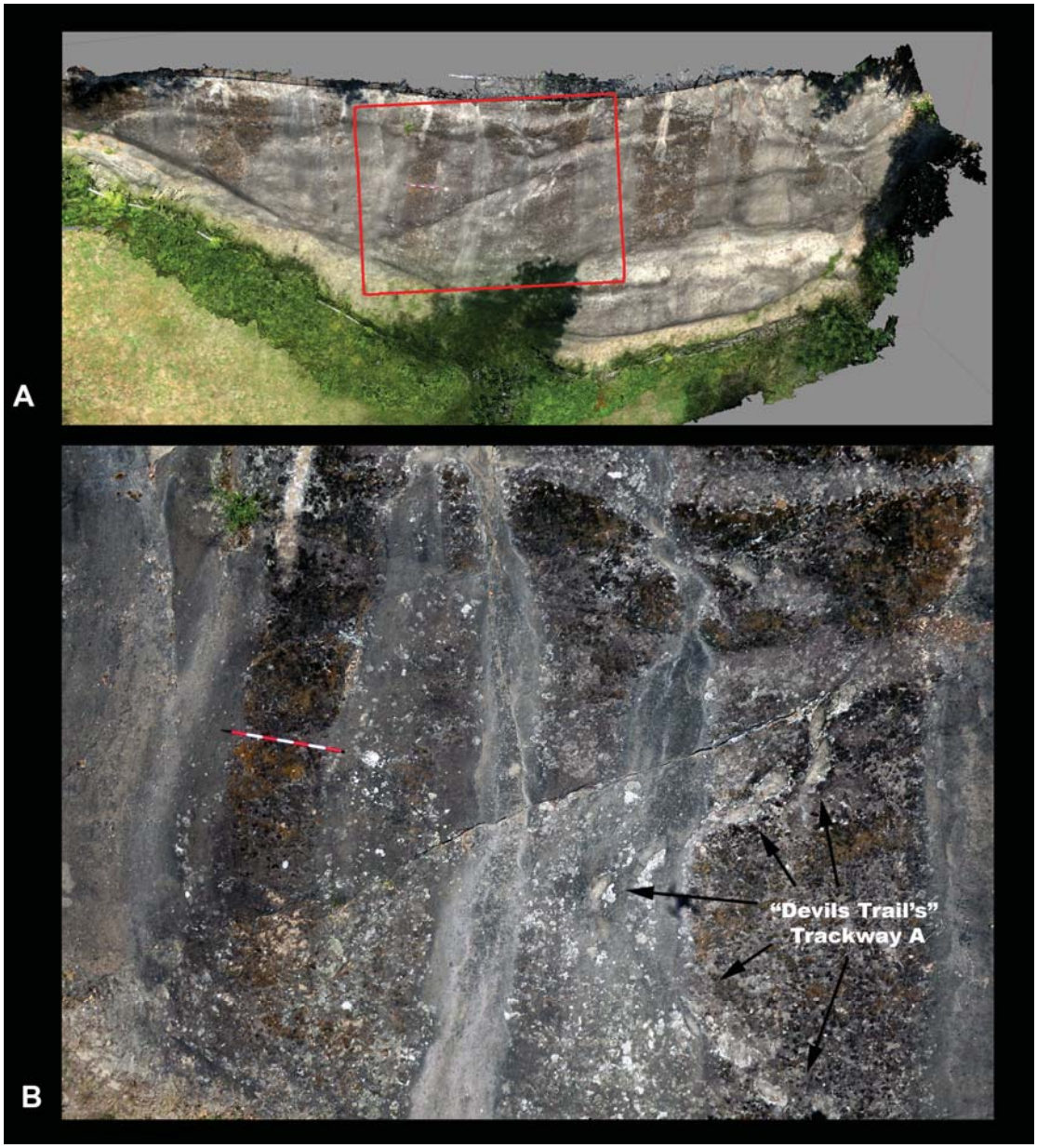

Fig. 12 - "Devil's Trails" site, images of paleosurface generated from 3D model: southern zenital view (A); close-up zenital photo of the area in the red box showing the alteration of the surface due to the exposure to weathering agents (scale bar: 140 cm) (B).

needed to properly identify the trackmaker of Artiodactipedida footprints found at the Foresta site.

Among the other potential mammal tracks preserved in the study area on the pyroclastic flow slope, a short track way would be tentatively ascribed to a horse (Hippipeda ichnotaxon, Vialov, 1966). The track way consists of 3 deep rounded buds (Fig. 14), crossing the human "Trackway B" (Avanzini et al., 2008; Panarello, 2016c). The footprints are sub-circular in shape (the width is approximately equal to the length of the tracks, with convexly arched anterior (?) part and slightly expanding to nearly parallel outer margins extending posterior (?), but the caudal frog, characterising mot (?) horse footprints, is not detectable, suggesting extreme caution and more investigation before even any hypothetical identification.

Some problematic, badly preserved tracks, which have still not been analysed in detail, are present in the thin mud layer interbedded between the surface of the pyroclastic flow preserving the human trails and the overlain volcanic deposit. A couple of impressions apparently show some similarities to bear footprints (Kowalski, 1961), especially known as regards cave bears ascribed by Dietrich (2011) the new ichnogenus

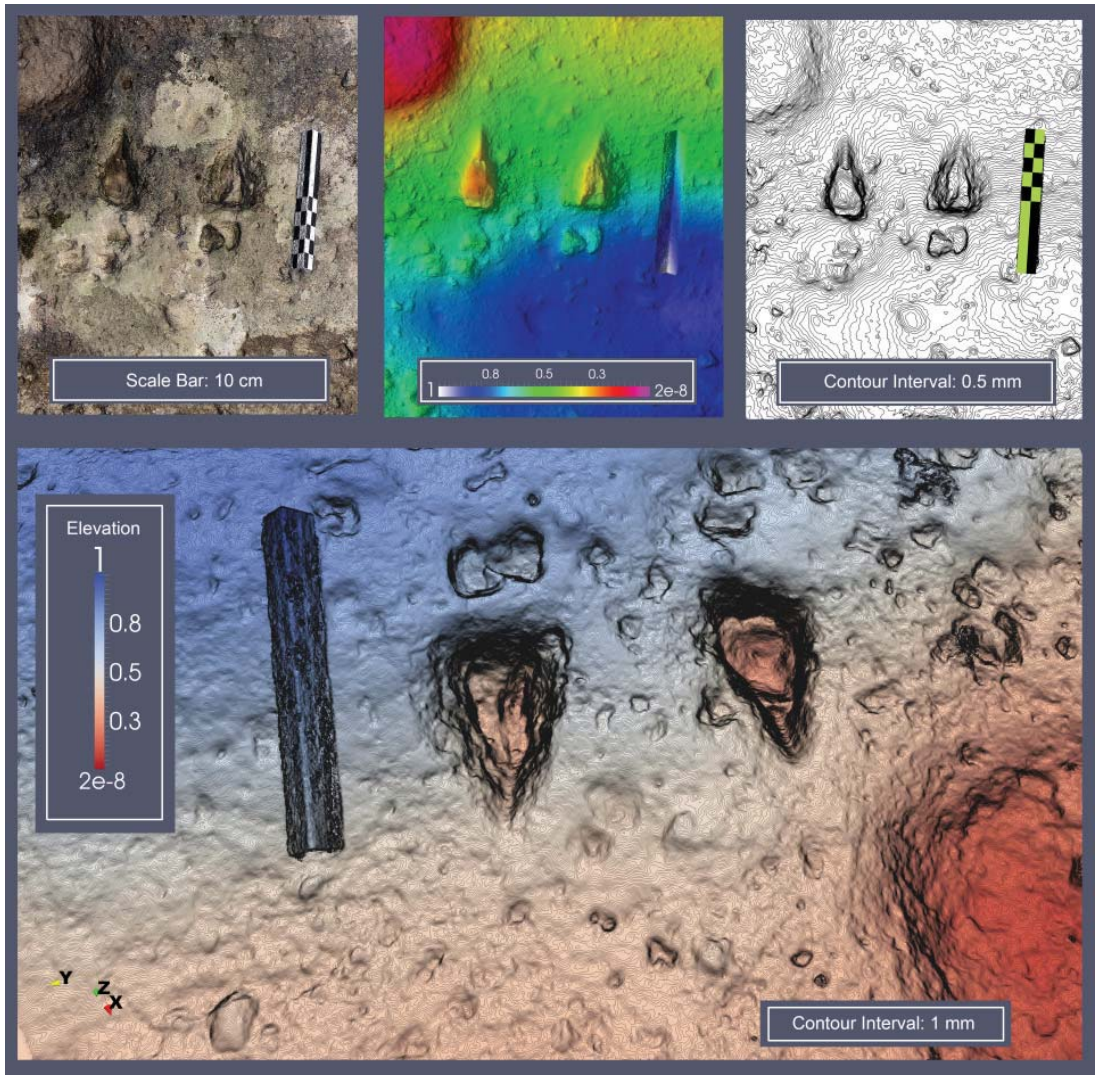

Fig. 13 - Middle sized ruminant artiodactyl footprints preserved on the surface of the prehistoric pathway: zenital photo (A); depth map (B); contour map

and species *Ursichnus europeus*, but rarely reported from Italian Pleistocene sites (Bocchini and Coltorti, 1978). A track shows a sub-oval, roughly kidney-shaped large depression that would correspond to the manus with five small oval depressions along its convex edge perhaps corresponding to digit impressions. Some pits in front of the "digit impression" would be claw marks that bear footprints usually have in front of the digits, especially when the prints are left on soft surfaces. However, due to the bad preservation and the uneven surface of the muddy layer, any identification of such traces as real footprints is, at the moment, highly speculative (Fig. 15).

It is worth noting, however, the high potentiality the Foresta site has to provide significant clues enhancing our knowledge about the environmental context of *Homo heidelbergensis* that inhabited the area during the Middle Pleistocene and whose remains have been found in a few sites, encompassing the age of the Foresta one (e.g. Cava Pompi, Passarello and Palmieri, 1968; Rubini et al., 2014; Ceprano, Manzi et al., 2010, Manzi, 2016).

4. Fear for the "Devil's Trails": remarks on the problems of preservation of the palaeontological site

A careful and accurate analysis of the fossil footprint bearing surface re-exposed by both anthropic and, especially, by natural agents about 200 years ago (De Angelis, 2009), was performed through a highly detailed photogrammetric survey. It revealed, also through 3D techniques, that a severe decay of BLT is under way in many places of the "Devil's Trails" palaeontological site. Middle-Pleistocene human and animal footprints are very close to some of the most critical points, with a realistic imminent risk that the palaeontological evidence may be irreparably damaged. This aspect has been unambiguously communicated to the authorities responsible for the preservation of the geosite and to the schol-

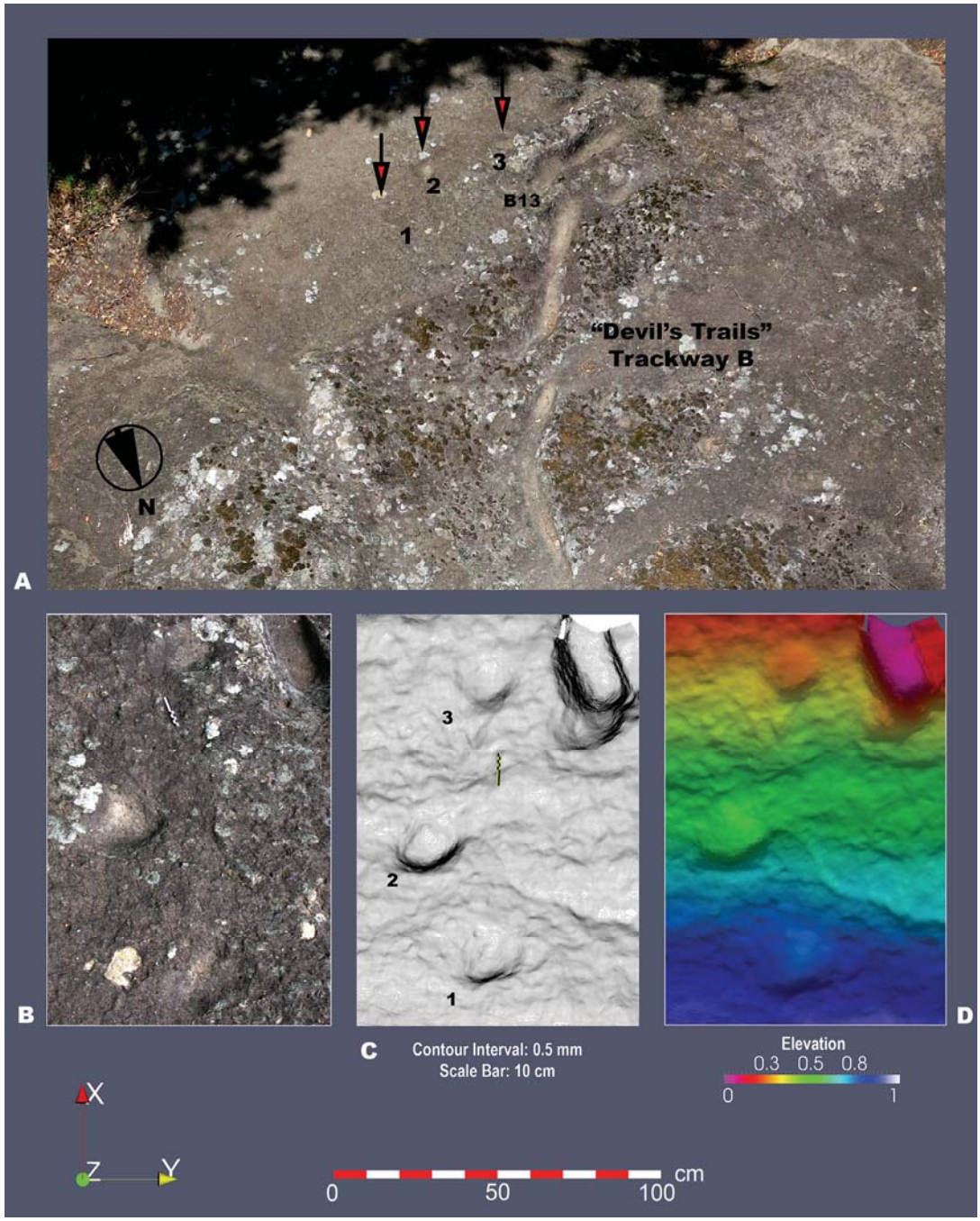

Fig. 14 - Animal fossil footprints flanking east the Trackway B: northern aerial photographic view (A); northern zenital detail photo (B); contour map (0.5 mm) (C); depth map (D).

ars who participated to the meeting which took place in the village of Tora within the "IV Week of the Planet Earth", under the sponsorship of the Italian Association of Quaternary Research (AQUA), of the Soprintenza Archeologia Belle Arti e Paesaggio for the provinces of Caserta and Benevento and of the Municipality of Tora and Piccilli. Although scientists led by Paolo Mietto (University of Padua) have been studying and communicating the risk of permanent loss of fossil footprints for years, no effective plan for the protection and the preservation of this important evidence has been developed by the authorities in charge. This is due to the lack of necessary funding and a bureaucratic maze. The aforementioned research team has, however, conducted a general mapping of the entire site and a high quality 3D modelling of the most important palaeontological details,

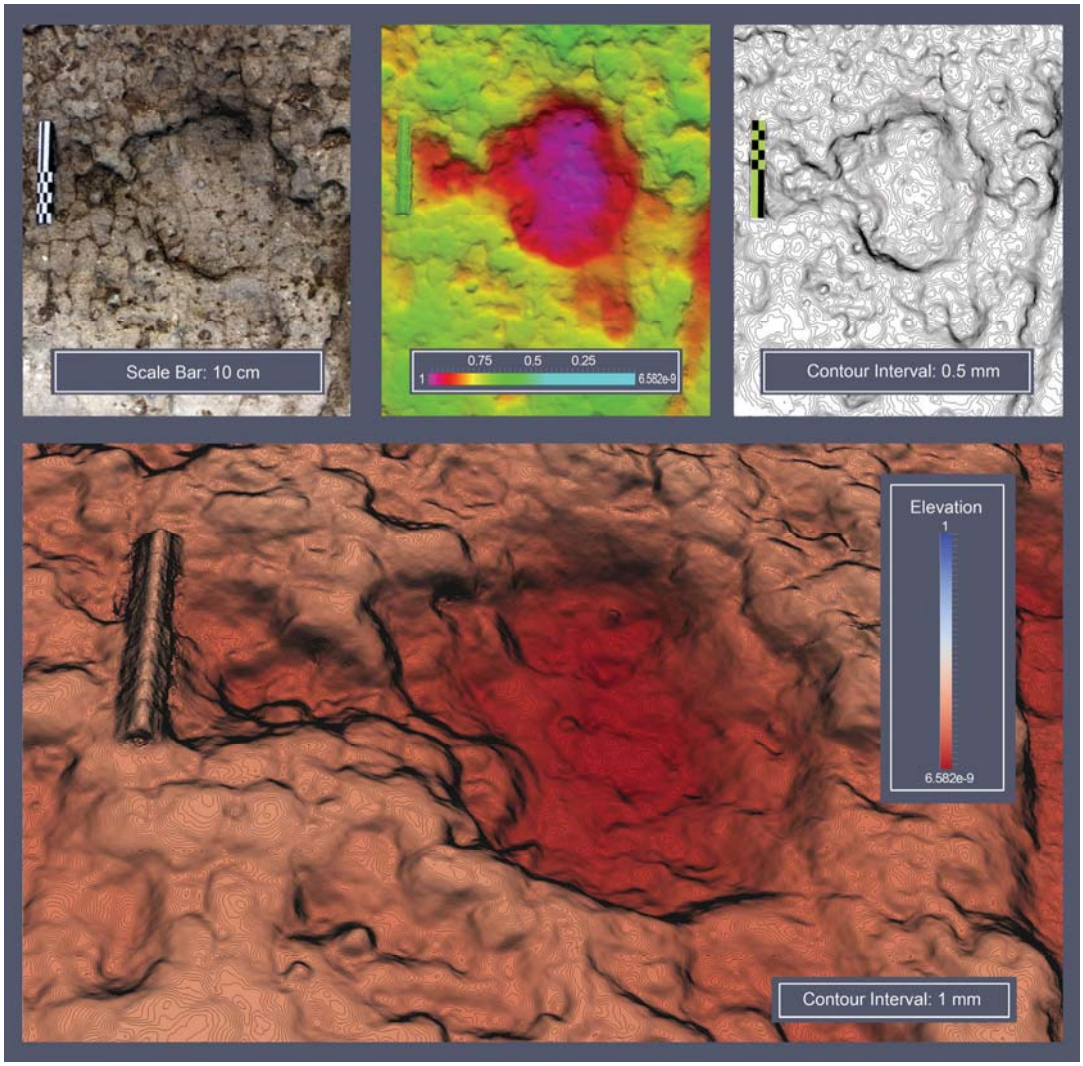

Fig. 15 - A footprint possibly referable to *Ursichnus europaeus*: zenital photo (A); depth map (B); contour map (0.5 mm) (C); southern close -up contoured depth map (1 mm) (D).

in order to preserve at least scientific data and to publish them in the form of a large monographic book about the geosite of the "Devil's Trails". If, however, the scientific data can be considered already safe, the preservation of the original palaeosurface bearing fossil footprints is still a serious problem, which scholars have, however, presented to scientific and official bodies, providing at the same time a possible solution on which to work.

The interventions carried out on the famous Laetoli site (Agnew & Demas, 1996, 1998a, 1998b, 2005; Agnew, 2002; Bennett et al., 2013) at the South African sites of Nahoon Point (Roberts, 2008, Jacobs & Roberts, 2009; Bennett et al., 2013) and Langebaan Lagoon (Roberts & Berger, 1997; Roberts, 2008; Bennett et al., 2013); and Central American Cuatro Cienegas (Gonzalez et al., 2007; Lockley et al., 2008; Gonzalez et al., 2009; Lockley & Rodríguez-de la Rosa, 2009; Morse, 2010; Bennett et al., 2013), respectively, showed that the consolidation and/or extraction of parts of the imprinted surface for their preservation inside museums are very risky and unsuitable solutions when other solutions are possible. The isolation and controlled frequentation of icnosites, where possible, seems to be the least risky and the most conservative and applicable solution. A strikingly successful example of this kind of preservation (and promotion) of an ichnosite is the structure created at Acahualinca (Schmincke et al., 2009, 2010; Bennett et al., 2013). If substantially geographical isolation of Laetoli site does not make it possible to create and manage a similar structure in that place (Dalton, 2008), the extremely favourable position of the "Devil's Trails" site, which is located close to important communication routes, makes the chance of creating a museum facility able to contain the whole geosite and to effectively control its frequentation not only possible but moreover advisable (Panarello, 2016a, 2016b, 2016c).

5. CONCLUSIONS

After extremely thorough analysis and verification of all the evidence, all actual footprints have been separated from the track-like ones. This has been done by applying the most recent and accurate methods (Morse et al., 2010; Bennett & Morse, 2014; Panarello, 2016; Panarello et al., 2017a; Panarello et al., 2017b). A detailed and specific analysis of footprints referable to palaeofauna is underway, both to record specific details of those already known and to identify and to analyse others. This is also in view of a palaeo-environmental and palaeoecological characterization of the general territorial environment in which the "Devil's Trails" site is located.

Moss removal from the western part of the trampled tuff slope has also been scheduled, in search of other evidence related to palaeofauna.

As already noted, the first palaeoanthropological surveys have already yielded important results and they will be further extended both in the volcanic area and in the surrounding alluvial and carbonate areas, with an increasingly detailed exploration. This survey is expected to provide a decisive aid in specifying the typology and the spread of prehistoric populations throughout the Roccamonfina volcano area.

A detailed ichnological study of Trackway B is in progress with regard also to the presence and relation of fossil prints left by other anatomical parts of the human body.

Furthermore, as far as permitted by the degree of preservation of the human footprints, some models for the study of locomotion and of other characteristics of the human body of trackmakers are being developed.

Finally, an ambitious and fascinating project for the preservation, management and international promotion of the entire geosite is going to be completed. It will be submitted to the competent authorities so that it can become a reality and become a museum and a teaching and touristic facility unique in the world, just like the "Devil's Trails".

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