

3D Geometric analysis and statistical methodology

The spatial analysis was performed using R (v4.1.0) with the 'spatstat' package (Baddeley et al. 2015) for point pattern analysis and Ripley's K function, and the 'stats' package for Monte Carlo simulations. Three complementary analyses were carried out: a Monte Carlo simulation with 10,000 iterations and a tolerance of 2% to evaluate the probability of randomness in the position of the painted point in relation to the three cupules, generating random points within the total area of the object and assessing the Euclidean distances; the Clark-Evans test to analyze the pattern of spatial dispersion, applying edge correction with a search radius based on the total area; and Ripley's K function to examine spatial distribution at different distance scales (0-140 mm, with increments of 10 mm). The coordinates of the points were normalized using the actual dimensions of the pebble, and a significance level of $\alpha = 0.05$ was established for all statistical tests. The R code is available in the supplementary material.

Multispectral analysis methodology

Various techniques were employed in the study's methodology:

- a. Graphic documentation of the artifact in the visible spectrum, following a photogrammetric protocol to generate a 1:1 3D model formed by 19 images. For the analysis of the image (surface texture of the pebble and not its morphology), better resolution is achieved with photogrammetry than with the 3D model obtained with the David SLS-3 scanner. These digital images were taken with a full frame Nikon D810 with a Nikon Micro Nikkor 105mm lens. The images were then processed and merged with the photogrammetric software Agisoft Metashape to make all the cupules on the pebble surface more perceptible (Fig. 7b).
- b. Focus stacking, of both the face of the pebble with the three natural cupules and the red dot, by stacking 46 images (Fig. 1a Supplementary File) and the particular area and detail of the ocher dot, with 86 images (Fig. 9). The artifact was lit with calibrated fluorescent photographic lights at an incidence angle of 45°. All the images were taken in 10 μ m steps, with a full frame Nikon D810 with a Nikon Micro Nikkor 105 mm lens and extension ring attached. The tethering was carried out with the macrofocus StackShot rail system and the images were later stacked with the macrophotography software Helicon Focus using a pyramid rendering algorithm.
- c. In order to locate the latent elements of the pebble surface and visualize the reactions induced by different wavelengths of the lighting sources, the pebble was documented with a multispectral optical device. The UV photoluminescence of the different components of the pebble were documented under sources of UV lighting with an emission peak of 365 nm, using a forensic Hammerhead LED torch by FoxFury at an incidence angle of 90°. The image was taken with a multispectral optical device with a quartz Nikon UV-Nikkor 105 mm lens (Supplementary File Fig. 1b). Then the infra-red photoluminescence of the pebble was documented under lighting sources with an emission peak of 625 nm, using a forensic Labino LED torch at an incidence angle of 90°. The image was captured with a multispectral camera with Nikon Nikkor 60mm lens and longpass filter. This allowed the discrimination of the induced reaction.
- d. The ultraviolet reflectography was documented next. Images of the whole pebble and the detail of the circular ocher dot were taken under UV lighting with an emission peak of 368nm using a forensic Crime-lite 82S LED torch by Foster & Freeman, at an incidence angle of 90° (Supplementary file Fig. 1d.), using a multispectral optical device with quartz Nikon UV-Nikkor 105mm lens and shortpass filter (Miralles-Mosquera et al. 2022; Uzal 2019; Goicoechea et al. 2019; Crowther 2022).

Dermatoglyphic analysis methodology

The photographic image obtained with multispectral techniques (Fig. 11) was sent to the Central Identification Unit for its study by specialists in dermatoglyphic identification in the General Headquarters of the Forensic Police.

First of all, it should be explained that in identification, the papillary ridges are defined as epidermal reliefs that form varied designs visible on the palms of hands and the soles of feet and their origin is due to the position of the papillae in the dermis (Supplementary File Fig. 2). These ridges are rounded and are full of microscopic holes called perspiration glands or pores that release sweat, and they are separated from one another by thin interpapillary furrows (Vela 1982).

The papillary ridges are characterized as perennial, immutable and diverse. They are perennial because once they form they remain invariable in their number, position, shape and direction. They are immutable because they never alter unless the dermis is severely damaged; and they are diverse because no two identical prints produced by different fingers have ever been identified (Vela 1982).

When the skin enters in contact with an object, an impression of the papillary surface may be left on it that records the shape and arrangement of the epidermal ridges (Králik and Nejman 2007). The prints may be formed in different ways. The first type is formed when the surface of the epidermal ridges is covered by a colored liquid or powder, or a

type of dye, and then applied to a solid surface, such as paper, rock or ceramic. A variant of this type would be a latent print where the medium would be sweat, the epidermal cells lost on the surface and fats, by addition or imprinting; i.e.: the case object of this study. The second type would be the three-dimensional impression of the epidermal ridges left in a plastic material such as potter's clay, wax or resin, by pressure or molding; i.e.: Königsau fingerprint (Mania and Toepfer 1973). The third intermediate type occurs when the epidermal ridges enter in contact with a surface covered by a dye and an image is left in the dye by its subtraction (Králík and Nejman 2007).

Because of the capacity of identification of fingerprints, there has been scientific interest in studying the variability of dermatoglyphs (the patterns formed by the impression of the surfaces of fingers, palms and the soles of feet) as regards the breadth and density of the ridges and topological patterns, among other aspects, to establish whether the sex, age and population group can be determined reliably (Gutiérrez et al. 2008, 2011, 2013a, 2013b, 2013c, 2014; Kumar et al. 2013; Rivaldería et al. 2016). One of the first complete studies was carried out on the breadth of ridges in the 1940s, when this variable was examined in different regions of the fingers and palm of the hand to observe differences depending on the sex and age (Cummins et al., 1941; Ohler and Cummins 1942).

The study of dermatoglyphs is attracting increasing interest in archaeology as fingerprints are often found on such objects as pottery, figures, lamps (Cummins 1942; Králík et al. 2002; Králík and Novotny 2003; Králík and Nejman 2007; Míguez et al. 2016; Lichtenberger and Moran 2018) and paintings (Martínez Sevilla et al. 2020). In these cases the term paleo-dermatoglyph is used to refer to ancient fingerprints on both archaeological and anthropological remains (mummies) and old texts (Bartsocas 1982). Studies focus on discerning whether the makers of the artifacts or paintings were children, men or women, or even if different objects were made by the same person. A common issue in the study of paleo-dermatoglyphs is that they are usually partial and it is difficult to determine if it really is a fingerprint or identify the exact area of the finger or hand that produced the print (Králík et al. 2002; Králík and Novotny 2003; Králík and Nejman 2007; Míguez et al. 2016).

Studies of the three markers

1) breadth of the epidermal ridge,

The ridge breadth (Supplementary File Fig. 3) is the distance between the center of an epidermal furrow and the center of the next one, measured at right angles to the direction of the furrows (Penrose 1968). The distance is compared with figures obtained in contemporary populations to verify if it is compatible.

2) *minutiae*

The term *minutiae* refers to small variations in the parallel direction of the ridges, irregularities in their direction, discontinuities and branches. It should be determined whether these characteristic identification points can be observed in the print.

3) ridge morphology

The morphology of the epidermal ridges is not completely smooth. During growth they acquire an irregular morphology or pearling caused by the papillary elements around the pores and the spaces between the elements where the ridge is lower. Therefore, an irregular morphology should be visible in the print.

If the ridge width in the image is compatible with the results described for studied populations, if *minutiae* are marked in the image, and the characteristic irregular morphology can be identified, the image will be compatible with a dermatoglyphic print.

Most of the studies of fingerprints conducted among contemporary populations have concentrated on analyzing the density of ridges on the fingers and palms to detect any differences between those regions and also whether they vary depending on the side, sex and population (Gutiérrez et al. 2008, 2011, 2013a, 2013b, 2013c, 2014; Rivaldería et al. 2016). Although the results can vary between populations, all the studies agree in that ridge density is higher in females and therefore their epidermal ridges are narrow than in males.

Although the ridge morphology does not change with age, some studies indicate changes in the ridge breadth during growth (David 1981) as it increases during infancy and stabilizes at adult age (Kamp et al., 1999). This variable has been measured to estimate age in several studies (David 1981; Kamp et al 1999; Králík et al. 2002; Králík and Novotny 2003; Gutiérrez et al. 2011; Martínez Sevilla et al. 2020).

Morphological assessment and description of the sample. The photograph obtained in the Photography Section of the Central Operative Coordination Unit was enlarged in order to appreciate more clearly the details in it and convert it into a gray-scale image to optimize its appreciation (Supplementary File Fig. 4).

Terms used in Specific Identification of The Forensic Police in the ABIS system: The abrupt end (A) is defined as a papillary ridge confined between two longer ridges that comes to a definitive end. These are classified in two kinds: initial (when the ridge begins on the left of the dactylogram) and final (when the ridge starts of the left of the

dactylogram and then ends); a bifurcation (B) is a point in which a papillary ridge starting on the left of the dactylogram splits into two ridges; a convergence (C) is a point in which two papillary ridges starting on the left of the dactylogram merge into one (Supplementary File Fig. 20).

Assessment of the three markers to determine its compatibility with a dermatoglyphic print.

The three markers described by Kralik and colleagues (Králik et al. 2002) were considered to establish whether the image observed in the photograph was compatible with a dermatoglyphic print:

- a) Measurement of the breadth of the colored lines: the breadth of the lines was measured as if they were ridges. The area of the image with the largest number of lines clearly visible was chosen and a transversal line was drawn that crossed at least ten lines (Supplementary File Fig. 5). The length of this transversal line was divided by the number of potential ridges to calculate their average breadth. As ridge breadth is not homogeneous, bearing in mind the definition given by Penrose (Penrose 1968), the breadth of each line was measured to determine the maximum and minimum breadth and the average was calculated. These measurements were made twice to minimize observer error.
- b) Marker of characteristic points: the variations in the directions of the lines were described to verify if they are compatible with the *minutiae* that occur in the pattern of papillary ridges in fingerprints.
- c) Description of the morphology of lines to verify if it is compatible with the characteristic morphology of pearls or beads in epidermal ridges. For this, the image was enlarged as much as possible to visualize the lines in detail.

Ridge count.

The colored lines in a surface area of 25 mm² were counted to determine whether the number was compatible with the results of several population studies that have been used as points of reference (Gutiérrez et al. 2008, 2011, 2013a, 2013b, 2013c, 2014; Kumar et al. 2013; Rivaldería et al. 2016). A 5 x 5 mm square was traced on the gray-scale image and a diagonal line was drawn across it. The number of lines it crossed were counted (Supplementary File Fig. 6) following Acree's method (Acree 1999).

Compatibility of the area of the hand of the dermatoglyphic image.

To specify the area or areas of the hand that might have produced the possible dermatoglyphic print, the Automated Biometric Identification System (ABIS), which stores a large amount in dermatoglyphic information (fingers and palm), was employed for its rapidity in the process of the search and comparison with prints taken of people and fingerprints detected at crime scenes. It enables an analysis of the regions in the stored prints that it agrees with most closely. The image of study was imported in the system, after re-sizing it by counting the ridges in a line perpendicular to them and making that agree with the marked measurement. After re-sizing, the *minutiae* in the image were indicated and compared with the images in the database of the ABIS. The images that the system offered were viewed to point out the *minutiae* that might coincide with the image of study.

The image was examined with two orientations, the one supplied by the Image Technology Section and the other turned 90° to the right (Supplementary File Fig. 7), compatible with the position of the pebble when it is oriented vertically with the two holes at the top.

Geometric and statistical results from the 3D model

By analyzing the geometric relationships between the points, several interesting aspects emerge, such as the proportional relationship between the three cupules and the red dot. The distances A-C (60.64mm) and B-C (61.81mm) are nearly identical, with a difference of only 1.17mm (1.93% difference), suggesting that point C (red dot), although slightly closer to A, is almost equidistant from points A and B. The distance between A and B is 32.7mm. Thus, the triangle formed by A-B-C is nearly isosceles, with the following angles: $\angle CAB = 76.50^\circ$; $\angle ABC = 72.54^\circ$; $\angle BCA = 30.96^\circ$ (Supplementary material. Fig. 27).

On the other hand, the distances A-D (133.75mm) and B-D (135.69mm) are also very similar, creating an apparent symmetry in the overall arrangement.

If we calculate the relationships between the distances, we observe the following: $AC/AB = 1.8544 \approx 11:6$ (error 2.11%); $BC/AB = 1.8902 \approx 11:6$ (error 5.69%). This pattern suggests that the distances AC and BC are very similar in relation to AB, both close to a 11:6 ratio. Regarding the relationship with CD, we observe: $AC/CD = 0.8294 \approx 5:6$ (error 0.39%); $BC/CD = 0.8454 \approx 6:7$ (error 1.17%). These last proportions observed between AC/CD are particularly

interesting because they show high precision (small errors), suggest simple relationships (5:6 and 6:7), and are very similar to each other (a difference of only 1.60%).

In this way, point C appears to be located according to a logic of simple proportions, especially in relation to CD. The most accurate proportions are those that relate AC and BC to CD (errors < 1.2%), with a tendency towards fractions with denominators 6 and 7. The similarity in the proportions AC/AB and BC/AB (a 3.58% difference) might suggest a search for symmetry in the location of point C, which seems to be placed in a position that creates bilateral symmetry relative to points A and B. Finally, the vertical line C-D forms an approximate central axis. This arrangement displays several characteristics that could suggest an intentional placement: the nearly perfect equidistance of point C from A and B; the general symmetry of the composition; the regular proportions between the distances.

Based on these observations regarding the geometry of the red dot in relation to the cupules, a statistical analysis of the position of point C (red dot) was performed to verify whether the arrangement is non-random.

The spatial analyses were carried out considering the actual kidney-shaped form of the pebble, digitized from photogrammetric documentation, instead of using a rectangular approximation. The area of the object was calculated by defining the polygonal contour of the pebble, resulting in an effective area of 18,734 mm². The positions of the points were recorded using a Cartesian coordinate system, with the origin (0,0) set at the position of cupole A. The recorded measurements between the points are: A-B: 32.7 mm; A-D: 133.75 mm; B-D: 135.69 mm; A-C: 62.81 mm; B-C: 62.81 mm; C-D: 73.11 mm.

Monte Carlo simulation

According to the Monte Carlo analysis, the probability that the location of point C is random is extremely low. Out of 10,000 simulated random positions, only 31 positions (0.31%) of the red dot met all the observed conditions (a similar relationship to the current one in relation to A, B, and D), while if we exclude point D and only consider the relationship of C with points A and B, 1,243 positions (12.43%) met the condition of being close to equidistance.

Point Pattern Analysis

The Clark-Evans test revealed an R Index of 3.47 (>1 indicates dispersion), which measures the ratio between the observed and expected distances if the distribution were random. This value indicates a significantly higher dispersion than 1, strongly suggesting that the points are farther apart from each other than would be expected by chance. The Z-score = 4.62 (statistically significant) measures how many standard deviations the observed value deviates from the expected, with a value above 1.96 being significant. In this case, the deviation from randomness (4.62) is highly significant. Finally, the P-value = 0.064 (a value <0.05 is considered statistically significant), though slightly above the conventional threshold for significance, still suggests a strong trend towards non-randomness. These results suggest that the spatial distribution of point C relative to the cupules shows a regular pattern that is likely not random. The results from the Ripley's K function analysis, adjusted to the real kidney-shaped outline of the cobble, show clear spatial structuring of the red dot: no points are observed at short distances (<50 mm), followed by a significant first increase at medium distances (50-70 mm), corresponding to nearly identical distances to cupules A and B (60.64 mm and 61.81 mm respectively), and a second increase at 70-80 mm, reflected in the distance to cupule D (73.11 mm). This pattern, where the observed K(r) differs significantly from what is expected under complete spatial randomness (CSR), especially in the 70-80 mm range (observed K = 19,874.32 vs. expected K = 15,393.80), shows more pronounced deviations. The stepped pattern of the K function, with clear inflection points at the characteristic distances, and the marked spatial structuring support the hypothesis of intentional placement of the red dot in relation to the natural cupules.

The convergence of different methods toward similar conclusions increases reliability; however, the interpretation should be approached with caution, only as a hypothesis based on a certain probability.

X-ray fluorescence spectroscopy results

The results, expressed as percentage of oxides of the major elements, and as parts per million (ppm) of the minor elements, are given in Tables 1-2 (Supplementary File), respectively.

As can easily be perceived by the data in Table 1 (Supplementary File), it is striking that the geochemistry of the clean leucogranite, the “zone around red dot”, and the red dot, observed in the percentage content of major elements (in oxides), in some cases is very similar (e.g., Al₂O₃), while in other cases it is very different:

- SiO₂: naturally 100 % in the quartz veins; it is higher in the clean leucogranite and lower in the zone around red dot (in favor of the CaO percentage) or the red dot (in favor of the Fe₂O₃ and MgO percentages).
- K₂O: values in the clean leucogranite almost double the values in the dirty zone and the red dot, since the presence of potassium feldspars (orthoses and microclines) in the leucogranite is higher than in the other two surfaces.

- CaO: values in the dirty zone are almost three times those of the red dot and leucogranite, as the silt film in the dirty zone contains calcium carbonate (calcite) and calcium magnesium carbonate (dolomite) cement and matrix.
 - Fe₂O₃: the values in the red dot double those of the zone around red dot, and these in turn double those of the clean leucogranite; which is logical if the red dot corresponds to a ferromagnesian mineral (garnet, biotite...) or to its alteration (iron oxides and hydroxides).
 - MgO: the values in the red dot and the zone around red dot are double those of the clean leucogranite; in the first case because it is a ferromagnesian mineral (garnet, biotite...) or its alteration; in the second case because of the remains of dolomite (calcium and magnesium carbonate) in the cement and matrix of the silt in the zone around red dot.
 - P₂O₅: values in the red dot and zone around red dot are four times those of the clean leucogranite; possibly due to the presence of phosphorus in the red dot alteration and phosphates in the silts of the zone around red dot.
 - TiO₂: the values of the zone around red dot are double those of the clean leucogranite, since the carbonates in the silt of the zone around red dot contain, together with iron oxides, titanium oxides (rutile) and iron and titanium oxides (ilmenite); as has been documented in the Los Huertos ore body on the 1:200.000 metallogenic map of Segovia. In Table 2 (Supplementary File), comparisons of the different areas can only be made based on the parts per million of minor elements such as rubidium (Rb), Zr (zirconium), strontium (Sr) and yttrium (Y). However, the quantities are so small that no geochemical explanation is thought to be worth considering.
- If we compare these geochemical compositions of the pebble with analyses of granitoids in the Spanish Central System (Tables 3-4 Supplementary File) (Villaseca and Barbero 1994), it can be seen that geochemically they are within the typical ranges of those rocks (especially the PS granites). However, if the geochemical composition is compared with analyses of garnets in Spanish Central System granitoids (Table 5 Supplementary File) (Villaseca and Barbero 1994), some differences are observed in which some oxides in the “reddish circular zone” elements fall outside the typical range of garnets. Particularly striking is the high concentration of silica in the reddish circular zone compared to the typical concentration in garnets; the low concentration of alumina, almost half that of garnets; and the low concentration of iron oxide, which is one third of that characteristic of garnets. This may be due to the fact that the reddish circular zone actually contains other minerals in the aluminosilicate group (sericite, cordierite, clay minerals...).

SEM results

The results show oxide compositions in the following ranges (Table 7 Supplementary File): SiO₂, 17.17 to 73.49%; Al₂O₃, 5.30 to 18.53%; K₂O, 1.88 to 3.77%; CaO, 1.74 to 25.74%; Fe₂O₃, 21.32 to 62.32%; MgO, 1.27 to 6.82%; SO₃, 0 to 25.61%; and NaO, 0 to 7.98%.

Three analyses produced anomalous results as regards their oxide composition:

- LZ1EDX5, with SO₃ content and high CaO, which may indicate the presence of gypsum (hydrated calcium sulfate); this may be due to analytical error, sample contamination, or a nearby source of gypsum.
- UZEDX1, containing only SiO₂, Al₂O₃ and NaO, corresponding to a sodium aluminosilicate, which could well be an albitic plagioclase-type feldspar crystal from the leucogranite itself.
- UZEDX2, with a high content of iron oxides, much higher than the rest.

If we eliminate the three anomalous analyses (LZ1EDX5, UZEDX1 and UZEDX2), the ranges of the other five are reduced: SiO₂, from 36.84 to 51.76%; Al₂O₃, from 12.74 to 17.09%; K₂O, from 2.59 to 3.77%; CaO, from 2.87 to 11.45%; Fe₂O₃, 23.47 to 36.60%; and MgO, 1.44 to 6.82%. Even so, they are still extraordinarily broad.

The fact that the UZEDX2 analysis has a significantly higher percentage of iron oxides than the rest of the analyses may suggest that either it was obtained from a natural deposit that was not homogenized (with zones of higher and lower amounts of iron oxides) or it is an artificial amalgamation and not sufficiently homogenized, with fractions more or less rich in iron oxides.

Dermatoglyphic results: Compatibility of the area of the hand of the dermatoglyphic image

The first marker to discern if the object of study is compatible with a dermatoglyphic print, the width of the colored line, has provided a mean width of 0.48mm, which is within the values several publications give for the width of epidermal ridges (Cummings et al. 1941; Ohler and Cummings 1942; Kamp et al. 1999; Králik et al. 2002; Králik and Novotny 2003; Míguez et al. 2016; Achtelek et al. 2019; Martínez Sevilla et al. 2020). The range is quite large (0.15 to 0.68 mm) as the width varies depending on the age, sex and population origin. The threshold value to determine

whether the print belongs to a male is between 0.48 and 0.52 mm, so that higher values than that threshold will correspond to a male (Ohler and Cummings 1942; Králik and Novotny 2003; Martínez Sevilla et al. 2020). It is difficult to establish a threshold value for women because of the interaction between sex and age (Králik and Novotny 2003), which means that it is not easy to differentiate between adult females and sub-adult males. Some studies suggest that values below 0.43mm would correspond to a female (Ohler and Cummings 1942; Králik and Novotny 2003). Some authors have established a threshold of 0.40 mm between childhood and maturity (Králik and Novotny 2003) whereas others indicate that values below 0.42 mm would correspond to individuals younger than 20 years of age (Martínez Sevilla et al. 2020). Above that threshold of 0.40 mm it becomes difficult to estimate age (Králik and Novotny 2003).

The study of the second marker has identified 13 characteristic points that concord with the morphology of the *minutiae* that appear in epidermal ridges in fingerprints. The third marker, the morphology of the colored lines, is compatible with the characteristic form of pearls or beads on the epidermal ridges. Bearing in mind these three markers, the object of study is compatible with a dermatoglyphic print.

The count of the ridges has obtained a result of 14 ridges per 25 mm², which is within the values obtained in contemporary populations. Depending on the zone being studied, these can vary from 8 to 21 ridges per 25 mm². Studies of ridge density have considered different zones of the finger and/or palm, as well as the differences depending on the side and sex (Gutiérrez et al. 2008, 2011, 2013a, 2013b, 2013c, 2014; Kumar et al. 2013; Rivaldería et al. 2016). These studies give threshold values to determine the individual's sex based on the density of ridges, but these were calculated from contemporary populations and therefore the application of those values to a Pleistocene context is limited because of the chronological difference.

It is not possible to determine definitively the region of the hand that the dermatoglyphic image is from, because it is a partial print, although the ABIS system found more coincidences with the nuclear system of the distal phalanx of a finger than with the palm. It should be noted that not all the regions of the hand are represented in the finger and palm prints stored in the system, because when they are taken, either by rolling or by laying the finger or palm on the surface, some regions are not recorded, such as the fingertips (Supplementary File Fig. 22). The dermatoglyphic image may therefore come from a region that is not included in the system.

In sum, it can be concluded that, considering the morphology of the lines in the pattern, their arrangement, width and identification of *minutiae*, this image seen with multispectral techniques in the other dot on the pebble is compatible with a fingerprint.

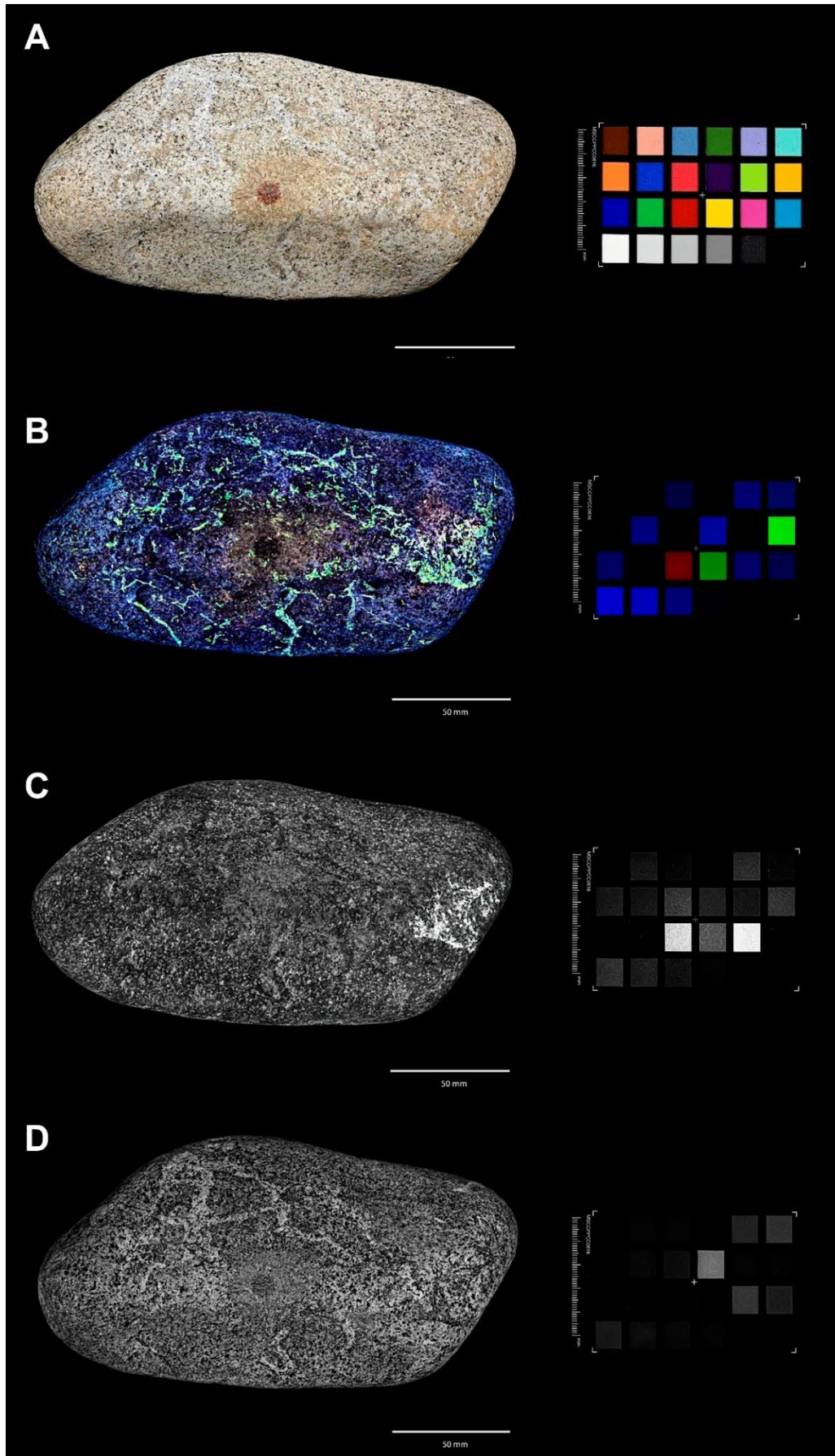


Fig 1. **A.** Focus stacking of the face of the pebble with the three hollows and ochre dot. Laboratory of the Image Technology Section of the General Headquarters of the Forensic Police (Spain); **B.** Ultraviolet photoluminescence of the face of the pebble with the three natural hollows and the ochre dot. Laboratory of the Image Technology Section of the General Headquarters of the Forensic Police (Spain). Most of the marks seen in this image (in other parts of the pebble and mostly linear) were made by the excavation tools during the initial excavation process; **C.** Infrared photoluminescence of the largest hollow detected with a multispectral camera. Laboratory of the Image Technology Section of the General Headquarters of the Forensic Police (Spain); **D.** Ultraviolet reflectograph of the whole pebble using a multispectral optical device. Laboratory of the Image Technology Section of the General Headquarters of the Forensic Police (Spain).

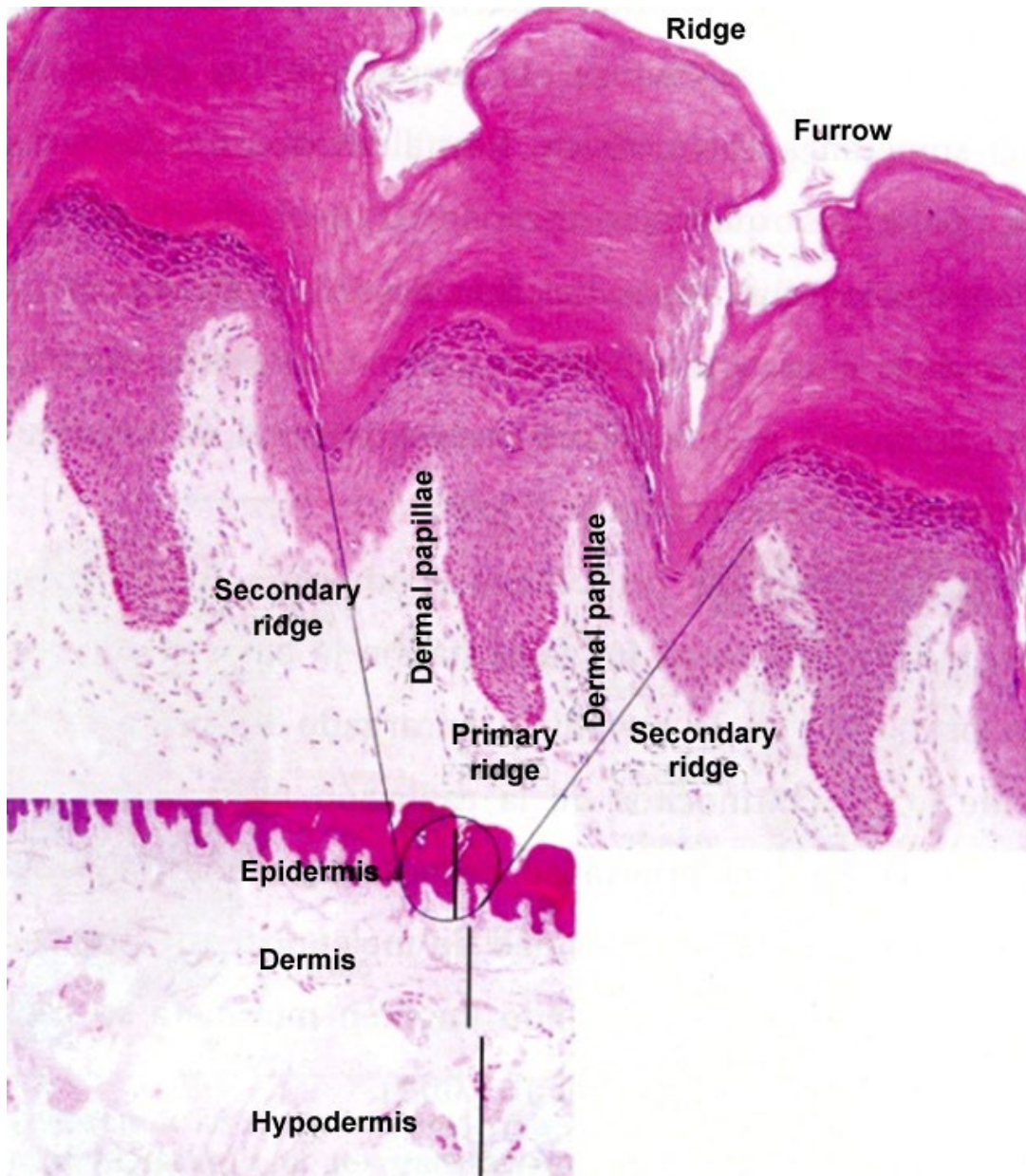


Fig 2. Histological section of the three layers of the skin (epidermis, dermis, hypodermis) (Rivaldería 2016)

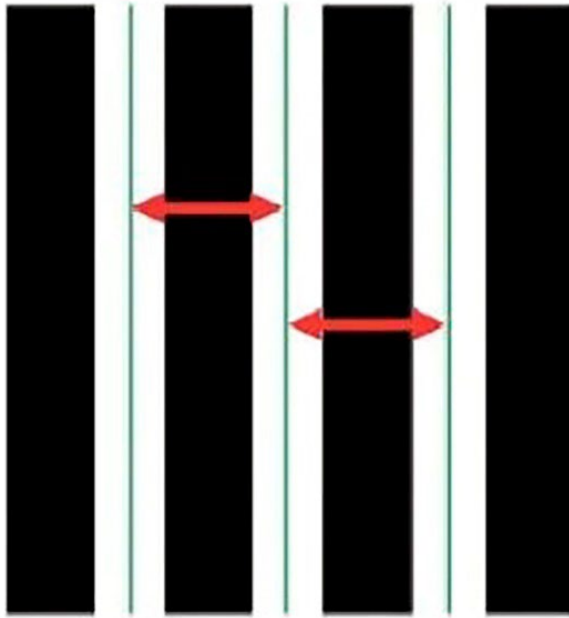


Fig 3. Representation of the width of a ridge (53)

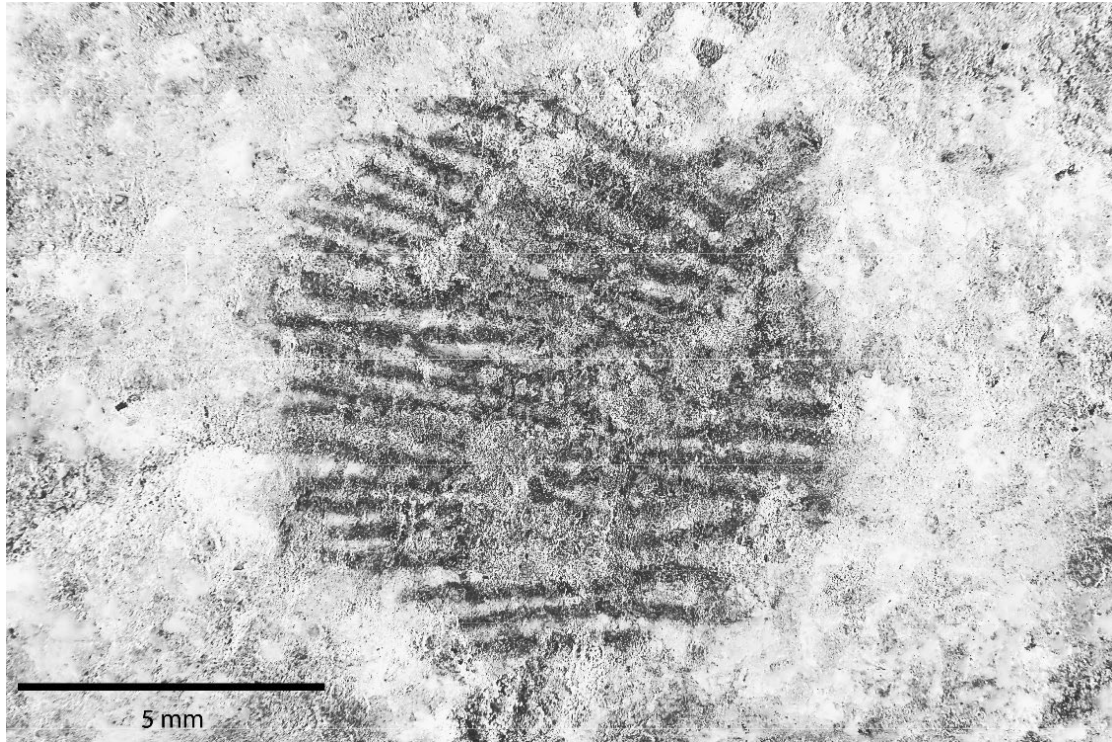


Fig 4. Image of the ochre dot in gray-scale.

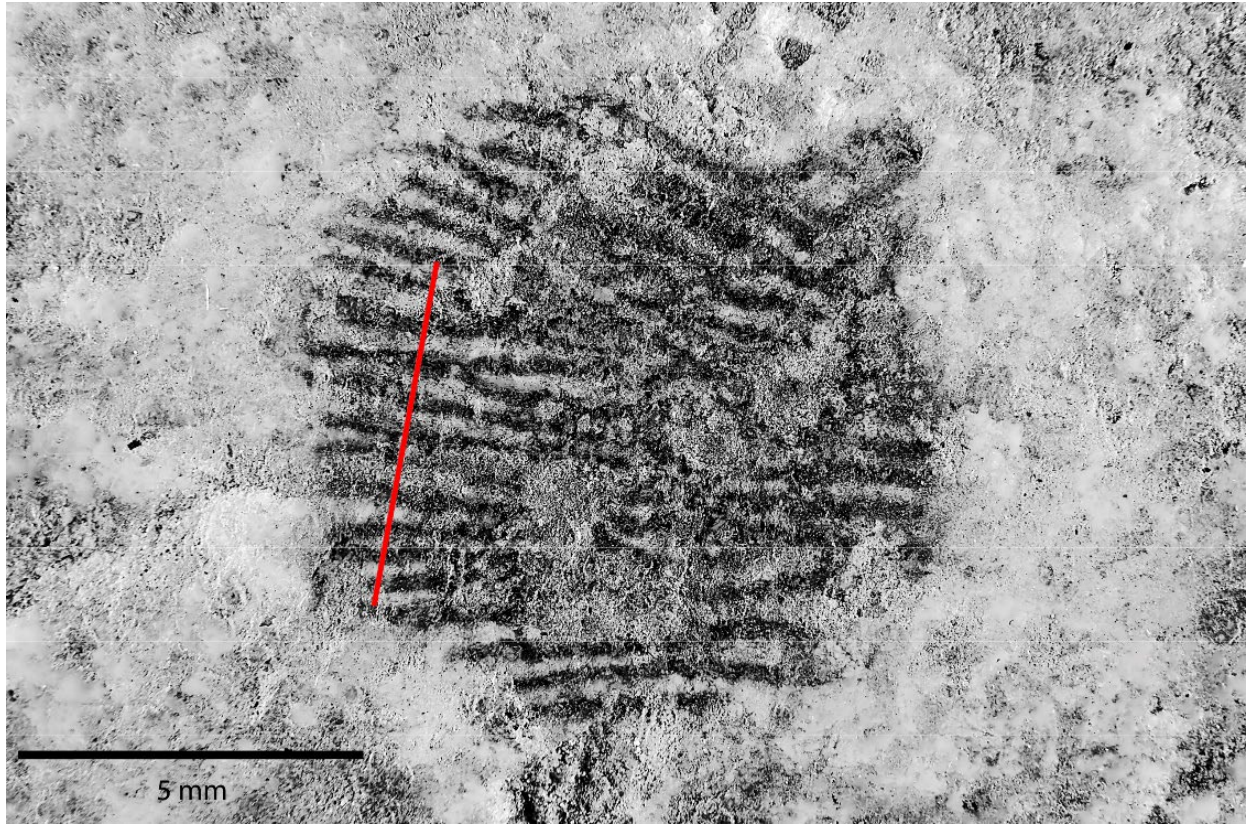


Fig 5. Figure 3 with a transversal line crossing ten lines.

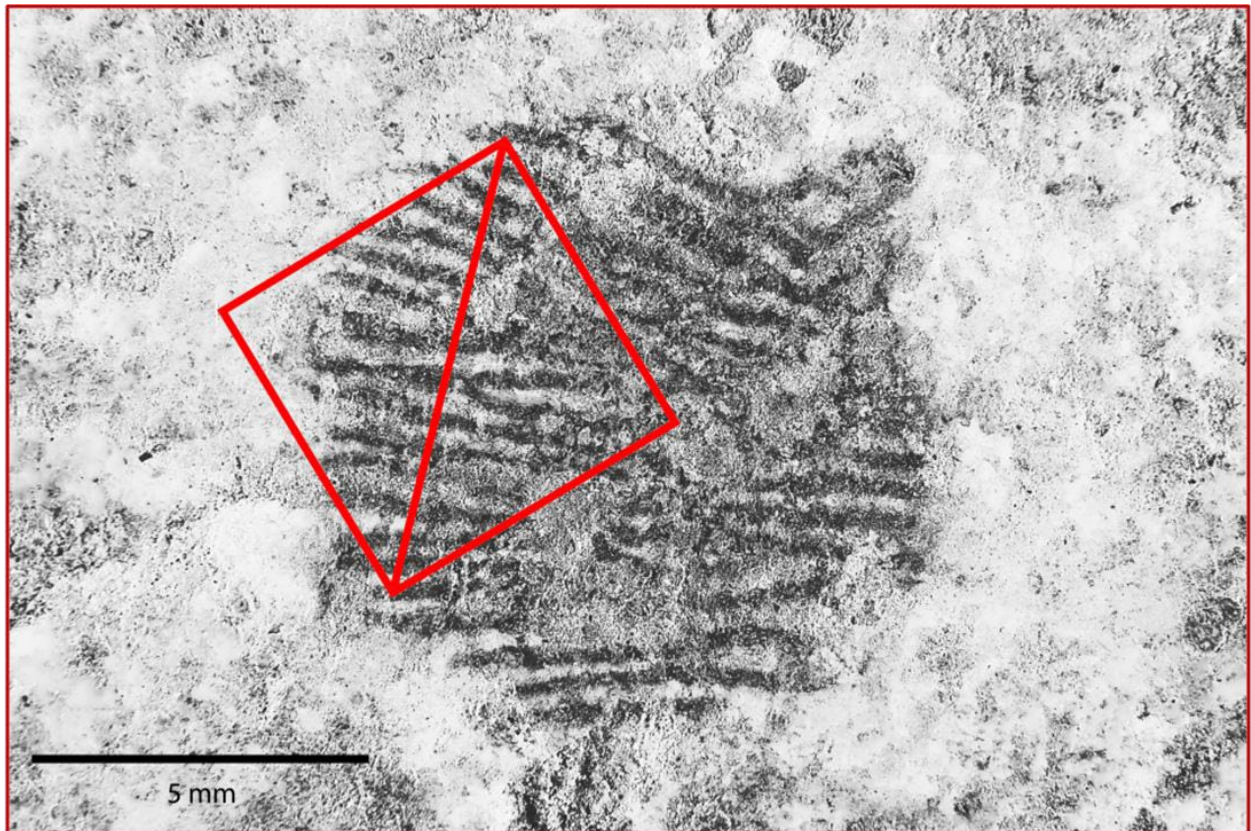


Fig 6. Figure 3 with a 25mm² square.



Fig 7. Figure 4 turned 90° to the right.

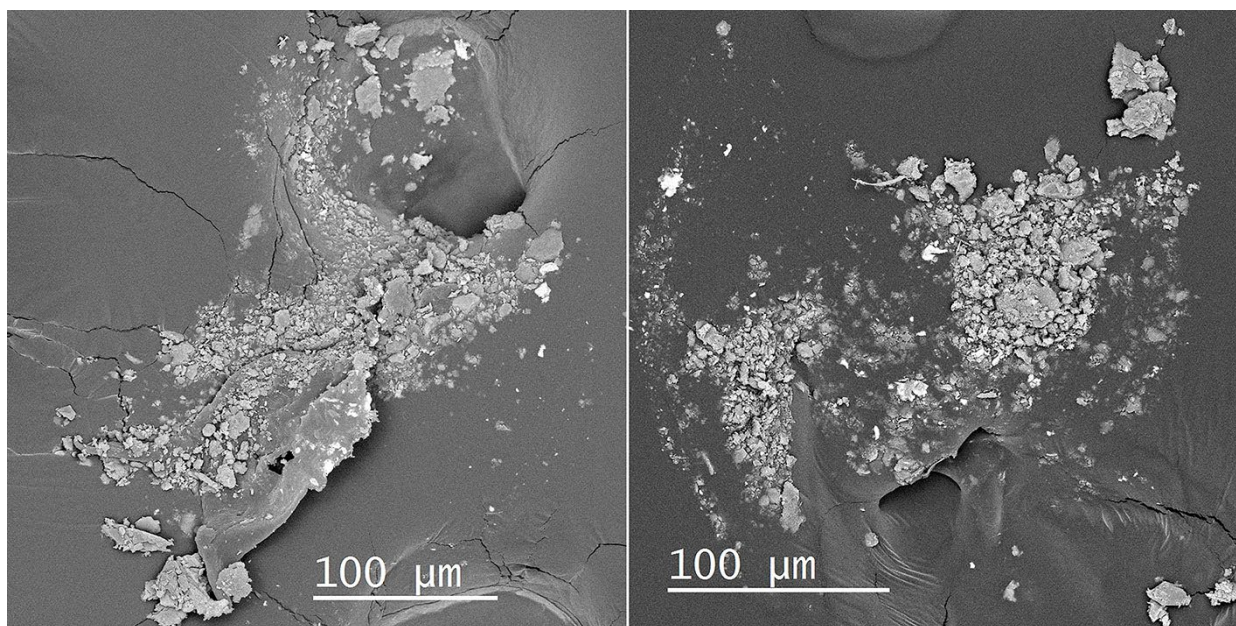


Fig 8. SEM-EDX images (300x 20kV BSE) of the micro-sample zones upper (left) and lower (right).

Spectrum processing :
Peaks possibly omitted : 0.260, 2.120, 2.160, 9.720 keV

Processing option : Oxygen by stoichiometry (Normalised)
Number of iterations = 3

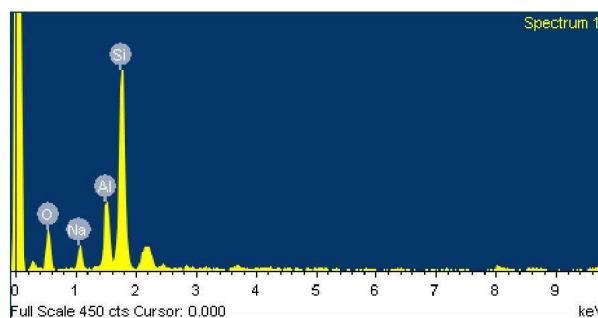
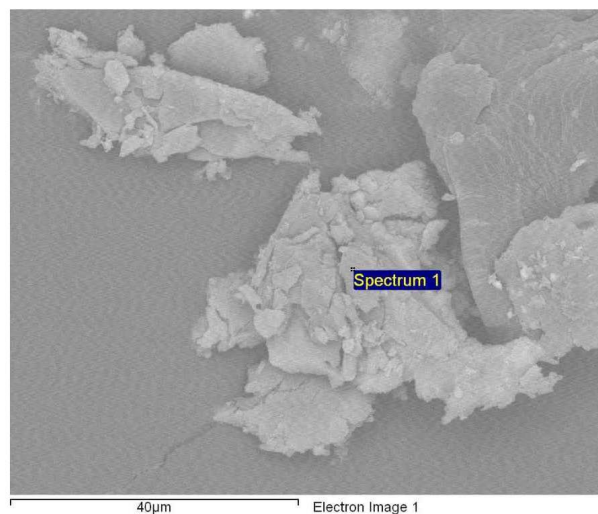
Standard :

Na Albite 1-jun-1999 12:00 AM

Al Al₂O₃ 1-jun-1999 12:00 AM

Si SiO₂ 1-jun-1999 12:00 AM

Element	Weight%	Atomic%	Compd%	Formula
Na K	5.92	5.19	7.98	Na ₂ O
Al K	9.81	7.32	18.53	Al ₂ O ₃
Si K	34.35	24.64	73.49	SiO ₂
O	49.92	62.85		
Totals	100.00			



Comment:

Inca

Fig 9. Sample upper zone, spot SEM-EDEX analysis 1, including: Service request code (date of request, DD-MM-YYYY); Date (DD/MM/YYYY) and hour (HH:MM:SS); Peaks possibly omitted (keV); Processing option; Element standards; Element weight (%), atomic (%), compd. (%) and formula; Electron image; Spectrum; and Comments.

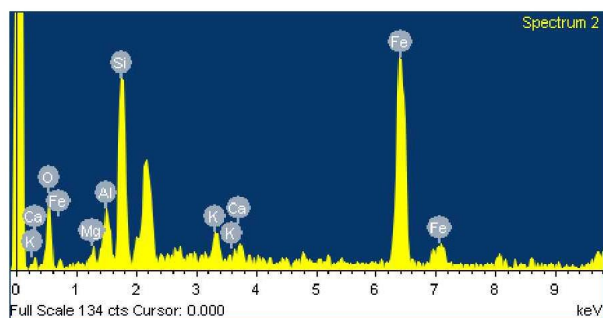
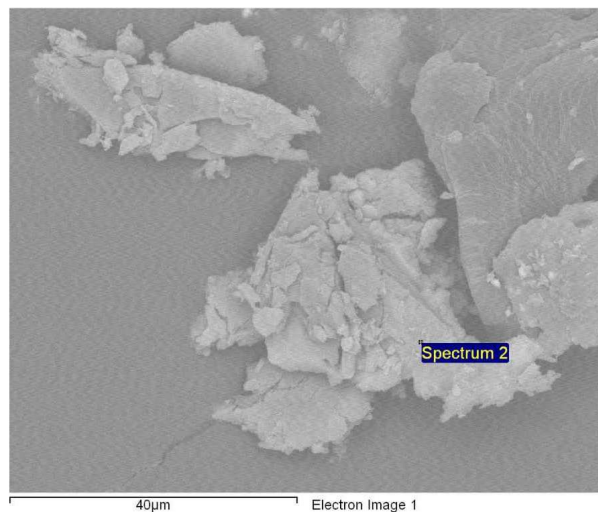
Spectrum processing :
Peaks possibly omitted : 2.151, 9.730 keV

Processing option : Oxygen by stoichiometry (Normalised)
Number of iterations = 2

Standard :

Mg MgO 1-jun-1999 12:00 AM
Al Al₂O₃ 1-jun-1999 12:00 AM
Si SiO₂ 1-jun-1999 12:00 AM
K MAD-10 Feldspar 1-jun-1999 12:00 AM
Ca Wollastonite 1-jun-1999 12:00 AM
Fe Fe 1-jun-1999 12:00 AM

Element	Weight%	Atomic%	Compd%	Formula
Mg K	1.30	1.51	2.16	MgO
Al K	2.81	2.94	5.30	Al ₂ O ₃
Si K	12.18	12.25	26.06	SiO ₂
K K	2.18	1.57	2.62	K ₂ O
Ca K	1.10	0.77	1.54	CaO
Fe K	48.44	24.49	62.32	FeO
O	31.99	56.47		
Totals	100.00			



Comment:

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Fig 10. Sample upper zone, spot SEM-EDEX analysis 2, including: Service request code (date of request, DD-MM-YYYY); Date (DD/MM/YYYY) and hour (HH:MM:SS); Peaks possibly omitted (keV); Processing option; Element standards; Element weight (%), atomic (%), compd. (%) and formula; Electron image; Spectrum; and Comments.

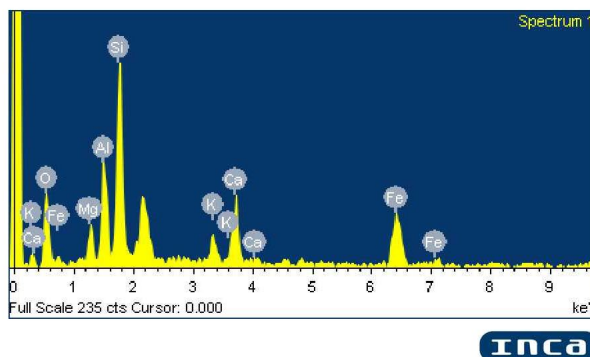
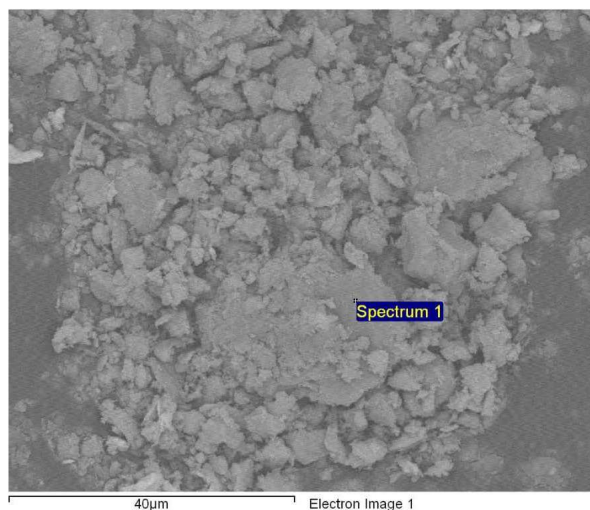
Spectrum processing :
Peaks possibly omitted : 2.140, 9.710 keV

Processing option : Oxygen by stoichiometry (Normalised)
Number of iterations = 3

Standard :

Mg MgO 1-jun-1999 12:00 AM
Al Al₂O₃ 1-jun-1999 12:00 AM
Si SiO₂ 1-jun-1999 12:00 AM
K MAD-10 Feldspar 1-jun-1999 12:00 AM
Ca Wollastonite 1-jun-1999 12:00 AM
Fe Fe 1-jun-1999 12:00 AM

Element	Weight%	Atomic%	Compd%	Formula
Mg K	3.88	3.77	6.43	MgO
Al K	8.40	7.37	15.88	Al ₂ O ₃
Si K	18.23	15.36	39.00	SiO ₂
K K	3.13	1.89	3.77	K ₂ O
Ca K	8.18	4.83	11.45	CaO
Fe K	18.24	7.73	23.47	FeO
O	39.93	59.05		
Totals	100.00			



Comment:

Fig 11. Sample lower zone 1, spot SEM-EDEX analysis 1, including: Service request code (date of request, DD-MM-YYYY); Date (DD/MM/YYYY) and hour (HH:MM:SS); Peaks possibly omitted (keV); Processing option; Element standards; Element weight (%), atomic (%), compd. (%) and formula; Electron image; Spectrum; and Comments.

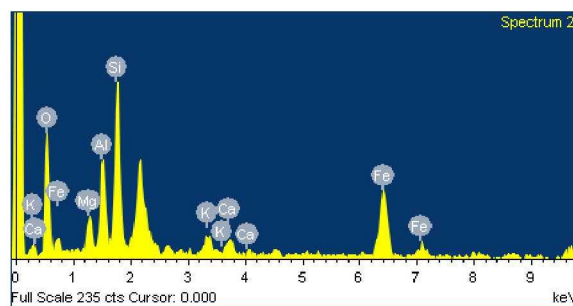
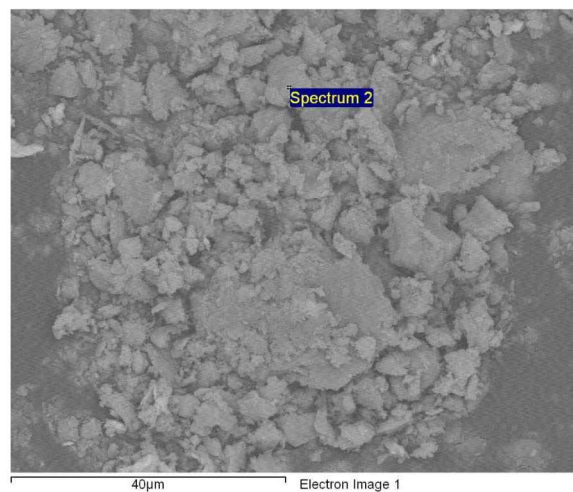
Spectrum processing :
Peaks possibly omitted : 2.132, 9.711 keV

Processing option : Oxygen by stoichiometry (Normalised)
Number of iterations = 3

Standard :

Mg MgO 1-jun-1999 12:00 AM
Al Al₂O₃ 1-jun-1999 12:00 AM
Si SiO₂ 1-jun-1999 12:00 AM
K MAD-10 Feldspar 1-jun-1999 12:00 AM
Ca Wollastonite 1-jun-1999 12:00 AM
Fe Fe 1-jun-1999 12:00 AM

Element	Weight%	Atomic%	Compd%	Formula
Mg K	4.11	4.08	6.82	MgO
Al K	9.05	8.09	17.09	Al ₂ O ₃
Si K	17.22	14.80	36.84	SiO ₂
K K	2.15	1.33	2.59	K ₂ O
Ca K	2.24	1.35	3.14	CaO
Fe K	26.05	11.26	33.51	FeO
O	39.17	59.09		
Totals	100.00			



Comment:

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Fig 12. Sample lower zone 1, spot SEM-EDEX analysis 2, including: Service request code (date of request, DD-MM-YYYY); Date (DD/MM/YYYY) and hour (HH:MM:SS); Peaks possibly omitted (keV); Processing option; Element standards; Element weight (%), atomic (%), compd. (%) and formula; Electron image; Spectrum; and Comments.

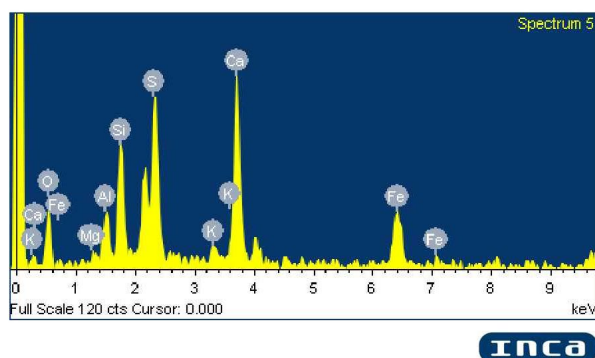
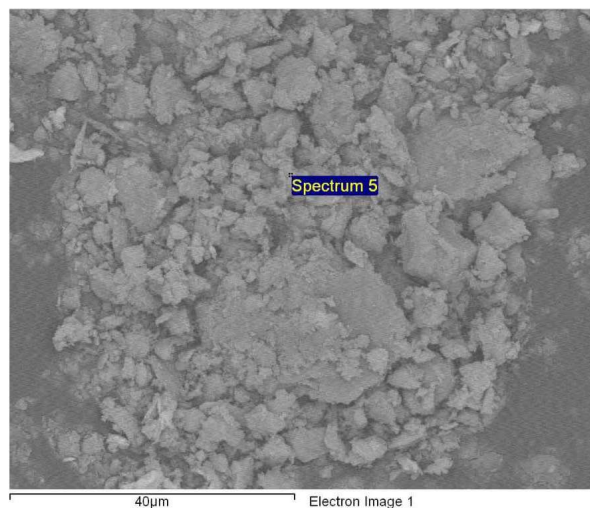
Spectrum processing :
Peaks possibly omitted : 4.520, 9.670 keV

Processing option : Oxygen by stoichiometry (Normalised)
Number of iterations = 3

Standard :

Mg MgO 1-jun-1999 12:00 AM
Al Al₂O₃ 1-jun-1999 12:00 AM
Si SiO₂ 1-jun-1999 12:00 AM
S FeS₂ 1-jun-1999 12:00 AM
K MAD-10 Feldspar 1-jun-1999 12:00 AM
Ca Wollastonite 1-jun-1999 12:00 AM
Fe Fe 1-jun-1999 12:00 AM

Element	Weight%	Atomic%	Compd%	Formula
Mg K	0.77	0.77	1.27	MgO
Al K	3.71	3.34	7.01	Al ₂ O ₃
Si K	8.02	6.94	17.17	SiO ₂
S K	10.26	7.77	25.61	SO ₃
K K	1.56	0.97	1.88	K ₂ O
Ca K	18.39	11.15	25.74	CaO
Fe K	16.57	7.21	21.32	FeO
O	40.71	61.84		
Totals	100.00			



Comment:

Fig 13. Sample lower zone 1, spot SEM-EDEX analysis 5, including: Service request code (date of request, DD-MM-YYYY); Date (DD/MM/YYYY) and hour (HH:MM:SS); Peaks possibly omitted (keV); Processing option; Element standards; Element weight (%), atomic (%), compd. (%) and formula; Electron image; Spectrum; and Comments.

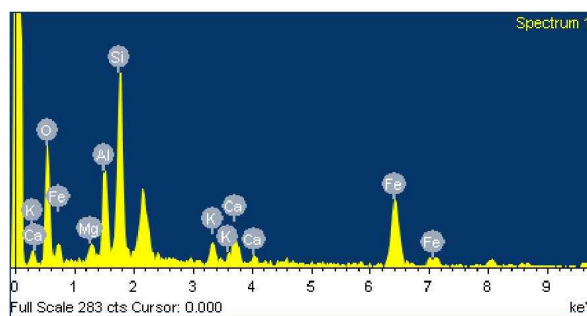
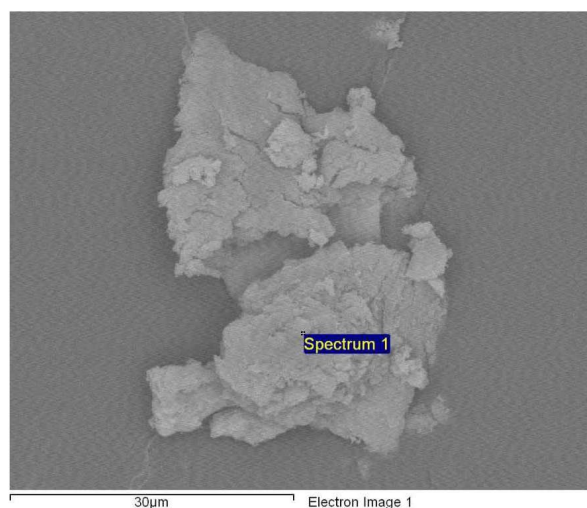
Spectrum processing :
Peaks possibly omitted : 2.130, 8.021 keV

Processing option : Oxygen by stoichiometry (Normalised)
Number of iterations = 3

Standard :

Mg MgO 1-jun-1999 12:00 AM
Al Al₂O₃ 1-jun-1999 12:00 AM
Si SiO₂ 1-jun-1999 12:00 AM
K MAD-10 Feldspar 1-jun-1999 12:00 AM
Ca Wollastonite 1-jun-1999 12:00 AM
Fe Fe 1-jun-1999 12:00 AM

Element	Weight%	Atomic%	Compd%	Formula
Mg K	1.72	1.72	2.85	MgO
Al K	8.81	7.96	16.64	Al ₂ O ₃
Si K	17.96	15.59	38.43	SiO ₂
K K	2.99	1.86	3.60	K ₂ O
Ca K	3.69	2.25	5.17	CaO
Fe K	25.90	11.30	33.32	FeO
O	38.93	59.32		
Totals	100.00			



Comment:

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Fig 14. Sample lower zone 2, spot SEM-EDEX analysis 1, including: Service request code (date of request, DD-MM-YYYY); Date (DD/MM/YYYY) and hour (HH:MM:SS); Peaks possibly omitted (keV); Processing option; Element standards; Element weight (%), atomic (%), compd. (%) and formula; Electron image; Spectrum; and Comments.

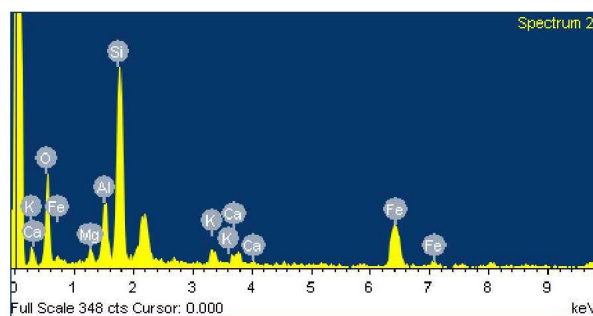
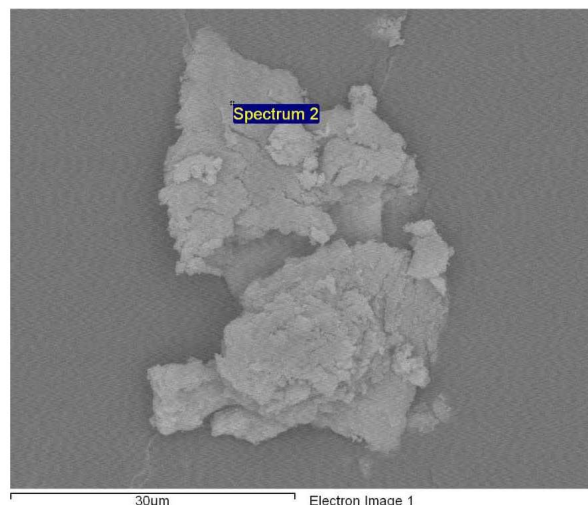
Spectrum processing :
Peaks possibly omitted : 2.149, 8.019, 9.689 keV

Processing option : Oxygen by stoichiometry (Normalised)
Number of iterations = 3

Standard :

Mg MgO 1-jun-1999 12:00 AM
Al Al₂O₃ 1-jun-1999 12:00 AM
Si SiO₂ 1-jun-1999 12:00 AM
K MAD-10 Feldspar 1-jun-1999 12:00 AM
Ca Wollastonite 1-jun-1999 12:00 AM
Fe Fe 1-jun-1999 12:00 AM

Element	Weight%	Atomic%	Compd%	Formula
Mg K	1.81	1.73	3.00	MgO
Al K	6.74	5.82	12.74	Al ₂ O ₃
Si K	24.20	20.04	51.76	SiO ₂
K K	2.63	1.57	3.17	K ₂ O
Ca K	2.05	1.19	2.87	CaO
Fe K	20.56	8.56	26.44	FeO
O	42.00	61.08		
Totals	100.00			



Comment:

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Fig 15. Sample lower zone 2, spot SEM-EDEX analysis 2, including: Service request code (date of request, DD-MM-YYYY); Date (DD/MM/YYYY) and hour (HH:MM:SS); Peaks possibly omitted (keV); Processing option; Element standards; Element weight (%), atomic (%), compd. (%) and formula; Electron image; Spectrum; and Comments.

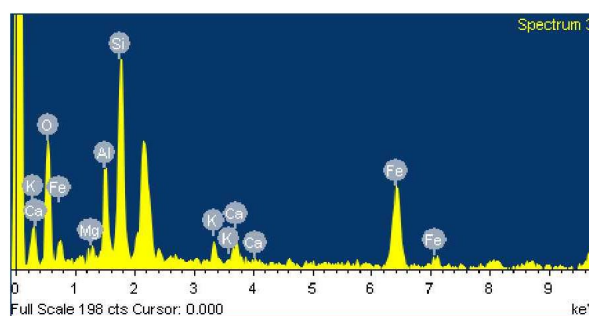
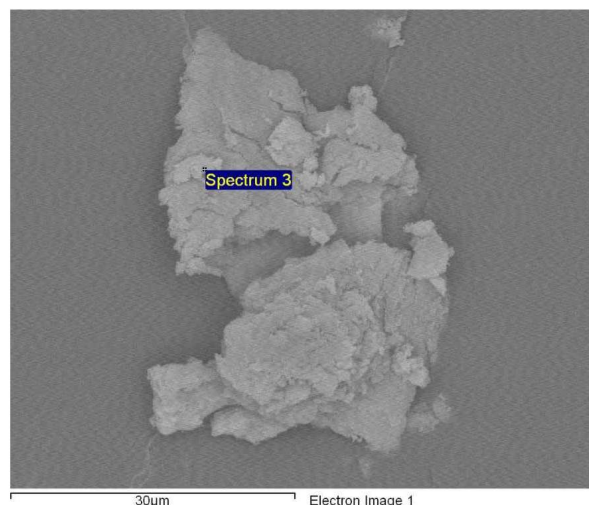
Spectrum processing :
Peaks possibly omitted : 2.132, 9.685 keV

Processing option : Oxygen by stoichiometry (Normalised)
Number of iterations = 3

Standard :

Mg MgO 1-jun-1999 12:00 AM
Al Al₂O₃ 1-jun-1999 12:00 AM
Si SiO₂ 1-jun-1999 12:00 AM
K MAD-10 Feldspar 1-jun-1999 12:00 AM
Ca Wollastonite 1-jun-1999 12:00 AM
Fe Fe 1-jun-1999 12:00 AM

Element	Weight%	Atomic%	Compd%	Formula
Mg K	0.87	0.87	1.44	MgO
Al K	7.99	7.27	15.09	Al ₂ O ₃
Si K	19.06	16.66	40.78	SiO ₂
K K	2.16	1.35	2.60	K ₂ O
Ca K	2.49	1.53	3.49	CaO
Fe K	28.45	12.51	36.60	FeO
O	38.98	59.81		
Totals	100.00			



Comment:

Fig 16. Sample lower zone 2, spot SEM-EDEX analysis 3, including: Service request code (date of request, DD-MM-YYYY); Date (DD/MM/YYYY) and hour (HH:MM:SS); Peaks possibly omitted (keV); Processing option; Element standards; Element weight (%), atomic (%), compd. (%) and formula; Electron image; Spectrum; and Comments.

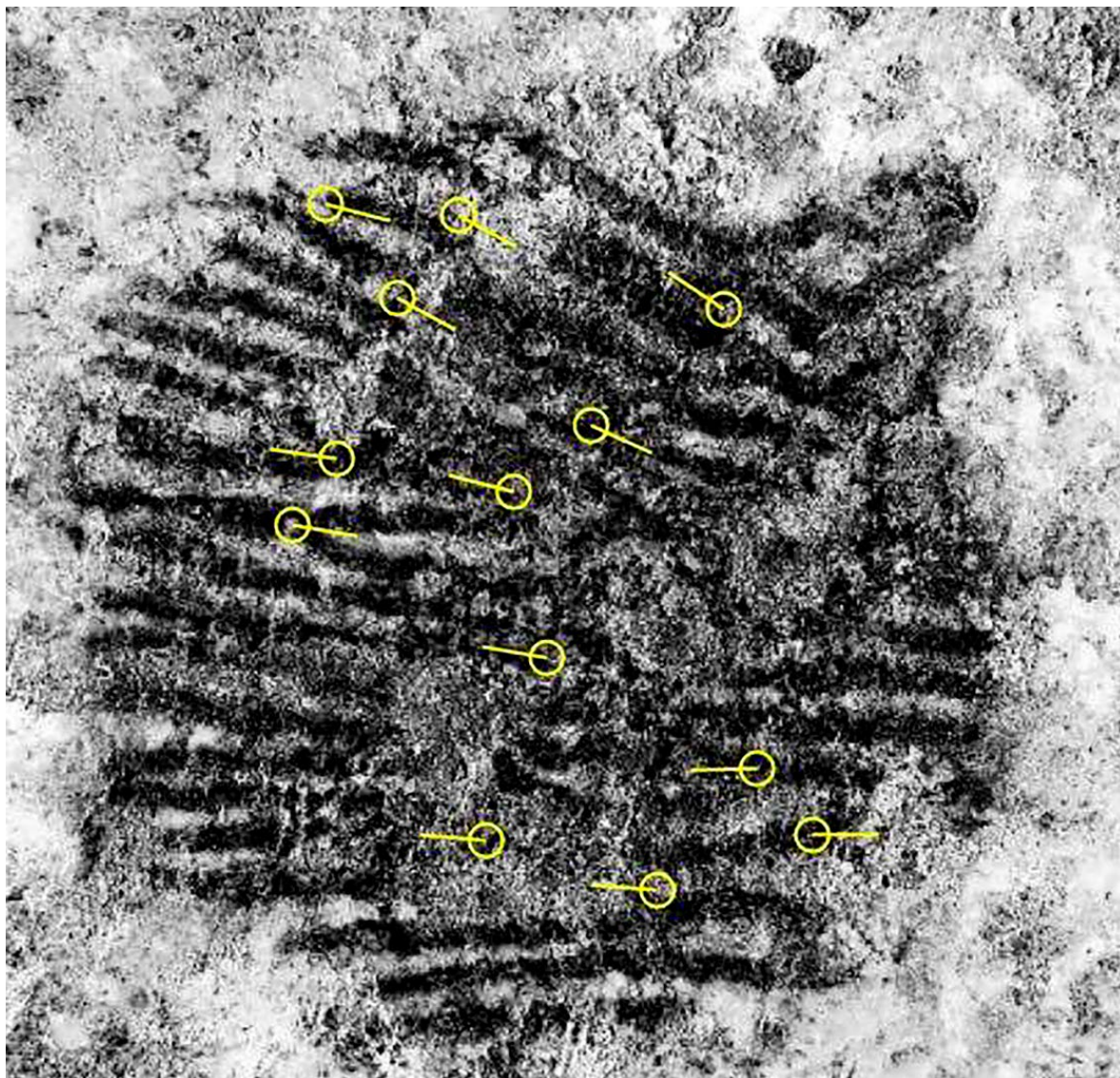


Fig 17. Figure 4, with the characteristic identification points marked.

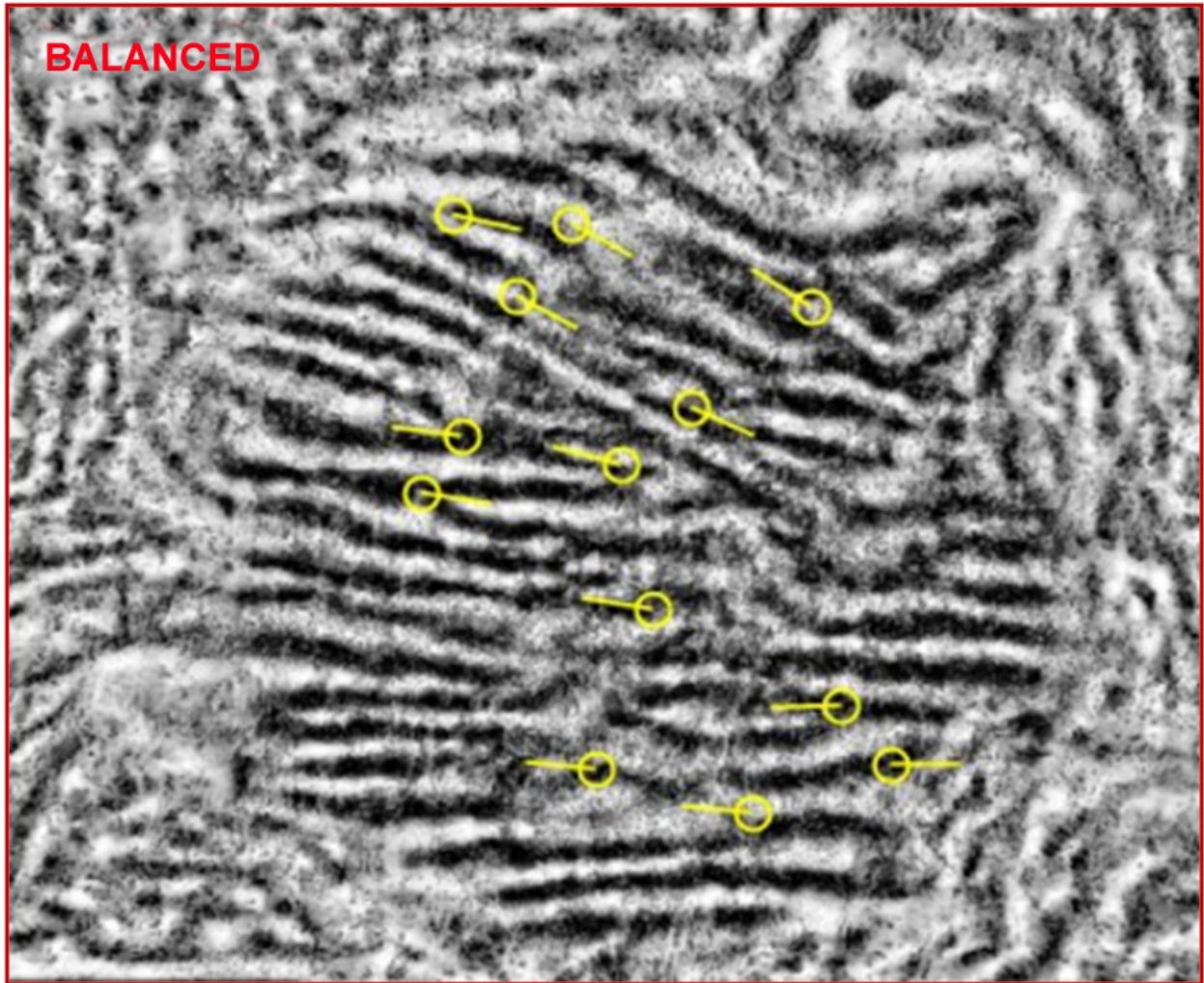


Fig 18. Figure 4, with the characteristic points marked and balanced visual effect.

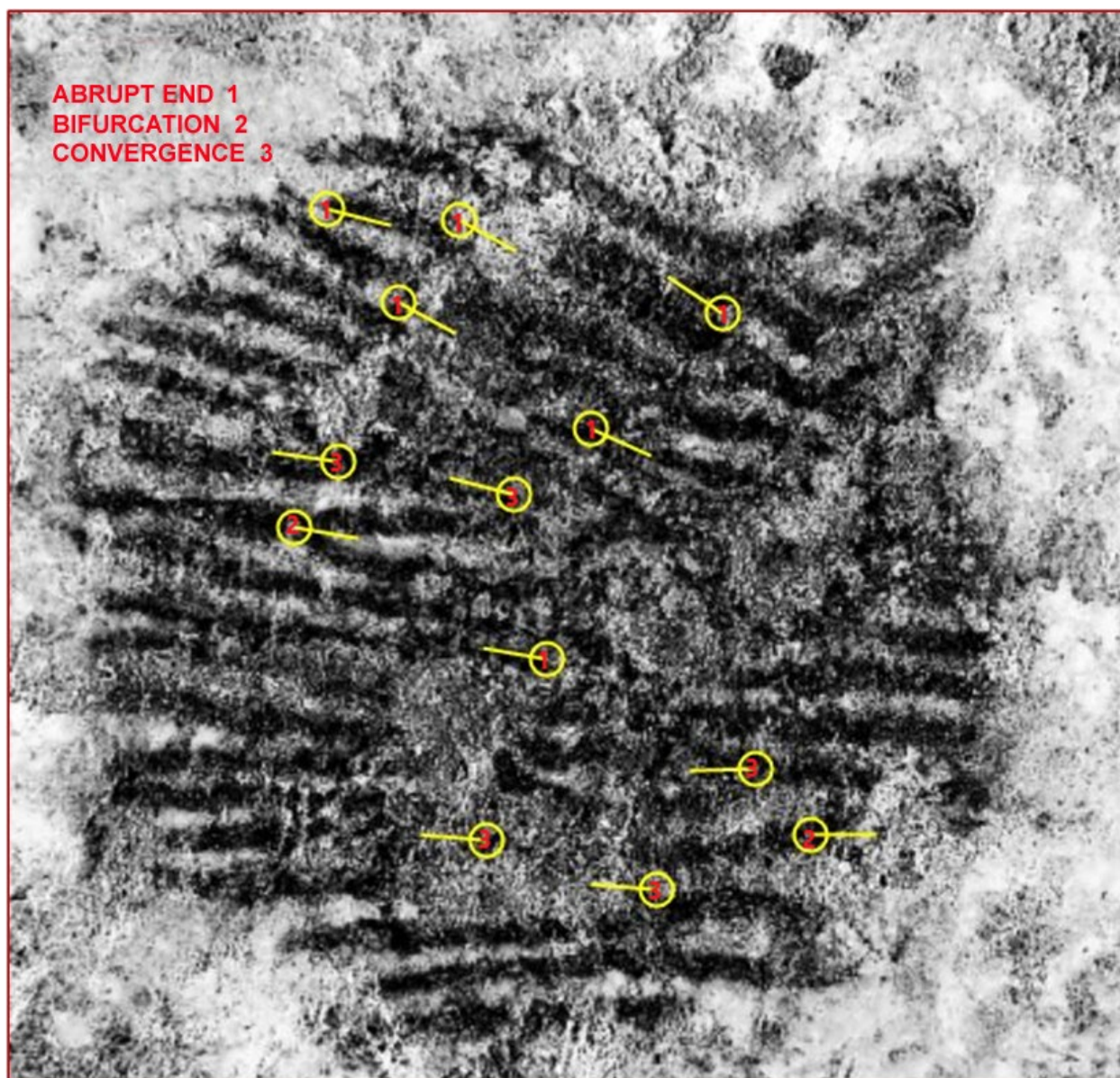


Fig 19. Image with the different types of characteristic points marked.

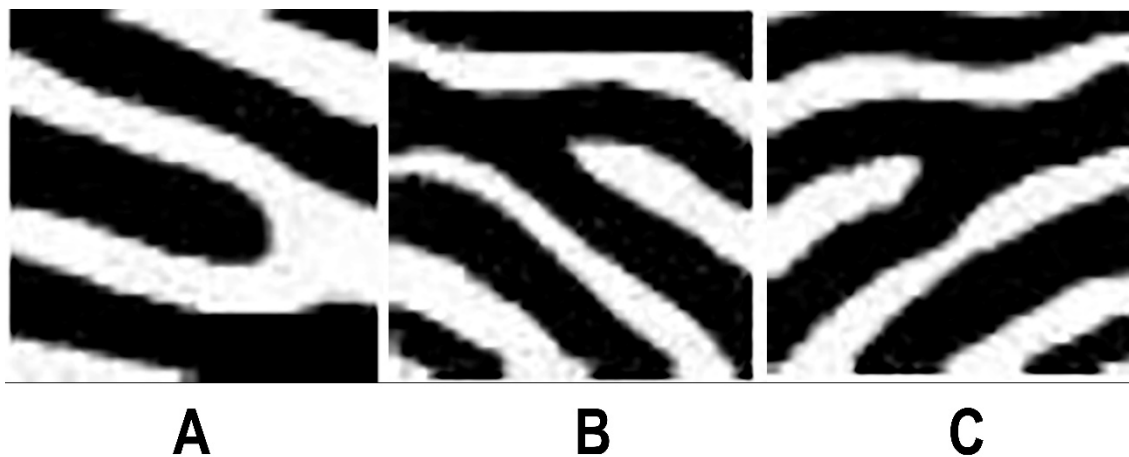


Fig 20. Characteristic points: Abrupt end (A); Bifurcation (B); Convergence (C)

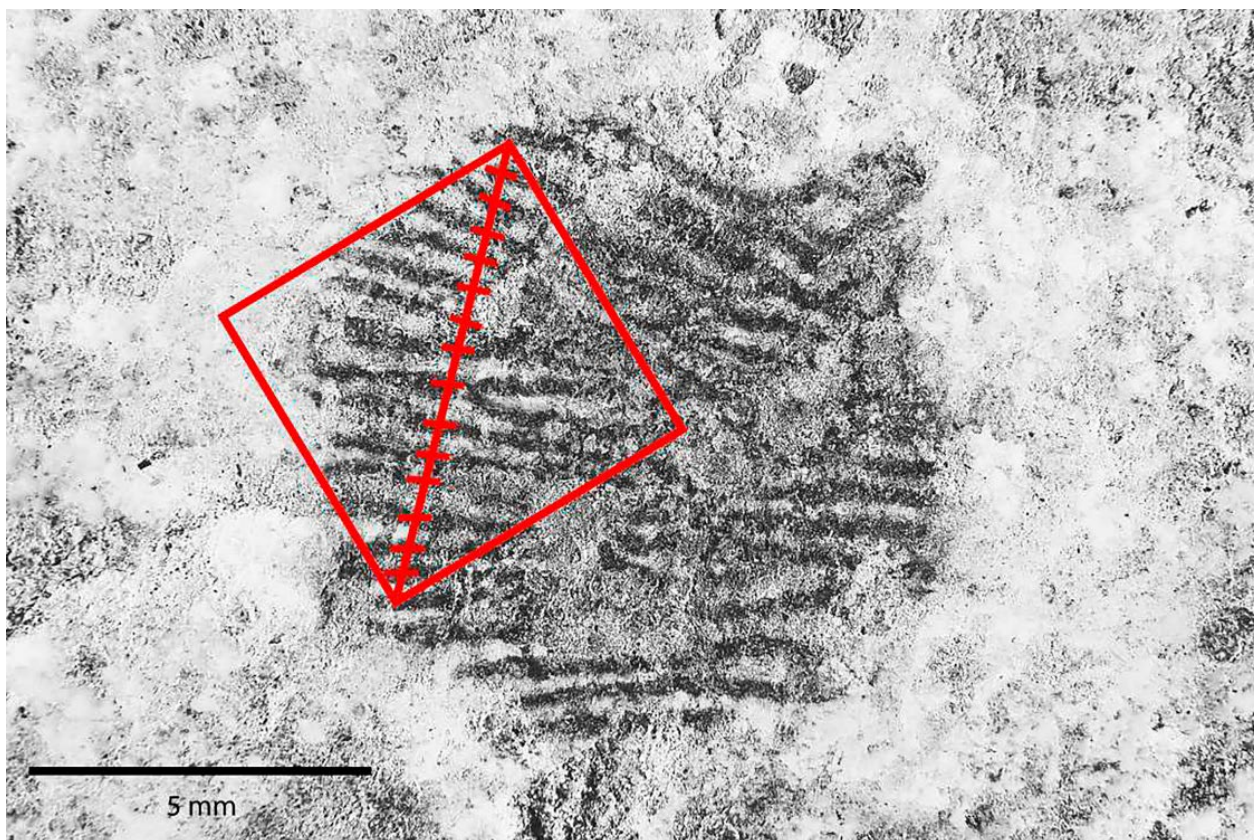


Fig 21. Gray-scale image of the ochre dot with a 25mm² square and 14 ridges marked.



Fig 22. Dermatoglyphic image of the tip of a right index finger.

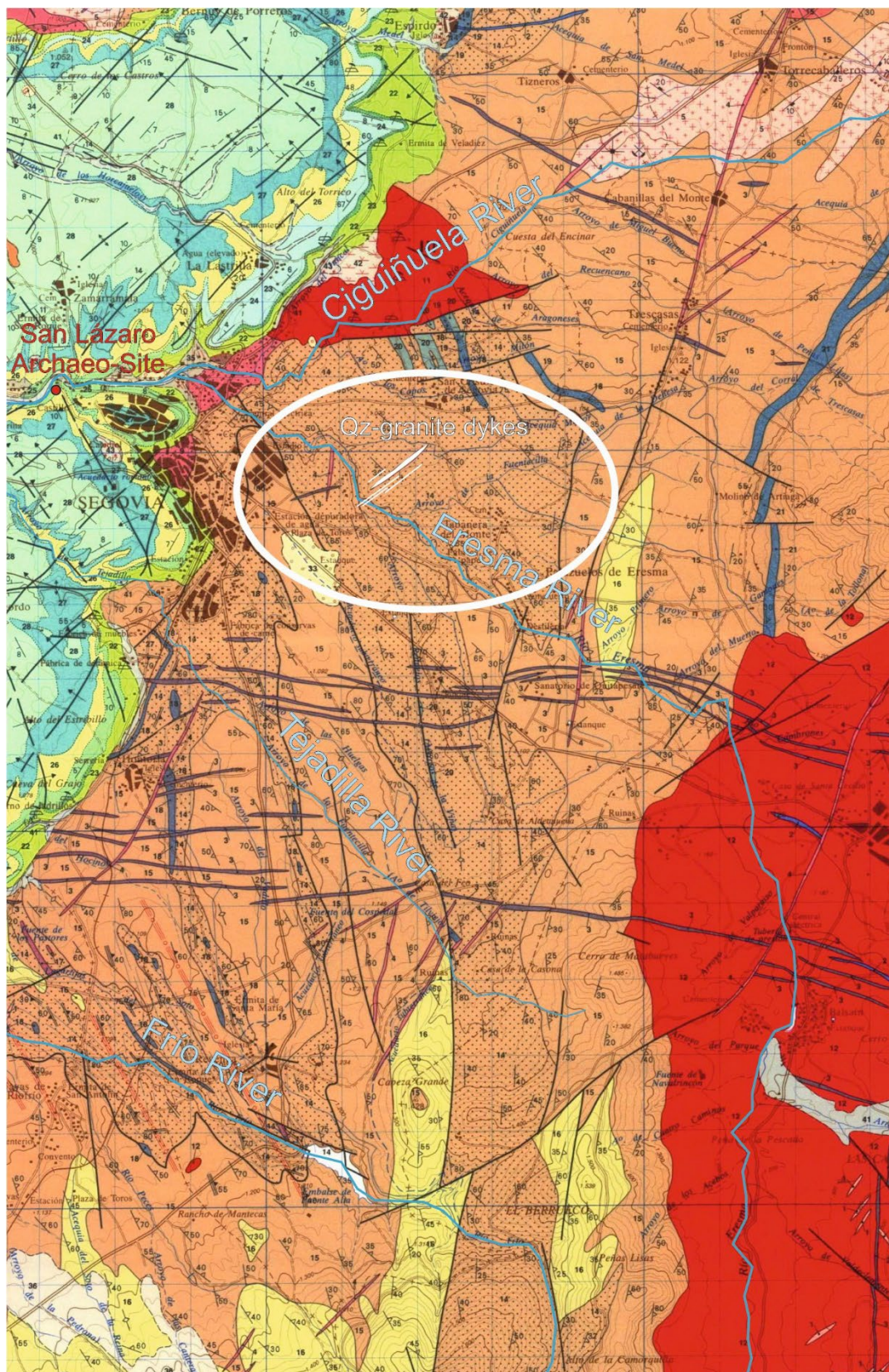


Fig. 23. Geological and river basin map around San Lázaro archæo-site (cut)



Fig. 24. Quarz-rich granite dykes in the Segovia's ring-road (Google Maps, Street View 2021)

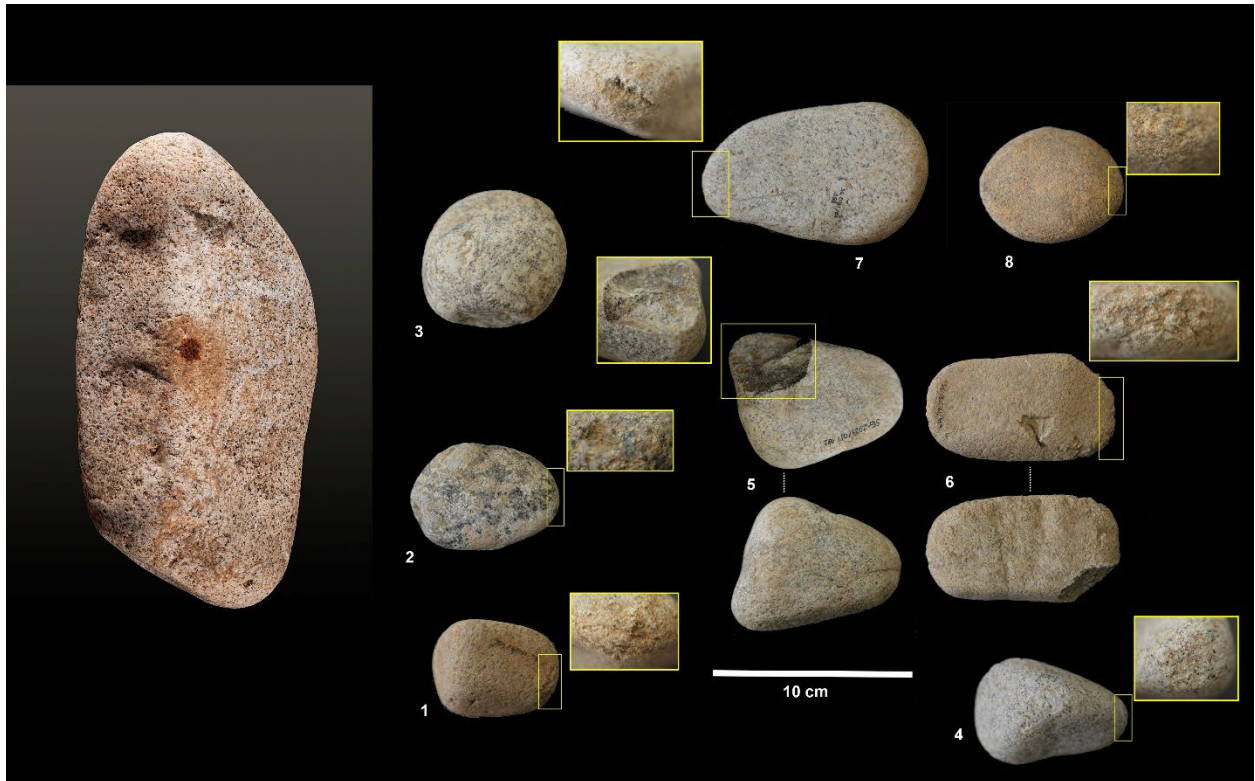


Fig. 25 Left: Pebble with a red dot (photo by Pedro A. Saura Ramos); Right: Hammerstones made of granite and gneiss from Level H.

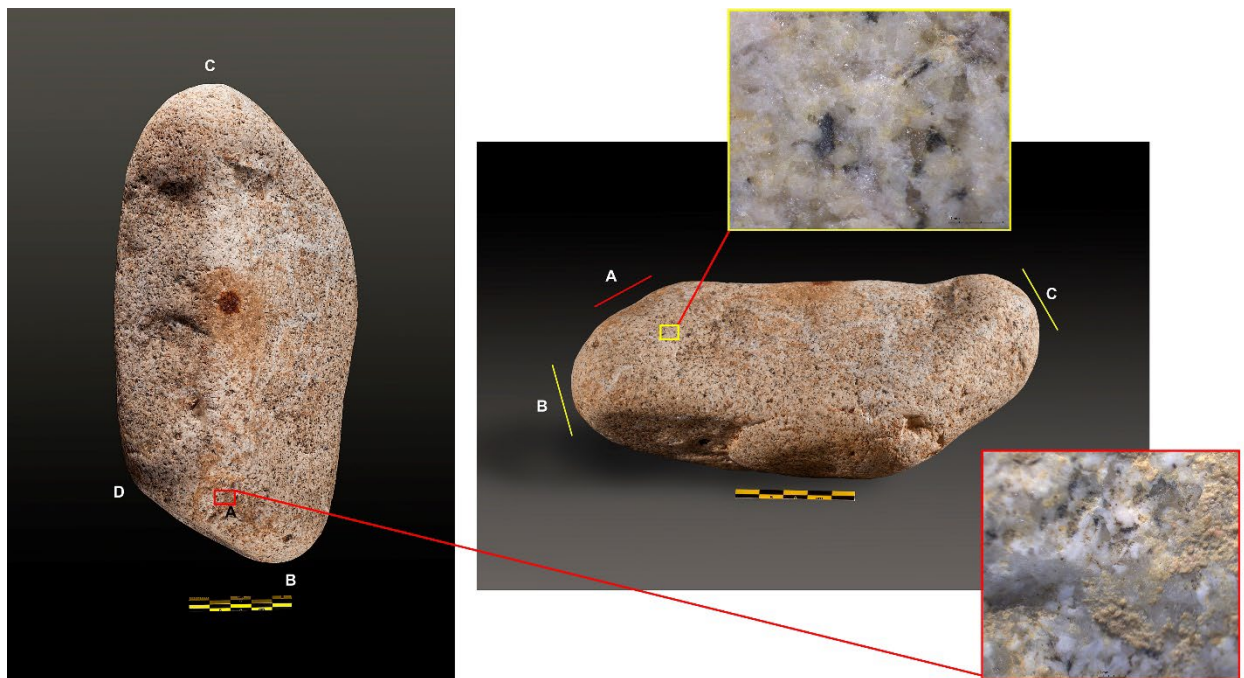


Fig. 26 Left: Identification of potentially active areas to be used as hammerstones, where there are no marks (B, C, D). Right: Detail of the indicated areas, showing the unaltered surface of the pebble and the altered area (photos by Pedro A. Saura Ramos).

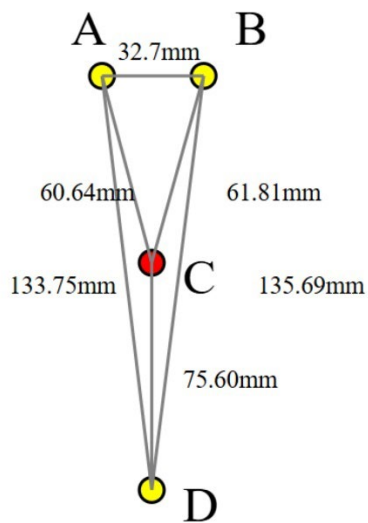


Fig. 27. Geometric analysis of the spatial distribution of the painted point (red) in relation to the three natural cupules (yellow) of the pebble, showing the distances measured in millimeters between points A, B, C, and D (Fig. 10c).

Table 1.

Majority chemical composition (in percentage of oxides) of the different surfaces of the pebble examined with a portable X-ray fluorescence spectroscopy analyzer.

SiO ₂	Al ₂ O ₃	K ₂ O	CaO	Fe ₂ O ₃	MgO	P ₂ O ₅	TiO ₂
------------------	--------------------------------	------------------	-----	--------------------------------	-----	-------------------------------	------------------

Red dot	47.56	12.7	2.79	2.77	4.27	4.79	1.44	
Dirty zone	52.25	13.35	2.58	8.45	2.1	3.81	1.74	0.2449
Q veins	100	3.3			0.1065			
Leucogranite	69.44	12.88	4.89	2.6	1.46	1.3	0.3761	0.1313

Table 2.

Minority chemical composition (in parts per million, ppm) of the different surfaces of the pebble examined with portable X-ray fluorescence spectrometry analyzer.

	Rb	V	Zr	Sr	Ta	Sn	Pb	Y	Zn	Nb	Mo
Red dot	128		31	25				12			
Dirty zone	160		58	40				20	35		
Q veins	300		27	36						20	
Leucogranite	225	205	45	43	39	36	22	21	14	13	6

Table 3.

Majority chemical composition (in percentage of oxides) of granites in the Spanish Central System (Villaseca and Barbero 1994), compared with that of the clean leucogranite surface of the pebble.

	SiO₂	Al₂O₃	K₂O	CaO	Fe₂O₃	MgO	P₂O₅	TiO₂
PS Granites	67-77	13-16	4-5	0.39-3	0.85-4.15	0.12-1.42	0.05-0.33	0.03-0.64
PI Granites	67-77	12-15	4-5	0.42-3	0.88-3.79	0.03-1.19	0.01-0.22	0.05-0.62
Leucogranite	69.44	12.88	4.89	2.6	1.46	1.3	0.3761	0.1313

Table 4.

Minority chemical composition (in parts per million, ppm) of granites in the Spanish Central System (Villaseca and Barbero 1994), compared with that of the clean leucogranite surface of the pebble.

	Rb	Zr	Sr	Y	Nb
PS Granites	166-335	60-224	10-168	16-31	5-18
PI Granites	184-370	48-140	10-162	31-77	3-15
Leucogranite	225	45	43	21	13

Table 5.

Majority chemical composition (in percentage of oxides) of garnet (cores) of granites in the Spanish Central System (Villaseca and Barbero 1994), compared with that of the 'reddish circle zone' on the pebble.

	SiO₂	Al₂O₃	CaO	Fe₂O₃	MgO
Granites PS	35.77-38.39	21.03-22.77	0.60-1.77	14.13-34.61	0.17-4.57
Granites PI	35.34-36.78	21.16-21.35	0.33-0.83	15.23-32.18	0.33-0.85
Red dot	47.56	12.7	2.77	4.27	4.79

Table 6.

Mineralogical composition interpreted from SEM-EDX plot analyses of the ochre patina micro-samples.

Sample zone	SEM-EDX plot analysis	Mineralogical composition
Upper	1	Albite
Upper	2	Iron oxides and clay minerals
Lower 1	1	Clay minerals and iron oxides
Lower 1	2	Clay minerals and iron oxides
Lower 1	5	Clay minerals and iron oxides (and gypsum)
Lower 2	1	Clay minerals and iron oxides
Lower 2	2	Clay minerals and iron oxides
Lower 2	3	Clay minerals and iron oxides

Table 7.

Chemical composition (in percentage of oxides) of the different spot analyses carried out in the three areas analyzed (two lower and one upper) of the particles extracted from the ochre patina on the pebble.

Micro-sample Zone	Spot EDX analysis	Chemical composition (%)							
		SiO ₂	Al ₂ O ₃	K ₂ O	CaO	Fe ₂ O ₃	MgO	SO ₃	NaO
Lower 1	1	39.00	15.88	3.77	11.4 5	23.47	6.43		
	2	36.84	17.09	2.59	3.14	33.51	6.82		
	5	17.17	7.01	1.88	25.7 4	21.32	1.27	25.61	
Lower 2	1	38.43	16.64	3.60	5.17	33.32	2.85		
	2	51.76	12.74	3.17	2.87	26.44	3.00		
	3	40.78	15.09	2.60	3.49	36.60	1.44		
Upper	1	73.49	18.53						7.98
	2	26.06	5.30	2.62	1.54	62.32	2.16		