The beauty microscopic mineral deposits in Southeastern Spain

/ Luis Arrufat Milán

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Abstract

The stacking of different focal planes process is featured below in order to solve the problem about depth of field in photomicrography of minerals. Due to the variety of mineral species, and therefore, the great variety of crystals, different lighting techniques are needed. Hence, those lighting system used for the enhancement of the specific characteristics of each mineral, are explained as well in this article.

The stacking technique is for some time now used in microscopy optics to get high-resolution images. Excellent results have been obtained in many different science fields. Thus, stacking becomes a perfect tool for scientific illustration.

Finally, different samples of some crystallised minerals, appeared from the southeast of the Betican mountain range, are presented. In addition, a opinion about collecting minerals and about the preservation of the natural heritage is expressed.

Resumen

A continuación, se presenta el proceso de apilar distintos planos de enfoque fotográfico para resolver el problema de la profundidad de campo en la fotomicrografía de minerales. Así mismo se explica el método empleado para fotografiar cristales de distintas especies minerales, utilizando para ello sistemas adecuados de iluminación que permiten realzar las características particulares de cada mineral. Este procedimiento se utiliza desde hace algún tiempo para obtener imágenes de gran resolución con microscopía óptica dando muy buenos resultados en muchos campos de la ciencia, con lo que se convierte en un instrumento perfecto para la ilustración científica.

Finalmente, se presentan varios ejemplos de algunos minerales bien cristalizados de las rocas que aparecen en sureste de la cordillera bética y se vierte una opinión sobre el coleccionismo de minerales y la conservación del patrimonio.

Key-words: *mineralogy, photomicrography, depth of field, stacking, stack and microscopy, photography of minerals, southeastern Spain, mineral lighting, lamproites.*

1. Introduction

The main motivation of this paper is to show how minerals are presented and how they can be photographed through microphotography, using therefore optics microscopy elements.
The colour, the shape, the texture, and the structure of the crystals are characteristics that are different in each mineral The latter being the aspect which this article mainly focus the attention at. Then, a review of the crystallized minerals found in the eastern of the Betica mountain range, and of how to photograph them.

The photographs of this document belong to a more exhaustive work which focuses on the idea of presenting the mineral just as it appears on the deposit. An idea that arose to solve the difficult research that is common on the countryside (mines, tailings, etc.), or other deposits where we could be collecting samples.

From the point of view of the descriptive mineralogy, it is pretty interesting and useful to know how the different species are presented, on what paragenesis appear and what kind of morphology they usually acquire. Besides, if all this it is associated to a specific deposit, this information can provide us very interesting data about its genesis, the chemical composition of the rocks, or the geological environment of the area. This activity becomes, therefore, into something more complex than what it seemed.

In short, the reasons explained so far are what made the author start taking shots of the minerals of a specific area, the southeast of the Betica mountain range. Nevertheless, it would be too lengthy to expose here all the species that are common on the Betica mountain range. Thus, I decided to show just a few samples that are related to volcanic outcrop.

In this article, a initiative is shown to enjoy the mineral heritage without destroying it: the use of photography, photographic collectionism, and photomicrography.

2. Material and Méthod

250 species of minerals from different geological deposits found on the Southeast of Spain have been collected and photographed. The minerals collected were only those that appeared well crystallised from the visited deposits.

The samples are mainly small crystals, most of them can be found on millimetre sizes.

These minerals have been classified into nature of deposits and according to their type of rock-bearing mineralization in order to be related to the geological formation of the Neogene vulcanism belonging to the southeast of Spain.

Every picture of the mineralogical samples displayed on this work has been taken with a Nikon D50 de 6.7 MP. This digital camera (SLR) consists of exchangeable lens, which allowed choosing the adequate lens for each case.

JPG being the output format chosen, it is compatible with all existing software for stacking images.

- Olympus Lens 4x /0,10 160mm, 10x/0,25 160mm
- JML Lens 20x /0,40 160mm
- Nikon AF Nikkor Lens 28mm 1:2.8
- Reicher Biovar Microscopy modified to adjust the different types of lens.
- Bellows for macro-photography with a maximum extension 12cm.
- Two flexible arms type gooseneck with cold-type lighting (Led).
- Circular crown for diffuse illumination and of dark field.

The name of the selected minerals, the type of rock and the place where they have been collected from are presented in the following table:

Name and Formula	*Place*	*Deposit*	*Rock*	*Kind of vulcanism*
Agardite (Y) $Cu^{2+}_6Y(AsO_4)_3(OH)_6 \cdot 3H_2O$	Mina-Sol	In the vein of quartz of epithermal origin.	biotite-hornblende andesites	Calc-alkaline
Armacolite $(Mg,Fe^{2+})Ti_2O_5$	La Aljorra	Vacuoles of degassing of rocks	Basalt	Lamproitic
Arthurite $CuFe^{3+}_2(AsO_4)_2(OH)_2 \cdot 4H_2O$	Min. Mª Josefa	epithermales veins mineralized with Pb-Zn(Cu- Ag-Au)	hornblende-biotite dacites	Calc-alkaline
Brochantite $Cu_4SO_4(OH)_6$	Mina-Sol	In the veins of quartz of epithermal origin.	biotite-hornblende andesites	Calc-alkaline
Calcite $CaCO_3$	Min. -Celia	In the altered zone of the lamproitc rocks	Jumillita	Ultrapotassic
Chayesite $K(Mg, Fe)_4FeSi_{12}O_{30}$	Coladas de lava de Cancarix	small vacuoles of degassing of the lamproitic rock	Basalts	Lamproitic

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Clinoptilolite $(Na)_{2\text{-}3}Al_3(Al,Si)_2Si_{13}O_{36}\cdot 12H_2O$	Escullos	In the altered rocks of the pyrocástic breccia	Dacites-Biotite -amphibolic	Calc-alkaline
Enstatite $MgSiO_3$	La Ajorra	Vacuoles of degassing of rocks	Basalt	Ultrapotassic
Ferrierite $[Mg_2(K,Na)_2Ca_{0.5}](Si_{29}Al_7)O_{72}\cdot 18H_2O$	Los Escullos	In the altered rocks of the pyrocástic breccia	Dacites-Biotite -amphibolic	Calc-alkaline
Fluorapatite $Ca_5(PO_4)_3F$	Min. Celia	In the altered zone of the lamproitc rocks	Jumillita	Calc-alkaline
Fluorophlogopite $KMg_3(Si_3Al)O_{10}F_2$	La Ajorra	Vacuoles of degassing of rocks	Basalts	Lamproitic
Gold Au	Filón 340	epithermales veins mineralized with Au(Cu-Te-Sn)	dacites -biotite rhyolites	Calc-alkaline
Granet- (almandine) $Fe^{2+}_3Al_2(SiO_4)_3$	El hoyazo Nijar	In the rocks eroded volcanic dome	potassic dacites	K-rich Calc-alkaline shoshonitic
Hematites Fe_2O_3	Min. Celia	In the altered zone of the lamproitc rocks	Jumillita	Ultrapotassic
Iodargirite AgI	Min. Mª Josefa	epithermales veins mineralized with Pb-Zn(Cu- Ag-Au)	hornblende-biotite dacites	Calc-alkaline
Mordenite $(Na^2,Ca,K^2)_4(Al_8Si_{40})O_{96}\cdot 28H_2O$	Cabo de Gata	Fractures and fissures of the rock.	volcanic tuff Dacitics rocks	Calc-alkaline
Motramite $PbCuVO_4(OH)$	Min Ronda y Resto	epithermales veins mineralized with Pb-Zn(Cu- Ag-Au)	Dacites-Biotite -amphibolic	Calc-alkaline
Olivenite $Cu_2AsO_4(OH)$	Mina-Sol	In the vein of quartz of epithermal origin.	hornblende andesites	Calc-alkaline
Opalo $SiO_2\cdot nH_2O$	Carboneras	In the altered rocks of the pyrocástic breccia	Andesite-amphibolic	Calc-alkaline
Parnauite $Cu_9(AsO_4)_2(SO_4)(OH)_{10}\cdot 7H_{20}$	Min. Mª Josefa	epithermales veins mineralized with Pb-Zn(Cu- Ag-Au)	hornblende-biotite dacites	Calc-alkaline
Pharmacoalumite $KAl_4(AsO_4)_3(OH)_4 6.5H_2O$	Min. Mª Josefa	epithermales veins mineralized with Pb-Zn(Cu- Ag-Au)	hornblende-biotite dacites	Calc-alkaline
Pharmacosiderite $KFe^{3+}_4(AsO_4)_3(OH)_4\cdot 6\text{-}7H_2O$	Min. Mª Josefa	epithermales veins mineralized with Pb-Zn(Cu- Ag-Au)	hornblende-biotite dacites	Calc-alkaline
Phillipsite $K_6(Si_{10}Al_6)O_{32}\cdot 12H_2O$	Terreros	In the altered rocks of the Gaps piroclastic proximities of the Black Isle.	hornblende-biotite dacite, and andesite	K-rich Calc-alkaline
Pyromorphite $Pb_5(PO_4)_3Cl$	Min Ronda y Resto	epithermales veins mineralized with Pb-Zn(Cu- Ag-Au)	Dacites-Biotite -amphibolic	Calc-alkaline
Quartz SiO_2	Mina-Sol	In the veins of quartz of epithermal origin.	biotite - hornblende andesites	Calc-alkaline
Rodalquilarite $H_3Fe^{3+}_2(Te_4+O_3)_4Cl$	Filón 340	epithermales veins mineralized with Au(Cu-Te-Sn)	Dacita-Biotítico-anfibólicas	Calc-alkaline
Sanidine $KAlSi_3O_8$	Cuevas del Almanzora-Los Lobos	Hydrothermally altered volcanic rocks. (bentonite)	potassic dacites and rhyodacites	K-rich Calc-alkaline
Scorodite $Fe^{3+}AsO_4\cdot 2H_2O$	Min. Mª Josefa	epithermales veins mineralized with Pb-Zn(Cu- Ag-Au)	Dacites-Biotite -amphibolic	Calc-alkaline
Warwickite$(Mg,Ti,Fe,Cr,Al)_2O(BO_3)$	La Ajorra	Vacuoles of degassing of rocks	Basalts	Lamproitic
Yuanfuliite $Mg(Fe^{3+},Al)O(BO_3)$	Min.Celia	In the altered zone of the lamproitc rocks	Basalts	Lamproitic

As far as the software is concerned, it could be said that there are quite a few microscopes that incorporate a camera inside and that bring their own software of stacking but there are also many software specialised on stacking. The most well-known and popular are: Helicon Focus, Combine ZP, Zerene Staker, and Picolay. Using any of them, someone can get really excellent results.

In the present work, the software that has been used for obtaining a definitive stack of the pictures added above is Zerene Staker from the company Zerene Systems LLC. I especially like this one because it is easy to use.

The preparation of the samples is also a very important issue, although this previous task provides really good results. That is to say, in order to obtain a good picture, the sample must be already good chosen, prepared and cleaned. Consequently, we remove the accumulated dust and the impurities.

But again, the task of choosing the sample we want to study is really important, even more than cleaning it. One should observe, select, and store in the retina the picture we wish whilst looking through all the samples. Although this process is time-consuming, it is worth doing it.

Regrettably, not always someone has the most adequate sample or the one we would like to have, but that should not be a reason not to try obtaining the best pictures of the species of minerals we have.

The effort of obtaining a good photograph is worth only by the beauty the minerals when observed in context. If we can enhance their properties, the picture obtained will receive an extra value.

Nevertheless, when we capture images of three-dimensional objects with an optical microscope, depth of field becomes into a great problem to be solved. This is because depth of field is decreased when multiplying with the increase of lenses. On the contrary, if we use a scanning SEM microscope, depth of field won’t be a problem. But, the increase of lenses does not provide a colour image. Then a very important type of information for mineralogy gets lost, optical properties.

However, the use of this method (stacking), for increasing the depth of field, allows us to get pictures with optical microscopes much better on high-resolution as compared with the ones obtained by scanning microscopes.

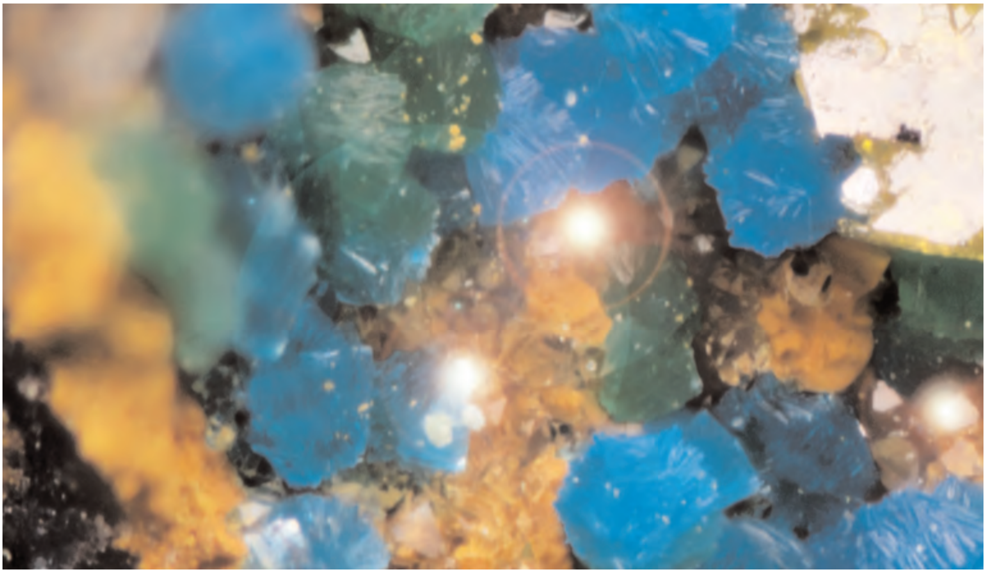

Image 1. Crystals of Iodargirite, lavendulana and cornwallite on a matrix of quartz. (Rodalquilar, Almería). In this picture, a bad definition can be appreciated what hinders the correct identification of the minerals.

Any crystallised mineral that we wish to photograph will always present certain different optical characteristics: colour, brightness, and transparency. These are the main common characteristics we usually notice. Furthermore, a crystal will always present a special texture and a different morphology for every kind. Thus, other variables should be taken into account such as reflection, refraction and diffraction. Likewise, it should not be forgotten that crystals could be, at the same time, related to other different species also crystallised and with distinct properties.

For that reason, all those variables are not controlled when we do the final composition of our picture. A miscellaneous of colours, reflections, and shadows can appear in our picture. Those are unexpected effects that would make the picture to be useless for our purpose. *(see image 1)*

Taking Images

The technique used for photographing the different types of minerals consists of stacking different focal planes of the photographed object. This technique is widely spread among microscopy and photomicrography since digital cameras appeared and were cheaper to be acquired whilst producing excellent results. Besides, the stacking technique gets a depth of field that photographs made with a single shooting could not achieve. Not to mention if dealing with a very small object (tenth or thousandth of millimetre).

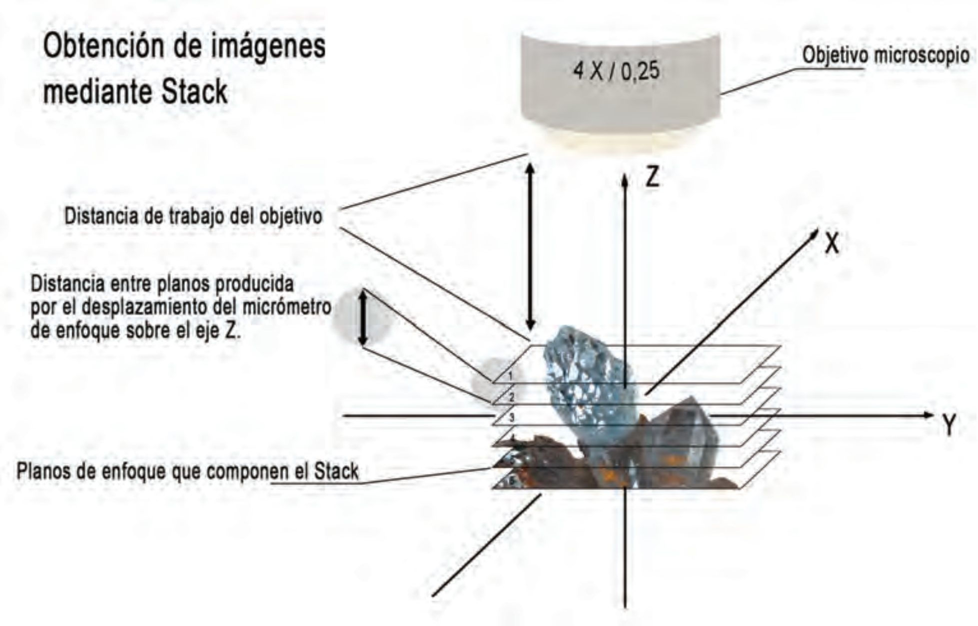

Image 2. Imaging through Stacking.

Using lenses from a great length is such a good advantage when lighting the sample. This distance would allow us to place the lights adequately always leaving space enough to handle without damaging the surface of the lenses. Consequently, one should be really careful if working with short distances since the surface of the lenses are quite easy to get scratched with the rocks.

The main key point to be solved in order to start stacking images is to take shots through focal micrometer accurate jumps of our microscope. Thus, each plane obtained is associated to each jump. Those intervals should be related to the lens used so that focal planes can get overlapped among them.

Noteworthy, every lens has an enlargement, a focal length, and a different numerical aperture so that there is a determined depth of field related to it. That is to say, each lens used will be related to a length among different photos.

Regarding the imaging with stacking, a vertical movement of the strip has been used in order to obtain different focal planes over axis Z. *(image 2)*

The accurate control about this vertical movement is made by the focal micrometer whether manual or motorised. Although there are people who prefer to set up this movement on any of both axis (X,Y), this is irrelevant provided that the movement is totally lineal and collimated to central axis of the lens.

As far as I am concerned, I would rather choose axis Z because at that area is where, no matter with what microscope, all the natural movement is performed. But this is only when handling with small samples. If dealing with bigger rocks it is more practical to set the movement on the horizontal axis due to the easiness for lighting the samples.

Resolution and Depth of Field

We have seen so far that methodology for stacking images are quite similar to those photographic sequences taken by a medical scanner. This is because each cut plane provides a specific data. But, what kind of separation should be there among planes? This is a key point if we want to get a high resolution and for this reason it should be further explained.

Every photographic camera has a resolution that is directly related to the size of the pixel of the sensor used. This is known as circle of confusion and it determines the resolution of the sensor used. Typically, if the size of the pixel were minor than the one of the circle of confusion, the resolution would be higher. In order to calculate this, the statement above should be followed:

$c = d/1500$

being the size of the circle of confusion and d the diagonal of the sensor or the diagonal of the film expressed on millimetres.

For this to be understood, let's use as an example the sensor of a camera which has the following dimensions 23, 7 mm X 15,5mm and as diagonal 28,37 mm. If we calculate c = 28,37 /1500, the size the circle of confusion would consist of 0,0189 mm. That is to say, our camera would not define points under this number.

Kenneth R. Spring - John C. Long y Michael W. Davidson explain in their web page about Nikon *http://www.microscopyu.com/tutorials/java/depthoffield/index.html* that depth of field of a determined lens is related to the number aperture of the lens and it is defined as follows:

$dtot = (\lambda \bullet n / NA2) + (n/M \bullet NA) \bullet e$ where:

- dtot Depth of field total of the lens in μm.
- λ Wave Length of the Light used expressed in μm.
- n Refractive Index of the medium
- NA Number Aperture of the lens
- M Magnification Factor of the lens
- e Shorter Distance to be solved with sensor of the camera (Camera Resolution)

Everything I have seen so far sums up into this formula. Then, in order to know what distance should be among shots is necessary to know beforehand the depth of field in our system (lens, camera, bellows, etc.) It can be appreciated that the higher the AN aperture or the magnification of the lens, the less depth of field of lens: they are inversely proportional.

Consequently, the distance among different focal planes is determined by the following:

nº fot = ptobj /dtot

It means,
- nº fot Number of photographs required.
- ptobj Depth total of the object to be photographed in mm.
- dtot. Depth of field total of the lens in mm.

It should be highlighted that in the composition of the final image/picture, it is extremely important that a part of the object should be unfocused in order to promote depth of field. Nevertheless, when taking shots systematically, many of the samples

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to be documented are so tiny that, sometimes, we have to focus the whole background. In this case, I like to left unfocussed part of the first shots so that depth is enhance at the beginning of the stack and what traps the attention is the object focussed on the background.

An excellent starting point for any one who would like to study thoroughly this issue is the information presented on *Charles Krebs. Website. http://krebsmicro.com*

Lighting

Like in any other work where photographic documentation is used, one of the variables to be controlled is the one of lighting. However, in this case, the process is a crucial issue due to the particular characteristics of each mineral. It is not the same to photography crystal minerals as photographing opaque objects.

Therefore, lighting is another main point when photographing crystals since these create problems: faces and edges disappear, especially when they are transparent. Hence, we must light (if possible) from the back with translucent and transparent material, and ensuring that this light is indirect. This would enhance the transparency but not the detail of the faces. This indirect way of lighting is perfect to avoid unexpected reflections.

On the other hand, if what should be highlighted is the faces and textures of rocks, lighting must be direct but from a very low-angle. An angle between 10 and 20 grades provides good results. *(Image 3)*.

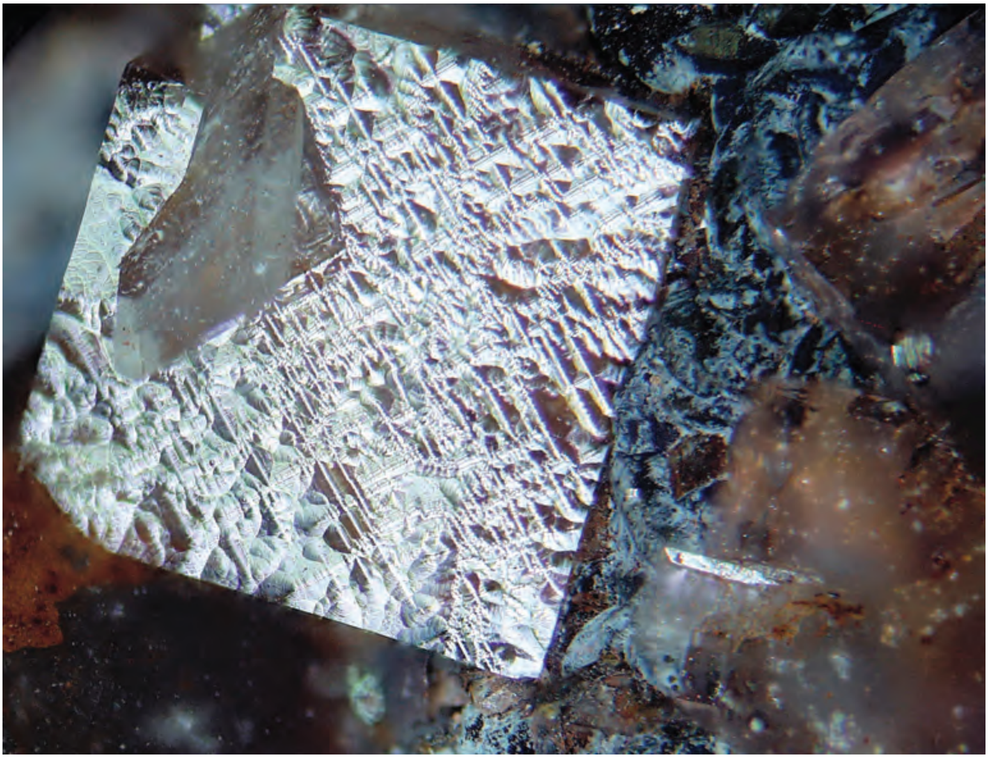

Image 3. Crystal of fluorite on manganese and barite, direct lighting and an angle inferior to 30º in order to enhance the epitaxial of the growing of the crystal. Col. and photomicrography Luis Arrufat.

The lighting I consider to be ideal for photographing crystals and the one I have

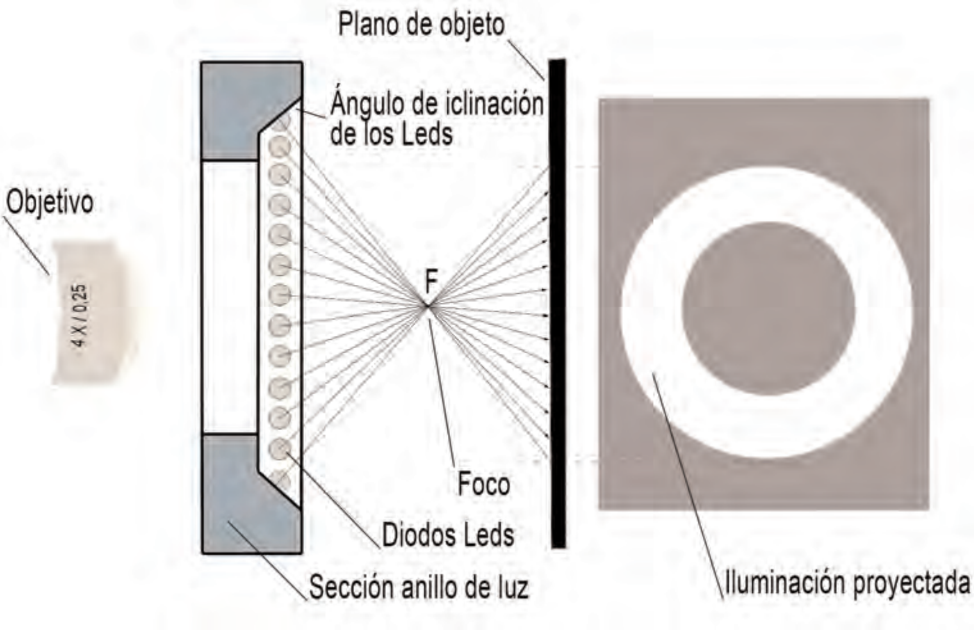

Image 4. Diagram of annulus with inverse geometry. It provides a total/dark field illumination, modifying the distance from the light focus to taste.

obtained better results with is the so-called dark field. I use for this a circular corona built for this reason, and to which I referred to as inverse geometry, with 50 Leds of white light and displayed with an inclination of 45º from the principal axis of the lens. Thus, the provided light is focused on a central point. The result is a point very illuminated that is linked mechanically to the fixed part of the optical system and that I can make coincide with the focal plane of the lens. *(image 4)*

This system allow us to enlighten completely in 360º avoiding the apparition of shadows. Additionally, if we vary the high in which the corona is set, the focal distance of that illuminated point will be also modified so that we are building a dark field. An adjustable power supply was added to this system. Then, the intensity of the emit light can be also modified.

The low-angle lighting usually results on good pictures and provides great details on surfaces of the sides by increasing the contrast.

Another way of lighting is using a diffuse light source. Despite of it being considered to be used when avoiding shadows and lighting completely a general plane, it is very appropriate for photographing greasy-shine minerals.

Nevertheless, I would not consider it to be adequate for lighting small parts or areas with shadow or with difficult access such as geode and vacuole of the rocks. For those cases, I would recommend using always a spot lighting.
Regarding spot lighting, I especially like using it for enhancing certain details altogether with a diffuse light. Also it is good option lighting in an indirect way the closest areas of the object to be photographed. In that case, I use two semi rigid termination of whit light and that I can adjust to taste.

In order to enhance the depth of field and the three-dimensional effect of the images, it should be taking into account the shadows. Shadows should not be flattened by excessive use of zenith lighting. However, this is very difficult to achieve when dealing with tiny crystals, often

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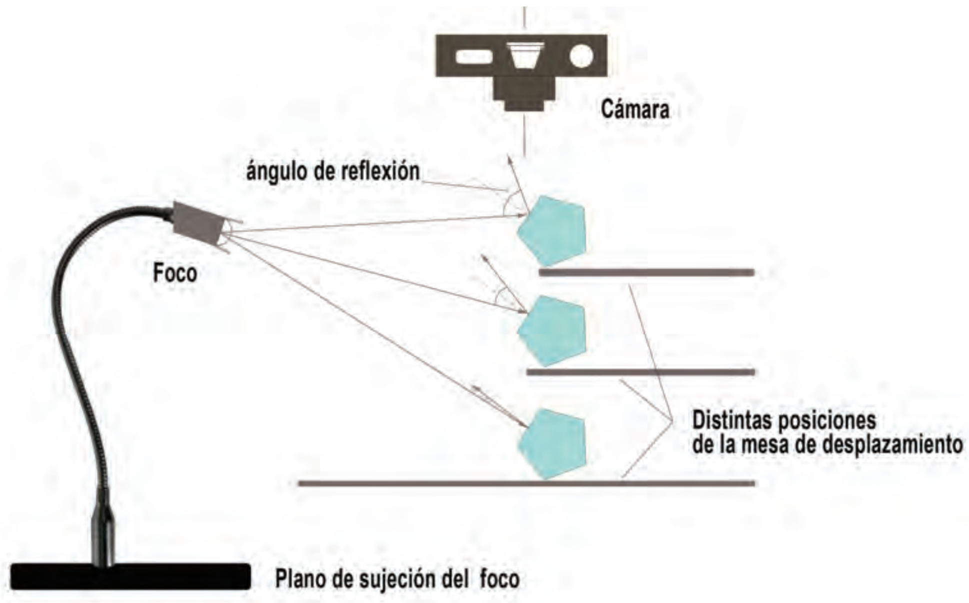


Image 5. Detail of the problem about the reflections when a light mechanically isolated is used from the movement desk.

imperceptible at first glance on the plane of the rock.

Another important factor is the control of reflections produced by the lighting. In order to avoid these reflections, the light source must be mechanically linked to the mobile part of the system, although it is not always possible. That is to say, I get the light to move at the same and in the same direction of the sample to be photographed. In this way, reflections won't vary their angle of incidence.

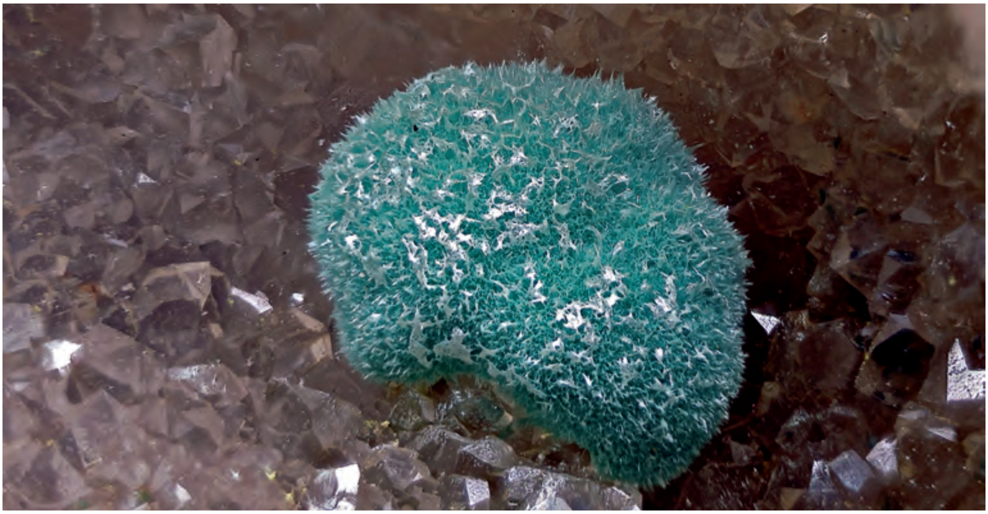
On the contrary, if the light source is not related to the mobile part but it is fixed in the static part of the system, the angle of incidence of the light will vary when modifying the position of each focal plane and will produce new reflections all different per every plane photographed. *See image (5).*

The rest relies on the chosen model and to taste of the photographer but there is no magic formula more than these performance standards. This is because in each determined case illumination must enhance the particular characteristics of a mineral.

Systematic. Peculiar minerals

The classification of the different kind of minerals is made by its physicochemical and crystallographic properties. Thus, this classification will be the one applied to described the samples of the minerals shown here.

There are many species (mentioned) from the volcanic rocks of the southeast of Spain, however, I preferred to show just a few which I considered to be representative for this type of volcanism. Therefore, I have chosen among the collected samples, the ones with best crystallisation to be observed.



1. Globular aggregation Agardite of yttrium crystals in the inside of a small quartz geode. Mine Sol Rodalquilar-Almería Col. and photomicrography Luis Arrufat.

Agardite (Y): $Y(Cu)_6(AsO_4)_3(OH)_6 \cdot 3H_2O$ Arsenites.
It appears as a secondary mineral on quartz seams that have endured an epithermal mineralization of low sulphuration on Pb Zn (Ag-Cu-Au).

2. Armalcolite y Fluorophlogopite crystals on sanidine y enstatite. La Aljorra- Murcia. Col. and photomicrography Luis Arrufat.

Armalcolite: $(Mg,Fe^{2+})Ti_2O_5$
Ismagnesium oxide and titanium lamproitics common in the Aljorra rocks.
Fluorophlogopite: $KMg_3(Si_3Al)O_{10}F_2$
it belongs to the micas group. It is a phyllosilicate quite usual on lamproitic rocks, and it appears in millimetrical sizes and not exceeding to the 5 mm. They can be found on the vacuoles of the rocks.

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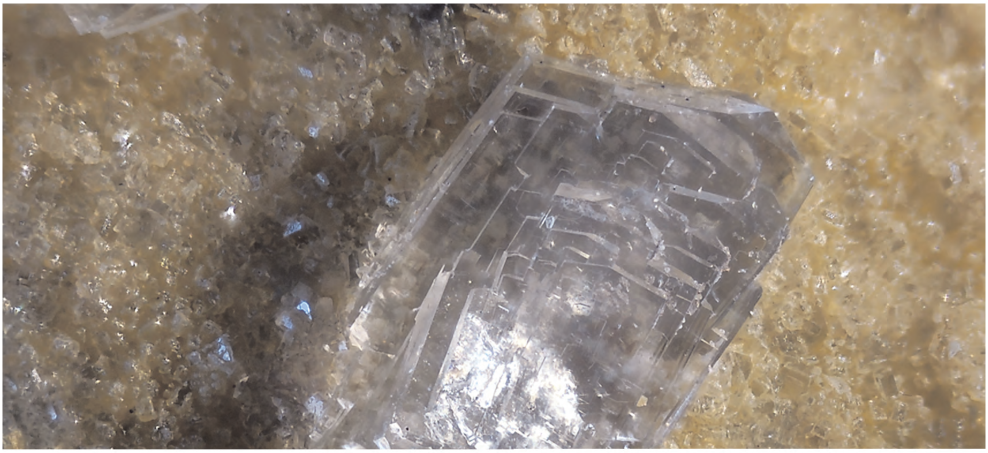
3. *Crystals of Arthurite with Olivenite, mine María Josefa Rodalquilar – Almería. Col Ángel Romero Escobar. photomicrography Luis Arrufat.*

Arthurite: $CuFe^{3+}{}_2(AsO_4)_2(OH)_2 \cdot 4H_2O$ Arsenates.
Appears in Maria Josefa mine with olivenite, cornwallite, Conichalcite and other arsenates of copper and iron as a secondary mineral. Radial aggregates is presented in emerald green.



4. *Clinoptilolite crystal collected on the edge of the caldera of the frailes. Los Escullos-Almería. Col. and photomicrography Luis Arrufat.*

Clinoptilolite: $(Na)_{2\text{-}3}\ Al_3\ (Al,Si)_2\ Si_{13}\ O_{36} \cdot 12H_2O$
Silicate belonging to the zeolite group. It appears on the alteration of the andesitic – amphibolic rocks. It usually appears altogether with ferrierite and phillipsite.

5. Hexagonal prismatic Chayesite Blue pale crystals. Cancaríx- Albacete. Col. and photomicrography Luis Arrufat.

Chayesite: $K(Mg, Fe)_4 FeSi_{12}O_{30}$ Ciclosilicates.
It appears on the lamproitic rocks from Cancarix, concretely on the lava flows that contain small vacuoles of degassing. It can be found on blue or brownish-grey colour.

6. Clinoptilolite crystal collected on the edge of the caldera of the frailes. Los Escullos-Almería. Col. and photomicrography Luis Arrufat.

Enstatite: $MgSiO_3$
it is a silicate of magnesium belonging to the pyroxenes group. Estantite is associated in this deposit to tridymite, armalcolite, sanidine, hematite, and flourophlogopite, fulfilling the vacuoles of the lamproitics. *Guiomar Calvo Sevillano et al, (2009).*

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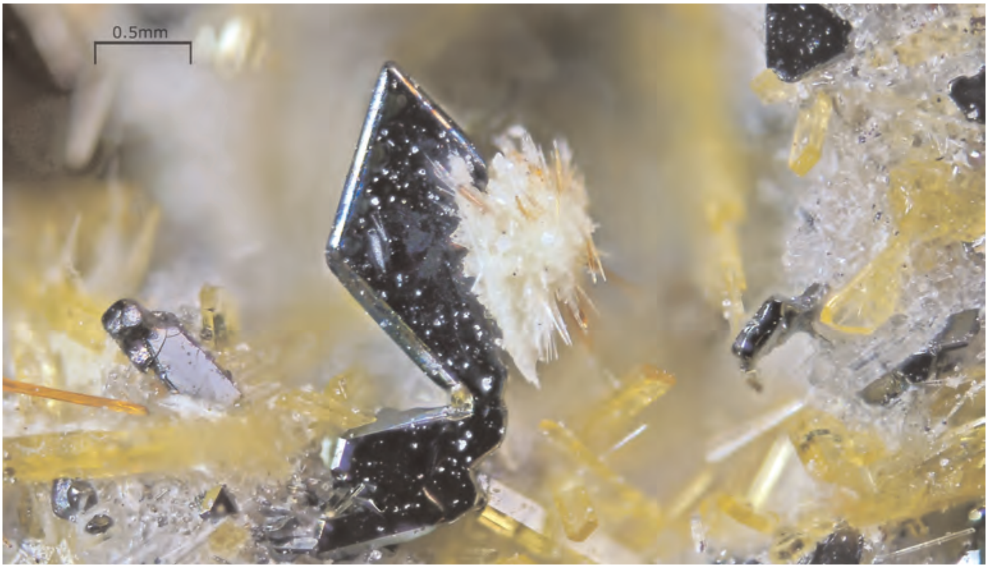

7. Hematite on diopside with Yuanfuliite crystals. Mina Celia, Jumilla. Col. and photomicrography Luis Arrufat.

Hematite: Fe_2O_3 Oxidos

It emerges together with fluorapatite filling the gaps of alteration on the rock and the crevices. It usually appears with a laminar form together with , calcite, flourphlogopite, sanidine, diopside, and tridimite. The latter being the most important mineralization. The paragenesis is very interesting but unfortunately it is disappearing due to the destructive brutality of collecting. For this reason, it is required the protection and control on the extraction of samples.

8. Acicular Mordenite crystals, radial groups 5mm. Srra Cabo de Gata- Almería Col. and photomicrography Luis Arrufat.

Mordenite: $(Na_2,Ca,K_2)_4(Al_2Si_{10}O_{24})7H_2O$.

Tectosilicate belonging to the zeolitas group, it appears on the faults and fissure on the dacítics-rhyolites tuffs from Cabo de Gata, probably as a result of an alteration related to the sea water.

9. Pharmacoalumite Crystals from the mine María Josefa. Rodalquilar- Almería. Col. and photomicrography Luis Arrufat.

Pharmacoalumite: $KAl_4(AsO_4)_3(OH)_4 \cdot 6.5H_2O$ Arseniate.
This mineral appears as a secondary product of the alteration on the epithermal seams of the crater from Rodalquilar.

10. Crystals of Phillipsite-K Terreros- Almería Col. and photomicrography Luis Arrufat.

Phillipsite: $K_6(Si_{10}Al_6)O_{32} \cdot 12H_2O$ Silicates.
It emerges as a result of alteration on the pyroclastic cracks of amphibolic andesites and it belongs to the zeolites group. This mineral has been collected from Terreros and Carboneras –Almería.

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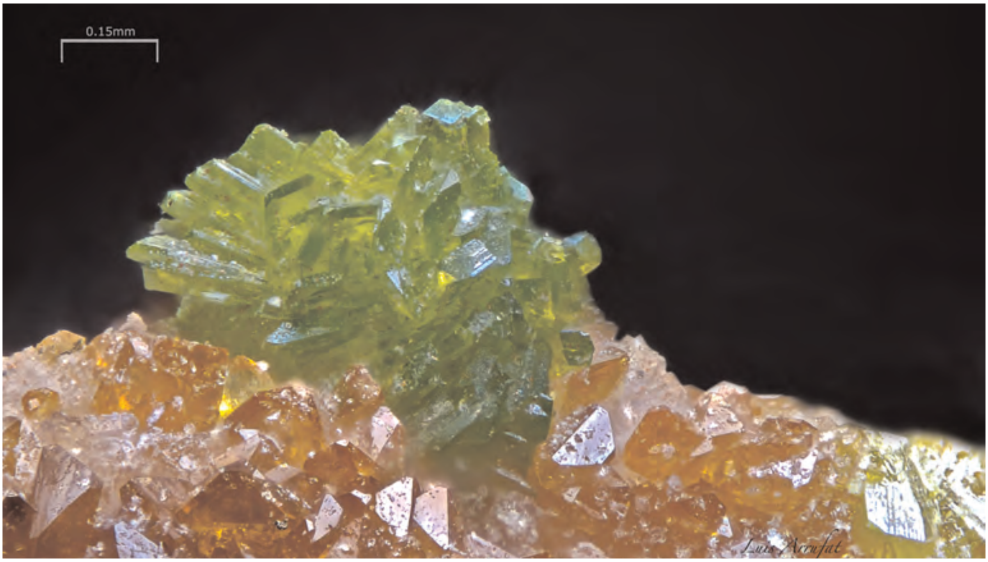

11. Rodalquilarite crystal on quartz and jarosite collected on the seam 340 Rodalquilar – Almería. Col. and photomicrography Luis Arrufat.

Rodalquilarite: $H_3Fe^{3+}2(Te_4+O_3)_4Cl$
It was discovered for the first time in Rodalquilar, so that it takes the name of this locality. It belongs to a group of oxides, and it appears on the small cavities of silice with advanced argilic alteration on seam 340. They are usually accompanied by jarosite, gold and tellurium.

12. Sheaf of warwickite crystals on sanidine, Canteras de la Aljorra. Col. and photomicrography Luis Arrufat.

Warwickita: $(Mg\ Fe_2+)_3Ti,(BO_3)_2O_2$ Borates.
This mineral is found with relative frequency on the lamproitic rocks from La Aljorra y Jumilla. It appears at the edge of the deposit where there is more degassing, together with the phlogopite and other minerals that fill the vacuoles of the Rocks. But always in sizes inferior to millimetre.

Collecting and Heritage

Thanks to this Preservation of Mineralogical and Petrological Heritage course, I would like to use this opportunity provided, to state my position concerning the defence of preservation of geomining heritage. Similarly, I would like to highlight that from mineral collecting something can be and it must be done for the preservation of our rich heritage. Although many geological places for tourism and mining facilities have been recovered recently, in Spain there is still too much to be done.

Unfortunately, because of the particular or political interests, national administrations may not have, in most cases, the required sensitivity to protect this natural heritage.

On the other hand, scientists are very busy and absorbed with their tasks in their offices. Amateurs are always focused on obtaining certain mineral objects. And some unscrupulous collectors are looking after every new discovery in order to feather one's nest (sometimes incited by some traders).

However, it does not mean that everybody with political responsibilities does not act as they should, nor that every scientist is not interested on protecting the natural heritage, nor that every collector spurs on deposits, nor that every trader acts without moral values. There are many people who spend their free time to research and collect minerals from mine tailings and fields of Spain. They also do an important documentary work, recovering and finding, in many cases, new paragenesis, or weird minerals that were unperceived before.

I am deeply concerned with the need of all the concerning sectors to come to an agreement about how to preserve our geological and mineralogical heritage, but of course, taking into account every activity and opinion. Indeed, all the activities regarding this natural heritage should be, in a coherent way, regulated because all of them can coexist and none excludes the other. Besides, a logical thing to be done would be that every single activity should complement each other working in one unique sense.

Recovering and preserving our rich geological and mineralogical heritage is not work of a few. It is work of everyone and that includes scientist and amateurs. But in order to get that, collaboration should be promoted between collectors and institutions. In fact, activities should be regulated as many European countries already do.

But not only the geological or paleontological heritage should be preserved, but also the historical mining and industrial heritage, which has been the sustenance of many generations in our country, should be value enhanced.

We cannot and should not allow this legacy to be forgotten in time. For that reason, the global trend for the use of geological heritage are geological and mining parks, they are an important chose to be preserved. It is clear that one cannot preserve what it is unknown but sometimes the best protection is to keep it unknown unless protection and supervisory measures are provided.

Apart from the value enhancement of many facilities able to recover, this type of actuation would help us to get to know this heritage, creating enrichment for mining areas, and also new job positions. But, again, this is my humble opinion.

Conclusion

Laws of optical physics determine depth of field as well as maximum resolution of a lens. But applying the stacking technique you can get amazing results. These results are comparable in resolution to the ones obtained by electronic microscopy, but of course without reaching level of magnificence.

In order to highlight the characteristics of a mineral, a correct and care illumination of the crystals when photographing will provide as excellent results. It must be recalled that minerals with different optical properties should not be photographed with the same type of lighting.

The volcanic rocks of the Spanish Southeast contain microscopic minerals, from millimetres to tenths of millimetre. These minerals, due to their paragenesis and rarity, should be considered to be part of the geological heritage.

Photographing minerals can be one of the most beautiful hobbies: an activity where study and leisure time go hand in hand.

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References

Abramowitz, M, (2003) Microscope Basics and Beyond, by New York Microscopical Society For Olympus America Inc. Vol. 1.

Arribas, A. (1998) "El yacimiento epitermal de oro de Rodalquilar" Boletín geológico y minero Vol.109. 5 y 6 pag. 15-28.

Atkins, B. (2013) Depth of Field in Depth. http://www.bobatkins.com/photography/technical/depth_of_field.html[retrieved: 20th February 2013]

Bac, N, Cardona, S., Gallardo-Arévalo M., Merino, I., Canals, A., Enrique, P., Melgarejo, J.C. (2012). "La Mina Sol, Rodalquilar(Almería): Mineralogía e Inclusiones Fluidas". Macla no 16, pag 252-253, Revista de la Sociedad Española de Mineralogía.

Camprubí, A, González-Partida, E, Levresse, G, Tritlla, J, Carrillo-Chávez, A (2003). Depósitos epitermales de alta y baja sulfuración: una tabla comparativa. Boletín de la Sociedad Geológica Mexicana 56, 1:10-18.

Cisneros, E., (2010) Automated Multifocus Imaging. Mineralogical Research Company 1584 E. Alta Vista Way. Axis, Volume 6, Number 2.

Davidson, M. W. and Abramowitz, M. (2002). Optical Microscopy. Encyclopedia of Imaging Science and Technology.

Guiomar Calvo Sevillano, Joan Viñals , Miguel Calvo Rebollar, (2009). "Minerales de las vesículas de las rocas lamproíticas de la Aljorra", Revista Macla, 11, pag, 43 y 44.

John I.Koivula, (2003) Photomicrography for gemologists.

Kenneth R., Davidson, M., (2000-2013). http://www.microscopyu.com/articles/formulas/formulasfielddepth.html [retrieved 13th February 2013]

Koren, N. (2000-2013) Depth of field and diffraction http ://www.normankoern.com /tutorials/MTF6.html [retrieved: 27th December 2012]

Krebs C. (2006) Some thoughts on selecting projection relay optics when using DSLR´s http//kerbsmicro/ relayDSLR/relayoptics1.html [retrieved: 1st March 2013]

Lopez-Ruiz, J., Rodriguez-Badiola, E., (1980). La región volcánica neógena del sureste de Espana. Estud. Geol. 36, 5–63.

Piper, J., (2010) Software-Based Stacking Techniques to Enhance Depth of Field and Dynamic Range in Digital Photomicrography, 193- 210. T.D. Hewitson, I.A. Darby (eds.), Histology Protocols, Methods in Molecular Biology 611 University of Melbourne.

Seghedi, I., Szakács A. , Hernandez Pacheco A. ,Brändle Matesanz, JL. (2007). "Miocene lamproite volcanoes in south-eastern Spain—an association of phreatomagmatic and magmatic products Journal of Volcanology and Geothermal Research 159, pag, 210–224.

Wes, W., Lutz, H. Jason, R. (2012) Resolution Criteria and Performance Issue http://www.olympusmicro.com/primer/digitalimaging/deconvolution/deconresolution.html [retrieved 14th March 2013]

Rottenfusser, R., Wilson, E., and Davidson, M., Education in Microscopy and Digital Imaging, http://zeisscampus.magnet.fsu.edu/articles/basics/resolution.html [retrieved: 3rd January 2013]