MOROCCO, LIGHT, SHAPE AND COLOUR

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Landscape of Morocco (Merzouga)
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ABSTRACT

At the 2017 Munich show, Mineralientage München, there were some very attractive pink Moroccan elbaites (tourmaline group), on a feldspar matrix, with quartz. These exhibits were scarce and elusive, but they created great expectations about the possibility of a new Moroccan locality with really interesting specimens, from both an aesthetic and geological point of view. They were labeled, at that time, as coming from the Ouarzazate region. Four years have passed since that fleeting appearance and it seems that, at last, the light is already visible at the end of the tunnel, revealing the locality of origin for these elbaite specimens, and it seems there will be pleasant surprises.

RESUMEN

En el año 2017 se vieron en la feria de Múnich-Mineralientage München, unas elbaítas (Grupo Turmalina) marroquíes de color rosado, muy atractivas, en matriz de feldespato y con cuarzo. Fueron escasos y escurridizos los ejemplares expuestos, pero crearon grandes expectativas por la posibilidad de aparición de un nuevo yacimiento marroquí con piezas realmente interesantes, tanto estética como geológicamente hablando. Se etiquetaron, por aquél entonces, como procedentes de la región de Ouarzazate. Han pasado 4 años desde esa fugaz aparición y parece ser que, por fin, ya se divisa la luz al final del túnel conociéndose la localidad de aparición de estos ejemplares de elbaíta al que nos referimos, y que parece deparará agradables sorpresas.

General map of the Alboran Sea with the Spanish and Moroccan coast. © Google Maps

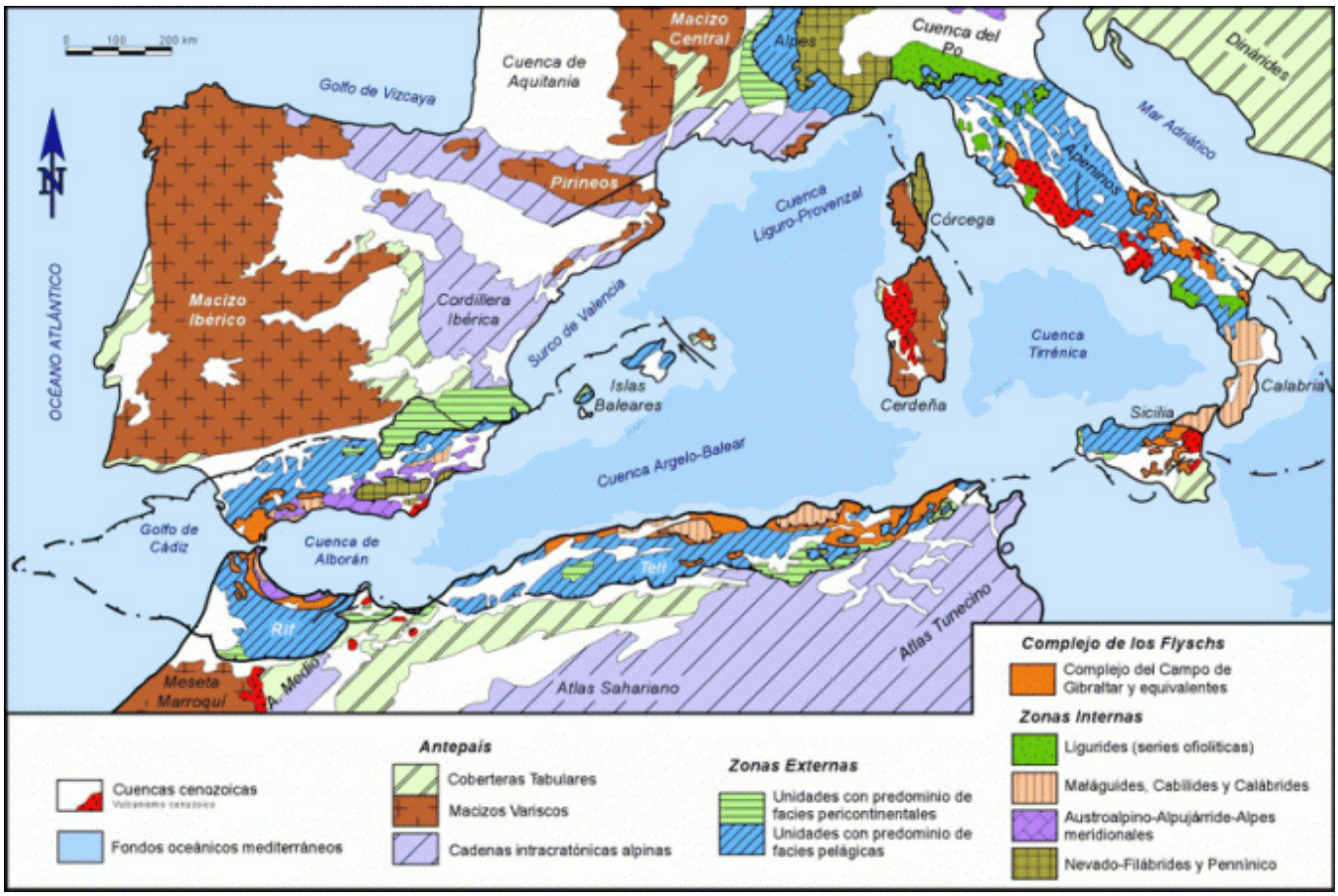
Geographical and geological context

We are dealing with the northern Moroccan coastal area, in the arc formed between the cities of Tetouan (Tétouan - تطوان) and Al Hoceima (Al Hoceïma - الحسيمة), bathed by the waters of the Alboran Sea.

This area belongs to the Rif (الريف), a mountain range in North Africa that is geologically part of the Gibraltar Arch along with the Betic Mountain Range (see next image), an alpine orogeny. The Rif massif is a consequence of the Alpine orogeny, caused by the movement of the African plate towards the north and the subsequent collision with the Eurasian plate during the Cenozoic, causing compression in a NNW-SSE direction. It is a typical alpine chain, with an ancient Paleozoic base on which Mesozoic and Cenozoic sediments rest, highly deformed by folds and thrusts, those of the north being superimposed on those of the south. This compression caused a particularly intense metamorphism in the coastal area that has, as we will see, great importance in the genesis of the mineralogy to which we will refer.

Focusing on the Rif Mountain Range, which is the area that interests us, it is located in the northern part of Morocco, whose northern limit is the Alboran Sea. It extends to the foreland basins of the Gharb to the southwest and Saïss to the south, where the cities of Fez and Meknès are located. It extends in a curve for more than 500 km from the Kebdana massif in the east to Tangier in the west (Anahnah, 2012).

This mountain range can be divided into three zones, like other Alpine mountain ranges, which from north to south are: Internal Zones, Flysch, and External Zones (Durand Delga et al., 1962; Andrieux, 1971; Kornprobst, 1974; Frizon de la Motte, 1985).



Geological diagram of the western Mediterranean with the main alpine orogenies (Vera, 2004). Note the apparent symmetry between the Betic Cordillera, in the south of the Iberian Peninsula, and the Rif Massif, in the north of the African continent, which together form the Arch of Gibraltar.

Internal Zones: These are represented by allochthonous terrain, in part metamorphic, derived from the Alboran Domain. The age of the rocks varies from Paleozoic to Lower Miocene. Stratigraphic and structural studies divide this area into three superimposed complexes that from wall to ceiling would be:

+ *Sebtide Complex:* the equivalent of the Alpujárride complex of the Betic Cordillera (Balanya and García-Dueñas, 1988). It corresponds to the internal area that has undergone metamorphism and which is divided into two units according to the degree of metamorphism:

- *Filali Unit*: characterized by the concentration of kinzigites (gneiss with cordierite and garnets), gneisses and mica schists. At the base are the ultrabasic rocks of Beni Bouzra (بني بوسيرة) that correspond to peridotites. This same lithology is found in Malaga's Sierra Bermeja, on the southwest flank of the Ronda massif.

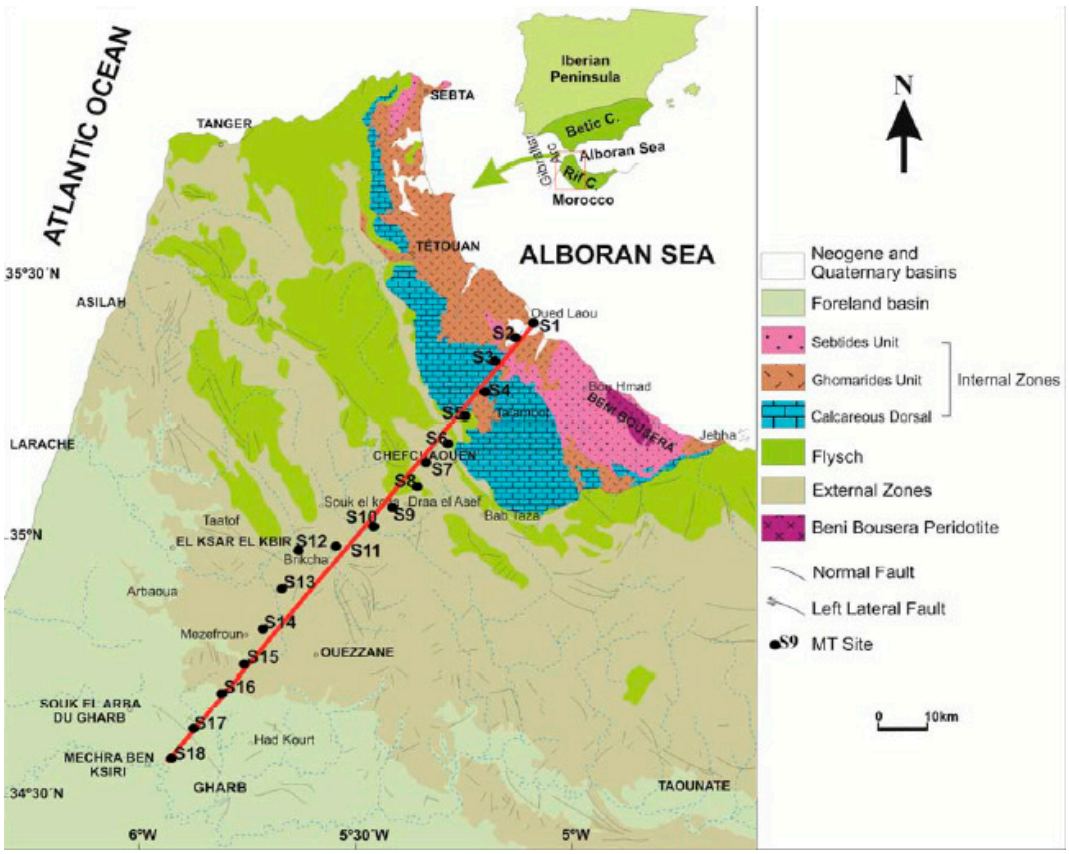
- *Federico Unit*: corresponds to the metamorphic cover of the Filali Unit and is formed by materials that range from the Carboniferous to the Triassic, with a lesser degree of metamorphism than the previous unit.

+ *Ghomarides Complex*: the equivalent of the Maláguide complex of the Betic Cordillera. It corresponds to Paleozoic terrain affected by metamorphism of the Variscan orogeny on which thin strata of Mesozoic and Cenozoic detrital rocks are located (Milliard, 1959).

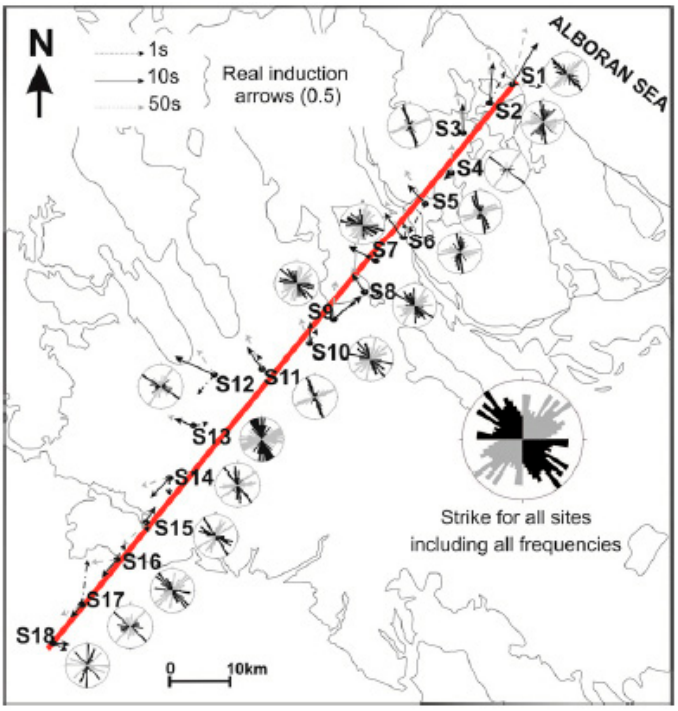
+ *Dorsal*: occupies the outermost position, intermediate between the Internal Zones and the Flysch, which in turn is divided into two zones:

- *Internal Dorsal*: fformed by relatively shallow Jurassic carbonate units. It is considered the partial cover of the Ghomarides Complex.

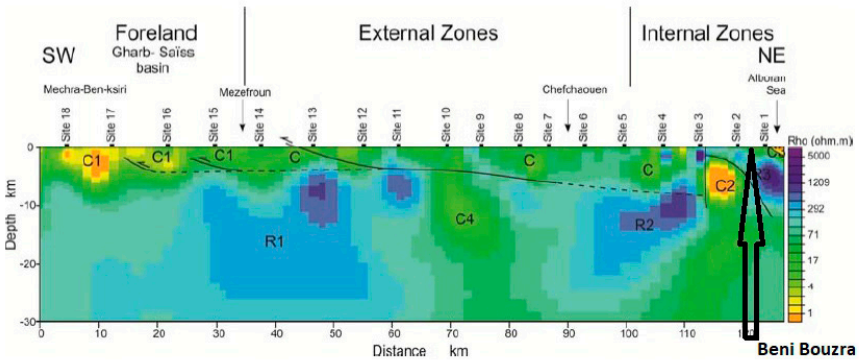
- *External Dorsal*: also formed by Jurassic carbonate units but with deep sedimentation.



Geological map of the western Rif showing the location of the magnetotelluric profile. (modified Ananah, 2012).



Real induction arrows at 1 s, 10 s, and 50 s (Parkinson's convention, pointing to conductors) for the 18 MT sites, and rose diagrams (Bahris method) for every sounding including all frequencies on a contour geological sketch of the studied area and a common rose diagram for all the sites and all the frequencies (modified Ananah, 2012).



Magnetotelluric 2D model across the studied area. The conductive bodies are noted as C and the resistive bodies as R (modified Ananah, 2012).

Elbaite specimen seen at the 2017 Munich show, Mineralientage München.

Flysch: Corresponds to detrital units formed by sandstones and pelites deposited in the depression between the Internal Zones and the External Zones. Its age varies from Cretaceous to Upper Eocene – Oligocene.

External Zones: A practically autochthonous structural complex that occupies the entire southern sector of the Rif cordillera and is made up of carbonate and terrigenous materials, mainly marl and limestone from the continental shelf. Its age ranges from Triassic to Cenozoic, with abundant Miocene exposures (Anahnah, 2012).

We are particularly interested in a part of the Internal Zones in terms of the location of the newly discovered elbaite deposit, specifically the Sebtide Complex and the Ghomarides Complex. Due to the geological correlation with the Alpujárride and Maláguide complexes, the reader will quickly note the potential for the discovery of possible new deposits on the "Spanish side". In fact, in an article published in 2008 in 'Mineralogistes de Catalunya', Utrera, C. et al., mention the remarkable specimens found in some pegmatites hosted in Paleozoic schists north of Estepona, and those found in an amphibolitic gneiss from

Elbaite specimen seen at the 2017 Munich show, Mineralientage München. Note the quality and beauty of these pieces that the locality labeled as "Ouarzazate".

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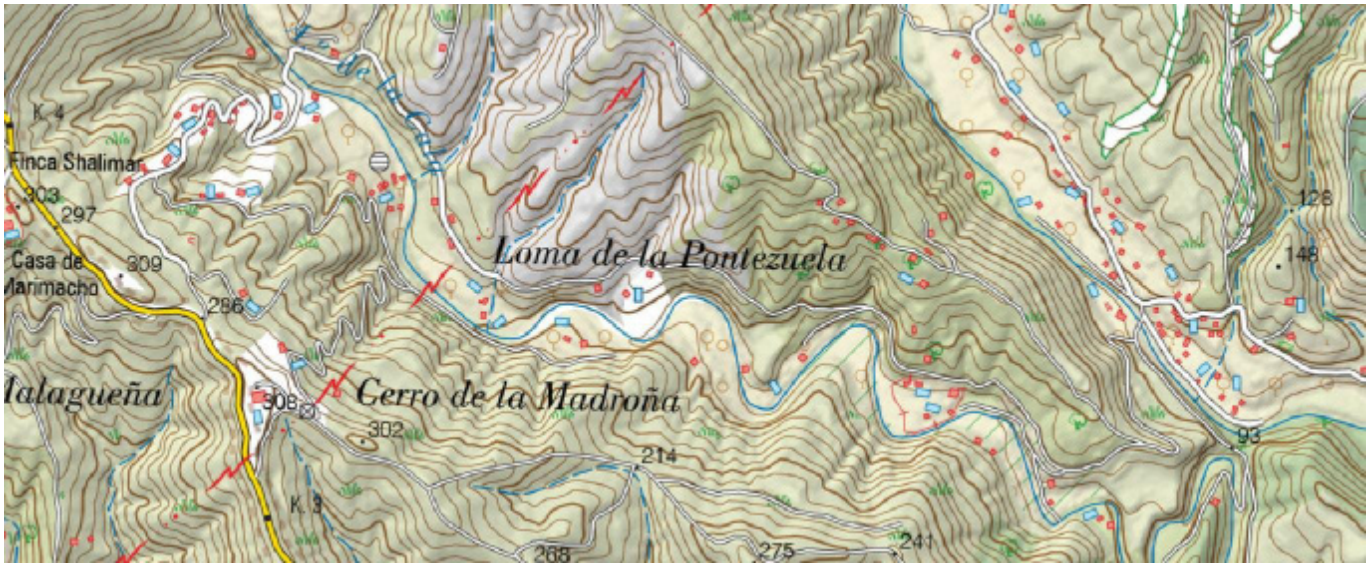
the Alpujárride Complex in Trascastillo, near Cártama, both in the province of Malaga. The elbaite crystals found in this area have a prismatic habit ending in a flat pinacoid face, with striations along the prism and a pink color, often with zoning of transverse bands of yellow, green or bluish color. These crystals have been found on quartz or feldspar, although they also



Detail of the National Topographic Map - Actual MTN - edited by the National Geographic Institute (IGN) of Spain, in which the indicated term of ‘Loma de la Pontezuela’ is observed.

Detail of the National Topographic Map - MTN50 - 1917 edition of the National Geographic Institute (IGN) of Spain, in which the term "Loma de la Portezuela" is observed.

appear loose. Schorl, spessartine (garnet group), microcline, quartz, chlorite and clinozoisite occur associated with the elbaites in both deposits, along with other less common species.

Elbaite (variety rubellite) with Quartz. Beni Bouzra (Bni Bouzra), Chefchaouen Province, Tanger-Tetouan-Al Hoceima Region, Morocco. Height 58 mm. Photo: Joaquim Callén.

Probably, the first discovery of the Malaga elbaites was made in the early 1990s by the brothers Fernando and Salvador Mancilla in the Loma de la Pontezuela, near the Padrón river, about 4 km north of Estepona. The small outcrop, approximately two meters square, provided very good pink elbaite crystals (perhaps the best in Spain) along with other good tourmaline group specimens that were green and black. The elbaite crystals that appear in this area have a prismatic habit and are terminated by a flat pinacoid face or, in some cases, a triangular pyramidal termination. They are striated in the direction of the prism and are pink in color, often zoned with yellow, green, or bluish transverse bands. These crystals have been found on quartz or feldspar, although they also appear loose. Schorl, spessartine garnets, microcline, quartz, chlorite, muscovite and clinozoisite appear associated with the elbaites in both deposits, as well as some other less common species.

In some publications, the *Loma de la Pontezuela* area appears as the misnomer *Loma de Portezuelas*, possibly due to the latter having erroneously appeared in some edition of the National Geographic Institute (IGN) maps. Specifically, we found that the name appeared as *Pontezuela* in the MTN50 National Topographic Map, 1916 edition, whereas in the 1917 edition it had changed to *Portezuela*, a spelling maintained until 1976,

Elbaíte with Microcline and Quartz. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain. Dimensions: 10 x 6,5 cm. Crystal 1,2 cm. Collection and photo: Fernando Mancilla.

after which it changed back to *Pontezuela*, as can be seen in Sheet 1072-1 of the MTN25, and continuing up to the current MTN.

Elbaíte with Microcline and Quartz. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain. Main crystal measures 12 mm. Collection and photo: Fernando Mancilla.

Although the Betic and Rif cordilleras are 'apparently identical' from a geological point of view, studies of seismicity and current deformation indicate that they are clearly asymmetric (Galindo-Zaldívar, J. et al.) The Rif Cordillera is characterized by the activity of faults with mobility towards frontal zones, while the Betic Cordillera is characterized by the existence of large folds over uplifted strata (Keuper facies).

One of the features that attracted the attention of the authors of this small article is the existence at the northern end of the Rif massif of a very conductive body, which does not outcrop on the surface, surrounded by a nonconductive body, that correspond, respectively, to the continuity to the north of the peridotites of Beni Bouzra and to the mica schists and gneisses of the Sebtide Complex. This fact is beyond the scope of this writing, although we consider that it may be of interest for future geochemical studies and the possible formation of pegmatite complexes that would favor the existence of the typical minerals

Elbaite (variety rubellite) with Quartz. Beni Bouzra (Bni Bouzra), Chefchaouen Province, Tanger-Tetouan-Al Hoceima Region, Morocco. Height 58 mm. Photo: Joaquim Callén.

in this context, such as elbaites, among others.

As is often the case with minerals, once a new deposit is found it is not an easy task for it to become known in a short time. If, in addition, it is a mineral like elbaíte and a country like Morocco, the effect is multiplied, and the "enigmas" and "confusion" grow exponentially. Four years have passed since the first specimens of Moroccan elbaíte were seen and where the Ouarzazate (تازازرو) area was claimed to be the locality of the discovery. But towards the end of 2020, and curiously also on dates that coincide with the Munich show, a new locality for this type of specimen was revealed - albeit without absolute confirmation - specifically the Demnate zone in Azilal province, Béni Mellal-Khénifra region, about 90 km north of Ouarzazate.

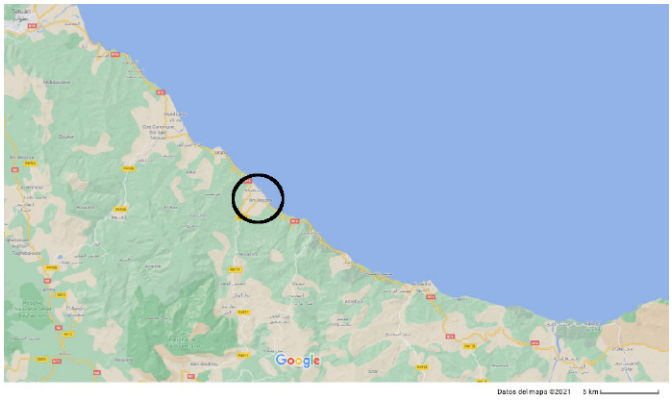
Finally, and well into 2021, it seems that things are finally clarifying, and not only in terms of the correct location for these specimens. As the crisis caused by Covid-19 begins to subside, and vaccination gives hope for a better future, it seems that minerals want to regain their prominence, and they will do so in splendid fashion.

Elbaite. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain.
Dimensions: 12 x 6 mm. Collection and photo: Fernando Mancilla.

Elbaite. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain.
Dimensions: 12 mm. Collection and photo: Fernando Mancilla.

Elbaite with Microcline, 'Mica' and Quartz. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain. Crystal height is 8 mm. Collection and photo: Fernando Mancilla.

The more convoluted the geology, the more difficult it becomes but also the more beautiful it becomes. In the area of Beni Bouzra these elbaites are being found. About 500 km NE of the first claimed and accepted location for these pieces, the enigma is solved and we have to wait to see what this new deposit will yield.



Detailed map of the Beni Bouzra area. ©Google Maps

Everything suggests that it will not be just another find ...

Acknowledgements

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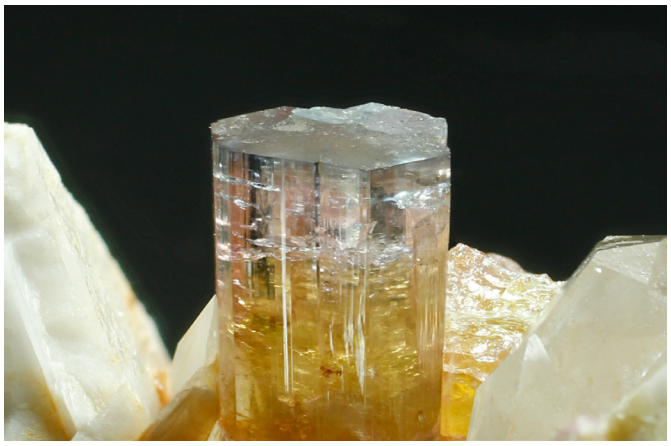
Elbaite. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain. Crystal height is 8 mm.
Collection: Miguel Calvo. Photo: Joaquim Callén.



Elbaite. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain. Crystal height is 8 mm.
Collection: Miguel Calvo. Photo: Joaquim Callén.

Elbaite. Trascastillo, Cártama, Comarca Valle del Guadalhorce, Malaga, Andalusia, Spain. Crystal height is 15 mm.
Collection and photo: Diego Navarro.

Elbaite and Quartz. Trascastillo, Cártama, Comarca Valle del Guadalhorce, Malaga, Andalusia, Spain.
Dimensions: 67 x 60 mm. Crystal: 15 mm.
Collection and photo: Daniel García.

Elbaite. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain.
Crystal: 20 x 6 mm. Collection and photo: Fernando Mancilla.

Elbaite with Quartz and Schorl. Trascastillo, Cártama, Comarca Valle del Guadalhorce, Malaga, Andalusia, Spain.
Dimensions: 75 x 60 mm. Elbaite crystal: 15 mm.
Collection and photo: Diego Navarro.

Elbaite and Quartz. Trascastillo, Cártama, Comarca Valle del Guadalhorce, Malaga, Andalusia, Spain. Elbaite crystal: 6 mm.
Collection and photo: Diego Navarro.

Elbaite and Quartz. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain. Elbaite crystal: 8 mm.
Collection and photo: Fernando Mancilla.

Elbaite and Quartz. Trascastillo, Cártama, Comarca Valle del Guadalhorce, Malaga, Andalusia, Spain.
Criytals of 9 and 6 mm.
Collection and photo: Diego Navarro.

Elbaite, Quartz, Schorl and 'Garnet' (Group). Trascastillo, Cártama, Comarca Valle del Guadalhorce, Malaga, Andalusia, Spain.
Elbaite crystal 15 mm.
Collection and photo: Diego Navarro.

Elbaite, Microcline and Quartz. Loma de la Pontezuela, Estepona, Comarca Costa del Sol Occidental, Malaga, Andalusia, Spain.
Dimensions: 5.2 x 4 cm. Crystal of 10 mm. Collection and photo: Diego Navarro.

Elbaite (rubellite variety). A similar specimen to those that appeared in Burma and what they called ‘mushroom’ type.
Beni Bouzra (Bni Bouzra), Chefchaouen Province, Tanger-Tetouan-Al Hoceima Region, Morocco.
Dimensions: 4,6 x 3,0 x 2,6 cm.

Elbaite (rubellite variety) with Quartz. Beni Bouzra (Bni Bouzra), Chefchaouen Province, Tanger-Tetouan-Al Hoceima Region, Morocco. Dimensions: 3,0 x 2,4 x 2,1 cm.

Elbaite (rubellite variety). Beni Bouzra (Bni Bouzra), Chefchaouen Province, Tanger-Tetouan-Al Hoceima Region, Morocco. Dimensions: 7,2 x 4,0 x 4,5 cm.

Elbaite on Quartz and Feldspar. Beni Bouzra (Bni Bouzra), Chefchaouen Province, Tanger-Tetouan-Al Hoceima Region, Morocco. Dimensions: 5,6 x 4,0 x 2,7 cm. Main crystal: 1,5 x 0,7 cm. Collection: Carles Manresa.

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