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A petrographic catalogue for the "Onyx Marbles and Alabasters Collection" of The Museum of Mineralogy and Petrography in Turin University

ABSTRACT

The paper reports information and results concerning 69 rock samples belonging to the "Onyx Marbles and Alabasters Collection", recently acquired by the Museum of "Mineralogy and Petrography" of the University of Turin. The collection is in loan for use to the "Museo Regionale di Scienze Naturali" in Turin. This set of specimens represents several onyx marble varieties currently available in the Italian ornamental stone market. Most of them are actually calcite-alabasters, sedimentary rocks formed in karst environments. Generally, they show a banded structure having nearly parallel layers that differ, from case to case, in colour, fabric and /or mineral composition. In order to examine the different features of this heterogeneous category, a multi-technique approach has been chosen. Detailed photographic documentation was acquired for each sample of the collection; moreover, a small amount of specimen was collected for chemical analysis and mineralogical investigations. Every sample has been scanned by electron microscopy and, for the most interesting varieties, a thin section was obtained and observed at the optical microscope. MicroRaman spectroscopy was used to determine the mineral phases present in each sample, as well as EDS analysis that added a chemical dataset to the characterization of the mineral species detected. ICP-OES spectroscopic analyses were done for the determination of trace elements of the carbonate fraction of each sample. All the information obtained were organized in a petrographic catalogue reported at the end of the paper.

Key words: calcite-alabaster, onyx marble, collection, catalogue.

INTRODUCTION

The European standard EN 12670:2001 (Natural stone - Terminology) defines as Onyx Marble "any compact, banded stone, consisting of coloured and transparent layers of calcite and/or aragonite, and capable of taking a polish". This term has been taken from the quarrymen language, which sometimes is far from scientific definitions, and is erroneously used as a synonym of alabaster (meant as calcite-alabaster).

Under the name of Onyx Marble are thus grouped many varieties of carbonate rocks with different genesis and petrographic classification. This group comprises calcite-alabaster, marble, limestone and travertine. The common factor is the easiness of cut and polish and (for the majority of varieties) the aesthetical aspect - with the banded structure as the main feature.

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Onyx Marble is a merely commercial definition; on the other hand, the petrographic nomenclature of this group of rocks is quite debated except for limestones and marbles varieties that can be ascribed as Onyx Marbles. The terminological issue concerns the rocks that different authors refer to as: alabaster, calcareous sinter, travertine, onyx marble, oriental alabaster. In other instances, the same name is used to denominate different stones, or similar varieties are denominated with different names. (EN 12440, 2008). This often results in a great deal of confusion causing misunderstandings.

Surprisingly, this terminological issue is more than a century old. In 1893 the Smithsonian Institute curator George P. Merrill, who collected many documents and carried out researches on onyx marbles, wrote in his introduction: "It is unfortunate in our discussion of the subject in hand, that both the popular names by which these stones are known are erroneous and misleading. The term onyx as properly used, includes a banded variety of chalcedony - a purely siliceous rock[…]. The term alabaster as applied to the stone is even more misleading than onyx, since both stones are used for the same purposes, and when reading published accounts we are not infrequently at a loss, unless descriptive qualities are mentioned, to know at all times whether the material under discussion is a true alabaster (gypsum) or an onyx marble". After his work, some nomenclature papers have been published by both European and American authors but, so far, a standard definition unanimously accepted was reached. Therefore, the confusion remains.

The current situation is that different research groups use mainly the definitions 'alabaster' and 'travertine' to describe the same sedimentary orthochemical carbonate rock. The German researchers Klemm & Klemm (1991) proposed the definition of calcite-alabaster for this speleothem-derived rock, while the American researcher Harrell (1990) stated that the technically correct name for the same stone is 'travertine' and its dense, non-porous variety may be classified as the sub-variety 'calcareous sinter', contrasting the former definition.

This work is not aimed towards dealing with the nomenclature issue, but a few words are spent to justify the set of definitions used in the catalogue.

We decided to follow the suggestion of Klemm & Klemm (1991)'s. The main discriminant in the classification, in our advice, should be the genetic conditions that originated the rock. Travertine forms in sub-aerial environment while calcite-alabaster precipitates in hypogeal environment such as cave and karst areas. It is a sedimentary orthochemical rock, generally layered alternating opaque brown and translucent white bands. It is composed mainly of calcite, rarely of aragonite. It has hypogeal origin in karst environment, occurring typically as reprecipitated calcite in limestones and/or dolomites (Fairchild and Baker , 2012).

Modern petrographers use the term "alabaster" to define an evaporitic gypsum rock, e.g. Volterra Alabaster. Nevertheless, the term was used since ancient times to define the carbonate rock quarried in Egypt starting from the Predinastic period (Klemm & Klemm, 2001). The origin of the word "Alabastron" could derive from an old Egyptian town and its quarries, near Thebes, where this rock was extracted and carved, or from a traditional typology of Egyptian jar (Harrell, 1995).

THE COLLECTION

The "Onyx Marbles and Alabasters Collection" has been donated to the Museum of Mineralogy and Petrography of the University of Turin with the aim of representing the availability on the Italian market of these kinds of rocks. The editing of this sort of catalogue represents the goal of a PhD project currently in progress at the Earth Sciences Department of the University of Turin. This research project deals with the mineralogical and petrographical characterization of the varieties of ornamental stones called Onyx Marbles (Marengo et al., 2014). During the first step of the project, several samples had to be collected; in doing so, we addressed to the Museo Regionale di Scienze Naturali and to companies operating in the trading and manufacturing of ornamental stones, which cooperated to provide the samples dealt in this work (Antolini Luigi & C. S.p.A. provided all of the specimens of the collection). The resulting collection is composed of 69 slabs representing 58 commercial varieties of onyx marble. Each specimen has the approximate size of 13 x 7.5 x 0.8 cm, represented by a thin rectangular block, polished on one side. For every sample, its commercial denomination is reported, together with an identification number. The collection comprises also 20 thin sections, chosen among the most interesting varieties from a petrographic point of view.

The specimens can be subdivided in two typologies, according to the cutting direction. The "vein cut" slabs (referred as vc in the catalogue) are cut normally to the deposition horizons of calcite\aragonite layers (this is also known as cutting "against the vein"). On the other hand, "cross cut" slabs (referred as cc in the catalogue) are sliced at a 90 degree angle with respect to the vein cut, thus it shows a cross section of the layers in the stone block (it is also called cutting "with the vein"). For some varieties, both vc and cc specimens were obtained. The different

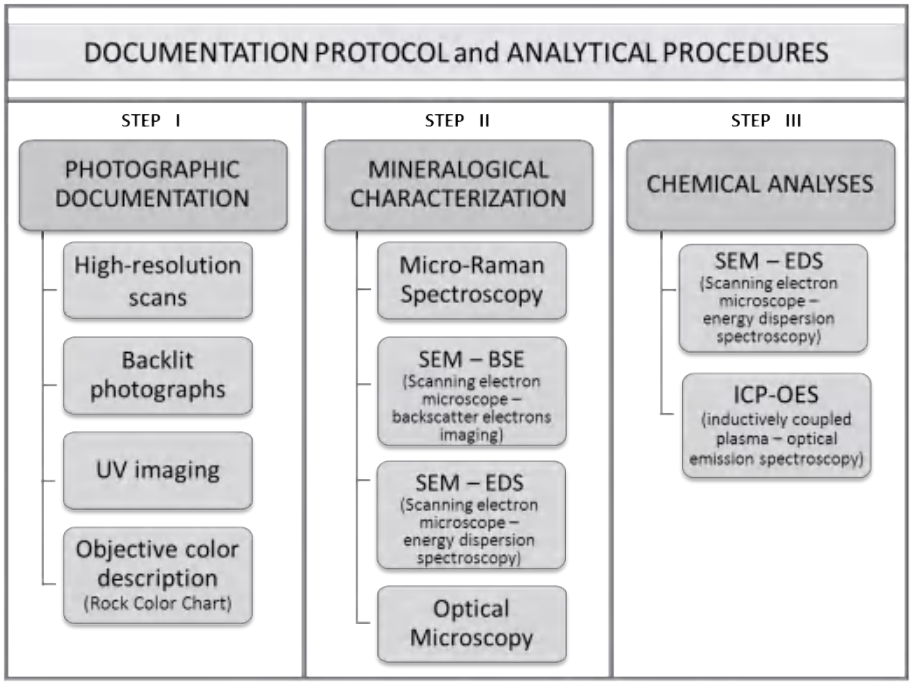

Chart showing the protocol followed in this work

cutting directions affect significantly the aesthetical appearance of the material, and this feature has been used since the ancient times to obtain peculiar decorative effects due to the particular texture of these rocks.

There are several provenance countries, such as Pakistan, Iran, Afghanistan, Mexico, Egypt, Tanzania, Argentina, Turkey, Tunisia and Italy. The exact locality is not been provided if the sample is currently commercialized (the sharp geographical location of the quarries is a confidential information).

The collection has been registered in the Catalogue of the museum with the series of numbers from M/U16701 to M/U16769.

DOCUMENTATION PROTOCOL AND ANALYTICAL PROCEDURES

Every item of the collection was characterized by using a multi-technique approach. An "analysis protocol" was designed to compile the petrographic catalogue. Non-destructive methods have been preferred to preserve the samples as much as possible. Despite this, for every specimen a small amount of material was collected (a small rectangular block about one centimeter wide). The analytical protocol is described in the chart below

I) *Photographic documentation*

High-resolution scans of every specimen were collected to grab some otherwise unnoticed features. Backlit photographs were taken only of totally or partially translucent varieties. A peculiar feature typical of "onyx marbles" and several calcite-alabaster is the translucence of some laminae. This is due to the morphology of the crystals and to presence or absence of impurities in certain layers. Taking advantage of this property, backlit pictures improve the visibility of macroscopic crystalline structures such as: crystal growth elongation, approximate size of crystals and sometimes macroscopic inclusions.

Ultraviolet photography is useful to observe how the composition of calcite influences the colour and the intensity of the luminescence, giving a hint about the nature of the fluorophores (usually trace elements and organic matter in calcite).

For an objective description, the sample colours have been compared with the USGS - Munsell Rock Color Chart (1991).

II) *Mineralogical characterization*

MicroRaman spectroscopy was used to determine the mineralogical composition of each sample; SEM observation in BSE mode was useful to identify the most common mineral inclusions and give complementary information about inclusions too small to be analyzed by MicroRaman. SEM-EDS analyses provided a chemical dataset to the characterization of the mineral species detected. Presence of barite, fluorite, strontianite and Mn and Fe compounds is statistically significant. All 20 thin sections were observed with a traditional optical microscopy in transmitted light.

III) *Chemical analyses*

The average chemistry of the samples is useful to characterize the formation environment and to understand how the initial conditions can influence the genesis of the rock; this could help to associate specific features to a particular compositional range. SEM-EDS analyses were performed to determine the major (and minor) elements of the carbonate fraction of each sample; ICP-OES spectroscopy was used to detect trace elements. The most explicative and immediate example of how chemical composition and physical characteristics are related is the colour of the rock. Despite the fact that both calcite and aragonite have no intrinsic colour,

onyx marbles are representative of a wide colour range, from translucent white to opaque black. Most commonly occurring colours are honey yellow, orange and various shades of brown; less common are bright green, red and purple. Several banded varieties often display many colours and the prevalent pattern is white translucent bands alternated with brown opaque ones. Many authors refer to the band alternation as an "annual lamination"; every couplet, e.g. white-brown or white-green bands, is developed in a year-time and the two bands represent the dry and wet season (Baker et al., 2008). Considering the data found in literature it is reasonable to suppose that the brown colour is due to humic and fulvic acids dissolved in the "mother" solution; these substances form in the soil from the breakdown of vegetal material. Red is usually due to the presence of ferric oxides and hydroxides. Green is given by ferrous or copper compounds. Black can be related to presence of manganese oxides (Hill & Forti, 1997). Presence and description of the chromophore compounds eventually detected in the samples is reported in the catalogue

ANALYTICAL SETUP

Chemical analyses of mineral phases are performed with a Cambridge Stereoscan 360 Scanning Electron Microscope, equipped with an Oxford Inca Energy 200 EDS microanalysis. All spectra are obtained using the following setup: accelerating voltage of 15 kV, working distance of 25 mm, probe current range 800 pA - 1.2 nA and exposure time range 60-500 s. Primary standardization performed on SPI Supplies and Polaron Equipment analytical standards, regularly standardized against a high purity metallic Co standard before each experimental session.

Raman spectra are obtained using a micro/macro Jobin Yvon LabRam HRVIS coupled to an Olympus optical microscope. The signal is collected with a 50× objective for non-oriented crystals. The 632.8 nm line of He-Ne laser is used as excitation; laser power (20 mW) is dosed through a series of density filters. The lateral and depth resolution are around 2 and 5 μm, respectively. The system is calibrated using the 520.6 cm-1 Raman band of Si before each experimental session.

Trace elements in the carbonate fraction are detected with a Spectro Iris Advantage II ICP-AES Emission Spectrometer. The instrument is calibrated before and during each experimental section with regularly, re-prepared standard solutions (Merck products) obtained for calibration range of 0-1 ppm.

THE CATALOGUE

For every item of the collection, the information is organized as follows:

1) *MRSN Catalogue Number*: the identification code of every sample is reported, ranging progressively from M/U16701 to M/U16769.

2) *Picture of the sample*: obtained by high-resolution scanning. The size of the printed picture is slightly reduced from its original size.

3) *Commercial name*: provided by the dealers. For each entry, an English translation is provided. Commercial names can vary, as different sellers may refer to the same variety (same provenance and aspect) in different ways. The most widely used names are given.

4) *Petrographic classification*: the meaning of the terms is as follows. Calcite-alabaster: (see introduction). Travertine: sub-aerial carbonate concretion. Limestone and marble: both

intended in sensu stricto as the sedimentary and metamorphic carbonate rock respectively. In some cases, the correct identification was not feasible by observing the small available specimen; a symbol (?) is then added after the classification hypothesis.

5) *Provenance*: as stated previously, for several varieties the sharp location of the quarry was omitted by providers for commercial reasons. The provenance areas indicated in square brackets are inferred from literature and online resources, such as 'stonecontact.com' and 'deutsches-natursteinarchiv.de'.

6) *Cutting and finishing*: some technical aspects of the specimens are described. For each entry the shape of the slab, its size, its cutting direction (indicated with vc and cc) and the finishing process (polished or smoothed) are reported.

7) *Description*: macroscopic features are described along with microscopic characteristics (where the thin section is available). Information about the colour(s), the structure, the mineralogical composition and porosity of the rock is also given.

8) *Other mineral phases*: list of minerals detected by micro-Raman spectroscopy and/or SEM-EDS analyses. The main component (calcite or aragonite) is not reported here, but in the Description (6). In some cases, a sharp identification was not reached even by combining the two techniques (destructive XRD was required). We chose not collect further amounts of material and to report the chemical nature of the unknown mineral(s) under a generic name (e.g. manganese compounds or iron oxide). If a SEM picture is present, it will be a back-scattered electron image (SEM-BSE), in which the different gray tones are related to the mean atomic mass of the object (the higher the atomic mean mass, the lighter the gray tone).

9) Translucence and fluorescence info: this section contains the information obtained through the photographic documentation phase. In some cases, the probable causes of the fluorescence colour is also reported here.

10) *Colour*: the objective description of the colour(s) is obtained by observing the dry polished specimens in natural daylight and comparing them to the USGS - Munsell Rock Color Chart (1991). Some samples were extremely complex to describe using this method, due to the high amount of shades and hues; for this the reason only the most frequent ones are listed here.

11) *Chemical composition of carbonate fraction*: all concentration values reported (unless for Mg) were obtained on 1 g powdered sample, dissolved by acid treatment and analyzed by ICP-OES (the lettering 'nd' means not determined i.e. the value is below the detection limit of 10 ppm). These values have to be interpreted as averaged concentrations of the sample. Mg values are obtained by averaging 5 punctual analyses collected on calcite crystals by SEM-EDS.

All the figures concerning sections 7, 8 and 9 of the single entries can be found at the end of the catalogue (Appendix I).

MRSN Catalogue number: M/U16701

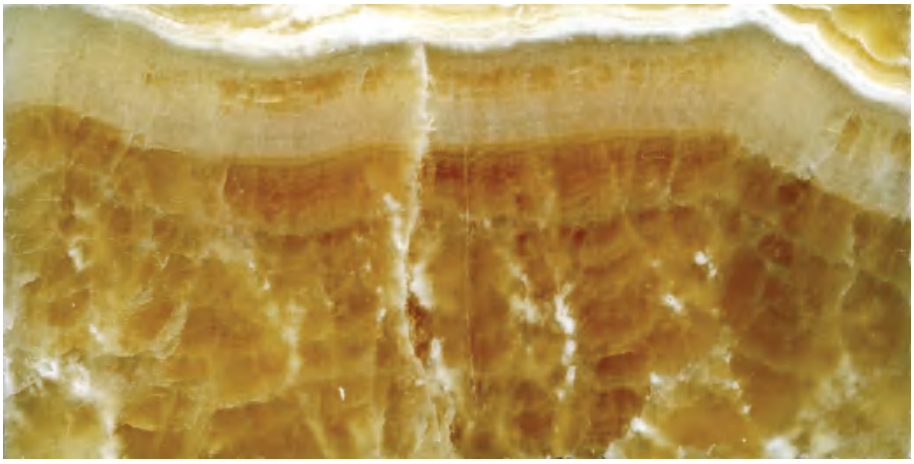

Fig. 1A

Commercial name: Alabastro Egiziano - Egyptian Alabaster

Petrographic classification: calcite-alabaster

Provenance: [Egypt]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the rock is composed of elongated calcite crystals oriented nearly perpendicularly to the growing surface; the colour of calcite layers is honey-yellow and a parallel banded structure is easily recognizable. Presence of few small cracks filled with white fine grained calcite.

Other mineral phases: Rare inclusions of hematite (Fig. 1B - small white rounded crystals, SEM-BSE image) and muscovite.

Translucence and UV fluorescence info: translucent; white secondary calcite fluoresces in light blue (Fig. 1C)

Colour: mainly 10YR8/6 with N9 veins

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16701	52.74	2.55	<1%	20	3970	nd	nd	200	50	nd

MRSN Catalogue number: M/U16702

Fig. 2A

Commercial name: Alabastro Persiano - Persian Alabaster

Petrographic classification: calcite-alabaster

Provenance: Central America

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the specimen is light brown with a radial banded structure, typical of speleothems, in which a stalactite/stalagmite arrangement is recognizable. It is composed of calcite; in thin section, the sweeping extinction across several individuals gives a *feathered* aspect to the crystals (Fig. 2B, cross polars). The calcite fabric is *elongated columnar* type, with crystals preferentially growing along the c-axis. This fabric suggests that probably calcite precipitated under high pH condition of the feeding water (Frisia et al 2010).

Other mineral phases: presence of hematite inclusions (Fig. 2C - small white crystals on calcite background, SEM-BSE image)

Translucence and UV fluorescence info: translucent; light yellow UV fluorescence.

Colour: principal colours are 10YR7/4, 10YR8/4, 10YR8/2 and N9

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16702	54.35	1.43	<1%	nd	210	nd	nd	nd	40	nd

MRSN Catalogue number: M/U16703

Fig. 3A

Commercial name: Onice Ambra extra - Amber extra Onyx

Petrographic classification: calcite-alabaster

Provenance: [Middle East]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: the main component is calcite, yellowishorange in colour. The slab is cut nearly perpendicular to the concretion growth surface, imparting a *cloudy* aspect to the specimen. The layered structure is compact and fine grained.

Other mineral phases: rare inclusions of barite (Fig. 3B - sub-rounded white crystal, SEM-BSE image) and strontianite.

Translucence and UV fluorescence info: translucent; not fluorescent in ultraviolet light.

Colour: shading from 10YR8/6 to 10YR6/6, N9 veinlets

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16703	54.07	1.49	<1%	nd	2480	nd	nd	800	50	nd

MRSN Catalogue number: M/U16704

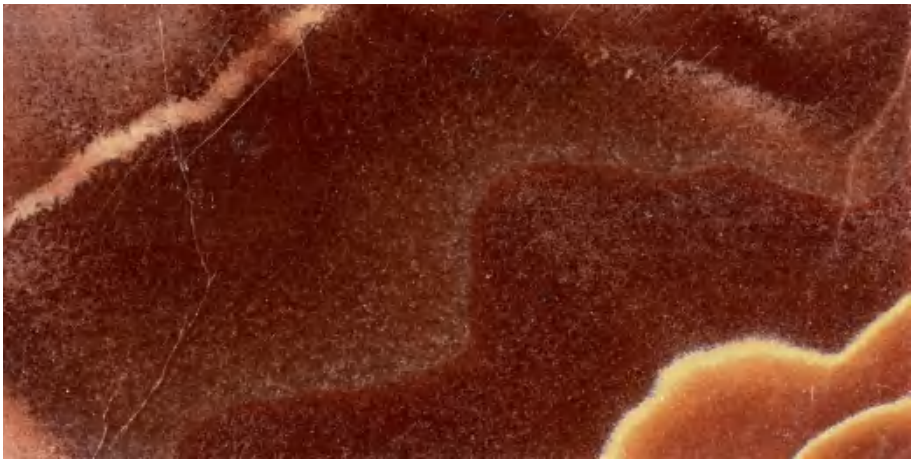

Fig. 4A

Commercial name: Onice Ametista extra - Amethist extra Onyx

Petrographic classification: calcite-alabaster

Provenance: Africa

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: banded structure, alternating deep red and orange layers of calcite. The particular colour is due to numerous micro-inclusion of iron oxides (probable of detrital origin, because of their rounded shape); in figure 4B (thin section picture, plane polars), hematite round inclusions of 2-4 mm of diameter are shown. In thin section one can see how the fabric changes from layer to layer. In figure 4C (thin section picture, cross polars) three different fabrics are distinguished: A) (top left) mosaic fabric: anhedral crystals are recognizable. Crystal mean diameter around 70mm. B) (middle) micritic fabric crystals few mm wide. In both cases individuals do not show any preferred elongation C) microcrystalline columnar fabric: crystals have a length/width ratio less than 6/1; they show irregular boundaries, extinction domains where crystallites may not have grown in optical continuity with the substrate. These three kind of fabrics suggest a probable high growth speed rate.

Other mineral phases: hematite and other iron oxides/hydroxides, manganese oxides.

Translucence and UV fluorescence info: the sample is not translucent and does not fluoresce in UV light, likely because of the presence of iron ions which are luminescence inhibitors in calcite.

Colour: background is 5R2/6 and 5R3/4, layers are 10YR8/6 and 5YR5/6

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16704	52.11	1.43	1.98	nd	3230	nd	nd	600	18050	3900

MRSN Catalogue number: M/U16705

Fig. 5A

Commercial name: Onice Arco Iris cc - Arco iris Onyx cc

Petrographic classification: calcite-alabaster

Provenance: Middle East [Iran]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: homogeneous, ivory coloured sample composed of coarse grained calcite. Crystals are cut perpendicularly to the elongation direction, showing a sub-rounded section. This sample belongs to the same "onyx" variety of M/U16706 (vein cut).

Other mineral phases: rare inclusions of Mn oxides and compounds.

Translucence and UV fluorescence info: translucent; strong pink fluorescence that could be due to the presence of Mn^{2+} ions (Fig. 5B).

Colour: 5Y8/1 and 5Y8/4

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16705	54.01	1.61	<1%	nd	590	nd	nd	nd	44	2930

MRSN Catalogue number: M/U16706

Fig. 6A

Commercial name: Onice Arco Iris vc - Arco iris Onyx vc

Petrographic classification: calcite-alabaster

Provenance: Middle East [Iran]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: banded structure, alternating thin dark bands and wide clear layers (see M/U16705). Whitish bands are composed of almost pure calcite while dark bands are full of detrital inclusions. In thin section, crystal show acicular fabric and are grouped in extinction domains (Fig. 6B, thin section picture, cross polars). The elongation of the individuals is along c-axis, lamination is not visible in acicular aggregates. Dark layers may suggest the occurrence of growth hiatuses, evidences show that this type of fabric develops when some periods of dryness occur during the 'speleothems' accretion (Frisia et al. 2010).
This sample belongs to the same "onyx" variety of M/U16705 (cross cut)

Other mineral phases: fluorapatite (Fig. 6C - in the centre of the picture, the fluorapatite crystal has a rounded shape, the background calcite is not compact as deduced by the presence of black areas corresponding to pores, SEM-BSE image), Mn oxides/hydroxides and compounds, Fe sulfate.

Translucence and UV fluorescence info: lighter bands are translucent and have a pink fluorescence (high Mn^{2+} content), while some not translucent bands have a lower mean quantity of Mn^{2+} implying a bluish fluorescence (Fig. 6D).

Colour: broader bands are N8, N9, N4, 5Y7/2, 10YR7/4, thinner bands are N1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16706	53.92	1.80	<1%	nd	900	nd	nd	nd	110	1490

MRSN Catalogue number: M/U16707

Fig. 7A

Commercial name: Onice Bianco - White Onyx

Petrographic classification: calcite-alabaster

Provenance: [Middle East]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: white homogeneous sample, composed of compact, fine-grained calcite; cut perpendicularly to the stratification; cloudy aspect.

Other mineral phases: iron oxides and hydroxides.

Translucence and UV fluorescence info: translucent; strong blue fluorescence despite the high Fe content (Fig. 7B).

Colour: N9 and 5G8/1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16707	53.62	0.70	1.51	54	1890	nd	nd	45	12100	840

MRSN Catalogue number: M/U16708

Fig. 8A

Commercial name: Onice Bianco extra - Extra white Onyx

Petrographic classification: calcite-alabaster

Provenance: [Middle East]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: pure white colour, extremely compact and fine grained. It is composed of calcite with banded structure and cloudy aspect.

This sample is a finest variety of M/U16707

Other mineral phases: iron compounds.

Translucence and UV fluorescence info: translucent; strong homogeneous blue UV fluorescence (Fig. 8B).

Colour: N9 and 5Y8/1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16708	53.81	0.87	1.33	nd	1580	nd	nd	nd	9600	400

MRSN Catalogue number: M/U16709

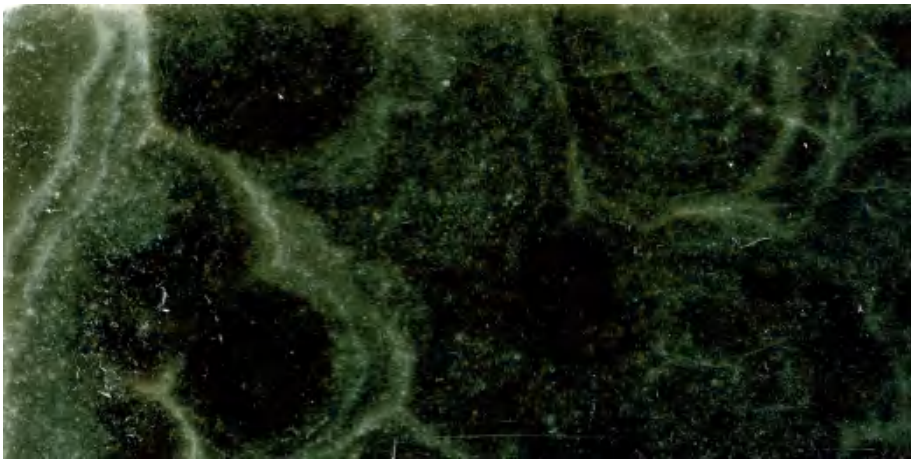

Fig. 9A

Commercial name: Onice Black - Black Onyx

Petrographic classification: calcite-alabaster

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 1.8 cm), cross cut, polished surface.

Description: banded structure, uncommon greenish black colour, fine-grained calcite crystals having milky appearance in the polished slab. In thin section (Fig. 9B, crossed-nicols picture) the fabric of crystals is recognizable as open columnar, because of the length/width ratio of crystals (around 6:1); presence of micro-pores and the uniform extinction of domains are attributes of this fabric.

Other mineral phases: rare fluorite inclusion (Fig. 9C - SEM-BSE image).

Translucence and UV fluorescence info: not translucent; not fluorescent.

Colour: 5G2/1, 5Y2/1 with 5Y6/1 veins

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16709	54.61	1.19	<1%	nd	2320	nd	nd	nd	260	720

MRSN Catalogue number: M/U16710

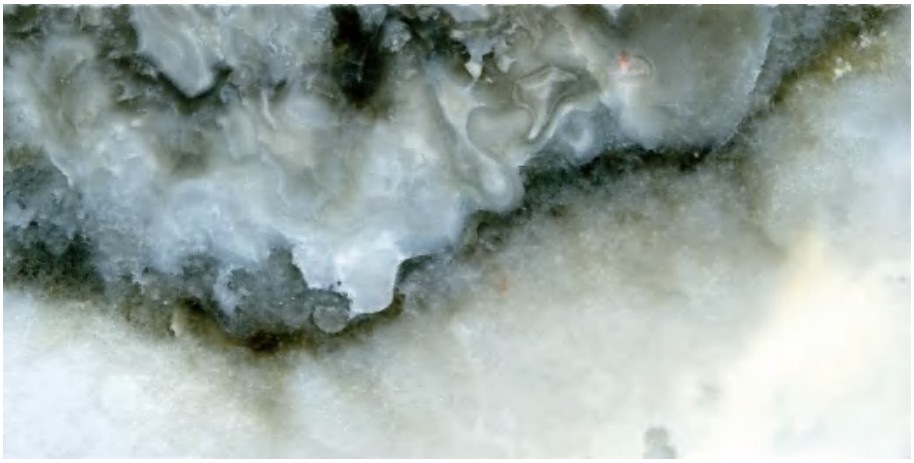

Fig. 10A

Commercial name: Onice Blue grey - Blue grey Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: the specimen presents a cloudy aspect because of its cutting direction. It is composed of white and bluish grey calcite stratifications forming a banded structure. It is finegrained with a low porosity.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: partially translucent; weak uniform bluish fluorescence (Fig. 10B).

Colour: N3, N5, 5Y6/1 on N8 and N9 background

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16710	54.22	1.49	<1%	55	450	nd	nd	nd	30	70

MRSN Catalogue number: M/U16711

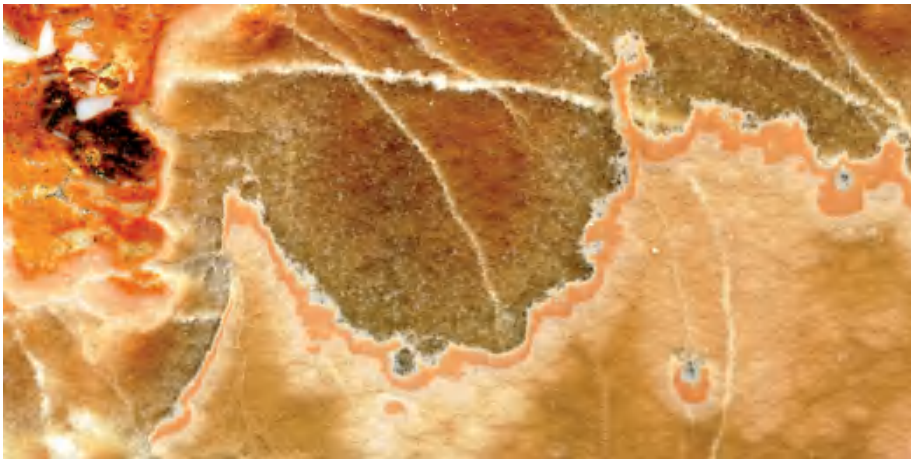

Fig. 11A

Commercial name: Onice Brecciato - Breccia Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: the sample has peculiar structure and colours. Despite the heterogeneity of the specimen, it is composed of almost pure calcite. Pink fine-grained stratifications are recognizable on a medium-grained orange background. Presence of oriented and parallel cracks, filled with white secondary calcite.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: not translucent; pink bands are bright red in fluorescent light (Mn^{2+} ions in calcite) (Fig. 11B)

Colour: stratifications are identified by 10R6/4, 5YR6/4, 5YR8/4 on a 10YR5/4 and 5YR5/6 background, N9 veins

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16711	54.84	0.86	<1%	nd	1680	nd	nd	1300	400	80

MRSN Catalogue number: M/U16712

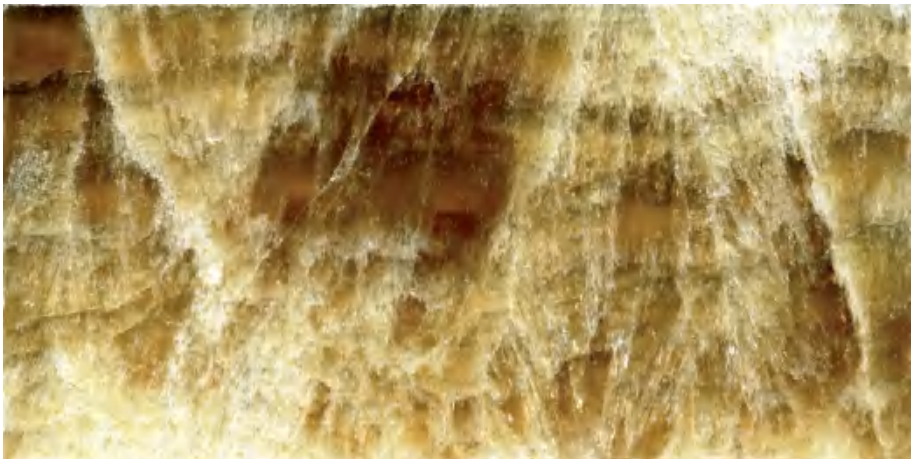

Fig. 12A

Commercial name: Onice Brown - Brown Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the sample is light brown, elongated crystals of calcite are disposed in layers of variable thickness. Colour is probably due to the presence of organic acids (mainly humic and fulvic acids).

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; weak uniform yellowish fluorescence that strongly suggests the presence of organic acids (Fig. 12B).

Colour: 10YR6/6 and 10YR8/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16712	54.87	1.01	<1%	30	370	nd	nd	nd	30	710

MRSN Catalogue number: M/U16713

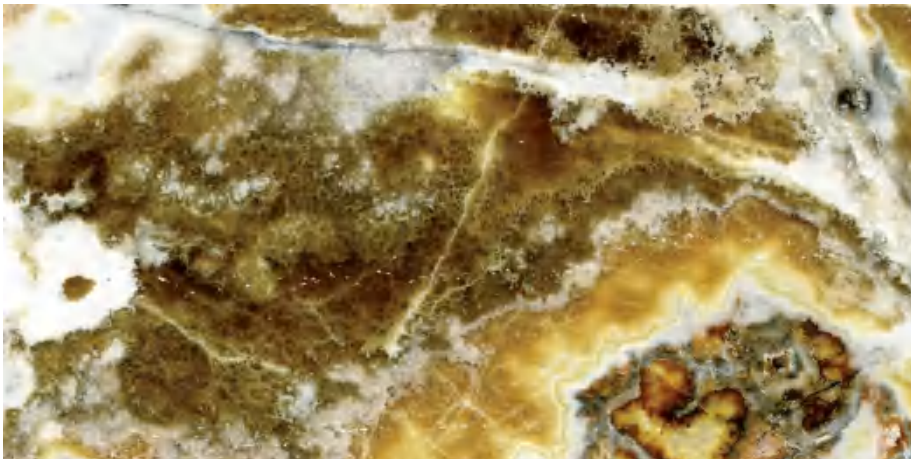

Fig. 13A

Commercial name: Onice Canyon cc - Canyon Onyx cc

Petrographic classification: calcite-alabaster

Provenance: [United States]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: heterogeneous sample that displays brown, orange and white, concentric stratifications of different grain size. It is mainly composed of calcite and characterized by presence of many mineral inclusions, especially in darker bands.

This sample belongs to the same "onyx" variety of M/U16714 (vein cut)

Other mineral phases: barite, hematite and other iron oxides and hydroxides, Mn compounds (Fig. 13B - iron and manganese oxides on homogeneous background of calcite; barite is the white mineral, SEM-BSE image).

Translucence and UV fluorescence info: not translucent; partially fluorescent, white calcite fluoresce in red while brown bands have a yellow fluorescence.

Colour: stratifications identified by 5Y7/2, 10YR6/2, 5YR2/1, 5G2/1, 10YR8/6 and 5YR4/4

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16713	55.17	0.63	<1%	1750	1240	nd	nd	nd	1240	6400

MRSN Catalogue number: M/U16714

Fig. 14A

Commercial name: Onice Canyon vc - Canyon Onyx vc

Petrographic classification: calcite-alabaster

Provenance: [United States]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: heterogeneous sample that displays brown, orange and white concretions of different grain size. It is composed of calcite and characterized by presence of many mineral inclusions mainly in darker bands. It is compact, but there are cracks of variable size filled with white micritic calcite.

This sample belongs to the same "onyx" variety of M/U16713 (cross cut)

Other mineral phases: barite, hematite and other iron oxides and hydroxides, Mn compounds.

Translucence and UV fluorescence info: not translucent; fluorescent, white calcite fluoresce in blue while brown bands have a yellow fluorescence (Fig. 14B).

Colour: concretions of N9, 10YR5/4, 10YR4/2, 10YR7/4 colours

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16714	55.75	0.24	<1%	nd	250	nd	nd	nd	890	700

MRSN Catalogue number: M/U16715

Fig. 15A

Commercial name: Onice Cappuccino - Cappuccino Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: composed of pure calcite, the specimen is homogeneous, honey-yellow in colour. The cross cut gives a cloudy aspect. Colour is probably due to the presence of organic acids (mainly humic and fulvic acids).

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; light blue and yellowish fluorescence indicating the distribution of organic acids in calcite layers (Fig. 15B).

Colour: shades of 10YR8/6 and 10YR8/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16715	55.33	0.51	<1%	nd	nd	nd	nd	nd	40	650

MRSN Catalogue number: M/U16716

Fig. 16A

Commercial name: Onice Caramel - Caramel Onyx

Petrographic classification: calcite-alabaster

Provenance: [Turkey]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: composed of brownish-yellow calcite layers. It is fine grained and its crystals are elongated perpendicularly to the stratification.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; dark red fluorescence due to the high manganese content (Fig. 16B).

Colour: 10YR6/6, 10YR8/6 and 10YR8/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16716	54.83	0.58	<1%	nd	160	240	nd	3650	30	6170

MRSN Catalogue number: M/U16717

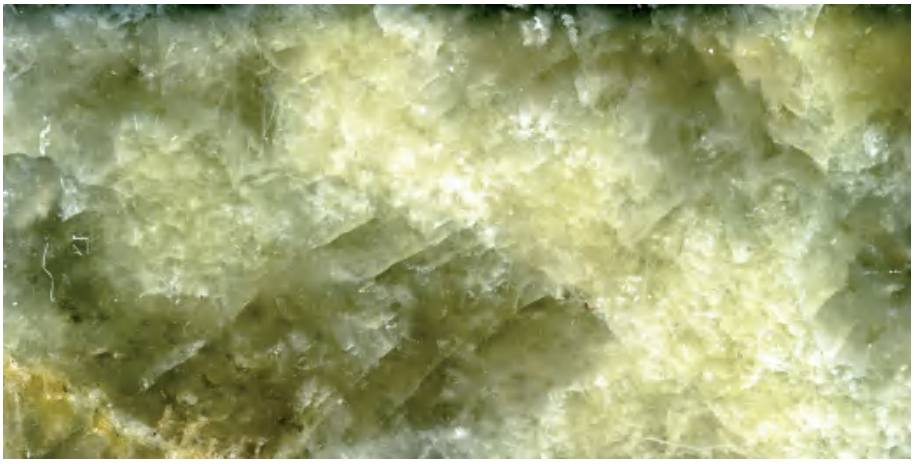

Fig. 17A

Commercial name: Onice cristallo - Crystal Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: rock of medium-sized grains, characterized by parallel bands of elongated calcite crystals cut through the growth direction. The structure is compact with small oriented cracks, probably due to cutting process. The cracks and voids are filled with a transparent resin.

Other mineral phases: iron oxides and hydroxides

Translucence and UV fluorescence info: translucent; a uniform strong blue UV fluorescence denoting a homogeneous composition (Fig. 17B)

Colour: 5Y8/4 and 5Y8/1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16717	53.59	0.53	1.94	nd	nd	nd	nd	nd	12700	620

MRSN Catalogue number: M/U16718

Fig. 18A

Commercial name: Onice cristallo striato - Banded crystal Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: parallel bands of elongated calcite crystals, with alternating yellowish and whitish layers. Crystal size is bigger in darker bands, presence of a big crack that crosses the specimen.

This sample is a finest variety of M/U16717.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; light blue UV fluorescence, one can notice the presence of brownish bands where organic acids are more concentrated (Fig. 18B).

Colour: N9, 10YR8/2, 10YR8/4

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16718	55.37	0.53	<1%	nd	710	nd	nd	nd	20	430

MRSN Catalogue number: M/U16719

Fig. 19A

Commercial name: Onice egeo - Aegean Onyx

Petrographic classification: travertine

Provenance: [Turkey]

Cutting and finishing: rectangular slab (13 x 7.5 x 1.8 cm), vein cut, polished surface.

Description: the specimen is unusual because of the presence of a thick brown band in the lower part of the sample. In the upper part, thin layers are alternating black and white colours. Though it is composed of calcite only, it is a rather heterogeneous material because of the presence of many inclusions. Dark layers are characterized by inclusions of manganese and iron compounds, white ones by fluorite and brown layers by presence of iron compounds. Calcite bands are fine-grained: brown layers are very compact, unlike the black and white ones that are porous with a great amount of cracks. Some of the voids are naturally filled with secondary calcite while others are artificially filled with two different kinds of resin, probably to improve the mechanical properties of the stone and give a better aesthetical effect.

Other mineral phases: fluorite (Fig. 19B - white particles of fluorite on gray calcite, SEM-BSE image), Mn compounds (Fig. 19C tiny inclusions of manganese oxides, SEM-BSE image), Fe oxides

Translucence and UV fluorescence info: not translucent; white layers are UV fluorescent with pink and bluish colours

Colour: in the upper part colours are N9, N3, N6, N7 - 10YR8/2; lower part is identified by 10YR4/6 and 5YR3/4

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16719	55.31	0.55	<1%	nd	520	nd	nd	nd	4540	830

MRSN Catalogue number: M/U16720

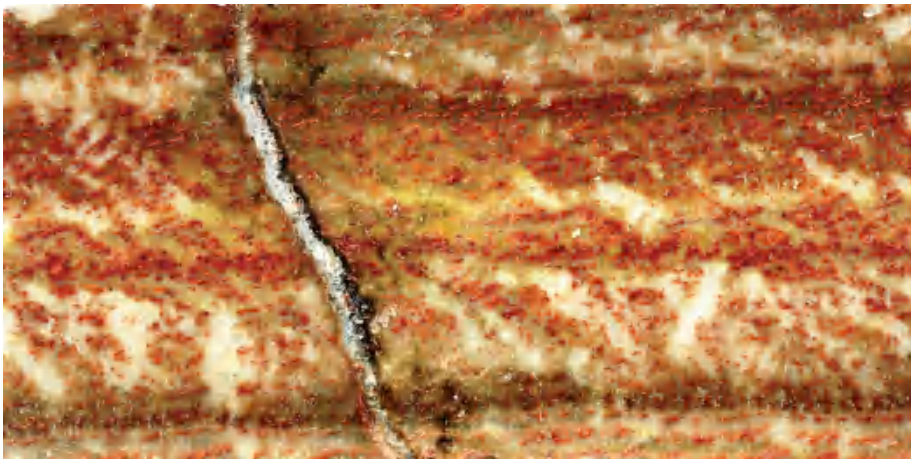

Fig. 20A

Commercial name: Onice Fantastico cc - Fantastic Onyx cc

Petrographic classification: calcite-alabaster

Provenance: Central America [Mexico]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: rock characterized by fine-grained, red layers on a whitish background. Red bands are characterized by hematite inclusions deposited between calcite layers. The rock is compact unless for a big crack that splits the specimen in two parts, filled with secondary calcite.

This sample belongs to the same "onyx" variety of M/U16721 (vein cut).

Other mineral phases: Mn compounds, hematite, unidentified arsenate (under investigation)

Translucence and UV fluorescence info: not translucent; the specimen presents a dark red UV luminescence where manganese compounds are more concentrated. The secondary calcite fluoresces in blue.

Colour: layers of 5R3/6 on a 10YR5/4, 5YR7/2, 5YR4/4, 10YR8/2 background

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16720	54.29	0.15	1.73	nd	250	nd	nd	120	1160	790

MRSN Catalogue number: M/U16721

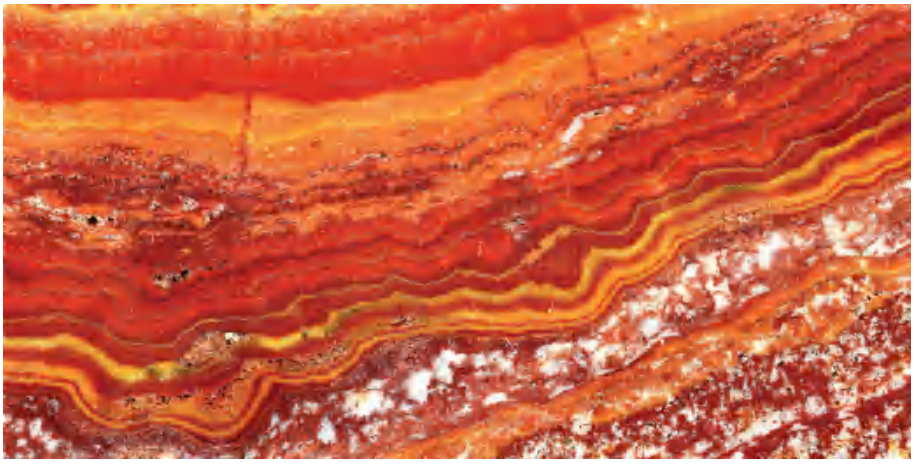

Fig. 21A

Commercial name: Onice Fantastico vc - Fantastic Onyx vc

Petrographic classification: calcite-alabaster

Provenance: Central America [Mexico]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: unusual specimen with brilliant, red, yellow and orange colours. Banded structure composed by fine-grained layers. The rock is porous, the voids are localized at the layers interface. Some of the bigger voids are filled with small crystals of white calcite. The specimen is characterized by the presence of many mineral inclusions. In thin section (Fig 21B, parallel nicols), in the lower bands short columnar fabric is recognizable while other bands show mosaic fabric with high porosity

This sample belongs to the same "onyx" variety of M/U16722 (cross cut).

Other mineral phases: hematite, manganese compounds and unidentified arsenate (under investigation)

Translucence and UV fluorescence info: not translucent; secondary calcite gives a blue luminescence

Colour: bands are of different colours N9, 5R3/4, 10YR8/6 and 10R4/6

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16721	54.82	0.08	1.25	nd	210	nd	nd	410	9210	140

MRSN Catalogue number: M/U16722

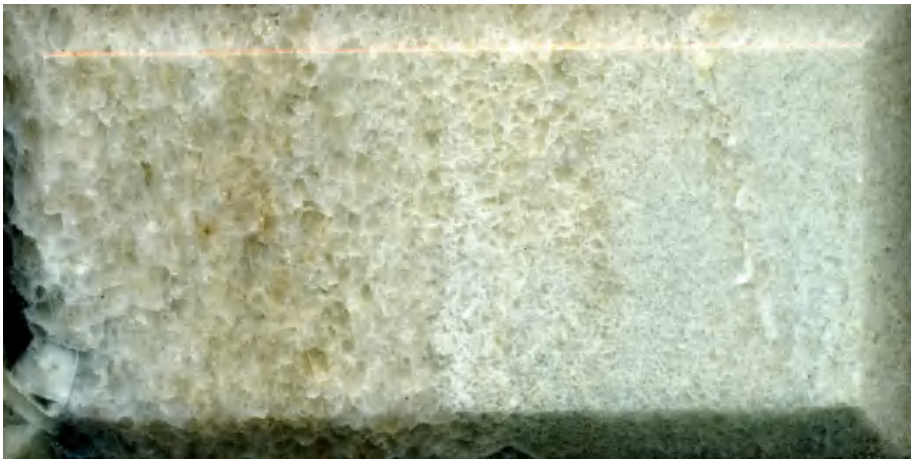

Fig. 22A

Commercial name: Onice Girasole - Sunflower Onyx

Petrographic classification: silicatic-bearing marble

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), polished surface.

Description: coarse-grained sample showing some crystals of centimetric size. Big white crystals are surrounded by some darker ones. This specimen represents one of the few metamorphic rock of the whole collection. It is composed of calcite and diopside with inclusions of talc, barite and tremolite. In thin section (Fig. 22B, crossed nicols) it can be seen that many calcite crystals are twinned. The rock is compact with no visible cracks, even under optical microscope.

Other mineral phases: diopside, talc, barite, tremolite

Translucence and UV fluorescence info: translucent; weak pink UV luminescence of calcite

Colour: N9, 10YR8/2 and N1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16722	37.74	15.11	<1%	nd	580	nd	nd	nd	290	130

MRSN Catalogue number: M/U16723

Fig. 23A

Commercial name: Onice Glaciale - Glacial Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: structure made up by nearly parallel thin calcite layers. It is fine grained, with layers having variable width. In the upper part of the sample there is a strong staining due to the oxidation of the iron compounds present as impurities, while in the lower part of the sample there are white and light blue stratifications. The rock is rather compact.

Other mineral phases: iron oxides and hydroxides

Translucence and UV fluorescence info: translucent; weak diffused pinkish luminescence (Fig. 23B)

Colour: layers are N9 alternated with 5B7/1 and 5G8/1, staining is 10YR8/6 with 5R4/6 dots

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16723	54.25	0.49	1.27	nd	1400	nd	nd	nd	7540	480

MRSN Catalogue number: M/U16724

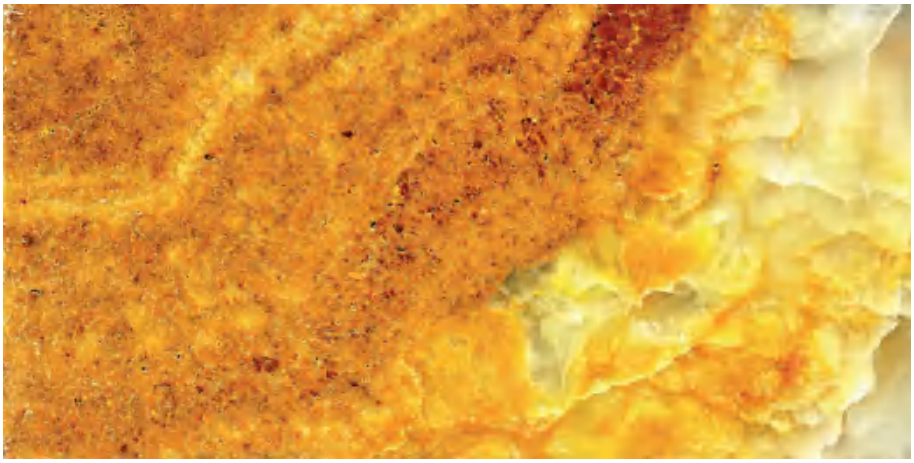

Fig. 24A

Commercial name: Onice Gold - Gold Onyx

Petrographic classification: calcite-alabaster

Provenance: [Turkey]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: the specimen colour varies from honey yellow to deep orange and has a layered structure. The grain size changes from layer to layer, reaching centimetric sixe. It is composed of calcite, characterized by the presence of detrital minerals deposited on the surface between those layers that show a higher level of porosity.

Other mineral phases: iron oxides and hydroxides

Translucence and UV fluorescence info: partially translucent; the resin utilized to fill cracks and pores luminesces in light blue (Fig. 24B)

Colour: 10YR7/6, 5YR 4/6, 10YR8/6 and 10YR8/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16724	54.28	0.69	1.00	40	2870	nd	nd	nd	7670	470

MRSN Catalogue number: M/U16725

Fig. 25A

Commercial name: Onice Honey extra - Honey extra Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: homogeneous, yellowish white sample. The structure is banded and the grain size varies from layer to layer. It is composed of calcite, which crystals are well defined and are elongated through the growth axis, perpendicular to the stratification. The rock is compact.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; light blue colour in UV light that points out some millimetric cracks, otherwise impossibleto see in visible light (Fig. 25B).

Colour: 5Y8/4 and 10YR8/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16725	54.51	1.27	<1%	nd	1330	nd	nd	520	25	nd

MRSN Catalogue number: M/U16726

Fig. 26A

Commercial name: Onice Incas extra - Incas extra Onyx

Petrographic classification: travertine

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm) cross cut, polished surface.

Description: heterogeneous sample in which brown and ochre concretions are associated to white calcite crystals. It is composed of calcite with diffuse inclusions of hematite (Fig. 26B - hematite crystals diffused in calcite background. The inset shows, at a higher magnification, the nodular structure of the metallic oxides, SEM-BSE image).

Other mineral phases: hematite

Translucence and UV fluorescence info: not translucent, white calcite fluoresces in light blue

Colour: concretions of various shades of 5YR3/4, 5YR5/6, 5R3/4 and 5YR2/2 with N9 secondary calcite crystals

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16726	49.06	0.3	7.33	nd	nd	nd	140	520	68900	370

MRSN Catalogue number: M/U16727

Fig. 27A

Commercial name: Onice Ivory - Ivory Onyx

Petrographic classification: calcite-alabaster

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the specimen shows a fine ivory colour, as suggested by the commercial name. It is composed of elongate crystals of calcite disposed in layers. In thin section (Fig. 27B, crossed nicols) columnar fabric - the most common in this type of rocks - is clearly recognizable. Characterized by a translucent appearance in thin section and a length-width ratio of crystals greater than 6:1, these crystals are elongated along the c-axis, show uniform extinction and there is a regular stacking of crystals in optical continuity. There is no visible lamination.

Other mineral phases: rare inclusions of iron oxides and manganese compounds (Fig. 27C - whitish aggregates of manganese compounds at the edge of a porous area, SEM-BSE image).

Translucence and UV fluorescence info: translucent; pinkish luminescence

Colour: 5Y9/1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16727	55.21	0.66	<1%	nd	240	nd	nd	nd	nd	1100

MRSN Catalogue number: M/U16728

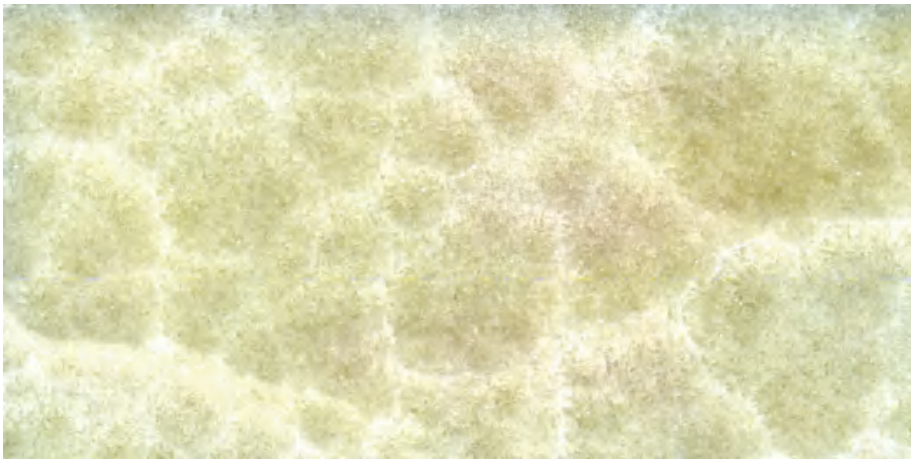

Fig. 28A

Commercial name: Onice Ivory extra - Ivory extra Onyx

Petrographic classification: calcite-alabaster

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: the specimen belongs to same variety of M/U16727 from which differs because of the cutting direction.

Other mineral phases: small muscovite inclusions

Translucence and UV fluorescence info: translucent; homogeneous pink UV fluorescence.

Colour: 5Y8/1 and N9

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16728	53.81	1.80	<1%	nd	1360	nd	nd	nd	40	1110

MRSN Catalogue number: M/U16729

Fig. 29A

Commercial name: Onice Jade - Jade Onyx

Petrographic classification: travertine

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the rock shows a layered structure with brown and yellow bands alternated to lighter layers. It is composed of calcite mixed with aragonite (only sample in the whole collection to present both calcium carbonate phases). Many layers are characterized by the presence of inclusions, some of them of detrital origin. The structure is heterogeneous, some layers are compact, while in others big pores can occur (the latter were artificially filled with resin to smooth the polished surface). There are many cracks naturally filled with white secondary calcite. The calcite/aragonite fabrics vary with the layer, a clue of fast rate changing conditions. In the picture (Fig. 29B, thin section, parallel nicols) three different kinds of layers are visible. From the top: a dark red layer of an unknown arsenate (a mineral of tricky identification which is still under investigation, see M/U16720-21) deposited in the empty spaces between crystals forming a dendritic-like texture. In the middle, aragonite needles form fan fabric crystals. These are translucent in thin section and show two termination types: square or straight edged (right) and acute or sharp edged (on the left). Aragonite crystals are elongated and radiate outwards from a central nucleus. At the bottom of the picture, mosaic fabric calcite crystals are present with no preferred elongation direction and almost anhedral shape. This fabric is commonly found as a replacement of ray and acicular fabrics of aragonite crystals. It is the most clear diagenetic fabric in speleothems (Frisia 2010)

Other mineral phases: most frequent inclusions are: hematite, strontianite, dolomite, manganese and iron compounds (Fig. 29C - concretions of iron and manganese oxides in calcite, SEM-BSE image), copper oxide and smithsonite.

Translucence and UV fluorescence info: not translucent; under UV light only secondary calcite gives a weak bluish luminescence

Colour: layers are described by these colours 5YR4/4, 5YR8/4, 5YR2/2, 10R4/2, 10R6/2,10YR8/2, 10YR6/6 and N8

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16729	51.99	1.41	2.18	nd	5970	60	nd	200	20300	1720

MRSN Catalogue number: M/U16730

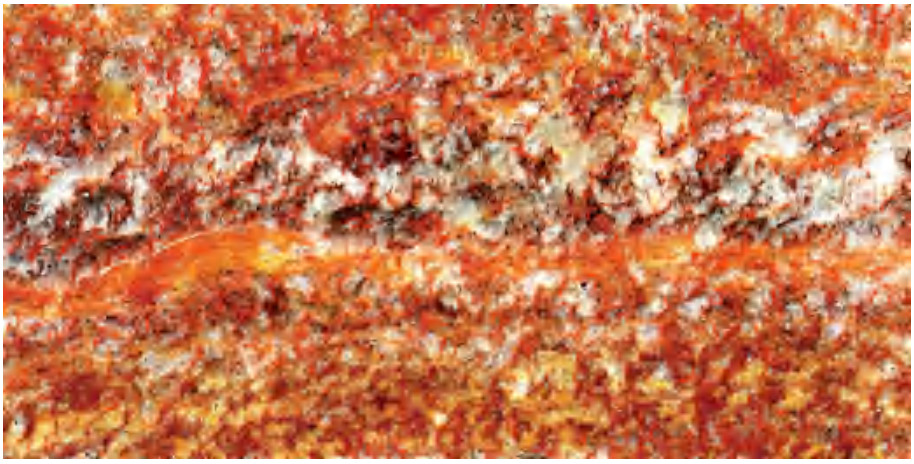

Fig. 30A

Commercial name: Onice Jasper - Jasper Onyx

Petrographic classification: calcite-alabaster

Provenance: Central America

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: stratifications of red and orange layers on a white background. Fine grained and compact, it is composed of calcite. Red bands are characterized by hematite inclusions deposited between calcite layers. Some crystals of dolomite are observed in the white parts (Fig. 30B, thin section, parallel nicols). In thin section, millimetric crystals of calcite of anhedral shape , showing no preferential elongation, interlayered with reddish-brown inclusions of hematite.

Other mineral phases: hematite, dolomite (Fig. 30C - dolomite inclusion [dark grey] in calcite. White small individuals of hematite are spread in the background, SEM-BSE image).

Translucence and UV fluorescence info: not translucent; the specimen presents a weak red UV luminescence where manganese inclusions are more concentrated and maysubstitute calcium in the white calcite.

Colour: 10R3/4, 10R4/6 and 5R4/6 on a 5YR5/6 and N9 background

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16730	54.34	1.08	<1%	nd	670	nd	nd	nd	6290	500

MRSN Catalogue number: M/U16731

Fig. 31A

Commercial name: Onice Kilimangiaro - Kilimanjaro Onyx

Petrographic classification: calcite-alabaster

Provenance: [Africa - Tanzania]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the sample is honey-yellow with white bands and dark thin layers. Grain size is variable and some layers show well defined calcite crystals with short columnar habit. In darker layers hematite is present with rare rounded shaped zircon crystals, possibly of detrital origin (Fig. 31B - zircon [white dot] in a calcite fissure, SEM-BSE image).

Other mineral phases: hematite, zircon

Translucence and UV fluorescence info: translucent; diffused yellow UV luminescence due to the presence of organic acids, dark layers are not UV fluorescent while white calcite fluoresces in blue (Fig. 31C)

Colour: 5Y8/6, N9, shades of 10YR7/4 and vainlets 10R7/4 and 5Y4/1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16731	54.97	0.92	<1%	nd	890	nd	nd	830	nd	nd

MRSN Catalogue number: M/U16732

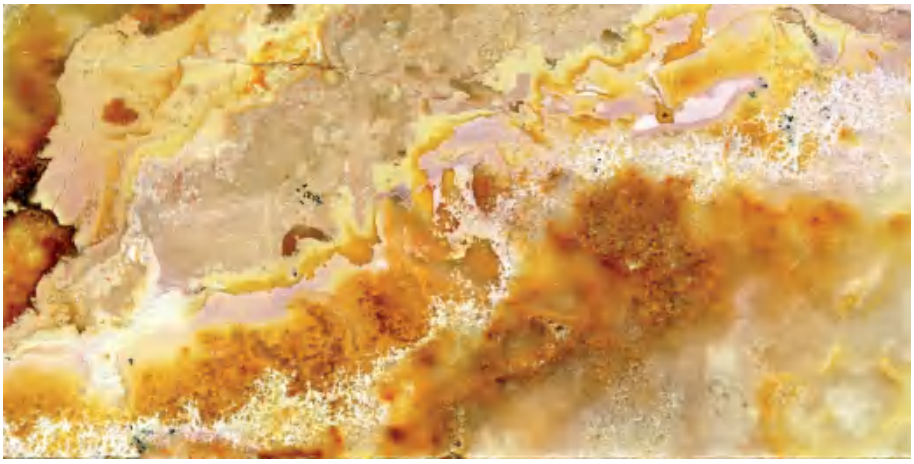

Fig. 32A

Commercial name: Onice Luna - Moon Onyx

Petrographic classification: calcite-alabaster

Provenance:[Turkey]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: peculiar sample with orange and pink layers, cut transversally to the concretion path, resulting in a cloudy effect. It is entirely composed of calcite, in which fine grained pinkish stratifications are alternated with medium grained orange ones.

Other mineral phases: small fluorite inclusions (Fig. 32B - subangular grains of fluorite, SEM-BSE image).

Translucence and UV fluorescence info: partially translucent; pink bands are bright red under fluorescent light while orange layers are yellowish in colour (Fig. 32C).

Colour: stratifications of various colours as 10YR8/6 shaded 10YR6/6, 5Y8/4, 5R8/2, 10R8/2, 5RP8/2, N9 and N1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16732	55.61	0.16	<1%	nd	1430	nd	nd	nd	700	130

MRSN Catalogue number: M/U16733

Fig. 33A

Commercial name: Onice Matisse - Matisse Onyx

Petrographic classification: calcite-alabaster

Provenance: Central America

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the sample shows a brecciated structure, pink and red-layered clasts are surrounded by yellowish secondary calcite. Some thin cracks cross the specimen, possibly deriving from the industrial cutting process. In figure 33B (thin section, parallel nicols), short columnar fabric in clear calcite layers with visible lamination is displayed. Crystals show uniform extinction under crossed nicols and the length/width ratio is less than 6:1. This type of fabric is characterized by the presence of few defects, with flat faces prevailing (spiral growth mechanisms); this suggests a slow rate growth in an equilibrium environment (Frisia, 2010). Alternated with clean layers, reddish bands are very fine-grained showing micritic fabric, whose crystals do not have preferred elongation forming tiny aggregates of sub-euhedral crystals (around 10-15 μm in diameter). The structure of this rock suggests the occurrence of a huge stress event that led to the formation of a brecciated structure. As seen in figure 33C (thin section, parallel nicols), in the empty spaces between the clasts precipitated and non-elongated crystals having an average diameter of 250 μm can be observed.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; under UV light clasts are pinkish while the background is yellow, suggesting a change in the environmental conditions before and after the stress episode (Fig. 33D).

Colour: 10YR8/6 and 5Y8/1 background, layered clasts are 10R7/4, 10R6/2, 10R4/6, 5R4/6 and 5YR8/1 in colour

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16733	55.53	0.49	<1%	nd	450	nd	nd	1460	60	nd

MRSN Catalogue number: M/U16734

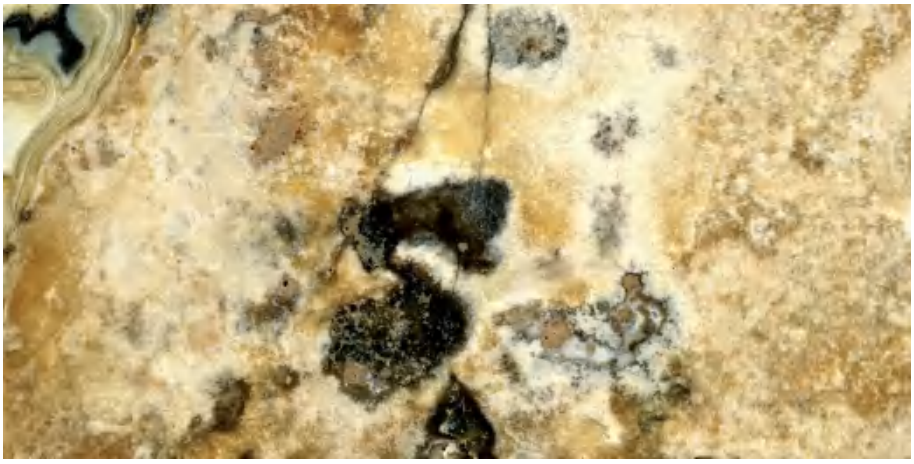

Fig. 34A

Commercial name: Onice Mediceo cc - Medicean Onyx cc

Petrographic classification: calcite-alabaster

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: heterogeneous sample with brown, orange and white concentric concretions of variable grain size. It is composed of calcite but mineral inclusions in darker bands are present. It is compact unless for some small cracks filled with secondary calcite. In thin section, milky small crystals can be identified with a microcrystalline fabric. Crystals have irregular boundaries and a length/width ratio of less than 6:1, except for some layers where elongated crystals occur. In figure 34B (thin section, crossed nicols) crystals aggregating around a layer composed of small micritic individuals are shown. The aggregate bends on itself, forming a stalactitic-like structure. Layers of acicular crystals with needle-like terminations are well visible while, in the lower part of the picture, a mosaic-like fabric is distinguishable.

This sample belongs to the same "onyx" variety of M/U16735 (vein cut).

Other mineral phases: manganese compounds

Translucence and UV fluorescence info: not translucent; secondary calcite fluoresces under UV light in pink-red and brownish bands in yellow

Colour: 10YR8/2, 10YR6/2, 10YR7/4, 10YR4/2 and 10YR3/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16734	54.61	1.21	<1%	nd	1460	nd	nd	nd	140	1050

MRSN Catalogue number: M/U16735

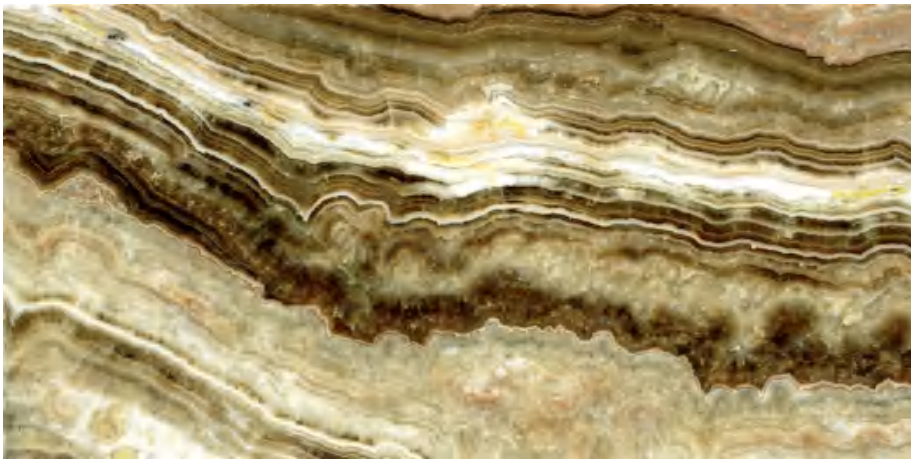

Fig. 35A

Commercial name: Onice Mediceo vc - Medicean Onyx vc

Petrographic classification: calcite-alabaster

Provenance: middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: heterogeneous sample, showing brown and whitish bands of different grain size. It is composed of calcite and characterized by nearly parallel layers of variable thickness. It is a compact stone.

This sample belongs to the same "onyx" variety of M/U16736 (cross cut).

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: clearer layers are translucent; under UV light, brown bands fluoresce in yellow (Fig. 35B)

Colour: banded with 10YR8/2, 10YR6/2, 10YR5/4, 5YR8/4 and N9 colours

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16735	54.52	1.29	<1%	nd	1280	nd	nd	nd	400	nd

MRSN Catalogue number: M/U16736

Fig. 36A

Commercial name: Onice Miele cc - Honey Onyx cc

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: homogeneous sample, yellowish white in colour, with a banded structure. Grain size varies from layer to layer, but in general calcite crystals are millimetric to centimetric in size. It is composed of almost pure calcite, with well defined crystals elongated through their growth axis. The rock is compact and does not have detected inclusions.

This sample belongs to the same "onyx" variety of M/U16737 (vein cut).

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; under UV light the sample is yellowish with some darker bands, probably due to the different concentrations of organic acids (Fig. 36B).

Colour: 5Y8/4 shaded 5Y8/1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16736	54.86	0.93	<1%	nd		nd	nd	1200	nd	nd

MRSN Catalogue number: M/U16737

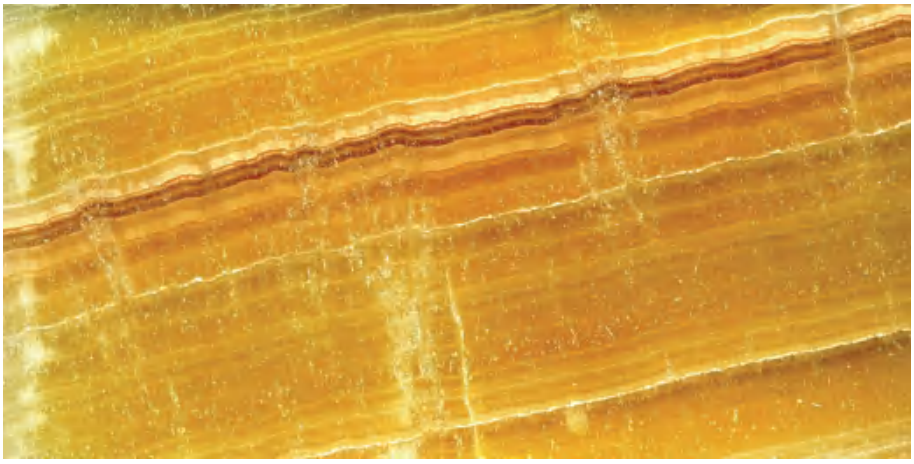

Fig. 37A

Commercial name: Onice Miele vc - Honey Onyx vc

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the specimen has a banded structure, with almost parallel layers of yellowish calcite. Crystals are elongated through their growth axis.

As suggested by its commercial name, this sample should belong to the same "onyx" variety of M/U16736 (cross cut), despite some petrographic and chemical discrepancies.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; weak yellowish UV-fluorescence (Fig. 37B)

Colour: 10YR8/6 with 5YR6/4 and N9

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16737	55.02	0.86	<1%	nd	1550	nd	nd	200	40	nd

MRSN Catalogue number: M/U16738

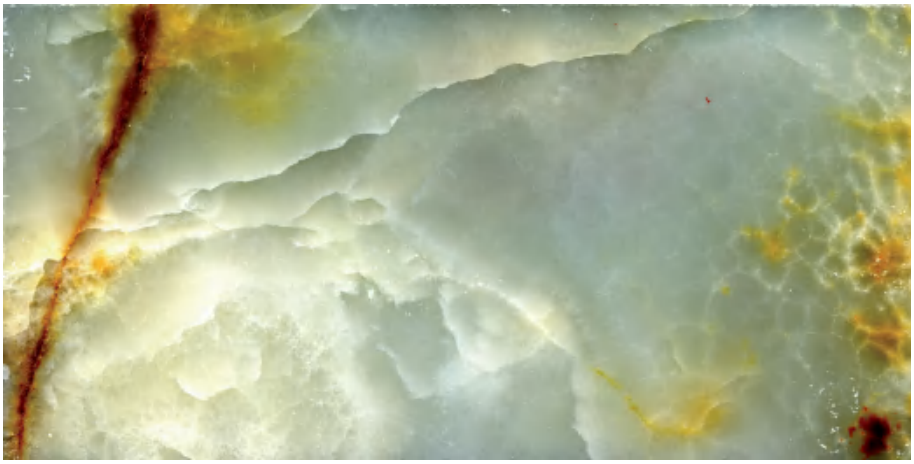

Fig. 38A

Commercial name: Onice Mirafiori - Mirafiori Onyx

Petrographic classification: calcite-alabaster

Provenance: [Afghanistan]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: the sample displays calcite concretions cut perpendicular to the accretion direction. White and light-blue layers are alternated and fine grained. Near the edges of the slab, there is a strong staining due to the oxidation of the iron compounds present as impurities. The rock is compact.

Other mineral phases: hematite

Translucence and UV fluorescence info: translucent; weak diffused pink UV luminescence (Fig. 38B)

Colour: 10Y8/2 and 10GY7/2 background with 10YR8/6 and 10YR6/6 staining

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16738	53.38	0.84	<1%	nd	120	nd	nd	nd	16400	880

MRSN Catalogue number: M/U16739

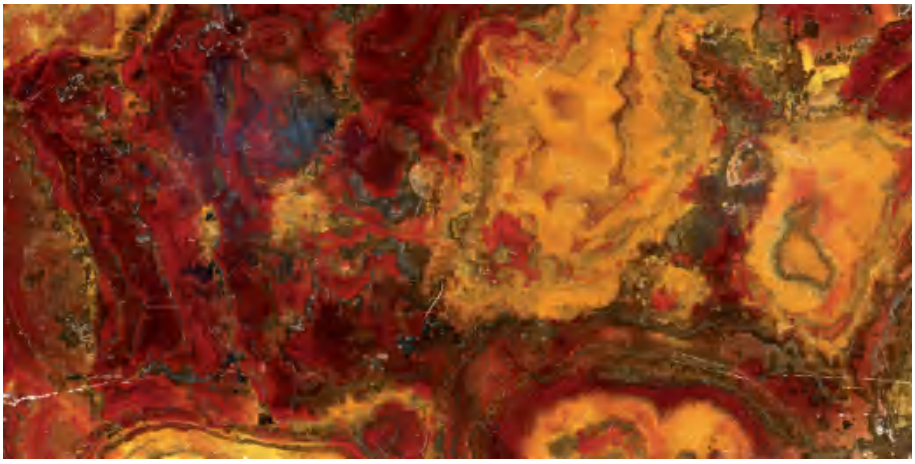

Fig. 39A

Commercial name: Onice Multicolour Pakistano - Multicolour Pakistan Onyx

Petrographic classification: calcite-alabaster

Provenance:[Pakistan]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.5 cm), cross cut, polished surface.

Description: banded fabric with deep red and orange concentric layers. It is composed of calcite, with abundant micro-inclusion of iron oxides which confer to the sample its characteristic colour.

Other mineral phases: celestine (Fig. 39B - celestine [white] microcrystalline aggregates in calcite, SEM-BSE image), manganese and iron compounds (Fig. 39C - nebular aggregate of iron and manganese oxide in calcite, SEM-BSE image).

Translucence and UV fluorescence info: not translucent; not fluorescent

Colour: concretions of 10R3/4, 5R2/6, 10YR6/6, 5YR3/4 and 5YR2/1 colours

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16739	49.80	0.26	5.22	nd	1320	nd	nd	100	25400	2110

MRSN Catalogue number: M/U16740

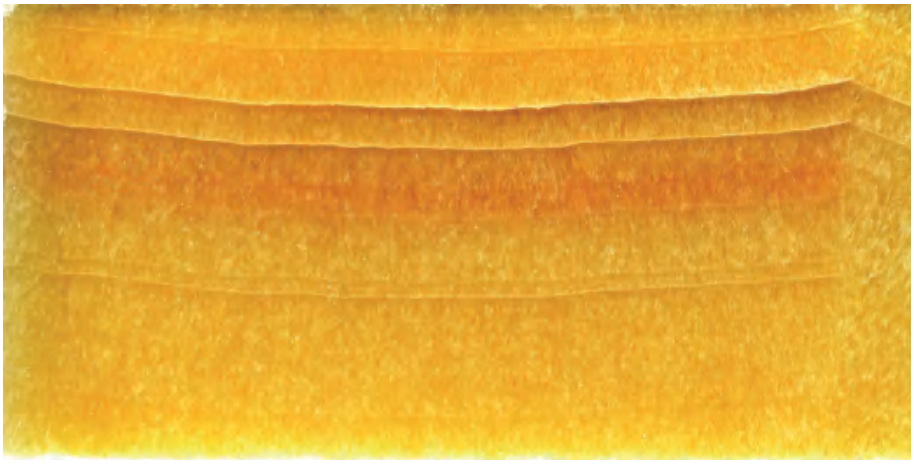

Fig. 40A

Commercial name: Onice Nuvolato extra - Cloudy extra Onyx

Petrographic classification: calcite-alabaster

Provenance: [Central America]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the specimen has a banded structure, with almost parallel layers of yellowish calcite. Crystals are elongated through the growth axis, perpendicular to the banding direction.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; weak yellowish UV fluorescence

Colour: 10YR8/6 shaded 10R6/6, 5Y8/1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16740	54.35	1.43	<1%	nd	3310	nd	nd	480	nd	nd

MRSN Catalogue number: M/U16741

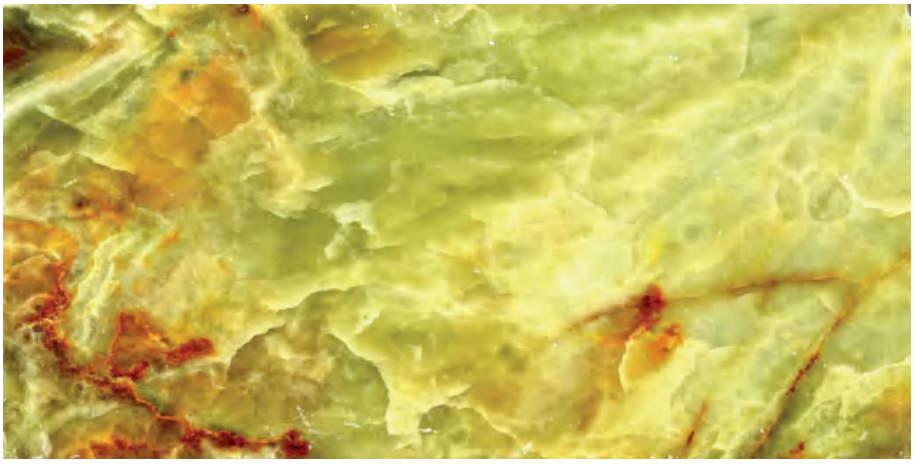

Fig. 41A

Commercial name: Onice Pakistano - Pakistan Onyx

Petrographic classification: calcite-alabaster

Provenance:[Pakistan]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: calcite concretions are cut perpendicular to the accretion direction. It is fine grained, with greenish layers having a cloudy aspect. Near the edges of the sample, there are some small cracks where strong staining due to the oxidation of the iron compounds (present as impurities) occurs.

Other mineral phases: iron compounds

Translucence and UV fluorescence info: translucent; not UV-luminescent likely because of the relatively high iron content

Colour: 5GY7/4, 5GY7/2 with 5YR5/6 staining

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16741	53.47	0.52	1.90	nd	3310	nd	nd	120	22550	2650

MRSN Catalogue number: M/U16742

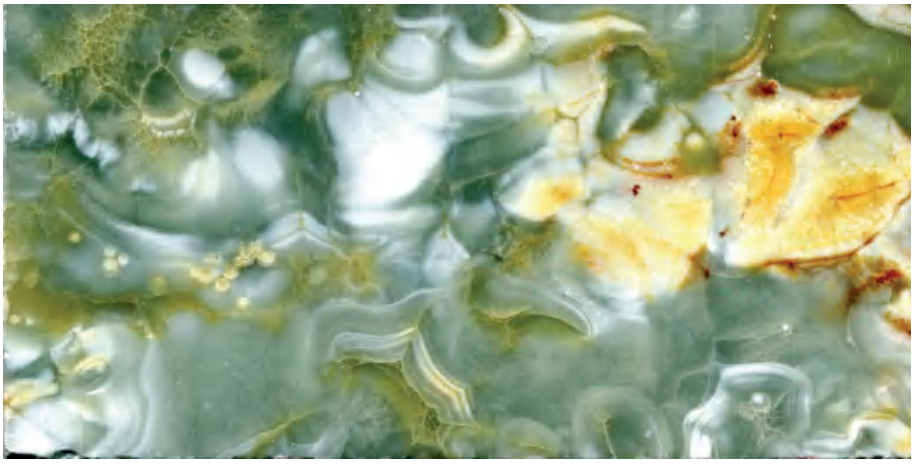

Fig. 42A

Commercial name: Onice Paradiso - Paradise Onyx

Petrographic classification: calcite-alabaster

Provenance: [Afghanistan]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: structure made up by thin calcite layers. It is fine grained, the layers have variable width. White and bluish bands are alternated, oxidation layers are present. The rock is rather compact

Other mineral phases: ilmenite, muscovite, fluorapatite

Translucence and UV fluorescence info: partially translucent; clear bands of calcite show a pink UV luminescence (Fig. 42B)

Colour: 5BG7/2, 5G6/1 and N9 bands with 10YR8/6 and 5YR5/6 oxidation layers

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16742	54.75	0.31	1.09	110	1890	nd	nd	nd	7710	830

MRSN Catalogue number: M/U16743

Fig. 43A

Commercial name: Onice Persiano top - Persian top Onyx

Petrographic classification: calcite-alabaster (?)

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: greenish white sample. Characterized by an extreme homogeneity. It is fine grained and compact.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; weak pinkish UV fluorescence

Colour: 10Y8/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16743	54.18	0.33	1.50	nd	1340	nd	nd	nd	15050	1700

MRSN Catalogue number: M/U16744

Fig. 44A

Commercial name: Onice Pink - Pink Onyx

Petrographic classification: calcite-alabaster

Provenance: [Iran]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: compact and fine grained specimen displaying a cloudy aspect due to creamy and pinkish stratifications. It is composed of fine grained calcite.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent, pinkish layers have a strong pink UV luminescence while creamy layers are weakly luminescent (Fig. 44B)

Colour: 5YR8/1 shaded 5Y8/1 and 5Y8/4

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16744	53.07	0.79	1.87	nd	940	nd	64	nd	16600	5150

MRSN Catalogue number: M/U16745

Fig. 45A

Commercial name: Onice Pink top - Pink top Onyx

Petrographic classification: calcite-alabaster

Provenance: [Iran]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: it is a finest variety of M/U 16744, compact and very fine grained with pinkish stratifications.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent, under UV light one side of the sample is fluorescent in pink while the other side fluoresces in blue (Fig. 45B), denoting a variation in calcite chemical composition

Colour: between 5YR8/1 and 10R8/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16745	55.27	0.58	<1%	nd	120	nd	60	nd	50	1100

MRSN Catalogue number: M/U16746

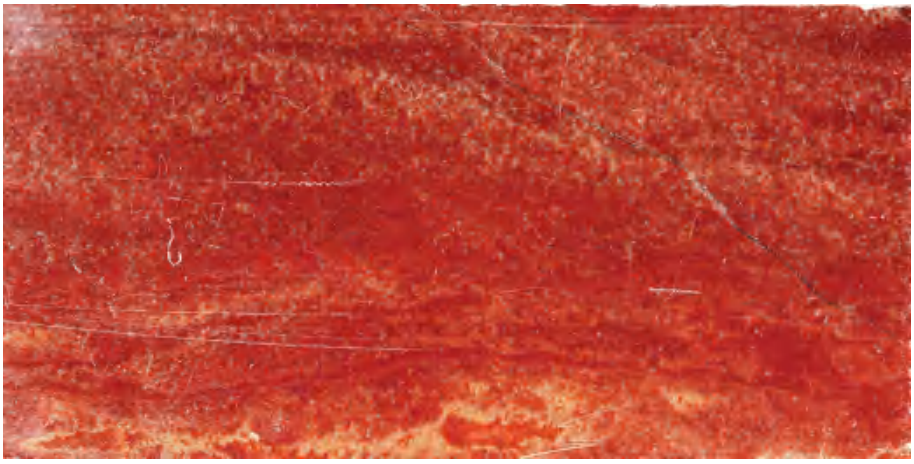

Fig. 46A

Commercial name: Onice Rosso Orientale - Oriental Red Onyx

Petrographic classification: calcite-alabaster

Provenance: [Middle East]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: red layers on a whitish background, fine grained. It is mainly composed of calcite. Red bands are characterized by hematite inclusions deposited between calcite layers. A crack crosses the sample, probably due to the industrial process of cutting or polishing.

Other mineral phases: hematite (Fig. 46B - rounded aggregate of hematite in calcite, SEM-BSE image), Mn compounds

Translucence and UV fluorescence info: not translucent; the specimen presents a very dark red UV luminescence where manganese inclusions are more present.

Colour: 5R4/6, 10R4/6, 5R2/6 crystals on 10YR8/2 background

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16746	55.42	0.21	<1%	nd	320	nd	nd	140	7110	800

MRSN Catalogue number: M/U16747

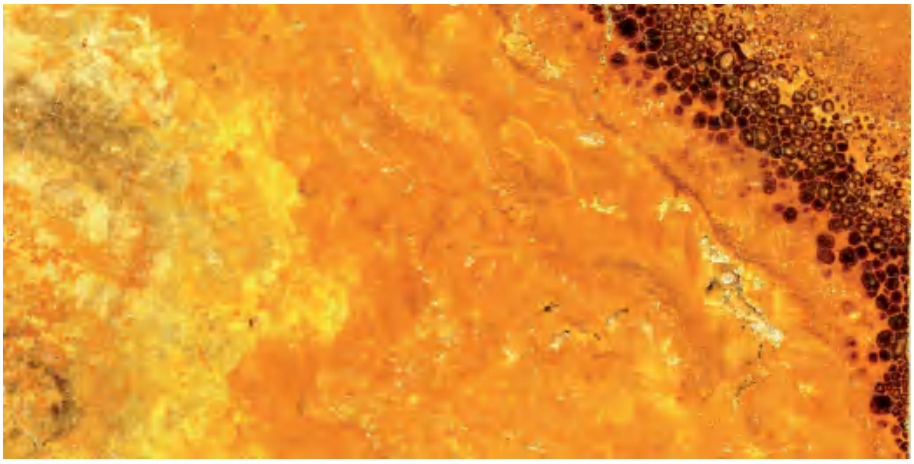

Fig. 47A

Commercial name: Onice Seta - Silk Onyx

Petrographic classification: limestone

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), polished surface.

Description: the specimen shows a golden-yellow colour. It is composed of calcite, and is quite porous. The thin section shows, radial aggregates of calcite crystal of spheroidal shape, similar to ooids or pisoids (Fig. 47B, parallel nicols)

Other mineral phases: fluorite (Fig. 47C - small crystals of fluorite [white] in calcite. The black areas are pores, SEM-BSE image), iron compounds (Fig. 47D - subangular aggregated crystals of iron oxides, SEM-BSE image).

Translucence and UV fluorescence info: not translucent; secondary calcite fluoresces in blue under UV light

Colour: 10YR6/6, 10YR8/6 and 10YR6/2 with 10YR2/2 rounded aggregates

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16747	54.04	1.3	1.01	nd	1570	nd	nd	40	10100	160

MRSN Catalogue number: M/U16748

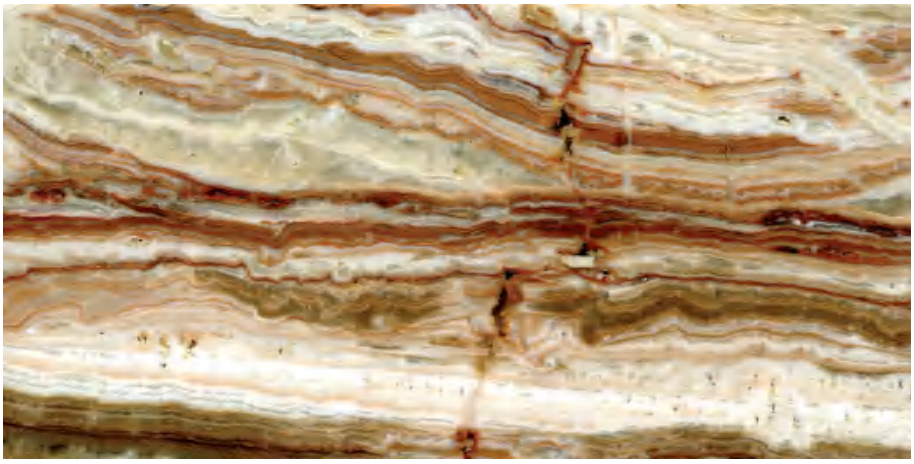

Fig. 48A

Commercial name: Onice Shadow - Shadow Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: sample characterized by the alternation of brownish red and white bands. The grain size is different, varying from band to band; some layers have well defined crystals of calcite with short columnar habit.

Other mineral phases: fluorite

Translucence and UV fluorescence info: not translucent; yellowish UV luminescence probably due to the presence of organic acids (Fig. 48B). Small area filled with resins lumineses in bright light blue.

Colour: N9, 5YR8/4, 10YR8/2, 5YR5/6 and 10YR5/4 bands

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16748	54.79	1.07	<1%	nd	950	nd	nd	nd	395	40

MRSN Catalogue number: M/U16749

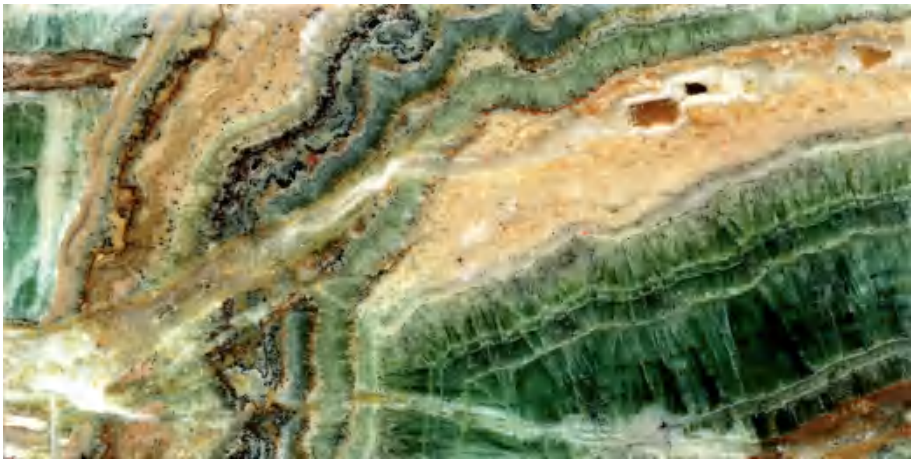

Fig. 49A

Commercial name: Onice Smeraldo cc - Emerald Onyx cc

Petrographic classification: calcite-alabaster

Provenance: Middle East, [Iran]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, one of the surfaces is "leather" finished (smooth surface, not polished).

Description: this sample belongs to the same "onyx" variety of M/U16750 (vein cut). It is the only lithotype composed of aragonite instead of calcite, showing beautiful acicular crystals with vivid emerald green colour, due to the presence of copper as a trace element in aragonite (confirmed by μ-XRF analysis). In the specimen, fractures filled with secondary calcium carbonate (crossing the stratification of the green aragonite strata) are visible.

Other mineral phases: manganese and iron compounds

Translucence and UV fluorescence info: green bands are translucent; weak pink UV luminescence diffused throughout the sample (Fig. 49B) The secondary calcium carbonate luminesces in whitish blue.

Colour: 5BG5/2, 5G6/6, 10GY3/2, 5GY7/2, 5YR8/4 and N1 bands

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16749	53.91	<1%	<1%	nd	19650	900	nd	200	2980	230

MRSN Catalogue number: M/U16750

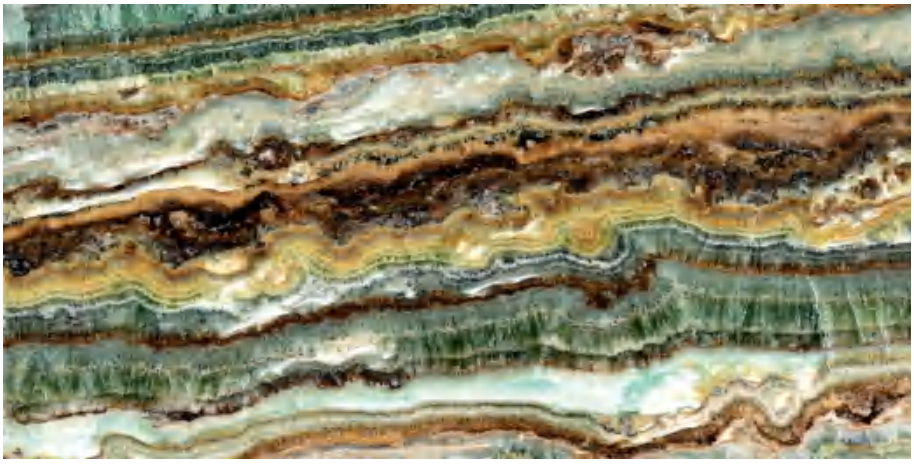

Fig. 50A

Commercial name: Onice Smeraldo vc - Emerald Onyx vc

Petrographic classification: calcite-alabaster

Provenance: Middle East, [Iran]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: M/U16749 and this sample belong to the same rock variety. It is the only lithotype composed of aragonite instead of calcite, showing beautiful acicular crystals with vivid emerald green colour, due to the presence of copper as a trace element in aragonite (confirmed by μ-XRF analysis). In thin section (Fig. 50B), layers of the same unidentified mineral found in other samples (21-47-29) are spread all over the specimen, and is clearly visible in the top of the picture. The huge layer of aragonite crystals (green in the macroscopic sample) shows straight-edged individuals, around 3 mm long and 0,1 mm wide, elongated along the growth axis with uniform extinction and square terminations. Other layers with smaller aragonite individuals occur, their acicular fabric showing needle-like terminations and crystals with a length/width ratio exceeding 6:1.

Other mineral phases: hematite, strontianite, manganese compounds (Fig. 50C - aggregates of manganese oxides and compounds filling the interstice between aragonite crystals), cuprite.

Translucence and UV fluorescence info: green bands are translucent; weakly fluorescent under UV light

Colour: 5G6/6, 10GY3/2, 5GY7/4, 10GY4/4, 10Y5/4, N9, N1, 10YR6/2 and 10YR4/2 bands

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16750	53.77	<1%	<1%	30	19850	990	nd	300	7500	840

MRSN Catalogue number: M/U16751

Fig. 51A

Commercial name: Onice Smoky - Smoky Onyx

Petrographic classification: calcite-alabaster

Provenance: [Turkey]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, one of the surfaces is "leather" finished (smooth surface, not polished).

Description: in this specimen, concretions alternated in dark-grey and white colours give a cloudy aspect. It is a heterogeneous material, composed of calcite, with dark zones characterized by presence of manganese oxides inclusion , and clear layers containing quartz inclusions. The grain size is very small, the material is compact, but some pores are observed in manganese oxides-rich layers.

Other mineral phases: quartz, manganese oxides

Translucence and UV fluorescence info: not translucent; diffused weak bluish UV fluorescence

Colour: N,8 N,- N6, N5, N4 with 5YR4/1 and 10YR8/2 veins

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16751	54.46	0.89	<1%	nd	110	nd	nd	nd	160	5630

MRSN Catalogue number: M/U16752

Fig. 52A

Commercial name: Onice Stratos vc - Stratos Onyx vc

Petrographic classification: calcite-alabaster

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: heterogeneous sample with brown, orange and white nearly parallel concretions with variable grain size and well defined crystals. It is composed of calcite with the presence of mineral inclusions, especially in darker bands. It is compact.

Other mineral phases: dolomite (Fig. 52B - dolomite layers included in calcite, SEM-BSE image), celestine (Fig. 52C celestine in light gray calcite background characterized by dolomite crystals, SEM-BSE image).

Translucence and UV fluorescence info: clear bands are translucent, under UV light, white bands have a pink fluorescence while yellowish layers have a strong yellow UV luminescence (probably due to the presence of organic acids).

Colour: alternated bands indicated by the colours N9, 5Y8/1, 10YR6/2, 5Y6/1 and 10YR7/4

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16752	53.48	2.11	<1%	nd	1550	nd	nd	nd	1190	600

MRSN Catalogue number: M/U16753

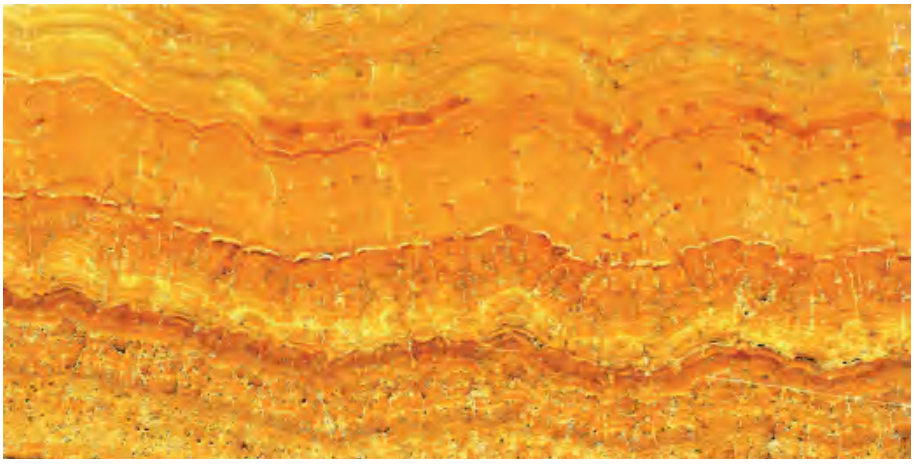

Fig. 53A

Commercial name: Onice Striato d'Oro - Golden banded Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the specimen has a narrow banded structure, with almost parallel layers of yellowish calcite. Crystals are elongated through the growth axis. Very thin veins of sparry calcite, almost perpendicular to the banding direction, cross the sample.

Other mineral phases: iron oxides

Translucence and UV fluorescence info: not translucent; sparry calcite under UV light is fluorescent in blue (Fig. 53B).

Colour: 5YR5/6 shaded 10YR6/6 and 10YR8/6

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16753	54.25	0.77	<1%	nd	1450	nd	nd	nd	8440	550

MRSN Catalogue number: M/U16754

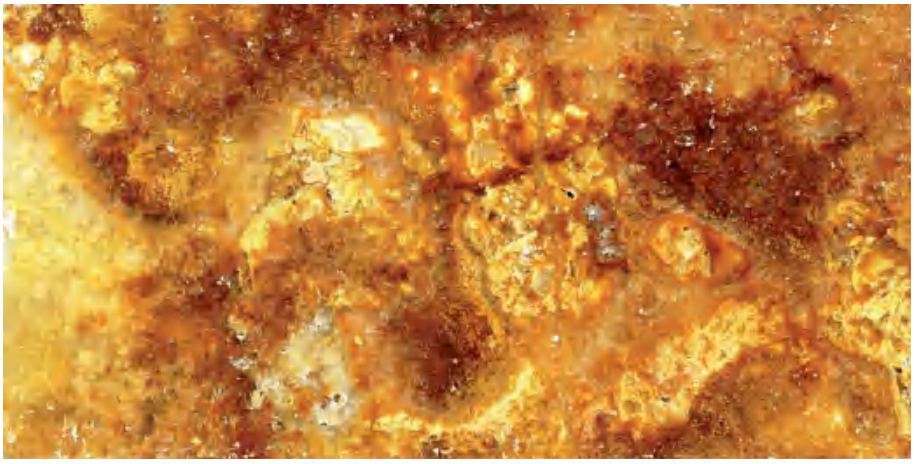

Fig. 54A

Commercial name: Onice Sultano cc - Sultan Onyx cc

Petrographic classification: calcite-alabaster

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: honey-yellow and brownish concretions of variable grain size. It is composed of calcite, with the presence of iron oxides between some bands showing a higher porosity. The calcite crystal columnar fabric is pictured in thin section (Fig. 54B, crossed nicols). The regular stacking of subeuhedral crystals is recognizable (around 300 μm wide). Bigger calcite crystals are present showing the typical cleavage.

This sample belongs to the same "onyx" variety of M/U16755 (vein cut).

Other mineral phases: hematite, siderite (Fig. 54C - small inclusions of white siderite in calcite, SEM-BSE image), barite.

Translucence and UV fluorescence info: partially translucent, secondary calcite filling cracks and pores luminesce in blue

Colour: concretions of various shades of 5YR4/4, 5YR3/4, 10YR7/4 and 10YR5/4

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16754	54.57	0.41	<1%	nd	nd	nd	nd	nd	4090	120

MRSN Catalogue number: M/U16755

Fig. 55A

Commercial name: Onice Sultano vc - Sultan Onyx vc

Petrographic classification: calcite-alabaster

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: brown, orange and whitish stratifications have nearly parallel arrangement and variable grain size. It is composed of calcite, but there are many mineral inclusions especially in darker bands.

This sample belongs to the same "onyx" variety of M/U16754 (cross cut).

Other mineral phases: siderite (Fig. 55B - siderite crystals in calcite; black areas are pores, SEM-BSE image), hematite, barite.

Translucence and UV fluorescence info: not translucent; partially fluorescent, clear bands fluoresces in whitish yellow (Fig. 55C).

Colour: banded with 5YR5/6, 5YR4/4 and 5Y8/4 colours

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16755	55.73	0.17	<1%	nd	nd	nd	nd	50	1600	220

MRSN Catalogue number: M/U16756

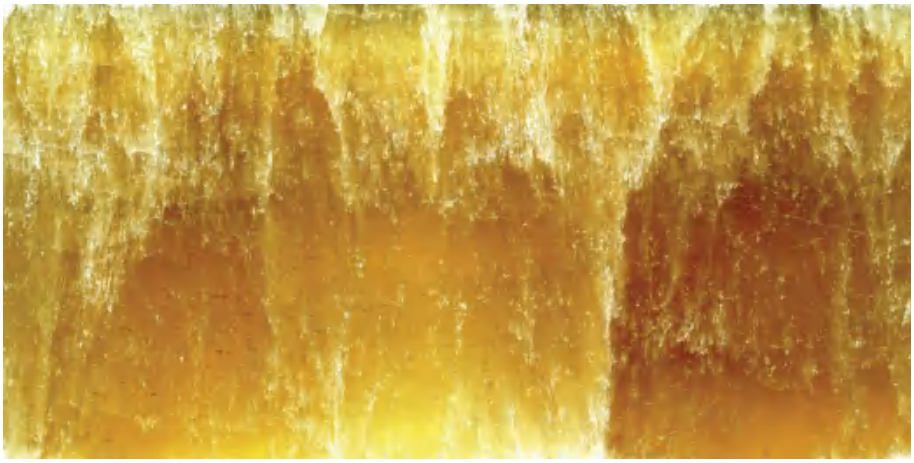

Fig. 56A

Commercial name: Onice Sun - Sun Onyx

Petrographic classification: calcite-alabaster

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 1.8 cm), vein cut, polished surface.

Description: light brown bands, elongated crystals of calcite are disposed in layers of variable size. The colour is probably due to the presence of organic acids in calcite crystals.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: translucent; weakly UV fluorescent in blue and yellow (Fig. 56B).

Colour: shades of 5Y7/6

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16756	54.88	1.00	<1%	15	1950	nd	nd	160	30	nd

MRSN Catalogue number: M/U16757

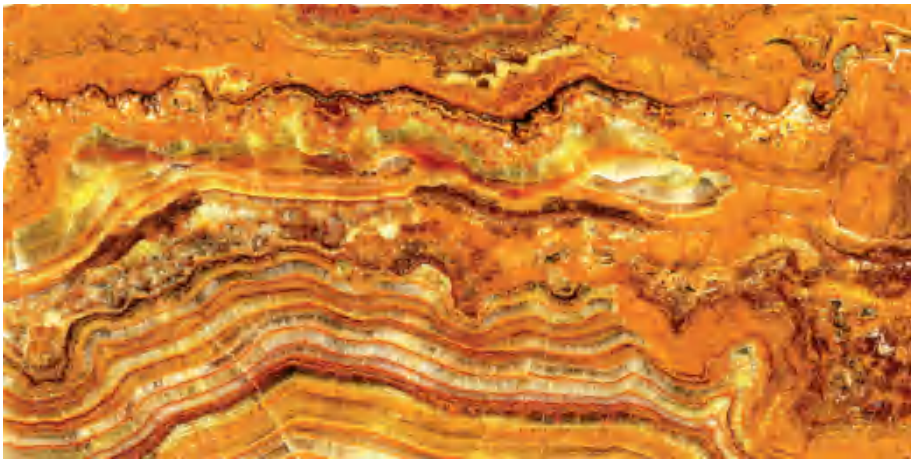

Fig. 57A

Commercial name: Onice Tiger - Tiger Onyx

Petrographic classification: calcite-alabaster

Provenance: Middle East [Turkey]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: the specimen has a banded structure, with almost parallel layers of yellowish orange and white calcite. Crystals of the white bands are elongated through the growth axis.

Other mineral phases: fluorite (Fig. 57B - fluorite aggregates in calcite background, SEM-BSE image), iron compound.

Translucence and UV fluorescence info: bands with well-defined crystals are translucent; not fluorescent under UV light

Colour: layers of 5YR3/4, 5YR4/4, 5YR2/2, 10YR6/6, 5Y8/4 and 5R2/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16757	53.16	0.74	2.22	nd	890	nd	nd	nd	22650	550

MRSN Catalogue number: M/U16758

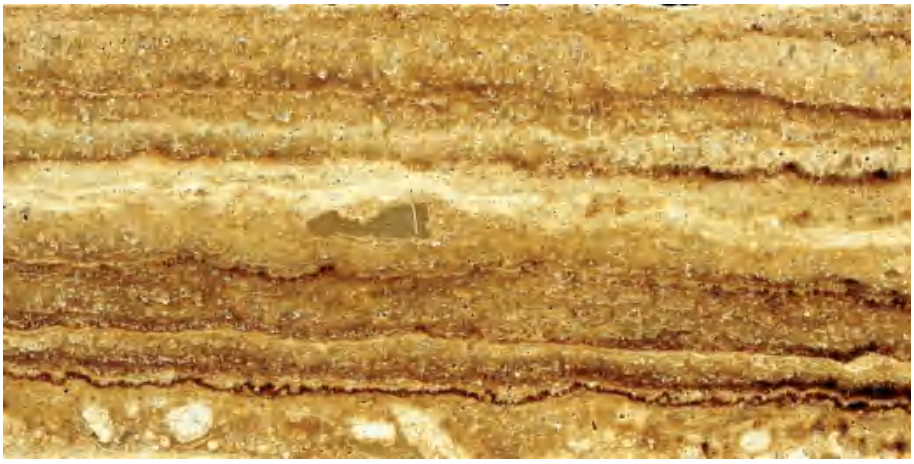

Fig. 58A

Commercial name: Onice Travertine - Travertine Onyx

Petrographic classification: travertine

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: light coloured travertine, with brownish bands. Fine grained and very porous, bigger pores are filled with an artificial resin to give a better aesthetical effect and to improve mechanical resistance of the material (Fig. 58B - fragments of calcite crystals immersed in resin, SEM-BSE image).

Other mineral phases: hematite.

Translucence and UV fluorescence info: not translucent; diffused bluish UV fluorescence.

Colour: 10YR8/2, 10YR6/2 and 5YR4/4 layers

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16758	55.45	0.46	<1%	nd	50	nd	nd	nd	79	nd

MRSN Catalogue number: M/U16759

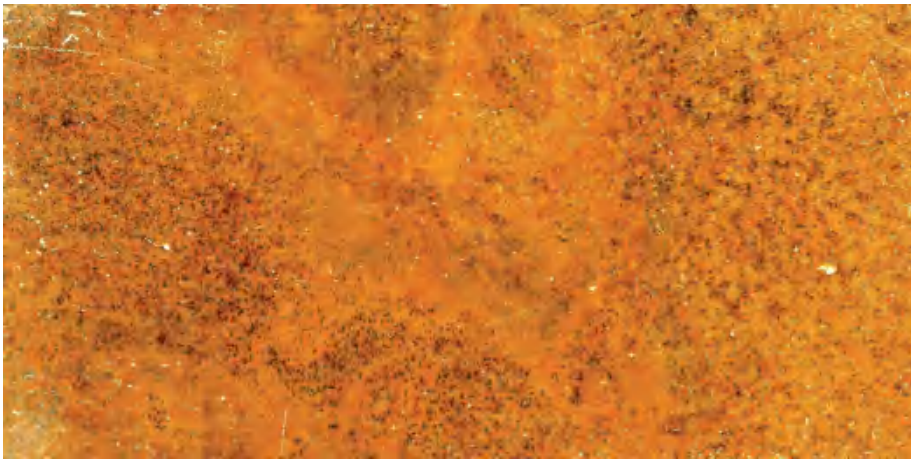

Fig. 59A

Commercial name: Onice Tropicale - Tropical Onyx

Petrographic classification: calcite-alabaster

Provenance: [Mexico]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: quite homogeneous, honey-yellow sample, showing brownish zones, fine grained and not very compact. It is composed of calcite; iron and manganese oxides were also detected, mainly in those areas where the sample shows a higher level of porosity.

Other mineral phases: iron and manganese compounds

Translucence and UV fluorescence info: not translucent; not fluorescent

Colour: between 5YR5/6 and 10YR6/6 with 5YR3/2 dots

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16759	55.79	0.24	2.04	nd	110	nd	nd	nd	16300	900

MRSN Catalogue number: M/U16760

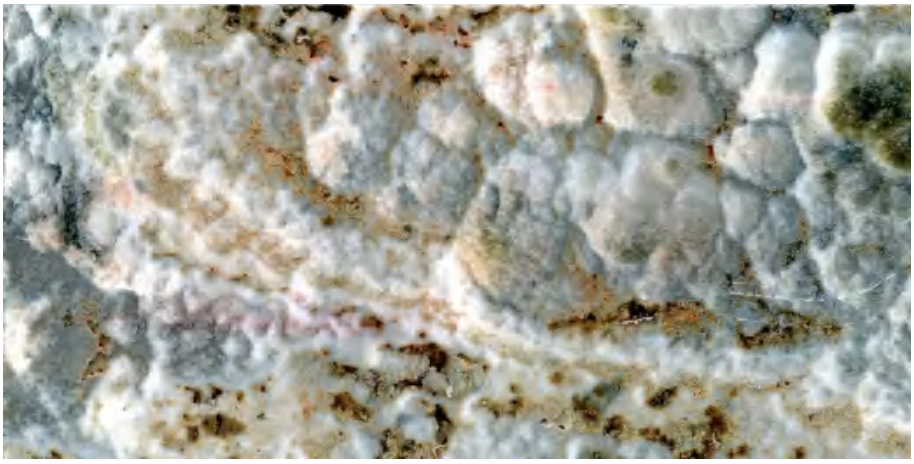

Fig. 60A

Commercial name: Onice Velluto cc - Velvet Onyx cc

Petrographic classification: calcite-alabaster

Provenance: Middle East [Turkey]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: in this specimen, concretions alternated in grey and white colours give a cloudy aspect. It is a heterogeneous material, composed of calcite, with dark zones characterized by presence of pyrite inclusions. The grain size is very small and the material is compact.

This sample belongs to the same "onyx" variety of M/U16761 (vein cut).

Other mineral phases: pyrite (Fig. 60B small inclusions of pyrite [white] in calcite, SEM-BSE image), manganese compounds.

Translucence and UV fluorescence info: not translucent, weak whitish fluorescence (Fig. 60C).

Colour: N8, N9, N7, N6, N5 with 10YR7/4 veins

Chemical composition of carbonate fraction

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16760	53.8	1.79	<1%	nd	770	nd	nd	nd	60	1430

MRSN Catalogue number: M/U16761

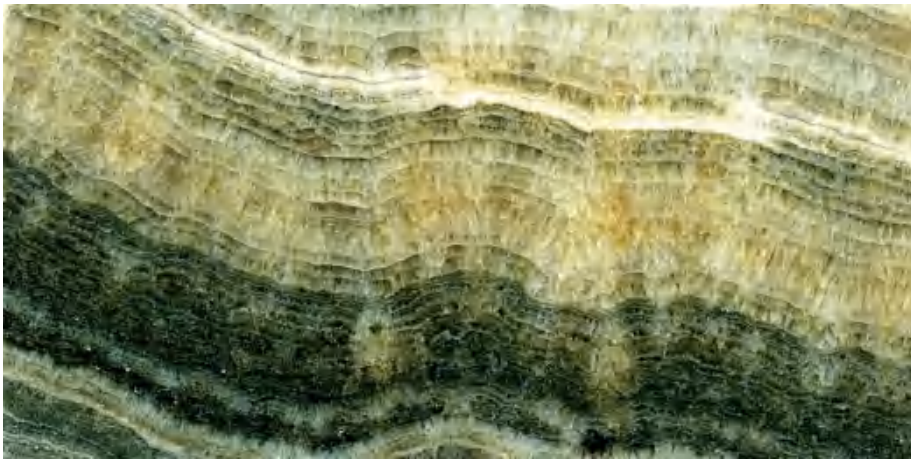

Fig. 61A

Commercial name: Onice Velluto vc - Velvet Onyx vc

Petrographic classification: calcite-alabaster

Provenance: Middle East [Turkey]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: thin layers alternated in dark grey and white colours characterize the specimen. Calcite bands are fine grained, crystals are visibly well defined, with medium porosity. In thin section (Fig. 61B, parallel nicols), layers of short columnar crystals are the main visible feature. Individuals are from 1 to 3 mm long and 0.3-0.5 mm wide. Laminations are visible and defined by the presence of impurities and pores.

This sample belongs to the same "onyx" variety of M/U16760 (cross cut).

Other mineral phases: pyrite, manganese compounds.

Translucence and UV fluorescence info: not translucent; white calcite layers are UV fluorescent in pink due to the presence of Mn (Fig. 61C).

Colour: 5Y8/4, 5Y8/1, N6, N5, N4 bands

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16761	53.57	1.89	<1%	nd	1330	nd	nd	nd	550	4140

MRSN Catalogue number: M/U16762

Fig. 62A

Commercial name: Onice Verde Persiano vc - Persian Green Onyx vc

Petrographic classification: calcite-alabaster

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: nearly parallel thin calcite layers make up the structure. It is fine grained. Characteristic white and green stratifications. The rock is rather compact. In thin section columnar crystals of different size, elongated perpendicular to the stratification, are visible (Fig. 62B, parallel nicols). Calcite individuals show uniform extinction and slight zoning.

Other mineral phases: calcite crystals have Fe-rich zoning (Fig. 62C - Fe-rich [lighter] zoning in calcite layers, SEM-BSE image).

Translucence and UV fluorescence info: translucent, not fluorescent under UV light.

Colour: 5GY7/4 and 10Y8/2 layers with 5YR5/6 staining

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16762	52.79	0.66	2.46	nd	1890	nd	99	690	25200	7090

MRSN Catalogue number: M/U16763

Fig. 63A

Commercial name: Onice Verde Persiano light - Persian light Green Onyx

Petrographic classification: marble

Provenance: Middle East

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), polished surface.

Description: greenish white sample, showing an extreme homogeneity. It is fine grained and compact. The thin section (Fig. 63B, parallel nicols) shows an equidimensional, polygonal mass of calcite crystals up to some millimeters (Fig. 63B).

Other mineral phases: hematite, copper compounds.

Translucence and UV fluorescence info: translucent, blue UV fluorescence.

Colour: 5Y8/1

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16763	54.58	0.48	1.03	nd	1440	nd	nd	nd	10600	850

MRSN Catalogue number: M/U16764

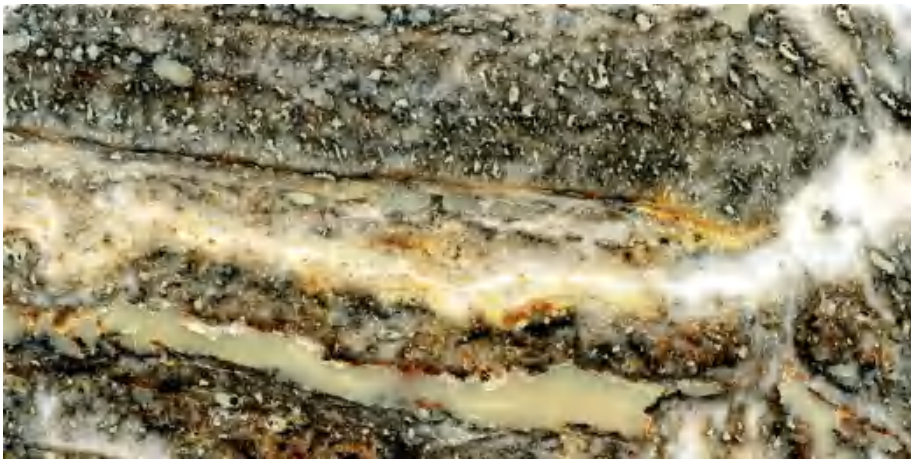

Fig. 64A

Commercial name: Onice Vintage - Vintage Onyx

Petrographic classification: travertine

Provenance: unknown

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: very porous variety of travertine with dark gray and white bands. Fine grained, bigger pores (vacuoles) were filled with an artificial resin to give a better aesthetical effect and improve mechanical strength.

Other mineral phases: not found in the analyzed section.

Translucence and UV fluorescence info: not translucent; resin used to fill voids fluoresces in strong blue (Fig. 64B).

Colour: 5YR4/1, 5YR6/1, N4 and 10YR6/6 bands with N9 secondary calcite

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16764	55.47	0.27	<1%	nd	760	nd	nd	nd	200	1470

MRSN Catalogue number: M/U16765

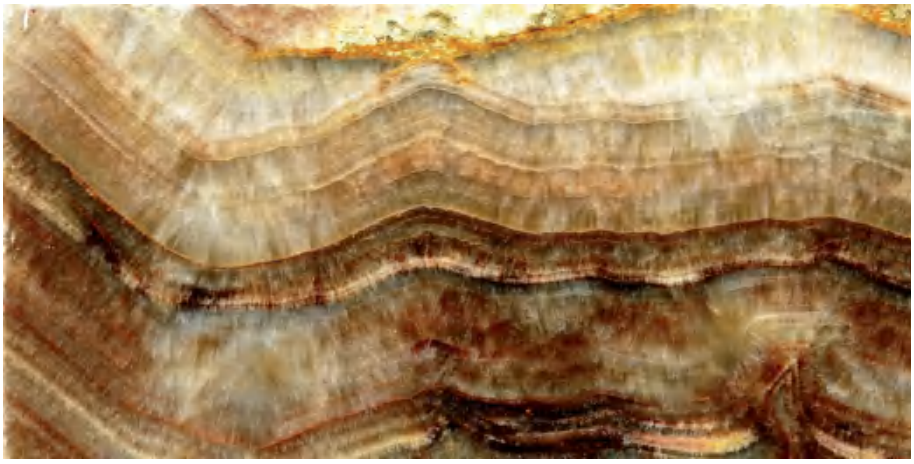

Fig. 65A

Commercial name: Onice Viola cc - Violet Onyx cc

Petrographic classification: calcite-alabaster

Provenance: [Africa]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: dark purple and whitish stratifications have nearly parallel arrangement and variable grain size, some layers have well defined crystals with short columnar habit. It is composed of calcite, with additional presence of mineral inclusions especially in the darker bands.

This sample belongs to the same "onyx" variety of M/U16766 (vein cut).

Other mineral phases: hematite (Fig. 65B - hematite in gray background calcite, SEM-BSE image).

Translucence and UV fluorescence info: translucent, slight yellow UV luminescence due to the presence of organic acids.

Colour: bands describable as 10R7/4, 10R3/4, 10R5/4, 5YR7/2 and 10YR8/2

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16765	54.62	0.38	<1%	nd	640	nd	nd	nd	93	1620

MRSN Catalogue number: M/U16766

Fig. 66A

Commercial name: Onice Viola vc - Violet Onyx vc

Petrographic classification: calcite-alabaster

Provenance: [Africa]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: stratifications of purplish and orange layers. Fine grained and porous, this sample is composed of calcite. Purple bands are characterized by inclusions of iron compounds deposited between calcite layers.

This sample belongs to the same "onyx" variety of M/U16765 (cross cut).

Other mineral phases: goethite (Fig. 66B - goethite inclusions in calcite, SEM-BSE image)

Translucence and UV fluorescence info: not translucent; not fluorescent.

Colour: 5R4/2 and 5R2/2 background with 10YR6/6 and 5RP4/2 dots

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16766	53.04	1.36	1.17	nd	4940	nd	nd	300	14100	2150

MRSN Catalogue number: M/U16767

Fig. 67A

Commercial name: Onice Wooden - Wooden Onyx

Petrographic classification: calcite-alabaster

Provenance: [Iran]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: sample characterized by brown, orange and white thin bands. The grain size is different varying from band to band; some layers have well defined crystals of calcite with short columnar habit.

Other mineral phases: hematite(Fig. 67B - hematite inclusions in calcite, SEM-BSE image), barite, Cu compounds, Mn compounds.

Translucence and UV fluorescence info: not translucent; clear layers fluoresces in blue.

Colour: 10YR6/6, 5YR5/6, 5YR3/4, 10YR8/2, N9 and 10YR2/2 bands

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16767	55.01	0.58	<1%	nd	300	nd	nd	nd	8650	880

MRSN Catalogue number: M/U16768

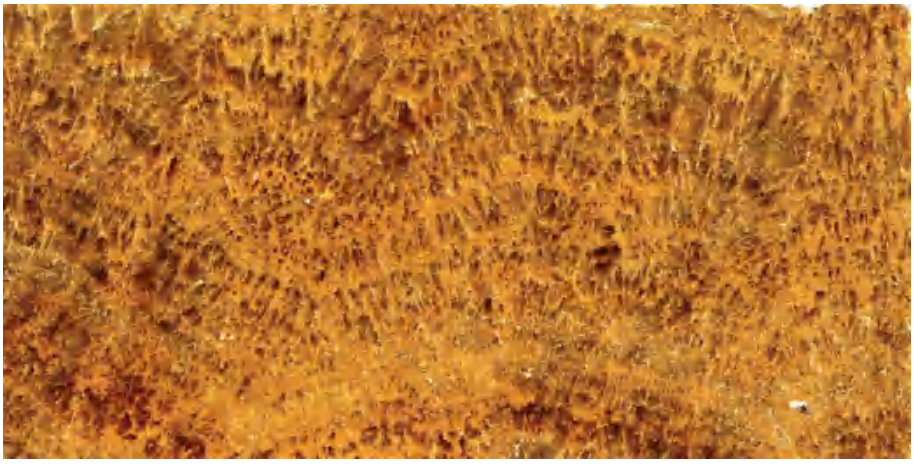

Fig. 68A

Commercial name: Stalattite Brown - Brown Stalactite

Petrographic classification: calcite-alabaster

Provenance: [Europe]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), vein cut, polished surface.

Description: composed of brownish yellow calcite layers, it is fine grained and its crystals are elongated perpendicularly to the stratification; darker layers are full of impurities.

Other mineral phases: zircon (Fig. 68B - detrital zircon fragment enclosed in intragranular calcite, SEM-BSE image), clay minerals, quartz, rutile, hematite.

Translucence and UV fluorescence info: not translucent; not fluorescent

Colour: 10YR7/6 - 10YR4/4

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16768	55.63	0.23	<1%	nd	1960	nd	nd	nd	1280	130

MRSN Catalogue number: M/U16769

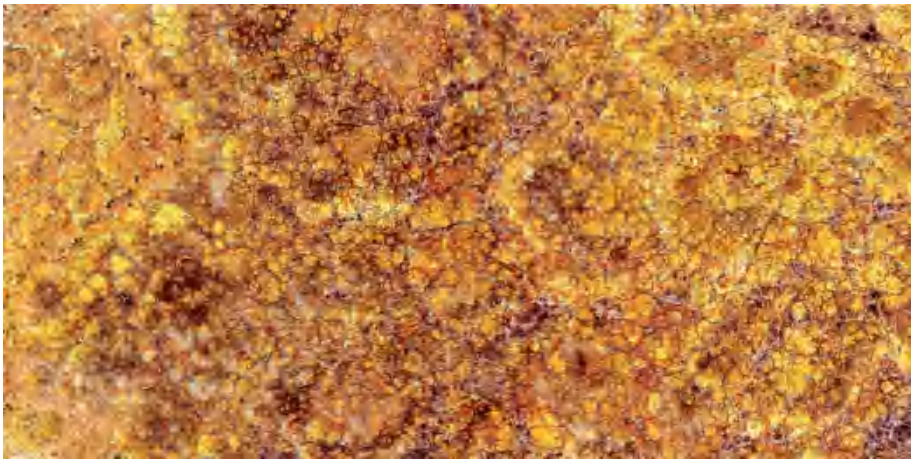

Fig. 69A

Commercial name: Stalattite Oro - Golden Stalactite

Petrographic classification: calcite-alabaster

Provenance: [Europe]

Cutting and finishing: rectangular slab (13 x 7.5 x 0.8 cm), cross cut, polished surface.

Description: composed of brownish and reddish calcite layers, it is fine grained and has a cloudy aspect; darker layers are full of impurities. In thin section (Fig. 69B, parallel nicols), radial aggregates of microcrystalline individuals are distinguishable. Milky, opaque, small crystals with a porous appearance have irregular boundaries; impurities, such as Fe compounds, precipitate in intergranular positions. Presence of big pores between the aggregates is observed.

Other mineral phases: hematite (Fig. 69C - small crystallites of hematite diffused in the calcite matrix, SEM-BSE image), goethite.

Translucence and UV fluorescence info: not translucent; not fluorescent

Colour: 5R2/6, 10YR6/6, 5YR6/4 and 5YR6/1 concentric concretions

Chemical composition of carbonate fraction:

	(%)			ppm						
	CaO	MgO	FeO	Ba	Sr	Cu	Co	Zn	Fe*	Mn
M/U16769	52.58	1.91	1.11	nd	6610	nd	nd	120	10500	840

ACKNOWLEDGEMENTS

The authors thank Antolini Luigi & C. S.p.a for providing the specimens of the "Onyx Marbles and Alabasters" Collection.

RIASSUNTO

Un catalogo petrografico per la Collezione "Marmi Onice e Alabastri" del Museo di Mineralogia e Petrografia dell'Università di Torino.

Il presente lavoro riporta informazioni, dati e risultati analitici riguardanti i 69 campioni di roccia appartenenti alla Collezione "Marmi Onice e Alabastri" recentemente acquisita dal Museo di Mineralogia e Petrografia dell'Università degli Studi di Torino. La Collezione si trova in comodato d'uso presso il Museo Regionale di Scienze Naturali di Torino. Le rocce facenti parte della Collezione sono rappresentative di un ampio numero di varietà di marmi onice attualmente in commercio in Italia. Da un punto di vista petrografico, la maggior parte dei campioni, può venire classificata come *alabastro calcareo*, una roccia sedimentaria che si forma in ambienti carsici che, generalmente, presenta una struttura a bande con caratteristici layers sub-paralleli che differiscono, a seconda dei casi, nel colore, fabric e/o nella composizione mineralogica. Data l'eterogeneità delle caratteristiche di questa categoria di rocce è stato scelto un approccio multi-analitico per esaminarne diversi aspetti e ottenere una caratterizzazione completa di ogni campione. Infatti, per ogni esemplare della Collezione è stata acquisita una documentazione fotografica dettagliata, ed è stata inoltre prelevata una piccola quantità di campione per indagini di tipo chimico e mineralogico. Ogni campione è stato osservato al microscopio elettronico a scansione e, per le varietà più interessanti, è stata ricavata una sezione sottile successivamente osservata sia in microscopia ottica che elettronica. Per la determinazione delle fasi mineralogiche presenti è stata utilizzata la spettroscopia micro-Raman ai cui risultati sono state integrate le informazioni derivanti dall'analisi elementare effettuata tramite microsonda EDS. Per quanto riguarda la determinazione della concentrazione degli elementi in traccia presenti nella frazione carbonatica di ogni campione è stata usata la spettroscopia ICP-OES. Tutte le informazioni ottenute sono state organizzate nel catalogo petrografico riportato in questo articolo.

Parole chiave: alabastro calcareo, marmi onice, collezione, catalogo.

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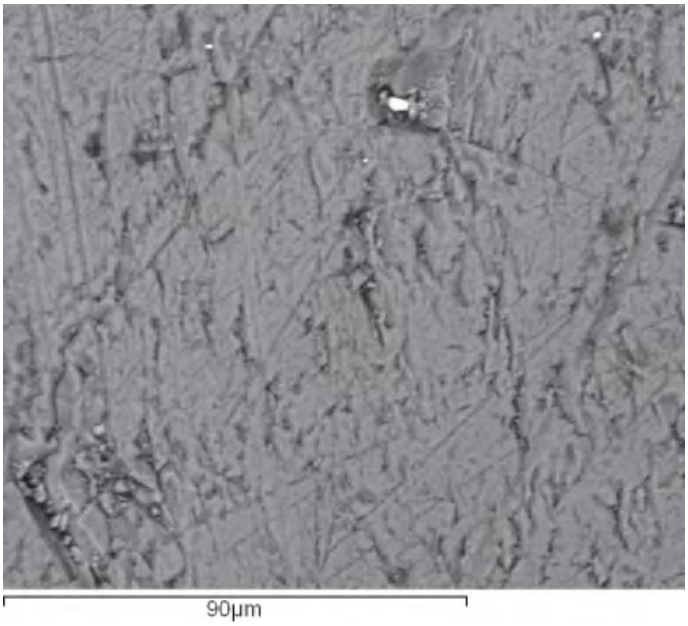
APPENDIX I

Supplementary colour plates

Fig. 1B. Inclusion of hematite, small white rounded crystal (SEM-BSE image).
Fig. 1C. White secondary calcite fluoresces in light blue (UV photograph).
Fig. 2B. Calcite crystals show a feathered aspect due to the sweeping extinction across several individuals (thin section, cross polars). Field of view: 6 mm.
Fig. 2C. Hematite inclusions, small white crystals on calcite background (SEM-BSE image).
Fig. 3B. Inclusions of barite, sub-rounded white crystal (SEM-BSE image).
Fig. 4B. Hematite round inclusions of 2-4 μm of diameter (thin section, plane polars). Field of view: 0.2 mm.
Fig. 4C. Three different fabrics of calcite crystals are shown (thin section, cross polars). Field of view: 6 mm.
Fig. 5B. Strong pink UV fluorescence due to the presence of Mn^{2+} ions (UV photograph).
Fig. 6B. Acicular fabric crystal are grouped in extinction domains (thin section, cross polars). Field of view: 6 mm.
Fig. 6C. fluoroapatite crystal (rounded shape), the background calcite is not compact as deduced by the presence of black areas corresponding to pores (SEM-BSE image).
Fig. 6D. Lighter bands have a pink fluorescence, while not translucent bands have a bluish fluorescence (UV photograph).
Fig. 7B. Strong blue fluorescence (UV photograph).
Fig. 8B. Strong homogeneous blue UV fluorescence (UV photograph).
Fig. 9B. Open columnar crystal fabric (thin section, cross polars). Field of view: 6 mm.
Fig. 9C. Fluorite inclusion (SEM-BSE image).
Fig. 10B. Weak uniform bluish fluorescence (UV photograph).
Fig. 11B. Pink bands are bright red in fluorescent light (UV photograph).
Fig. 12B. Weak uniform yellowish fluorescence (UV photograph).
Fig. 13B. Barite, hematite and other iron oxides and hydroxides (SEM-BSE image).
Fig. 14B. White calcite fluoresce in blue while brown bands have a yellow fluorescence (UV photograph).
Fig. 15B. Light blue and yellowish fluorescence (UV photograph).
Fig. 16B. Dark red fluorescence (UV photograph).
Fig. 17B. A uniform strong blue UV fluorescence denoting a homogeneous composition (UV photograph).
Fig. 18B. Light blue UV fluorescence, one can notice the presence of brownish bands where organic acids are more concentrated (UV photograph).
Fig. 19B. Fluorite inclusions (SEM-BSE image).
Fig. 19C. Inclusions of manganese oxides (SEM-BSE image).
Fig 21B. In the lower bands short columnar fabric is recognizable while other bands show mosaic fabric with high porosity (thin section, parallel polars).
Fig. 22B. Twinned calcite crystals (thin section, cross polars).
Fig. 23B. Weak diffused pinkish luminescence (UV photograph).
Fig. 24B. Resin used to fill cracks and pores luminesces in light blue (UV photograph).
Fig. 25B. Light blue color in UV light that points out some millimetric cracks (UV photograph).
Fig. 26B. Hematite crystals. The inset shows, at a higher magnification, the nodular structure of the metallic oxides (SEM-BSE image).

Fig. 27B. Columnar fabric of calcite crystals is clearly recognizable (thin section, cross polars). Field of view: 6mm.
Fig. 27C. Iron oxides and manganese compounds (SEM-BSE image).
Fig. 29B. Three different kinds of layers are shown (thin section, parallel nicols). Field of view: 6mm.
Fig. 29C. Concretions of iron and manganese oxides in calcite (SEM-BSE image).
Fig. 30B. Dolomite crystals are observed in the white parts (thin section, parallel polars). Field of view: 6mm.
Fig. 30C. Dolomite inclusions in calcite. White small individuals of hematite are spread in the background (SEM-BSE image).
Fig. 31B. Zircon in a calcite fissure (SEM-BSE image).
Fig. 31C. Luminescence is due to the presence of organic acids, dark layers are not UV fluorescent while white calcite fluoresces in blue (UV photograph).
Fig. 32B. Subangular grains of fluorite (SEM-BSE image).
Fig. 32C. Pink bands are bright red under fluorescent light while orange layers are yellowish in color (UV photograph).
Fig. 33B. Short columnar fabric in clear calcite layers with visible lamination is displayed (thin section, parallel nicols). Field of view: 6mm.
Fig. 33C. Non-elongated crystals can be observed (thin section, parallel nicols). Field of view: 6mm.
Fig. 33D. Under UV light clasts are pinkish while the background is yellow (UV photograph).
Fig. 34B. Crystals aggregating around a layer composed of small micritic individuals are shown (thin section, crossed nicols). Field of view: 6mm.
Fig. 35B. Brown bands fluoresce in yellow (UV photograph).
Fig. 36B. Under UV light the sample is yellowish with some darker bands(UV photograph).
Fig. 37B. Weak yellowish UV-fluorescence (UV photograph).
Fig. 38B. Weak diffused pink UV luminescence (UV photograph).
Fig. 39B. Celestine microcrystalline aggregates in calcite (SEM-BSE image).
Fig. 39C. Nebular aggregate of iron and manganese oxide in calcite (SEM-BSE image).
Fig. 42B. Clear bands of calcite show a pink UV luminescence (UV photograph).
Fig. 44B. Pinkish layers have a strong pink UV luminescence while creamy layers are weakly luminescent (UV photograph).
Fig. 45B. Under UV light one side of the sample is fluorescent in pink while the other side fluoresces in blue (UV photograph).
Fig. 46B. Rounded aggregate of hematite in calcite (SEM-BSE image).
Fig. 47B. Radial aggregates of calcite crystals of spheroidal shape, similar to ooids or pisoids (thin section, parallel nicols). Field of view: 6mm.
Fig. 47C. Small crystals of fluorite in calcite, the black areas are pores (SEM-BSE image).
Fig. 47D. Subangular aggregated crystals of iron oxides (SEM-BSE image).
Fig. 48B. Yellowish UV luminescence probably due to the presence of organic acids (UV photograph).
Fig. 49B. Weak pink UV luminescence diffused throughout the sample (UV photograph).
Fig. 50B. Huge layer of aragonite crystals with straight-edged individuals (thin section).Field of view: 6mm.
Fig. 50C. Aggregates of manganese oxides and compounds filling the interstice between aragonite crystals (SEM-BSE image).



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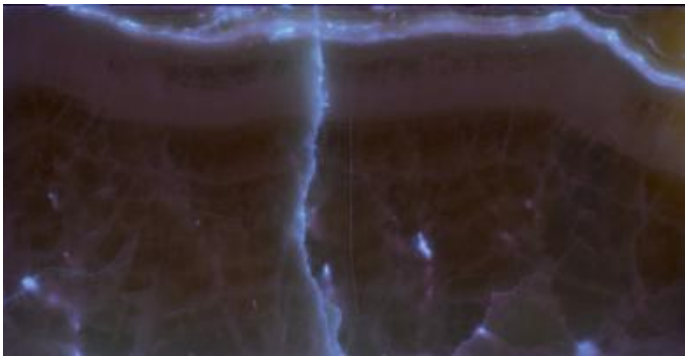
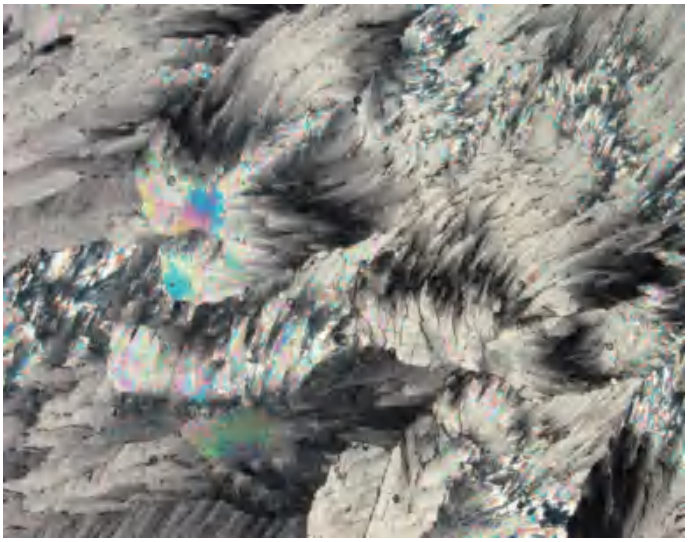


Fig. 1C



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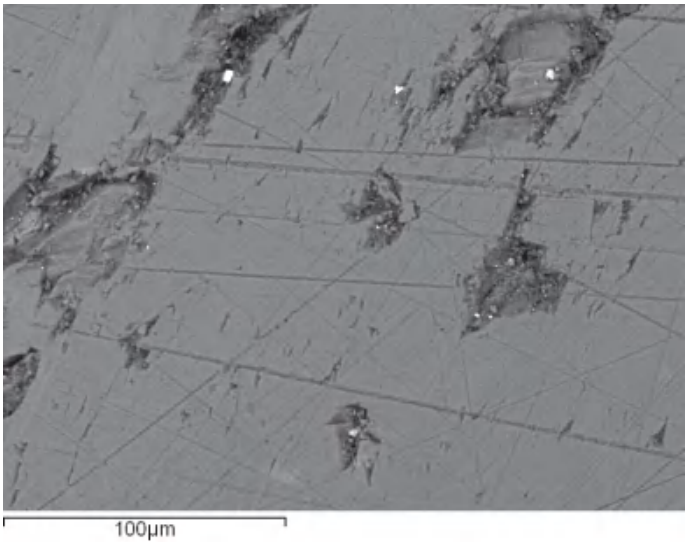
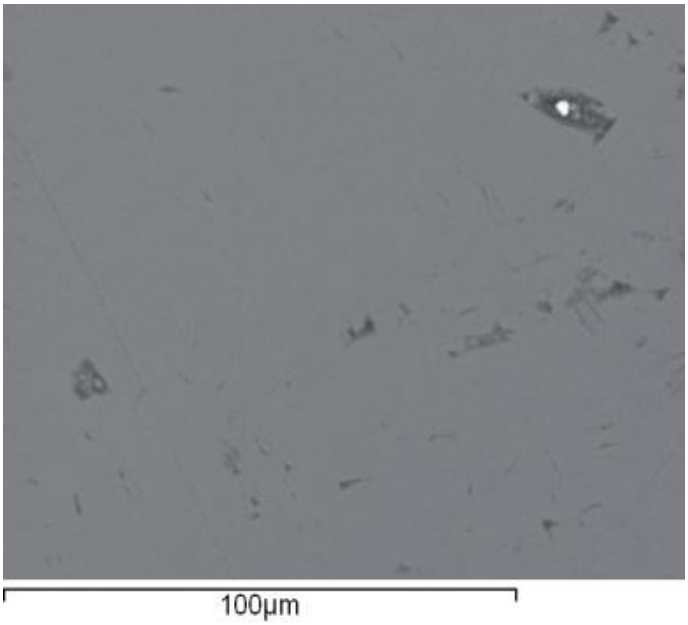


Fig. 2C



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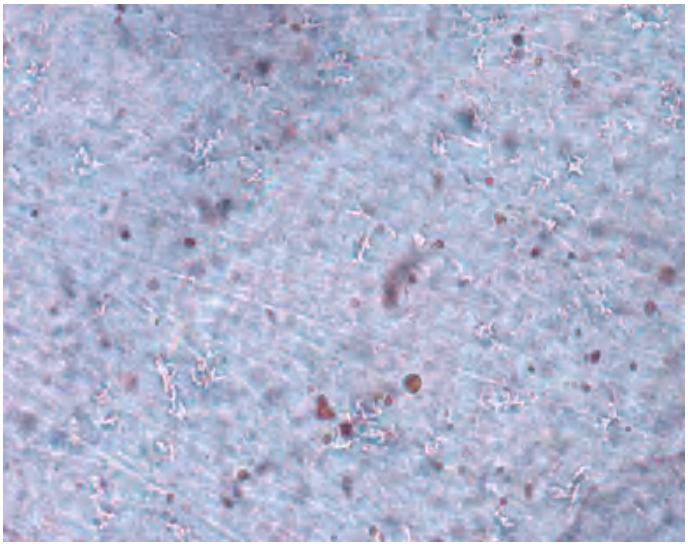


Fig. 4B

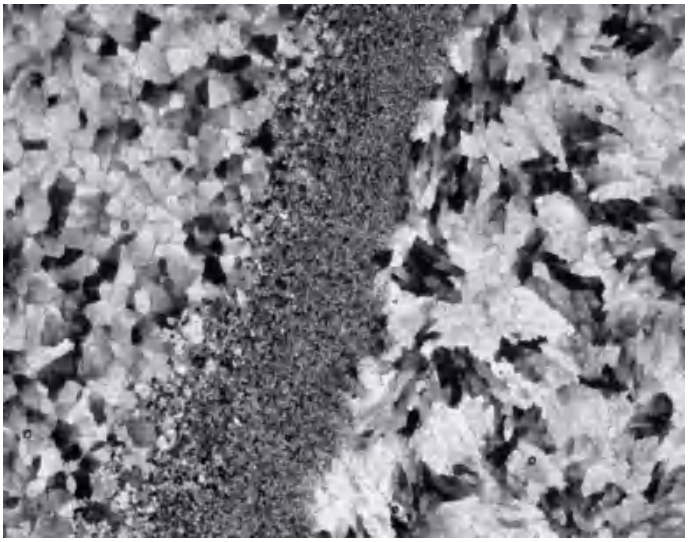
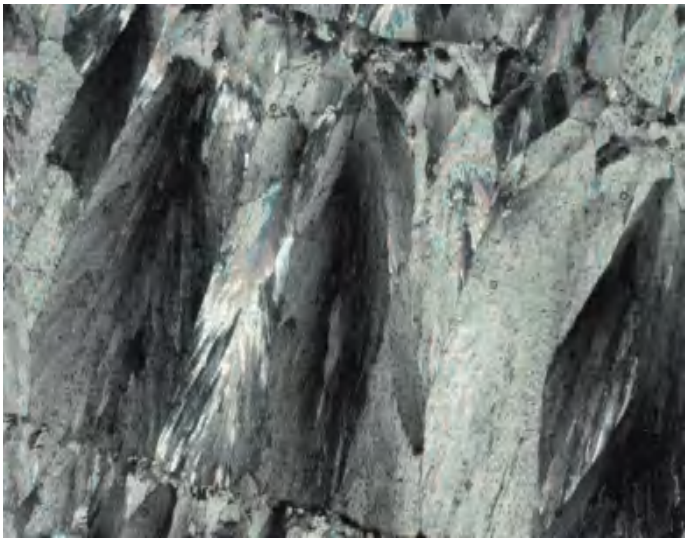


Fig. 4C

Fig. 5B



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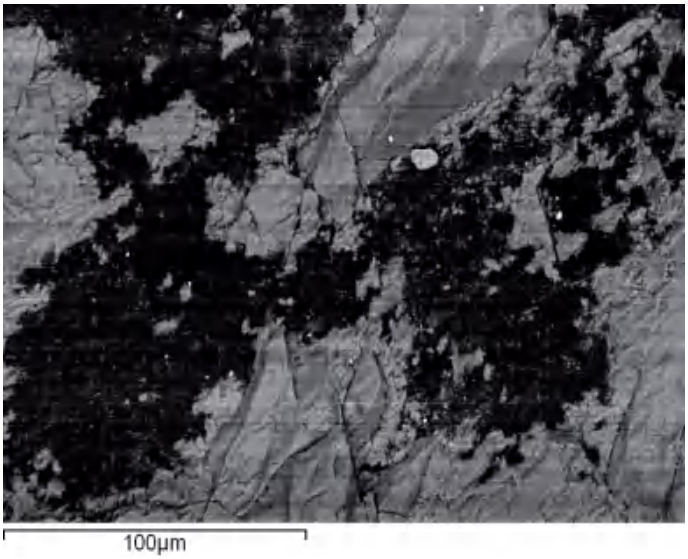

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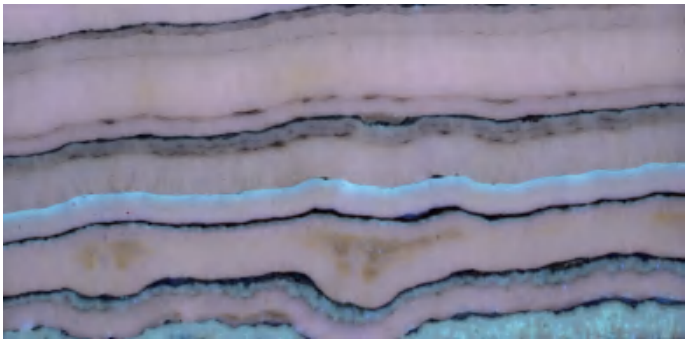
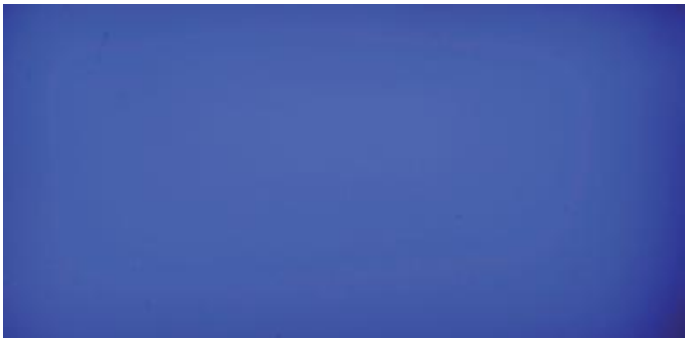


Fig. 6D

Fig. 7B



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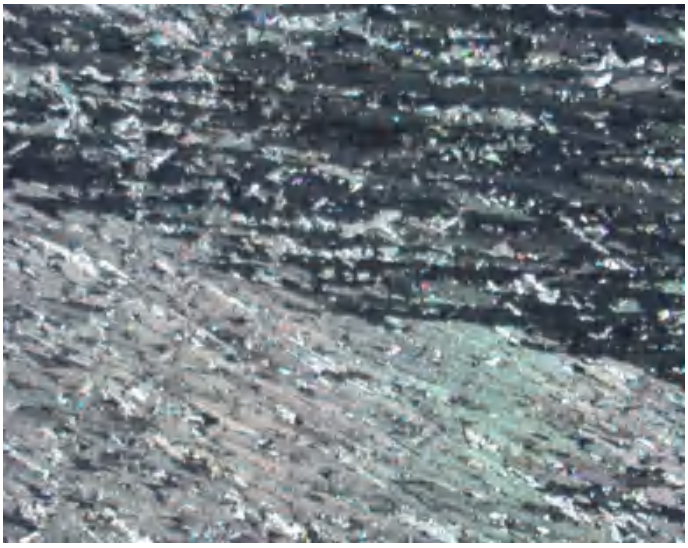

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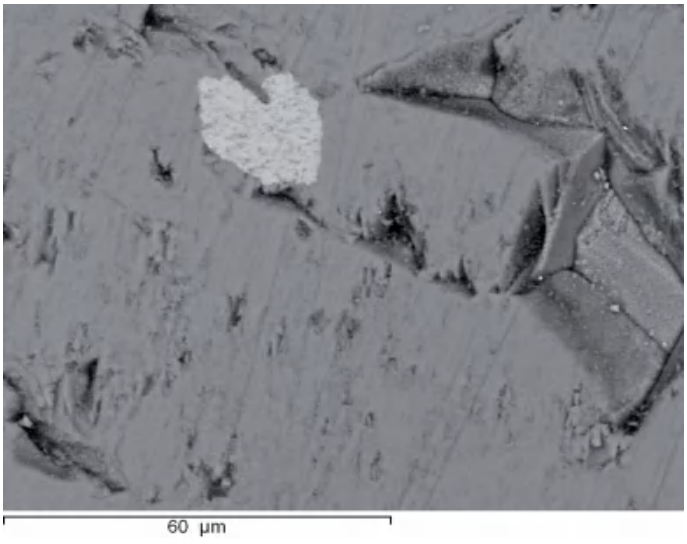


Fig. 9C

Fig. 10B

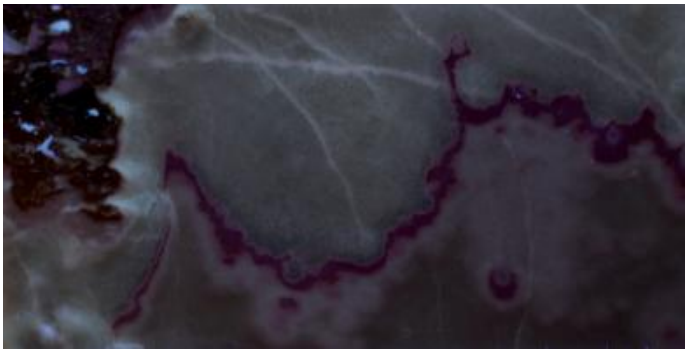


Fig. 11B

Fig. 12B

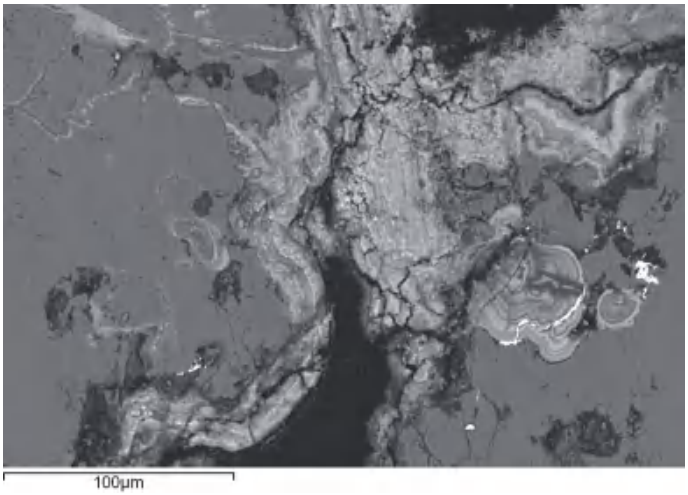


Fig. 13B

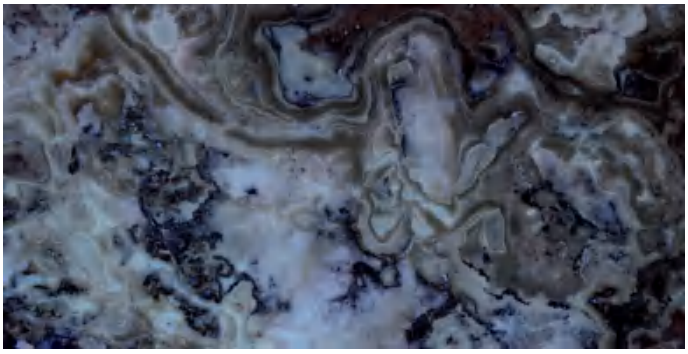


Fig. 14B

Fig. 15B

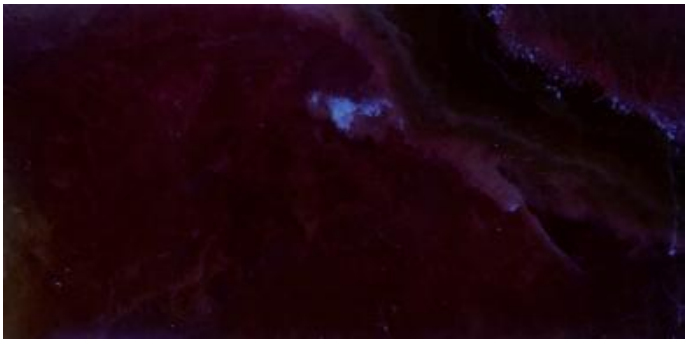
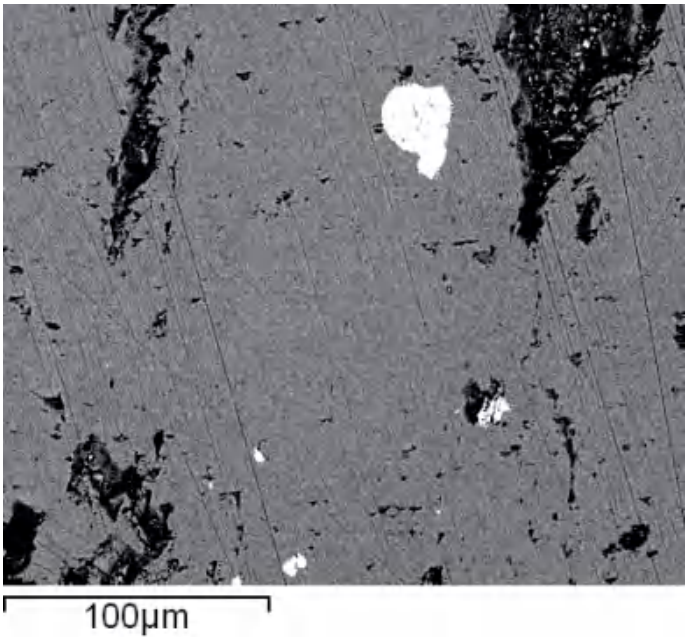


Fig. 16B

Fig. 17B

Fig. 18B



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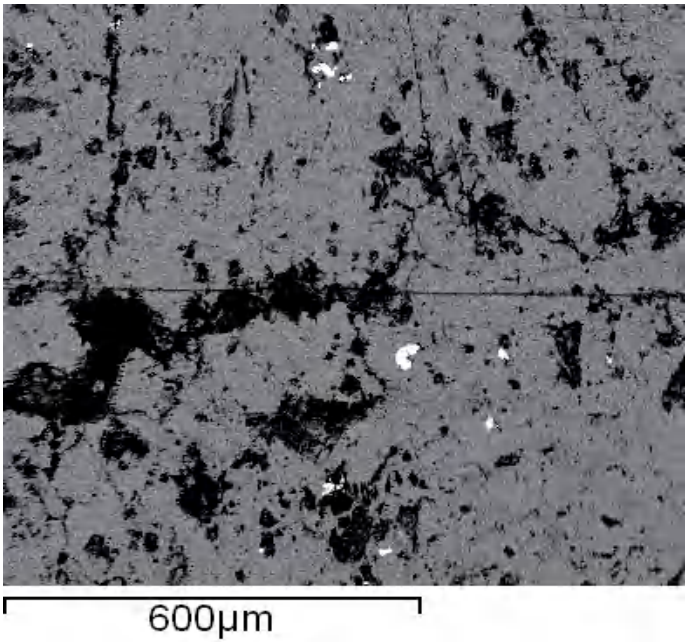
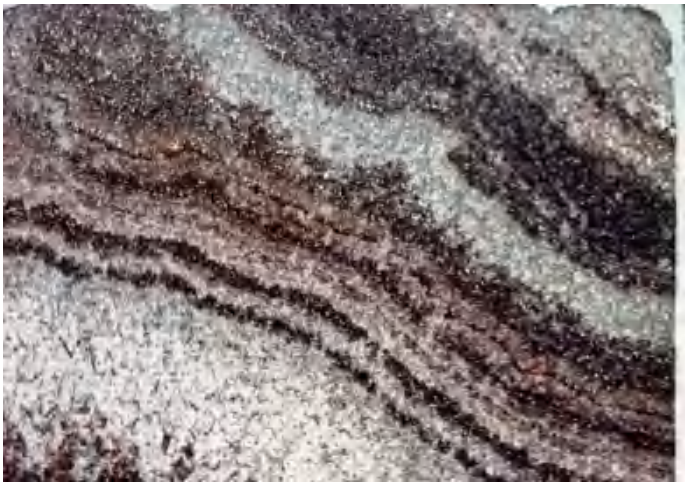


Fig. 19C



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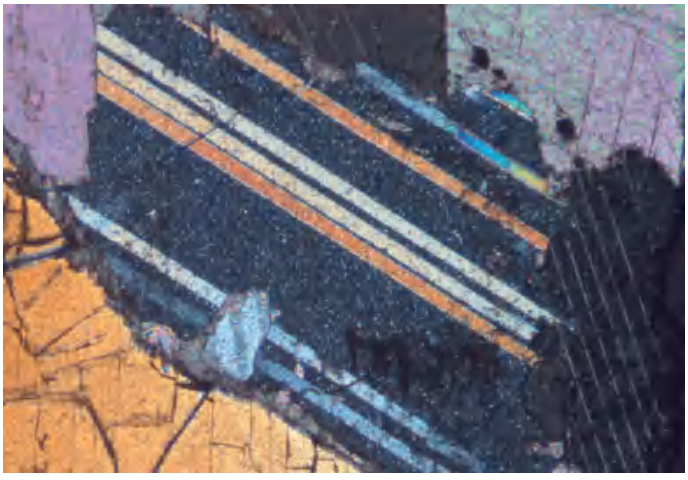

Fig. 22B

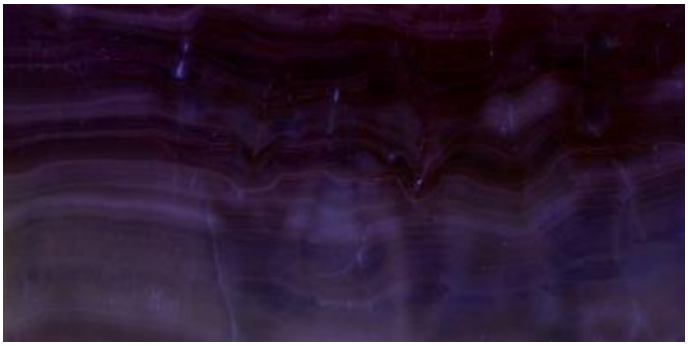

Fig. 23B

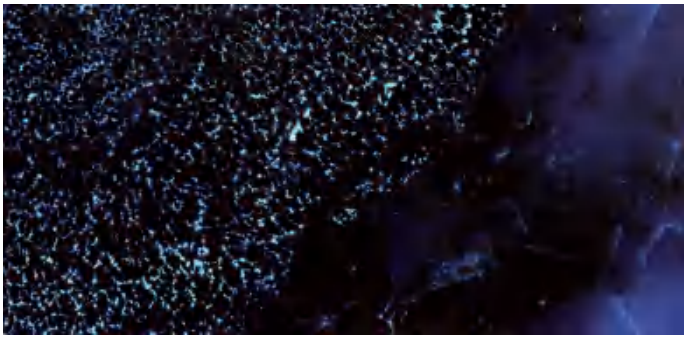

Fig. 24B

Fig. 25B

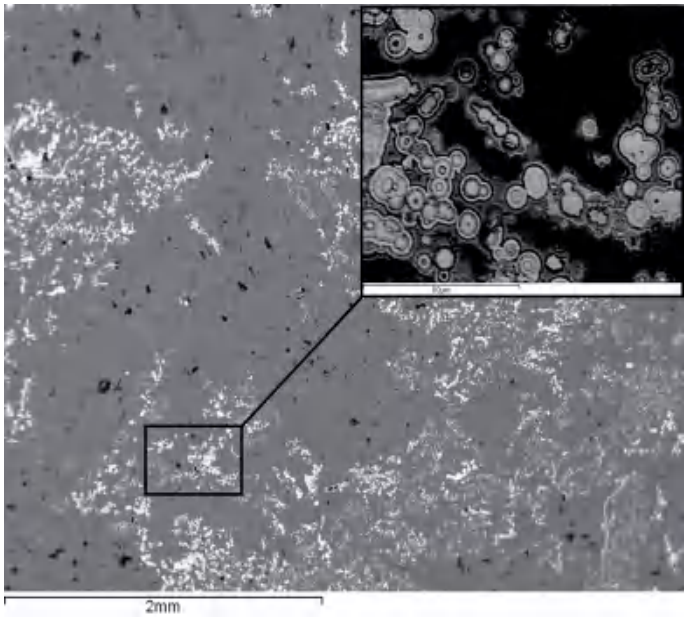

Fig. 26B

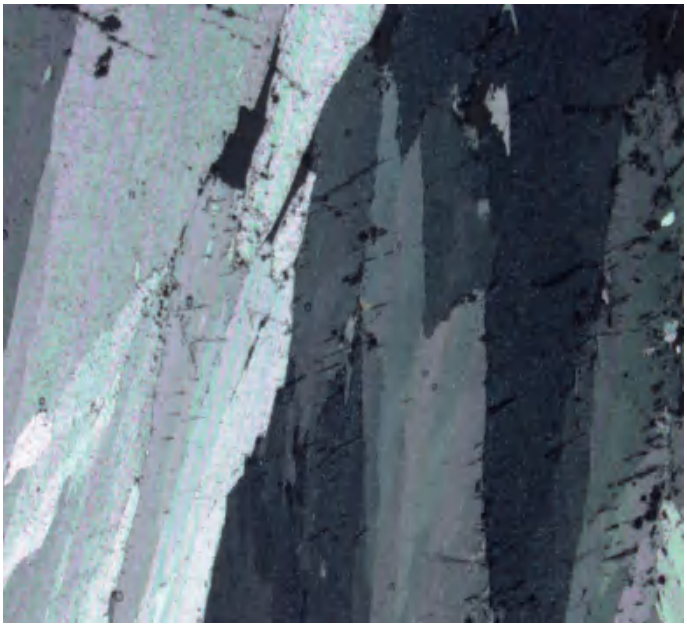

Fig. 27B

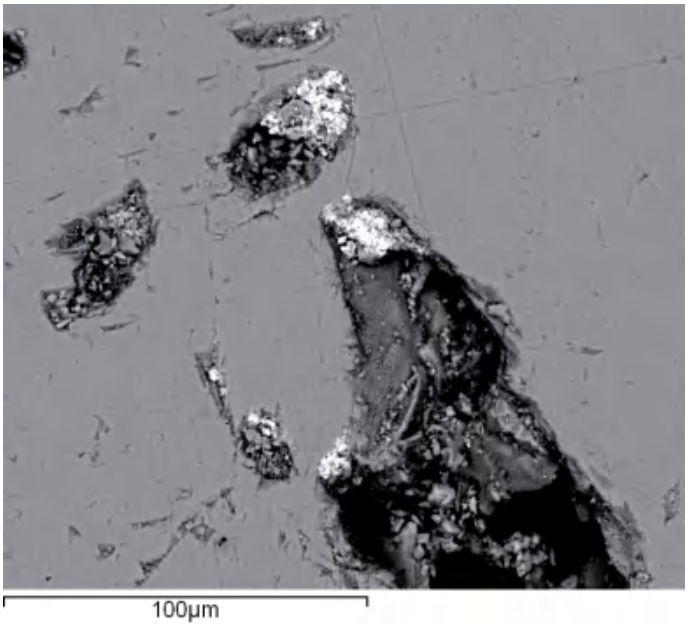

Fig. 27C

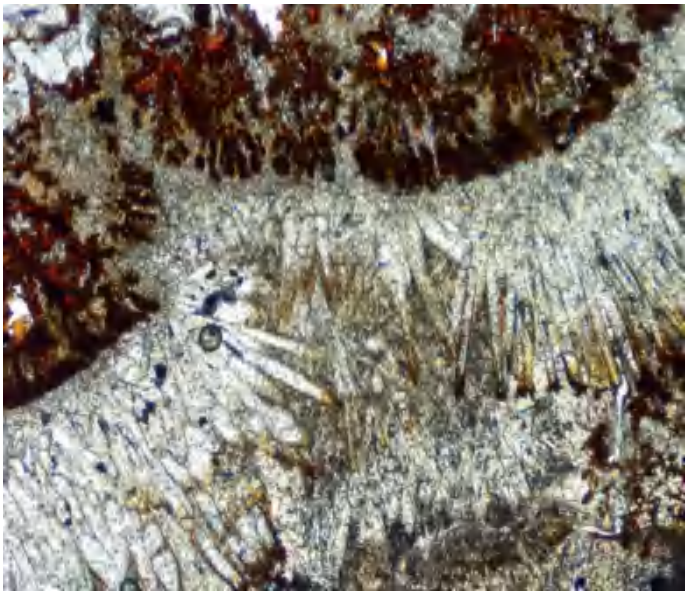

Fig. 29B

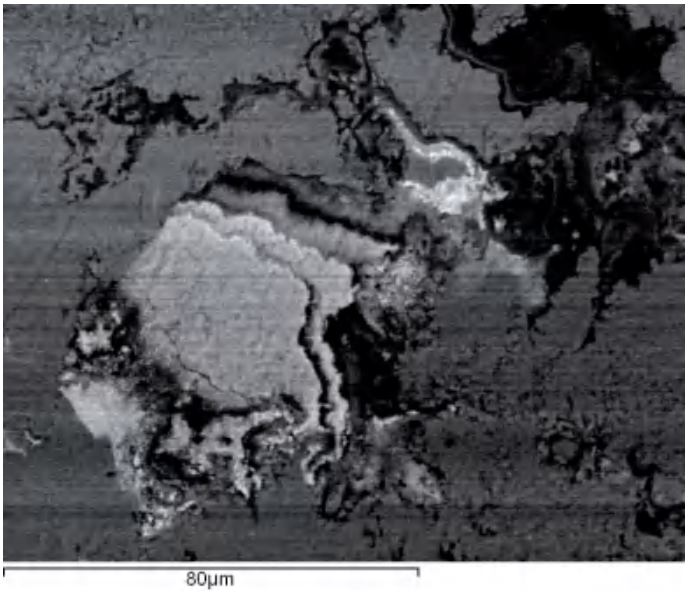

Fig. 29C

Fig. 30B

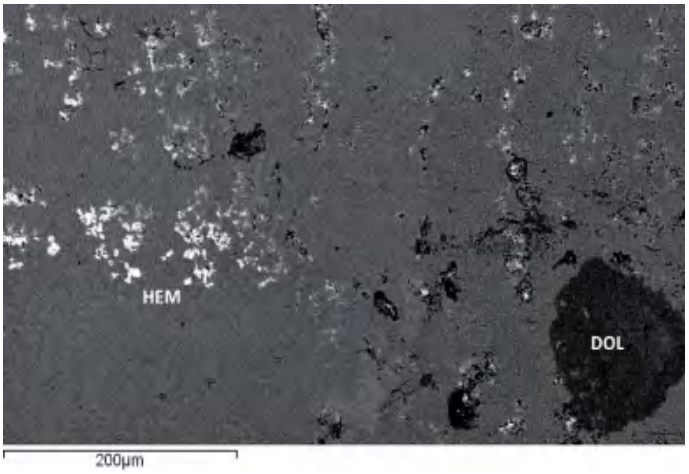

Fig. 30C

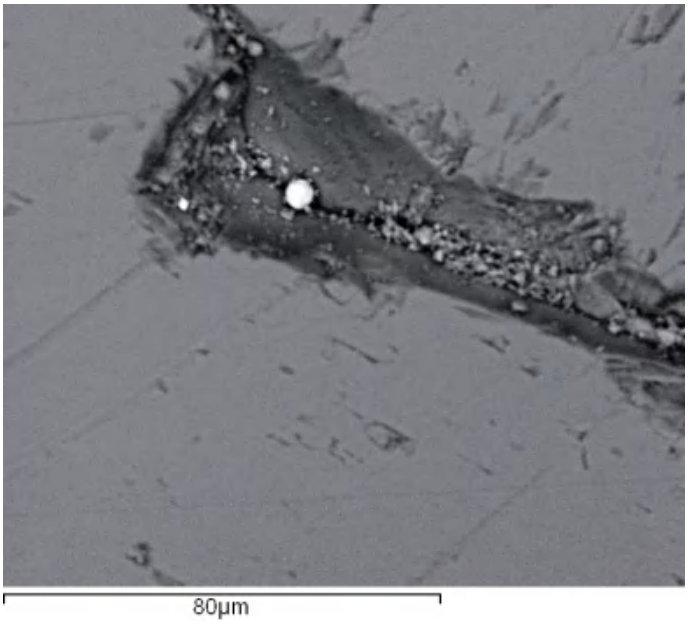

Fig. 31B

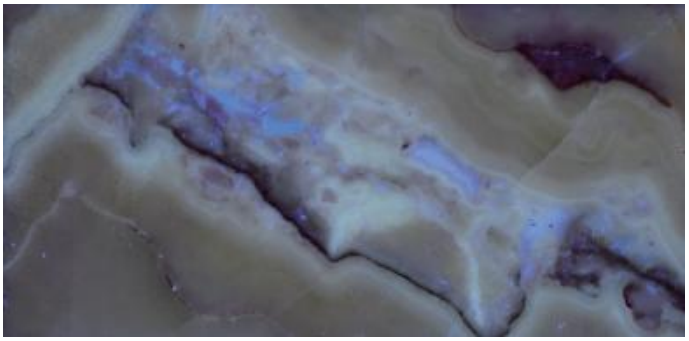

Fig. 31C

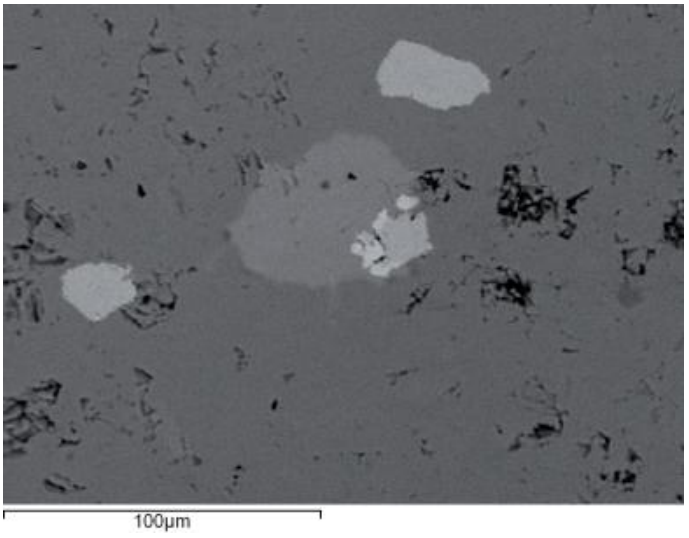

Fig. 32B

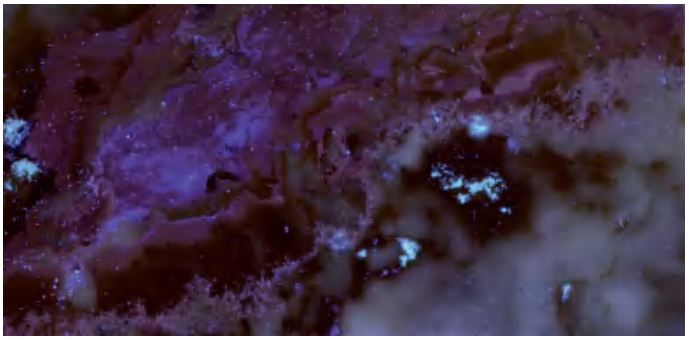

Fig. 32C

Fig. 33B

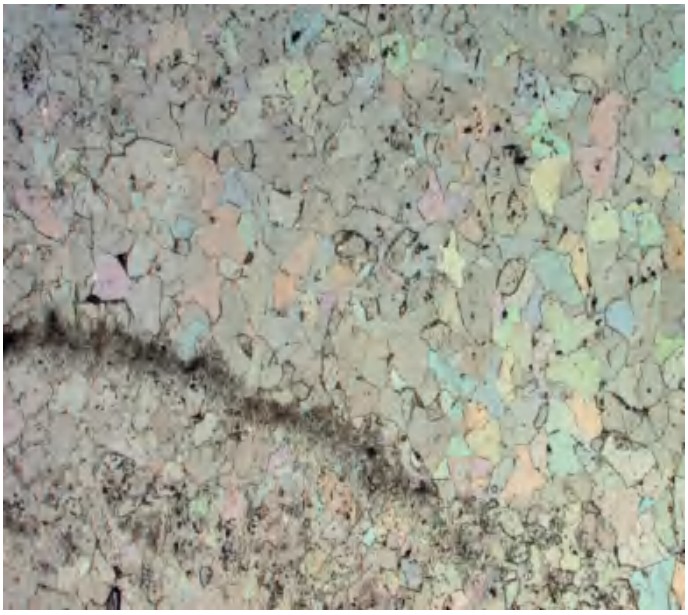

Fig. 33C

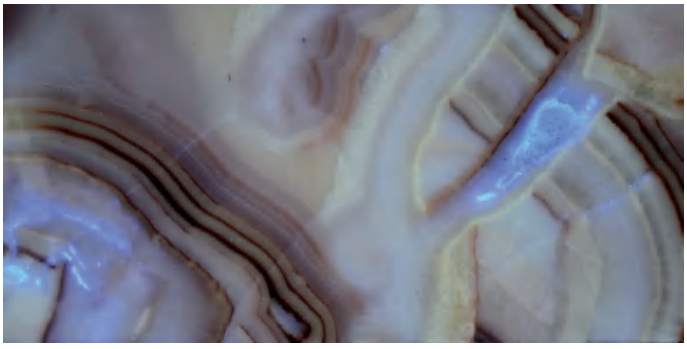

Fig. 33D

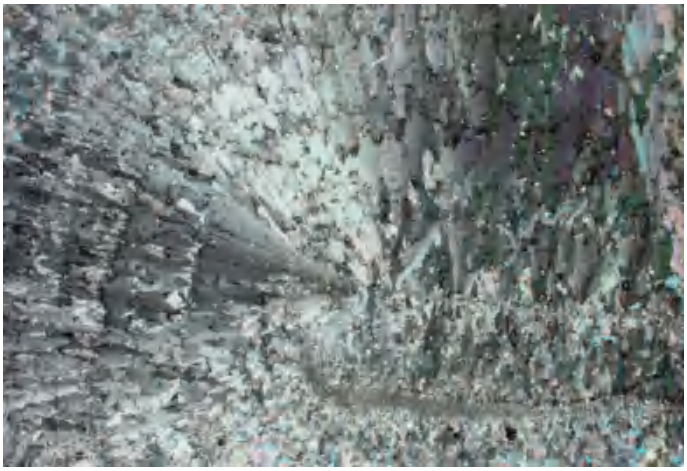

Fig. 34B

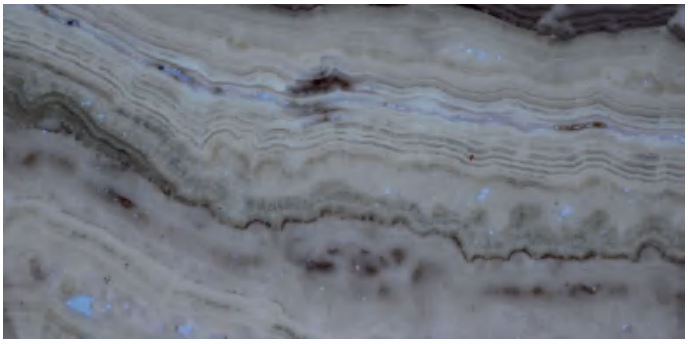

Fig. 35B

Fig. 36B

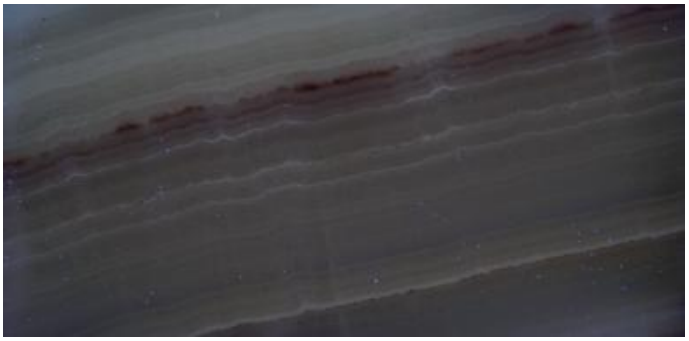

Fig. 37B

Fig. 38B

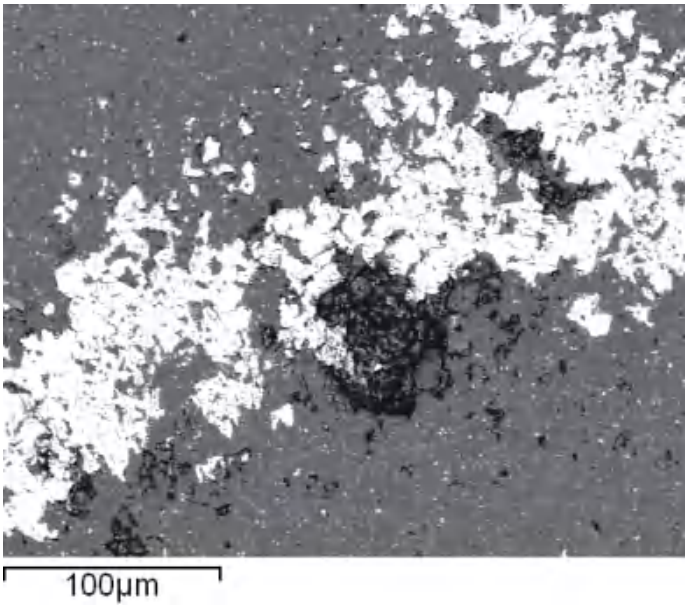

Fig. 39B

Fig. 39C

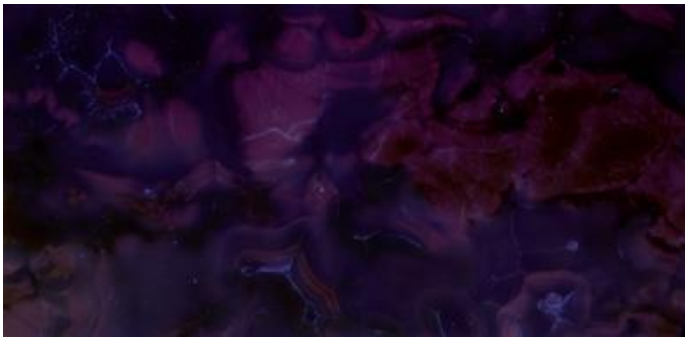

Fig. 42B

Fig. 44B

Fig. 45B

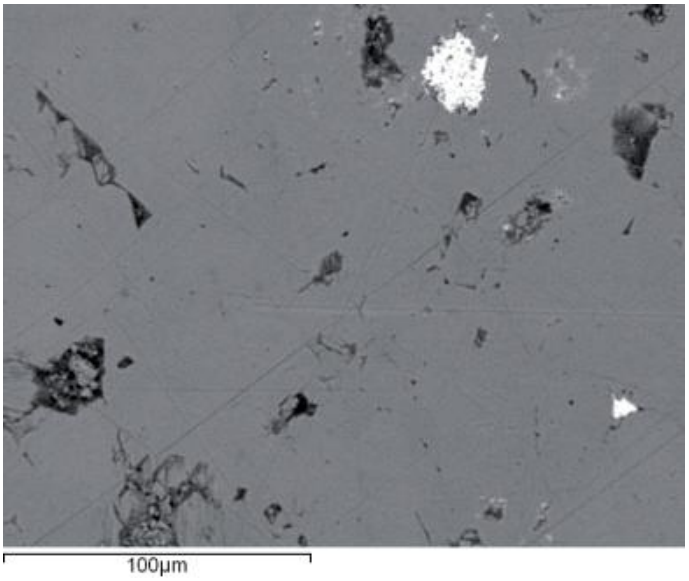

Fig. 46B

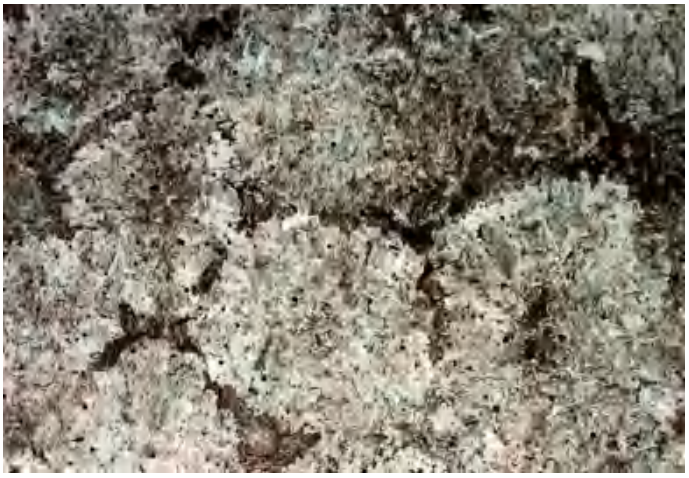

Fig. 47B

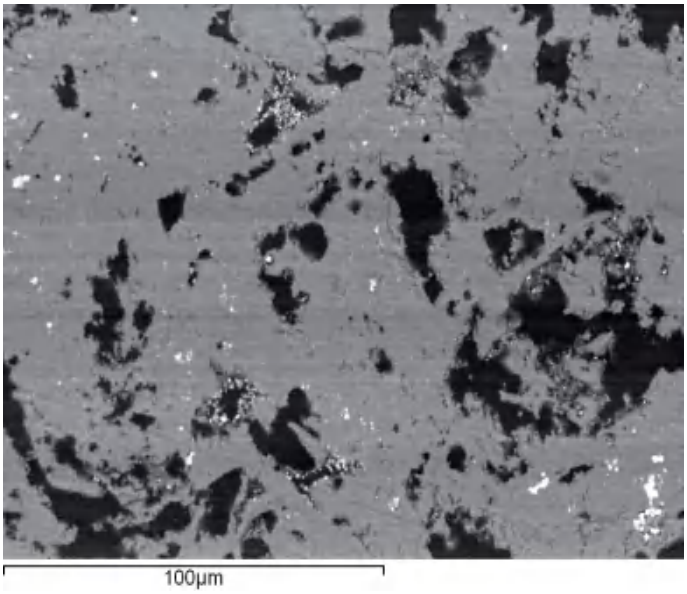

Fig. 47C

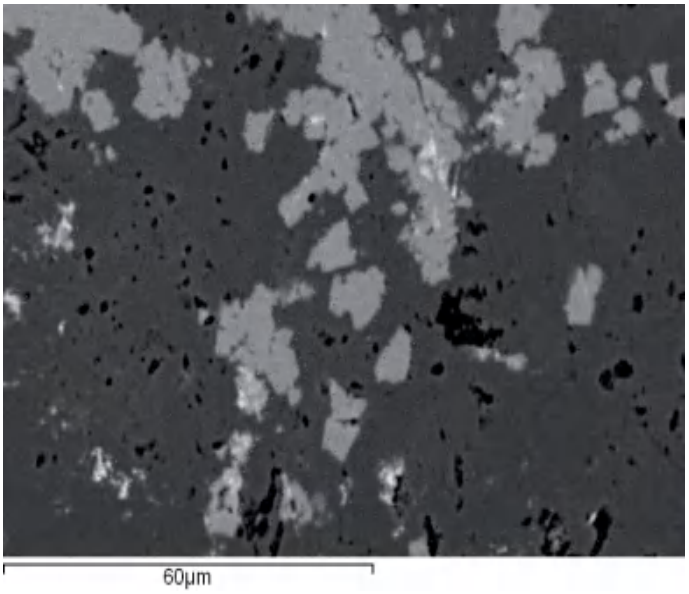

Fig. 47D

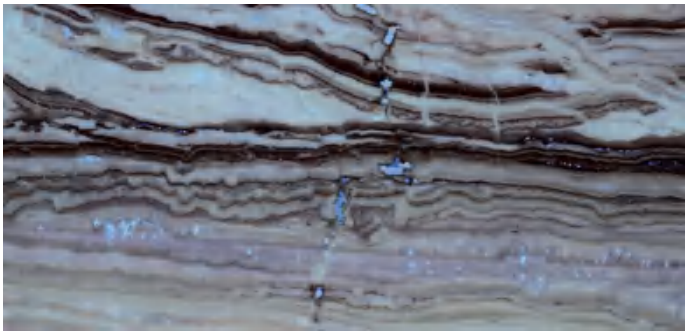

Fig. 48B

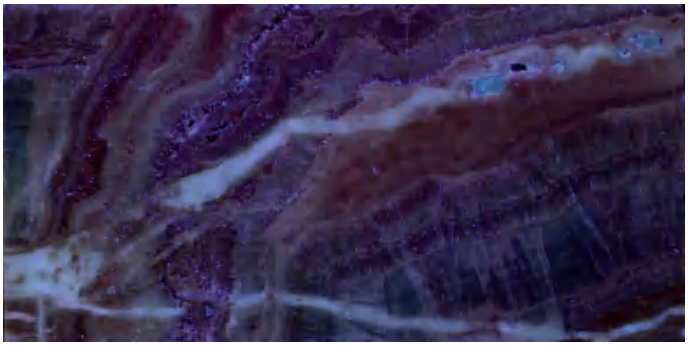

Fig. 49B

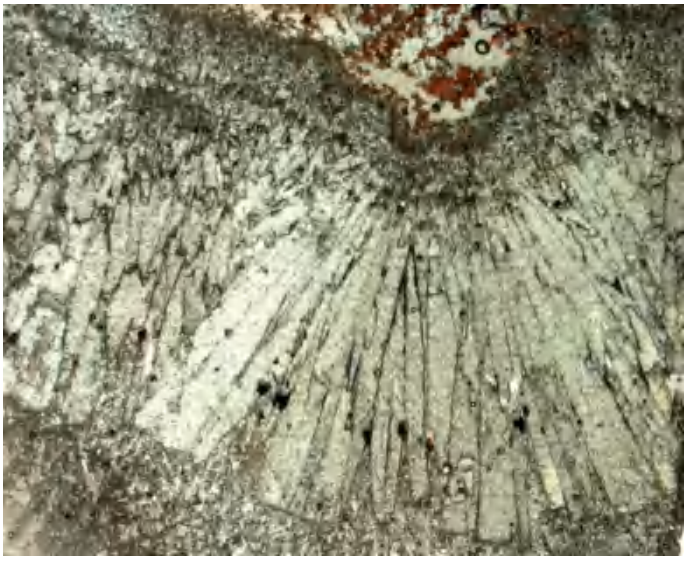

Fig. 50B

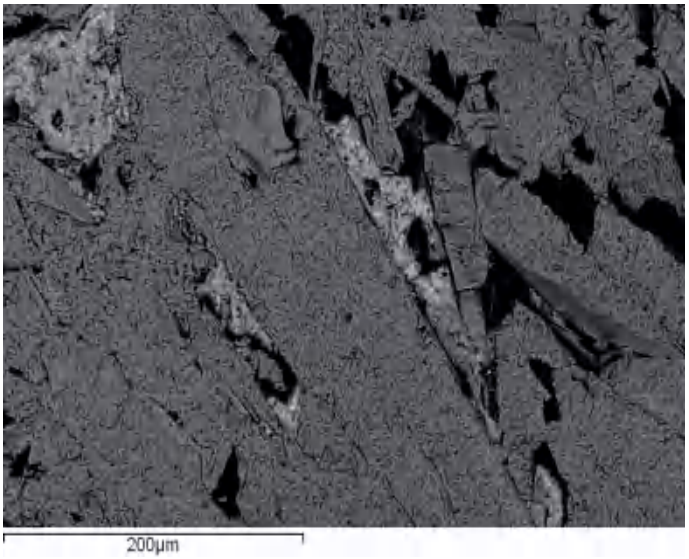

Fig. 50C

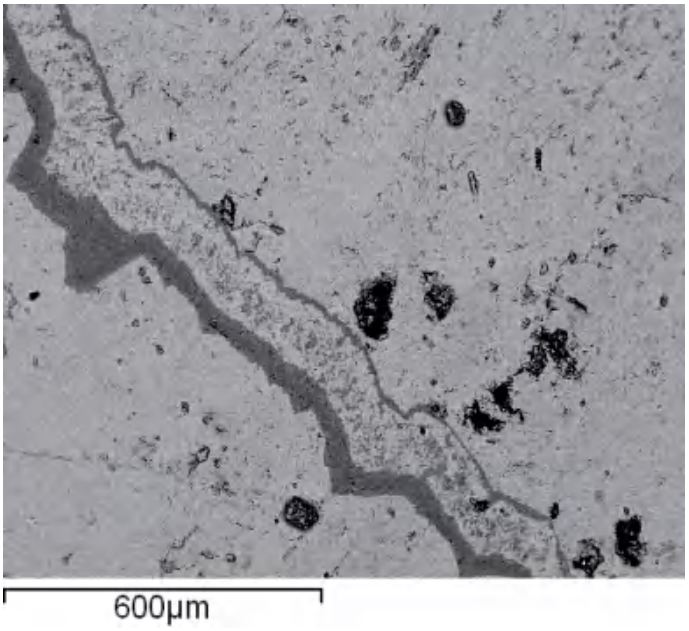

Fig. 52B

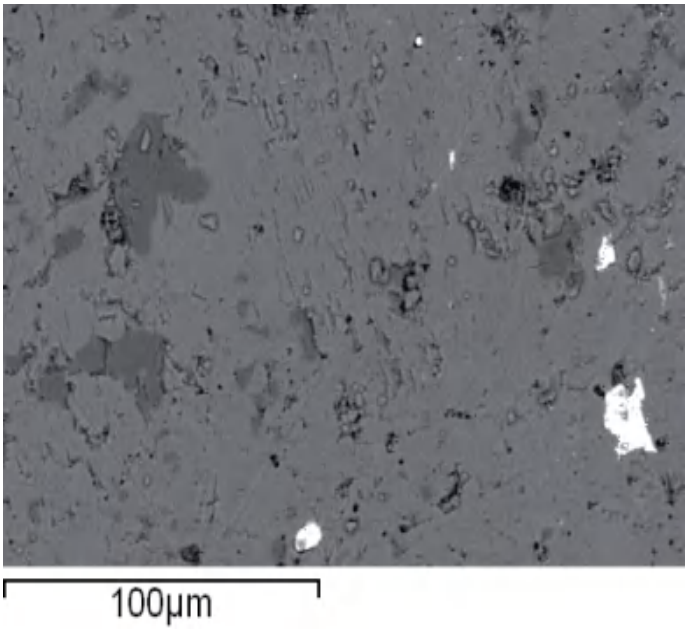

Fig. 52C

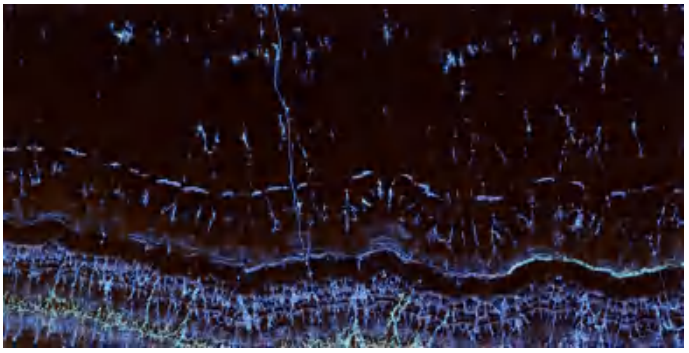

Fig. 53B

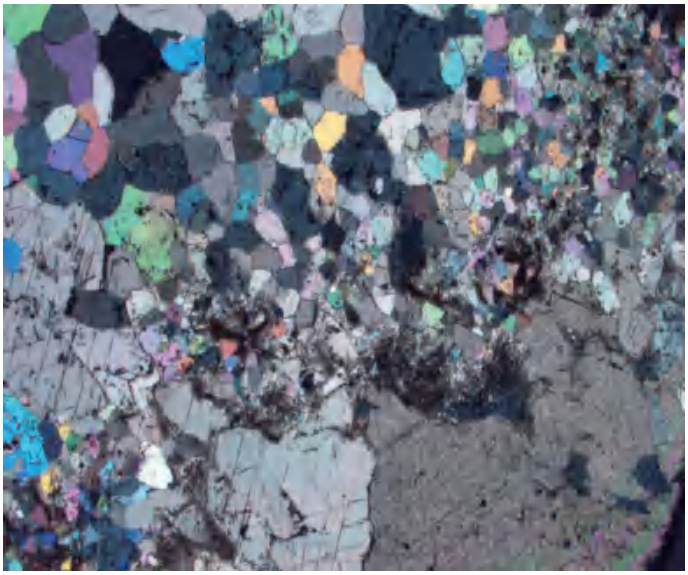

Fig. 54B

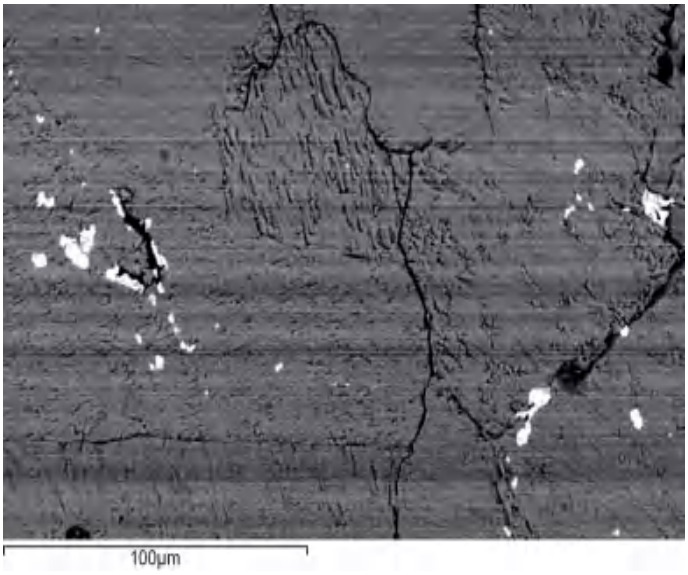

Fig. 54C

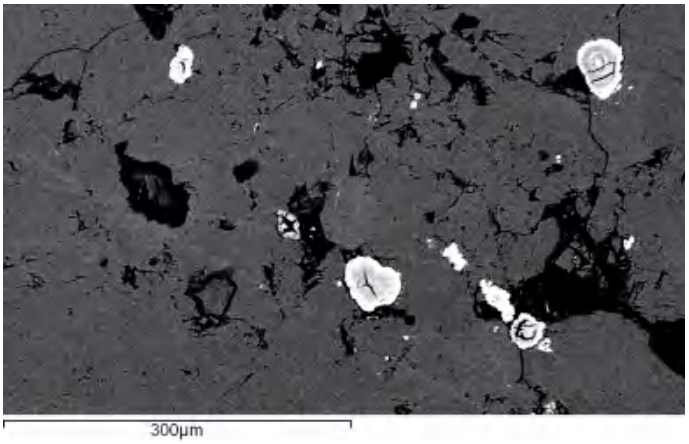

Fig. 55B

Fig. 55C

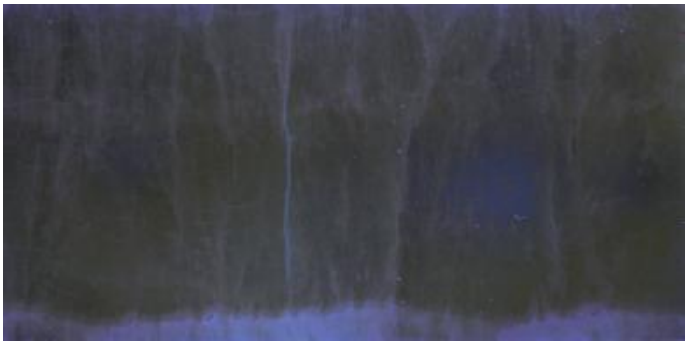

Fig. 56B

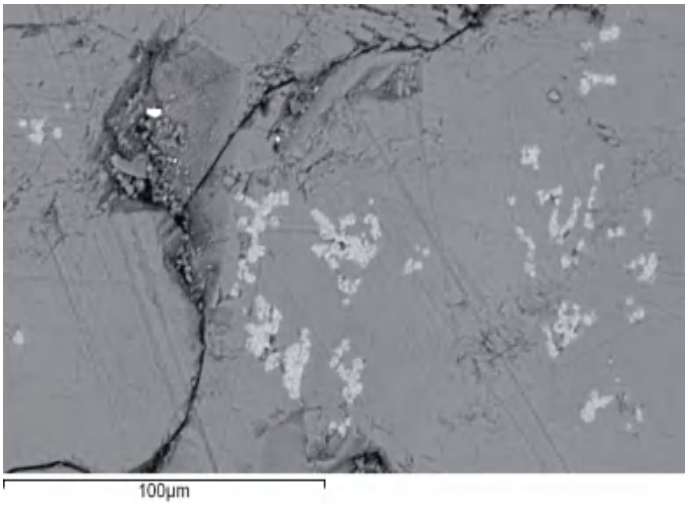

Fig. 57B

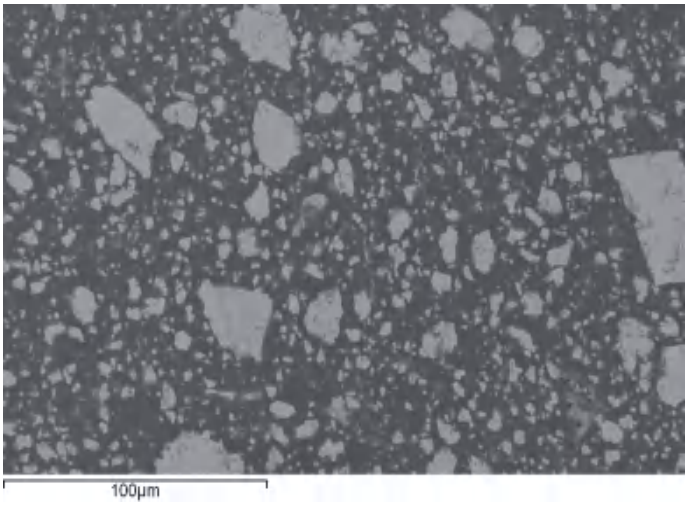

Fig. 58B

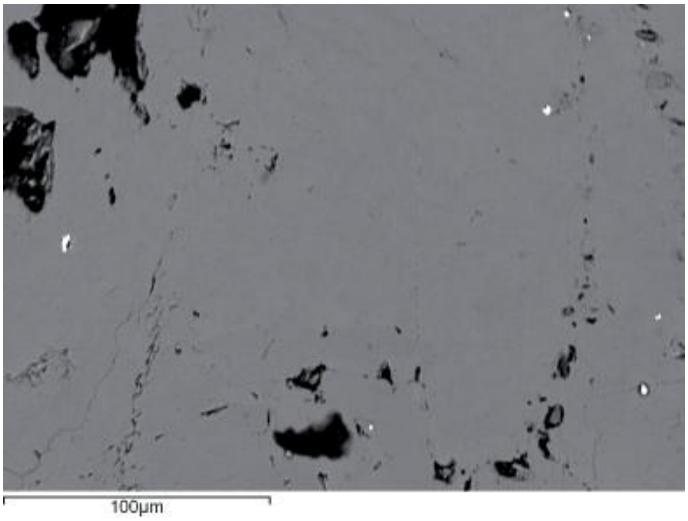

Fig. 60B

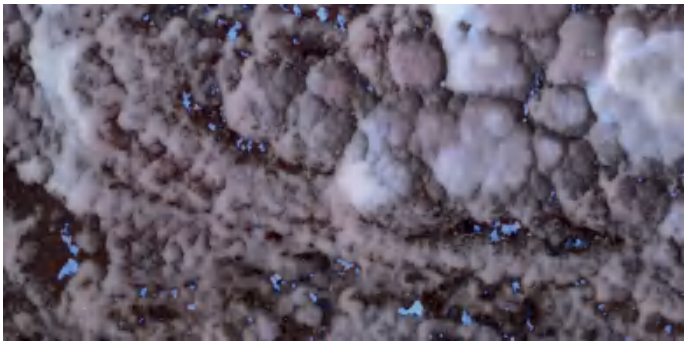

Fig. 60C

Fig. 61B

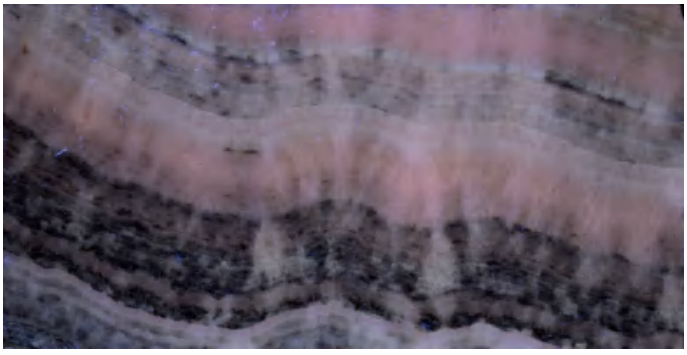

Fig. 61C

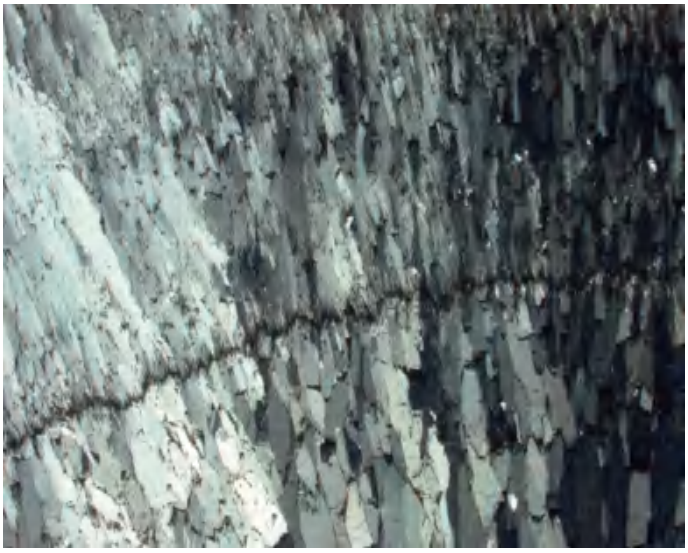

Fig. 62B

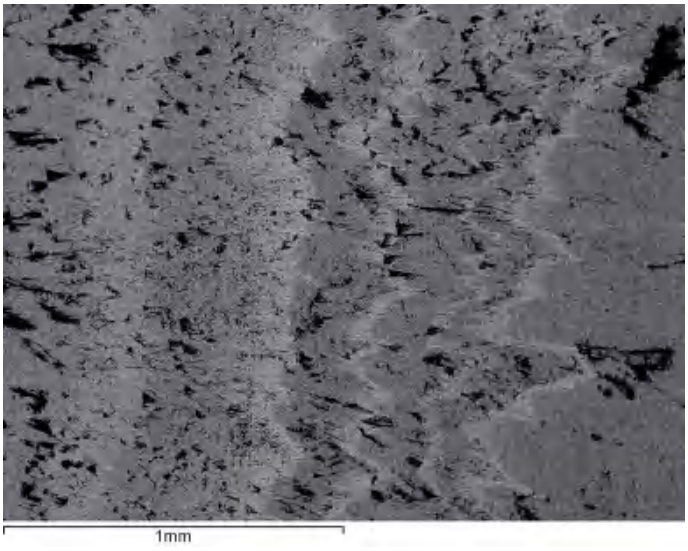

Fig. 62C

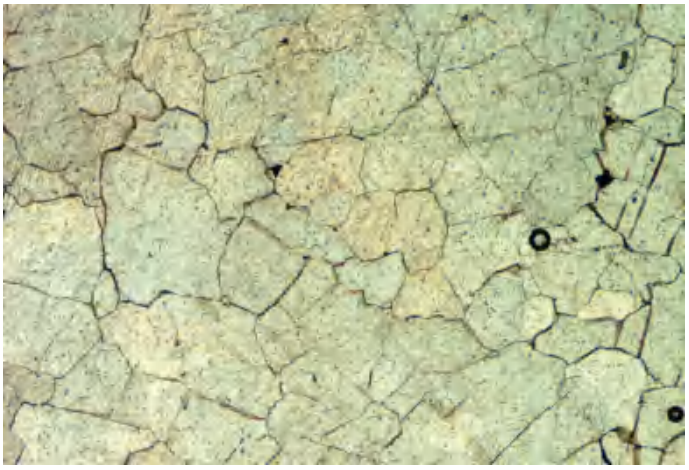

Fig. 63B

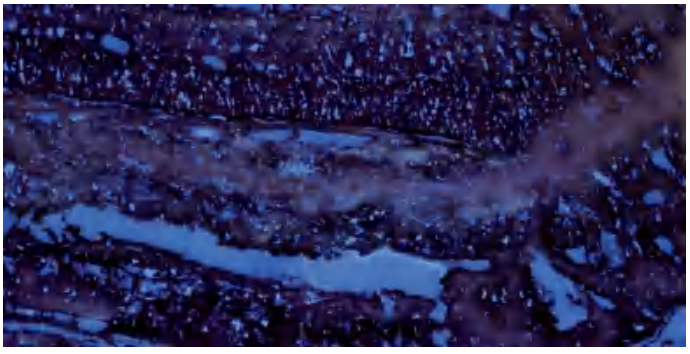

Fig. 64B

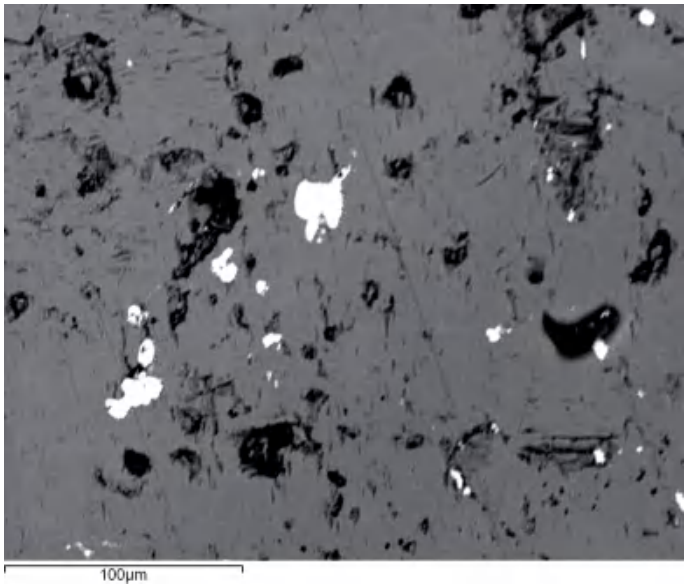

Fig. 65B

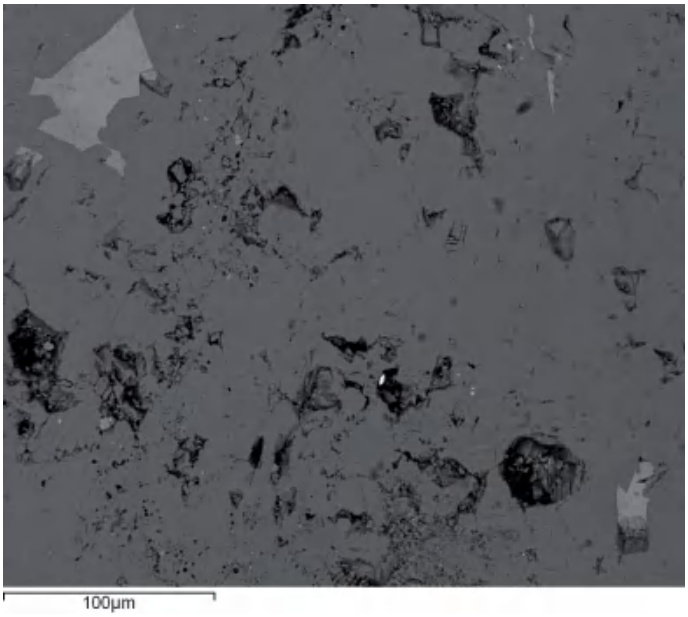

Fig. 66B

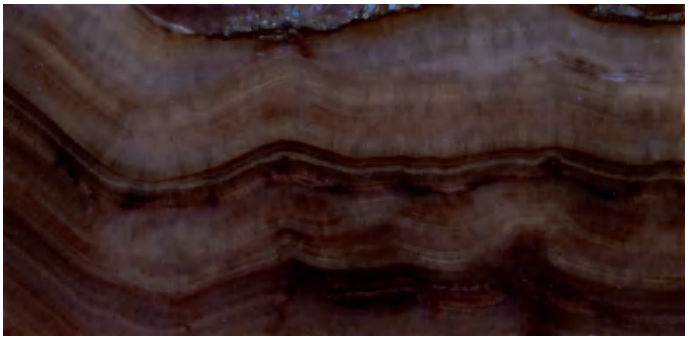

Fig. 66C

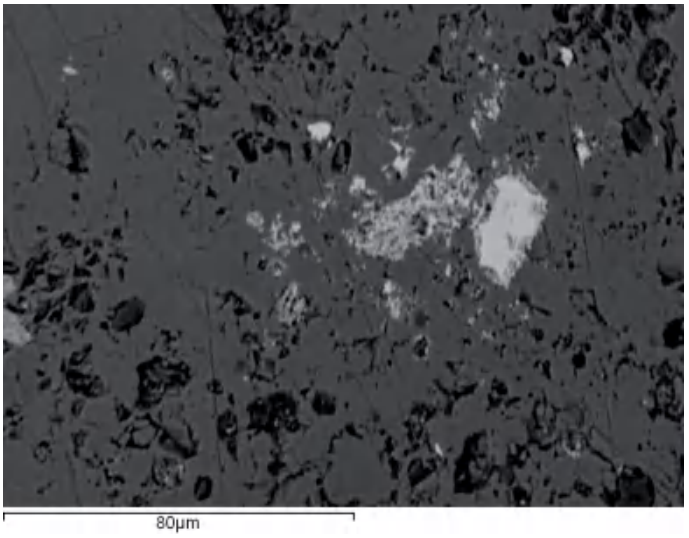

Fig. 67B

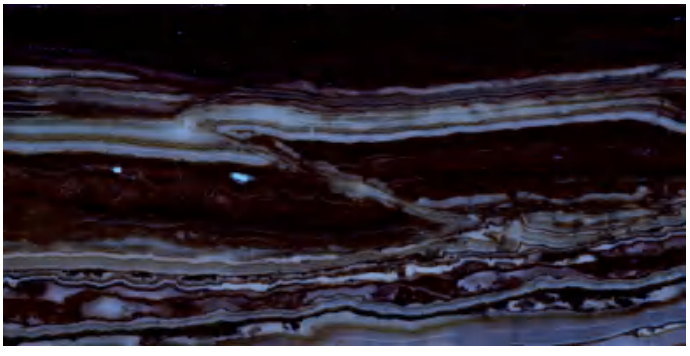

Fig. 67C

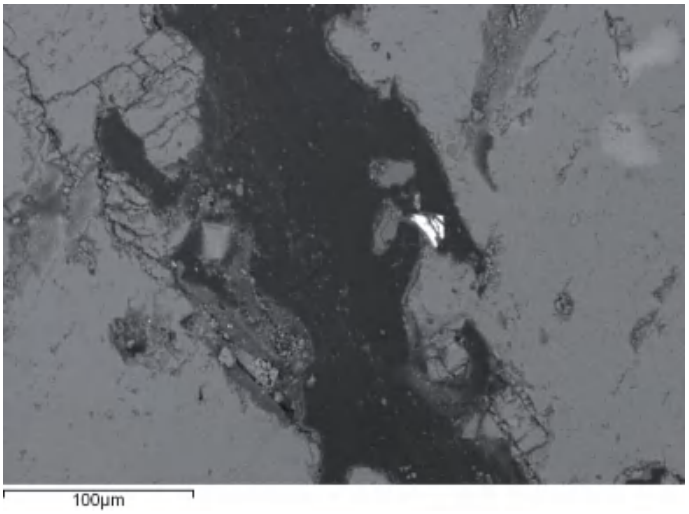

Fig. 68B

Fig. 69B

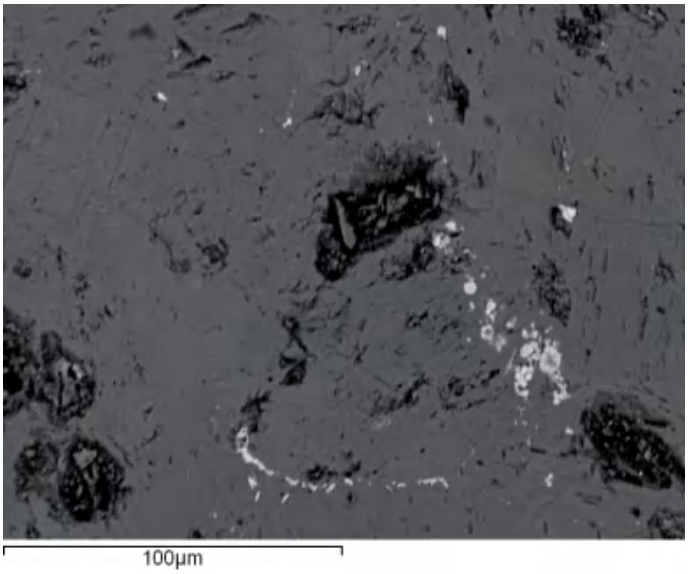

Fig. 69C