



CIBJO Guides

Opal

"A well-balanced global understanding of precious and common opal



Opal is one of the most versatile of gemstones with a wide range of gem quality varieties, both precious and common. Hence there being a clear need for a CIBJO Opal Guide that takes the curious of a journey through an opal wonderland. Seen in this image are some of the varieties of opal available on the market today. Images by Emil Weis Opals KG, and Francesco Mazzero (lower three)

Acknowledgements

The concept of a CIBJO Opal Guide originated several years ago when Andrew Cody presented a conceptual draft during a CIBJO Congress. The idea was supported within CIBJO by the late President of Sector A, Roland Naftule, who recognized that the nomenclature surrounding precious and common opal was insufficiently understood and lacked global standardisation. He noted that the terms listed in the annexes of the CIBJO Coloured Stone Blue Book required more comprehensive explanations than were then provided.

Building on this legacy, Australian members submitted updated classification system to the CIBJO Coloured Stone Commission, serving as a foundation for the development of a potential guide. In 2024, it was agreed that a formal guide would be produced under the leadership of Charles Abouchar, President of the CIBJO Gemstone Commission. To initiate the process, Charles assembled an Opal Guide Working Group composed of opal specialists from Australia, Mexico, Brazil, and Ethiopia, including representatives from major gemmological laboratories. Under Charles' leadership, the Working Group included: Ken Scarratt (Editor), Anthony Smallwood, Damien Cody, Emmanuel Fritsch, Erico Gomes, Francesco Mazzero, Gaetano Cavalieri, Hanco Zwaan, Jenni Brammall, Juergen Schuetz, Katherine Kovacs, Kathy King, Kurt Steffens, Nilam Alawdeen, Paulo Souza, Peter Semrad, Ronnie Bauer, Black Opal Direct, Steve Jaquith, Terry Coldham, and Tewodros Sintayehu.

Language

While CIBJO documents may be, and are, often translated into other languages, the official language for all CIBJO Documents is English. Therefore, all understandings and interpretations shall refer back to the English original.

Foreword

CIBJO is the French acronym for the Confédération Internationale de la Bijouterie, Joaillerie, Orfèvrerie, des Diamants, Perles et Pierres, which translates as the International Confederation of Jewellery, Silverware, Diamonds, Pearls and Stones (normally shortened to the International Jewellery Confederation). Founded in 1926 as BIBOAH, a European organisation whose mission was to represent and advance the interests of the jewellery trade in Europe, it was reorganised in 1961 and renamed CIBJO, in 2009 it was once again reorganized and officially named “CIBJO, The World Jewellery Confederation”. Today CIBJO, which is domiciled in Switzerland, is a non-profit confederation of national and international trade associations including commercial organisations involved in the jewellery supply chain. It now has members from countries representing all five continents of the world. CIBJO printed its first deliberations on terminology and trade practices in 1968.

The work of CIBJO is accomplished through Working Groups, Committees, Commissions and Sectors. Working Groups, Committees and Commissions consider standards for use in the jewellery supply chain. Sectors represent levels of trade in the jewellery industry. Sectors and commissions advise the Executive Committee on current trade practices and issues that affect the jewellery industry.

Three independent sectors exist within the confederation:

Sector A - The Products Sector

Sector B - The Supply Chain Sector

Sector C - The Service Sector

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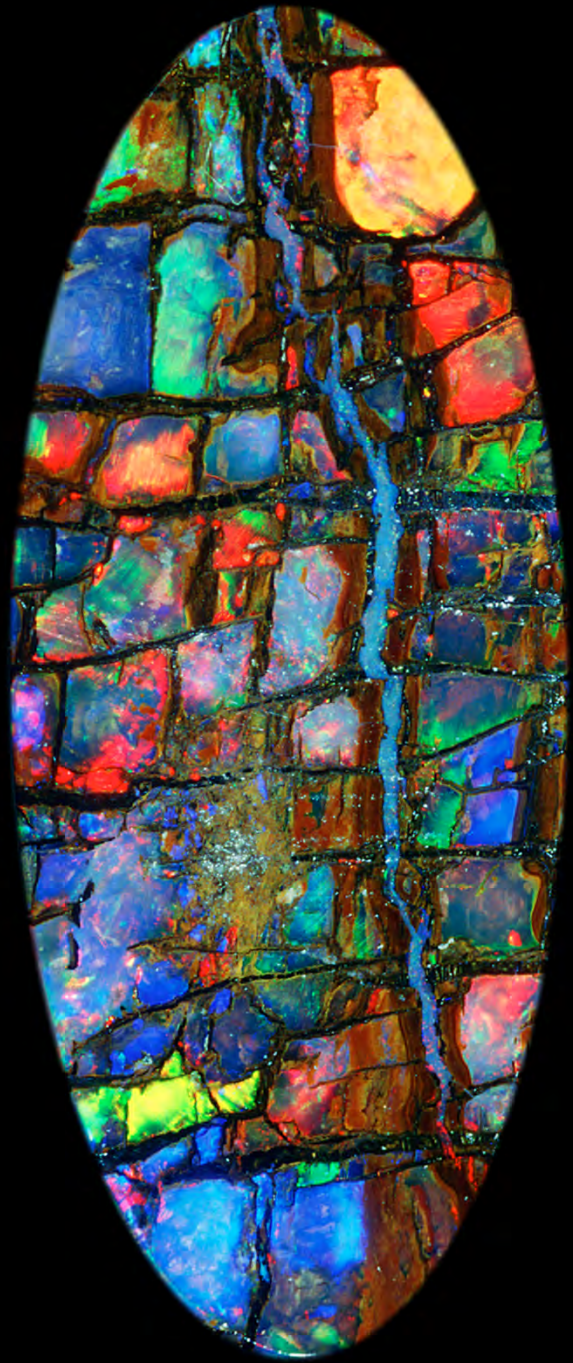
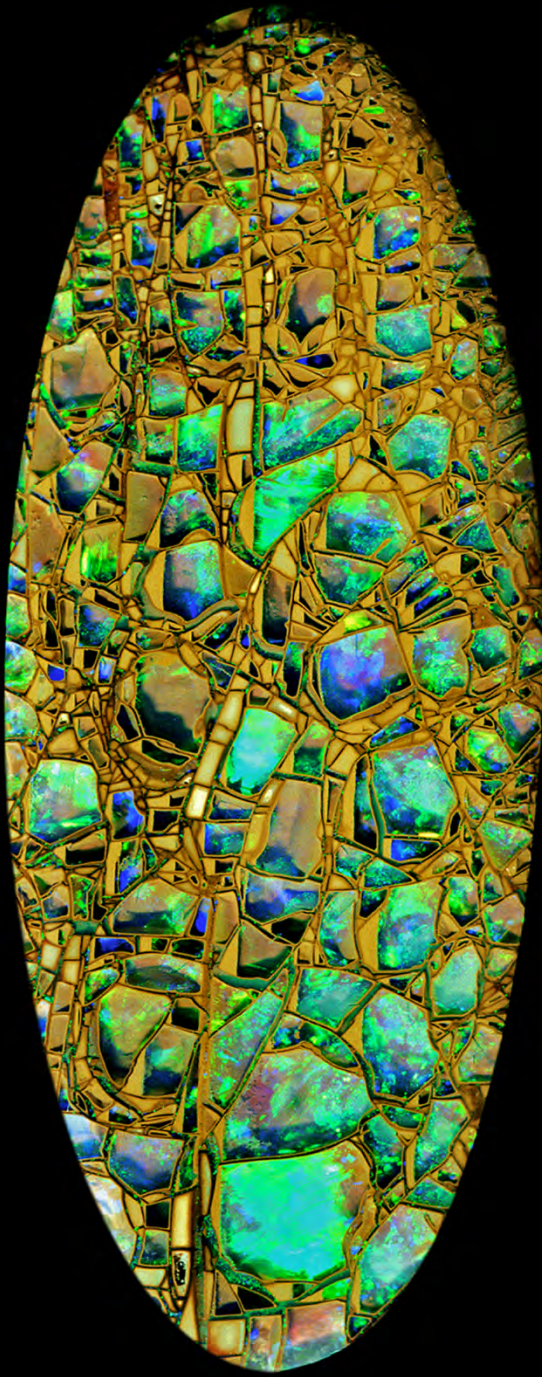
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Background

CIBJO's status on the Economic and Social Council of the United Nations (ECOSOC) enables it to represent the jewellery industry and present its strategy and objectives in support of the UN development goals. CIBJO's strategy in this respect is multi-layered. It serves to protect its constituents from factors that threaten the confidence of consumers in the jewellery industry, as well as factors that threaten the confidence of consumers in the jewellery product itself, and at the same time promote the jewellery industry, which creates sustainable economic and social opportunity in the countries and regions in which it is active.

The harmonisation of industry standards is a critical element of CIBJO's mission and stands at the heart of its effort to protect the confidence of consumers in the jewellery product itself. To advance the goal of universal standards and terminology in the jewellery industry, CIBJO developed its "Blue Book" system, which involves a definitive set of standards for the grading, methodology and nomenclature of diamonds, coloured gemstones, pearls and other organic materials, precious metals and gemmological laboratories.



Two very unusual opals with colour distributions and structures akin to cathedral windows (images Emil Weis Opals).

7.07ct red on black opal (image Cody Opal)

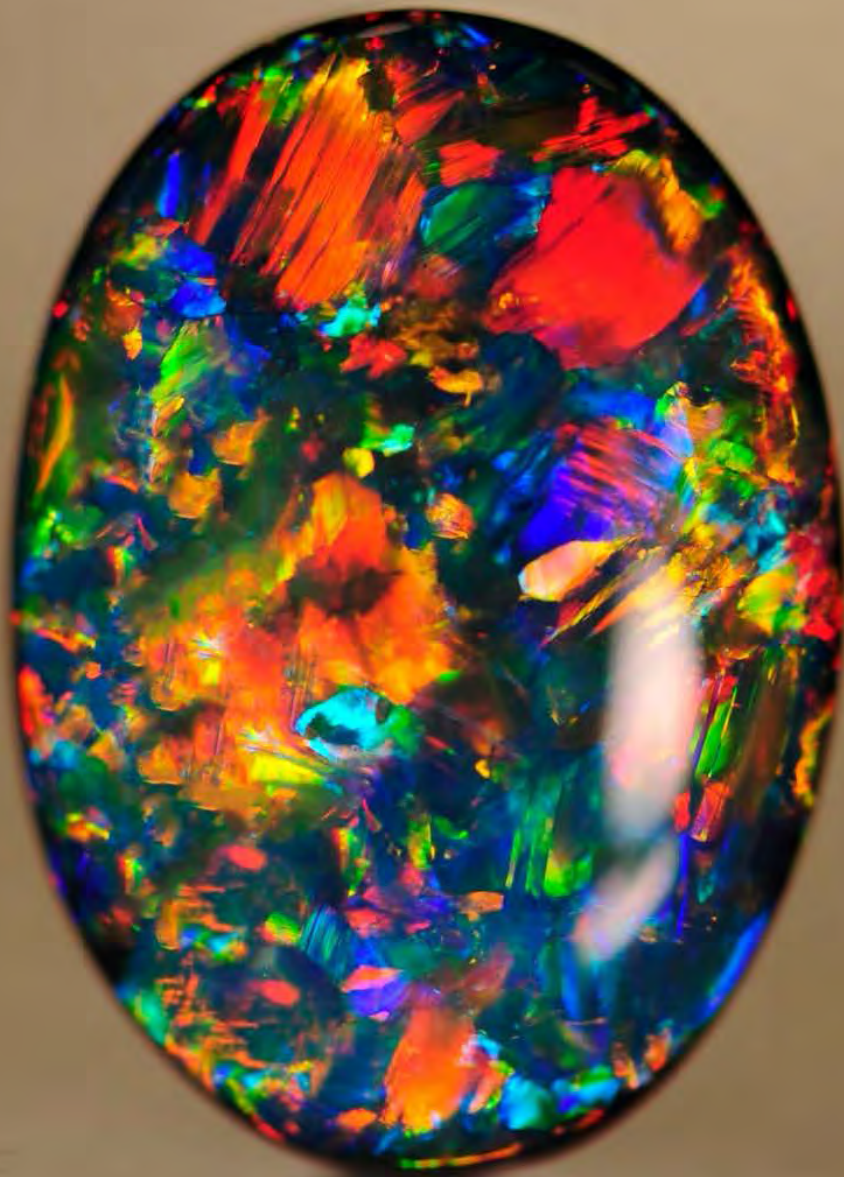


Table of Contents

ACKNOWLEDGEMENTS.....	3
LANGUAGE	4
FOREWORD	5
BACKGROUND.....	6
1. DEFINITIONS.....	12
2. UNDERSTANDING OPAL.....	17
2.1. INTRODUCTION	17
2.2. OPAL CLASSIFICATION.....	17
2.2.1. OPAL CLASSIFICATION TABLE.....	18
<i>Opal type</i>	18
<i>Description</i>	18
<i>Characteristic</i>	18
<i>Description & Instructions</i>	18
2.2.2. OPAL CLASSIFICATION EXAMPLE (A).....	19
<i>Opal Type</i>	19
<i>Description</i>	19
<i>Decision example</i>	19
<i>Characteristic</i>	19
<i>Description of Characteristics</i>	19
<i>Decision example</i>	19
2.2.3. OPAL CLASSIFICATION EXAMPLE (B).....	20
<i>Opal Type</i>	20
<i>Description</i>	20
<i>Decision example</i>	20
<i>Characteristic</i>	20
<i>Description of Characteristics</i>	20
<i>Decision example</i>	20
2.2.4. OPAL CLASSIFICATION EXAMPLE (C).....	21
<i>Opal Type</i>	21
<i>Description</i>	21
<i>Decision example</i>	21
<i>Characteristic</i>	21
<i>Description of Characteristics</i>	21
<i>Decision example</i>	21
2.3. OPAL CHARACTERISTICS	22
2.3.1. <i>Absorbency</i>	22
2.3.2. <i>Hydrophane</i>	22
2.3.3. <i>Impermeable</i>	23
2.4. PLAY OF COLOUR	23
2.4.1. <i>Dominant/Predominant Colours</i>	28
2.4.2. <i>Brightness and Intensity</i>	28
2.4.3. <i>Patterns</i>	28
2.4.4. <i>Directionality and Consistency</i>	31
2.5. BODY TONE	31
2.5.1. <i>Black opal</i>	31
2.5.2. <i>Dark opal</i>	31
2.5.3. <i>Light opal</i>	31

2.6.	DIAPHANEITY	35
	<i>Diaphaneity</i>	35
	<i>Explanation</i>	35
	<i>Example image</i>	35
2.7.	TREATMENT	35
2.7.1.	<i>Impregnation</i>	36
2.7.2.	<i>Dyeing</i>	36
2.7.3.	<i>Carbonisation</i>	36
2.7.4.	<i>Foil-backing</i>	37
2.7.5.	<i>Black paint backing</i>	37
2.8.	ADDITIONAL FEATURES AND VALUE FACTORS	38
2.8.1.	<i>Percentage coverage in relation to play of colour</i>	38
2.8.2.	<i>Other optical phenomena</i>	39
2.8.3.	<i>Clarity and inclusions</i>	40
2.9.	CUT AND FINISH	41
3.	DESCRIBING COLOUR	47
4.	TYPES OF OPAL	47
4.1.	NATURAL OPAL	47
4.2.	PRECIOUS OPAL	47
4.3.	COMMON OPAL	48
4.3.1.	<i>Types and varieties of Common Opal</i>	49
4.3.2.	<i>Potch</i>	50
5.	TYPES OF COMPOSITE OPAL	51
5.1.	COMPOSITE OPAL	51
5.2.	DOUBLET	52
5.3.	TRIPLET	53
5.4.	MOSAIC AND INTARSIA	55
5.5.	INLAY	56
6.	TYPES OF SYNTHETIC OPAL	56
7.	IMITATION OR SIMULANTS	57
7.1.	SLOCUM STONE	58
7.2.	MULTICHROIC GLASS	59
8.	OPAL-LIKE NATURAL MATERIALS	59
8.1.	AMMOLITE	59
8.2.	LABRADORITE	59
9.	THE CLASSIFICATION TABLES	60
9.1.	NATURAL OPAL – SOLID OPAL	61
9.2.	NATURAL OPAL – OPAL ON HOST ROCK (PRESENTED NATURALLY ATTACHED TO THE HOST ROCK)	62
9.3.	NATURAL OPAL – OPAL IN HOST ROCK (NATURAL OPAL AS INFILLINGS OF VOIDS OR BETWEEN GRAINS OF A HOST ROCK. PRESENTED IN ONE PIECE)	63
9.4.	COMPOSITE OPAL (OPAL OF ANY VARIETY WHICH HAS BEEN MANUALLY ATTACHED TO ANY MATERIAL)	64
9.5.	SYNTHETIC OPAL (MANUFACTURED MATERIAL THAT HAS THE SAME OR VERY SIMILAR COMPOSITION TO OPAL I.E. $\text{SiO}_2 \cdot \text{NH}_2\text{O}$)	65
9.6.	IMITATION OR SIMULANT OF OPAL	66
10.	OPAL PRODUCTION	67
10.1.	HISTORY	67
10.2.	IMPORTANT WELL KNOWN OPAL PRODUCING COUNTRIES	70
10.2.1.	<i>Australia</i>	70
10.2.1.1.	<i>Geology</i>	71
10.2.1.2.	<i>Lightning Ridge New South Wales – Home of black precious opal</i>	74

10.2.1.3.	<i>White Cliffs, New South Wales – Australia’s first precious opal field</i>	82
10.2.1.4.	<i>South Australian Opal Fields</i>	86
10.2.1.5.	<i>Queensland Opal Fields – Home of boulder opal</i>	99
10.2.1.6.	<i>Other Australian Locations</i>	106
10.2.2.	<i>Brazil</i>	108
10.2.2.1.	<i>Geology</i>	109
10.2.2.2.	<i>Major Brazilian Opal-Producing Regions</i>	110
10.2.2.2.1.	<i>Piaui</i>	110
10.2.2.2.2.	<i>Rio Grande do Sul</i>	119
10.2.2.2.3.	<i>Bahia</i>	121
10.2.2.2.4.	<i>Other Brazilian Locations</i>	122
10.2.3.	<i>Ethiopia</i>	126
10.2.4.	<i>Mexico</i>	136
10.2.5.	<i>Peru</i>	143
10.3.	OTHER OPAL PRODUCING LOCALITIES (LESS KNOWN, HISTORICAL AND CURRENT)	144
10.3.1.	<i>Austria</i>	145
10.3.2.	<i>Bulgaria</i>	146
10.3.3.	<i>Canada</i>	147
10.3.4.	<i>Chile</i>	148
10.3.5.	<i>France</i>	149
10.3.6.	<i>Germany</i>	150
10.3.7.	<i>Honduras</i>	151
10.3.8.	<i>Hungary</i>	152
10.3.9.	<i>Indonesia</i>	152
10.3.10.	<i>Kenya</i>	156
10.3.11.	<i>Kosovo</i>	157
10.3.12.	<i>Madagascar</i>	158
10.3.13.	<i>Mali</i>	159
10.3.14.	<i>Nicaragua</i>	160
10.3.15.	<i>Portugal</i>	161
10.3.16.	<i>Slovakia</i>	163
10.3.17.	<i>Spain</i>	170
10.3.18.	<i>Tanzania</i>	171
10.3.19.	<i>Turkey (Türkiye)</i>	172
10.3.20.	<i>United States of America</i>	174
10.4.	EXTRATERRESTRIAL OPAL	176
11.	OPAL CARE	177
11.1.	CRAZING AND WHITENING	178
12.	APPENDIX A – LMHC INFORMATION SHEET #13 HYDROPHANE OPAL	180
	REFERENCES	181

1. Definitions

Absorbency; absorbency in opal relates to the absorption, or loss, of water or another liquid by an opal either when immersed, or exposed in air, under normal conditions. Absorbency varies; some opal is not very absorbent and changes very little in mass or appearance, but in some cases changes to the appearance, mass and/or stability of the opal can be dramatic.

Absorption Factor; is measured by percentage change in weight after immersion in a fluid. Hydrophane opal may have varying rates of absorption and capacity for absorption (see Appendix A).

Artificial; all material that simulates or resembles natural opal but is manufactured.

Black Opal; shows play of colour within or on a black body tone when viewed face up and may be designated N 1, N2, N3 or N4 on the Scale of Body Tone.

Black Crystal Opal; shows a degree of transparency and the colours are often brilliant and can appear to come from the depths of the gemstone.

Body Hue; the hue or colour of the body of an opal when ignoring its play of colour (if present).

Body Lightness; synonym for body tone (cross ref).

Body Hue/Colour Saturation; the intensity or purity of a colour.

Body Tone; the relative darkness or lightness of an opal when ignoring its play of colour (if present). It is assessed from the 'Face Up' or top view of the stone, not the base.

Boulder Opal; Natural Opal presented as one piece where the opal naturally occurs in or on the host rock.

Brightness in play of colour; The intensity level of the light within the play of colour returned to the observer after diffraction by the opal.

Colour play; See play of colour.

Common Opal; an historical mineralogical or gemmological term used to describe an opal that does not exhibit play of colour.

Composite; natural and/or synthetic opal composed of two or more components which have been assembled by bonding or other artificial methods.

Composites include but are not limited to doublets, triplets, mosaics, inlay and plastic embedded opal.

Contra-luz opal; a transparent opal that shows play of colour when light is transmitted through it. The words contra-luz literally translates to “against the light.”

Crazing; the formation of a network of fine cracks or fissures on or in an opal

Crystal Opal; opal with play of colour that is transparent.

Cutting and polishing; the process of sawing, grinding and polishing an opal from rough; includes carving

Dark Opal; opal with a dark body tone (body lightness) is N5 and N6 when viewed face up and may be designated N1, N2, N3 or N4 for black opal on the scale of body tone.

Diaphaneity; diaphaneity refers to the degree of transparency of an opal. An opal may be described as transparent, translucent or opaque – see the definitions for these terms below.

Diffraction; the process by which a beam of light or other system of waves is spread out as a result of passing through a narrow aperture or across an edge or lattice, typically accompanied by interference between the wave forms produced.

Directionality; Directionality implies a tendency or ability to move or be oriented in a specific direction.

Doublet; a composite of two pieces where a slice of natural or artificial opal is cemented to a base material.

Fire Opal; a transparent to translucent opal that has a yellow, orange, or red body hue. Fire opal may present with or without a play of colour.

Face; presentation face of a stone.

Host Rock; the rock in which opal forms. The rock is sometimes included in the opal when cut as a gemstone.

Hyalite Opal; a type of opal that is transparent, colourless, or pale light green in colour, and is often found in botryoidal (grape-like) shapes. Its most distinctive feature is its bright green or yellow fluorescence under UV light, and sometimes it fluoresces in ambient light without needing UV light

Hydrophane Opal; opal with or without play of colour that is absorbent. Hydrophane opal can change appearance, mass and/or stability depending on the amount of water it contains at any given point in time (see Appendix A)..

Hydrothermal opal; opal found in a hydrothermal environment. It results from the contact of basic subvolcanic rocks with sedimentary rocks.

Imitation; imitation opal is material manufactured to simulate or resemble natural opal but that has different chemical composition, optical or physical properties to natural opal.

Impermeable; Impermeable opal does not absorb, or lose water or other liquid, either when immersed, or exposed in air.

Inlay; embedding pieces of an opal manually attached to any material, flush with its surface or pieces of precious opal that have been cut and fitted into specially cast pieces of jewellery and are polished flat and flush to the surface of the item.

Intarsia; 'stone in stone' inlay. In opal intarsia, pieces of opal are inlaid into stone.

Ironstone; a sedimentary rock, either deposited directly as a ferruginous sediment or created by chemical replacement, containing a substantial proportion of an iron compound

Jelly opal – (also called water opal); is transparent to semi-transparent and exhibits no to slight play-of-colour.

Light Opal; translucent to semitranslucent opal with play of colour against a white or light body tone (N7, N8, N9).

Matrix Opal (Natural Opal in Host Rock); that is, opal presented in one piece where the opal is intimately diffused as infillings of veins, pores or holes or between grains of the host rock.

Mosaic; a picture or pattern produced by arranging multiple small pieces of opal closely adjacent to one another and manually attached to a base of any material or are a composition of a small flat or irregularly shaped pieces or 'tiles' of natural opal cemented as mosaic pattern on a dark base material. Sometimes pieces of opal are also encompassed in a resin as in 'opal chip' gemstones.

Moss opal; opal containing dendrite inclusions of another mineral that cause a moss or fern-like appearance within the gem

Multichroic glass; is glass which can display multiple different colours depending on lighting conditions, sometimes referred to as dichroic glass,

Natural Opal; opal derived solely from nature presented in one piece in a natural state except for cutting and polishing.

Nomenclature; the devising or choosing of names for things, especially in a science or other discipline. The terms used and names given in the classification of opal.

Non-Absorbent; does not absorb or soak up liquids.

Opal; Opal is an hydrated amorphous form of silica $\text{SiO}_2 \cdot n\text{H}_2\text{O}$.

Opal-A; a variety of amorphous, hydrated silica ($\text{SiO}_2 \cdot n\text{H}_2\text{O}$), without a crystalline structure, a mineraloid, characterized by a broad and diffuse band ($d=4.10\text{\AA} / 4.12\text{\AA}$) in X-ray diffraction.

Opal-CT; Includes sectors or nano-size areas of cristobalite and/or tridymite, which are silica polymorphs and cryptocrystalline. These regions are stacked together with amorphous non-crystalline silica. Like this it can be looked at as a key intermediate phase between amorphous opal (in its entirety) and chalcedony (cryptocrystalline in its entirety).

Oolitic opal; opal containing dark black, brown or white spherical inclusions.

Opal in host rock; opal presented in its natural state (apart from cutting and polishing) where the opal is intimately diffused as infilling veins, pores, holes and voids, or between grains in the host rock.

Opal on host rock; opal presented in its natural state (apart from cutting and polishing) and naturally attached to the host rock as a layer or where there is a substantial amount of opal on the presentation face.

Opaque; not transparent or translucent; impenetrable to light; not allowing light to pass through.

Play of Colour; the phenomenon whereby opal may display spectral colours. It is caused by the diffraction of white light. The presence of play of colour identifies the opal as precious opal.

POC: Play of Colour.

Potch; colloquial term for some Australian common opal.

Precious Opal; opal which exhibits a play of colour.

Refraction; the deflection of electromagnetic radiation, e.g., visible light, infrared, passing through the interface between one medium and another.

Sandstone; is a clastic sedimentary rock composed mainly of sand-sized (0.0625 to 2 mm) silicate grains, cemented together by another minerals. Sandstones comprise about 20–25% of all sedimentary rocks

Sedimentary opal; descriptive term for opal formed within a sedimentary environment.

Simulant; a material which exhibits a visual appearance similar to opal but that does not have the same structural or chemical properties of opal.

Solid opal; term has been traditionally used to describe homogeneous opal.

Synthetic opal; synthetic opal is a manufactured material with the same chemical composition ($\text{SiO}_2 \cdot n\text{H}_2\text{O}$), microstructure, optical and physical properties as natural opal¹.

Translucent; transmitting and diffusing light so that objects beyond cannot be seen clearly.

Transparent; allowing light to pass through so that objects behind can be clearly seen.

Treated opal; opal that has been treated in order to change its appearance or properties, for example to change body tone or colour, stability or hardness. Includes, but is not limited to, dying, smoking, painting, coating, impregnation, filling, stabilisation, heating, or enhancement processes of any kind. Cutting and polishing is not considered a treatment.

Variety; factors such as diaphaneity, diffracted colours, patterns, body colour, phenomena, morphology, form and other gemmological factors can all play a role in the determination of an opal's variety.

Volcanic opal; opal found in volcanic environments.

Water opal; is transparent (clear) opal from Mexico, exhibiting no to slight play-of-colour.

White opal; white opals are those that exhibit a white or light grey bodycolour with or without a play of colour.

¹ It should be noted that much of the material presently marketed as synthetic opal does not meet the definition of a synthetic as it does not have the same chemical composition, under such circumstances it should be referred to as an opal imitation.

2. Understanding Opal

2.1. Introduction

This guide has been created to aid in describing and classifying opal.

Opal as a gemstone occurs in many differing types, from a multitude of differing localities, each displaying its own special features and characteristics making it desirable as a gem material. Opal may be subjected to treatments, manufactured, or combined with other materials before being fashioned as a gemstone.

The name opal likely derives from the Latin word opalus and was mentioned in Pliny the Elder's Natural History (Pliny the Elder 1855–1857), the word opalus may have derived from ancient Sanskrit “upala” a precious stone.

The fascination for opal may be due its principal features: its play of colour and wide range of body colours. A range of spectral colours can be enjoyed within a single gem. Opal is a form of hydrated silica, a naturally occurring mineral composed of disordered silicon dioxide molecules and attached “water”² molecules with the general formula $\text{SiO}_2 \cdot n\text{H}_2\text{O}$, where 'n' is the number of “water” molecules in the chemical formula, as the amount of “water” in opal may vary (Gaillou, Delaunay, et al. 2008). Traditionally the water content is quoted as a weight percent mass (Graetsch, Flörke, and Miehe 1985). Opal does not have a single crystal structure, and it is unusual for a mineral as it has such a variable component – “n” has no limit. Opal may have unique features such as body colour, patterning, translucency or opacity and other optical phenomena making it suitable to be used as a gem material (Gaillou, Fritsch, et al. 2008). In this guide the term “opal” is used as the name for any form of opal considered to be a gemstone.

For the formation of opal millions of years ago three main factors were needed, a source of silica, a means of transporting the silica and sometimes a void into which it may be deposited. Most opal occurs in sedimentary rocks, examples being Australia and Brazil, or volcanic rocks examples being Mexico and Ethiopia. In Brazil, opals are found in hydrothermal environments, in subvolcanic and sedimentary rocks

2.2. Opal Classification

Classification is the categorization of an opal according to Type and Characteristics using defined Nomenclature (see definitions). The classification system adopted in this guide was created in 2021 by the Australian Opal Association and the Gemmological Association of Australia on behalf of the Australian opal industry.

² The quotation marks here follow a scientific practice for which water is not necessarily the liquid everybody knows, but the components of water (oxygen and hydrogen) present in a variety of forms : molecular water, bond water, hydroxyl groups (OH), even hydrogen is sometimes listed under “water”.

2.2.1. Opal Classification Table

To use the Classification Table below, first decide what the type of opal is by selecting one of the four options in the left-hand Opal Type column then decide how to describe the opal by referring to the description column. Once this is decided, decide on the other characteristics one by one as listed in the Characteristics Column along with the relevant descriptions or instructions indicated. The following three examples, 2.2.2, 2.2.3, and 2.2.4., explain this further.

Opal type		Description
Natural Opal	▷	Natural Homogeneous Opal (Solid Opal)
		or
		Natural Opal on Host Rock
		or
Composite Opal	▷	Natural Opal in Host Rock
Synthetic Opal	▷	Type and composition
Imitation/Simulant opal	▷	Manufacturer/Trade name
		Materials/Composition

Characteristic		Description & Instructions
Absorbency	▷	Impermeable: Opal that does not absorb water or other liquid
		or
		Absorbent (Hydrophane): Opal that does absorb water or other liquid
Play of Colour	▷	Exhibits Play of Colour (Precious Opal)
		or
		Does not exhibit a Play of Colour (Common Opal)
Body Tone	▷	Black (N1, N2, N3, N4 on the scale of body tone)
		or
		Dark (N5 or N6 on the scale of body tone)
		or
		Light (N7, N8, N9 on the scale of body tone)
Diaphaneity	▷	Opaque
		or
		Translucent
		or
		Transparent
Treatment	▷	No Treatment (apart from cutting and polishing)
		or
		Treatment (detail all treatments)

2.2.2. Opal Classification Example (a)

Example (a) below shows how the classification decision making process (ticks placed in the right-hand column) results in a classification of a “**natural hydrophane translucent opal**”.

Opal Type	Description	Decision example
Natural Opal	Natural Homogeneous Opal (Solid Opal)	✓
	or	
	Natural Opal on Host Rock	
	or	
Composite Opal	Natural Opal in Host Rock	
Composite Opal	Type and composition	
Synthetic Opal	Manufacturer/Trade name	
Imitation/Simulant Opal	Materials/Composition	

Characteristic	Description of Characteristics	Decision example
Absorbency	Impermeable: Opal that does not absorb water or other liquid	
	or	
	Absorbent (Hydrophane): Opal that does absorb water or other liquid	✓
Play of Colour	Exhibits Play of Colour (Precious Opal)	✓
	or	
	Does not exhibit a Play of Colour (Common Opal)	
Body Tone	Black (N1, N2, N3, N4 on the scale of body tone)	
	or	
	Dark (N5 or N6 on the scale of body tone)	✓
	or	
	Light (N7, N8, N9 on the scale of body tone)	
Diaphaneity	Opaque	
	or	
	Translucent	✓
	or	
	Transparent	
Treatment	No Treatment (apart from cutting and polishing)	✓
	or	
	Treatment (detail all treatments)	
Example result	=	Natural Hydrophane Translucent Opal

2.2.3. Opal Classification Example (b)

Example (a) below shows how the classification decision making process (ticks placed in the right-hand column) results in a classification of a “natural opal on host rock”.

Opal Type	Description	Decision example
Natural Opal	Natural Homogeneous Opal (Solid Opal)	✓
	or	
	Natural Opal on Host Rock	
	or	
Composite Opal	Natural Opal in Host Rock	
	Type and composition	
Synthetic Opal	Manufacturer/Trade name	
Imitation/Simulant Opal	Materials/Composition	

Characteristic	Description of Characteristics	Decision example
Absorbency	Impermeable: Opal that does not absorb water or other liquid	✓
	or	
	Absorbent (Hydrophane): Opal that does absorb water or other liquid	
Play of Colour	Exhibits Play of Colour (Precious Opal)	✓
	or	
	Does not exhibit a Play of Colour (Common Opal)	
Body Tone	Black (N1, N2, N3, N4 on the scale of body tone)	
	or	
	Dark (N5 or N6 on the scale of body tone)	✓
	or	
	Light (N7, N8, N9 on the scale of body tone)	
Diaphaneity	Opaque	✓
	or	
	Translucent	
	or	
	Transparent	
Treatment	No Treatment (apart from cutting and polishing)	✓
	or	
	Treatment (detail all treatments)	
Example result	=	Natural Opal on Host Rock

2.2.4. Opal Classification Example (c)

Example (c) below shows how the classification decision making process (ticks placed in the right-hand column) results in a classification of a “synthetic light opal”.

Opal Type	Description	Decision example
Natural Opal	Natural Homogeneous Opal (Solid Opal)	
	or	
	Natural Opal on Host Rock	
	or	
Composite Opal	Natural Opal in Host Rock	
	Type and composition	
Synthetic Opal	Manufacturer/Trade name	✓
Imitation/Simulant Opal	Materials/Composition	

Characteristic	Description of Characteristics	Decision example
Absorbency	Impermeable: Opal that does not absorb water or other liquid	✓
	or	
	Absorbent (Hydrophane): Opal that does absorb water or other liquid	
Play of Colour	Exhibits Play of Colour (Precious Opal)	✓
	or	
	Does not exhibit a Play of Colour (Common Opal)	
Body Tone	Black (N1, N2, N3, N4 on the scale of body tone)	
	or	
	Dark (N5 or N6 on the scale of body tone)	
	or	
	Light (N7, N8, N9 on the scale of body tone)	✓
Diaphaneity	Opaque	✓
	or	
	Translucent	
	or	
	Transparent	
Treatment	No Treatment (apart from cutting and polishing)	✓
	or	
	Treatment (detail all treatments)	
Example result	=	Synthetic opal

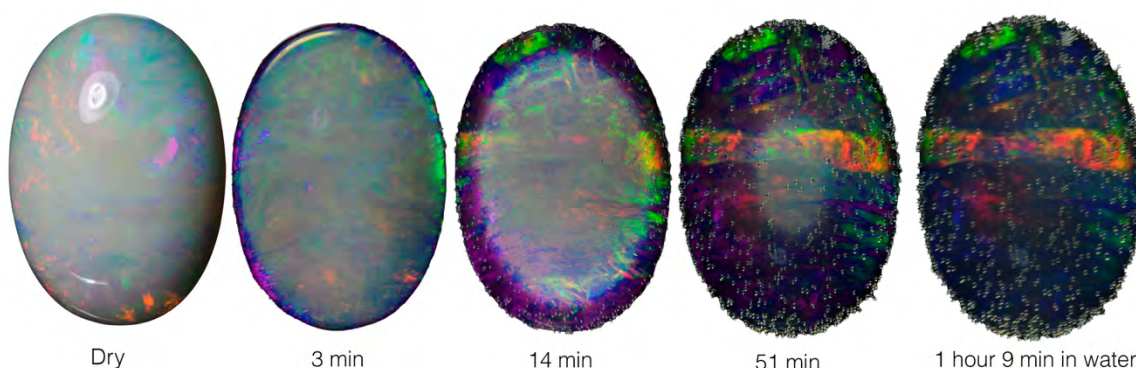
2.3. Opal Characteristics

2.3.1. Absorbency

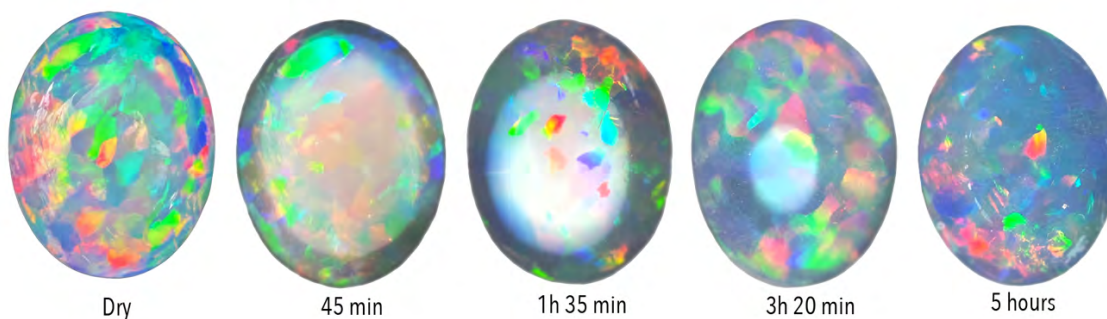
Absorbency in opal relates to the absorption, or loss, of water or another liquid by an opal either when immersed, or exposed in air, under normal conditions. Absorbency varies; some opal is not very absorbent and changes very little in mass or appearance, but in some cases changes to the appearance, mass and/or stability of the opal can be dramatic.

2.3.2. Hydrophane

Opal with or without play of colour that has various degrees of water absorption. Hydrophane opal can change appearance, mass and/or stability depending on the amount of water it contains at any given point in time (see Appendix A).



23.64ct Hydrophane Opal from Wollo before immersion in water (left) and after one hour and nine minutes of immersion in water (right) with weight increased to 26.575ct. The appearance of air bubbles indicate the absorbent nature of the stone. In this instance the opal becomes more transparent and the POC becomes more prominent. In some cases, the POC diminishes. (Image Cody Opals)



7.36 ct Hydrophane Opal from Wollo before immersion in water (Left) and after five hours of immersion in water (right) with weight increased to 7.85ct. The opal becomes more transparent and the POC becomes more prominent. (Image Tewodros Sintayehu).

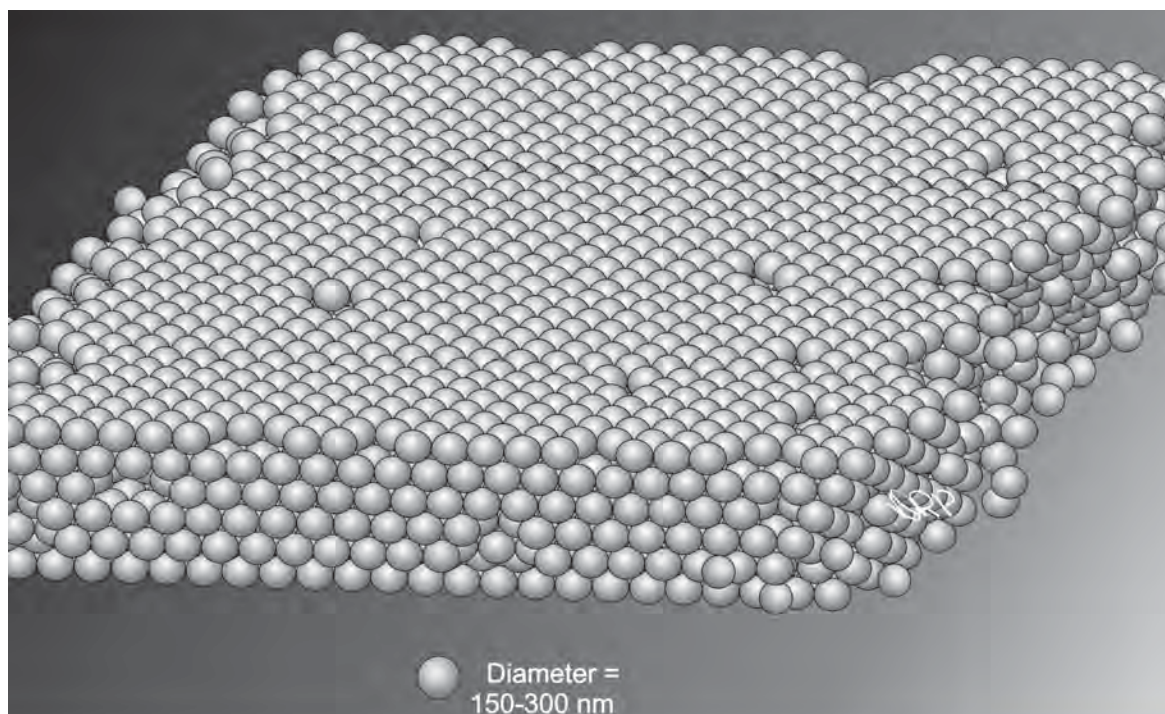
2.3.3. Impermeable

Impermeable opal does not absorb, or lose water or other liquid, either when immersed, or exposed in air.

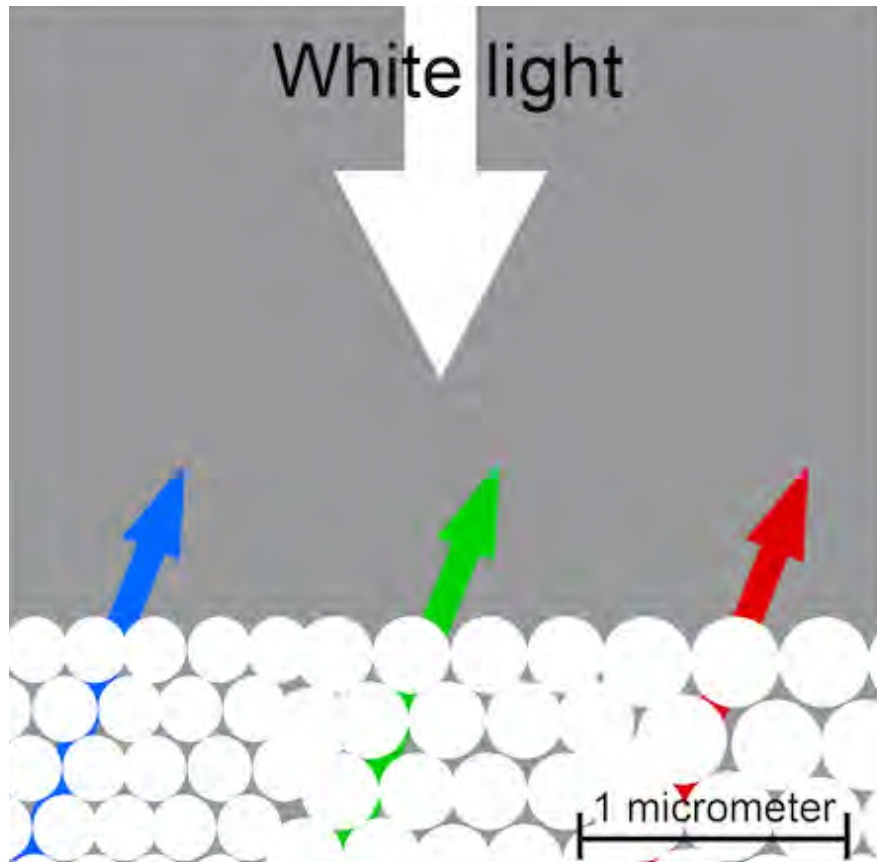
2.4. Play of Colour

‘Play of colour’ is the phenomenon whereby opal may display spectral colours. It is caused by the diffraction of white light. The presence of play of colour identifies the opal as Precious Opal. Precious opal is composed of tiny, microscopic sized spheres of silica of various size. When laid down in a regular arrangement light, reflecting off, and passing through these spheres, frequently causes interference and diffraction of light, which we are able to perceive as Play of Colour. This phenomenon is different than rainbows which form as light is refracted and partially reflected in water droplets in air.

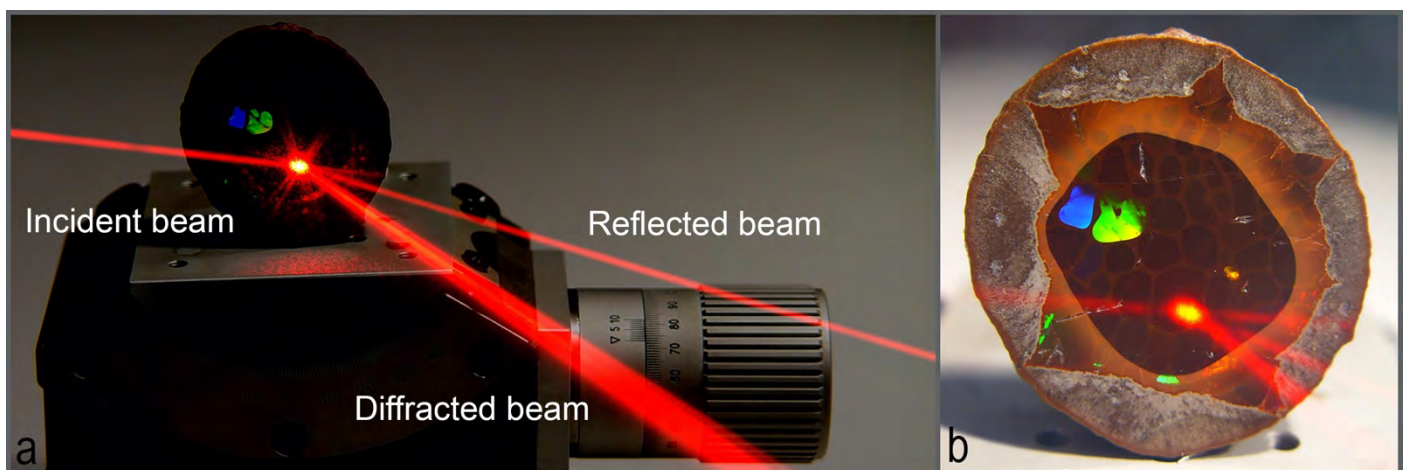
While opal may be essentially colourless, they may still have play of colour that is revealed as the gem catches the light. Consider the percentage of play of colour compared to background colour (body tone), its brightness and intensity, dominant colours, range of colour and pattern (Gauthier et al. 2025).



Opal molecular structure via scanning EM (idealized) By Dpultzer - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=137276056>

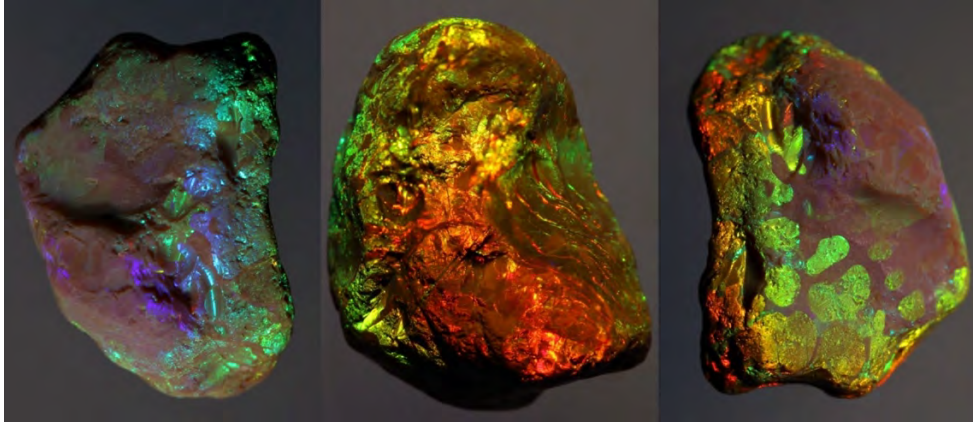


The colours diffracted by the opal depend on the sizes of three-dimensionally ordered microscopic silica spheres (Image Francesco Mazzero).

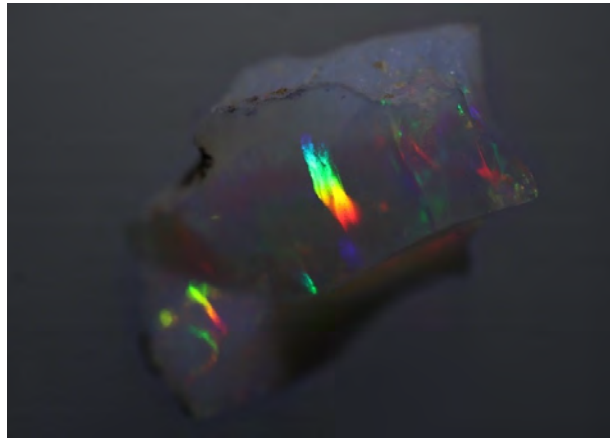


Precious opal is a natural photonic crystal³. This is clearly seen in this opal from Mezezo, Central Ethiopia, diffracting a HeNe laser beam like a man made reflective interferential filter (Image Francesco Mazzero).

³ A photonic crystal is a nanostructured material with a periodic arrangement of components that modulates the propagation of light



Here a paradox corrected by the diffraction. This 10mm piece of rough Ethiopian opal from Mezezo is intense in bright colours despite not being a polished gemstone. The ordered structure made of microspheres is regular all through the specimen and always diffracts light (Image Francesco Mazzero).



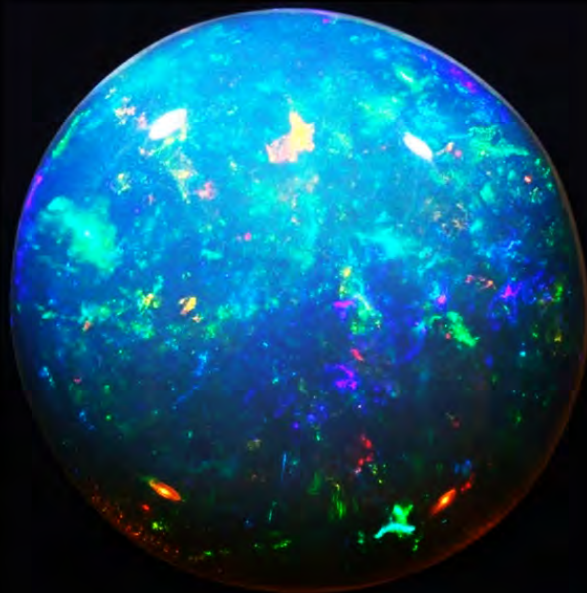
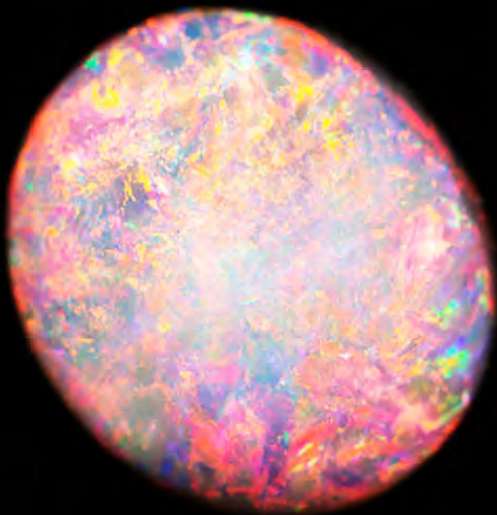
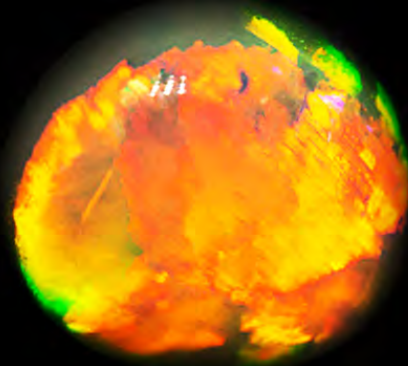
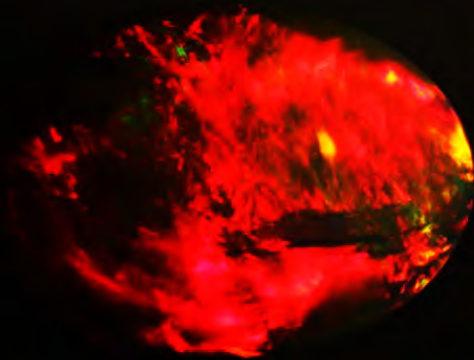
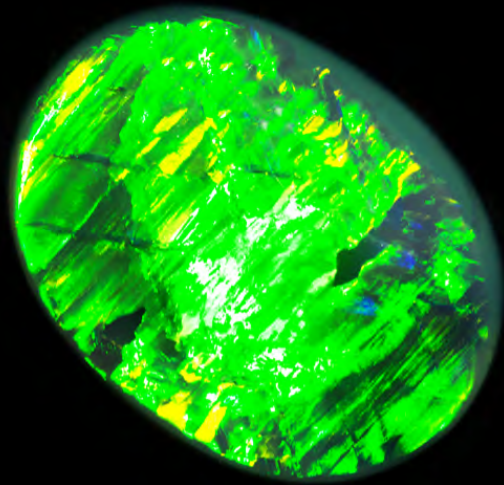
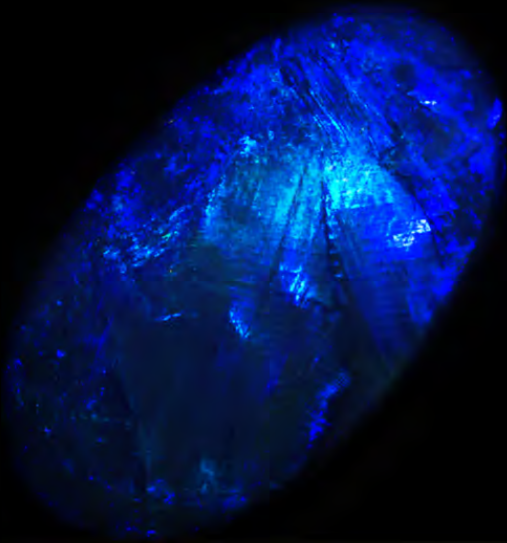
Opals from the central Ethiopian Wollo deposits often display “rainbows floating in air” in front of the stone, a phenomenon is presently not clearly understood (Image Francesco Mazzero).

One type of opal known as “Contra Luz” only displays Play of Colour when light is passed through it.



An example of Contra Luz opal from Mexico displaying Play of Colour when a light source is applied. (Left) no light (Centre) white light, (Right) warm light (Image T S Coldham).

Common opal does not display POC as any silica spheres present are disordered and often of mixed sizes resulting in no interference or diffraction of light occurring.



A selection of images showing single dominant colours in precious opals.

left to right leading down the page -

mainly blue POC opal (Black opal Direct), mainly green POC opal (Black Opal Direct)
mainly red POC opal (Francesco Mazzero), mainly orange POC opal (Black Opal Direct)
mainly pink POC opal (Black Opal Direct), mainly blue POC opal (Francesco Mazzero)

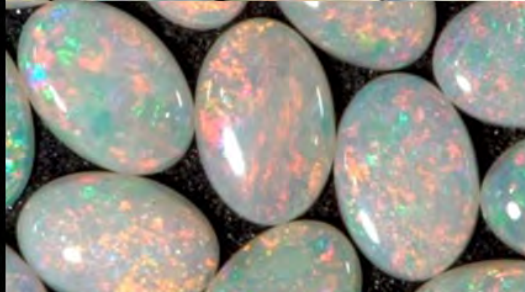
Faint



Subdued



Moderately bright



Bright



Very bright



2.4.1. Dominant/Predominant Colours

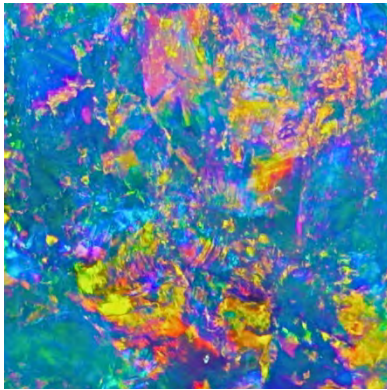
An opal might display a single colour, two or three colours, or all the colours of the rainbow.

2.4.2. Brightness and Intensity

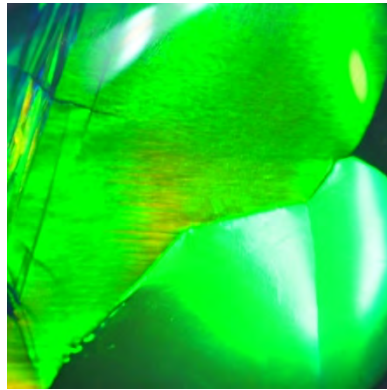
The brightness of the play of colour has been traditionally described as faint, subdued, moderately bright, bright, and very bright, (with vivid often being used as well). Previous page for some examples.

2.4.3. Patterns

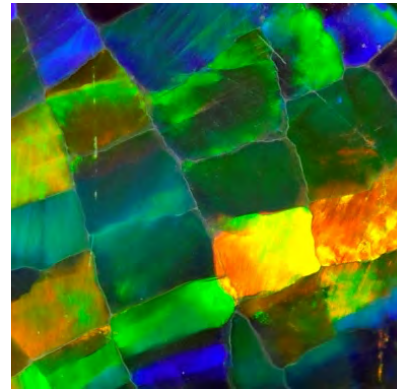
There are a great variety of patterns of play of colour that have been described by various individuals, companies and organizations. Similar to observing clouds in the sky, various observers may see and describe patterns differently. This section simply highlights the existence of various play of colour patterns that have been described but where interpretations may differ. A patchwork of images follows containing some of the play of colour patterns variously described by individuals, companies or organisations.



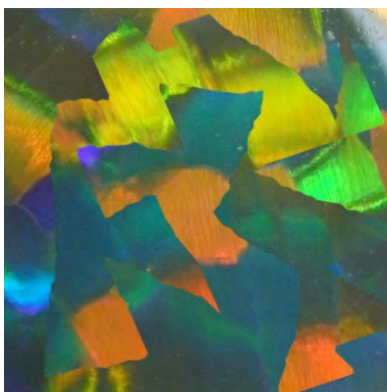
Pinfire



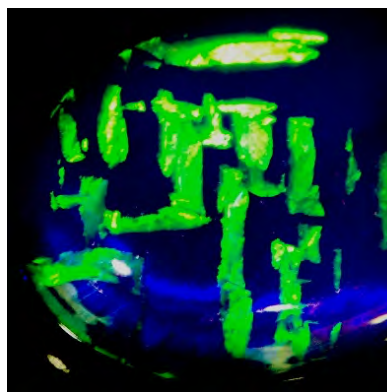
Broad flash



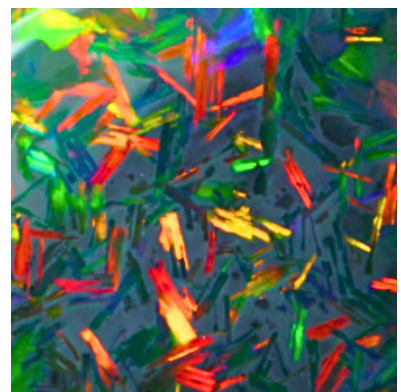
Harlequin



Flagstone

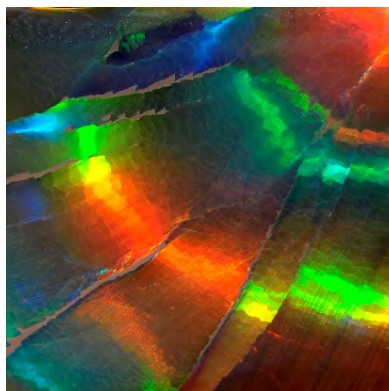


Chinese Character

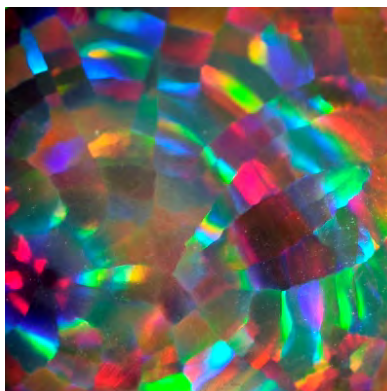


Straw

CIBJO Opal Guide



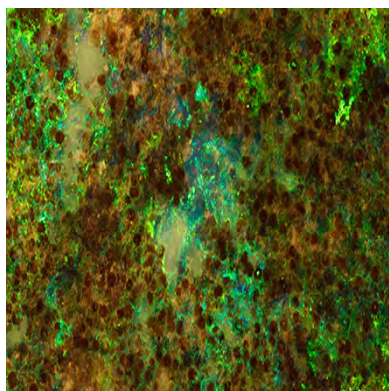
Peacock



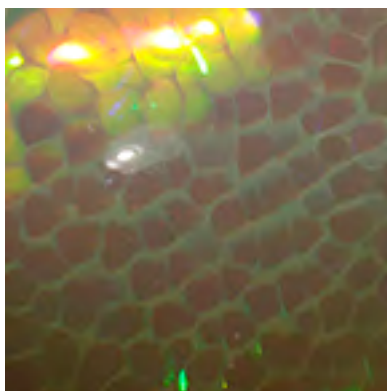
Ribbon



Rolling Flash



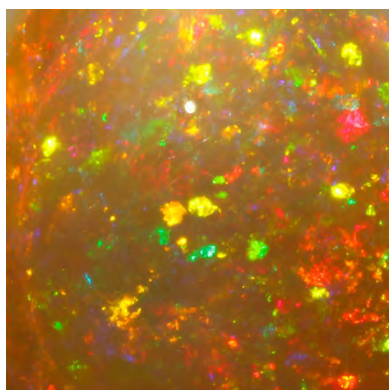
Oolitic



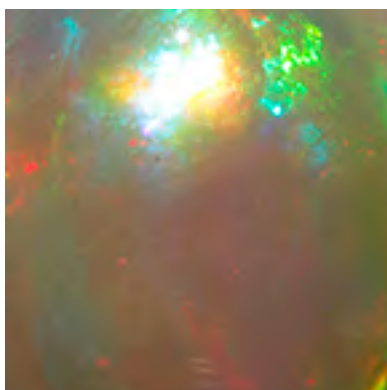
Honeycomb (Eth)



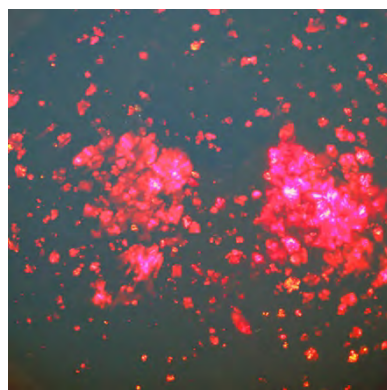
Digit (Eth)



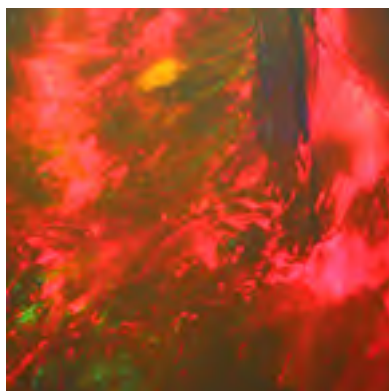
Pinfire (Eth)



Optic (Eth)



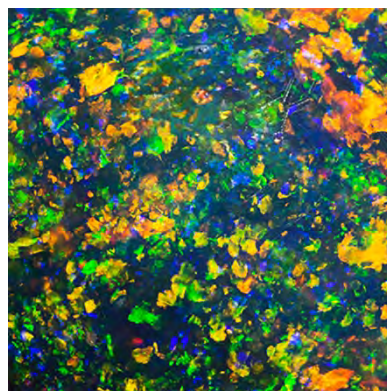
Stellar /Stars (Eth)



Broad flash (Eth)



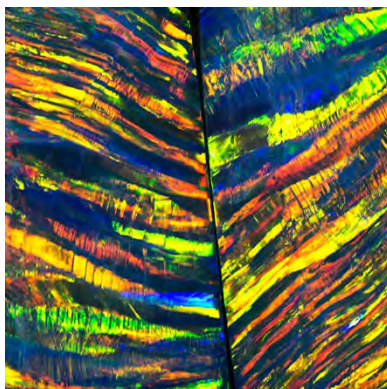
Digit (Eth)



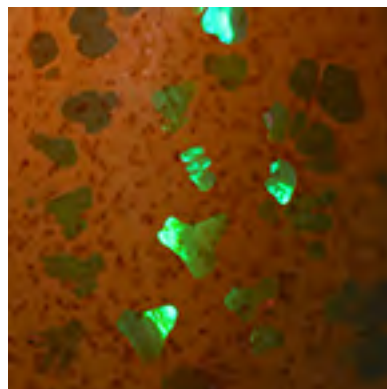
Pinfire



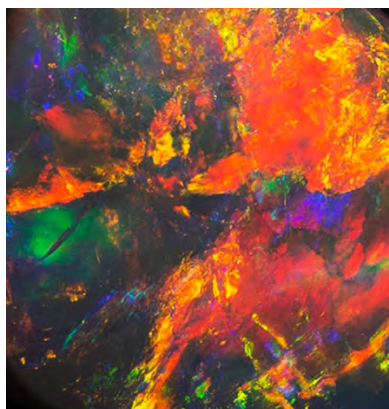
Digets



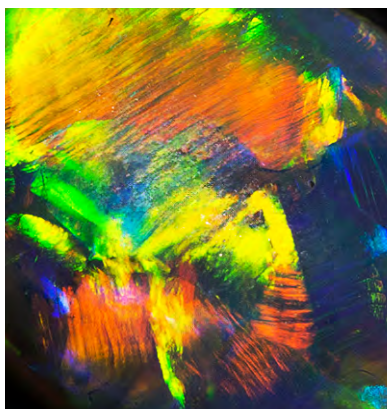
Striated



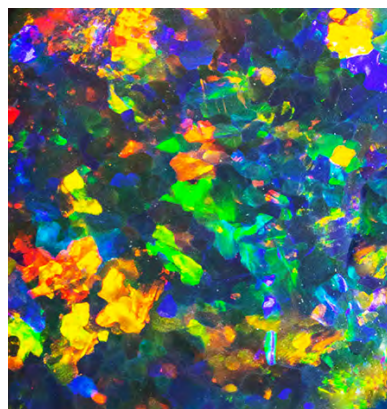
Snake (Eth)



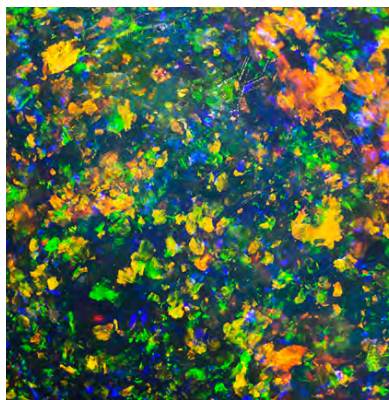
Flame



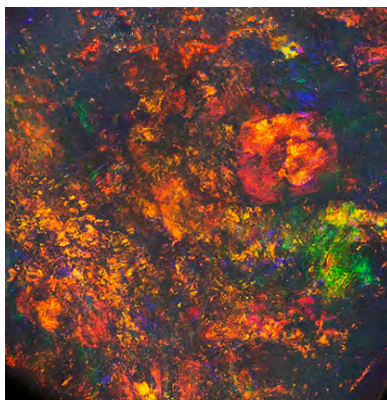
Chaff



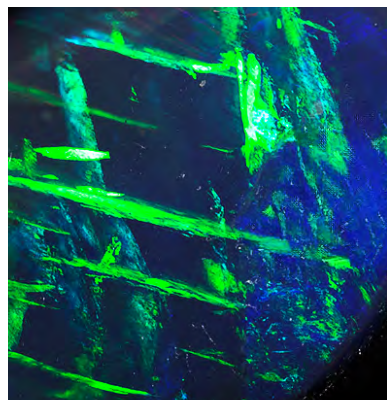
Cloverleaf



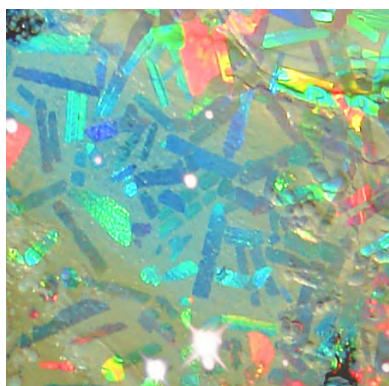
Floral



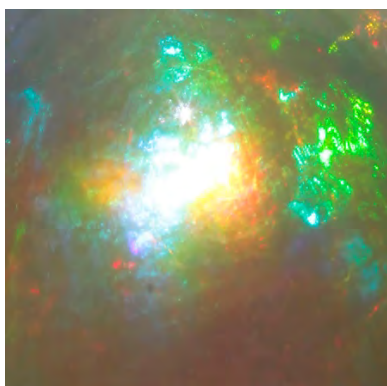
Moss



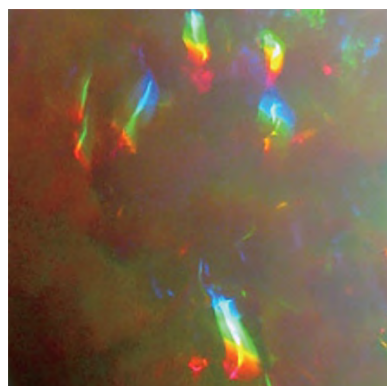
Straw



Graphic



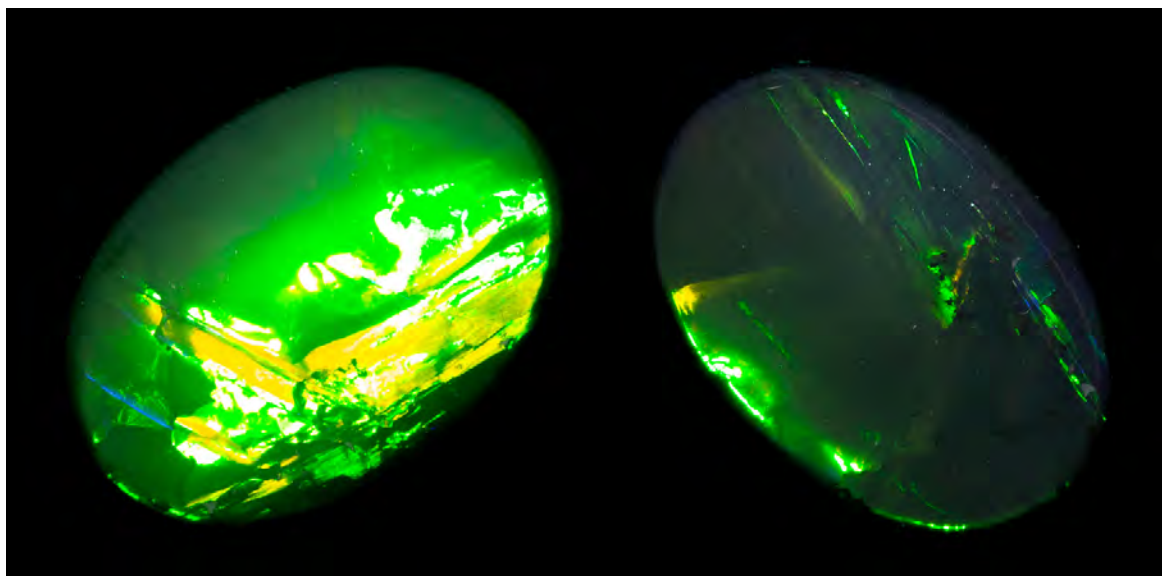
Optic



Rainbow

2.4.4. Directionality and Consistency

This is when opal displays strong play of colour only when viewed from a certain angle or in a certain part of the stone.



An example of directionality of POC in opal (images Black Opal Direct)

2.5. Body Tone

Body tone refers to the relative darkness or lightness of an opal when ignoring its play of colour (if present). It is assessed from the 'Face Up' or top view of the stone, not the base. In the Munsell scale there are 9 values/tones from black (1) to white (9), with the interval between each equal.

2.5.1. Black opal

A term only to be applied to natural precious opal. Exhibits a black body tone according to the opal body tone grading scale.

2.5.2. Dark opal

A term only to be applied to Natural precious opal. Exhibits a dark or grey body tone according to the opal body tone grading scale.

2.5.3. Light opal

A term only to be applied to Natural precious opal. Exhibits a light body tone according to the opal body tone grading scale.

Note: these terms are only applied to natural opal, they must not be used as terms for treated opal, composite, synthetic or imitation opal.

Opal Body Tone Scale

Munsell Tone Scale



Black

Dark

Light

Multiple opals with play of colour examples against the body tone scale (Cody Opal)



Black

Dark

Light

Single opal with play of colour examples against the body tone scale (images Black Opal Direct)



Cabochon opal with no play of colour examples in order of body tone from N4 (left) to 9 (right) (images xgx Ltd.)

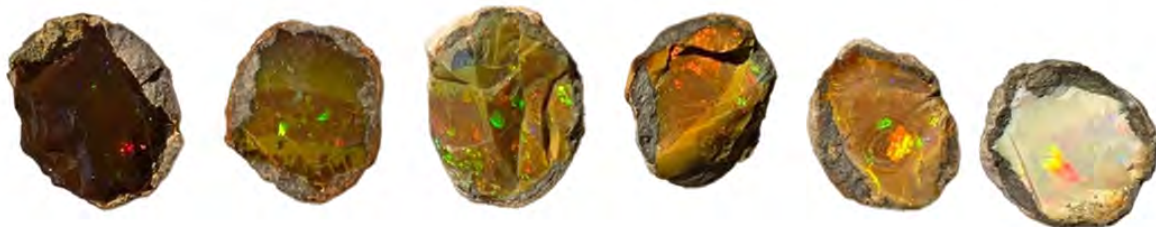


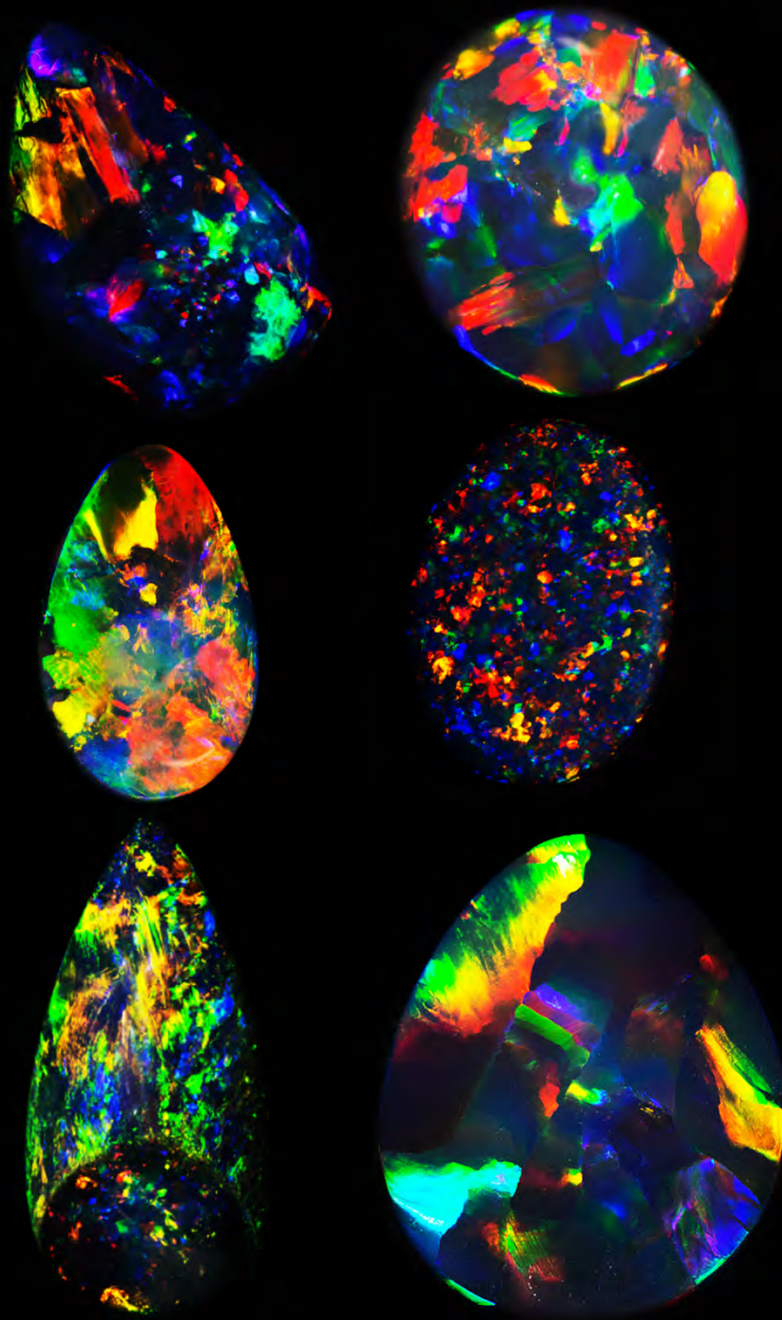
Tone scale example of opened Mezezo opal nodules (image Francesco Mazzero)

Black

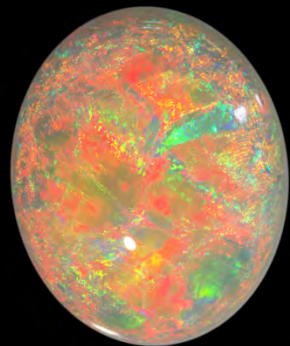
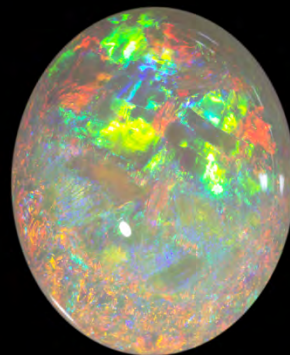
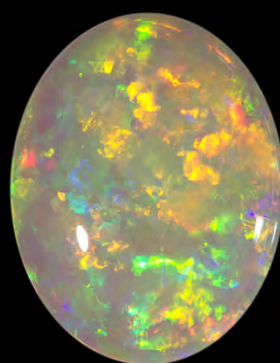
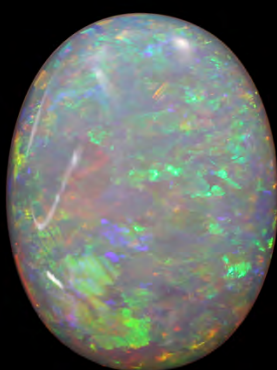
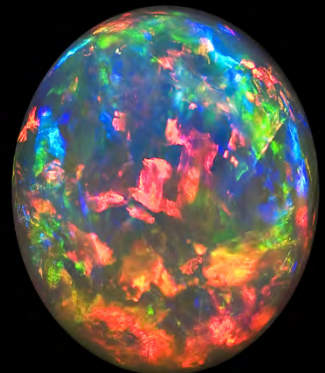
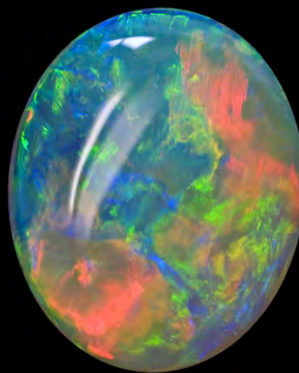
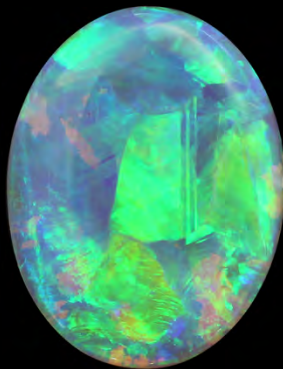
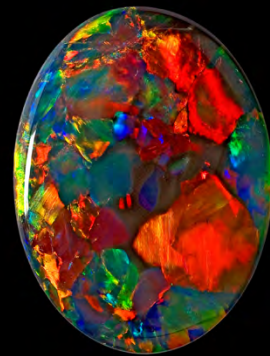
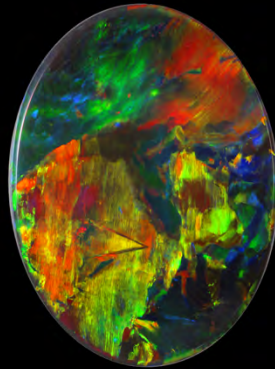
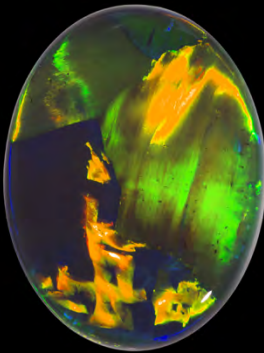
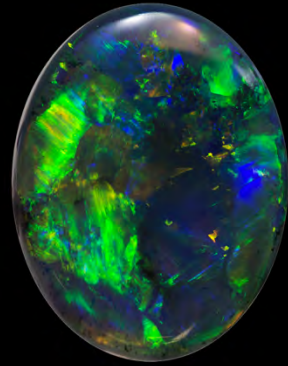
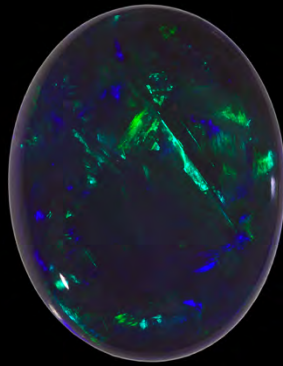
Dark

Light





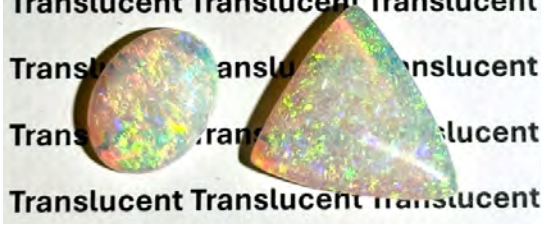
A range of "black opals" (images Black Opal Direct)



Progressions through Black, (upper two rows), to dark (third row) and light (lower row.) opals.
(images Emil Weis Opals).

2.6. Diaphaneity

Diaphaneity refers to the degree of transparency. There are only three possible interactions: Transparent, Translucent or Opaque (images Cody Opals).

Diaphaneity	Explanation	Example image
Transparent	allows light to pass through so that objects behind can be clearly seen	
Translucent	transmitting and diffusing light so that objects beyond cannot be seen clearly	
Opaque	not transparent or translucent; impenetrable to light; not allowing light to pass through	

2.7. Treatment

There are many kinds of treatments that opals are subjected to. Most are designed to “stabilize” the gem, or deepen the colour, or cause the play of colour to stand out against a darker body colour.

Note: The term “Precious Opal” shall not be used for any opal that has been treated. Treated opal shall never be termed “Black Opal”

2.7.1. Impregnation

Using oils, wax or plastic – this treatment may improve play-of-colour and mask the effects of crazing.

2.7.2. Dyeing

A treatment that causes the body tone of opals to look darker or black or changes the body hue to another colour (Wu et al. 2022; Renfro 2011). The results are unstable, care advice is needed.



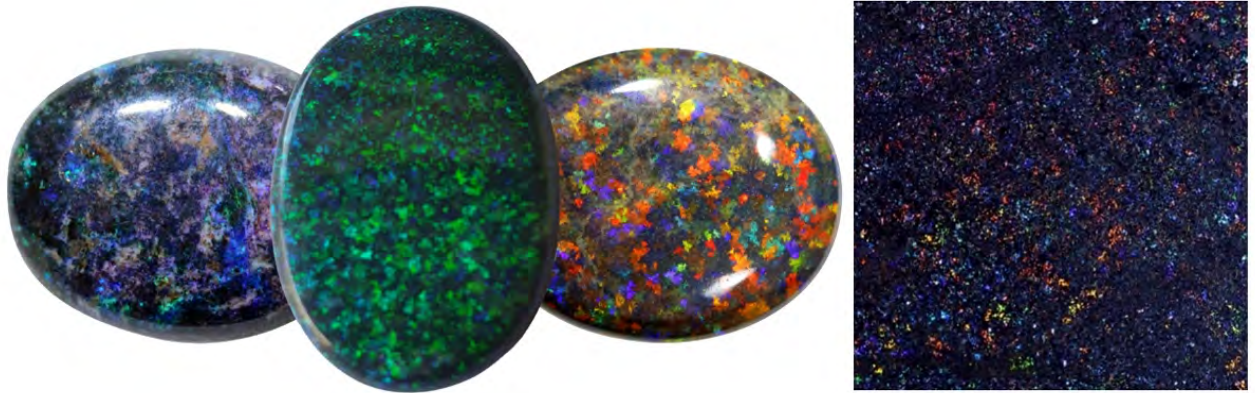
Dyed pink Ethiopian opal.
<https://www.etsy.com/listing/1281911148/dyed-pink-ethiopian-opal-cabochons-oval>



A “smoked” Ethiopian opal (left) where care advice has not been followed and the colour has faded.
 (images Kathy King).

2.7.3. Carbonisation

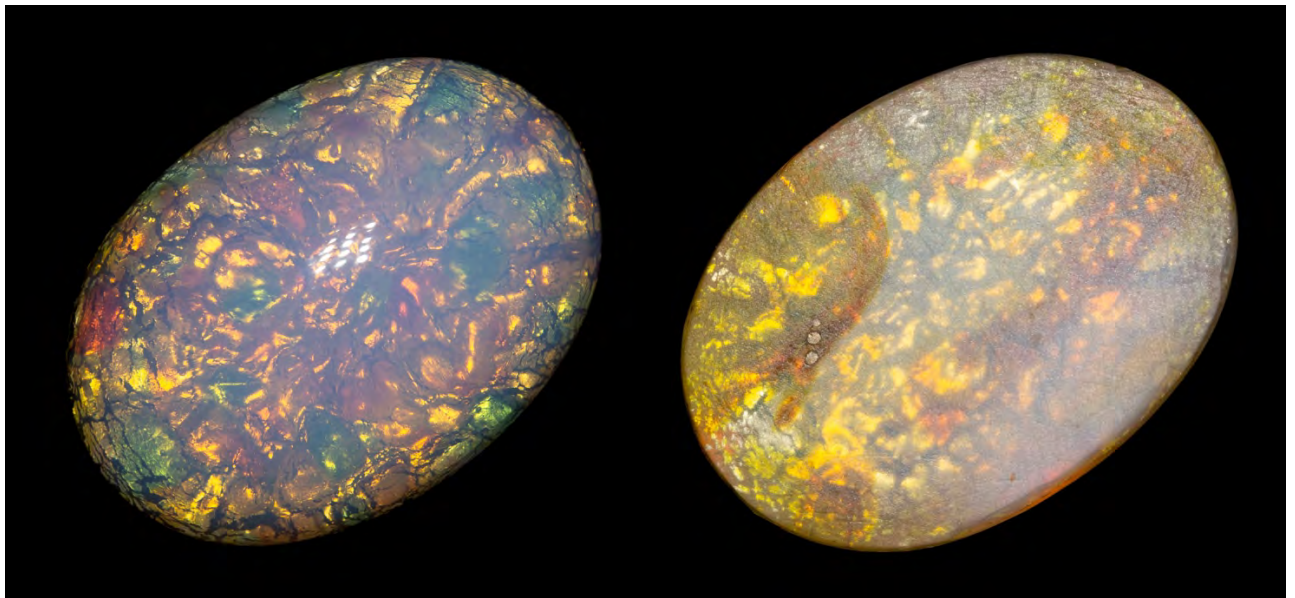
The deposition of black carbon in the pores of opal to enhance or create play of colour, either by soaking in carbon rich compounds such as oil or sugar and applying heat or being subjected smoke impregnation. Queensland Fairy Opal and Andamooka matrix opal are types of Australian opal found in sandstone, known for having glittery colourful opal specks. They are commonly treated with carbonised sugar, oil, or resin to darken the sandstone matrix thus enhancing the opal's fire and making it resemble more expensive black or boulder opal. The treatment involves heating the opal with sugar/oil to carbonize the sandstone, followed by polishing or resin sealing for a permanent, glossy finish, also applied to Ethiopian opal (Williams 2011).



Carbon treated Andamooka opal may be found in a wide range of qualities, two example (images from the Gemmological Association of Australia's online course Certificate in Opal Studies and (centre) Emil Weis Opals with inset a magnified image of the treated surface)

2.7.4. Foil-backing

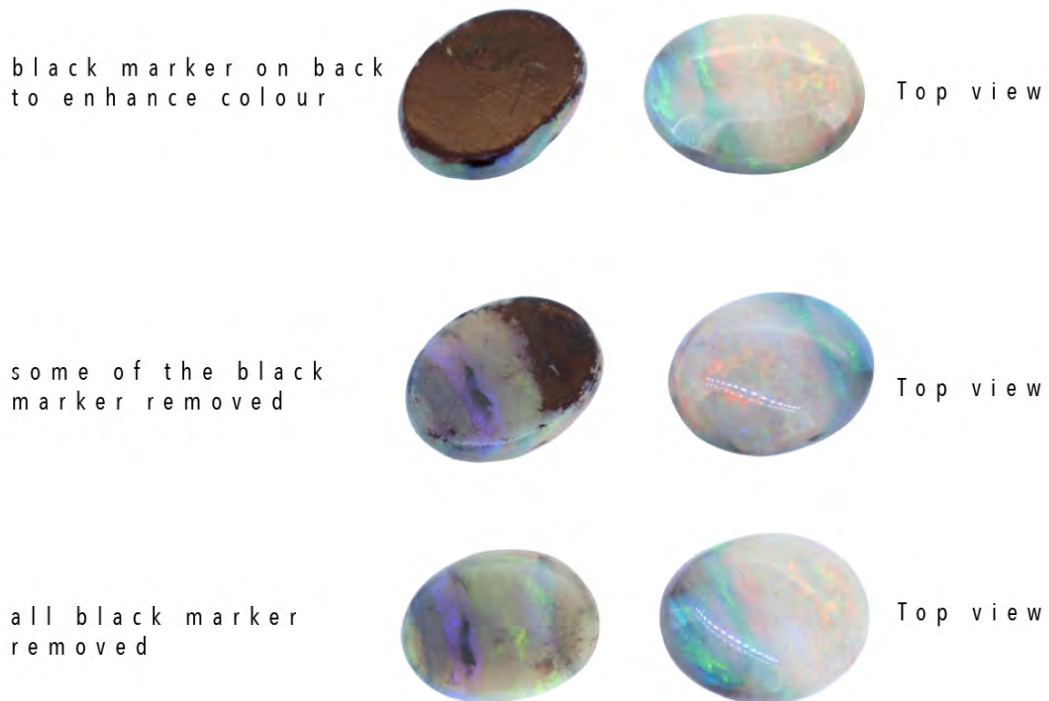
Adhering reflective foil to the base of an opal may result in the darkening of tone and enhancing play of colour.



Foil backed opal, left top view and right the back view .Images Balack Opal Direct)

2.7.5. Black paint backing

Applying black paint or dye to the base of an opal may result in the darkening of tone and enhancing play of colour

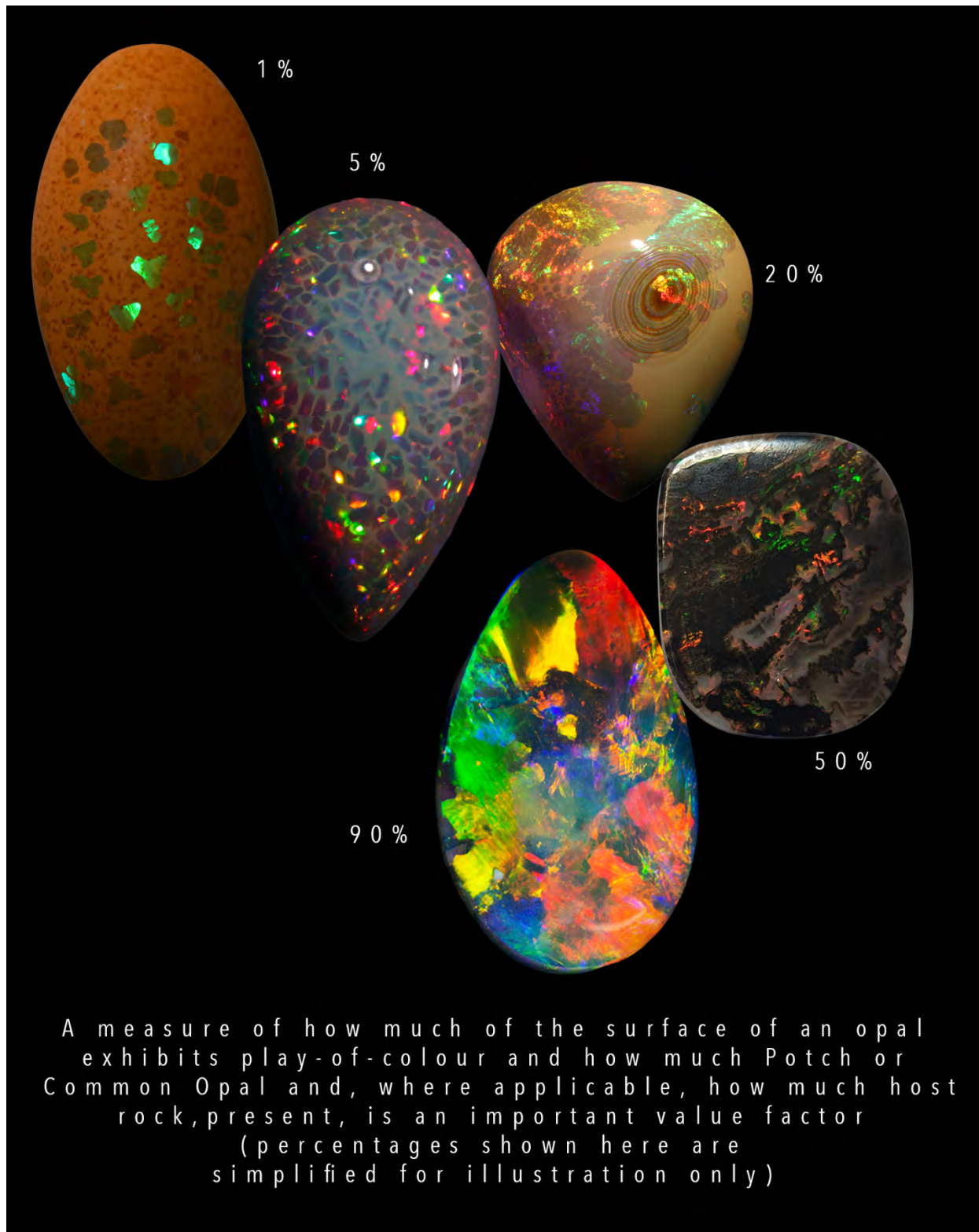


An opal with a black marker applied to the back to enhance the colour (top) and progressively removed (middle and lower) (images Kathy King).

2.8. Additional features and value factors

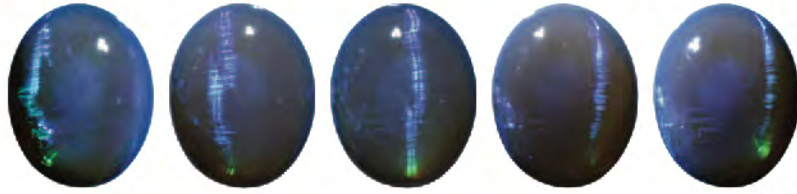
2.8.1. Percentage coverage in relation to play of colour

A measure of how much of the surface of an opal exhibits play of colour and how much is Potch or Common Opal and where applicable how much host rock.



2.8.2. Other optical phenomena

Cats-eye” or “Star” opal. On rare occasions either precious or common opal may display chatoyancy resulting in a Cats-eye or Star opal.

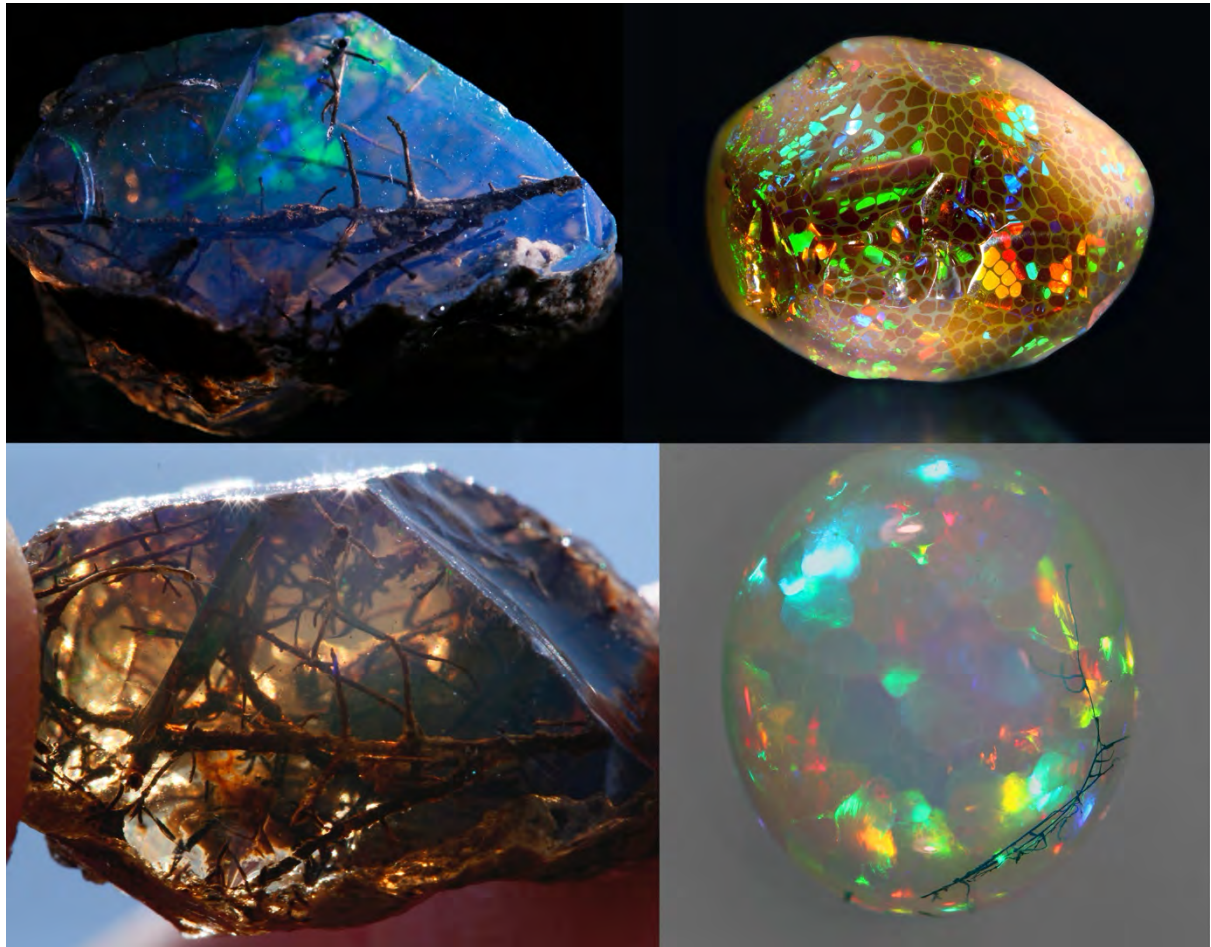


A grey transparent opal showing dominant blue play of colour with a distinct chatoyancy seen in various light orientations (from (Miura 2021))

2.8.3. Clarity and inclusions

The clarity of an opal may be affected by the presence of inclusions of sand, host rocks, minerals such as gypsum or organic material. Clarity is also affected by the presence of “webbing” and “crazing”.

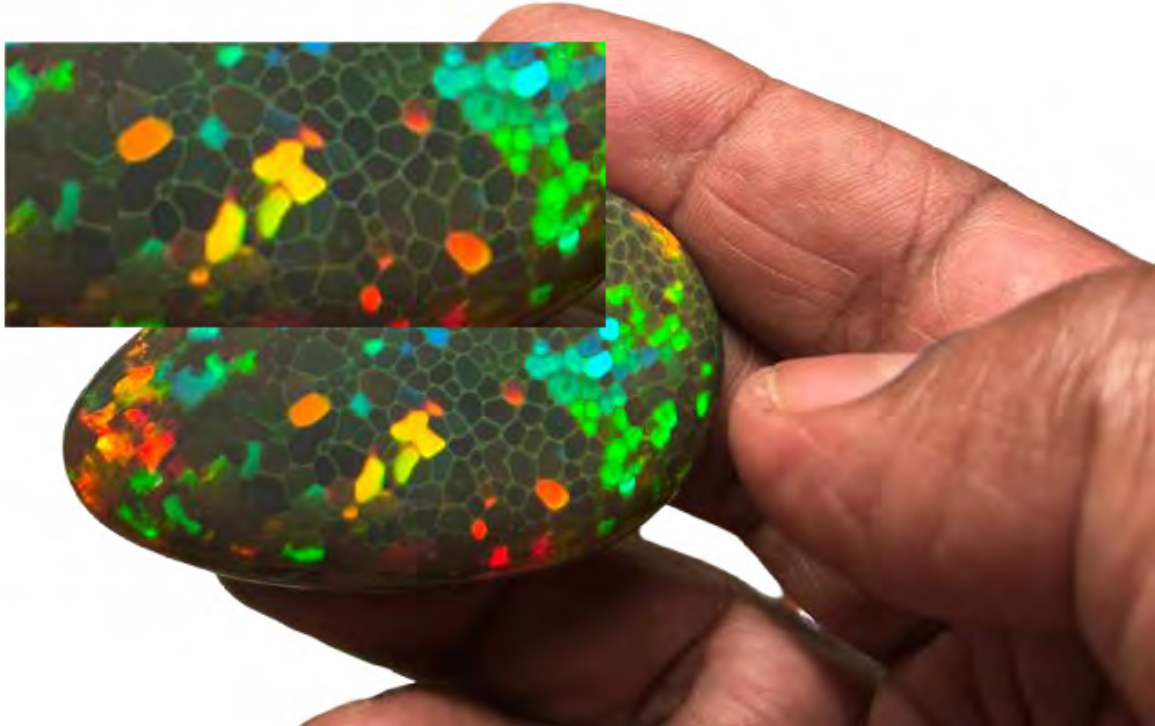
Iridescence in cracks in an opal may display spectral colours that can be mistaken for Play of Colour.



Organic and webbing Inclusions in opal from Ethiopia (images Francesco Mazzero)



Surreal sceptre. An unusual tube growth formation with larger terminating crystals (left) and (right) Fire and water. Coral-like stalagmite/stalactite formations are clearly seen in this magnification of this month's featured fire opal. (images: Wimon Manorotkul)



The macro, sometimes micro, structure described as 'webbing' (similar to the structure of a spider's web) in natural opal (image Tewodros Sintayehu).

2.9. Cut and finish

Cutting an opal from the rough to the finished gemstone requires, not only extraordinary skillsets, but a vision that only comes after years of experience in rough opal evaluation and a respect for what nature provides.

The opal cutting process involves the selection and evaluation of the rough, observing the colour distribution and evaluating the best points that will serve as the gem's surface. Using a diamond saw or coarse grinder to trim away excess material, cracks, and potch until the basic shape is achieved. For shaping the opals are attached to a dop stick using hot wax, allowing for more precise control when grinding into a

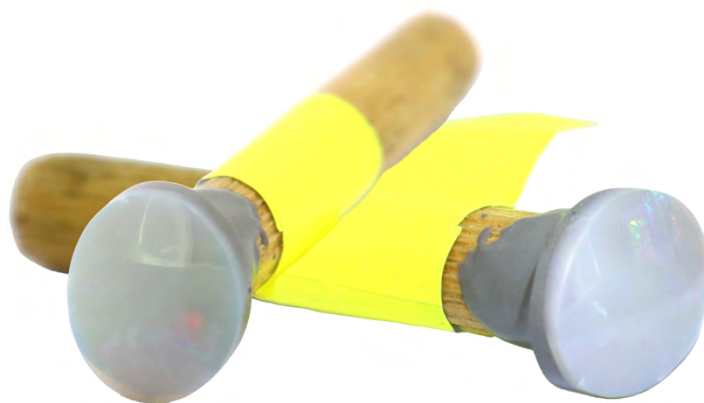
cabochon, or other forms. The final step uses a leather or felt pad with cerium oxide to buff the surface to a smooth, mirror-like shine.

During the process water must be constantly supplied to reduce friction, as high heat can cause opal to burn, crack, or become brittle (crazing). The goals of the cutter is to maximize the size of the gemstone, preserving as much of its colour as possible, even in freeform shapes. The challenge lies in opal's low hardness so care must be taken to avoid pressing the gemstone too hard against the grinder.

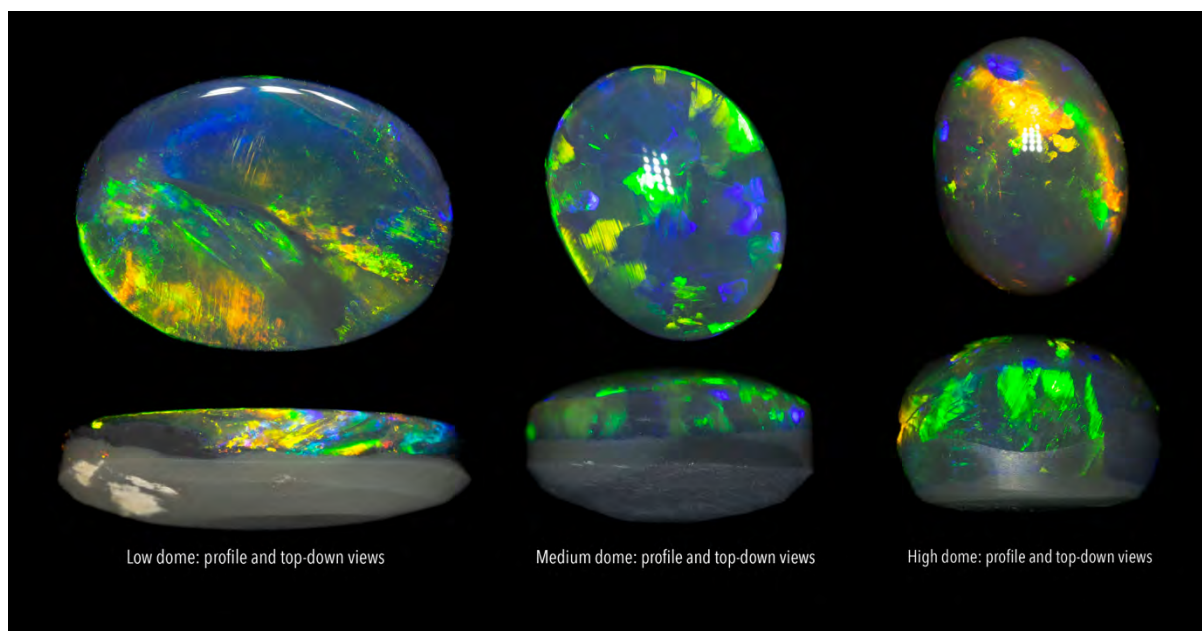
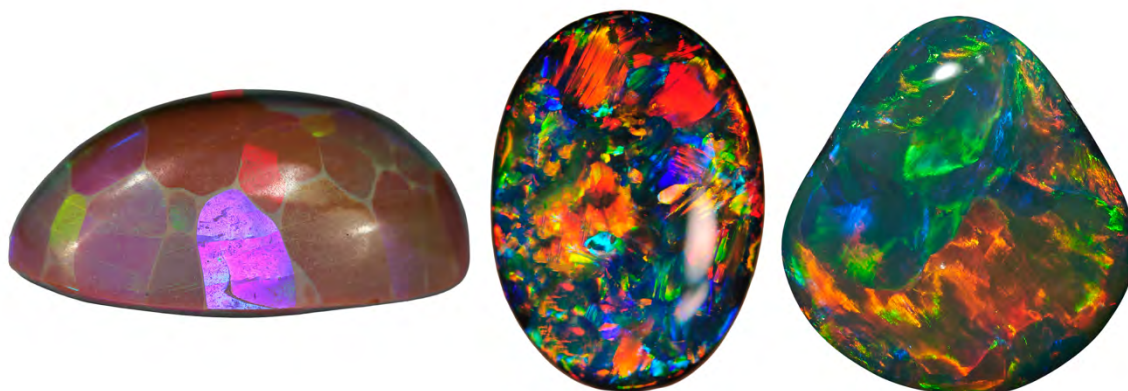
Evaluate the qualities of a finished opal by assessing and describing the cut (cabochon, faceted, or carved) and the homogeneity (the presence and percentage of host rock remaining), shape, size, and proportions, as well as the quality of the polish and surface condition. If the opal is artistically carved the quality of the workmanship should be evaluated, as well as the effective use of the colour distribution.



Cutting an opal (image Cody Opals)



Opal on a dopping stick, (images Kathy King)



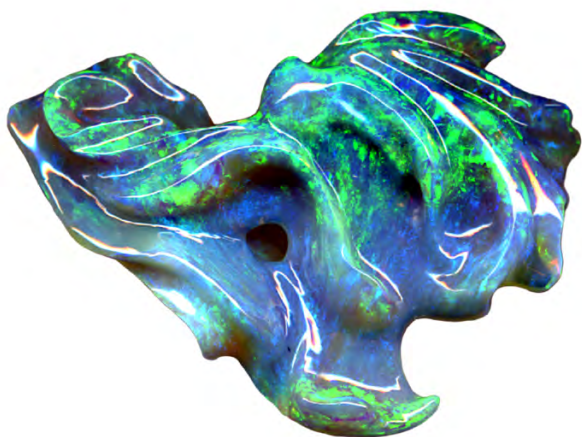
Example of Cabochon shapes and dome heights (images Black Opal Direct)



Variously faceted fire opal (images Emil Weis Opals).



Ethiopian opal cut as beads (images Tewodros Sintayehu).



Example of carved opal (image Anthony Smallwood)



Example of carved opal (image T S Coldham)



Examples of carved opal (images Emil Weis Opals)



Carved matrix opal from Yowah, Queensland 233,20cts. -50x40x10m (image Emil Weis Opals)



A clock with different types of carved opal (image Emil Weis Opals)

3. Describing colour

Colour metrically correct terms; Adjectives as a function of tone and chroma

Tone $\triangleright$	High	Medium	Low
Saturation (Chroma) ∇			
High	Vivid	Intense	Deep
Medium	Light	Medium	Dark
Low	Pale	Grey-brown	Dull

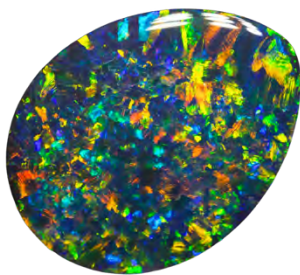
4. Types of Opal

4.1. Natural Opal

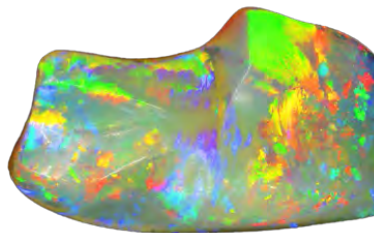
Natural Opal is naturally occurring opal that has not undergone any manufacturing processes other than cutting and polishing.

4.2. Precious Opal

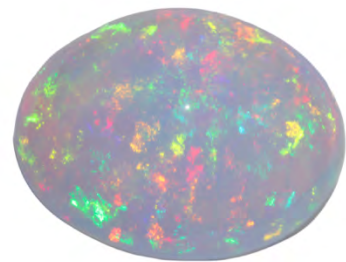
Precious is any natural opal that displays dancing spectral colours known as “Play of Colour” (POC). Note: The term “Precious Opal” should not be used for any opal that has been treated.



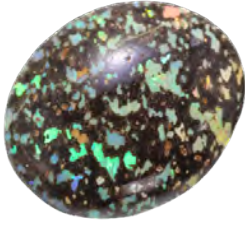
Australian black opal (Black Opal Direct)



Brazilian light precious opal Roça mine, Pedro II, Piauí, Brazil. Property of Bené do Tucum. (Carlos Comejo)



Ethiopian precious opal (Francesco Mazzero)



Leopard Opa I (image Emil Weis Opals).



Cantera (Mexican Boulder) Opal, (image Kathy King)



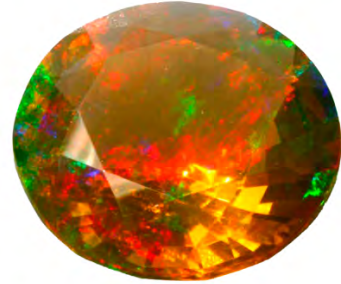
Boulder matrix opal (Francesco Mazzero)



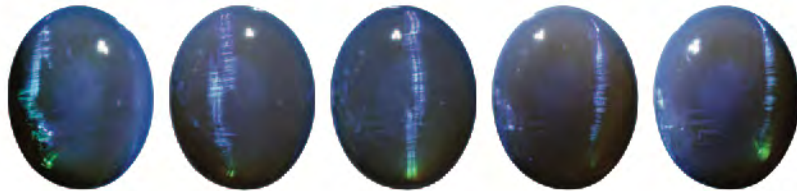
Mexican jelly opal (opal Auctions)



Mexican fire opal (GIA FB India)



Ethiopian fire opal (Francesco Mazzero)

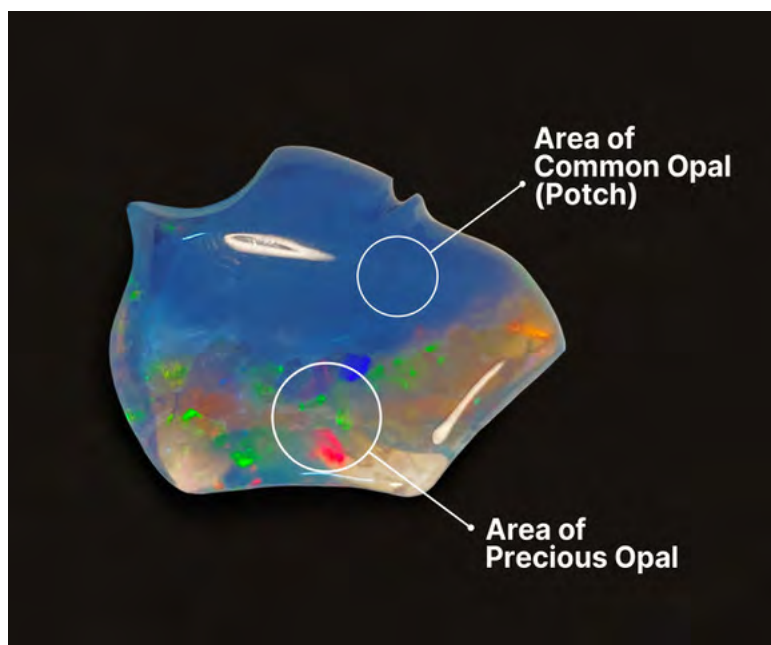


A grey transparent opal showing dominant blue play of colour with a distinct chatoyancy seen in various light orientations (from (Miura 2021))

4.3. Common Opal

Common opal is opal that does not display observable play of colour (POC), irrespective of body colour, transparency, or geological origin.

Mineralogically, common opal is a hydrated amorphous silica mineraloid ($\text{SiO}_2 \cdot n\text{H}_2\text{O}$) composed of nanoscale silica particles. These particles may occur as spherical units, irregular particles, or fused aggregates, but they lack regular size uniformity and ordered structure required to diffract visible light. Where silica spheres are present, they are typically irregular in size, randomly packed, or both, resulting in the absence of play of colour.



This piece of Australian opal would be classified as Precious opal although consisting of sections of both common opal and precious opal.

Acknowledgement:

Reproduced with the permission from The Gemmological Association of Australia's online course "Certificate in Opal Studies". (image T. S. Coldham – Gemmological Association of Australia)

Common opal may be structurally continuous with precious opal, and there is not always a sharp boundary between them. Transitional material is common, and single pieces of opal may contain distinct zones of precious opal and common opal. Any opal displaying play of colour in any part is classified as precious opal whilst opal entirely lacking play of colour is classified as common opal.

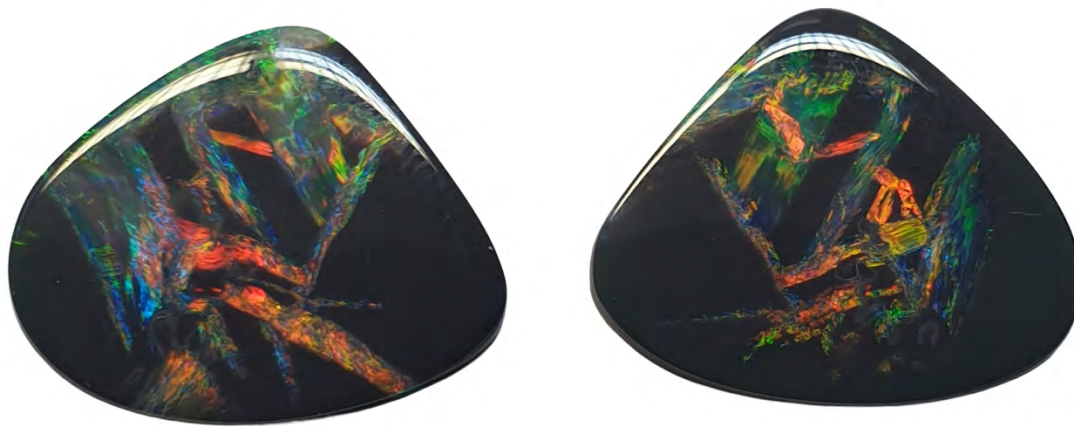
In common opal, light may be scattered, transmitted, or absorbed, and may produce, attractive body colours and patterns and optical phenomena such as chatoyancy. Although it lacks play of colour, common opal shares the same chemistry and formation processes as precious opal. Aesthetically, it may display spectacular colour and patterning, transparency that exceeds many precious opals, and an excellent polish. Common opal has a long cultural history, notably in Andean, Mesoamerican, and ancient European traditions, and continues to be used today not only in jewellery, but also as beads, carvings, seals, and ornamental objects.

4.3.1. Types and varieties of Common Opal

Due to trace elements such as iron, manganese, copper, and nickel, common opal may occur in a wide range of colours. One of the best-known varieties is Fire Opal (often termed Common Fire Opal), a transparent to translucent opal with body colour ranging from yellow through orange to red. The most famous examples are from Mexico, although fire opal is found in many other localities worldwide. When play of colour is present, the material is classified as Precious Fire Opal. Some common opal is valued primarily for unique and/or characteristic patterns, examples being opalised wood and picture stones, while others are prized for optical phenomena for example cat's-eye (chatoyant) opal.

4.3.2. Potch

In Australia, the term “Potch” has traditionally been used to describe common opal occurring in association with precious opal, either within the same stone or within the same deposit. For example, Australian black opal commonly consists of a layer of Precious Opal overlying black or grey Potch. Parcels of rough opal containing both precious opal and common opal are often termed “Potch and Colour.”



An opal with both potch and colour in the face (Image Emil Weis Opals KG).

The term Potch is increasingly being adopted in other opal-producing countries.

Note: Characteristics such as Body Hue, Body Tone, Transparency, Diaphaneity, and absorbency used to describe an opal can be applied to common opal just as they may be for precious opal. Common opal is also subjected to treatments, especially dying.



75.50 carat intense yellowish-orange fire opal from Brazil. Smithsonian, National Gem Collection.



2ct Peruvian pink opal (Shop LC)



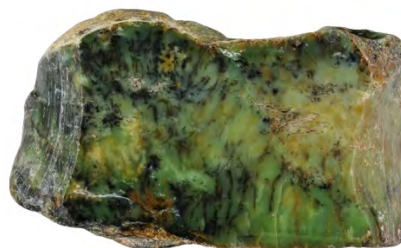
25ct Peruvian blue opal (e-Bay)



Pink opal from Western Australia (Fossilera minerals)



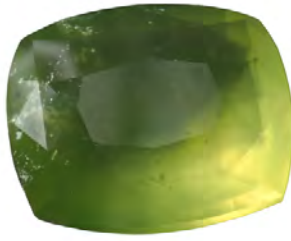
Green opal Madagascar (Fossilera minerals)



Moss opal Australia (Fossilera minerals)



*Dendritic opal from Turkey
(Heart of Stone Studio)*



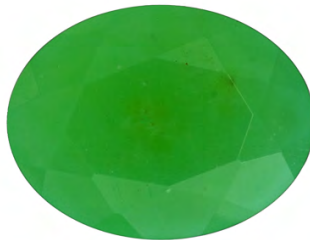
Brazilian green opal (Karatz)



Australian fire opal (ETSY)



*Cat's-eye opal from Brazil (Emil
Weis Opal)(Liddicoat 1966)*



*Green opal from Tanzania (Emil
Weis Opal)*



*Wood opal from Slovakia (Gemstone
CZ)*



*Opal with green body colour,
Brazil. (Image G Linselljpg from
the Gemmological Association of
Australia's online course
Certificate in Opal Studies).*



*Opal with yellow body colour,
Brazil. (Image G Linselljpg from the
Gemmological Association of
Australia's online course Certificate
in Opal Studies).*



*Cat's-eye opal from Tanzania (Image
Emil Weis Opals KG)*

5. Types of composite Opal

5.1. Composite Opal

Opal composites are generally made by laminating or adhering pieces of opal to other materials. Doublet and triplet opals are the most common opal composites.

Although composites are usually made using natural opal, they are also sometimes manufactured using synthetic or imitation opal.

5.2. Doublet

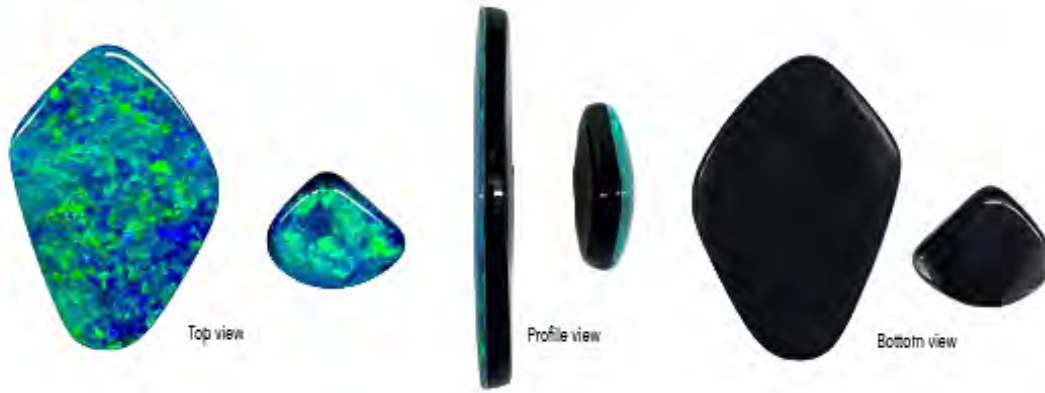
Opal doublets are composites in which a layer of opal with play of colour is cemented onto a base layer of another material such as potch, ironstone, diabase, black glass, plastic, or any other natural or manufactured material.



Two carved parts for a manufactured opal doublet (image T.S. Coldham)



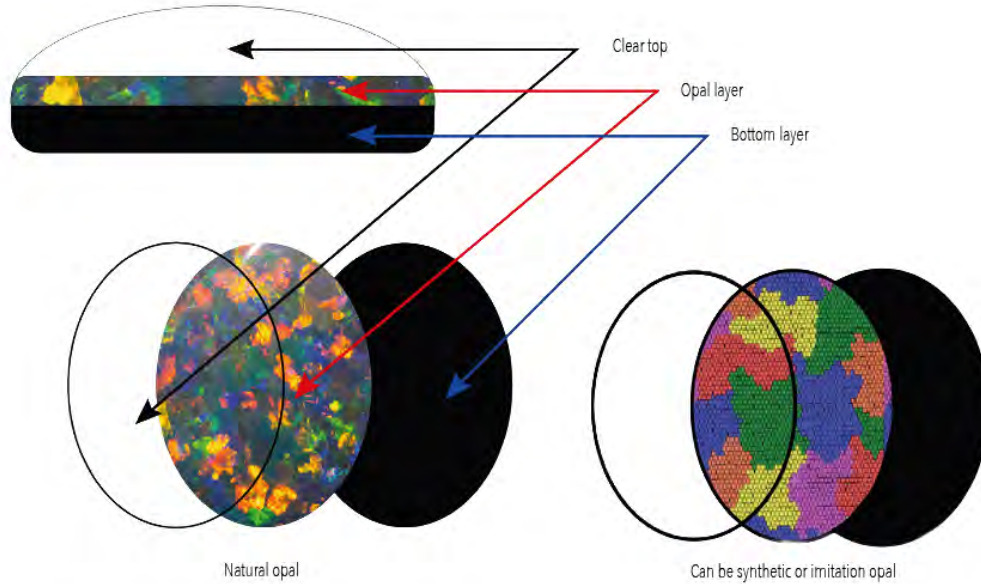
Opal doublet construction (images taken from <https://www.youtube.com/watch?v=zrjdeeEeN8>)



Courtesy; The Gemmological Association of Australia's online course "Certificate in Opal Studies".

The top, profile and bottom views of an opal doublet (image T. S. Coldham – Gemmological Association of Australia)

5.3. Triplet



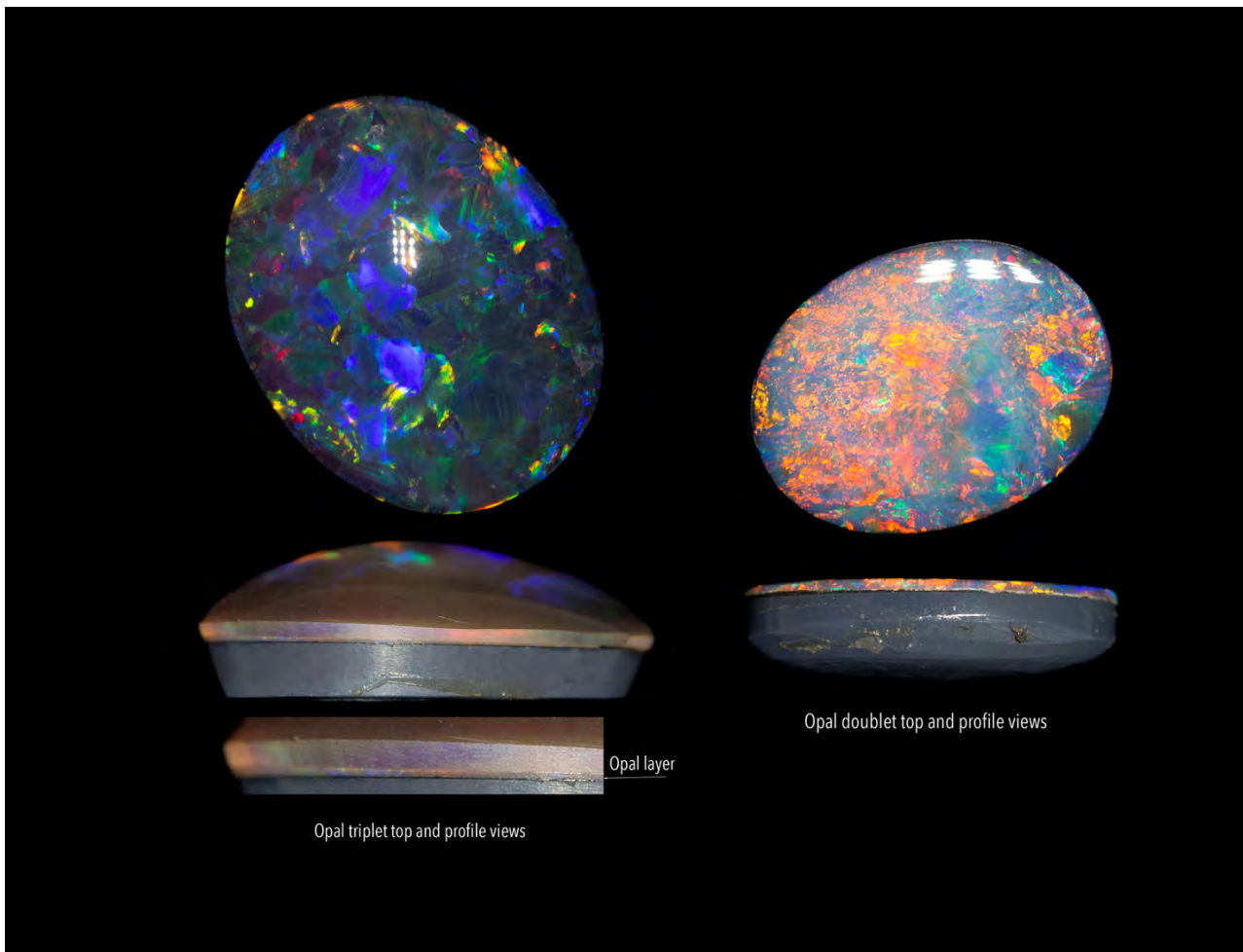
Courtesy; The Gemmological Association of Australia's online course "Certificate in Opal Studies".

A drawing of the construction of an opal triplet (image T. S. Coldham – Gemmological Association of Australia)

Triplet Opals are composites consisting of three layers, featuring a thin slice of opal with play of colour cemented between a base material and a transparent, colourless top layer of quartz, glass, synthetic spinel, or plastic.



The top, profile and bottom views of an opal triplet (image T. S. Coldham)



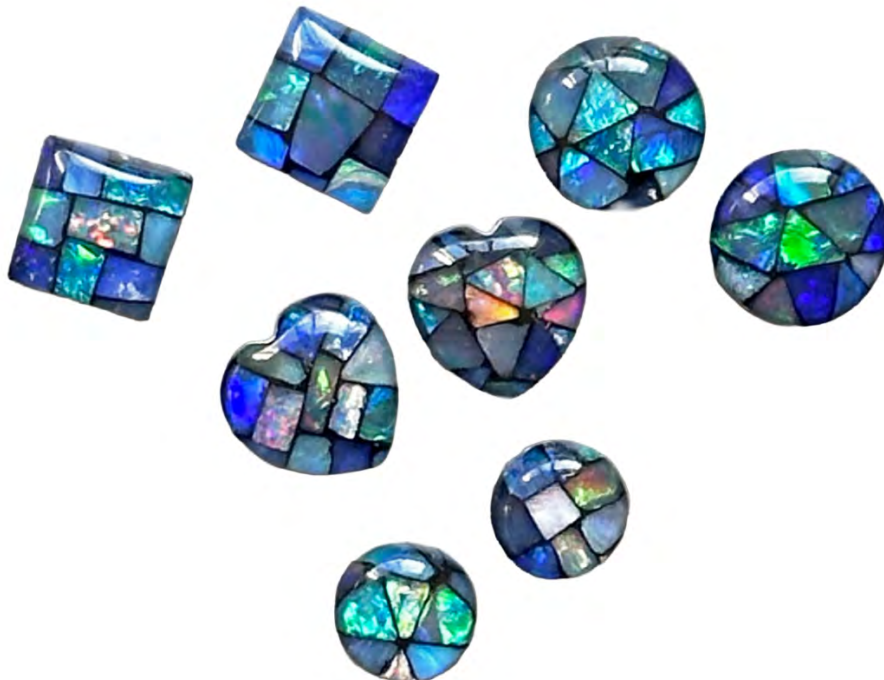
Examples of opal doublet and opal triple construction (Images Black Opal Direct)

5.4. Mosaic and Intarsia

Mosaic is a composition of small pieces of natural opal cemented to or embedded in a dark base material or in a resin (Scarratt, Kammerling, and Koivula 1993). Intarsia is a mosaic of opal mixed with other materials including other gemstones.



An ornate opal mosaic (image Emil Weis Opals)



Mosaic opals made by villagers using chips recovered from old mining operations (image T. S. Coldham – Gemmological Association of Australia)

5.5. Inlay

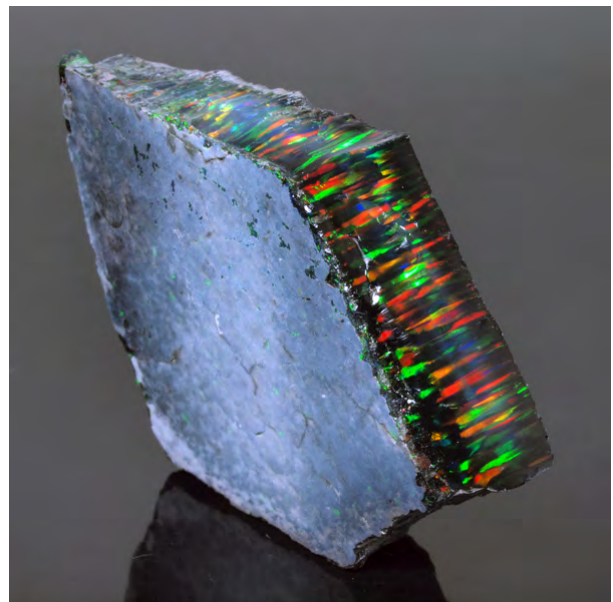
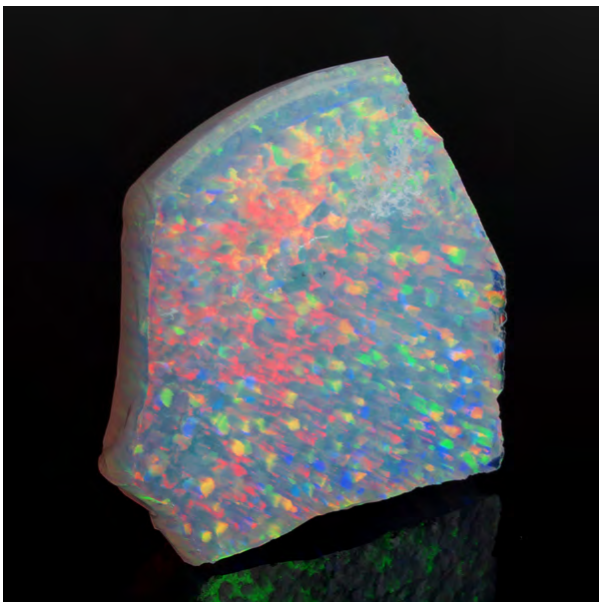
Opal inserted into precious metal or other material. Commonly, transparent or translucent opal is used.



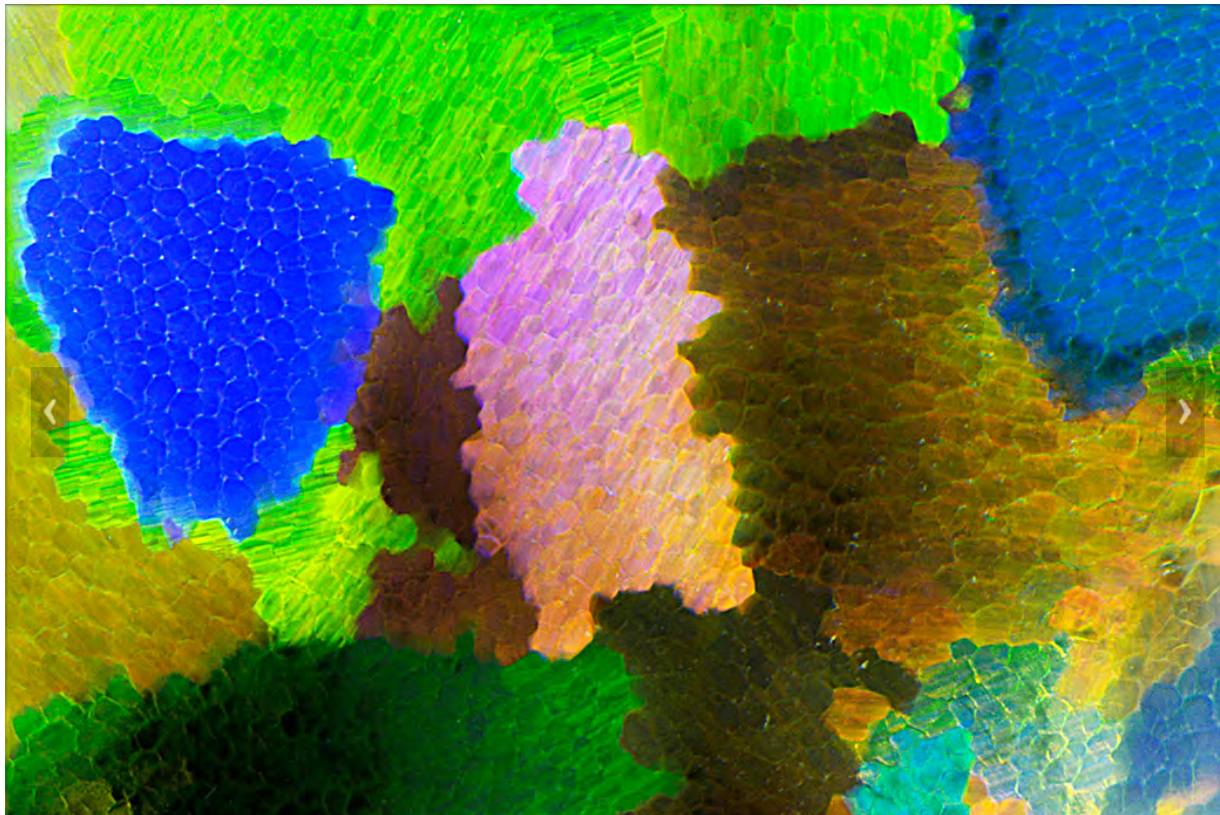
Natural opal inlay earrings (image T. S. Coldham – Gemmological Association of Australia)

6. Types of synthetic opal

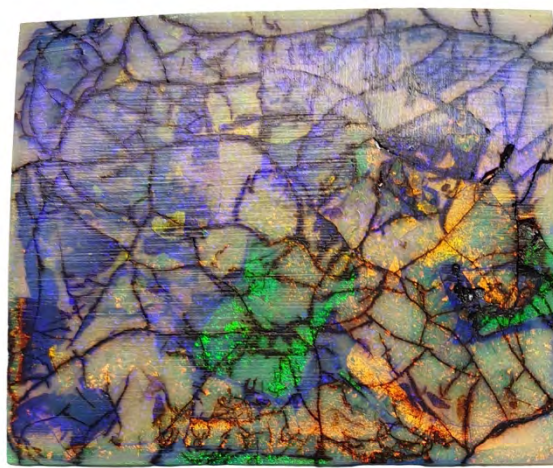
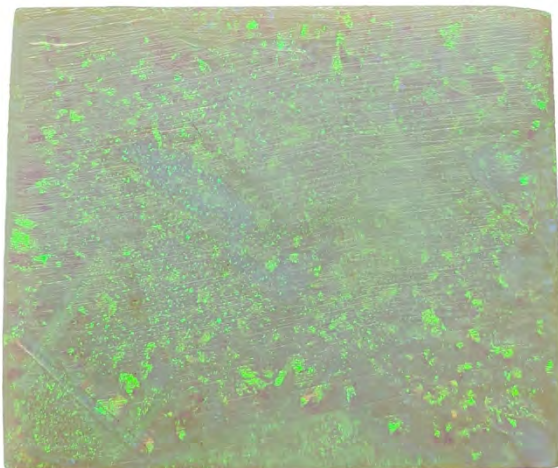
Manufactured material that has the same or very similar chemical composition to opal i.e. $\text{SiO}_2 \cdot n\text{H}_2\text{O}$. (Jobbins, Statham, and Scarratt 1976; Scarratt 1976, 1983, 1987, 1994; Liddicoat 1972, 1974; Robertson)



¹<https://www.gilson-opals.com/>



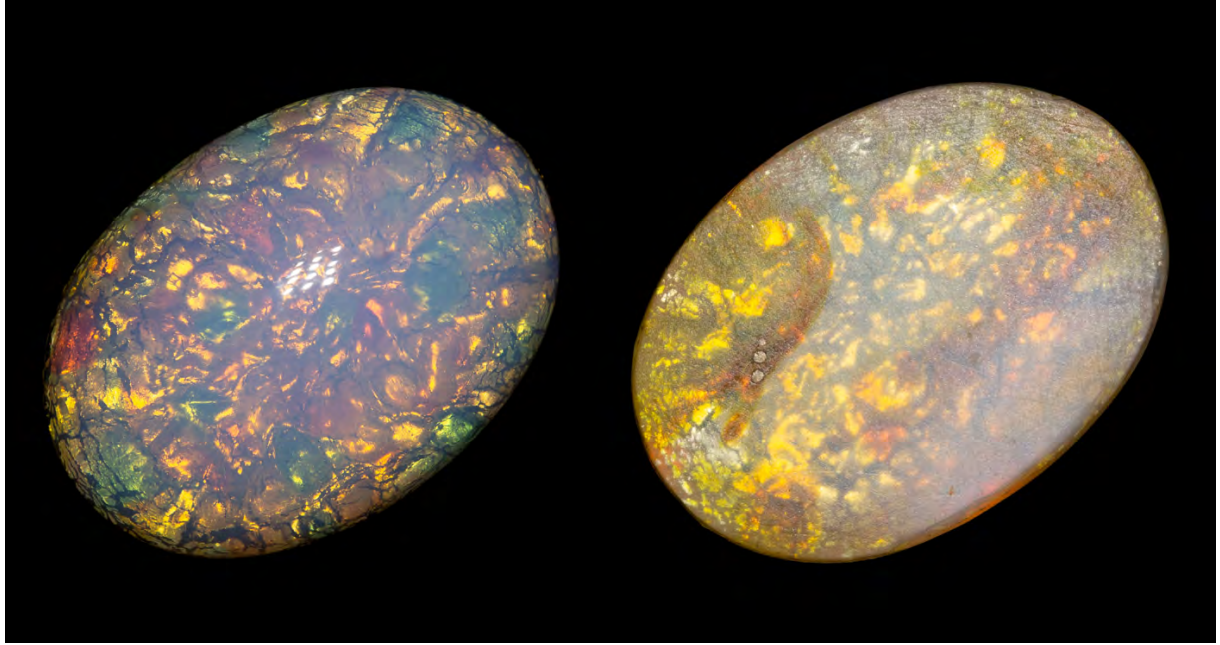
A snakeskin or "chicken-wire" cellular pattern is diagnostic for many types of synthetic opal, including this material manufactured by Gilson. Field of view 2.88 mm. (Renfro 2019)



Two varieties of Sterling synthetic Opal manufactured in the USA, sometimes sold under the trade name Monarch Opal, Galaxy Opal, Monet Opal and Exodus Opal (Images Emil Weis Opals)

7. Imitation or simulants

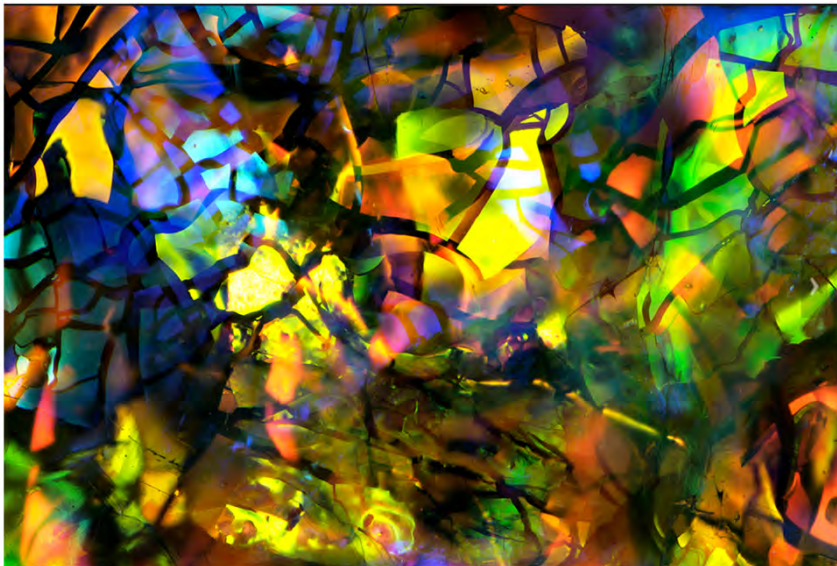
Natural or manufactured materials that are not opal but have opal-like characteristics.



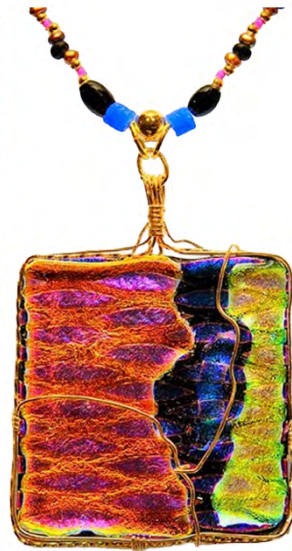
The top and bottom views of an imitation opal (images Black Opal Direct)

7.1. Slocum Stone

John Slocum brought Slocum Stone, which is a silicate glass which shows traces of sodium, magnesium, aluminium and titanium, to the market in 1974. It was manufactured in several base colours, and the “POC” produced by very thin layers of metallic film in the form of translucent flakes, producing a thin-film interference effect. Bubbles and swirls typical of glass are typical inclusions which may be noticed under magnification (Renfro 2019) (https://en.wikipedia.org/wiki/Slocum_stone).



Slocum stone imitation glass was manufactured by John Slocum of Michigan. Thin layers of metallic film fragments suspended in a glass matrix are responsible for the interference colours observed. Field of view 5.75mm. Image from Renfro 2019.



Multichroic glass (Wikipedia)
<https://commons.wikimedia.org/w/index.php?curid=9431364>

7.2. Multichroic glass

Multichroic glass; is glass which can display multiple different colours depending on lighting conditions.

8. Opal-like natural materials

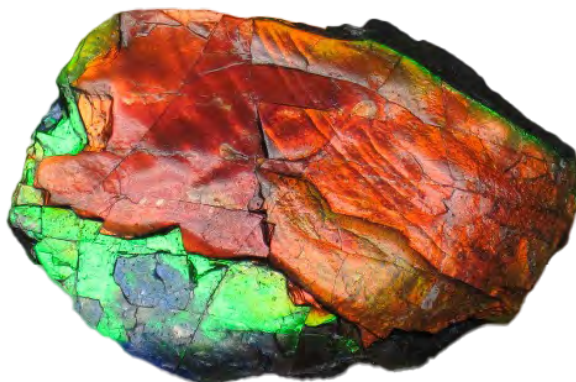
8.1. Ammolite

Ammolite: is a rare, iridescent, gemstone formed from the fossilized shells of extinct marine animals called ammonites. It is primarily found in Alberta, Canada, and is prized for its vibrant, rainbow-like colours that shift depending on the viewing angle. Officially recognized as a gemstone in 1981 by CIBJO, it is also a significant cultural and spiritual item for some Indigenous peoples.

The iridescent colour flashes of ammolite come from the interference with the light that rebounds from thin platelets. The thicker the platelet layers, the more reds and greens are produced; the thinner the layers, the more blues and violets predominate. The material may require treatments in order to reveal the colours' full potential.



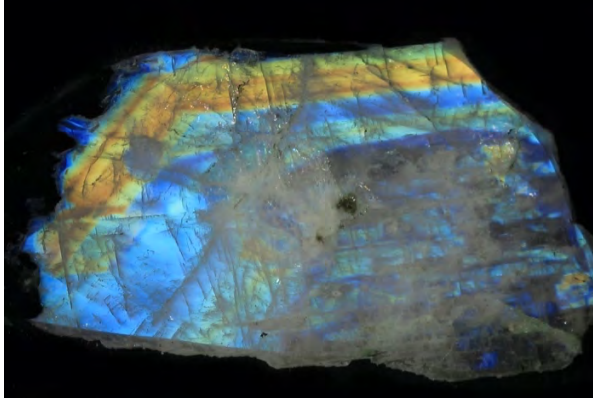
Ammolite with blue POC (Francesco Mazzero)



*Ammolite from southern Alberta, southwestern Canada) CC BY 2.0,
<https://commons.wikimedia.org/w/index.php?curid=35398011>.
Image: By James St. John*

8.2. Labradorite

Labradorite: is a feldspar characterized by the phenomenon known as "labradorescence," a multitude of colours such as blue, green, gold, and purple that radiate from within the stone when viewed from different angles. This play of colour is caused by the thin-film interference of light.



Labradorite with labradorescence By Boris Lobastov - Own work, CC BY 4.0, <https://commons.wikimedia.org/w/index.php?curid=90837213>



Labradorite with labradorescence, Kluka assumed - CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=763378>

9. The Classification Tables

Classifying opal based on the Official Gemstone Book. This system allows for the classification of any opal or opal like substance encountered.

Use these tables to:

- Firstly, determine its variety.
- Then list its characteristics.
- Then list any other distinctive features.

9.1. Natural opal – Solid opal

Variety	Characteristics	Description of characteristics	Terms used	Examples of additional descriptive terms that may be applied.
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Natural Homogenous Opal

Absorbency	Impermeable		
	Absorbent	Hydrophane Opal	
Play of Colour	Exhibits Play of Colour	Precious Opal	
	No Play of colour	Common Opal	
Body Tone	Black Dark Light		
Diaphaneity	Opaque Translucent Transparent		
Treatment	No Treatment Treatment	Treated	dyed, smoked, carbonised, filled, impregnated, coated,
Other Features	Body Hue		Colour/s such as pink, blue, grey, yellow.
	Presentation	Fashioned	Cabochon, carved, shape, polished slab, object.
		Rough	Seam, nobby, specimen
	Special features		Fossil, pseudomorph
	Optical Phenomena		Cats eye,
	Source		Country, location, field, area

9.2. Natural opal – Opal on host rock (presented naturally attached to the host rock)

Variety	Characteristics	Description characteristics	Terms used	Examples of additional descriptive terms that may be applied.
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Opal on Host Rock

	Absorbency	Impermeable		
		Absorbent	Hydrophane	
	Play of Colour in opal	Exhibits Play of Colour	Precious Opal	Predominant colours, Brilliance, Pattern
		No Play of colour	Common Opal	
	Body Tone of opal	Black Dark Light		
	Diaphaneity of opal	Opaque Translucent Transparent		
	Treatment	No Treatment Treatment	Treated	dyed, smoked, carbonised, filled, impregnated, coated,
Other Features	Body Hue			Colour/s such as pink, blue, grey, yellow.
	Presentation	Fashioned		Cabochon, carved, shape, polished slab, object., full face, split,
		Rough		Nut, pipe, split,
	Special features			fossil, pseudomorph
	Host Rock Type			Ironstone, sandstone, quartzite, basalt, andesite, diabase.
	Source			Country, location, field, area

9.3. Natural opal – Opal in host rock (Natural opal as infillings of voids or between grains of a host rock. Presented in one piece)

Variety	Characteristics	Description	Term	Examples of additional descriptive terms that may be applied.
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Opal in Host Rock

	Absorbency of opal	Impermeable		
		Absorbent	Hydrophane	
	Play of Colour in opal	Exhibits Play of Colour	Precious Opal	Predominant colours, Brilliance, Pattern
		No Play of colour	Common Opal	
	Body Tone of opal	Black Dark Light		
	Diaphaneity of opal	Opaque Translucent Transparent		
	Treatment	No Treatment Treatment	Treated	dyed, smoked, carbonised, filled, impregnated, coated,
	Other Features	Body Hue		Colour/s such as pink, blue, grey, yellow.
		Presentation	Fashioned Rough	Cabochon, carved, shape, polished slab, object., full face, split, Nut, pipe, split,
		Special features		fossil, pseudomorph, patterns - rivulet, conglomerate, granular
		Host Rock Type		Ironstone, sandstone, quartzite, basalt, diabase, andesite.
		Source		Country, location, field, area

9.4. Composite opal (opal of any variety which has been manually attached to any material)

Variety	Description	Characteristics	Components	Examples of additional descriptive terms that may be applied.
Opal Composite				
	Doublet	Two layers cemented together to form one piece.	Top Layer	Precious opal black, dark, or light, synthetic opal, opal simulant, treated opal.
			Base Layer	Common opal, ironstone, ironstone/epoxy composite, onyx, plastic, diabase.
	Triplet	Three layers cemented to form one piece.	Top Layer	Quartz, synthetic spinel, plastic, glass.
			Centre Layer	Precious opal, synthetic opal, imitation opal, diffraction grating
			Base Layer	Common opal, ironstone, ironstone/epoxy composite, onyx, plastic, diabase.
Mosaic			Opal component	Precious opal, synthetic opal
			Base	Common opal, onyx, plastic or resin, diabase.
			Other components	Transparent top layer, glass, clear epoxy
Intarsia			Opal Component	Precious opal, synthetic opal
			Other Components	Common Opal, any gem material, metal, wood, epoxy,
Inlay			Opal Component	Precious opal, synthetic opal
			Other Components	Resin, epoxy and metal

9.5. Synthetic opal (Manufactured material that has the same or very similar composition to opal i.e. $\text{SiO}_2 \cdot n\text{H}_2\text{O}$).

Type	Characteristics	Components	Term	Examples of additional descriptive terms that may be applied.	
Gilson	Old Gilson	Silica Plus Resin			
	Recent Gilson				
Monarch		Silica Plus Resin			
Arura		Resin Plus Silica			
Kyocera	Also known as Imamora	Silica Plus Resin			
Russian		Silica			
	Absorbency	Impermeable Absorbent			
	Play of Colour	Exhibits Play of Colour	Synthetic opal	Pattern, boundary shape, predominant colours, Brilliance,	
		No Play of colour	Common Opal		
	Body Tone	Black Dark Light			
	Diaphaneity	Opaque Translucent Transparent			
	Treatment	No Treatment Treatment	Treated	dyed, smoked, carbonised, filled, impregnated, coated,	
	Other Features	Body Hue		Colour/s such as pink, blue, grey, yellow.	
		Presentation	Fashioned	Cabochon, carved, shape, polished slab, object.	
			Rough		
		Special features		Play of colour patterns and boundaries,	
		Source		Manufacturer	

9.6. Imitation or simulant of opal

Variety	Type	Description	Characteristics	Components	Term	Other descriptive terms to be applied when known
Opal Imitant or Simulant		Natural or manufactured materials that are not opal but have opal-like characteristics.				
	Natural Materials	Iridescent Shell	Displaying spectral colours			Paua Shell, Fossil ammonite (Ammolite)
		Iridescent gem materials	Displaying spectral colours			Labradorite, Fire Agate, Rainbow Moonstone
	Manufactured Materials	Iridescent manufactured materials	Displaying spectral colours			Slocum Stone, Coloured foil in Glass, Plastic or resin, dichroic glass, glass or plastic with light diffracting properties
			Other Features	Presentation	Fashioned	Cabochon, carved, shape, polished slab, object.
					Rough	
				Special features		
				Source		Manufacturer or brand name

10. Opal Production

10.1. History

Whilst precious opal has been described since early Greek and Roman times, the source of their opal remains unclear. The mining of precious opal has been known to occur since the 15th century in what is now modern Slovakia and previously the Kingdom of Hungary. Semrád (Semrád 2022) discusses three opals originating from Červenica-Dubník (Hungary/Slovakia) held by the British Museum prior to 1881.

An historically important Hungarian opal cameo of Louis XIII (1601-1643, Louis King of France as a child) from the early 1600's, is listed and described in *Bibliothèque nationale de France* (<https://catalogue.bnf.fr/ark:/12148/cb445114651>). Set in a brooch the opal cameo is surrounded by an enamelled trellis of *cosse de pois* (pea pods). Described by Knowles (Knowles 2017), “the cameo shows a chubby-cheeked infant, his chest decorated with the sash and the cross of the Saint-Esprit. Where the setting touches the infant's shoulders, two strands of three peas, enamelled black, spring from greenish pods. The opal displays an obvious play of colour on the face and reverse.



The face and reverse of a Hungarian cameo opal set in a brooch, c. 1615–25 white and black opaque enamel, translucent green enamel, 6.2 - 4.3 cm. Paris: Bibliothèque nationale, Image BnF.

Interestingly, during the 16th. Century when Europeans first visited the Americas, they found the Aztecs had a special name for opal “vitzitiltecpati” or “hummingbird stone”. However, up until the late 1800's the main source of precious opal remained Slovakia (Hungary).



An Edwardian opal
cameo pendant,
attributed to
Wilhelm Schmidt
(1845-1938).

[https://www.woolleyandwallis.co.uk/
departments/jewellery/jw171120/view-
lot/306/](https://www.woolleyandwallis.co.uk/departments/jewellery/jw171120/view-lot/306/).



Suite of opal set jewellery designed Sybil Dunlop (1934) V & A Museum London
(Image T S Coldham)



10.2. Important well known opal producing countries

10.2.1. Australia

Australia has been a world leader in the production of precious opal throughout the 20th and into the 21st centuries, with commercial deposits in South Australia, New South Wales and Queensland.

The discovery of opal in Australia has a fascinating history, with many sporadic and small finds made during the second half of the 19th Century.

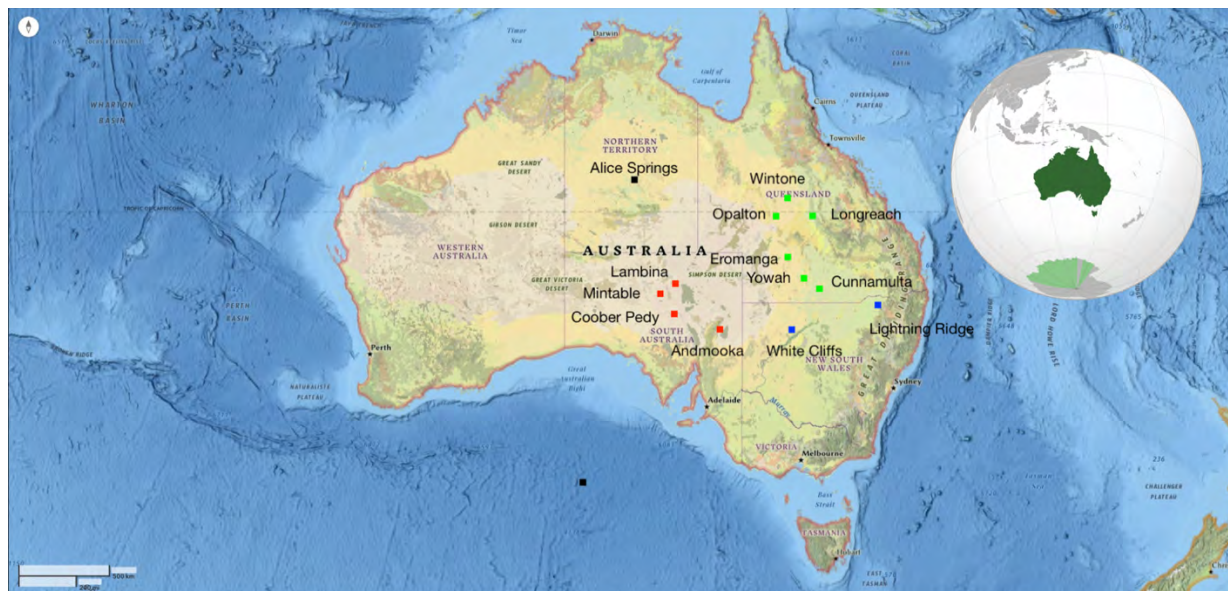
The first recorded discovery was by the German mineralogist Johannes Menge, in the Barossa Valley north of Adelaide in the 1840's. The South Australian Register reported in 1841 that "Opal occurs in great abundance, partly as milk opal, common opal, semi-opal and precious opal". Some of Menge's samples were displayed at the Great Exhibition in London, in 1851.

The first major precious opal discovery occurred in the late 19th century, when precious boulder opal was discovered on Listowel Downs Station, Barcoo region in Queensland and reported in a lecture given to the Royal Society of New South Wales, delivered by Rev. W.B. Clark in 1872. Many other small occurrences and mines followed and in 1874, Queensland boulder opal (opal on rock) was seen in the London market for the first time. Although this form of opal was initially not well recognised, there was wider appreciation following the work of Tully Wollaston, who travelled the outback in 1888 and went on to champion Australian opal in world markets. His diary entries, published in *Opal: Gem of the Never Never*, document the beginning of the opal industry in Australia.

Reports of minor early occurrences, with minimal mining and commercial activity, include those at Springsure in Queensland (1872) and Rocky Bridge Creek south of Bathurst, New South Wales (1875).

The first written report of precious opal in New South Wales was of a find by a shepherd on Moomba Station in the hills around the now-famous White Cliffs opal fields. The establishment of consistent mining and trading at White Cliffs in the 1880-90s is regarded as the beginning of the Australian opal industry.

While opal occurrences in South Australia, New South Wales and Queensland are geographically widespread, they share a common geological setting in the Great Artesian Basin (GAB), a large sedimentary basin that hosts the majority of Australia's opal deposits.

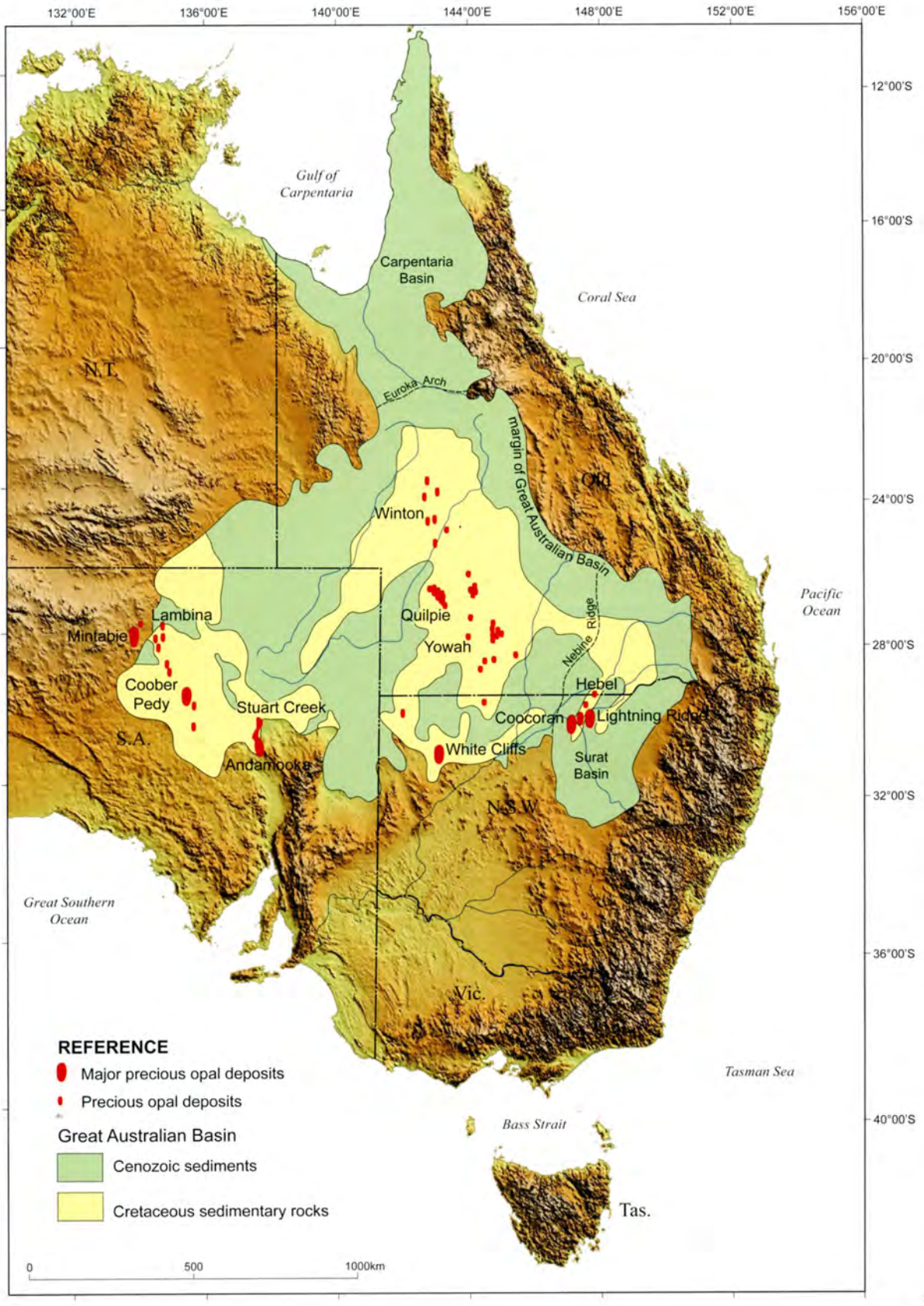


The Australian opal fields of South Australia, New South Wales and Queensland and Australia's orthographic projection CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=9397159>.

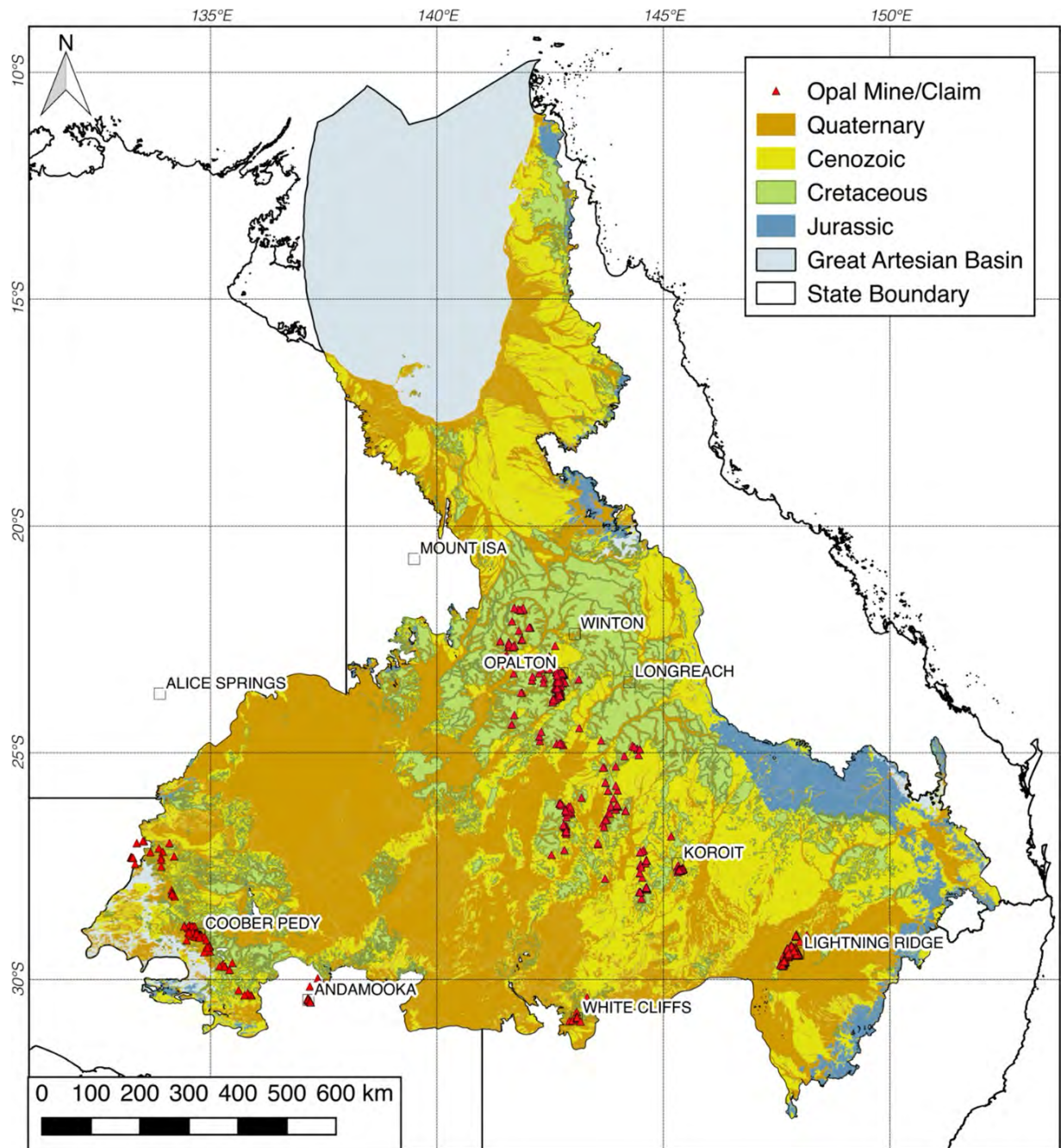
10.2.1.1. Geology

The Great Artesian Basin (GAB) formed during the Jurassic to Early Cretaceous geological periods, as sediments accumulated in the broad, shallow Eromanga, Surat and Carpentaria sub-basins. During the Early Cretaceous geological periods, much of the GAB was inundated by the Eromanga Sea - a shallow, inland sea characterised by low-energy conditions. This environment promoted the accumulation of fine-grained marine sediments, including shales and mudstones interbedded with sandstones, many of which are fossil-rich and contain elevated organic and iron content. These sedimentary units form the primary host rocks for opal mineralisation.

Following regression of the Eromanga Sea in the Late Cretaceous, the basin underwent uplift, erosion and prolonged weathering. Oxidation of iron- and pyrite-rich sediments generated acidic conditions that mobilised silica from feldspars and volcanic material. As groundwater migrated through permeable sandstones and into less permeable clay-rich units, changes in pH and redox conditions caused silica to precipitate as a gel. Over time, this gel dehydrated and organised into the silica sphere framework characteristic of precious opal, typically forming along weathering fronts, permeability contrasts, and in fossil cavities and structural pathways.



The Great Australian Sedimentary Basin showing the position of the major opal fields. Courtesy of the Commonwealth of Australia, Geoscience Australia 2011.



Great Artesian Basin outline showing Cretaceous and younger geological units and opal mining locations. Surface geology is derived from Geoscience Australia's Surface Geology of Australia, 1:1 000 000 scale, 2012 edition. Great Artesian Basin outline and opal mining location data are sourced from Geoscience Australia. Map produced by K Steffens.

10.2.1.2. Lightning Ridge New South Wales – Home of black precious opal

Lightning Ridge is in the north-west of New South Wales, approximately 770km north-west of Sydney. The settlement is said to have been named for an incident in the 1870s in which a shepherd, his dog and several dozen sheep were killed by a lightning strike on one of the opal-producing ridges (Townsend 1995).

First Nations people encountered opal in the Lightning Ridge area long before it was documented in written records. Opal was noted around 1873 by Robert Moore on Muggarie (Angledool) Station. Prior to 1902, Mrs Ann Ryan also collected pieces of opal at Angledool. In 1902 gold prospector Charlie Nettleton arrived at Lightning Ridge and began prospecting after seeing Mrs Ryan's finds.

The black precious opal found at Lightning Ridge was initially regarded as of little value because it differed so markedly from the better-known light opal. In 1903, Nettleton took a parcel of black opal to White Cliffs and sold it to E. F. Murphy, who showed it to T. C. Wollaston. Wollaston went on to introduce black opal to the world market, promoting Australian opal at international exhibitions and events in the early 1900s.

By 1906 a substantial mining community had formed. The field's fame spread rapidly as specimens of vivid black precious opal reached Sydney and London dealers. Throughout the twentieth century, "the Ridge", as it is known locally, grew and the opal fields expanded, drawing miners from across Australia and, from the 1950s, from Europe, Asia and elsewhere.

Lightning Ridge produces precious opal in body tones ranging from black to light, diaphaneities from transparent to opaque, and play of colour spanning the visible spectrum. Precious opal is often found mixed or intimately associated with common opal locally known as "potch".

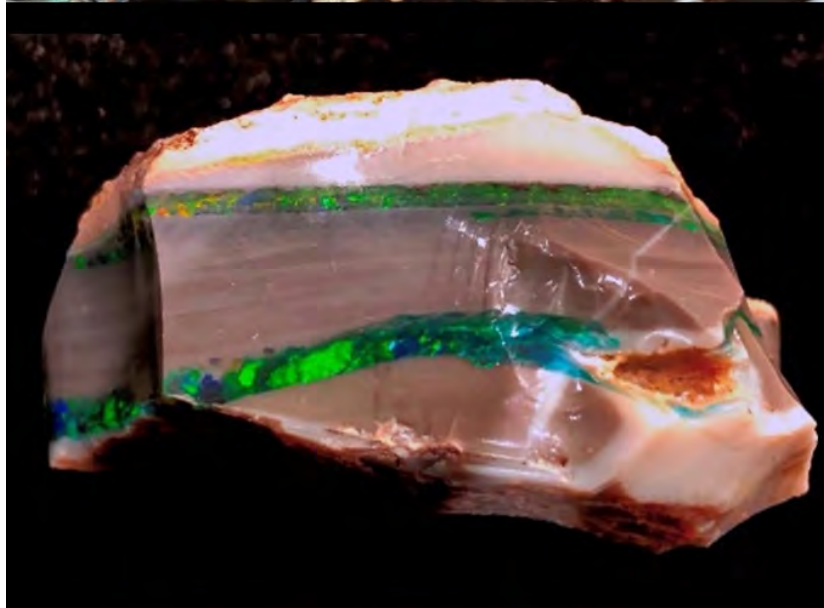
The Ridge is most famous for black precious opal displaying play of colour on or in black or very dark potch, promoting colour intensity. Lightning Ridge remains the major source of this opal type and is renowned worldwide for producing the most highly valued black opals.

The opal occurs as infillings of voids in the Griman Creek Formation, in Cretaceous sedimentary sandstone and claystone deposited 96 – 100 million years ago under freshwater and near-coastal conditions. Most opal at the Ridge is found at depths between 10 and 30 meters, in claystone or "opal dirt" (known locally as "the level"), often below a layer of hard fine-grained sandstone cemented with silica and termed "shincracker". Some mines contain more than one opal level.

The two most typical forms of opal at Lightning Ridge are nobby and seam. "Nobbies" are nodular opal formations, thought to be unique to Lightning Ridge and found primarily in fields at or near the town, Coocoran and other northern fields. "Seam opal" infills planar fractures in the sedimentary host layers and may be found in any field in the area. Grawin, Glengarry, Sheepyard and associated fields southwest of Lightning Ridge are best known for their seam opal.



Upper left image; Lightning Ridge seam opal rough (image Anthony Smallwood). Centre left image; Lightning Ridge seam precious opal rough with two colour bars (image Down To Earth Opals). Lower left image; Lightning Ridge seam precious opal rough (image Cody Opal).





(Left) Lightning Ridge nobby opal rough (image Anthony Smallwood). (Right) Lightning Ridge black opal rough (image Cody Opal).

Opal is also found as fossil replacement of diverse Cretaceous plant and animal remains. Lightning Ridge is one of the richest fossil assemblages of its age, with dozens of opalised fossil taxa preserved including plants, invertebrates, fish, turtles, crocodiles, plesiosaurs, pterosaurs, the only dinosaur fossils found in New South Wales, and the state's only dinosaur-aged mammal fossils.



Upper) Rare opalised fossils, part of the Australian Opal Centre collection (image Australian Opal Centre collection)
Lower) Toe bone of a raptor dinosaur (image Cody Opal).

Mining is conducted under licence from the New South Wales Government, within a regulatory framework governing claim sizes, titles, environmental rehabilitation and safety (NSW Department of Regional NSW, Opal Prospecting and Mining Guidelines, current edition). Active opal fields extend many kilometres beyond the township, within the Narran Warrambool Reserve. A significant proportion of opal fields are within Lightning Ridge Area Opal Reserve (LROAR), a Crown Reserve managed by a board of management. Opal production figures are not systematically published.

Underground shaft and tunnel methods are most common, with open-cut extraction used only where further valuable opal is evident and underground extraction can no longer be conducted safely.

Vertical shafts are sunk using a Calweld drilling rig, then horizontal drives extended into the opal level using a jackhammer or hydraulic “digger”. Mined material is typically raised to the surface using an automatic hoist or by vacuum, using a “blower”. Most miners process prospective material in a modified cement mixer or agitator (colloquially known as an “agi”) to remove softer clays and sandstone, after which the remaining tailings are “tailed out” and visually inspected to recover precious opal.



Mining Lightning Ridge (image Kathy King)



Top) Lightning Ridge small hoist mining (image Anthony Smallwood). (Centre) Lightning Ridge drilling (image Black Opal Direct). (Bottom) Mining Lightning Ridge (image Kathy King).





Tailing out Mining Lightning Ridge (image Kathy King).

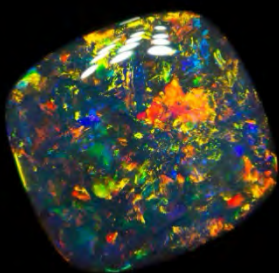


Tailing out Mining Lightning Ridge (image Anthony Smallwood)

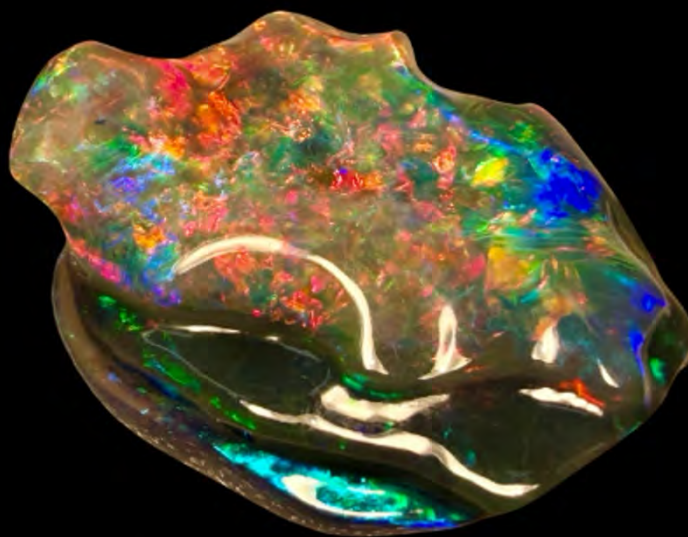
Most miners work alone or in small partnerships. The absence of large-scale mining significantly shapes the character of the industry.

Lightning Ridge precious black opal is sold through diverse channels, including direct miner-to-end-user sales, but predominantly through multiple levels of wholesale and retail. Wholesale trade occurs both at Lightning Ridge and in domestic and international markets.

Lightning Ridge precious black opal is recognised internationally as a benchmark gemstone. Fine quality stones, particularly those displaying full-spectrum play of colour dominated by red, may sell for figures comparable to high-grade ruby, emerald or sapphire. Per-carat prices are sensitive to hues, brightness, patterns and relative consistency of the play of colour, as well as body tone, inclusions and, for finished stones, shape and quality of finish.



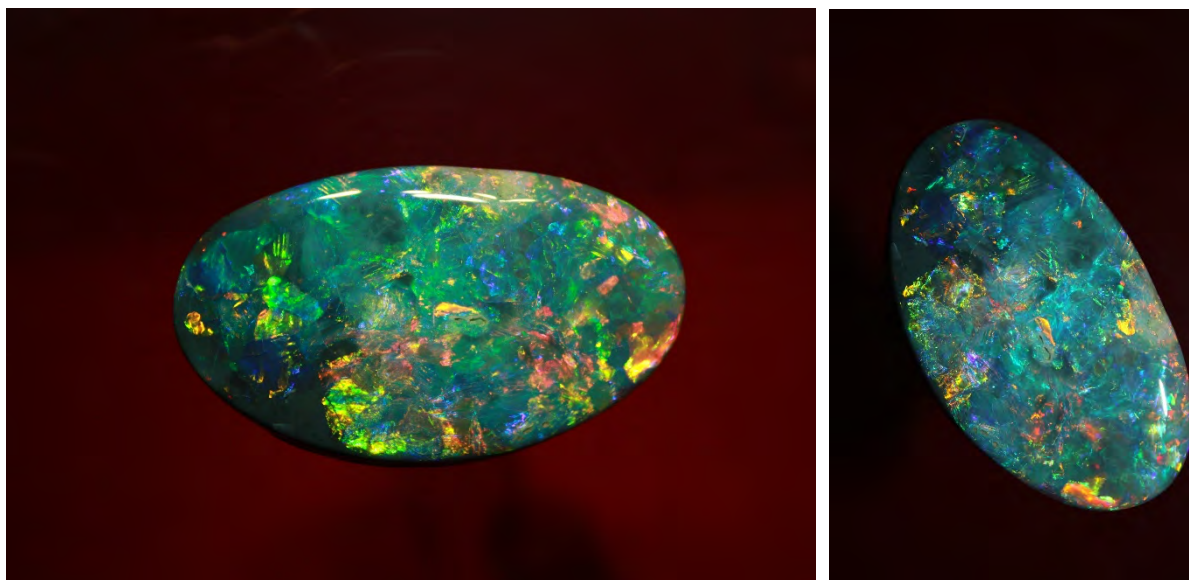
A selection of Lightning Ridge opals (images Black Opal Direct).



Lightning Ridge "Fire and Ice" mined by Peter Cooke and Sam Westra at the "Old Nobby" field, sculpted by Andrew Kemeny from Down To Earth Opals, weighing 34.2ct and measuring 22.7x31.0x9.2mm (image provided by Down To Earth Opals)

Lightning Ridge opal appears regularly at major international auction houses and has been set by leading jewellery houses. Its reputation confers a meaningful provenance premium in the trade.

Historically significant named stones include the Flame Queen, a 263-carat black opal unearthed in 1914, and the Aurora Australis, a 180-carat black opal found in 1938 and widely cited as the most valuable single opal ever auctioned (Cody 2023); other famous names stones include the Butterfly or Red Admiral, Pride of Australia or Red Emperor, Black Prince and Halley's Comet.



The Aurora Australis measures 7.62x4.57cm, dug from an old seabed by Opal miner Charlie Dunstan, it has dominant red, green and blue colours against a black background (image provided by Fiona Altmann, Altmann + Cherny)

The resident population of Lightning Ridge is estimated at 2,500 to 5,000, fluctuating seasonally (Australian Bureau of Statistics, 2021 Census). The population is notably multicultural, with waves of migration from Europe in the 1950s through the 1980s, and more recently, Asia and elsewhere. Gamilaraay, Yuwaalaraay and Yuwaalayaay people have deep connections to the region predating the opal industry.

Like other Australian opal-producing settlements, the town's social fabric is shaped by the opal resource and industry. Geographic isolation, unpredictable outcomes, fluctuating markets, individual enterprise and the perpetual hope of a significant find have fostered a distinctive culture of toughness, tolerance, self-reliance and resilience.

Lightning Ridge Miners' Association (LRMA), a non-profit organisation established in 1974, plays a key role representing the interests of the opal mining community. The Australian Opal Centre (AOC), formerly Lightning Ridge Opal and Fossil Centre, is a community-initiated not-for-profit organisation formed in the late 1990s that runs educational, scientific and cultural programs and that manages the world's premier collection of rare opalised fossils and opal-related geological specimens, publications and cultural artefacts; it is constructing a major new facility at the historic Three Mile opal field, Lightning Ridge.

The annual Lightning Ridge Opal Festival draws visitors from across Australia and the world. The Australian Opal Awards (AOA), founded in 2000 as the 'Opal Jewellery Design Awards Association', provides a platform for opal jewellery designers and opal artisans to showcase their talent and creativity.

Lightning Ridge is a major opal-producing centre, significant regional service hub and major tourist destination, with underground show mines, guided and self-guided tours, retail stores, art galleries, cafés and Artesian Bore Baths fed by the Great Artesian Basin.



Opal mining aerial – the famous Lunatic Hill Open Cut (image courtesy of Lightning Ridge Tourism Association)

10.2.1.3. White Cliffs, New South Wales – Australia's first precious opal field

Opal was initially discovered near White Cliffs in 1884. By 1891, due to its rich opal resource, the area supported 2500 miners and in 1898, White Cliffs was proclaimed a town. It was named for its low flat-topped hills of Cretaceous white sedimentary rock, capped by resistant Tertiary silcrete. This discovery really initiated the start of the opal trade in Australia

Wollaston wrote: "The stones was something quite new and exceedingly interesting, noble Opel more of the Hungarian type but occurring in flat cakes quite free of adhering

matrix and opalized fossil shells, saurian and strange bunches of crystals” (Wollaston 1924).

Opal occurs in the Cretaceous sandstone and claystone, often in horizontal seams ranging from 1mm to 75mm, or infilling voids resulting from burial of organic remains.



White Cliffs showing shaft with self-loading bucket hoist in foreground (image Anthony Smallwood)

White Cliffs produces mostly light opal, often with bright play of colour in a translucent to transparent body. Thin seam material is sought after for making composite opals such as doublet opals.

White Cliffs is famous for its rare “opal pineapples,” which are opal pseudomorphs of glauberite or ikaite. Opalized fossils of marine molluscs, reptiles and fish, and occasionally wood, are also encountered.

White Cliffs and its satellite fields still produce opal, although in recent years mining activity has reduced dramatically.

White Cliffs is a small, character-filled township, existing for the opal mining community and the tourists it attracts. It has under 200 residents, many of whom live in comfortable “dugouts” to escape the temperature extremes.



*Opal 'Pineapple'
pseudomorph White
Cliffs (image Cody
Opals)*



*Freshly mined White
Cliff opal. Note the
opal fossils in the
foreground (image T.
S. Coldham –
Gemmological
Association of
Australia)*

Prospective areas are often investigated using prospecting drill rigs and mining is either by shaft and tunnel or open-cut methods.



(Top) Shaft with bucket hoist, White Cliffs (image T. S. Coldham – Gemmological Association of Australia) (Bottom) Open cut excavation with old drive exposed, White Cliffs (image T. S. Coldham – Gemmological Association of Australia)

Miners sort and grade their production prior to offering it to visiting rough buyers, both Australian and overseas.

White Cliffs and its satellite fields still produce opal, although in recent years mining activity has reduced dramatically.

White Cliffs is a small, character-filled township, existing for the opal mining community and the tourists it attracts. It has under 200 residents, many of whom live in comfortable “dugouts” to escape the temperature extremes.

10.2.1.4. South Australian Opal Fields

South Australia is home to several important opal fields, Andamooka, Coober Pedy, Mintabie and Lambina. Each field has its own characteristics with Coober Pedy being the largest in terms of population, mining activity and opal production. Mintabie and Lambina are virtually closed to mining. In South Australia there are now two opal producing areas; Coober Pedy and Andamooka.

10.2.1.4.1. Coober Pedy

Coober Pedy is located in South Australia, 838 kilometres north of the state capital, Adelaide, along the Stuart Ranges. It is the most significant opal-producing field in the state and the largest producer of precious opal in Australia. Coober Pedy has remained in continuous production for more than a century and is widely regarded as the world's premier source of precious light opal, particularly light-based seam opal and light crystal opal.

The discovery of opal at Coober Pedy is attributed to Willie Hutchinson, a 15-year-old member of a prospecting party searching for gold and water at the foot of the Stuart Ranges in 1915. The first recorded production of opal in the area followed in 1916. However, the discovery coincided with World War I, and although some early buyers and prospectors made the difficult journey to the remote field, development was slow. Further activity was later affected by drought and the Great Depression of the 1930s.

A major turning point came in 1946, when an Aboriginal woman named Tottie Bryant made a significant find at what is now known as the Eight Mile field. This discovery, together with the post-war boom after World War II, led to a rapid increase in production as miners returned to the fields and international markets expanded.

Further discoveries and technological developments contributed to expanded production. In 1957, deeper sinking below earlier workings led to the discovery of high-grade opal and initiated another period of increased activity.

During the 1960s and 1970s, an influx of predominantly European migrants contributed significantly to the growth of Coober Pedy. This increase in population brought new

skills, labour, and entrepreneurial energy to the field, supporting the development of new mining areas, including the Olympic field, which became recognised for its consistent production and good-quality material.

The discovery of the Southern Cross field in the early 1980s further expanded the known opal-bearing ground. Today, opal workings extend over a considerable area surrounding the town.

Opal in the Coober Pedy region is hosted in sedimentary sandstones and claystones of Cretaceous age that have been altered by weathering and leaching. The surrounding terrain is marked by flat ridges capped with silcrete, with weathered slopes descending towards open plains. The material commonly occurs as seams or veins along horizontal levels, and also within steeply inclined fractures and joints where cavities in the host rock have been filled by silica-rich material.

The Coober Pedy area is principally associated with precious light opal, including white opal, light opal and light crystal opal. Much of the production is seam opal, with material ranging from opaque white body colour through to translucent or semi-transparent crystal opal. Play of colour may occur in a broad range of hues and patterns. Potch is also encountered and may occur separately or in association with precious opal.

Opal may also be encountered as fossil material, including marine shells, belemnites, crinoids and the remains of marine vertebrates such as fish, plesiosaurs and more rarely, ichthyosaurs.

Mining at Coober Pedy is predominantly underground, with opal-bearing levels typically occurring at depths of approximately 25 to 30 metres, depending on local conditions. Exploration commonly begins with grid drilling using small-diameter drill rigs to identify areas of opal “trace”. Where results are promising, shafts are sunk to the opal-bearing level, and horizontal drives are developed using mechanical tunnelling equipment. Excavated opal bearing ore is brought to the surface using blower systems.

Open-cut mining is undertaken in areas where the opal level is shallow. Excavated mullock is commonly sieved using a trommel, with the resulting material then sorted using ultraviolet light, often in 'noodling machines'. Rough material is then graded, and both rough and cut opal are sold in Coober Pedy.

Noodling, or fossicking, is the search for precious opal in mullock heaps. These heaps consist of rock brought to the surface during mining and they may contain pieces of opal overlooked during extraction. Noodling remains a distinctive feature of Coober Pedy's opal culture, carried out by visitors, hobbyists and, in some cases, people who search or process mullock heaps more seriously as a source of income.



Coober Pedy commercial noodling machine (image Anthony Smallwood)

Coober Pedy is located on the traditional lands of the Antakirinja people, with the Umoona community playing an important role in the life of the town. Today, Coober Pedy is an important regional hub, providing essential services to residents and the surrounding mining community. The town has around 3,500 residents, representing more than 45 nationalities, reflecting the diverse communities that have contributed to its development as an opal mining centre.

Coober Pedy is also a significant tourism destination, receiving approximately 150,000 visitors annually. It is home to retail and wholesale opal operations, restaurants, museums, and other cultural and community places of interest, and remains an important centre for the opal industry.

The town is particularly notable for its distinctive underground architecture. Many homes, commercial premises, community buildings, churches, clubs, and accommodation houses have been constructed below ground, taking advantage of the more stable temperatures beneath the surface in an otherwise extreme arid environment. Its distinctive combination of arid landscape, opal mining, cultural diversity, tourism and underground living has made Coober Pedy one of Australia's most recognisable mining towns.



View of Coober Pedy township (image Anthony Smallwood)



Coober Pedy dugouts (image Anthony Smallwood)

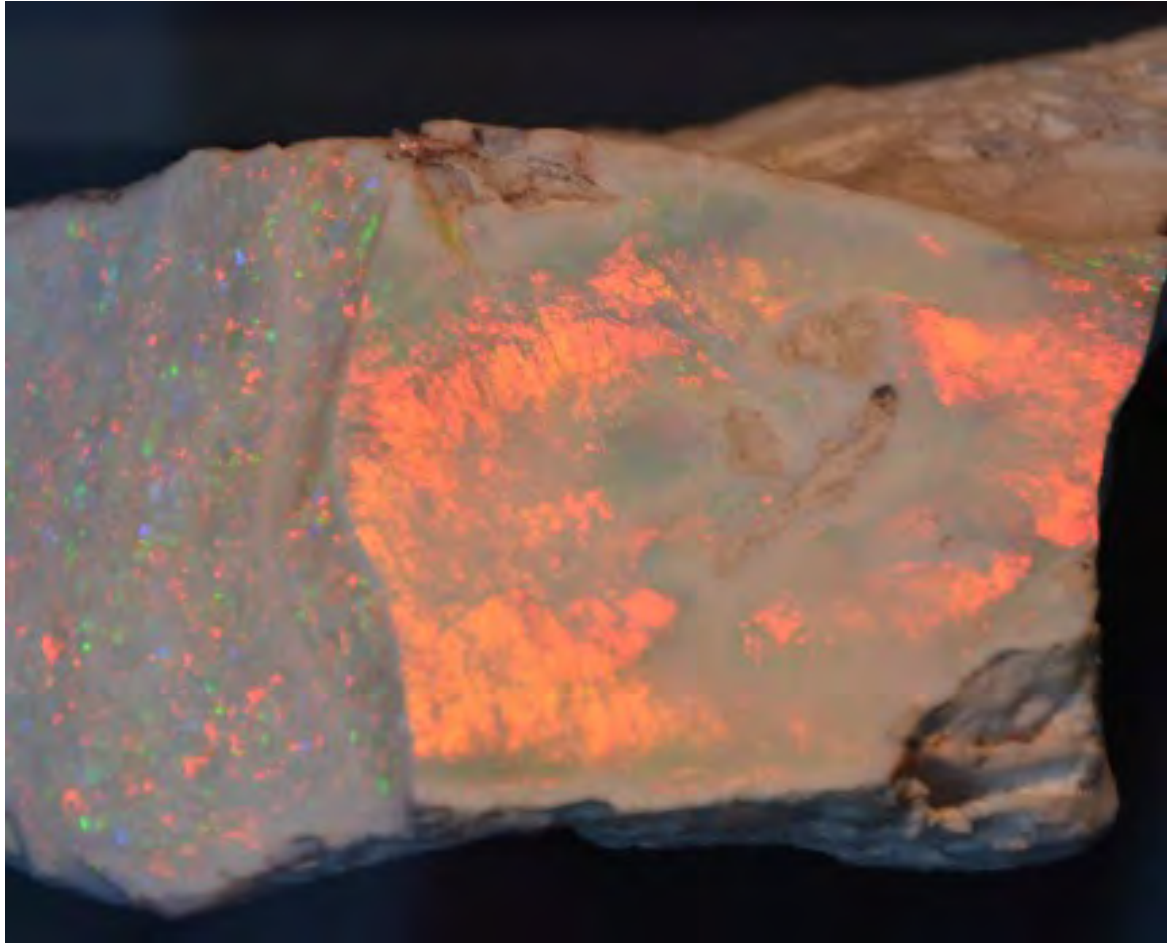


Coober Pedy mining (image T. S. Coldham – Gemmological Association of Australia)



Coober Pedy mining (image T. S. Coldham – Gemmological Association of Australia)

Coober Pedy has produced several important opals of historical and gemmological significance. Among these is the “Fire of Australia”, discovered by Walter Bartram in 1946. Weighing close to 5,000 carats, or approximately 998 grams, it is noted for its exceptional size and vivid play of colour



The ‘Fire of Australia’, a 998 gram uncut opal mined by Walter Bartram in 1946 at the Eight Mile field in Coober Pedy (image R. Mannella, specimen South Australian Museum)

Another significant discovery is the “Olympic Australis”, found in 1956 and named in honour of the Olympic Games held in Melbourne that year. Weighing approximately 17,000 carats, or 3,450 grams, it is one of the largest precious opals ever found.

The field is also renowned for rare opalised fossils, including the belemnite specimen known as the “Virgin Rainbow Belemnite” discovered in 2003. The Virgin Rainbow weighs 72.65 carats and displays a full spectrum of colour. It is considered one of the finest-quality opalised fossils recovered from Coober Pedy.



The 'Olympic Australis' weighing 17,000 carats and measuring 28 x 11.5cm (image provided by Fiona Altmann, Altmann + Cherny)



The 'Virgin Rainbow' (image R. Mannella, specimen South Australian Museum)



Opalised shell fossil from Coober Pedy, 37x26x20mm, 14.66 grams (image The Opalcutter)



Shell bed from Coober Pedy, preserving opalised bivalve and gastropod molluscs, donated by Paul Sedawie to the Australian Opal Centre under the Australian Government's Cultural Gifts Program. Photo by L. Jenkins, courtesy Australian Opal Centre.



Precious opal fossil snail shell (Specimen courtesy Dale Price Opals, image Anthony Smallwood)

10.2.1.4.2. Andamooka

Andamooka is a small township (population of around 2600 in 2021) 479km southeast of Coober Pedy. Boulders with veins of opal were found by boundary riders and the first prospecting lease was pegged in 1932. Opal buyer Ernie Sherman of Sydney purchased the first parcel of fine grade material that year. Mining peaked in the 1960s and was largely played out by the early 1970s.

Andamooka lies near Lake Torrens, a large salt pan. Its opal occurs within the Bulldog Shale, an Early Cretaceous formation deposited 100 to 145 million years ago when a shallow sea covered the region.

The rock profile has three distinct layers. The uppermost, called kopi, is a pale, heavily weathered claystone, typically 7 to 13 meters thick. Below it sits the conglomerate band, a boulder-bearing sandy layer whose lower boundary marks "the level" - the horizon where opal is most likely to be found. Beneath this lies the mud, a less weathered claystone up to 4 meters thick.

Small faults occur throughout the sequence, and miners have long associated these with opal occurrences.

Andamooka is considered a premier source of stable, high-quality crystal opal. The opal is translucent to transparent and the finest exhibits intense play of colour in vivid

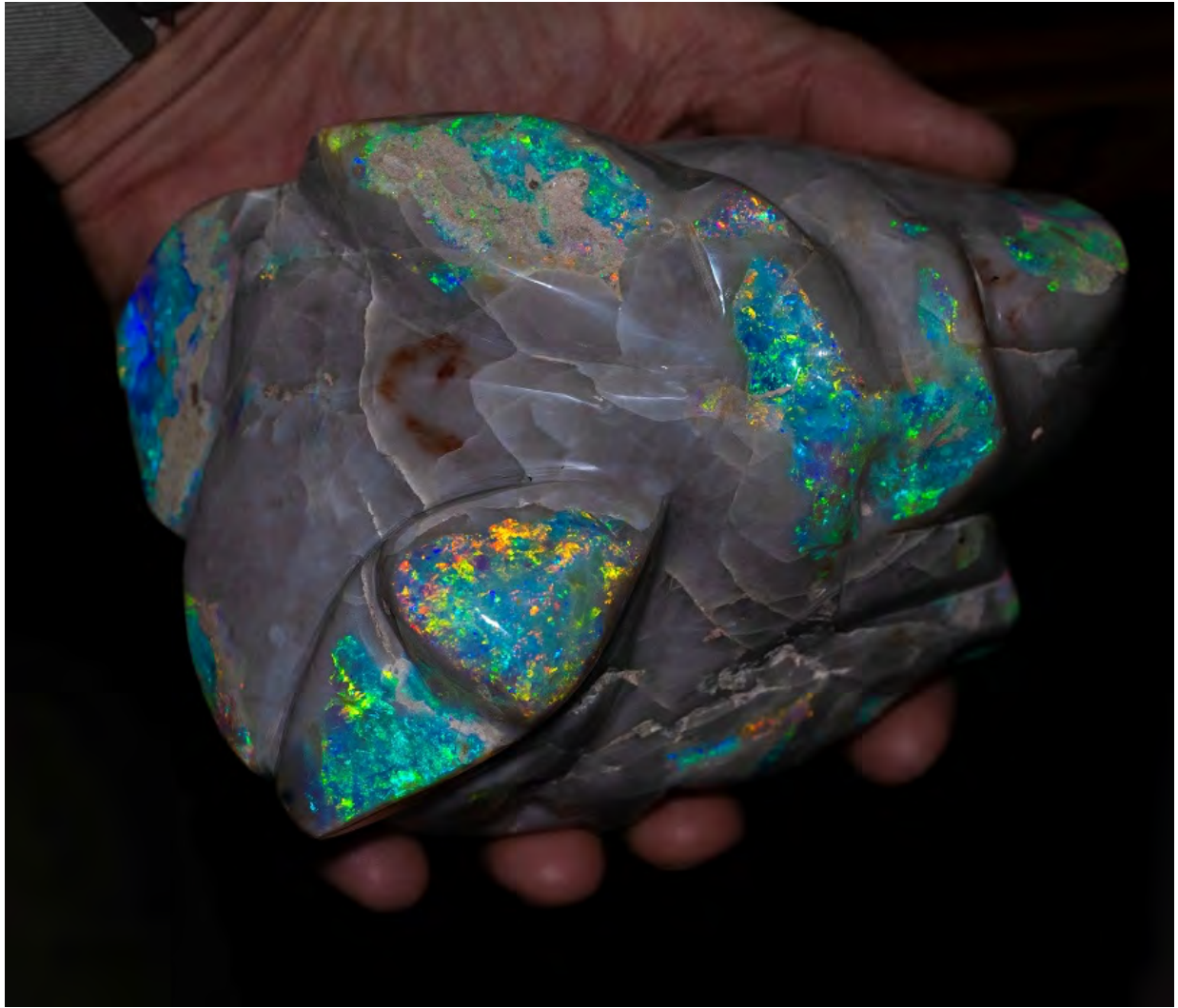
pastel hues. Fine-quality Andamooka crystal opal is rare in the market today, with most available material being from historic diggings. A large specimen of Andamooka crystal in quartz is considered a mineralogical rarity. Small pockets of dark and black opal have also been recorded.



Andamooka opal buyer Greg Sherman in dugout (credit Sherman Opal Archives)



Andamooka Crystal Rough (image Black Opal Direct).



Dwayne Andamooka Opal in Quartz Specimen (image Black Opal Direct)

Andamooka is also well known for its “opal in host rock”, commonly known as Andamooka matrix opal. In this material, opal is diffused throughout the host material, where it binds sand particles to form a porous rock. Andamooka matrix opal is commonly treated by soaking cut and polished material in a sugar solution, then boiling it in sulfuric acid to fill the pore spaces with black, carbonised sugar, thereby enhancing the play of colour by darkening the body tone of the host rock.

Like Coober Pedy and White Cliffs, Andamooka also produces opalised fossils preserving traces of life from the ancient inland sea, including mollusc shells and rare plesiosaur bones.

Andamooka continues to produce opal in small quantities. Its small, dynamic community supports opal mining and processing, natural history, dark sky astronomy, cultural activities and outback tourism.



Andamooka natural Black Opal Triangle left, and Andamooka Treated Opal Matrix right (images Anthony Smallwood)

10.2.1.4.3. Mintabie

Mintabie is situated approximately 272 kilometres north of Coober Pedy. From 1987 to 1991, Mintabie was a major opal producer. Miners employed both shaft and tunnel and open cut methods, with material mostly sold in rough form on the fields, after being graded by miners. Currently there is very little mining activity at Mintabie.

The geology of the Mintabie opal field differs from that of other Australian fields, with opal occurring in horizontal seams and vertical joint planes within older Palaeozoic rocks of Ordovician age

Mintabie produces predominantly light and crystal opal, as well as being well-known for dark and some black opal.



*Mintabie opal rough
(image T. S. Coldham
– Gemmological
Association of
Australia)*



Mintabie town (image Anthony Smallwood)



Mintabie opal field (image T. S. Coldham – Gemmological Association of Australia)

10.2.1.4.4. Lambina

Around 70kms northeast of Marla is the Lambina opal field, which between 1989 and 2001 saw substantial production. Currently there is little or no mining. The opal is relatively hard, and occurs as light, crystal and dark seam opal. Opalised marine snails, belemnites, and bivalves have also been found at Lambina.

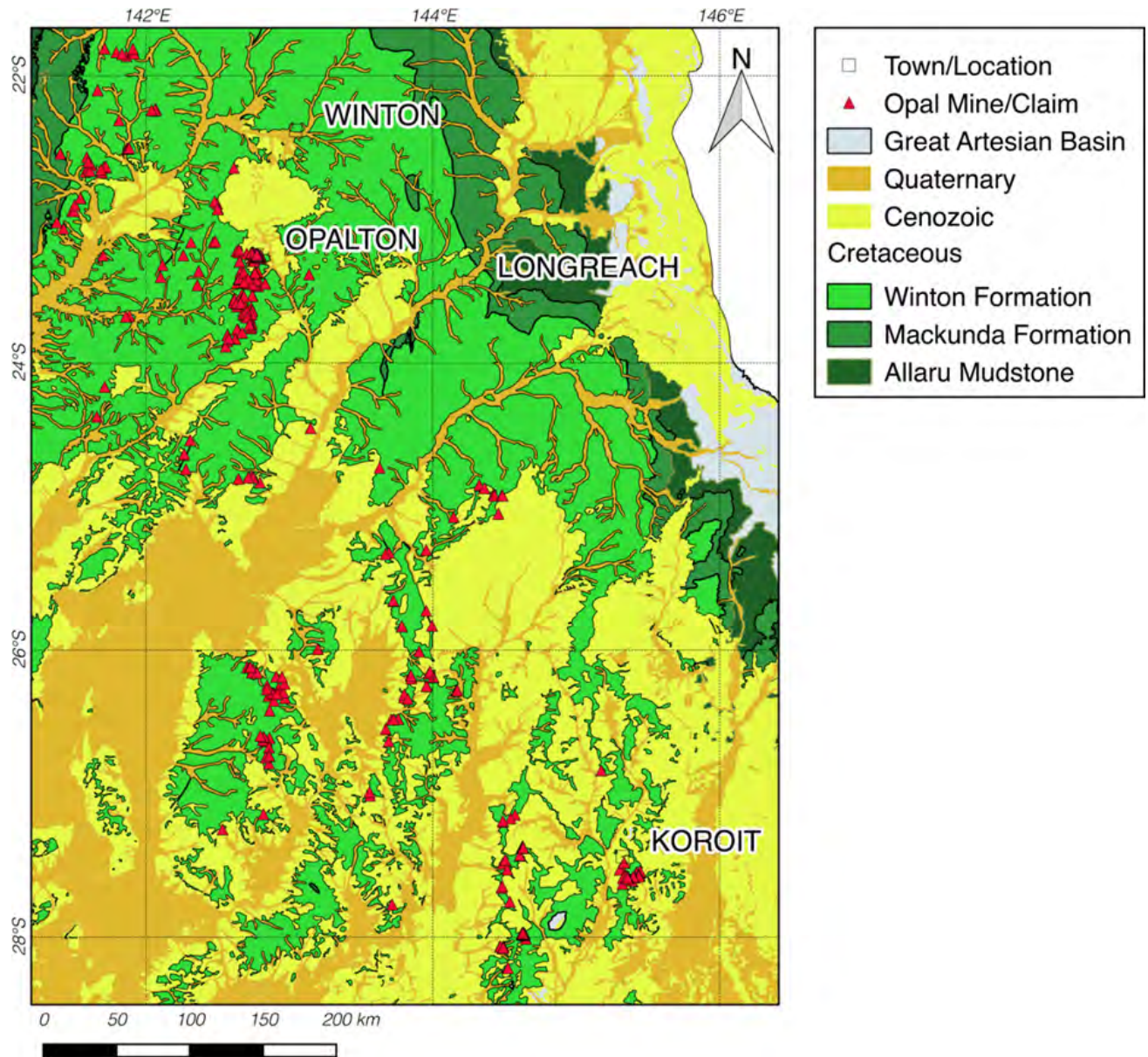


Lambina opal (image T. S. Coldham – Gemmological Association of Australia)

10.2.1.5. Queensland Opal Fields – Home of boulder opal

Opal was first reported in Queensland in 1869, with production continuing across a wide but sparsely populated region of south-west and central Queensland. Queensland's opal deposits are distributed over a vast area extending from around Woodstock in the north to Cunnamulla in the south.

In Queensland, opal mining is closely tied to small, remote communities such as Opalton, Quilpie, Yowah and Koroit. These towns developed around opal discoveries and continue to rely on mining as both an economic driver and a strong part of their cultural identity. Mining also occurs around Eromanga, Winton, Jundah and Longreach.



Queensland opal deposits. Surface geology is derived from Geoscience Australia's Surface Geology of Australia. Opal mining location data are sourced from Geoscience Australia. Map produced by K Steffens.

Queensland opal deposits are hosted primarily within the desert sandstone of the Winton formation and underlying Rolling Downs Group units within the GAB. These sequences comprise interbedded claystones, siltstones and sandstones deposited in shallow marine to marginal marine and continental environments.

A defining feature of the Queensland fields is the widespread development of ironstone within these sediments. Ironstone occurs as nodules, concretions and laterally extensive lenses, commonly developed within clay-rich horizons or at contacts between lithologies. These ironstones, known as 'Boulders' are ferruginous and variably silicified, forming the primary host for opal mineralisation.



Large open cut boulder opal mine, Alaric, north of Quilpie in Queensland (image T. S. Coldham – Gemmological Association of Australia)



Close up of boulder in opal mine wall, Alaric, north of Quilpie in Queensland (image Anthony Smallwood)

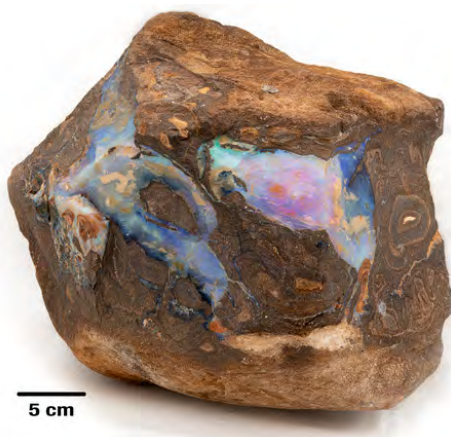
Queensland produces diverse varieties of opal; all closely linked to its ironstone-hosted geology.

The dominant form is boulder opal, where precious opal occurs within or attached to ironstone host rock. Opal typically forms as thin seams, veins or infill within fractures and cavities, and stones are commonly cut with their natural rock backing.

Several distinctive boulder subtypes are recognised. Pancake boulders are flat, tabular ironstone bodies, in contrast to the more common rounded or “football-shaped” nodules. Sandy boulder contains less iron and more clay-rich material, forming larger concretions where opal seams commonly develop along the outer margins.



Pancake boulder with gem opal seams found at the Cragg Mine (image James Evert)



Queensland boulder opal specimen 15kg, from Woodstock 120km west of Winton, Boulder Opal Mines Australia (image Valentine McDonald)



Opening a boulder opal split (image T. S. Coldham – Gemmological Association of Australia)



Queensland boulder opal split (image Anthony Smallwood)



Queensland boulder opal split in butterfly brooch (image Valentine McDonald, Collection from Brisbane Opal Museum)

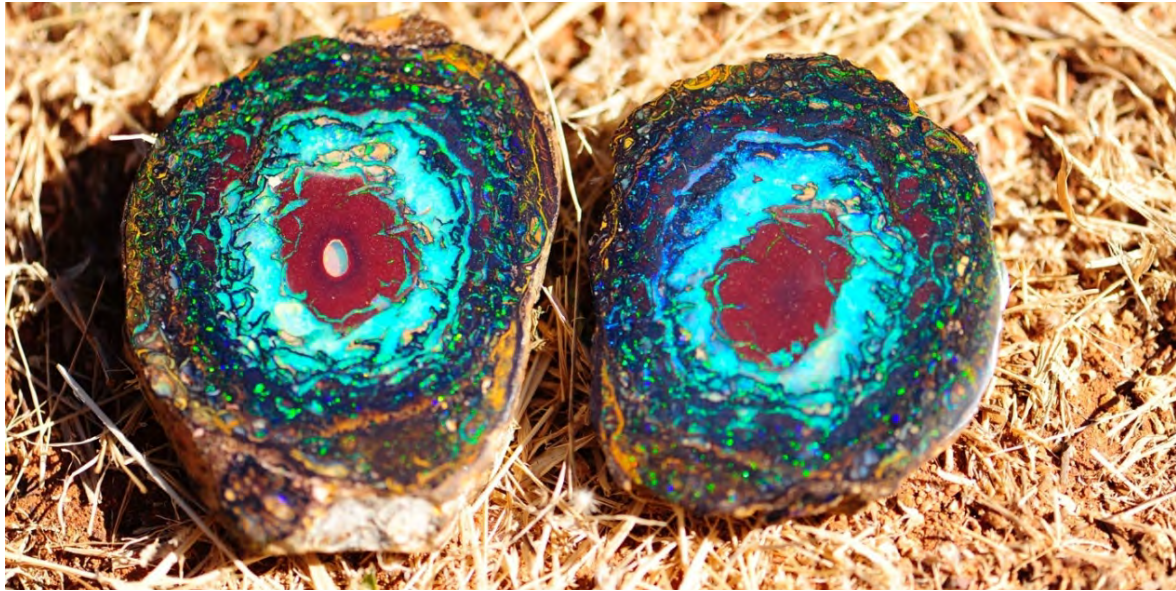


Yowah boulder matrix opal "pudding" stone cabochon (image T. S. Coldham – Gemmological Association of Australia)



Matrix opal (image by Valentine McDonald, Collection from Brisbane Opal Museum)

Yowah Nuts are smaller boulders with concentric outer layers that occasionally contain a core of precious opal. While these occur across several Queensland fields, they are most associated with the Yowah and Koroit areas.



Yowah nut (image Cody Opal)

Other important products include boulder matrix opal, where precious opal occurs as fine veins, patches or disseminations within the host rock, producing a more integrated mixture of opal and ironstone rather than a discrete seam. Finished pieces of boulder opal and matrix are often freeform shapes, reflecting the irregular distribution of opal within the ironstone host. Boulder opal can also produce naturally occurring “picture stones”, where colour, ironstone textures and internal patterns can resemble landscapes, figures or other recognisable scenes.



Queensland boulder picture opal “beach scene” (image taken by Valentine McDonald, Collection from Brisbane Opal Museum)

Additional forms such as pipe opal commonly occur within sandstone-hosted structures and as at other Australian opal fields, opalised fossil material is frequently found, in which organic remains have been replaced by opal. Wood and other plant

fossil replacement is most common; there are also occurrences of polychaete worm burrow structures and, very rarely, dinosaur bone or teeth.



Queensland boulder pipe opal (image by Valentine McDonald, Collection from Brisbane Opal Museum)

Sometimes larger pieces of boulder opal rough are processed to produce ornamental objects such as spheres, carvings and artworks (Brown 1990a; Brown 1990b; Höbelt 1990; Wise 1993).



Queensland boulder panel, made in the mid '60's decorates the altar in Quilpie's church (image Kathy King)

Mining has historically been small-scale and remains dominated by individual operators, with activity centred around the key fields of Opalton, Quilpie, Yowah and Koroit.

Mining methods are typically shallow and selective, ranging from small shafts and open cuts to larger-scale excavations using bulldozers, excavators and front-end loaders.

Production levels vary depending on market conditions, access and seasonality, reflecting both the remote setting and the highly variable nature of the deposits.



Opal mining at the Koroit opal field Southwest Queensland located about 80 km north northwest of Cunnamulla. It is not a town. It has neither electricity nor running water. Koroit is close to the town of Yowah which also produces a similar type of opal (image Cody Opal)

10.2.1.6. Other Australian Locations

Australia's commercial opal fields are located in sedimentary geological environments. Opal with play of colour is also found associated with volcanic geological environments at locations around Australia, including but not limited to Tintenbar and the Warrumbungles in NSW, Springsure and Maleny in Queensland, and sites in Western Australia and Victoria. None of these minor occurrences are currently being commercially exploited.

Common opal of diverse varieties is also found in locations across Australia and exported to lapidaries worldwide.

Tintenbar in NSW, and deposits in Western Australia, are the best-known Australian opal deposits outside the major fields in NSW, Queensland and South Australia.

10.2.1.6.1. Tintenbar New South Wales

Opal was first discovered in the district in 1901 and mining began in 1919. Government records of the time report 27 miners working on the field.

Precious opal is found loose in the surface soil, between the first and second Lismore basalt lava flows, and as amygdales (cavity infillings) liberated by weathering from decomposed vesicular basalt. The lava flows are associated with the Tweed Volcano, remnants of which were named Mt Warning by Captain James Cook on his discovery expedition of Australia. The historical literature refers to opal-production at Teven, Mullumbimby and Houlahan's Creek.

The opal is recovered in pieces mostly 5 to 50mm in diameter, at depths down to two metres from the surface. It is usually transparent and has a propensity to craze. Some has a dark cloudiness and some an orange or dark brown body hue. Play of colour may be very bright.



Jar of opal from Tintenbar (image Australian Opal Centre collection)



Eternal-flame (image Black Opal Direct)

A notable opal gemstone specimen found in the district, named "The Eternal Flame," is reported to weigh 568 carats.

There is currently no significant commercial opal production in the area.

10.2.1.6.2. Opal in Western Australia

Precious opal is found in two deposits in Western Australia – Cowarna and Three Mile Hill in the Kalgoorlie Mining district.

At Cowarna, 100 km south of Kalgoorlie, test drilling was conducted for opal in 1972-73. Later, 14 Calweld holes were sunk. Traces, veinlets and pockets of precious and common opal were found but not regarded to be of commercial significance. About 15.6 kg of precious opal was recovered. Solids, doublets and triplets were cut and polished and a few dozen stones were marketed. The deposit is located within thinly bedded Archean graphitic quartz schist and tuff beds. Precious opal veinlets are up to 1.2cm thick and patch veins up to 7.5cm. There is presently no production.

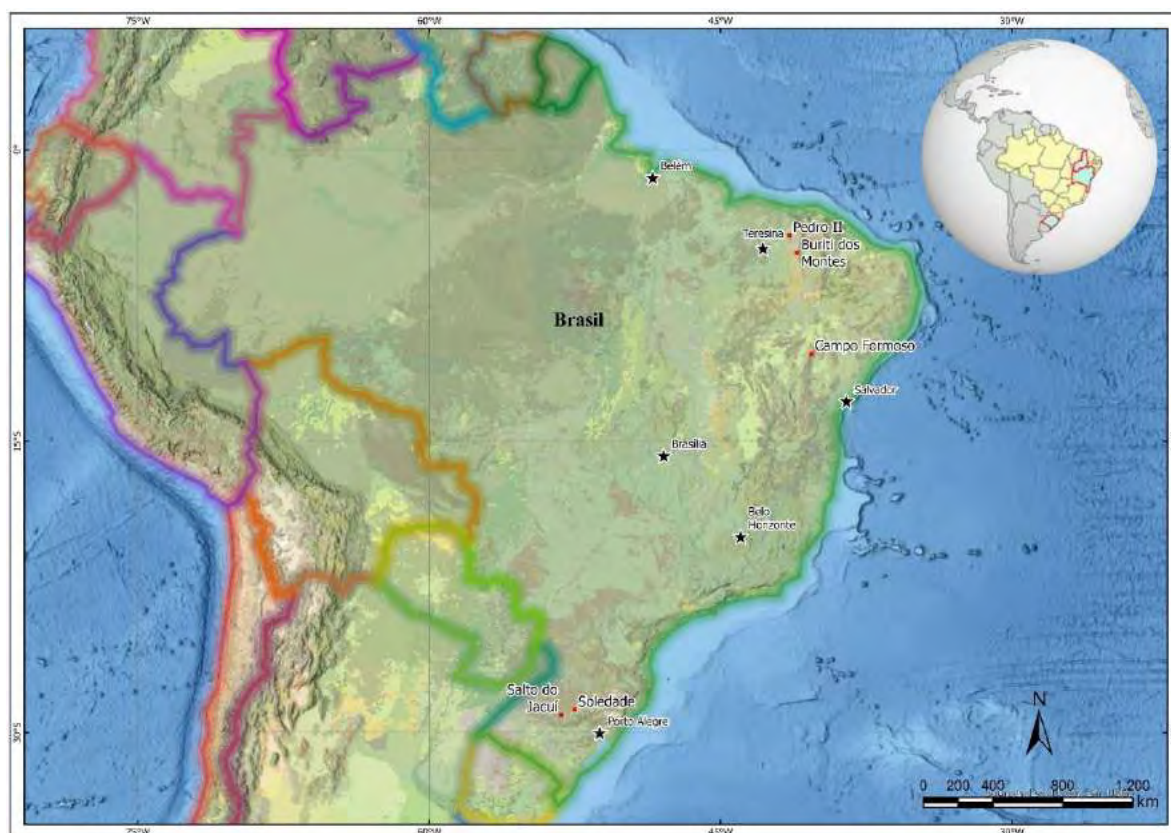
At Three Mile Hill, about 5km north-northeast of Coolgardie, there has been intermittent opal mining and production since 1904. The original Williams mine produced insufficient material and was abandoned. In 1960, several 5cm diameter concretions of precious opal were recovered from an open cut mine. This mine too was abandoned – until 1989, when it was operated profitably for a short period. Most of the opal occurs

in thin seams and some composite stones were manufactured. When the original workings were extended to depths of 10-12 meters, gem quality precious black and grey opal was recovered along with some crystal and light opal. Two larger specimens, one weighing 16.5 kg and another 2.5kg, were recovered. The opal is found within an area of Archean metamorphosed interbedded basic lavas, ultramafic, and metasedimentary rocks.

Common opal is found throughout Western Australia in a variety of forms and colours, including translucent green and yellow-orange opal suitable for faceting, and ornamental varieties including cats-eye, dendritic, moss, lace and banded opal ranging through white, green, pink, red and brown body hues suitable for cabochon and other lapidary work. Lustrous translucent fire opal without play of colour, in orange/red hues suitable for cabochons and faceted gems, is found at Laverton, Western Australia (Fetherston 2017)

10.2.2. Brazil

In Brazil, precious opals were discovered in the late 1930s in the city of Pedro II, in the state of Piauí. Common opals also occur in various Brazilian states; notably, yellow, orange, and red opals were found in the 1940s in the city of Buriti dos Montes, Piauí. In Bahia, green opals with a cat's-eye effect were discovered in the early 1980s. Meanwhile, in Rio Grande do Sul, yellow, red, and blue opals are found alongside agate and amethyst geodes.



An orthographic location of Brazil (inset by Érico Gomes), highlights the location of opals in the states of Piauí, Bahia, and Rio Grande do Sul

In the municipality of Pedro II, precious opals from the Boi Morto mine stands out; they were discovered in the early 1940s by farmer Francisco Silvino Mendes while plowing the land for cultivation. A precious opal weighing approximately 250 grams, lying on the soil surface, caught his attention as it reflected the intense sun rays, displaying all the colours of the rainbow. Subsequently, the municipal administrator and pharmacist Lauro Cordeiro Brandão was responsible for the initial registration of this mine, filing a claim for 40 hectares in 1944 and securing the publication of Decree No. 17,615 (dated January 18, 1945) in the *Diário das Leis*. On August 1, 1962, the rights to the area were transferred to the company EMIBRA (Empresa de Minérios Brasil Norte-Nordeste Ltda), which conducted mining operations there until 1984. Since then, the area has been worked by artisanal miners.

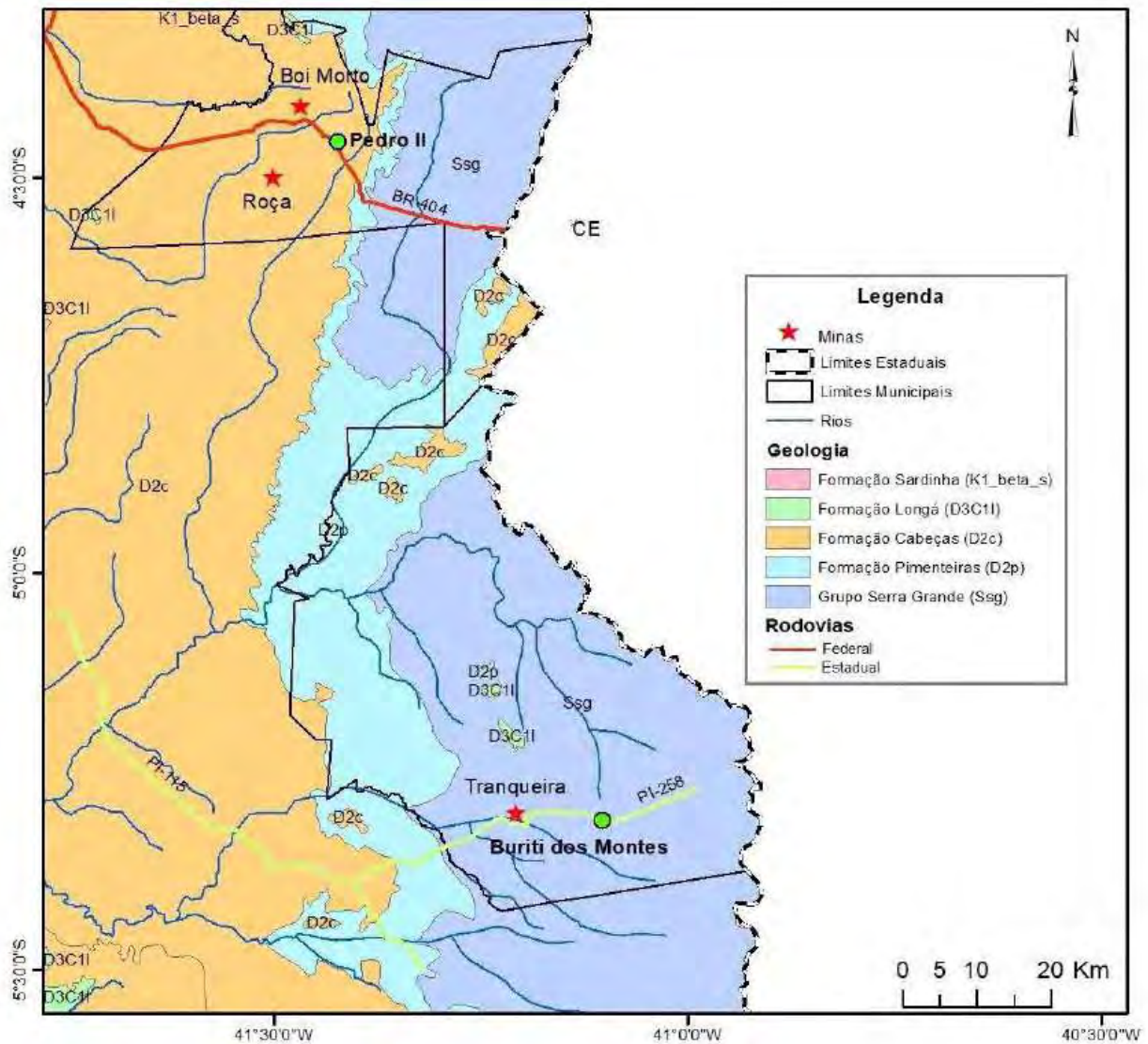
Precious opal was discovered at the Roça site in 1960 during the extraction of white clay—used for the artisanal manufacture of tiles and roofing tiles—from the banks of the Corrente River. In contrast, opals at the Mamoeiro, Pajeú, Centro and Limão mining sites were discovered during the 1970s, in chance encounters involving farmers and hunters.

10.2.2.1. Geology

The precious opals are located in the Parnaíba Sedimentary Basin (PSB). The stratigraphic units directly related to the opals are represented by sedimentary rocks of the Serra Grande and Canindé Groups, whose ages range from the Silurian to the Devonian. The PSB was affected by basic, fissural magmatic activity that began in the Late Triassic to the Cretaceous Age, respectively, in the Mosquito and Sardinha formations (Góes, 1994; Vaz et al., 2007). Diabase sills are located at the base of the sandstones of the Serra Grande Group and the Cabeças and Pot formations.

The sandstones of the Serra Grande Group and Cabeças Formation, which overlie the diabase sill, are silicified, highly fractured, and faulted. This was driven by both brittle tectonics and the stresses associated with diabase sill emplacement and intense hydraulic fracturing.

(Gomes 1994; Marques 2015; Gomes 2022) state that the opal is associated with a hydrothermal environment resulting from basic intrusion into the siliciclastic rocks of the Cabeças Formation (in the Pedro II region). This intrusion heated the water within the host sandstones, destabilizing the silicates and releasing silica into the solution. The silica-rich solution migrated through hydraulic and/or tectonic fractures, where the opal precipitated. The diabase emplacement acted as thermal agent, while sedimentary rocks and the diabase itself served as the hydrothermalized sources of silica and the hosts for opal mineralization.

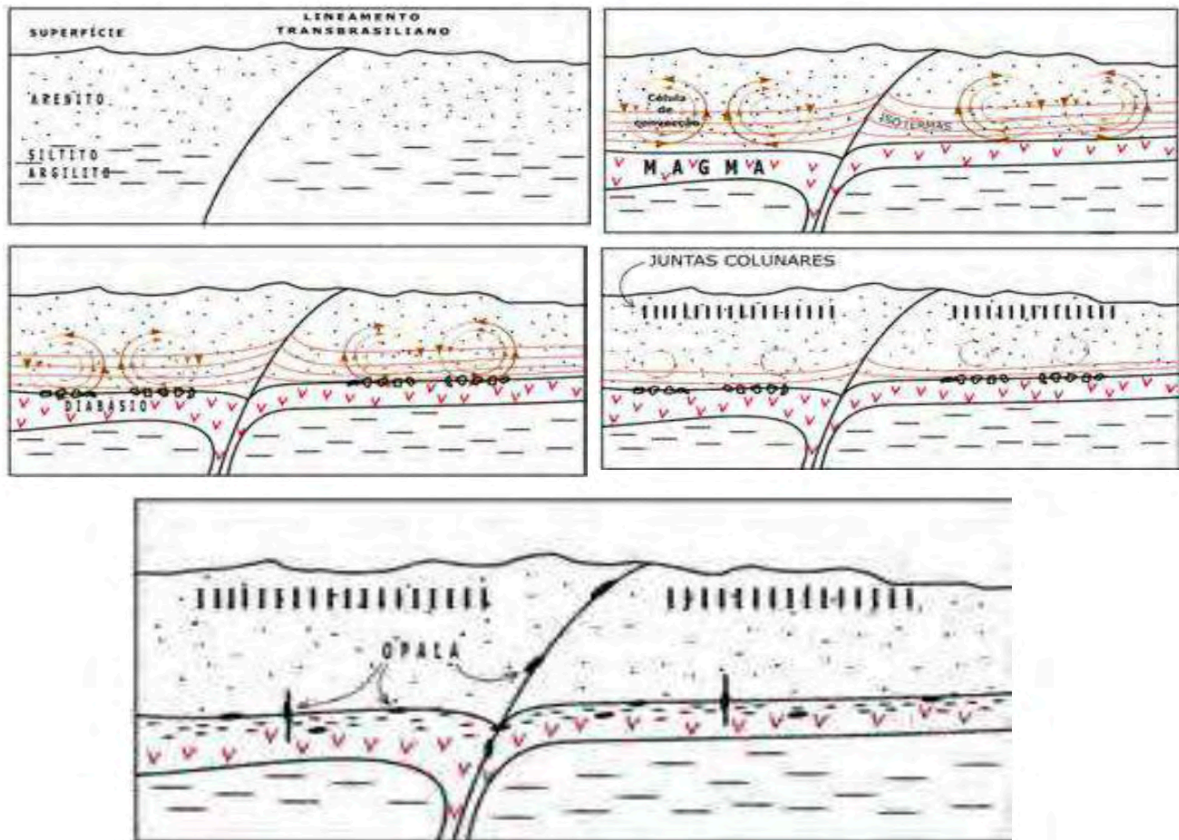


Geological map highlighting the sandstones of the Cabeças Formation and the Serra Grande Group, which host the precious and common opals found in Pedro II and Buriti dos Montes, respectively, along with the location of the main mines. (Image: (Gomes 2022).

10.2.2.2. Major Brazilian Opal-Producing Regions

10.2.2.2.1. Piauí

The main mining sites producing precious opals in Brazil are located in the municipality of Pedro II, situated 190 km from Teresina, the capital of the state of Piauí. The region stands out for producing a variety of precious opal types, but predominantly light opal, sometimes in large pieces, with a body tone ranging from white to light brown. This opal is known to be highly stable and can display a play of colour across the full range of spectral colours, within a translucent to transparent body. Other varieties such as “opal in rock” and “opal on rock” may also be encountered. Opals are often cut into small, thin slices to produce doublets, triplets, and mosaics.



Schematic representation of the sedimentary rocks found in Pedro II, with sandstones at the top, siltstones and claystones at the base. Magma intrusion at the base of the sandstone, heating the fluids. Development of hydrothermal fluid convection cells. Hydraulic fracturing at the contact of the sedimentary rocks with the diabase sill. Intensifying hydrothermal alteration. Cooling of the hydrothermal system with the precipitation of opal in the fractures. (images: (Gomes 2022).

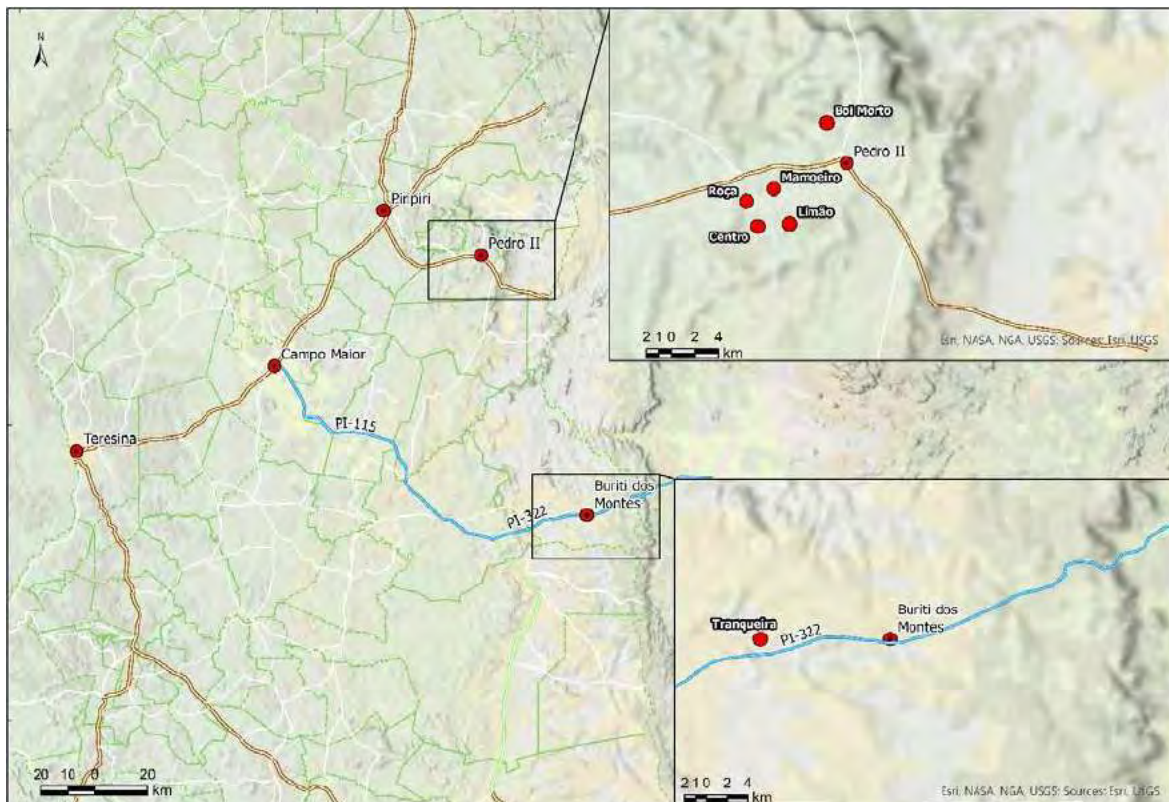


Map of Northeastern Brazil showing the location of Pedro II, around which Brazilian precious opal mining is concentrated.



Entrance to the city of Pedro II (Image: MS Imagens Aéreas)

In the municipality of Buriti dos Montes, located 120 km south of Pedro II, near the village of Tranqueira, common opals—ranging from transparent to translucent and notably featuring yellow, orange, and red hues—were discovered filling fractures in the sandstones of the Serra Grande Group.



Location map of the municipalities and their respective seats—Pedro II, Buriti dos Montes, and Teresina—in the state of Piauí. (Image: Érico Gomes).

In 2004, a Prospectors' Cooperative was founded, establishing a small but regular production of opal. Historically, the Boi Morto, Roça, Mamoeiro, Centro, Limão, Pajeú, and Bom Lugar mines stand out as the most significant among the dozens of opal mines in the Pedro II region due to the quantity and quality of their precious opal.

Boi Morto: The Big Mine

The opal deposit at Boi Morto was officially registered for the first time in 1944, beginning as a rudimentary mining operation. In 1959 occurred the first expansion with the launch of new open-pit and gallery mining operations that followed the opal veins within fractured sandstones and diabases. The year 1962 marked the beginning of systematic mineral exploration and opal extraction under the control of entrepreneurs from outside Pedro II.

In 1966, the Final Research Report was approved, estimating total reserves at 59 tons of opal. Production reached its peak with the mechanization of mining operations, which continued until the early 1980s. After the departure of the outside entrepreneurs, production declined.

Entrance to the city of Pedro II (Image: MS Imagens Aéreas)



Mining front of the Boi Morto mine, (Gomes 2025).

The opal-bearing mineralized layers are divided into two main sets: a) within sedimentary rocks, where opals fill brittle features such as veins and hydraulic breccias in the sandstones, which are frequently silicified; b) within the hydrothermal alteration clays of the diabase and the diabase itself, where opals fill fractures, are locally disseminated within interstices, and cement the breccias. Opal types found here include light opal, opal in rock and opal on rock.



Opals from the Boi Morto mine. Left: white opal, 45.0 ct. (image: Brazil Opals). Right: opal on rock (opal in sandstone; size: 15.0 mm). (image: (Gomes 2025).

During precious opal mining operations at the Boi Morto mine— conducted by the company EMIBRA between the 1970s and 1980s—opal fragments were discarded along with the mining tailings. Today, these opals supply approximately 50 mosaic-making workshops, that produce jewellery such as the ones in the figure below:



Mosaic Opal crafted into the shapes of the state of Piauí, and Brazil (Size: 22.0 mm). (image: Gomes et al., 2025)

Mamoeiro, Roça and Pajeu: Opals in the Corrente River valley

Opal was discovered at the Roça site in 1960. For more than 20 years, mining was restricted to the alluvium of the Corrente River valley. Beginning in the late 1980s, veins were discovered in the upper portion of the diabase sill, prompting miners to

prioritize primary mineralization opal.

Today, hydraulic mining still occurs, but this activity is undergoing mechanization. The process involves removing layers of sedimentary rock until the top of the diabase sill is exposed, where the highest concentrations of opal occur—predominantly in highly fractured and brecciated zones in the form of veins and pockets of precious opals. Production consists mainly of light opal, but dark opals have recently been discovered.



View of a mining front at the Roça mine, (Gomes 2025)



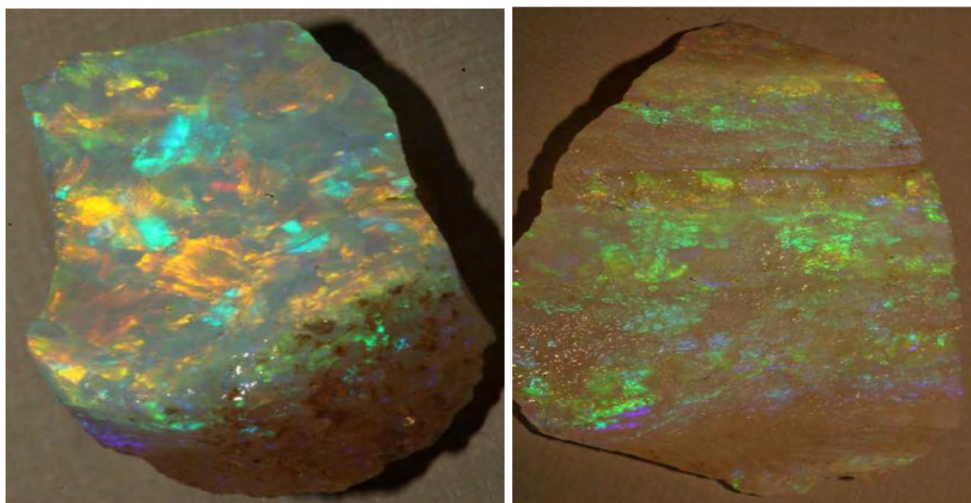
Crystal opal from the Roça mine. Left: 4.0 ct; right: 18.0 ct. (image: Brazil Opals)

At the Mamoeiro and Pajeú sites, precious opals are concentrated within breccias

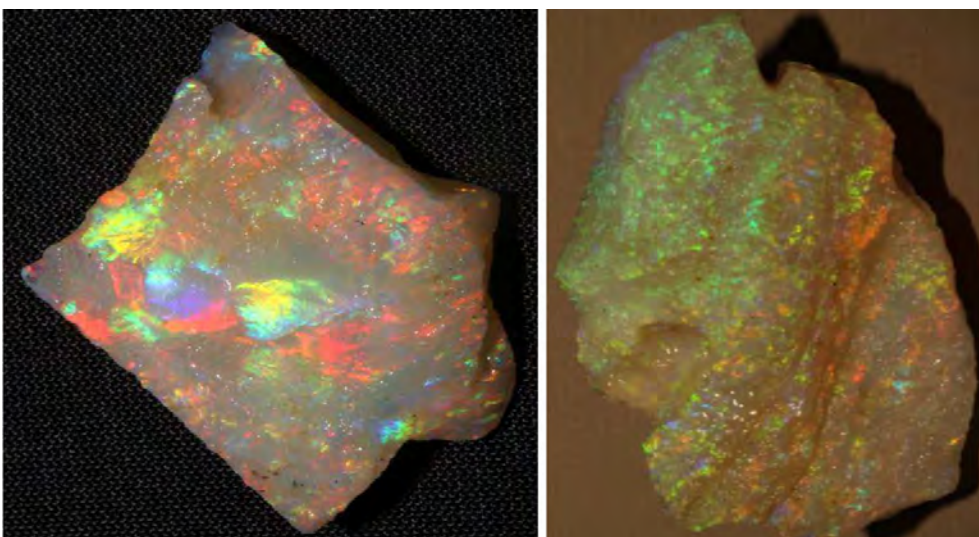
and veins in the sandstone and the argillic zone resulting from the hydrothermal alteration of the basic diabase sill.



Mamoeiro mine, showing a package of orange-tone sedimentary rocks, overlying the reddish argillic layer of the diabase, at the base of the profile. (Image: (Sachs 2015)).



Opal from the Mamoeiro mine. Left: 4.0 g. Right: 24.0 g. (image: Brazil Opals)



Opal from the Mamoeiro mine. Left: 2.0 g. Right: 4.0 g (images: Brazil Opals)

Bom Lugar, Centro and Limão: Opals in the plateau

The Bom Lugar, Centro, and Limão Mines share similar geological characteristics. Opals are found in pockets, generally at depths between 1 and 3 metres, in an area where the sandstone is modified by a dense network of fractures and breccias.

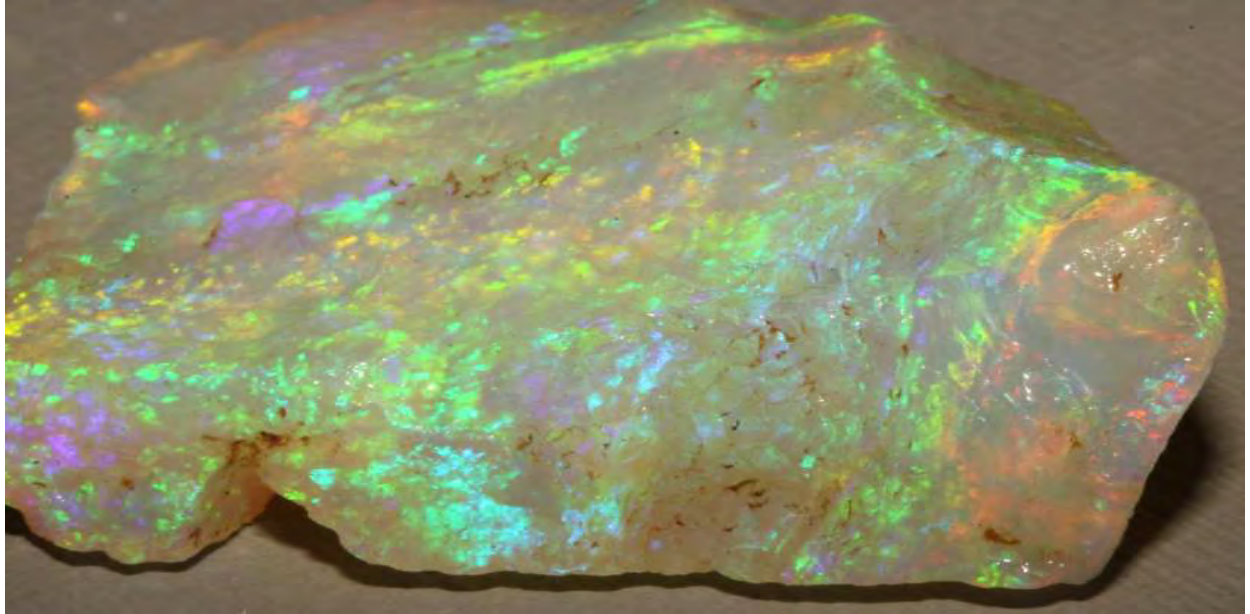
Crystal opal predominates in the area. Research is currently being conducted at deeper levels, targeting the contact zone with the diabase sill.



Figure 2 Mining area of the Limão mine, highlighting the dense fracturing of the sandstone where opal occurs. The fractured layer is 2.0m thick (Gomes 2025).



Left: crystal opal from the Limão mine, 15.0 ct; Right: crystal opal from the Centro mine, 23.0 ct. (images: Brazil Opals).



Opal from the Centro mine, 8.0 g (image: Brazil Opals)

Tranqueira Mine: Land of the Piauí fire opal

The Tranqueira Mine is located in the rural area of the municipality of Buriti dos Montes, in the state of Piauí. Oral history indicates that common opals without play of colour ('fire opals') have been extracted here intermittently since the 1940s. Opal occurs as veins in sandstone, featuring base colours ranging from yellow to orange to red, with a transparent to translucent clarity.



Side view of the hill containing the main veins of orange opals, embedded in the sandstones of the Serra Grande group. (Image: (Gomes 2002)).

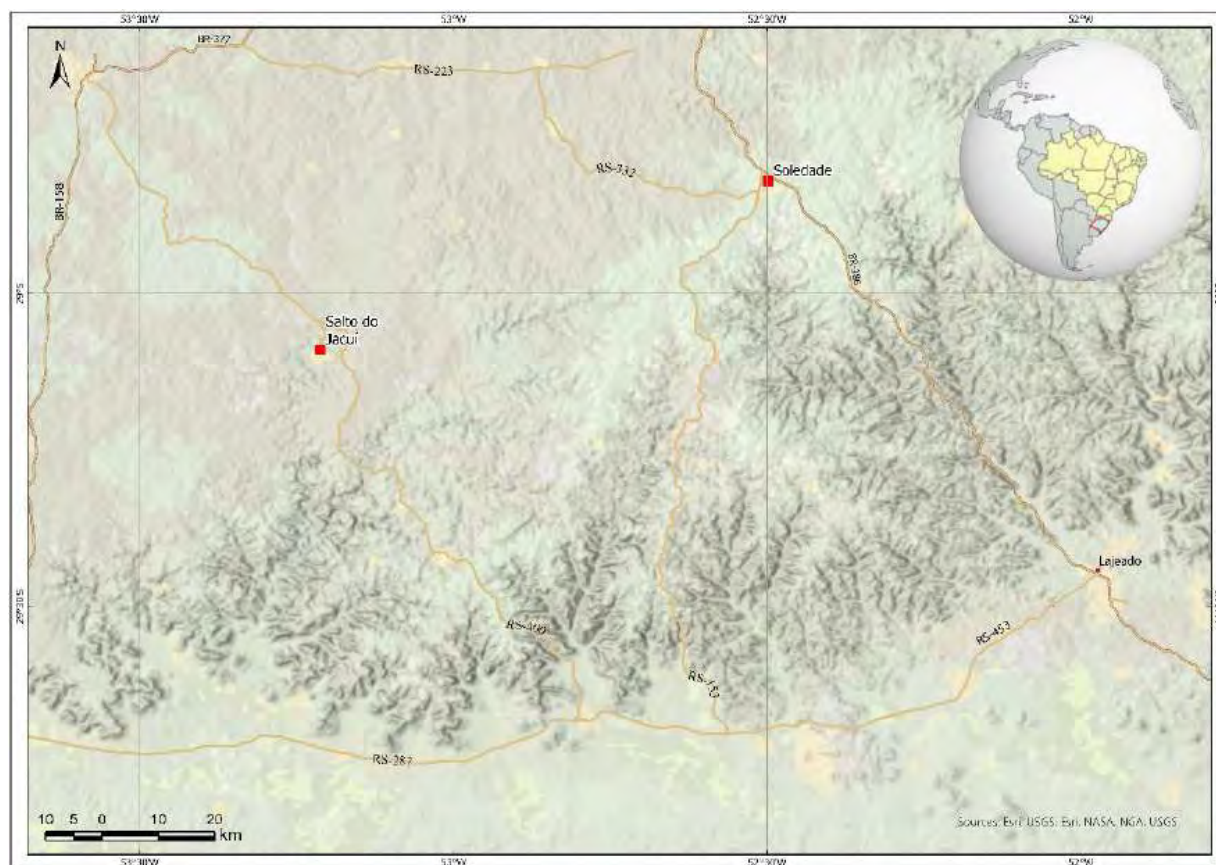


*A parcel of faceted Brazilian fire opals (approx. 80x95 mm) from Buriti dos Montes, Piauí, Brazil, displaying nearly all of their characteristic tones: light yellow, yellow, orangey-yellow, orange, reddish-orange, red, and dark red. Property of Bené do Tucum. Photo by Carlos Cornejo. (Image from the book *Minerals and Precious Stones of Brazil*, (Solaris 2010)). Right: Top view of the "Fire of Piauí" red common opal, weighing 23,000 carats and measuring 22.5 x 15.0 x 12.5 cm, illuminated by transmitted light (Gomes 2007)*

10.2.2.2. Rio Grande do Sul

Rio Grande do Sul stands out in the global gemological landscape due to the extensive agate and amethyst deposits found in the volcanic rocks of the Serra Geral Group, within the Paraná Sedimentary Basin (PSB). The PSB is situated in the east-central region of South America. The Serra Geral volcanism consists of extensive sequences of volcanic rocks resulting from intense fissure volcanism during the Early Cretaceous, associated with the breakup of the supercontinent Gondwana. Alongside the agates, occurrences of common opal are also documented. Linked to a hydrothermal environment within acidic volcanic rocks such as rhyolites and rhyodacites, these opals are found in geodes and fractures, cementing breccias, or deposited along flow structures (Brum 2014)

Common opals of economic interest occur in the region between the municipalities of Soledade and Salto do Jacuí. The opals exhibit a variety of colours, including colourless, white, pink, yellow, blue, brown, and black, as well as various shades of orange and red. The red and blue varieties particularly stand out for their gemological quality.



Location map of the municipalities of Soledade and Salto do Jacuí, in the state of Rio Grande do Sul (Image: Érico Gomes).



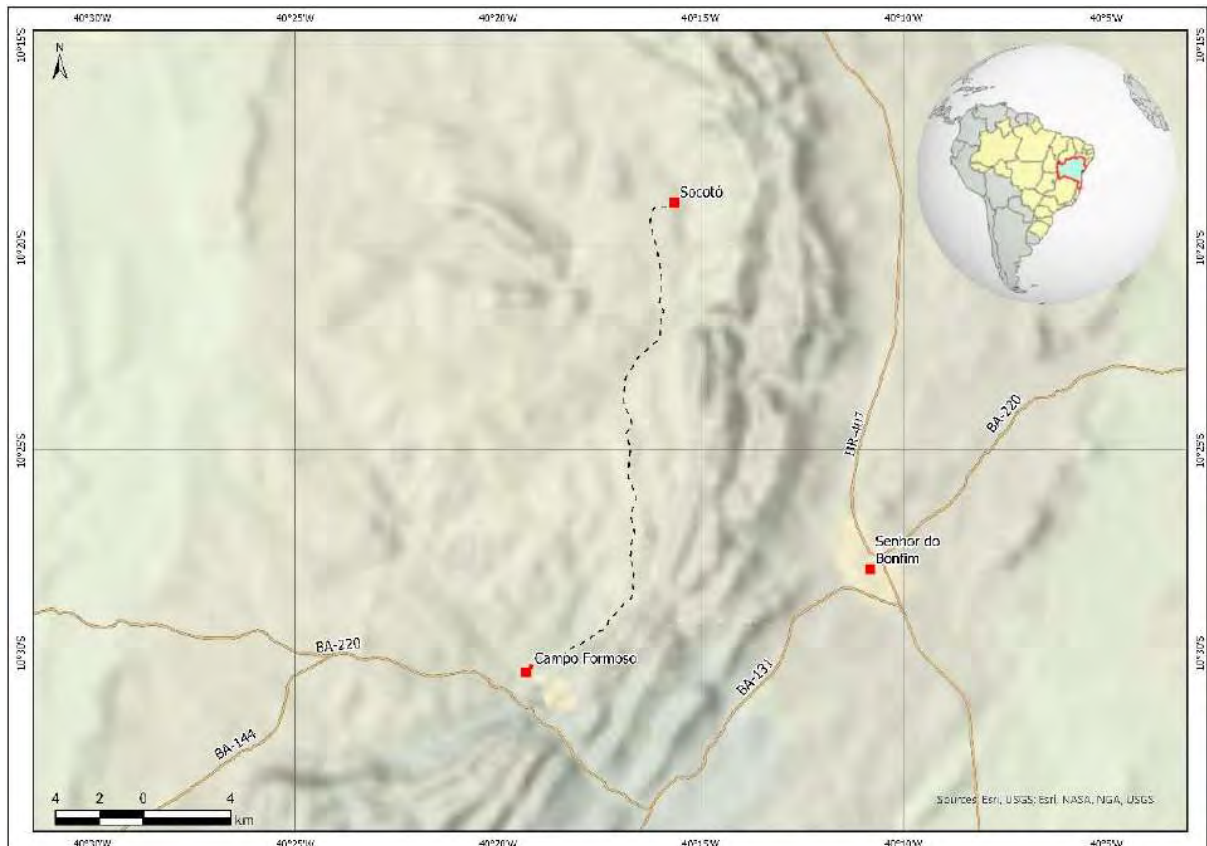
Common opal in shades of white, blue, pink, yellow, orange and red (Juchem 2023).



Left: Common opal associated with agate, filling a geode (image (Brum 2014) Right: Red common opal (Gemology Laboratory/UFRGS photo collection)

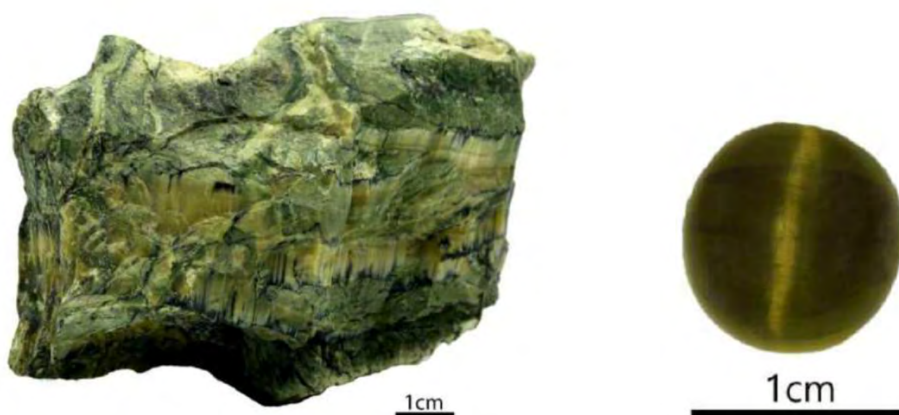
10.2.2.2.3. Bahia

Green cat's-eye opal was found in the same region as the emerald deposit near the village of Socotó, north of the city of Campo Formoso and approximately 400 km from Salvador, the capital of the state of Bahia. The first record in the literature was made by Fryer (1983).



Location of and access to the village of Socotó, north of the city of Campo Formoso, in the state of Bahia (image: Érico Gomes)

Emerald and opal mineralization occurs in the northern part of the Gavião Block—the northern section of the São Francisco Craton—associated with the intrusion of Campo Formoso Batholith rocks into the Paleoproterozoic metasediments of the Jacobina Group and the Archean Mafic-Ultramafic Complex, followed by hydrothermal alteration processes. The opal formed during a hydrothermal phase—specifically carbonatization—as part of a mineral assemblage consisting of magnesite, talc, dolomite, and quartz ((Zaccatini 2006; Barbosa 2012; Cassedane 1990) described the gemological characteristics of these green cat's-eye opals. (Santiago 2015) demonstrates via SEM/EDS that the cat's-eye optical effect is produced by a microstructure of fine, parallel, and spaced-out serpentine fibres intergrown with the opal. Furthermore, the green colour of this opal results from the combined absorption caused by Fe^{3+} , Ni^{2+} , and Cr^{3+} ions present in micro inclusions, alongside scattering driven by the Rayleigh effect.



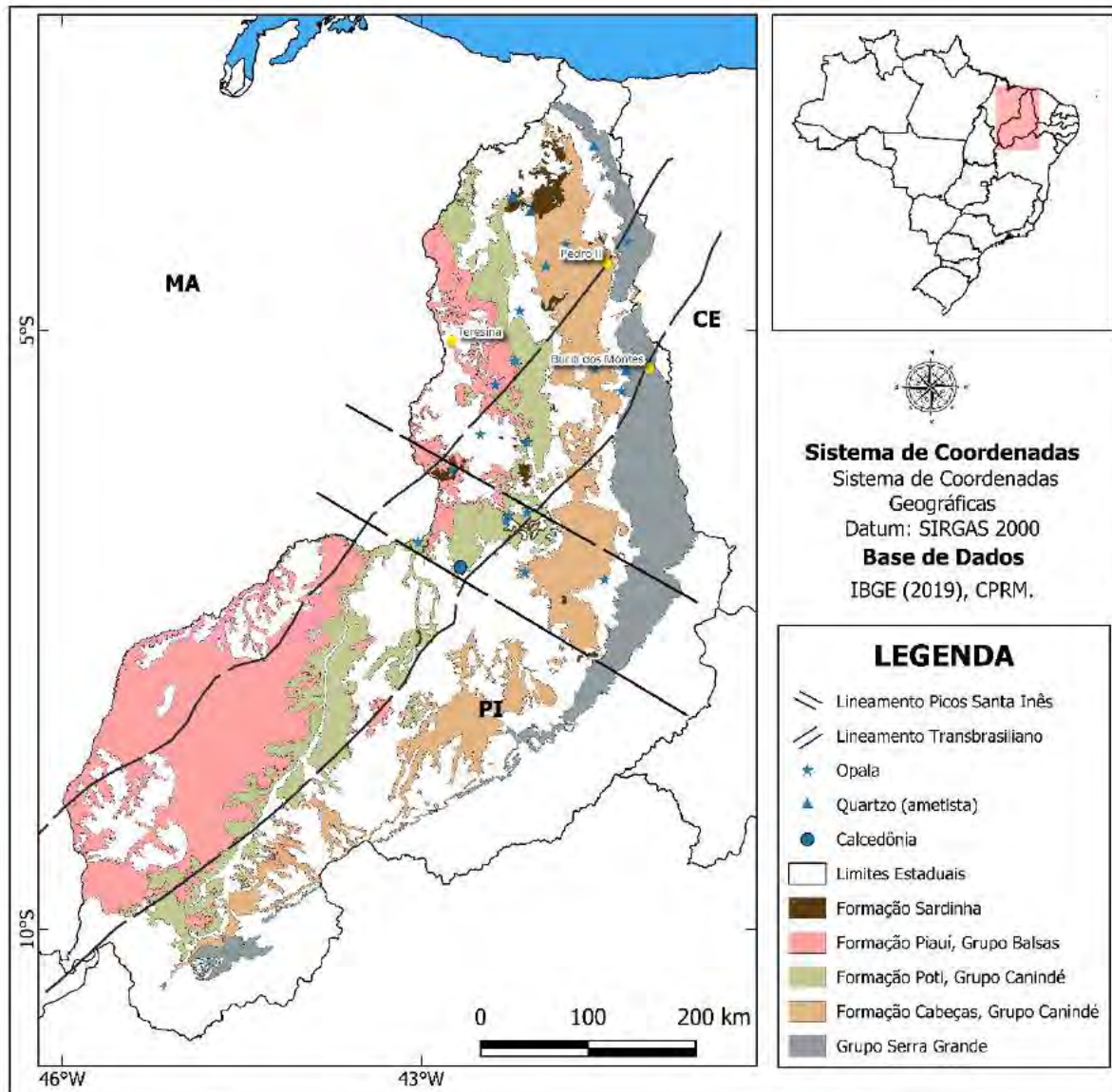
Left: Highlighted yellowish specimens displaying the cat's-eye effect. Right: Cabochon showing the cat's-eye effect (images: Santiago, 2015).



Rough and cabochon-cut samples of Brazilian cat's-eye opal (Images Emil Weis Opals).

10.2.2.2.4. Other Brazilian Locations

Numerous occurrences of common opal—in yellow, orange, red, blue, green, and white—have been documented across the state of Piauí, distributed throughout the municipalities of Alto Longá, Angical, Beneditinos, Barra d’Alcântara, Buriti dos Montes, Campo Maior, Capitão de Campos, Castelo, Domingos Mourão, Floriano, Lagoa de São Francisco, Oeiras, Picos, Piripiri, São Félix do Piauí, São Miguel dos Tapuios, Tanque, and Várzea Grande (Gomes 2025). These common opals frequently occur in association with quartz and chalcedony.



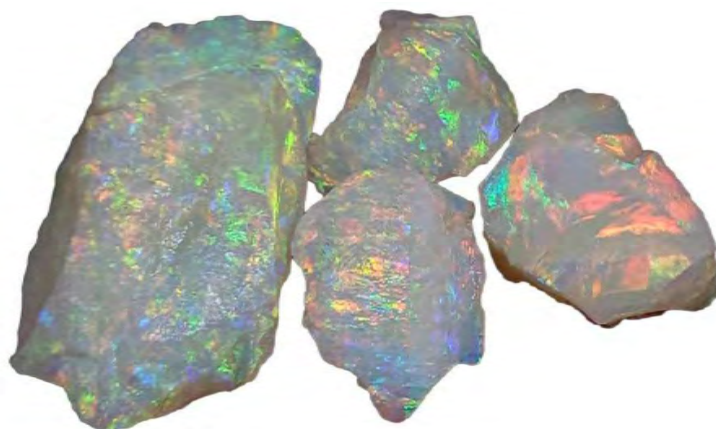
Geological map showing the geological units formed by sandstones and diabases, the Transbrasilian Lineament, and the locations of opal, amethyst, and chalcedony occurrences (Gomes 2022)

Common opals in various shades of green have also been found in the municipality of Boa Nova, Bahia (Cassedanne and Cassedanne 1975; Rocha 2014). In the state of Pará, there are records of yellow and orange common opals in the municipality of São Geraldo do Araguaia (Collyer and Kotschoubey 2000).

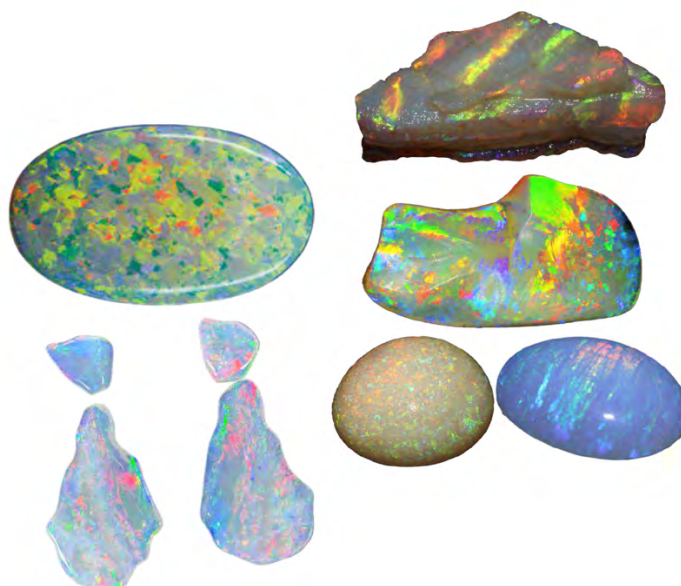
In the state of Rio Grande do Sul, common opals occur in white, yellow, orange, red, pink, blue, and black. They are found within deposits in the municipalities of Espumoso, Tunas, Campos Borges, Barros Cassal, Fortaleza dos Valos, Jacuizinho, Mormaço, Lagoão, and Tupanciretã, and are generally associated with amethysts and agates (Brum 2014; Martins 2024).

An occurrence of precious opal in the state of Minas Gerais was described by (Schnellrath J. 2007)

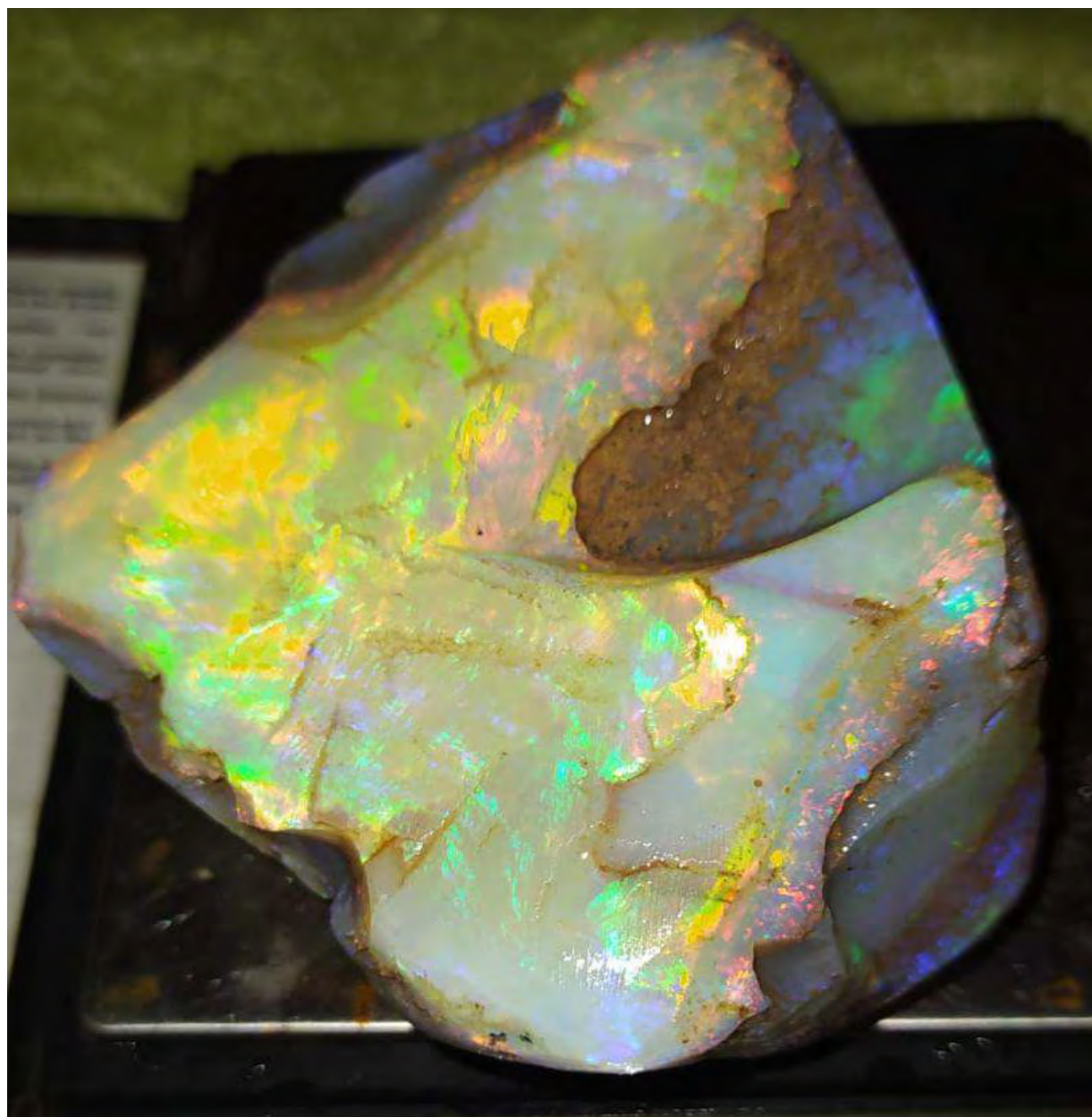
Additionally, some records cite occurrences of common opal in the states of Bahia (red common opal), Goiás (pink), Mato Grosso (white), Paraná (red), and Rondônia (red).



Brazilian opal (Images: Emil Weis Opals)

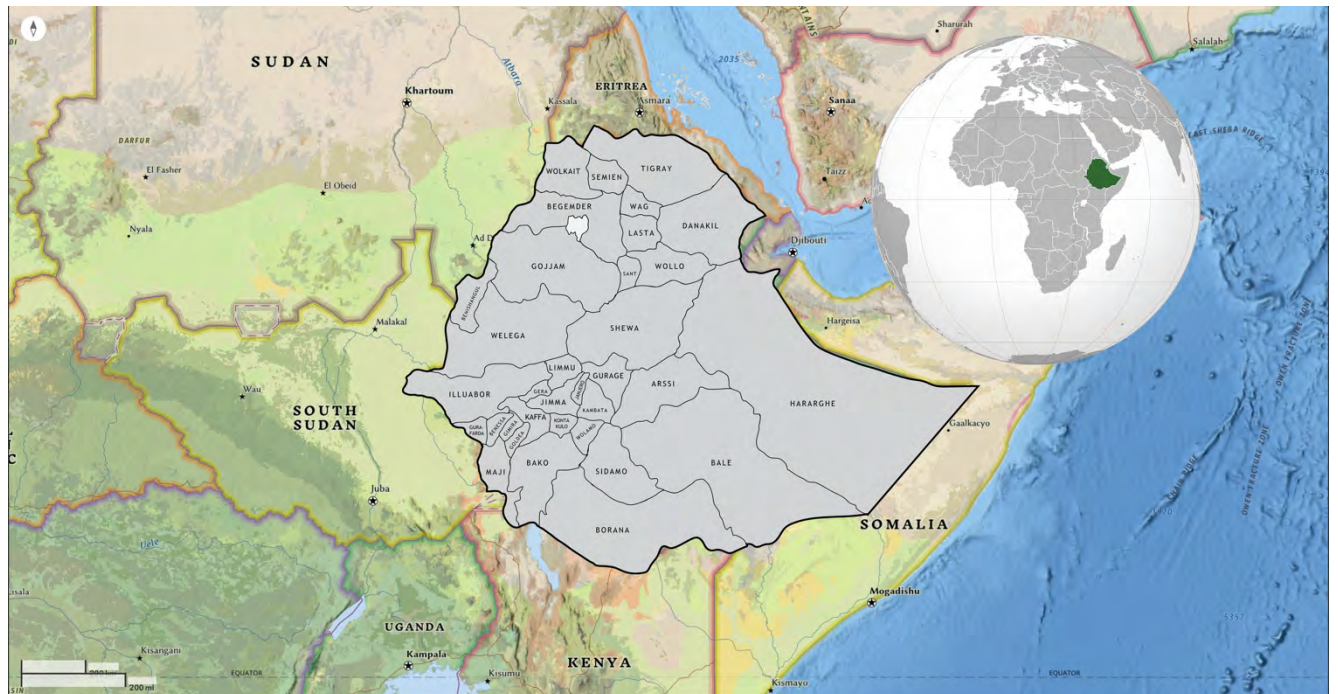


Left column top: Light opal, oval cabochon (28 x 18 mm and 21 ct), Pedro II, Piauí, Brazil. Property of Bené do Tucum. Image by Carlos Cornejo. (Image from the book Gemas do Brasil, Carlos Cornejo, Solaris, 2023). Left column bottom: Light opal from Brazil (image T.S. Coldham) Right column top: Light opal (crystal opal), Mamoeiro mine, 12 ct, Pedro II, Piauí, Brazil, (Image: Jivago Castro). Right column center: light crystal opal 72.40 ct; 53 x 29 mm), Roça mine, Pedro II, Piauí, Brazil. Property of Bené do Tucum. Image by Carlos Cornejo. Image from the book Mineral Collections of Brazil, Cornejo and Bartorelli, Solaris, 2020. Right column bottom left: light opal, Mamoeiro mine, 130g, Pedro II, Piauí, Brazil, (Image: Jivago Castro). Right column bottom right: light crystal opal, Mamoeiro mine, 22 ct, Pedro II, Piauí, Brazil, (Image: Érico Gomes).



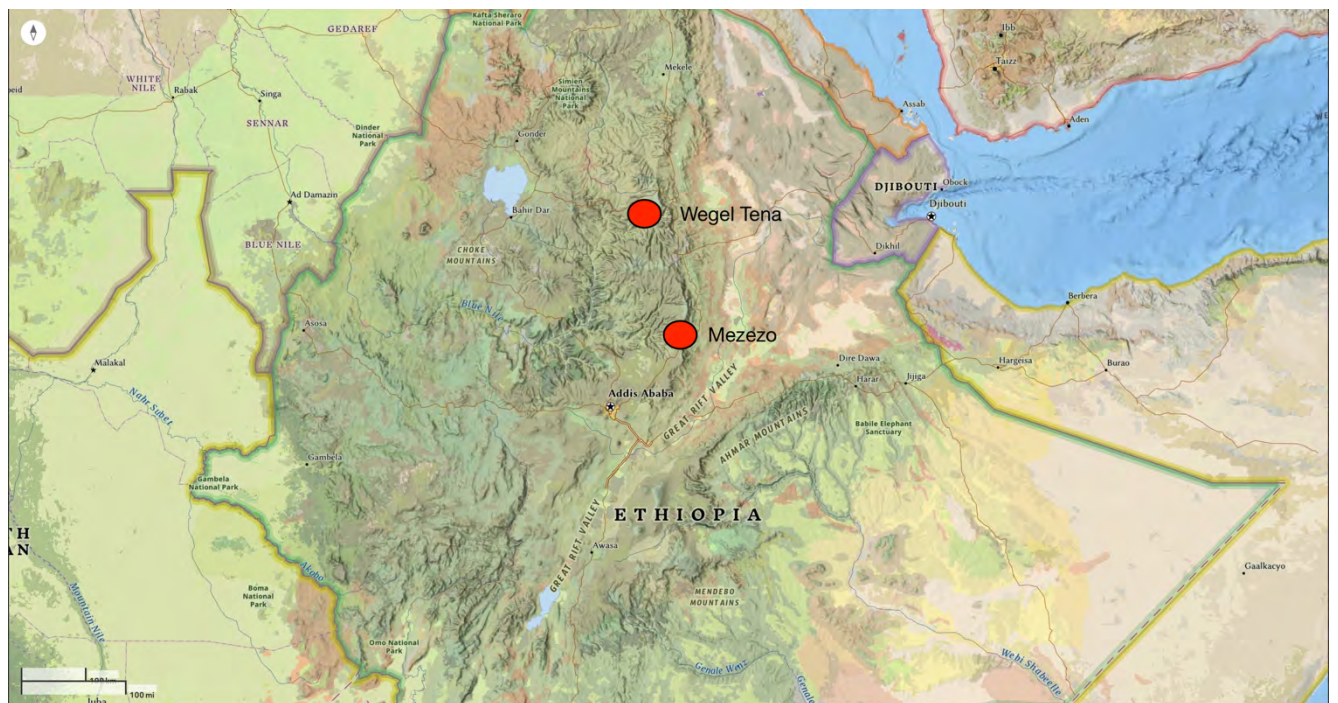
Opal from Mamoeiro mine. 292.5 g (image: Érico Gomes)

10.2.3. Ethiopia



The geographic location of Ethiopia and its provinces; Provincial mapping by Varavour CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=27541430>, orthographic projection by Martin23230 <https://commons.wikimedia.org/w/index.php?curid=8841388>.

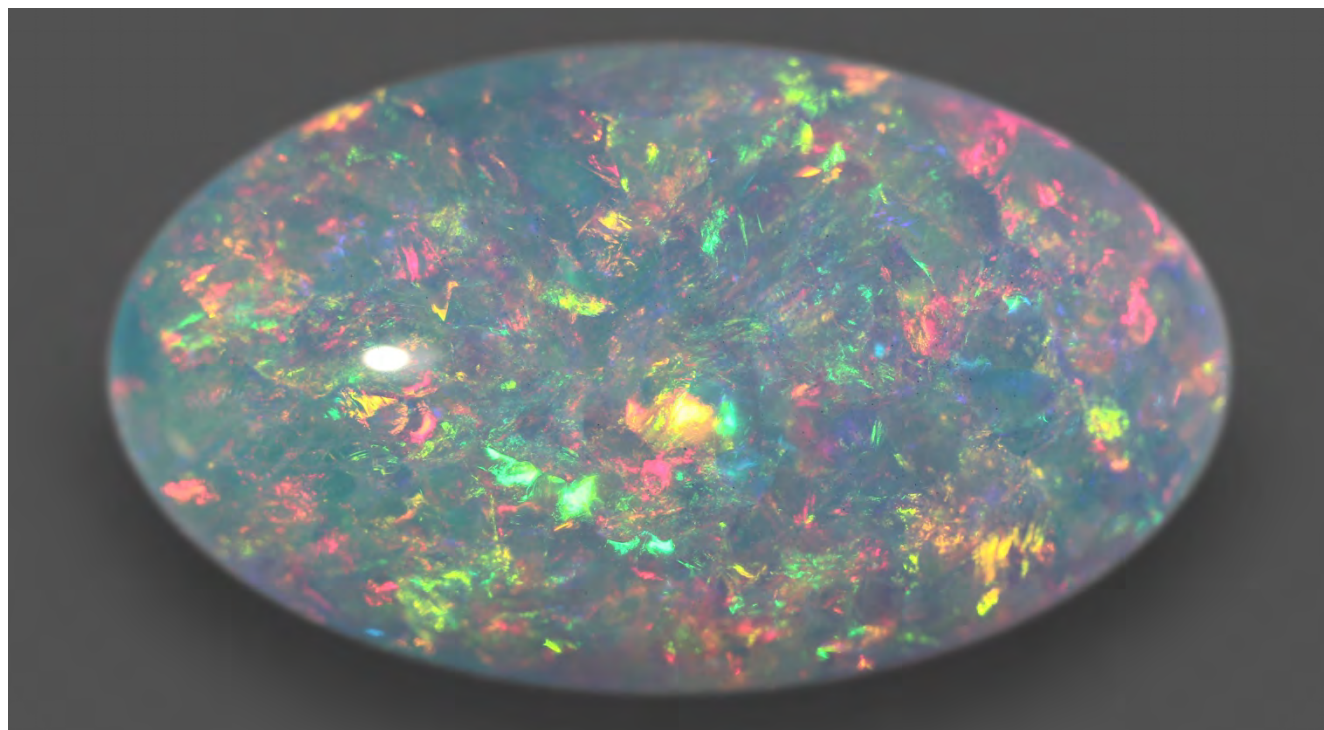
10.2.3.1.1. Shewa and Wollo



The locations the Wegel Tena and Mezezo north of Addis Ababa

During the 1990's precious "chocolate opal" was discovered in north Shewa province around a locality called Mezezo. Then in 2008, white precious opal was found in the

province of Wollo near Wegel Tena about 550 km north of Addis Ababa. The Wegel Tena deposits continue to produce large amounts of white and crystal precious opal.



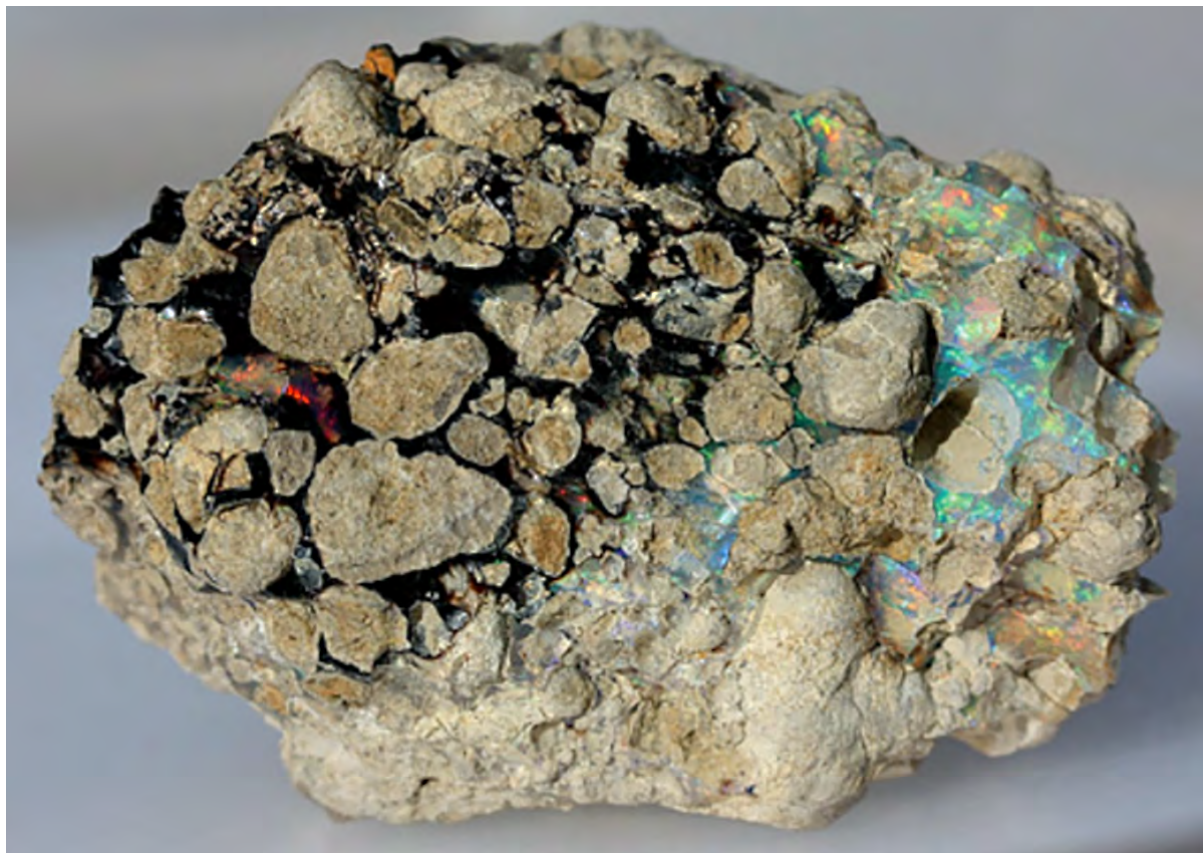
White opal from the province of Wollo (Francesco Mazzero)

In 2013 another source was discovered in Wollo, at the Stayish mine near the town of Gashena that yielded mostly dark and black opal, along with some white and crystal opal (Koivula and Fritsch 1994, 1995; Hoover, Yohannes, and Collins 1996; Johnson and Koivula 1997; Gauthier et al. 2004; Tucci 2005; Mazzero et al. 2010; Rondeau et al. 2010; Rondeau, Fritsch, Mazzero, Cenki, et al. 2011).

Over the entire volcanic series, only one very thin seam (less than 1 metre thick), hosted by ignimbrite, is mineralized with opal. Common opal and play of colour opal most often cement grains of volcanic debris or fill in fractures or cavities in the rock. As a result, the rough gem material often has an irregular shape. The host rock consists of mixed altered material, including clays and common opal.

The Wegel Tena opal occurs in a range of body colours, often white with some pale yellow, honey coloured orange to reddish brown. Diaphaneity ranges from transparent to almost opaque. A special feature of Ethiopian opals is their vivid and often spectacular POC present in a variety of patterns. Much of the opal is commonly absorbent and can be described as “Hydrophane opal”, often turning translucent or transparent in the process of absorbing water. This effect is usually fully reversible and repeatable.

The earlier production of opal from Mezezo was prone to cracking however production from Wegel Tena is much more stable. Being absorbent, the majority of Ethiopian opal can be readily dyed using pigments or inducing carbon by “smoke treatment” to imitate black opal. The search for opal in Mezezo ended in 2009 when the Wollo deposit came to be known. (Mazzero 2003; Gauthier J.P. 2004; Mazzero F. 2009)



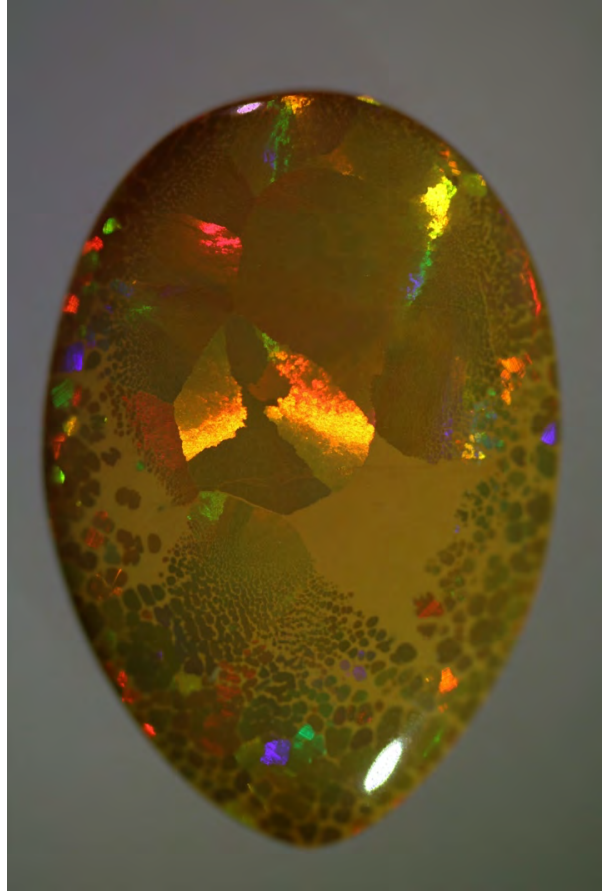
"Opal rough cement"; The opal typically fills spaces between pieces of volcanic rock debris. This specimen measures 7 x 5 x 3 cm. Image Francesco Mazzero.



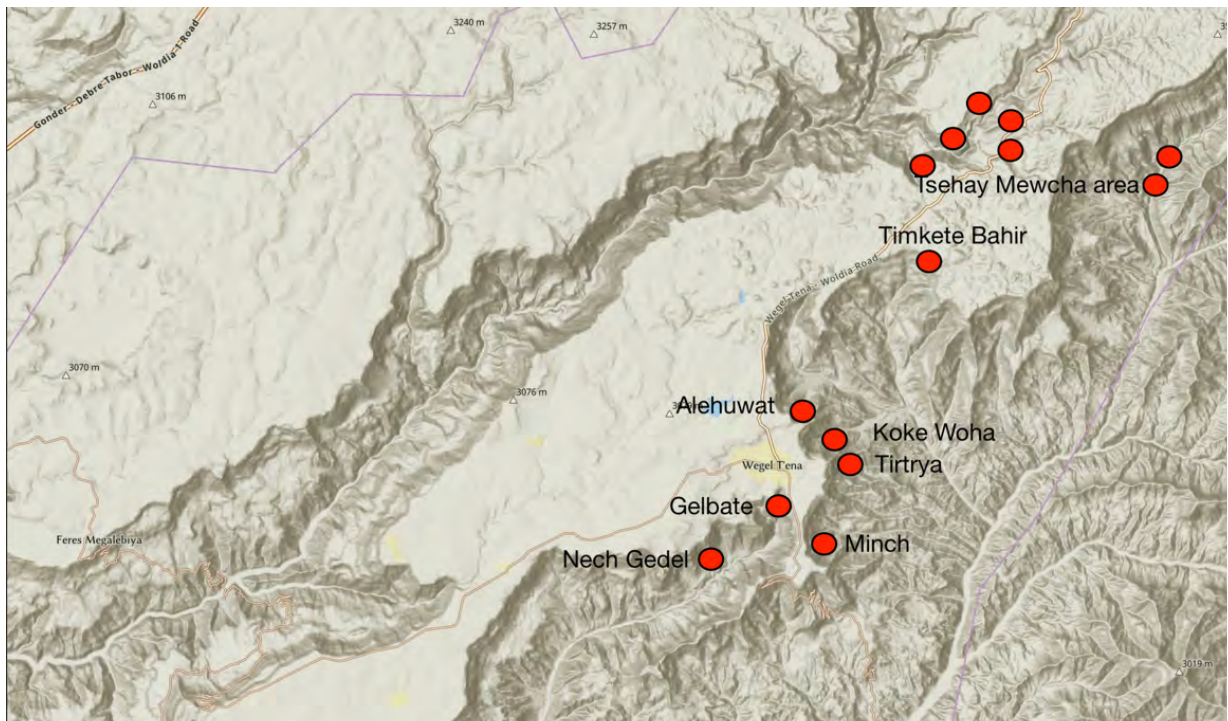
Opal nodules rhyolitic ignimbrite at the Shela digay deposit in Mezezo (image by Benjamin Rondeau)



Mezezo opal contra-luz (image Francesco Mazzero)



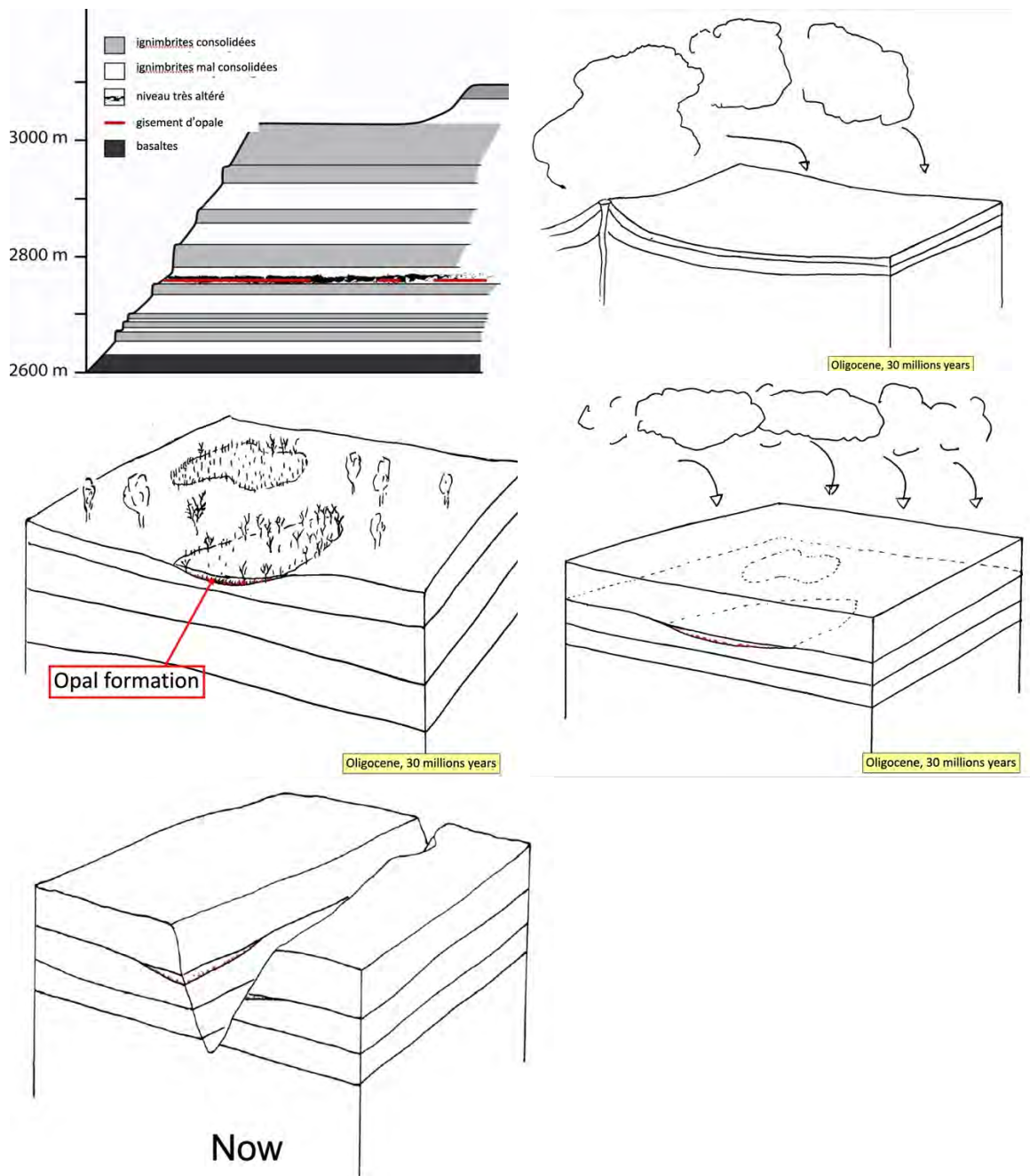
Mezezo opal (image Francesco Mazzero)



In April 2013 4001 miners were officially registered at the Mine Office in Wegel tena. There was well over 20 mines nearby Wegel tena including 17 official cooperatives.



The Kokeweha mine (Francesco Mazzero).



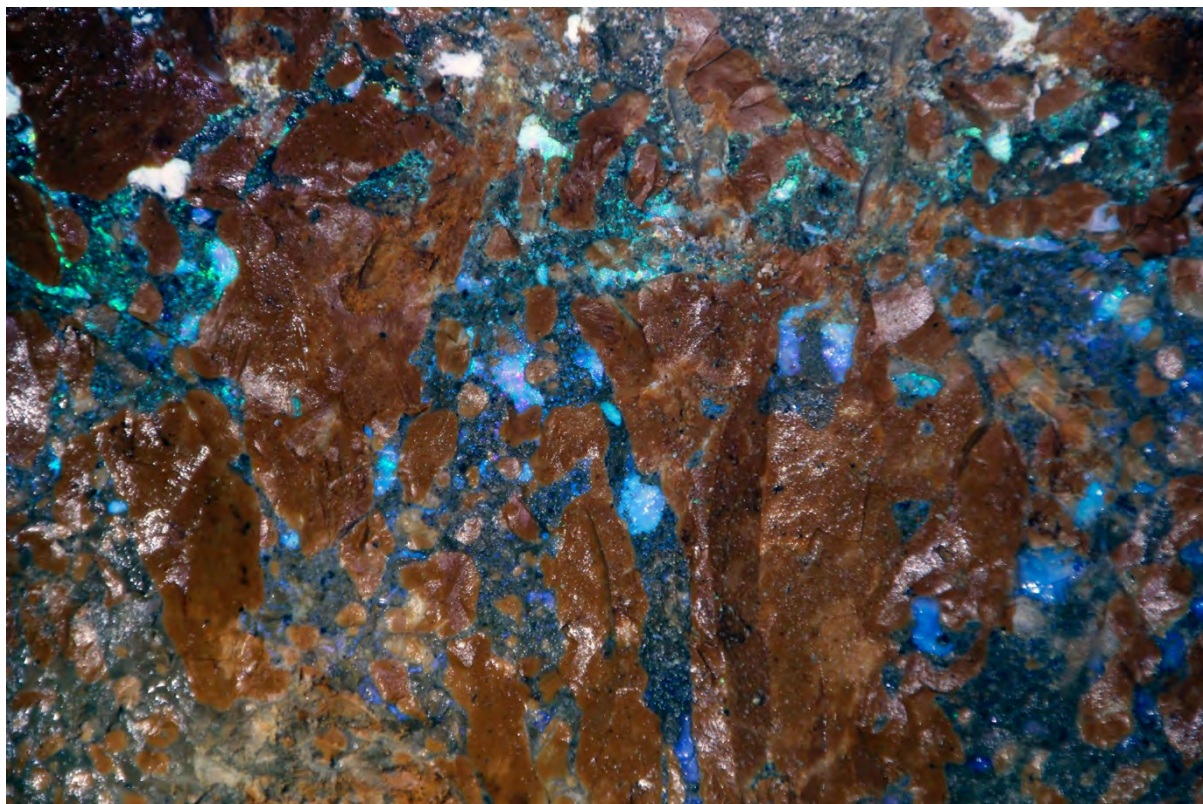
An illustration of the geological genesis of Ethiopian opal. Drawings by Benjamin Rondeau, see also (Chauvire 2017).



The galleries of the Kokeweha mine. (image Francesco Mazzero)



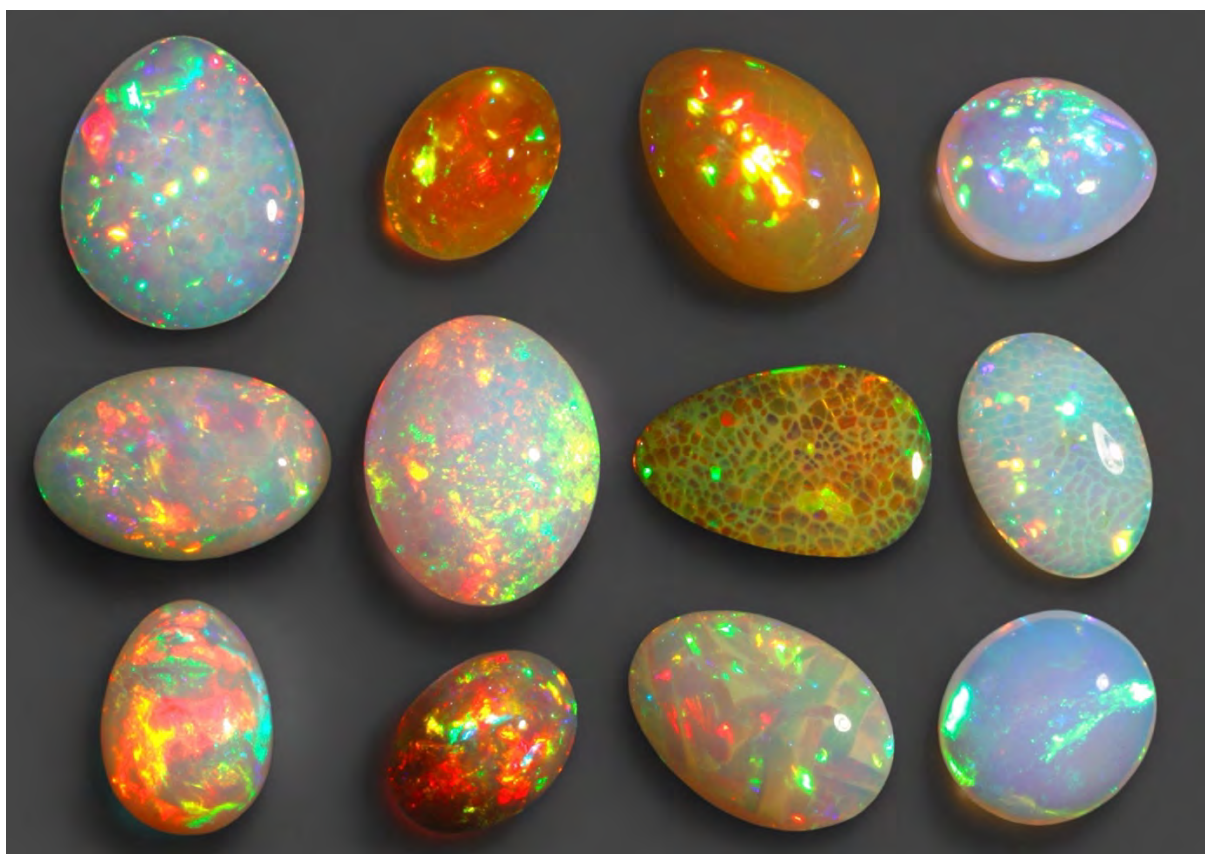
Minors at Gelbate (images Francesco Mazzero).



Opal in situ in a gallery of the Koke Weha mine. The view is around 60 cm wide. Photo by T. Cenki/OPALINDA during the 2013 expedition, a rare example of the aspect of the deposit.



Afar fire opal (ImagesTewodros Sintayehu).



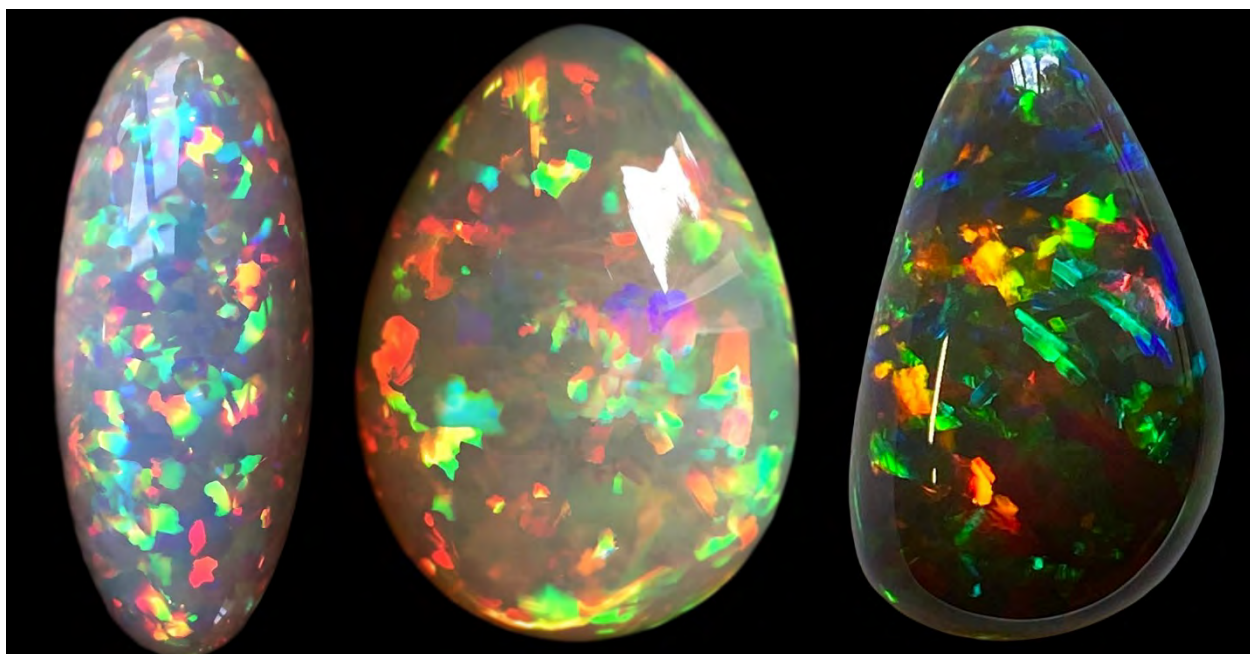
Examples of opals from Wollo (image Francesco Mazzero)



Wollo opal rough (left) and high-domed cabochon (right) (images Francesco Mazzero)

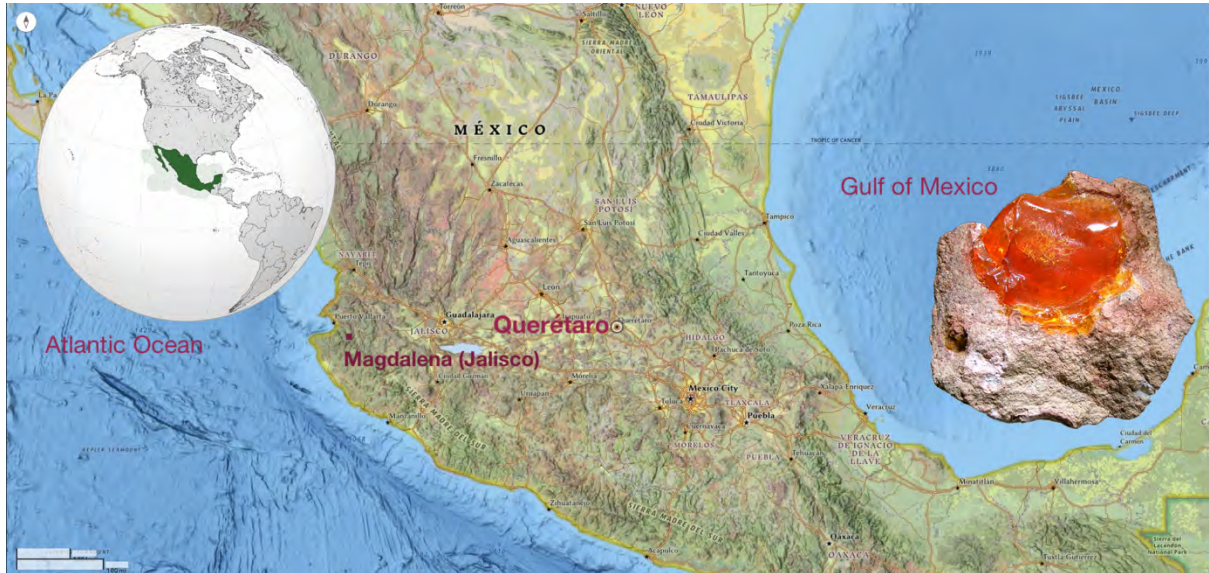


Wollo vegetal - Vegetal fossils in a 4.5 carats Wollo opal / face and back. (images Francesco Mazzero)



Wollo precious opal (Image Tewodros Sintayehu).

10.2.4. Mexico



Map showing the geographic positioning of Mexico and the location of Querétaro and Magdalena where the Mexican fire opal mines are located. Inset Mexican Fire from Chihuahua, (Locality at mindat.org) -! ex Zinn Collection 6.3 x 5.9 x 3.3 cm By Rob Lavinsky, iRocks.com – CC-BY-SA-3.0, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=10126911>

Mexico has been producing opal from fields in the State of Querétaro especially the Magdalena area since the late 1800's. "Zimapan" is the locality often provided for Mexican opal, although there is no fire opal production there today (except the "leopard" variety).



Fire Opal Mine Santa Cecilia, Magdalena (images by Juergen Schuetz – emilweis)



Opal mine St. Simon in Mexico (image Emil Weis Opals).

Production peaked in the 60's and 70's and continuing at a lesser rate to the present time. Opal occurs in a rhyolitic tuff of very varied colour, appearance and texture. This opal bearing formation (T_{3v} on geological maps) extends at least through the states of Queretaro, Jalisco and Nayarit, all the way to the Pacific Ocean. Opal is often found as infillings in vesicles, but also as veinlets. Most of it is dark orange to brown, opaque, with no commercial value. As in most gem mines, only a small proportion is worth faceting.

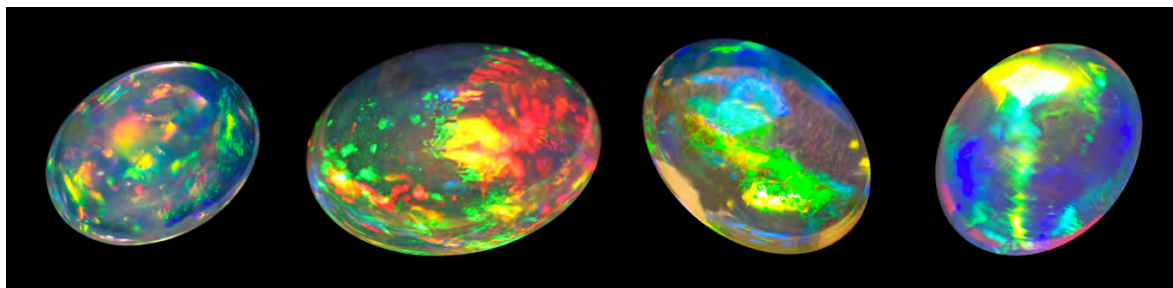
There is no systematic prospection, discoveries are random and based on what is seen in previous deposits. Opal mining is almost entirely by hand; there is minor mechanisation to exploit the rhyolitic rock ("cantera"). as a building material in some places (for ex. Mina Iris in Queretaro), opal being then a by-product the opal deposits being usually associated with water points.

Mexico produces four main varieties of opal; Fire Opal faceted with or without a of colour, Water Opal (near colourless) faceted with a play of colour, Contra Lunz opal, Boulder Opal (the so called Cantera Mexican Boulder Opal) and leopard opal. It should be noted that **there is plenty of artisanal smoke-treated opal available: porous opal is covered with brown wrapping paper, held in place by some kind of wire, and just put into a wood or coal fire. This works beautifully, but some such samples degrade over time (patches of white may reappear.** (Anonymous 1947; Mayers 1947; Foshag 1953; Mallory 1969; Marshall 1974; Zeitner 1979; Fryer 1981; Heylmun 1983, 1984a; Gübelin 1985a, 1985c, 1985b, 1986c, 1986a, 1986d, 1986b; Zeitner 1987; MacFarland 1911; Koivula, Fryer, and Keller 1983; Heylmun 1984b):



Mexican pre and smoke treated opal (images Emil Weis Opals.

Water (Crystal) Opal faceted with play of colour: Water opal is the variety with a water clear near colourless body colour (Sanders 1983).



Examples of Mexican water opals from Magdalena (images by Emil Weis Opals).

Mexican Boulder Opal, so called Cantera Mexican Boulder Opal:



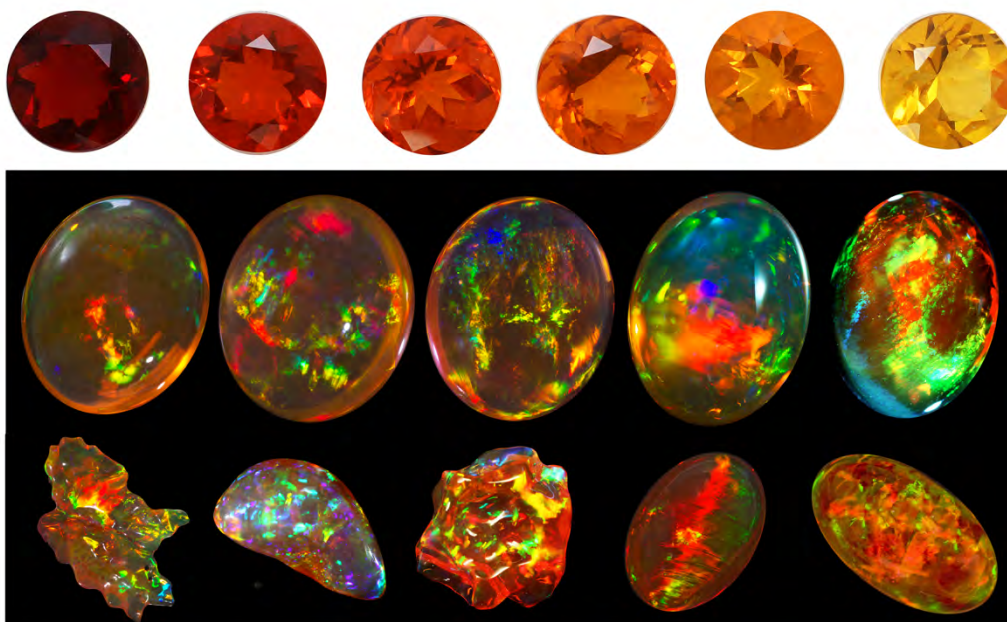
Examples of Mexican Boulder opals (images by Emil Weis Opals).

Mexican Cantera Fire Opals: while not always, they may have an intense play of colours, ranging from vivid red to yellow. It can also display a range of body colours, including white, Gray and brown. The term “Cantera” is said to refer to a type of quarry, suggesting that these opals may have been initially mined from open-pit excavations or quarries in Mexico.

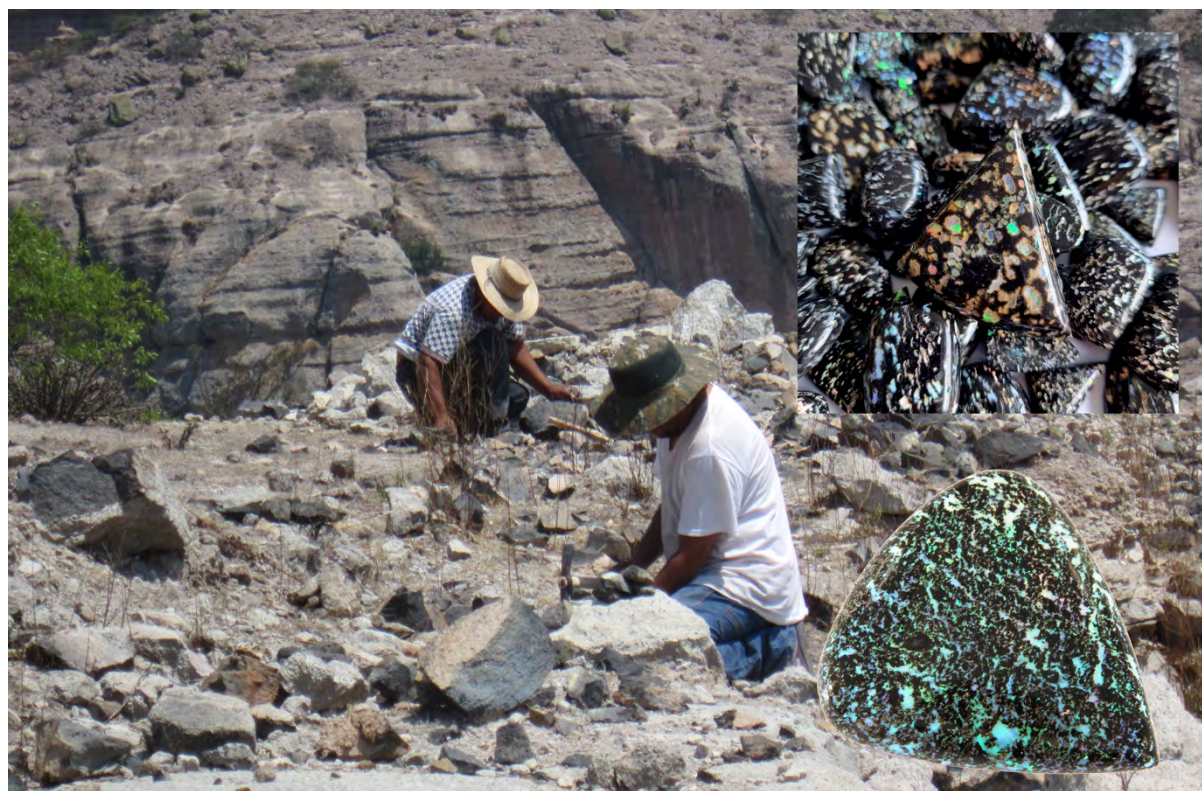
In Zimapán, Hidalgo State a variety of matrix opal known as “Leopard opal” is found in a form of vesicular basalt impregnated with precious opal. The even distribution and small size of the opal-filled vesicles make the opal attractive when cut or carved and polished. Irregular masses of play of colour opal showing various body colours (red, white, and colourless to pale blue) have also been deposited along joints and fractures within the basalt flow. This opal deposit, may have been worked in pre-Columbian times (Coenraads and Zenil 2006; Johnson and Koivula 1996; Boyd 2009).

There is translucent pink common opal in the states of Durango (Mapimi) and Michoacan (near Uruapan). Access to the second mine is said to be impossible because of narcotraffic in the areas (Fritsch et al. 2004).

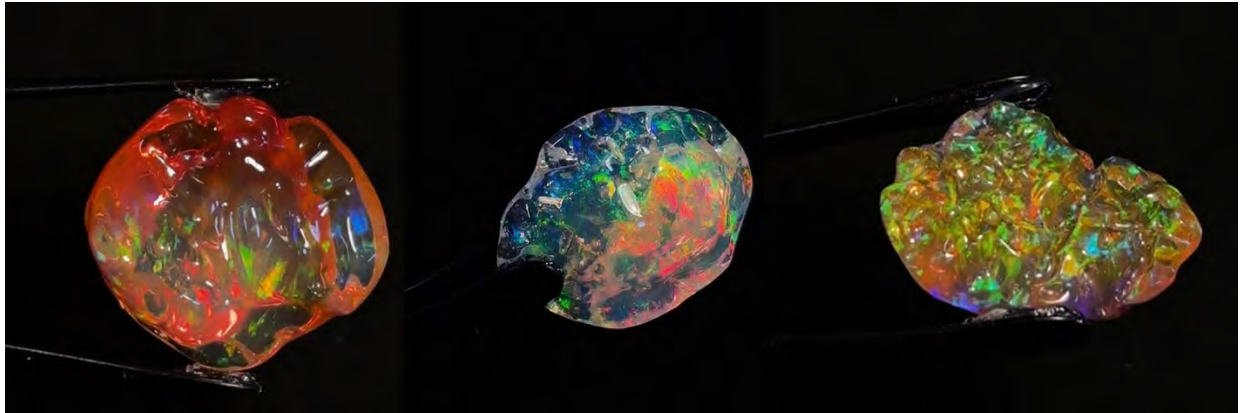
In the western part of the state of Zacatecas can be found a common or hyalite opal, discovered in 2013 in a volcanic caldera made of tertiary rhyolite, like many other Mexican opals. It possesses a spectacular colour behaviour, appearing near-colourless or pale-to moderate yellow in incandescent light and vivid greenish yellow to yellowish green in indirect sunlight. The daylight-induced green luminescence is related to the presence of trace amounts of the uranyl molecular ion (UO_2^{2+}). Several dozen high-quality transparent gemstones in the 1– 6+ ct range have been faceted from this material so far, in addition to hundreds of smaller stones (Fritsch E. 2015).



Mexican fire opal may vary significantly in appearance, some examples are shown here (images by Emil Weis Opals).



The Leopard Opal Mine with example of leopard opal inset.



Mexican opals cut as free forms elevating the possible rich play of colour (image by Kiai co Ltd through XGX Ltd).



Mexican fire opal loose and set from the Lisa Chen collection

Mexican opals are probably more plentiful than the current deposits and production lead us to believe, as many opal deposits have been found in Tertiary volcanics, of which many have never been prospected for opal. Opal is given little attention by Mexican geologists who have a metal-deposit (in particular silver) oriented culture.

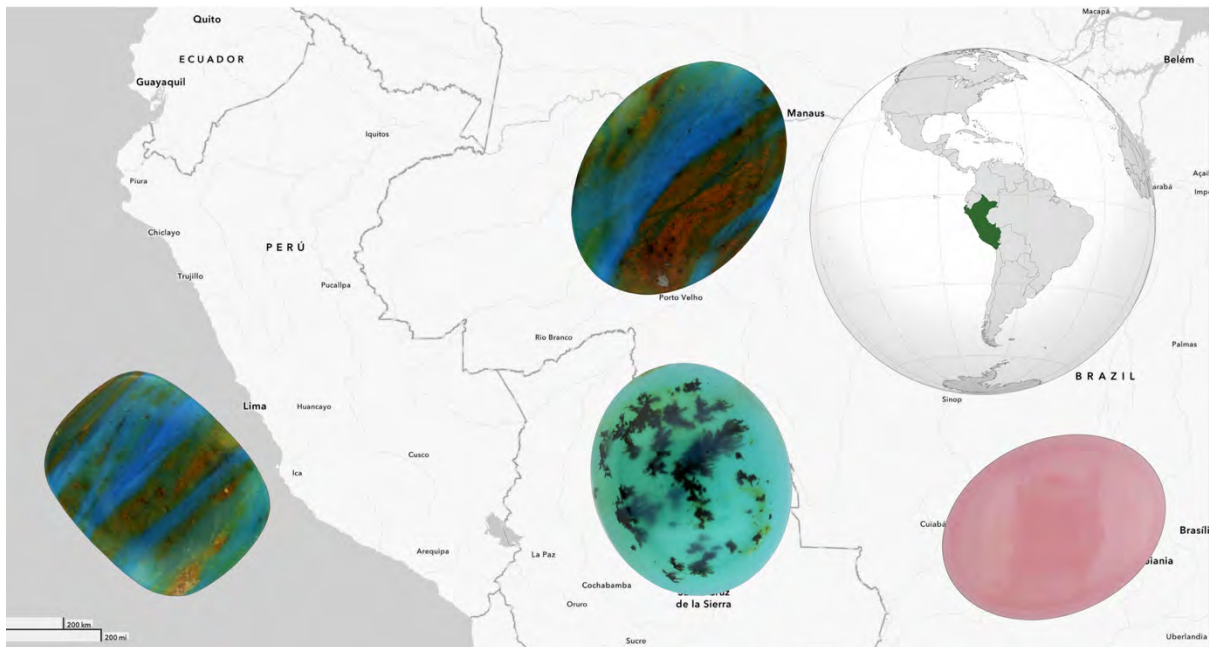


A carving in Mexican fire opal (image Emil Weis Opals).



An unusual colour pattern in a Mexican fire opal (image Emil Weis Opals).

10.2.5. Peru



Map showing the global positioning of Peru with inset examples of Peruvian (sometimes described as Andean) opal. (images Emil Weis Opals)

Common opal from Peru, is mainly found in the Andes Mountains and consequently referred to as Peruvian or Andean opal. It is typically an opaque milky, pale to medium pink or various shades of blue or green. The material is ideal for fashioning into cabochons and beads, with some translucent blue-green varieties being faceted.



Blue Opal, from Peru (image Emil Weis Opals)



Pink opal rough, carved and cabochon (image Emil Weis Opals)

10.3. Other opal producing localities (less known, historical and current)

Opal deposits may occur in many counties, below some more are listed and described.

10.3.1. Austria



Map showing the global positioning of Austria and inset an image of Austria moss opal (image- Emil Weis Opals).

Most opals in Austria are common opals, with the most prominent varieties being moss opal and forcherite⁴. Although Austria does not have the large-scale commercial opal mines it is an important mineral deposit for collectors. Opal is commonly found in the Waldviertel region of Lower Austria, particularly in Dobersberg, Waldkirchen, and Lexnitz. Its distinctive feature is the presence of iron and manganese inclusions that resemble twigs or moss within the rock matrix. Forcherite, an orange-yellow opal is found in the Ingering Valley and Spielberg regions of Styria. Hyalite is found in the Pauliberg basalt quarry in Burgenland and some areas in Lower Austria.

⁴ listed in (Bayliss 2000) It is described as opal + orpiment (arsenic sulfide)

10.3.2. Bulgaria



The geographical positioning of Bulgaria and reported positioning of opal occurrences in the Bulgarian Rhodope Mountains (<https://www.mindat.org/loc-249883.html>). Inset Wood Opal from the Rhodope Mountains, with the very bark-like exterior still intact, and the center has been completely mineralized. This specimen came out of an Eastern European museum collection, By Rob Lavinsky, iRocks.com – CC-BY-SA-3.0, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=10132340> and Bulgarian green opal rough from Vishegrad (ETSY).

Investigated opals from Bulgarian Eastern Rhodopes, show different colours such as light-apple and yellowish green; the diaphaneity is opaque or opaque/translucent with lustre waxy/dull/greasy, (Caucia 2020).

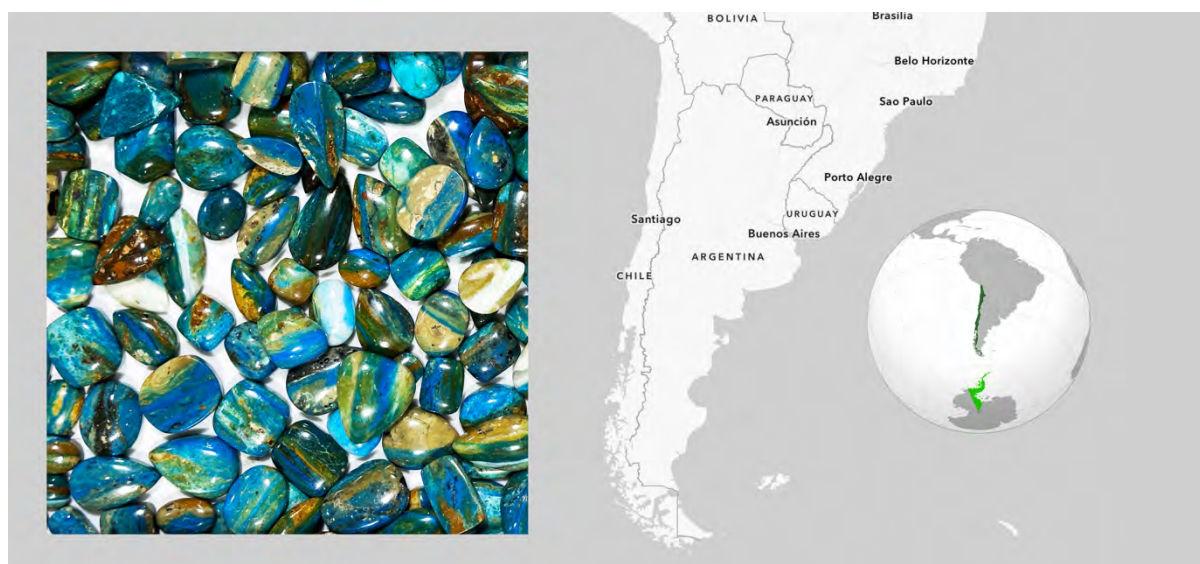
10.3.3. Canada



Map showing the global positioning of Canada and the approximate position of the Okanagan opal source. Inset Canadian opals, Image TripAdvisor - https://www.tripadvisor.ca/Attraction_Review-g154946-d630726-Reviews-Klinker_Opal_Property-Vernon_Okanagan_Valley_British_Columbia.html

Canada produces opal (known as Okanagan Opal) primarily from the Klinker Opal Deposit, located near Vernon, British Columbia, it is Canada's first significant precious opal discovery and was discovered on Thanksgiving Day October 1991. Known for its boulder and solid "play of colour" opals found in volcanic rock. The deposit is located approximately 10 kilometres from Vernon within a paleo-basin that extends 150 kilometres from the west side of Okanagan Lake to East of Kamloops.(Simandl 1997b, 1997a)"

10.3.4. Chile



A map showing the global positioning of Chile with inset an image of common opal from Chile (image) T S Coldham. orthographic projection by Addicted04 (talk) - Own work, CC BY 3.0, <https://commons.wikimedia.org/w/index.php?curid=78>

Brigida reports that during the 2024 Tucson Gem Shows she came across an ocean blue variety of opal from Chile, exhibited by Chilean Rocks and Minerals. Reportedly from Copiao Province, the material on view “was opaque to semitranslucent with an overall colour banding and greasy lustre, tumbled or cut as cabochons. The most prized pieces contained slightly greenish and vivid blue colours. Less valuable polished stones showed alternating blue and solid white layers or the presence of green material and sometimes brown matrix in their bands”. The cutters used the natural banding to their advantage, resulting in attractive colours and patterns that often evoke pleasant seascapes. After cutting Brigida reports, “the material is polymer impregnated” to create a tough and durable finished product (Brigida 2024).

10.3.5. France



Map showing the global positioning of France and an example of common opal from Biot, Grasse Arrondissement, Alpes-Maritimes, Provence-Alpes-Côte d'Azur, France (MinDat) (image copyright Alain Tuel (permission needed))

Opal can be found in France as small occurrences, of limited (local at best) commercial significance. We know of no play of colour opal in this country. Mostly gem common opal comes from the volcanic region of the “Central Massif” of France, often the administrative Auvergne-Rhône Alpes region. Currently, the nicest specimens found in France are blue opals (similar to Andean specimens), found in small amounts close to Biot, near Grasse (southern France), and incorporated in local jewelry. Historically, the pink common opal from Quincy, Cher, was produced in small quantities, and examples of so-called “quincyite” may be found in mosaics in the presidential palace (Palais de l'Élysée, Paris). Pink common opal nicknamed “opalite” comes from Les pics, Urcay, Allier department. Otherwise, the most common opal is called “reisnite”. This brown common opal is found in Saint-Pierre-Eynac, Haute-Loire, France, a nicer yellow variety is found in the Limagne region, St Beauzire, Puy de Dôme department and they are lighter colour, nearly white specimens from Busseol, in the same department, all in the Auvergne-Rhône-Alpes region. Finally, very rare, bright yellow opaque “forcherite”⁵ opal variety comes from the same region, but the Saint Nectaire area (better known for cheese). It owes its bright yellow colour to **pararealgar** like the “bumble-bee stone” of Indonesia. Aquitaine regions.

⁵ listed in (Bayliss 2000) It is described as opal + orpiment (arsenic sulfide)



Rose opal from Mehun-sur-Yèvre, Cher, France (image- Emil Weis Opals)



(left) Résinite (translated as wax opal in English, Sumarly et al. 1998), Saint-Pierre-Eynac, Haute-Loire, France: Photo taken by Valentine McDonald, Collection from Brisbane Opal Museum, Quincyite (Centre) This opal is found within a 3-4 km zone around Mehun-sur-Yèvre: : Photo taken by Valentine McDonald, Collection from Brisbane Opal Museum, (right) Yellow opal from Saint-Nectaire, called Forcherite when it comes from Austria: : Photo taken by Valentine McDonald, Collection from Brisbane Opal Museum

10.3.6. Germany



A map of Germany showing its global positioning with inset wood opal from Germany (image - Emil Weis Opals)

Mindat lists opal (hyalite) from Rüdighheim, Neuberg, Main-Kinzig-Kreis, Darmstadt, Hesse, and from Johanngeorgenstadt, Erzgebirgskreis, Saxony.

10.3.7. Honduras



A map showing the global positioning of the Republic of Honduras with inset an opal nodule in rhyolite from Honduras – Natural History Museum London – (image T.S. Coldham).

The Republic of Honduras is a country in Central America (Latin America). It was formerly known as Spanish Honduras to avoid confusion with British Honduras (now Belize). It borders Guatemala to the west, El Salvador to the southwest, Nicaragua to the southeast, the Pacific Ocean to the south, and the Gulf of Honduras and the Caribbean Sea to the north. Honduras is the site of several important ancient civilizations. Most famously, the Maya civilization was conquered by Spain, whose influence continues to affect language and customs in many aspects from the 16th century onwards. Honduras declared independence in 1821 and became a republic after the end of Spanish rule. Its capital is Tegucigalpa (Wikipedia).



Opal from Honduras (image by - Emil Weis Opals).

It is believed that precious opal found at Erandique (see map) was known to the Indians before Spanish arrived. Government records show mining commenced in 1853

and by 1882 increased production saw Honduran opal competing on the world market (the locality given in more recent scientific Honduran opal literature is Gracias, which appears to be 60 km north, a little west, from Erandique). Opal is found filling seams, horizontal cracks, and irregular gas vesicles in a rhyolitic tuff that is particularly “fresh” (collapsed bubbles still visible in thin sections). It is also a Tertiary volcanic, as for Mexican opal. Black opal matrix is abundant and widely sold as “Black Honduran Opal”

10.3.8. Hungary

See Slovakian opal 10.3.16

10.3.9. Indonesia



Map showing the global positioning of Indonesia and Banten Province where much of the Indonesian opal production is produced. (Coldham 2021) (inset by Addicted04, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=8376146>)

Occurrences of precious opal in Java have been known since the 16th century. In the 1970's there was some activity and from 1993- 2000 it was mined extensively. Presently production is sporadic.

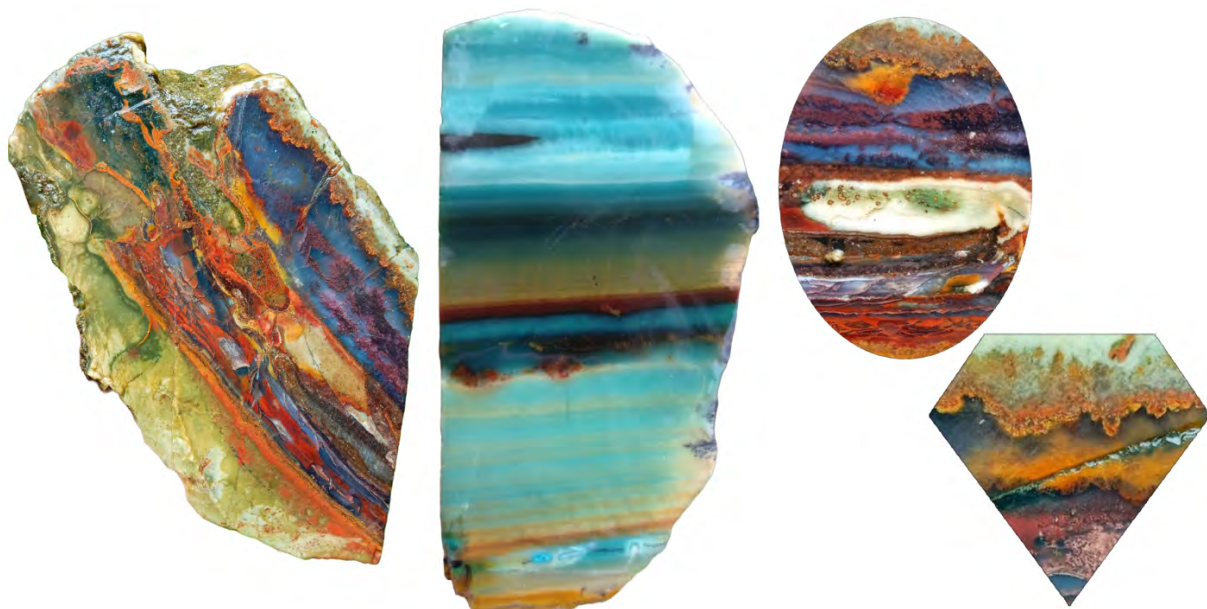
The area is characterised by Tertiary to Quaternary volcanoclastic deposits of weathered vitrified volcanic ash. Opal occurs in voids and cavities resulting from the break down and dissolution of organic matter, in particular vegetation but also such things as snails.

A wide variety of precious opal varieties are recovered ranging from light to black in tone, from transparent to opaque, from absorbent hydrophane to non-absorbent. A commonly encountered material, sometimes referred to as “limb casts” are shaped like branches with a dense black body colour and displaying play of colour when placed under a strong light source. Some patterns of POC are unique to Indonesia, a good example being the so called “laser” opal.

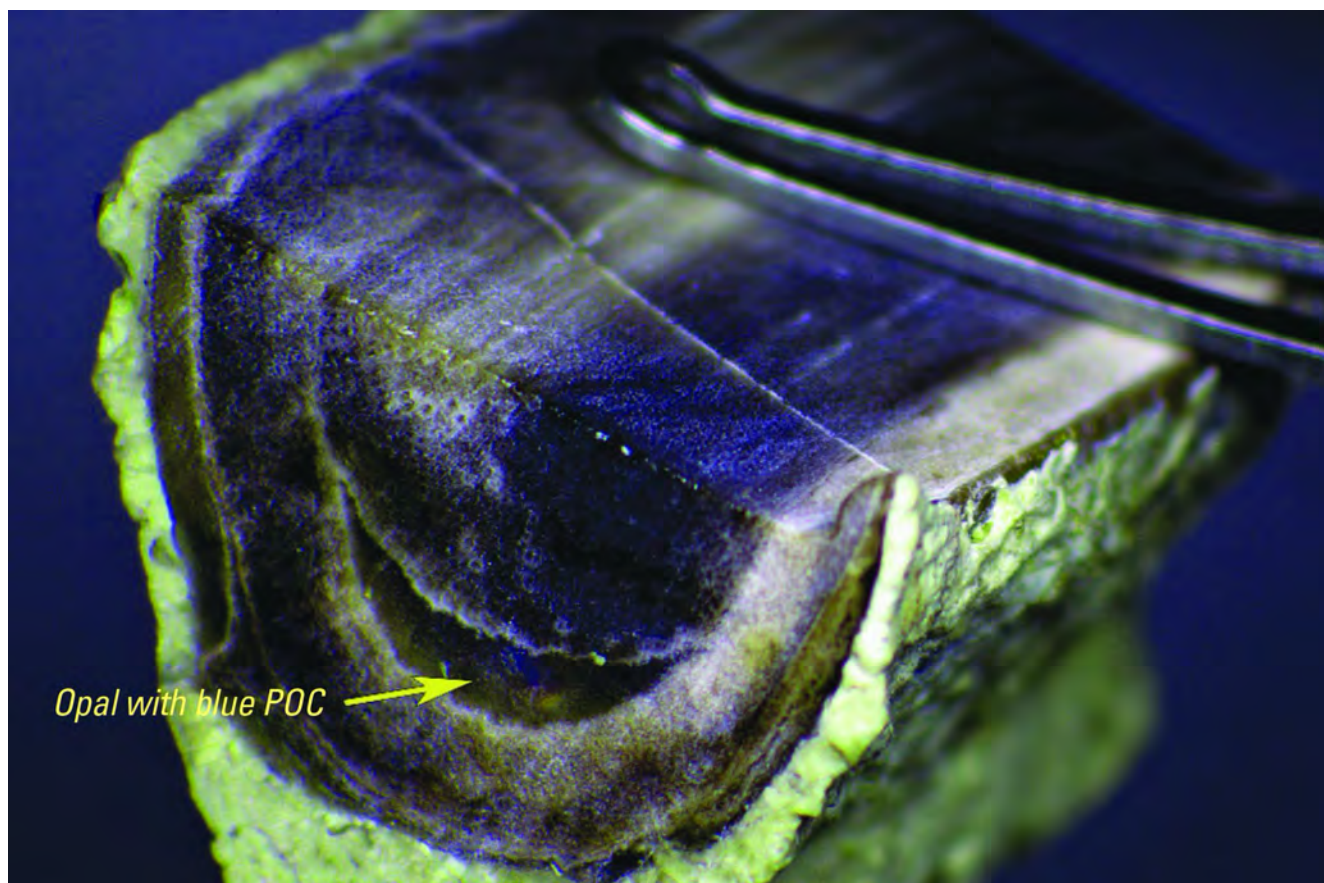
Other types of precious opal found are, transparent crystal opal, translucent “tea” coloured opal, light opal, and Potch.



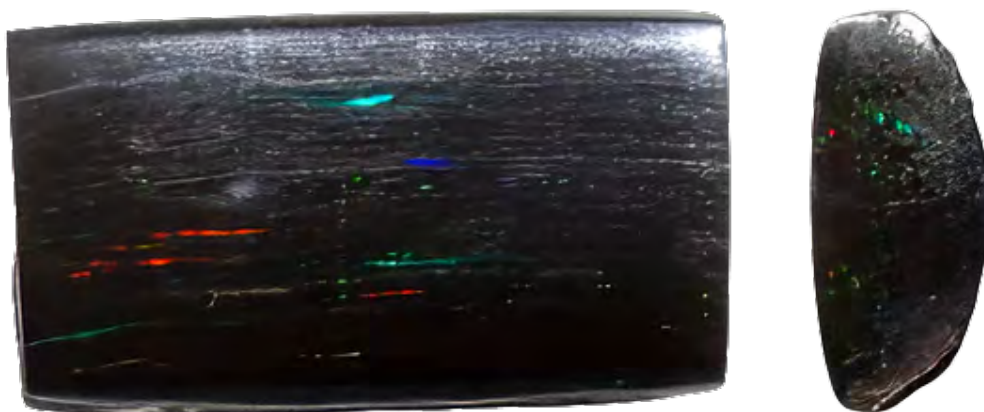
Indonesian opal mine shaft with miner underground (inset) (image T.S. Coldham -edited)



Various opals from Indonesia (images by Emil Weis Opals).



Opalised wood (magnification 50x. (Image T.S. Coldham).



Indonesian wood opal, top view (left) and cross section (right) (Image T.S. Coldham).



Indonesian "wood " or "limb cast" opal (Image T.S. Coldham).

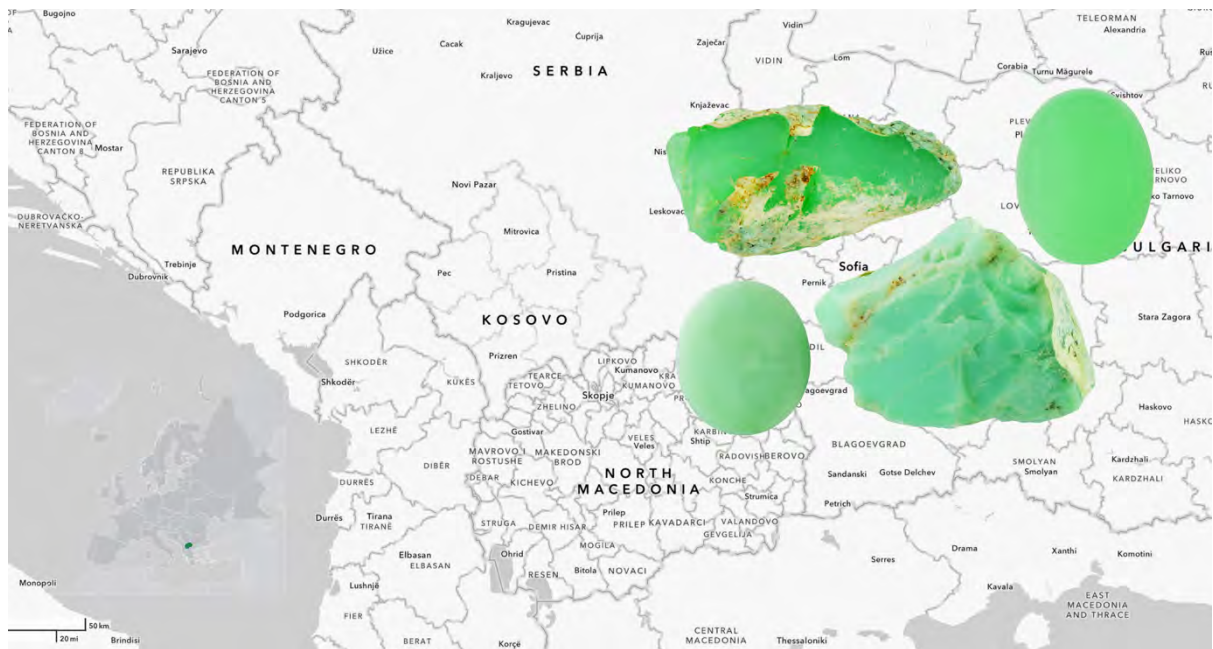
10.3.10. Kenya



A map showing the global positioning of Kenya with inset Kenyan yellow opal
https://www.etsy.com/market/kenyan_opal

The discovery of ancient Kenyan opals predates many other known historical uses, highlighting Africa's early connection to the gem. Some of the earliest evidence of opal use comes from artifacts found by Dr. Louis Leakey (https://en.wikipedia.org/wiki/Louis_Leakey) in caves, suggesting its use by Stone Age people. Modern Kenyan opal includes a colourful yellow opal variety.

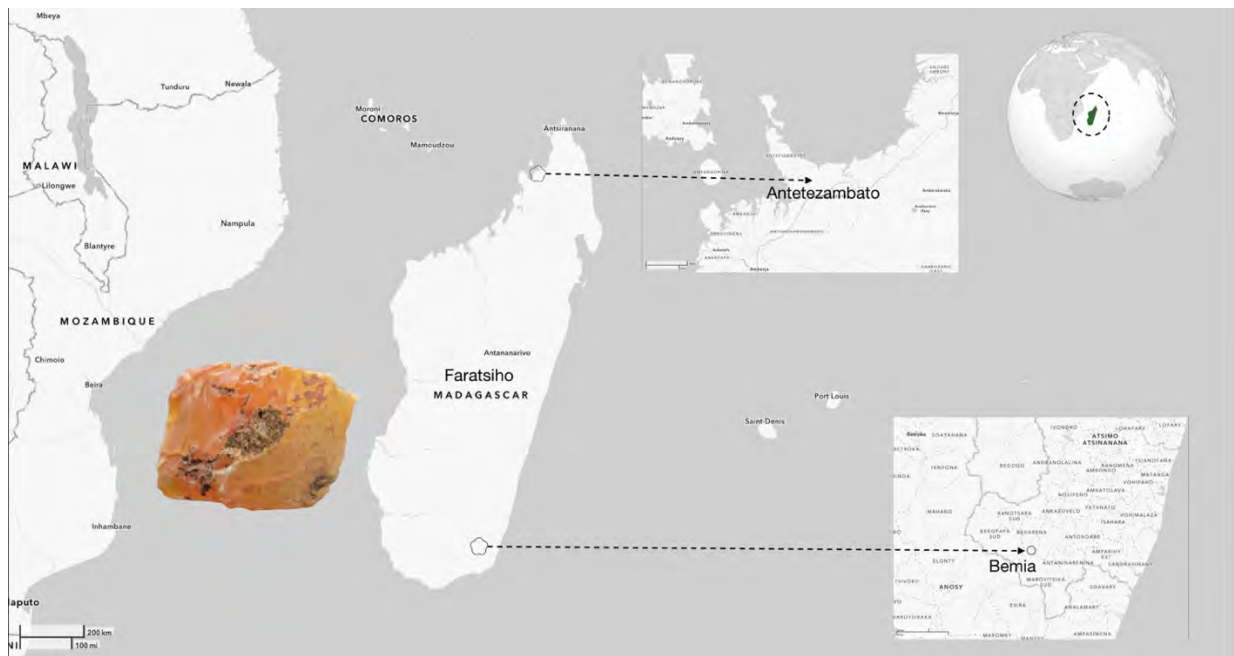
10.3.11. Kosovo



Map showing the global positioning of Kosovo with inset rough and cabochon examples of green opal from Kosovo (images by Emil Weis Opals).

Opal deposits in Kosovo, specifically green opal and chrysoprase, are found in the Golesh Mountains near Magura and in the Gllavice (Glavika) mine. These deposits, often associated with magnesite and ultramafic rocks, were notably discovered or explored during the 1960s-1990s, with some mining activities occurring in the area since the early 1990s.

10.3.12. Madagascar



Madagascar opal occurrences near Bemia, Antetazambato and Faratsiho with insert Madagascar fire opal (ETSY)

Various varieties of opal have been found in several regions of Madagascar, particularly the Faratsiho deposit, located near the capital Antananarivo, since early in the 20th century, (Lacroix 1922, 1923), Early this century an occurrence of fire opal was found near Bemia in the southwest of the island associated with volcanic rocks (Simoni 2010). The opal is similar in appearance to Mexican fire opal, but without play of colour. Recently opal was also reported from Antetazambato, North-western Madagascar (Monico 2025).

10.3.13. Mali



A map showing the global positioning of the Republic of Mali and the reported yellow opal occurrence near Nioro du Sahel Cercle, Kayes Region (<https://www.mindat.org/loc-31090.html>), with inset image of opal from Mali (<https://e-rocks.com/item/clb546575/opal?sid=28158b03cfa8fa271584f1ca46978c2d>).

Discovered in 2007 but still rare to the market are opals found in Mali, which are reported to have a vibrant yellow green. The Opal occurrence, Nioro du Sahel Cercle, Kayes Region, (<https://www.mindat.org/loc-31090.html>).

10.3.14. Nicaragua

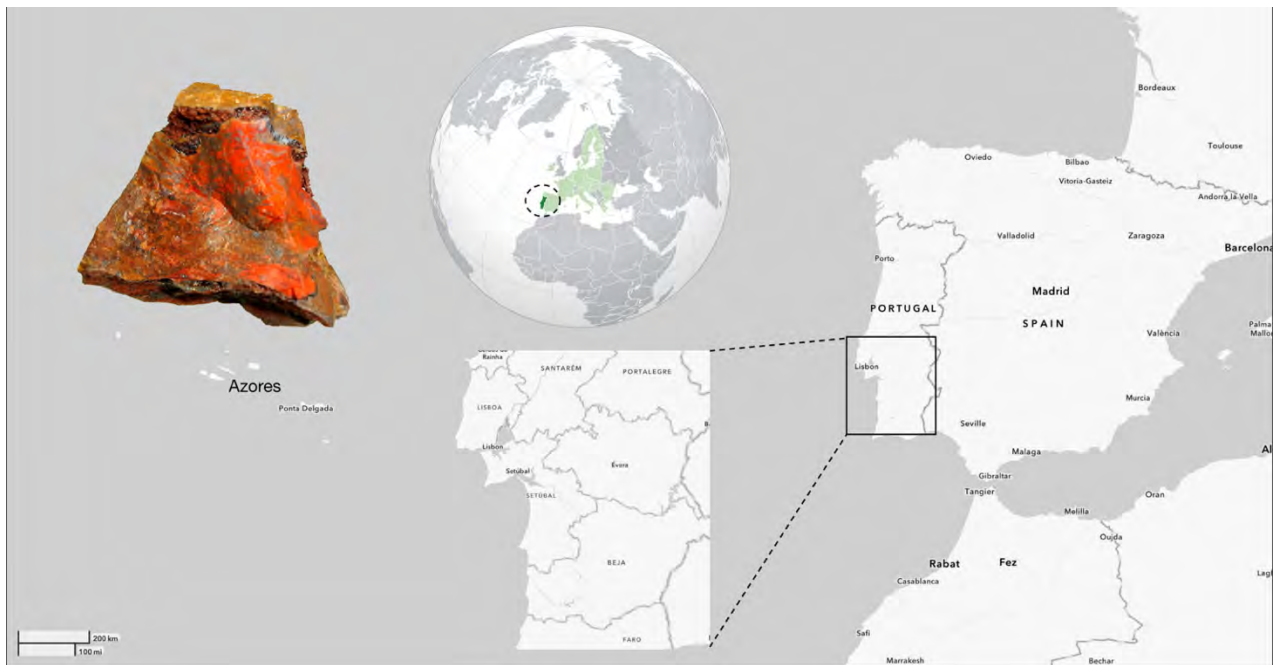


A map showing the global positioning of the Nicaragua

Opal from Nicaragua, while less famous than Australian or Ethiopian varieties, is a minor source of, precious, fire, and black matrix opals often found in volcanic, basaltic rock (Franklin 1972). These stones are often characterized by their dark matrix and pinfire colour play.

Similar to Honduran opal, these opals are formed in volcanic, black basalt matrixes. They are known for their dark, often matte, base with vibrant flashes of colour. While Nicaragua itself is listed as a producer, many online listings for "Nicaragua opal" may also refer to regional Central American material, including Honduran opal and Mexican fire opals.

10.3.15. Portugal



Map showing Portugal relative to the rest of Europe, the positioning of the Azores and Beja with insert of Cherry opal from Portugal (Mindat).

"Portuguese Opal" may at times refer to opals found in Portugal or the Azores such as the cherry opal from Beja, or more commonly, an opal that has been "Portuguese Cut"⁶, a specific faceting style. Portugal does yield opals, but the cut style is a significant part of the "Portuguese" link in gemmology.

Localities are reported in the Guarda and Viseu districts, with sites including the Portugal quarries in Malpartida (for Cherry Opal) , the Cêrro da Oca Mine near Serpa (Beja), and mines in the Gestoso landscape (Viseu) , alongside historic dumps at the Panasqueira Mines, offering various opal types from common to potentially gem-quality finds in historic mining regions.

⁶ It's a popular faceting technique used on many stones, including opals, creating a distinctive look

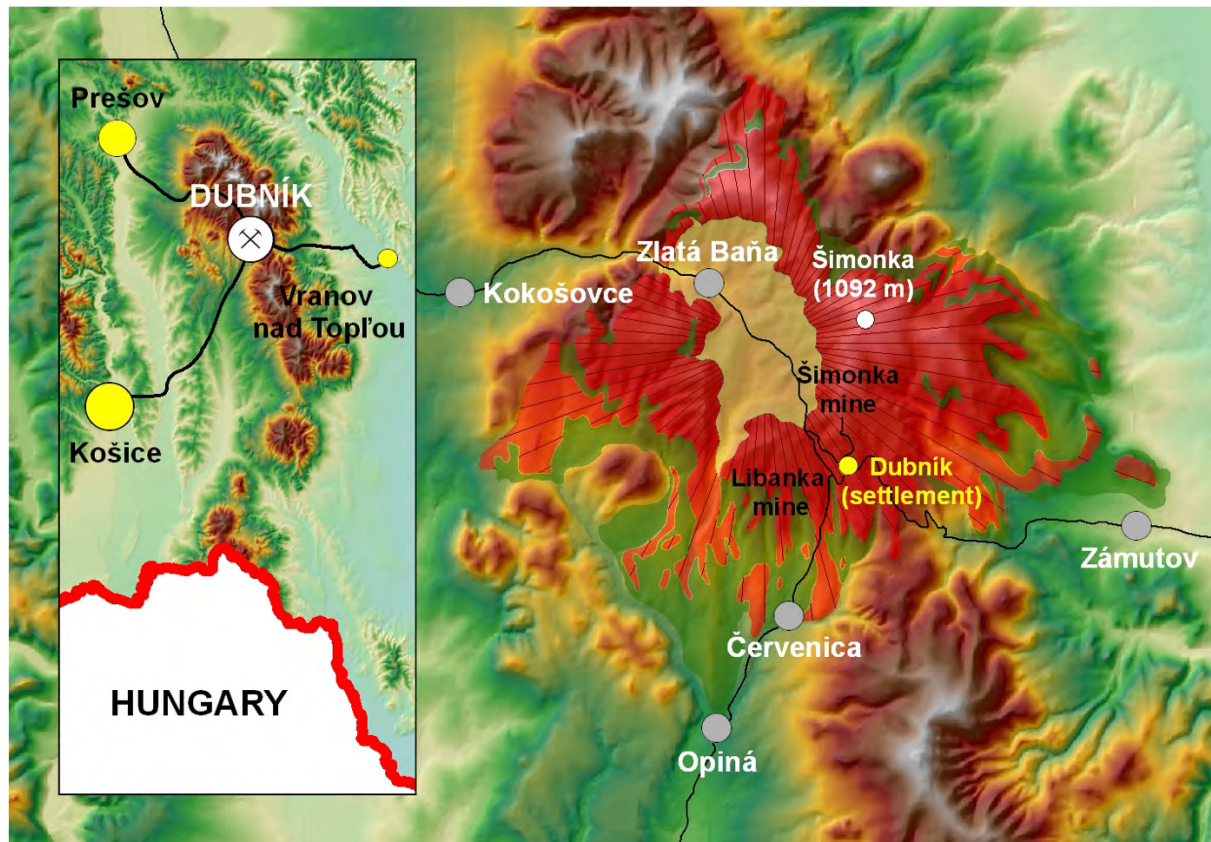


An opal mine site in Portugal and inserted a variety of Portuguese opals.

10.3.16. Slovakia



Map showing the geographic location of Slovakia and the area near Dubník in which the opal mines are located.



Maps showing position of the locality in the Slanské vrchy Mountain as well as the Zlatá Baňa stratovolcano (yellow – central zone, red – transitional zone, green – peripheral zone). Compiled by the Peter Semrád.



A panorama-view of the Červenica–Dubník (old Hungarian: Vörösvágás–Opálbánya), is situated to the north of the Slanské vrchy Mountains in an area of the Slovak Republic that was, until 1918, part of the Kingdom of Hungary. It is therefore no surprise that, prior to 1918, the European gem was commonly marketed as “Hungarian Noble Opal” (Semrád 2015).

The European region for precious opal, Červenica–Dubník (old Hungarian: Vörösvágás–Opálbánya), is situated to the north of the Slanské vrchy Mountains in an area of the Slovak Republic that was, until 1918, part of the Kingdom of Hungary. It is therefore no surprise that, prior to 1918, the European gem was commonly marketed as “Hungarian Noble Opal” (Semrád 2015).

The mines at Dubník were quite likely the first known source of precious opal to consistently supply material to international gemstone markets. However, the absence of trustworthy evidence prevents us from determining who extracted the very first specimen and when this occurred. Reliable breakthrough records exist only from the late 16th to early 17th century. Emperor Rudolf II initiated prospection for opal and other gemstones within the Kingdom and subsequently established small-scale operations at the locality during that period. These and later activities were recorded, as reflected in the words of French gem merchant and traveller Jean Baptiste Tavernier, Baron d’Aubonne (1676): “As far as Hungary is concerned, there is a mine wherein opals are mined. There is not any other like this in the whole world.”

Mining efforts expanded dramatically over the course of the nineteenth century, when private entrepreneurship flourished at the locality. The “golden era” of 1845–1880 saw the opal mines leased to the Goldschmidt family. Beginning on November 1, 1896, gem mining was carried out by the state, which owned the deposits. Unfortunately, the state did not send the extracted stones to the market but to the treasury of the Ministry

of Finance in Budapest (Butkovič 1970). During the same period, the abundant Australian deposits emerged as a formidable competitor to Hungarian opal (Cram 1998). After World War I, Czechoslovakia could not afford to continue operations, which ceased in 1922

The Vienna Imperial Opal, with dimensions of 13×7×7 cm and a weight of 574.9 g is considered the largest known solid precious opal from the locality. The stone likely came to light sometime in the 17th century, as suggested by the words of an English physician and member of the Royal (Academic) Society in London, who in 1668 saw in one of the display cabinets of the Imperial Treasury in Vienna a rather large opal—possibly the one known today as the Vienna Imperial Opal. Among his descriptions of the items in the cabinet, he writes (verbatim): “An Opal bigger than my hand, as it was taken out of the Mine; and many other fair Opals.” (Brown 1677). The stone can be seen today in the Naturhistorisches Museum in Vienna.

Today, the Červenica–Dubník locality certainly cannot supply the market with opal on a large scale. Even its apparent disadvantages—limited access to reserves and a yield consisting mostly of small cut stones—could, in fact, become an asset, as scarcity tends to increase both demand and price. The market is well supplied with opal, including large cut stones from various sources, yet some people will specifically desire a Slovakian stone. The body colour of precious opal from this locality is predominantly white, while its opacity can vary significantly. In addition, a very attractive bluish, transparent variety without play of colour occurs here and is today known as Slovak Ice Opal.



Opal-hunting-underground (image Peter Semrád)



A “very good find” of Slovakian opal (image Peter Semrád)

If one wishes to discover this historical site, Slovenské opálové bane Ltd. which manages on-site activities such as conventional medium-sized group underground tours or more adventurous small-group tours that may include opal hunting. One can also explore the nature interpretive trail that leads visitors around the historical mining terrain. However, unauthorized opal searching is strictly prohibited, as this area is protected.



A vintage collectible trade card from a "Les Minéraux" set, produced by the French chocolate brand Chocolat Poulain. It depicts two individuals in traditional Hungarian attire with a mountain landscape behind them. The right side showcases various jewelry items adorned with opals. The text "Les Minéraux," "L'Opale," and "Hongrie" translates to "Minerals," "Opal," and "Hungary".

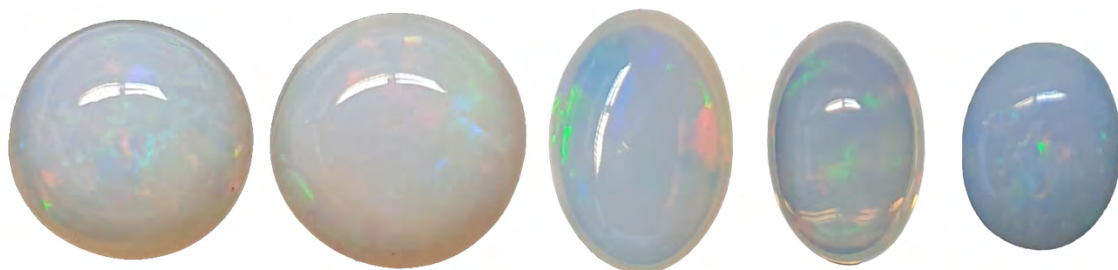
The aim of the nature trail is to present the history of opal mining in this location, to draw visitors' attention to the wildlife of the Slanské vrchy Mountains, the need for its protection, and, to a necessary extent, to sustainable forest management, taking into account the use of forests by visitors to the mines, tourists, and, last but not least, the population living in the countryside.



Slovakian opal matrix (left) and "in-situ" (right). (images Peter Semrád)



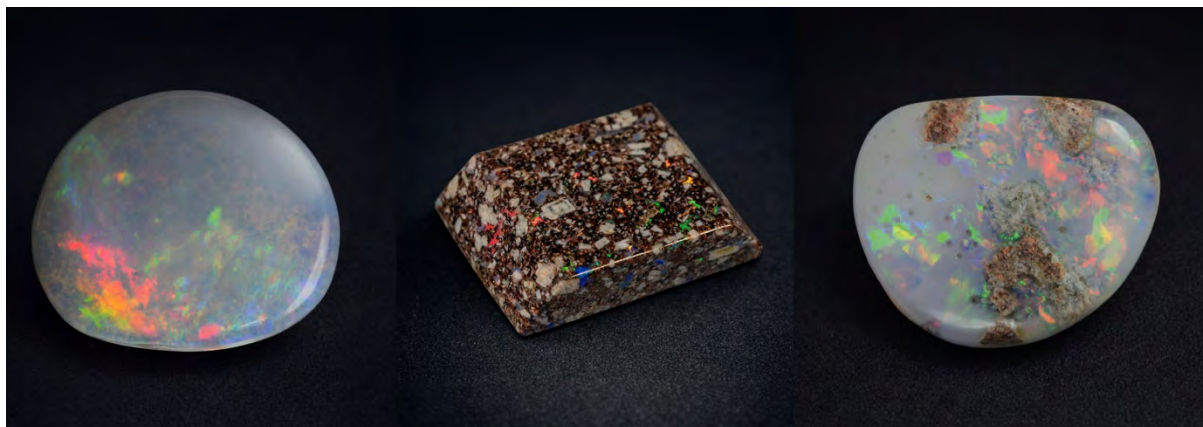
Slovakian glassy AKA "ice" opal (left) and precious opal (right) (images Peter Semrád)



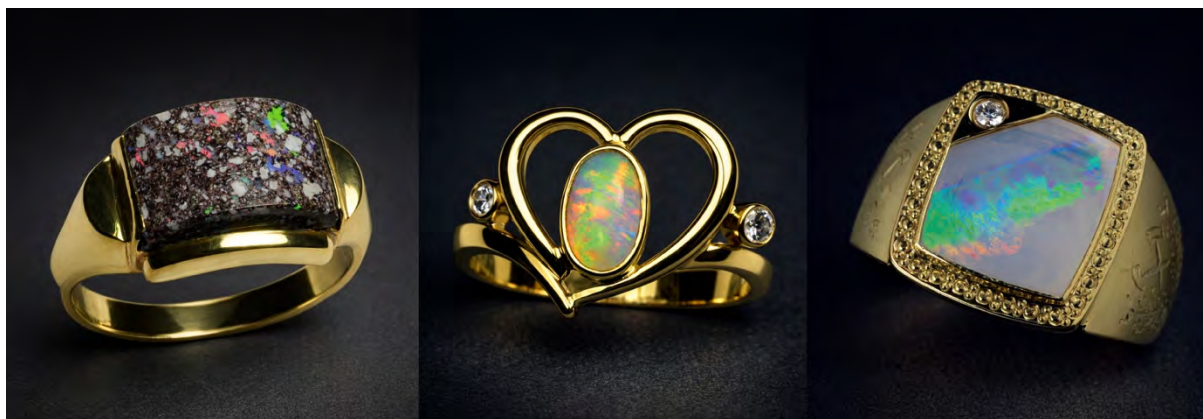
A group of "Hungarian" (Slovak) opals (image Emil Weis Opals)



Solid Slovak Opal from Cervenica-Dubník, non-banded (left) and banded (right). (images Peter Semrád)



Slovak Opal from Cervenica-Dubnik, boulder full-face (left), matrix (centre) and boulder with rock-in-face (right).
(images Peter Semrád)



Slovak Opal from Cervenica-Dubnik set in rings, opal in matrix (left) solid (centre) and banded (right). (images Peter Semrád)



Geoturism

10.3.17. Spain



Map showing the global positioning of Spain and the district around Agramón where menilite opal nodules are found. Inset orthographic projection by Nice4What - Own work, derived from File:EU-Spain.svg, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=169093443>. Inset lower - Menilite opal is white and rounded (El ópalo menilito es de colour blanco y forma redondeada). By Posible2006 - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=94911719>

Primarily Menilite opal (Ménilite), an opaque, massive opal often found as nodules in diatomaceous earth (diatomite). Ranges from light grey to caramel, sometimes with reddish-brown plumes, often incorporating silica from fossilized microorganisms (diatoms). Valued by mineral collectors for its unique formations and inclusions and sometimes used for opaque lapidary work. Found in the region around Agramón in Spain (<https://www.mindat.org/gm/49382>)

10.3.18. Tanzania



The global positioning of Tanzania (inset orthographic representation by Marcos Elias de Oliveira Júnior - Own work, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=15556836>) with inset two examples of Tanzanian green opal typically found in the area of Dodoma images from <https://www.opalauctions.com/learn/a-z-of-opals/tanzanian-green-opal> . and one dendritic opal (image Emil Weis Opals)



Cat's-eye opal from Tanzania (image Emil Weis Opals)

Tanzanian Opal refers to various opals from Tanzania, most famously prase opal , an apple-green to leek-green variety with a rolling flash, found near Dodoma at Hanety Hill and Iyobo. It's a common opal stated to be coloured by chlorite, different from precious opals but valued for its unique green hues and sometimes dendritic (mossy) inclusions, offering distinct chatoyancy (cat's-eye effect).

10.3.19. Turkey (Türkiye)



A map showing the geographic location of Turkey (Türkiye). Inset to the upper left an opal from Turkey image Le Comptoir Géologique and to the lower right another opal from Turkey from Donna Beaton. A new deposit of “emerald”-green common opal is situated 40 km ENE of Oltu.

Various forms of opal are found in Turkey, including dendritic opal with moss-like inclusions, fire opal, and often yellow or green-hued nodules with good transparency and strong fluorescence, frequently occurring in volcanic rocks like dacite and sometimes linked to hydrothermal activity, making it a subject of geological study and sought after by collectors. Found in regions like Gümüldür and southeastern Turkey.

Donna Beaton reported in 2016 that on display during the Tucson shows where dendritic opal cabochons) fashioned from rough obtained from Simav, Turkey. This material was called “Turkish dendritic opal,” has been cut “so that each piece shows clearly delineated opaque white and semi-transparent areas, embedded with fine branched black inclusions reminiscent of traditional Japanese tategaki characters”.

A new deposit of “emerald”-green common opal was discovered around 2010 at Turnali, a small village 40 km ENE of Oltu by car, in the Erzurum Province, NE Turkey. This locality provides opal of such quality that it has already been mounted locally in rings and pendants. All this jewellery activity is located in Oltu (Fritsch 2011).



Turkish green opal in local jewelry, photo by H. KoLayli

10.3.20. United States of America



A map showing the global location of the USA ((inset orthographic representation by Addicted04 with Natural Earth Data, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=16937043>). Also inserted Blue Precious opal Arizona, note pink Play of Colour (centre), Arizona opal cab (left) and Oregon Opal (right), images T.S. Coldham.



Cabochons of Spencer opal with a pink body colour USA (Image from the Gemmological Association of Australia's online course Certificate in Opal Studies – edited).

In 1893 opal was discovered at Opal Butte Oregon, 1900 in Idaho (Sanders 1976) at panther Creek and then 1905 at Virgin Valley Northern Nevada where in 1926 an extraordinary precious opal of 2585 opal was found. Named the Roebeling Opal it is now at the Smithsonian National Museum of Natural History. 1948 the Spencer Mine was found in Idaho.



Opalised wood from Virgin Valley, Nevada USA. (image Emil Weis Opals)

In 1989 blue coloured opal was reported from Arizona and Sandstone matrix opal from Louisiana. In 2023 matrix opal was named Mississippi's Official State Gemstone.

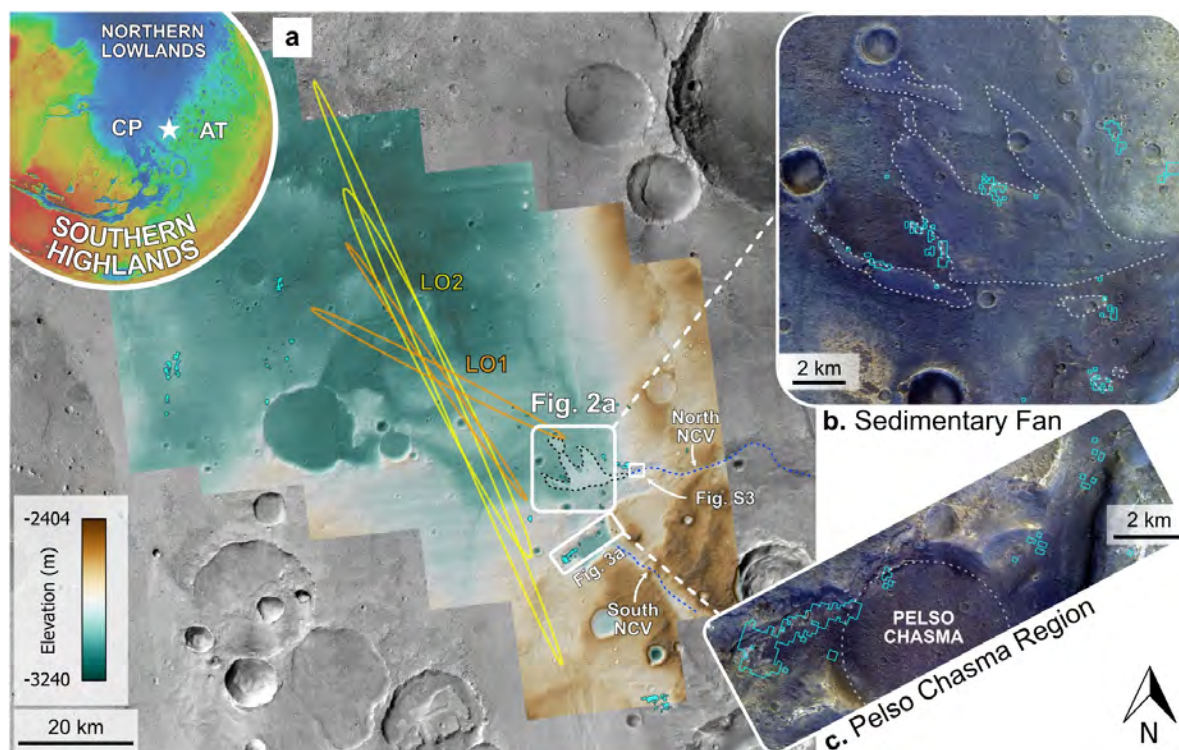
All the US opal deposits are associated with volcanic rocks. In Nevada precious opal is often found replacing organic matter such as wood and rarely pinecones. In Idaho the opal occurs in voids in basalt and rhyolite flows.

The type of opal varies from location to location. Nevada opal is famous for translucent opal with vibrant POC. It is also known for having a high-water content which causes it to become unstable if allowed to dry out. Idaho produces a more stable milky light opal with muted play of colour and opal from Mississippi is matrix opal. Precious opal is also reported from California (Sanders and Dietz 1967). These days most US opal mines primarily cater for rockhounds and tourists

10.4. Extraterrestrial opal

McNeil et. Al., (McNeil 2025) used orbital remote sensing data to identify deposits containing hydrated silica (opal) in Oxia Planum, the future landing site of the ExoMars Rosalind Franklin rover. The opal occurs between clay-rich plains and an overlying sedimentary fan, and within topographic lows south of the sedimentary fan.

Compositional data indicate that opal is mostly amorphous in structure, resulting from weathering of other rocks. While we cannot rule out that some opal was transported from elsewhere, it most likely formed in place by falling out of solution or through later groundwater or soil-forming activity. We have identified opal in local regions within the fan, as well as possible opal deposits near the center of the Rosalind Franklin landing site, which are prime targets for the rover's search for past habitable conditions and signs of past or present life.



From (McNeil 2025) "Regional geography of Oxia Planum. (a) CTX DTM showing elevation and 3-sigma 2028 landing ellipses for the ExoMars RFR mission (orange: launch opportunity 1 (LO1), yellow: launch opportunity 2 (LO2)). Inset Mars Orbiter Laser Altimeter globe indicates Oxia Planum's location near the dichotomy boundary between Arabia Terra (AT) and Chryse Planitia (CP). The sedimentary fan is outlined in black dots, and the northern and southern Neocoon Valles (NCV) are indicated by blue dotted lines. Mars Orbital Catalog of Aqueous Alteration Signature (MOCAAS) locations of silicate minerals (Carter et al., 2023) shown in cyan correspond to 100 m/pixel detections of hydrous aluminosilicates or hydrated silica (locally in Oxia Planum refined to "hydrated silica $\pm$ kaolins"). (b) CaSSIS NIR-PAN-BLU (NPB) mosaic of the fan region, with the margins of the fan outlined. MOCAAS hydrous aluminosilicates/hydrated silica shown as cyan outlines. (c) CaSSIS NPB mosaic of Pelso Chasma, south of the fan. The quasi-circular shape of Pelso Chasma is indicated by a dotted line. Geographic nomenclature follows the scheme of Fawdon et al. (2021)".

11. Opal Care

The appropriate care of opal depends primarily on whether the stone is impermeable or absorbent (hydrophane), and on whether it is a solid natural opal, opal on host rock, or a composite.

Impermeable opal

The majority of Australian and Brazilian precious opal is impermeable - it does not absorb water or other liquids. Solid natural opal and opal on host rock (boulder opal) of this type is relatively durable in normal wearing conditions. Water and routine liquid contact do not present a risk to impermeable material. Standard jewellery care applies: avoid abrasion, ultrasonic cleaning, and exposure to harsh chemicals.

Absorbent (Hydrophane) opal

Not all opal from Ethiopia is hydrophane, however a significant proportion of Ethiopian precious and common opal is absorbent to varying degrees. Some Indonesian opal is also hydrophane. Absorbent opal can change in appearance, mass, and stability depending on its water content at any given time. The following precautions apply:

- Contact with water, sweat, or body oils may cause the opal to become temporarily or permanently opaque or alter its apparent colour or play of colour.
- Prolonged or repeated exposure to coloured liquids, perfumes, or cosmetics may cause permanent staining.
- Sweat and body oils absorbed during wear may affect the stone's clarity or colour over time; stones should be gently wiped clean with a dry or lightly dampened cloth after wearing.
- Storage in excessively dry conditions may cause moisture loss and increase the risk of crazing (see 11.1).

Composite opal

Doublets and triplets require particular care regardless of whether the opal component is impermeable or absorbent. Prolonged immersion in water or exposure to moisture may compromise the adhesive bond between layers, causing lifting or separation. Composite opals should not be soaked, and exposure to steam, ultrasonic cleaners, or harsh cleaning agents should be avoided. Surface cleaning with a soft damp cloth is recommended.

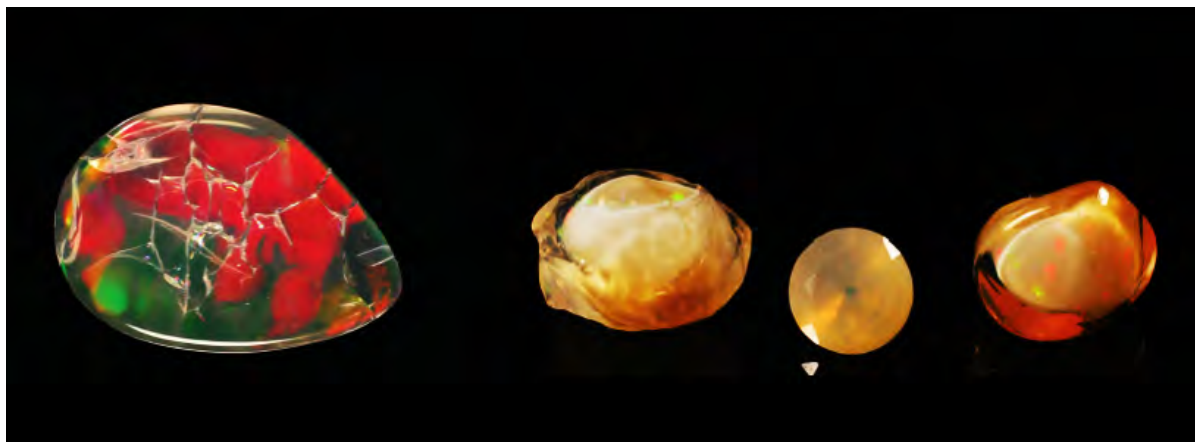
Faceted opal

Some opals, notably Mexican fire opal and Ethiopian precious crystal opal, are faceted rather than cut as cabochons. Care should be taken to avoid abrasion, particularly along facet edges.

11.1. Crazing and Whitening

Opal stability varies considerably. Some archaeological specimens have remained intact for thousands of years; others develop structural changes over time. Stability can be influenced by the locality from which the opal originates, and in some cases may change depending on the environmental conditions in which the stone is stored or worn. Reputable dealers and jewellers will generally be aware of stability issues associated with particular producing localities and are a valuable source of guidance. Those purchasing rough opal directly from opal fields are advised to develop knowledge of the characteristics of individual fields, as stability can vary significantly not only between localities but within them, enabling more informed decisions about material that may carry a higher risk of crazing.

The two most common forms of instability are crazing — the formation of fine surface or internal cracks, often resembling a spiderweb — and whitening, in which opaque white areas develop within an otherwise transparent stone (Chauviré et al. 2023; Rondeau et al. 2011a).



Cracking (left) is common in transparent "crystal" opal from Wollo, Ethiopia (Photo: B. Rondeau) The three opals, to the right, from the state of Queretaro, Mexico experienced the development of a white areas from the interior, this whitening can also affect the entire body of an opal, as in the faceted opal seen in the centre (Photo: B. Rondeau) (Rondeau, Fritsch, Mazzero, and Gauthier 2011).



Opals with crazing © Chauviré & al. (2023) (Chauviré 2023)

Causes

- **Moisture loss:** Prolonged exposure to dry environments or heat causes water within the opal's structure to evaporate, increasing brittleness.
- **Thermal shock:** Rapid temperature changes — such as sudden immersion in cold water after heat exposure, or prolonged exposure to direct sunlight in a closed vehicle — can induce cracking.

- **Improper storage:** Storing opal with desiccants (e.g. silica gel) or in excessively dry conditions draws moisture from the stone.
- **Natural instability:** Certain opals are inherently more prone to crazing, particularly those from Wollo, Ethiopia, Virgin Valley, Nevada and Tintenbar, Australia, if not properly maintained.
- **Impact:** Physical shock can initiate or propagate cracking.

Prevention

- If an opal is not worn for extended periods, store it in a sealed bag with a slightly damp cotton ball to maintain ambient humidity.
- Avoid exposure to direct sunlight, halogen lamps, or other heat sources.
- Clean with a damp cloth only; ultrasonic cleaners should not be used, as vibration may expand existing cracks.
- Regular wear can assist moisture balance, as skin contact and ambient humidity help stabilise the stone.

Effect on Value

Crazing is typically permanent and substantially reduces value - in some cases to 10–20% of the original. Crazed stones are generally unsuitable for use in jewellery due to risk of fracture.

Remediation

Crazing cannot be repaired, but two approaches may partially address surface damage:

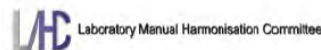
- **Resin filling:** Opticon or similar resins may be used to fill cracks, improving appearance and providing temporary structural reinforcement. This constitutes a treatment and must be disclosed.
- **Recutting:** Where crazing is confined to the surface, recutting and repolishing may be possible, though this reduces the size of the stone.

Summary

Informed opal care begins with an understanding of the stone's type and origin. Impermeable opals, including the majority of Australian and Brazilian material, are relatively robust in everyday wearing conditions, while absorbent hydrophane opals require greater care around liquid exposure, wear, and storage. Composite opals present additional considerations due to their assembled construction. Regardless of type, opal benefits from protection against abrasion, thermal shock, and harsh chemicals. Stability is not uniform across localities or even within them, and crazing, where it occurs, is generally permanent. Purchasing from knowledgeable and reputable sources, and seeking guidance on the characteristics of specific origins, remains the most reliable means of ensuring that opal is selected, worn, and maintained appropriately.

12. Appendix A – LMHC Information sheet #13 Hydrophane Opal

LMHC Standardised Gemmological Report Wording (version 3; May 2025)



LMHC Information Sheet # 13

Hydrophane Opal

- Definition
- Suggested Testing Procedure
- Report wording

Members of the Laboratory Manual Harmonisation Committee (LMHC) have standardised the nomenclature that they use to describe hydrophane opal.

Definition

Hydrophane opal is opal that will absorb liquids to the point of affecting the appearance and potentially the weight of the gemstone. Most opals have a porous structure to some extent, but when this porosity is considerable the term hydrophane may apply. Such opals could come from any opal locality, but opals from deposits in Ethiopia produce an unusually high percentage of such gemstones.

Suggested Testing Procedure

- a) Place a drop of water on the surface of the opal. Observe under the microscope how and if the water drop is absorbed by the stone. If absorbed in few seconds, then considered hydrophane opal.
- b) Immersion of the stone in water for five minutes. Afterwards quick drying of stone with tissue. If the weight changed by more than 1% compared to before immersion, then considered hydrophane opal. In some cases, this test may result in cracking or change of appearance of the stone.

When the weight of an opal varies over a certain amount of time (e.g. several days), it is already considered a first indication that the stone may be a hydrophane opal.

Report wording

Hydrophane opal shall be described as,

Identification:

Species: (natural)¹ opal

Variety: (hydrophane)¹ (opal)²

Further information

(may be called hydrophane opal in the trade)¹

(Due to its natural porosity, this gemstone may absorb liquids and as a result its weight and appearance may change.)¹

¹ Wording and text in parentheses is optional.

² If 'hydrophane' is not used in the 'variety' section, the word 'opal' shall be used.

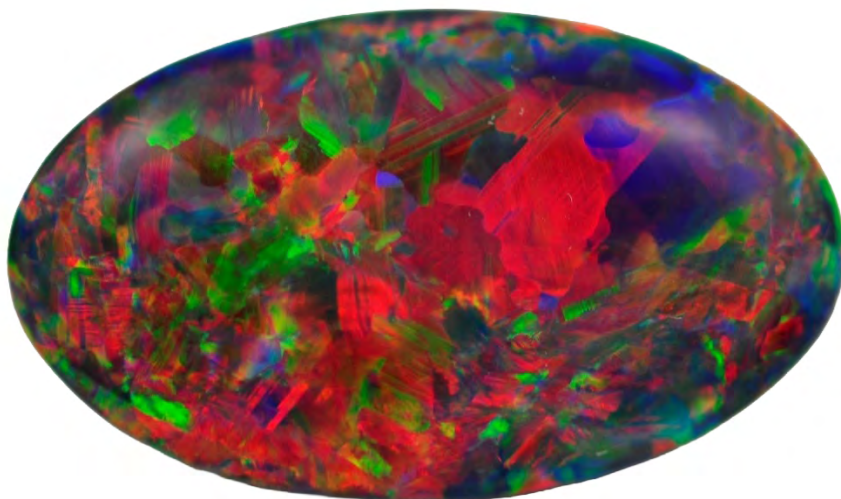
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The "Crimson Rosella" precious black opal from Lightning Ridge showing extremely bright red play of colour (image Anthony Smallwood)

End page