Tracing the maceral origin in combustion chars. The inertinite in Combustion WG of ICCP.

Exercise on identification of char material in high rank coal C and high rank coal B (ISO 11760: 2005)
Vitrinite random reflectance Rr > 2.0%

INCWG Exercise HRC-B (ICCP 2009)

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This exercise was prepared to test agreement on the identification of the optical texture of coal char material. The exercise was carried out by the participants in the Inertinite in Combustion W.G. of the ICCP in the years 1999, 2000 and 2007

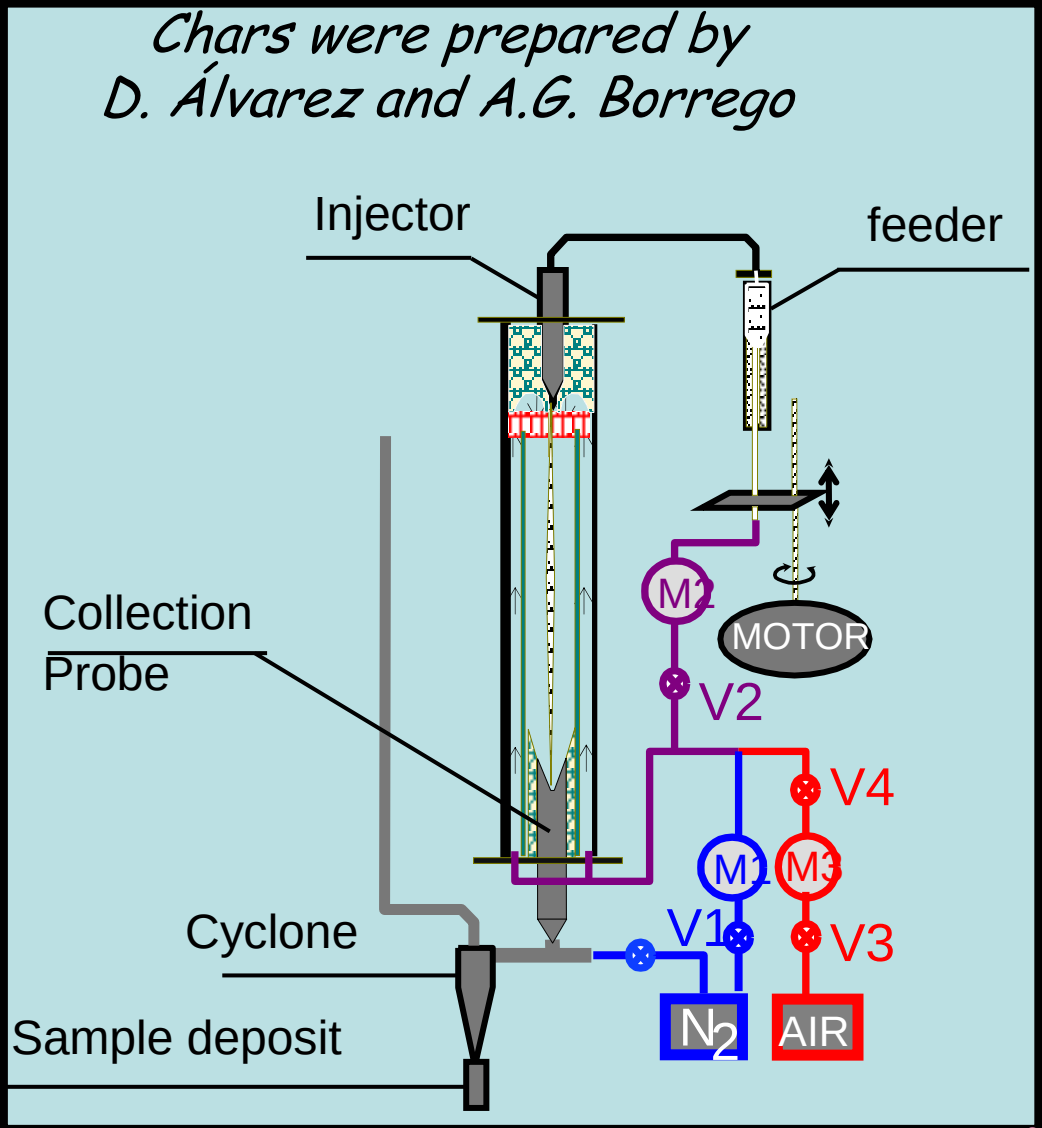
The results of the participants have been used to prepare the ICCP Atlas “Tracing the maceral origin in coal chars” (Borrego et al., 2009). The exercise consists of 4 presentations listed below and an excel sheet in which the results can be reported and evaluated against the WG results. The images have been taken with crossed nicols using 1 λ retarding plate

INCWG Exercise LRB-A
INCWG Exercise MRD-C
INCWG Exercise MRB-A
INCWG Exercise HRC-B
INCWG Results sheet

Chars were prepared in the Drop Tube Reactor existing at INCAR-CSIC under the conditions described below

Conditions

Temperature: 1300 ºC
Particle size: 36-75 µm
Feed rate: 1 g min^{-1}
Residence Time: 0.3 s
Flow Rate: 900 L h^{-1}
Atmosphere: 2.5% O_2 in N_2



Images belong to any of the following coals from which chars were prepared. Their rank and maceral analyses are given below.

Coal	Rr (%)	Vitrinite (%)	Inertinite (%)	Liptinite (%)	VM-daf (%)	ISO	ASTM	Country
H	2.11	60.8	39.2		14.4	HRC	lvb	SA
F	2.44	99.4	0.6		9.9	HRC	sa	ES
W	3.23	61.8	38.2		6.2	HRB	a	DE

The lettering in white, close to the image, refers to the image identification code: Thus, a code "*Rn"* means images from coal R, "*Ln"* images from coal L and so on.

Classification of Char Optical Texture. ICCP System 1996

A rather simple classification scheme was established in the Meeting held in Heerlen (1996), in which the criteria to distinguish between classes consider both the optical texture (isotropic/anisotropic) and the porosity development. The system has 7 different classes that cover all the possible char occurrences.

Origin	Behaviour	Optical texture	Porosity	Group
Vitrinite				G1 (VT)
Inertinite	Fused	Anisotropic	Porous	G2 (AP)
			Dense	G3 (AD)
		Isotropic	Porous	G4 (IP)
			Dense	G5 (ID)
	Unfused		Massive	G6 (UM)
			Fusinoid	G7 (UF)

The counting procedure considers **the material under the crosswire** with a homogeneous optical appearance and **not the whole particle**.

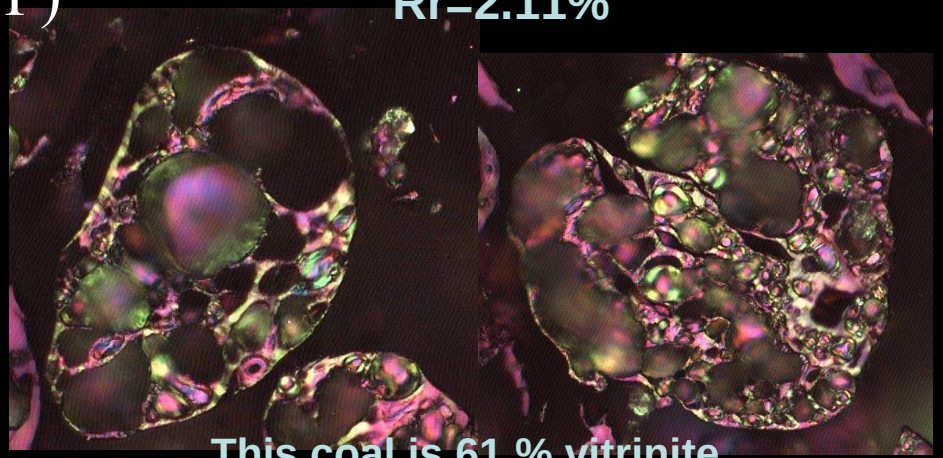
Classification of Char Optical Texture. ICCP System 1996

- **G1** refers to all kind of domains which could derive from vitrinite (**VT**), and these can be isotropic or anisotropic, fused or unfused, depending on the rank of the coal.
- **G2** refers to anisotropic porous (**AP**) materials which have been presumably formed from inertinites, but have been highly altered during pyrolysis, showing both anisotropic texture and an important porosity development (ρ > 50%).
- **G3** refers to anisotropic dense (**AD**) materials formed from inertinites which have developed an appreciable anisotropy and without significant porosity development (ρ < 50%).
- **G4** refers to isotropic porous (**IP**) inertinite-derived material, which have devolatilized developing a porous structure (ρ > 50%).
- **G5** would include the isotropic dense (**ID**) domains with evidence of having fused (i.e.: small spherical degassing pores) (ρ < 50%).
- **G6** refers to unfused massive (**UM**) inertinites not showing cellular structure. They will be mainly massive isotropic material without any sign of transformation.
- **G7** would only include the unchanged fusinites (**UF**). They will be typically isotropic but might also exhibit wavy-like anisotropy.

As you cannot have a look of the sample to figure out how typical vitrinite-derived material looks like, below there are some images showing selected views of vitrinite-derived material in the anthracite C coal chars

Vitrinite-derived material in Anthracite C (Rr=2-3%) coals (samples H & F)

Rr=2.11%



This coal is 61 % vitrinite

Coal H

50 μm

Rr=2.44%

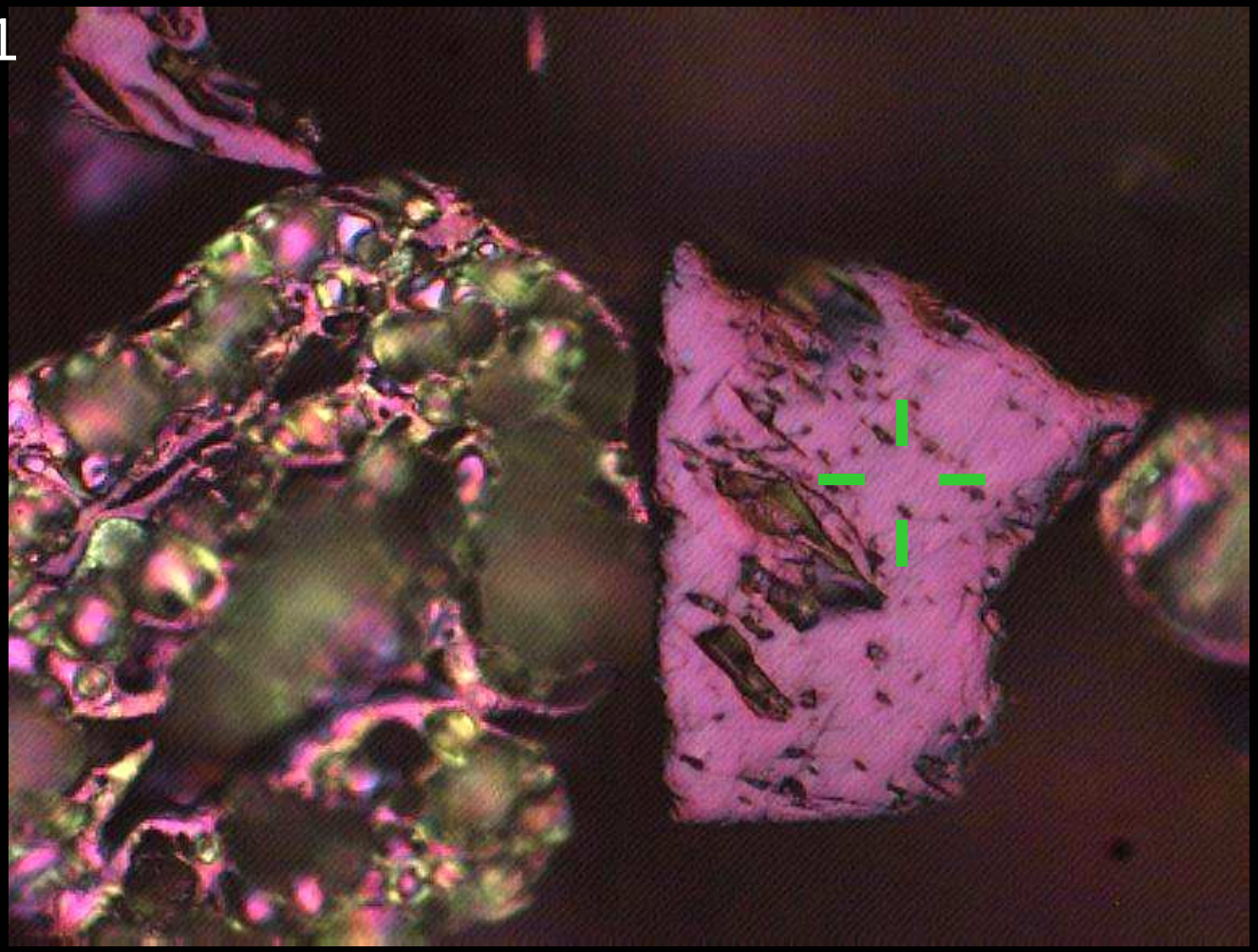
This coal is 99 % vitrinite

Coal F

Vitriniite devolatilizes by entering the combustion chamber yielding multi-chambered particles particles with signs of having fused to certain extent. The higher the rank, the lower the capacity of vitrinite to be modified in the reactor. Therefore the particles of coal F show some degassing bubbles and wavy-like anisotropy but retain angular shape.

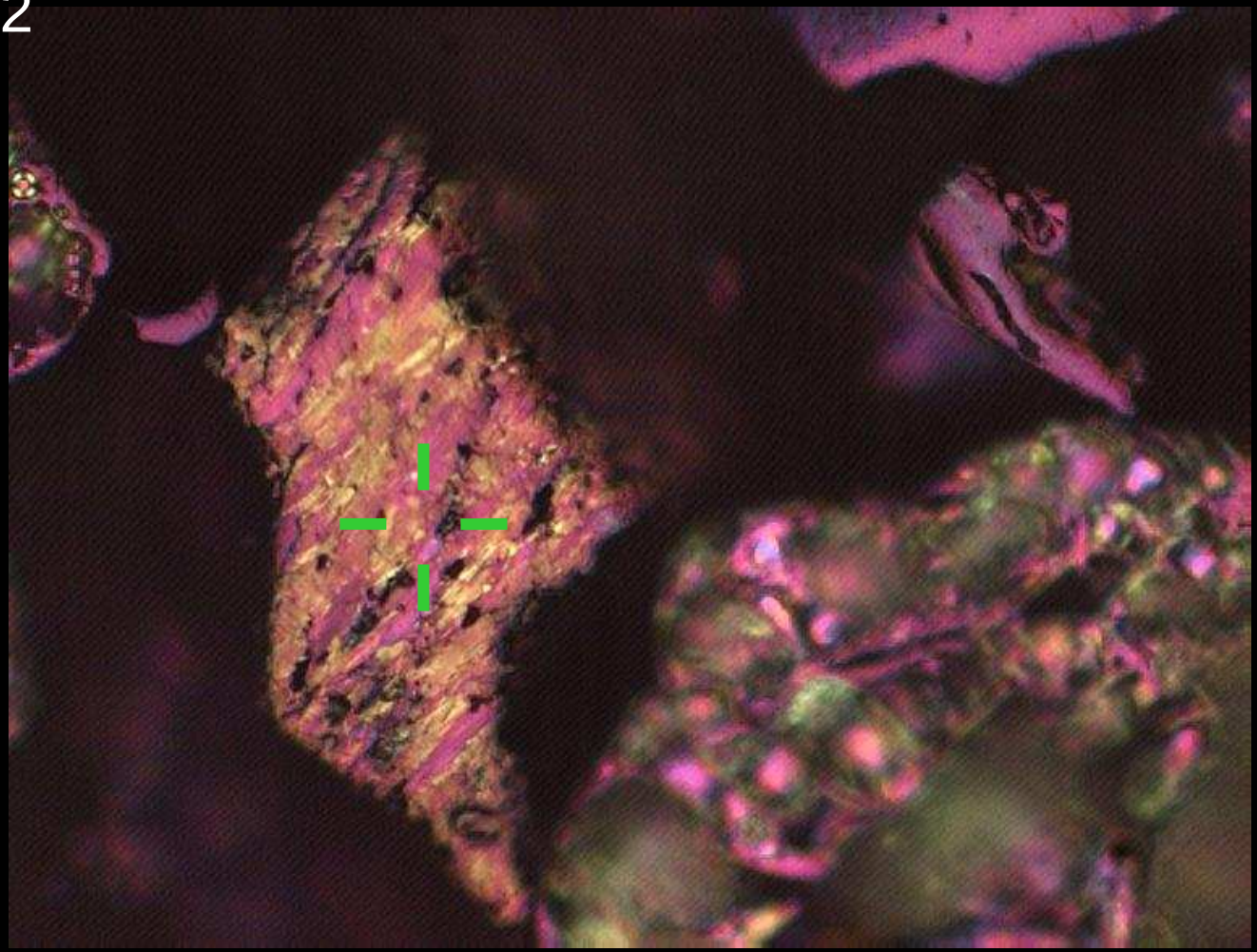
Good Luck!!

H1



50 µm

H2



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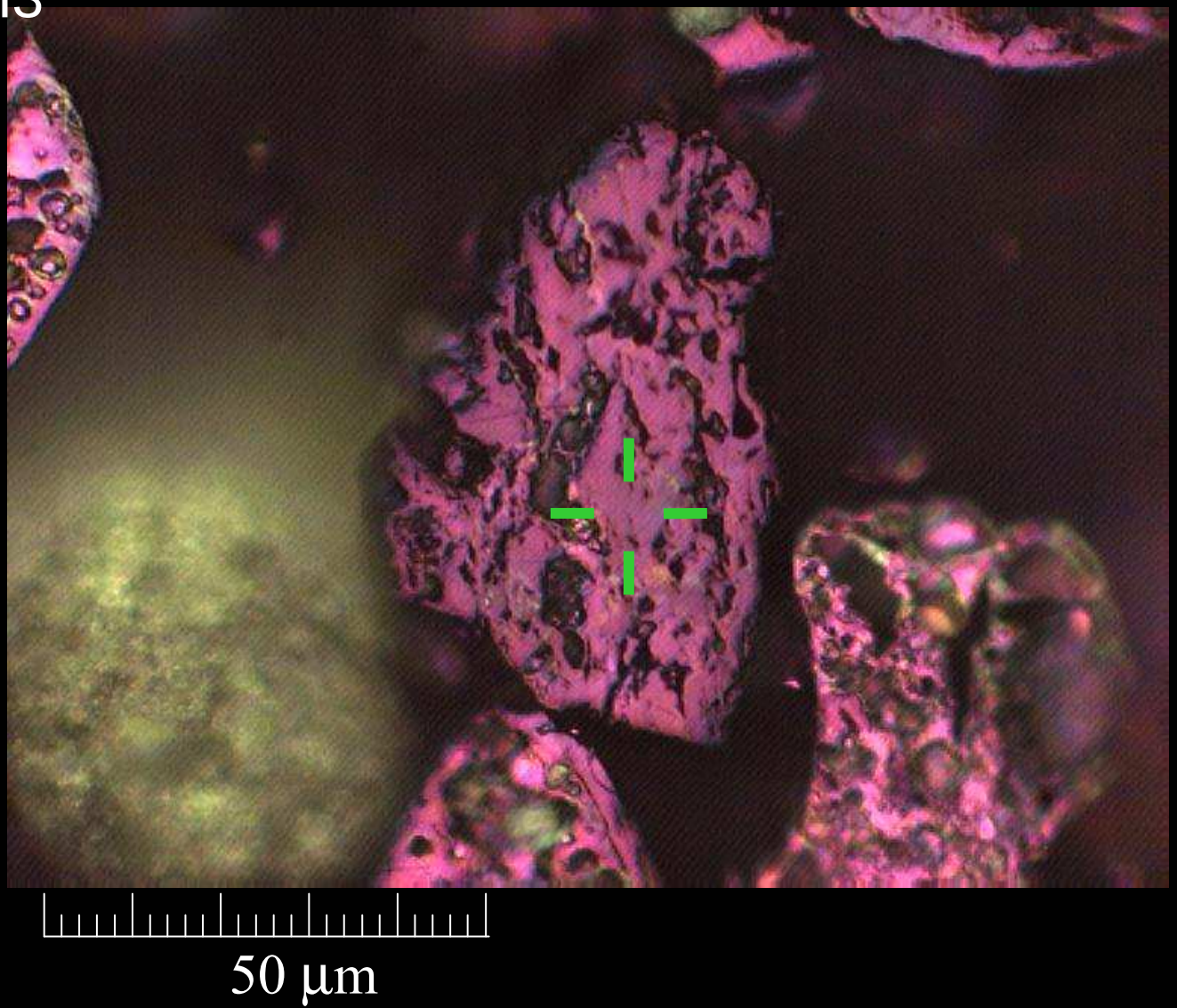

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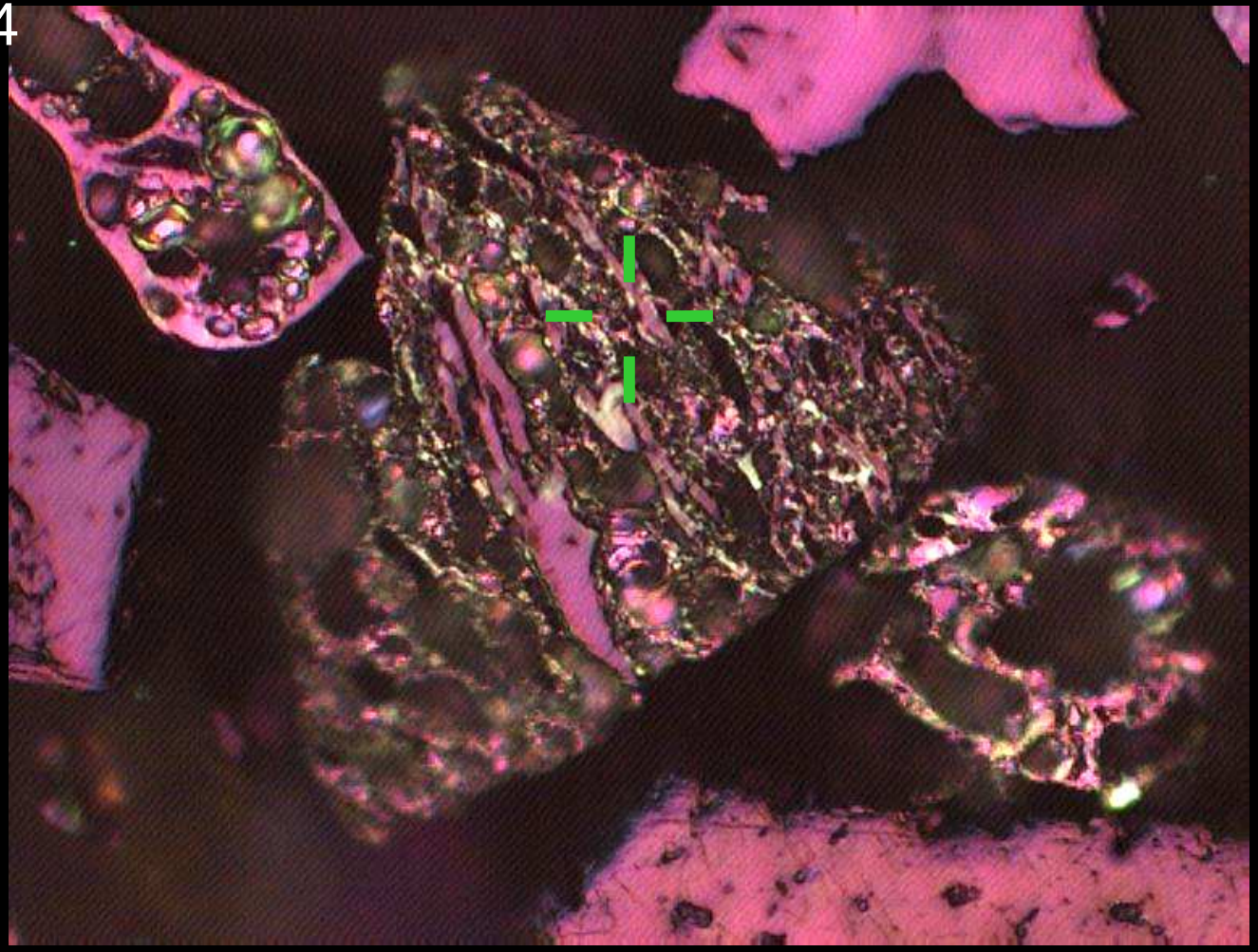

50 µm

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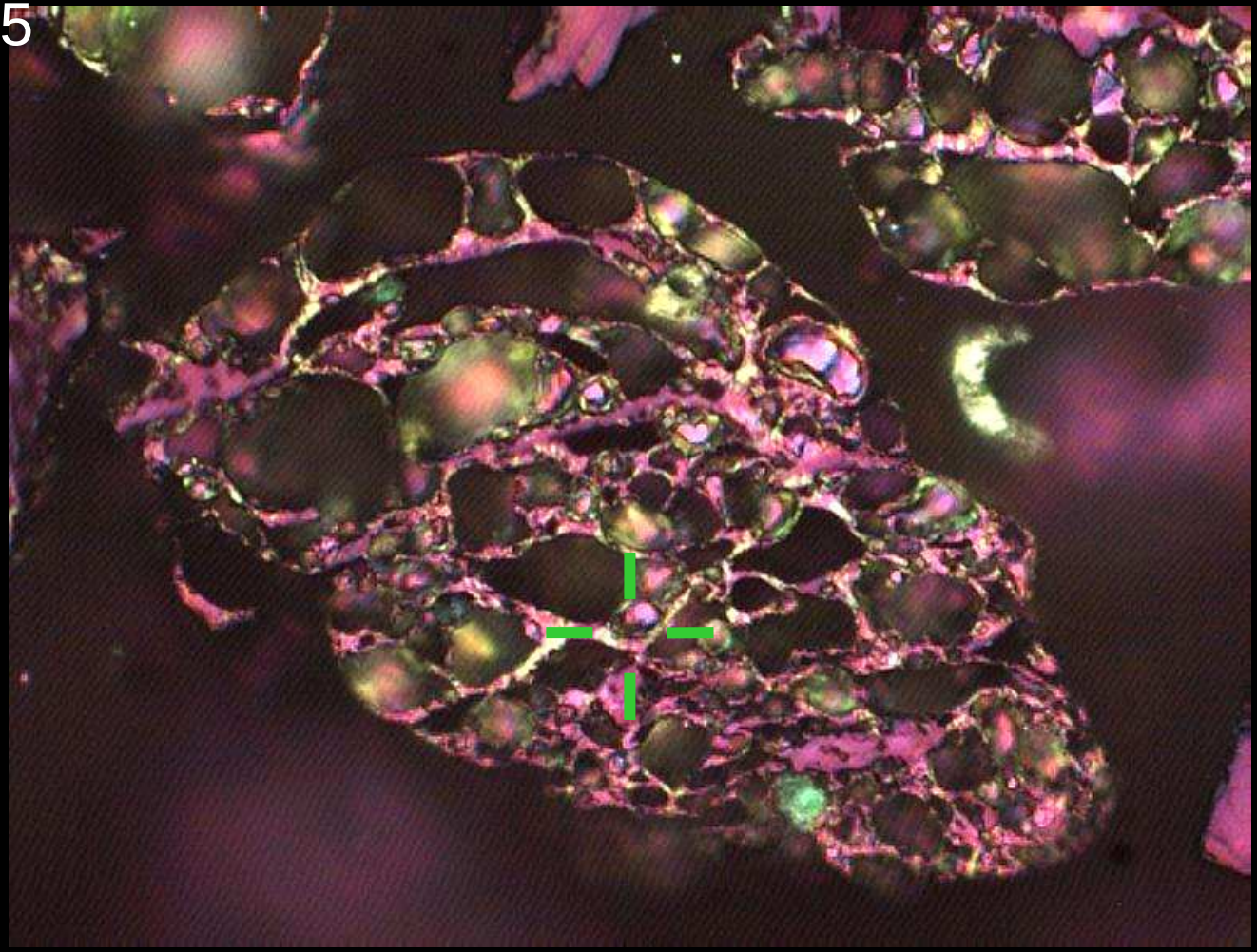

50 µm

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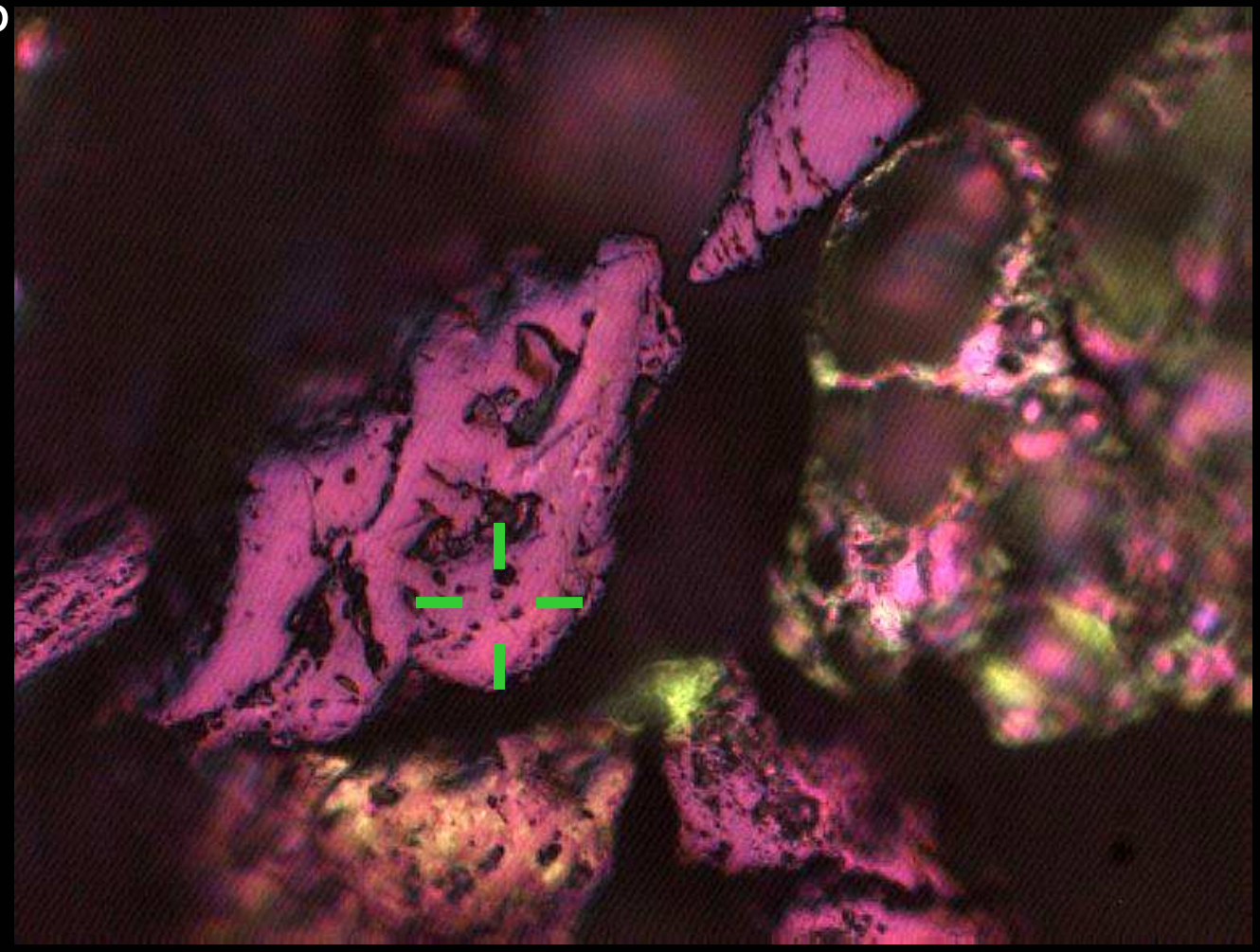

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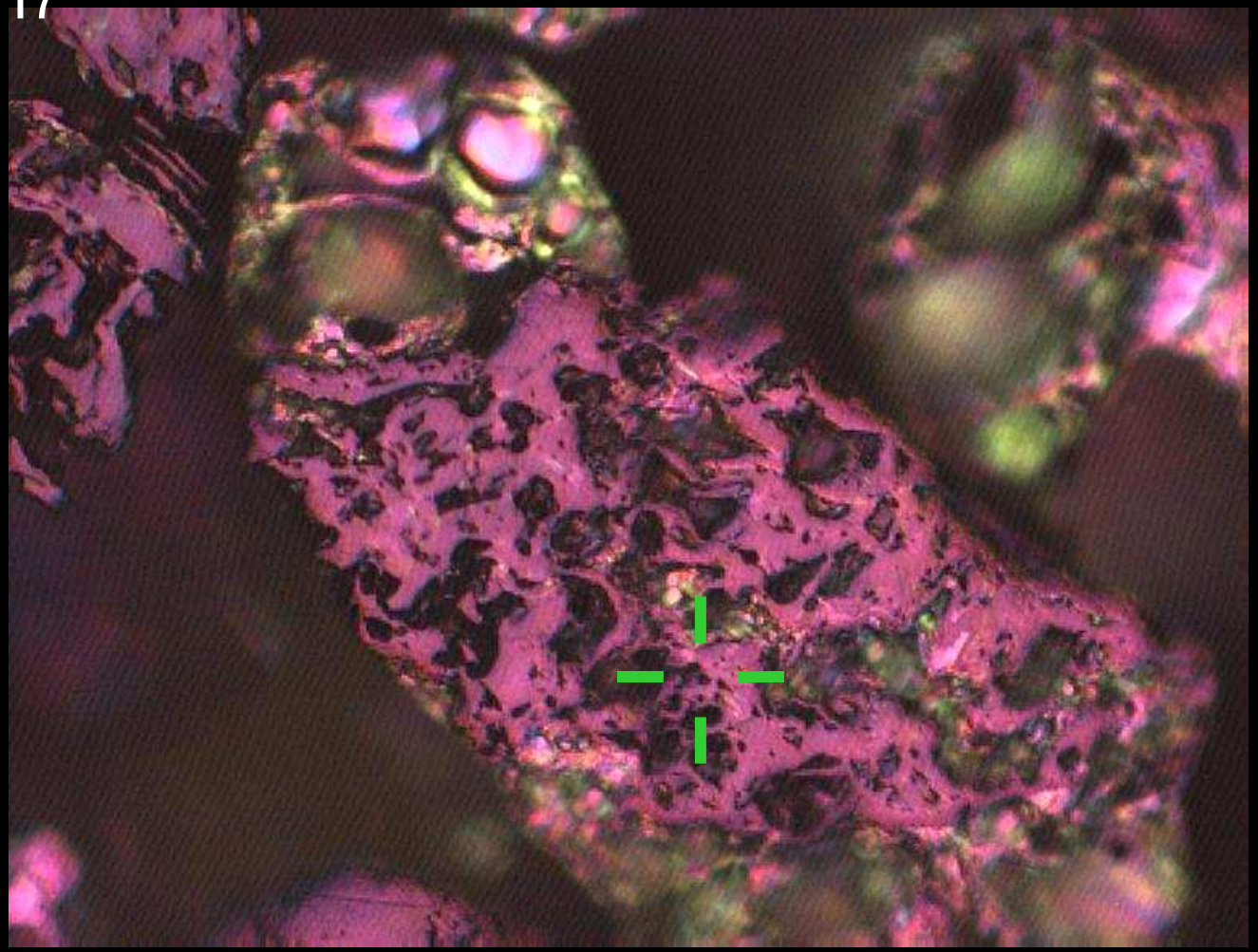

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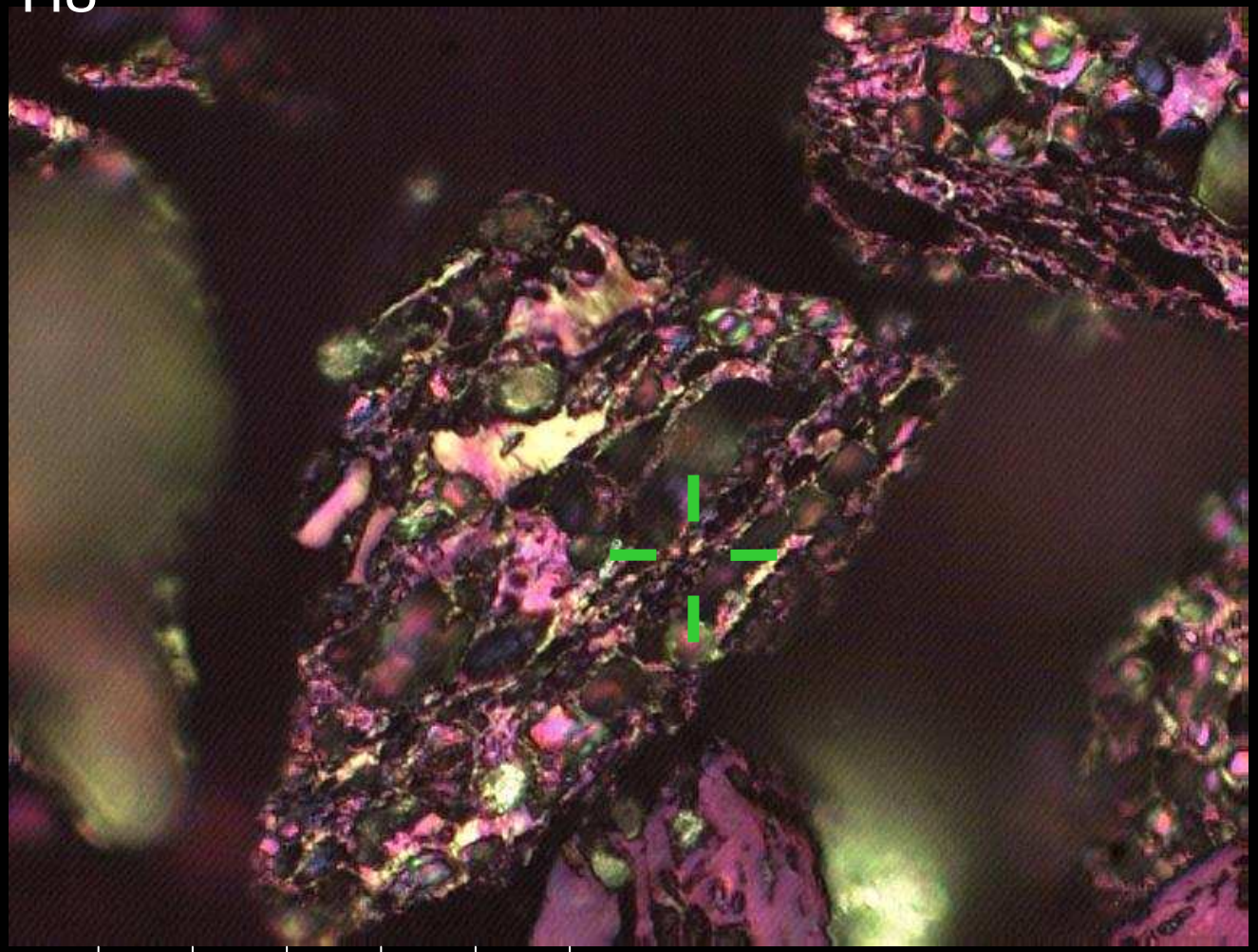

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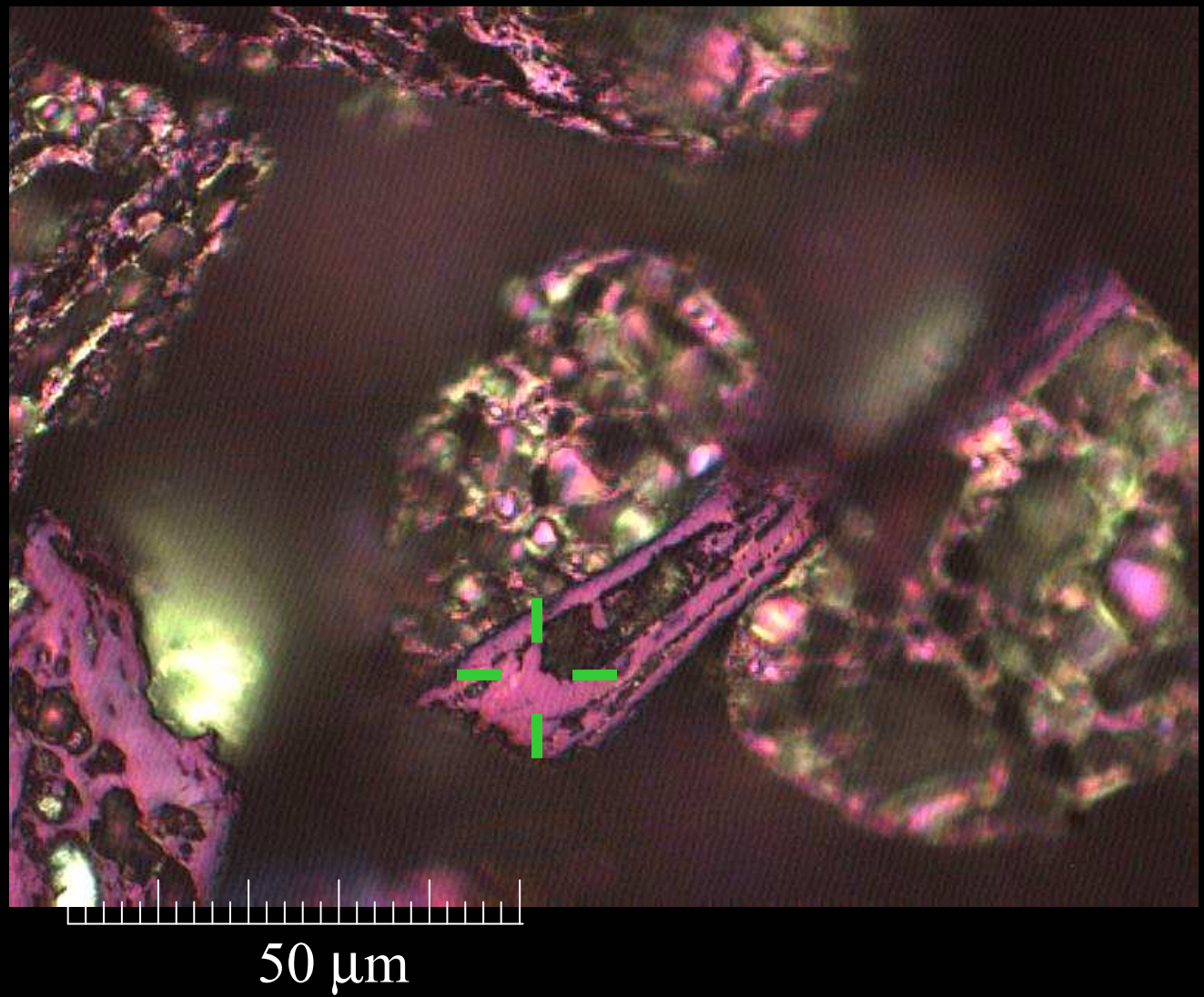

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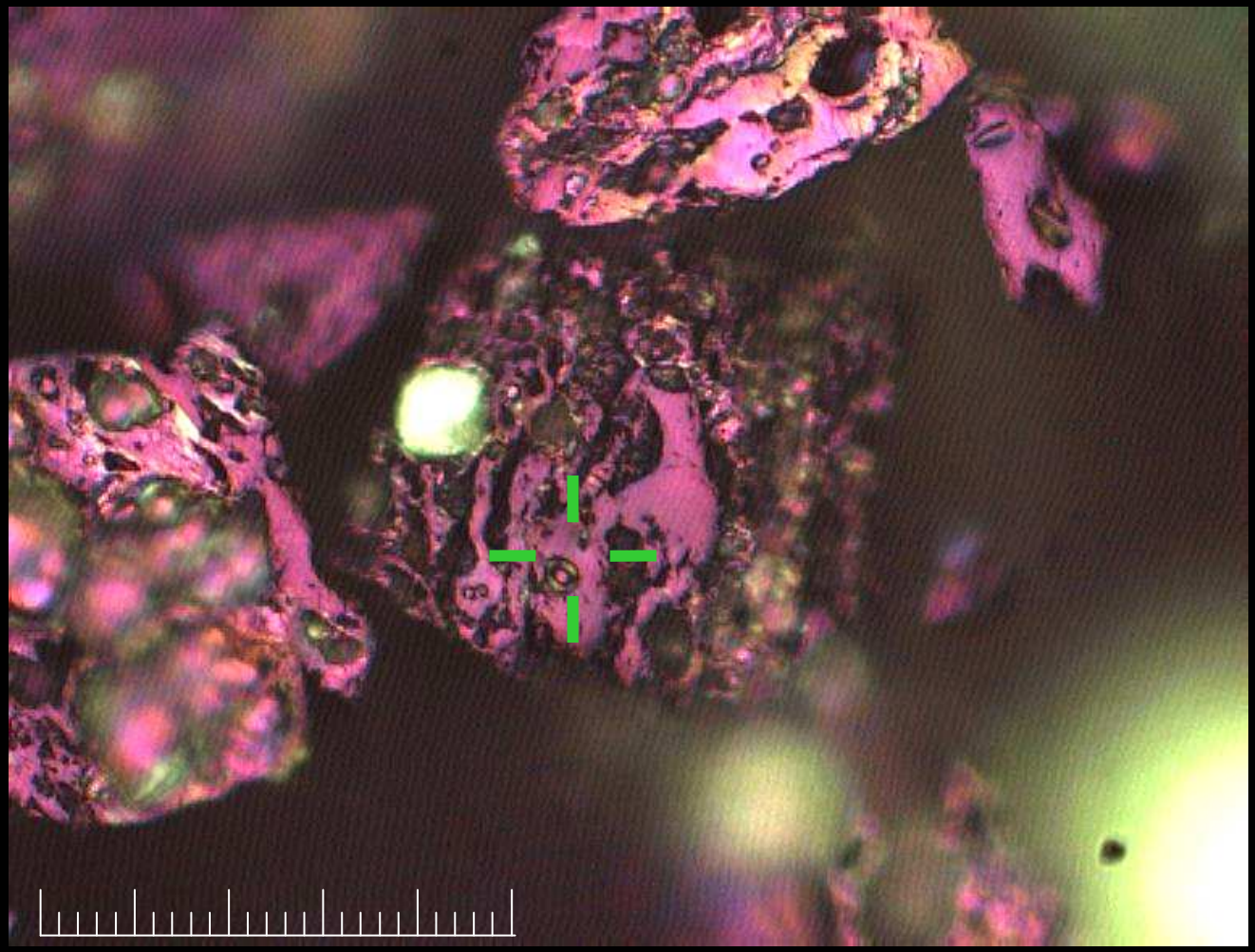

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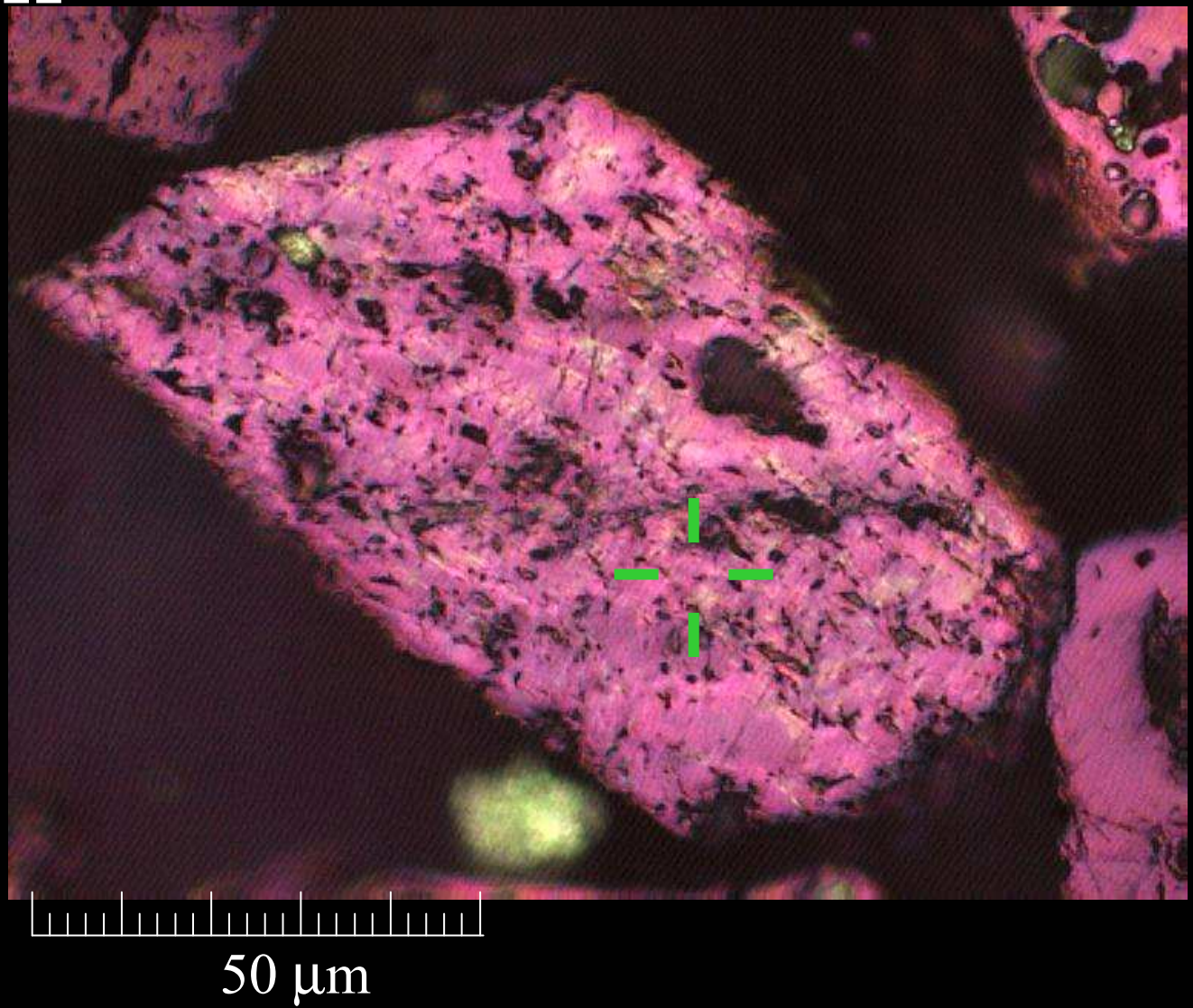

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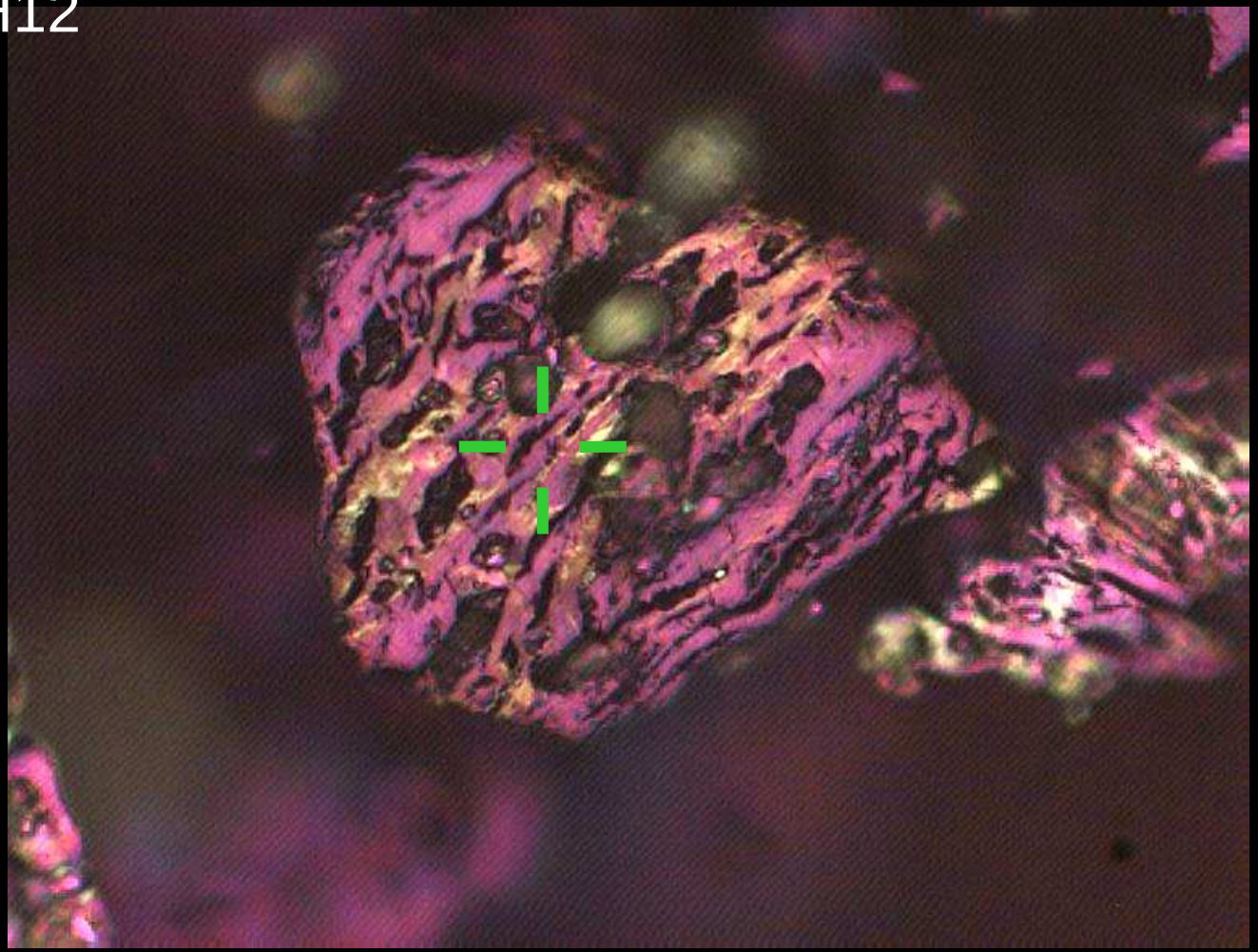

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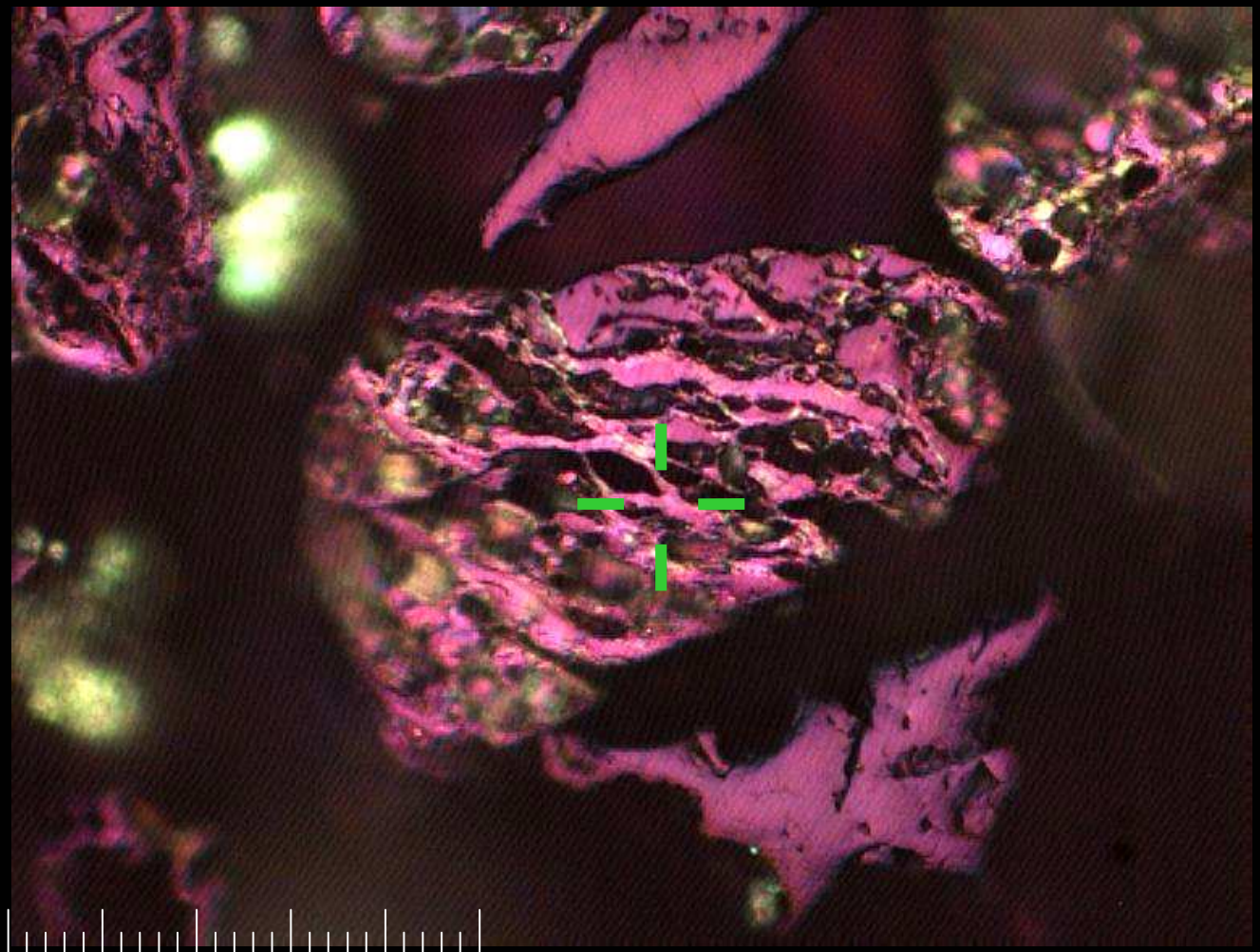

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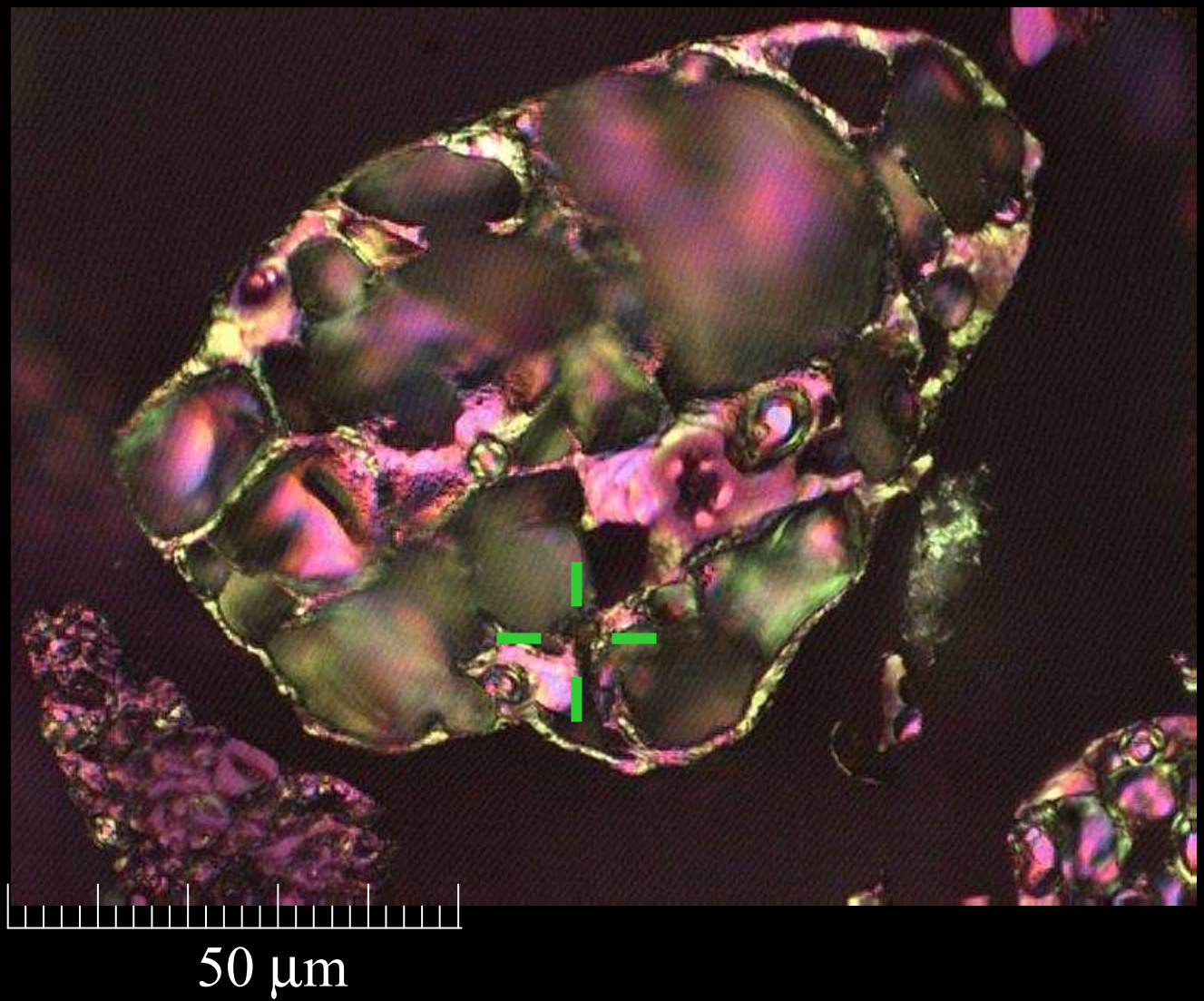

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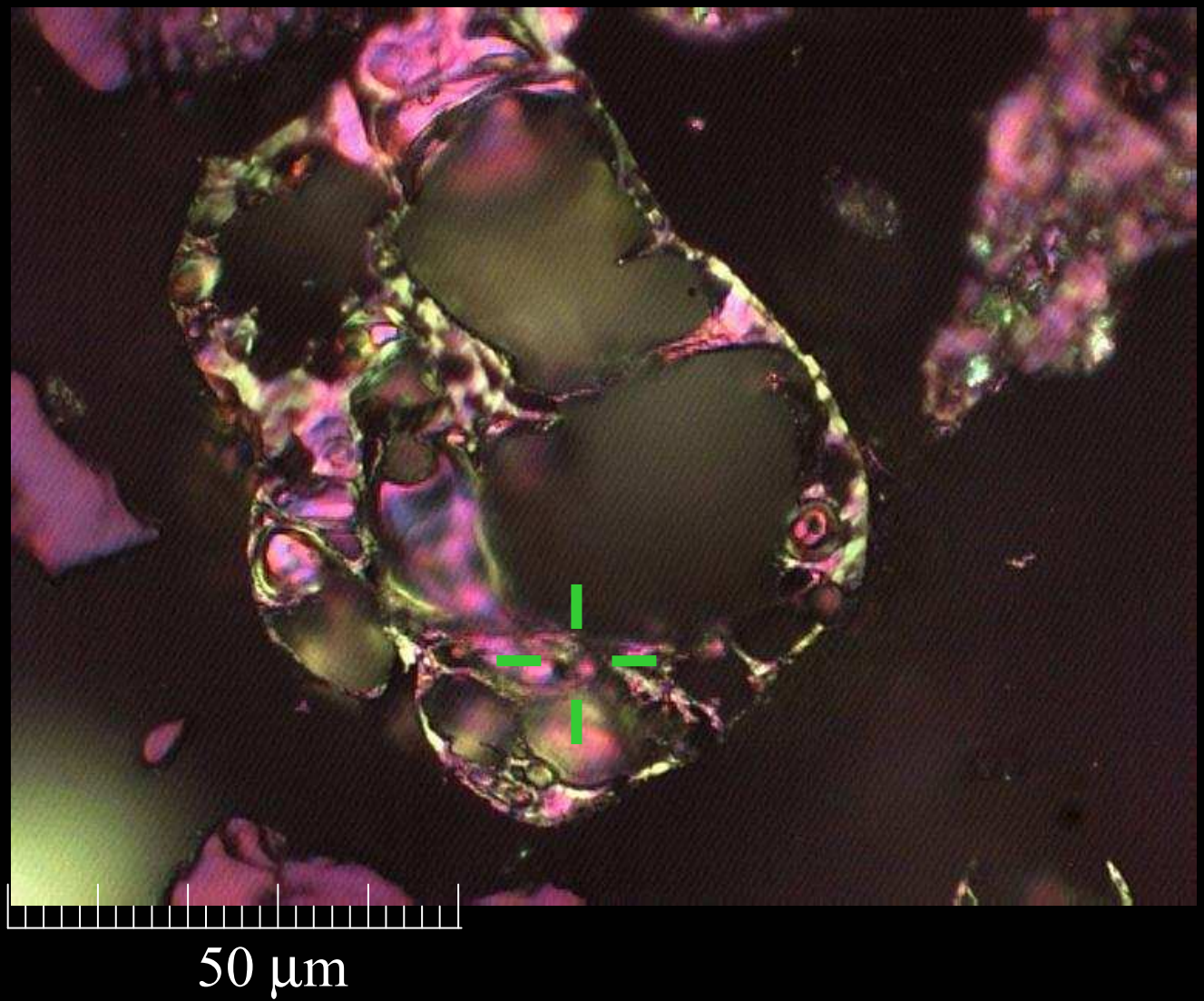

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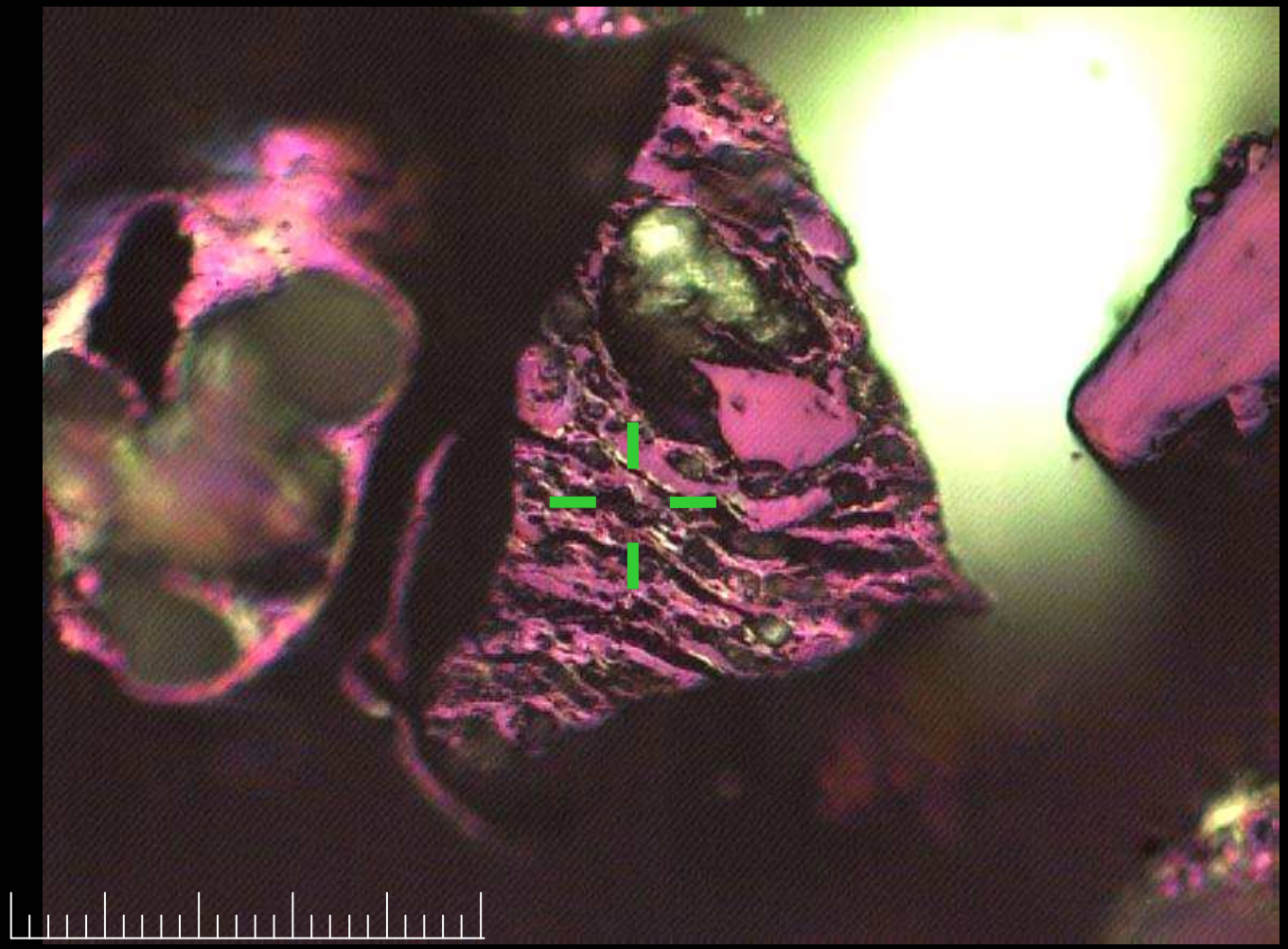

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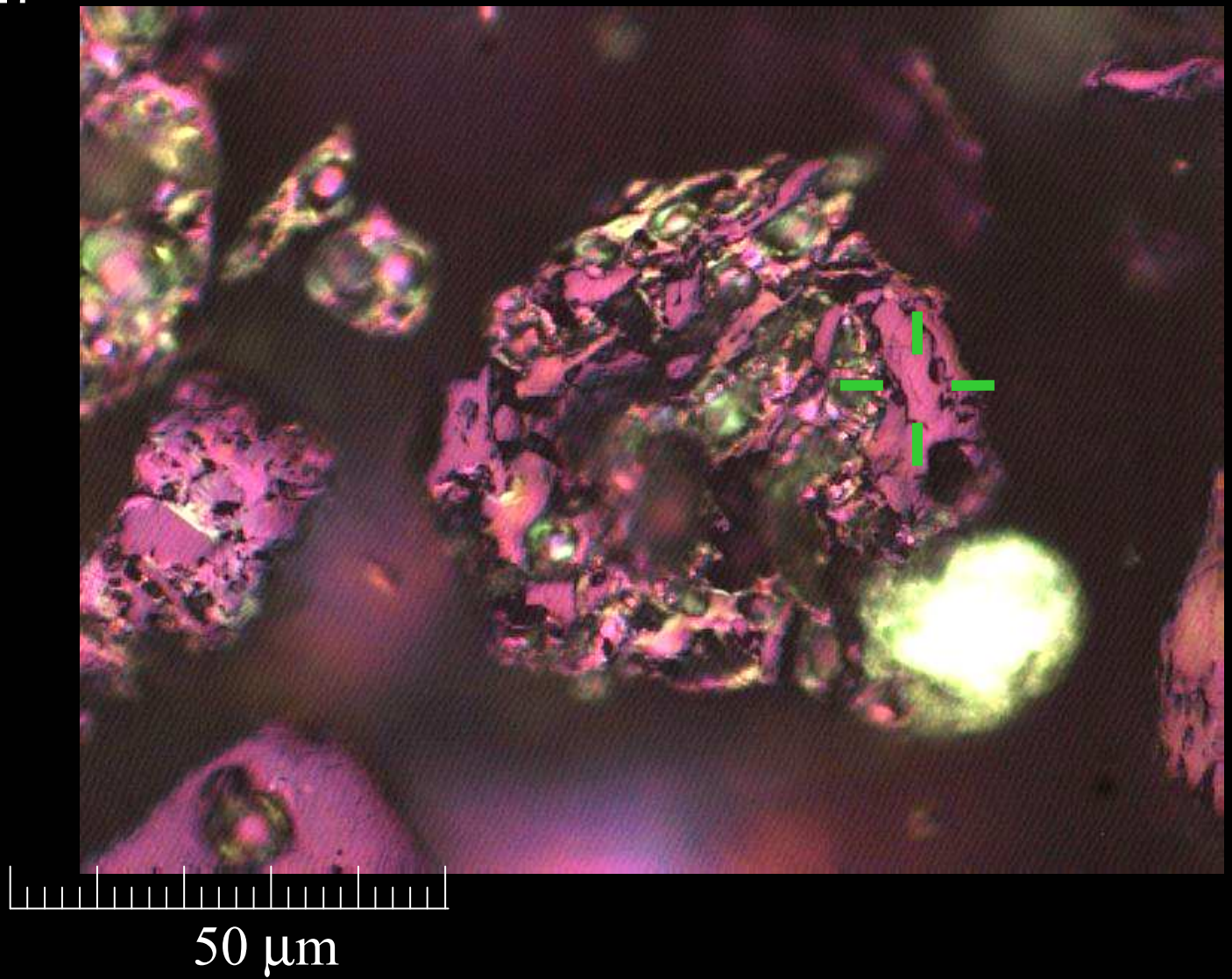

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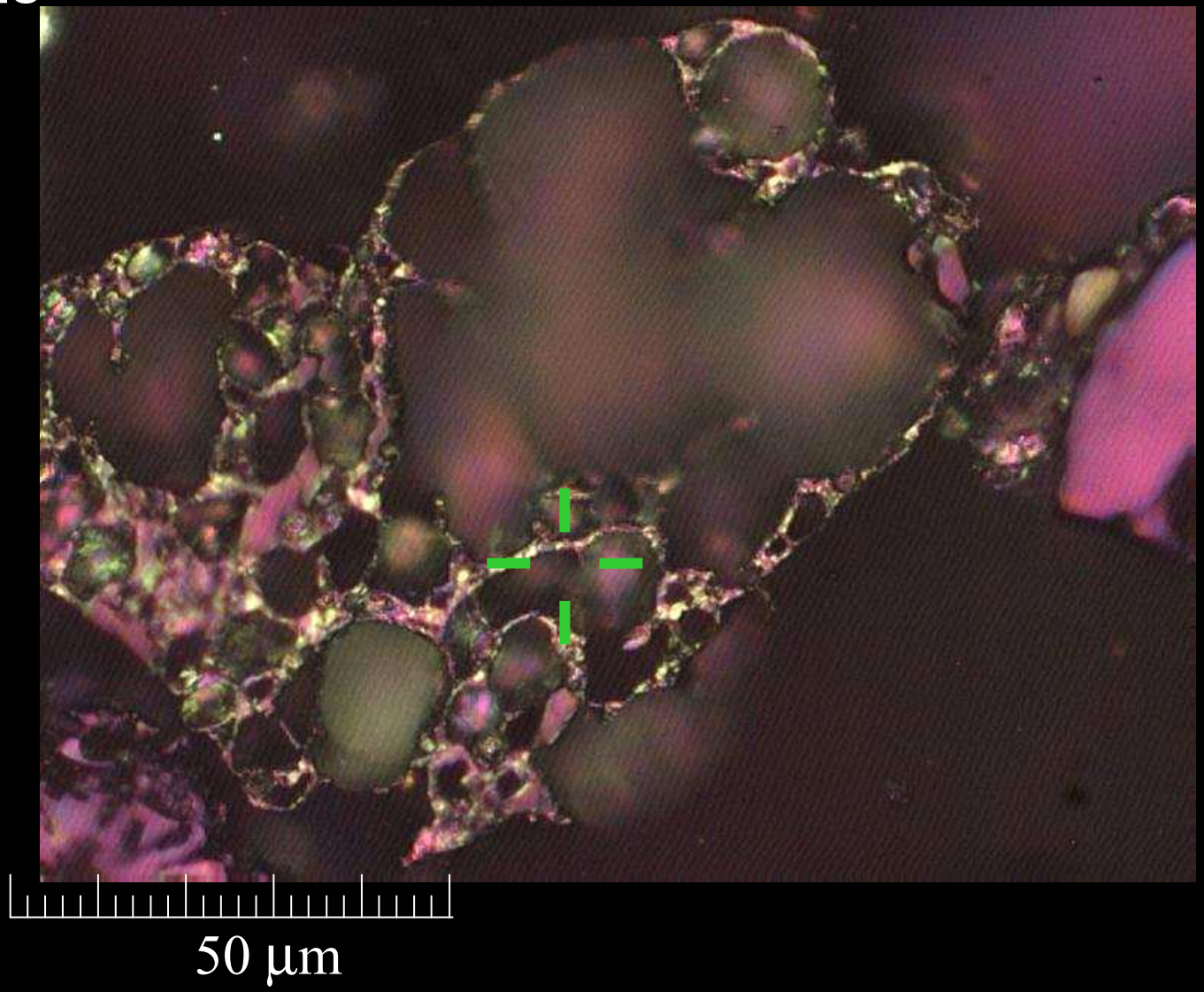

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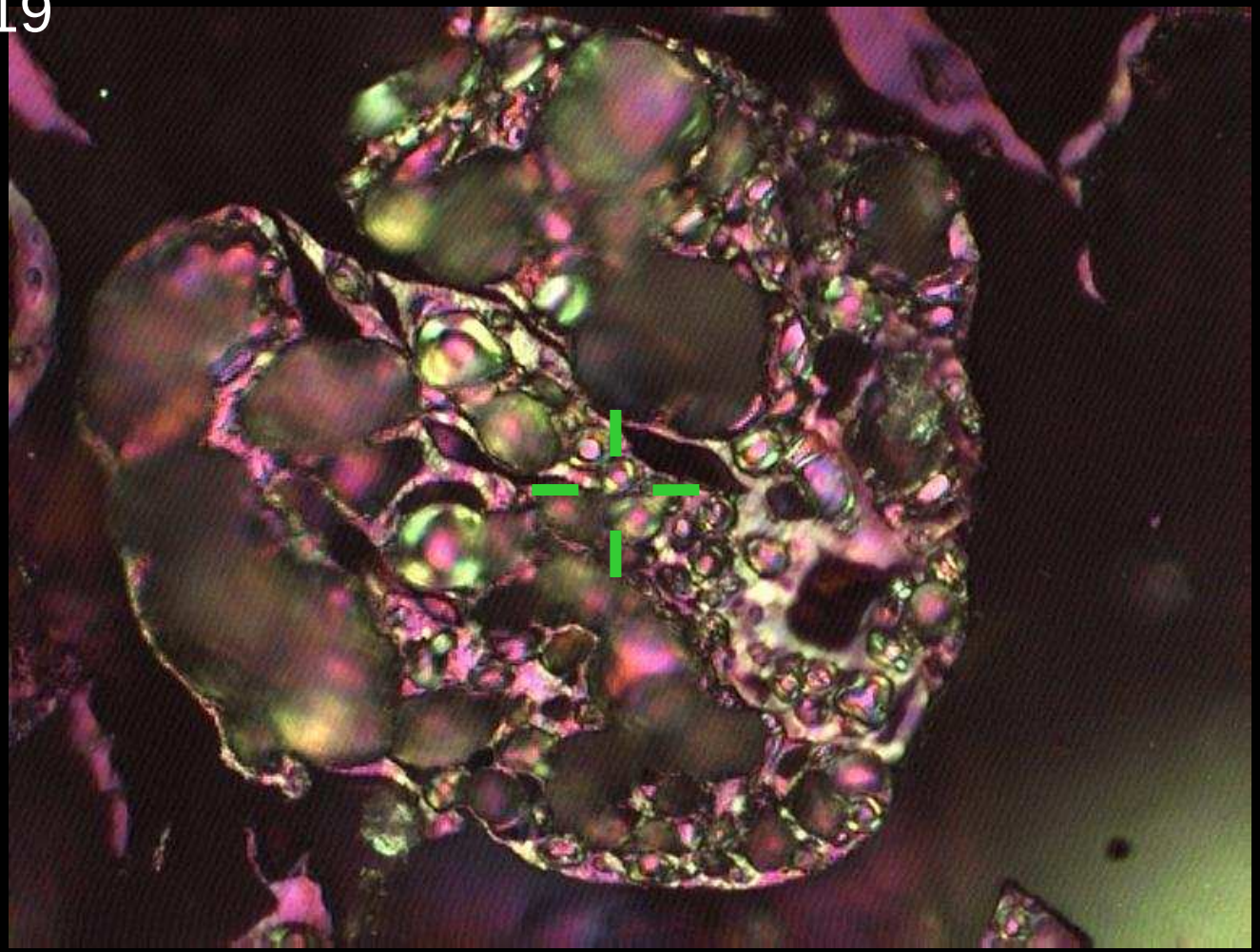

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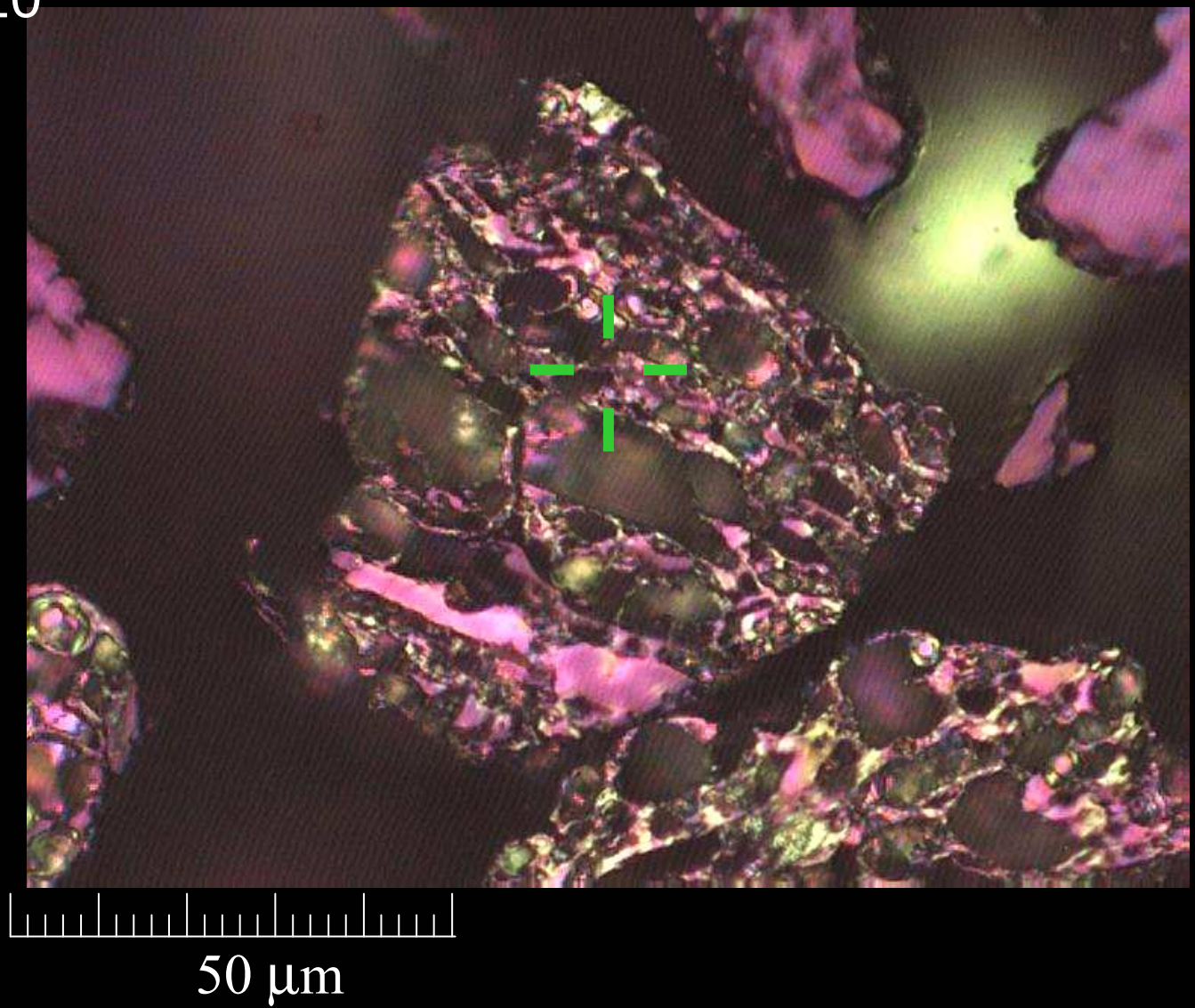

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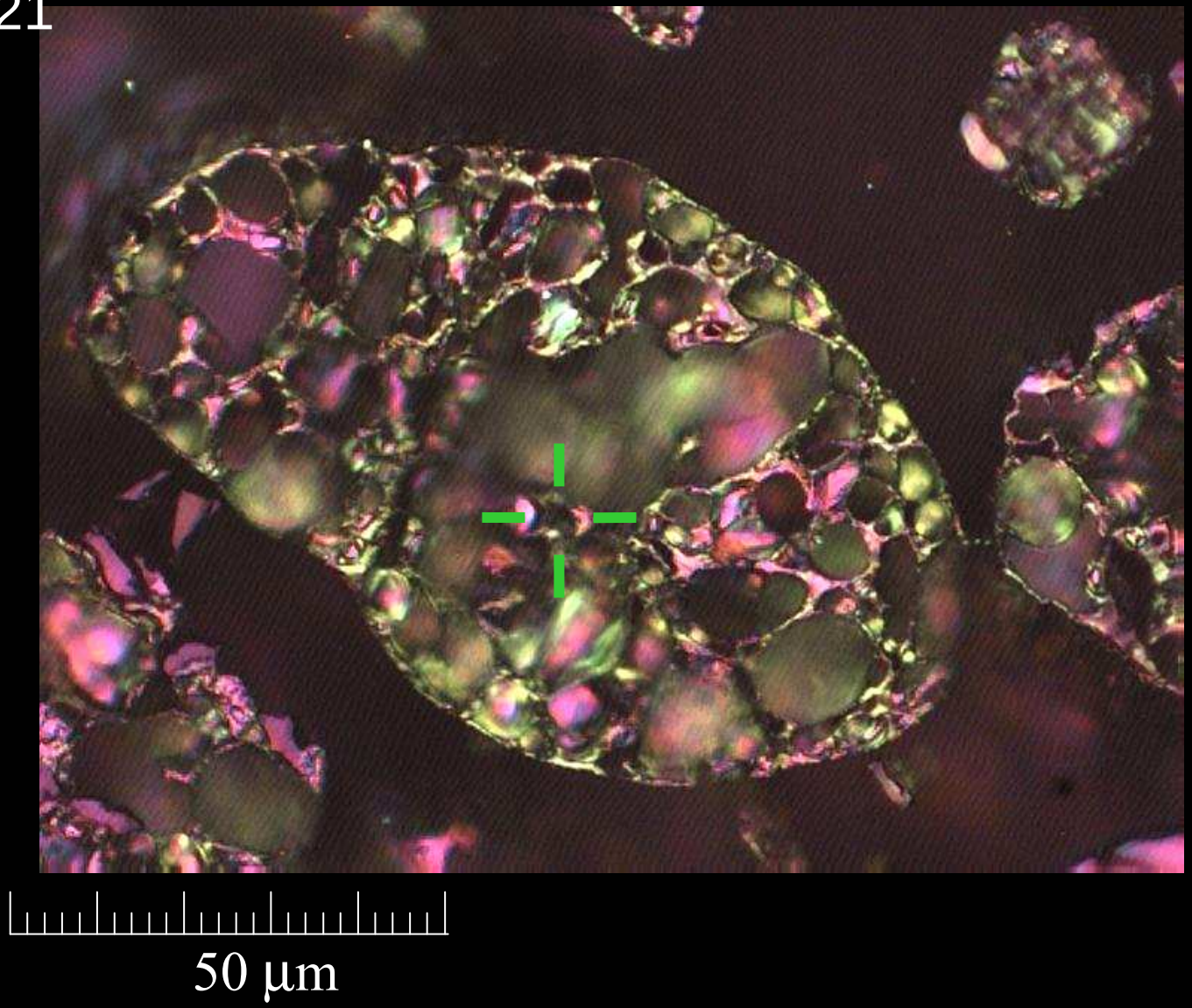

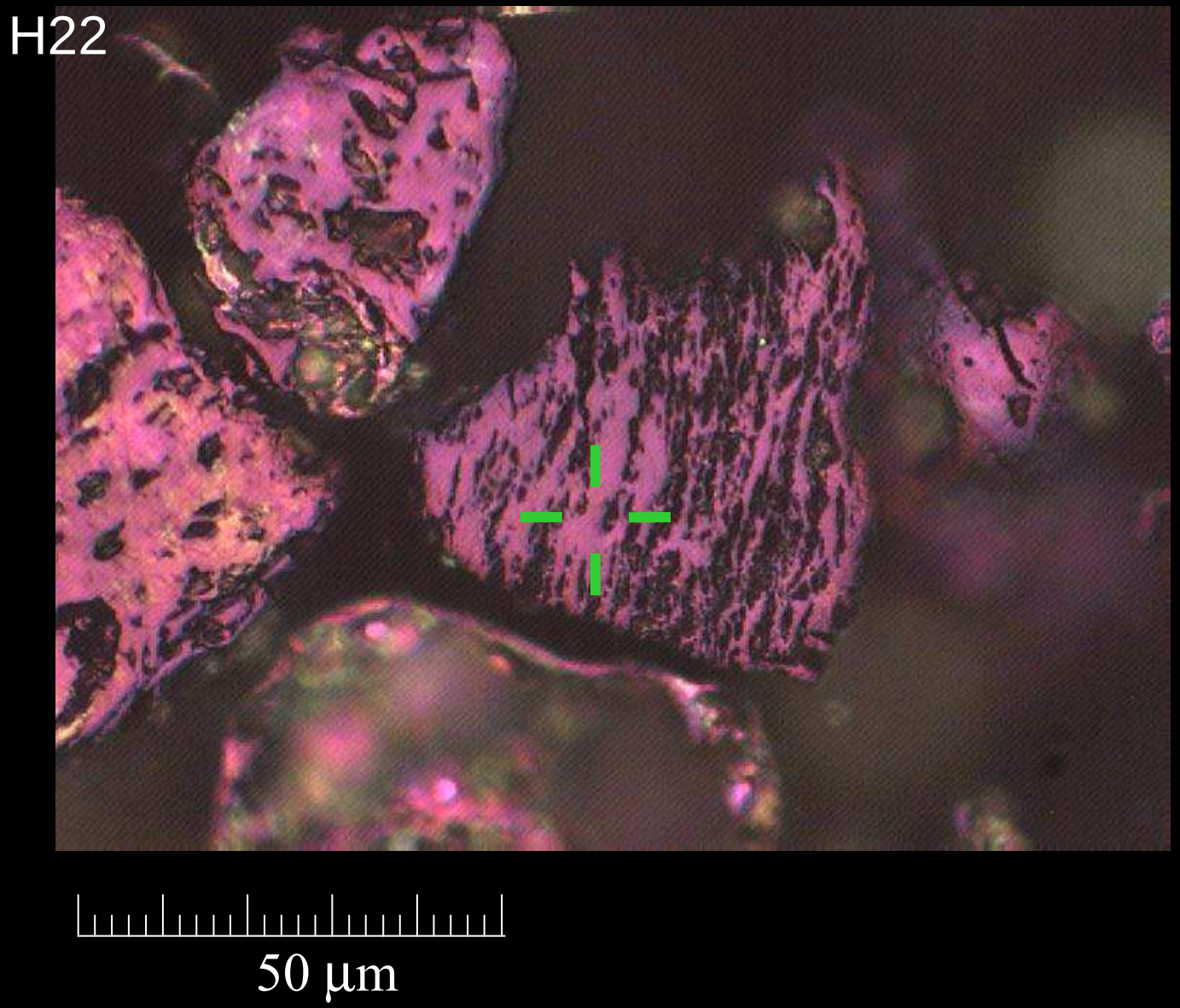

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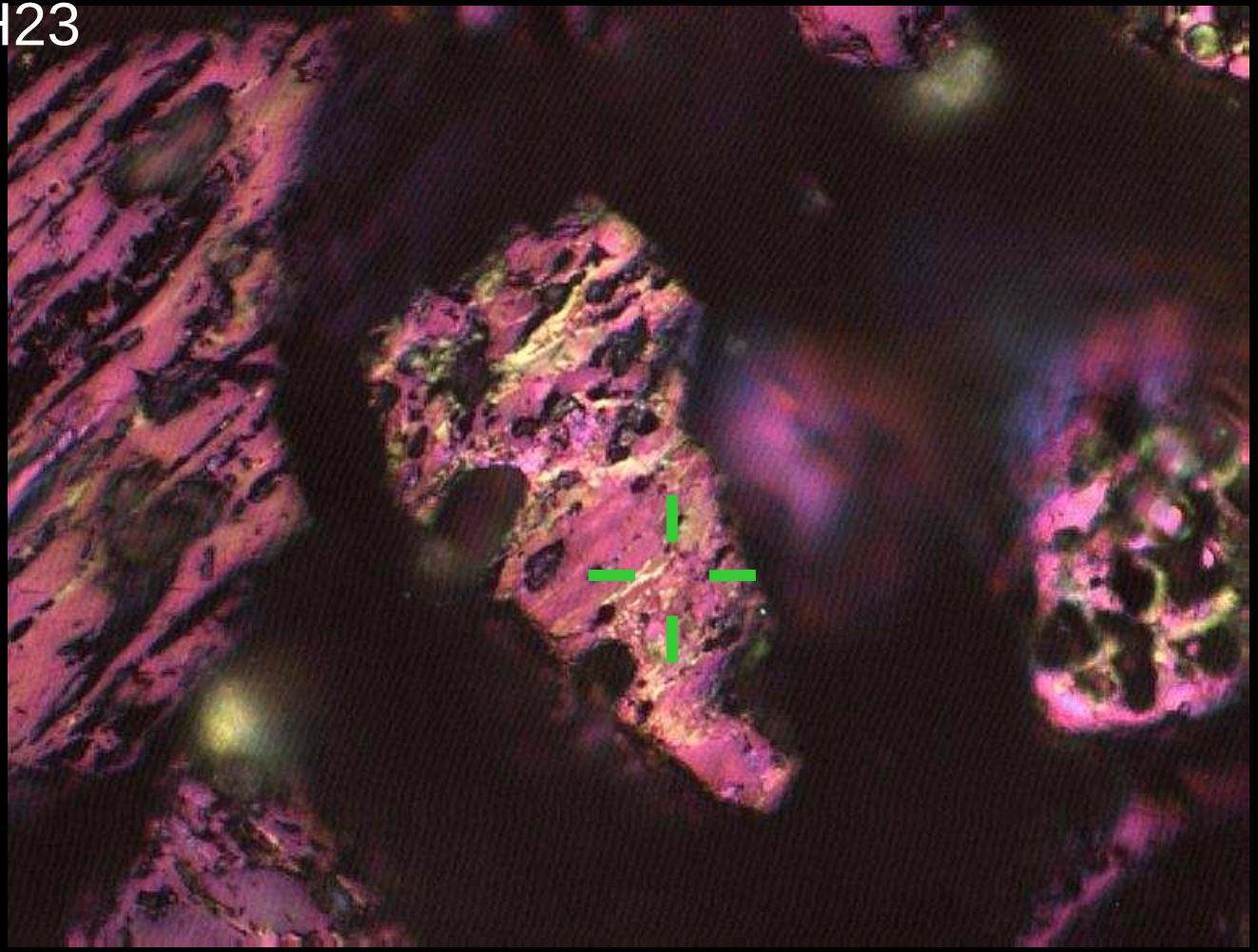
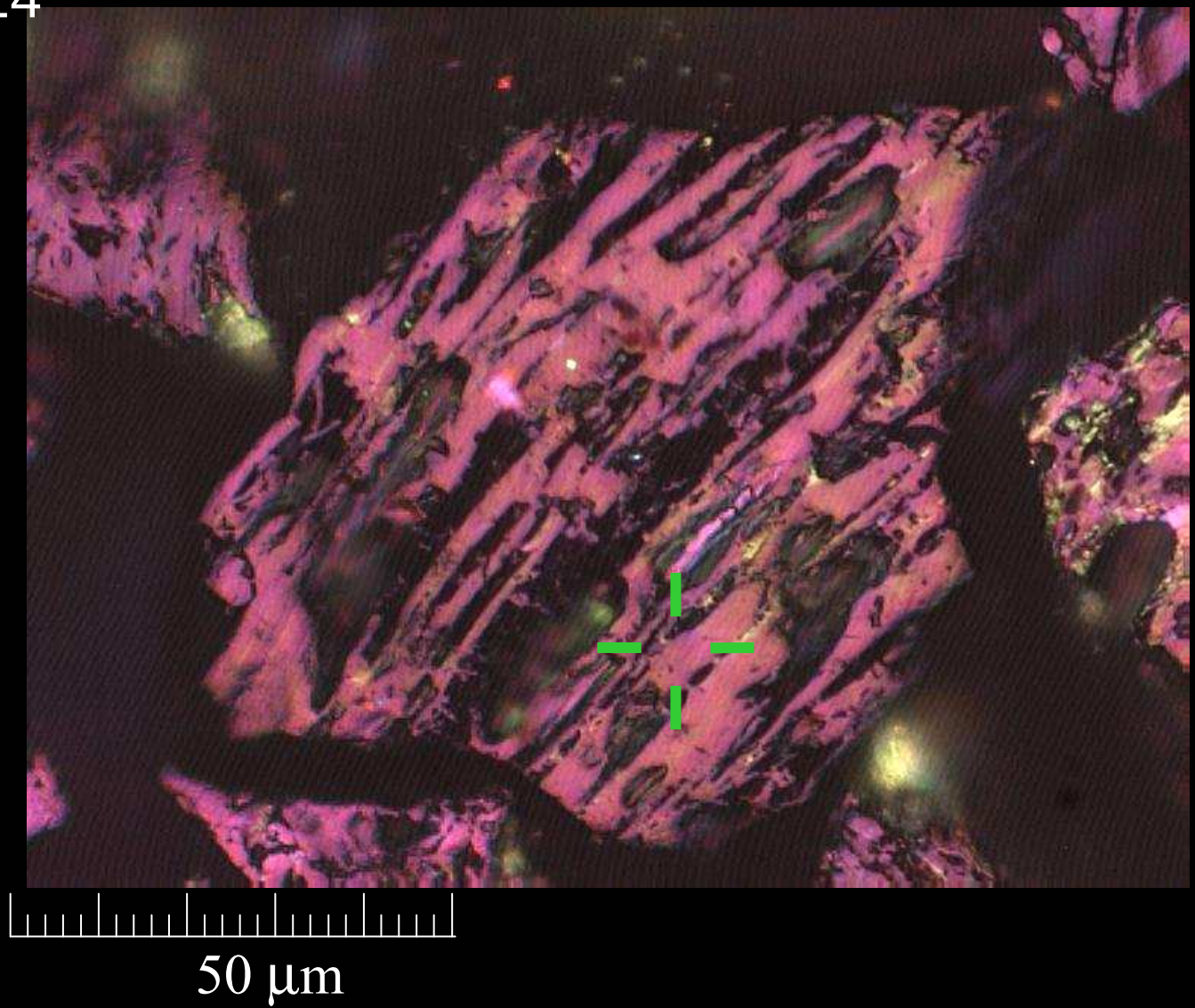


50 µm

H24



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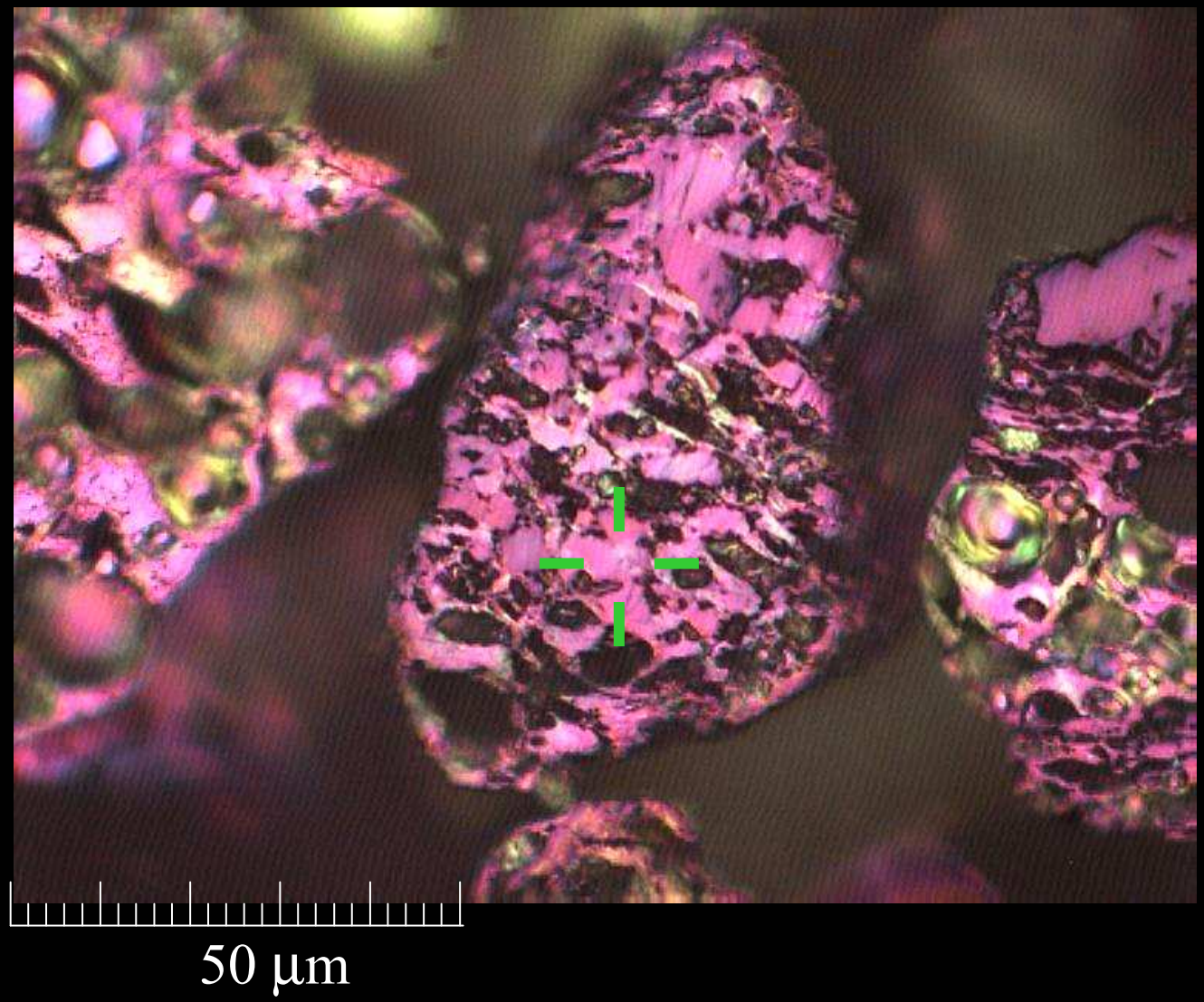

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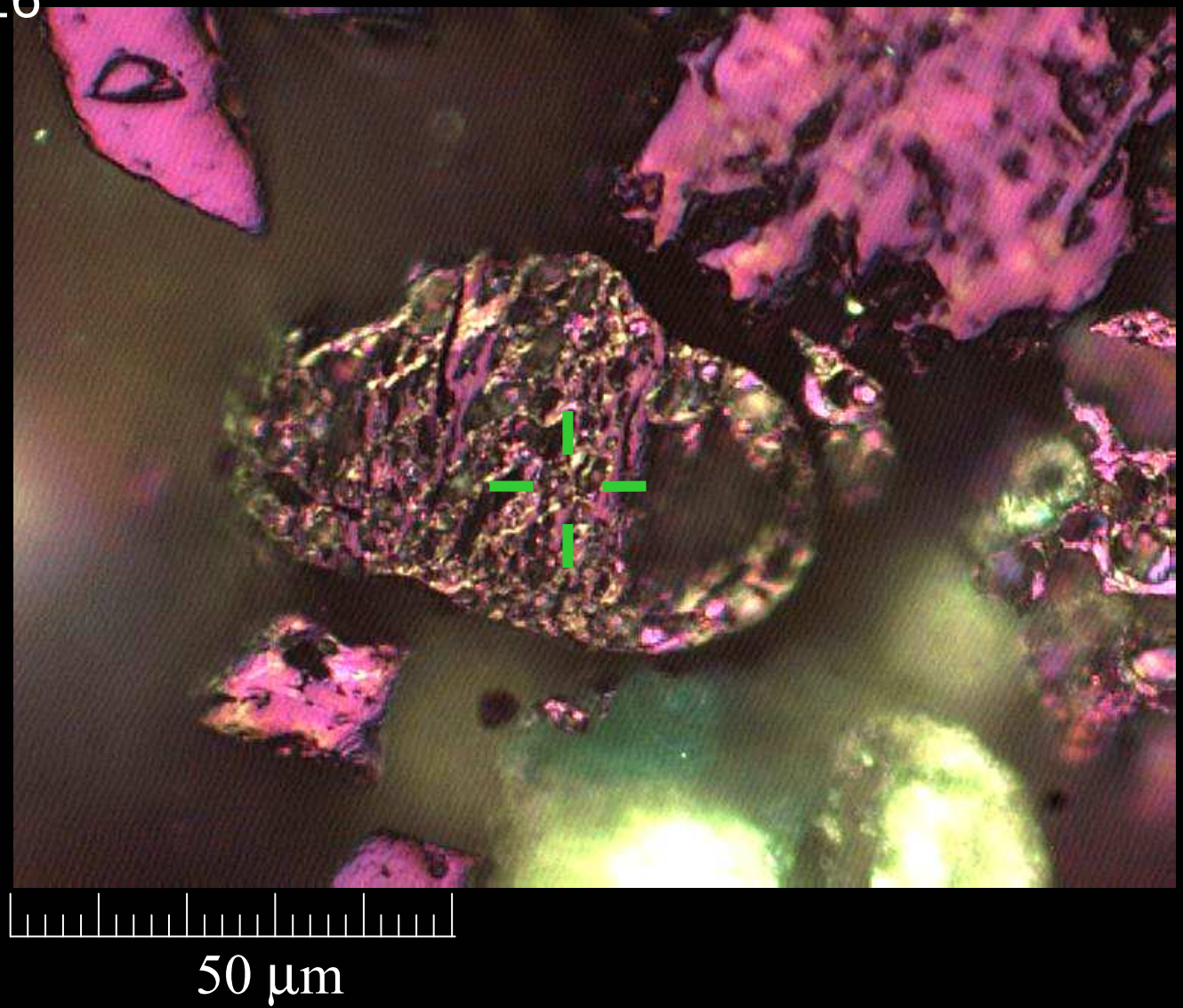

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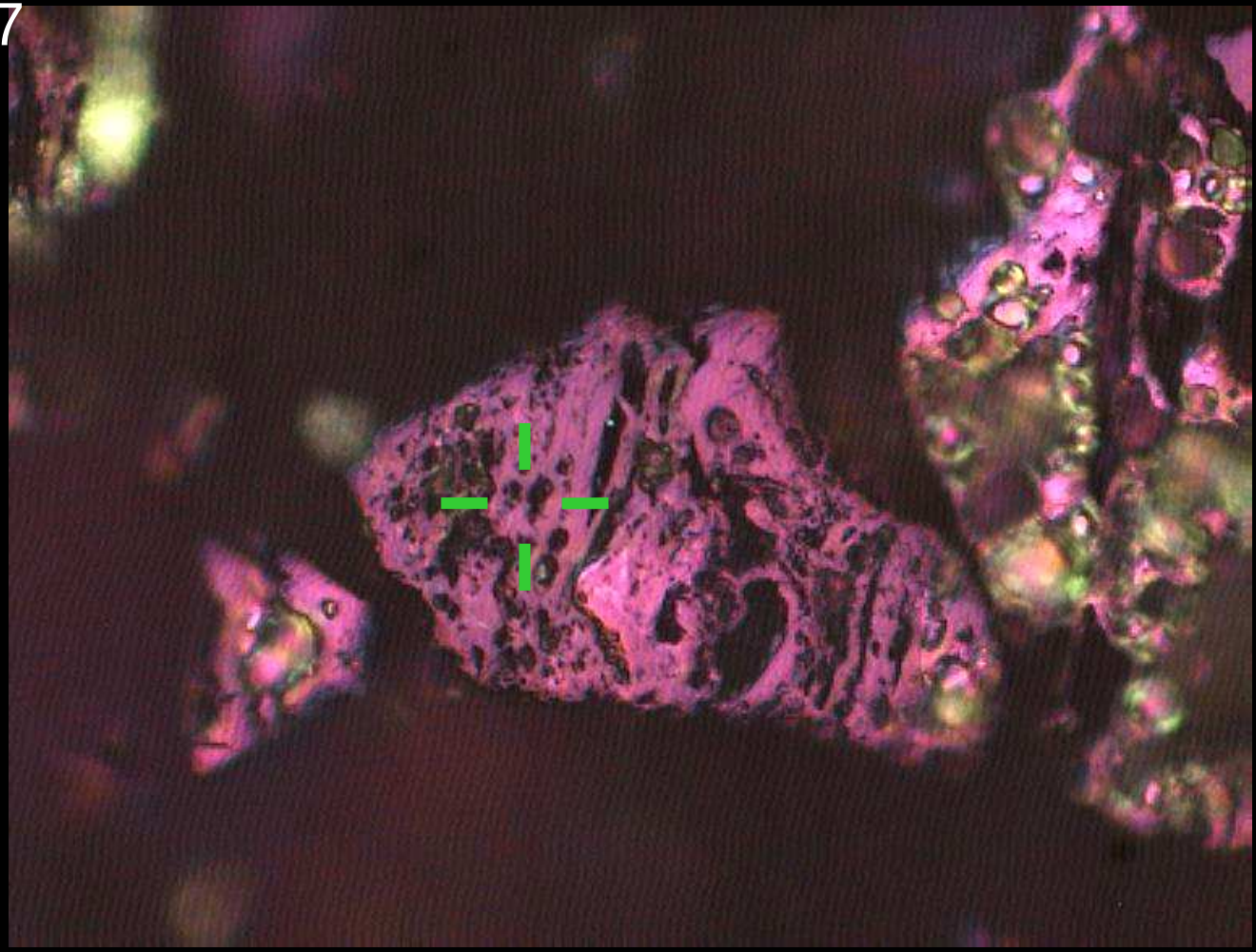

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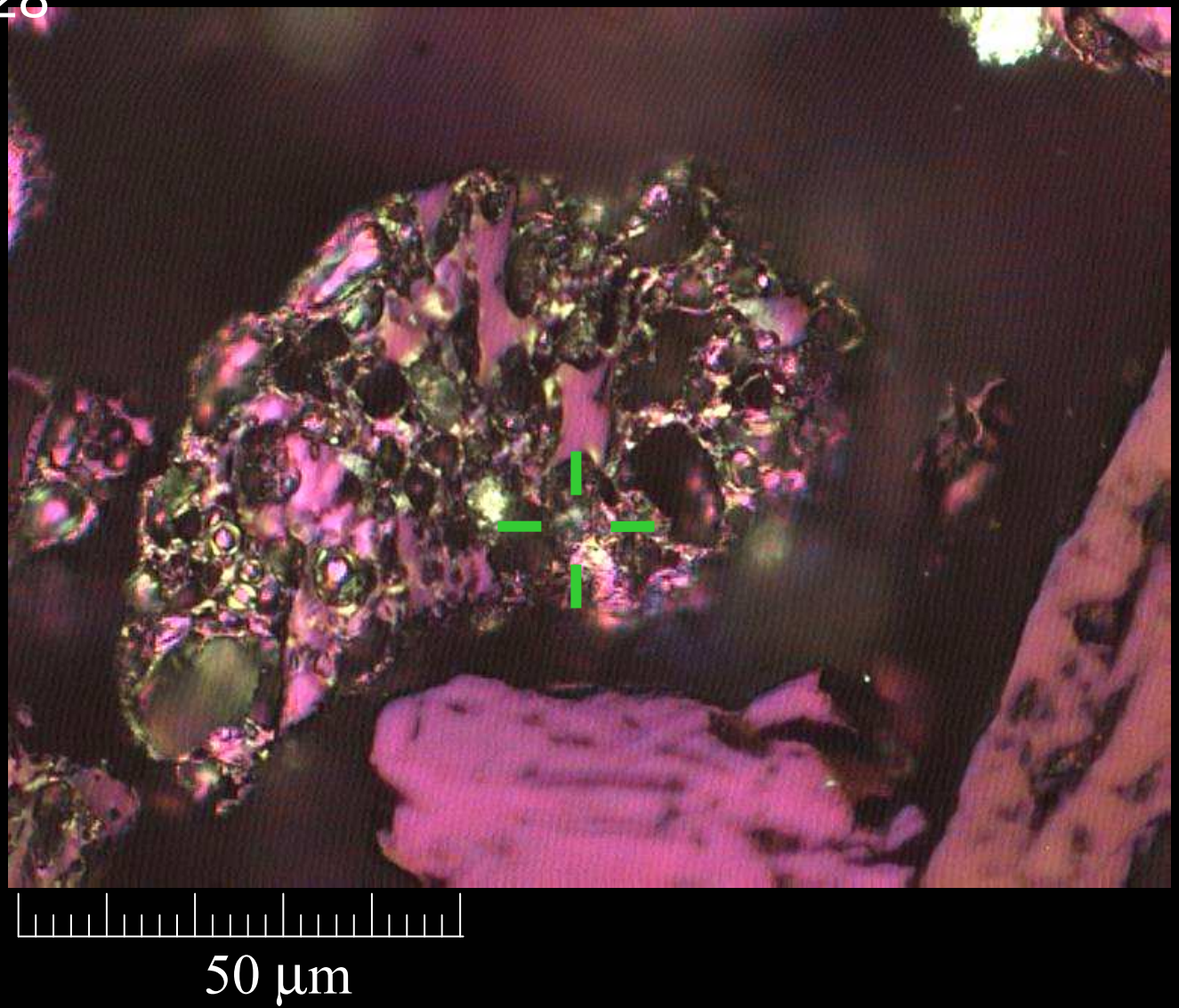

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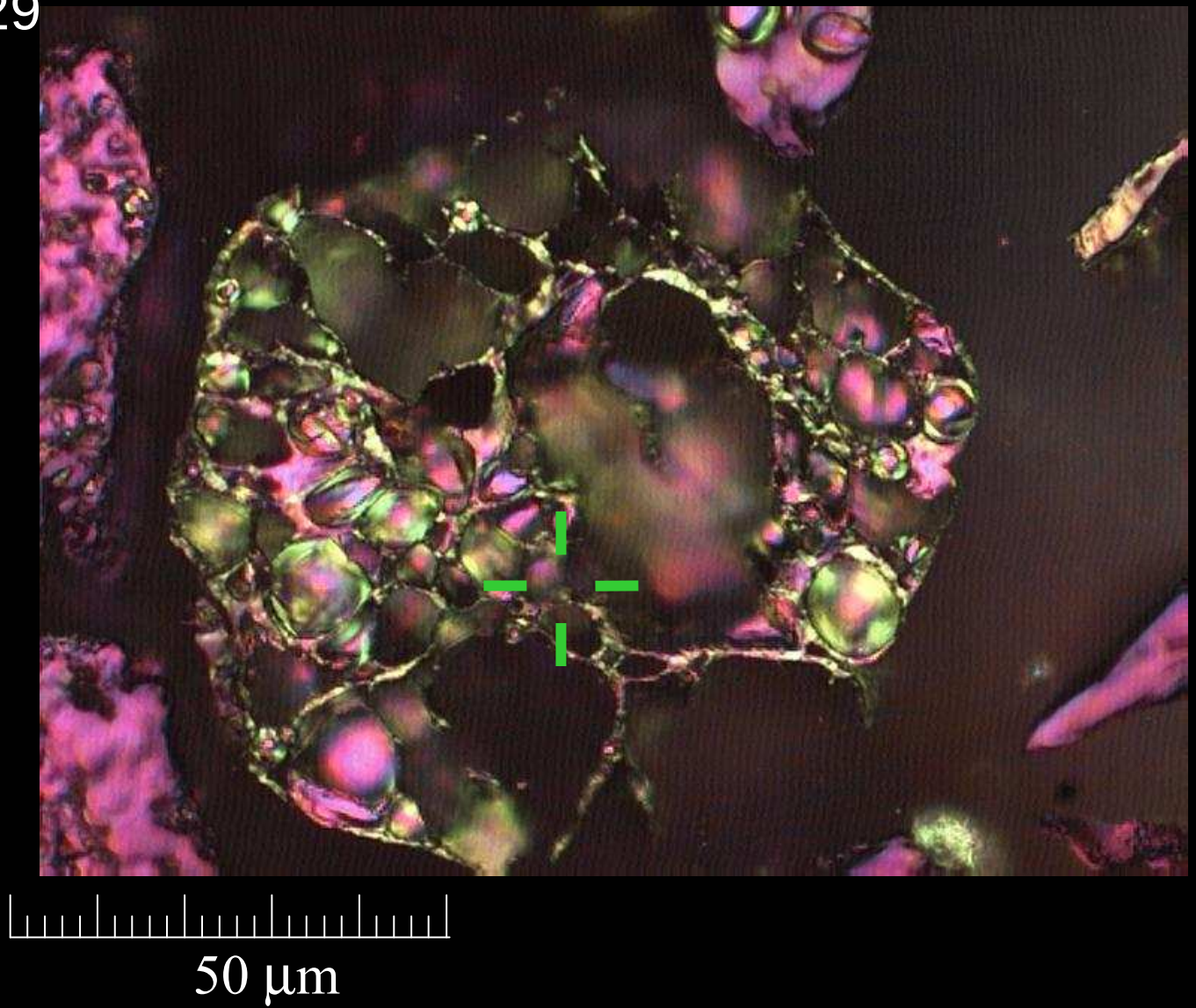

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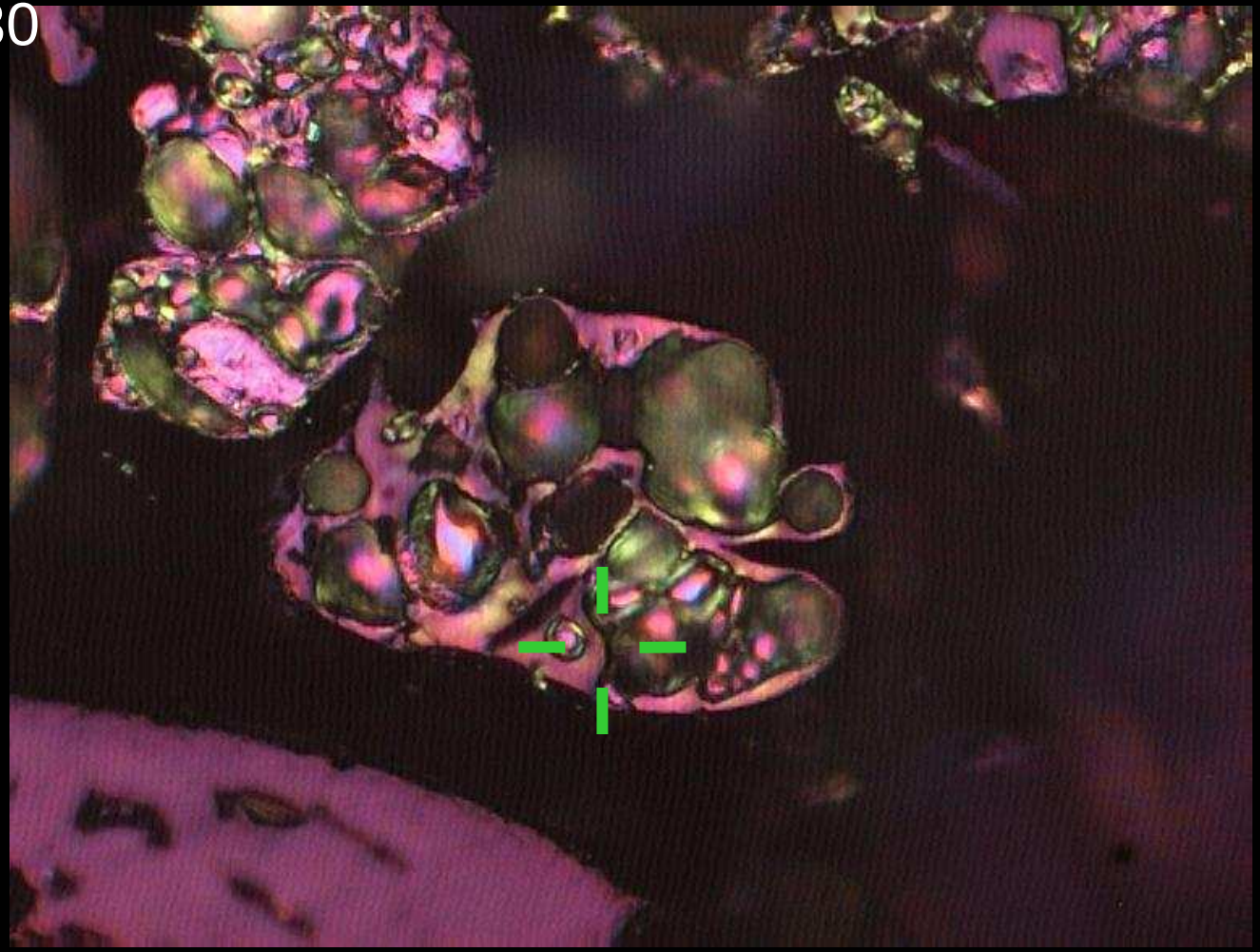

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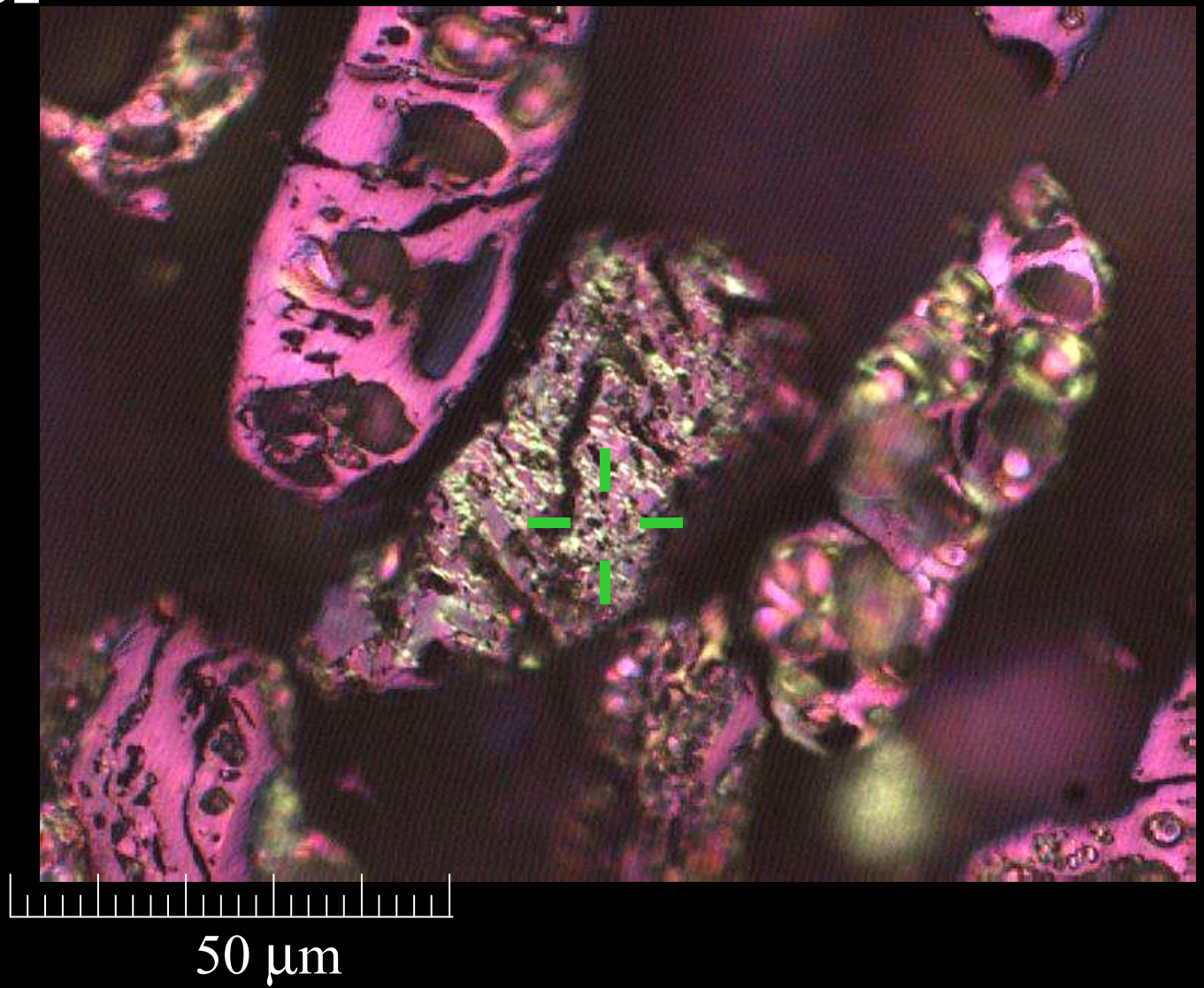

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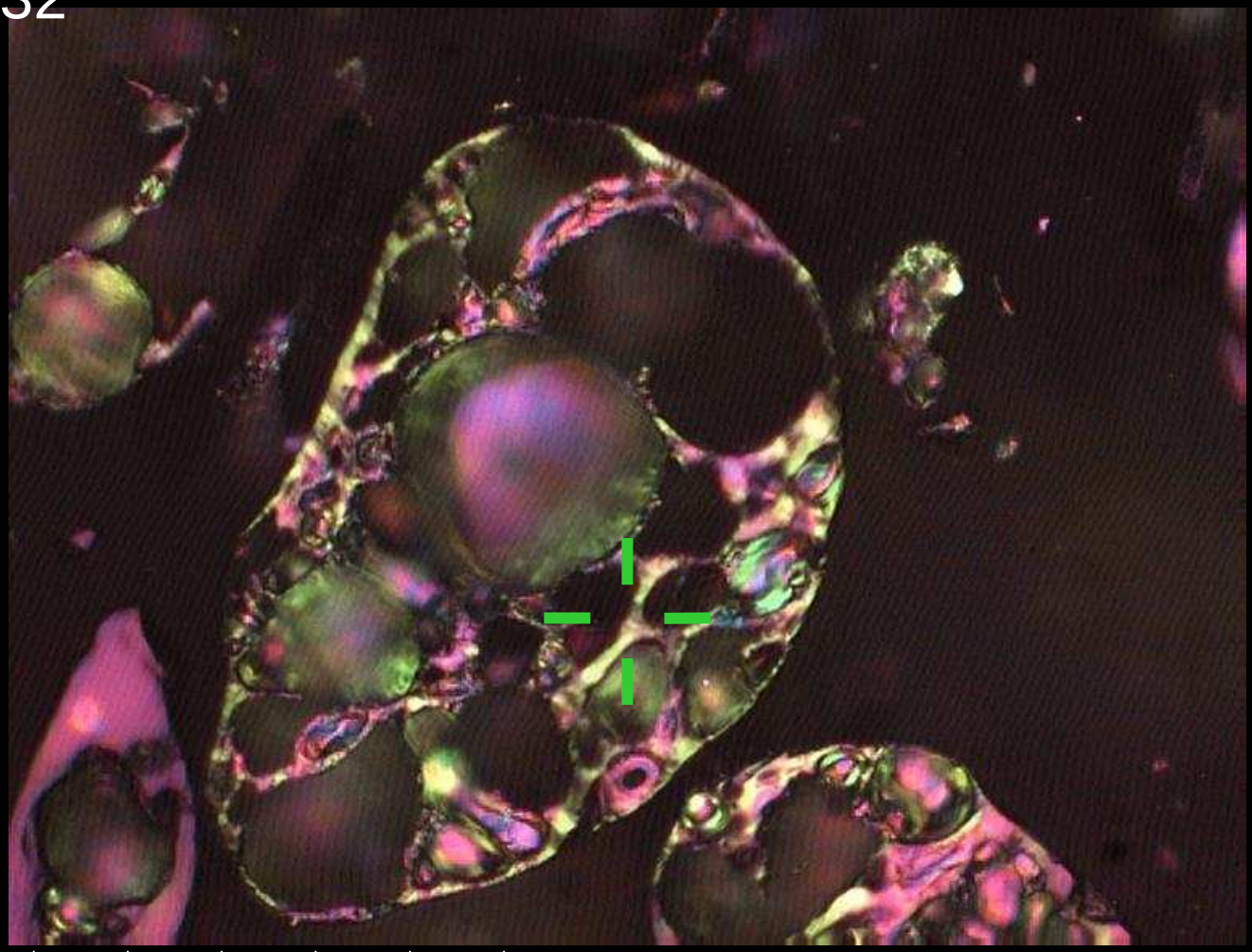

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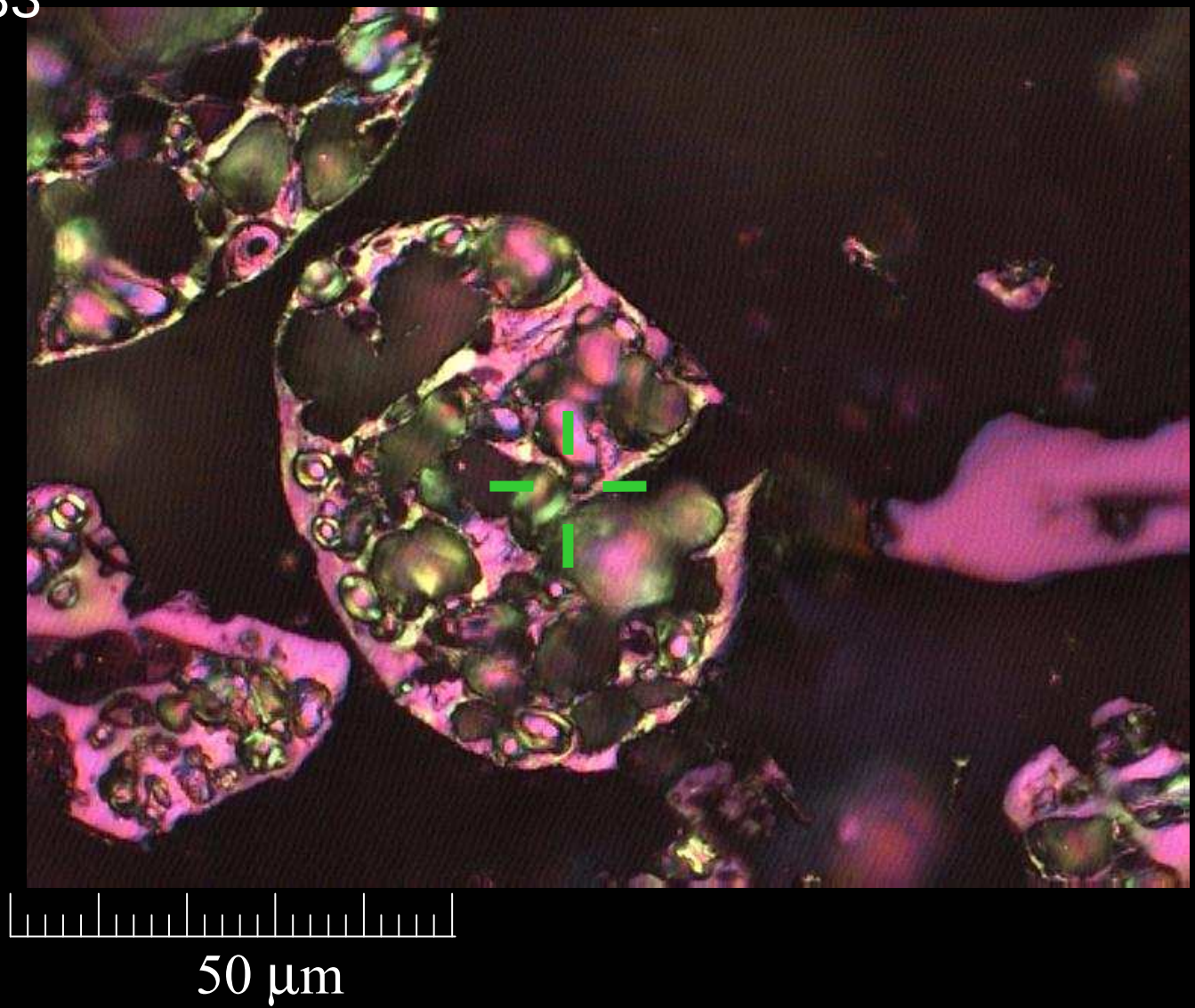

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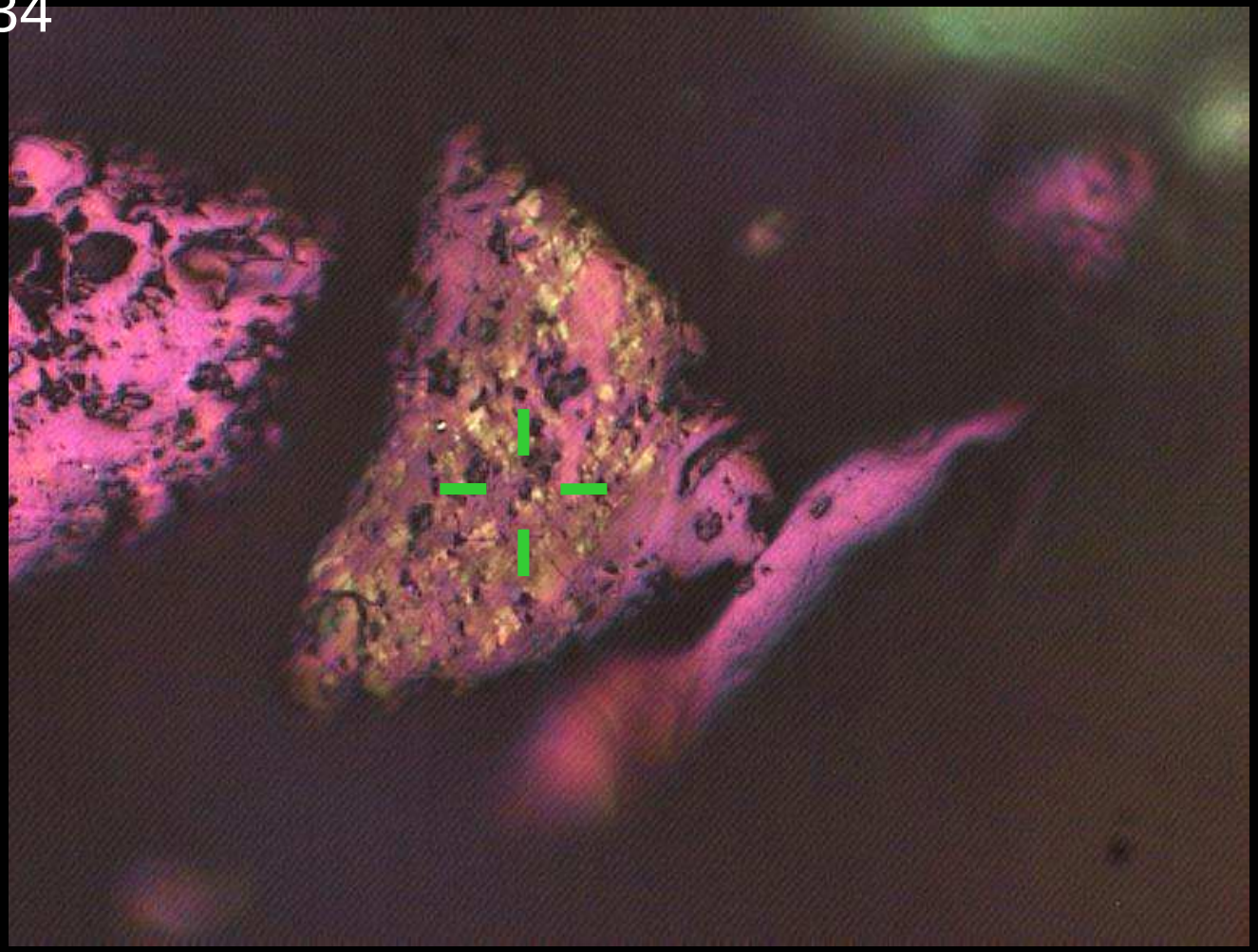

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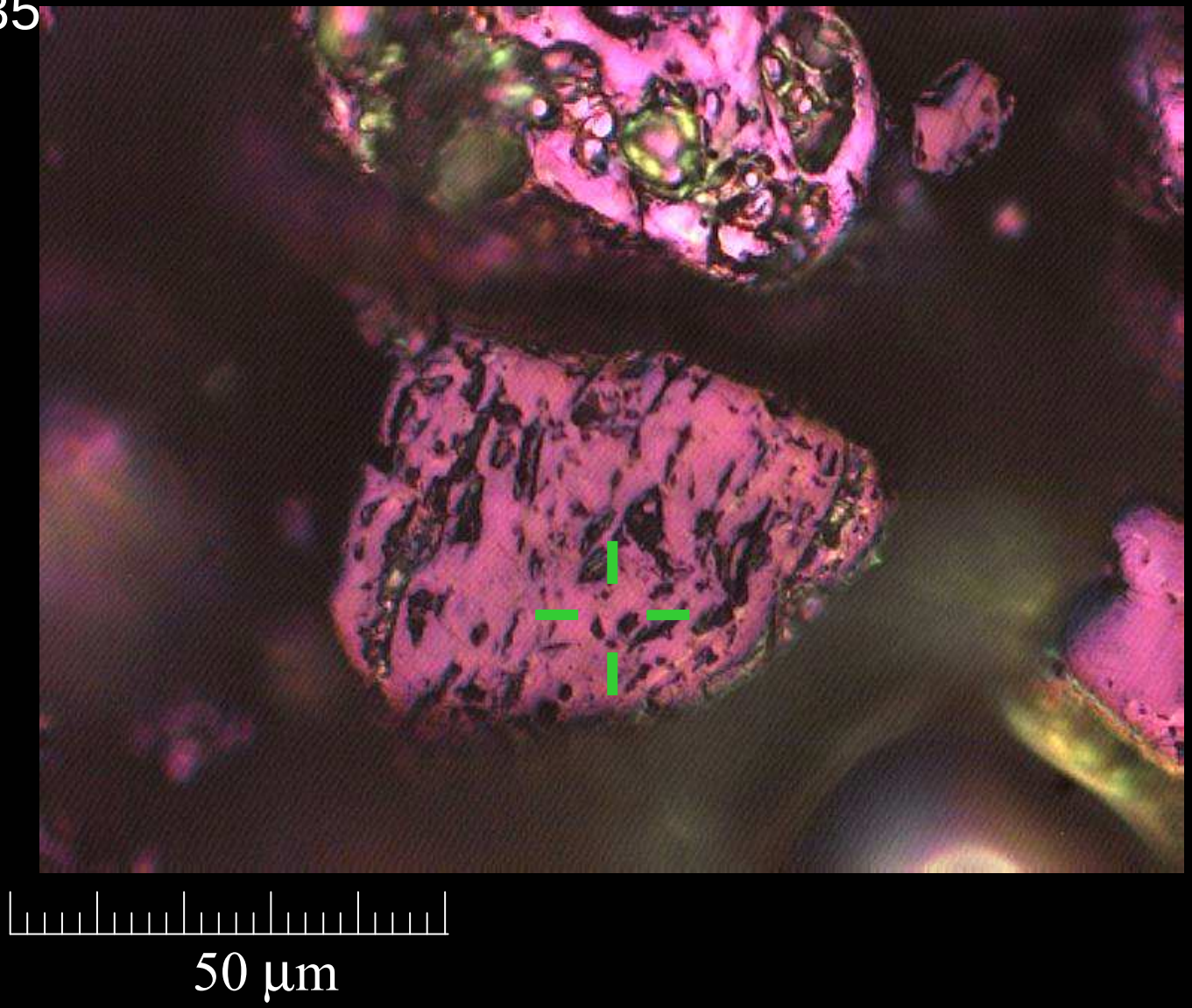

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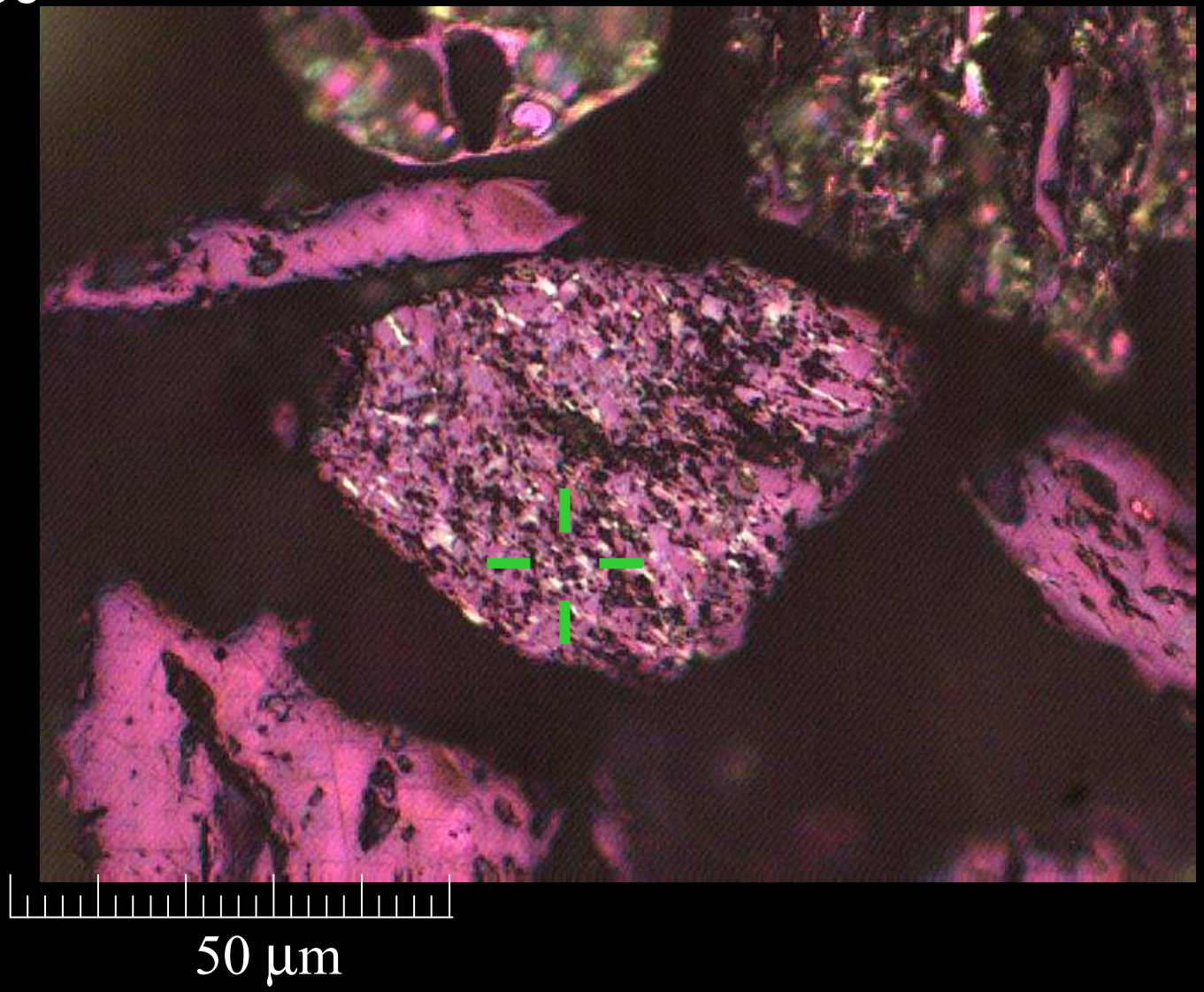

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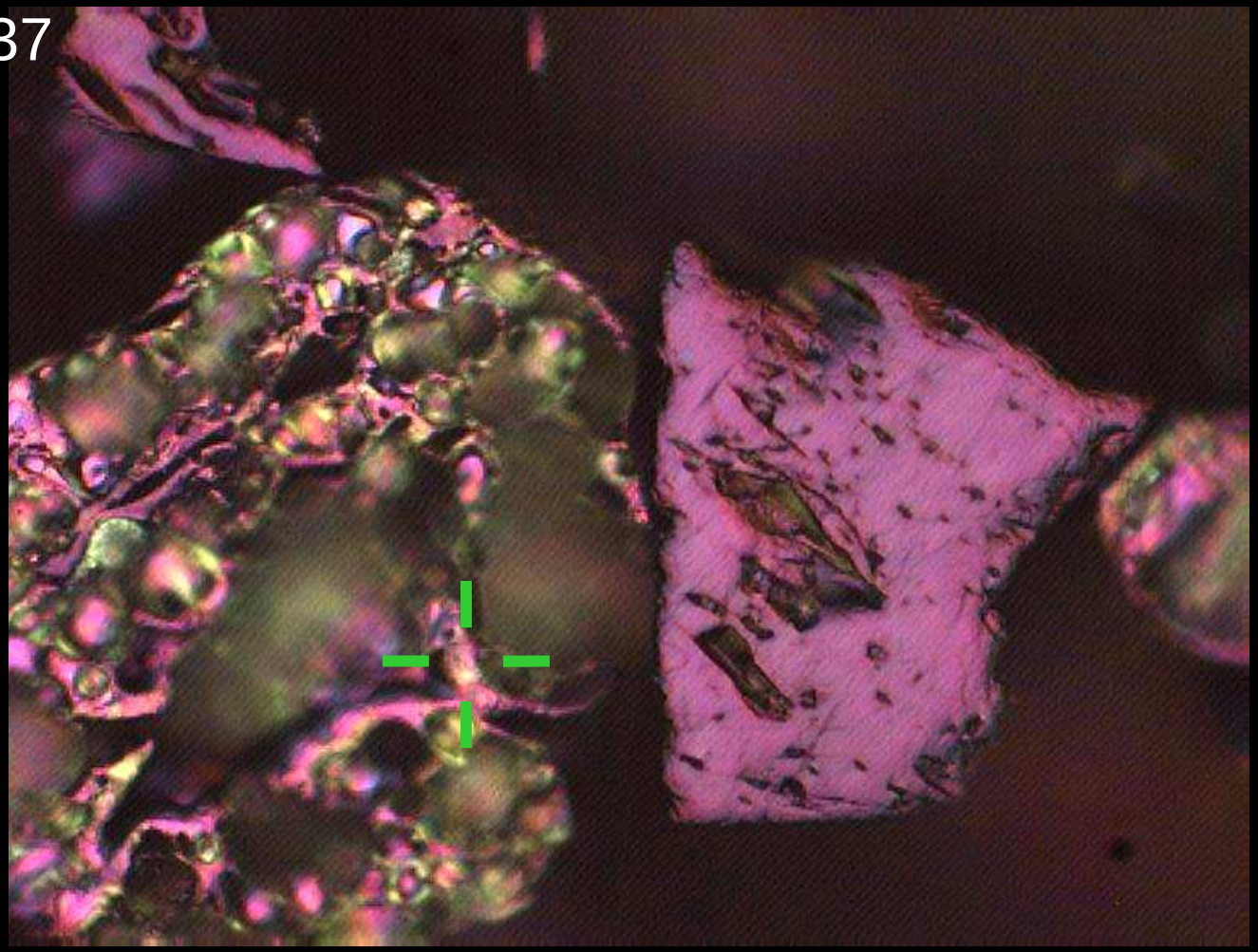
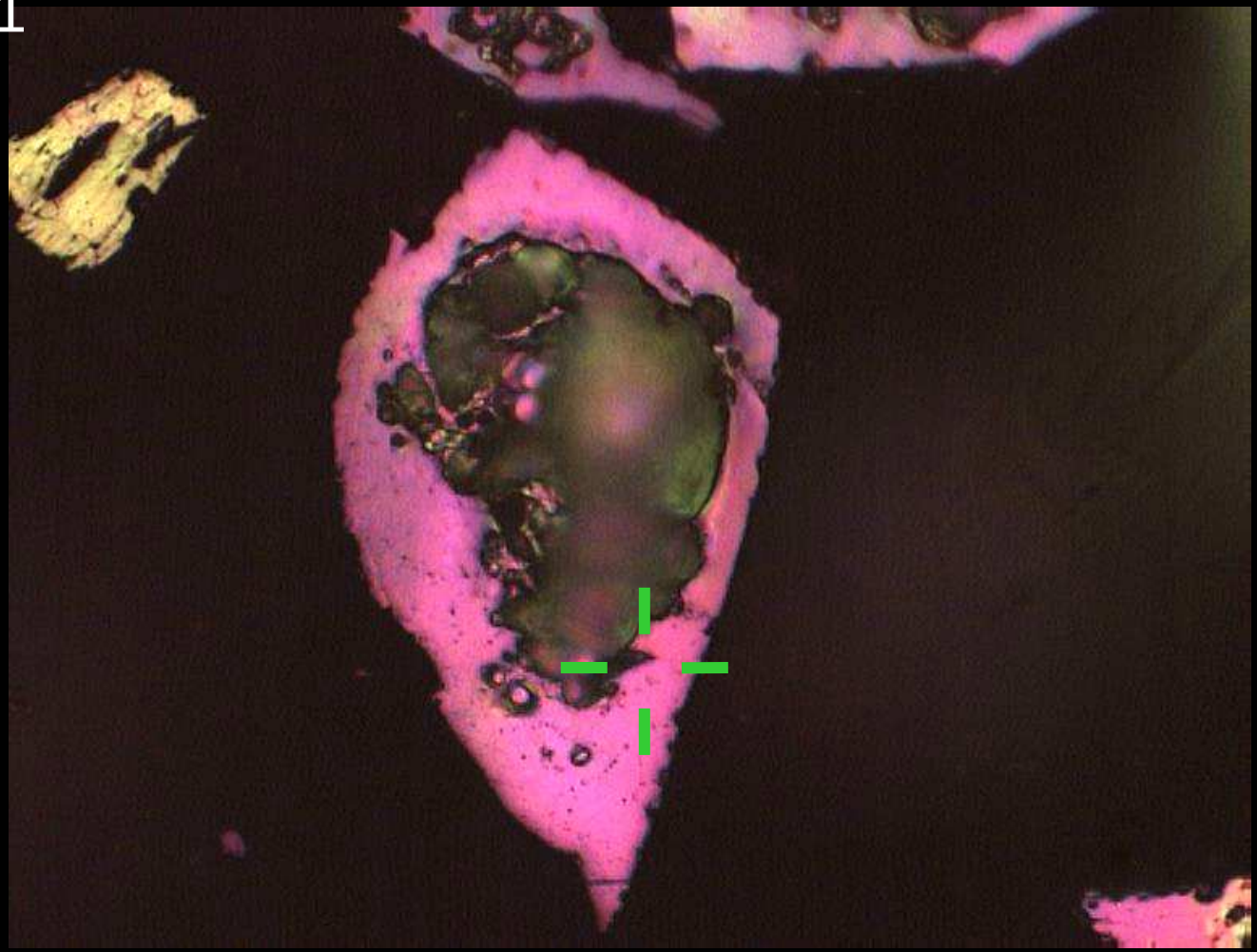


50 µm

F1



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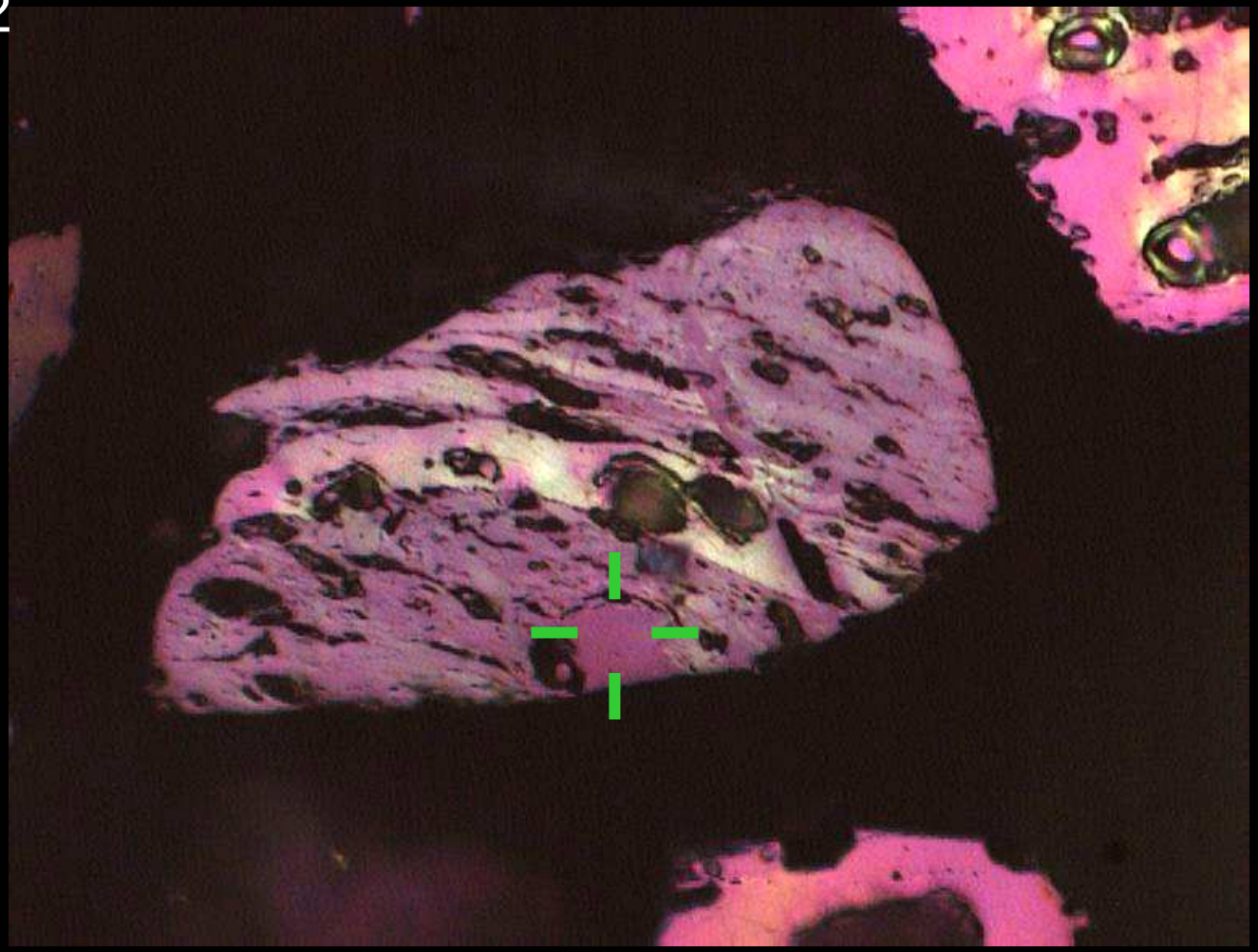

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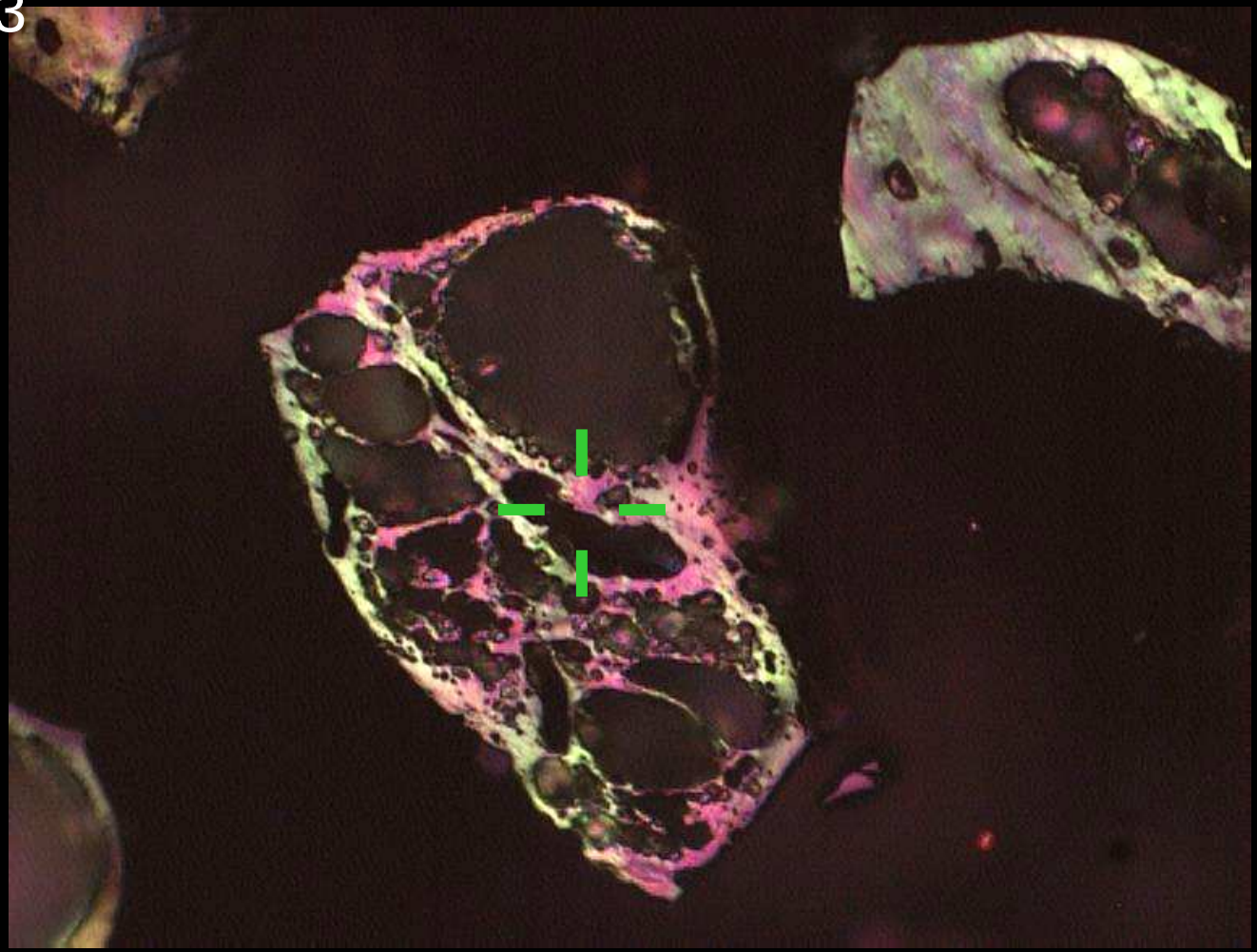

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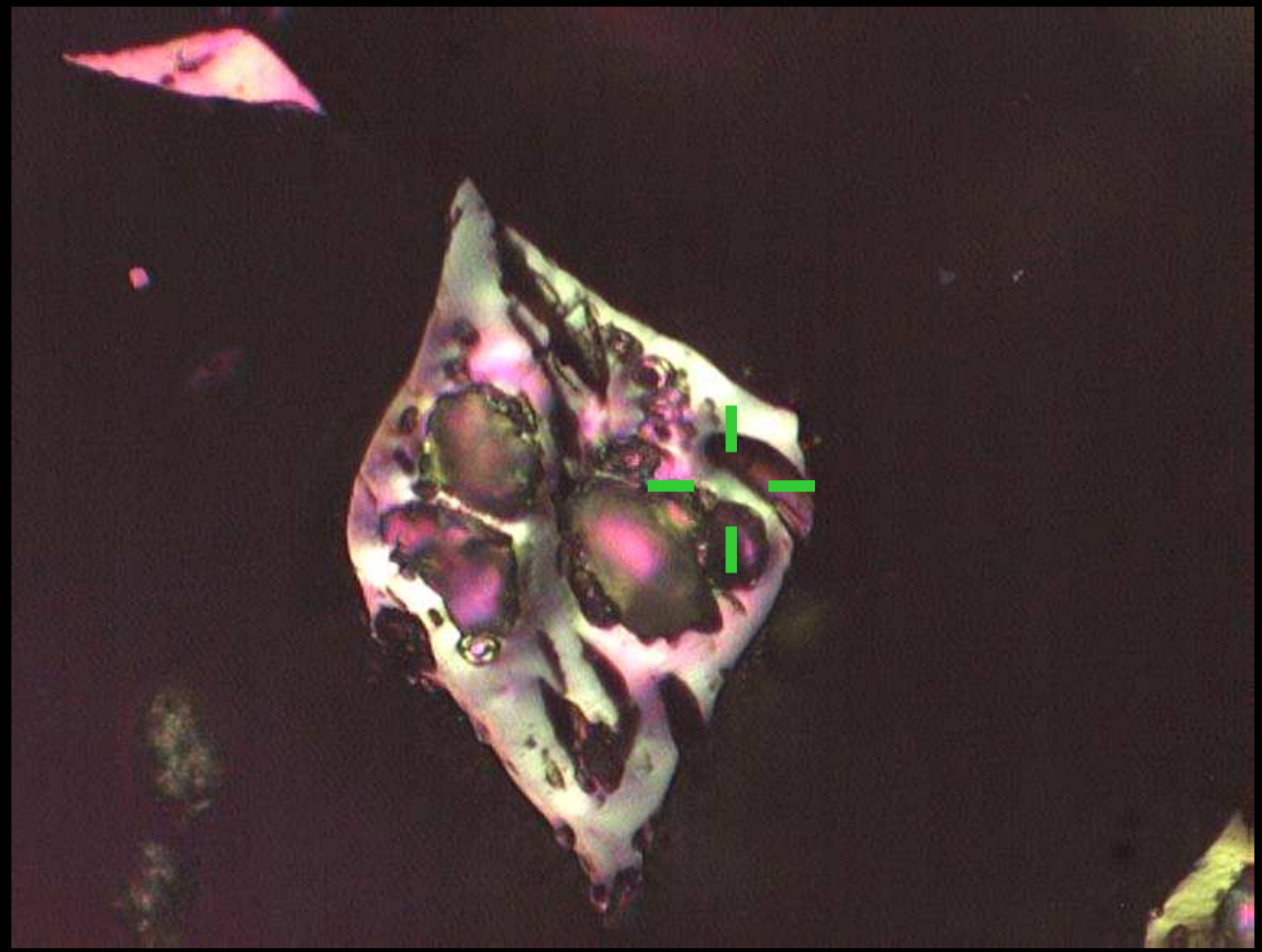

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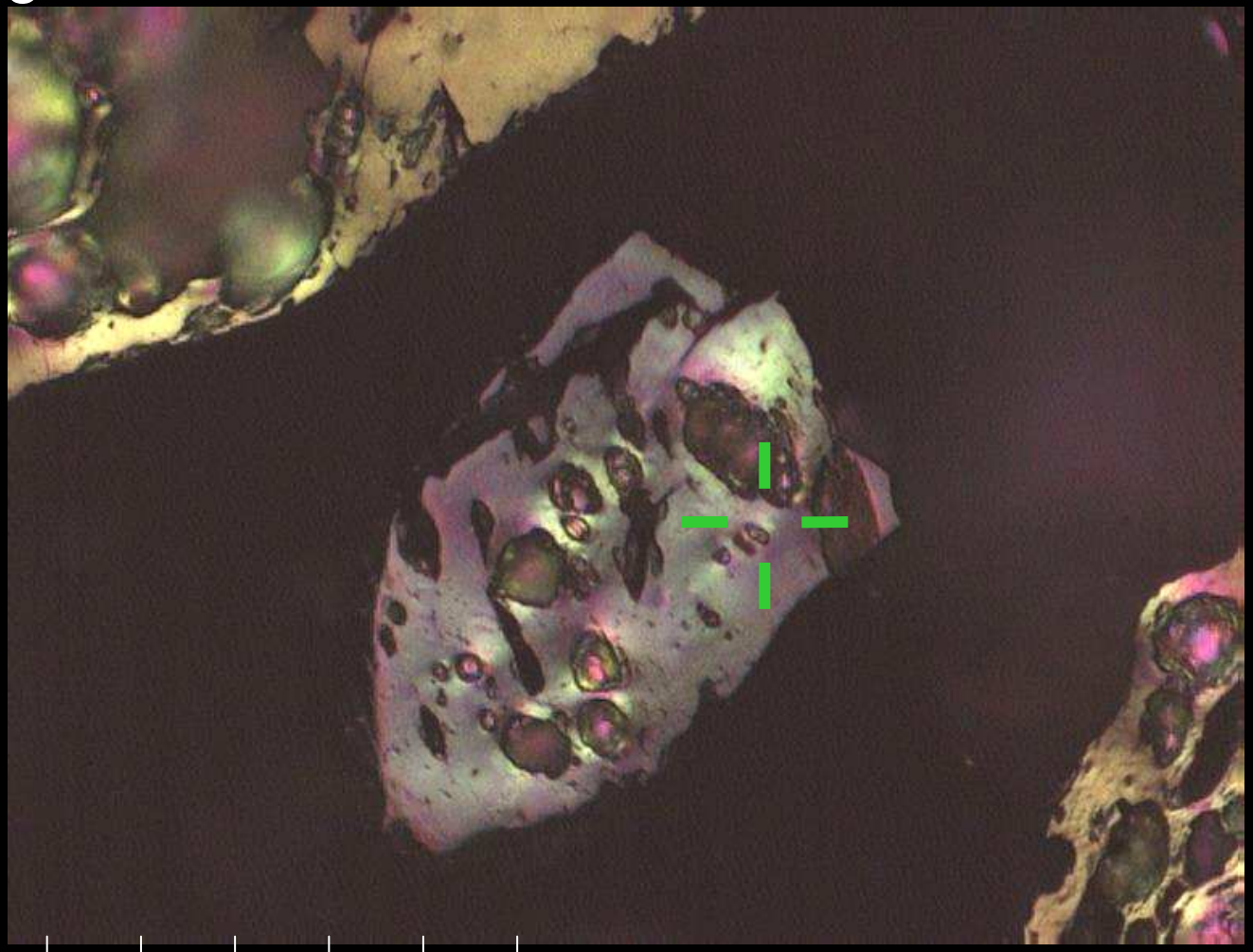

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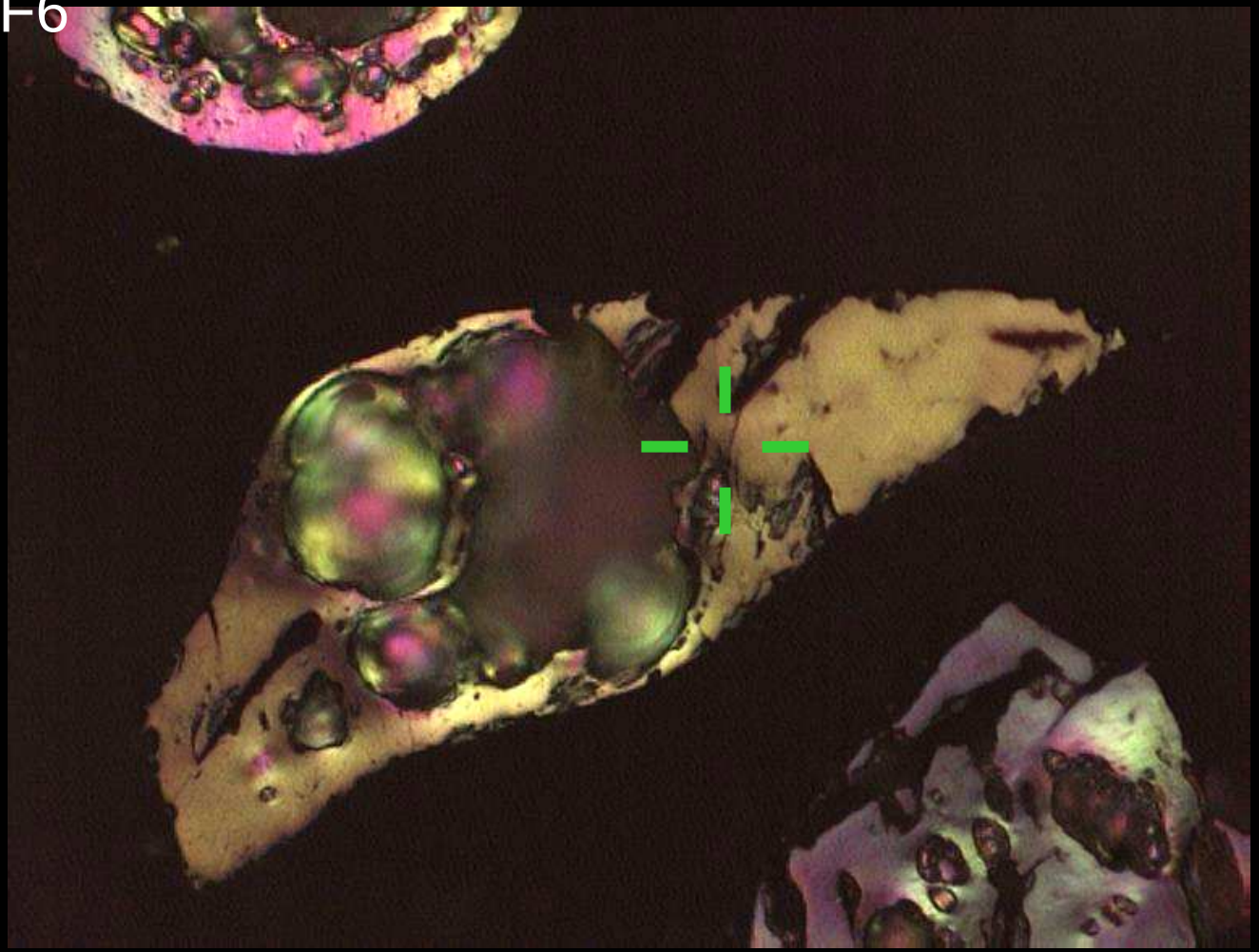

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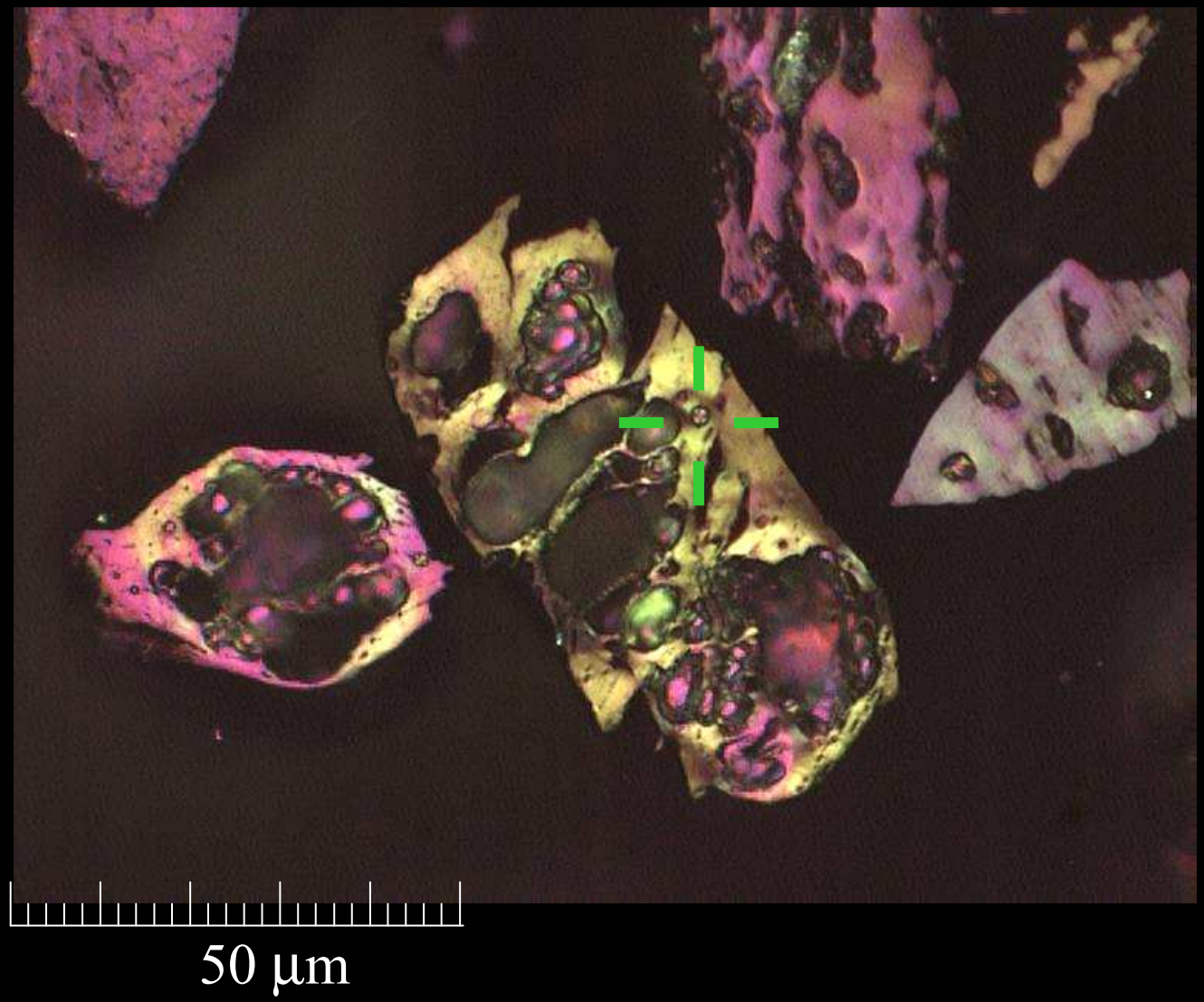

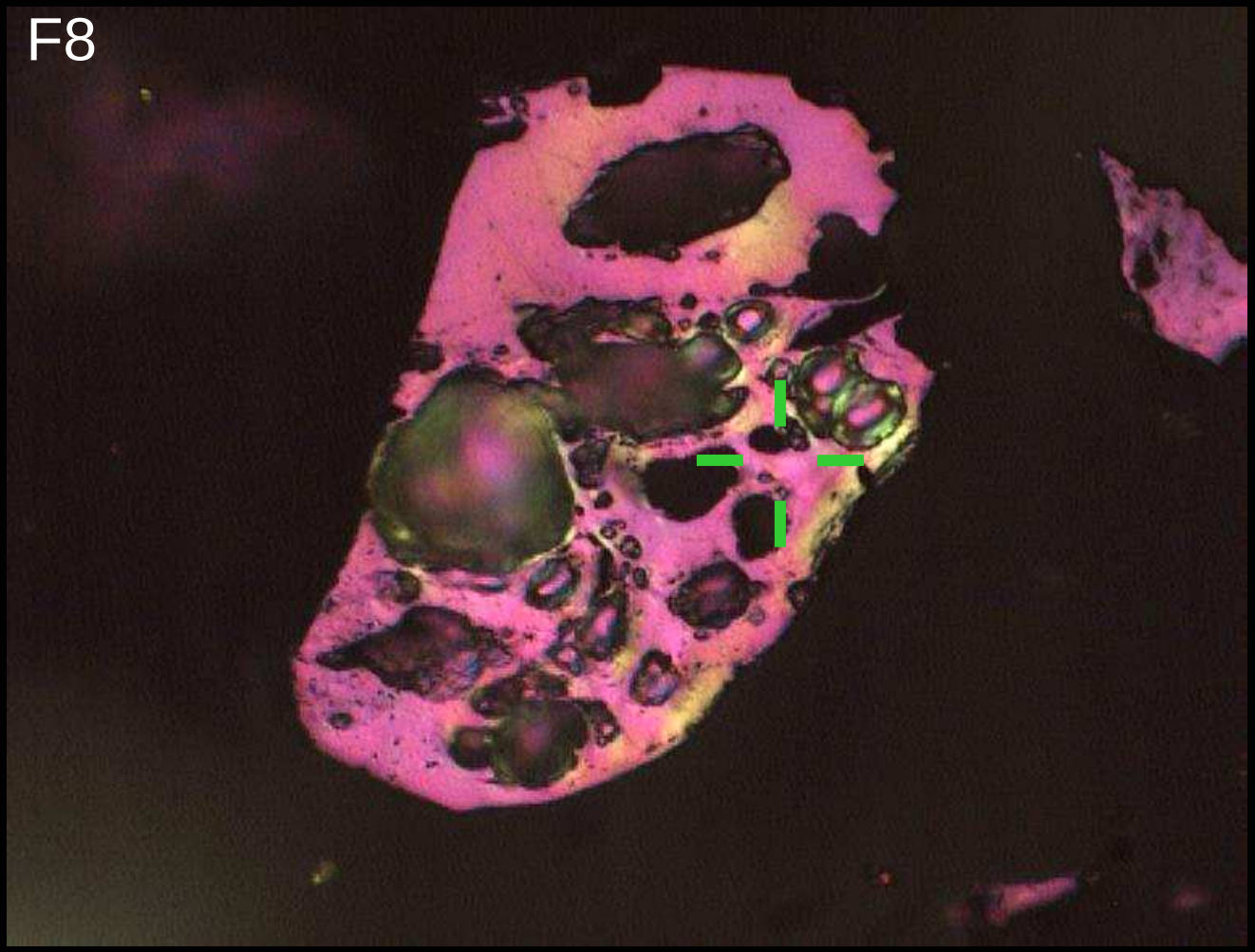

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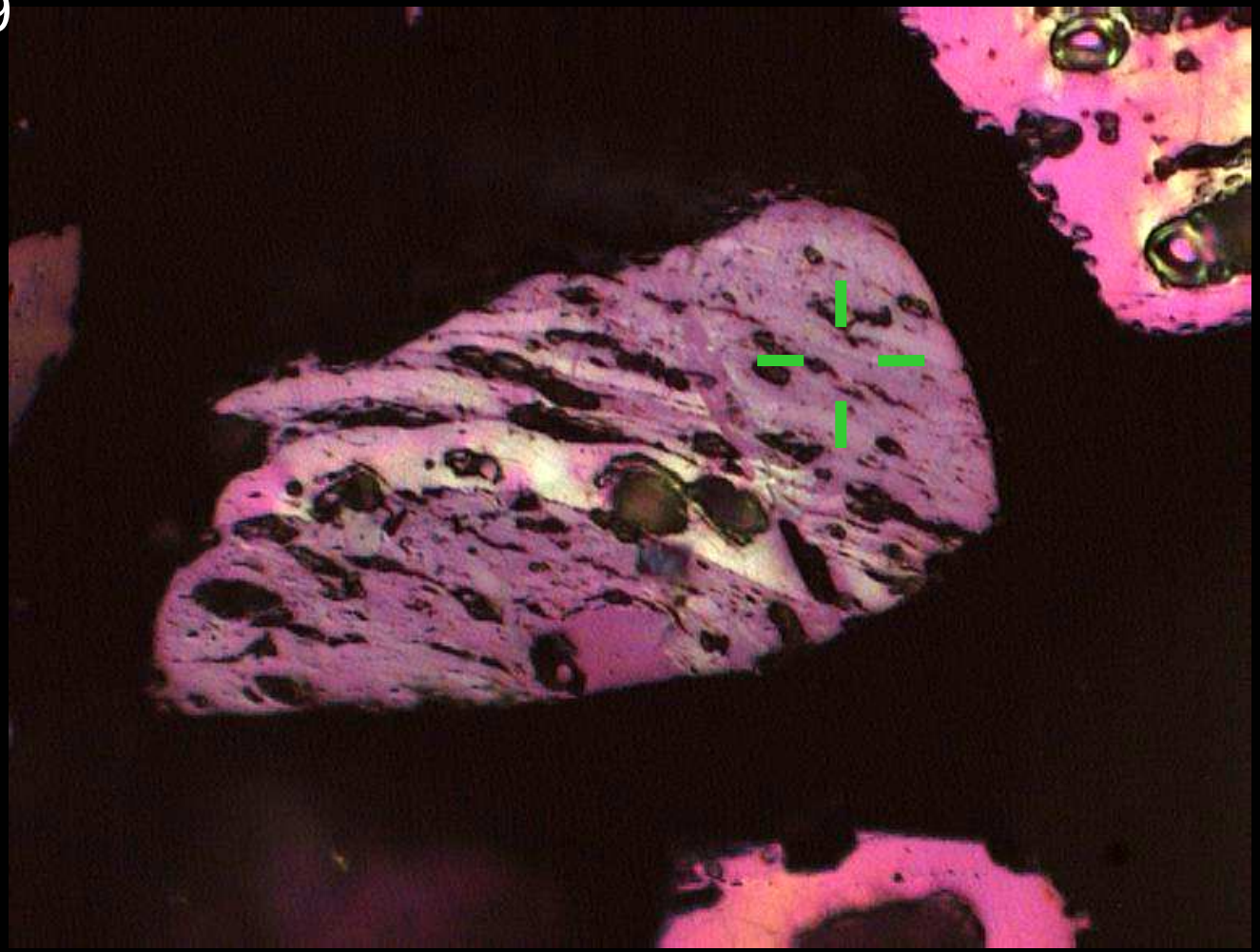

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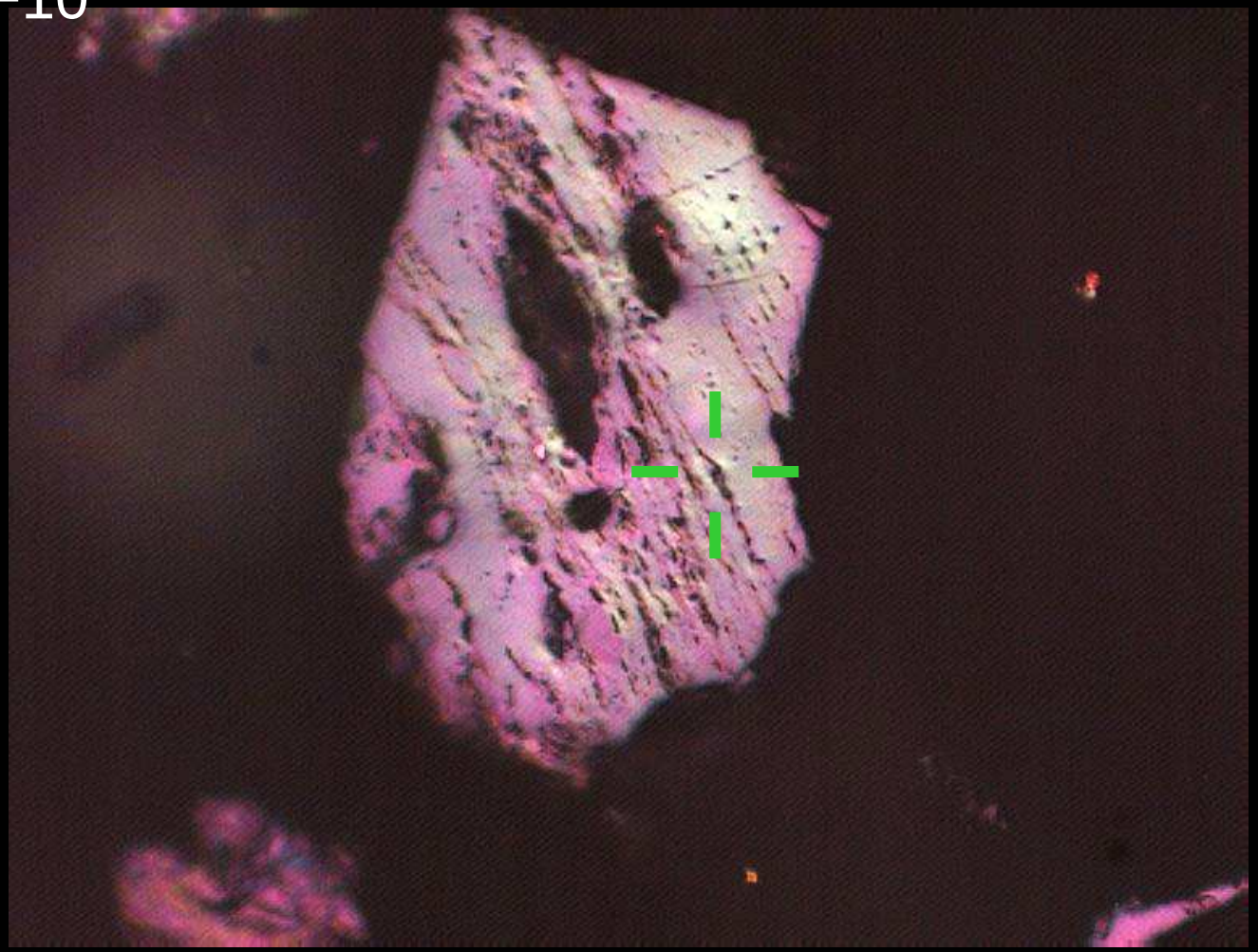

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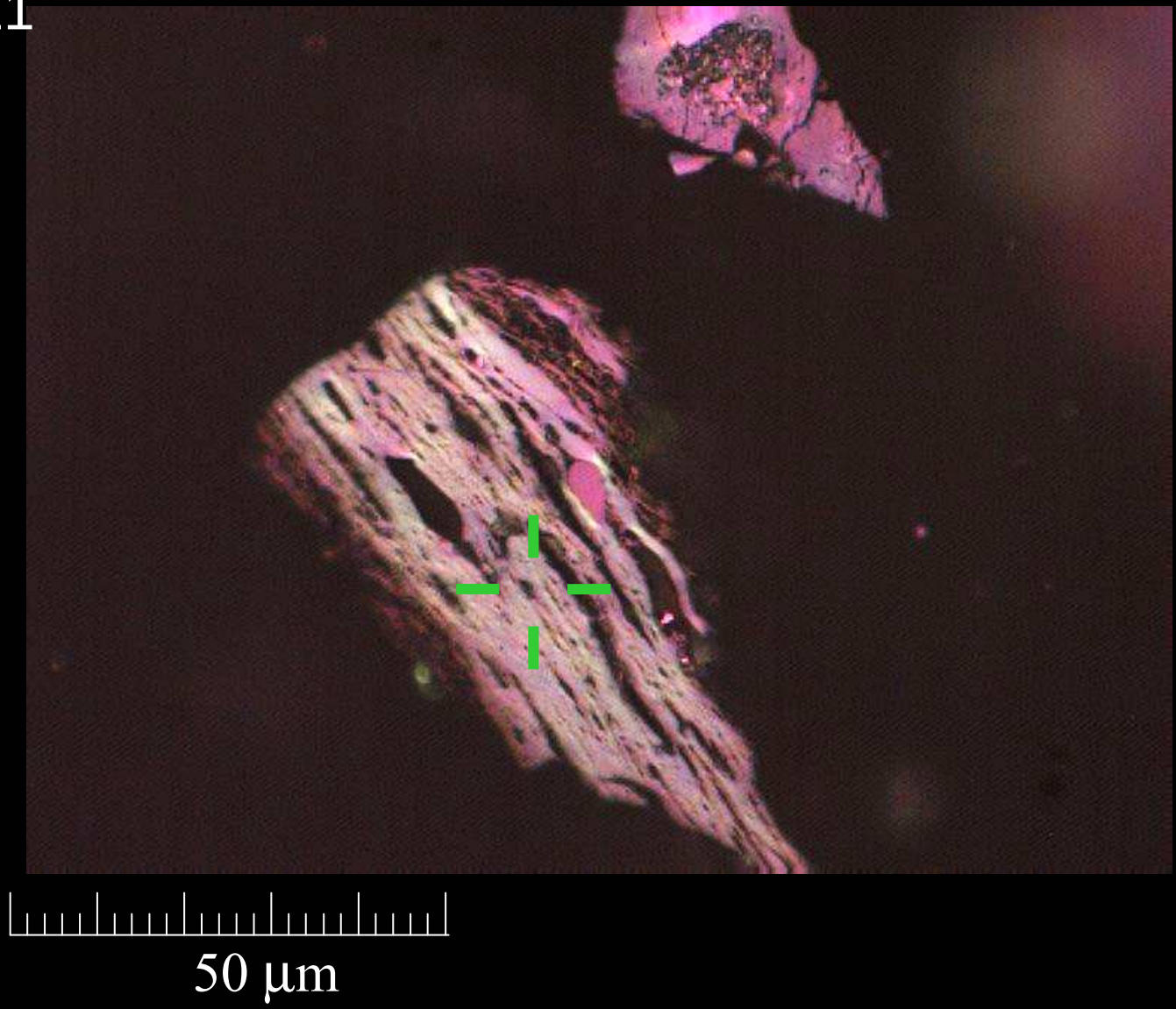

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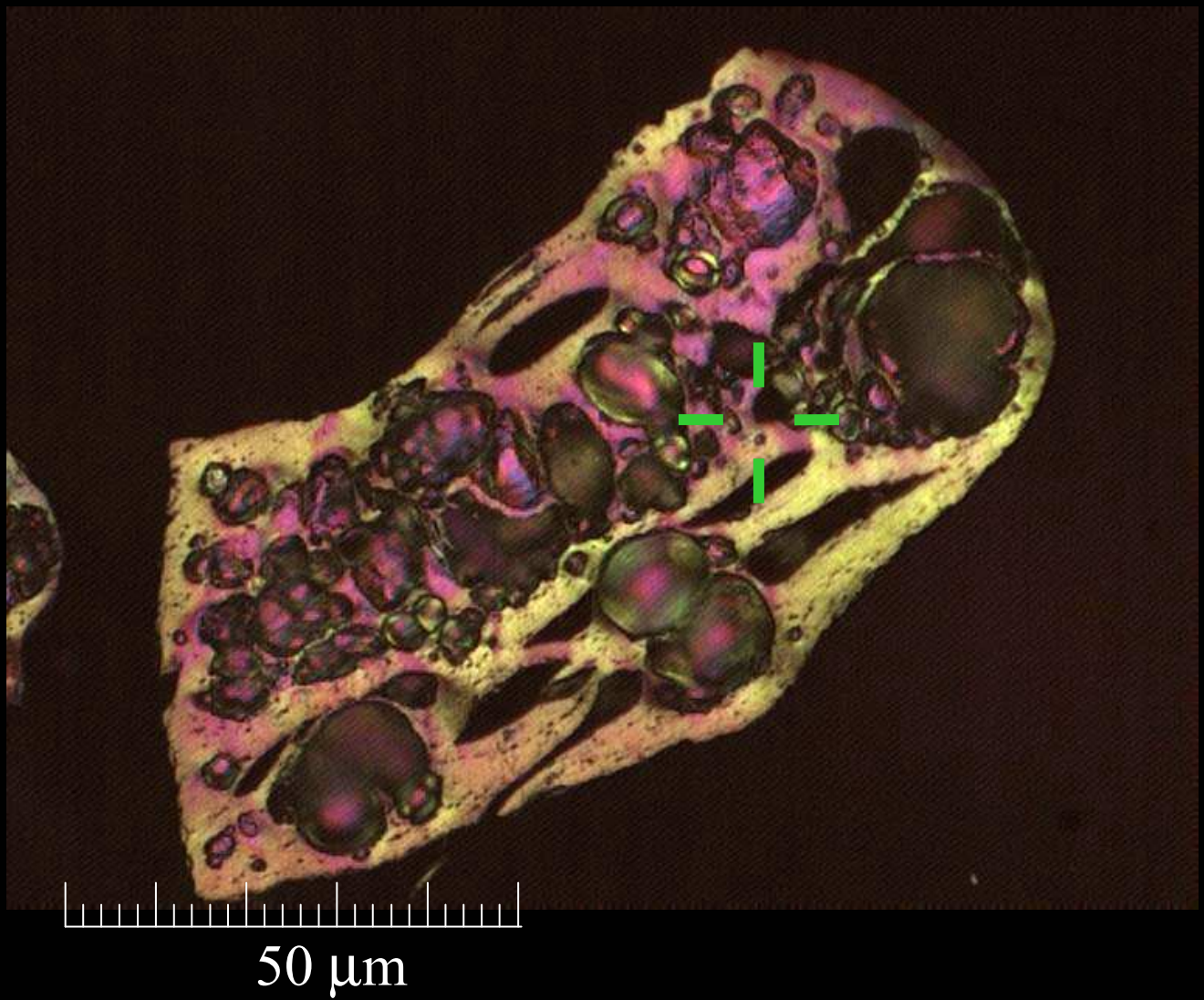
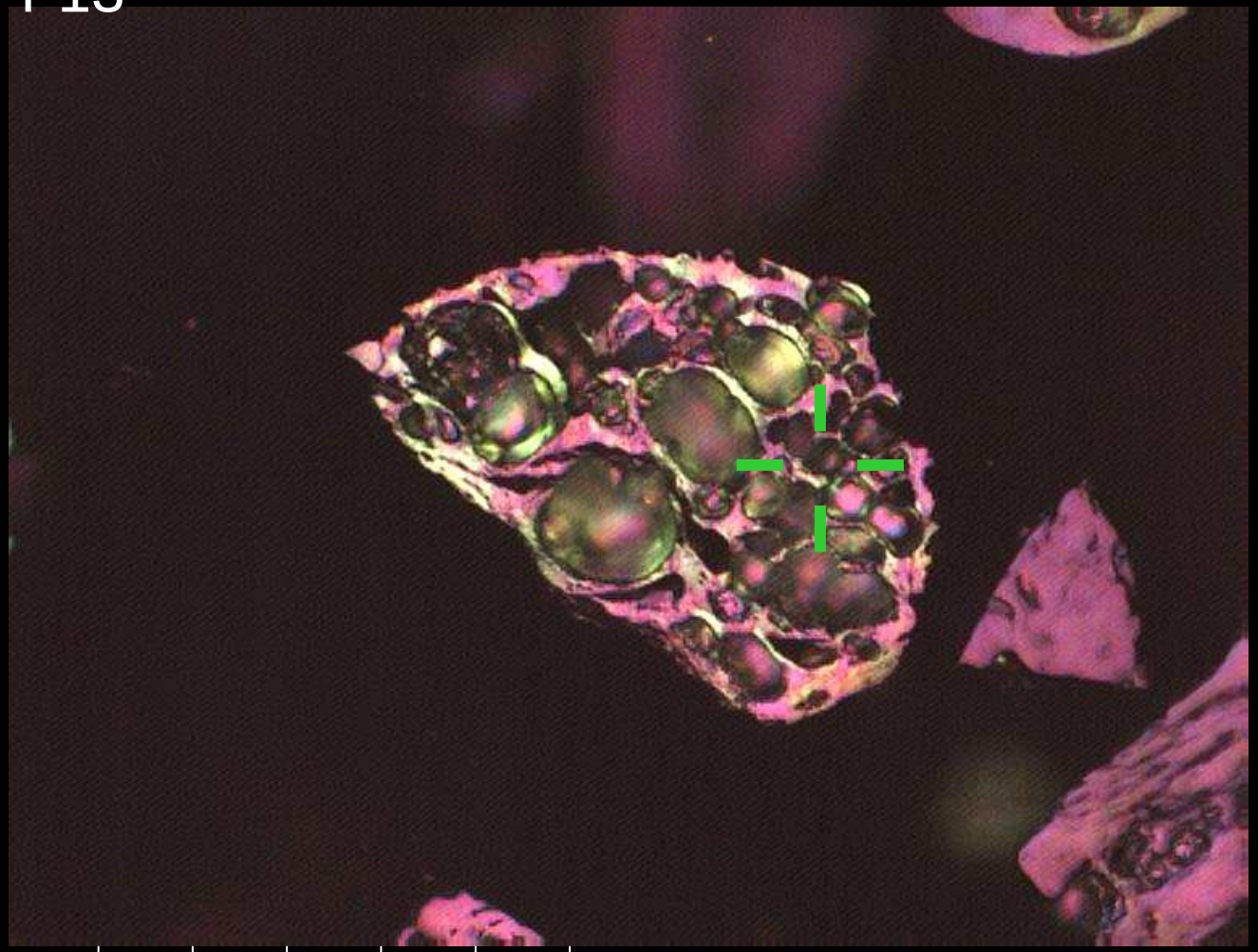
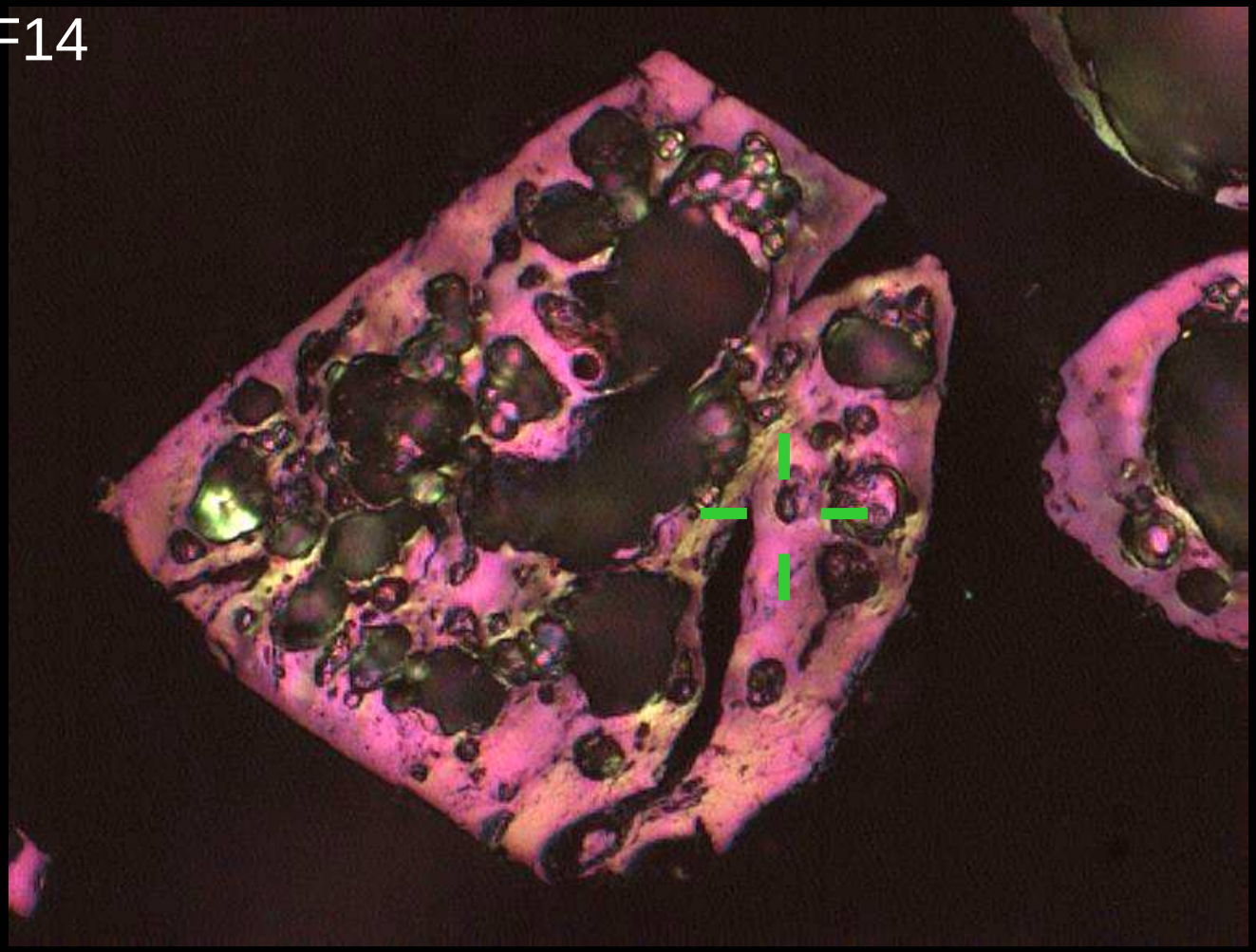


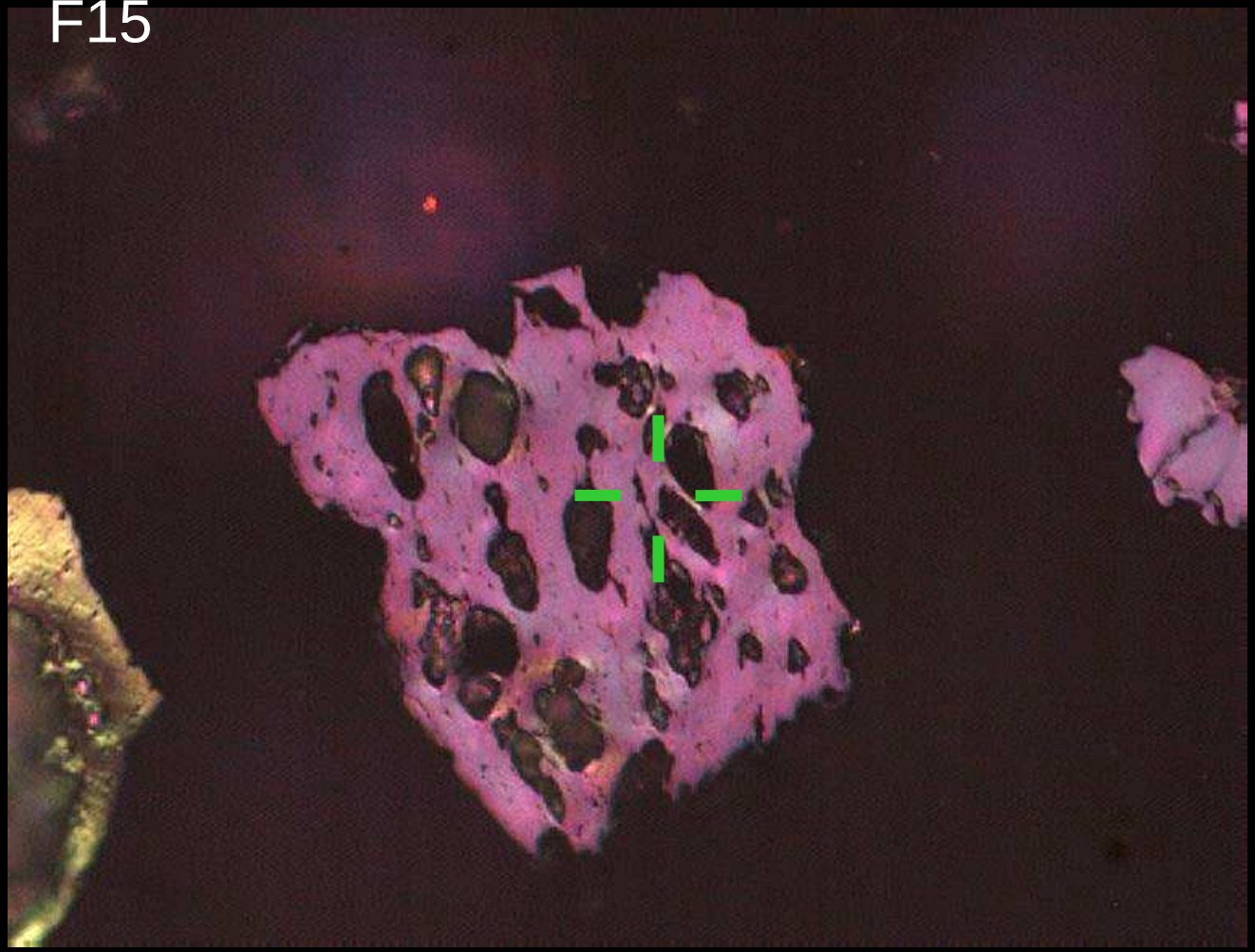
F13



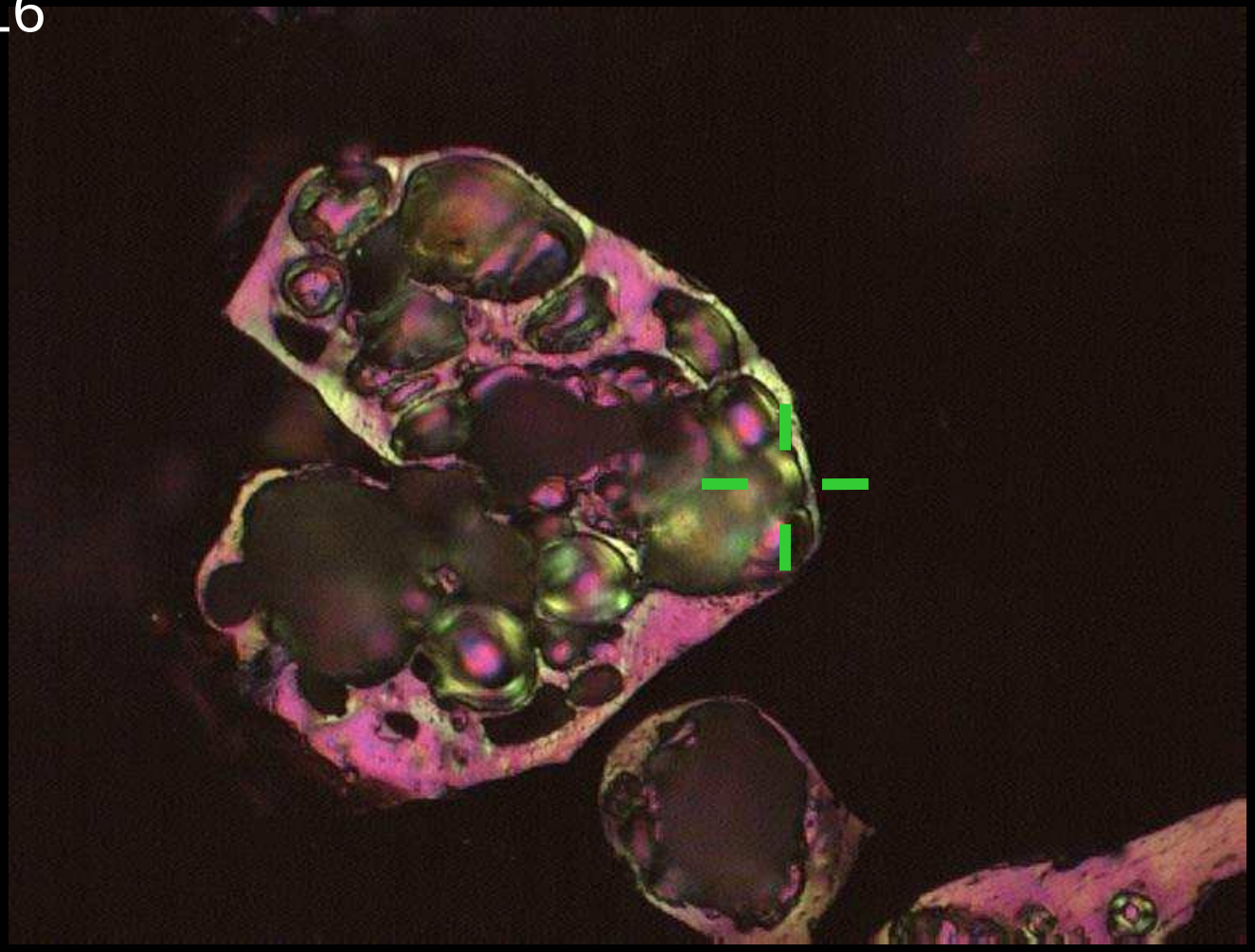
F14



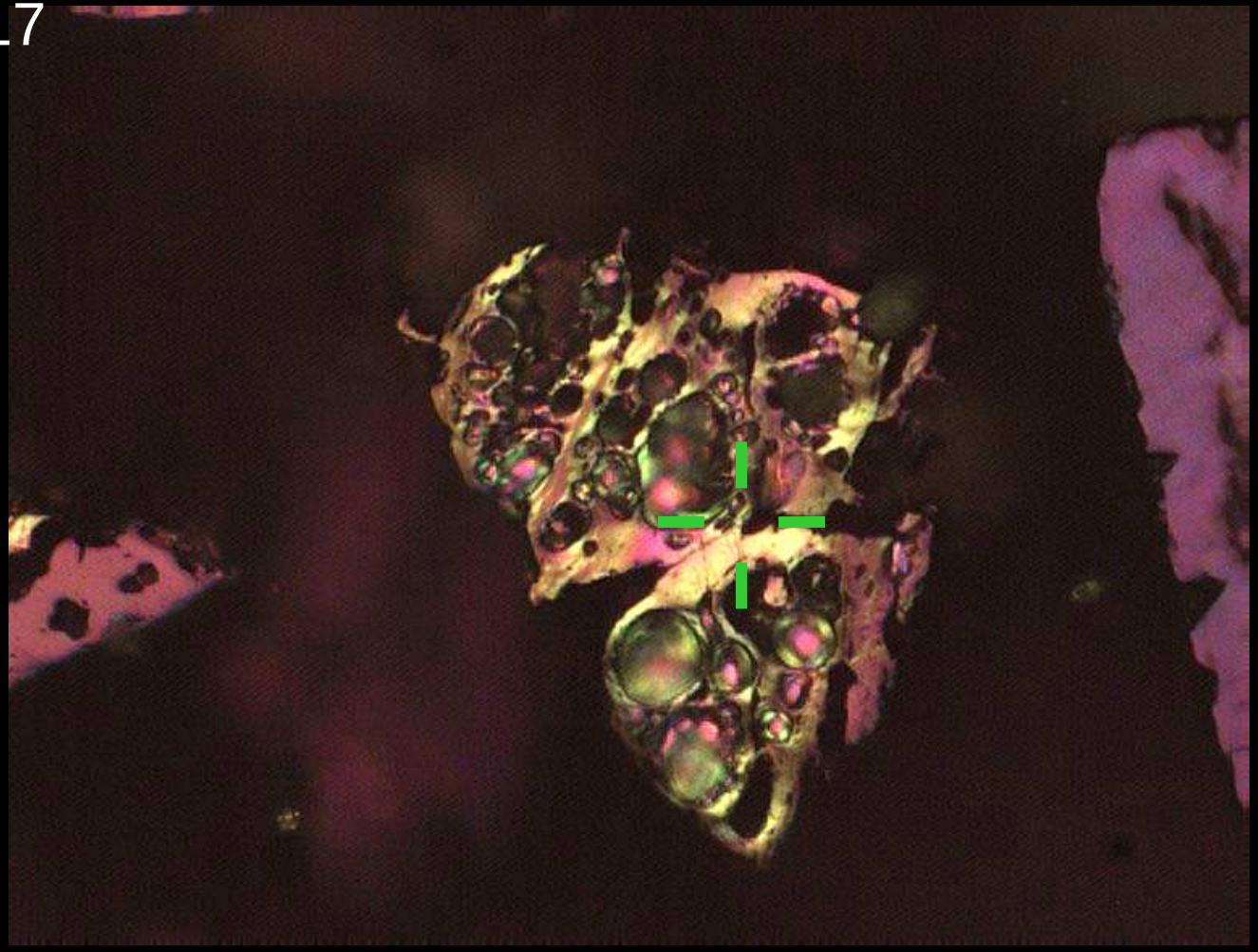
50 µm



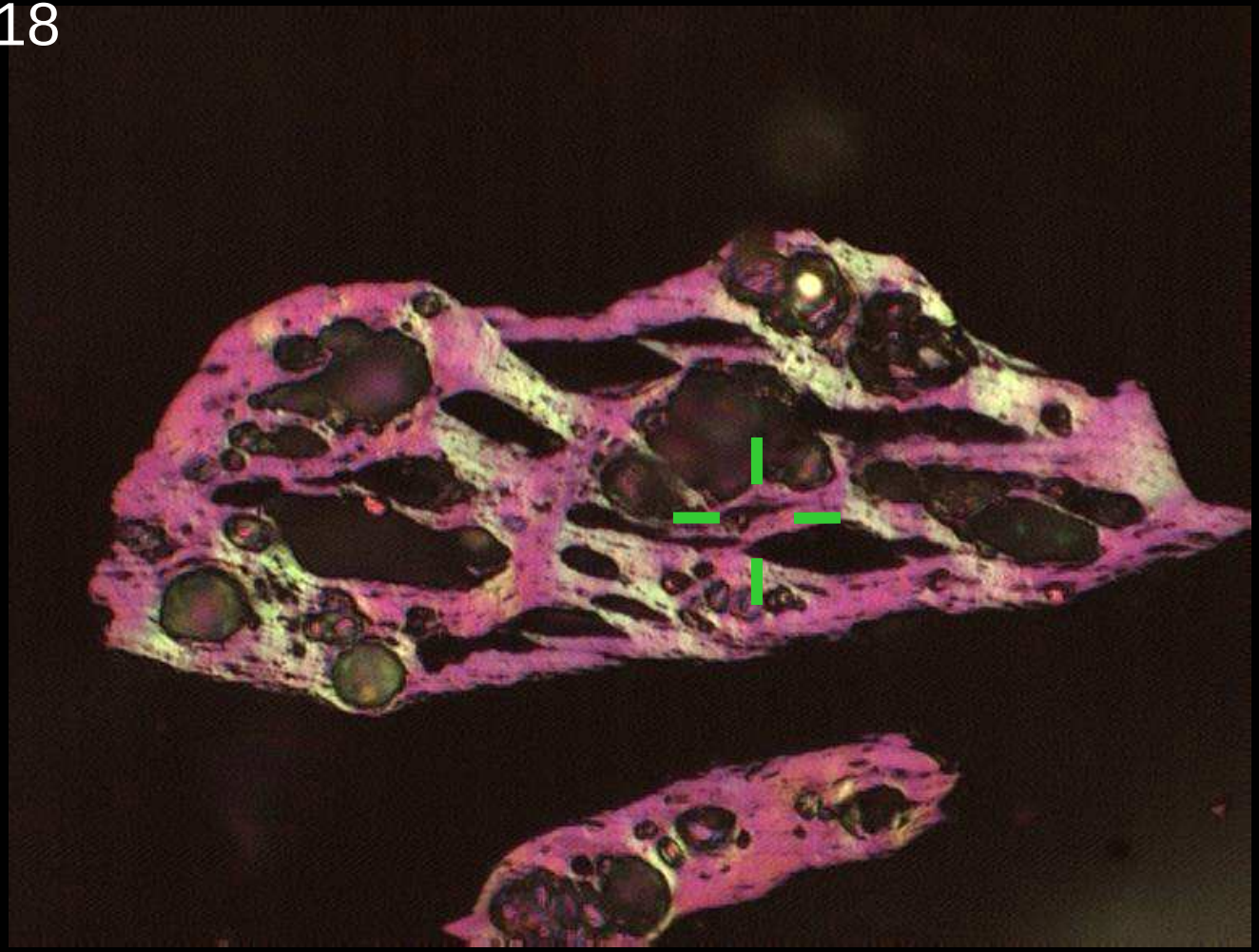
F16



F17

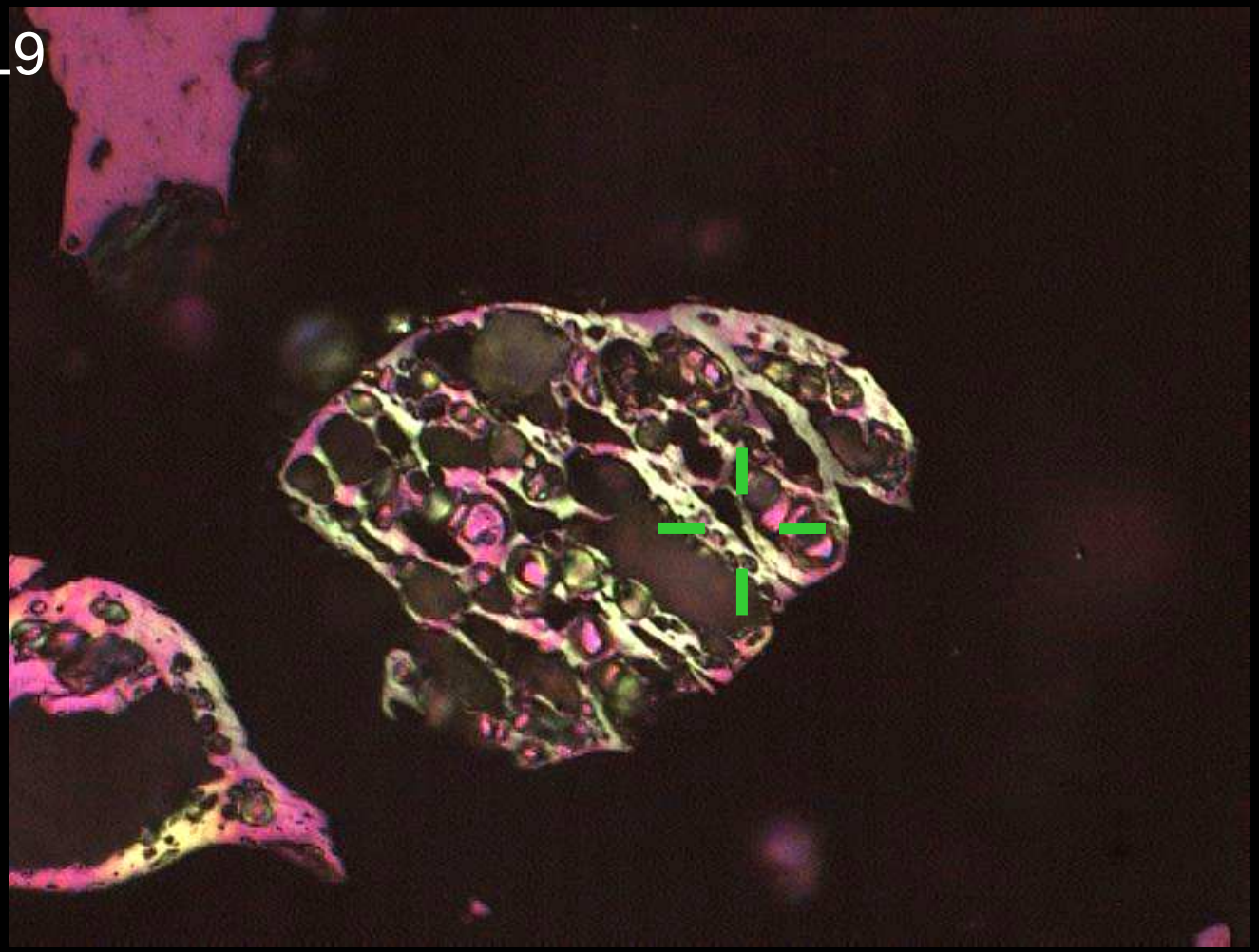


F18



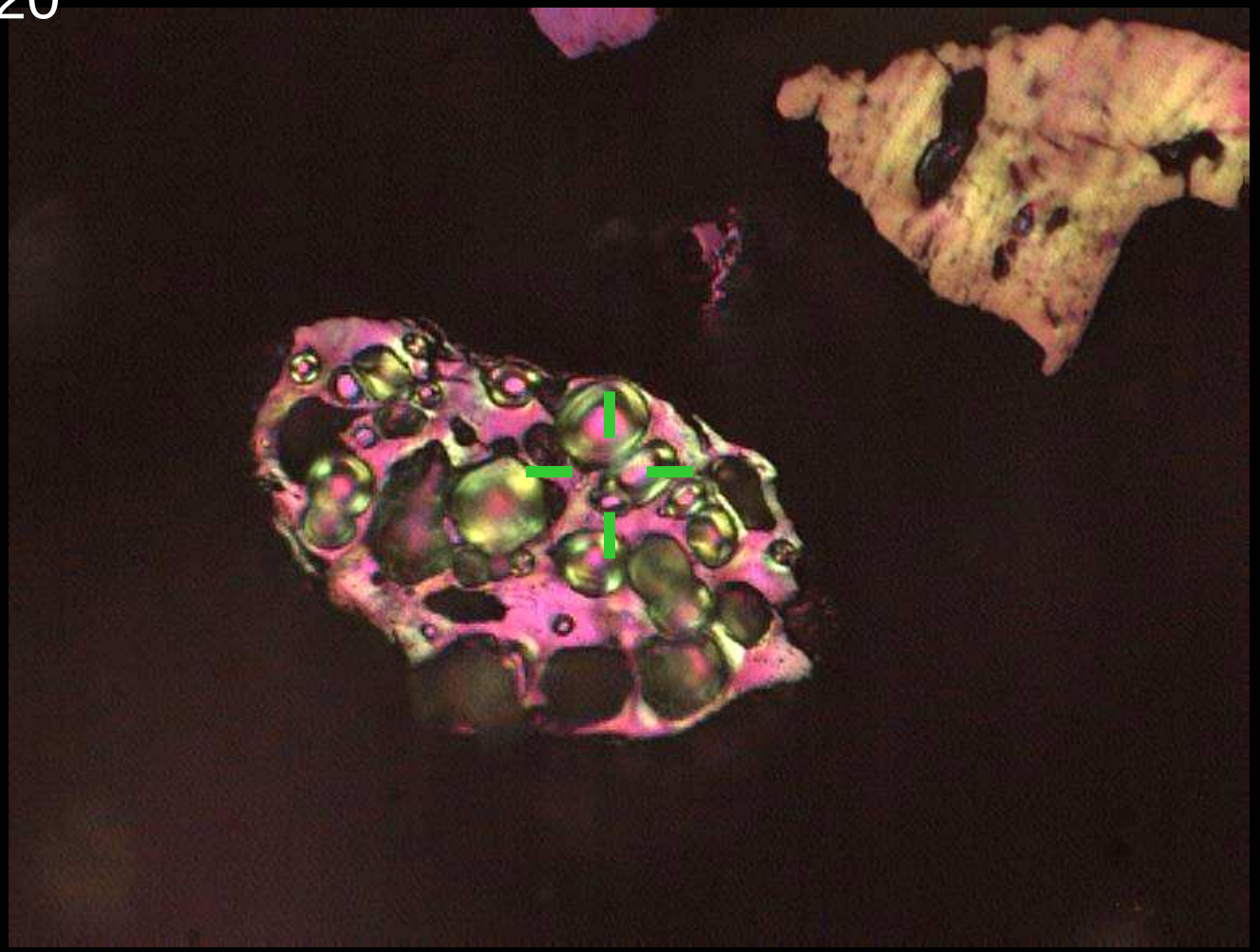
50 µm

F19



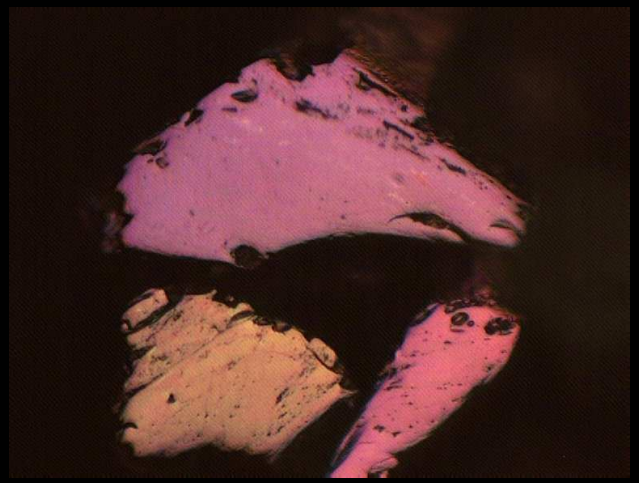
50 µm

F20



As you cannot have a look of the sample to figure out how typical vitrinite-derived material looks like, below there are some images showing selected views of vitrinite-derived material in the anthracite B and A coal chars

Vitrinite-derived material in Anthracite B&A (Rr>3%) coals (Sample W)



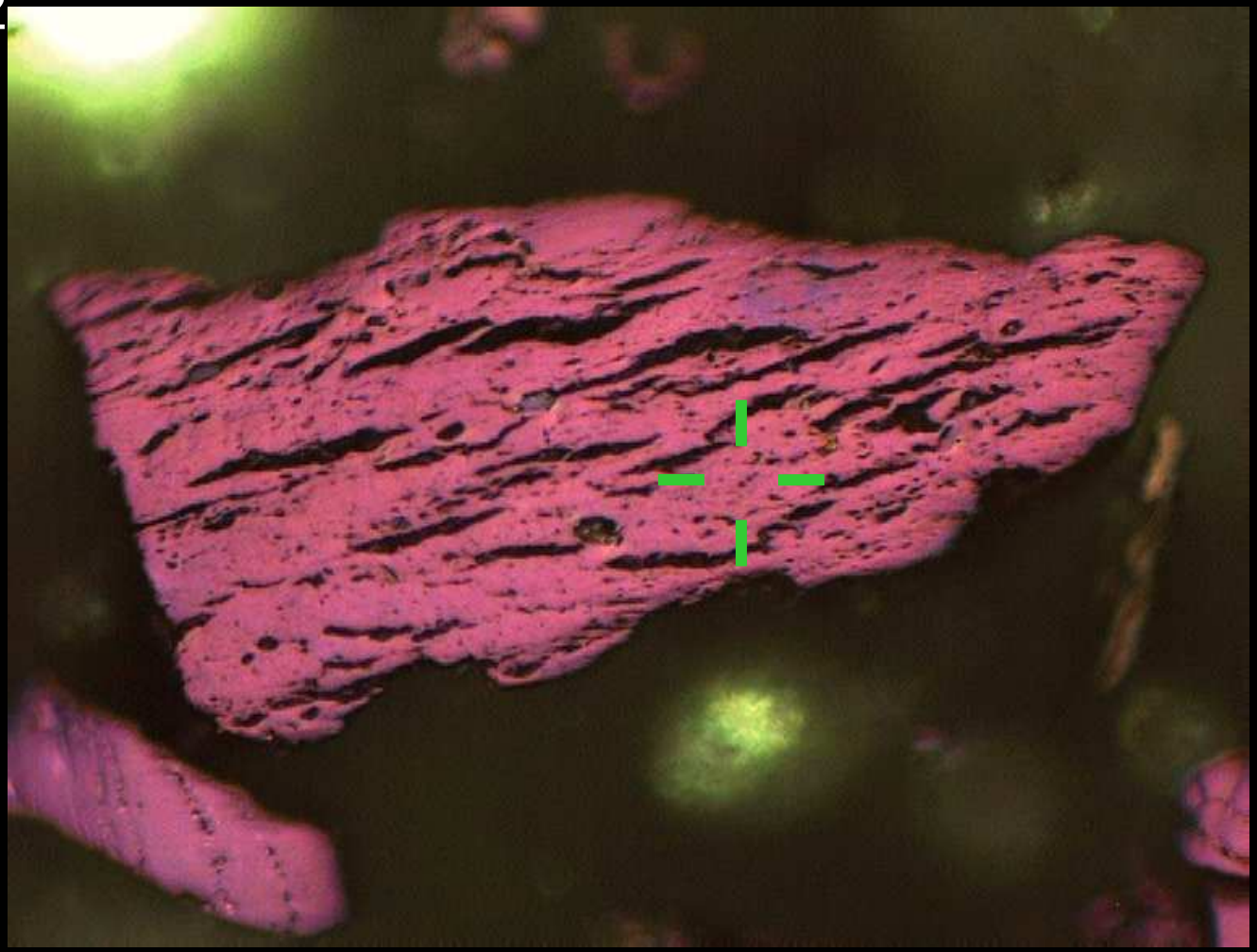
50 μm

At this rank neither vitrinite nor inertinite fuse under combustion conditions. The anthracite particles remain unchanged except for some contraction cleats in the structure due to the lost of the volatiles. The particles are mono-colored but anisotropic as shown by the different colour or different intensity of the various grains in an image

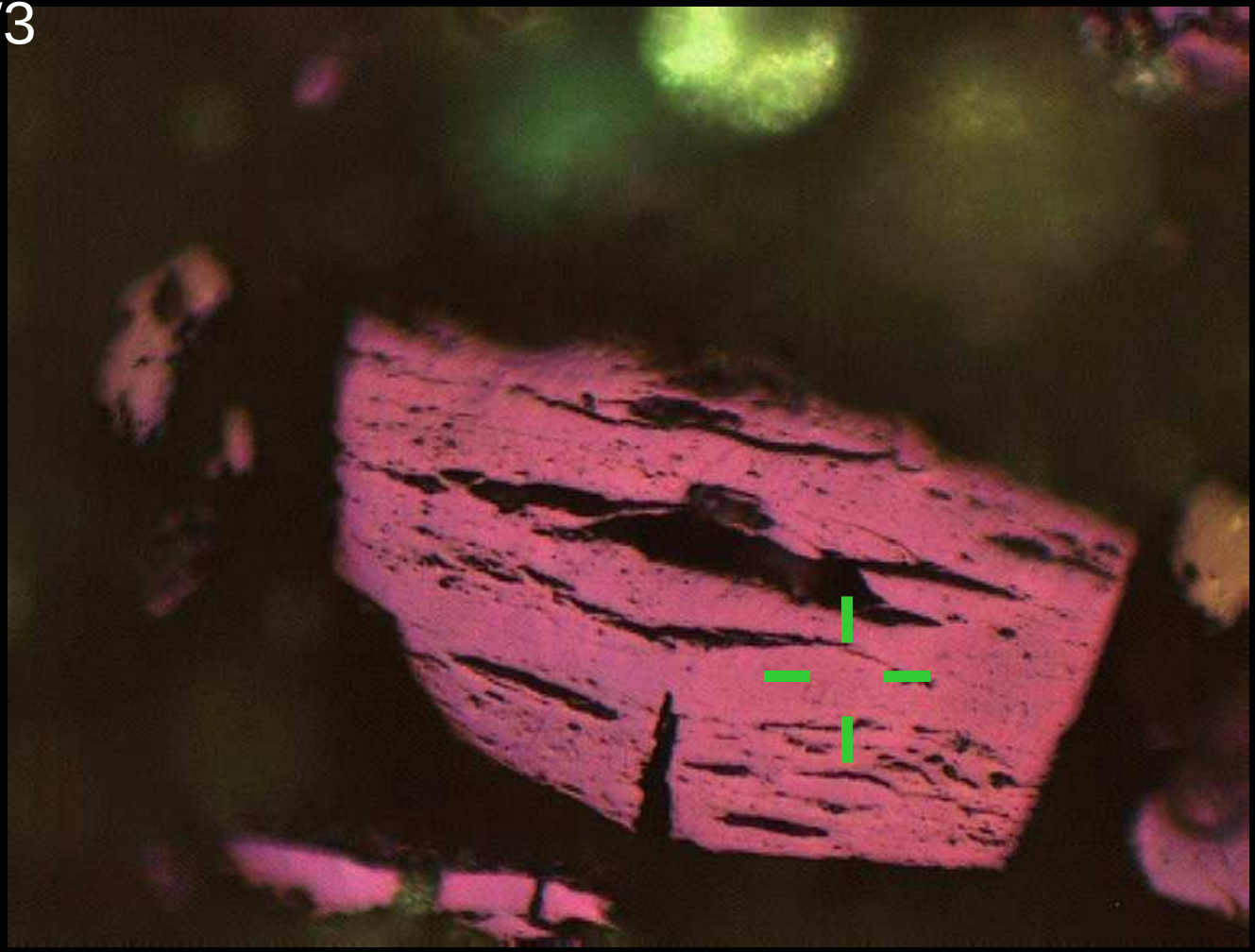
Good Luck!!

W1

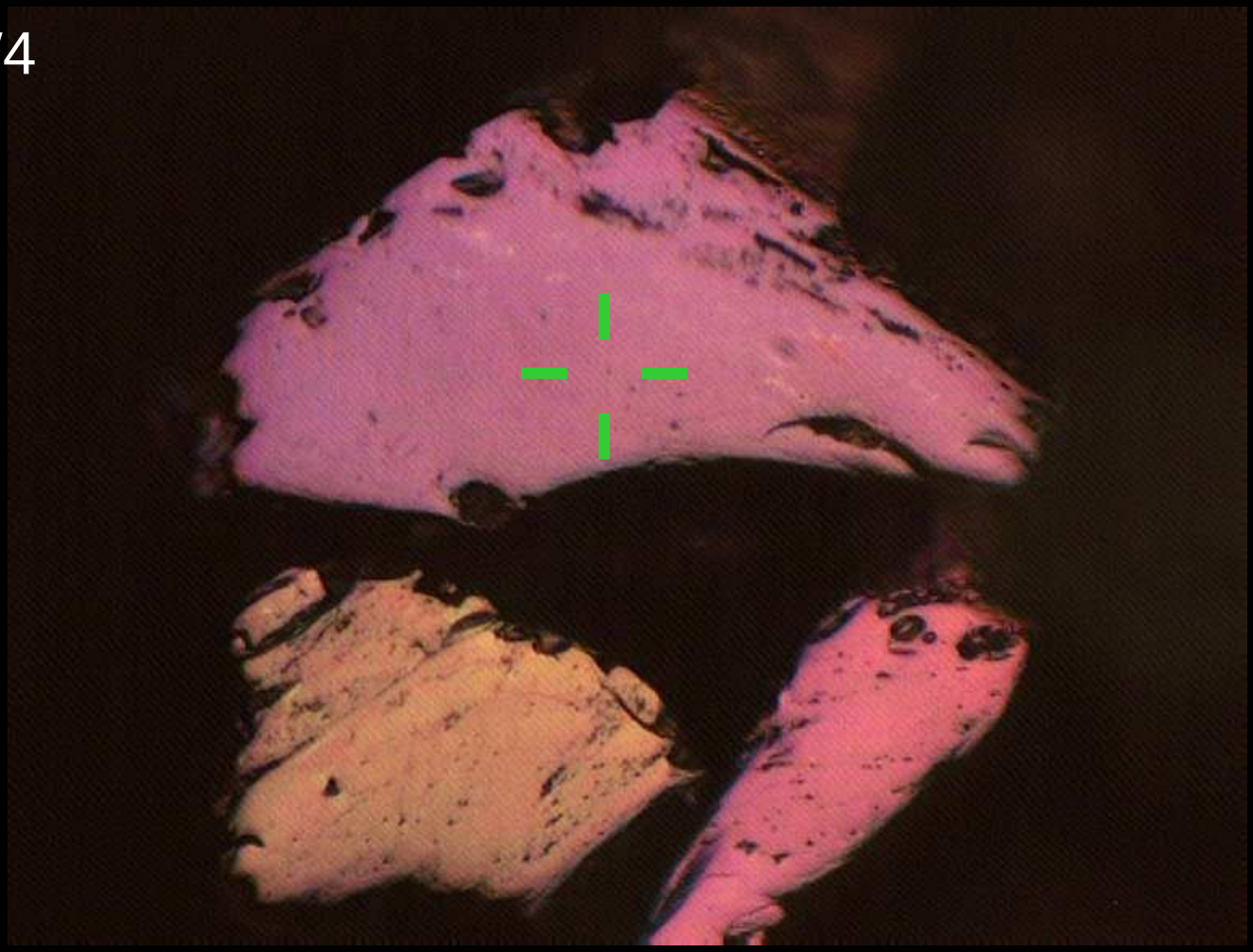
W2



W3

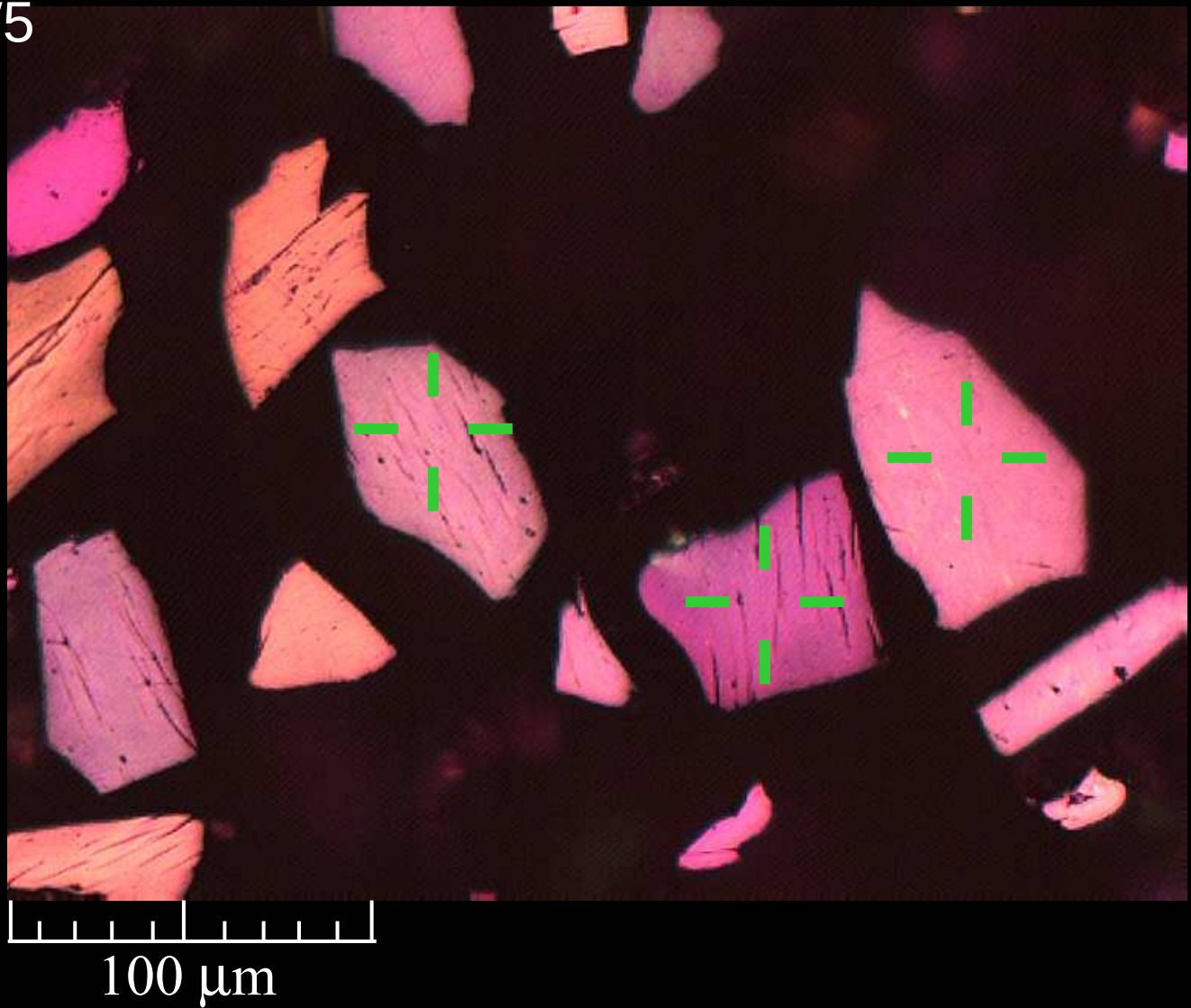


W4

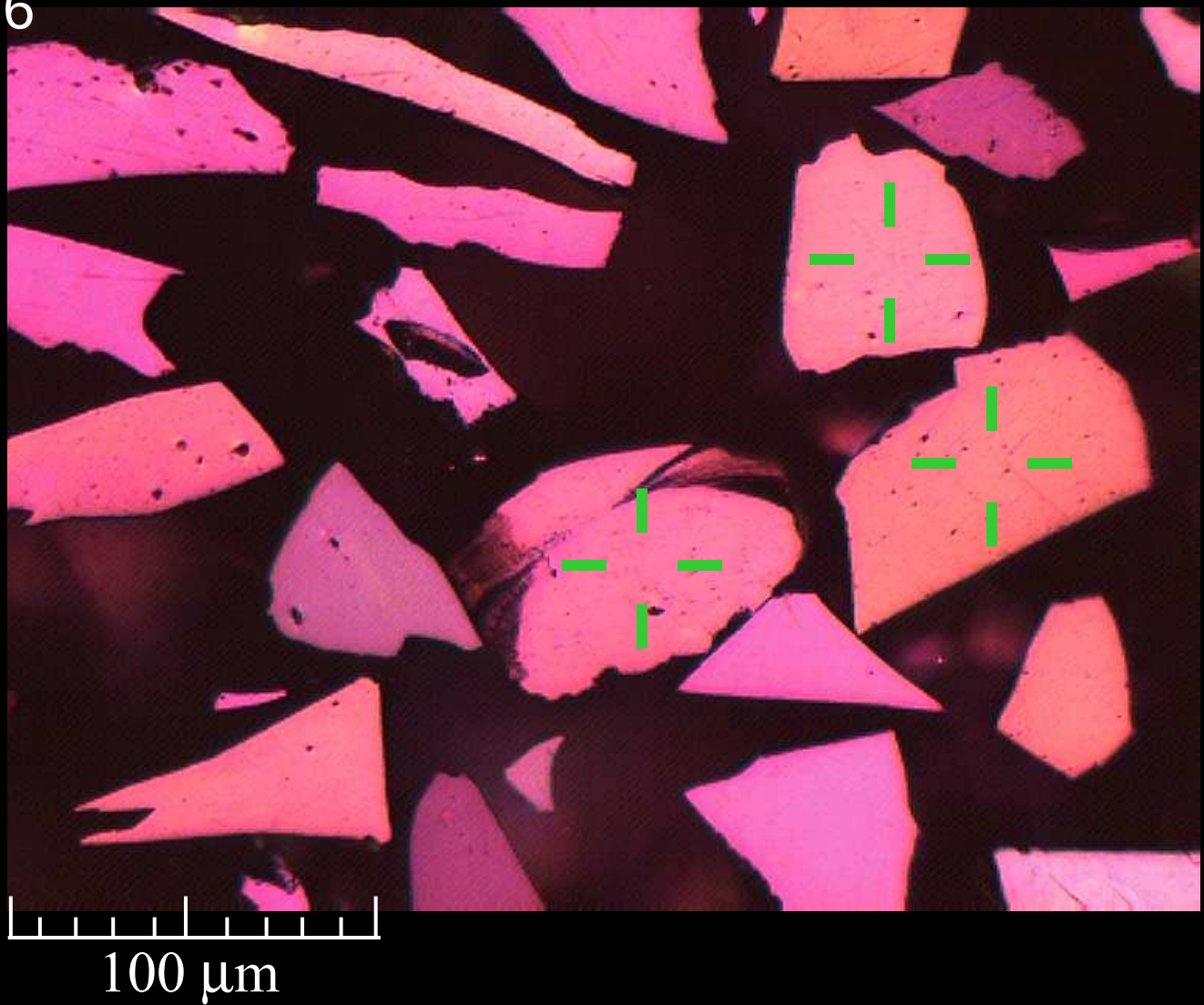


50 µm

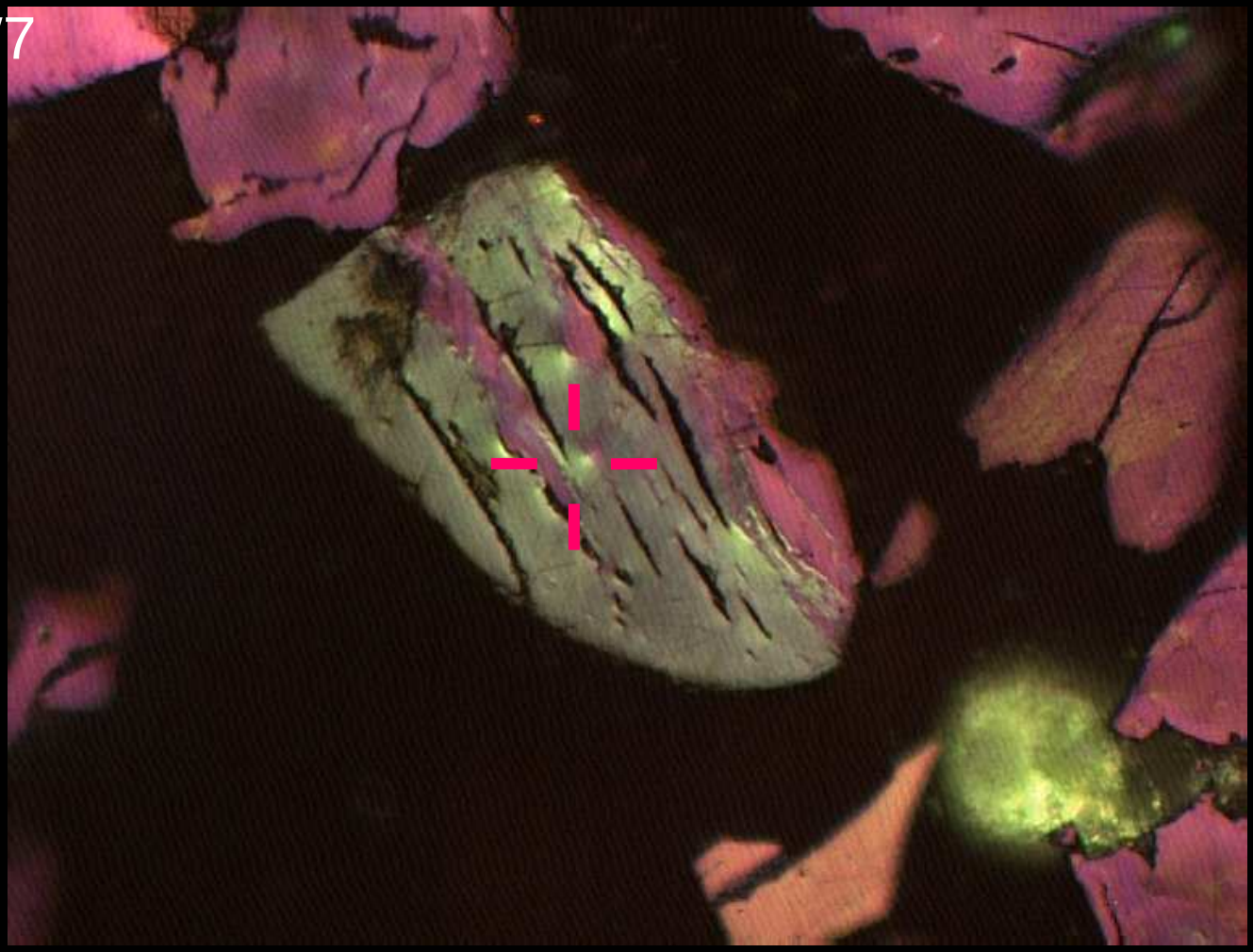
W5



W6

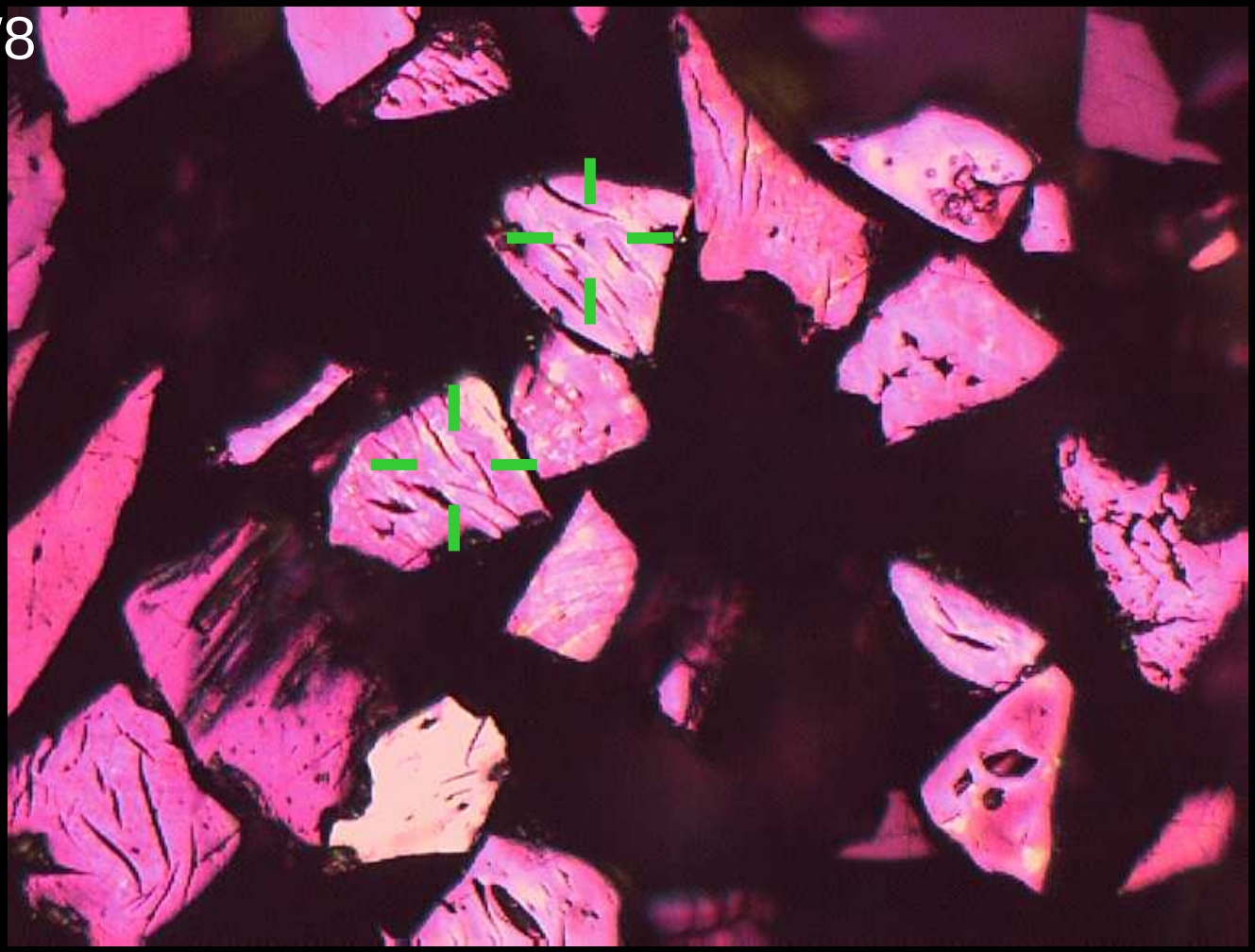


W7

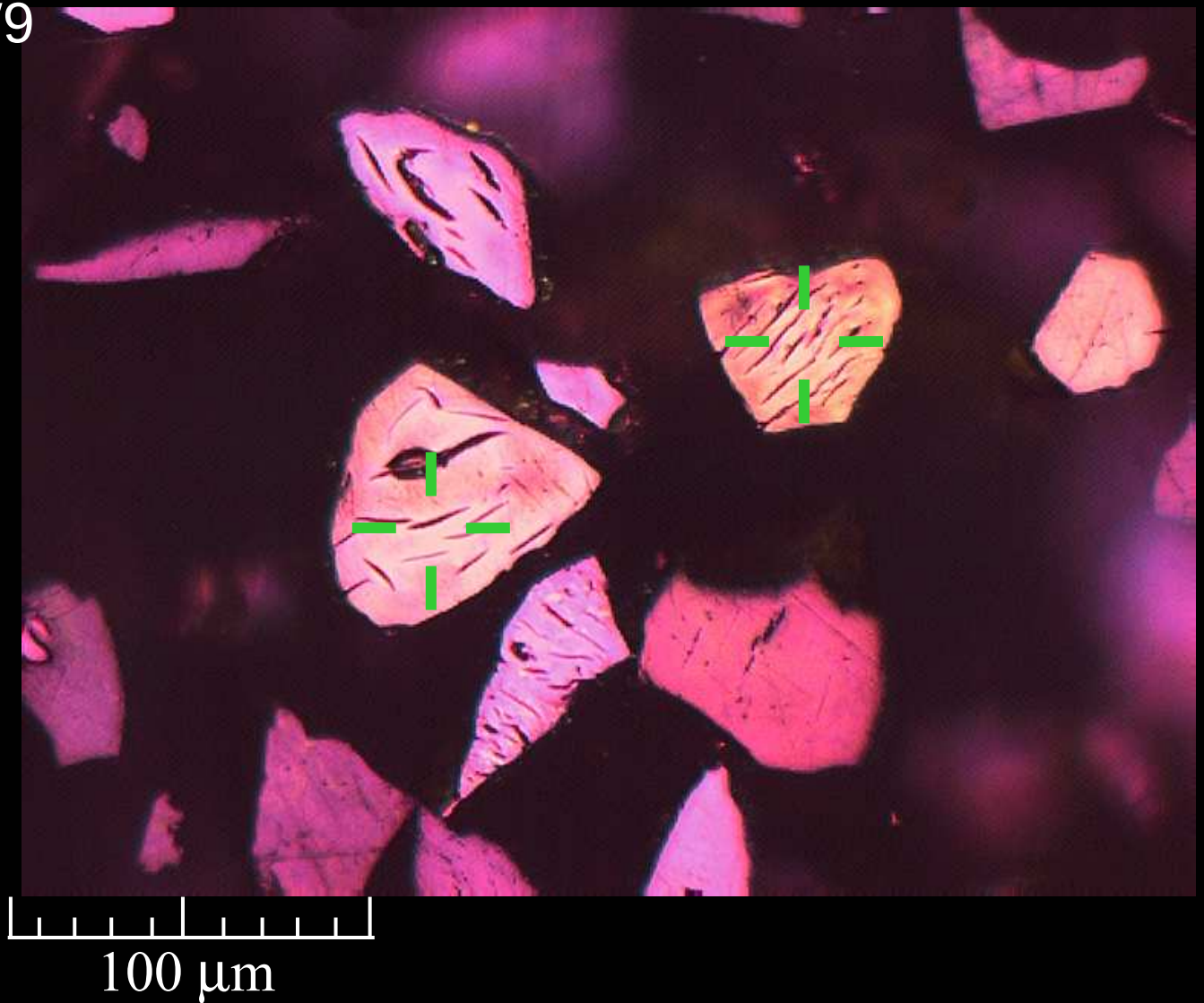


50 µm

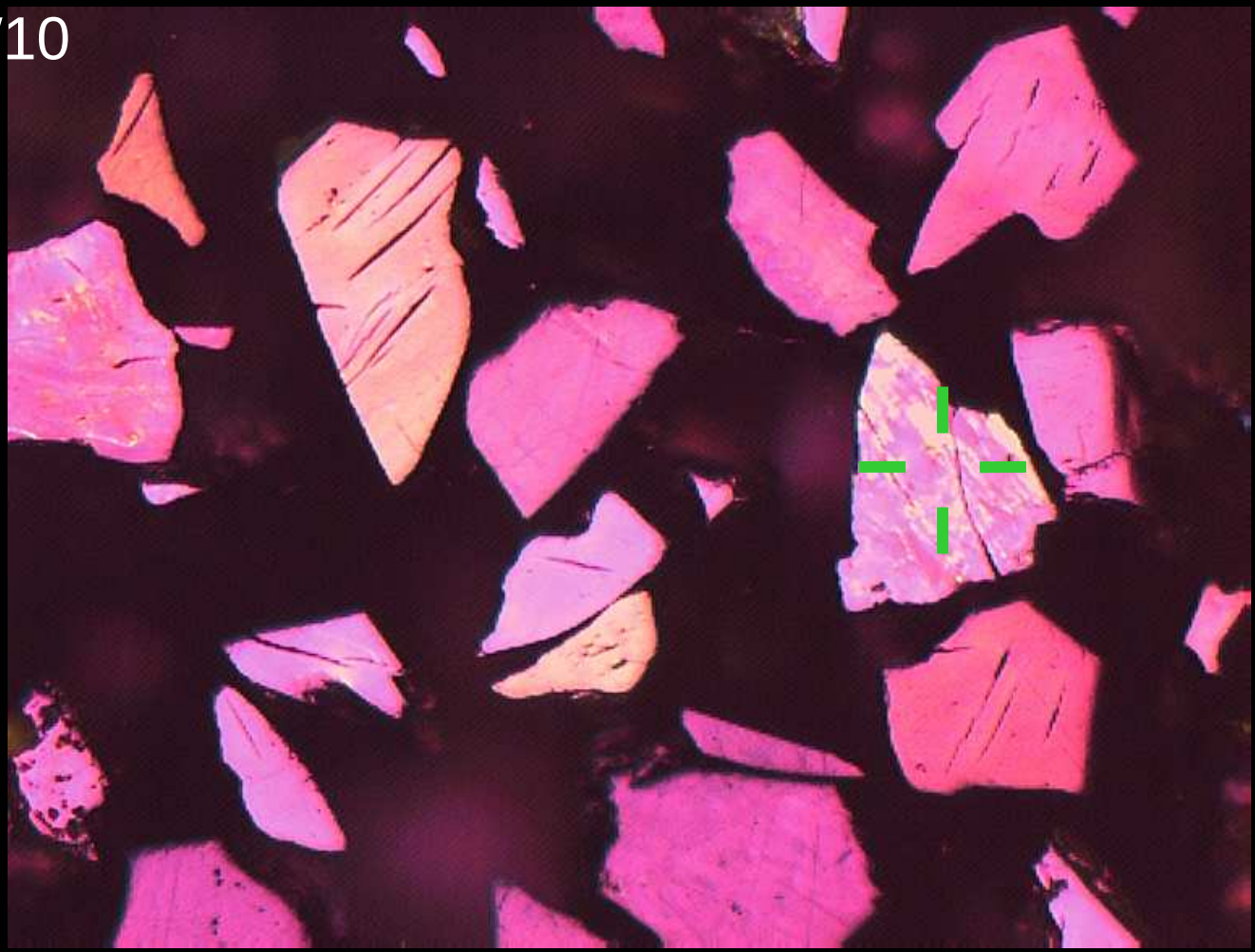
W8

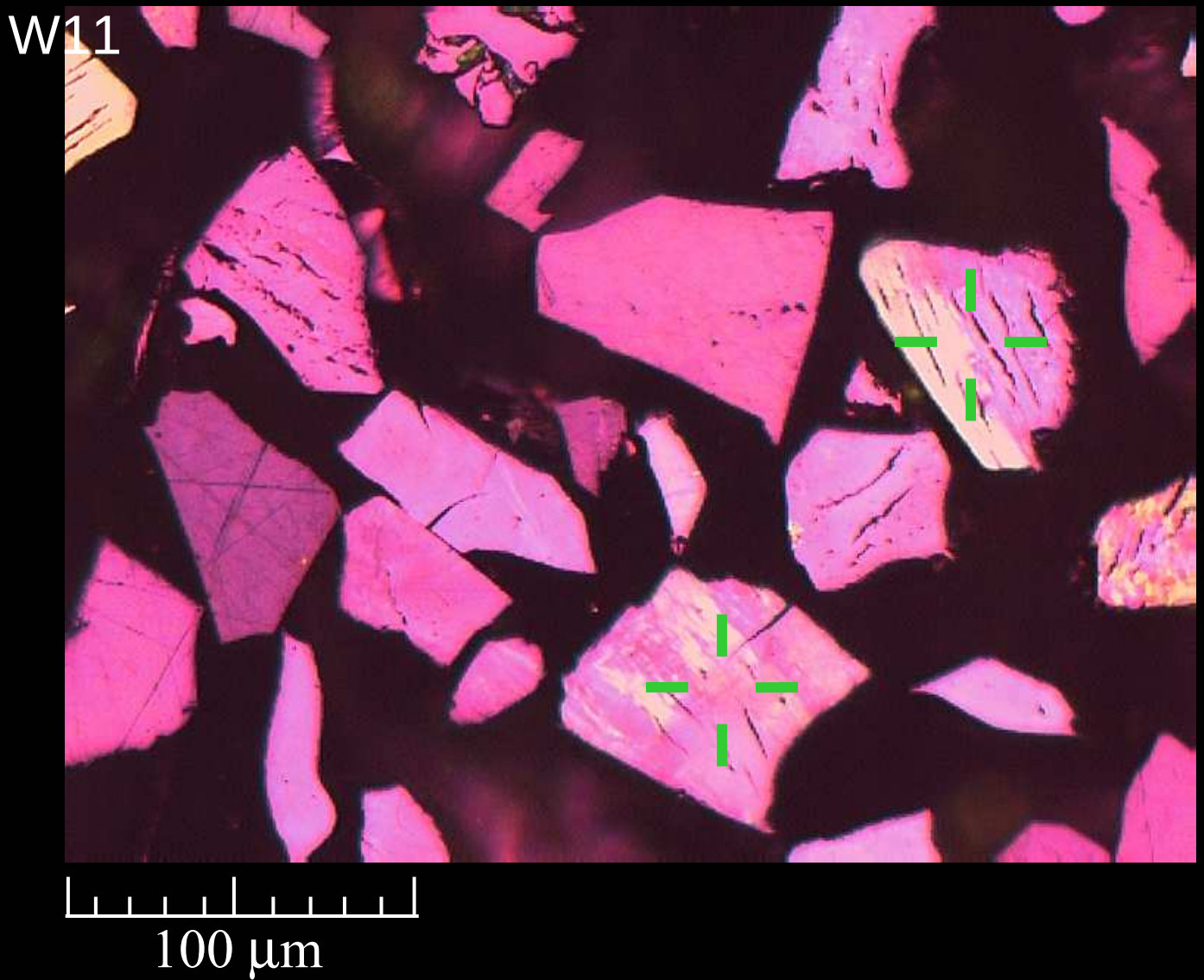


W9



W10





W12