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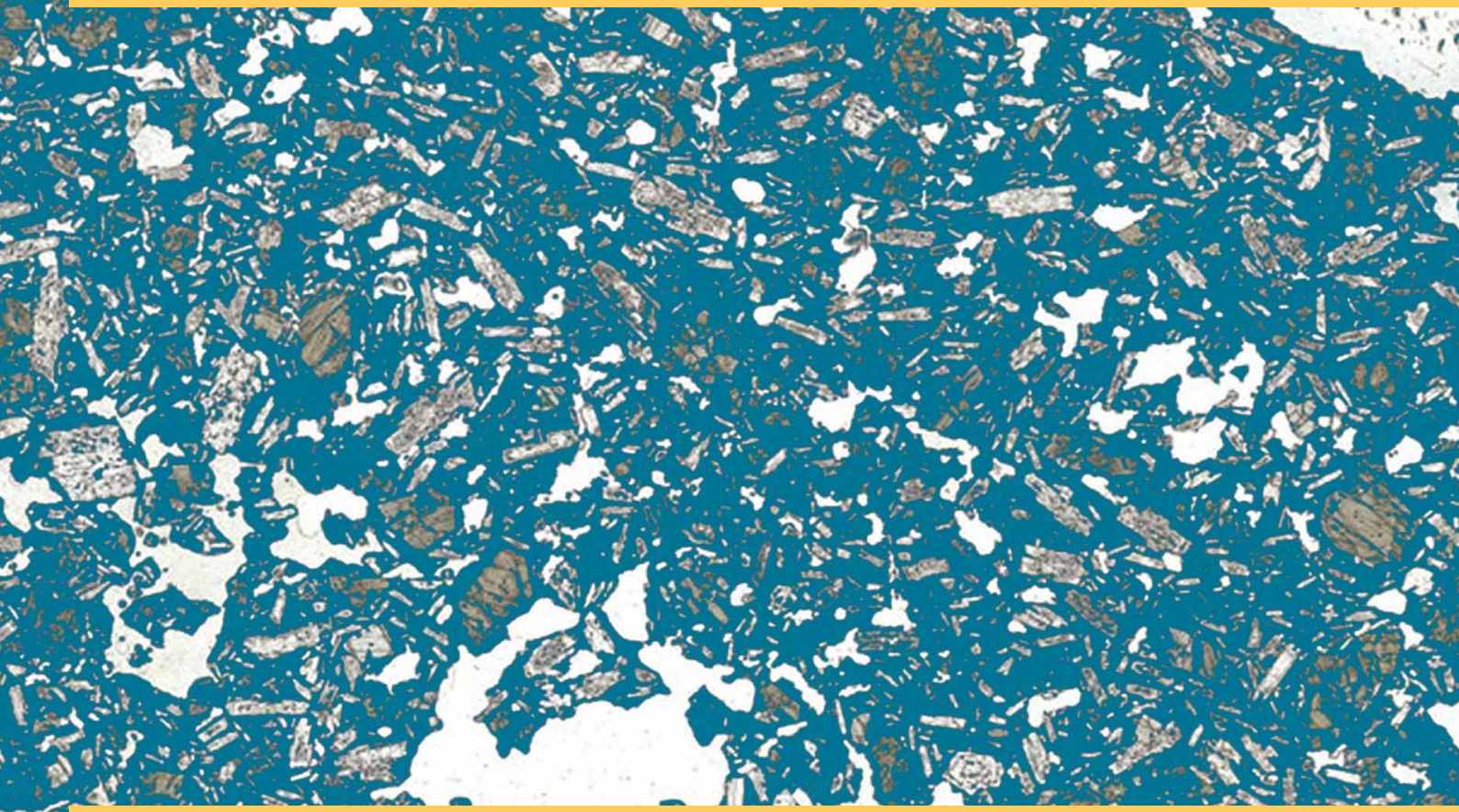

RAPPORTI TECNICI INGV

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RAPPORTI TECNICI INGV

A database recording the key features of thin sections from Etna eruptive products

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Cover | *In copertina* Example thin section with porphyritic texture, in plane polarized light; processed by B. Angioni

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Abstract

The Istituto Nazionale di Geofisica e Vulcanologia - Osservatorio Etneo (INGV - OE) hosts a collection of thin sections – thin slices of rock made for petrographic observation and chemical characterization under the microscope. Thin sections are from eruptive products of Etna, collected over the last 30 years for monitoring purposes. This collection is a resource that can be utilized by the INGV staff to support volcano monitoring as well as by researchers for investigating petrological processes and contributing to the understanding of the genesis of recent Etna magmas.
To facilitate and encourage these activities we created a database, in the form of a Microsoft Excel™ spreadsheet with defined fields, designed to describe the key petrographic properties of samples cut into thin sections, in a consistent way. The freely available database, which includes linked images of the thin sections, allows researchers interested in studying Etna volcanism to gain an overview of the main petrographic features of the rocks, which can help them to select the most appropriate samples for their research project(s). The information included in the database can also be utilized for monitoring purposes via comparison with samples from ongoing eruptive events. The database currently contains the description of 33 thin sections from the 2007-2008 eruptions of Etna, with the remaining thin sections in the INGV - OE collection to be added in future. This work has been designed to be incorporated, in the future, into the TSDSystem (Time Series Database), a resource developed over many years by the INGV - OE Information Technology (IT) staff, the purpose of which is to archive, update and distribute data from INGV - OE monitoring activities. It is hoped that this resource, once available for the scientific community, will both inspire and facilitate research projects involving Etna eruption products, making full use of this extensive but otherwise scarcely studied sample collection, with the ultimate aim of improving understanding of volcanic activity at Etna.

Keywords Thin sections; Petrology; Etna volcano

Introduction

Over many years of monitoring the volcanic activity at Etna, the INGV - OE and previously the IIV (Istituto Internazionale di Vulcanologia, CNR) have collected rock samples representative of the eruption products from the 1970's to present, which are archived in the OE lithoteque. A significant number of rock samples have been cut into thin sections (typically 30 microns thick slices of rock) for detailed petrographic and geochemical analysis under the microscope. This collection of thin sections provides a valuable resource for detailed studies, using specialist analytical equipment. For example, thin sections can be analysed petrographically (identification of mineral phases, textures, mineral zoning patterns, vesicle content, etc) via optical and scanning electron microscopy (SEM). The chemistry of the mineral phases and volcanic glass contained within the thin sections can also be analysed via techniques such as scanning electron microscopy equipped with microanalysis (SEM-EDS), Electron Microprobe (EPMA) and Laser ablation – inductively coupled plasma – mass spectrometry (LA-ICP-MS). The timespan of Etna's activity covered by the thin sections in the collection is broad enough to assess possible temporal trends in petrographic characteristics and mineral and groundmass chemistry. Finally, in case the outcrops for sampling specific eruptions are no longer accessible, due to burial by more recent activity, the thin sections in the INGV - OE collection represent precious tools for the study of past eruptions.

This work describes a new database, in the form of a Microsoft Excel™ spreadsheet whose contents will be hosted on the TSDSystem [Cassisi et al., 2015] of INGV - OE. This System was initially created to archive and manage different types of temporal data series (from volcano monitoring activities), but has been recently updated to archive geological data [Montalto et al. 2016] and chemical analyses of volcanic rocks [Corsaro and Miraglia, 2020; Miraglia, 2021a; b; c; d]. The proposed database summarizes the key petrographic features of selected thin sections from the INGV - OE collection. This resource is designed to be of use for monitoring and research activities aimed at studying the petrology of Etna volcanic products in greater detail. The database provides the users with an organized overview of the research materials currently available and allows them to select the thin sections with the most appropriate characteristics for monitoring purposes or research project(s). The information in the database can also be used to determine whether there is a need to collect additional samples in the field, or the thin section can be employed for different analytical methods (e.g. EMPA, SEM etc.) to carry out specific research activities.
So far, the database spreadsheet has started to be populated with information on the 33 thin sections of 2007 and 2008 Etna activity. This period has been selected because it involved both explosive and effusive eruptions that produced pyroclasts (bombs and lapilli) and lava flows whose petrographic and compositional features are quite variable. The database spreadsheet uses predefined fields, allowing consistent and easy descriptions of other thin sections to be added in the future.

1. Structure of the database

The database only provides the users with an overview of the key petrographic properties of the thin sections in a systematic way. The detailed description of the thin sections is left to the researchers in the context of their specific studies. The main sheet of the database ("Thin sections database") contains 16 fields (Appendix 1), each describing a different petrographic property or recording information about the thin sections included. Each field is listed in a separate column. The chosen fields can be implemented if required for future description of other Etna products or other volcanoes. Extra fields may also be added in future if sample types other than igneous rocks e.g. sedimentary xenoliths are to be described in the database.
To ensure consistency, certain fields such as "Groundmass texture" (Figure 1) are filled in using set descriptive terms, which are defined in the "Vocabulary" tab of the spreadsheet (Figure 1, Appendix 2). New terms could be added to the "Vocabulary" tab and used throughout the database, in case the next thin sections will contain different petrographic features that do not fit those in the current list. The spreadsheet format combined with the use of consistent descriptive terms allows the database to be easily searched and/or sorted. This enables the user to quickly identify thin sections with particular and/or desirable characteristics. The spreadsheet format also makes it simple for the user to download and modify the database to suit their needs.

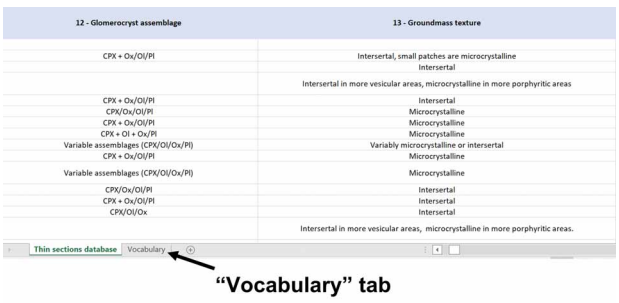

Figure 1 Screenshot from the main tab of the database spreadsheet, with field headings (blue highlighted band) and "Vocabulary" tab labelled.

The database is accompanied by images for each thin section (Appendix 3). Images were acquired with a scanner and show a portion of each thin section with dimensions of 36.5 x 24.3 mm. The chosen scanner is a Reflecta RPS 10M, used for Negative, Positive, B/W as strip (35 mm) or slide (5x5 cm). With a resolution of 10.000 dpi, a dynamic range of 4.2 Dmax and a high scanning speed. This scanner represents a good compromise in terms of speed and resolution. Images in Appendix 3 provide users with the additional benefit of viewing features such as the overall texture of the thin sections and the distributions of mineral phases and vesicles. It is hoped that in future, the database can be improved via the provision of images in cross polarised light, allowing the user to identify additional features not described in detail in the database such as mineral zoning, prior to selecting a thin section for their study.

2. Database fields

This section outlines the 16 fields in the database and provides definitions for the descriptive terms used to fill out each field, where applicable. Alongside the descriptive terms used for the 2007-2008 thin sections that make up the contents of the database so far, we have pre-emptively provided definitions for other descriptive terms that are likely to be used in the description of other thin sections in the future.
Each thin section in the database is described using the following 16 fields (also see Appendix 1).

1 – Thin section box name
Provides the name of the box in the INGV - OE collection in which the thin section is stored.

2 – Position of thin section in box
The thin section storage boxes have numbered positions – this value in the database refers to the position of the thin section in its storage box.

3 – Thin section label
The label of the thin section, which is identical to the label of the rock specimen archived in the lithoteque of INGV - OE, from which the thin section is derived. The label represents a unique identifier code that in the future will link the database of thin sections and the INGV - OE database of rock samples archived in the lithoteque. This will greatly enhance the background information available for thin sections encompassing all the metadata used to characterize the rock sample (e.g. onset-end of the eruption, type of activity, vent location, type of sample, sampling method, etc). The database of rock sample will also contain the geographic coordinates of the rock sample from which the thin section has been cut.

4 - Date of rock sample eruption
The date of eruption of the rock sample from which the thin section is derived.

5 – Rock type
The type of rock represented by the hand specimen/rock sample from which the thin section was made. If the rock sample is from an effusive eruption, the rock type is described as “Lava flow”. For products of explosive activity (pyroclasts), rock types are described based on their size. Pyroclasts with diameter between 2-64 mm are referred to as “Lapilli”, while pyroclasts with a diameter > 64 mm are referred to as “Bomb/Block”. If pyroclasts with diameter < 2 mm are described in the database in the future, they will be referred to as “Ash”.

6 – Thin section dimensions (mm)
The dimensions (length and width) of the thin section in mm.

7 – Thin section thickness (microns)
The thickness of each thin section in microns. Some destructive analytical techniques e.g. LA-ICP-MS may require knowledge of thickness. The section thickness also affects the birefringence colours of mineral phases in cross polarised light under an optical microscope, hence is important to know for identification of mineral phases.

8 – Thin section type
Thin sections are described as either "Polished" if they are not carbon coated, "Polished (cc)" if carbon coated, and "Cover slip" if they are supplied with a cover slip. Different specialist analytical methods require thin sections to prepared in particular ways. For example, analysis via SEM and EPMA requires thin sections to be carbon coated, whereas analysis via LA-ICP-MS requires polished thin sections.

9 – Texture
Describes the overall texture of the thin section. All thin sections described in the database so far (2007-2008) show porphyritic texture, defined in the "Vocabulary" tab of the database, as "Larger crystals set in a fine grained or glassy groundmass. Crystals are typically > 0.5 mm and are significantly larger than groundmass phases". An example of a thin section with porphyritic texture is shown in Figure 2. The "Vocabulary" tab also contains definitions for the descriptive terms "aphyric" and "holocrystalline" (Appendix 2).
Other descriptive terms for this field can be added to the "Vocabulary" tab to be used in the database in the future as required.

Figure 2 Example thin section (190608A in database) with porphyritic texture, in plane polarized light. Red scale bar = 5 mm.

10 – Mineral phase assemblage
Description of the mineral phases present in the thin section. The 2007-2008 thin sections described in the database so far contain four mineral phases – Olivine (Ol), Clinopyroxene (Cpx), Plagioclase (Pl) and Opaque oxides (Ox).

11 – Relative abundances of mineral phases
An estimate of the relative abundances of the mineral phases present in the thin section. Where two phases are listed together e.g. "Cpx + Pl > Ol > Ox", this indicates that Cpx and Pl are present in near equal abundance and that both of these phases are more abundant than Ol (and Ox). It is recommended that users quantitatively determine mineral abundances when using the thin sections for detailed study.

12 – Glomerocryst assemblage
Glomerocrysts (aggregates of several crystals) are a common feature of Etna eruptive products

and, if present, details of the mineral associations are provided in this separate column. Where a specific assemblage is listed, e.g. "Cpx + Ox/Pl/Ol", this means that Cpx and Ox are always found in the glomerocryst assemblage and that some glomerocrysts additionally contain Ol and/or Pl. If the assemblage is listed as "Cpx/Ox/Ol/Pl", Cpx is always present in the glomerocrysts, with Ox and/or Ol and/or Pl. Where the glomerocryst assemblage is described as "Variable assemblages (Cpx/Ol/Ox/Pl)" the combinations of minerals forming glomerocrysts are not consistent.

13 – Groundmass texture

Two descriptive terms are used in the database so far (2007-2008 thin sections) for the "Groundmass texture" field and are defined in the "Vocabulary" tab of the database spreadsheet. "Intersertal" groundmass texture is defined as "the space between crystals (groundmass) is filled with a mixture of glass and microlites". "Microcrystalline" groundmass texture is defined as "the space between crystals (groundmass) is composed almost entirely of microlites (most commonly plagioclase feldspar and oxides)". Examples of thin sections with these groundmass textures are shown in Figure 3. This terminology is consistent with the descriptions of some of these samples given in Corsaro and Miraglia [2014]. The "Vocabulary" tab also contains definitions for the descriptive terms "cryptocrystalline" and "glassy" (Appendix 2). Once again, the "Vocabulary" tab can be updated to include more descriptive terms for thin sections with different groundmass textures added to the database in the future.

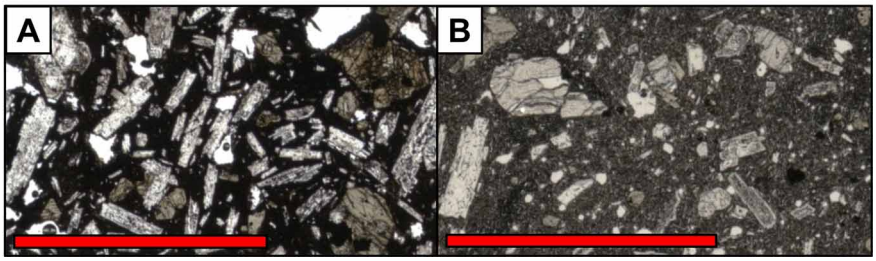

Figure 3 Example thin sections (a) 190608A and b) 170608 in database, with a) intersertal and b) microcrystalline groundmass texture, in plane polarized light. Red scale bar = 2.5 mm.

14 – Estimate of porphyricity (%)

Defined as the percentage (%) of the whole thin section (composed of crystals, vesicles and groundmass) that consists of larger crystals clearly distinct from microlites in the groundmass, typically > 0.5 mm. Estimates provided represent an average for the whole thin section. Estimates were made visually, using the reference diagrams of Jerram and Petford [2011] (Figure 4) and hence are only rough evaluations. Quantitative analysis via point counting is recommended for accurate estimations of this parameter if using the thin sections for more detailed study.

15 – Estimate of vesicularity (%)

Defined as the percentage (%) of the whole thin section (composed of crystals, vesicles and groundmass) that consists of vesicles. Estimates provided represent an average for the whole thin section. Estimates were made visually, using the reference diagrams of Jerram and Petford [2011] (Figure 4) and hence are only rough evaluations. Quantitative analysis via point counting is recommended for accurate estimations of this parameter if using the thin sections for more detailed study.

16 – Notes
This field describes any other features of note in the thin sections not covered by the other fields.

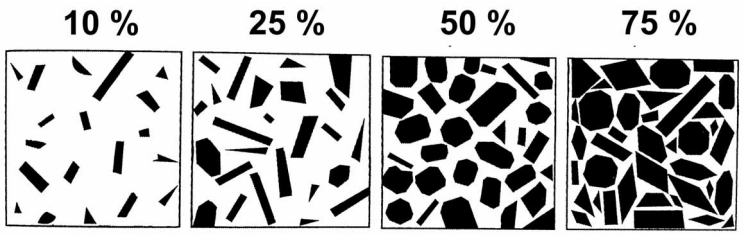

Figure 4 Reference diagrams for visual estimation of porphyricity/vesicularity, modified from Jerram and Petford [2011]. If the abundance of crystals/vesicles in the thin section was determined to be between the values shown on two of the reference diagrams, an appropriate intermediate value was assigned.

3. Current database. Thin sections from 2007-2008 eruption products

The database spreadsheet, currently filled in with descriptions of 33 thin sections from 2007-2008 eruption products, is displayed in full in Appendix 1. From a brief look at the database, the user can identify key petrographic features of the 2007-2008 samples. For example, all samples have a porphyritic texture and contain the mineral phase assemblage Cpx, Ol, Ox, Pl. The wide range of values in the "Estimate of porphyricity and vesicularity" fields shows that some samples are markedly more vesicle or crystal rich. Such information is valuable to the user/researcher when selecting samples for investigation of specific issues. For example, a researcher may want to investigate chemical differences between samples with high and low crystal/vesicle content, or study chemical and textural differences in a specific mineral phase (e.g. Cpx) present across all the samples. It is hoped that over time, the remainder of the thin sections in the INGV - OE collection will be systematically described and included in the database. This resource will be made freely available to researchers with the aim of facilitating a wide range of petrological studies making use of this extensive and well characterized (but little studied) collection of thin sections.

4. Conclusions

We have created a database, in the form of a simple Microsoft Excel™ spreadsheet that can be easily edited and updated, for consistent description of key petrographic properties of thin sections from Etna eruption products belonging to the INGV - OE collection. The database currently contains information and images on thin sections from 2007-2008 eruption products and will be updated with descriptions of the rest of the collection in the future. The use of consistent fields for thin sections description, and predefined descriptive terms, allows easy searching/sorting of the database to find samples with specific characteristics. An additional "Vocabulary" tab allows new descriptive terms to be added and used as required when further samples are added to the database. We hope this database will become a valuable tool supporting Etna volcano monitoring and the scientific community interested in obtaining samples/thin sections for detailed petrological investigation of Etna volcanism. To help achieve

this aim, this database has the potential to be incorporated into multidisciplinary distributed Research Infrastructure which facilitates the integrated use of data and data products from the solid Earth Science community, such as the Volcanic Gateway data Hub [Puglisi et al., 2022] created for EPOS, the European Plate Observing System, Volcanic Observations Thematic Core Service (VO-TCS). Ultimately, the database represents a continuously expanding resource for petrological studies on recent Etna eruption products. The high quality research utilizing the thin sections described in the database will help to improve broader understanding of volcanic activity at Mt Etna, supporting the monitoring efforts of INGV - OE.

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Appendix 1

1 -Thin section box name	2 - Position of thin section in box	3 - Thin section label	4 - Date of rock sample eruption	5 - Rock type	6 - Thin section dimensions (mm)	7 -Thin section thickness (microns)	8 - Thin section type	9 - Texture	10 - Mineral phase assemblage	11 - Relative abundances of mineral phases
ETNA 2007	1	CSE290307A	29/03/2007	Lapilli	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Cpx + Pl > Ol > Ox
	2	CSE290307B	29/03/2007	Lava flow	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Cpx + Pl > Ol > Ox
	3	CSE110407A	11/04/2007	Lapilli	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Cpx + Pl > Ol > Ox
	4	110407A	11/04/2007	Lapilli	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	5	110407B	11/04/2007	Bomb/Block	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	6	CSE110407B	11/04/2007	Bomb/Block	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	7	CSE070507	07/05/2007	Lava flow	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	8	CSE310807A	31/08/2007	Bomb/Block	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	9	CSE040907L	04/09/2007	Lava flow	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	10	CSE040907D	04/09/2007	Bomb/Block	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	11	CSE040907F	04/09/2007	Bomb/Block	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	12	CSE040907B	04/09/2007	Lava flow	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	13	CSE040907C	04/09/2007	Lapilli	48 x 28	30	Cover slip	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	14	CSE231107A	23/11/2007	Lava flow	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	15	CSE231107B	23/11/2007	Bomb/Block	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	16	CSE231107D	23/11/2007	Bomb/Block	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
ETNA 2008	1	CSE1000508B	10/05/2008	Lava flow	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	2	130508I	13/05/2008	Lava flow	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	3	130508H	13/05/2008	Lava flow	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	4	130508E	13/05/2008	Bomb/Block	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	5	130508M	13/05/2008	Lava flow	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	6	130508G	13/05/2008	Lava flow	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	7	140508B	14/05/2008	Bomb/Block	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	8	290508	29/05/2008	Bomb/Block	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol + Ox
	9	110608	11/06/2008	Bomb/Block	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	10	170608	17/06/2008	Lava flow	48 x 28	30	Polished (cc)	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	11	190608A	19/06/2008	Lava flow	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	12	290608	29/06/2008	Lava flow	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	13	050708	05/07/2008	Bomb/Block	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	14	110708	11/07/2008	Bomb/Block	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Cpx + Pl > Ol > Ox
	15	210708LAP	21/07/2008	Lapilli	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	16	210708	21/07/2008	Lava flow	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox
	17	070908	07/09/2008	Lapilli	48 x 28	30	Polished	Porphyritic	Cpx, Ol, Ox, Pl	Pl > Cpx > Ol > Ox

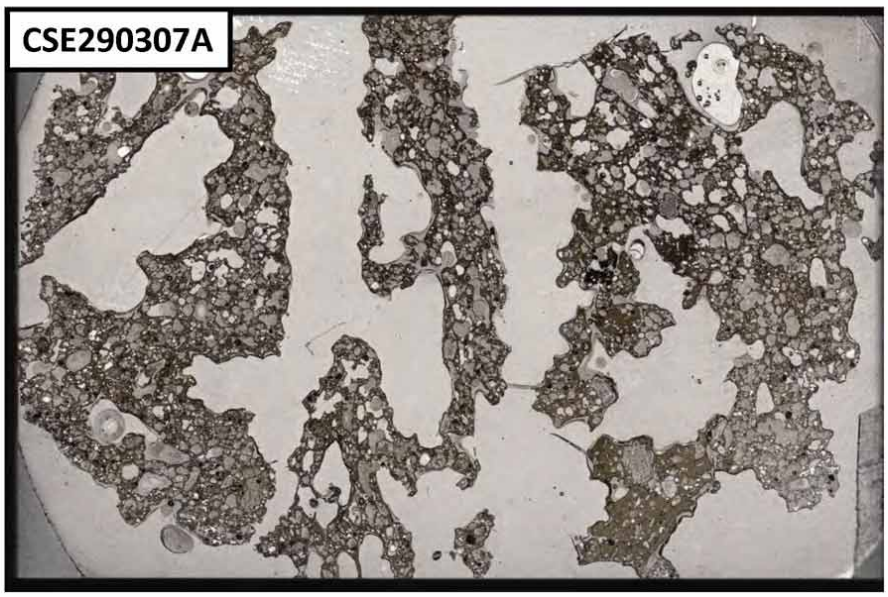
12 - Glomerocryst assemblage	13 - Groundmass texture	14 - Estimate of porphyricity (%)	15 - Estimate of vesicularity (%)	16 -Notes
	Intersertal	5	50	
Variable assemblages (Cpx/Ol/Ox/Pl)	Variably microcrystalline or intersertal	10	10	Patches of intersertal groundmass defined by black glass.
Cpx + Ox/Ol/Pl	Intersertal	5	60	
Cpx/Ox/Ol/Pl	Microcrystalline	25	5	
Cpx + Ox/Ol/Pl	Microcrystalline	20	15	
Cpx + Ox/Ol/Pl	Intersertal	5	60	
	Intersertal in more vesicular areas, microcrystalline in more porphyritic areas	15	30	Some areas of the section have > vesicularity, less phenocrysts, and vice versa.
Cpx + Ol + Ox/Pl	Microcrystalline	15	40	
Cpx + Ox/Ol/Pl	Microcrystalline	20	5	
Cpx/Ol/Ox	Intersertal	5	70	
	Intersertal in more vesicular areas, microcrystalline in more porphyritic areas.	15	20	Some areas of the section have > vesicularity, less phenocrysts, and vice versa.
Cpx + Ox/Ol/Pl	Mostly microcrystalline, patches intersertal	20	10	Patches of intersertal groundmass defined by black glass and appear darker than rest of groundmass.
Cpx + Ox/Ol/Pl	Intersertal	5	65	
Cpx + Ox/Ol/Pl	Intersertal, small patches are microcrystalline	20	50	
Variable assemblages (Cpx/Ol/Ox/Pl)	Microcrystalline	20	20	Contains a Cpx + Pl + Ol + Ox microxenolith with blebs of brown glass between crystals.
Cpx/Ox/Ol/Pl	Intersertal	5	70	
Variable assemblages (Cpx/Ol/Ox/Pl)	Mostly microcrystalline, patches intersertal	20	10	Patches of intersertal groundmass defined by black glass and appear darker than rest of groundmass.
Variable assemblages (Cpx/Ol/Ox/Pl)	Some areas microcrystalline, some areas intersertal	20	10	Areas of intersertal groundmass defined by black glass and appear darker than rest of groundmass.
Cpx/Ox/Ol/Pl	Microcrystalline	20	15	
Cpx + Ox/Ol.	Mostly intersertal, microcrystalline at edges	5	80	Areas of microcrystalline groundmass appear paler brown than rest of groundmass.
Variable assemblages (Cpx/Ol/Ox/Pl)	Microcrystalline	25	5	
Variable assemblages (Cpx/Ol/Ox/Pl)	Microcrystalline	15	20	
Variable assemblages (Cpx/Ol/Ox/Pl)	Intersertal	10	40	
Variable assemblages (Cpx/Ol/Ox/Pl)	Microcrystalline	10	65	
Cpx/Ox/Ol/Pl	Mostly microcrystalline, small patches intersertal	20	20	Small patches of intersertal groundmass defined by black glass and appear darker than rest of groundmass.
Cpx + Ox/Ol/Pl	Microcrystalline	20	5	
Variable assemblages (Cpx/Ol/Ox/Pl)	Mostly intersertal, patches microcrystalline	30	15	Patches of microcrystalline groundmass appear darker brown than rest of groundmass.
Cpx/Ox/Ol	Microcrystalline	20	10	
Cpx/Ox/Ol/Pl	Microcrystalline	10	30	
Cpx + Ox/Ol/Pl	Intersertal	10	40	
Cpx + Ox/Ol/Pl	Microcrystalline	15	20	
Cpx + Ox/Ol/Pl	Intersertal	20	15	
Variable assemblages (Cpx/Ol/Ox/Pl)	Some areas microcrystalline, some areas intersertal	20	15	Areas of intersertal groundmass defined by black glass and appear slightly darker than rest of groundmass.

Appendix 2

Field	Descriptive term used in database	Definition for descriptive term used in database
Texture	Porphyritic	The thin section contains larger crystals set in a fine grained or glassy groundmass. Crystals are typically > 0.5 mm and are significantly larger than groundmass phases.
	Aphyric	The thin section contains < 5 % crystals (typically > 0.5 mm) and/or only microlites.
	Holocrystalline	The thin section is composed entirely of crystals (no groundmass is present).
Groundmass texture	Intersertal	The space between crystals (groundmass) is filled with a mixture of glass and microlites.
	Microcrystalline	The space between crystals (groundmass) is composed almost entirely of microlites. (Most commonly plagioclase feldspar and oxides).
	Cryptocrystalline	The space between crystals (groundmass) is composed of very small microlites, that cannot be individually distinguished using an optical microscope.
	Glassy	The space between crystals (groundmass) is filled with only glass. No microlites can be observed using an optical microscope.

Appendix 3. Thin section images

This appendix contains images of all thin sections from the 2007-2008 Etna eruptive products described in the database so far. These images provide an overview of the thin sections allowing the user of the database to observe some of the features described. All thin section images show a portion of the slide with dimensions of 36.5 x 24.3 mm, which represents the maximum scan area of the scanner used for the imaging. As with the database spreadsheet, this document can be modified to incorporate images of further thin sections added to the database in the future.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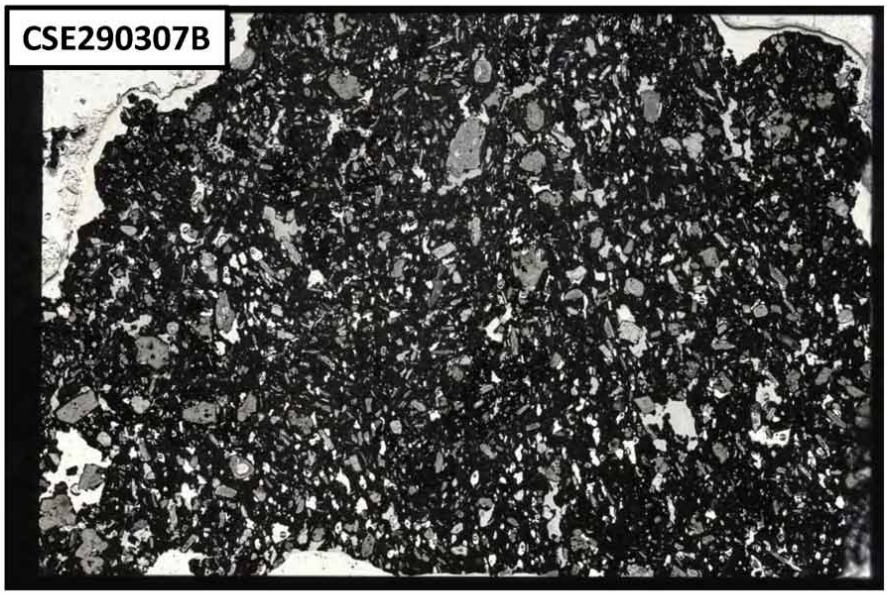
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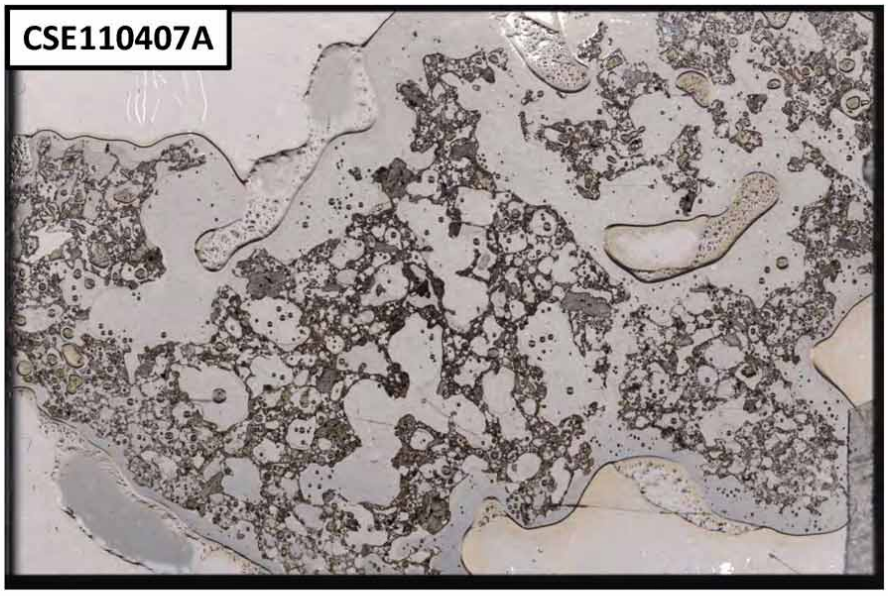
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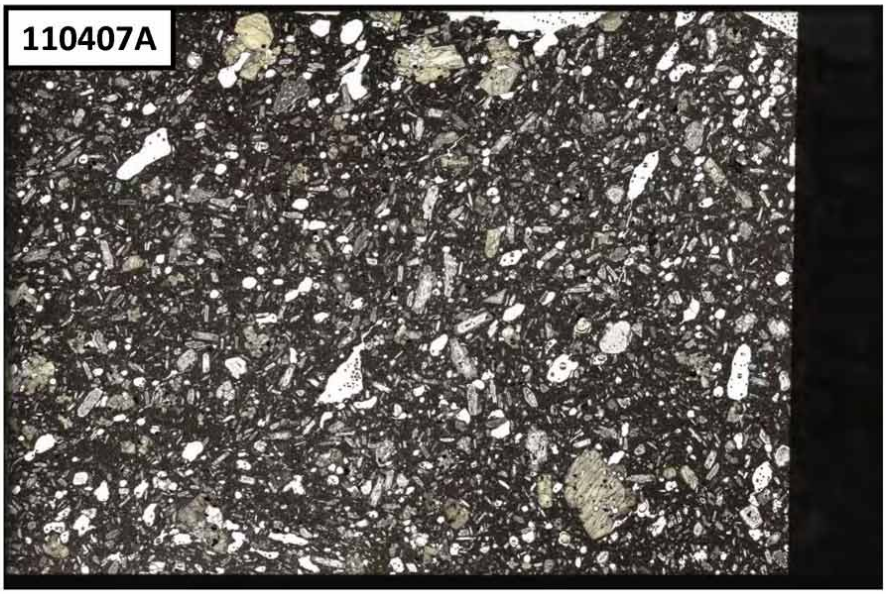
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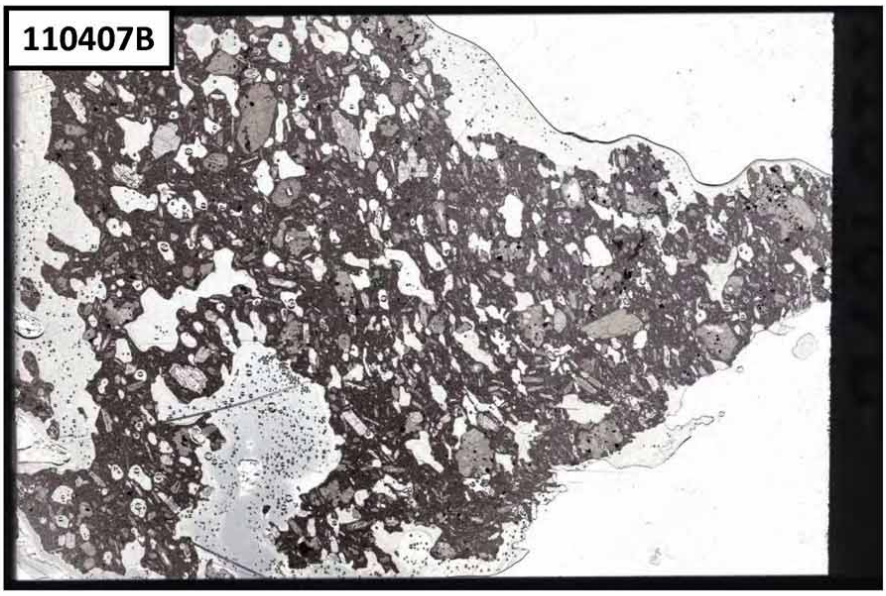
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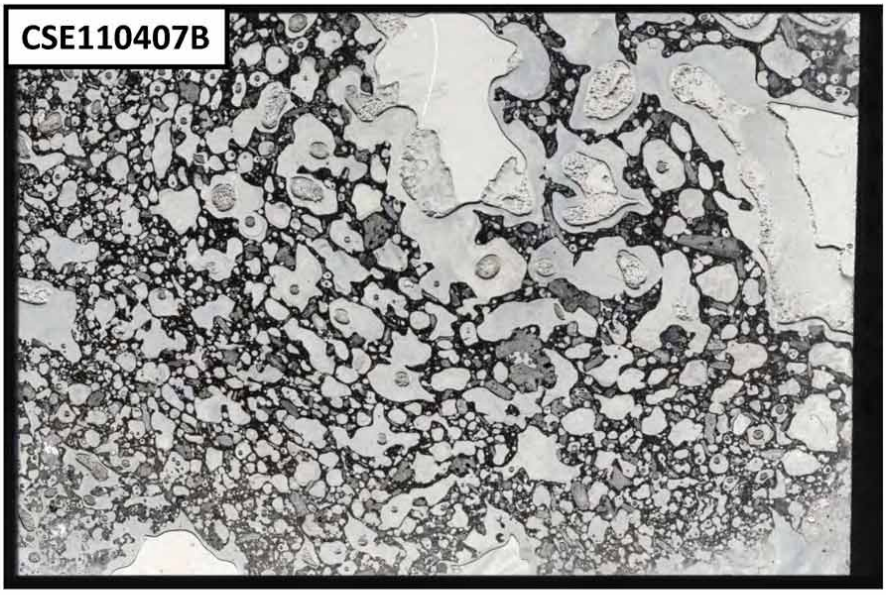
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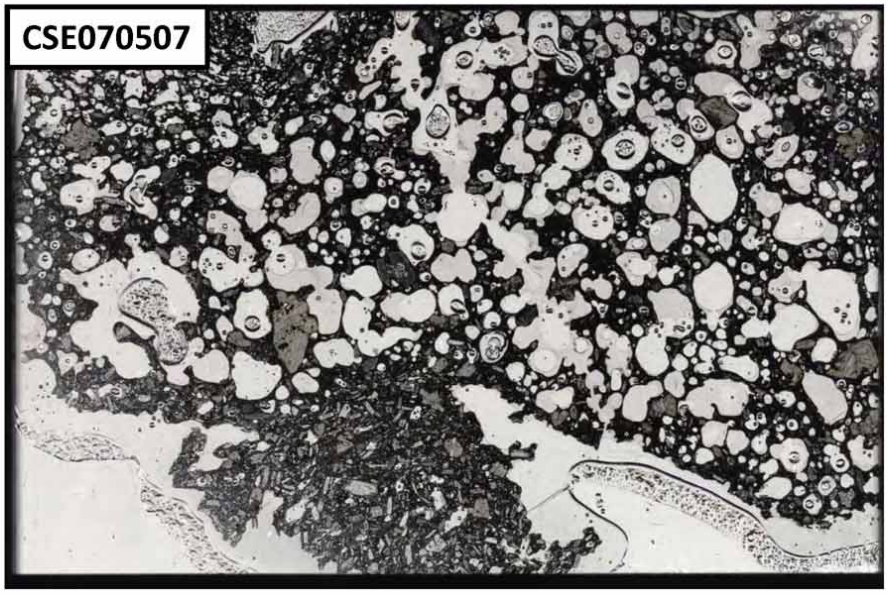
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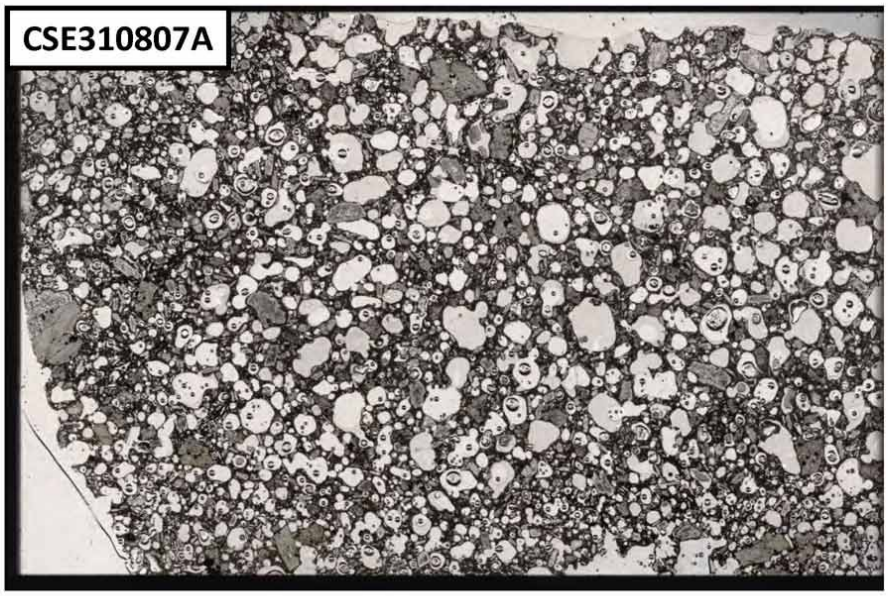
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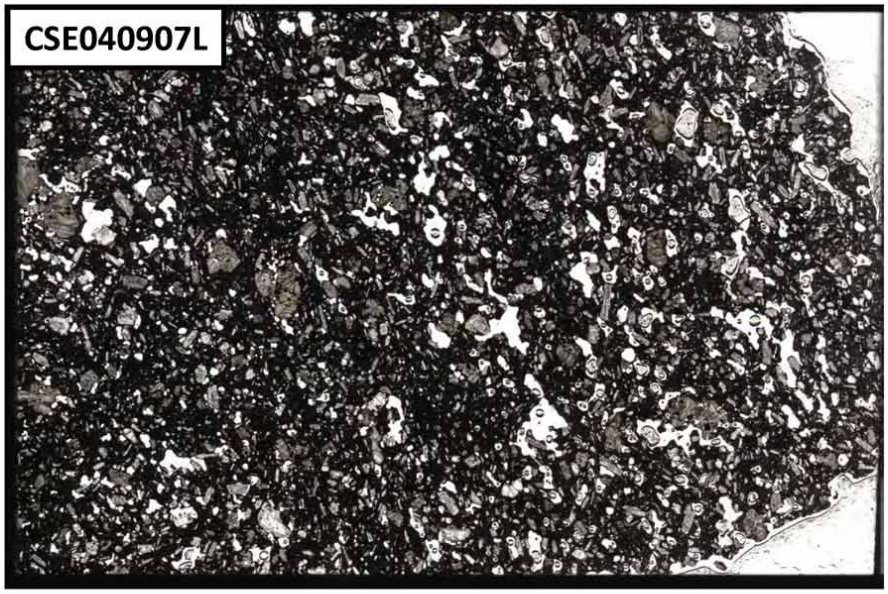
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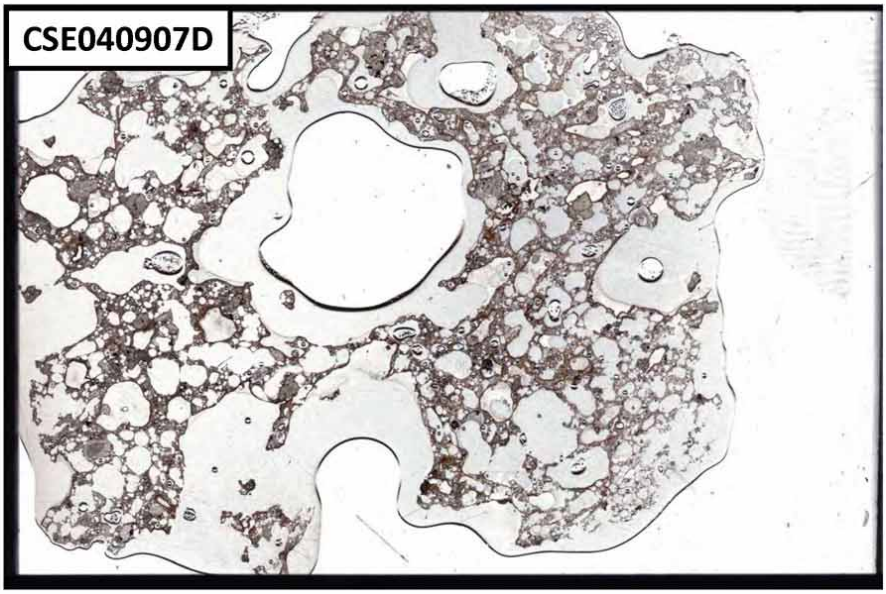
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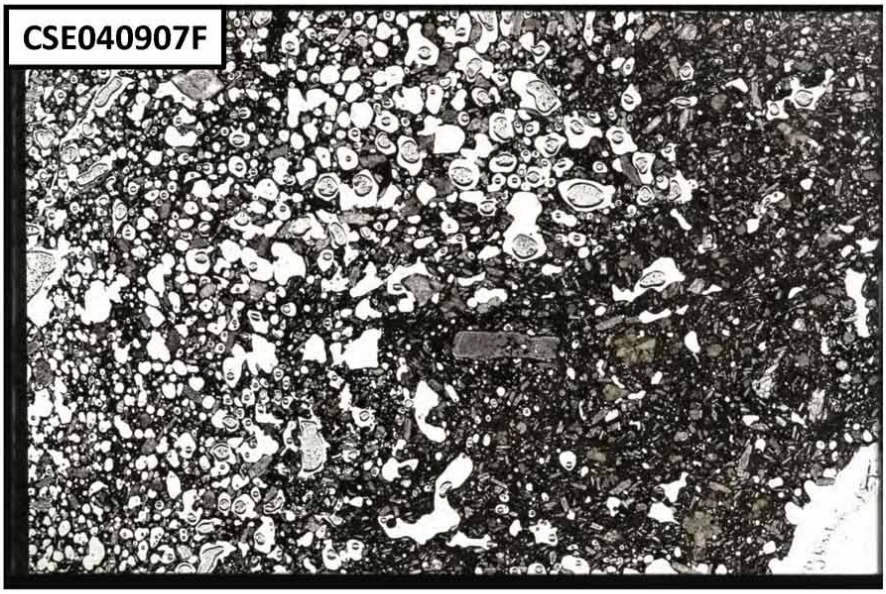
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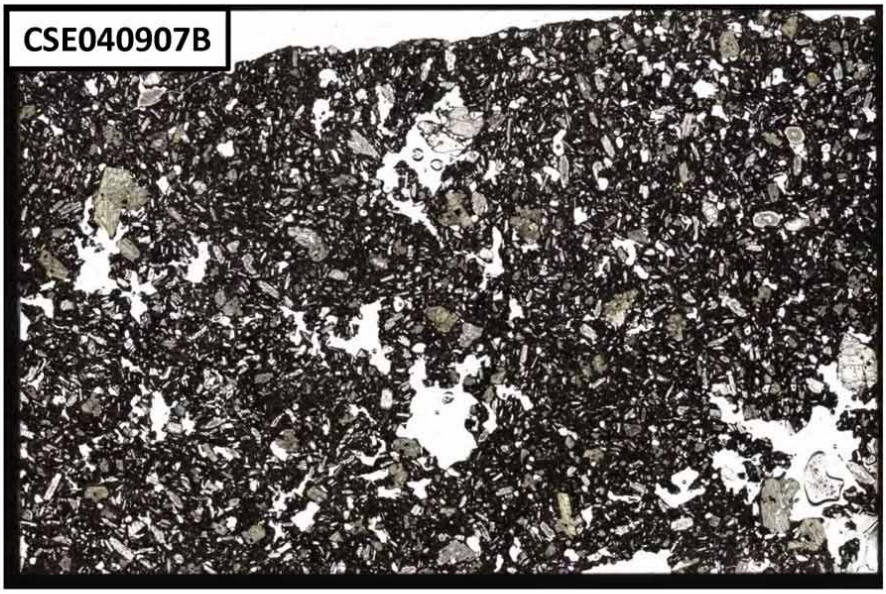
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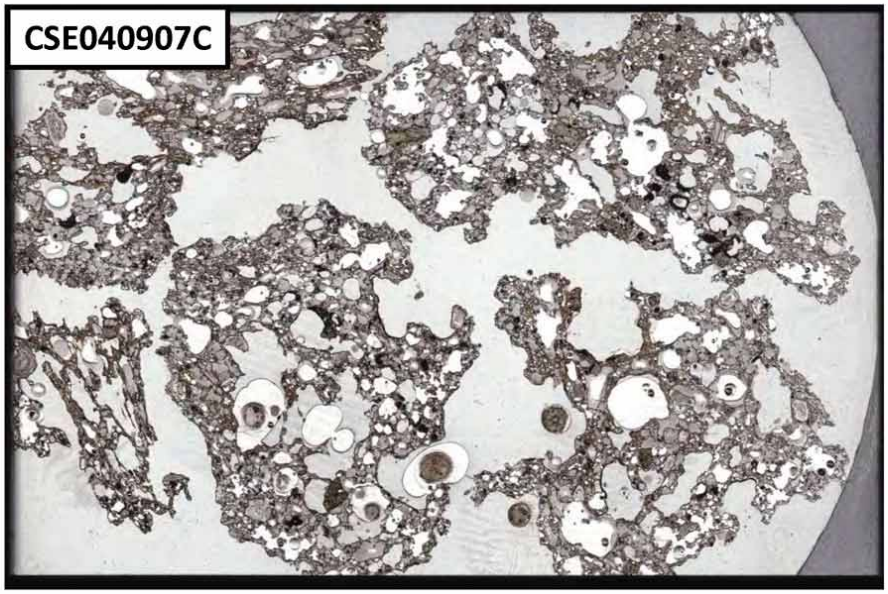
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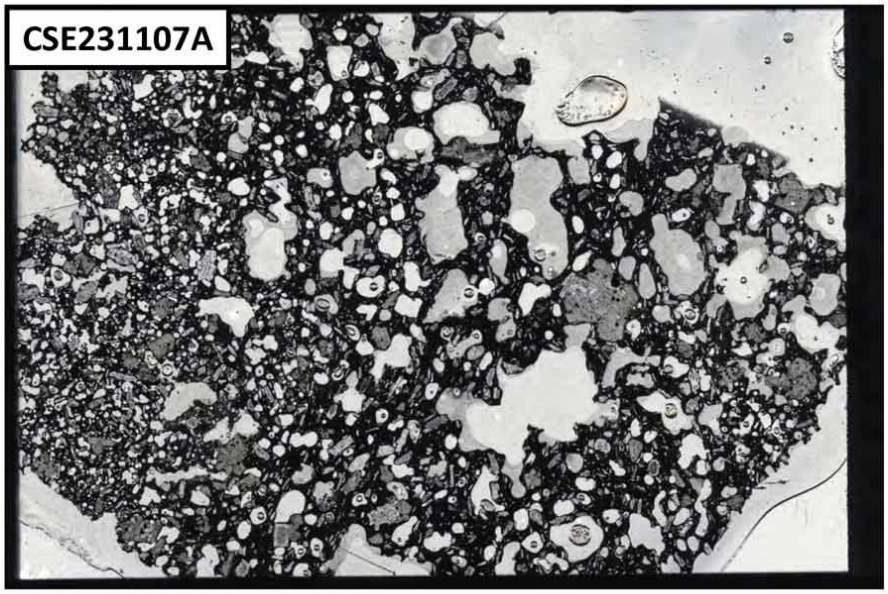
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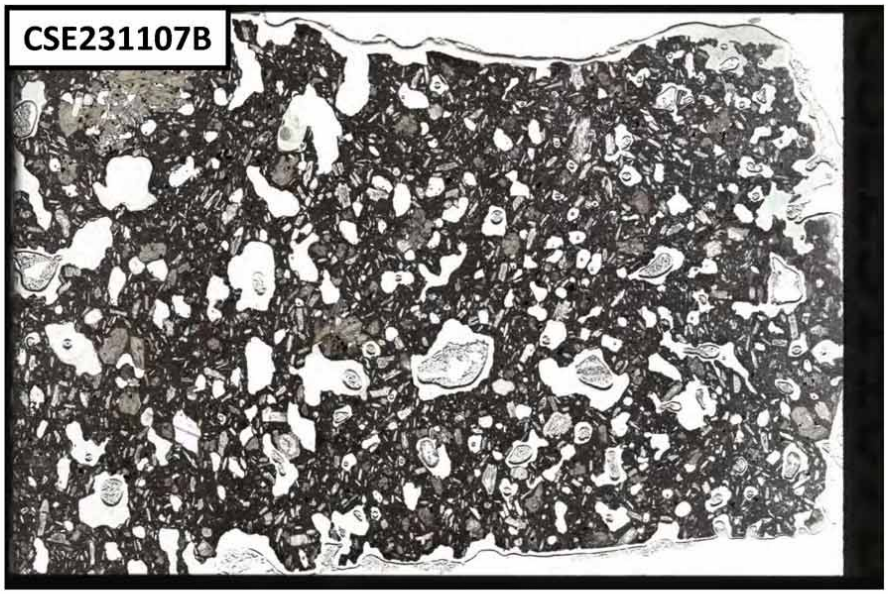
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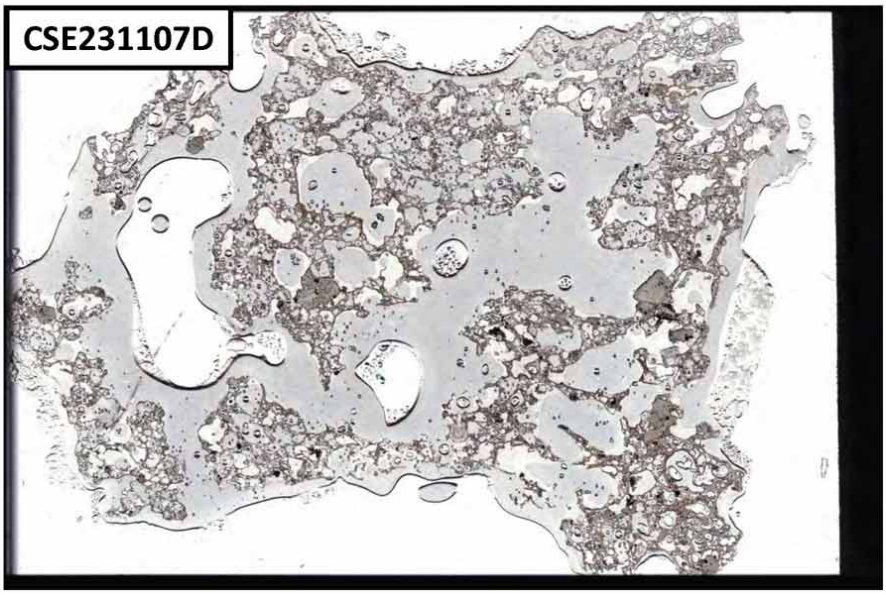
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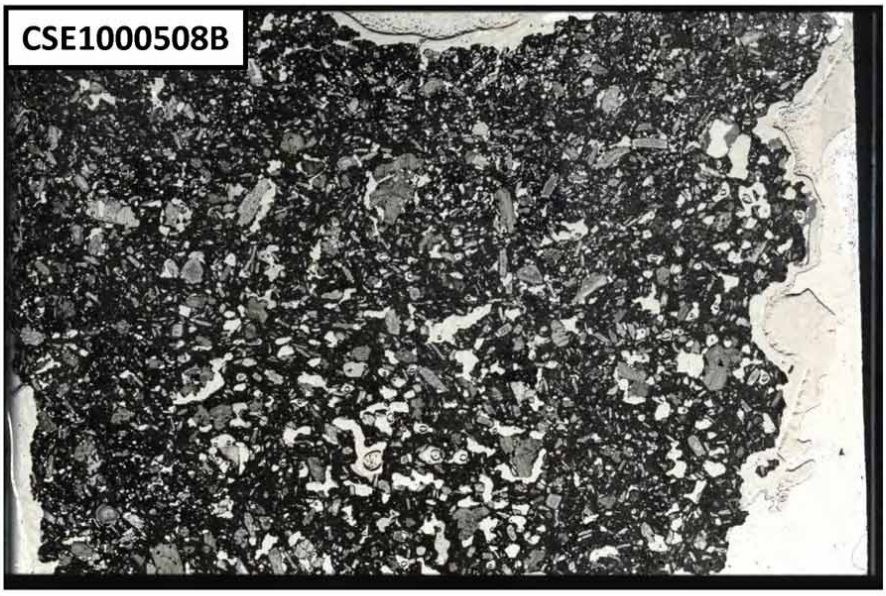
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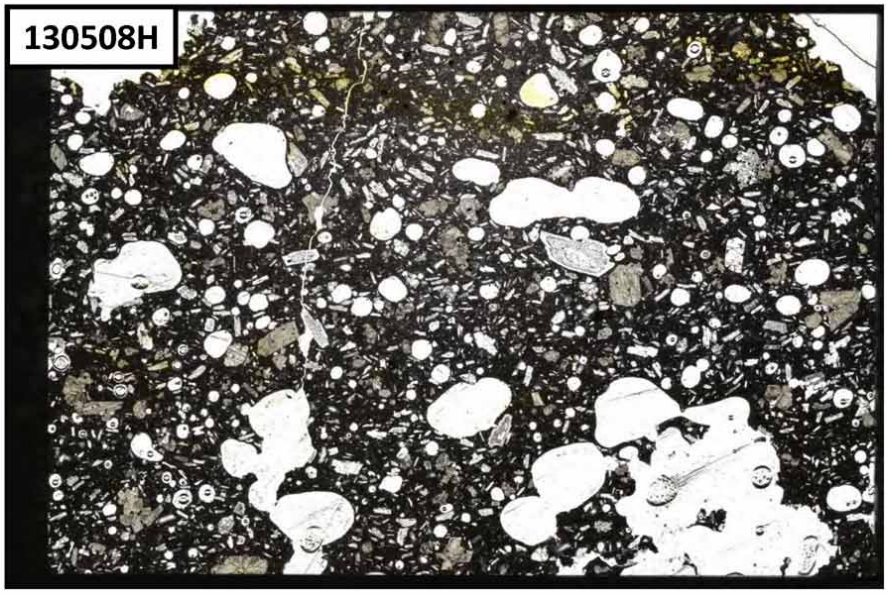
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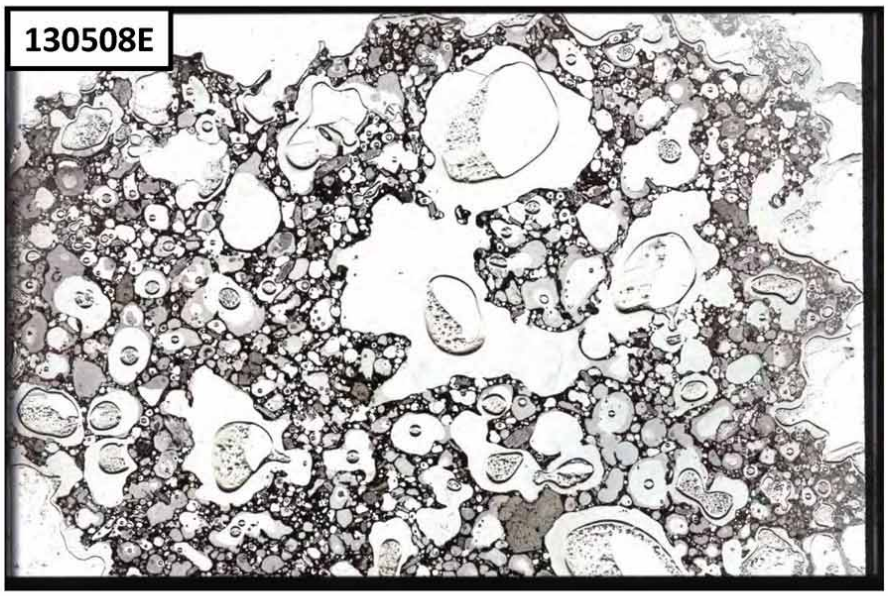
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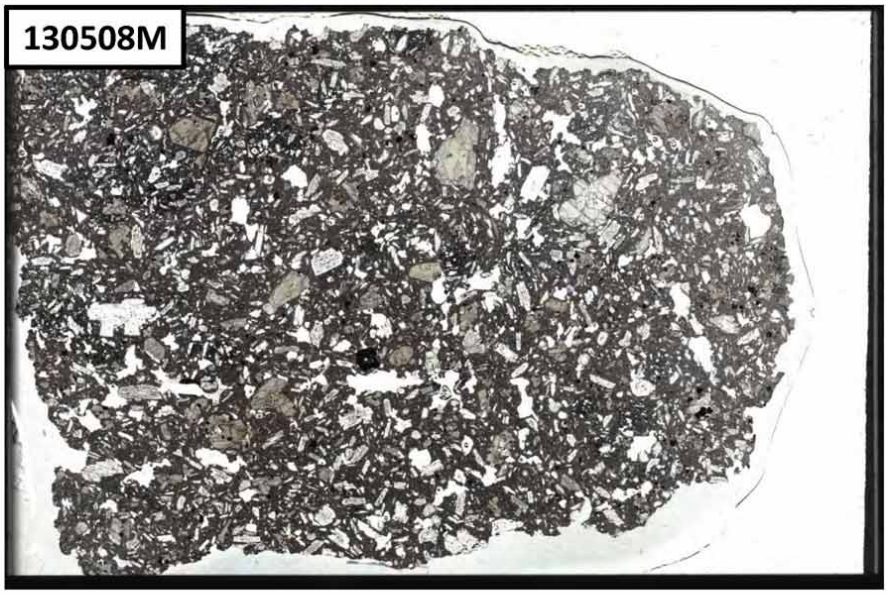
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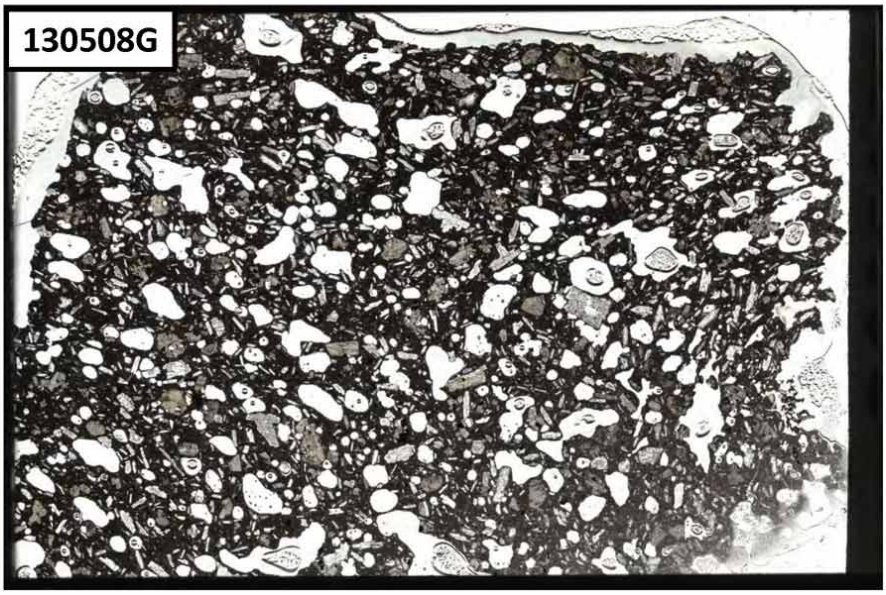
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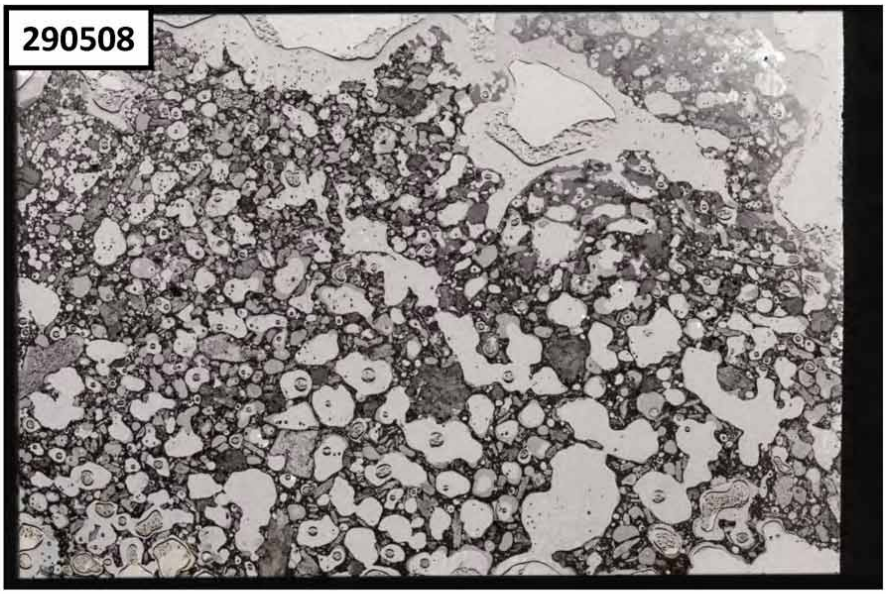
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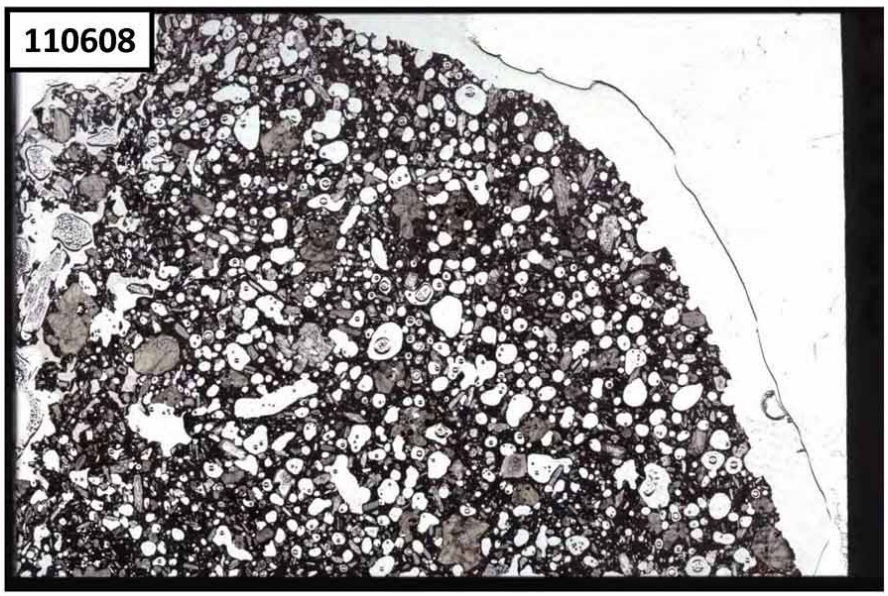
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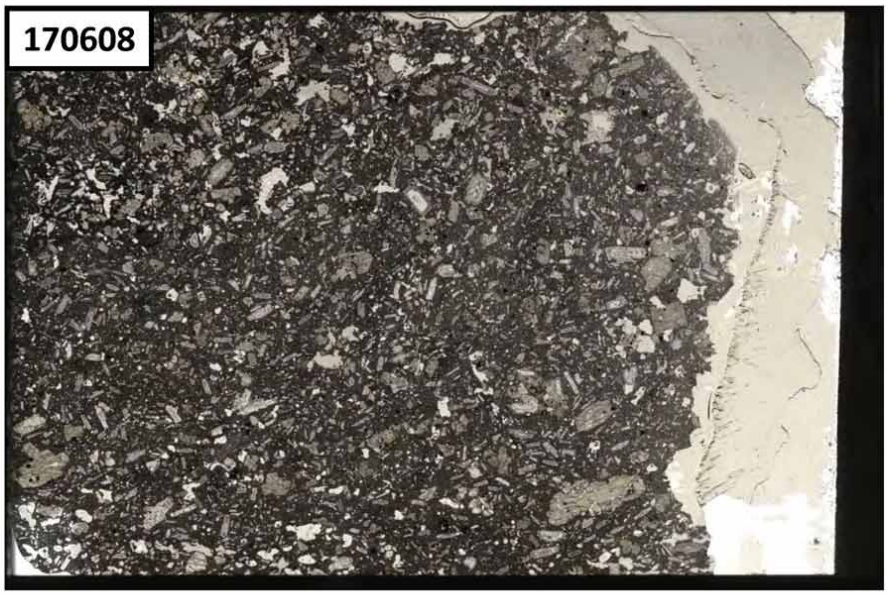
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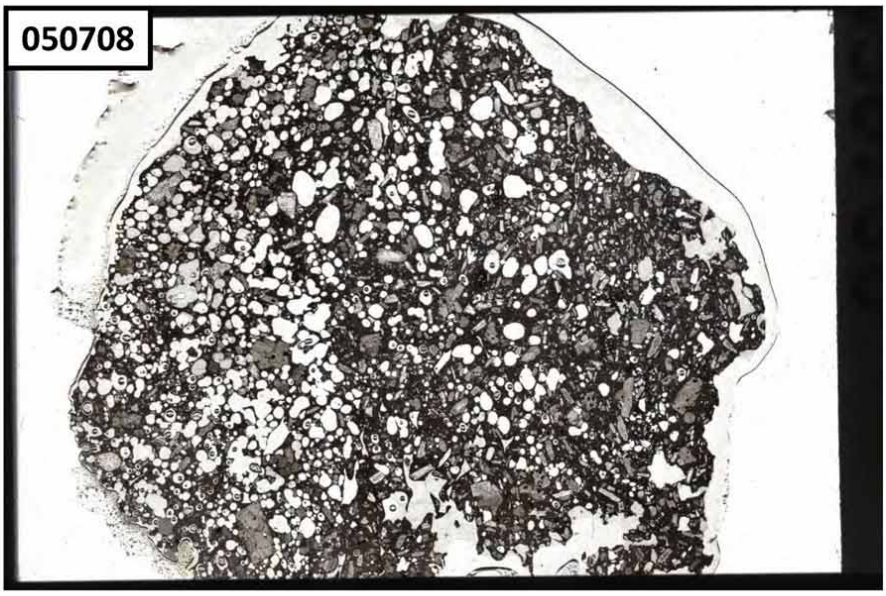
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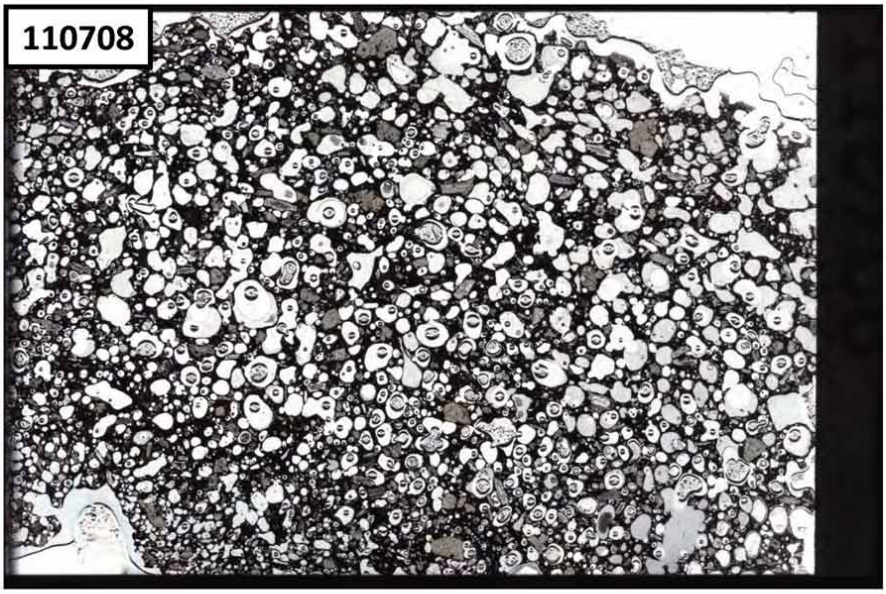
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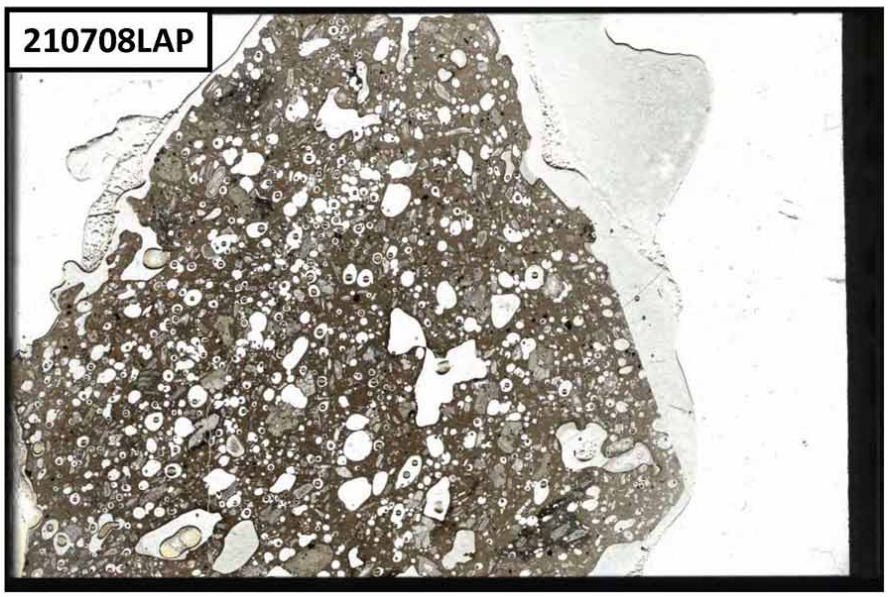
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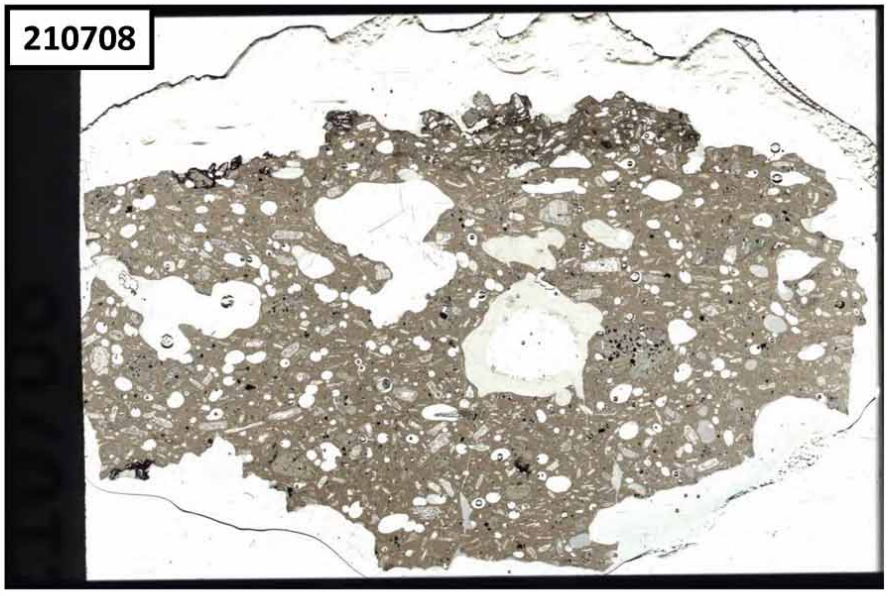
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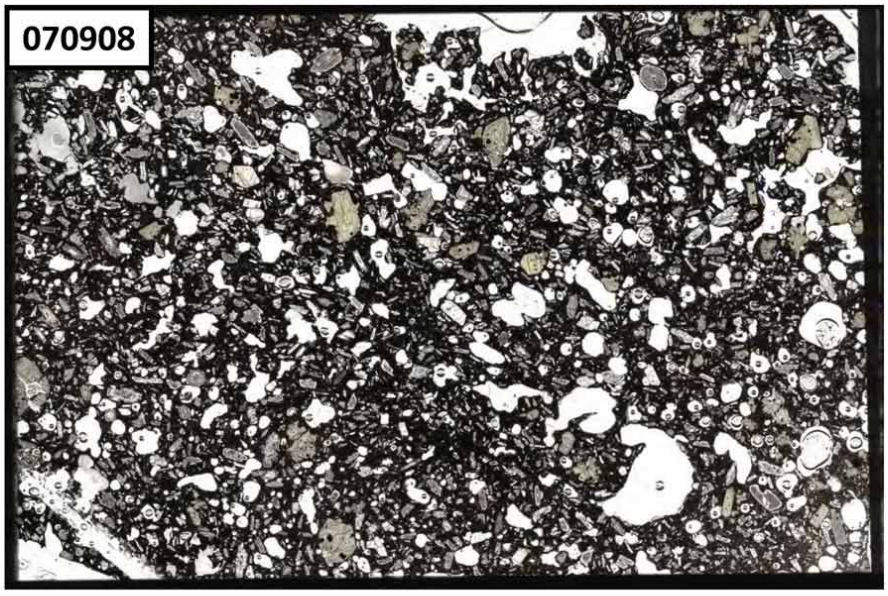
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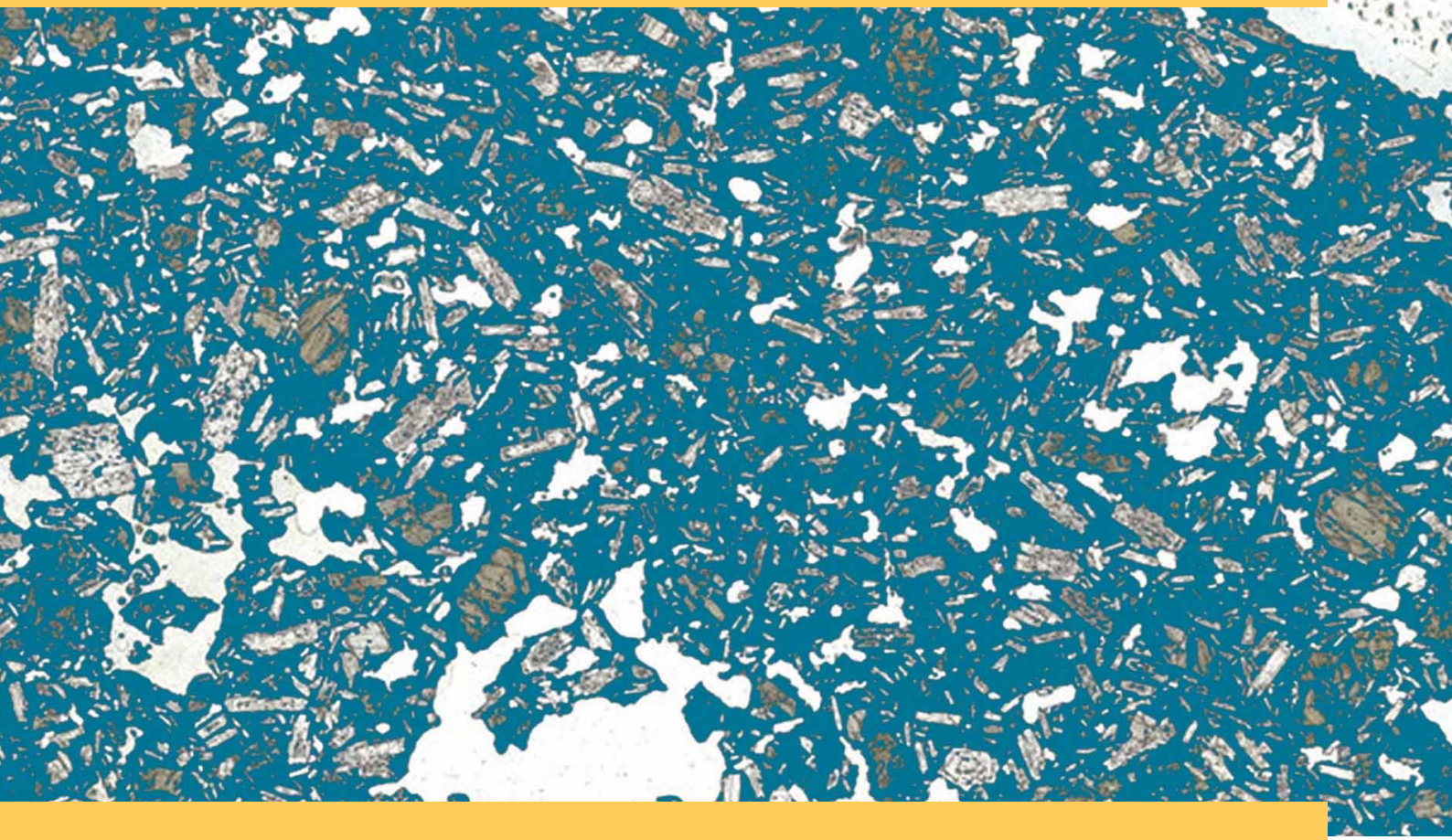

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