STRABOMICRO

USER GUIDE

StraboMicro Version 2.0.15 · April 14, 2026

Contents

1 Introduction

1.1 Overview of the StraboSpot Ecosystem

The StraboSpot ecosystem is a suite of interconnected applications and software tools designed to support the collection, management, integration, and sharing of field and laboratory data in the geosciences. Its primary objective is to align data practices with the FAIR principles: Findable, Accessible, Interoperable, and Reusable, by providing a unified system for managing multidisciplinary geologic data.

Developed through ongoing community input, the StraboSpot ecosystem includes several specialized applications: **StraboField**, which supports workflows in structural geology, petrology, sedimentology, and tephra volcanology; **StraboMicro**, the modern rewrite of the original StraboMicro application, which facilitates microscopy-based geoscience research with enhanced performance and new capabilities; and **StraboExperimental**, which serves the experimental deformation community. Each of these platforms utilizes controlled vocabularies developed by their respective scientific communities to promote standardized data collection and to improve the discoverability and interoperability of geologic data.

StraboSpot offers more than just a centralized data repository, it also includes tools for capturing and organizing field and laboratory observations, including images. The system is built around the concept of *spots*, which represent observations applied across defined spatial scales. This hierarchical structure allows users to nest observations from the regional to the microscopic scale and to organize data and images according to their specific workflow needs. This flexible framework enables users to capture and relate geologically complex information in a coherent and connected manner.

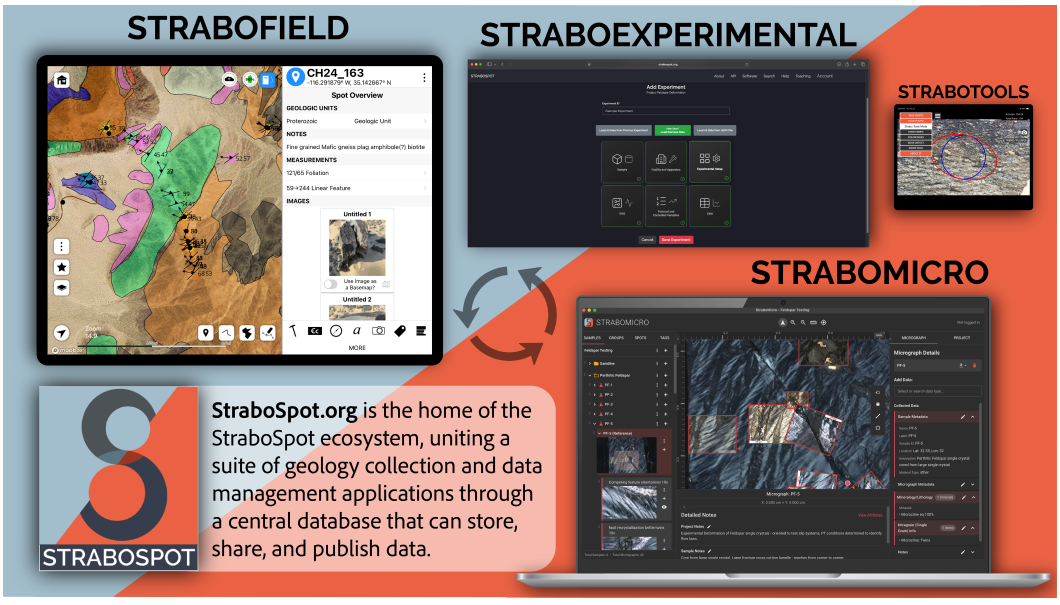


Figure 1. The StraboSpot ecosystem: StraboField, StraboMicro, and StraboExperimental are all connected to the database at StraboSpot.org

1.2 StraboMicro: A Modern Platform for Microscopy-Based Geoscience Research

StraboMicro 2.0.0 is a complete overhaul of the original StraboMicro desktop application, rewritten using modern technologies to deliver superior performance, reliability, and user experience. Designed specifically for microscopy-based workflows in geoscience research, StraboMicro provides a unique, image-centric organizational structure that enables users to efficiently manage and annotate micrographs while preserving spatial relationships and associated scientific metadata.

Modern Architecture

StraboMicro is built on a modern Electron + React technology stack, providing:

- **Cross-Platform Support:** Native performance on macOS, Windows, and Linux from a single codebase
- **High-Resolution Image Support:** Optimized handling of large micrographs (100MB+ TIFF files) with smooth panning and zooming
- **Dynamic Level-of-Detail Rendering:** Associated images remain sharp at any zoom level through intelligent multi-resolution rendering
- **30+ New Features:** Significant enhancements over the legacy application, including AI-powered tools, version history, and advanced analysis capabilities

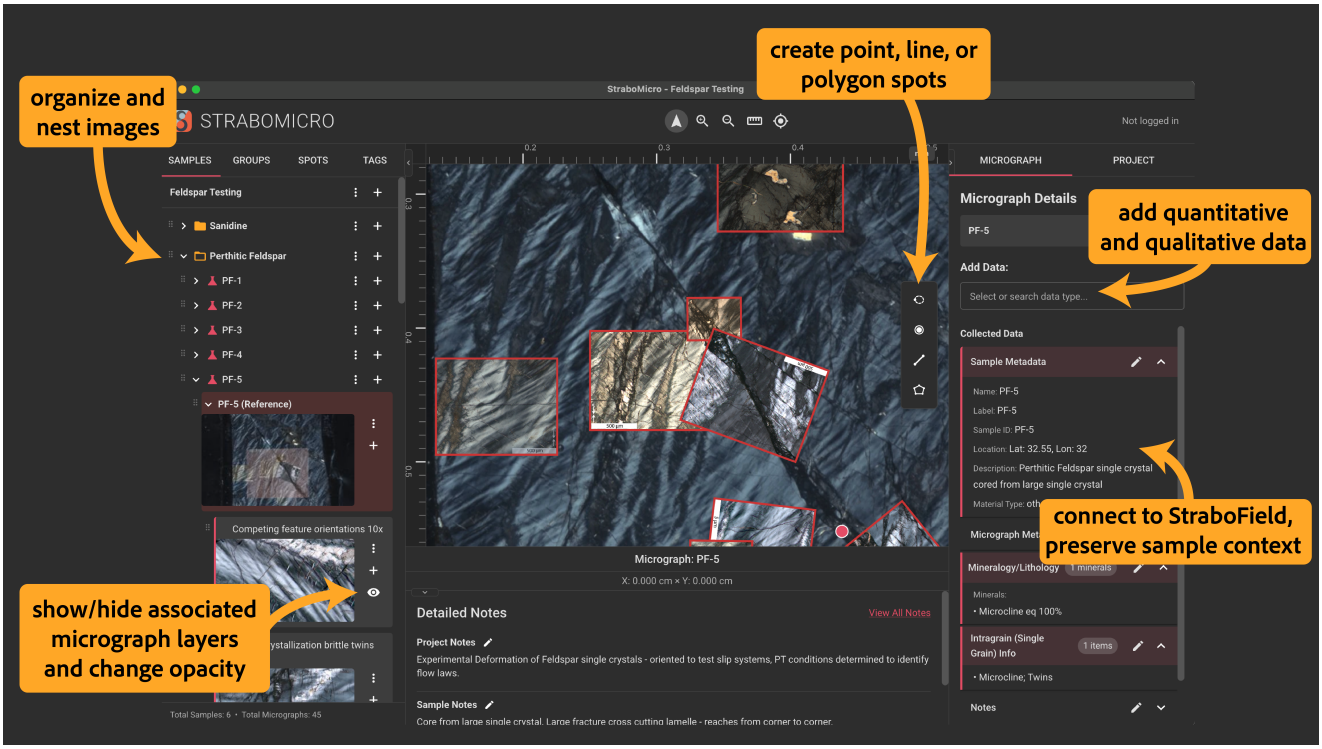


Figure 2. StraboMicro main interface showing the standard layout with left navigation pane, micrograph viewer, and right side properties pane

Core Functionality

StraboMicro allows users to create and manage projects composed of geological samples. Each sample includes:

- **Reference Micrographs:** Typically lower magnification, full-sample scans or stitched images that provide contextual overviews.
- **Associated Micrographs:** Higher magnification micrographs of the sample, often collected using different imaging techniques or instruments. These can be precisely aligned using several location, orientation, scale options.

Geoscience-Specific Metadata

A key feature of StraboMicro is its ability to link spatial image data with detailed geoscientific metadata. Users can add metadata at the project, dataset, sample, and spot levels. Geologically meaningful metadata and data, such as:

- Mineralogy and Lithology
- Grain Size, Share, and SPO
- Fabrics
- Clastic Deformation Bands
- Grain Boundaries and Contacts
- Intragranular Structures
- Veins
- Pseudotachylyte
- Folds
- Faults and Shear Zones
- Extinction Microstructures
- Fractures
- Notes
- Associated Files
- Links

See section 6.2

Spatial Annotation with Spots

Users can add spatial annotations called *spots* directly onto images. Spots may be defined as points, lines, or polygons, each capable of storing customized observational data. This feature supports rigorous documentation of spatially-resolved geological features. StraboMicro enhances this with Quick Apply Presets for rapid classification of multiple features.

Project Management and Data Sharing

StraboMicro is designed to facilitate the lifecycle of a research project:

- As new samples and observations are added, projects evolve in an organized and traceable manner.
- The new Version History System ensures you never lose work—restore any previous state with a single click.
- Projects can be shared publicly online, allowing others to view and search the data.
- A Digital Object Identifier (DOI) can be generated for each project, ensuring proper citation and long-term accessibility for publication and archiving purposes.

1.3 What's New in StraboMicro 2.0

StraboMicro 2.0 introduces over 30 new features and significant improvements over the legacy application. Here are the major highlights:

Never Lose Your Work

- **Version History System:** Every change is automatically saved with full version history. Restore any previous state of your project with a single click.
- **Automatic Updates:** Stay current with the latest features and bug fixes through seamless automatic updates.

Enhanced User Experience

- **Dark/Light Theme Support:** Choose your preferred visual theme for comfortable viewing in any lighting conditions.
- **Quick Apply Presets:** Save commonly used spot configurations and apply them with a single click for rapid classification of features.
- **Sketch Overlay System:** Create freeform annotations with customizable pen colors and widths for quick markup and teaching purposes.

AI-Powered Tools

- **FastSAM Grain Detection:** Leverage artificial intelligence to automatically detect and outline grains in your micrographs, dramatically speeding up the annotation process.

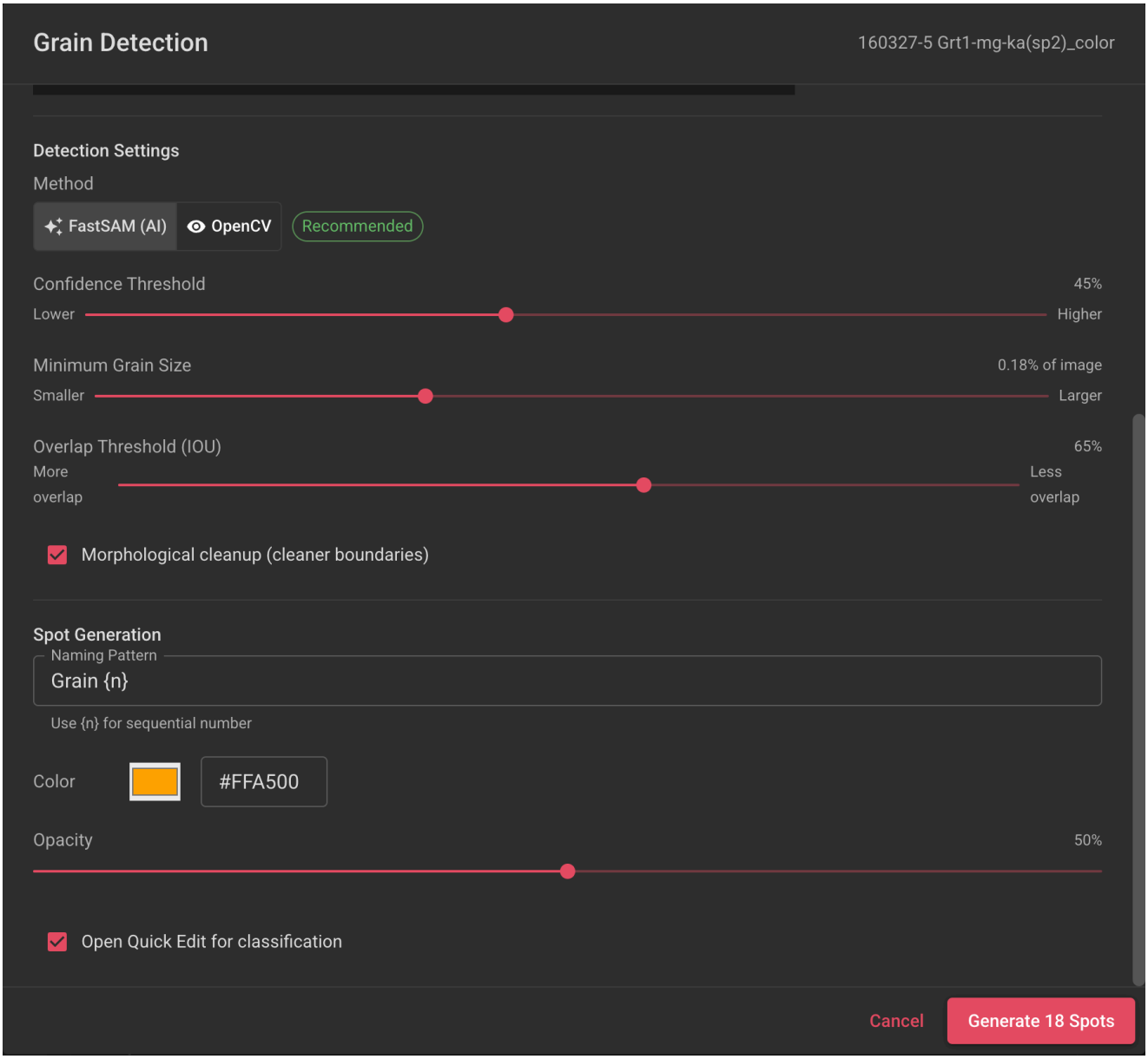


Figure 3. AI-powered grain detection using FastSAM automatically identifies and outlines grains in micrographs

Advanced Analysis Features

- **XPL/PPL Synchronized Viewing:** View cross-polarized and plane-polarized images side-by-side with synchronized panning and zooming.
- **Grain Size Analysis:** Generate statistical analysis of grain populations with automatic histogram and rose diagram generation.
- **3-Point Registration:** Precisely align associated images using a simple three-point correspondence system for accurate spatial overlay.

Export and Sharing

- **SVG Vector Export:** Export your annotations as scalable vector graphics for publication-quality figures that remain sharp at any size.

1.4 System Requirements

StraboMicro is designed to work on any modern computer. There are no specific hardware requirements for running the software. The application runs natively on macOS, Windows, and Linux operating systems.

While higher-performance systems with more RAM may offer improved speed and responsiveness when working with very large micrographs, the software does not mandate any minimum system specifications. StraboMicro's intelligent Level-of-Detail rendering system ensures smooth performance even on modest hardware.

1.5 Getting Help and Support

To get started with StraboMicro and to enhance your understanding of its features, we recommend the following resources:

- **YouTube Tutorials:** Watch the official StraboMicro tutorial videos available on our YouTube channel for step-by-step guidance.
- **User Manual:** Refer to this manual for detailed explanations of functions and features.
- **Weekly Office Hours:** Join our live support sessions held every Thursday from 1:00 PM to 3:00 PM CDT (UTC-5).
  Register here: `https://strabospot.org/help`
- **Email Support:** For additional help, contact us at StraboSpot@gmail.com.

2 Installation and Setup

2.1 Creating a StraboSpot Account

To use StraboMicro and access associated data services, you must first create a StraboSpot account. Follow the steps below to register:

1. Open your web browser and navigate to `https://www.StraboSpot.org`.
2. On the homepage, go to the `Account` menu in the top navigation bar and select `Register`.
3. Fill out the registration form with your full name and a valid email address. Please use a real and accessible email address, as it will be used to verify your account and for future communication.
4. After submitting the form, check your email inbox for a confirmation message from StraboSpot.
5. Open the email and click the confirmation link to activate your account.
6. Once confirmed, you may log in to the StraboSpot website using your new credentials.

Note: If you do not receive the confirmation email within a few minutes, check your spam or junk folder. If the issue persists, contact support at StraboSpot@gmail.com.

2.2 Downloading the Application

Follow the steps below to download the latest version of **StraboMicro**:

1. Open your web browser and navigate to `https://www.StraboSpot.org`.
2. Log in to your account:
   (a) On the homepage, click `Account > Log In`.
   (b) Enter your login credentials.
3. Navigate to the StraboMicro download page:
   (a) Select `Software > StraboMicro > Download StraboMicro`.
4. Download the installer appropriate for your operating system:
   - **Windows:** Download the `.exe` installer
   - **macOS:** Download the `.dmg` file (choose Apple Silicon or Intel version based on your Mac's processor)
   - **Linux:** Download the `.AppImage` file

2.3 Installing on Windows/macOS/Linux

Windows:

- Double-click the downloaded `.exe` installer file.

- Follow the on-screen instructions in the installer wizard.
- After installation, launch the application from your Start Menu or desktop shortcut.

macOS:

- Open the downloaded `.dmg` file.
- Drag the StraboMicro application into the `Applications` folder (Figure 4).
- Launch the app from your Applications folder or Launchpad.
- If prompted with a security warning, click `Open` to confirm. You may need to allow the app in System Settings under `Privacy & Security`.

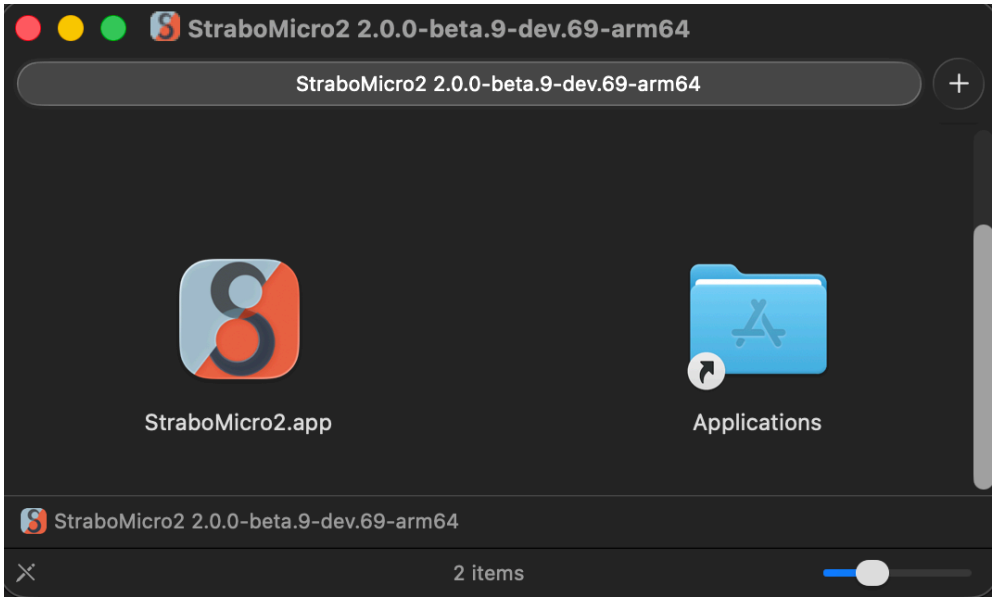


Figure 4. Drag StraboMicro2 to Applications folder on macOS.

Note for macOS users: Two versions are available—one for Apple Silicon (M1, M2, M3, M4 processors) and one for Intel processors. To determine your processor type, click the Apple menu and select `About This Mac`. The chip or processor information will indicate whether you need the Apple Silicon or Intel version.

Linux:

- StraboMicro is distributed as an AppImage file, which runs on most Linux distributions without installation.
- After downloading, make the file executable:

```
chmod +x StraboMicro2-*.AppImage
```

- Run the application directly:

```
./StraboMicro2-*.AppImage
```

- Optionally, move the AppImage to a convenient location such as `/opt` or `~/Applications`.

2.4 First-Time Setup

When launching StraboMicro for the first time (Figure 5):

- You may be prompted to grant necessary system permissions for file access.
- The application will create a default data folder named `StraboMicro2Data` in your Documents directory. This folder stores your project data and local files.
- Application cache and settings are stored in platform-specific locations:
  - **macOS:** `~/Library/Application Support/StraboMicro2`
  - **Windows:** `%APPDATA%\StraboMicro2`
  - **Linux:** `~/.config/StraboMicro2`
- A separate tile cache is maintained for high-resolution image rendering. This cache stores pre-generated image tiles for faster display of large micrographs and is managed automatically by the application.
- Ensure you are connected to the internet to enable automatic syncing with your StraboSpot account and access to vocabulary updates.

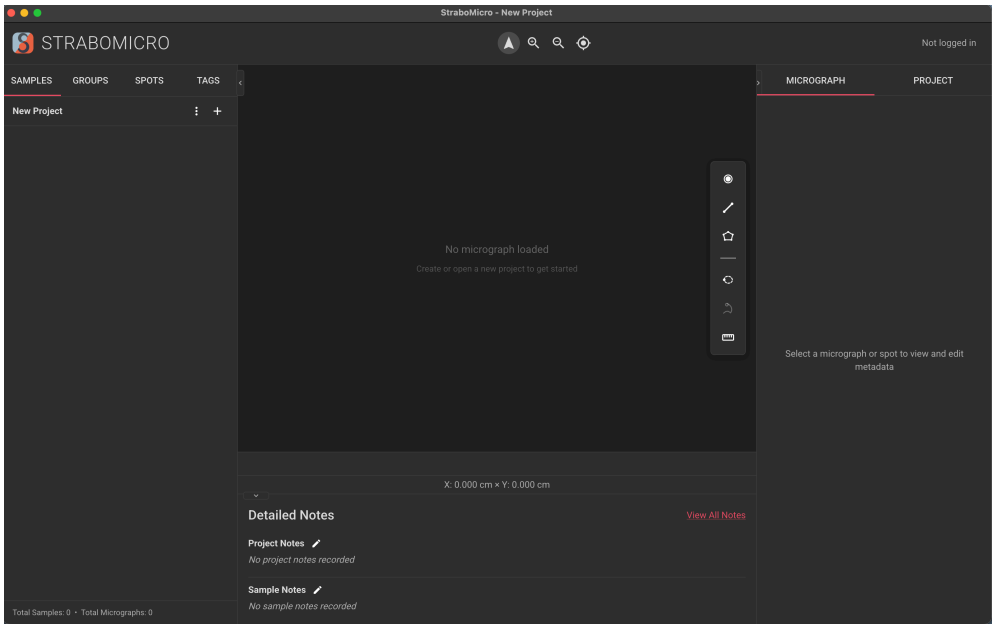


Figure 5. StraboMicro 2.0 first-time launch screen.

2.5 Automatic Updates

StraboMicro includes built-in automatic update functionality to ensure you always have the latest features and bug fixes:

- The application automatically checks for updates when launched and every 30 minutes while running.
- When an update is available, it downloads in the background without interrupting your work.

- Updates are installed automatically the next time you launch the application.
- No manual updating is required under normal circumstances.

2.5.1 Checking for Updates Manually

To manually check for updates at any time:

1. Open the StraboMicro application.
2. Click the `Help` menu in the top navigation bar.
3. Select `Check for Updates`.
4. If an update is available, you will be notified and can choose to download it immediately.

2.5.2 Checking Your StraboMicro Version

To verify your current version of the application:

1. Open the StraboMicro application.
2. Click the `Help` menu in the top navigation bar.
3. Select `About StraboMicro`.
4. The version number will be displayed in the dialog window (Figure 6).

Figure 6. The About StraboMicro dialog showing version information.

2.6 StraboMicro Instrument Catalog

The **StraboMicro Instrument Catalog** enables laboratories and research groups to associate instrumentation with current and past research projects. It is designed to reduce redundancy in the data input process by storing instrument metadata, including:

- Instrument name

- Type and make
- Location
- Collection and post-processing software
- Detectors
- Additional notes

Once instrument information is entered into the catalog, any StraboMicro user can select that instrument during data entry. Relevant metadata will automatically populate, streamlining the workflow and ensuring consistency.

2.6.1 Becoming an Institution Principal Investigator (PI)

There are two ways to become a designated PI for an institution or laboratory:

1. During the 'Add New Sample' upload process within StraboMicro, a link to add a new institution to the catalog can be found in the 'Select Instrument' modal (Figure 7). Clicking the link generates an email request.

   Requesting a New Institute Entry:

   - If your institution is not listed, click the blue link at the top of the modal: **"Need your institute added to the database? Click here."**
   - This generates an email to `StraboSpot@gmail.com` with the following template:

     ```
     Hello,

     Please add the following institute to the StraboMicro Apparatus Repository:

     Lab or Facility Name:
     Institute Name:

     StraboSpot Account: *your account email address*

     Thanks,
     *your account name*
     ```

   - Complete the Lab/Facility and Institute fields before sending.
2. Alternatively, you may directly email the development team to request PI access. See Section 1.5 for contact information.

2.6.2 Accessing and Updating the Instrument Repository

Once approved as a PI, you can manage instruments associated with your institution by visiting `https://www.strabospot.org`. After logging in:

1. Navigate to your account.
2. Select **My Instruments**.

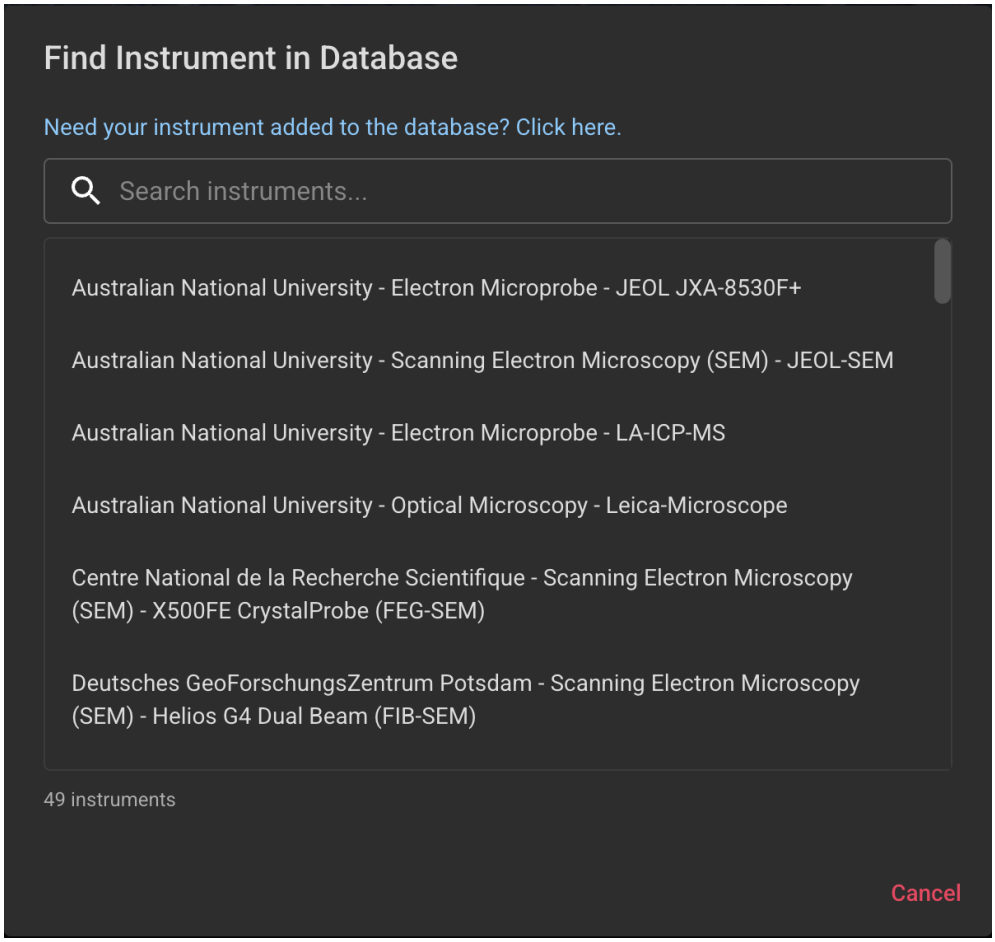


Figure 7. Screenshot of the **StraboMicro Select Instrument** modal.

3. Access the **StraboMicro Instrument Catalog**, where you can view existing institutions and instruments.
4. Use the provided links to add or edit instruments and institutional affiliations.

3 Manage StraboMicro Projects

StraboMicro projects differ slightly in structure from other StraboSpot applications. In StraboMicro, each **Project** contains one or more **Samples**, which store the data. Projects are saved locally in the `StraboMicro2Data` folder within your Documents directory and can be uploaded to StraboSpot.org for backup and sharing.

To create a new project, open the StraboMicro desktop application. For installation details, see Section 2: *Installation and Setup*.

From the **File** menu, choose either **New Project** or **New Project from Field Data**.

3.1 New Project

The **New Project** modal includes the following fields:

- **Project Name***
- Start Date
- End Date
- Purpose of Study
- Team Members
- Area of Interest
- GPS Datum (default: WGS84)
- Magnetic Declination
- Notes

Required field.* After entering project details, you will be prompted to provide a **Dataset Name.

Once complete, the interface automatically opens the **New Sample** modal—the same one used when selecting *Add / New Sample* or *Create New Sample* (see Section 5).

3.1.1 New Project from Field Data

Navigation: `File > New Project from Field Data`

This option creates a micrograph-based project using field data collected in StraboField.

Step 1: Select a Project

Opens the **Select a Project from Server** modal, listing all projects associated with your StraboSpot account.

- Select a project and click **Next**.

Step 2: Select a Dataset

Choose a dataset within the selected project.

- All available datasets will be listed.
- Click a dataset to view associated samples.

Step 3: Choose a Sample

A searchable list of samples appears.

- Select a sample to begin the **New Sample** workflow.
- The process starts at the **Load Reference Micrograph** step (see Section 5.2).

Note: You may return later to import additional samples from the same dataset.

Metadata Auto-Population

Field samples automatically import the following metadata:

- **Project and Dataset:**
  - Project Name, Start Date, GPS Datum, Magnetic Declination
  - Last Modified Timestamp, Location, Dataset Name
- **Sample:**
  - Sample ID/Name, Direct Link (StraboSpot.org), Location
  - Sampling Purpose, Description, Material Type, Inplaceness
  - Orientation Info, Size, Weathering, Notes

3.2 Open Existing Projects

StraboMicro allows you to open existing projects stored locally, in your StraboSpot account, or shared via code or DOI.

3.2.1 Open a Local Project

To open a local `.smz` file:

1. Launch the StraboMicro application.
2. Go to `File` → `Open Local Project`.
3. Navigate to the `.smz` file on your device.
4. Select the file and click `Open`.

3.2.2 Open a Remote Project

To open a project from your StraboSpot account:

1. Ensure you're logged into StraboMicro.
2. Confirm your login at the top of the window (`Logged in as [email]`).
3. Go to `File` → `Open a Remote Project`.
4. Select the project and click `Open`.

3.2.3 Open a Project with a Share Code

To access a shared project:

1. Launch StraboMicro.
2. Go to `File` → `Open a Project with a Share Code`.
3. Enter the provided code and click `Next`.

See Section 3.10.2 for instructions on generating share codes.

3.3 Recent Projects Menu

StraboMicro maintains a list of recently opened projects for quick access. This feature streamlines your workflow by allowing you to quickly switch between projects without navigating through file dialog.

3.3.1 Accessing Recent Projects

Navigation: `File > Recent Projects`

The Recent Projects submenu displays up to **10 recently opened projects**, sorted by most recently accessed. Each entry shows:

- **Project name**
- **Relative date** indicating when the project was last opened:
  - "Today" for projects opened today
  - "Yesterday" for projects opened yesterday
  - Day of the week (e.g., "Monday") for projects opened within the past week
  - Full date for older projects
- A **checkmark** next to any project that is currently open

3.3.2 Working with Multiple Projects

StraboMicro allows you to have **multiple projects open simultaneously**. When you select a project from the Recent Projects menu:

- If the project is already open, StraboMicro will switch focus to that project's window.

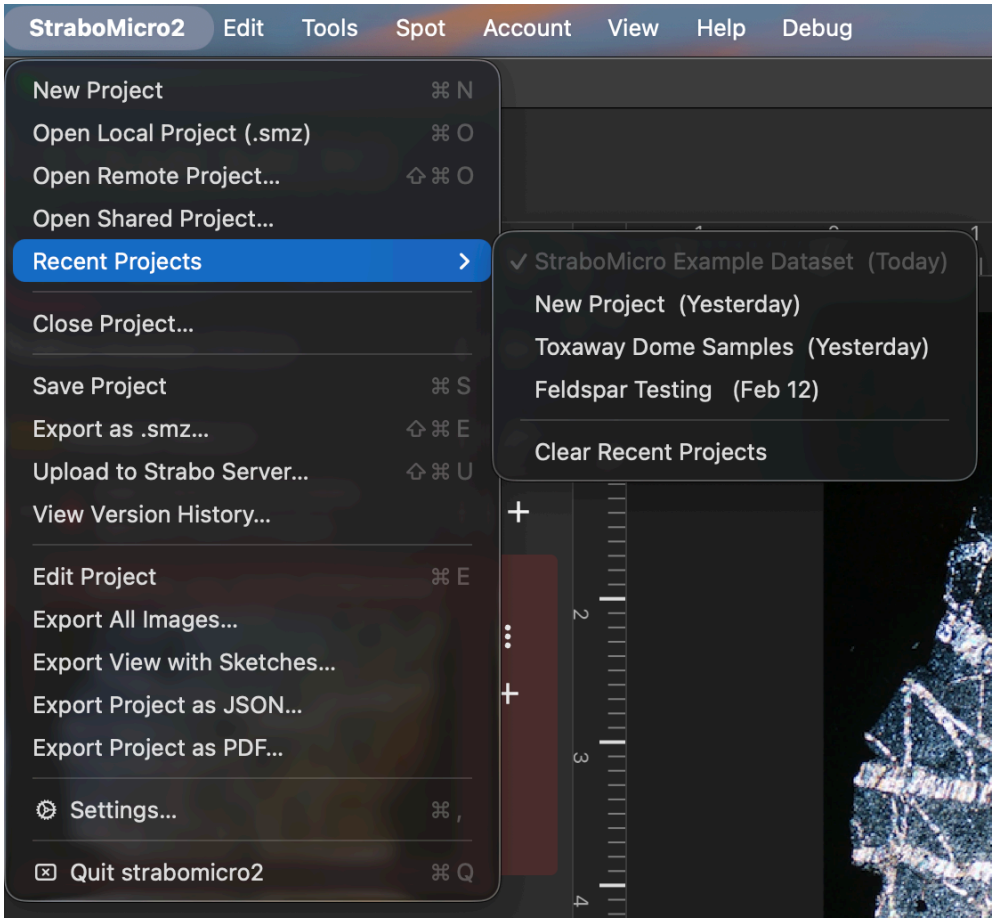


Figure 8. The Recent Projects menu showing recently accessed projects with relative dates and a checkmark indicating the currently open project.

- If the project is not open, StraboMicro will open it in a new window.
- If your current project has unsaved changes, you will be prompted to save before switching.

Tip: Having multiple projects open is useful when comparing samples across projects or transferring observations between related studies.

3.4 Save Projects

3.4.1 Save to Local Device

To save the currently open project:

1. Go to `File` > `Save Project`, or use the keyboard shortcut:
   - **macOS:** `Cmd+S`
   - **Windows/Linux:** `Ctrl+S`
2. The project is automatically saved to `~/Documents/StraboMicro2Data/`.

Note: Projects are saved with the `.smz` extension. If you wish to save to a different location, use `File > Save Project As...` and choose your preferred destination folder.

3.4.2 Upload to StraboSpot Server

To back up or share your project online:

1. Go to `File` > `Upload Project`.
2. Read the upload prompt:

   > *Uploading your project backs up your data and makes it accessible via StraboSpot.org.*

3. If the project already exists, check `Project Already Exists. Overwrite?` to proceed.

Note: StraboSpot.org retains version history. Frequent uploads are recommended to prevent data loss and preserve project history.

3.5 Autosave System

StraboMicro includes an automatic save system designed to protect your work and prevent data loss. The autosave feature operates transparently in the background without interrupting your workflow.

3.5.1 How Autosave Works

- **Inactivity-based saving:** StraboMicro automatically saves your project after **5 minutes of inactivity**. This ensures your recent work is preserved even if you step away from your computer.
- **Save on close:** When you close the application or quit StraboMicro, the system checks for unsaved changes. If changes exist, your project is automatically saved before the application closes.
- **Version snapshot creation:** Each autosave creates a new **version snapshot** in the Version History system (see Section 3.6), allowing you to recover previous states of your project if needed.

3.5.2 Autosave Indicators

The application displays subtle indicators to show autosave status:

- A small **cloud icon** or **save indicator** in the title bar shows when changes are being saved.
- The window title shows an asterisk (*) when there are unsaved changes.
- After a successful autosave, the asterisk disappears.

Note: Autosave does not replace intentional saves. It is recommended to manually save (`Cmd+S` or `Ctrl+S`) after completing significant work, especially before closing the application.

3.6 Version History System

StraboMicro includes a comprehensive version history system that tracks changes to your project over time. This feature provides peace of mind by allowing you to review past versions and restore previous states of your project when needed.

3.6.1 Accessing Version History

Navigation: `File > View Version History`

The Version History dialog opens, displaying a chronological list of all saved versions of your project.

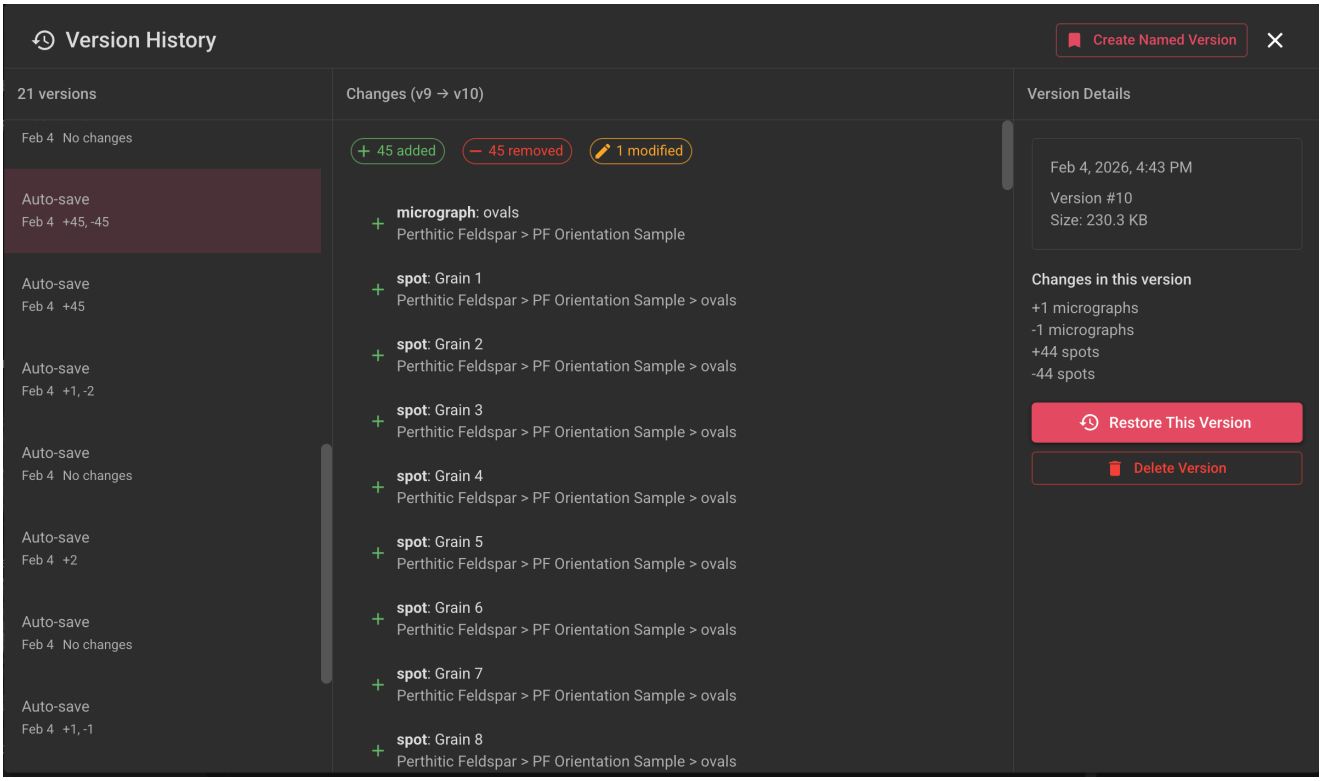


Figure 9. The Version History dialog showing a list of project versions with timestamps, change summaries, and options to preview or restore. The visual diff preview showing added (green), removed (red), and modified (yellow) entities between two project versions, refer to Section 3.6.4 for more information.

3.6.2 Understanding Version Snapshots

Each time you save your project (manually or via autosave), StraboMicro creates a **version snapshot**. Each snapshot records:

- **Timestamp:** The exact date and time the version was created.
- **Save type:** Whether the save was manual, autosave, or a named checkpoint.
- **Change summary:** A brief description of what changed since the previous version.

3.6.3 Named Checkpoints

You can create **named checkpoints** to mark important milestones in your project. Named checkpoints have special properties:

- **Custom names:** Assign meaningful names like "Before grain analysis" or "Final review version".
- **Protected from auto-pruning:** Named checkpoints are never automatically deleted, even when the version limit is reached.
- **Easy identification:** Named checkpoints appear with a bookmark icon in the version list.

To create a named checkpoint:

1. Go to `File > Create Named Checkpoint` (or use `Cmd+Shift+S` / `Ctrl+Shift+S`).
2. Enter a descriptive name for the checkpoint.
3. Click `Create`.

3.6.4 Visual Diff Preview

Before restoring a version, you can preview the differences between that version and your current project state. Refer to Figure 9 for an example screenshot. The visual diff shows:

- **Added entities:** New samples, micrographs, or spots that exist in the current version but not in the selected version (highlighted in green).
- **Removed entities:** Items that exist in the selected version but have been deleted in the current version (highlighted in red).
- **Modified entities:** Items with changed metadata or positions (highlighted in yellow).

3.6.5 Restoring a Previous Version

To restore your project to a previous state:

1. Open the Version History dialog (`File > View Version History`).
2. Select the version you wish to restore.
3. Click **Preview Changes** to review the project differences (optional but recommended).
4. Click **Restore This Version**.
5. Confirm the restoration when prompted.

Important: When you restore a previous version, StraboMicro automatically creates a backup of your current state before applying the restoration. This means you can always return to where you were if you change your mind.

3.6.6 Auto-Pruning Policy

To manage storage space, StraboMicro automatically prunes old versions according to the following policy:

- **Maximum versions:** Up to 200 versions are retained per project.
- **Retention period:** Versions older than 30 days may be pruned.
- **Minimum kept:** At least 10 versions are always retained, regardless of age.
- **Named checkpoints:** Named checkpoints are never automatically pruned.

When the version limit is reached, the oldest unnamed versions are removed first.

3.6.7 Storage Usage

To view how much storage space your version history is using:

1. Open the Version History dialog.
2. Click **Storage Info** at the bottom of the dialog.
3. A summary shows total storage used by version history and individual version sizes.

Tip: If storage is a concern, you can manually delete old unnamed versions that are no longer needed while keeping your important named checkpoints.

3.7 Download Projects

3.7.1 Download `.smz` File

Method 1: From StraboSpot.org

1. Go to `https://strabospot.org` or access it via the StraboMicro app (`File > Go to My Data`).
2. Log in and navigate to `Account > My StraboMicro Data`.
3. Click `Options` next to a project and select `Download`.

Method 2: From the Online Viewer

1. Go to `https://strabospot.org`, log in, and open the desired project via `My StraboMicro Data > View`.
2. Click `Download .SMZ` in the top-right corner of the viewer.

3.7.2 Export Project as PDF

StraboMicro can export your entire project as a professionally formatted PDF document, ideal for sharing with collaborators, including in publications, or archiving.

PDF Export Features The exported PDF includes:

- **Table of Contents:** Automatically generated with clickable links to each section.
- **Internal hyperlinks:** Cross-references between samples, micrographs, and spots are clickable within the PDF.

- **All micrographs:** Full-resolution images with annotations and spots visible.
- **Complete metadata:** All entered metadata for the project, samples, and spots.

Method 1: From the Desktop App

1. Open your project in StraboMicro.
2. Go to `File > Export Project as PDF`.
3. Choose a destination folder.
4. Click `Export`.

Method 2: From the Online Viewer

1. Log in to `https://strabospot.org`.
2. Navigate to `Account > My StraboMicro Data`.
3. Open the project via `Options > View`.
4. Click `Download PDF` in the viewer.

Note: Projects must be uploaded to the server before they can be viewed or exported online.

3.7.3 Export Project as JSON

1. In StraboMicro, go to `File > Export Project as JSON`.
2. Select the destination folder.
3. The project will be saved as a JSON file containing all metadata and structural information.

Tip: JSON exports are useful for data analysis, integration with other tools, or programmatic access to your project data.

3.8 Download Project Images

3.8.1 Export All Images

Navigation: `File > Export All Images`

StraboMicro allows you to export all micrographs from your project in a batch operation, with flexible format options.

1. Go to `File > Export All Images`.
2. The **Export Images** dialog appears with the following options:
    - **Image Format:**
        - **JPEG** — Smaller file size with adjustable quality (70-100%).
        - **SVG (Vector)** — Vector format that preserves spots and annotations as scalable graphics, ideal for publication figures.

- **Include Annotations:** Check this option to include spots, lines, and polygons in the exported images.
- **Include Scale Bar:** Check this option to embed the scale bar in exported images.

3. Select a destination folder.
4. Click `Export`.

The app exports a `.zip` archive containing all micrographs organized by sample, with a folder structure matching your project hierarchy.

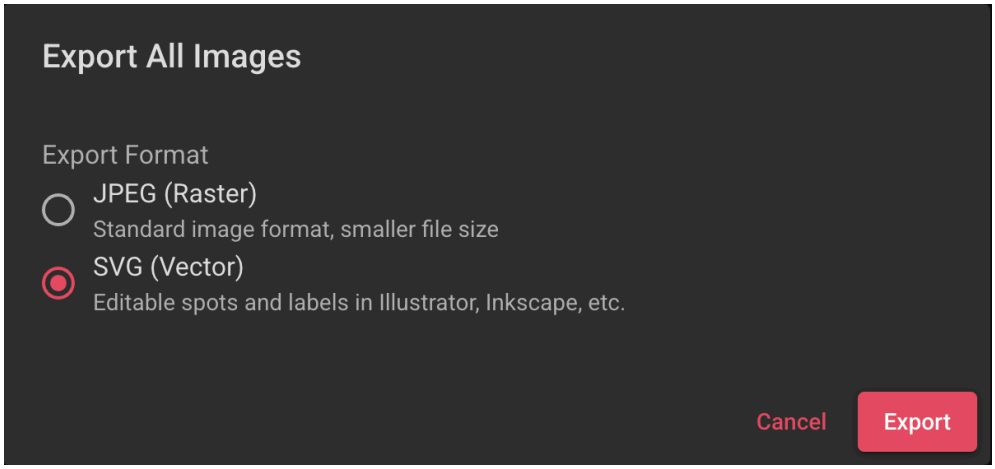


Figure 10. The Export All Images dialog showing format options (JPEG and SVG) and annotation settings.

3.8.2 Export Individual Annotated Images

To export a single micrograph with its annotations:

1. Open the micrograph in the Micrograph Viewer.
2. Click the **Download** button in the right panel.
3. Choose your preferred format (JPEG or SVG).
4. Select a destination and click `Save`.

Tip: To hide overlays in exports, use the **Show/Hide** icon for each layer before downloading. Only visible annotations will be included in the export.

3.8.3 SVG Vector Export

The SVG export option is particularly valuable for publication-quality figures:

- **Scalable graphics:** SVG files can be scaled to any size without loss of quality.
- **Editable annotations:** Spots, lines, and polygons remain as separate vector objects that can be edited in vector graphics software (e.g., Adobe Illustrator, Inkscape).
- **Raster + Vector hybrid:** The micrograph image is embedded as a raster element while annotations are preserved as vectors.

Note: SVG exports are best suited for figures with clear annotations. For very large micrographs, JPEG may be more practical for general sharing.

3.9 Project Privacy

All projects are private by default in StraboMicro and StraboSpot. Users have full control over project visibility and can change privacy settings at any time.

To update a project's privacy, visit `www.strabospot.org` and log in. Navigate to your account, then select **My StraboMicro Data**. A list of your projects will be displayed, each with a toggle labeled **Public?** next to the project title.

If the toggle is switched to the right and appears green, the project is public and discoverable by other users through the StraboSpot search interface. If your project is public and you would like to make it private again, simply toggle the switch back to the left.

3.10 View and Share Projects

3.10.1 View in Online StraboMicro Viewer

1. Log in at `https://strabospot.org`.
2. Go to `Account > My StraboMicro Data`.
3. Click `Options > View` next to a project.

Ensure the latest version has been uploaded before viewing online.

3.10.2 Sharing Projects

The `Share` feature allows others to download your project using a short code—no login required. Shared projects are independent copies; changes made by others do not affect your original.

Important: Share codes always retrieve the most recent uploaded version, not a snapshot. To share a static version, use a `.smz` export or create a DOI (see Section 3.11).

3.10.3 Generate a Share Code

1. Log in at `https://strabospot.org`.
2. Go to `Account > My StraboMicro Data`.
3. Click `Options > Share` next to the desired project.
4. Follow on-screen instructions to generate and copy the share code.

Note: Shared projects are not collaborative; each copy is independent.

3.11 DOI Creation

You can generate a DOI (Digital Object Identifier) for a static, citable version of your project. Once created, the DOI links to a permanent snapshot, unaffected by future changes.

3.11.1 Generate a DOI

1. Log in at `https://strabospot.org`.
2. Go to `Account > My StraboMicro Data`.
3. Click `Options > Get DOI for Project`.
4. Follow the instructions to finalize DOI creation.

3.11.2 View a Project via DOI

1. Go to `https://strabospot.org`.
2. Navigate to `Search > Search All StraboSpot Data`.
3. Log in to your account.
4. Enter the DOI and click `Add`.
5. Select `View` next to the desired project.

Tip: DOIs are ideal for citing your data in publications. Include the DOI in your manuscript's data availability statement to ensure reviewers and readers can access your project data.

4 User Interface Overview

StraboMicro features a modern, responsive user interface designed for intuitive navigation and efficient interaction with micrograph data and metadata. The interface has been completely redesigned using modern web technologies while preserving the familiar workflow from the original StraboMicro application. The layout is organized into four main panels, all of which are resizable and collapsible to suit your workflow preferences.

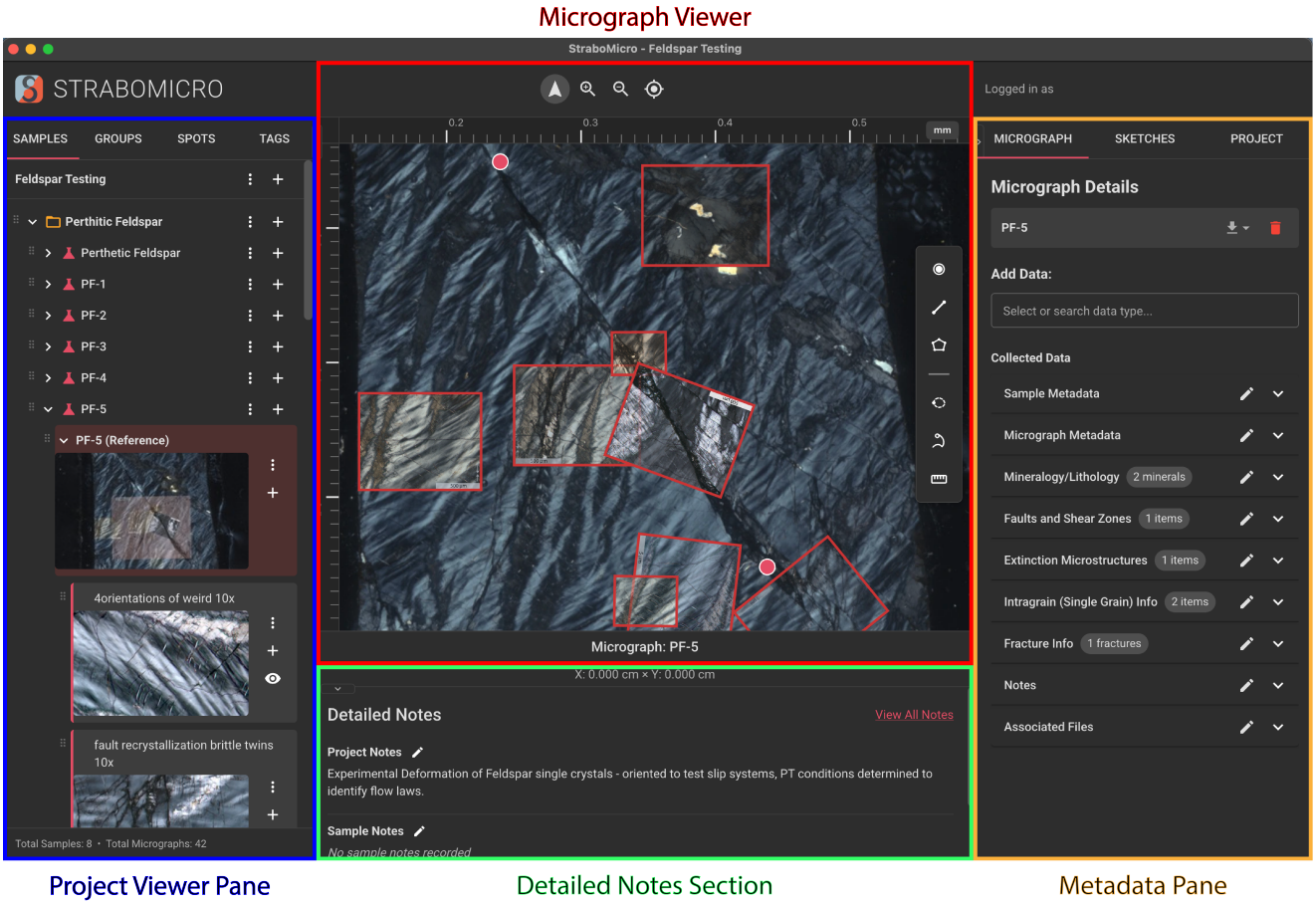


Figure 11. Overview of the StraboMicro desktop application. The interface features a modern three-pane layout with resizable panels, a collapsible bottom notes section, and enhanced navigation capabilities.

- **Left Panel (Project Viewer):** The primary navigation pane where users browse and select samples and micrographs within a project. Navigation tabs at the top allow organization by **Samples**, **Groups**, **Spots**, or **Tags**. **NEW:** A statistics footer displays total counts for samples and micrographs in the current project.
- **Center Panel (Micrograph Viewer):** Displays the currently selected micrograph for viewing, annotation, and analysis. Built on the high-performance Konva.js canvas engine with advanced rendering capabilities. **NEW:** Supports up to 20x zoom with dynamic Level-of-Detail (LOD) rendering for consistently sharp imagery.
- **Right Panel (Metadata Pane):** The metadata and information pane where users enter and manage structured data associated with each micrograph or spot. Features tabbed organization for **Micrograph/Spot** data, **Sketches**, and **Project** settings.

- **Bottom Panel (Detailed Notes):** A collapsible detailed notes section containing all notes from any of the fields available for the selected micrograph or spot. This section updates dynamically based on the current selection.
- **Menu Bar:** Provides access to core application functions, including file management, editing tools, view options, analysis tools, account settings, and help documentation.

4.1 Panel Flexibility

NEW: All panels in StraboMicro 2.0 are fully resizable and collapsible, giving you complete control over your workspace layout:

- **Resizable Panels:** Drag the divider between any two panels to adjust their relative sizes. The application remembers your panel sizes between sessions.
- **Collapsible Panels:** Each side panel can be collapsed by clicking its edge or using the collapse button, maximizing space for the micrograph viewer when needed.
- **Double-Click Reset:** Double-click any panel divider to reset panels to their default proportions.

This modular layout supports a streamlined and customizable workflow: navigate samples and micrographs on the left, analyze them in the center, view or enter detailed data on the right, and review notes below. The tabbed navigation system in the Project Viewer pane enhances flexibility by allowing users to organize data according to their preferred context.

4.2 StraboMicro Terminology

Understanding key terms used in StraboMicro will help users organize and interpret their image data effectively. Two important concepts in the platform are **Reference Micrographs** and **Associated Micrographs**.

Reference Micrograph

A **Reference Micrograph** is typically a low-resolution or stitched image—often a full thin section scan—that serves as a spatial framework for other, more detailed images. It provides context and scale for viewing and organizing high-resolution micrographs.

Associated Micrograph

An **Associated Micrograph** is any image that is spatially linked to a Reference Micrograph. These images inherit the scale and spatial position defined by the reference image, allowing users to relate high-magnification data (e.g., specific features, grains, or deformation structures) back to the broader context of the thin section.

There is no limit to the number of nested Associated Micrographs. Users can create hierarchical relationships among images at increasing levels of magnification or focus. This nested structure supports the documentation of geologic features from the thin section scale down to the grain or subgrain level.

Example Hierarchy

- **Reference:** Thin Section Scan
- **Associated:** Shear Zone Micrograph
- **Associated:** Specific Area within Shear Zone
- **Associated:** Image of Individual Grain
- **Associated:** EBSD Map of Grain

This hierarchical framework allows for the integration of multiple scales of observation, supporting detailed documentation and analysis within a consistent spatial context.

4.3 Project Viewer Pane: Project Navigation

The **Project Viewer Pane** in StraboMicro serves as the primary navigation area for organizing and accessing project content, including samples, micrographs, groups, spots, and tags. The pane is designed to support flexible workflows and customizable data organization.

Navigation Tabs

At the top of the Project Viewer Pane are four navigation tabs that control how data is displayed:

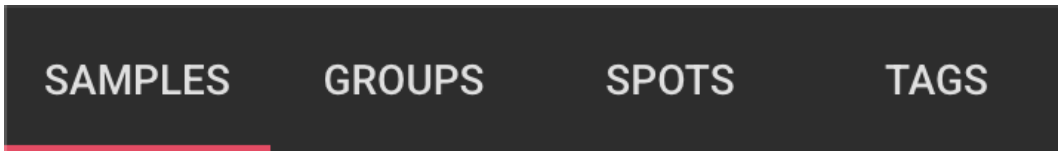


Figure 12. Navigation tabs in the Project Viewer Pane allow switching between different organizational views.

- **Samples (Default):** Displays a hierarchical view of all samples, including reference and associated micrographs. Each sample is represented with a thumbnail image and can be expanded to reveal its related micrographs.
- **Groups:** Displays groups of micrographs organized by user-defined themes or characteristics. For example, users can group all micrographs showing chessboard extinction or those containing garnet. Selecting a group filters and displays only the relevant micrographs, streamlining analysis by feature or objective.
- **Spots:** Lists all labeled spots across the project. Each micrograph displays a hyperlink list of its corresponding spots. Clicking a spot will load the related micrograph in the main viewing window and show its metadata in the Metadata Pane.
- **Tags:** Displays all tags used in the project. Clicking a tag will show all associated spots, each linked to its corresponding micrograph. Selecting a spot from the list opens the related micrograph in the main window and displays the tagged spot's metadata in the Metadata Pane.

Managing Samples and Micrographs

In the **Samples** tab, there are 4 hierarchy levels: Project, Dataset, Sample, Micrograph, refer to Figure 13 for a labeled example. Users can manage project data as follows:

Project Section:

- **3-Dot Menu** contains the option to `Edit Project Metadata`
- **+ Button** contains the option to `Add New Dataset`

Dataset Section:

- **3-Dot Menu** contains the following options:
  - `Edit Dataset Metadata`
  - `Delete Dataset`
- **+ Button** contains the following option:
  - `Add New Sample`

Sample Section:

- **3-Dot Menu** contains the following options:
  - `Edit Sample Metadata`
  - `Delete Sample`
- **+ Button** contains the following options:
  - `Add New Reference Micrograph`
  - `Batch Import New Reference Micrographs`

Micrograph Section, Reference Micrograph:

- **3-Dot Menu** contains the following options:
  - `Add to Group(s)`
  - `Edit Micrograph Metadata`
  - `Delete Micrograph`
- **+ Button** contains the following options:
  - `Add Associated Micrograph.` Associated micrographs inherit scale and spatial positioning from the reference and are displayed on top of it in the main viewer.
  - `Batch Import Associated Micrograph`

Micrograph Section, Associated Micrograph:

- **3-Dot Menu** contains the following options:
  - `Add to Group(s)`
  - `Edit Micrograph Metadata`
  - `Edit Micrograph Location`

  - `Edit Micrograph Opacity`
  - `Delete Micrograph`
- **+ Button** contains the following options:
  - `Add Associated Micrograph`
  - `Batch Import Associated Micrograph`
- The **eye icon** toggles visibility of the associated micrograph.

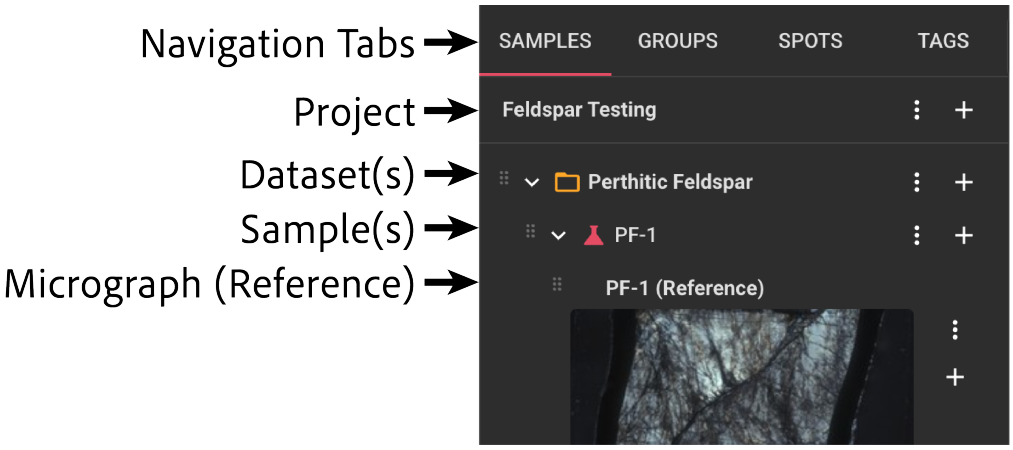


Figure 13. Sections in the Project Navigation Pane, including: Navigation Tabs, Project, Dataset(s), Sample(s), and Micrographs (both Reference and Associated). All sections and associated actions are covered in this section, Section 4.3.

Drag-and-Drop Reordering

NEW: StraboMicro supports intuitive drag-and-drop reordering of items in the Project Viewer:

- **Drag samples** to reorder them within the project hierarchy.
- **Drag micrographs** to change their order within a sample or move them between samples.
- **Visual feedback** shows the drop target location as you drag items.
- Items can also be reordered using `Ctrl+Up/Down` (Windows/Linux) or `Cmd+Up/Down` (macOS) keyboard shortcuts.

Project Stats Footer

NEW: At the bottom of the Project Viewer Pane, a statistics footer displays real-time counts:

`Total Samples: X • Total Micrographs: Y`

This provides a quick overview of your project's scope without needing to manually count items.

4.4 Micrograph Viewer: Image Display

The **Micrograph Viewer** in StraboMicro displays the micrograph currently selected in the Project Viewer Pane. This is the primary workspace for viewing, analyzing, and annotating images. The viewer is built on the high-performance Konva.js canvas engine, providing smooth panning,

zooming, and rendering of even very large images. Refer to Figure 11 for screenshot of the application with labeled sections.

Image Display and Scale

The displayed image includes dynamic scale rulers along the top and left edges. As the user zooms in, zooms out, or pans across the image, the rulers adjust in real time to reflect the current magnification level and visible region. This ensures accurate spatial interpretation at any zoom level.

At the bottom edge of the image window, the **live coordinate readout** displays the current position of the cursor as:

```
X: [value] unit, Y: [value] unit
```

These coordinates correspond to the location of the cursor on the image and are dynamically updated as the user moves the mouse. The units used are based on the spatial scale defined when the image was initially uploaded.

Enhanced Zoom Capabilities

NEW: StraboMicro 2.0 significantly improves zoom capabilities:

- **Maximum zoom increased from 5x to 20x**, allowing detailed examination of fine microstructures.
- **Smooth zoom transitions** using mouse wheel or trackpad gestures.
- **Zoom-to-cursor** behavior centers the zoom on your point of interest.
- Zoom level indicator displayed in the toolbar.

Dynamic Level-of-Detail (LOD) Rendering

NEW: StraboMicro introduces intelligent Level-of-Detail rendering for associated micrographs:

- **Automatic quality adjustment:** The system automatically selects the appropriate image resolution based on current zoom level and screen coverage.
- **Three rendering modes:**
  - *Thumbnail mode:* Used when the image covers less than 10% of the screen or when zoomed out significantly.
  - *Downsampled mode:* Used at moderate zoom levels with 10–40% screen coverage.
  - *Full tile mode:* Activated at high zoom or when the image covers more than 40% of the screen, providing maximum detail.
- **Consistent sharpness:** Overlays remain crisp and clear at any zoom level, eliminating the blurry appearance that could occur in the legacy application.

Progressive Tile Loading

NEW: Large images are loaded progressively using a tiled approach:

- **Instant initial display:** A low-resolution preview appears immediately while high-resolution tiles load in the background.
- **Visual loading indicators:** Subtle shimmer effects show which tiles are still loading.
- **Priority loading:** Tiles in the current viewport are loaded first, followed by adjacent areas.
- **Intelligent caching:** Previously loaded tiles are cached for instant display when revisiting areas or re-opening projects.

Detailed Notes Section

Beneath the main image display is the **Detailed Notes** section. This collapsible section shows image-specific metadata, notes, or other user-entered information related to the currently displayed micrograph or selected spot. It provides an accessible overview of contextual or observational data without needing to expand individual metadata sections in the Metadata Pane.

This combination of responsive navigation, accurate spatial coordinates, intelligent rendering, and linked metadata supports a seamless and precise workflow for image-based geologic analysis.

4.5 Metadata Pane Overview

The **Metadata Pane** displays metadata associated with the currently selected micrograph or spot. This includes both the information provided during the micrograph upload process and any additional metadata entered by the user. The pane is organized with tabs for different data categories.

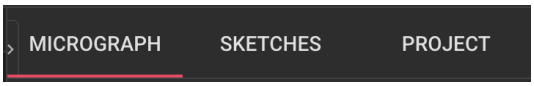


Figure 14. The Metadata Pane with tabbed organization for Micrograph or Spot data, Sketches, and Project information. Either Micrograph or Spot will appear as the first tab depending on what is actively selected in the Micrograph Viewer, Micrograph is the default tab.

4.5.1 Spot Tools

Between the **center viewing window** and the metadata pane are vertical buttons for creating and managing spots (from top to bottom):

Show/Hide Metadata Pane – Toggle the visibility of the right panel to maximize viewing area.

Add Spot – Spots are useful for marking small, specific features such as unique observations, individual grains, or regions analyzed with other instruments.

Add Line Spot – Line Spots are used to annotate linear features, transects, or boundaries.

Add Polygon Spot – Polygon Spots allow users to define custom shapes representing larger spatial areas of the micrograph.

Lasso Spots – The Lasso Spots Tool allows users to draw a line around all spots they would like to select, similar to the Lasso Tool in StraboField. The Lasso Tool can also be used with the keyboard shortcut Shift+Drag.

Users can customize the **color and transparency** of a single spot 2 ways:

1. Select the Spot, right-click the spot and choose `Edit Spot Metadata`
2. Select the Spot, locate the Spot Metadata section in the right Metadata Pane (Figure 11), click the `Edit` pencil button.

Users can customize the **color and transparency** of *several* spots 2 ways:

1. Using the Lasso Tool (or Shift+Drag), select multiple Spots, right-click the spots and choose `Edit Selected Spots...`
2. Select the Spots, in the upper menu bar go to `Spot > Edit Selected Spots`

Sketch – The Sketch Mode Button activates the Sketch Tool, see below in Section 8.3 for more information.

Measure Tool – Measure distances on the micrograph. **NEW:** Now displays measurements in real-world units (micrometers, millimeters, etc.) based on the image scale.

4.5.2 Toolbar Functions

The toolbar provides essential navigation and measurement tools:

Cursor Tool – Pan the image and select objects. Click and drag to pan; click on spots or micrographs to select them.

Zoom Out – Decrease magnification. You can also use the scroll wheel or trackpad pinch gesture.

Zoom In – Increase magnification up to 20x. You can also use the scroll wheel or trackpad pinch gesture.

Re-Center – Reset view to the original position and zoom level, fitting the entire micrograph in the viewer.

Below the toolbar, the **micrograph name and type** are displayed, followed by **Download** and **Delete** buttons.

4.5.3 Data Entry Section

The **data section** begins below the micrograph name. A label, ``Add Data:'', appears above a search bar where users can search for a data input type. Alternatively, a dropdown menu provides a list of available data pages.

There are **18 specialized data entry pages** for geological metadata. These are described in detail in **Section 6: Data Entry and Observation Tools**. The available pages include:

- Project/Dataset Metadata
- Sample Metadata
- Micrograph Metadata
- Mineralogy/Lithology
- Grain Information
- Fabric Information
- Clastic Deformation Bands
- Faults and Shear Zones
- Extinction Microstructures
- Grain Boundary/Contact Information
- Vein Information
- Pseudotachylyte Information
- Fold Information
- Notes
- Associated Files
- Links

4.6 Top Menu Overview

At the top of the **StraboMicro2** window, you will find the main menu bar. The primary menu categories include:

- **StraboMicro2**, which contains standard `File` options.
- **Edit**
- **Tools**
- **Spot**
- **Account**
- **View**
- **Help**

Each menu contains tools and options designed to manage your project, customize your view, access analysis tools, and get help. The following is a summary of the options available in each menu.

StraboMicro2 Menu

- **New Project** – Create a new local project. Local means the project will be saved to your device until manually uploaded to the server.
- **Open Local Project (.smz)** – Open a StraboMicro project saved on your device.
- **Open Remote Project** – Open a project from your StraboSpot account.
- **Open Shared Project** – Open a project shared by another user using a sharing code.

- **NEW: Recent Projects** – Quick access submenu showing recently opened projects for fast navigation.
- **Close Project** – Closing the Project will: Delete all project files from your Documents folder; remove the project from the Recent Projects menu; clear all version history. Warning: this action cannot be undone.
- **Save Project** (`Cmd+S`/`Ctrl+S`) – Save the project locally to your device.
- **Export as .smz** – Export the project as a .smz file.
- **Upload to Strabo Server** – Upload the StraboMicro project to your StraboSpot account online.
- **NEW: View Version History** – View and restore previous versions of your project (requires cloud sync).
- **Edit Project** – Opens the Project Metadata for editing.
- **Export All Images** – Opens the Export Dialog with JPEG and SVG download options, see Section 3.8.1 for more information.
- **Export View with Sketches** – Opens the Export Image with Sketches dialog with options including: what to include in the export, Sketch Layers, Export Format, and Resolution. See Section 8.7 for more information.
- **Export as JSON** – Creates a JSON file of your project for external use and opens the file directory for users to chose where to save the JSON file.
- **Export as PDF** – Creates a PDF file of the project including images, annotations, and metadata.
- **Quit StraboMicro2** – Exit the application (`Cmd+Q` on macOS, `Alt+F4` on Windows).

Edit Menu **NEW:** The Edit menu provides quick access to editing functions:

- **Undo** (`Cmd+Z`/`Ctrl+Z`) – Undo the last action.
- **Redo** (`Cmd+Shift+Z`/`Ctrl+Y`) – Redo the previously undone action.
- **Cut** (`Cmd+X`/`Ctrl+X`) – Cut selected item.
- **Copy** (`Cmd+C`/`Ctrl+C`) – Copy selected item.
- **Paste** (`Cmd+V`/`Ctrl+V`) – Paste from clipboard.
- **Select All** (`Cmd+A`/`Ctrl+A`) – Select all spots on the current micrograph.
- **Clear All Spots** – Delete all Spots on the current Micrograph in the Micrograph Viewer.

Tools Menu **NEW:** The Tools menu provides access to advanced analysis capabilities:

- **NEW: Point Count** – Open the point counting tool for modal analysis.
- **NEW: Grain Detection** – Automatically detect and outline grains in the current micrograph.
- **Image Comparator** – Compare two micrographs side by side with synchronized navigation.

- NEW: **Grain Size Analysis** – Analyze grain size distribution from detected or manually marked grains.

Spot Menu

- **Quick Spots Presets** – Open the Quick Spot Presets dialog for creating Spot templates either globally (associated with the StraboSpot account) or for the specific Project open.
- NEW: **Quick Edit Spots** – Open the batch editing dialog for modifying multiple spots simultaneously.
- **Edit Selected Spots** – Open the Edit Spots dialog and edit Primary Mineral, Color, and/or Opacity of all Spots at the same time.
- **Merge Selected Spots** – Will merge two polygon Spots into one Spot. Merge cannot be applied to point or line Spots.
- **Split Spot with Line** – Allows a polygon Spot to be split into two polygon Spots with a user drawn line. Split cannot be applied to point or line spots.
- **Configure Mineral Colors** – Opens the Configure Mineral Colors dialog, which displays minerals and their assigned colors. The dialog shows both:
  - **Global Colors** – Color assignments associated with the StraboSpot user account.
  - **Project Colors** – Project specific mineral color assignments that differ from the Global color settings.

Account Menu

- **Login to StraboSpot** – Log in to your StraboSpot account.
- **Logout** – Log out of your StraboSpot account.

View Menu

- **Show Rulers** – Toggle visibility of the scaled rulers surrounding the micrograph viewing area.
- NEW: **Show Original Spot Labels** – Toggle visibility of spot name labels on the micrograph.
- NEW: **Show Mineralogy Spot Labels** – Toggle visibility of mineral abbreviation labels on the micrograph if mineralogy has been defined for the spots.
- **Hide Spot Labels** – Hide visibility of spot name labels on the micrograph.
- NEW: **Show Overlay Outlines** – Toggle red outlines around associated micrographs when viewing a reference image.
- NEW: **Show Recursive Spots** – Display spots from associated micrographs on the reference image.
- **View Spots by Spot Color** – Show defined spot color on the Micrograph.
- NEW: **View Spots by Mineral Color** – Show defined mineral color on the micrograph.

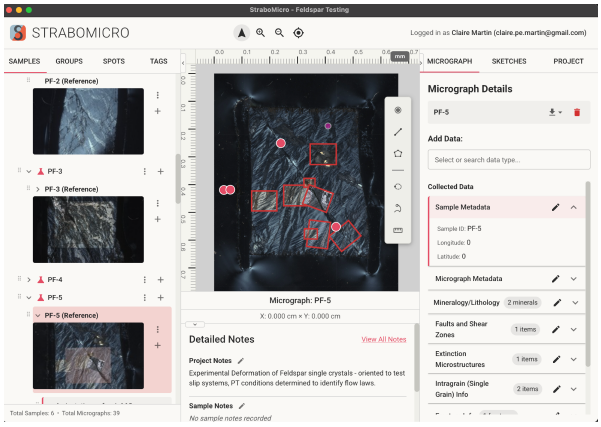
- NEW: **Theme** – Submenu for theme selection:
  - **Light** – Light color scheme.
  - **Dark** – Dark color scheme.
  - **System** – Follow operating system theme setting.

Help Menu

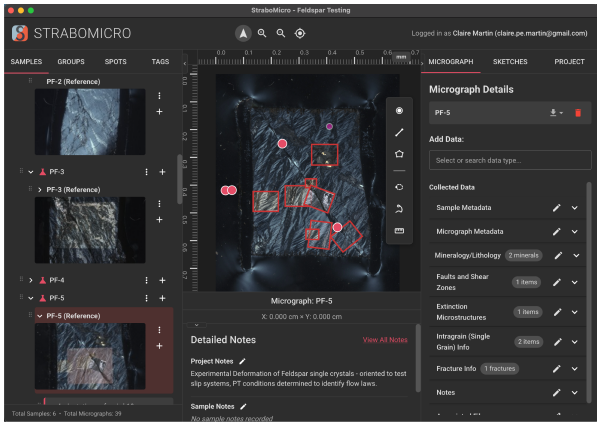
- **About StraboMicro** – Displays version information and license details.
- **StraboMicro User Guide** – Opens the user manual and documentation.
- **Check for Updates** – Check if a newer version of StraboMicro is available.
- **View Error Logs** – Opens a list of Error Logs that can be viewed, copied to the clipboard, or emailed to StraboSpot support.
- **Send Error Report** – Send a record of recent actions to developers to help diagnose issues.

4.7 Theme Support

NEW: StraboMicro now includes comprehensive theme support to reduce eye strain and accommodate different working environments:



(a) Light Theme



(b) Dark Theme

Figure 15. StraboMicro supports both Light and Dark themes, with smooth transitions between them.

Available Themes

- **Light Theme:** A bright interface with light backgrounds, ideal for well-lit environments. This is the classic appearance similar to the original StraboMicro.
- **Dark Theme:** A dark interface with muted colors that reduces eye strain in low-light conditions. Particularly useful for extended analysis sessions.

- **System Theme:** Automatically follows your operating system's theme setting. When your OS switches between light and dark mode (e.g., based on time of day), StraboMicro will switch automatically.

Changing Themes

To change the application theme:

1. Navigate to `View > Theme` in the menu bar.
2. Select your preferred theme: **Light**, **Dark**, or **System**.
3. The theme change takes effect immediately with a smooth transition animation.

Your theme preference is saved automatically and will persist between application sessions.

4.8 Keyboard Shortcuts

NEW: StraboMicro includes comprehensive keyboard shortcuts to accelerate common workflows. Below are some of the most frequently used shortcuts:

Action	macOS	Windows/Linux
Save Project	`Cmd+S`	`Ctrl+S`
Undo	`Cmd+Z`	`Ctrl+Z`
Redo	`Cmd+Shift+Z`	`Ctrl+Y`
Zoom In	`Cmd+Plus`	`Ctrl+Plus`
Zoom Out	`Cmd+Minus`	`Ctrl+Minus`
Fit to Window	`Cmd+0`	`Ctrl+0`
Delete Selected	`Delete`	`Delete`
Select All Spots	`Cmd+A`	`Ctrl+A`
Toggle Full Screen	`Cmd+Ctrl+F`	`F11`
Move Item Up	`Cmd+Up`	`Ctrl+Up`
Move Item Down	`Cmd+Down`	`Ctrl+Down`

For a complete list of all keyboard shortcuts, see **Appendix 10.2: Complete Keyboard Shortcuts Reference**.

Tip: Most menu items display their keyboard shortcut next to the menu item text, making it easy to learn shortcuts as you work.

5 Sample and Spot Management

This section covers the complete workflow for creating samples, adding micrographs, and managing spots in StraboMicro. Several new features have been added to improve workflow efficiency and enable more precise spatial analysis.

5.1 Add / New Sample

To begin adding a new sample, click the **+** button next to the Dataset, see Section 4.3 and Figure 13 for more information.

The following sections outline each modal that appears during the new sample creation process.

5.1.1 Sample Info

The **Sample Info** modal collects descriptive metadata for your sample:

- **Sample ID/Name***
- **IGSN:** International Generic Sample Number
- **Location:** Latitude and Longitude
- **Main Sampling Purpose:**
  - Fabric / Microstructure
  - Petrology
  - Geochronology
  - Geochemistry
  - Active Eruption
  - Other
- **Description**
- **Material Type:**
  - Intact Rock
  - Fragmented Rock
  - Sediment
  - Tephra
  - Carbon or Animal
  - Other
- **Sample Notes**

Required field.* Click **Create Sample to add the sample to the dataset.

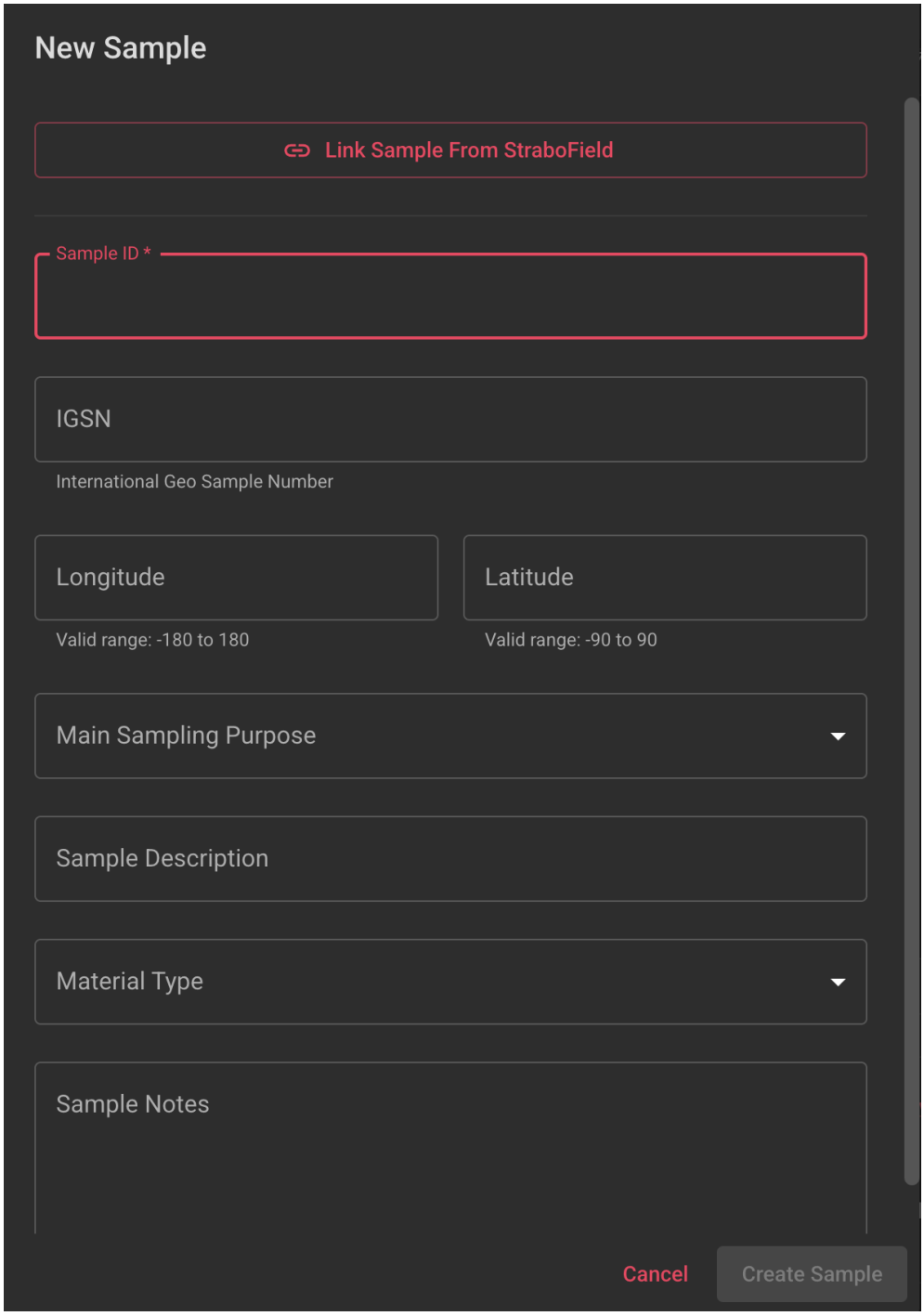


Figure 16. New Sample: Sample Info modal in StraboMicro

5.2 Load Reference Micrograph

5.2.1 Step 1 of 7: New Reference Micrograph

Locate the Sample in the Project Navigation Pane the Reference Micrograph should be added to. Click the **+** button.

- Choose `Load Reference Micrograph` to add 1 reference micrograph.
- Choose `Batch Upload Reference Micrographs` to add multiple reference micrographs to the sample at the same time.

Supported image formats: `.jpeg`, `.png`, `.bmp`, `.tiff`

- In the **Load Reference Micrograph** modal, click **Browse** to select and upload an image file from your computer.
- **Important:** The image must include a clearly visible **scale bar**.
- Click **Next** to proceed to the **Instrument and Image Info** section.

5.2.2 Step 2 of 7: Instrument and Image Information

In the **Instrument and Image Information** modal, you can:

- Use the **Load Metadata from Previous Image** option to import metadata from a previously uploaded micrograph in the project.
- Use the **Select...** dropdown to choose an existing sample, which will auto-fill its Sample ID/Name.
- Choose the instrument manually from the dropdown, or click **Find Instrument in Database** to search the shared StraboMicro instrument repository.
- For additional details about the instrument repository, see **Section 2.6.**

Metadata Input by Instrument Type

- If selecting a new instrument manually, choose from the following **Instrument Types**:
  - Optical Microscopy
  - Scanner
  - Transmission Electron Microscopy (TEM)
  - Scanning Transmission Electron Microscopy (STEM)
  - Scanning Electron Microscopy (SEM)
  - Electron Microprobe
  - Fourier Transform Infrared Spectroscopy (FTIR)
  - Raman Spectroscopy
  - Atomic Force Microscopy (AFM)
  - Other

Supported Image/Data Types per Instrument:

- **Optical Microscopy:** Plane Polarized Light, Cross Polarized Light, Reflected Light, 1/4 Lambda Plate, Cathodoluminescence, Gypsum Plate.
- **Scanner:** No Polarizer, Plane Polarized, Cross Polarized, Other.
- **TEM:** Bright Field, Dark Field, Electron Diffraction (SAED, CBED, NBD, LACBED), EDS (with periodic table element selection), ACOM, EDS Tomography.
- **STEM:** Bright Field, Dark Field, ADF, HAADF, EDS (element selection), EELS, CL (Panchromatic, Wavelength-Filtered, Spectroscopy).

- **SEM:** SE, BSE, FSE, EBSD (Euler, IPF-X/Y/Z, Band Contrast, Phase Map, Grain Boundaries), TKD, ECCI, EDS/WDS (element selection), CL (Panchromatic, Wavelength-Filtered), FIB Imaging.
- **FTIR:** False Color Map, Intensity Map.
- **Raman Spectroscopy:** False Color Map, Intensity Map.
- **AFM** Topography Image.

Metadata Entry Options

- Enter metadata manually or load from the StraboMicro instrument database.
- When applicable (e.g., for EDS, WDS), use the interactive periodic table to select elements.
- Input data for specific analytical modes such as EBSD, CL, or EELS where prompted.

Refer to **Appendix 10.1** for explanations of abbreviations.

5.2.3 Step 3 of 7: Instrument Data

Click **Next** to open the **Instrument Data** modal.

The instrument type you previously selected will appear (e.g., *Instrument Type: Optical Microscopy*).

Fields to Complete:

- **Instrument Brand:**
- **Instrument Model:**
- **Instrument Location:** Institution and lab name
- **Software (Data Collection):** Application name and version
- **Software (Post-Processing):** Application name and version
- **Notes:** Optional field for any additional information

For certain instrument types, an additional **Detectors** section may appear, including:

- **Type**
- **Make**
- **Model**

Note: If you selected a preloaded instrument from the StraboMicro repository, these fields will be auto-filled and do not require manual input.

5.2.4 Dependent Step: Instrument Settings

Click **Next** to continue the upload process. For certain instrument types, an additional **Instrument Settings** modal will appear. The fields shown in this modal are specific to the selected instrument.

For Scanning Electron Microscopy (SEM) or Electron Microprobe:

- Acceleration Voltage (kV)
- Beam Current (nA)
- Spot Size (μm)
- Aperture
- Working Distance (mm) replaces Camera Length
- Other fields may vary depending on instrument configuration

For Transmission Electron Microscopy (TEM):

- Acceleration Voltage (kV)
- Beam Current (nA)
- Spot Size (μm)
- Aperture
- Camera Length (mm)

For Scanning Transmission Electron Microscopy (STEM): Includes all TEM fields, plus:

- Camera Binning
- Dwell Time (s)

For Fourier Transform Infrared Spectroscopy (FTIR):

- Instrument Purged (Yes/No)
- Environment Purged (Yes/No)
- Aperture (μm^2)
- Scan Time (s)
- Resolution (Hz)
- Spectral Resolution (cm^{-1})
- Wavenumber Range
- Averaging
- Background Composition (KCl, NaCl, Other)
- Background Correction Frequency
- Notes

For Raman Spectroscopy:

- Excitation Wavelength (μm)
- Laser Power (mW)
- Spot Size (μm)
- Diffraction Grating (grooves/mm)

- Integration Time (s)
- Objective (magnification, e.g., 10x, 50x)
- Spatial Resolution (μm)
- Averaging
- Calibration

For Atomic Force Microscopy (AFM):

- Mode (Contact, Intermittent Contact [Tapping])
- Cantilever Stiffness (N/m)
- Tip Diameter (μm)
- Operating Frequency (kHz)
- Scan Dimensions (pixels)
- Scan Area (μm)
- Spatial Resolution (μm)
- Room Temperature (°C)
- Relative Humidity (%)
- Sample Temperature (°C)

Note: Only the fields relevant to the selected instrument type will be displayed. If metadata was preloaded via the instrument repository, these fields may already be filled in.

5.2.5 Step 4 of 7: Micrograph Metadata

In this section, you will be prompted to enter the following metadata:

- **Name:** A text field to assign a unique name or identifier to the micrograph.
- **Polished:** A checkbox indicating whether the sample surface is polished.
  - If selected, an additional field will appear to describe the polishing method or details.
- **Notes:** An optional text field for any additional observations or comments.

5.2.6 Step 5 of 7: Orientation of Reference Micrograph

Define the orientation of the reference micrograph by selecting one of the following three options:

1. **Unoriented Thin Section**
   - No additional metadata is required.
2. **Trend and Plunge of Edges / Strike and Dip of Surface**
   - This option requires users to define the micrograph orientation using geologic measurements.

- A message at the top of the modal instructs:

  "Provide **TWO of THREE**: Select the arrow on each edge that represents a lower hemisphere plunge, and enter the trend and plunge information and/or provide the strike and dip of the thin section."

- Input fields include:
  - Trend and Plunge values for both horizontal and vertical axes
  - Corner selection to define orientation direction
  - Strike and Dip of the thin section surface

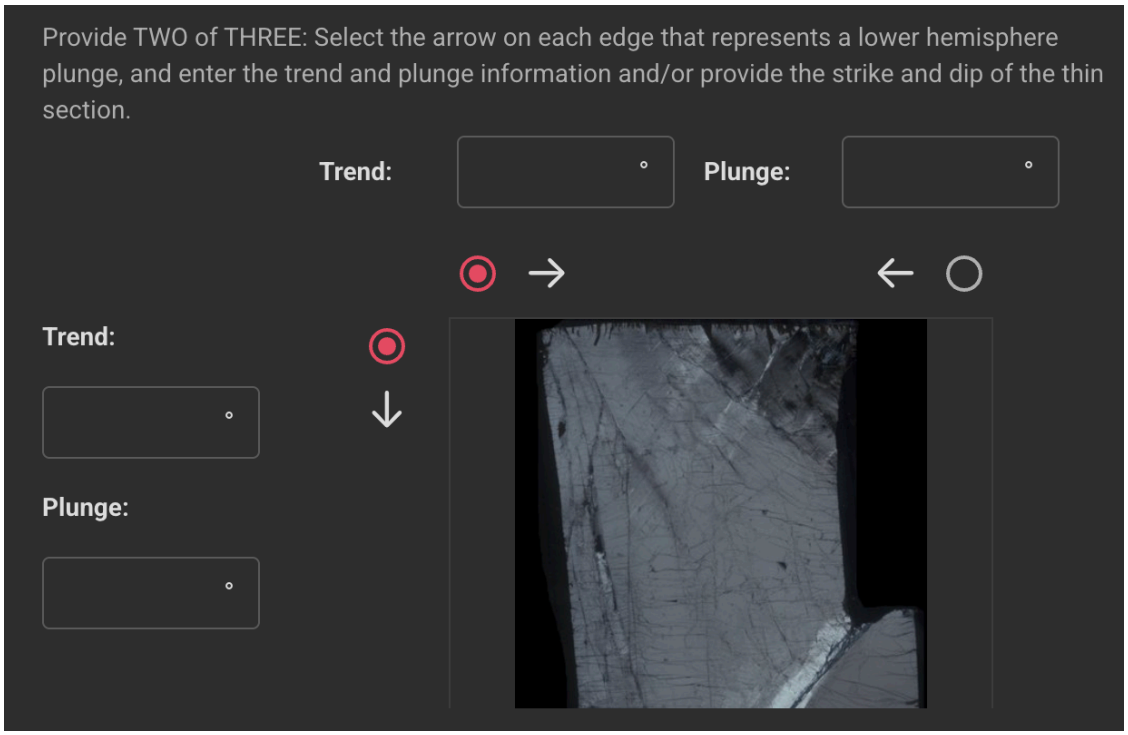


Figure 17. Example modal for entering Trend and Plunge or Strike and Dip orientation data.

3. **Fabric Reference Frame (XZ, YZ, XY Thin Sections)**
   - Select the orientation of the thin section based on the structural fabric:
     - **XZ** – Lineation (X) and foliation normal (Z)
     - **YZ** – Perpendicular to lineation (Y) and foliation normal (Z)
     - **XY** – Lineation (X) and perpendicular to lineation (Y) in the foliation plane
   - Required metadata:
     - **Foliation Orientation:** Strike and Dip (Geographic coordinates)
     - **Lineation Orientation:** Either
       - Trend and Plunge, or
       - Rake (Right-Hand Rule, 1–180°)
     - **Look Direction:** Specify whether the image was taken:

    - Looking down through the micrograph (toward the lower hemisphere), or
    - Looking up through the micrograph (toward the upper hemisphere)
  - A note in the modal provides clarification:

    "When viewing the reference micrograph, are you looking toward the lower hemisphere or upper hemisphere in geographic coordinates?"

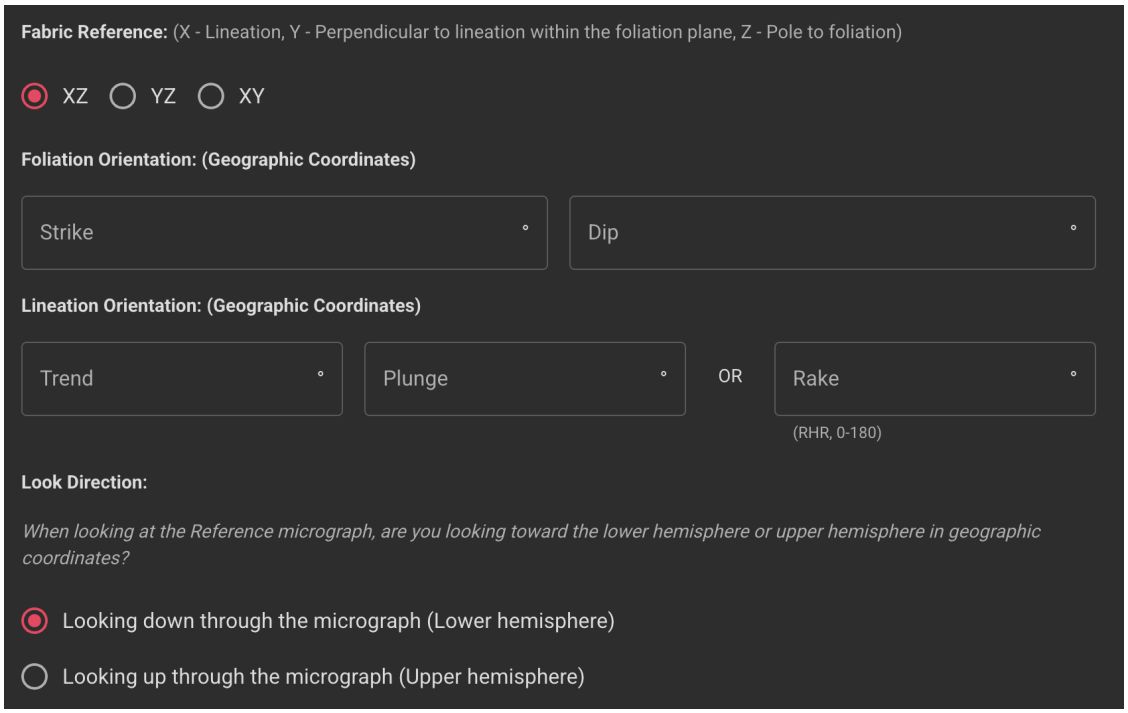


Figure 18. Fabric Reference Frame modal with XZ/YZ/XY options and orientation metadata fields.

5.2.7 Dependent Step: Define Top Corner (Fabric Reference Frame Only)

If you selected the *Fabric Reference Frame* option, an additional modal will appear: **Define Top Corner**.

- The micrograph image is displayed with clickable buttons at each corner.
- Select the corner that is **highest in geographic coordinates** by clicking the corresponding button.

5.2.8 Step 6 of 7: Set Micrograph Scale and Location

After defining the orientation, the next step is to set the scale and spatial information for the micrograph. StraboMicro provides five methods for setting scale, including a new 3-Point Registration system for precise alignment of overlay micrographs.

Choose one of the following scale-setting methods:

1. **Trace Scale Bar**
   - Use drawing tools to trace a line across the visible scale bar in the image.

- Tools include:
  - **Pointer Tool:** Move or reposition the micrograph.
  - **Line Tool:** Click and drag to draw a line. Repeat as many times as needed to appropriately trace the scale bar in the image.
- The pixel length is automatically calculated. Enter the corresponding real-world length and select the correct unit (μm, mm, cm).
- Use mouse scroll to zoom in/out on the image.
- Optionally, check **Flip Image** to mirror the micrograph across the vertical axis.

2. **Pixel Conversion Factor**
   - Enter the pixel-to-distance conversion factor directly.
   - Input the number of pixels and its real-world equivalent (units: μm, mm, cm).
   - **Flip Image** option is also available.
3. **Provide Width/Height of Image**
   - Enter the total width and height of the image manually.
   - Select the units from the dropdown.
   - The **Flip Image** checkbox is included.
4. **Copy Size from Existing Micrograph**
   - Select a previously uploaded micrograph to copy its size.
   - A dropdown menu lists all available micrographs.
   - **Flip Image** option is also included.
5. **3-Point Registration (Affine Transform Placement)** *NEW* **NOTE: The 3-Point Registration is only available if you are loading a Associated Micrograph.**
   - This method enables precise spatial alignment of child micrographs onto parent micrographs using three corresponding control points.
   - The 3-point registration calculates an affine transformation that accounts for:
     - **Translation** – positioning the image at the correct location
     - **Rotation** – aligning orientation between images
     - **Scale** – matching magnification differences
     - **Shear** – correcting for distortion or skew

   How to Use 3-Point Registration:

   (a) Select **3-Point Registration** from the scale method options.

   (b) The parent micrograph is displayed in the left panel. Click to place **three control points** on recognizable features (e.g., grain boundaries, mineral inclusions, or other identifiable landmarks).

(c) The child micrograph is displayed in the right panel. Click to place **three corresponding points** that match the features selected on the parent.

(d) As you place points, a **live preview** shows the calculated transformation overlaid on the parent micrograph.

(e) Adjust point positions as needed by clicking and dragging until the alignment is satisfactory.

(f) Click **Apply** to finalize the registration, or **Reset** to start over.

Tips for Accurate Registration:

- Choose control points that are spread apart across the image for better accuracy.
- Select features that are clearly visible in both micrographs.
- Zoom in when placing points for sub-pixel precision.
- The transformation quality indicator shows the estimated alignment error.

5.2.9 Step 7 of 7: Scale Input

Once the selected method is selected in step 6, a corresponding modal will prompt you to finalize the micrograph's location and scale. The fields shown in this final step directly correspond to your earlier selection. After all required inputs are entered, click **Finish** to add the reference micrograph to the sample and save it to the project.

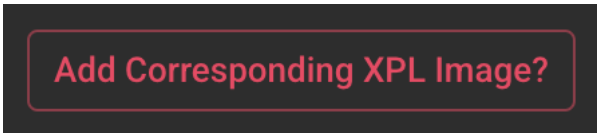
5.3 XPL/PPL Synchronized Viewing

StraboMicro introduces synchronized viewing of plane-polarized light (PPL) and cross-polarized light (XPL) micrographs. This feature allows researchers to quickly toggle between polarization modes while maintaining their current view position, enabling efficient mineral identification and analysis.

5.3.1 Linking PPL and XPL Images

To link two micrographs for synchronized viewing:

1. Right-click on a PPL or XPL micrograph in the sample tree and select **Link Sibling PPL/XPL Pair**.
2. In the dialog that appears, select the corresponding XPL micrograph from the dropdown list.
3. Once linked, a chain icon appears next to both micrographs in the sample tree.



PPL/XPL Link During Micrograph Upload

PPL/XPL Linked Micrograph Icon

Figure 19. PPL/XPL micrograph upload process and pairing icon.

5.3.2 Toggling Between Views

Once images are linked:

- Press **X** on the keyboard to toggle between PPL and XPL views.
- Alternatively, click the **Toggle PPL/XPL** arrow button in the micrograph viewing area.
- The current polarization mode is indicated in the status bar.

5.3.3 Synchronized Pan and Zoom

When viewing linked micrographs:

- **Pan operations** are synchronized – moving the view in one mode moves the corresponding area in the other.
- **Zoom operations** are synchronized – zooming in PPL view zooms to the same level in XPL view.
- The synchronization maintains the exact same field of view when toggling.

5.3.4 Shared Spots

- All spots created on a PPL micrograph automatically appear on its linked XPL counterpart, and vice versa.
- Spot modifications (moving, resizing, property changes) are reflected in both views.
- This ensures consistent annotation across polarization modes.

5.3.5 Handling Different Image Dimensions

If the linked PPL and XPL images have slightly different dimensions:

- StraboMicro automatically calculates the scale relationship between the images.
- The synchronized view adjusts pan and zoom to maintain alignment.
- A warning icon appears if the dimension difference exceeds 5%, suggesting the use of 3-Point Registration for better alignment.

5.4 Spot Management

Spots are a central concept in StraboSpot, representing spatial observations at multiple scales. In StraboMicro, a spot might represent a grain, a mineral inclusion, or any localized feature

within a thin section or micrograph. This multiscale framework enables users to document observations consistently, from the field to the microscope.

StraboMicro 2.0 introduces several new spot management features including batch editing, multi-select operations, merge and split tools, and recursive spot viewing.

5.5 Adding a New Spot

Once a micrograph has been loaded, users can add new spots directly onto the image to annotate and analyze specific features. Each spot is associated with editable metadata, accessible via the **right metadata pane**, which includes information entered during micrograph upload and any user-provided observations.

5.5.1 Spot Tools

To the right of the **central viewing window**, a vertical toolbar provides access to spot creation tools:

Show/Hide Right Panel

Add Spot – For marking discrete features such as mineral grains or points of interest.

Add Line Spot – For linear features such as foliations, transects, or crystal boundaries.

Add Polygon Spot – For selecting areas like individual grains, mineral zones, or deformation domains.

5.5.2 How to Add a Spot

Follow these steps to add a spot to a micrograph:

1. **Determine the appropriate spot type:** Choose whether you are marking a point, a line feature, or an area (polygon).
2. **Click the corresponding button** in the vertical toolbar to activate that spot mode. The selected tool will highlight in red.
3. **Navigate the micrograph:** Use click-and-drag to move the image, scroll to zoom, or use the zoom buttons in the top-right corner.
4. **Add the spot to the micrograph:**
    - **Point:** Click once to place the spot.
    - **Line:** Click to add vertices. Double-click the final point to complete the line.
    - **Polygon:** Click to define each corner. The shape appears as you add points. Double-click the last vertex to close the shape.
5. **Fill out spot information:** Once the spot is placed, a configuration modal appears (see Figure 20).

6. **Enter metadata:** Provide the spot name, label color, spot color, transparency, and optional notes.
7. **Save the spot:** After saving, the spot appears in the micrograph and is listed in the **Spot Metadata** panel on the right side (see Figure 21).
8. **Edit the spot:** Click the pencil icon (see Figure 21) in the metadata panel to make changes or add more details.

Tip: If you activate a spot tool but decide not to place a spot, click the **Cursor tool** (top-right) or press the Escape key (**esc**) to exit spot mode and return to default navigation.

5.5.3 Spot Options

After selecting a spot type—**Point**, **Line**, or **Polygon**—a configuration modal appears (Figure 20) allowing you to define the following:

- **Spot Name:** Assign a unique label.
- **Label Color:** Defines the text color for the spot label on the micrograph.
- **Spot Color:** Controls the fill or line color of the spot.
- **Transparency:** Adjust the opacity using a slider.
- **Notes:** Optional free-text field for observations, interpretations, or measurements.

All spot types can be customized further by navigating to:

```
Metadata Pane > Spot Metadata Section > Edit > Spot Color > Custom Color > Edit Transparency
```

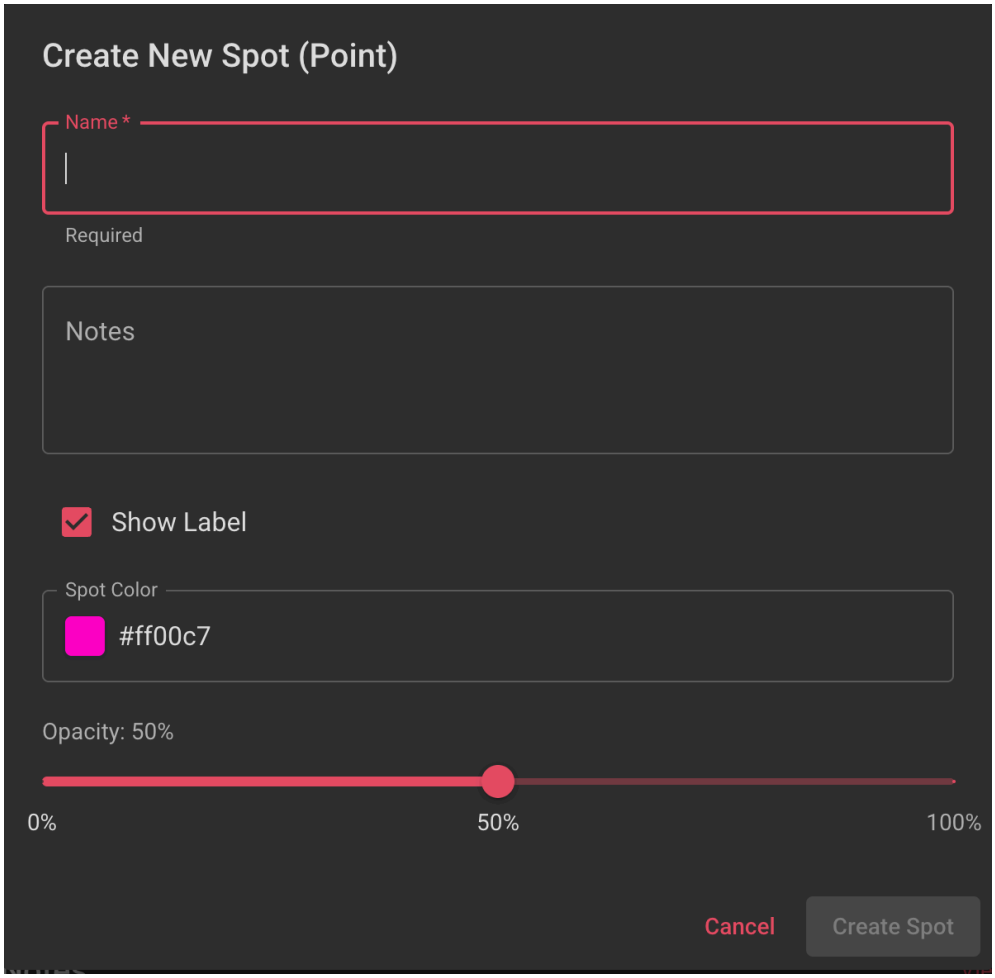


Figure 20. Add Spot configuration modal showing customization options for spot name, label color, spot color, transparency, and notes.

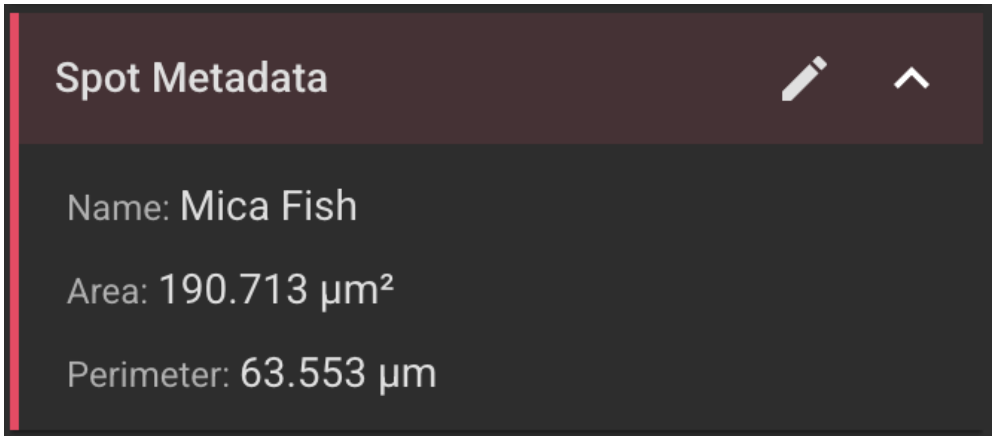


Figure 21. Spot Metadata panel showing saved spot entries and editable fields. The pencil icon is used to edit spot metadata.

5.5.4 Real-World Spot Measurements

StraboMicro automatically calculates and displays real-world measurements for line and polygon spots when the micrograph has a defined scale.

Line Spot Measurements:

- **Total Length:** The sum of all line segments, displayed in the spot properties panel.
- For multi-segment lines, individual segment lengths are also available in the detailed view.

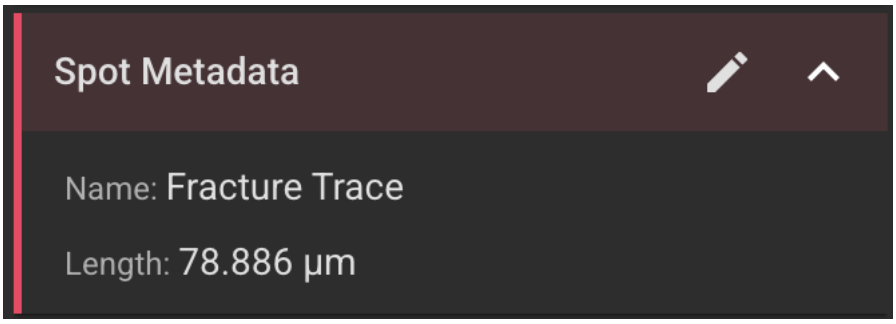
Polygon Spot Measurements:

- **Area:** The enclosed area of the polygon.
- **Perimeter:** The total boundary length of the polygon.

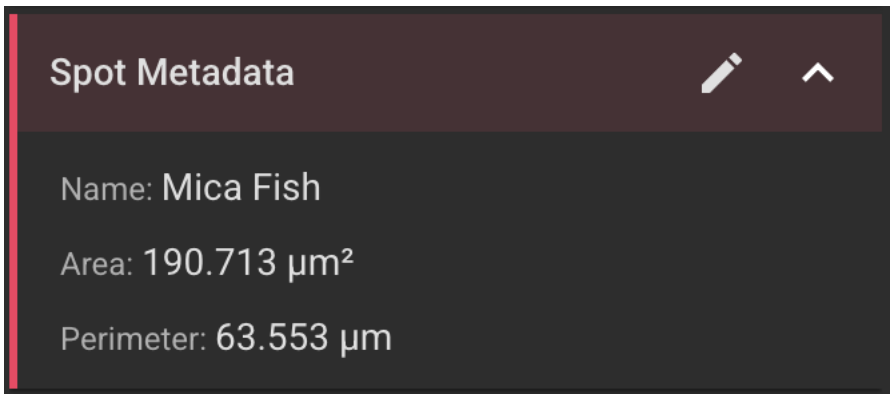
Smart Unit Selection:

Measurements are automatically displayed in the most appropriate unit based on magnitude:

- Values less than 1000 μm are displayed in **micrometers** (μm or μm^2)
- Values between 1 mm and 10 mm are displayed in **millimeters** (mm or mm^2)
- Values greater than 10 mm are displayed in **centimeters** (cm or cm^2)



(a) Line Spot Measurements



(b) Polygon Spot Measurements

Figure 22. Spot properties panel showing real-world measurements for a polygon and line spot, including length, area, and perimeter with smart unit display.

5.6 Batch Edit and Multi-Select

StraboMicro introduces powerful batch spot editing capabilities that allow you to select and modify multiple spots simultaneously, significantly improving workflow efficiency when working with many annotations.

5.6.1 Multi-Select Methods

Lasso Selection:

1. Hold **Shift** and click-drag to draw a freeform selection area.
2. All spots fully enclosed within the lasso will be selected.
3. Selected spots are highlighted with a distinct selection indicator.

Click Selection:

- **Cmd+Click** (Mac) or **Ctrl+Click** (Windows/Linux) to add individual spots to the current selection.
- Click an already-selected spot with the modifier key to remove it from the selection.
- **Cmd+A** or **Ctrl+A** selects all spots on the current micrograph.

Selection from Spot List:

- In the Spot Metadata panel, hold **Shift** and click to select a range of spots.
- Use **Cmd/Ctrl+Click** to toggle individual spots in the list.

5.6.2 Batch Property Editing

With multiple spots selected, you can modify shared properties:

- **Color:** Apply a uniform color to all selected spots.
- **Mineral Assignment:** Assign the same mineral type to multiple grain spots.
- **Tags:** Add or remove tags from all selected spots.
- **Transparency:** Adjust opacity for all selected spots simultaneously.

To batch edit:

1. Select multiple spots using any method described above.
2. Right-click to open the context menu and select **Batch Edit Properties**.
3. In the batch edit panel, modify the desired properties.
4. Click **Apply to All** to update all selected spots.

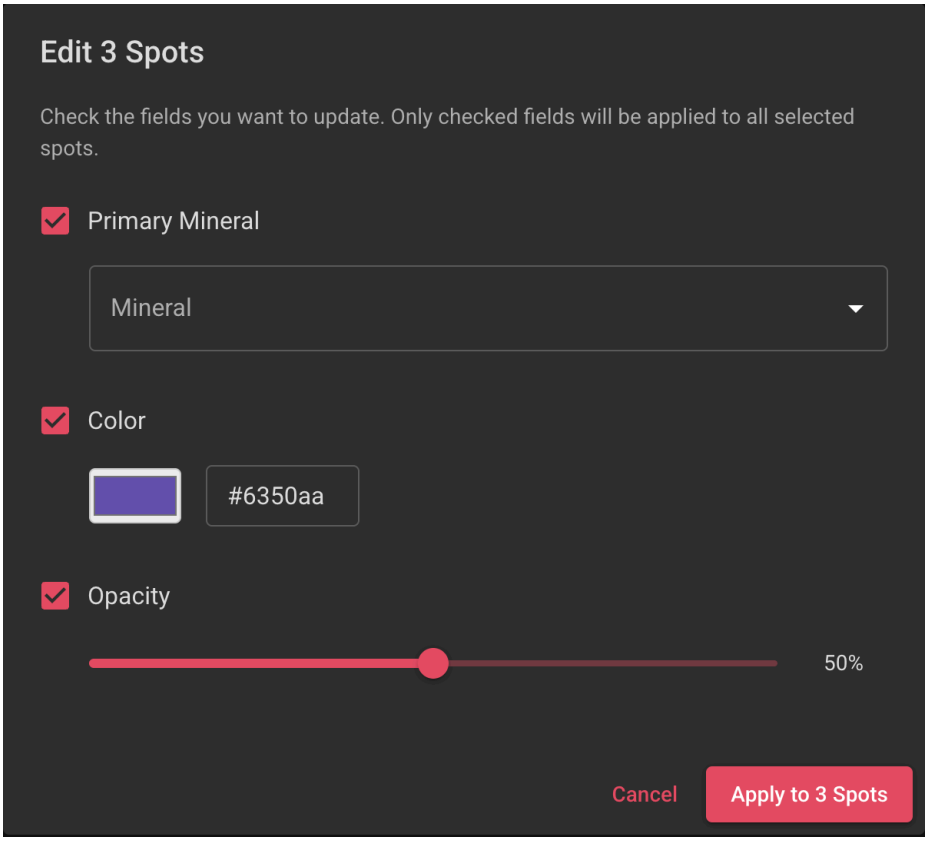


Figure 23. Batch Edit panel showing editable properties for multiple selected spots.

5.6.3 Batch Delete

To delete multiple spots at once:

1. Select the spots you wish to delete.
2. Press **Delete** or **Backspace**, or right-click and select **Delete Selected Spots**.
3. A confirmation dialog shows the number of spots to be deleted.
4. Click **Confirm** to proceed or **Cancel** to abort.

Note: Batch delete operations can be undone using **Cmd+Z** (Mac) or **Ctrl+Z** (Windows/Linux).

5.7 Merge and Split Tools

NEW FEATURE

StraboMicro2 provides tools for combining and dividing polygon spots, enabling flexible refinement of annotations as your analysis progresses.

5.7.1 Merge Tool

The merge tool combines multiple adjacent polygon spots into a single unified polygon.

How to Merge Polygons:

1. Select two or more polygon spots that share boundaries or overlap.

2. Press **M** on the keyboard, or right-click and select **Merge Selected Polygons**.
3. The polygons are combined into a single polygon encompassing all selected areas.
4. A dialog prompts you to choose which spot's properties to retain for the merged result, or to enter new properties.

Merge Behavior:

- Adjacent polygons are combined along shared edges.
- Overlapping polygons create a union of their areas.
- Non-adjacent polygons can be merged into a multi-part polygon if needed.
- The merged polygon inherits the ID of the first selected spot by default.

5.7.2 Split Tool

The split tool divides a single polygon into two separate polygons using a drawn line.

How to Split a Polygon:

1. Select a single polygon spot.
2. Press **/** (forward slash) on the keyboard, or right-click and select **Split Polygon**.
3. The cursor changes to a crosshair indicating split mode.
4. Draw a line across the polygon to define the split boundary:
    - Click to start the line outside or on the polygon edge.
    - Click additional points to create a multi-segment split line if needed.
    - Double-click to end the line outside or on the opposite edge.
5. The polygon is divided into two separate spots along the drawn line.
6. Each resulting polygon appears as a new spot, with properties copied from the original.

Split Behavior:

- The split line must cross the polygon completely.
- Both resulting polygons inherit properties from the original.
- New spot IDs are automatically generated for the split results.
- Press **Escape** to cancel split mode without making changes.

5.7.3 Undo/Redo Support

Both merge and split operations fully support undo and redo:

- **Cmd+Z** (Mac) or **Ctrl+Z** (Windows/Linux) to undo.
- **Cmd+Shift+Z** (Mac) or **Ctrl+Y** (Windows/Linux) to redo.
- The undo history preserves the original spot geometries and properties.

5.7.4 Provenance Tracking

StraboMicro maintains a record of merge and split operations for data integrity:

- Merged spots record the IDs of their source spots in the metadata.
- Split spots record the ID of their parent spot.
- This provenance information is preserved when exporting data and syncing with StraboSpot.
- Access provenance details via **Spot Metadata > History**.

5.8 Recursive Spots

When working with hierarchical micrograph stacks (parent micrographs with child overlays), StraboMicro can display spots from child micrographs on the parent view. This **Recursive Spots** feature provides a comprehensive overview of all annotations across the image hierarchy.

5.8.1 Enabling Recursive Spot Display

To show spots from child micrographs on the parent view:

1. Navigate to a parent micrograph that has associated child micrographs.
2. Go to **View > Show Recursive Spots** in the menu bar, or press **Cmd+R** (Mac) / **Ctrl+R** (Windows/Linux).
3. Spots from all child micrographs are now displayed on the parent view.
4. A status indicator in the toolbar shows when recursive spots are active.

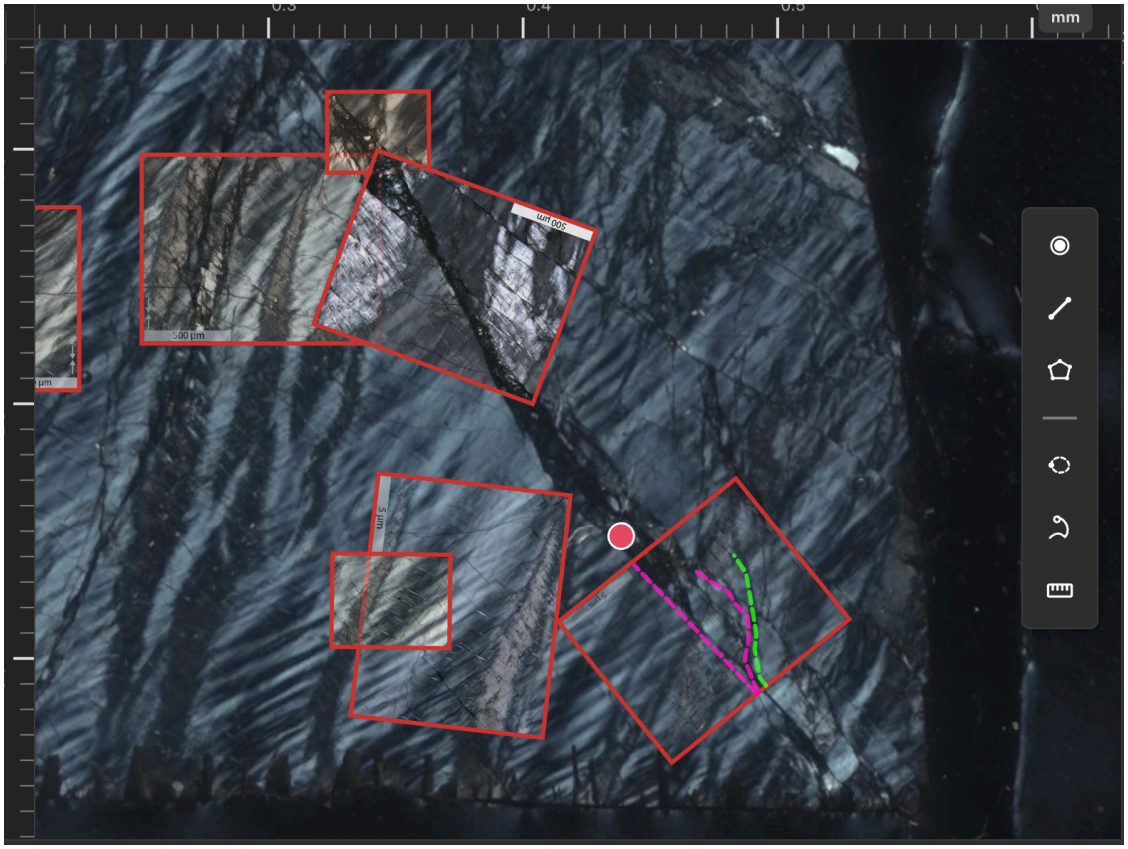


Figure 24. Parent micrograph with recursive spots enabled, showing annotations from a child micrograph displayed with correct spatial transformations. Recursive line spots are plotted on the associated child micrograph in pink and green.

5.8.2 How Recursive Spots Are Rendered

When recursive spot display is enabled:

- **Position:** Spots are transformed to the correct location on the parent micrograph based on the child's placement.
- **Scale:** Spot sizes are adjusted to match the scale relationship between parent and child.
- **Rotation:** If the child micrograph is rotated relative to the parent, spots are rotated accordingly.
- **Visual Distinction:** Recursive spots display with a subtle border or badge indicating their source micrograph.

5.8.3 Interacting with Recursive Spots

Recursive spots support full interactivity:

- **Click to select:** Clicking a recursive spot selects it and displays its properties.
- **Right-click menu:** Access the standard spot context menu, plus an option to **Go to Source Micrograph**.
- **Editing:** Modifying a recursive spot updates the original spot on its source micrograph.

- **Hover information:** Hovering displays a tooltip showing the spot name and source micrograph.

5.8.4 Filtering Recursive Spots

To manage which recursive spots are displayed:

- **By depth:** Use **View > Recursive Spot Depth** to limit how many levels deep to show (e.g., only immediate children, or all descendants).
- **By micrograph:** In the sample tree, toggle visibility of individual child micrographs to show/hide their spots.
- **By spot type:** Use the spot filter controls to show only points, lines, or polygons.

Note: Recursive spot rendering is computationally intensive for deeply nested hierarchies with many spots. If performance is affected, consider limiting the recursive depth or hiding some child micrographs.

5.9 Spot Navigation

The tabs at the top of the **left Project Navigation Pane** allow users to choose how they navigate through the project. Once spots have been added to reference and associated micrographs, they will appear in a nested structure within the panel, organized by micrograph and spot name.

Each spot name functions as a clickable hyperlink. Clicking a spot name will:

- Load and display the corresponding micrograph in the **central viewing panel**.
- Highlight the selected spot on the micrograph with a red outline, indicating it is active.
- Open the **Spot Metadata** toggle panel on the right side, showing detailed metadata for the selected spot (see Figure 21).

This navigation structure enables efficient browsing between spots, micrographs, and related metadata, helping users quickly access and update their observations across the project.

5.9.1 Keyboard Navigation

StraboMicro supports keyboard shortcuts for efficient spot navigation:

- **Arrow Up/Down:** Scroll the Project Navigation Pane up/down.
- **Tab:** Move to the next spot in the list.
- **Enter:** Open the selected spot for editing.

6 Data Entry and Observation Tools

StraboMicro provides a flexible framework for entering detailed observational data across multiple spatial contexts. Users can choose to associate data with an entire **micrograph image**, a specific **point (spot)**, a **line** representing a transect or trace, or a **polygon** outlining an area of interest. This structure allows observations to be scaled and shaped according to the nature of the feature being studied—ranging from localized points and linear structures to broader areas or the full thin section.

In addition, features and observations can be explicitly linked to previously defined mineralogical or lithological classifications, supporting consistent interpretation and integrated analysis.

This section describes how to enter data at each spatial level and outlines the types of information that can be recorded within each context.

6.1 Adding Data

To begin entering data:

- **To add data to a micrograph:** Click anywhere on the micrograph (not on a spot) to ensure it is selected and active.
- **To add data to a spot:** Click the spot to select it. When active, the spot will be outlined in red and its metadata panel will appear on the right (see Figure 25).

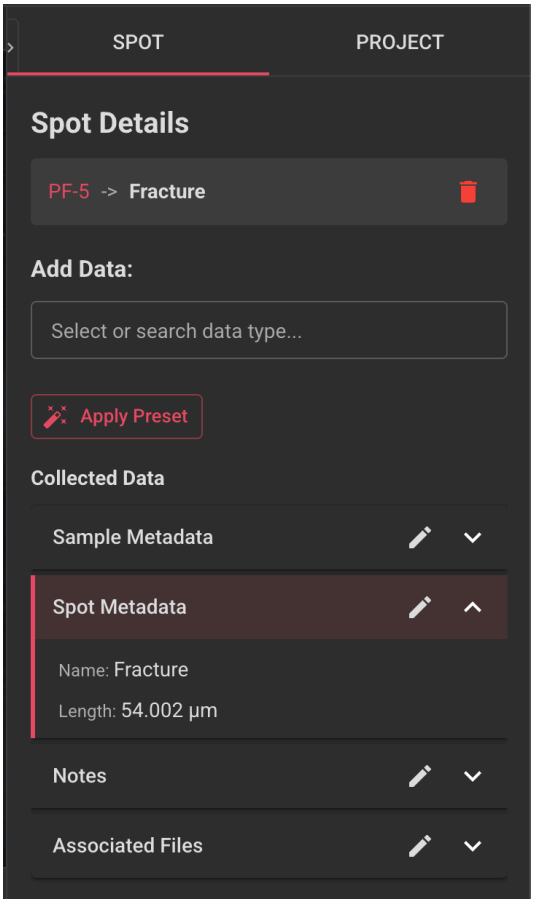


Figure 25. Spot Metadata panel showing selected spot with editable data fields.

Once the correct layer is selected (either a micrograph or spot), use the **Add Data** field to add data. You may either scroll through the list or use the search bar to find a specific option. Click the desired data type and complete the corresponding form. Details for each data type are outlined in the sections below.

6.2 Types of Data

The following subsections provide descriptions and example screenshots for each type of data entry modal available in StraboMicro.

6.2.1 Mineralogy and Lithology

Use this panel to document mineral constituents and lithologic characteristics of the sample.

- **Mineralogy Tab:** Add observed minerals and include optional notes. (See Figure 26.)
- **Lithology Tab:** Describe lithology and add supporting notes. (See Figure 27.)

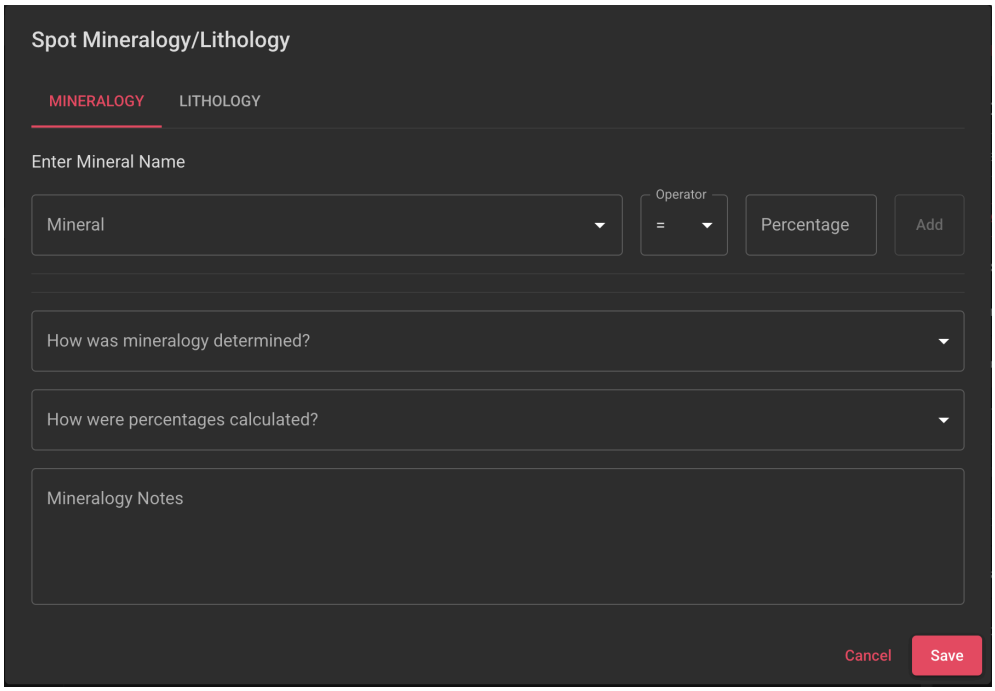


Figure 26. Mineralogy data modal for entering observed minerals.

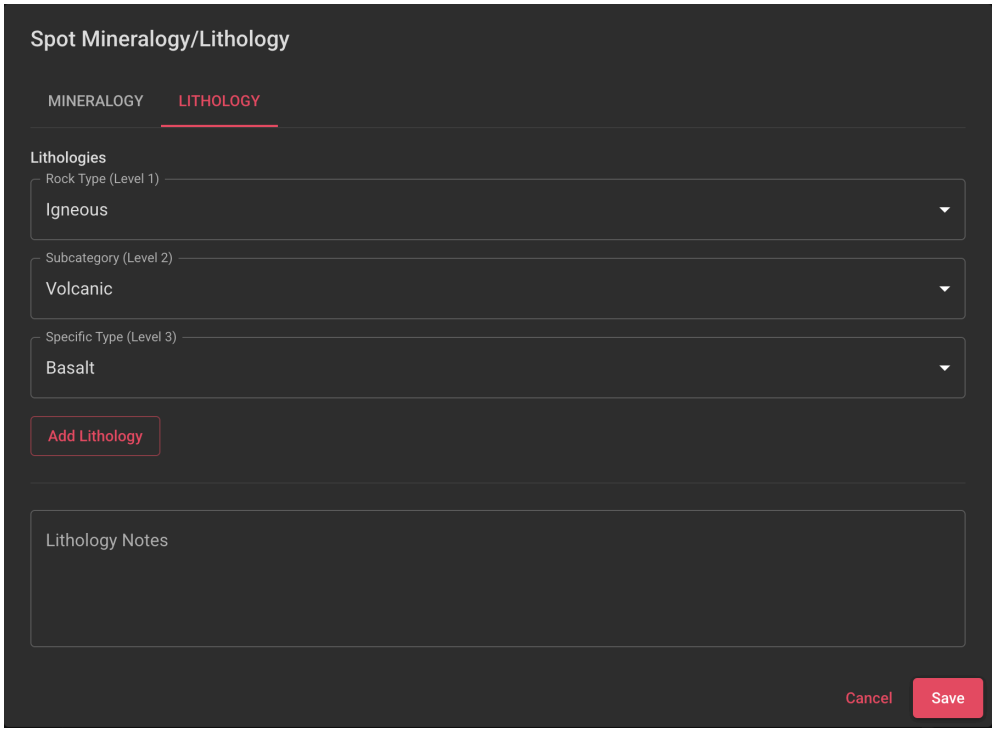


Figure 27. Lithology data modal with fields for rock type and additional notes.

6.2.2 Grain Size, Shape, and SPO

These options allow detailed documentation of grain characteristics after mineralogy has been entered.

- **Grain Size:** Enter modal or observed grain sizes. (See Figure 28.)
- **Grain Shape:** Record observed grain morphologies. (See Figure 29.)
- **Shape Preferred Orientation (SPO):** Add SPO information to describe directional alignments. (See Figure 30.)

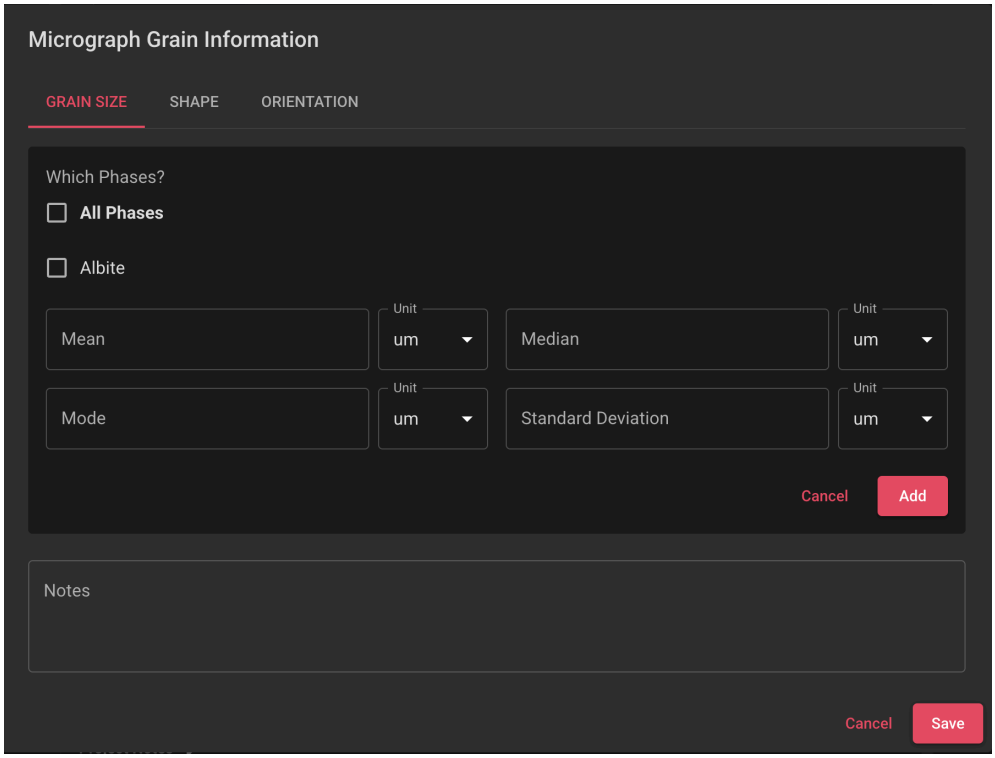


Figure 28. Grain Size data modal with fields for entering quantitative grain size information.

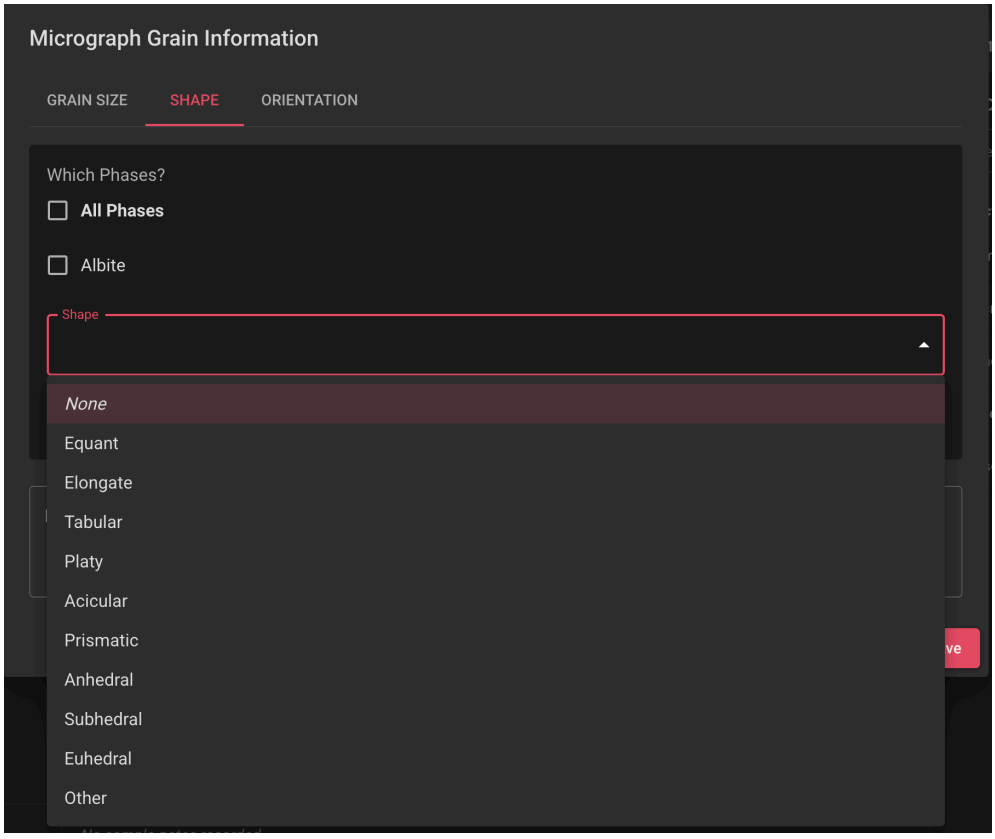


Figure 29. Grain Shape modal showing morphology options.

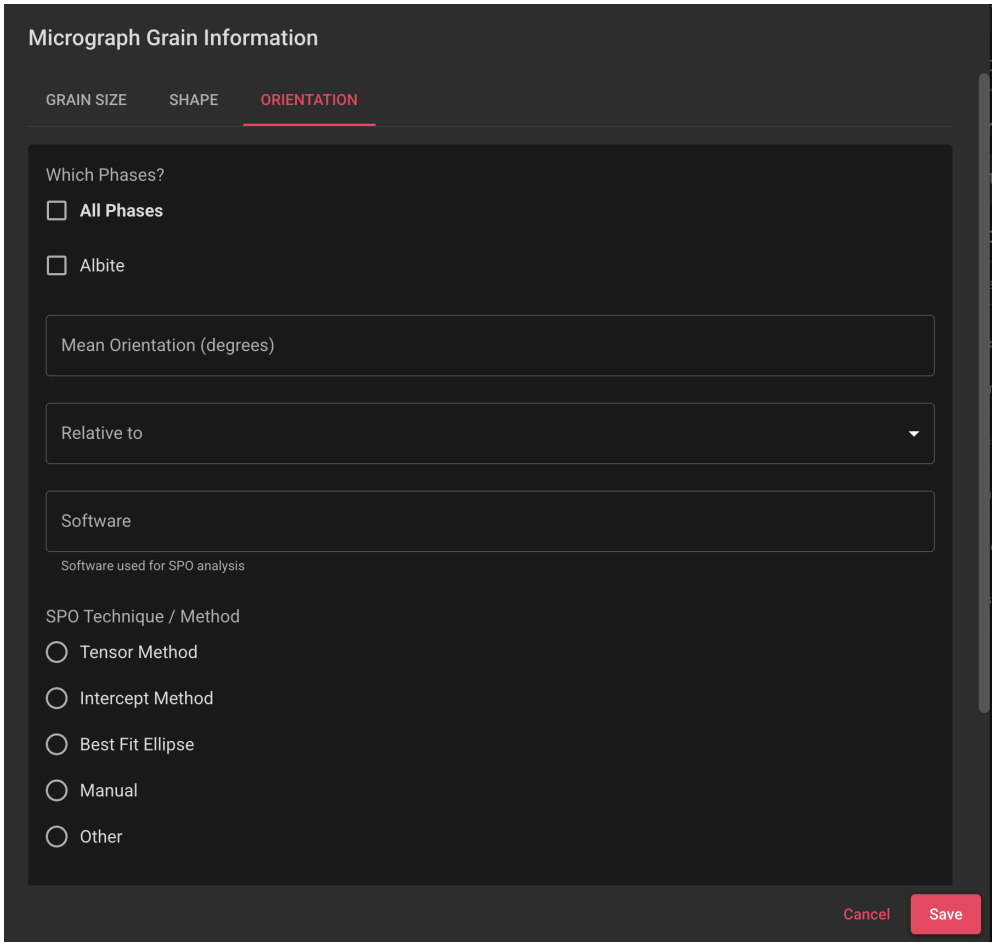


Figure 30. Shape Preferred Orientation (SPO) modal for documenting alignment of grains.

6.2.3 Fabrics

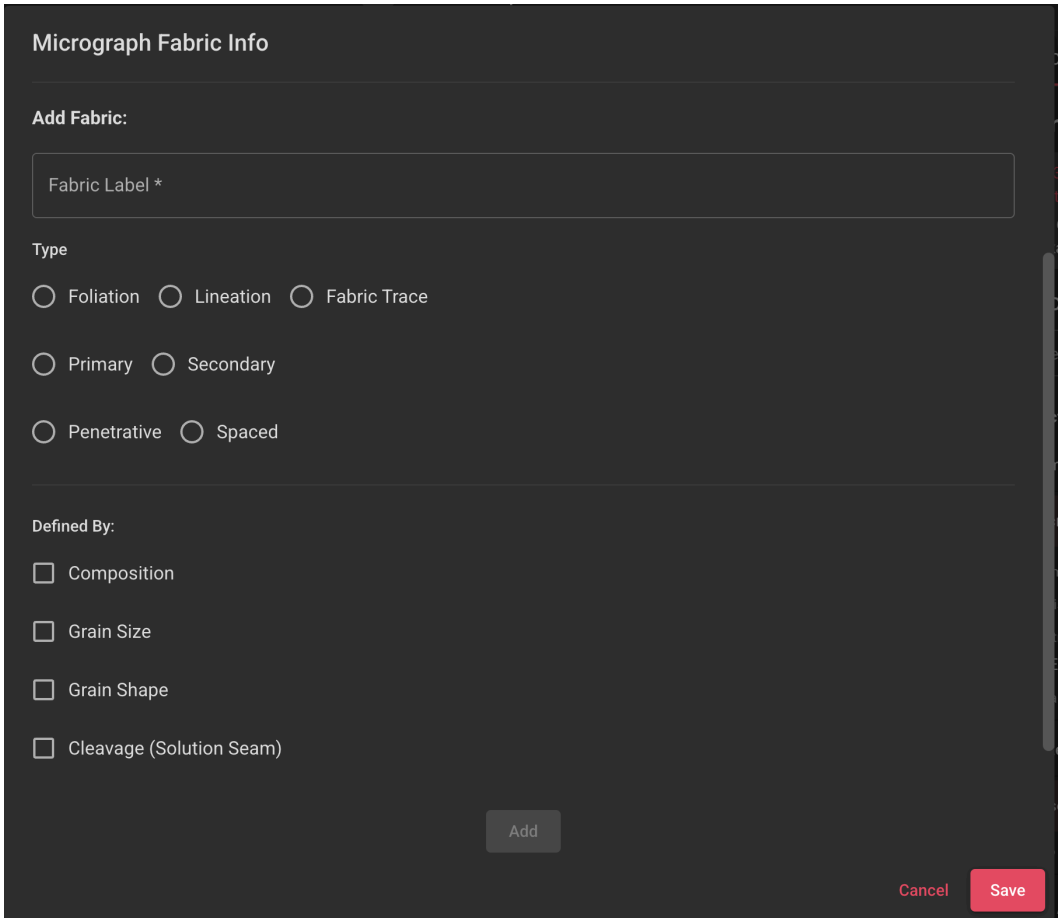
Fabrics can be classified as **foliation**, **lineation**, or **fabric trace**, and further characterized as either **primary** or **secondary**, and **penetrative** or **spaced**.

When adding a fabric, you must choose a **"Define By"** option. This selection determines which additional metadata fields are available. The four options are:

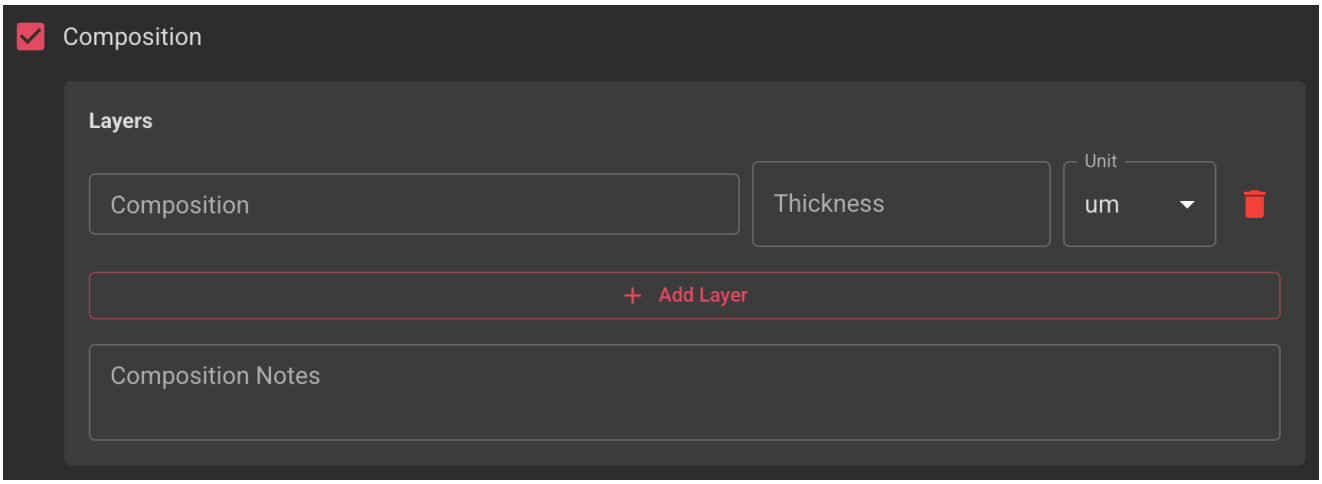
- **Composition**
- **Grain Size**
- **Grain Shape Orientation**
- **Cleavage (Solution Seam)**

Each option enables a different data entry form, as shown in the figures below.

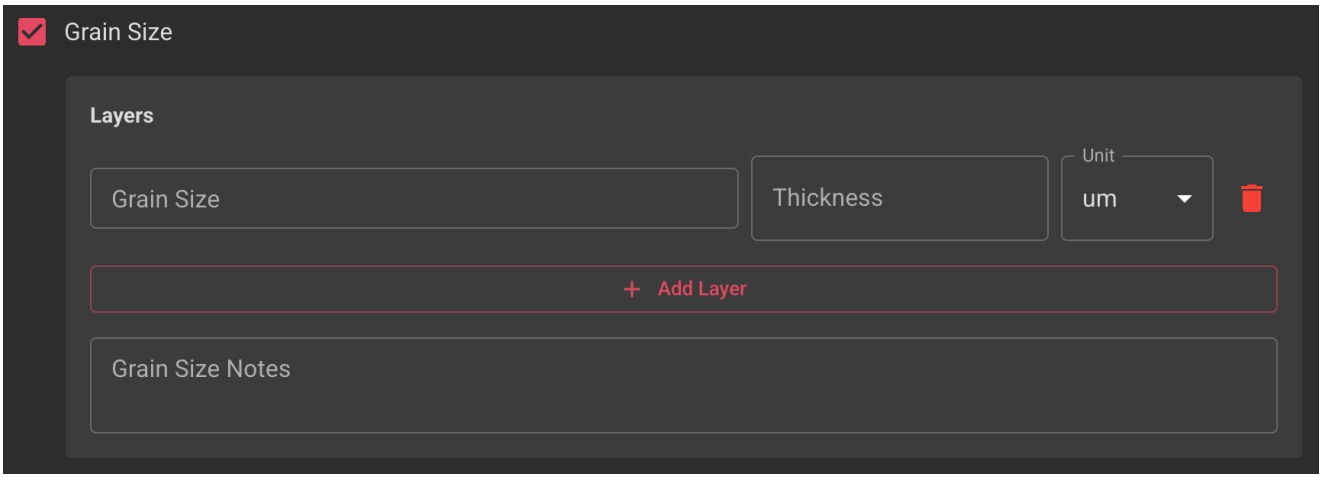
Fabric Data Entry Form



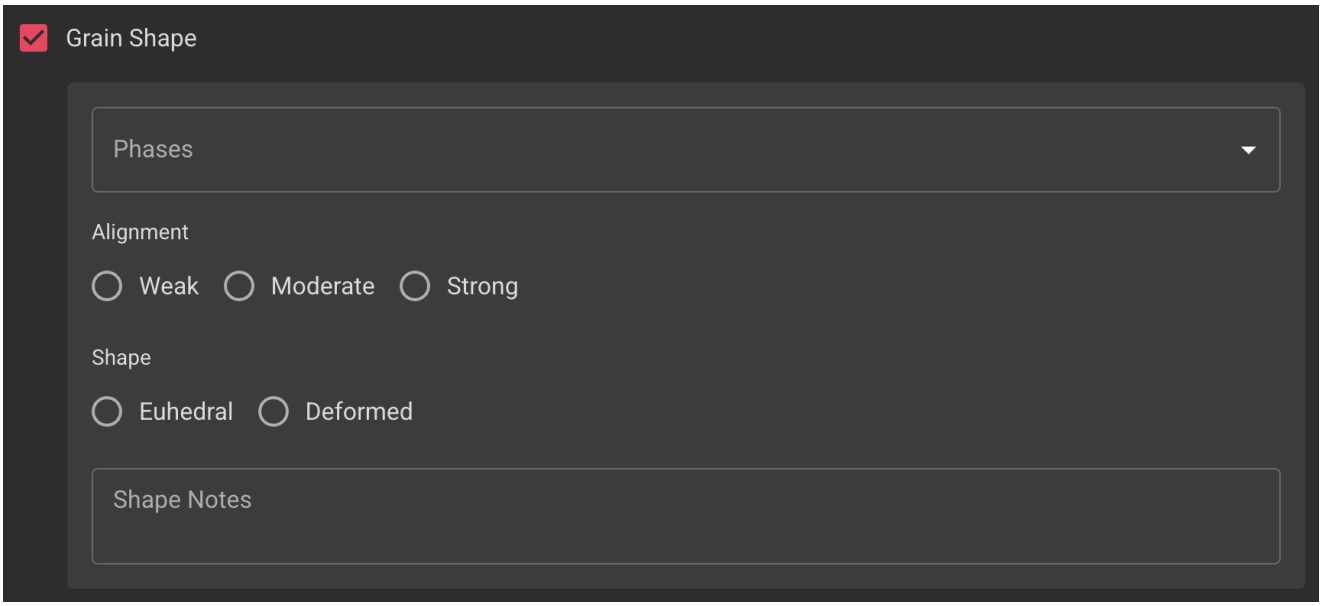
Fabric defined by Composition



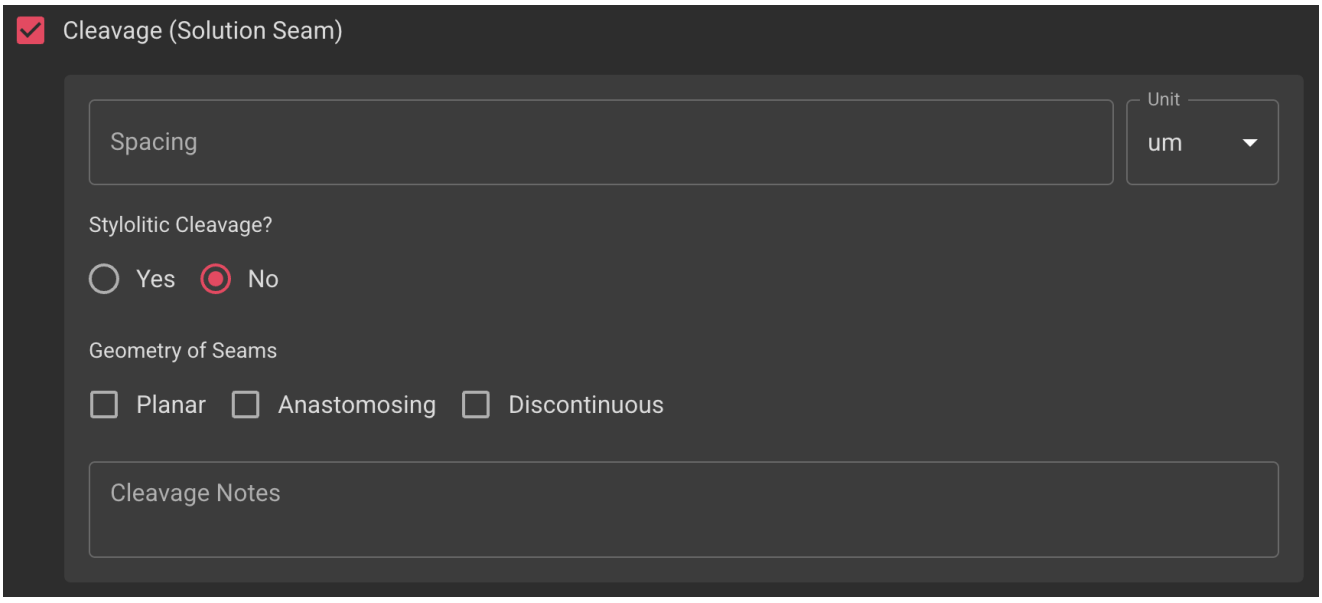
Fabric defined by Grain Size



Fabric defined by Grain Shape



Fabric defined by Clevage



Multiple fabrics may be defined for a single spot or micrograph if needed.

6.2.4 Clastic Deformation Bands

Clastic deformation bands can be characterized by several properties:

- **Type:** Select one or more from the following—*cataclastic*, *dilation*, *shear*, or *compaction*.
- **Thickness:** Specify the thickness of the band.
- **Cement Type:** Optionally note the type(s) of cement present.

These input fields appear in the clastic deformation band data modal.

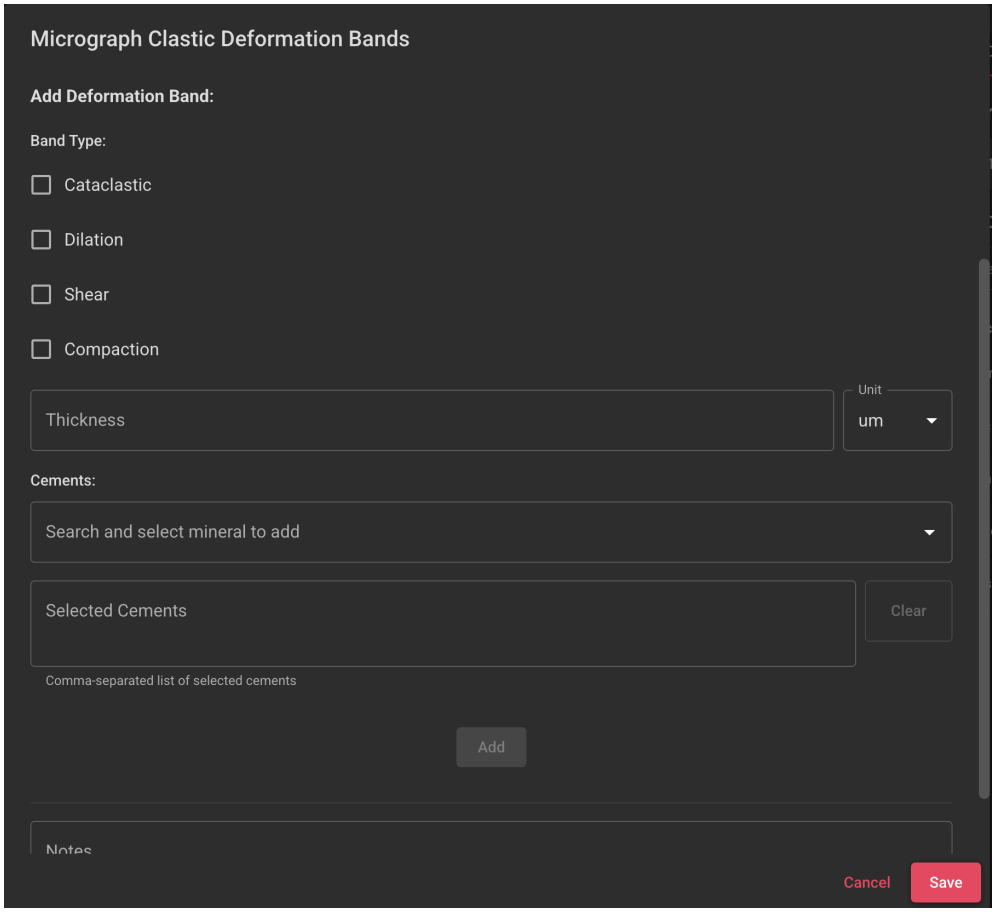


Figure 31. Data entry modal for clastic deformation bands

6.2.5 Grain Boundaries and Contacts

All grain boundary and grain contact observations can be linked to previously defined mineralogy or lithology for the selected image or spot, improving contextual understanding and interpretive accuracy. A variety of grain boundary morphologies may be selected using check boxes—multiple selections are allowed as applicable. Boundary descriptors can be further refined using additional criteria based on the initial selection.

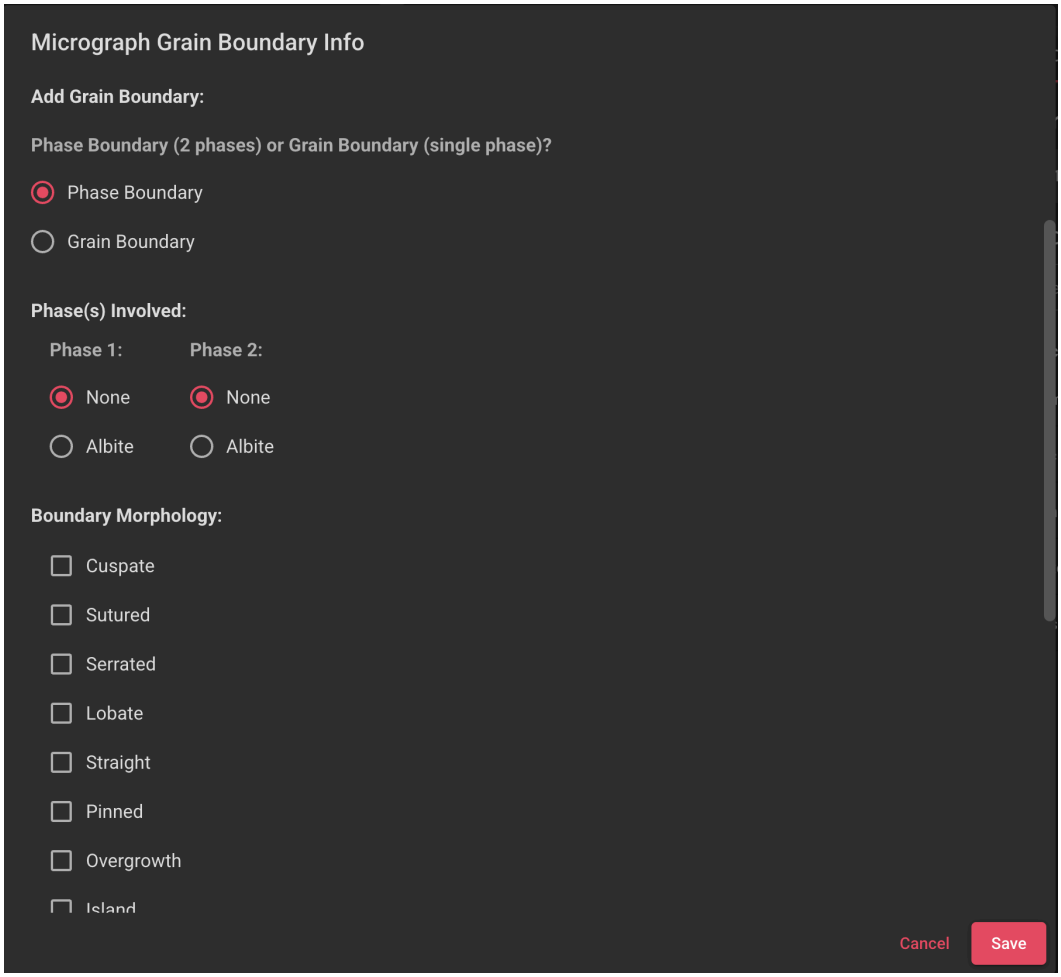


Figure 32. User interface options for grain boundary characterization, including point and line spot tools, mineralogical associations, and descriptor check boxes.

6.2.6 Intragranular Structures

Intragranular structures are features that occur within individual mineral grains. When documenting these structures, users can specify the associated mineral by selecting from the previously defined mineralogy or lithology list.

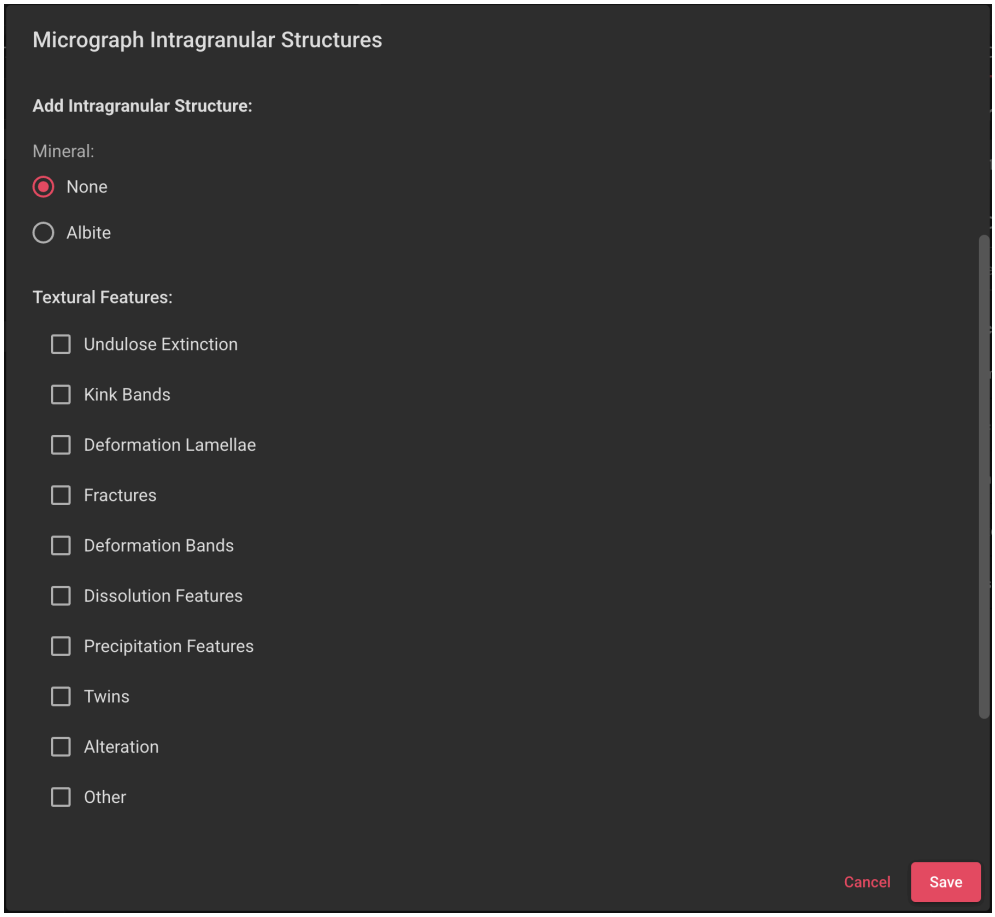


Figure 33. Interface for adding Intragranular structures, showing the option to associate each feature with a defined mineral.

6.2.7 Veins

Observational data related to veins within a thin section can be entered directly within this form. Unlike other features, vein mineralogy is defined here and does not need to be selected from the previously defined mineralogy or lithology list.

Users can document various characteristics of veins, including crystal shape, growth morphology, inclusion trails, kinematic indicators, and any additional relevant notes. This allows for detailed description of vein textures and formation processes.

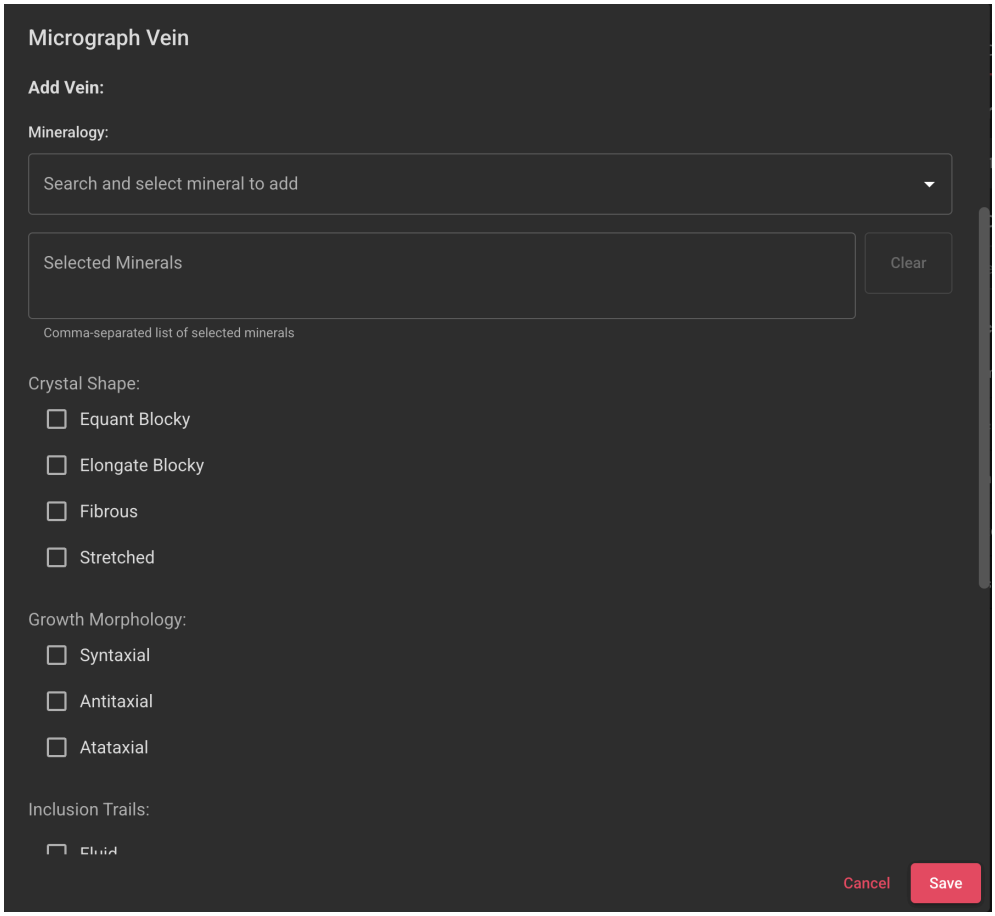


Figure 34. Interface for entering vein-related observations, including mineralogy, morphology, and kinematic features.

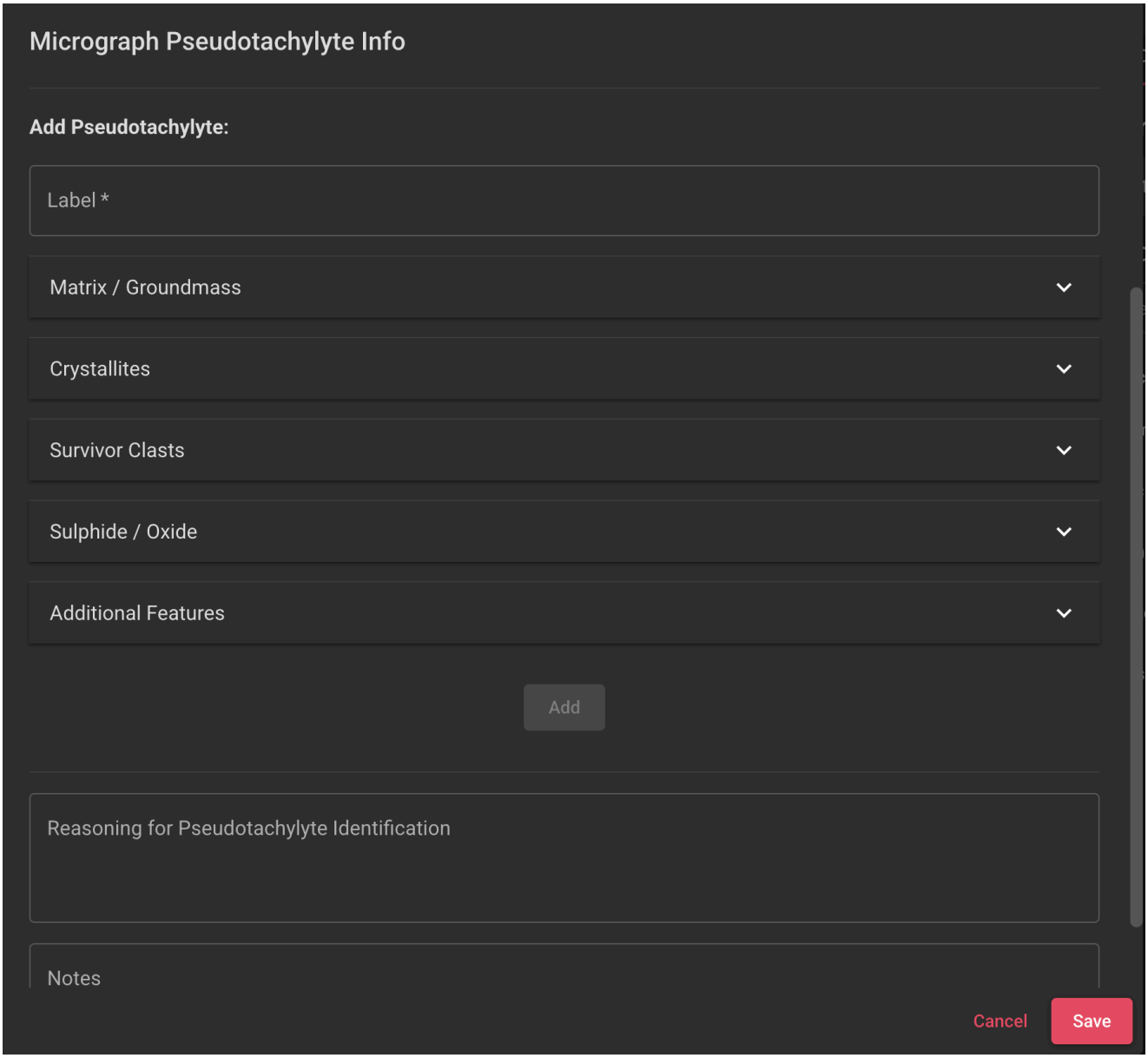
6.2.8 Pseudotachylyte

Pseudotachylyte data entry can be further refined by selecting from a set of observed features. These options allow for detailed characterization of textures and components associated with pseudotachylyte formation.

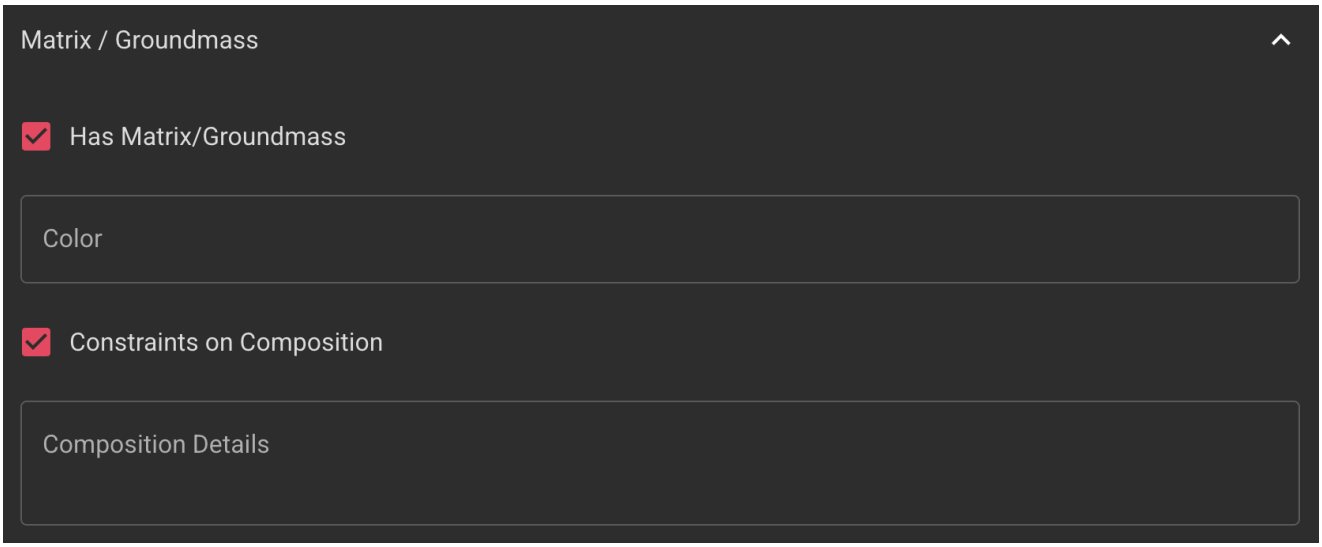
The figures below display all available metadata input options. The first figure shows the primary metadata modal, followed by individual conditional fields that appear based on the selected feature. Observed features include:

- Matrix / groundmass
- (Micro)crystallites
- Survivor clasts
- Sulphide / oxide droplets
- Fabric
- Injection features
- Chilled margins
- Vesicles / amygdules

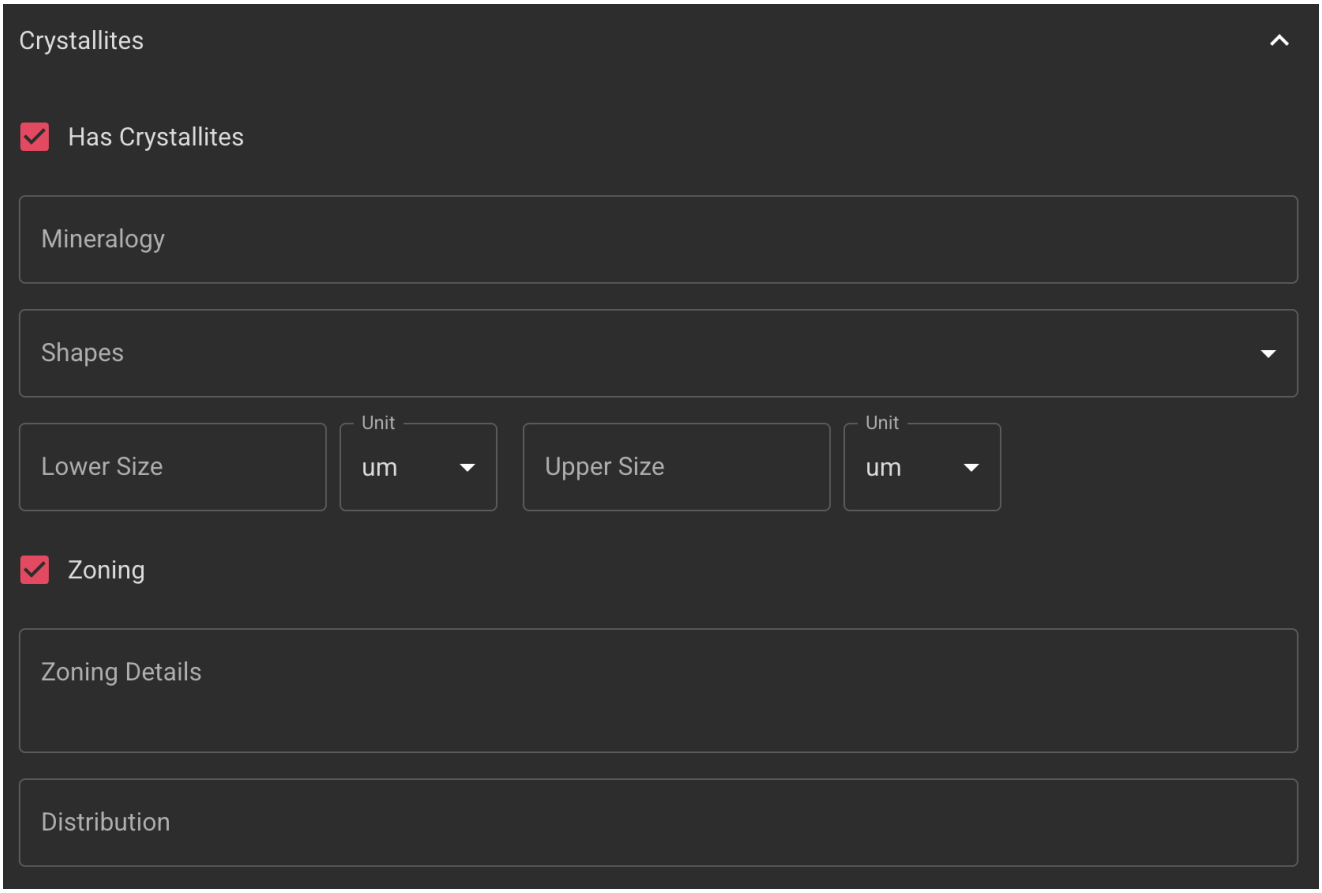
Main Metadata Modal



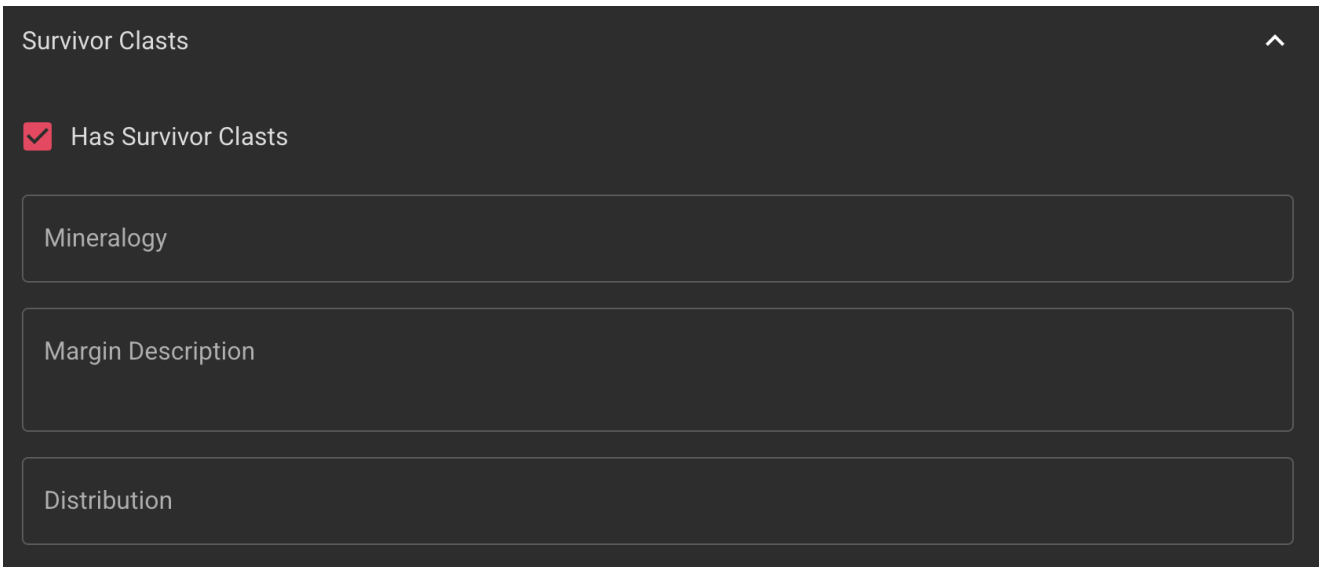
Matrix / Groundmass



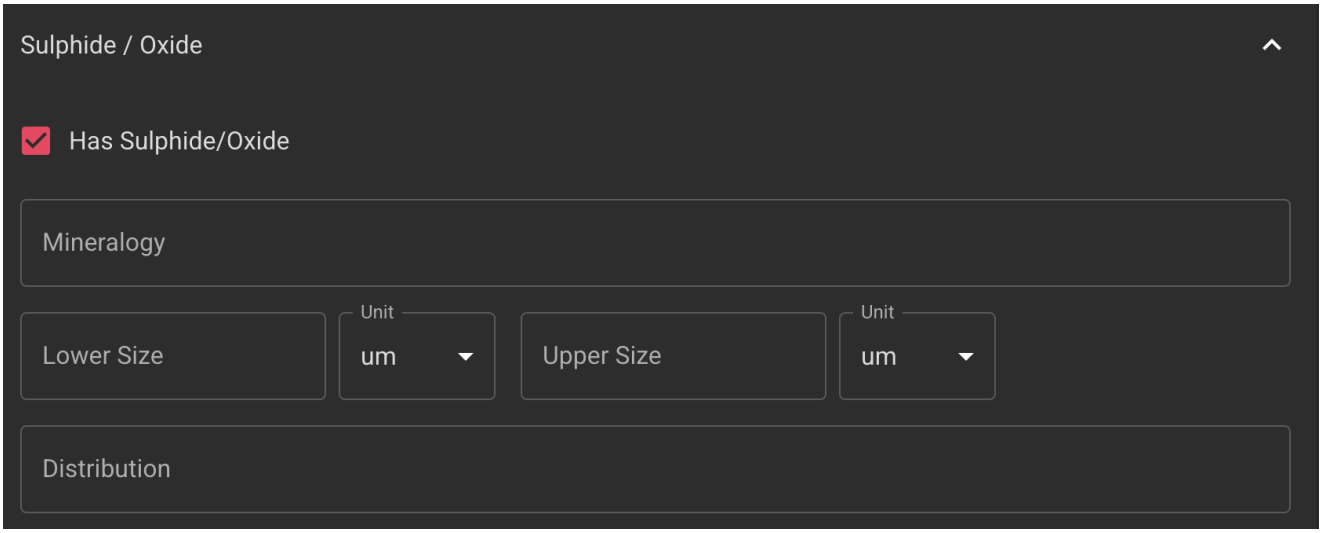
(Micro) Crystallites



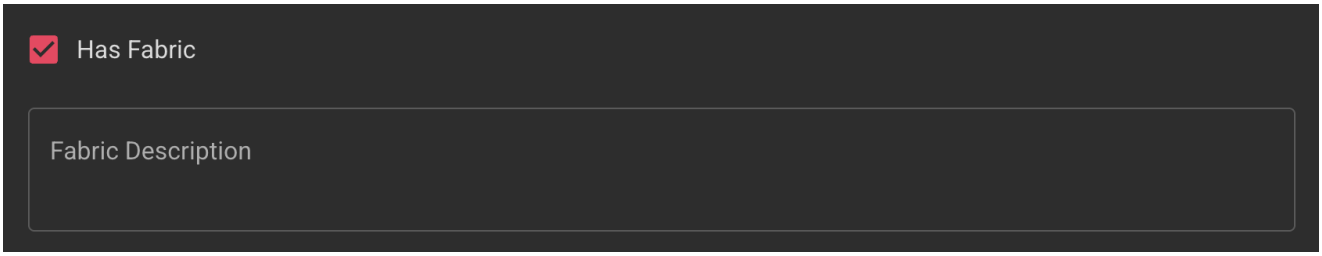
Survivor Clasts



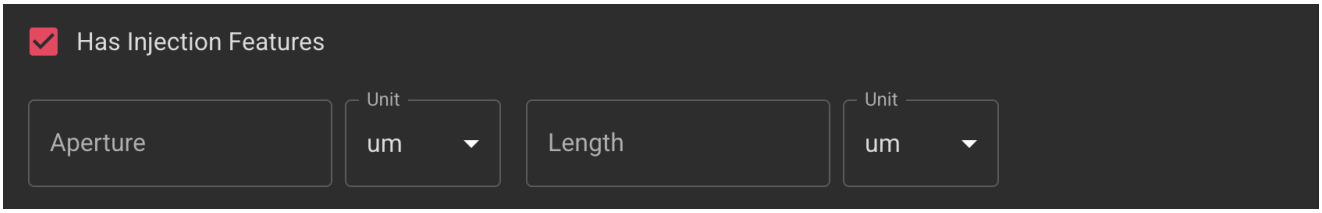
Sulphide / Oxide Droplets



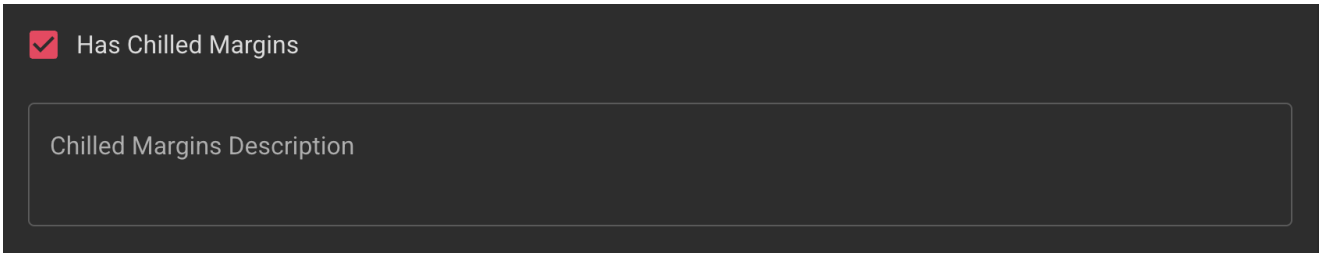
Fabric



Injection Features



Chilled Margins



Vesicles / Amygdules

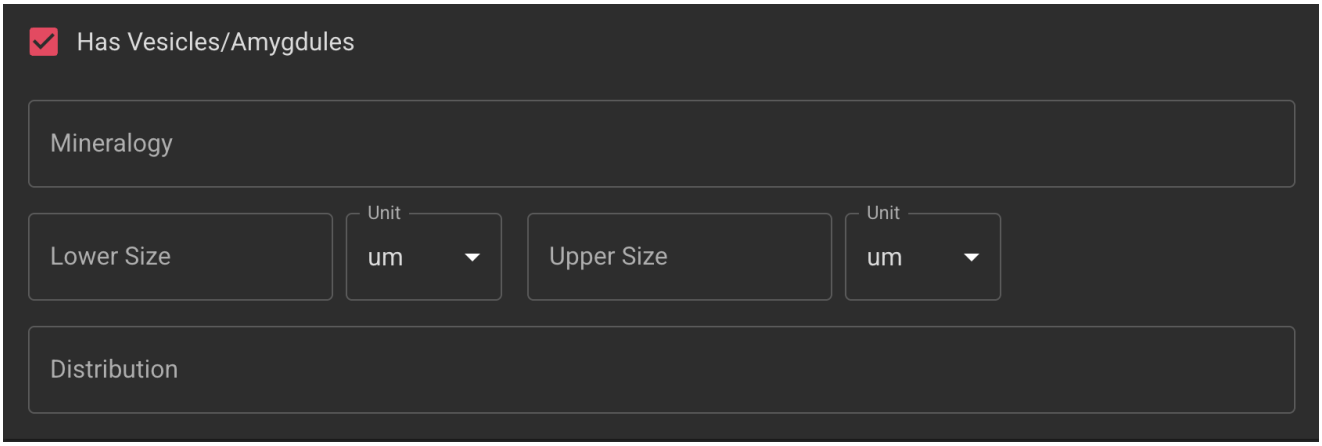


Figure 35. Pseudotachylyte metadata entry options. Each screenshot shows the available fields for a specific observed feature when selected in the form interface.

6.2.9 Folds

The **Folds Modal** provides a structured approach for describing key characteristics of folds. Users can specify attributes such as:

- Custom labels
- Interlimb angle geometry
- Closure geometry
- Axial trace orientation
- Symmetry
- Fold style
- Continuity
- Facing direction
- Additional notes

This allows for consistent and comprehensive documentation of fold structures at the micro-graph or spot level.

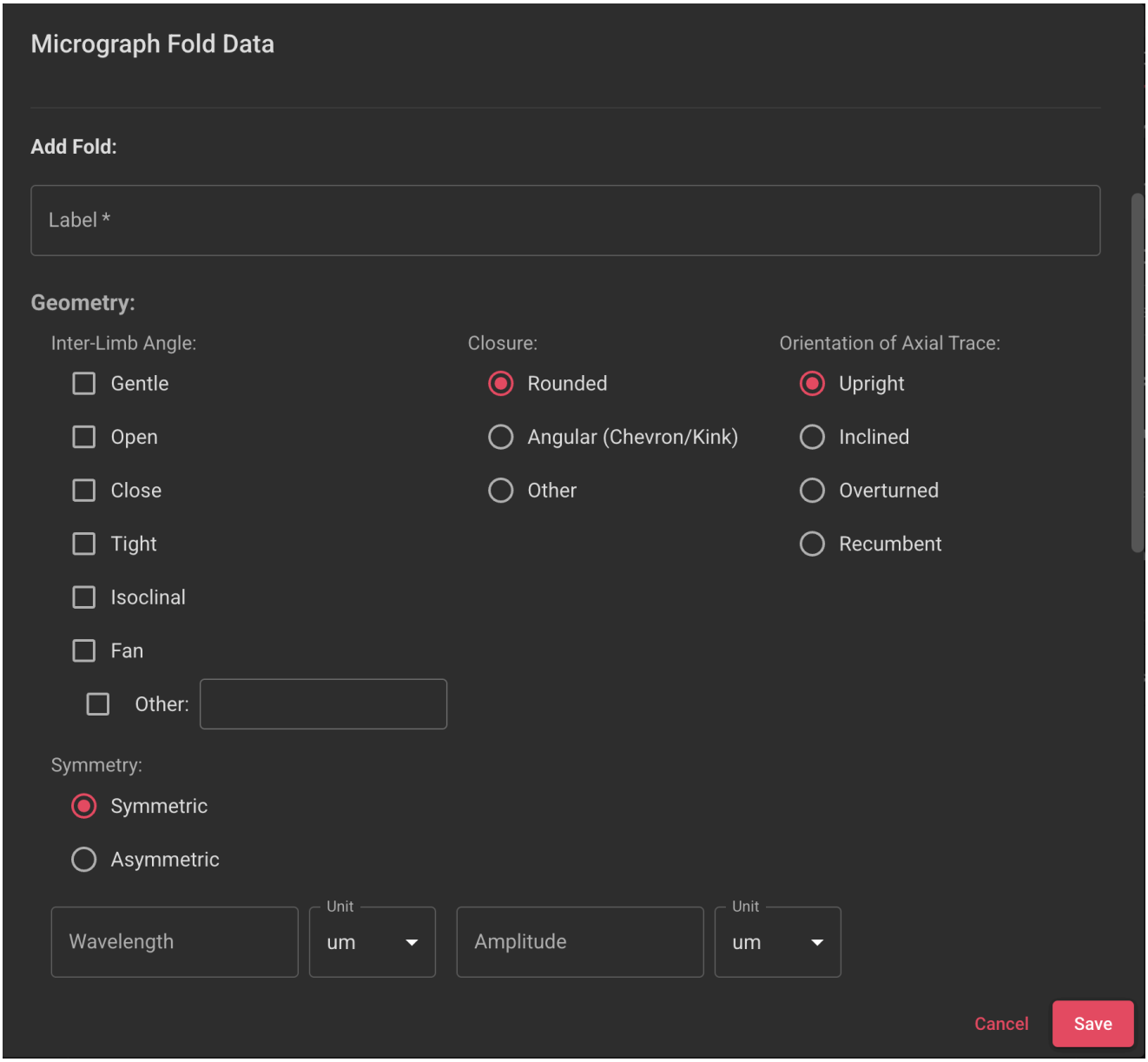


Figure 36. Fold Modal: Fold Geometry

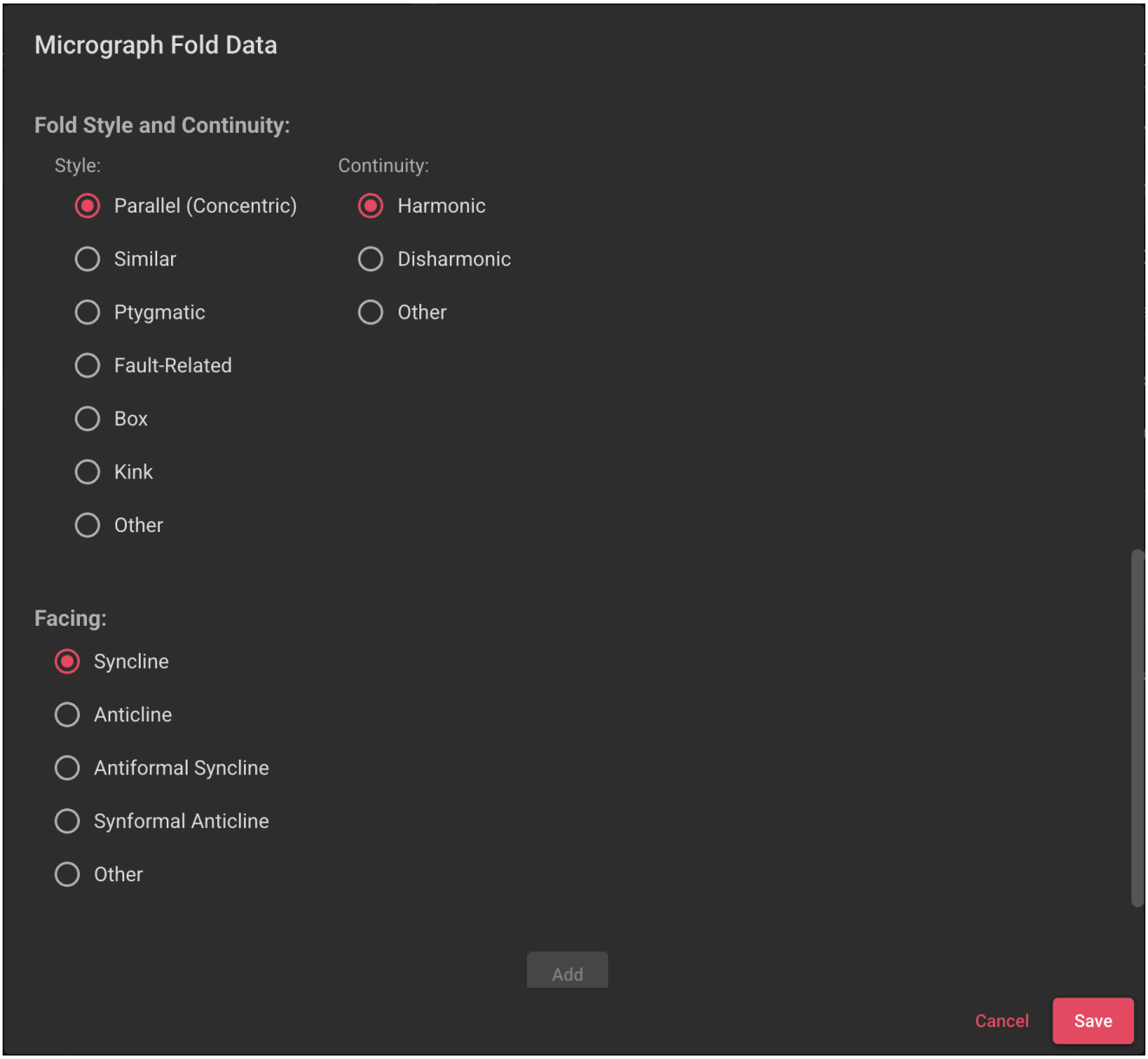


Figure 37. Fold Modal: Fold Style and Continuity

6.2.10 Faults and Shear Zones

The **Faults and Shear Zones** modal allows users to input structural data directly onto micrographs or spatial points (spots). Users can define shear sense and specify associated shear sense indicators. Additional metadata such as measured offsets and zone widths can be recorded, along with any relevant observations entered into the freeform notes field.

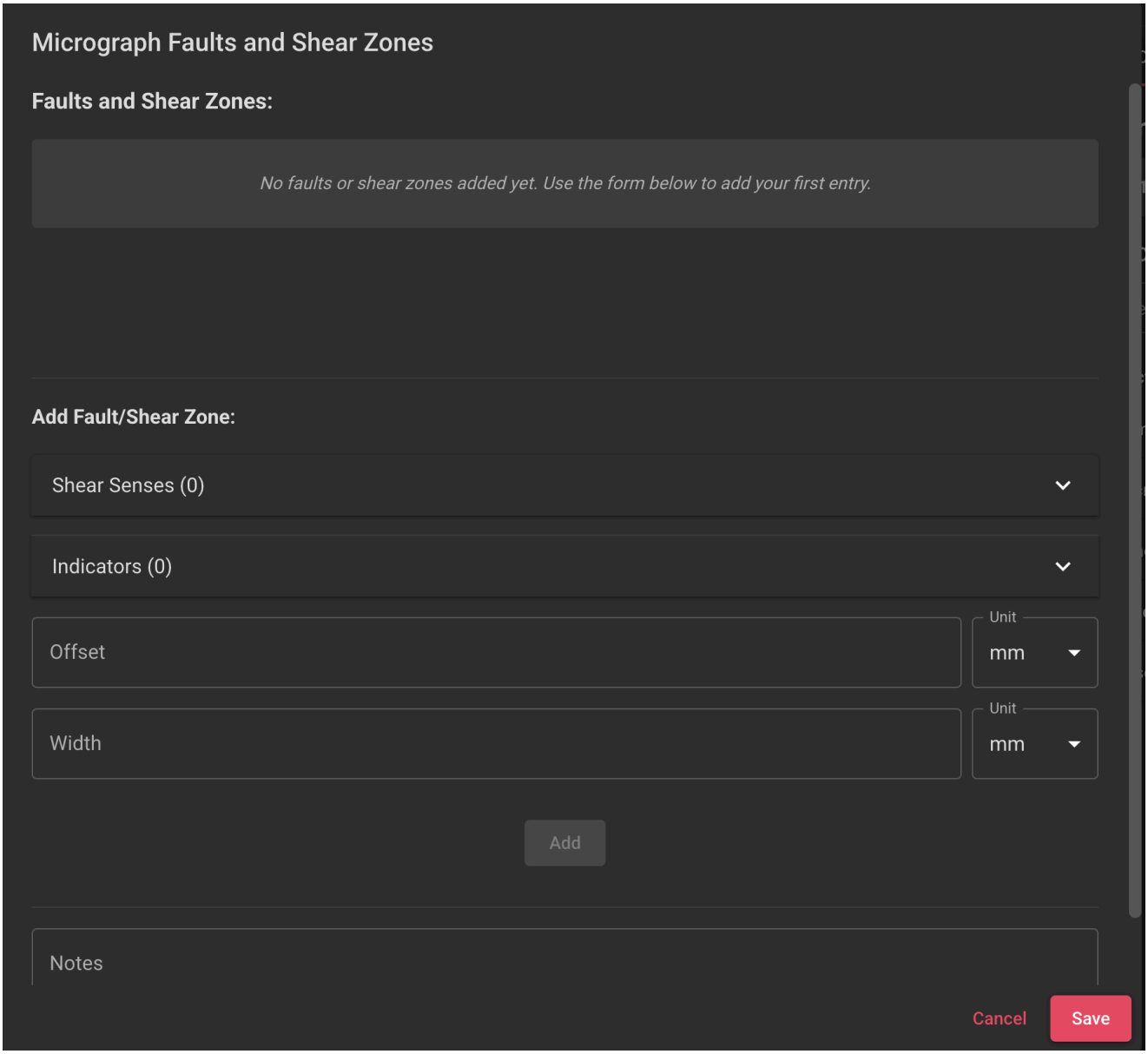


Figure 38. Screenshot of the *Faults and Shear Zones* data input modal.

6.2.11 Extinction Microstructures

Extinction microstructure metadata can be added to a micrograph or spot and includes attributes such as the mineral phase, type of heterogeneous extinction, presence of subgrain structures, extinction bands, and dislocations.

Multiple microstructures can be recorded in this section. For example, if a sample exhibits chessboard extinction in quartz and patchy, undulose extinction in feldspar, both structures can be documented as separate entries within the metadata.

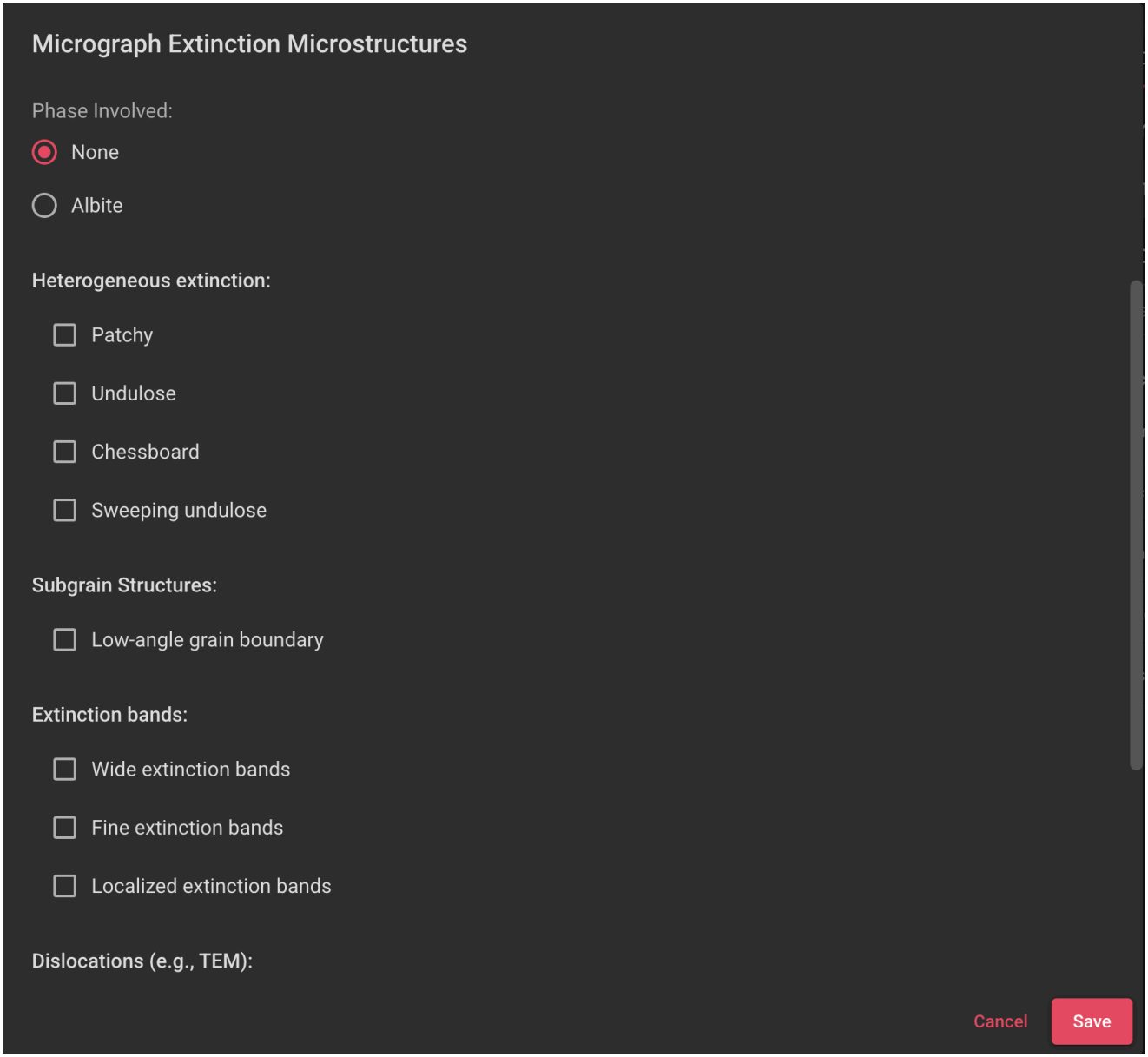


Figure 39. Screenshot of the *Extinction Microstructures* data input modal.

6.2.12 Fractures

Fractures can be recorded on a micrograph or spot using the **Fractures** modal. The mineralogy of fractured phases does not need to be predefined—relevant minerals can be specified within the modal itself. Users can also define the kinematic mode, input measured aperture or offset values (with units), and indicate whether the fracture is sealed or healed using a checkbox. A freeform notes field is available for additional observations.

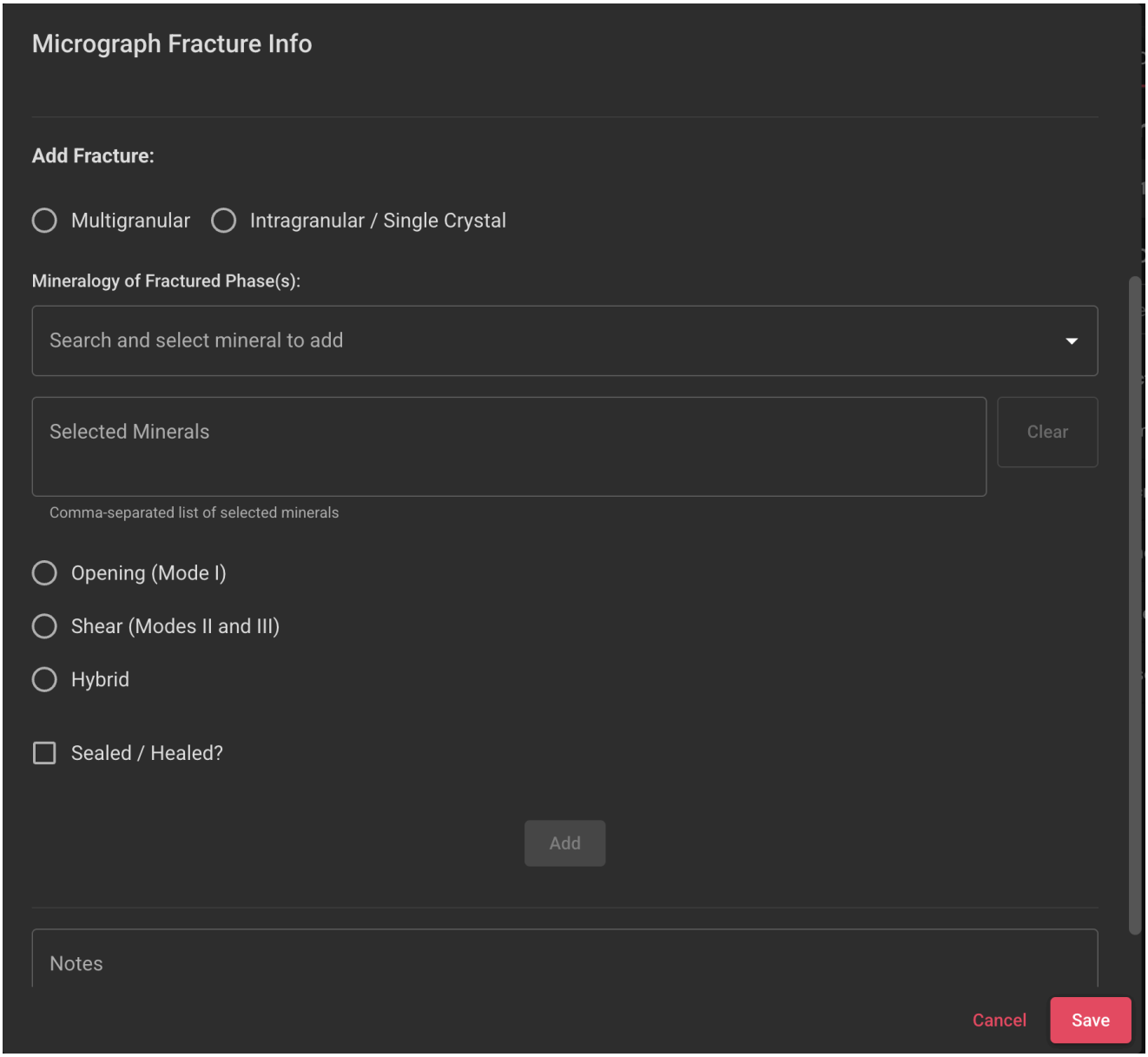


Figure 40. Screenshot of the *Fractures* data input modal.

6.2.13 Notes

The **Notes** field provides a freeform text area for entering and editing descriptive or contextual information. This section supports extended text and is ideal for capturing observations, interpretations, or any additional metadata that may not fit into predefined fields.

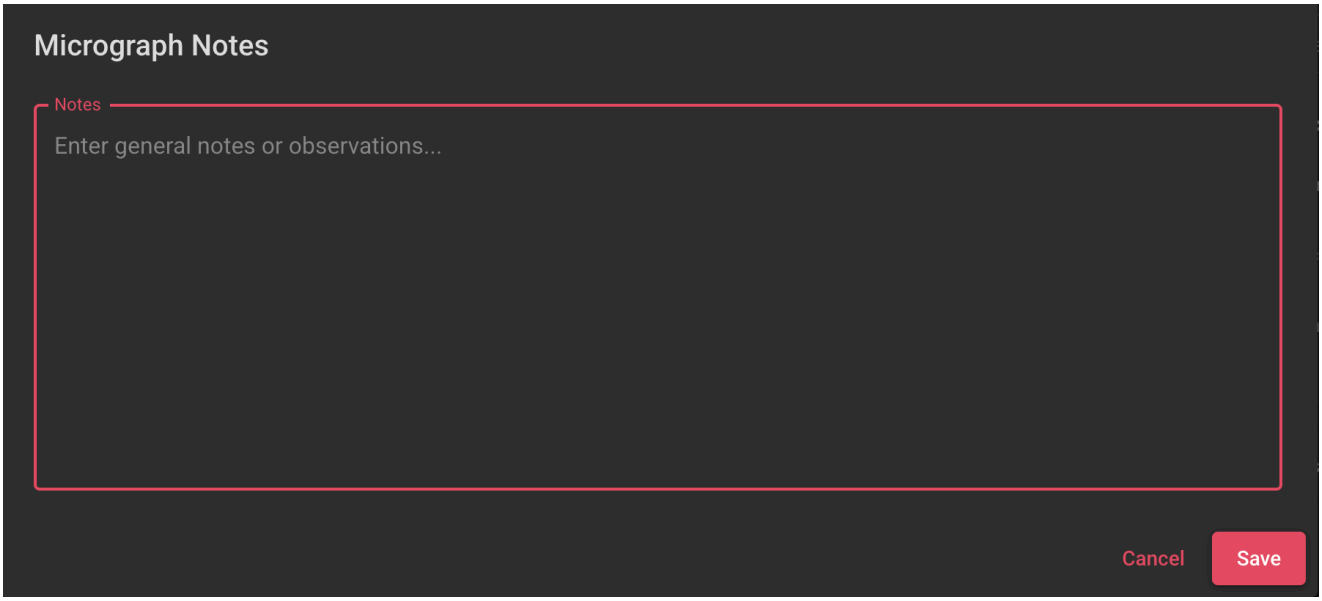


Figure 41. Screenshot of the *Notes* text entry modal using the Add Data funtion in the metadata pane.

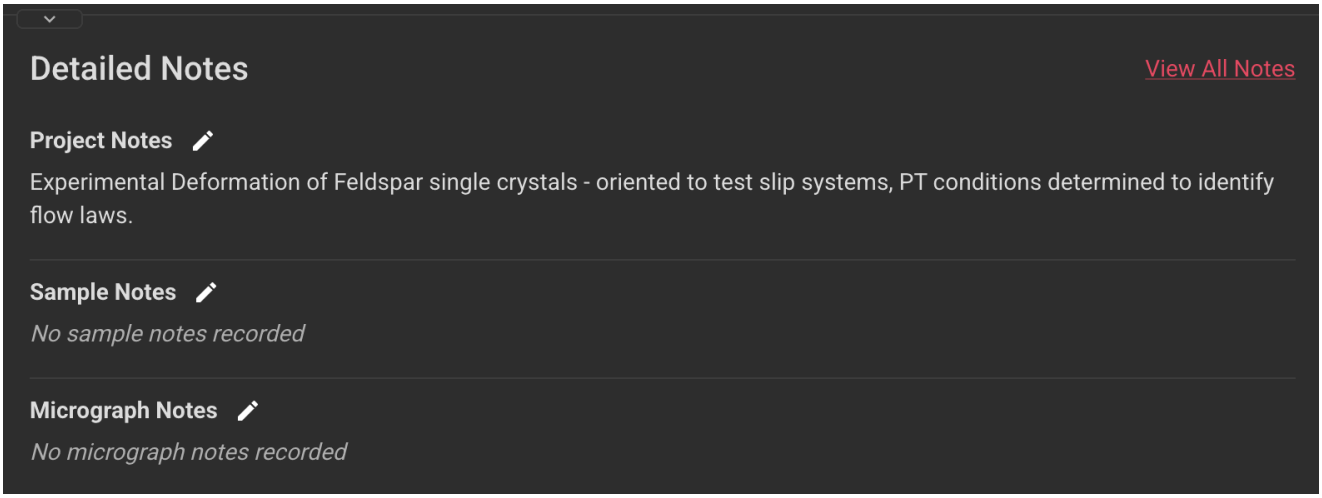


Figure 42. Screenshot of the *Notes* text entry field under the micrograph view.

6.2.14 Associated Files

Users can attach external files to a micrograph or spot using the **Associated Files** modal. Files can be added individually or in bulk by selecting multiple files at once.

Single File Import To add a single file, select the appropriate file type from a dropdown menu (Figure 43), and an optional note can be attached. Notes are linked to the currently selected file and will reset after each upload to ensure clear association.

Bulk File Import (New in StraboMicro) StraboMicro introduces a streamlined bulk import workflow for adding multiple associated files simultaneously:

- **Multi-select files:** Use `Cmd+click` (macOS) or `Ctrl+click` (Windows/Linux) in the file picker to select multiple files at once.

- **Preview selected files:** Selected files appear as removable chips in the dialog, allowing you to review and remove individual files before import (see Figure 44).
- **Shared metadata:** A single file type and notes field applies to all selected files, streamlining the process when importing files of the same category.
- **Progress tracking:** A progress indicator displays during import, showing the current file being processed and overall completion status.

Clickable File Names (New in StraboMicro) Associated file names are now interactive links that open the file using the system's default application:

- **Visual indicator:** A small external link icon appears next to clickable file names to indicate they can be opened.
- **Edit dialog:** File names in the Associated Files edit dialog are clickable links.
- **Accordion summary:** File names displayed in the collapsed accordion view are also clickable for quick access.
- **System integration:** Clicking a file name launches the appropriate application based on file type (e.g., PDFs open in Preview or Adobe Reader, images open in the default image viewer).

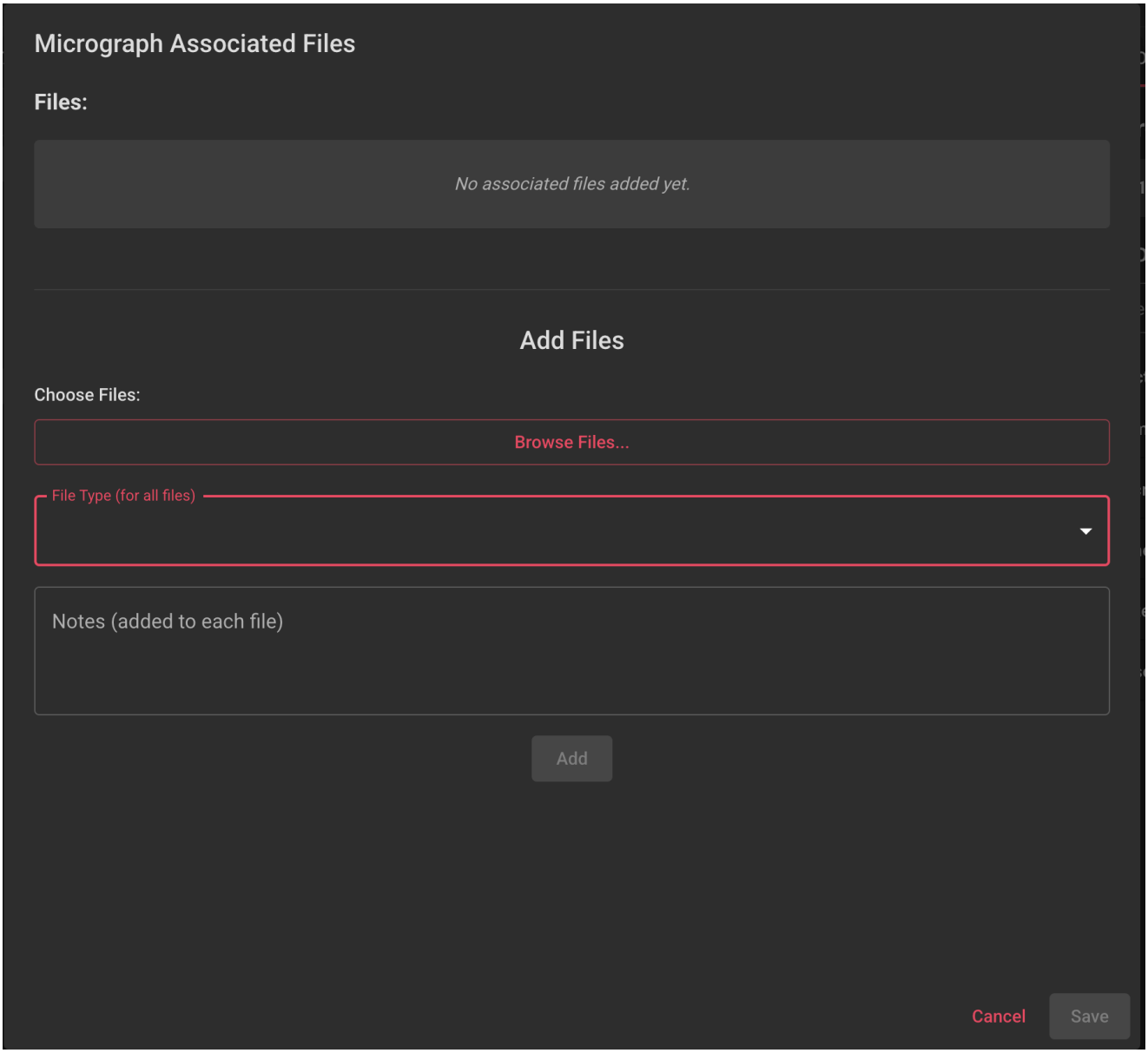


Figure 43. Screenshot of the *Associated Files* modal, showing file selection and type dropdown.

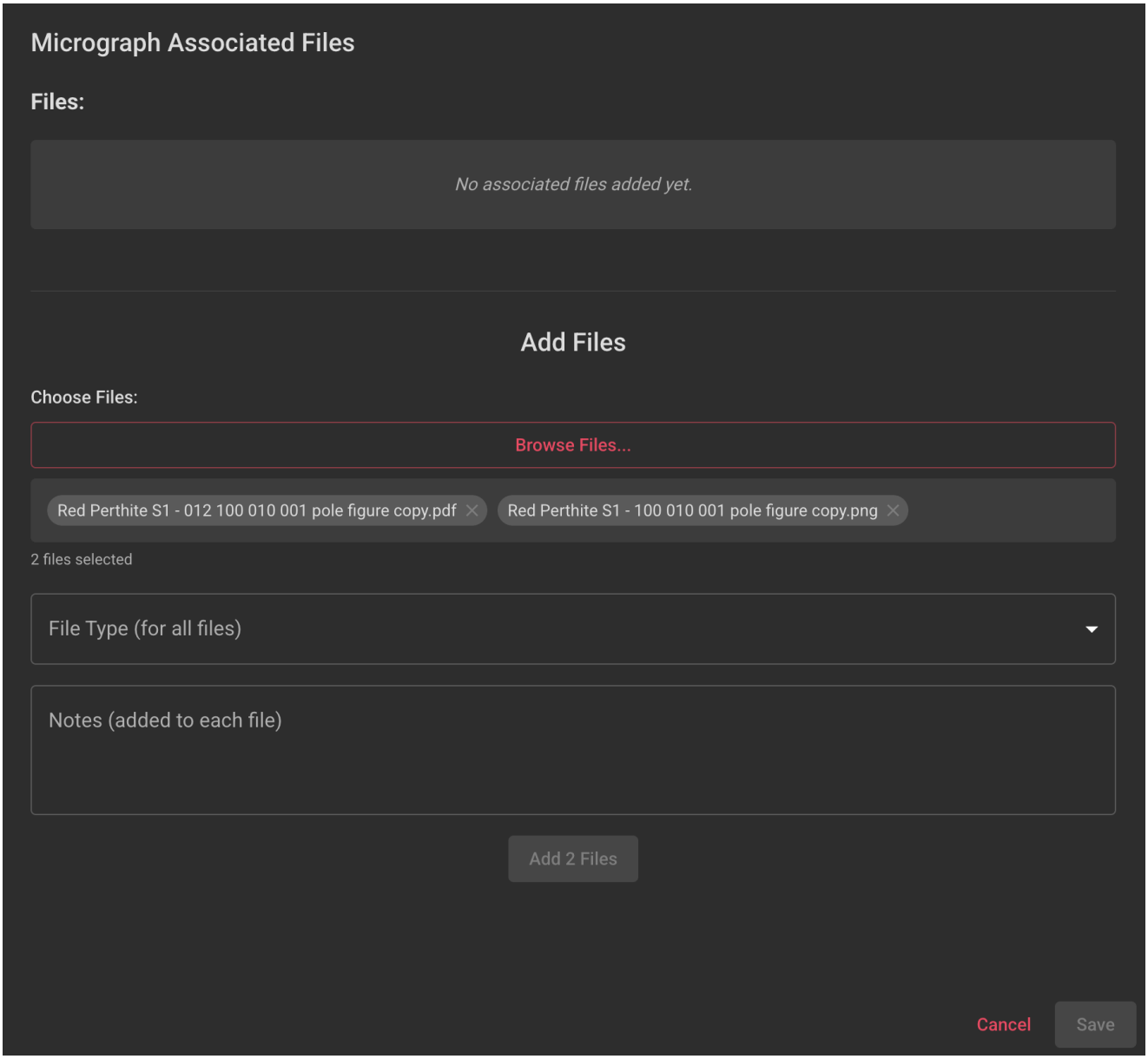


Figure 44. Bulk import interface showing multiple selected files as removable chips with shared metadata fields.

6.2.15 Links

The **Links** section allows users to add one or more external or internal references. Multiple links can be added as needed to connect relevant documents, datasets, or resources.

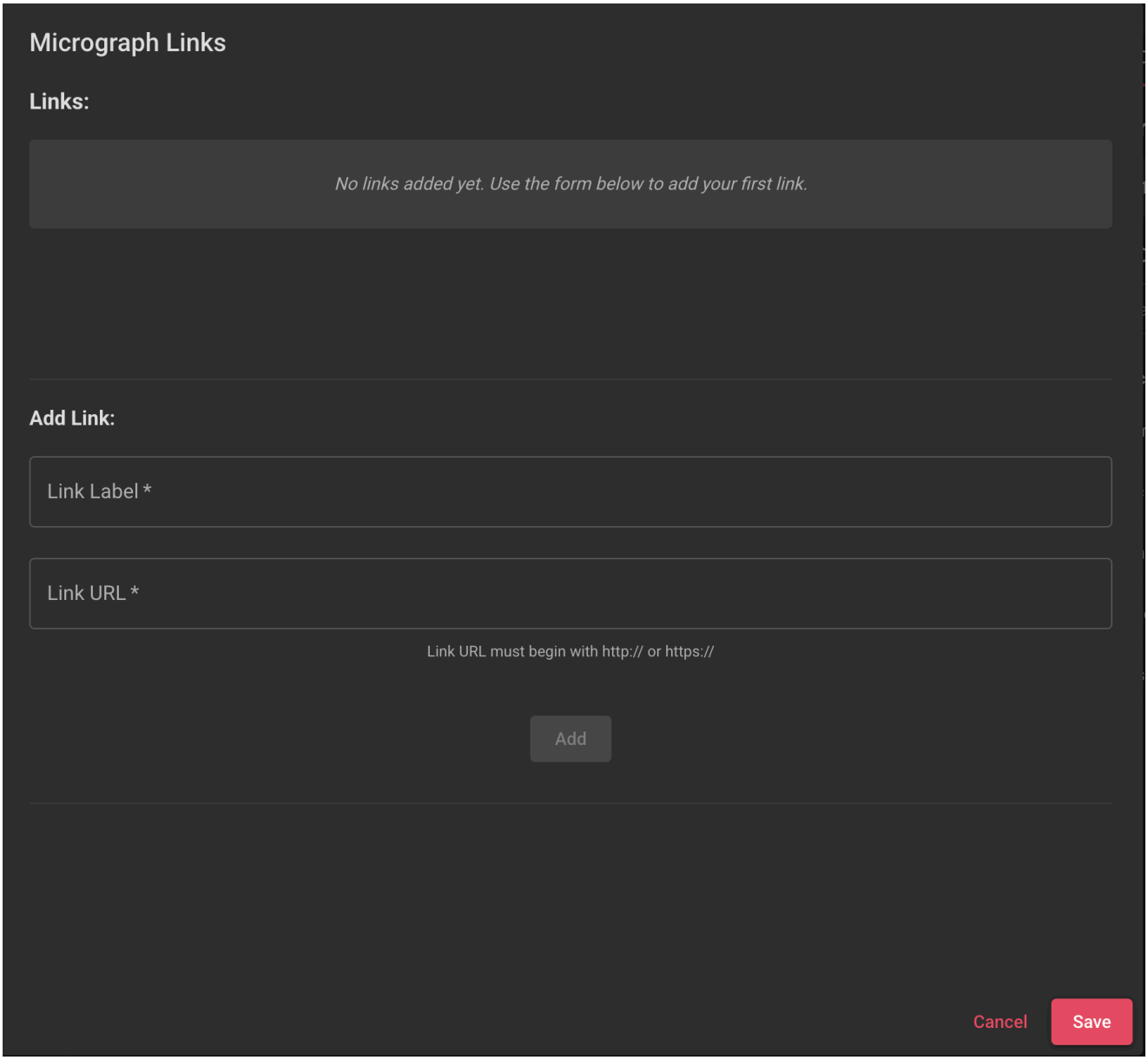


Figure 45. Screenshot of the *Links* data entry interface.

7 Advanced Tools

StraboMicro introduces a suite of powerful analytical tools designed to accelerate petrographic workflows. These advanced features enable systematic point counting, automated grain detection using both classical computer vision and AI-powered methods, rapid spot classification, reusable metadata presets, quantitative grain size analysis, and multi-image comparison. This section provides detailed documentation for each tool.

7.1 Point Count System

The Point Count System enables systematic modal analysis and petrographic studies through structured point counting on micrographs. Access this tool via `Tools > Point Count`.

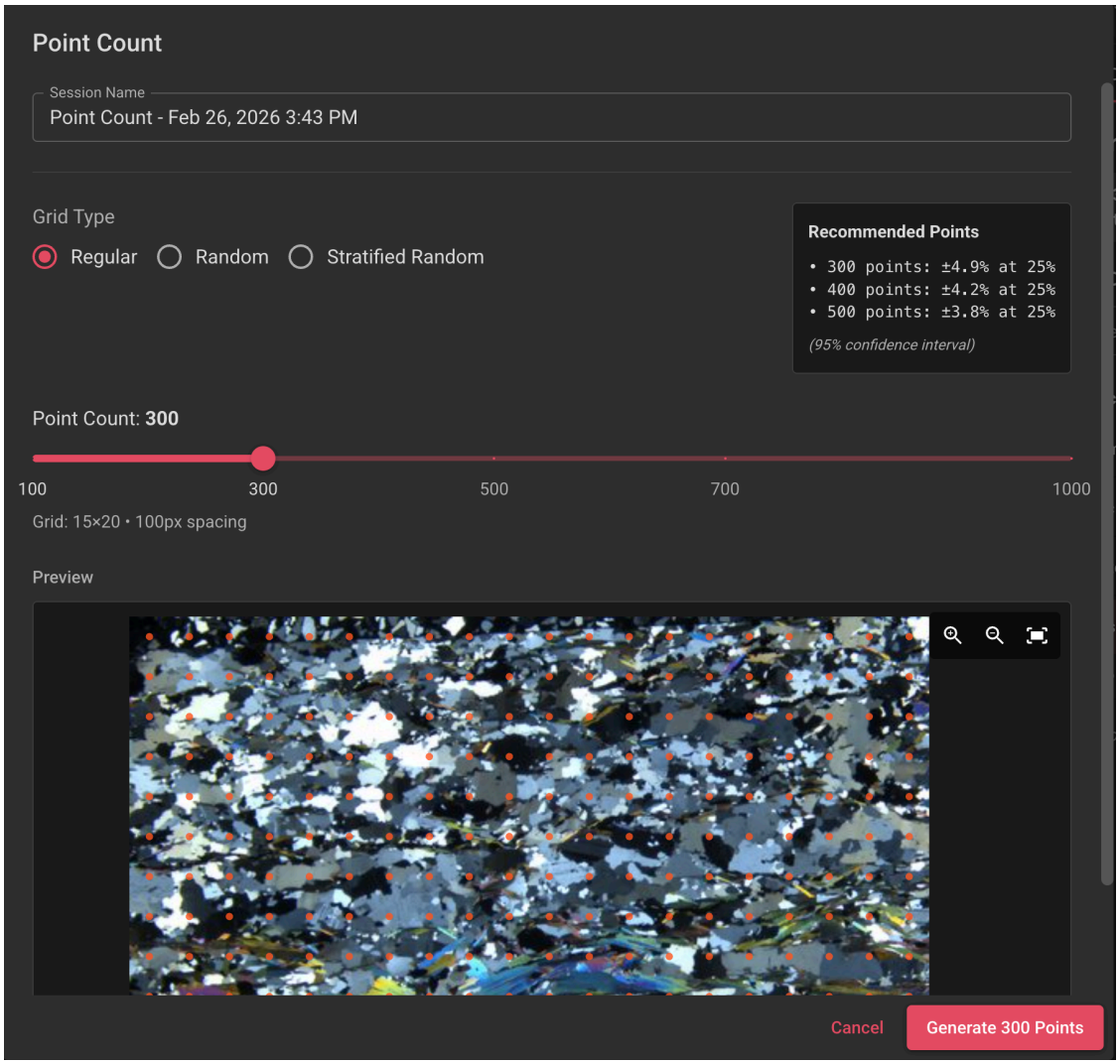


Figure 46. Point Count interface showing the grid overlay, active counting point, and statistics panel.

7.1.1 Purpose and Applications

Point counting is a fundamental technique in petrology for determining the modal composition of rocks. The Point Count System provides:

- Systematic sampling across the micrograph using a customizable grid
- Rapid mineral identification using keyboard shortcuts
- Real-time statistics with counts and percentages
- Session persistence for long counting sessions
- Export capabilities for further analysis

7.1.2 Grid Generation

When initiating a point count session, configure the sampling grid:

- **Grid Spacing:** Set the distance between counting points in micrometers. Smaller spacing yields more points but requires longer counting time.
- **Grid Offset:** Optionally offset the grid origin to avoid edge effects or to target specific regions.
- **Random Offset:** Enable slight random perturbation of grid points to reduce bias from periodic textures.
- **Point Count Target:** Set a target number of points (e.g., 300, 500, 1000) commonly used in petrographic studies.

7.1.3 Keyboard Navigation

Navigate efficiently through counting points using keyboard controls:

- **Arrow Keys:** Move to adjacent grid points (Up, Down, Left, Right)
- **Tab, Space, or Enter:** Advance to the next uncounted point
- **Back Arrow:** Return to the previous point

The current counting point is highlighted with a crosshair indicator, and the micrograph view automatically centers on the active point at high magnification.

7.1.4 Quick Mineral Shortcuts

Assign minerals to counting points rapidly using letter keys:

- **A–Z Keys:** Each letter can be mapped to a mineral in your project's mineralogy list
- **Customizable Mappings:** Configure which mineral each key represents via the shortcut configuration panel
- **Common Defaults:** Q=Quartz, F=Feldspar, M=Mica, O=Olivine, P=Pyroxene, etc.
- **Visual Feedback:** The assigned mineral appears briefly on screen after each keystroke

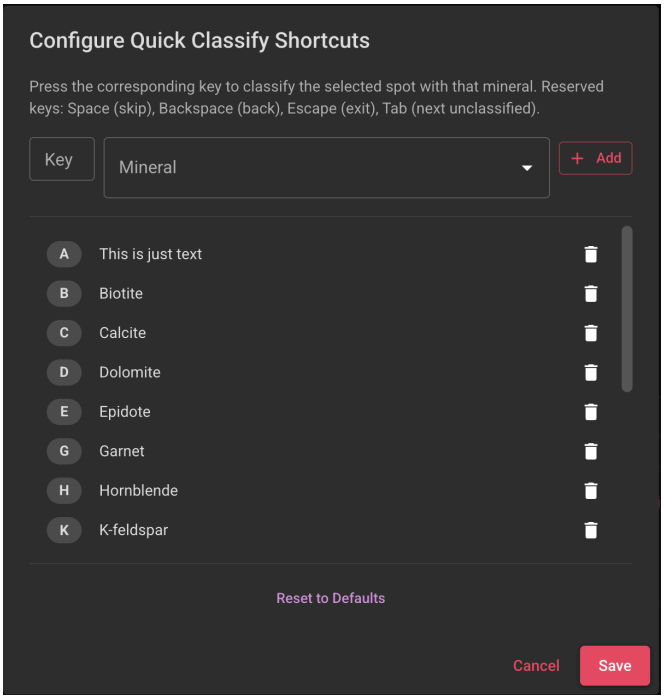


Figure 47. Keyboard shortcut configuration panel for mineral assignments.

7.1.5 Statistics Panel

The statistics panel displays live counting data:

- **Total Points:** Number of points counted vs. total grid points
- **Mineral Counts:** Raw count for each identified mineral
- **Percentages:** Modal percentage for each mineral (with standard error)
- **Progress Bar:** Visual indicator of counting progress

7.1.6 Session Management

Point count sessions can be saved and resumed:

- **Auto-Save:** Sessions are automatically saved at regular intervals
- **Resume Session:** Reopen a previous session to continue counting
- **Multiple Sessions:** Maintain separate sessions for different areas or counting schemes
- **Session Notes:** Add notes to document counting criteria or observations

7.1.7 Export Results

Export point count data for external analysis:

- **CSV Export:** Tabular data with point coordinates, assigned minerals, and summary statistics
- **Include Metadata:** Option to include micrograph metadata and session parameters
- **Statistical Summary:** Separate summary file with modal percentages and confidence intervals

7.2 Grain Detection – OpenCV Method

The OpenCV grain detection method uses classical computer vision algorithms to identify and outline grain boundaries automatically. Access via `Tools > Grain Detection > OpenCV Detection`.

7.2.1 Algorithm Overview

The OpenCV method employs a multi-stage processing pipeline:

1. **Preprocessing:** Noise reduction and contrast enhancement
2. **Canny Edge Detection:** Identifies potential grain boundaries based on intensity gradients
3. **Watershed Segmentation:** Separates touching grains using marker-based watershed algorithm
4. **Contour Extraction:** Converts segmented regions to polygon boundaries
5. **Filtering:** Removes artifacts based on size and shape criteria

7.2.2 Preview Mode

Before committing detected grains to your project, use Preview Mode to evaluate results:

- **Overlay Display:** Detected boundaries shown as colored outlines on the micrograph
- **Toggle View:** Switch between original image and detection overlay
- **Zoom Inspection:** Examine detection quality at high magnification
- **Statistics Preview:** View count of detected grains and size distribution

7.2.3 Adjustable Parameters

Fine-tune detection by adjusting these parameters:

- **Sensitivity:** Controls the threshold for edge detection. Higher values detect more boundaries but may include noise.
- **Minimum Grain Size:** Excludes detected regions smaller than this threshold (in square micrometers). Useful for filtering noise and inclusions.
- **Maximum Grain Size:** Excludes regions larger than this threshold. Helpful for ignoring background or matrix areas.
- **Edge Threshold:** Adjusts the Canny edge detector's sensitivity to intensity gradients.
- **Smoothing:** Controls the degree of boundary smoothing applied to detected polygons.

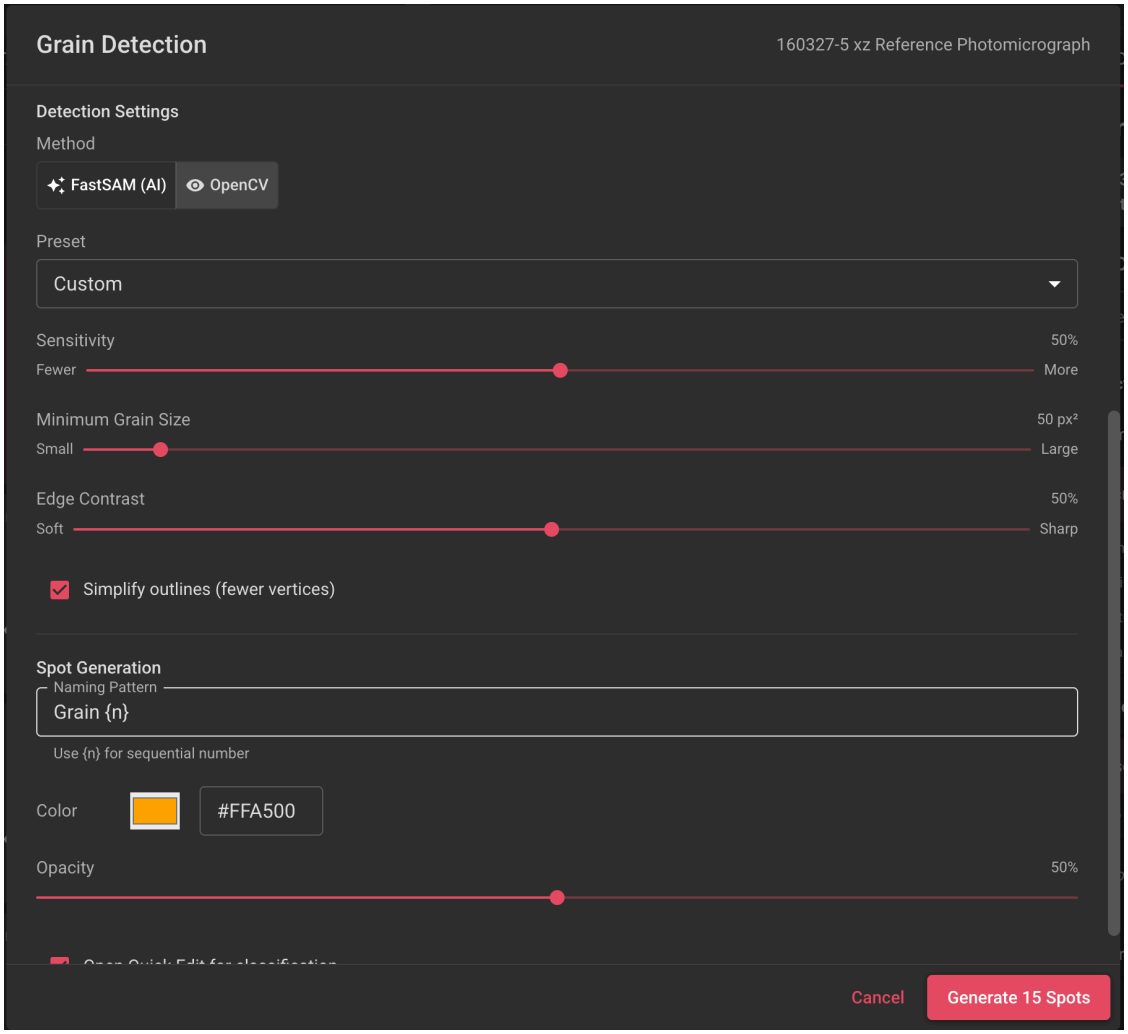


Figure 48. Parameter adjustment panel for OpenCV grain detection.

7.2.4 Creating Polygon Spots

After reviewing the detection results, commit detected grains to your project:

- **Accept All:** Creates polygon spots for all detected grains
- **Selective Accept:** Click individual detections to include/exclude them
- **Naming Convention:** Spots are automatically named with a configurable prefix (e.g., “Grain_001”)
- **Default Properties:** Set default color, transparency, and initial classification for new spots

7.3 Grain Detection – FastSAM AI Method

The FastSAM AI method uses a neural network trained for image segmentation, providing superior accuracy for complex textures and challenging grain boundaries. Access via `Tools > Grain Detection > AI Detection`.

7.3.1 Technology Overview

The AI detection method leverages:

- **FastSAM Neural Network:** A fast segment-anything model optimized for real-time segmentation
- **GrainSight Algorithm:** Custom post-processing optimized specifically for thin section micrographs
- **ONNX Runtime:** Cross-platform inference engine for model execution
- **GPU Acceleration:** Utilizes available GPU hardware for faster processing

7.3.2 Automatic Model Download

On first use, the AI model is automatically downloaded:

- **Source:** Models are hosted on HuggingFace for reliable distribution
- **Size:** Approximately 150 MB download
- **Storage:** Models are cached locally in the application data directory
- **Updates:** The application checks for model updates periodically

7.3.3 Advantages Over Classical Methods

The AI method excels in scenarios where classical methods struggle:

- **Complex Textures:** Better handling of porphyroblastic, poikiloblastic, and granoblastic textures
- **Variable Lighting:** More robust to uneven illumination and optical artifacts
- **Subtle Boundaries:** Detects low-contrast boundaries between similar minerals
- **Intergrown Grains:** Improved separation of interlocking crystal boundaries

7.3.4 Cross-Platform Support

The AI detection runs on all supported platforms:

- **macOS:** Native support for Apple Silicon (M1/M2/M3) and Intel processors
- **Windows:** Support for NVIDIA GPUs via CUDA, or CPU fallback
- **Linux:** Full support with GPU acceleration where available

7.3.5 GPU Acceleration

When available, GPU acceleration significantly improves processing speed:

- **Automatic Detection:** The application automatically detects and uses available GPU
- **CPU Fallback:** If no compatible GPU is found, processing uses CPU (slower but functional)
- **Memory Management:** Large images are processed in tiles to manage GPU memory
- **Performance Indicator:** Status bar shows whether GPU or CPU is being used

7.4 Quick Edit Mode

Quick Edit Mode provides a streamlined interface for rapidly reviewing and classifying spots after grain detection. Access via `Edit > Quick Edit Spots` or `Cmd+Shift+Q` (macOS) / `Ctrl+Shift+Q` (Windows/Linux).

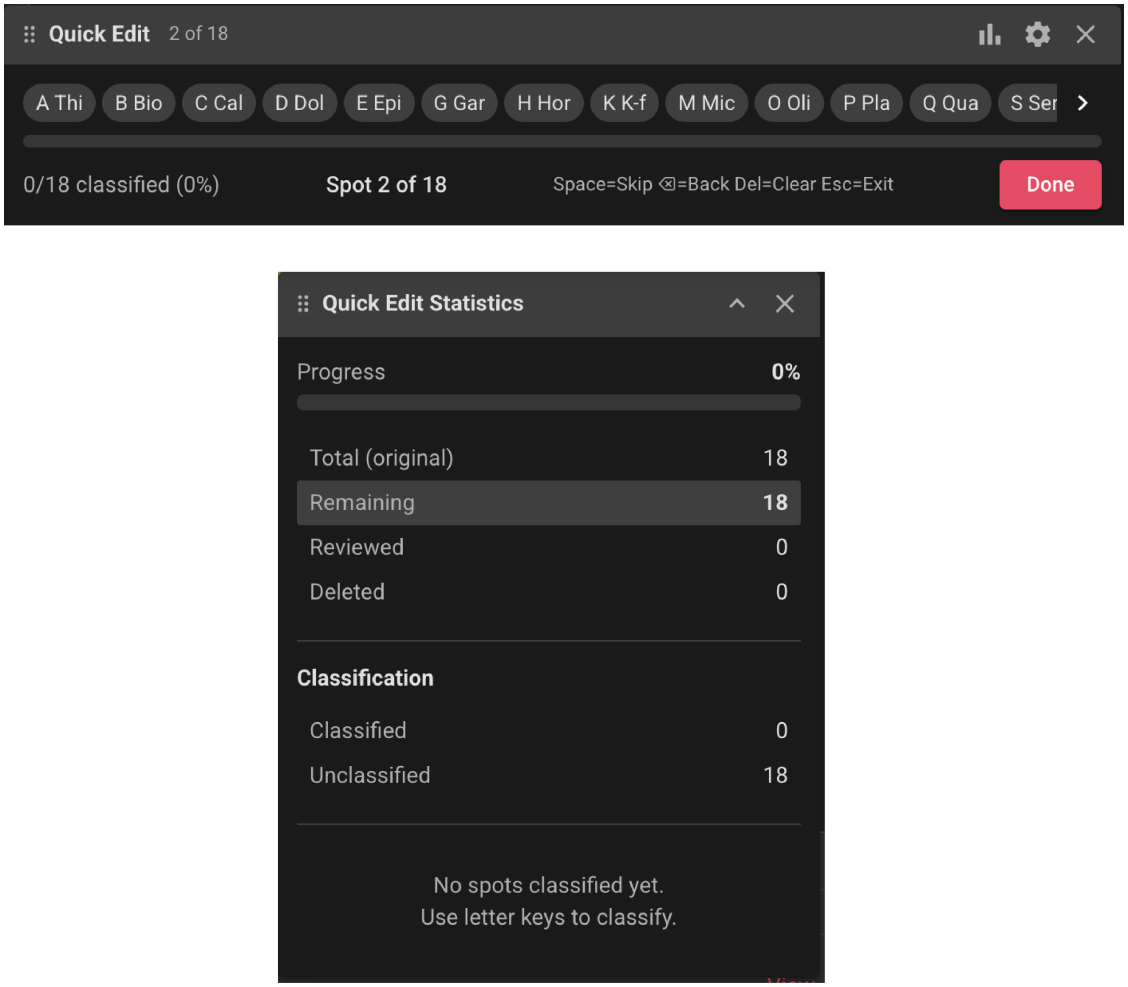


Figure 49. Quick Edit Mode interface showing spot navigation, classification states, and statistics panel.

7.4.1 Purpose

After automated grain detection creates hundreds of polygon spots, Quick Edit Mode enables rapid:

- Review of detected boundaries for accuracy
- Mineral classification assignment
- Deletion of incorrectly detected spots
- Batch operations on multiple spots

7.4.2 Keyboard Navigation

Navigate between spots efficiently:

- **Arrow Keys:** Move to adjacent spots (based on spatial position)
- **Tab:** Advance to next unreviewed spot
- **Shift+Tab:** Return to previous spot
- **Space:** Mark current spot as reviewed (without classification)
- **Delete/Backspace:** Remove current spot

7.4.3 Quick Mineral Assignment

Assign minerals instantly using letter keys:

- **A–Z Keys:** Each letter maps to a mineral from your project's mineralogy
- **Configurable Mappings:** Customize which mineral each key represents
- **Auto-Advance:** After assignment, automatically moves to next unreviewed spot
- **Undo Support:** `Cmd+Z` / `Ctrl+Z` reverses the last assignment

7.4.4 Statistics Panel

Track your progress through the review:

- **Total Spots:** Number of spots in the current micrograph
- **Reviewed:** Count and percentage of reviewed spots
- **Remaining:** Count of spots still requiring review
- **By Mineral:** Breakdown of classifications by mineral type

7.4.5 Lasso Selection

Select multiple spots for batch operations:

- **Shift+Drag:** Draw a lasso to select multiple spots
- **Batch Edit:** Right-click to edit all selected spots
- **Batch Delete:** Press Delete to mark all selected spots for removal
- **Clear Selection:** Press Escape to deselect all spots

7.5 Quick Apply Presets

Quick Apply Presets allow you to create reusable metadata templates for rapid spot classification. Access via `Edit > Quick Apply Presets` or `Shift + Cmd + P` on Mac or `Shift + Ctrl + P` on Windows.

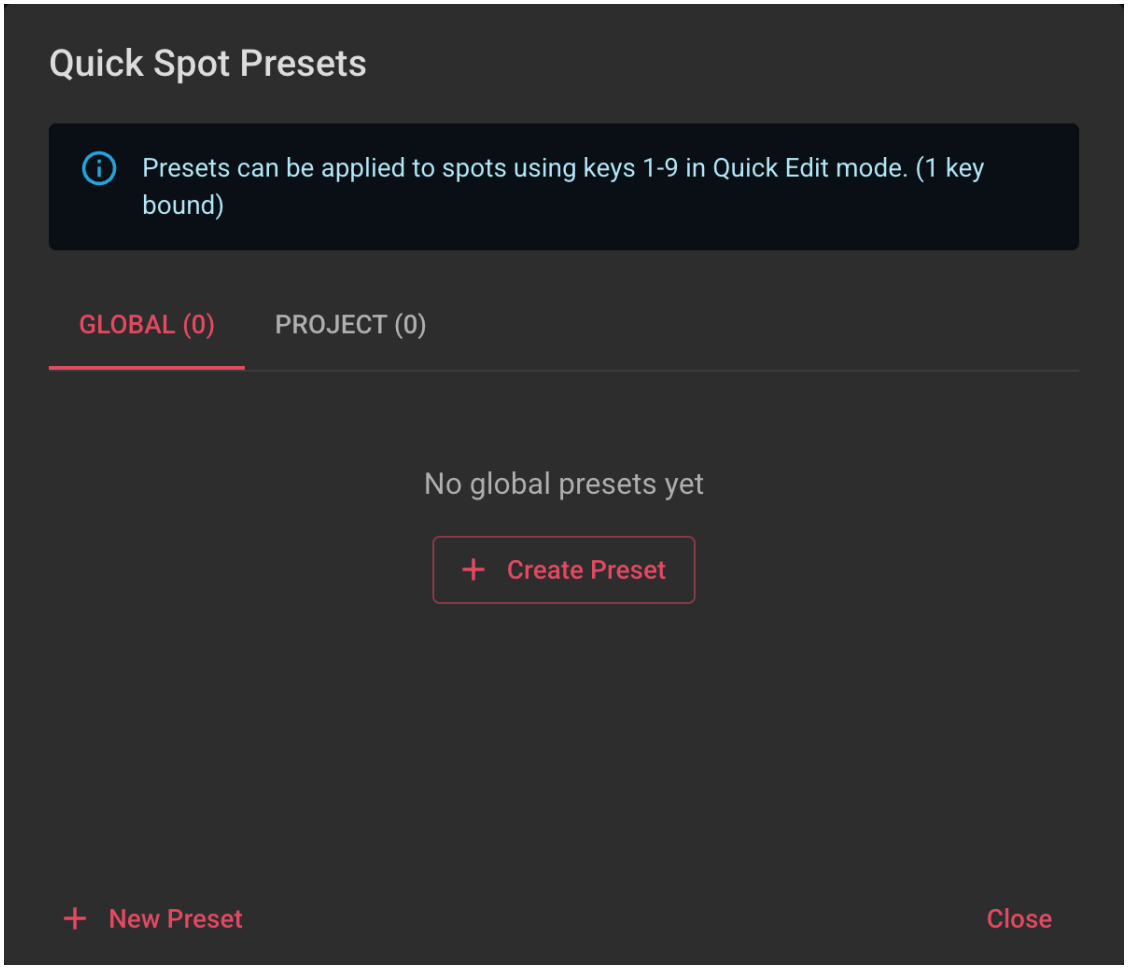


Figure 50. Quick Apply Presets panel showing global and project-level presets with keyboard shortcuts.

7.5.1 Purpose

When classifying spots, you often need to apply the same combination of metadata repeatedly. Presets enable:

- One-click application of complex metadata combinations
- Consistent data entry across multiple spots
- Time savings when processing large numbers of grains
- Standardized classification schemes within a project or across projects

7.5.2 Preset Scope

Presets can be defined at two levels:

- **Global Presets:** Available across all projects. Useful for standard classifications (e.g., “Quartz – Strained”, “Feldspar – Perthitic”)
- **Project Presets:** Specific to the current project. Useful for sample-specific categories or temporary classifications

7.5.3 Keyboard Shortcuts

In Quick Edit Mode, apply presets instantly:

- **Keys 1–9:** Apply preset 1 through 9 to the selected spot
- **Preset Order:** Arrange presets in the panel to assign their shortcut numbers
- **Visual Indicator:** Shortcut numbers displayed next to each preset name

7.5.4 Additive Merge Behavior

Presets merge with existing spot data:

- **Non-Destructive:** Applying a preset does not erase existing metadata
- **Field Override:** Preset values replace existing values only for fields included in the preset
- **Field Addition:** Preset values are added to empty fields
- **Merge Lists:** For list fields (e.g., associated minerals), preset values are appended

7.5.5 Batch Application

Apply presets to multiple spots at once:

- **Multi-Select:** Select multiple spots using lasso or Shift+click
- **Apply to Selection:** Use keyboard shortcut or right-click menu to apply preset
- **Confirmation:** Optional confirmation dialog for large batch operations

7.5.6 Creating Presets from Existing Spots

Build presets from already-classified spots:

- **Select Spot:** Choose a spot with the desired metadata configuration
- **Create Preset:** Go to `Spot > Quick Spot Presets...` in the menu, choose scope (global or project). Click `New Preset`.
- **Select Copy from Existing Spot:** Review and edit the selected spot information.
- **Name and Save:** Provide a descriptive name and click `Create`

7.6 Grain Size Analysis

Grain Size Analysis provides quantitative morphometric measurements of polygon spots, enabling statistical characterization of grain populations. Access via `Tools > Grain Size Analysis` or `Cmd+Shift+A` (macOS) / `Ctrl+Shift+A` (Windows/Linux).

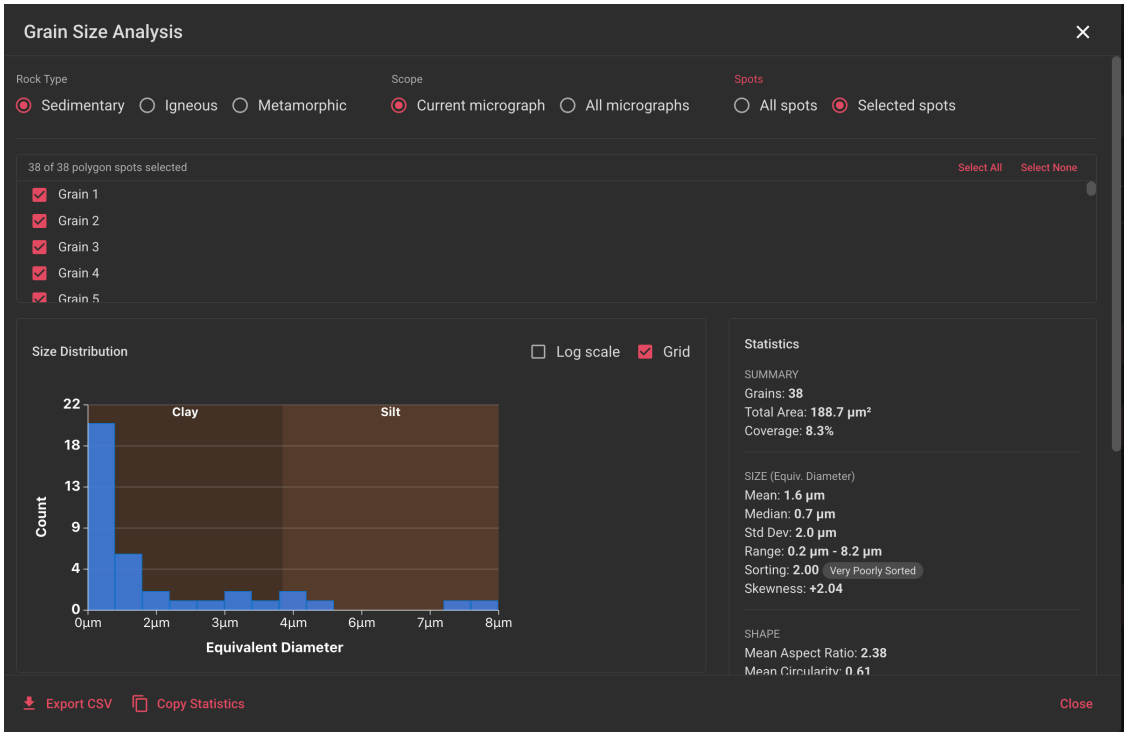


Figure 51. Grain Size Analysis interface showing per-grain metrics, population statistics, and visualization options.

7.6.1 Per-Grain Metrics

For each polygon spot, the following measurements are calculated:

- **Area:** Total area enclosed by the polygon boundary (in μm^2 or mm^2)
- **Perimeter:** Length of the polygon boundary
- **Equivalent Diameter:** Diameter of a circle with equivalent area: $d_{eq} = 2\sqrt{A/\pi}$
- **Aspect Ratio:** Ratio of major to minor axis of the best-fit ellipse
- **Orientation:** Angle of the major axis from horizontal (0–180°)
- **Circularity:** Measure of how circular the grain is: $4\pi A/P^2$ (1.0 = perfect circle)

7.6.2 Population Statistics

Aggregate statistics for the grain population:

- **Mean:** Average value for each metric
- **Median:** Middle value when sorted (less sensitive to outliers)
- **Standard Deviation:** Measure of spread around the mean
- **Skewness:** Measure of distribution asymmetry (positive = tail toward larger sizes)
- **Sorting Coefficient:** Measure of size distribution uniformity (well-sorted = narrow range)

7.6.3 Rock Type Classification Schemes

Apply standard geological classification schemes:

Wentworth Scale (Sedimentary)

- Clay: $< 4\ \mu\text{m}$
- Silt: 4–62 μm
- Sand (very fine to very coarse): 62 μm – 2 mm
- Gravel: > 2 mm

Igneous Classification

- Aphanitic: < 1 mm (grains not visible to naked eye)
- Phaneritic fine: 1–2 mm
- Phaneritic medium: 2–5 mm
- Phaneritic coarse: 5–30 mm
- Pegmatitic: > 30 mm

Metamorphic Classification

- Very fine grained: < 0.1 mm
- Fine grained: 0.1–1 mm
- Medium grained: 1–5 mm
- Coarse grained: 5–30 mm
- Very coarse grained: > 30 mm

7.6.4 Visualizations

Generate publication-ready charts:

Size Histogram

- **Bin Configuration:** Adjustable bin width and range
- **Scale Options:** Linear or logarithmic x-axis
- **Classification Overlay:** Optional vertical lines showing classification boundaries
- **Normal Curve:** Optional fitted normal distribution overlay

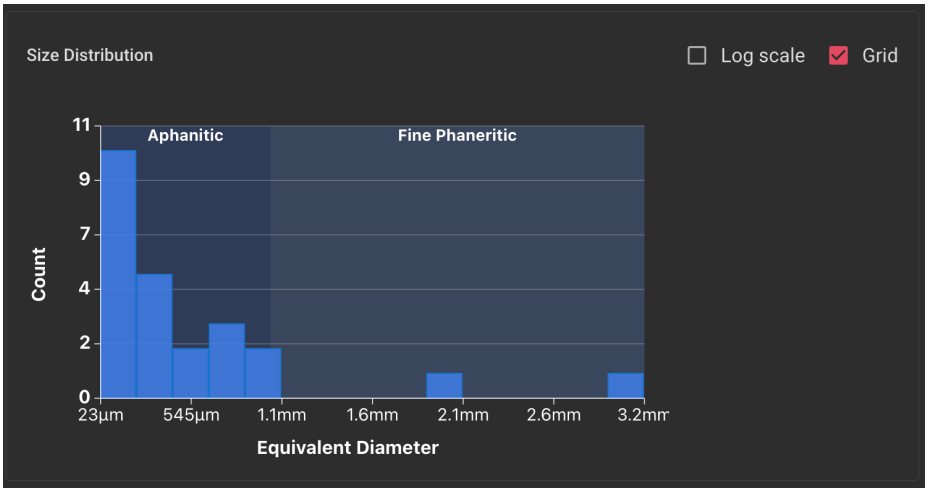


Figure 52. Grain size histogram with Igneous classification boundaries overlaid.

Rose Diagram

- **Orientation Distribution:** Circular histogram of grain long-axis orientations
- **Symmetry:** Choose bidirectional (0–180°) or unidirectional (0–360°) plotting
- **Mean Vector:** Display mean orientation with confidence interval
- **Fabric Strength:** Calculate and display fabric intensity metrics

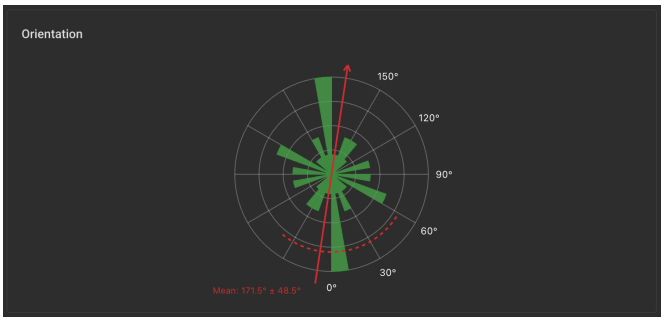


Figure 53. Rose diagram showing preferred orientation of grain long axes.

7.6.5 Spot Grouping

Generate statistics grouped by spot choice:

- **All Spots:** Size distribution statistics for all polygon spots on the micrograph
- **Selected Spots:** Include or exclude specific spots from analysis

7.6.6 Scope Options

Choose the scope of analysis:

- **Current Micrograph:** Analyze only spots on the active micrograph
- **All Micrographs:** Aggregate analysis across all micrographs in the sample
- **Selected Spots:** Analyze only currently selected spots

7.6.7 Export Options

Export analysis results for external use:

- **CSV Export:** Complete per-grain measurements in tabular format
- **Summary Statistics:** Separate file with population statistics
- **PDF Report:** Formatted report including charts, statistics, and methodology
- **Chart Images:** Export individual charts as PNG or SVG

7.7 Image Comparator

The Image Comparator provides a full-screen multi-canvas view for comparing multiple micrographs side by side. Access via `Help > Image Comparator`.

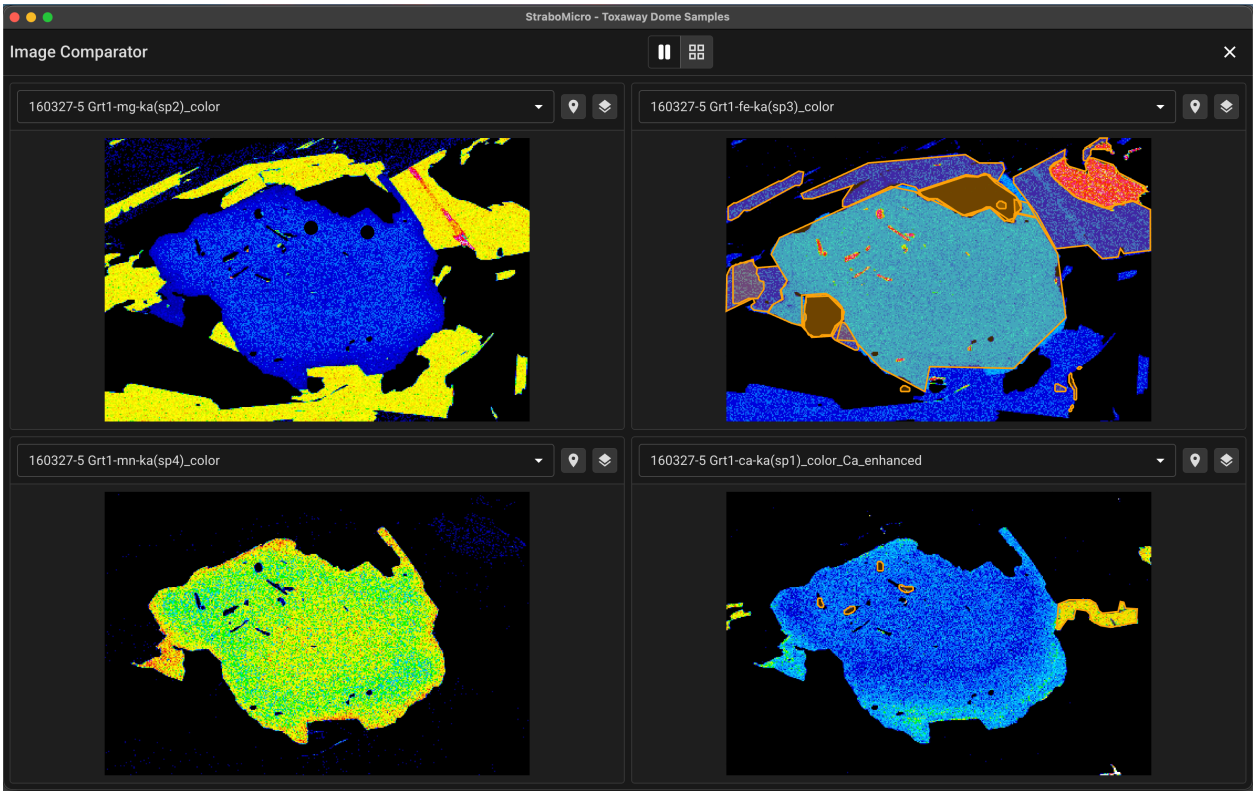


Figure 54. Image Comparator showing a 2x2 grid layout with four micrographs displayed simultaneously.

7.7.1 Purpose

The Image Comparator enables:

- Visual comparison of different imaging modes (PPL, XPL, BSE, etc.) of the same area
- Comparison of similar features across different samples
- Before/after comparison of processed images
- Teaching and presentation with multiple images visible

7.7.2 Grid Layout

Configure the comparison view:

- **Layout Options:** 2x1 or 2x2 grid configurations
- **Flexible Assignment:** Chose micrographs from the project using the dropdowm list

7.7.3 Independent Pan and Zoom

Each canvas operates independently:

- **Individual Navigation:** Pan and zoom each image separately
- **Zoom Controls:** Mouse wheel or pinch gesture to zoom
- **Pan Controls:** Click and drag to pan the image
- **Reset View:** Double-click to fit image to canvas

7.7.4 Overlay Support

Display spot overlays in the comparator:

- **Show Outlines:** Toggle visibility of spot outlines on each canvas
- **Per-Canvas Control:** Enable overlays independently for each image

7.8 StraboTools

7.8.1 Background and Overview

StraboTools was originally developed as an iOS mobile application to support geologists conducting fieldwork. Designed for rapid, in-situ analysis, the application enables users to extract quantitative data from photographs of rock outcrops and hand samples.

The tool was initially created with a focus on plutonic rocks, such as granite, where fabric analysis and mineral proportion estimation are essential. However, its functionality extends to a wide range of lithologies and is equally applicable to the analysis of thin sections in laboratory settings.

The StraboTools iOS mobile application operates by analyzing images either captured directly within the application or imported from the device. By leveraging image processing techniques, it provides measurements that are otherwise difficult to estimate visually in the field.

7.8.2 Edge Fabric Tool

The Edge Fabric tool is designed to quantify rock fabric by analyzing image brightness gradients. It computes and plots an ellipse that summarizes the dominant orientations present in the image.

In deformed rocks, this ellipse represents the orientation and intensity of the fabric:

- The **orientation of the ellipse** corresponds to the principal fabric direction.

- The **axial ratio** provides an estimate correlated with bulk deformation.
- The **long axis** defines a lineation in space, which can be used to interpret structural features.

For planar fabrics, the resulting lineations typically lie along a great circle, aiding structural interpretation. This tool is useful both for outcrop-scale observations and for photomicrograph analysis.

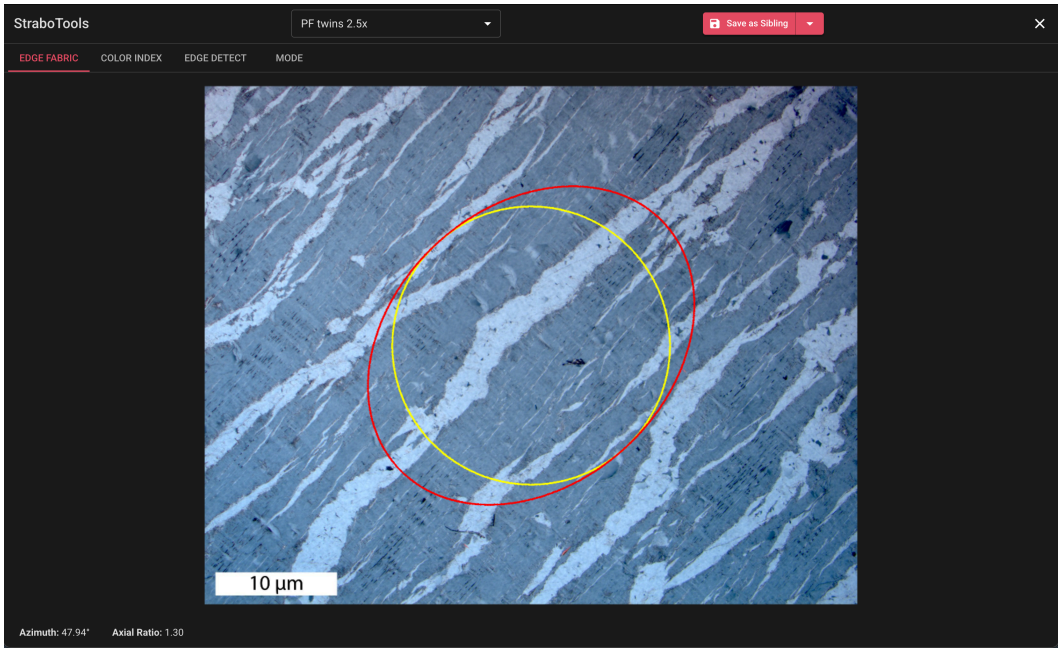


Figure 55. Edge Fabric tool interface showing ellipse fitting to brightness gradients.

7.8.3 Color Index Tool

The Color Index (CI) tool enables quantitative estimation of the proportion of dark minerals within a rock sample. This is expressed as the area percentage of pixels below a specified brightness threshold.

The workflow consists of:

- Capturing or importing an image.
- Adjusting a threshold slider to isolate darker pixels.
- Viewing the calculated percentage of selected pixels.

Two thresholding modes are available:

- **Adaptive Thresholding**: Adjusts dynamically based on local image conditions.
- **Global Thresholding**: Applies a uniform threshold across the entire image.

This tool provides a fast and repeatable method for estimating mineral proportions in both field and laboratory contexts.

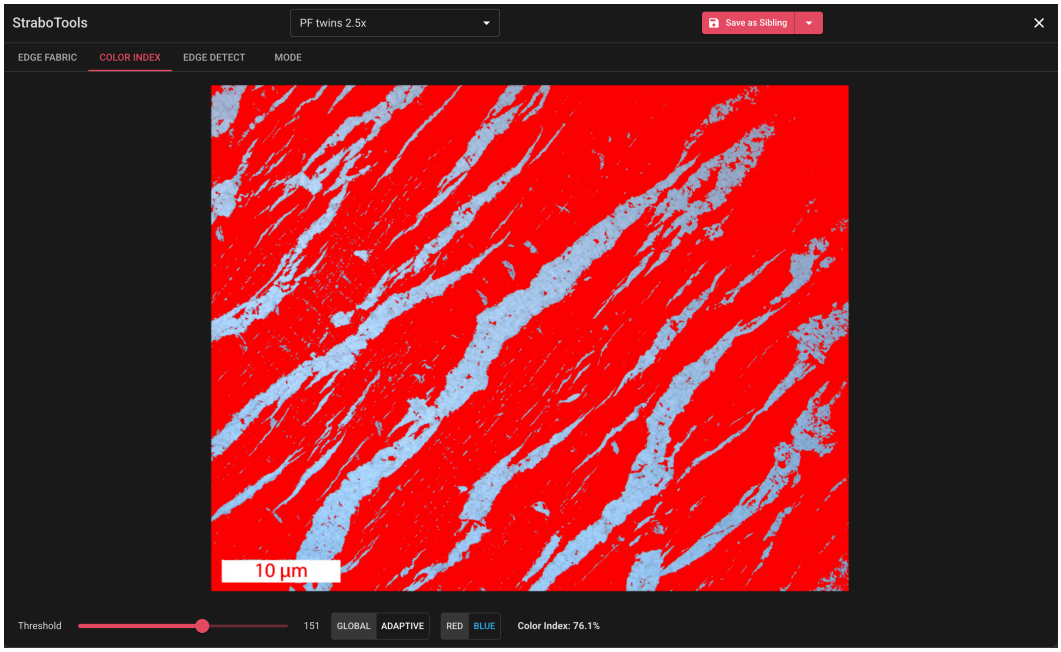


Figure 56. Color Index tool highlighting dark mineral pixels using threshold adjustment.

7.8.4 Edge Detect Tool

The Edge Detect tool applies an edge detection filter to the input image, enhancing boundaries and subtle structural features that may not be easily visible in the original photograph.

This functionality is particularly useful for:

- Identifying fine-scale structures in outcrops.
- Improving interpretation of fabric patterns.
- Assisting in the visualization of features prior to Edge Fabric analysis.

By clarifying gradients and discontinuities, this tool supports more accurate downstream analysis and interpretation.

7.8.5 Mode Tool

The Mode tool provides quantitative modal analysis by segmenting an image into a user-defined number of distinct phases. This enables estimation of the relative abundance of different mineral or compositional groups within a sample.

The user selects between **2 and 6 phases**, after which the application:

- Classifies pixels into discrete groups based on image characteristics.
- Assigns a unique color to each identified phase for visual distinction.
- Calculates and displays the **modal percentage** of each phase.

This functionality is particularly useful for:

- Rapid modal estimation of mineral assemblages in the field.
- Supporting petrographic analysis of thin sections.

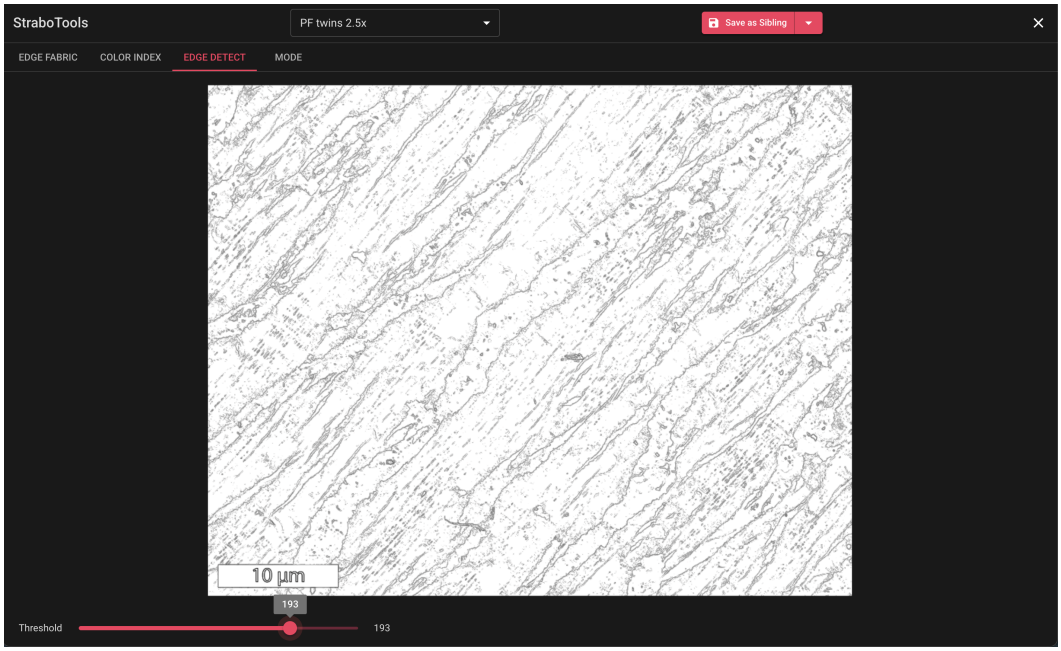


Figure 57. Edge Detect tool output highlighting structural features in the image.

- Providing reproducible, quantitative data for comparison between samples.

The color-coded output allows users to visually assess phase distribution while simultaneously obtaining precise modal proportions.

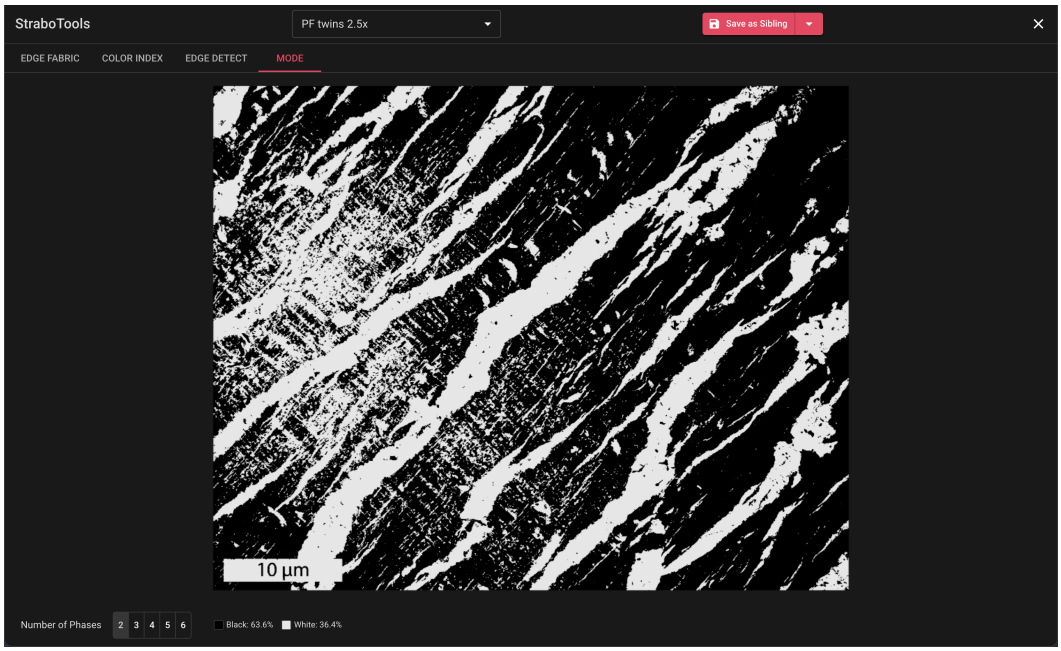


Figure 58. Mode tool displaying phase segmentation with color-coded regions and modal percentages.

8 Sketch Overlay System

8.1 Introduction to Sketch Overlay

The Sketch Overlay system provides an “acetate overlay” capability for freeform annotations on your micrographs. Think of it as placing a transparent acetate sheet over a physical thin section slide and drawing on it with colored markers. You can add notes, highlight features, and mark up the image without affecting the underlying scientific data.

Key Concept: Sketches are intentionally separate from the scientific spot annotation system. While spots represent formal geological observations with structured metadata, sketches are designed for informal markup and visual communication.

8.1.1 Common Use Cases

- **Teaching and Presentations:** Highlight features of interest when explaining concepts to students or colleagues
- **Informal Markup:** Quickly mark areas for later investigation without creating formal spot annotations
- **Contextual Notes:** Add text labels and reminders directly on the micrograph
- **Feature Highlighting:** Use the marker tool to draw attention to specific regions
- **Collaborative Review:** Annotate micrographs for discussion with collaborators
- **Draft Annotations:** Sketch preliminary boundaries before creating formal polygon spots

Multiple sketch layers can be created per micrograph, allowing you to organize different types of annotations separately—for example, one layer for grain boundaries and another for teaching notes.

8.2 Entering and Exiting Sketch Mode

Sketch mode provides a dedicated drawing environment with specialized tools for freeform annotation.

8.2.1 Entering Sketch Mode

To enter sketch mode, use one of the following methods:

- Click the **Sketch** button in the main toolbar (Figure 59)
- Press the S key on your keyboard

When sketch mode is active:

- The normal spot tools (Point, Line, Polygon) are replaced with sketch tools
- The toolbar displays sketch-specific controls including tool selection, color picker, and width slider

- The **X3** button changes to **Exit Sketch**
- A visual indicator confirms you are in sketch mode

Figure 59. The Sketch button in the main toolbar. Click to enter sketch mode. Refer to Section 4.5.1 or 5.5.1 for more information about the main toolbar.

8.2.2 Exiting Sketch Mode

To exit sketch mode and return to normal operation:

- Click the **Exit Sketch** button in the toolbar
- Press the Escape key on your keyboard

All sketches remain visible after exiting sketch mode, but you cannot draw new strokes until you re-enter sketch mode.

8.3 Sketch Tools

Four drawing tools are available in sketch mode (Figure 60). Each tool is optimized for different annotation tasks.

Figure 60. Sketch tools in the toolbar: Pen, Marker, Eraser, and Text.

8.3.1 Pen Tool

Keyboard shortcut: 1

The Pen tool creates precise, thin strokes ideal for detailed annotations and tracing features.

- **Stroke width:** 2–5 pixels (thin, precise lines)
- **Opacity:** 1.0 (fully opaque)
- **Best for:** Outlining grain boundaries, tracing fractures, detailed markup

How to use:

1. Select the Pen tool by clicking its icon or pressing 1
2. Click and drag on the micrograph to draw
3. Release the mouse button to complete the stroke

8.3.2 Marker Tool

Keyboard shortcut: 2

The Marker tool creates thick, semi-transparent strokes that work like a highlighter pen.

- **Stroke width:** 15–30 pixels (thick, visible strokes)
- **Opacity:** 0.4 (semi-transparent)
- **Best for:** Highlighting regions of interest, emphasizing features, drawing attention to areas

How to use:

1. Select the Marker tool by clicking its icon or pressing 2
2. Click and drag to highlight areas on the micrograph
3. The semi-transparent nature allows the underlying image to remain visible

8.3.3 Eraser Tool

Keyboard shortcut: 3

The Eraser tool removes strokes from the current sketch layer.

- **Deletion mode:** Deletes entire strokes (not partial segments)
- **Visual feedback:** Strokes highlight when the eraser hovers over them
- **Works on:** Both pen and marker strokes in the active layer

How to use:

1. Select the Eraser tool by clicking its icon or pressing 3
2. Click on any stroke to delete it entirely
3. Alternatively, click and drag across multiple strokes to delete them in sequence

Note: The eraser deletes complete strokes. If you need to remove only part of a stroke, delete the entire stroke and redraw the portion you want to keep.

8.3.4 Text Tool

Keyboard shortcut: 4 or T

The Text tool allows you to place text annotations directly on the micrograph.

- **Placement:** Click to position text at any location
- **Editing:** Text can be repositioned by dragging after creation
- **Color:** Uses the currently selected color from the color picker

How to use:

1. Select the Text tool by clicking its icon or pressing 4 (or T)
2. Click on the micrograph where you want to place the text

3. An input field appears—type your text and press Enter to confirm
4. The text is placed at the clicked location

To reposition text:

- With the Text tool active, click and drag existing text to move it

To edit existing text:

- Double-click on existing text to open the edit input field
- Modify the text and press Enter to confirm changes

8.4 Color and Width Controls

The sketch toolbar provides controls for customizing the appearance of your annotations (Figure 61).

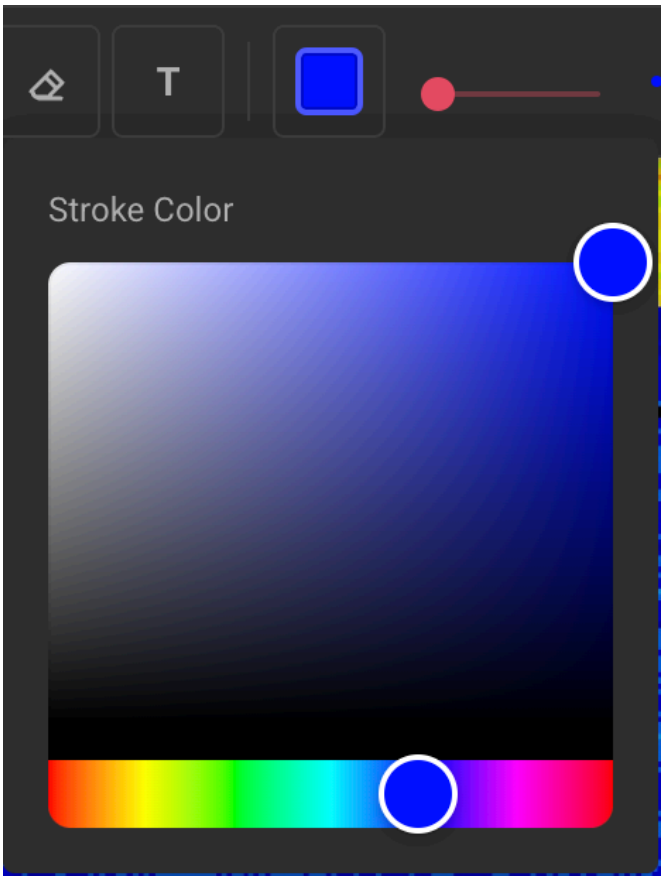


Figure 61. Color picker and width slider in the sketch toolbar.

8.4.1 Color Picker

The color swatch in the toolbar displays your current drawing color. Click the swatch to open the full spectrum color picker.

- **Full spectrum:** Choose any color from the complete color spectrum
- **Hex input:** Enter specific hex color codes for precise color matching

- **Applies to:** Pen strokes, marker strokes, and text annotations

The color picker closes automatically when you click outside of it, or you can click the swatch again to dismiss it.

8.4.2 Width Slider

The width slider adjusts the stroke width for the Pen and Marker tools.

- **Range:** 1–50 pixels
- **Preview:** A visual preview shows the current width and color
- **Default values:** Pen defaults to thin strokes; Marker defaults to thick strokes

Adjust the slider before drawing to set the width for subsequent strokes. Existing strokes are not affected by width changes.

8.5 Layer Management

Each micrograph can have multiple sketch layers, allowing you to organize annotations by purpose. Layers are managed through the **Sketches** tab in the right Properties panel (Figure 62).

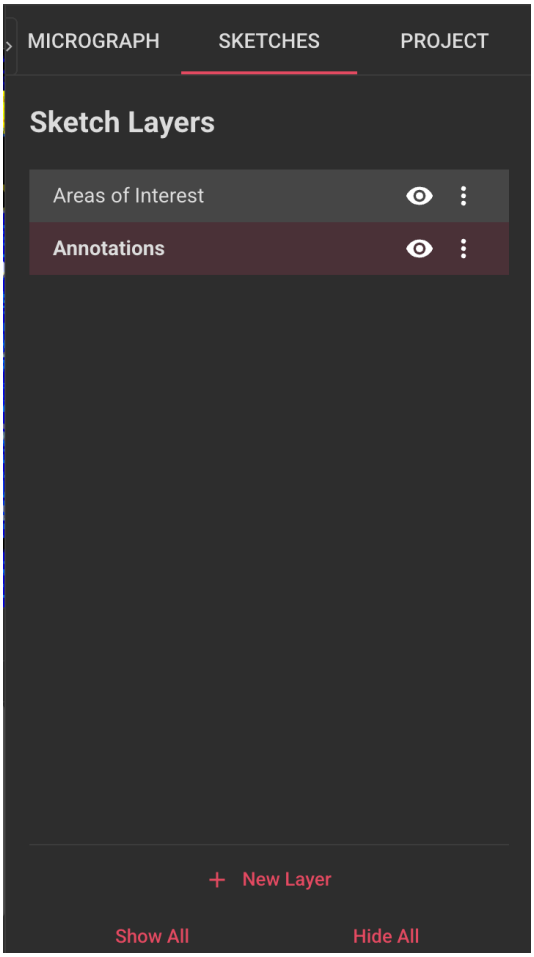


Figure 62. The Sketches tab in the Properties panel showing layer management controls.

8.5.1 Accessing Layer Management

1. Select a micrograph in the Sample Tree (left panel)
2. In the right Properties panel, click the **Sketches** tab
3. The panel displays all sketch layers for the current micrograph

8.5.2 Creating a New Layer

1. Click the **+ New Layer** button at the bottom of the Sketches panel
2. A new layer is created with a default name (e.g., “Layer 1”)
3. The new layer becomes the active layer for drawing

8.5.3 Selecting the Active Layer

Click on a layer name in the list to make it the active layer. All new drawing operations will be added to the active layer. The active layer is highlighted in the list.

8.5.4 Layer Visibility

Each layer has an eye icon indicating its visibility status:

- **Eye icon visible:** Layer is shown on the micrograph
- **Eye icon hidden/crossed:** Layer is hidden
- Click the eye icon to toggle visibility

Quick visibility controls:

- **Show All:** Click to make all layers visible
- **Hide All:** Click to hide all layers

8.5.5 Renaming a Layer

To give a layer a descriptive name:

1. Double-click on the layer name in the list
2. The name becomes editable—type the new name
3. Press Enter or click outside to confirm the change

Tip: Use descriptive names like “Grain boundaries”, “Teaching notes”, or “Draft annotations” to keep your layers organized.

8.5.6 Deleting a Layer

To delete a layer and all its contents:

1. Click the three-dot menu button (**...**) next to the layer name
2. Select **Delete** from the context menu

3. Confirm the deletion when prompted

Warning: Deleting a layer removes all strokes and text on that layer. This action can be undone using Undo (`Cmd+Z` on Mac, `Ctrl+Z` on Windows).

8.6 Undo and Redo

The sketch system supports full undo and redo functionality, integrated seamlessly with the main application's undo system.

8.6.1 Undo

- **macOS:** Press `Cmd+Z`
- **Windows/Linux:** Press `Ctrl+Z`

Undo reverses the most recent action, including:

- Drawing a stroke (pen or marker)
- Deleting a stroke with the eraser
- Adding text
- Deleting text
- Moving text
- Creating or deleting layers

8.6.2 Redo

- **macOS:** Press `Cmd+Shift+Z`
- **Windows/Linux:** Press `Ctrl+Shift+Z`

Redo restores an action that was previously undone.

Note: The undo/redo system works across both sketch operations and spot operations. For example, you can undo a sketch stroke, then undo a spot creation, maintaining a unified history.

8.7 Exporting with Sketches

StraboMicro allows you to export micrograph images with your sketch annotations composited on top.

8.7.1 Export Options

To export a view with sketches:

1. Go to `File > Export View with Sketches`
2. The Export dialog appears (Figure 63)
3. Configure the export options as described below

4. Click **Export** and choose a save location

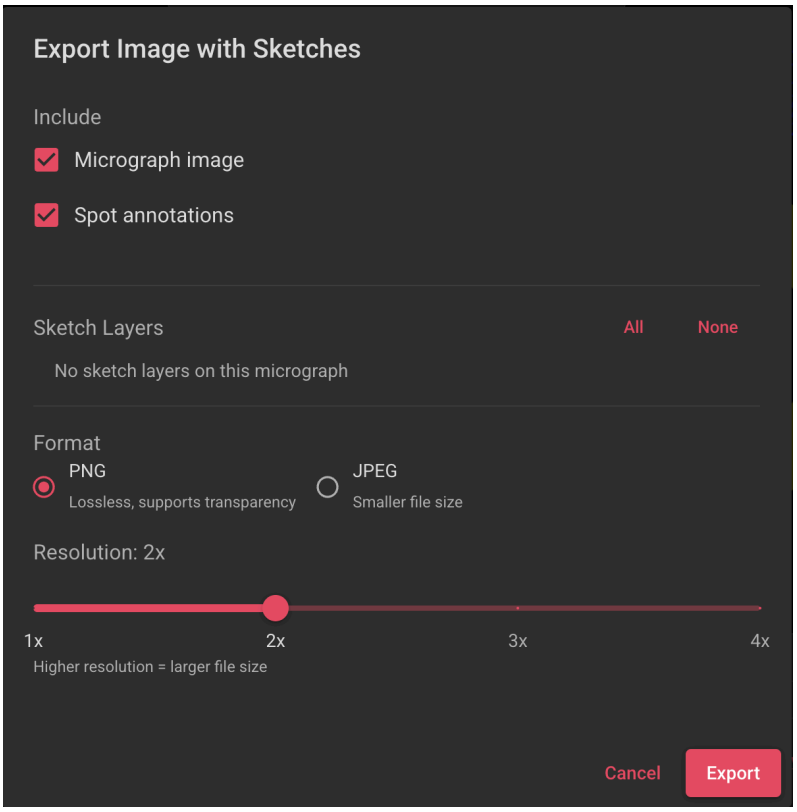


Figure 63. Export dialog with sketch layer selection options.

8.7.2 Include/Exclude Options

The export dialog provides checkboxes to control what is included in the exported image:

- **Micrograph image:** Include or exclude the base micrograph
- **Spot annotations:** Include or exclude scientific spot overlays
- **Sketch layers:** Select which sketch layers to include (each layer has its own checkbox)

Tip: To export only the sketches on a transparent background (without the micrograph), uncheck the “Micrograph image” option and select PNG format.

8.7.3 Format and Resolution

Format options:

- **PNG:** Supports transparency; recommended for sketches-only export
- **JPEG:** Smaller file size; no transparency support

Resolution options:

- **1x:** Standard resolution (matches screen display)
- **2x:** High quality (recommended for presentations)
- **3x:** Very high quality
- **4x:** Maximum quality (for print or large displays)

8.8 Keyboard Shortcuts Summary

Table 2 summarizes all keyboard shortcuts for the sketch overlay system.

Table 2. Sketch Overlay Keyboard Shortcuts

Action	macOS	Windows/Linux
Enter sketch mode	`S`	`S`
Exit sketch mode	`Escape`	`Escape`
Pen tool	`1`	`1`
Marker tool	`2`	`2`
Eraser tool	`3`	`3`
Text tool	`4` or `T`	`4` or `T`
Undo	`Cmd+Z`	`Ctrl+Z`
Redo	`Cmd+Shift+Z`	`Ctrl+Shift+Z`

8.9 Tips and Best Practices

8.9.1 Organizing Your Annotations

- **Use separate layers for different purposes:** Create distinct layers for teaching notes, draft annotations, and final markup
- **Name layers descriptively:** Names like “Grain boundaries”, “Fracture traces”, or “Student questions” help you find annotations quickly
- **Use Hide All before presentations:** Hide all sketch layers, then selectively show only the layers relevant to your presentation

8.9.2 Choosing the Right Tool

- **Pen tool:** Best for precise work—tracing grain boundaries, marking small features, or creating detailed annotations
- **Marker tool:** Best for highlighting—drawing attention to regions, emphasizing features in presentations, or creating visual hierarchy
- **Text tool:** Best for labels and notes—mineral names, measurement values, or reminders for future analysis

8.9.3 Export Strategies

- **For presentations:** Export at 2x resolution with both micrograph and selected sketch layers
- **For different audiences:** Create separate exports with different layer combinations—one for students, another for colleagues
- **For overlay creation:** Export sketches only (without micrograph) as PNG with transparency, then composite in presentation software

8.9.4 Workflow Integration

- **Draft before finalizing:** Use sketches to draft polygon boundaries before creating formal spot annotations
- **Review workflow:** Collaborators can add sketch annotations for discussion before formal data entry
- **Teaching workflow:** Create a “Teaching” layer on frequently-used micrographs that can be shown or hidden as needed

9 Troubleshooting and FAQs

9.1 Getting Help

If you experience any problems or issues with StraboMicro, please use the `Help > Send Error Report` option to send issues directly to the StraboMicro developers. This interface automatically includes error logs which are essential for troubleshooting and debugging. Providing detailed error logs helps our team quickly identify and resolve issues.

For additional support resources, refer to Section 1.5 for contact information and office hours.

9.2 Common Issues and Fixes

1. **StraboMicro Crashes and Fails to Launch:** If StraboMicro crashes and subsequently fails to open, it is possible that the current project or cached data has become corrupted. In such cases, it may be necessary to delete the application's cached data.

   > To remove cached data, navigate to the `StraboMicro2Data` folder located in your `Documents` directory, and delete the cached project folders within it.

   Important: Before deleting any data, ensure you create a backup copy of the contents of the `StraboMicro2Data` folder to preserve any data that may be recoverable.

2. **Performance Issues with Large Images:** StraboMicro 2.0 uses an advanced tiled rendering system designed to handle large images (100MB+ TIFF files) efficiently. If you experience performance issues:
   - Clear the tile cache by navigating to your Application Support folder:
     - **macOS:** `~/Library/Application Support/StraboMicro2/tile-cache`
     - **Windows:** `%APPDATA%\StraboMicro2\tile-cache`
   - Delete the contents of the `tile-cache` folder
   - Restart StraboMicro2—tiles will be regenerated as needed

3. **Project Won't Open:** If a project fails to open or appears corrupted:
   - Try using `File > View Version History` to restore a previous version of your project
   - Check if the `.smz` file has been moved, renamed, or corrupted
   - Ensure the project file is not being accessed by another application

4. **Overlay Images Appear Pixelated:** StraboMicro uses a Level-of-Detail (LOD) rendering system that dynamically loads image resolution based on zoom level and screen coverage.
   - Zoom in closer to the image—higher resolution tiles will load automatically
   - Wait a moment for tile loading to complete (a loading indicator may appear)
   - Check if the original image was imported at full resolution

5. **Spots Not Appearing on Image:** If spots are not visible on your micrograph:
    - Ensure `View > Show Spot Labels` is enabled
    - Check if the spots are on a hidden layer in the layer panel
    - For spots on child micrographs, try `View > Show Recursive Spots` to display spots from associated images on the parent micrograph

9.3 Frequently Asked Questions (FAQs)

Do I have to manually update StraboMicro?

No, StraboMicro updates automatically. Updates are downloaded in the background and installed when you next launch the application. You will be notified when a new version has been installed.

Where is my project data stored?

Projects are stored in `~/Documents/StraboMicro2Data/`. Each project has its own folder containing the original images and a `project.json` file with all metadata and annotations. You can also export projects as `.smz` files for backup or sharing.

Can I recover a previous version of my project?

Yes! StraboMicro automatically saves version history for your projects. Use `File > View Version History` to see all saved versions and restore any previous state. This is useful if you accidentally delete data or want to revert changes.

How do I change between dark and light themes?

Go to `View > Theme` and select your preferred option:

- **Dark:** Dark background with light text
- **Light:** Light background with dark text
- **System:** Automatically follows your operating system's theme setting

What image formats are supported?

StraboMicro supports the following image formats:

- **TIFF:** Full support including large files (100MB+) with progressive loading
- **JPEG:** Standard support
- **PNG:** Standard support
- **BMP:** Standard support

Large TIFF files are handled efficiently through the tiled rendering system, allowing smooth navigation even with very large micrographs.

Can I work offline?

Yes, all core features of StraboMicro work offline. Projects are saved locally on your computer. The only features that require an internet connection are:

- Uploading projects to StraboSpot.org
- Downloading projects from StraboSpot.org
- Sending error reports
- Checking for updates

How do I export my micrographs with annotations?

There are several export options available:

- `File > Export All Images` for batch export of all micrographs with annotations
- Use the download button on individual micrographs in the sample tree for single-image export
- SVG vector export is available for annotations that need to be scaled or edited in vector graphics software

What's the difference between spots and sketches?

Spots and sketches serve different purposes in StraboMicro:

- **Spots:** Scientific annotations with structured metadata. Spots can contain detailed information such as mineralogy, fabric characteristics, deformation features, and other geoscientific data. Spots are designed for rigorous documentation and can be uploaded to StraboSpot.org.
- **Sketches:** Freeform drawings for informal markup, teaching, or highlighting features. Sketches include tools like pen, highlighter, and shapes. They are useful for quick annotations, presentations, or educational purposes but do not contain structured metadata.

How do I use keyboard shortcuts in Quick Edit mode?

Quick Edit mode provides efficient keyboard-driven editing of spot data:

- **Arrow keys:** Navigate between spots on the current micrograph
- **Letter keys (A–Z):** Quickly assign minerals from the mineral list
- **Number keys (1–9):** Apply saved presets to the current spot
- **Enter:** Save changes and advance to the next spot
- **Escape:** Exit Quick Edit mode

See Section 7 for detailed information on Quick Edit mode.

Can multiple people work on the same project simultaneously?

StraboMicro does not support simultaneous collaborative editing of the same project. However, you can share projects with collaborators:

- Use the Share feature to give others a copy of your project
- Each copy is independent and changes are not synchronized
- For collaborative workflows, consider dividing work by sample or micrograph and merging results later

Why should I update StraboMicro?

Updating software is a simple but powerful way to protect your system, enjoy new features, and ensure smooth operation. Updates may include:

- Bug fixes and stability improvements
- New features and enhancements
- Performance optimizations
- Security patches

Ignoring updates can lead to compatibility issues and may prevent you from opening projects created with newer versions.

10 Appendices

10.1 Glossary of Terms

Abbreviations (Alphabetical)

- **ACOM** – Automated Crystal Orientation Mapping
- **ADF** – Annular Dark Field
- **AFM** – Atomic Force Microscopy
- **BSE** – Backscattered Electron
- **CBED** – Convergent Beam Electron Diffraction
- **CL** – Cathodoluminescence
- **ECCI** – Electron Channeling Contrast Imaging
- **EBSD** – Electron Backscatter Diffraction
- **EDS** – Energy Dispersive X-ray Spectroscopy
- **EELS** – Electron Energy Loss Spectroscopy
- **FIB** – Focused Ion Beam
- **FSE** – Forescattered Electron
- **FTIR** – Fourier Transform Infrared Spectroscopy
- **HAADF** – High-Angle Annular Dark Field
- **IPF** – Inverse Pole Figure (e.g., IPF-X, IPF-Y, IPF-Z)
- **LACBED** – Large Area Convergent Beam Electron Diffraction
- **NBD** – Nano Beam Diffraction
- **PI** – Principal Investigator
- **SAED** – Selected Area Electron Diffraction
- **SE** – Secondary Electron
- **SEM** – Scanning Electron Microscopy
- **STEM** – Scanning Transmission Electron Microscopy
- **TEM** – Transmission Electron Microscopy
- **TKD** – Transmission Kikuchi Diffraction
- **WDS** – Wavelength-Dispersive X-ray Spectroscopy

StraboMicro Application Terms

- **Dataset** – A collection of related samples within a project

- **Micrograph** – A digital image captured through a microscope
- **Overlay** – An associated micrograph placed on top of a reference image
- **Project** – The top-level container for all data in StraboMicro
- **Sample** – A physical specimen containing one or more micrographs
- **Sketch Layer** – A transparent drawing layer for annotations
- **Spot** – A user-defined region of interest on a micrograph (point, line, or polygon)
- **.smz File** – StraboMicro project archive format (ZIP-based)

10.2 Keyboard Shortcuts

StraboMicro provides extensive keyboard shortcuts for efficient workflow. On macOS, use `Cmd`; on Windows/Linux, substitute `Ctrl` for `Cmd`.

General Shortcuts

Shortcut	Action
`Cmd+N`	New Project
`Cmd+O`	Open Project
`Cmd+S`	Save Project
`Cmd+Shift+S`	Save Project As
`Cmd+Z`	Undo
`Cmd+Shift+Z`	Redo
`Cmd+Q`	Quit Application

Navigation

Shortcut	Action
`Click and Drag`	Pan canvas
`Scroll / Pinch`	Zoom in/out

View Options

Shortcut	Action
`Cmd+Shift+L`	Toggle Spot Labels
`Cmd+Shift+O`	Toggle Micrograph Outlines
`Cmd+Shift+R`	Toggle Recursive Spots (show spots from child micrographs)

Drawing Tools

Shortcut	Action
`V`	Select tool (default selection mode)
`P`	Point spot tool
`L`	Line spot tool
`G`	Polygon spot tool
`M`	Measure tool

Spot Editing

Shortcut	Action
`Double click`	Confirm geometry (complete polygon/line)
`Escape`	Cancel editing

Sketch Mode

Shortcut	Action
`S`	Enter sketch mode
`Escape`	Exit sketch mode
`1`	Pen tool
`2`	Marker tool
`3`	Eraser tool
`4` or `T`	Text tool

Quick Edit Mode

Quick Edit Mode provides rapid data entry across multiple spots. Activate with `Cmd+Shift+Q`.

Shortcut	Action
`Arrow Keys`	Navigate between spots
`A--Z`	Assign mineral using single-letter shortcut
`1--9`	Apply preset to selected spot(s)
`Enter`	Advance to next spot
`Shift+Drag`	Lasso select multiple spots

Advanced Tools

Shortcut	Action
`Cmd+Shift+Q`	Open Quick Edit Mode
`Cmd+Shift+P`	Open Quick Apply Presets panel
`Cmd+Shift+G`	Open Grain Size Analysis tool

Reordering Items

Use these shortcuts when an item is selected in the Sample Tree or Spot List:

Shortcut	Action
`Cmd+Up`	Move item up in list

Shortcut	Action
`Cmd+Down`	Move item down in list

10.3 Data Schema Overview

Project Hierarchy

StraboMicro organizes data in a hierarchical structure:

```
Project
  |-- Dataset
  |     |-- Sample
  |           |-- Micrograph (Reference Image)
  |           |     |-- Spot (Point, Line, or Polygon)
  |           |     |-- Associated Micrograph (Overlay)
  |           |           |-- Spot
  |           |           |-- Associated Micrograph (nested)
  |           |                 |-- ...
  |           |-- Micrograph
  |                 |-- ...
  |-- Dataset
        |-- ...
```

- **Project**: Top-level container with metadata (name, description, PI, dates)
- **Dataset**: Logical grouping of related samples
- **Sample**: Physical specimen with associated micrographs
- **Micrograph**: Digital image with spatial registration data
- **Spot**: Region of interest with geological observations

.smz File Format

Projects are saved as `.smz` files, which are ZIP archives containing:

```
project.smz (ZIP archive)
  |-- project.json          # All project metadata and structure
  |-- images/
  |     |-- <uuid>.tif      # Original micrograph images
  |     |-- <uuid>.tif
  |     |-- ...
  |-- thumbnails/
  |     |-- <uuid>.png      # Generated thumbnail images
  |-- sketches/
  |     |-- <uuid>.png      # Sketch layer images
  |-- cache/                # (Optional) Pre-generated tile cache
        |-- <hash>/
              |-- metadata.json
              |-- tile_0_0.png
              |-- ...
```

project.json Structure

The `project.json` file contains the complete project data in JSON format:

```
{
  "formatVersion": "2.0",
  "projectId": "<uuid>",
  "name": "Project Name",
  "description": "...",
  "created": "2024-01-15T10:30:00Z",
  "modified": "2024-01-20T14:45:00Z",
  "datasets": [
    {
      "datasetId": "<uuid>",
      "name": "Dataset Name",
      "samples": [
        {
          "sampleId": "<uuid>",
          "name": "Sample Name",
          "micrographs": [...],
          "properties": {...}
        }
      ]
    }
  ],
  "preferences": {...}
}
```

Compatibility

StraboMicro 2.0 maintains backward compatibility with legacy StraboMicro `.smz` files. When opening a legacy file, it will be automatically upgraded to the new format. A backup of the original file is created before migration.

10.4 Licensing and Attribution

StraboMicro2 License

StraboMicro2 is released under the MIT License:

> Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the “Software”), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:
>
> The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.
>
> THE SOFTWARE IS PROVIDED “AS IS”, WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

Third-Party Attributions

StraboMicro2 incorporates the following open-source libraries and models:

Component	License	Description
FastSAM	Apache 2.0	Fast Segment Anything Model used for AI-powered grain boundary detection. Developed by CASIA IVA Lab.
Konva.js	MIT	High-performance 2D canvas library used for image rendering and interactive drawing tools.
Sharp	Apache 2.0	High-performance Node.js image processing library used for TIFF decoding, tile generation, and image manipulation.
Electron	MIT	Framework for building cross-platform desktop applications with JavaScript, HTML, and CSS. Developed by GitHub/OpenJS Foundation.
React	MIT	JavaScript library for building user interfaces. Developed by Meta.
Zustand	MIT	Lightweight state management library for React applications.

Component	License	Description
SQLite	Public Domain	Embedded SQL database engine used for mineral and lithology reference data.

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For more information about StraboSpot and related tools, visit strabospot.org.