



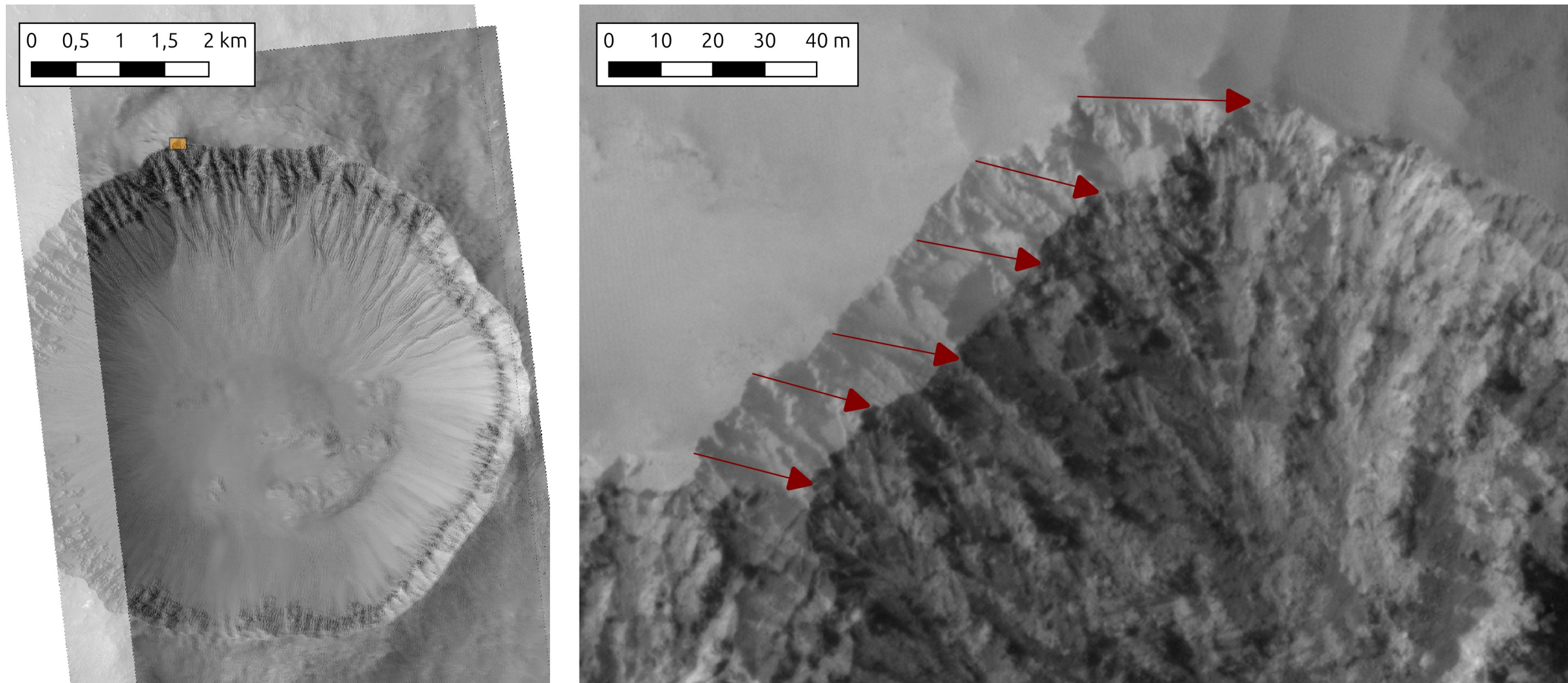
HiLiner - High resolution image aLi(g)ner

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Motivation

Studying active processes on Mars relies on comparing overlapping HiRISE images taken at different dates. Unfortunately, at such a high resolution (due to uncertainties in spacecraft pointing and other reasons such as emission angle differences) it is impossible to achieve perfect alignment between the images based on georeferencing alone.



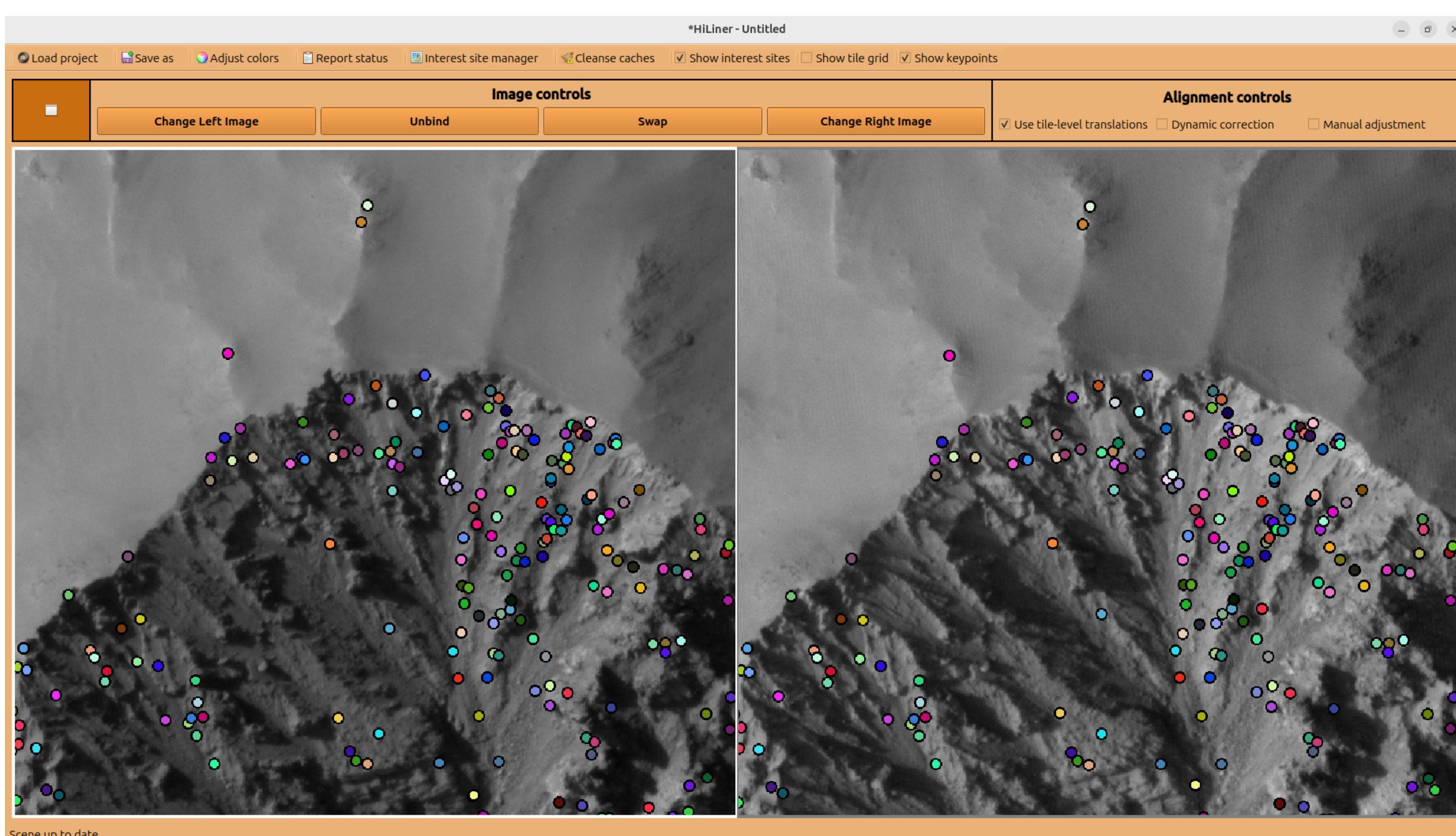
Left: Two HiRISE images of the same crater overlain as semi-transparent (PSP_003939_1420_RED on top of ESP_032078_1420_RED). At this scale, georeferencing seems to be sufficient to align the images. The brown rectangle indicates the scope of the image on the right. Right: At a scale of tens of meters, the misalignment becomes apparent, making it impossible to understand the differences between the two images. Arrows drawn manually indicate corresponding details of the crater rim in the two images.

HiLiner - project setup and viewing modes

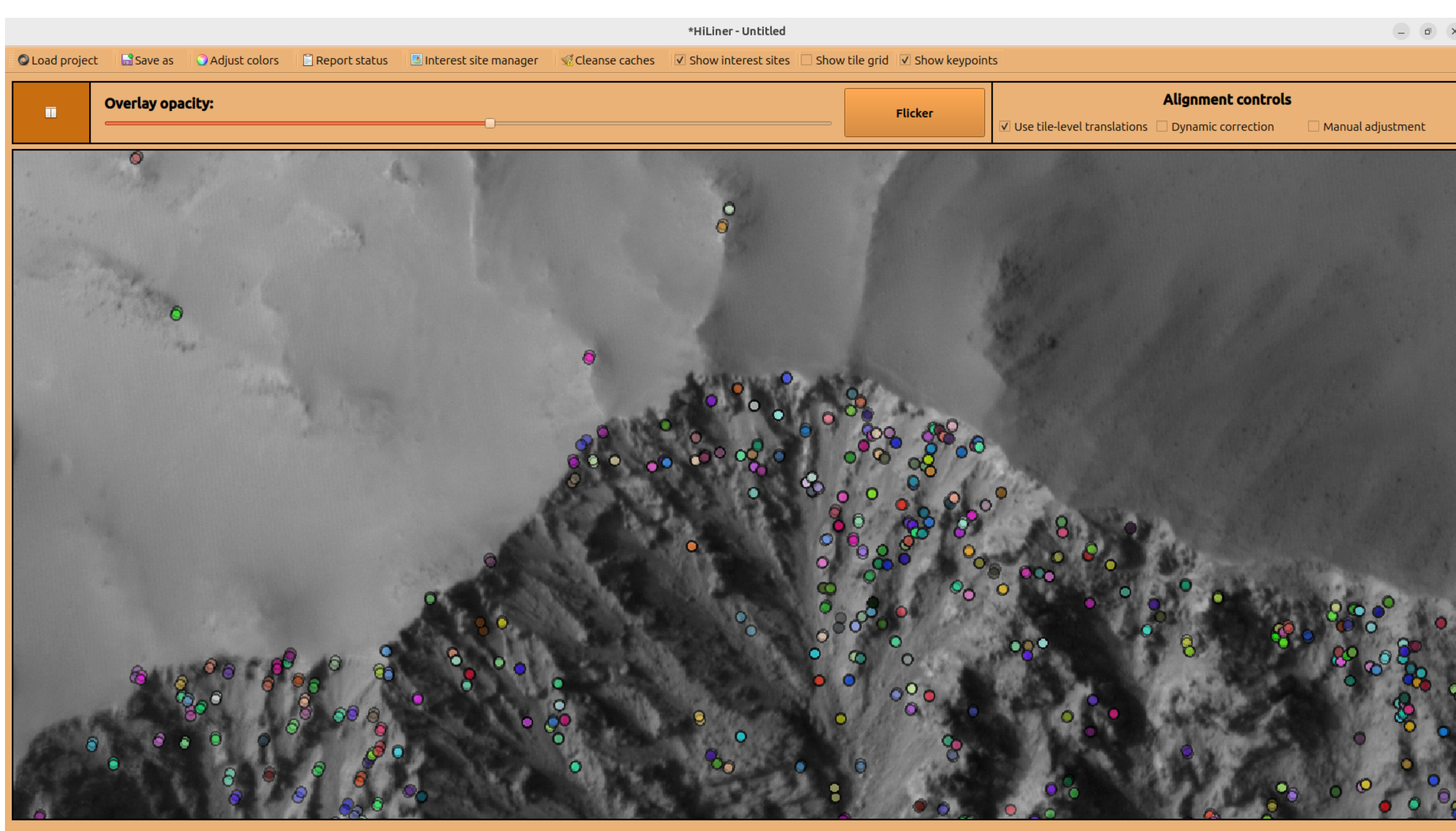
We present a new lightweight geospatial desktop application *HiLiner*, with a core objective of improving the alignment between HiRISE images using computer vision. At a start of a new project two actions are performed in the background:

- **Deep zoom pyramid generation** for each of the two images uploaded
- **Recursive keypoint search** with the SIFT algorithm between overlapping tiles at each zoom level, as soon as the user presses the **Bind** button

Outputs are cached for future use, and the pair of images can be inspected in two ways:



Side by side mode with synchronous panning and zooming if the images are bound. Colored dots (optional overlay) symbolize different keypoints used to align the images.

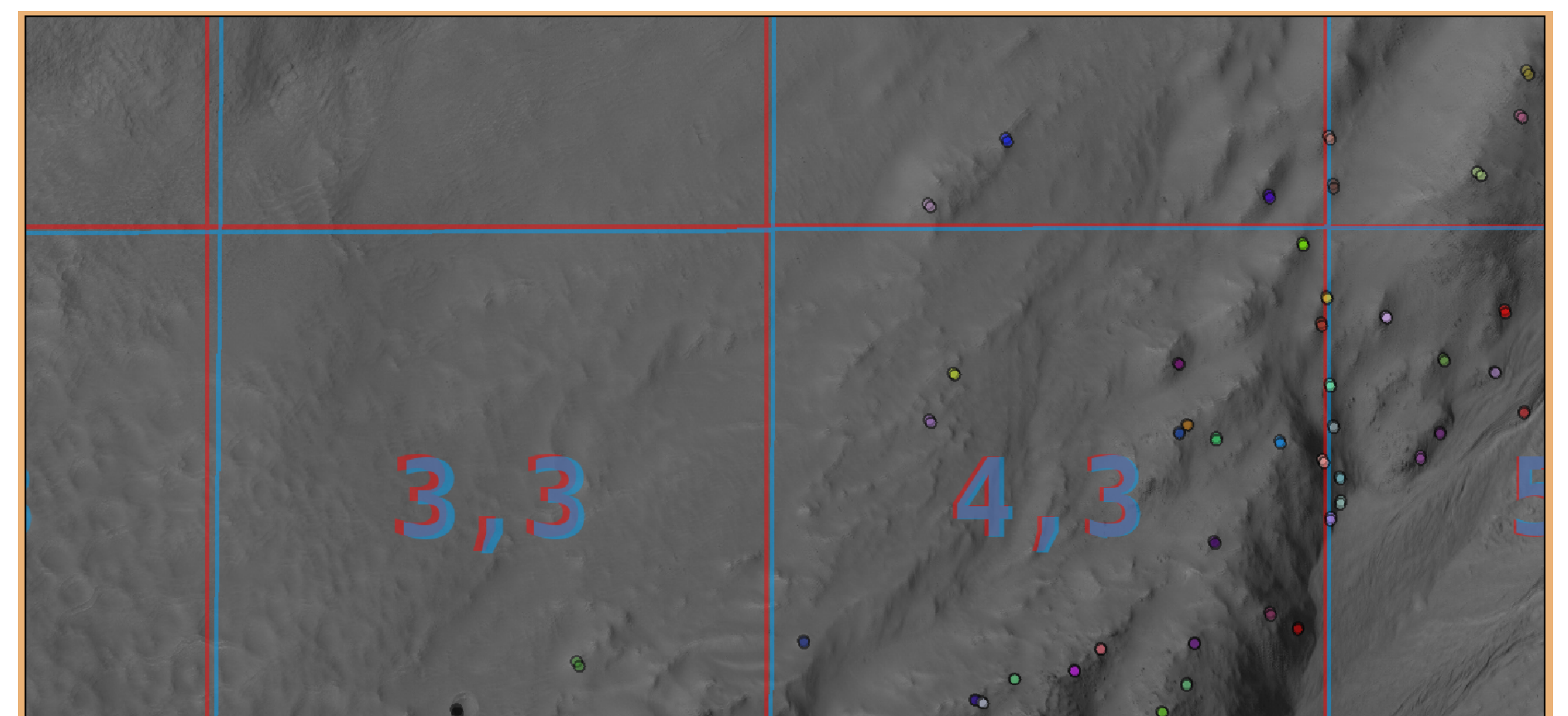


Overlay mode (images must be bound). There is an **opacity** slider and it is also possible to activate **Flicker**, which will alternate between one image and the other with panning and zooming still active.

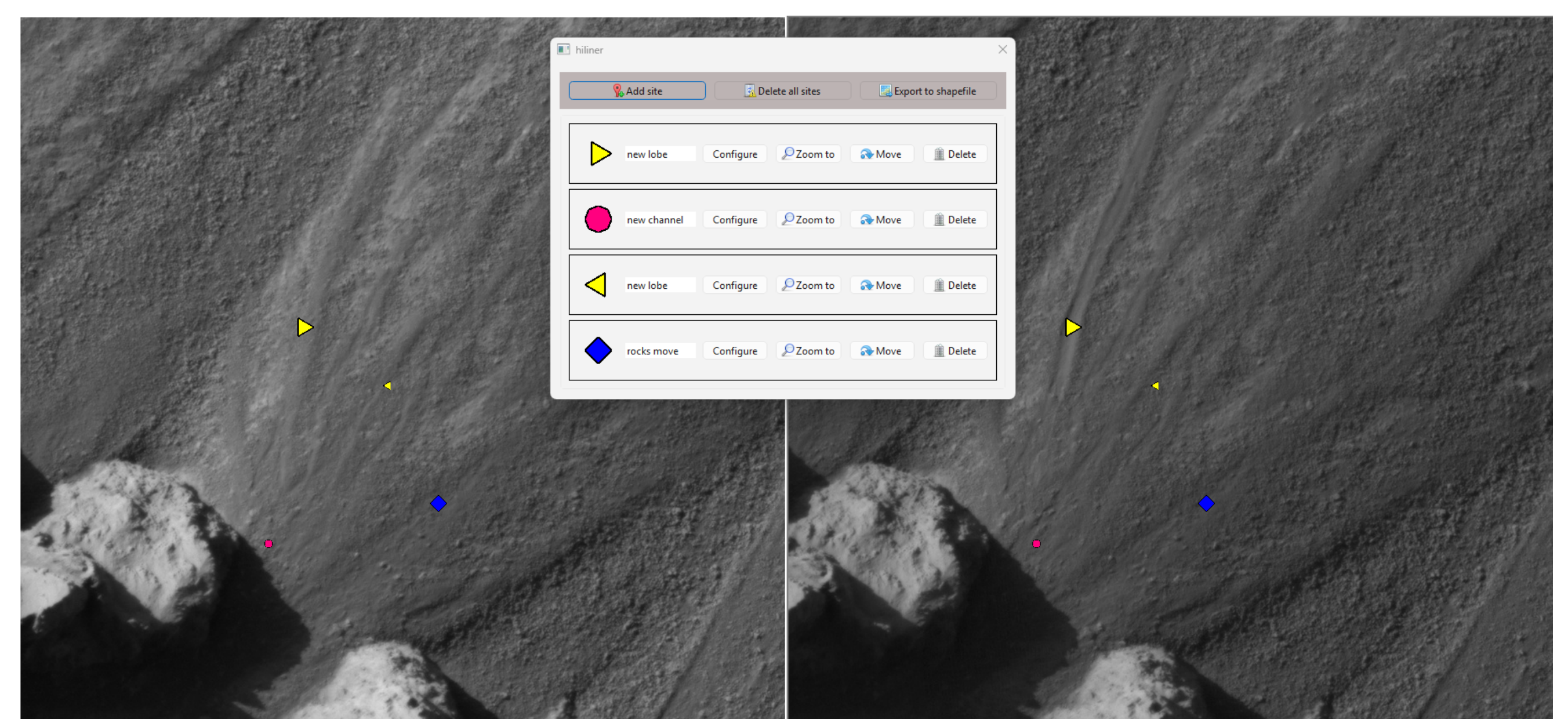
HiLiner - functionalities

The following capabilities exist in the *HiLiner* software:

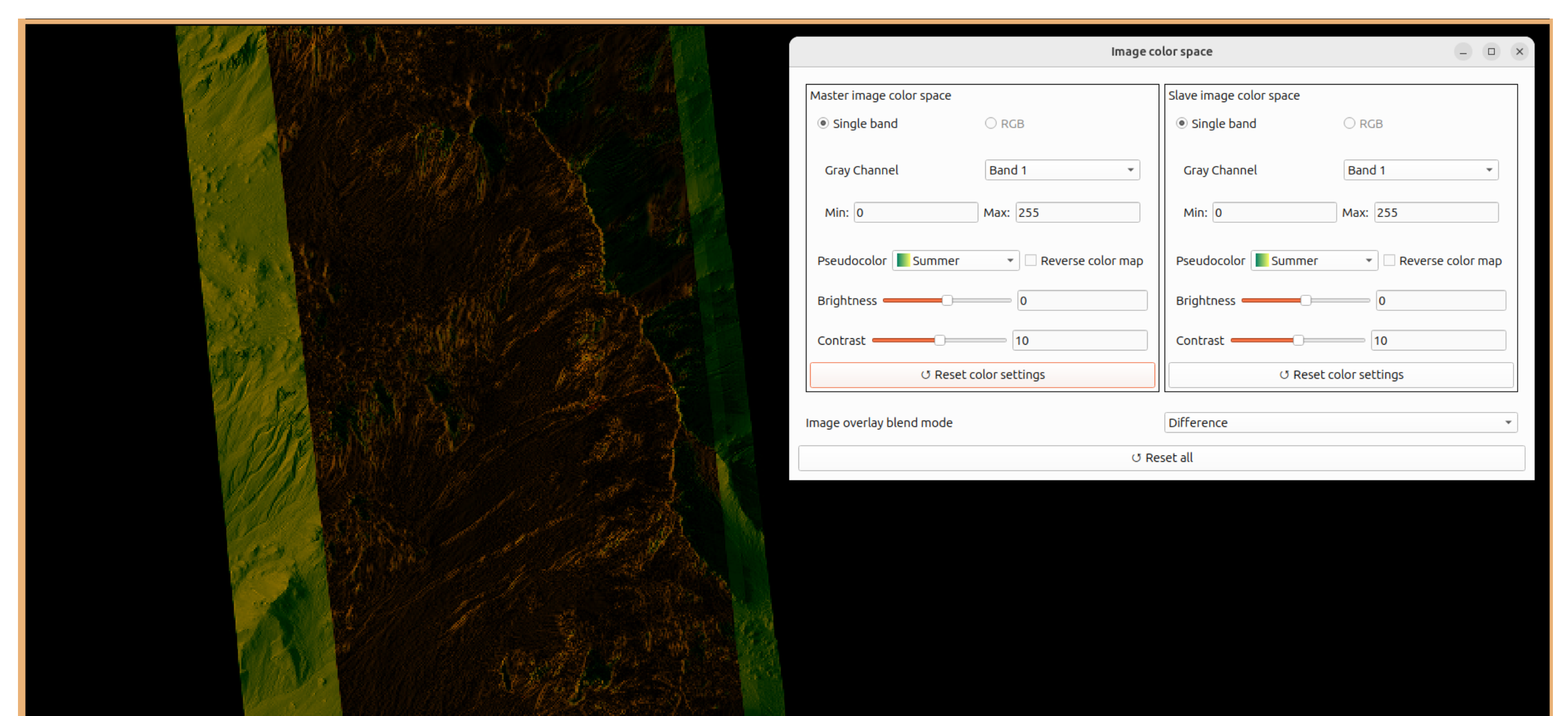
- Alignment toggles:
 - **Use tile-level translations** - if active, uses precomputed tile-level keypoints and shifts, otherwise georeferencing only
 - **Dynamic correction** - if active, performs improved on-the-fly alignment by running the SIFT algorithm on the current view and applying a best fit affine transform
 - **Manual adjustment** - If active, the user can refine alignment manually by dragging the image or using arrow keys for finer movements
- Marking **sites of interest** and exporting them to a shapefile
- Basic **color space** manipulations
- **Status report** of the current position and alignment specs
- **Saving a project** to reopen at the same location, zoom and display settings



Dynamic alignment mode. Showing the keypoints used for on-the-fly alignment and tile grids - notice how the blue grid of the overlying image is distorted due to affine transform).



Example project with 4 sites of interest, corresponding to genuine changes spotted in Karratha Crater thanks to the software. They can be added (from **Interest site manager** or **Ctrl + A**) and explored in either viewing mode, and it is possible to configure the name as well as symbol appearance for each site. Locations and names can be also exported to a shapefile for further analysis in *QGIS*



In this example, both images have the same color settings (pseudocolor and contrast), and the overlay mode is **Difference**. This could be a way to look out for changes, however at a larger scale it is more sensitive to illumination differences and image distortions.

Installation



Scan the QR code and clone the *GitLab* repository, then proceed depending on the operating system:

- **Linux** - run the installation script which allows integration as a desktop app
- **Windows / Mac OS** - run from *Anaconda Prompt* in a custom environment