Hands-on guide for 3D image creation for geological purposes

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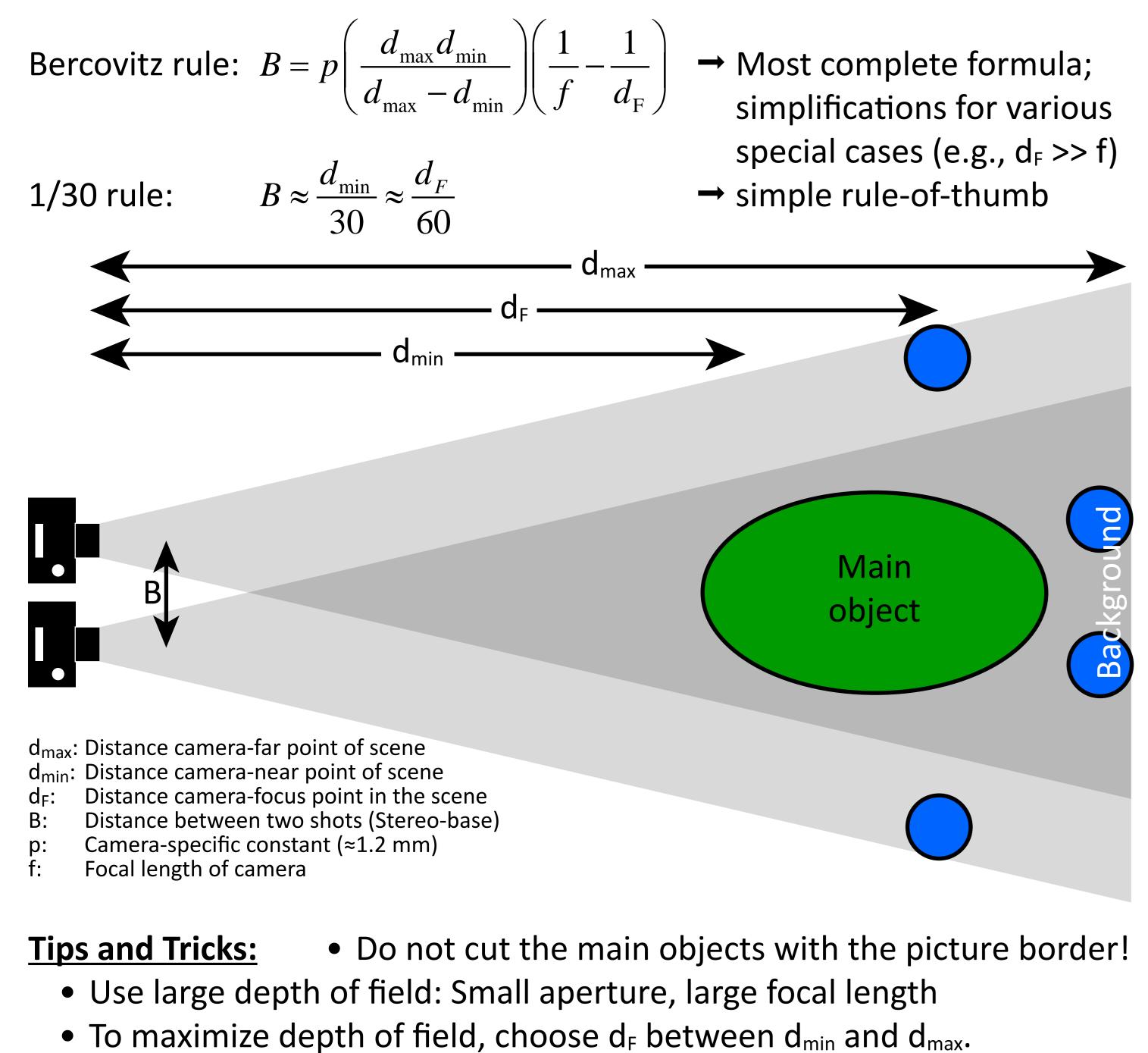Geological Institute, ETH Zurich, Switzerland
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Introduction

3D geological structures are better understandable if viewed in 3D. 3D models can be created, manipulated, and looked at from all sides on a screen (e.g., photogrammetry or laser scanning data). 3D visualizations for publications or conference posters are more challenging as they have to live in a 2D-world. Perspective views of 3D models do not fully transmit the "feeling and depth of the third dimension"; but this feeling is desirable for a better examination and understanding of a structure under consideration.

A stereoscopic image is in fact two images of the same object taken from two offset viewpoints. Through special glasses each image is seen only by one eye, which together lead to the "3D effect". One simple type of stereoscopic image is the anaglyph, i.e. two overlain images saturated in red and cyan, respectively. The image is viewed through red-cyan glasses.

How to take the pictures

Shoot two <u>parallel</u> pictures with distance B (the Stereo-base)

Bercovitz rule: $B = p \left(\dfrac{d_{max} d_{min}}{d_{max} - d_{min}} \right) \left(\dfrac{1}{f} - \dfrac{1}{d_F} \right)$ → Most complete formula; simplifications for various special cases (e.g., $d_F \gg f$)

1/30 rule: $B \approx \dfrac{d_{min}}{30} \approx \dfrac{d_F}{60}$ → simple rule-of-thumb

d_{max}: Distance camera-far point of scene
d_{min}: Distance camera-near point of scene
d_F: Distance camera-focus point in the scene
B: Distance between two shots (Stereo-base)
p: Camera-specific constant (≈1.2 mm)
f: Focal length of camera

Tips and Tricks:
• Do not cut the main objects with the picture border!
• Use large depth of field: Small aperture, large focal length
• To maximize depth of field, choose d_F between d_{min} and d_{max}.
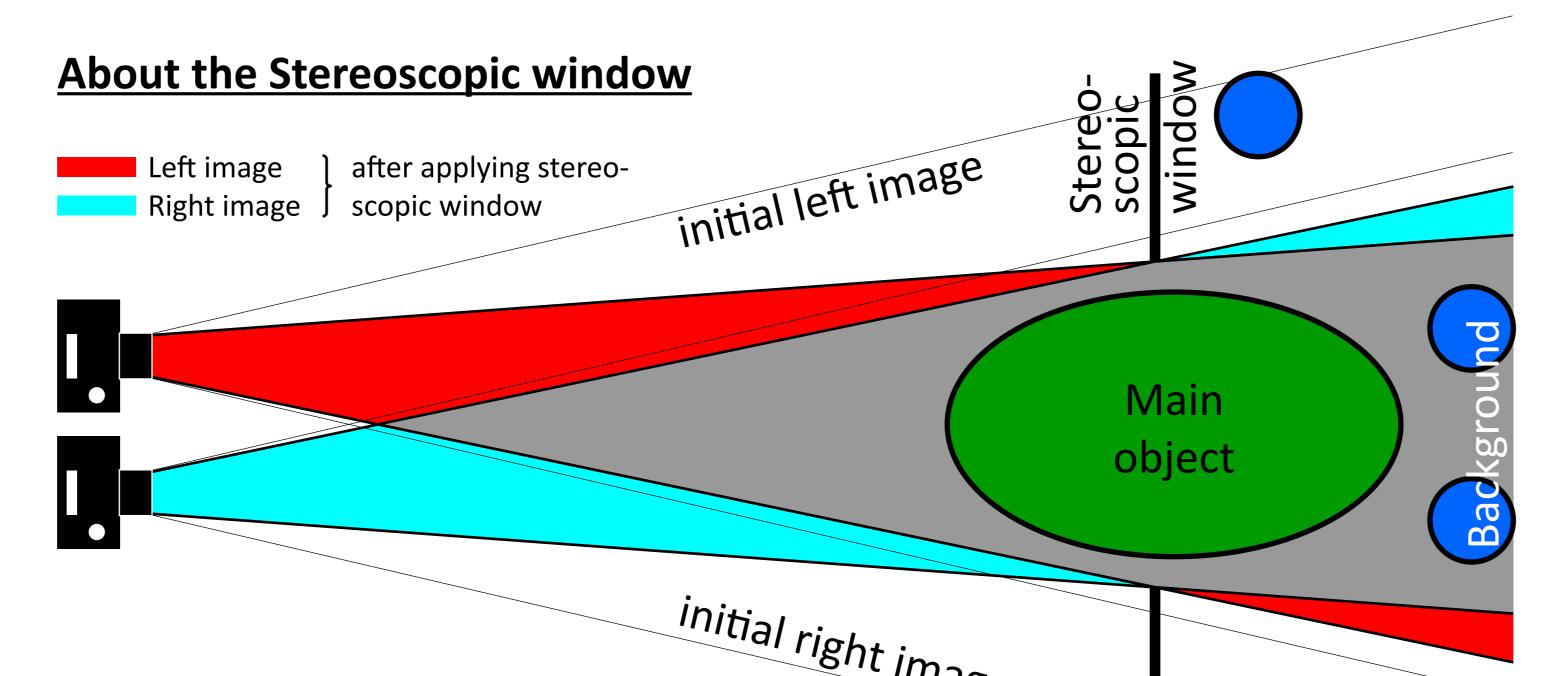• Avoid moving objects if using only one camera to take the two images.

Creating the 3D image

Various software is available for creating 3D images (many for free). We use the free software Stereophotomaker. All programs can do the following:
• Import left and right image
• Pattern recognition to align the two images
• Color the two images in red (left) and cyan (right)
• Apply the stereoscopic window and cut the two images accordingly
• Creating anaglyph (red-cyan image-file) or side-by-side images

About the Stereoscopic window

Left image | after applying stereo-
Right image | scopic window

It is like a real window:
• Left image shows more on the right
• Right image shows more on the left (see figure above)

Stereoscopic window = plane of 2D display (e.g., poster board). Objects behind it will appear behind display; objects in front will stick out of display. Make sure that sticking-out objects are not cut by the picture frame. Stereoscopic window can be defined by horizontaly shifting the two images.

Software screenshots

Gray anaglyph display:
Using the arrow keys, the two images can be shifted horizontally with respect to each other. By doing this, the stereoscopic window moves down and up in the third dimension.

Open, Save | Display choices | Auto and manual adjustment

Side-by-side display: Note the left image shows more on the right and vice versa.
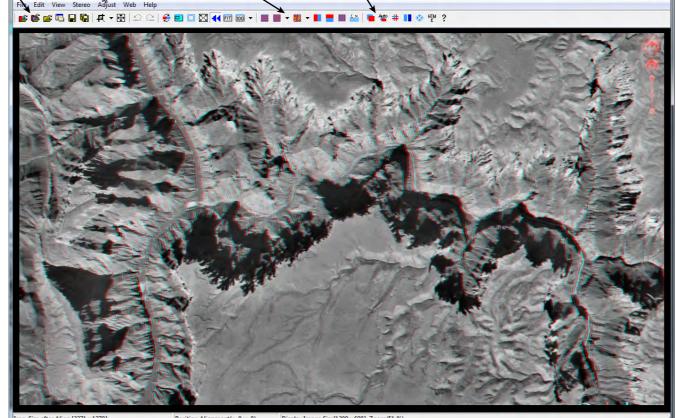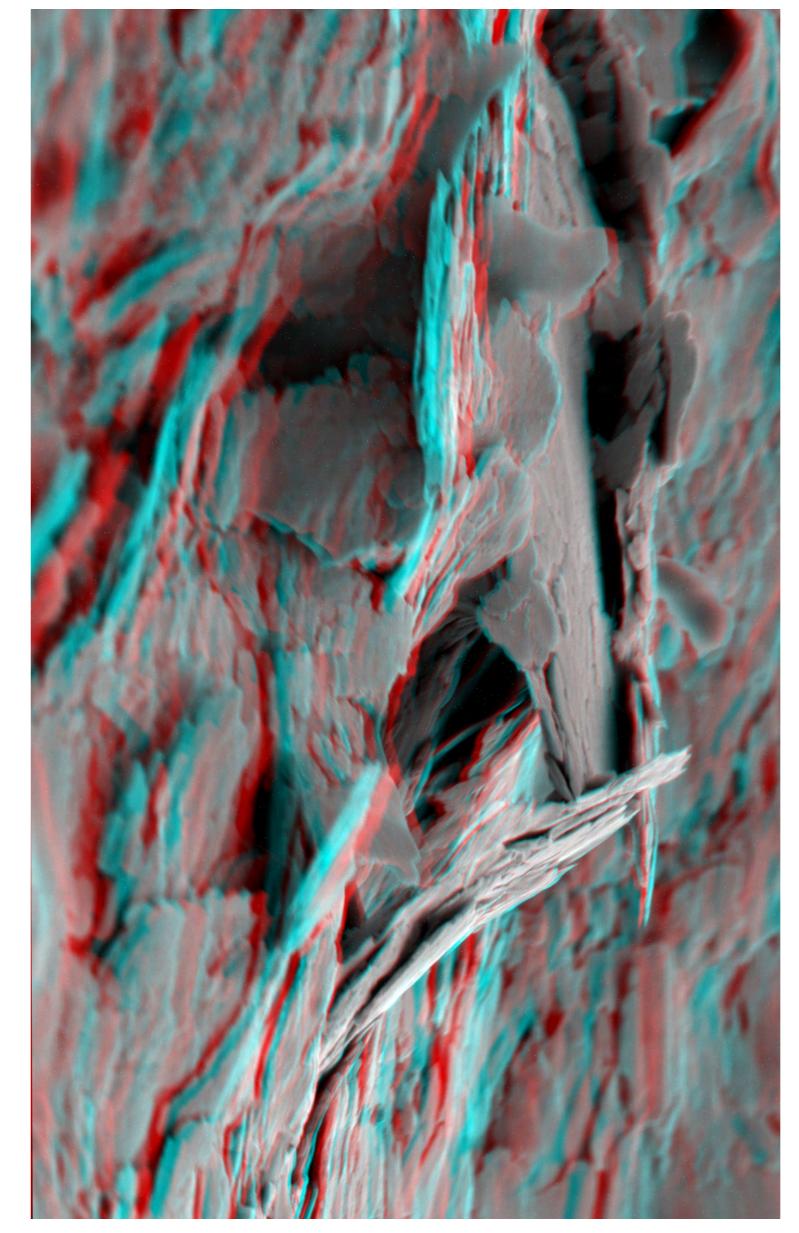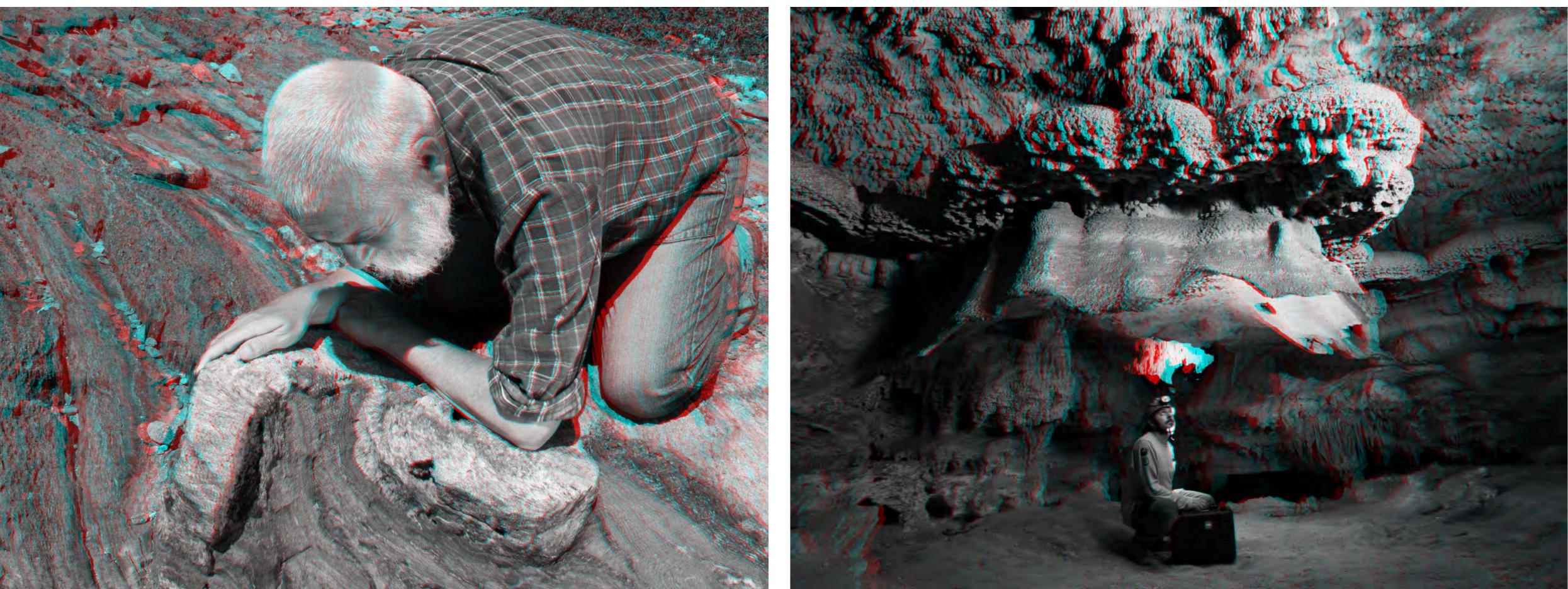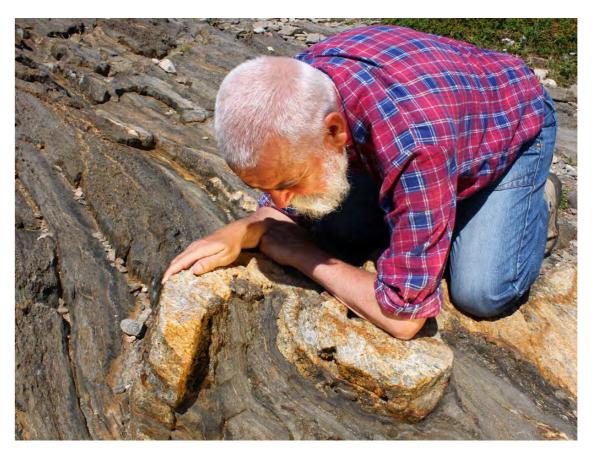

Examples

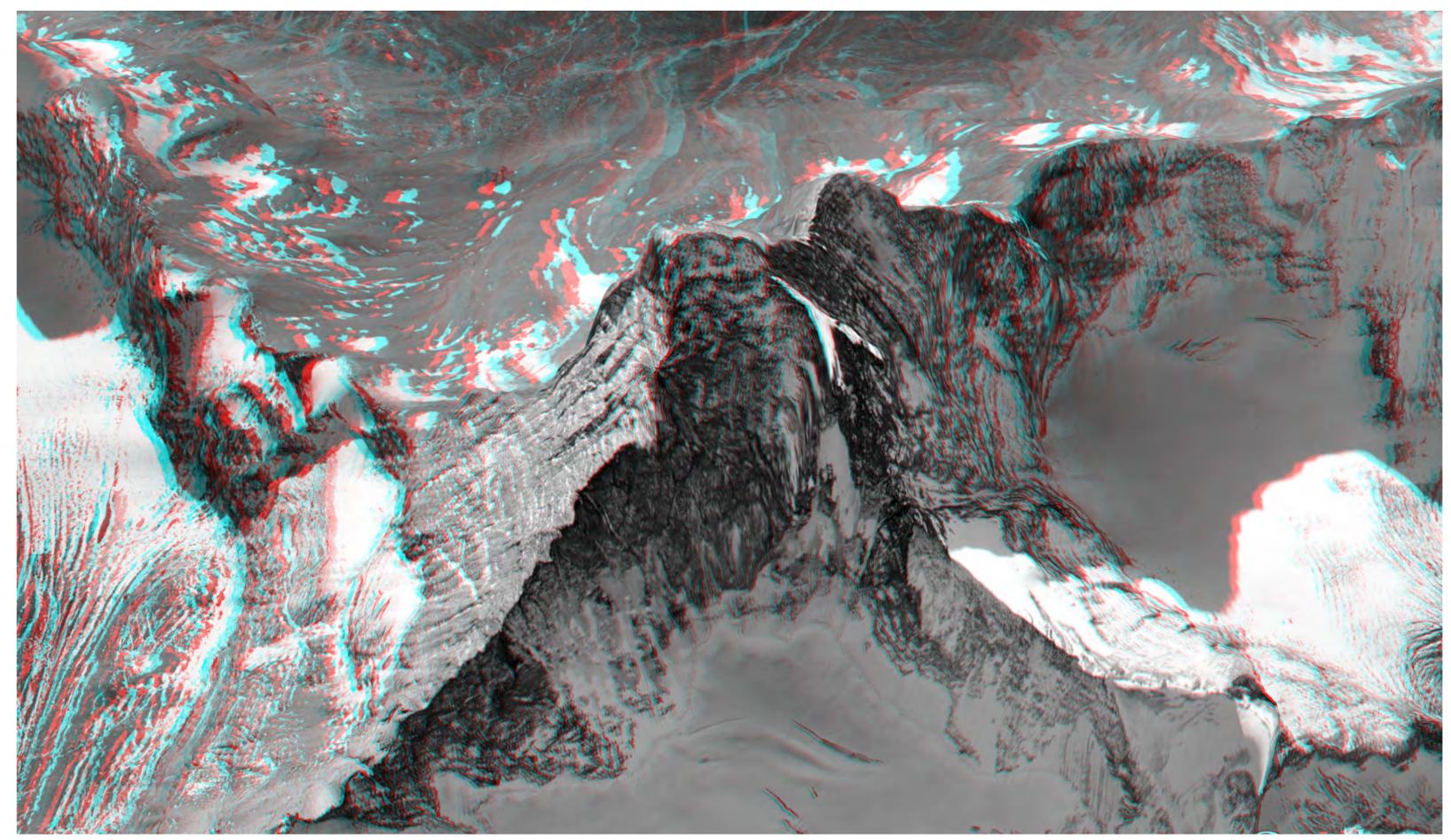*Scanning Electron Microscope (SEM) image of phyllosilicates in an artificial shale.*

Jean-Pierre Burg studying a folded pegmatite dike in Cap de Creus, Spain. Note how his head sticks out of the poster.

Curious umbrella-shaped calcite speleothem in the Santa Catalina Cave, Cuba (www.lasalle3d.com)

Same picture as above as plain 2D image and not as anglyph for comparison. Note that the 3D depth of the fold can almost not be estimated.

Matterhorn on the border between Switzerland and Italy as seen in Google Earth. The software Stereophotomaker provides a direct link to and import of left-right images from Google Earth.

Remarks / Discussion

3D images are easy and cheap to create even with standard photographic equipment, but some rules have to be followed when taking the picutres.

Advantages / Disadvantages of Anaglyphs

+ Anaglyphs can be printed on paper, as opposed to other viewing methods such as polarized light (cinema) or shuttering glasses (3D TV).

+ Stereoscopic images better represent the 3D depth structure than simple 2D photographs, and even allow for quantitative 3D analysis.

− Anaglyphs have difficulties to represent colors. It is possible to create color-anaglyphs, but gray anaglyphs are usually of higher quality.

− Anaglyphs often contain ghosts, i.e. left eye sees things that only the right eye should see and vice versa. This can be due to low-quality stereoscopic glasses or badly shot images. Ghost are diffcult to avoid.

→ Drawbacks can be solved using side-by-side images and a 3D screen.

Links
Software for creating anaglyphs:
• Stereophotomaker by Masuji Suto and David Sykes: http://stereo.jpn.org/eng/stphmkr
• AnaBuilder by Etienne Monneret and Didier Leboutte: http://anabuilder.free.fr
• Anaglyph Maker by Takashi Sekitani: http://www.stereoeye.jp/software/index_e.html
Software for calculating Stereo-base (both are using the assumption $d_F \gg f$)
• BaseCalc software by Pierre Meindre: http://pmeindre.free.fr/basecalc.html
• Stereo Calc software by Takashi Sekitani: http://www.stereoeye.jp/software/sbcalc_e.html
App for iOS 6 devices (iPad, iPhone): i3DSteroid by Spmaker