

# The Peakfinder Program

## A Tool for Archaeoastronomy

A Practice-Oriented Guide

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## Version 2.0:

Revision of the document after the upgrade of the Peakfinder program 2021, with change of the menu structure. In addition, for the panorama display the settings allow now to switch from (default) perspective- to cylinder projection, which however, has no influence on the measurement values required here. At the release of this doc version 2.1, the feature of the sun or moon trajectory, which has been extended as a dotted line between the local and mathematical horizon, was still under construction.

## 1 What is "Peakfinder"?

In the past, on mountain hikes, discussions about the identification of peaks were on the order of the day. Today, this problem is smartly solved by the Peakfinder App [2], which can be installed on any smartphone for a very small fee. The software works nearly worldwide, completely offline, and is based on digital terrain models, as well as an extensive summit directory. This application was developed by Fabio Soldati, Swiss computer scientist ZHAW, and well-known outdoor expert. The picture from the Peakfinder website shows him in 2014 on the Appalachian Trail [1].

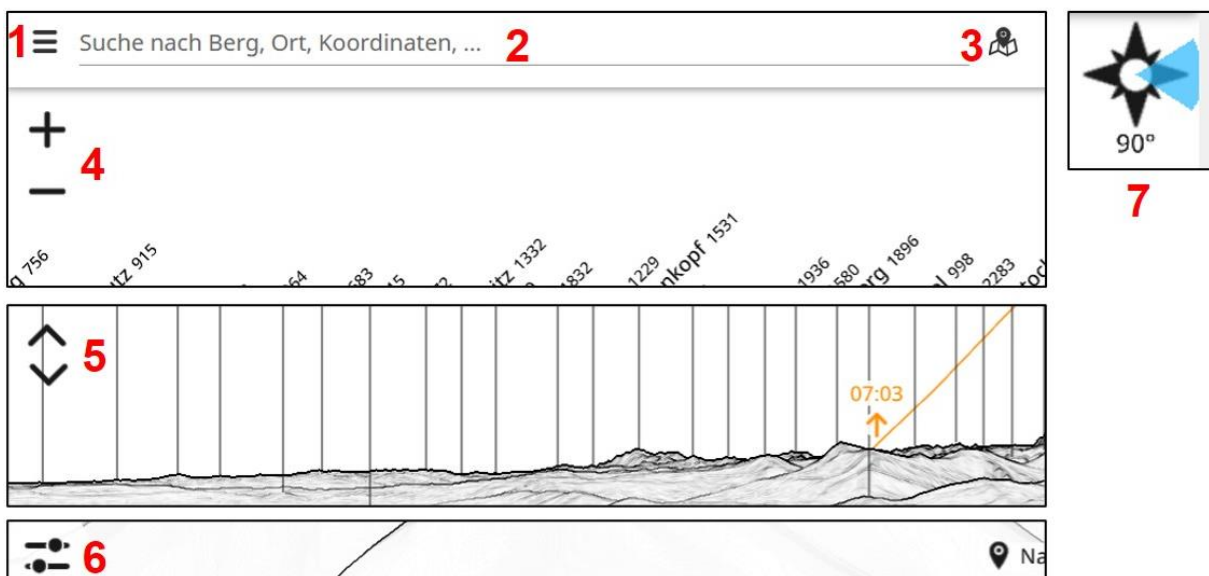


Note: The *peakfinder.org* website must not be confused with *peakfinder.com*, which just shows a Canadian peak directory.

## 2 Peakfinder for the PC - The basic functions

For the PC, there exists an Internet-based online version [1], which can even be accessed free of charge. After calling the website, a display of the horizon with labeled peaks appears, based on a certain location.

### 2.1 The most important control elements



- 1: Calls up the menu, among other things for location and settings
- 2: Direct input of a mountain, place or coordinates
- 3: Direct access to the location map
- 4: Zoom, alternatively adjustable by mouse wheel
- 5: Setting of the camera height above ground
- 6: Input date and local time (CET, CEST) for sun and moon trajectories
- 7: Currently displayed panoramic sector

## 2.2 Setting of the location

The location for the panorama can be adjusted by three ways, either within the settings (1) or with direct input into the header bar (2).

- on a map
- by a summit directory
- with input of the coordinates

With the mouse pointer you can move the section of the 360° panorama and zoom with the mouse wheel. So far, a rough overview of the basic functions, which are also used by the "normal users". For more information, see in the program under "Support".

## 3 Peakfinder and Archaeoastronomy

### 3.1 Introduction

On the initiative of the Archaeological Institute of the University of Basle around Rita Gautschy, the Peakfinder software was extended by Fabio Soldati within the framework of a project with various functions, which are now available for archaeoastronomical investigations and have proven to be as extraordinarily useful. Many thanks to Fabio Soldati for this very helpful program!

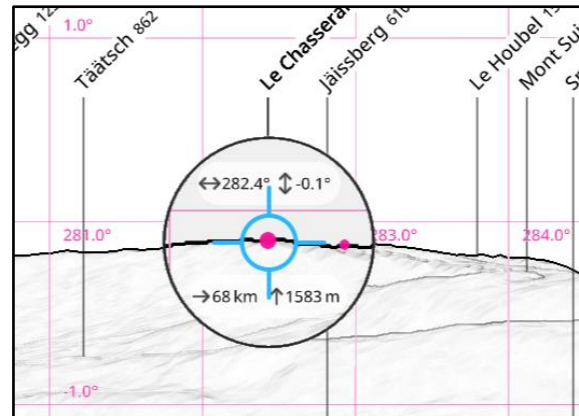
Also, the author of this paper was asked by Christine Hatz in March 2016 for corresponding wishes resp. inputs. This institute plays a pioneering role, as it also offers lectures and exercises on archaeoastronomy [3]!

These subsequently implemented additional functions can be accessed in the Peakfinder program under the "Settings" (1). Here the solar and/or lunar trajectory, as well as the grid, corresponding to a perspective projection, can be displayed. Tests of the author with practical applications showed that such analyses, at least in Switzerland, are sufficiently accurate for archaeoastronomical applications. Thus, the local horizon, even for today's built-up or forested sites, can be conveniently displayed and measured in a good approximation. Deviations from the results, which were tested with the methods and algorithms according to [4] and [5], turned out to be very marginal. However, it must be taken into account that – because the program is based on a terrain model – the horizon is logically represented without an anyway hypothetical forestation. This influence decreases of course with increasing distance. Furthermore, depending on the geological conditions, erosion processes and landslides can cause (mostly) a lowering of the horizon line.

### 3.2 Azimuth and elevation angle of a horizon point

To assess a possible archaeoastronomical relevance of a measured azimuth, the comparison with a relevant "standard catalog" for such directions is necessary. This must have been calculated for this latitude and the mathematical horizon [4], [5]. For an analysis, therefore, the measured azimuth must first be reduced from the observed local horizon to the mathematical horizon with elevation angle  $0^\circ$ . For this, however, the elevation angle of the local horizon at the measured azimuth must be known. Here the Peakfinder program provides probably the most valuable contribution for archaeoastronomy.

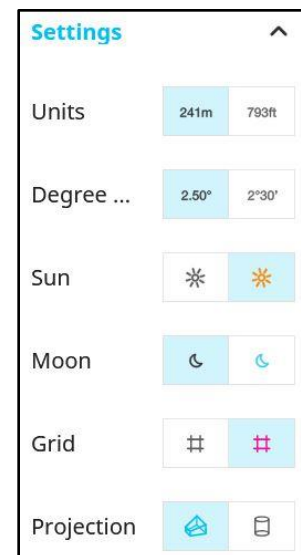
By the settings (1) the "grid" (violet) can be displayed. It shows the mathematical horizon with the azimuth values, as well as parallel running lines with positive and negative elevation angles. With a mouse click on the horizon line, a movable measuring tool, quasi a "magnifying glass", can be displayed. In the upper part azimuth and elevation are displayed and in the lower part the sight distance and the sea level.



The example shows here the Chasserai, situated in the Swiss Jura, observed from the summit of the Napf, located in the Emmental. The azimuth is  $282.4^\circ$  and the elevation angle  $-0.1^\circ$ , i.e. slightly below the mathematical horizon.

With this elevation angle, (here with negative sign!) and the latitude of the location, the observed azimuth  $H_{az}$  can now be reduced to the mathematical horizon  $H_{az\ math}$  by the Excel-based calculation tool [5], in table 6. The further procedure is then carried out according to [4] resp. [5].

However, by displaying the sun- or moon trajectory, simpler alternatives can be opened here (see below).



### 3.3 Displaying the solar trajectory

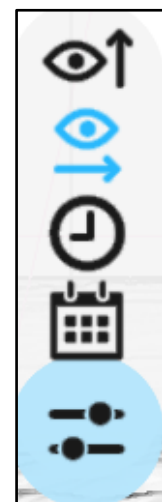
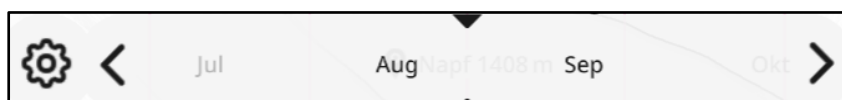
By clicking on the Sun icon, the entire day arc of the sun's trajectory with the corresponding rising and setting times, is displayed for the current date. The corresponding data have been provided by the Department of Physics of the University of Basle (former Astronomical Institute).

Clicking the "Slider" icon shows the calendar and clock icons, which allow adjusting the date and time. The corresponding values can now be tuned at the bottom of the screen, using the according slider.

Local time:



Date:



### 3.4 Setting of date and time

The cog icon (left) can be used to display buttons with arrows allowing a faster and more precise adjustment of date and time in steps of hours, months and centuries.

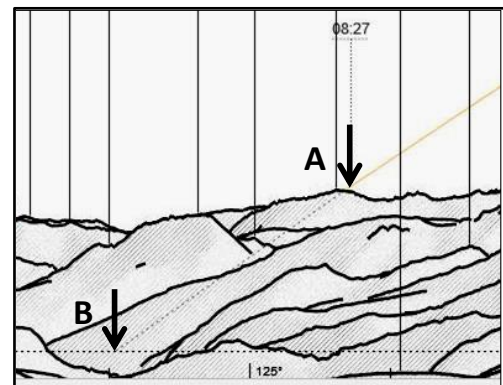
These values can be adjusted fastest also directly by overwriting in the address line. The following address fragment shows September 16, 379 BC 0801 hrs (negative sign = pre-Christian (BC) date).

=45&date=-379-09-16T08:01:36Z&cfg...



### 3.5 The analysis of the solar trajectory

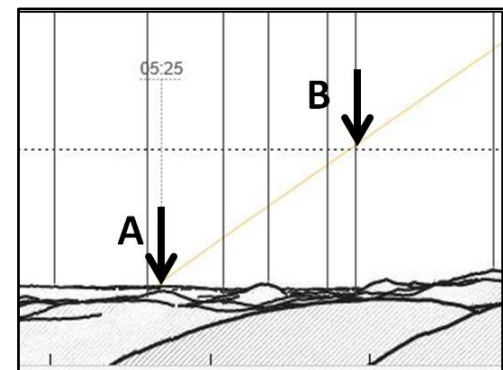
The following example shows at point A on the local horizon (observed from location Stierenberg) the sunrise on January 5, 2018 at 08:27. The sun's path appears here as an orange line, which is extended below the terrain dotted until it reaches the mathematical horizon at point B. This allows the direct measurement of the reduced azimuth without mathematical reduction via the elevation angle.



### 3.6 Rising and setting points below the mathematical horizon

Even on relatively low peaks, major horizon sections may show clearly negative elevation angles, i.e. they are below the mathematical horizon! In this case, the correction must be made in the opposite direction.

Example: The sunrise on the Pilatus summit (CH) occurred on June 21, 2018 at 05:25, approx.  $1.1^\circ$  below the mathematical horizon at point A. The reduced azimuth must therefore be measured here at the intersection of the ascending solar trajectory with the astronomical horizon at point B. This procedure has practical applications, e.g. for an archaeoastronomical investigation of a temple on a mountain top.



### 3.7 Adjusting the azimuth to the upper limb definition

The azimuth of the summer solstice measured here at B, yields  $53.7^\circ$  and corresponds precisely, up to one decimal place (!), to the value to be calculated at this latitude with the present solar declination  $\delta_{\max} = +23.43^\circ$  [5]. It refers to the apparent center of the disk for the Sun and Moon, which represents the usual standard for astronomical programs. In archaeoastronomical considerations, however, for these celestial bodies usually the apparent *upper edge* of the disk is assumed [4]. Thus the "First Light" at the rising point occurs a little earlier and the "Last Light" in the evening slightly later. However, according to [5] Tab. 4, for the 47th latitude the resulting azimuth difference is very small and amounts to only  $0.36^\circ$ . For this case this value must be subtracted from the rising azimuth or added to the setting azimuth.

### 3.8 Displaying and analyzing of the lunar trajectory

By clicking on the Moon icon, the complete visible arc of the moon trajectory with rising and setting times for the current date is displayed. Analogous to the solar trajectory, it is also possible to adjust the date here. Here e.g., the pendulum motion of the rising and setting azimuths occurring in a ~27-day rhythm can be demonstrated, which is responsible for the occurrence of the lunistics [4].

### 3.9 Prehistoric data for the solar and lunar trajectories

Of course, not the present but mostly long past epochs are of interest for archaeoastronomy. The variability of the ecliptic slope  $\epsilon$  is caused by a small inclination variation of the earth axis, with a period of more than 40'000 years and influences here above all the extremal rising and setting azimuths. As a result, the difference for the solar azimuth between today and 2000 BC is about  $0.8^\circ$  or slightly more than the apparent diameter of the solar or lunar disk [5]. The precession movement of the earth axis with a period of approx. 25'700 years, has however no influence here [4].

Plotting these prehistoric azimuths by the Peakfinder functions is feasible with good accuracy, but somewhat complicated. The problem: The calendar dates for the solstice azimuths, defining the solar year and thus the seasons, are shifting in the past. For example, if for the date June 21, one clicks the time back in century steps, we can notice the following:

- Until 1583, i.e., one year after the Gregorian calendar reform, only slight differences in the solstice azimuth are detectable, because until then, the Gregorian switching rules, still valid today, have been applied.
- With the Gregorian calendar reform, Thursday October 4, 1582, was immediately followed by Friday October 15. As a correction at that time, the 10 intermediate days have been simply skipped. With the Peakfinder program these "phantom days" can be called up, but the solar trajectory appears accordingly corrected.
- For earlier dates, back to the ice age, the program applies the Julian calendar, which just provides an additional leap day (February 29) every 4 years, without considering the additional, Gregorian switching rules. Thus, the average calendar year extends from here on from 365,2425 to 365,25 days. This, together with additional effects, result in the following shift dates for the summer solstice:

2020 AD: ~ June 21  
 1581 AD: ~ June 11     "Gregorian jump"  
 1000 AD: ~ June 17  
 0:            ~ June 25  
 1000 BC ~ 3 July  
 2000 BC: ~ July 10  
 3000 BC: ~ July 17  
 4000 BC: ~ July 26

BC: "Before Christ",  
 AD: After Christ or "Anno Domini"

This difference does not only concern the solstice dates, but must also be considered for the equinoxes, as well as all intermediate azimuths, e.g. the quarter days. Dates for other epochs can be determined somewhat complicated, i.e. step by step by trial and error ("manual simulation").

- The determination of the extremal azimuths, due to the lunistics occurring in the ~18-year rhythm, is feasible but time-consuming. For this period, the maximum and minimum

pendulum deflection of the daily rising and setting points must be searched for each year by trial and error. The procedure according to [4] and [5] is therefore much faster. The Peakfinder program is suitable here primarily for the determination of the elevation angle at the local horizon.



## 4 Links

[1] PeakFinder, PC-Version

<https://www.peakfinder.org>

[2] PeakFinder Smartphone App

<https://www.peakfinder.org/de/mobile/>

[3] Rita Gautschy, Universität Basel: *41262-01 - Vorlesung mit Übungen: Archäoastronomie: Eisenzeit bis Frühmittelalter 3 KP*

<https://vorlesungsverzeichnis.unibas.ch/de/semester-planung?id=200499>

[4] Richard Walker, *The Analysis of Archaeoastronomical Orientations*

<https://www.ursusmajor.ch/downloads/the-analysis-of-archaeoastronomical-orientatio.pdf>

[5] Richard Walker, *Excel Tool for archaeoastronomical calculations*

<https://www.ursusmajor.ch/downloads/tool-for-archeoastronomical-calculations-3.0.xls>

Further publications on the subject can be found on the author's homepage.

<https://www.ursusmajor.ch/astrospektroskopie/richard-walkers-page/index.html>