

# Towards understanding the astronomical orientation of the Old Kingdom pyramids

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*Key words and phrases.* Pyramids, Old Kingdom, astronomical orientation, precession.

The remarkable northern orientation of some of the Old Kingdom pyramids—Snofru’s Meidum, Bent und Red pyramids, Khufu’s, Khafre’s, Menkaure’s (4th Dynasty), and Neferirkare’s (5th Dynasty) pyramids—was formerly presumed to be a consequence of the constructions having been aligned to the position of the North Celestial Pole (NCP). However, in the range of the widely agreed upon Egyptian chronologies,<sup>1</sup> the maximal azimuthal deviation of the star closest to the NCP (Thuban) from true north varied between  $\pm 1^\circ$  and  $\pm 1^\circ 40'$ ; and thus couldn’t support the measured precision of the orientation of the pyramids in the range from  $-35.4'$  to  $30'$  (with the precision of the orientation of Khafre’s pyramid better as  $-3.7'$ ). In 1984 an important observation was published by S. Haack [5] that the orientation of the pyramids of the Fourth Dynasty follows a special pattern of digression from true north and this progressive deviation in orientation was understood to be a consequence of the pyramids having been aligned to a star whose celestial position changed due to the effect of the general precession of the rotational axis of the Earth. S. Haack proposed that the primary alignment direction was true east, which was determined by observation of  $\beta$  *Scorpii* as first visible at its rising; however one couldn’t explain why the orientation of the pyramids was based upon adjustment to a relatively faint star in the east. Instead of a single star, later publications considered a possible usage of some notable stellar configurations exhibiting an azimuthal trend similar to the trend in the orientation of pyramids. All these publications considered the astronomical data to be known with great precision and treated the conventional Egyptian chronologies of this period as only relative. Accordingly, the discrepancies between the azimuths of the sides of the pyramids and the azimuths of the proposed stellar alignments

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<sup>1</sup>Several chronologies of the period are available; the three most agreed-upon chronologies are von Beckerath’s [1], Malek’s [2], and Hornung et al. [3], all modified according to Stadelmann’s [4] proposal by having 48-years for the duration of Snofru’s reign.

were interpreted purely as a consequence of erroneous historical dating and the astronomical data were used to anchor the archeological data in time. Such attempts at explanation forced researches to shift the existing Old Kingdom chronologies by some significant (and different) number of years. We have evaluated the aforementioned proposals<sup>2</sup> with the help of the actual long-term precession theory [10] and analyzed for each variant the corresponding errors of the alignments of the pyramids to the the selected stellar configurations against the conventional or proposed chronologies of the Old Kingdom; it was shown that practically all the methods reveal a secular trend in the alignments and do not match the trend properly.

We assume that some other ideas played a role in the orientation of pyramids—e.g. a vertical alignment of stars might have been considered as a sort of a stellar elevator to the celestial realm, the king's final destination as stated in the *Pyramid Texts*:<sup>3</sup> "A stairway to the sky is set for you among the Imperishable Stars [Circumpolar stars]." A remarkable geometrical configuration of stars is known for us as the constellation Little Dipper where two sides of the Dipper can each be observed as a vertical configurations at low altitude. We propose and discuss a new solution based upon the vertical alignment of Kochab and  $\zeta$  UMi which shows an impressive degree of agreement with the trend in the orientation of the pyramids for von Beckerath's classical chronology and thus do not demand any temporal shift in dating of the pyramids. The special pattern of digression in the orientation of the pyramids from true north is displayed in Figure 1 where the y-axis gives the azimuths of the east sides of the pyramids,<sup>4</sup> the trendline 'c' is running as a guide to the eye through these azimuths,<sup>5</sup> and the time-axis follows von Beckerath's chronology. The dashed line 'a' is a trendline through the points corresponding to the azimuth of the vertical alignment of Kochab and  $\zeta$  UMi at the lower position. The precision of the orientation towards this stellar alignment calculated for every pyramid along trendline 'c' separately is at a surprisingly high level: the mean deviation of the orientation of the pyramids towards the stellar vertical is ca.  $-4'$  with a standard deviation of  $2'$  (Tupikova [16], Fig. 30). Such a small deviation is, in fact, close to the limit of naked-eye observations.

Even better match can be obtained for the west sides of the pyramids where only scarce measurements are available. As shown in Figure 2, the precision of this orientation is very impressive and cannot be questioned for the Meidum, Bent and Khufu's pyramids. The only visible deviation from the trendline 'a' is for Menkaure's pyramid. One should take into account, however, that because the

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<sup>2</sup>Spence [6]; Rawlins and Pickering [12]; Belmonte [8]; Puchkov [9].

<sup>3</sup>Faulkner [11], 156, Nt. 773–74.

<sup>4</sup>The azimuths to the west from true north are given as negative and to the east as positive numbers. With this counting, azimuth becomes equivalent to the deviation of a direction from true north.

<sup>5</sup>The known problem of the orientation of Khafre's pyramid, however, is that it is identical with that of Khufu's pyramid in spite of more than 30 years between the accession dates of the two kings. The proposed hypotheses to explain this were copying of alignment [12] or that two pyramids were laid down simultaneously ("Khufu's double project", see [13], [14] and [15]).

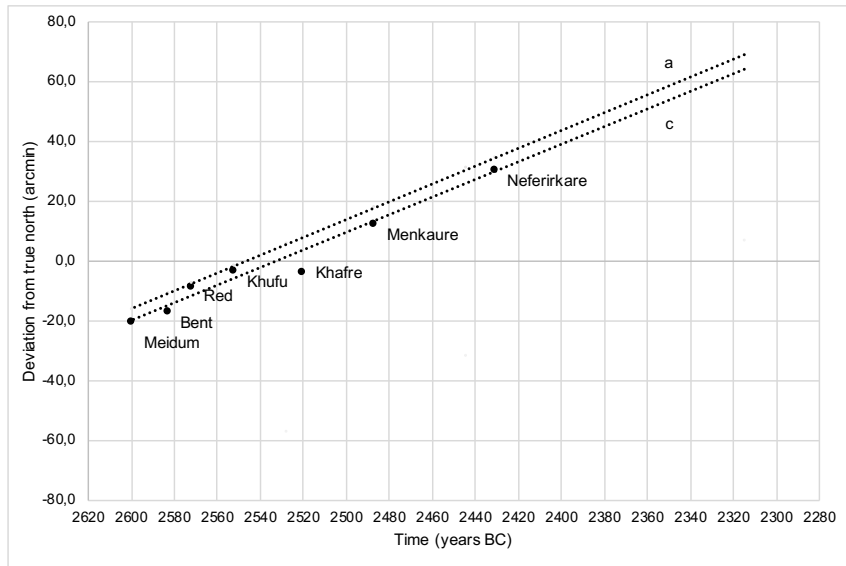


FIGURE 1. Deviation of pyramid orientations (east sides) from true north over time vs. azimuth of the lower vertical alignment of Kochab and  $\zeta$  UMi (von Beckerath's chronology).

foundation of the pyramid was covered with rubble, Nell and Ruggles [17] were only able to survey the alignment of courses of stones on the pyramid itself. The results for two block courses (9th and 11th) were given with orientations of  $29.5'$  and  $19.7'$ , correspondingly; for the latter figure, the azimuth of the west side of Menkaure's pyramid would lie exactly on the line 'a' (this position is marked at Fig. 2 with a cross).

Another remarkable stellar alignment could have been used as a crossover check for the orientation of pyramids. As we have shown, in the time of the Old Kingdom two other prominent bright stars aligned horizontally—Alioth and Mizar in the constellation Big Dipper—support von Beckerath's chronology with Mizar being a target of observations at the moment of such alignment (Tupikova [16], Figs. 19–21). It was shown that the azimuths of these two different stellar alignments would match the trend in the orientation of the pyramids with similar precision. That these alignments occurred at the time of the construction of the Old Kingdom pyramids close to true north is, in our opinion, a fortuitous event which is mainly responsible for the remarkable northern orientation of these pyramids.

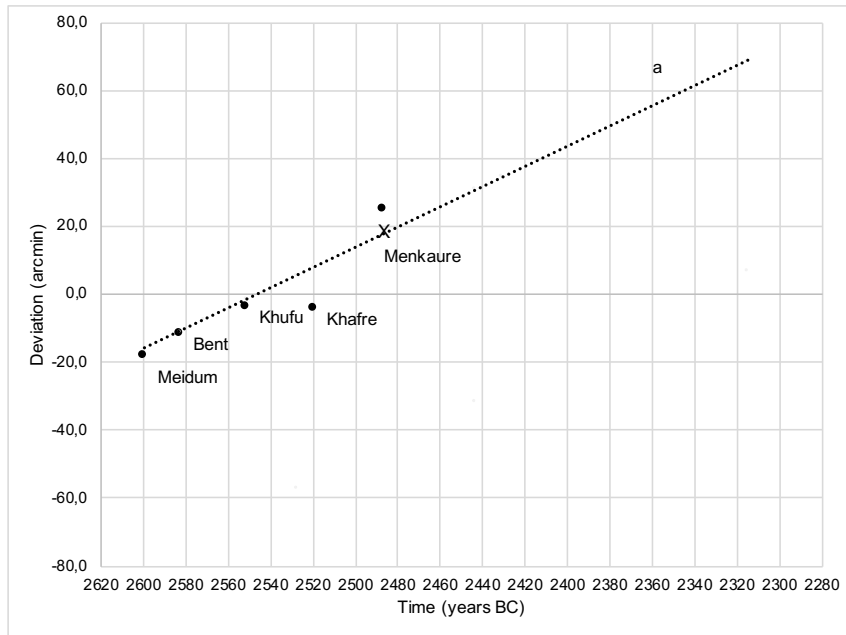


FIGURE 2. Deviations of pyramid orientations (west sides) from true north over time vs. azimuth of the lower vertical alignment of Kochab and  $\zeta$  UMi (von Beckerath's chronology).

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