



LXVII. Observations on the entrance passages in the Pyramids of Gizeh

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To cite this article: Sir John F.W. Herschel Bart. F.R.S. & Col. Howard Vyse (1844) LXVII. Observations on the entrance passages in the Pyramids of Gizeh , Philosophical Magazine Series 3, 24:162, 481-484, DOI: [10.1080/14786444408644906](https://doi.org/10.1080/14786444408644906)

To link to this article: <http://dx.doi.org/10.1080/14786444408644906>



Published online: 30 Apr 2009.



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THE
LONDON, EDINBURGH AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE.

SUPPLEMENT TO VOL. XXIV. THIRD SERIES.

LXVII. *Observations on the Entrance Passages in the Pyramids of Gizeh.* By Sir JOHN F. W. HERSCHEL, Bart., F.R.S., with Introductory Remarks by Col. HOWARD VYSE*.

AS it had been supposed that the inclined passages were intended for astronomical purposes, I mentioned the circumstance to Sir John Herschel, who with the utmost kindness examined the annexed table, and entered into various calculations to ascertain the fact. I also informed Sir John of the allusion in the Quarterly Review to M. Caviglia's remarks respecting the polar star, and likewise of its having been seen by Captains Irby and Mangles from the inclined passage in the Great Pyramid at the period of its culminating, on the night of 21st March 1817.

M. Caviglia's remarks, contained in a letter to Mr. Hamilton, dated September 21st, 1818, are as follow:—

“Tous les chemins qu'il y a dans l'intérieur de ce monument (la Grande Pyramide), ceux qui sont en pente, forment un angle de 27° avec ceux qui sont en ligne horizontale. Mais ce qui a mérité mon attention est que l'on cesse de voir l'étoile polaire on avant qu'on eût bouché le chemin l'on cessoit de descendre pour monter.”

M. Caviglia no doubt could have seen the star from this passage, but the manner in which he observed it is not clearly described, nor can, after all, any conclusion be drawn from the present length of the passage, either from the entrance to the beginning of the ascending communication, or in any other parts of it, because, owing to the dilapidated state of the exterior of the pyramid, the top of the passage has lost twenty-one feet six inches of its original length, and of course the bottom proportionably more.

It would appear that the direction of the passage was determined by the star, which was polar at the time when the pyramid was constructed, and that the exact aspect of the

* Extracted from Col. Vyse's work, entitled “Operations carried on at the Pyramids of Gizeh in 1837,” vol. ii. p. 105.

building was regulated by it; but for the reasons already stated, it could not have been used for celestial observation. The coincidence of the relative position of α Draconis with the supposed date of the pyramid is at all events very remarkable.

A Table showing the exterior angles of the buildings, the inclinations and proportions of the inclined passages, and also the dimensions of the sarcophagi, that have been found in the nine existing Pyramids at Gizeh.*

| Passages. | | | | | | | Sarcophagi. | | |
|------------|--------|---------|-----|---------|-----|----------|---------------------------|--------------------|-----------------|
| Pyramids. | Angle. | Length. | | Height. | | Breadth. | Height above base. | Angle of building. | Height. Width. |
| | | ft. | in. | ft. | in. | ft. in. | ft. in. | | ft. in. ft. in. |
| Great ... | 26 41 | 320 | 10 | 3 | 11 | 3 5½ | 49 0 | 51 50 | 3 5 3 3 |
| Second... | 25 55 | 104 | 10 | 3 | 11 | 3 5½ | 37 8 | 52 20 | 3 0 3 6½ |
| Third ... | 26 2 | 104 | 0 | 3 | 11½ | 3 5½ | 13 0 | 51 0 | 2 11 3 1 |
| Fourth... | 27 0 | 27 | 0 | 3 | 6 | 3 3 | { without the building. } | in steps. | 2 7 2 7 |
| Fifth ... | 27 12 | 56 | 9 | 3 | 11½ | 3 5½ | | | |
| Sixth ... | 30 0 | 47 | 9 | 3 | 11 | 3 2 | { without the building. } | in steps. | No sarcophagus. |
| Seventh . | 33 35 | 55 | 3 | 4 | 0 | 3 6 | | | |
| Eighth ... | 34 5 | 37 | 0 | 4 | 0 | 3 6 | at the base. | 52 10 | Not found. |
| Ninth ... | 28 0 | 53 | 0 | 3 | 11 | 3 5 | 8 9 | 52 10 | Not found. |
| | | | | | | | 2 6 | 52 10 | Not found. |

The base of the Great Pyramid was above high Nile, in 1837, 138 ft. 9 in.

The base of the Second is above the base of the Great Pyramid 33 ft. 2 in.

The base of the Third is above the base of the Great Pyramid 41 ft. 7 in.

The base of the three pyramids, south of the Third, are lower than the base of the Third 16 ft. 8 in.

The bases of the three pyramids east of the Great Pyramid, appear to be on a level with it.

The Second Pyramid is about 400 ft. to the south of the Great Pyramid.

The Third Pyramid is about 750 ft. to the south of the Second.

Sir John Herschel's Observations on the Entrance Passages in the Pyramids of Gizeh.

Four thousand years ago the present polar star, α Ursæ

* The three pyramids of Abouseir are situated about seven miles to the south-eastward from Gizeh, on a ridge about eighty feet above the plain. The angle of building of the northern is $51^{\circ} 35'$; that of the descending passage in the northern front $27^{\circ} 5'$. The angle of building of the middle pyramid, and that of the entrance, could not be ascertained on account of its dilapidated state. The angle of building of the southern pyramid was not discovered, but that of the entrance was 26° .

Minoris, could by no possibility have been seen at any time in the twenty-four hours through the gallery in the Great Pyramid, on account of the precession of the equinoxes, which at that time would have displaced every star in the heavens, from its then apparent position on the sphere, by no less a quantity than $55^{\circ} 45'$ of longitude, and would have changed all the relations of the constellations to the diurnal sphere.

The supposed date of the pyramid, 2123 years B.C., added to our present date, 1839, form 3962 years (say 4000), and the effect of the precession on the longitudes of the stars in that interval having been to increase them all by the above-named quantity, it will follow that the pole of the heavens at the erection of the pyramid must have stood very near to the star α Draconis, that is, $2^{\circ} 51' 15''$ from it to the westward, as we should now call it; α Draconis was therefore at that time the polar star; and as it is comparatively insignificant, and only of the third magnitude, if so much*, it can scarcely be supposed that it could have been seen in the daytime even in the climate of Gizeh, or even from so dark a recess as the inclined entrance of the Great Pyramid. A latitude, however, of 30° , and a polar distance of the star in question of $2^{\circ} 51' 15''$, would bring it at its lower culmination to an altitude of $27^{\circ} 91'$, and therefore it would have been directly in view of an observer stationed in the descending passage; the opening of which, as seen from a point sixty-three feet within, would, by calculation, subtend an angle of $7^{\circ} 7'$, and even from the bottom, near the sepulchral chamber, would still appear of at least 2° in breadth. In short, speaking as in ordinary *parlance*, the passage may be said to have been directly pointed at α Draconis at its inferior culmination, at which moment its altitude above the horizon of Gizeh (lat. 30°) would have been $27^{\circ} 9'$, refraction being neglected as too trifling (about $2'$) to affect the question. The present polar star, α Ursæ Minoris, was at that epoch 23° more or less in arc from the then pole of the heavens, and of course, at its lower culmination, it was only 7° above the horizon of Gizeh. No other astronomical relation can be drawn from the table containing the angles and dimensions of the passages, for although they all point within five degrees of the pole of the heavens, they differ too much and too irregularly to admit of any conclusions.

The exterior angles of the buildings are remarkably uniform, but the angle 52° is not connected with any astronomical fact, and was probably adopted for architectural reasons.

* In the Catalogue of the Astronomical Society, the magnitude of α Draconis is stated as intermediate between the third and fourth. It is certainly inferior to the third; and it is to be observed, that there is not any larger star near it, which could at that epoch have been preferred as a pole star.

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Calculations.

Por. of α Draconis for 1839.

R.A. 1830 = $13^h 59^m 46^s \cdot 6$ Due 1830 = $65^\circ 11' 26''$ (see Astr. Soc. Cat.)

Precession + 9 years = $+14^s \cdot 6$ Pre. + 9 years = $-2 \ 36$

$\frac{14 \ 0 \ 1 \cdot 2}{65 \ 8 \ 50} = \delta$ for 1839.

Reduced to arc $210^\circ 0' 18'' = \alpha$

Precession in longitude for + 1 year, epoch 1800..... + $50'' \cdot 22350$

Variation for 2000 years backwards, to obtain a mean rate } - $0 \cdot 04886$

of precession for 4000 } + $50 \cdot 17464$

Multiply by years..... -4000

Precession in long. = $-200697'' \cdot 56 = -55^\circ 44' 57'' \cdot 56$ - $200697 \cdot 56000$

or correctly enough for the purpose $55^\circ 44' 58''$

P the present place of the north pole.

P' its place 4000 years ago.

α the star α Draconis.

β its projection on the equinoctial.

$\gamma \hat{=} \beta = 210^\circ 0' 18'' = \alpha$

$\gamma \hat{=} = 180$

$\hat{=} \beta = 30 \ 0 \ 18 = \text{angle}$

$\hat{=} P \alpha$

In spherical triangle P Π P'.

Given angle P Π P = $55^\circ 44' 58''$.

P Π = P' Π = obliquity of ecliptic at α mean epoch, 2000 years back.

Obliquity 1800 = $23^\circ 27' 55''$

Var. for -20007 = + $1 \ 31$

$23 \ 29 \ 26 = \text{obliquity to be, and} = P \Pi = P' \Pi$.

Solution of triangle Π P P'.

Sin $\frac{1}{2} P \Pi P' = \sin 27^\circ 52' 29'' \dots 9 \cdot 6698186$

Sin obliquity $9 \cdot 6005350$

Sin $\frac{1}{2} P P' = 10^\circ 44' 25'' \dots 9 \cdot 2703536$

Required 1st side P P'.

2nd angle P' P Π .

Tan $27^\circ 52' 29'' \dots 9 \cdot 7233852$

Cos obliquity $9 \cdot 9624319$

Cotan $64^\circ 7' 22'' \dots 9 \cdot 6858171$

Angle P' P $\Pi = 64^\circ 7' 22''$

P P' = $21^\circ 28' 50''$.

$\hat{=} P \Pi = 90^\circ$.

$\hat{=} P \alpha = 30^\circ 0' 18''$

α P $\Pi = 59 \ 59 \ 42$

P' P $\Pi = 64 \ 7 \ 22$

P' P $\alpha = 4 \ 7 \ 40$

In triangle P' P α given P P' = $21^\circ 28' 50''$

P $\alpha = 24 \ 51 \ 10 = 90 - \delta$.

Angle P Π P $\alpha = 4 \ 7 \ 40$

Required α P'.

Co ϵ . $4^\circ 7' 40'' \dots 9 \cdot 9988720$

Tan $21 \ 28 \ 50 \dots 9 \cdot 5949652$

Tana $21 \ 25 \ 48 \dots 9 \cdot 5938372$

$24 \ 51 \ 10$

$\alpha' \ 2 \ 25 \ 22$

Cos $21 \ 28 \ 50 \dots 9 \cdot 9687359$

Cos $2 \ 25 \ 22 \dots 9 \cdot 9996116$

$9 \cdot 9683475$

Cos $21 \ 25 \ 48 \dots 9 \cdot 9688865$

Cos P' $\alpha = 2 \ 51 \ 15 \dots 9 \cdot 9994610$

Note.—These calculations, which take in all the influence of the secular variations of precession, &c., may be considered quite equal, in point of precision, to any direct observation that an Egyptian astronomer of that date could have made.

