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On the date of early Christian Basilicas (central Greece)

George Pantazis and Evangelia Lambrou

National Technical University of Athens, School of Rural and Surveying Engineering, Department of Topography, Laboratory of General Geodesy (gpanta@central.ntua.gr and litsal@central.ntua.gr)

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Abstract

The exact foundation date of many early Christian churches is still unknown or according to archaeologists' estimation it is attributed to a large time interval. According to a new astrogeodetic methodology, today it is feasible to assess it. This paper deals with the determination of the orientation, the foundation date and the dedication of nine Early Christian basilicas, situated in Central Greece. According to the suggested methodology, the appropriate geodetic and astrogeodetic measurements were carried out on the site of each Early Christian basilica in order to: Determine the accurate position on the surface of the earth by the calculation of its coordinates, Draw the accurate digital plan, Define the basic longitudinal axis, Calculate the astronomical azimuth of the basic axis via observations to Polaris (α Ursa Minoris), Create the profile of the perceptible horizon, Determine the apparent transit of the Sun for different dates. Combining all the above data for each Early Christian Basilica, the total geometric documentation of the monument was made. The detection of its foundation date and its dedication were achieved with adequate precision and reliability. Last, their selectable and systematical astronomical orientations were registered and a data base including all the above data had been created.

Keywords: *Geometric documentation, astrogeodetic, Polaris (α Ursa Minoris), Geodetic, perceptible horizon, diurnal.*

Introduction

According to the Christian tradition, the sun is the celestial body which symbolizes Christ. So, the churches ought to be oriented to the sunrise for selectable days of the year. These days may be the solstices or the equinoxes or a significant day, such as the celebration of the name day of the church according to its dedication.

By this way, the sunshine would light the conch of the bema and the holy altar, the time when the

priest prepares the Holy Communion and the congregation attends the mass. It was preferred to have the orientation of a church exactly towards the East, as the sunlight lights the holy altar more days in a year. Otherwise, the church was oriented towards the apparent sunrise from the place at celebration of the name day of the church (Migne 1863; (Potamianos 2000).

The drawing and the orientation of these monuments was carried out very carefully using the advanced astronomical knowledge of those years, as it is proved by the scriptures, which were found out. (Pantazis 2002; (Potamianos 2000).

Following the above tradition, in case, the orientation of the church and the day that the sun path coincides its azimuth line are known, then the church dedication and the date of its erection can be determined.

About the Early Christian Basilica

It would be useful to make a short reference to this type of monuments which were erected on the first centuries A.D. Two types of early Christian basilica were erected according to the roof type: The Hellenistic type, which is wooden – roofed, and was erected at the Greek-Roman areas. The eastern type is arch-roofed. This was erected at the eastern districts of the Roman Empire (Mesopotamia, Syria, Asia Minor, and rarely in the Balkan Peninsula).

The basic parts of an early Christian basilica complex are: the circuit, the atrium, the propylon, the narthex and the apse or the conch of the Bema.

The wooden roofed Hellenistic type basilica may be classified according to its ground plan in the following categories:

- *The single - naved basilica.* It has not inner props and is often named single aisled.

- *The simple basilica.* It is a rectangular building, it has inner props, mainly columns which are located in parallel to the longitudinal axis of the church. The columns separate the church to long and narrow arcades named aisles. Depending on the number of aisles the church is named three-aisled, or five aisled.

- *The transept-aisle basilica.* In many cases between the aisles and the eastern wall of the church, in front of the central apse, a longitudinal transversal room is formed.

- *The cross – shaped basilica.* It was the evolution of the small single - naved cross-shaped testimony which was erected in the early Christian ages over a martyr burial or over a sacred place [Gioles 1998].

The examined Early Christian Basilicas

Nine early Christian basilicas, which have been revealed via excavations at the area of central Greece, are examined. The map (Fig.1) illustrates the positions of these basilicas.

At the town of Larissa two early Christian churches, of the type of three-aisled basilica were revealed. They were situated at the fortress in the ancient acropolis. The bigger one named "Basilica of the fortress"(Fig. 2) was about 29m x 21m. It was situated at the position of an old open – air weekly market. The church contains small parts of mosaic floor. [Moka 2004].

The second church was about 13m x 11m (Fig.

Fig.1: *The positions of the nine Early Christian basilicas.*

Fig.2: *The main basilica (Larissa).*

3). It was found at the eastern side of the enclosed fortress area. Also, three burials were included in the central and the southern aisle [Mougia 2004].

The investigations in the little village Kastri, situated outside the greater area of the town of Elassona, yielded a three-aisled basilica with narthex (Fig. 4). Its dimensions are 23m x 13m. The central aisle was covered by a mosaic floor preserved excellently.

Fig.3: *The small basilica (Larissa).*

In the village of Azoros, in the same district, another three - aisled early Christian basilica with buildings in both sides was excavated (Fig. 5) Its size is about 20m in length and 10m in width. [Polichronopoulos 2004].

Finally, at Milea village the excavations unveiled the third three - aisled church of this region. It was the bigger one, 43m in length and 18m in width (Fig.6). (Kaliaropoulos 2004).

In Nea Anchialos, near the town of Volos, a significant complex of basilicas was revealed near the southern wall of the ancient town. The bigger one was the basilica of Bishop Peter (Fig. 7). Its dimen-

Fig.4: *The basilica of Kastri.*

Fig.5: *The basilica of Azoros.*

Fig.6: *The basilica of Milea.*

sions are about 88m x 27m (Tziafeta 2004).

The basilica A′ of St. Demetrios was of the three - aisled Hellenistic type (Fig. 8). It was 60m in length and 34m in width. It has narthex and a big atrium as well as a semicircular apse at the eastern side.

At the southern side of the Pirasos hill, the hellenistic basilica B′ of Bishop Elpidios (Fig.9) has been revealed at the side of the national road. It was 22m in length and 17m in width. It contents narthex, atrium and portico. (Mamma 2004).

On a small island, named Strogili, at Aegean Sea

Fig.7: *The basilica of Bishop Peter.*

Fig.8: *The basilica A′ of St. Demetrios.*

Fig.9: *The basilica B′ of Bishop Elpidios.*

Fig.10: *The basilica on Strogili island.*

a cross-shaped basilica with narthex was found (Fig. 10). Its size is 10m x 7m. (Katsoulis 2004).

Geometric Documentation

The geometric documentation of the above mentioned churches was carried out by geodetic and astrogeodetic measurements. For each basilica the following field - works were carried out:

- The determination of its position on the earth's surface in the world's reference coordinate system. The determination of the geodetic coordinates φ, λ was carried out using the GPS (Global Positioning System) measurements. The coordinates not only define its accurate position but also they are used for the calculation of the astronomical orientation of the church.

- The survey of the church by geodetic methods using modern reflectorless total stations. The precision of the calculated coordinates of each measured point varies from ±5mm to ±10mm. The digital plan, which was drawn at a cad program, provides all the geometric details needed by the achieved accuracy. It was plotted at a scale of 1:50.

- The astronomical orientation of the created plans. This was obtained by sightings to the polar star (α Ursa Minoris). A high accuracy total station connected to a GPS receiver which provides accurate UTC time was used (Lambrou 2003). The astronomical azimuth of any line of the church was easily achieved by the astronomical oriented plans via mathematical calculations. Figure 11 presents the astronomical oriented plans of the nine basilicas.

The Dating

The dating of an early Christian church constitutes a very difficult task for the archaeologists. As only the foundations of these churches are usually excavated they have least elements to evaluate. Thus, in most cases a large time interval for their erection, about two or three centuries, was determined. For the same reasons, the dedication of the church is usually unknown. The indispensable dating method-

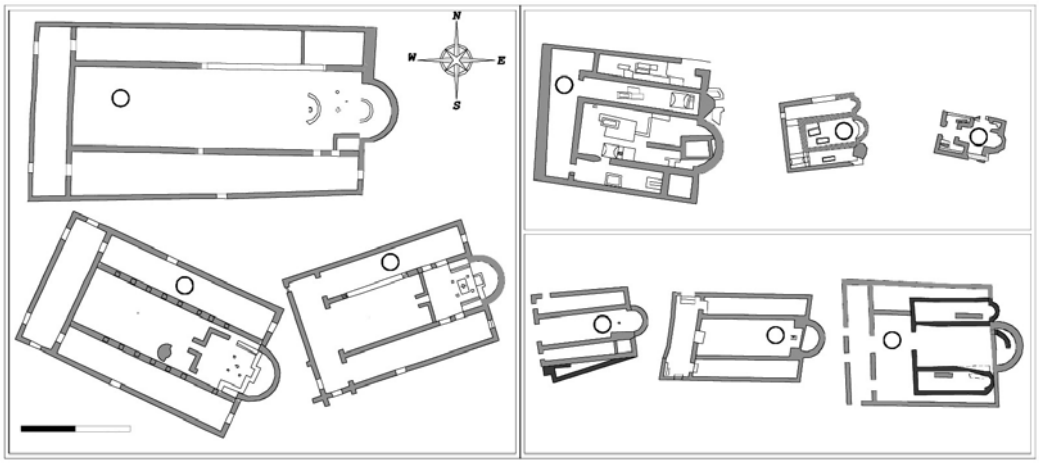

Fig.11: *The oriented plans relative to the astronomical north, of the nine Early Christian basilicas*

Fig. 12: *The marble base of the holy altar.*

ology, according to the astronomical orientation of each church, offers a significant help, as it eliminates the time space of the calculated erection date and determines its dedication. According to the suggested methodology the following elements must be known:

- *The astronomical azimuth of the basic longitudinal axis*. The basic longitudinal axis of each basilica is calculated by the produced oriented digital plan, as the best fitting line to selected points by the least squares method. The points that were used are the middles of the eastern and western wall, the middles of lines which crossed analogous points at the northern and southern wall of the church and the center of the marble base of the holy altar.

In most of the cases, the marble base of the holy altar was founded in the conch of the Bema. The center of this base indicates a very significant point of the church, which is usually marked by a cross (Fig.

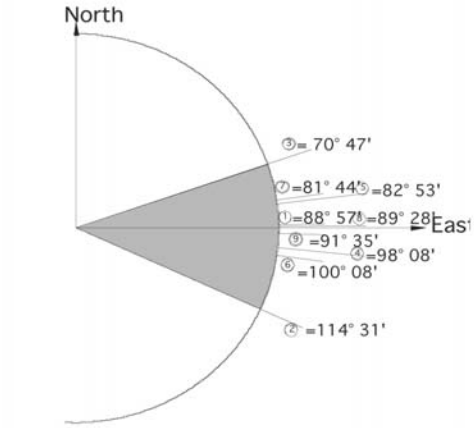

Fig. 13: *The astronomical azimuths of the basic longitudinal axis of the nine churches.*

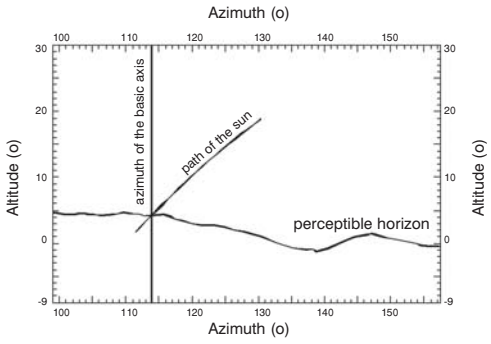

Fig.14: *The three indispensable lines needed for the dating.*

	EARLY CHRISTIAN BASILICAS	Coordinates (WGS '84) φ (°) λ (°)	DEDICATION	ASTRONOMICAL AZIMUTH OF THE BASIC AXIS (°)	FOUNDATION DATE	UNCERTAINTY (years)
LARISSA FORTRESS	The main basilica	39° 38′ 27_ 22° 24′ 57_	-	98° 07′ 57_	5/3/409	± 64
	The small basilica	39° 38′ 30_ 22° 24′ 59_	**Birthday of the Virgin Mary**	82° 53′ 19_	8/9/446	± 37
ELASSONA	Milea	40° 02′ 06_ 22° 06′ 20_	**Annunciation**	91° 35′ 02_	25/3/491	± 17
	Azoros	39° 58′ 53_ 22° 05′ 07_	**Prophet Moses**	81° 43′ 44_	4/9/406	± 18
	Kastri	40° 03′ 08_ 22° 07′ 21_	**Prophet Zacharias**	89° 28′ 41_	5/9/553	± 24
NEA ANGHIALOS	Bishop Peter	39° 16′ 23_ 22° 48′ 58_	**Equinox**	88° 56′ 57_	19/9/542	± 3
	A' of St. Demetrios	39° 16′ 36_ 22° 49′ 08_	**Saint Gregory**	114° 30′ 58_	25/1/410	± 4
	B' of Bishop Helpidios	39° 16′ 41_ 22° 49′ 19_	**Saint Paraskevi**	70° 46′ 56_	26/7/674	± 48
	Strogili Island	38° 48′ 33_ 22° 49′ 16_	**Saint John the Baptist**	100° 08′ 01_	24/2/947	± 46

Table 1: The dating results of the nine Early Christian basilicas.

12). When the erection of a church started, the base of the holy altar was put initially at the desired place. The basic longitudinal axis of the church ought to surpass from this point. Figure 13 sums up the nine astronomical azimuths of the basic longitudinal axis of the churches.

- *The boundary line of the perceptible horizon.* Above this line the sun is visible from the church place and it lights the holy altar in specific days and hours. Horizontal and vertical angles' measurements were carried out from the middle of the holy altar to the points of the boundary line which was defined by a building or a mountain crest or a hill situated in front of the eastern side of the church. If the instrument is impossible to be set on the selected point then the reduction of the measurements at this point is needed. Fig. 14 presents a diagram of azimuths and altitudes, where the line of the perceptible horizon was drawn.

- *The apparent path of the sun from the monument's place in a specific day of the year.* The line which presents the apparent path of the sun can be calculated by means of the software sky map pro 8 (Marriot 2004) which is a virtual planetarium of the celestial sphere.

The requested date is when the line of the path of the sun coincides or is closer to the point where the line of the astronomical azimuth of the basic axis and the line of the perceptible horizon coincide (Fig. 14). As this may happen for only one day in a year, the foundation date of each church and its dedication can be determined. Table 1 presents the characteristic parameters and the results for each basilica.

The Dating uncertainty

The uncertainty of the determination of the foundation year depends on the following two factors:

- The total precision (σtotal) that the above mentioned parameters have been calculated. Name-

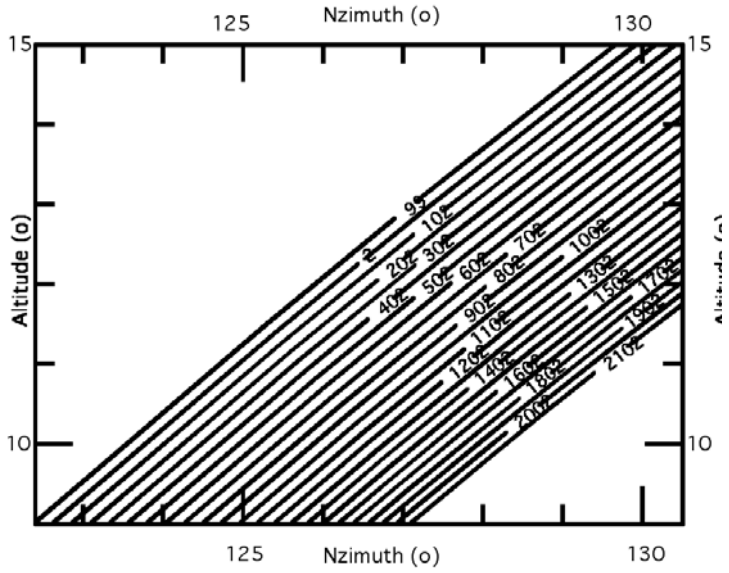

Fig. 15: *The change of the azimuth of the sun's path during the centuries.*

ly the precision of the determination:

- of the astronomical azimuth
- of the basic axis
- of the boundary line of the perceptible horizon
- of the line of the path of the sun.

• The change (dSun) of the Sun's position at a specific day during centuries. It was calculated that this change varies from 5′ to 20′ every century for the dates of the solstices and the equinoxes correspondingly. Fig.15 presents the change of the azimuth of the sun's path during the centuries for a place situated at geographical latitude φ = 39° for an accidental date (Marriot 2004).

The uncertainty is calculated by the equation: Date uncertainty = $\pm\ \sigma_{total} / d_{Sun}$(years)

Concluding remarks

The astronomical orientation of the nine Early Christian basilicas that were examined was different. It varied from 70° to 114°.

Seven of them are oriented towards the sunrise of the day in which their name day is celebrated, while one of them is oriented towards the equinox.

The dating uncertainty varies from ±3 to ±64 years.

The dating uncertainty depends on the achieved total precision by the measurements and the calculations. In these cases it is smaller than ±5′.

The dating is in accordance with the archaeological studies. The provided results help archaeologists to come up to more reliable and documented conclusions.

A data base which includes information as plans, historical elements, photographs, the astronomical orientation, the dating and the dedication for each basilica was created. It would be very useful for many scientists who would be occupied to this subject.

The described methodology:

- Uses geodetic and astrogeodetic measurements for the correct and accurate documentation of a basilica.
- Is easy to apply.
- Determines the accurate position of the basilica on the surface of the earth.
- Provides the astronomical orientation of a basilica by a precision of some arc seconds. The achieved precision depends mainly on the size and the preservation of the monument.
- Allows an indispensable approach for dating basilicas.

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