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Prospecting in Ostia Antica (Italy) and the Discovery of the Basilica of Constantinus I. in 1996

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After the huge excavations in 1938 to 1942 in Ostia Antica, the ancient habour of Rome for the World Exhibition 1942 in Rome, there remained about 40 hectare of the area of the ancient city untouched. This is about 50 to 60% of the original built up area. On one hand the untouched area would be a chance for future research work in Ostia, at the other hand this was always a handicap for urbanistic research. The ideas about the building structure in some quarters of the city (regiones) as well as about the distribution and type of various buildings will be almost hypothetical. Even the location of some important buildings like the amphitheatre and the temple of Volcano are still unknown. Therefore the department Rome of the German Archaeological Institute began to organize a experimental project testing modern methods for archaeological prospecting for urbanistic research. The combination of aerial photo interpretation of several sources, digital terrain modelling and geophysical prospecting (caesium magnetometry and resistivity surveying) were applied on the base of the same coordinate system.

An area of about 15 ha, the biggest untouched area, in regio V in the southeast of the ancient city was selected for a first test for geophysical prospecting in August 1996. The limits of this test area were chosen very close to the excavated parts of this regio, to the south and east it was spread far beyond the ancient city wall reaching the modern fence of the archaeological area. Hopefully in this area used as ploughed field for agriculture the archaeological structures should remained untouched and buried not very deeply.

Considering the time of ten days only for this first test in August 1996 caesium magnetometry was applied only, because resistivity surveying seemed to slow for vast areas. The summer in 1996 was also very dry with temperatures sometimes above 36° Celsius (in the non-existing shadow), which would have caused severe electrical contact problems to the ground. After a very limited test for resistivity surveying in area where the basilica was found in 1997 there was a bigger area surveyed by resistivity methods in June 1998, which gave almost no additional information about the archaeology in the ground that could be seen already in the magnetograms.

This was also the first test for a quadro-sensor caesium magnetometer system mounted on a non magnetic chariot (the so-called "Magneto-Scanner"(Fig. 1). This new system consists of 4 caesium magnetometers Scintrex SMARTMAG SM4G-Special with quadro-sensor configuration, 2 gradiometer consoles, data loggers, power supply (4 batteries 12V/6Ah), interface electronics and automatic distance trigger mounted on a nonmagnetic chariot, total weight about 50 kg. A fifth magnetometer can be used for compensating the daily magnetic variation synchronised in a variometer mode. The whole system (5 magnetometers and the chariot) can be packed into any normal personal car (there is no van necessary). The "Magneto-Scanner" had to be built up rather quickly to be ready for the test in Ostia within some weeks. Several persons and companies helped for this fast construction: The main part of this system was sponsered by the Bayerische Motorenwerke AG BMW, the nonmagnetic chariot was built by my brother Dr. Thomas Becker – the construction was made during manufacturing – and Scintrex (Canada) succeeded in fast delivery even for the modified sensor-systems SM4G-Special. Jörg Fassbinder helped solving many problems due to the interface electronics and the distance triggering and Rainer Appel succeeded finishing a software

Fig. 1. "Magneto-Scanner" of the Bavarian State Authorities for Monument Conservation at its first test in Ostia Antica 1996, consisting of four caesium magnetometers Scintrex SMARTMAG SM4G-Special with quadro-sensor configuration, two gradiometer consoles-data loggers, power supply (4 batteries 12V/6Ah) and automatic distance trigger mounted on a nonmagnetic chariot, total weight about 50 kg), prototype 1996

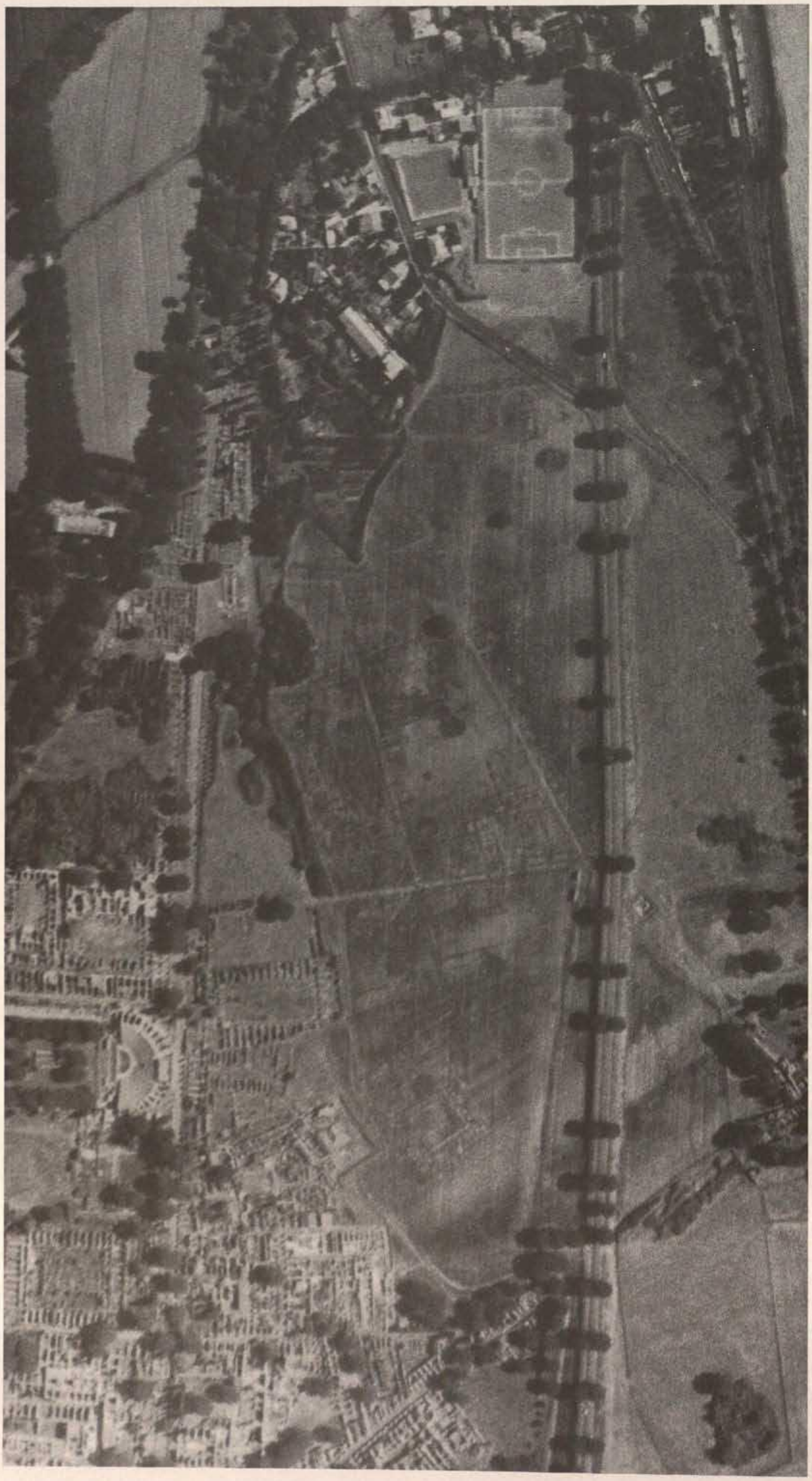

Fig. 2. Ostia-Antica. Aerial photo of unknown source (after world war II.) of the regio V with the so-called Via del Sabazeo, the Porta Secondaria in the South and parts of the Republican city wall as crop marks. This field showing the crop marks is covered almost completely by the first test for magnetic prospecting in 1996

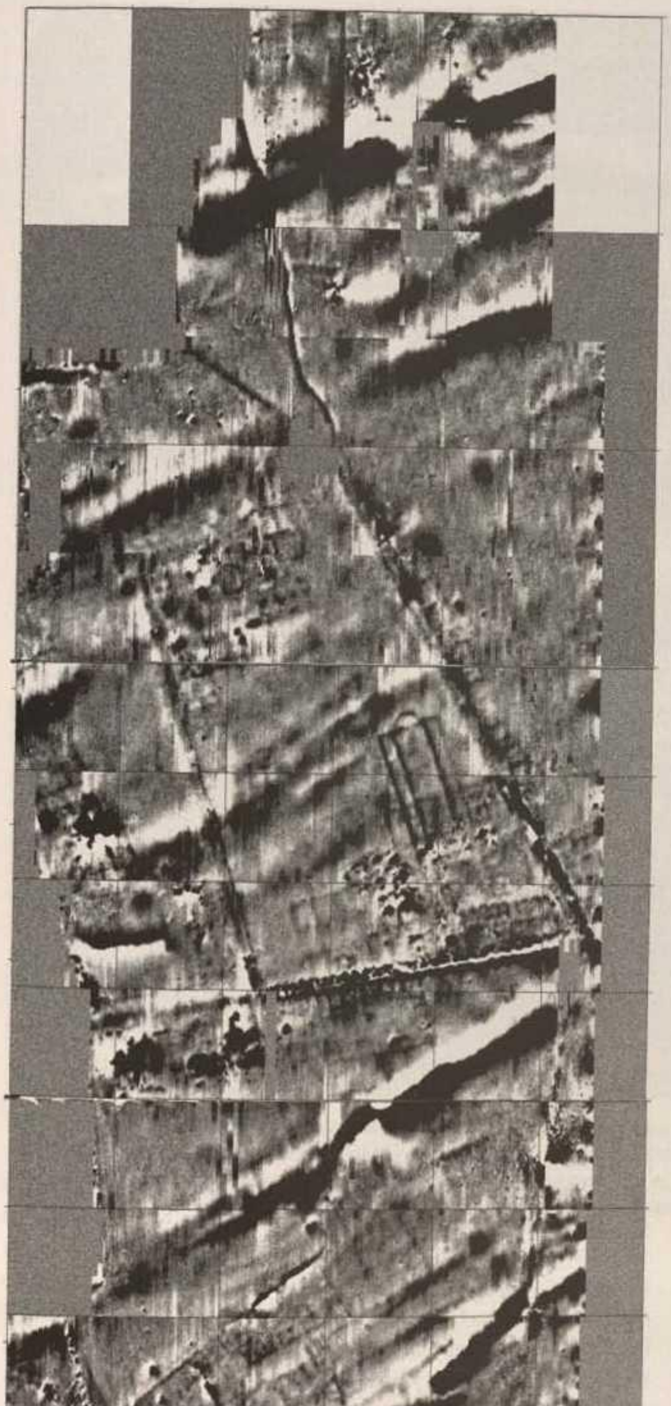

Fig. 3a. Ostia-Antica 1996. Part of the magnetogram of regio V with many structures of archaeological evidence (refer to the text for details). The newly discovery basilica of Constantinus I., the Great, is clearly visible in the corner near the gate of the Via del Sabazeo and the city wall to the south. Caesium magnetometry SM4G-Special in quadro-sensor configuration, sensitivity 10 pT (=0.01 nT Nanotesla), Dynamics-50.0/+ 50.0 nT in 256 grayscales (white/black), raster after resampling 0.25/0.5 m, 1 Hz bandpass filter, reduction of the diurnal geomagnetic variation by line mean value, 40 m grid

Fig. 3b. Ostia-Antica 1996. Part of the magnetogram of regio V after highpass filtering 10 x 5 pixel, same technical data as Fig. 3a, but dynamics -10.0/+ 10.0 nT

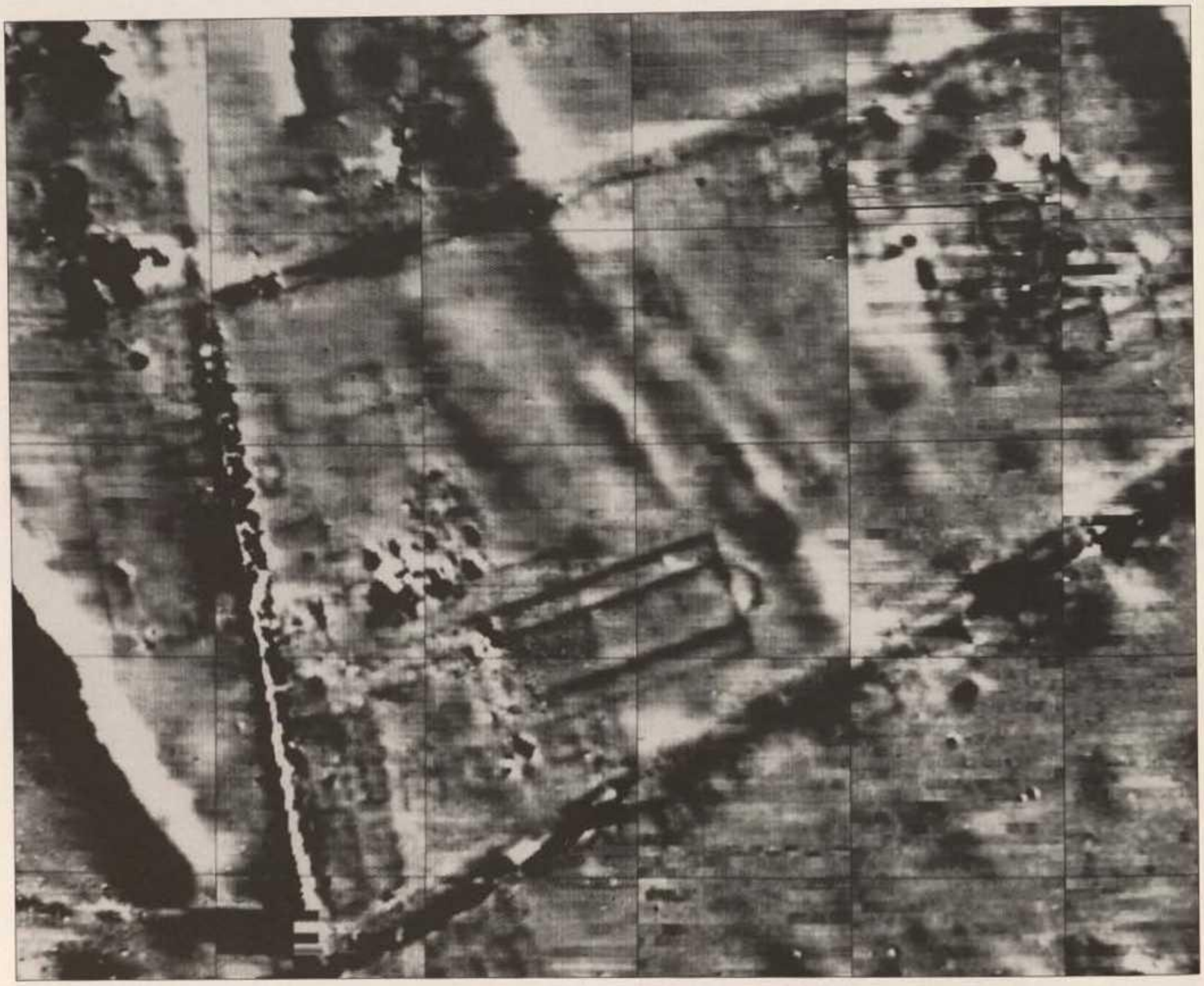

Fig. 4. Ostia-Antica 1996. Detail of the magnetogram of regio V with the newly discovered basilica of Constantinus I., the Great, clearly visible in the corner near the gate of the Via del Sabazeo and the city wall to the south. Caesium magnetometry SM4G-Special in quadro-sensor configuration, sensitivity 10 pT (= 0.01 nT Nanotesla), dynamics -50.0 /+ 50.0 nT in 256 grayscales (white/black), raster after resampling 0.25/0.5 m, 1 Hz bandpass filter, reduction of the diurnal geomagnetic variation by line-mean value, 40 m grid

package for the data processing of the quadro-sensor system during the last night before departure to Ostia. Another and more solid Magneto-Scanner had been constructed too, but this needs a van or minibus for transportation.

The quadro-sensor configuration corresponds to a double duo-sensor configuration, which was already successfully tested at the calcolithic fortified settlement of Monte da Ponte, Conceilho Evora, Portugal early in spring 1996, which achived double speed for prospecting compared with a single track instrument (Becker 1997). In an open area with a smooth surface 1 hectar with 0.1/0.5 m spacial resolution (about 500,000 measurements) may be measured with the quadro-sensor system in 2 hours. But for the 15 ha of the test area in regio V about 7 days were necessary. The reason for this rather slow field procedure was a rather rough surface of the field and a very short day because the site was closed at 5.00 p.m. The whole measurements were made by the author, but assisted by 2 or 3 students changing the 40 m lines every 2 m and also pushing the chariot uphill.

Unfortunately the automatic distance trigger by the rotation of the wheel could not be finished in time, therefore manual trigger-pulses were switched every 5.0 m into the data-set and later on interpolated to 0.25 cm. The magnetometer achive a cycle of 0.1 sec (10 measurements per second with 10 pT sensitivity), but this was set to 0.2 sec, which corresponds to a spacial resolution of 20 cm at normal walking speed. The distance values were only triggered on the first magnetometer console and transfered to the second console by synchronizing the interior clocks. In respect to the expected high external noise due to the nearby and very busy road to the sea, the International Airport Rome and many electric cables in the ground for illumination and alarm systems, a fifth magnetometer was used as base station in variometer mode monitoring the geomagnetic time variations. For data processing only the double duo-sensor configuration was used, because the fifth system gave no improvements on the data set. The field survey was carried out on the base of 40 m grids, which were marked by wooden pegs (the baseline had a length of 760 m). Data processing was done during night by the normal procedure of a duo-sensor configuration with resampling and speed dependent shift correction to 0.25 cm on the line (Becker 1999). The diurnal geomagnetic variations were corrected to the mean value of a 40 m line, which follows nicely the path of the daily variation, and to the mean value of a 40 m grid in order not to loose archaeological structure directly orientated in the line. Many anomalies due to the nearby traffic on the Via Ostiense could not be corrected by this method and remained in the data. This correction could only be done by mounting the fifth magnetometer on the chariot too, but then it would be to heavy for the rough conditions on the field in Ostia. A compromise concerning spacial resolution, sensitivity and speed had to be made for the speed firstly regarding the huge area. In a last step (JOIN4 software) the two double tracks were brought together to a 80 x 160 m matrix (spacial resolution 0.25/0.5 m) for a 40 m grid. Geoplot V2.0 software (Geoscan, Bradford) was applied for additional corrections (edge matching and desloping) and first visualization of the magnetograms (only up to four 40 m grids at once). Final data processing and visualization was done by SURFER6 (Golden Software, USA) and OPTIMAS6 (USA) digital image processing. Prints with high resolution inkjet printers were made the first time (Fig. 3a, 3b), but they can not achieve the quality of the monitor photography by medium size cameras (Hasselblad 6x6 with 150 mm lenses) (Fig. 4).

The interpretation of the archaeological structures in the magnetograms are in some parts very simple and clear, but in others rather problematic possibly caused by the multi layer structure of many building phases of this important city over many centuries. The peculiar wide positive/negative anomalies (black/white stripes in the magnetogram Fig. 3a) are geologically caused by the shore lines of the Tiber delta with a concentration of geological magnetite due to the wash of the waves. Their effect can be slightly improved by highpass filtering of the data (Fig. 3b). But there are also many archaeological structures to be seen in the magnetograms. Very dominant shows traces of the Via del Sabazeo (from north to south) possibly due to a channel made by baked bricks in the underground (cloaca maxima), but there are also some other streets visible in the magnetogram by the highly magnetized pavement with basaltic rocks. The Late Republican city wall is drawn only by a narrow line corresponding to the little width of the wall, which was made in opus quasi reticulatum technique. But if one looks at a very oblique angle exactly in the direction of the wall (in Fig. 3a, 3b in 297° from the centre of the gate of Via del Sabazeo to the west = left) is to be defined as a very clear black line (positive magnetic anomaly caused by the building mode as opus quasi reticulatum made from volcanic tuff). Outside of this southeastern part of the city wall there was found a road leading from the porta secondaria directly to the Via del Sabazeo. To the west this road seems to be a bypassing route directly to the Via Laurentina. Adjacent on the outside there is a row of rather early burial monuments. In the interior area of the city there a several buildings arranged in a insulae.

The most significant discovery in 1996 was a early christian basilica, which may be the basilica of Constantinus I., the Great, also mentioned in the liber potificalis in the vatican, which is clearly visible in the corner at the gate of the Via del Sabazeo and the city wall to the south. The overall dimension reaching nearly 90 m in length provides strong evidence having found the basilica of Constantinus I. indeed. This nearly eastwest oriented building consists of three arches with a apsis, but without the lateral hall. The part of the basilica adjactent to the Via del Sabazeo is not clearly visible, but west to the main building there is clearly visible the atrium. At the southern side of the atrium there may be a round building with 9.0 m diameter, which could be a baptisterium. Also clearly visible is another older building underneath the basilica which may be leveled for the foundations of the basilica. In the meantime this interpretation of having discovered the basilica of Constantinus I. was proved by a directed sondage excavation early in 1998.

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