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**REPORT ON THE CHEMICAL FIELD METHODS APPLIED**  
**DURING THE 1994 EXCAVATION SEASON**

The chemical soil investigations reported here took place under the supervision of Dr Erik Østby and Dr Gullög Nordquist as a part of the archaeological field project in the sanctuary of Athena Alea in Tegea, Arcadia, in July 1994.

The primary purpose of the investigation was to establish whether the spot-test and potassiumthiocyanate methods are useful when applied to soils in Greece, especially the Peloponnese. At this point I am able to say that the methods worked as intended.

The spot-test method was used in order to see whether it could detect changes in human activities in the excavated area causing variations in the amount of phosphorus. In any area where domestic refuse, food waste, vegetal and animal remains and excreta are deposited there will be an increase in the phosphate concentration. The residues created during decomposition should be compared to the amount of dead vegetal and animal tissue, partially decayed residues and completely decayed humus in order to better understand the organic matter at the site.

The samples were collected inside and outside of the temple at a depth ranging from 0.15 to 0.35 m below the excavated surface. The samples were collected with a drill used for pedogenic purposes. Sampling was made at 5 m intervals in three lines 10 m apart. Soil samples of about 5 g put on filter paper were used in the process of extracting phosphorus. The solutions used were ammoniumheptamolybdate solution and 20% citric acid, prepared as follows:

1) 5 g of ammoniumheptamolybdate ( $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}$ ) dissolved in 100 ml of cold distilled water and mixed with 35 ml diluted nitric acid ( $\text{HNO}_3$ ) and 17.5 ml  $\text{H}_2\text{O}$ . As an alternative, 30% HCl diluted with 50% distilled water can be used.

2) 0.5 g ascorbic acid ( $\text{C}_6\text{H}_8\text{O}_6$ ) dissolved in 100 ml cold distilled water.

About 50 mg soil is placed on a filter paper where two drops of liquid 1 are added with a pipette. After 30 seconds two drops of liquid 2 are added. After about 30 seconds a radiant bluish colour eventually appears, surrounding the soil sample. The method is quantitative, and used with a scale of five degrees.

The potassiumthiocyanate or rhodanide method was used in order to confirm the function of certain circular features as postholes. The same method was also used to confirm or disconfirm visible root channels.

Whereas wood decays, and in many cases may not leave any visible evidence, it is still possible to detect it since wood leaves traces of iron oxide hydrates,  $\text{Fe}_3+$  ions. I have separated these ions from the soil using 1% potassiumthiocyanate, KSCN, in an acidic environment, using a 30% HCl solution. The ground should be free from vegetation before the liquid is sprayed. If the tested area contained wood the iron ions together with the cyanate will colour the area with a vivid red. In soils rich in carbonates the dissolved iron ions almost immediately change to iron hydroxide, which means that the contour of the posthole is seen as a reddish limit. At Tegea this effect fades in a few seconds if new acid is not continually added, due to the chalky environment.

When we tested this on visible root-channels, the reddish area was less distinct than was the case with the postholes. This may be a result of the size of the decayed wood and the amount of dissolvent water.

Several standard wet-chemical analyses were carried out at the Swedish National Board of Antiquities, Institute for Conservation, Department of Analysis. The analysis consisted of phosphate, chlorides, resistivity, soil classification, loss by ignition, pH-KCl, PH- $\text{H}_2\text{O}$ , and cations exchange capacity.

Four samples all taken from the temple area, were taken for analysis. The result is shown in *Tab. I* below.

Table 1

Sample	Exchangeable acidity		Chlorides ppm	Soil classification	Resistivity $\mu\text{mhos}$	pH – H <sub>2</sub> O	pH – KC1
	NaOH	HCl					
I	0.14	0.10	1540	Loam or loamy silt	218	7.59	7.26
II	0.12	0.12	110	Loam or loamy silt	241	7.53	7.40
III	0.10	0.08	80	Silty or clayish loam		7.70	7.41
IV	0.16	0.14	180	Silty or clayish loam		7.47	6.76
	Phosphate (ppm PO <sub>4</sub> )		Loss in % H <sub>2</sub> O	Loss in % organic content			
I	15000.8		0.83	2.93			
II	4971.4		1.01	3.29			
III	2599.6						
IV	1299.8						

Noteworthy is the high value of chloride and phosphate in the sample from the bothros area (Sample I). This sample was taken at a depth well below the level of the excavation and may possibly be connected with the function of that area in early periods.

Tab. 2 below shows trace elements extracted with 1-M ammoniumacetate pH 4.8. The analysis was carried out with a computer-controlled flame-modula spectrometer (ICP), at the Department of Geology and Geochemistry at Stockholm University.

Table 2

Sample	Na	Mg	Al	K	Ca	Mn	Fe	Cu	Zn
I	85	97	212	470	1338	50	56	1.1	4.2
II	57	91	135	309	2993	39	45	1.0	5.0

Unit: ppm

A preliminary soil stratigraphy, Tab. 3, concludes the analysis from the 1994 season. This was carried out on cores taken in the temple area with a pedogenic drill that provided samples of 0.15 m diameter. Levels (L)

are given for each layer as measured with a measuring tape. The classification was carried out in the field using Atterberg's grain-size curve.

Table 3

Sample	Location	Description
1	C1a/6	L 0.26 m. Three visible limits: 1) dark silt, fine sand; 2) lighter with small fragments of chalk and coal; 3) consists of a clear coal seam, below which the light and dark brown/grey silt and fine sand continues.
2	C1a/6-7	L 0.26 m. No distinct limits, the upper part was more clayish. Silt and sand.
3	C1d, northern part	L 0.26 m. Two layers can be distinguished: 1) dark loamy sand; 2) light silt and sand.
4	C1d	L 0.26 m. Three layers can be distinguished: 1) dark clayish sand; 2) dark loamy sand; 3) dark silt.
5	D1/16	L 0.26 m. Dark to black clayish sand with fragments of red-coloured brick. A sherd was found 0.022 m into the core. Abundant organic material.
6	D1	L 0.23 m. Two layers: 1) dark to dark grey/black sand with little clay; 2) fine sand and silt, very dark to black colour.
7	D1	L 0.26 m. Two layers visible: 1) sand and fine sand with little clay, dark to black colour with fragments of brick; 2) dark to black sand and fine sand.
8	B1Sa/11	L 0.20 m. One layer of sand and fine sand, black, with little clay.
9	B1Na/4	L 0.46 m. One layer of fine sand and fine sand, dark brown, with fragments of charcoal and burnt clay.
10	(no unit number)	L 0.19 m. One layer of medium brown, silty sand. Terrace wall?
11	(no unit number)	L 0.55 m. Black, dark clay, 'more than 0.10 cm long rolls'. Possibly an alluvial sediment.
12	(no unit number)	L 0.46 m. Two layers: 1) fine sand and sand with very small clay incrusts dark and dark brown in colour.
13	E1S/108	L 0.27 m. Four layers: 1) dark brown to black clay and fine sand; 2) as 1 but fatter, with fragments of bone; 3) fat and very organic, more brown in colour; 4) black, fat and more clayish.
14	East of E1S/19	L 0.255 m. One layer of fine sand and brown sand with fragments of chalk, charcoal, brick and adobe.
15	C1a/32	L 0.27 m. One layer of fine sand and sand with some more clay toward the bottom. Colour brown to dark brown, with fragments of pottery, brick, burnt clay, adobe and charcoal.