Figures from Chapter 3

FIGURE 3.1. Photomicrograph of lettering on Plaque I preserved in cuprite; x40 magnification.

FIGURE 3.2. Another region of Plaque I with concreted soil minerals and small botryoidal growths of malachite overlying the cuprite layer; x40 magnification.

FIGURE 3.3. Part of an unusual area of Plaque II showing flattened light blue corrosion over a light green-blue chalky surface; x50 magnification.

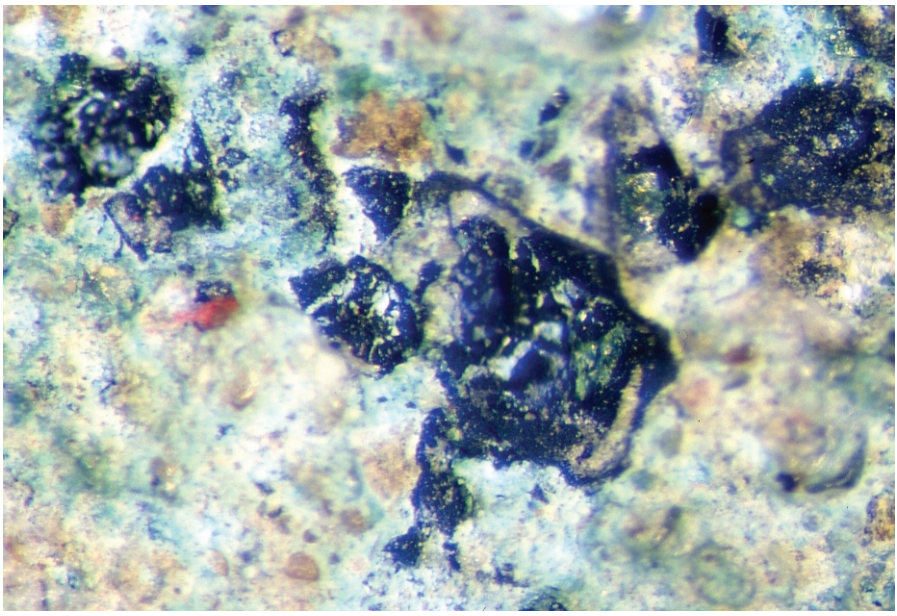

FIGURE 3.4. Azurite crystals with malachite background from Plaque II. These small crystals are often found intergrown with malachite on ancient copper alloys, especially in areas of elevated carbon dioxide concentration; x90 magnification.

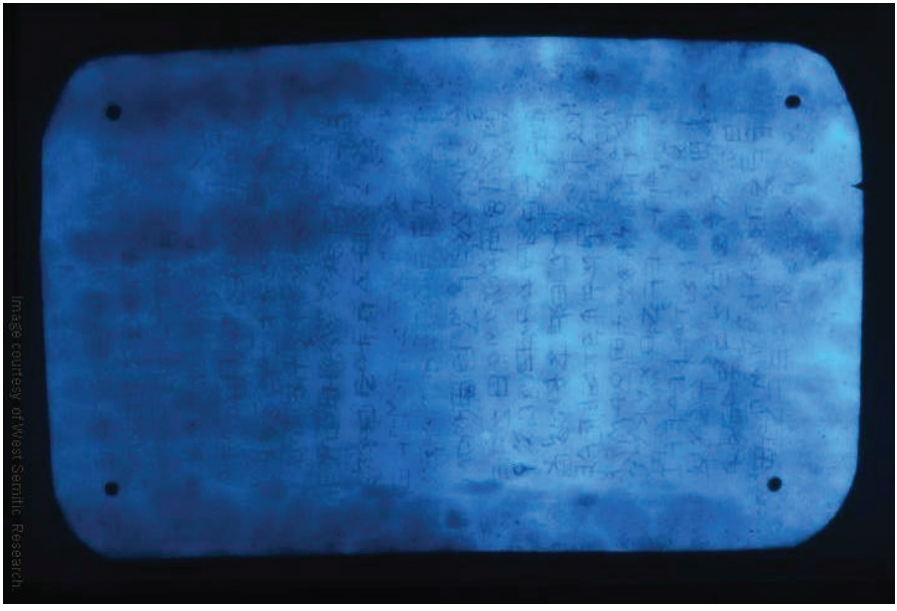

FIGURE 3.5. X-radiograph of the Greek Plaque II, showing characteristic mottling from hammering to shape and well-preserved lettering, some totally obscured by overlying corrosion.

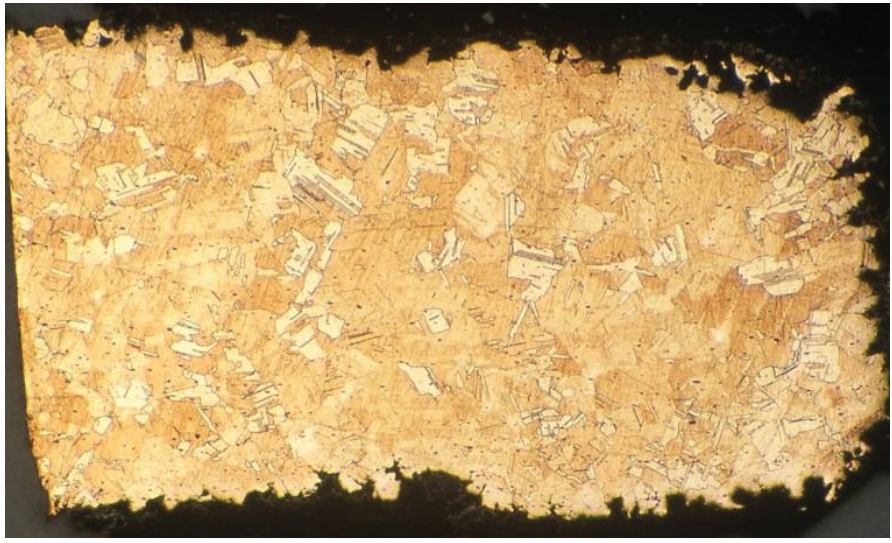

FIGURE 3.6. Photomicrograph of Plaque I, etched in alcoholic ferric chloride, showing large, twinned copper grains resulting from working and annealing of the copper to shape the plaques; x200 magnification.

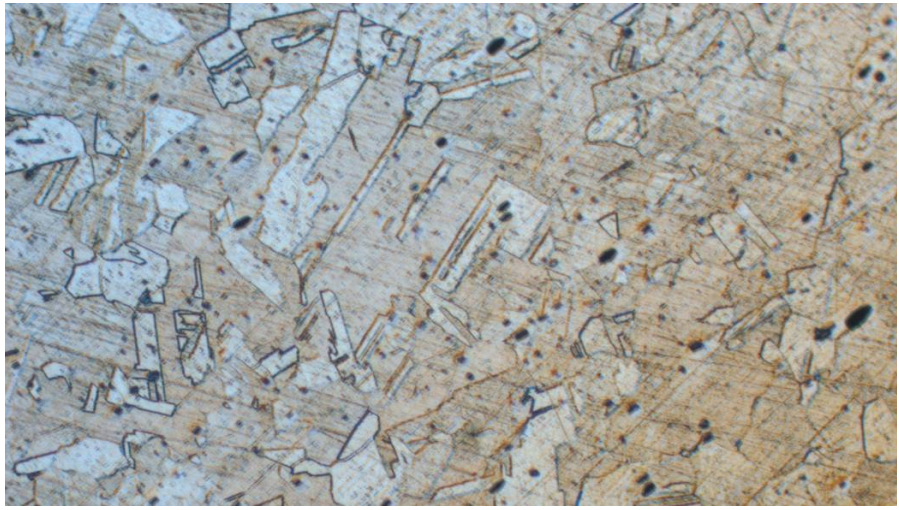

FIGURE 3.7. Photomicrograph of Plaque III, etched in alcoholic ferric chloride, showing the same large, recrystallized grains with straight twin lines; x250 magnification.

FIGURE 3.8. Unetched cross polar view of the cross section through Plaque I showing well-crystallized cuprite patina under a complex malachite crust. The tiny red spots visible in this section are of cuprite, showing that the copper was smelted from quite pure oxidized ores; x280 magnification.

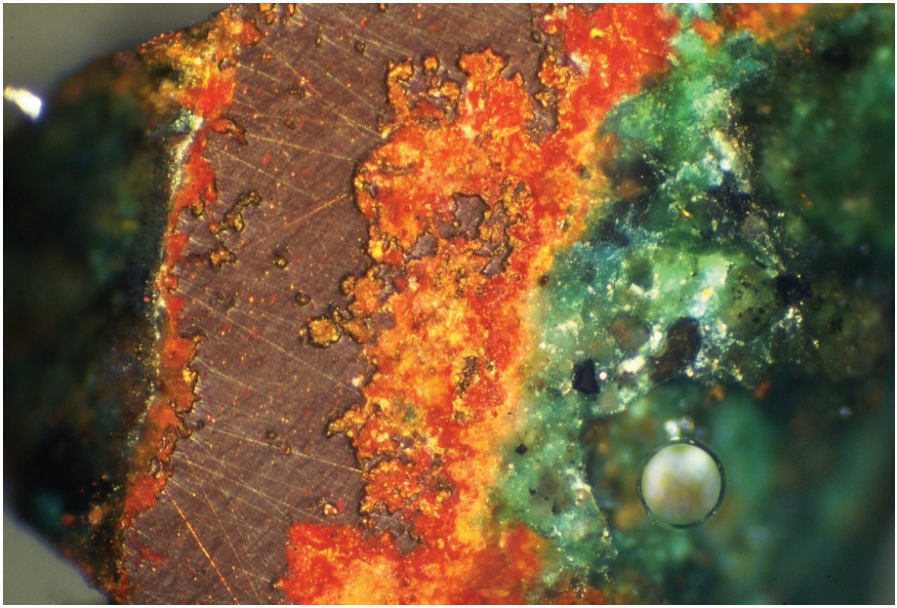

FIGURE 3.9. Photomicrograph of Plaque II under crossed polars, showing that cuprite has penetrated more than 500 microns into the copper grains with a crystalline malachite crust overlying this, particularly visible on the left-hand side of the photomicrograph; x180 magnification.

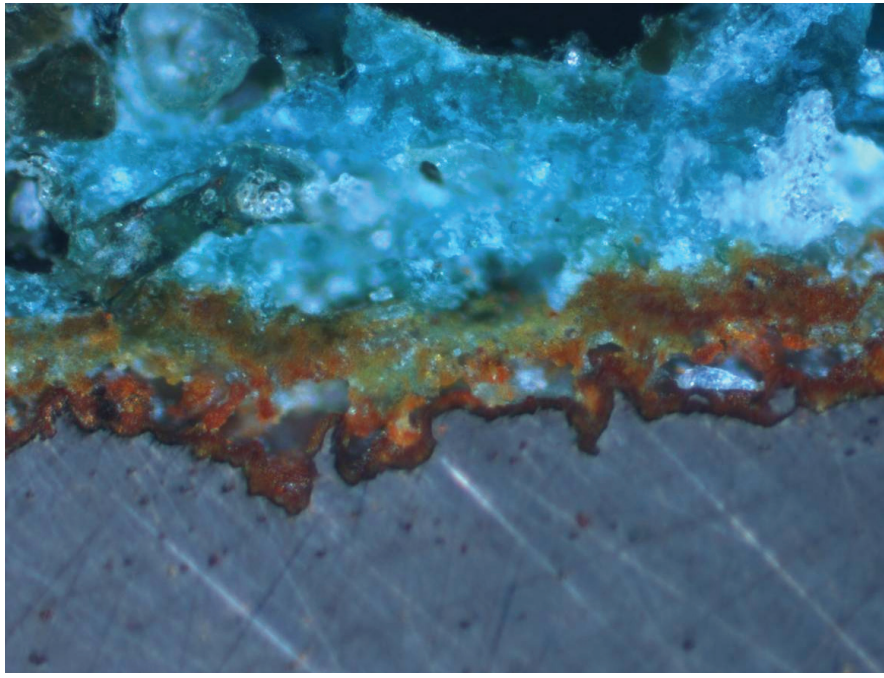

FIGURE 3.10. Polarized light view of the section through Plaque III showing some cuprite penetration along grain boundaries with a crystalline crust overlying the cuprite, shown to be a mixture of paratacamite and malachite; x260 magnification.

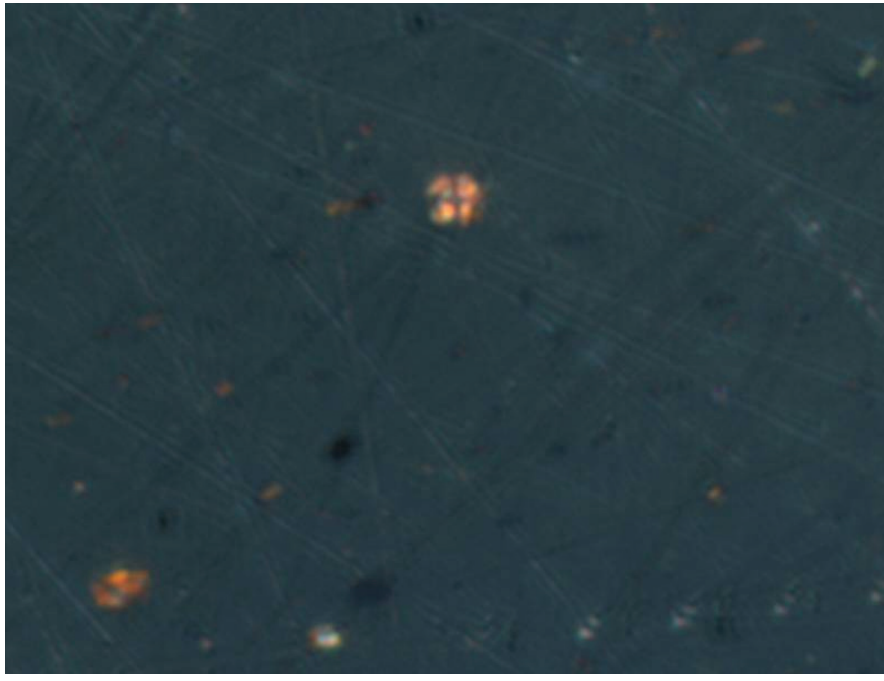

FIGURE 3.11. Cuprite under polarized light showing the stationary cross of the cubic optical indicatrix; x350 magnification, unetched.

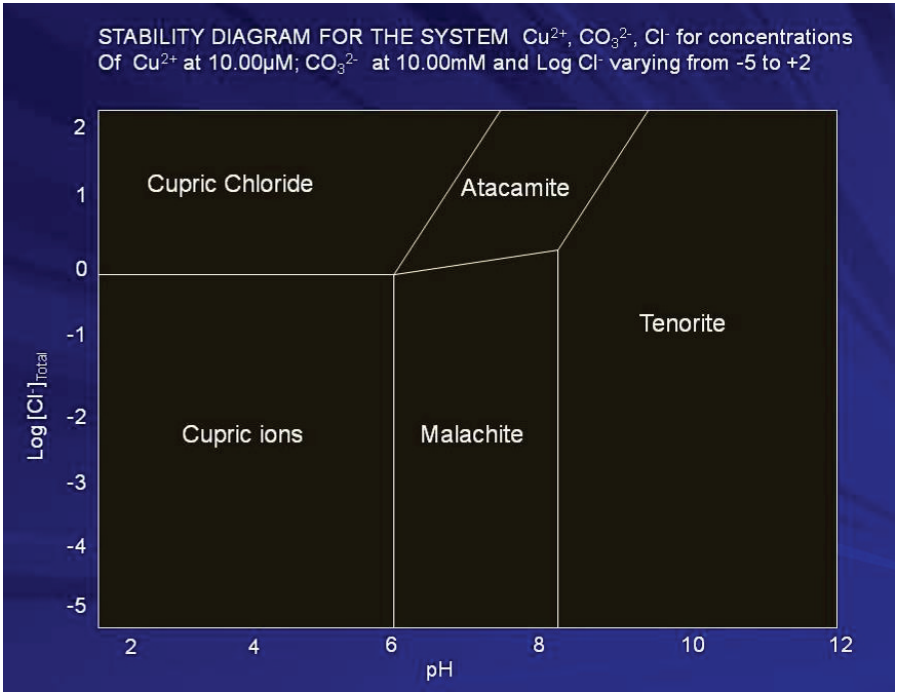

FIGURE 3.12. Pourbaix stability diagram for copper in solutions containing both chloride and carbonate ions.

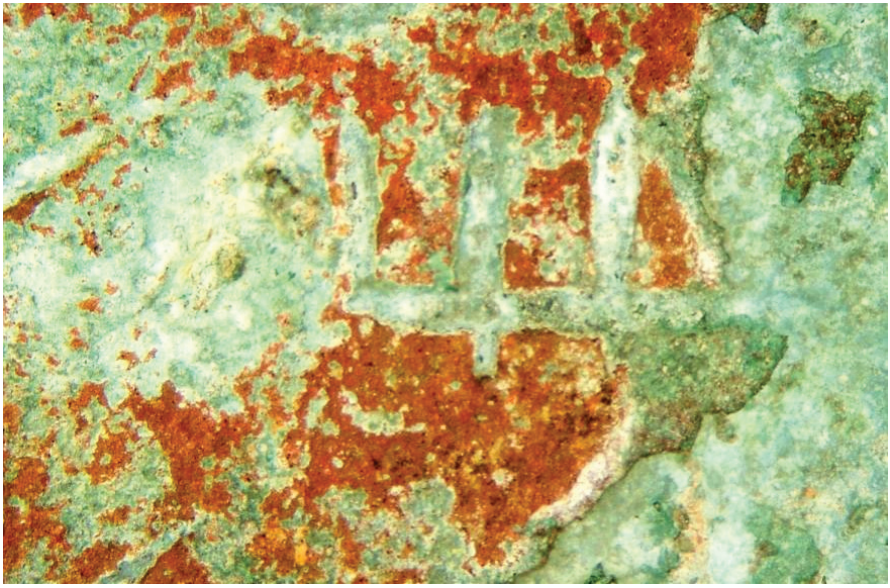

FIGURE 3.13. Epitaxial preservation of lettering within the cuprite layer is responsible for the perfect retention of shape of the inscribed letters (Plaque II); x90 magnification.

FIGURE 3.14. ESEM scanning electron photomicrograph showing spiral thickening of wood hardwood cells; uncoated, x2100 magnification. From this view it appears that the copper corrosion products are deposited over the thin spiral cellular structures.

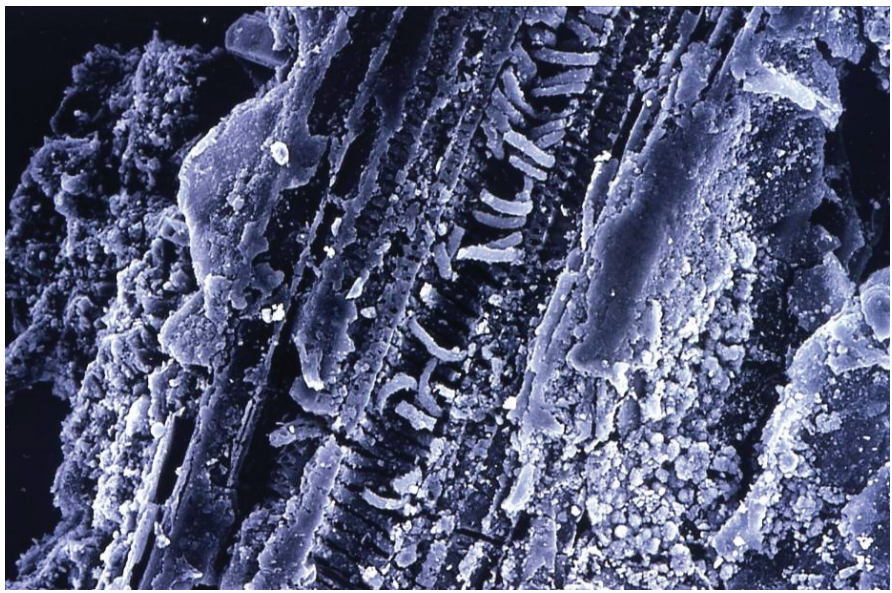

FIGURE 3.15. ESEM scanning electron photomicrograph of a surface area of Plaque I showing different regions of preservation of organic, wood structures with collapsed coils of malachite replacing spiral thickening of the tracheid cells; x1900 magnification.

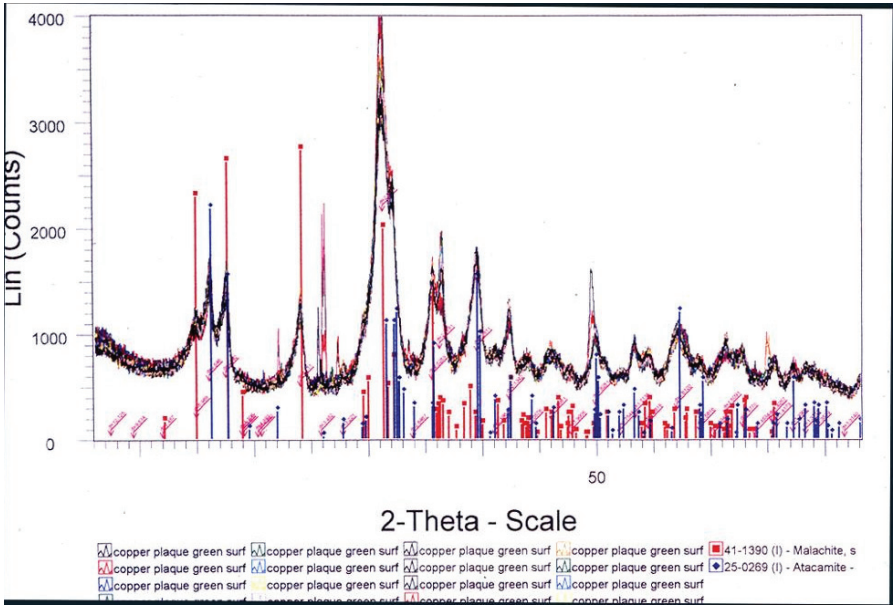

FIGURE 3.16. X-ray diffraction obtained in situ for Plaque III showing evidence for the presence of malachite and atacamite in the region chosen for examination.

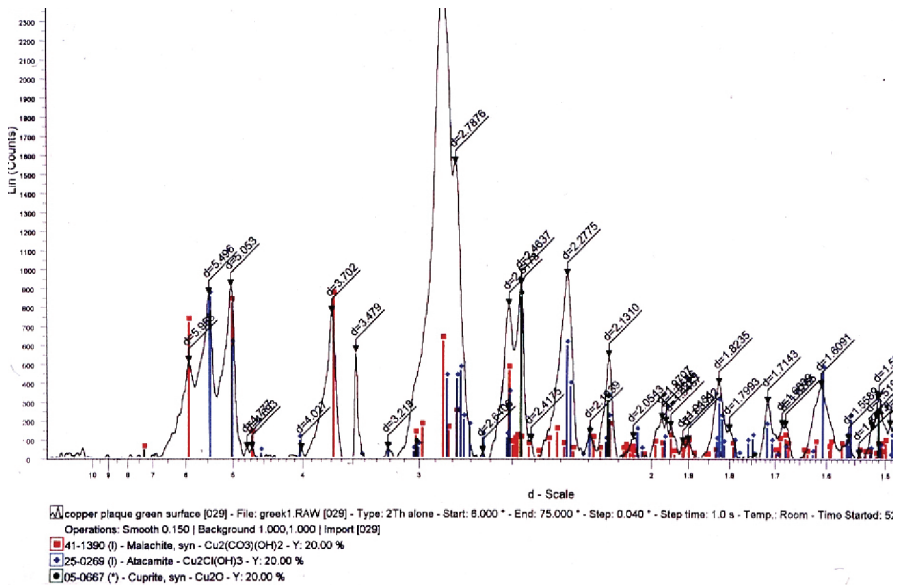

FIGURE 3.17. X-ray diffractogram for Plaque III showing the presence of cuprite, atacamite, and malachite.

Tables from Chapter 3

Plaque 1 "Norway 1"

	S	O	Pb	Sb	Sn	Cu	As	Ni	Fe	Total
#1	0.007	0.410	0.003	0.000	0.000	99.967	0.000	0.129	0.018	100.534
#2	0.000	0.562	0.000	0.000	0.000	100.113	0.000	0.241	0.013	100.929
#3	0.020	6.544	1.571	7.205	0.000	80.105	0.000	6.361	0.020	101.826
#4	0.010	0.525	0.003	0.000	0.000	99.386	0.000	0.173	0.015	100.112
#5	0.000	0.369	0.031	0.000	0.000	100.105	0.000	0.106	0.016	100.627
#6	0.009	0.409	0.110	0.053	0.000	98.744	0.000	0.276	0.016	99.617
#7	0.004	0.414	0.000	0.000	0.000	99.500	0.000	0.176	0.016	100.110
#8	0.010	0.350	0.016	0.000	0.000	99.708	0.000	0.170	0.005	100.259
#9	0.000	0.403	0.027	0.000	0.000	99.718	0.000	0.165	0.011	100.324
#10	0.009	0.365	0.000	0.000	0.000	100.260	0.000	0.148	0.013	100.795
#11	0.011	0.339	0.000	0.000	0.000	101.519	0.000	0.135	0.011	102.015
#12	0.009	0.318	0.000	0.000	0.000	99.843	0.000	0.149	0.004	100.323
#13	0.012	0.364	0.000	0.000	0.000	100.961	0.000	0.138	0.018	101.493
#14	0.014	0.346	0.029	0.000	0.000	100.000	0.000	0.292	0.011	100.692
#15	0.006	0.348	0.006	0.000	0.000	100.532	0.000	0.152	0.016	101.060
#16	0.001	0.395	0.074	0.030	0.000	99.884	0.000	0.327	0.016	100.727
#17	0.006	0.341	0.027	0.000	0.000	101.059	0.000	0.128	0.013	101.574
#18	0.000	0.368	0.000	0.000	0.000	101.361	0.000	0.143	0.014	101.886
#19	0.000	0.352	0.020	0.000	0.000	101.279	0.000	0.155	0.011	101.817
#20	0.000	0.489	0.042	0.000	0.000	100.082	0.000	0.488	0.009	101.110

TABLE 3.1. Electron Probe Microanalysis Data for Greek Plaque I

Plaque 2 "Norway 2"

	S	O	Pb	Sb	Sn	Cu	As	Ni	Fe	Total
#21	0.004	0.540	0.063	0.094	0.000	99.028	0.000	0.529	0.008	100.266
#22	0.000	0.349	0.000	0.000	0.000	99.343	0.000	0.089	0.012	99.793
#23	0.002	0.350	0.028	0.000	0.000	99.134	0.000	0.119	0.014	99.647
#24	0.004	0.454	0.008	0.093	0.000	98.556	0.000	0.308	0.012	99.435
#25	0.002	0.443	0.002	0.000	0.000	99.045	0.000	0.326	0.012	99.830
#26	0.005	0.369	0.006	0.000	0.000	99.901	0.000	0.201	0.011	100.493
#27	0.000	0.328	0.006	0.000	0.000	99.778	0.000	0.171	0.017	100.300
#28	0.071	1.326	7.016	0.000	0.000	88.168	0.890	0.112	0.008	97.591
#29	0.006	0.321	0.004	0.000	0.000	98.917	0.000	0.124	0.015	99.387
#30	0.007	0.419	0.069	0.000	0.000	98.637	0.000	0.171	0.017	99.320
#31	0.000	0.354	0.039	0.000	0.000	100.265	0.000	0.077	0.013	100.748
#32	0.010	0.357	0.000	0.000	0.000	99.981	0.000	0.163	0.013	100.524
#33	0.010	0.509	0.036	0.000	0.000	98.153	0.000	1.282	0.013	100.003
#34	0.007	1.559	0.179	0.721	0.000	94.903	0.000	2.519	0.005	99.893
#35	0.003	0.334	0.013	0.000	0.000	99.446	0.000	0.163	0.011	99.970
#36	0.005	0.357	0.000	0.013	0.000	99.229	0.086	0.418	0.008	100.116
#37	0.006	0.356	0.014	0.000	0.000	99.919	0.000	0.266	0.015	100.576
#38	0.000	0.376	0.014	0.000	0.000	101.216	0.035	0.143	0.015	101.799
#39	0.008	0.468	0.008	0.071	0.000	99.938	0.000	0.289	0.014	100.796
#40	0.000	0.337	0.025	0.000	0.000	100.107	0.000	0.162	0.011	100.642

TABLE 3.2. Electron Probe Microanalysis Data for Greek Plaque II

Plaque 3 "Wurtzberg"

	S	O	Pb	Sb	Sn	Cu	As	Ni	Fe	Total
#41	0.015	0.323	0.000	0.000	0.000	97.892	0.000	0.152	0.000	98.382
#42	0.009	0.293	0.000	0.000	0.000	98.107	0.000	0.153	0.003	98.565
#43	0.024	0.329	0.006	0.000	0.000	98.349	0.000	0.154	0.003	98.865
#44	0.009	0.342	0.000	0.000	0.000	98.212	0.000	0.152	0.007	98.722
#45	0.011	0.351	0.023	0.000	0.000	98.713	0.000	0.180	0.000	99.278
#46	0.012	0.365	0.011	0.000	0.000	97.476	0.014	0.157	0.009	98.044
#47	0.012	0.311	0.019	0.030	0.000	98.683	0.000	0.354	0.000	99.409
#48	0.012	0.321	0.032	0.000	0.000	97.780	0.000	0.240	0.000	98.385
#49	0.011	0.324	0.028	0.000	0.000	98.391	0.162	0.133	0.000	99.049
#50	0.017	0.339	0.023	0.000	0.000	99.193	0.000	0.133	0.007	99.712
#51	0.008	0.337	0.000	0.000	0.000	98.444	0.000	0.114	0.004	98.907
#52	0.020	0.366	0.532	0.000	0.000	97.835	0.000	0.112	0.003	98.868
#53	0.011	0.337	0.009	0.000	0.000	98.618	0.141	0.145	0.003	99.264
#54	0.022	0.346	0.000	0.000	0.000	98.501	0.000	0.146	0.000	99.015
#55	0.019	0.360	0.013	0.000	0.000	98.459	0.000	0.147	0.000	98.998
#56	0.024	0.342	0.014	0.000	0.000	98.329	0.000	0.183	0.009	98.901
#57	0.006	0.284	0.040	0.000	0.000	98.501	0.139	0.138	0.001	99.109
#58	0.012	0.725	0.230	0.383	0.000	95.637	0.000	0.637	0.002	97.626
#59	0.020	0.333	0.024	0.000	0.000	99.152	0.000	0.162	0.000	99.691
#60	0.031	0.320	0.000	0.000	0.000	98.271	0.000	0.191	0.007	98.820

TABLE 3.3. Electron Probe Microanalysis Data for Greek Plaque III