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Evaluation of 348 samples of the AIA (Anatolian Iron Age) project concerning pottery from Kinet Höyük
(publ. Grave, P., Kealhofer, L., Marsh, B., Gates, M.-H., 2008, Using neutron activation analysis to identify scales of interaction at Kinet Höyük, Turkey, JAS 35, 1974 – 1992)

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Part of the Anatolian Iron Age (AIA) project 2005-2009 concerned measurements of elemental concentrations of samples from Kinet Höyük, Turkey, spanning the periods from the LBA to the Hellenistic. This project has been described besides in the publication also in the web at: https://opencontext.org/projects/81d1157d-28f4-46ff-98dd-94899c1688f8 with the list of samples including photos and a link to the csv file for download. (https://opencontext.org/tables/10a33c66-0bc1-40fb-b832-8f55aca970c5.csv). G. Lehmann did send me this link and also the data in 2018.
The NAA data have been measured at the McMasters University research reactor in Ontario, Canada.

This data bank holds 348 samples with labels: Sample No or Sherd No (synonymous to AIA sample No). It contains the No's
3950 – 3961, 732 – 888, and 1545 – 1723. In the 2008 paper data of 12 sediments/clays samples (No 2248 – 2259) are given that are named in the web file 3950 – 3961. Additionally, 290 ceramic samples are mentioned in the publication (sum 302 samples). All clay samples have Cr values > 1000 ppm except 3952 and 3956 corresponding to 2250 and 2254, respectively.

The data bank gives the concentration values of 25 elements:

As,Ba,Ca,Ce,Co,Cr,Cs,Eu,Fe,Hf,K,La,Lu,Na,Nd,Rb,Sb,Sc,Sm,Ta,Tb,Th,U,Yb,Zn

No experimental uncertainties are given, so a general 5% for all elements and samples is inserted into the bank. The raw data of the 348 samples are listed in Appendix 1.

The search for samples of similar composition pointing to a similar clay paste used in one or several neighbouring pottery workshops at a certain location and therefore to a common origin is done here with the Bonn filter procedure (Mommsen et al. 1988, Beier and Mommsen 1994) considering experimental uncertainties and possible concentration variations (dilutions or enhancement) by the potter's recipes. The 19 elements

Ce, Cr, Cs, Eu, Fe, Hf, K, La, Lu, Nd, Rb, Sb, Sc, Sm, Tb, Th, U, Yb, K, Zn

have been used. Not considered during the group formation are 6 elements. Co and Ta (and W, not measured) are known to scatter, if a tungsten carbide (WC) burr has been used for the drilling during the sample taking. Sometimes Co values above 100 ppm are encountered that are certainly a measurement or recording error. As and Na are known to vary in pieces made in the same workshop due to firing conditions (As) or to pottery making practices (Na), respectively. They are not used, since they are measurable with NAA with an uncertainty of only about 1% and would because of their large weight influence or even dominate the group forming, since the uncertainties are considered. Ba and Ca scatter also due to a possible

contamination during storage in the ground or for Ca also due to possible pottery making practices. Since as mentioned, experimental uncertainties are considered in the statistical grouping calculations, elements measurable with NAA with low precision (like K, Nd, Rb, Sb, Tb, U, Zn) can be included, but, not knowing their experimental uncertainties, are allowed to vary in the formed groups up to 15 - 20%.

Other labels (Record, AIA) designate samples from other sources: the Sardis (Kealhofer et al. 2013) and the Troy data set (Grave et al. 2013), respectively. Members from these 2 sets in the Kinet groups are rare (labels Record from Sardis, AIA from Troy).

In the 2008 publication photos of sherds with given AIA No are shown in Fig. 4. These samples are in different groups here except for the 3 samples of group KHB3.6, that are with high probability assigned to a workshop at Miletos (MiGD, total 6 samples). Group KH2.1 holds many samples in our groups Ki-5 and Ki14. Other samples in KH2.2, KH2.5, and KH2.6 are here in the group Ki-5, too. The 4 samples of group KH4 are all very different in composition and singles.

The following groups could be formed here. We give the sample lists of the group members and the best relative fit factor of the sample with respect to its grouping values in brackets. Associated samples are given with a 'minus' and in most cases not members of the group, but singles.

Published Grave et al. 2008 group values KH3A2 (8 samples) are similar to the Bonn group KelA assigned to Kelenderis. A group of 28 (not 8) samples in the AIA data bank match pattern KH3A2 named here KeGA (Lehmann e al., in press).

Bonn KelA, here
KeGA (28) Sherd 748(0.95), 809(1.05), 811(0.97), 814(0.95), 815(0.88), 816(0.96), 822(1.04), 823(1.08) 827(0.99), 828(0.98),
Sherd 829(0.95), 834(1.01), 837(0.96), 838(1.14), 839(0.94), 844(0.96), 846(0.93), 852(1.13), 854(0.94), 855(0.95),
Sherd 1688(1.23), 1691(1.01), 1692(0.96), 1693(1.04), 1699(0.97), 1703(0.94), 1709(1.02), 1710(1.04),
KeGA - (1) Sherd 808

KH3A4 (2) Sherd 1573(0.98), 1585(1.02) (only these 2)

KH3A4+(2) Sherd 1716(1.00), 1717(1.00) (only these 2)

Ki-1 (5) Record 3722(1.01), 3759(1.01),Sherd 747(1.04), 1672(0.97),AIA 1056(0.95)

Ki-2 (31) Sherd 732(1.01), 734(1.04), 735(1.01), 736(1.02), 739(0.97), 754(0.97), 757(1.14), 760(1.03), 762(1.03), 789(1.00),
Sherd 791(1.00), 804(0.92), 813(0.91), 825(0.91), 831(0.94), 833(0.91), 853(0.90), 881(0.93), 888(0.96), 1556(1.06),
Sherd 1558(1.10), 1578(0.97), 1619(0.96), 1634(1.06), 1636(0.93), 1652(1.07), 1655(1.04), 1670(1.06), 1671(1.05), 1708(0.89),
Sherd 1712(1.06),

Ki-3 (6) Record 3720(1.00),Sherd 843(1.00), 850(0.86), 1679(1.05), 1687(0.97), 1696(1.10)

Ki-4 (9) Record 3659(0.85),Sample 3952(0.93),Sherd 800(1.01), 824(0.98), 836(1.13), 885(0.93), 1637(1.06), 1640(1.29),AIA 1045(0.89)

Sample 3952 is the clay No 2250 in the paper 2008, location 36 in Fig. 1b (~10 km north of Iskenderun). Th Cr value is low in this group (370 ppm).

Ki-4, Ki-6, Ki-7, Ki-8, Ki-9 all very similar except for Cr (but max. only 650 ppm for Ki-7) and Cs.

Ki-5 (51) Sherd 742(0.94), 759(0.93), 764(1.00), 780(1.08), 786(1.00), 787(0.93), 790(0.95), 792(0.93), 795(0.95), 796(0.91),
Sherd 801(0.88), 818(1.06), 819(0.95), 857(0.93), 866(1.15), 871(0.98), 874(1.11), 884(0.94), 1545(1.02), 1549(0.92),
Sherd 1559(1.06), 1560(1.12), 1566(1.04), 1567(1.25), 1568(1.02), 1569(0.85), 1589(0.95), 1594(0.90), 1595(0.87), 1597(1.04),
Sherd 1598(1.01), 1599(0.96), 1600(0.99), 1601(1.05), 1608(0.98), 1616(1.19), 1621(0.99), 1623(0.97), 1631(0.94), 1635(0.95),
Sherd 1638(0.98), 1639(0.97), 1657(1.04), 1658(0.88), 1659(1.01), 1661(1.05), 1683(1.04), 1684(1.17), 1711(0.96), 1713(1.13),
Sherd 1714(0.95)
Ki-5 - (6) Sherd 768 Sherd 812 Sherd 830 Sherd 851 Sherd 1586 Sherd 1627
sim. (factor 0.91) to Ki22 with Cr lower (375 ppm)

Ki-6 (12) Sherd 751(1.13), 763(1.11) 797(0.91), 807(0.89), 861(1.31), 868(1.32), 878(1.15), 1561(0.83), 1611(1.13),AIA 1040(0.80),
AIA 1041(0.80), 1084(0.88),
Ki-6 - (1) Sherd 1575
sim. (factor 1.18) to Ki-4 with Cs lower

Ki-7 (8) Record 3696(1.08),Sherd 793(0.92), 794(0.95), 799(0.96), 835(1.08), 1689(0.97),AIA 1069(0.93), 1817(1.11)
Ki-7 - (1) Sherd 798
sim. (factor 0.99) to Ki-4 with Cr higher
sim. (factor 1.10) to Ki-8 with Cr higher

Ki-8 (4) Sherd 810(1.07),AIA 1068(1.02), 1790(0.95), 1792(0.94)
Ki-8 - (2) Sherd 733 Sherd 1706
sim. (factor 0.91) to Ki-7 with Cr lower
sim. (factor 0.91) to Ki-4 with Cr lower and Sc higher

Ki-9 (13) Record 3679(0.84), 3747(0.93),Sherd 826(0.94), 1624(1.36), 1675(0.93), 1676(0.91), 1681(0.88), 1682(0.96),AIA 1001(1.12), 1022(0.94),
AIA 1054(0.91), 1070(1.30), 1826(1.10),
sim. (factor 0.80) to Ki-4 with Cs higher

Ki10 (2) Sherd 777(0.98), 1553(1.01)

Ki11 (3) Sherd 1552(1.02), 1555(0.95), 1622(1.02)

Ki12 (3) Sherd 782(1.03), 879(0.98), 887(0.98)
Cr 2600 ppm

Ki13 (6) Sherd 746(0.96), 788(0.91), 859(1.15), 864(1.20), 865(0.96), 1550(0.96), 1581(0.86), 1584(1.04), 1645(0.88), 1653(1.09),
Cr 1350 ppm

Ki14 (7) Sherd 773(0.98), 774(0.96), 776(0.96), 778(0.99), 779(1.05), 1626(1.14), 1660(0.94)
sim. (factor =0.96) to Ki-5 with Cs, Sc, Fe higher

Ki15 (3) Record 3681(0.93), 3723(1.04), 3753(1.03)

Ki16 (2) Sherd 1574(1.15), 1646(0.93)
Ki16 - (2) Sherd 1590 Sherd 1702

Ki17 (4) Sherd 1551(0.90), 1582(1.10), 1614(1.04), 1628(0.97)

Ki18 (2) Sherd 1674(1.01), 1677(0.99)
Ki18 - (1) Sherd 1673

Ki19 (3) Sherd 1564(0.98), 1565(1.02), 1571(1.00)

Ki20 (25) Sherd 737(1.08), 741(1.01), 753(1.04), 755(1.04), 756(0.93) 758(0.82), 767(1.06), 841(1.06), 876(0.70), 883(0.89),
Sherd 1548(1.16), 1557(1.02), 1562(0.91), 1563(0.95), 1572(0.92), 1587(0.90), 1591(1.03), 1596(1.09), 1602(1.05), 1612(0.86),
Sherd 1613(1.35), 1629(1.11), 1632(1.04), 1656(0.95), 1663(1.10),
Cr 1450 ppm
Ki20 – (!) Sample 3958 = 2256, K -, clay sample location 44 in Fig. 1b, north-east of Kinet Höyük

Ki21 (5) Sherd 738(0.97), 749(1.10), 775(0.79), 860(1.04), 1592(1.12)
Cr 1100 ppm

Ki22 (5) Sherd 770(0.90), 832(0.92), 1546(1.05), 1588(1.03), 1603(1.09)
sim. to Ki-5 except Cr higher (580 ppm)

possible provenance due to comparison with Bonn groups (is this archaeologically ok? please check):

Bonn EuA, here
EuGA (12) Record 923(0.84), 3754(0.98),Sherd 766(0.98), 802(1.14), 856(0.99), 1605(0.96), 1662(0.97), 1697(0.98),AIA 989(0.96), 1042(0.90), 1061(1.10), 1809(1.18),
EuGA - (1) Record 3755
EuGA x factor 1.04 = EuA with deviating Lu-Yb-Cr+

Bonn MilA/MilD, here
MiGD (6) Sherd 806(1.08), 1685(0.98), 1686(1.09), 1701(0.98), 1704(0.97),AIA 1049(0.89)
MiGD x factor 0.98 = MilD with deviating Sm+ only.

Bonn TeosB, here
TeGB (14) Record 892(1.04),Record 897(0.95),Record 3680(0.96), 3730(1.01) 3733(0.96), 3734(0.96),Sherd 840(1.00), 845(0.99), 847(1.01), 1667(1.05),

Sherd 1668(1.02), 1669(1.03), 1694(0.96), 1695(1.01),
TeGB - (1) Sherd 1700
TeGB x factor 1.09 = TeosB with deviating Sm+La+Cr+Eu (??? too many deviations??? TeGB really from Teos?)
A subgroup of 6 samples [Record 892(1.04), 3680(0.96), 3730(1.00),Sherd 840(1.00), 1694(0.96), 1695(1.01)] may be close also to a group Ulo3 with 'Lesbos Grey Ware' members.

more pairs:

=001	2 Sherd 1716	Sherd 1717	= KH3A4+ (2) see above
=002	2 Sherd 1570	Sherd 1625	
=008	2 Sherd 1610	Sherd 1698	
=010	2 Sherd 1577	Sherd 1579	(Cr 850 ppm)
=011	2 Sherd 750	Sherd 873	(Cr 700 ppm)
=025	2 Sherd 1641	Sherd 1642	(Cr 8000ppm)
=026	2 Sherd 3955	Sherd 3960	(Cr 1750 ppm, both clay samples close to Kinet Höyük)

The photos of the samples mentioned and shown in Fig. 4 are now mostly in different groups except for the 3 samples of group KH3B6 that are members of group MiGD probably assigned to Miletos.

Further matches with lower probabilities because of larger differences might be, please check, if archaeologically possible or better certain:

Ki-1 -- MYBE (north eastern Peloponnese: Argolid, Corinth)? (the 2 sherds from Sardis (label Record, s. above) are Corinthian!)
Ki-2 -- CypI (Enkomi)?
Ki-3 -- KroP (myc. Athens/Attica)?
Ki-4 -- TarB (Tarsus?)?
Ki-9 -- SamJ (Samos)?
Ki14 -- AlmA (Al Mina)?

Summary

The high and strongly varying Cr values in the Kinet Höyük plain shown by the clay samples suggest a regional local production of the vessels with these high Cr values. Therefore, the groups Ki12, Ki13, Ki20, and Ki21 can be assigned with high probability to local or regional production workshops, also the pairs =025 and =026.
The 22 chemical singles that have Cr concentrations > 1000 ppm are also probably locally made (740, 743 745, 752, 772, 798, 803, 821, 842, 851, 862, 1547, 1583, 1615, 1617, 1618, 1620, 1633, 1644 (9910 ppm!), 1649, 1650, 1702). Such variable Cr content occurs, if a small corns of a Cr mineral in varying numbers happened to be in the sample.
The imported pieces in the groups KeGA, EuGA, MiGD, TeGB should be archaeologically checked and validated as well as the other possible matches. The assignments (except for KeGA) are not certain due to possible inter-laboratory differences.

References:

Beier, Th., Mommsen, H., 1994, Modified Mahalanobis filters for grouping pottery by chemical composition, Archaeometry 36, 287 – 306.

- the same, 1994, A method for classifying multidimensional data with respect to uncertainties of measurement and its application to archaeometry, Naturwissenschaften 91, 546 – 548.

Grave, P., Kealhofer, L., Marsh, B., Gates, M.-H., 2008, Using neutron activation analysis to identify scales of interaction at Kinet Höyük, Turkey, JAS 35, 1974 – 1992.

Peter Grave, Lisa Kealhofer, Pavol Hnila, Ben Marsh, Carolyn Aslan, Diane Thumm-Dograyan, Wendy Rigter, 2013, Cultural dynamics and ceramic resource use at Late Bronze Age/Early Iron Age Troy, north-western Turkey." Journal of Archaeological Science 40(4): 1760-1777.

Kealhofer, L., Grave, P., Marsh, B., 2013, Scaling ceramic provenience at Lydian Sardis, Western Turkey, JAS 40, 1918 – 193.

Lehmann 2018, private communication

Lehmann, G., Shalev, Y., Mommsen, H., Ben-Shlomo, D., Daszkiewicz, M., Schneider, G., and Gilboa, A., in press, The Kelenderis Pottery Workshop(s): Newly-Identified Agents in East Mediterranean Maritime Exchange Networks in the Achaemenid Period, Levant

Mommsen, H., Kreuser, A., Weber, J., 1988, A method for grouping pottery by chemical composition, Archaeometry 30, 47 – 57.