PRELIMINARY REPORT ON INVESTIGATIONS OF WĀDĪ ATH THAAMD CLAY, CENTRAL JORDAN

Maria-Louise Sidoroff

Introduction

Wādī Ath THamad, and the clay therein, has been of interest to geologists (Bender 1975; Cordova *et al.* 2006), potters (Jacobs 2008; Sidoroff 2013: 79), and archaeologists (Braun 2007; Daviau 2012; Steiner 2006).This preliminary study of clay in Wādī Ath THamad begins with a geological overview of the region and describes investigations to determine if recent deposits of alluvial clay in the *wadi* were suitable for pottery manufacture.

So far, there is no evidence of pottery workshops in the Al Mudaynah Ath THamad Regional Survey area (Daviau *et al.* 2012), world-wide data (Arnold 1985: 21) attest to potters' preferred distance of one kilometer to travel for clay resources. This includes evidence from antiquity: Petra ('Amr 1997), Ayla (Parker 2014), and Lehun (van As and Jacobs 1995). This preference also holds true in Jordan for modern household workshops (Ali 2010; London and Sinclair 1991) and an industrial factory (Sidoroff 2015) as well as elsewhere in the region (Nicholson and Patterson 1985; Annis 1996-1997; Hasaki 2005). Furthermore, suitable potting clay from Wādī Ath THamad has been already identified by the Leiden University Ceramic Laboratory (Jacobs 2008).

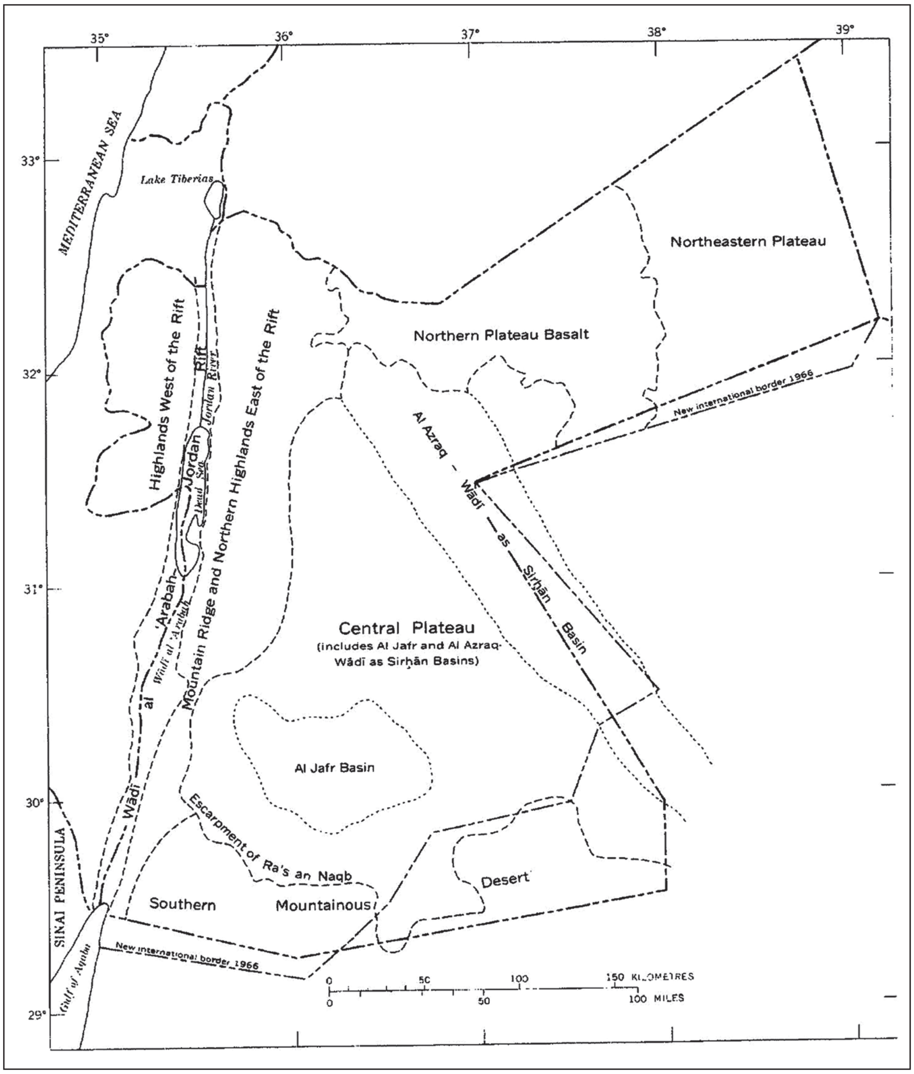
There are two complex archaeological sites within less than a kilometer of the *wadi*, the Iron Age town KHirbat Al Mudaynah and a Nabataean settlement with reservoir and villa (Daviau *et al.* 2012).This investigation seeks evidence to answer the question: Was Wādī Ath THamad the resource procurement zone for ceramic artisans who responded to consumer demands for domestic ware, ovens, and other clay objects?

Geology of Wādī Ath THamad Region

During the late Eocene, calcareous sediments were deposited in a shallow marine environment at a time when all of Jordan probably remained covered by the Tethys Sea (Bender 1975: 111). In this marine environment lived organisms that formed calcium carbonate shells and skeletons. When these animals died, their shell and skeletal debris accumulate as sediment that formed into deposits of limestone, the regional parent rock. The weathering of these formations creates the ath-Thamamad graben comprised of Cretaceous sediments.

The Wādī Ath THamad lies on the Mādabā-DHībān Plateau in the Northern Highlands east of the Rift (**Fig. 1**). The drainage of the Wādī Ath THamad graben is controlled by this tectonic structure. The depressed block of land which includes the Wādī Ath THamad is bordered by parallel faults between 10-20m above the *wadi* bottom, which is easily identified by the reddish brown color of its fill where pockets of sedimentation occurred (Cordova *et al.* 2005: 42). Red Mediterranean soil (RMS) (**Fig. 2**) comes from sediments eroded from more recently exposed Red Mediterranean Soils on the adjacent plateaus (Cordova *et al.* 2005: 33).

The Thamamd Terrace (**Fig. 3**) is a prominent feature; it is the highest of all the tectonic increase in land elevation. This is typical in a river system, due to the deposition of sediment in terraces between 10-20m above the *wadi*



1. Physiographic-geologic provinces, Jordan, (Bender 1975: 59).

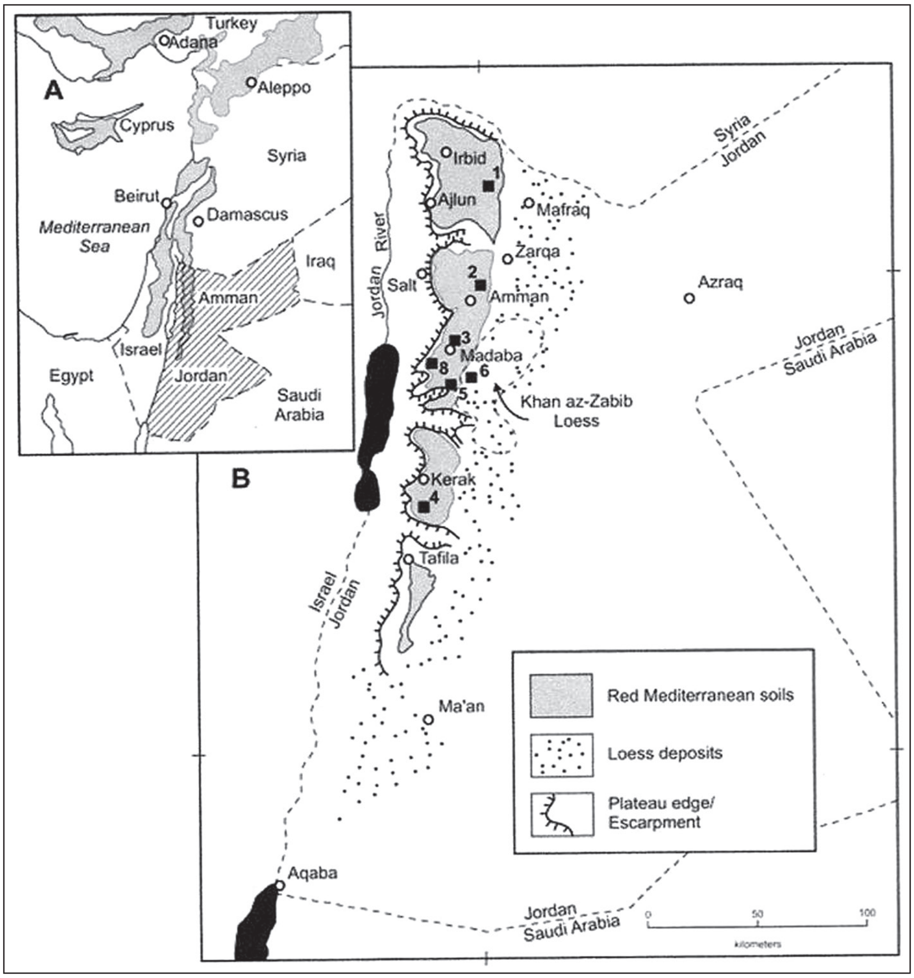
bottom, which is underlain by a thick and varied sequence of alluvial fill. Annual precipitation events in Central Jordan deposit between 200 and 400mm of water (Cordova *et al.* 2005: 30). Fine textured clay develops during transport through interaction of fast-moving waters and boulders. This naturally levigated alluvial clay is laid down several meters thick in recent deposits (Braun 2007). Annual precipitation events in central Jordan deposit between 200 and 400mm of water (Cordova *et al.* 2005: 30). Fine textured clay develops during transport through the interaction of fast moving waters and boulders. This naturally levigated alluvial clay is laid down several meters thick in recent period deposits (Braun 2007).

Color changes occur in raw *wadi* clay due to the presence of calcareous materials and RMS. Comparative analysis of colors of dried sediments, sampled in various years and locations, shows a variety of colors. For example, dried samples collected at 1-2 meters depth by Braun (2007) (**Fig. 4)** are very pale brown at 1-2 meters whereas Cordova's dried samples are light gray from one meter and yellowish brown at two meters depth from the surface (Cordova *et al.* 2005: 36).

Methodology

The approach in this report includes previous studies of Wādī Ath THamad clay and artifacts from excavations in widely separated time periods: Iron Age II town KHirbat Al Mudaynah (*ca.* 800-700 BC) and a Nabataean settlement (100 AD) with reservoir and villa (Daviau *et al.* 2012). (**Fig. 5**) aerial view)

To assess whether recent deposits of Wādī Ath THamad clay were suitable for pottery manufacture, samples were collected by University of Toronto graduate student G. Braun



2. Distribution of Red Mediterranean Soils in the Eastern Mediterranean,and deposits in Jordan (Cordova et al. 2005: 33).

(2007) and five years later by the author. The two groups of moist clay were tested for the property of plasticity. Test tiles were formed then fired to analyze for color and hardness. Also included, are two petrographic studies: a quantitative analysis of *wadi* clay and a study of pottery from the Nabataean site.

Method to DetermineP of a Clay Through Analysis of Particle Size of the Moist Clay

The term clay refers to very fine particles of a specific size, smaller than 2 micrometers. Typically, a good potting sediment must carry 35% of fine clay particles (Rice 1987: 38-39). In moist samples, this particle size is the indication of potting clay with good plasticity. For this analysis, 40ml of water were shaken in a clear plastic container with 10 ml moist clay until the clay particles were in complete suspension.

As explained by geochemist Velde (2012: 3), if one takes the product of weathering (that is, soil) and puts it into a beaker or glass, then stirs it up, a mechanical sorting is affected. The lightest and, more importantly, the smallest grains settle more slowly. As most silicates have about the same density (around 2.5 times that of water), grain size is an important factor in settling. The finer the grain, the more friction is affected on its surface as it falls through the water. This action is basically controlled by the ratio of the surface of the grain to its volume. As clays are the smallest materials in RMS, they tend to stay afloat longer and can be separated from larger grains. If the water remains cloudy after 2 hours this indicates the soil is god potting clay.

Test Firings for Color and Hardness Uniformity

Jordan probably remained covered by the Tethys Sea (Bender 1975: 111). In this marine environment, organisms existed capable of forming calcium carbonate shells and skeletons. When these animals died their shells and skeletal debris accumulate as sediment that formed into deposits of limestone becoming the regional parent rock. The weathering of these formations creates the Ath THamad graben comprised of Cretaceous sediments.

Besides quantities of clay within the *wadi*, growing along the edges of the *wadi* are grasses and low lying shrubs, which modern inhabitants collect for cooking fuel (pers. com.). They are also documented as a fuel among modern potters in the Middle East (Matson 1966: 151; 1974: 346) and elsewhere (Miller 2009: 125; Rice 1987).

For uniformity, all test firings were conducted in electric kilns with oxidizing atmospheres and colors were recorded with Munsell Soil Color codes. In order to understand the limits of the temperature range of fired local clay, test samples were fired at both low (650°C) and high (1023°C) temperatures.

A set of rectangular tiles (N=9) was made with Braun's moist clay samples, each measured: 5×3×0.5cm. The clay exhibited sufficient plasticity to roll out the ties without crumbling. A. Cordell, Director, Ceramics Lab, Florida Museum of Natural History, conducted the firing in an electric kiln at 650°C. This low temperature was used because spalls occur in pottery fired at high temperatures due to an abundance of calcium carbonate in the regional parent rock. During a firing, calcium carbonate decomposes and forms lime between 650°C and 900°C depending on duration and the atmosphere in the firing (Rice 1987: 98). When the fired object is exposed to atmospheric moisture, the lime swells and defects appear such as cracking and spalling in the clay walls.

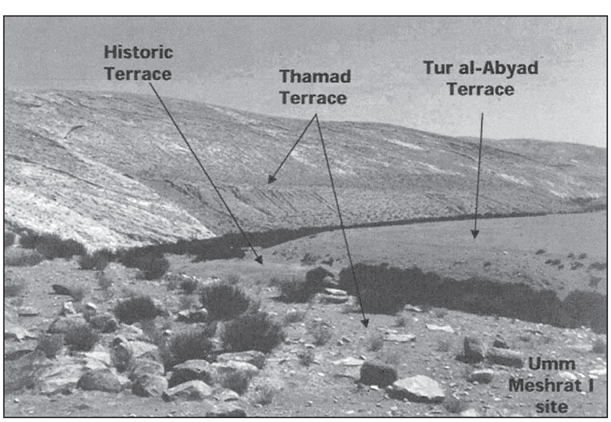
Round clay tokens (N=22), made with samples collected by the author, each measured 3cm diameter×0.5cm thickness. All were fired to cone 06 (1023°C) in the kiln of an art pottery studio. The following year another set of clay samples was collected by the author in Jordan. This time, upon return home, U.S Customs considered the moist clay samples as organic material and confiscated most of the clay. Only a small sample the size of a lemon was permitted. Two very thin tiles (2mm thick) were formed and fired hard at 650°C. This low temperature provides an insight into the technology of cooking pots with very thin walls, which were were excavated at the Nabataean settlement **(Fig. 6).**

The third group in the color study was Iron Age unfired clay artifacts excavated at KHirbat Al Mudaynah: loom weights (N=12) and oven fragments (N=5). The artifacts were later fired at 800°C by Laboratory Director Jacobs, at Leiden University (Jacobs 2008).

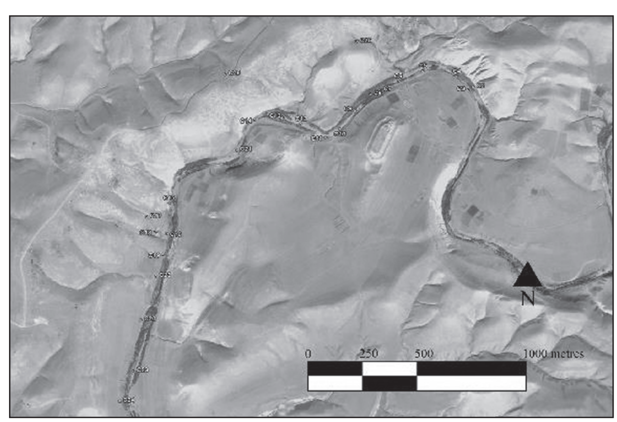
Methods in Quantitative Observations of Thin Sections of *Wadi* Clay

Fired samples of *wadi* clay collected by Braun (**Fig.4**) were thin sectioned at Spectrum Petrographics, Vancouver, WA. A select group of thin sections (N=9) was examined with a Westover petrographic microscope at 25× Grain size range was measured with Wentworth Scale (1922).

In a petrographic study of a group of Nabataean sherds (N=24) the slides were examined for provenance and technology with a focus on the *wadi* as a possible source of clay (Sidoroffand Ownby 2016) The study facilitated comparison of painted and unpainted ware excavated at the Reservoir and Villa at the Nabataean settlement.



3. Wādī Ath THamad (Cordova et al. 2005: 46).



4. Clay sampling map of Wādī Ath THamad (Braun 2007).

Results

Multidisciplinary evidence in this investigation of Wādī Ath THamad clay confirms the recent alluvial deposits as suitable for pottery manufacture and strongly suggests the clay was used by potters in antiquity.

Results of Particle Test of Moist Clay from Wādī Ath THamad and Colors of Fired Clay

Overall, samples of naturally levigated *wadi* clay may be characterized as having medium size clay particles since 75% of the clay samples from the *wadi* settled within less than 1/2 hour. This test suggests the clay might not be well suited for pottery. (**Table1)**

Since fine clay particles form the best potting clay, the author consulted L. Cowell, an experimental potter who made vessels with Braun's **clay sample** (WaT c 21), which is of medium not fine particle size**.** Cowell found this clay very plastic ("fat"). In an experimental study, she was able to throw several small thin-walled (3mm) Petra style bowls on a fast wheel. Each bowl was completed in less than one minute (Sidoroff 2013: 79).The bowls fired hard in Cowell's electric kiln at cone 06 (1023°C).

Results of Fired Colors in *Wadi* Clay Samples and Iron Age Artifacts

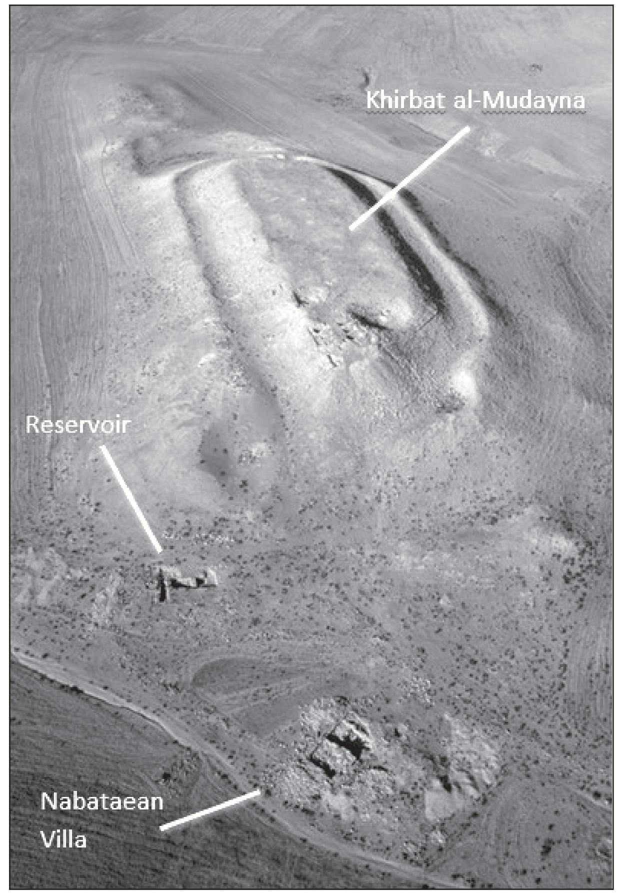
Color data from fired *wadi* clay and refired Iron Age artifacts were from three contributors: Braun (2007), Sidoroff (2013) and Jacobs(2008) (**Table 2**).

Braun's clay tests (N=9) fired to 650°C could be broken at the corner with two exceptions (WaTc 20 (pink) and WaTc 24(reddish yellow). Both samples were gathered at 1-2 meters depth with Braun describing them as RMS due to iron content. Clay that contains iron becomes a reddish or pinkish color when fired in an oxidized atmosphere between 850°C- 1000°C degrees Hamer and Hamer 1975: 25).

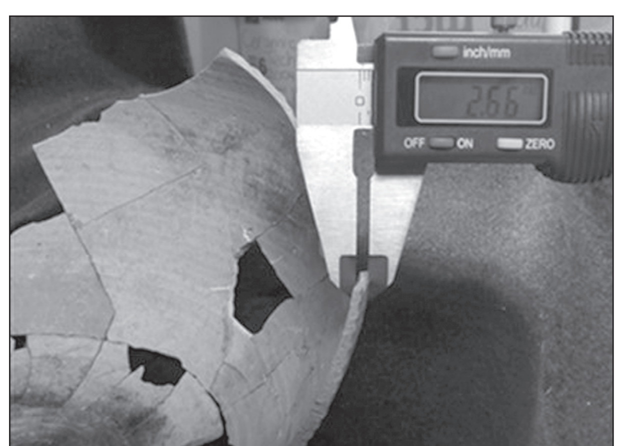
Reddish yellow (7.5 YR 6/6) the most frequent fired color of recent *wadi* clay is also the color of Iron Age refired loom weights. This reddish color*Terra Rosa* was influenced by Red Mediterranean soils in the regional clay(**see Fig. 2**).

Most of the Sidoroff clay tokens (N = 22) fired at 1023°C spalled upon removal from the kiln. Only four tokensfired hard: two 5YR7/4 (pink) and two7.5YR7/6 (reddish yellow). The small lemon size ball of clay was formed into two thin test tiles (thickness = 2mm) and fired hard at 650°C.

Clay in the Iron Age loom weights (N=7) fired hard at 800°C though containing Ostracoda (N=3) and organic fiber (N =2), both probably



5. Aerial view of KHirbat al-Muddyna and the Nabataean settlementon the south bank of a bend in Wādī Ath THamad (APAME_1998052-DLK-0006, David Kennedy).



6. Cooking pot P704, thickness of walls 2.66mm (Photo: B. Haberstroh MD).

added as temper (Jacobs 2008). The clay in some loom weights (N=4) was identified as good for pottery manufacture. Oven fragments (N = 5) fired to light colors: white, pale brown with more than half fired pink (Jacobs 2008). Light firing clay may be exclusive to oven construction and firing temperatures have been controlled at 800°C.

Table 1: Unfired and fired clay colors with results of particle test.

Sample #	Color of unfired clay	Unfired clay particle size	Color of Oxy fired clay	UTM coordinates (WGS84 datum) (Braun 2007)	Extraction location (Braun 2007)	Comments (Braun 2007)
WaT c 5	7.5YR 7/3 (pink)	medium	7.5YR 6/6 (reddish yellow)	36R 0776116/3498839	*wadi* bed	recent alluvial deposit
WaT c 7	10YR 7/4 (very pale brown)	medium	7.5YR 7/4 (pink)	36R 0775921/3498747	*wadi* bed	recent alluvial deposit; relatively few inclusions
WaT c 17	10 YR 7/4(very pale brown)	fine	7.5YR 7/4 (pink)	36R 0774862/3498138	vertical cut in upper terrace	located 1-2 meters below surface; adjacent to Umm Meshrat I
WaT c 20	10 YR 7/4 very (pale brown)	medium	7.5YR 7/4 (pink)	36R 0774843/3497665	vertical cut in lower terrace	located 1-2 meters below surface; adjacent to Umm Meshrat I; RMS deposit?
WaT c 21	10YR 7/4 (very pale brown)	medium	7.5YR 7/4 (pink)	36R 0775270/3498454	*wadi* bed	recent alluvial deposit; relatively few inclusions; 2 kg to L. Cowell
WaT c 22	10YR 7/4 (very pale brown)	medium	7.5YR 6/6 (reddish yellow)	36R 0774910/3497865	bank of lower terrace	surface; eroded RMS deposit?
WaTc 23	10YR 7/4 (very pale brown)	medium	7.5YR 6/6 (reddish yellow)	36R 0774910/3497426	*wadi* bank	Historical recent alluvial deposit
WaT c 24	10YR 7/4 (very pale brown)	medium	7.5YR 6/6 (reddish yellow)	36R 0774756/3497290	vertical cut in lower terrace	located 1-2 meters below surface; RMS deposit
WaT c 25	10YR 7/4 (very pale brown)	finel	7.5YR 6/4 (light brown)	36R 0775805/3498957	vertical cut in upper terrace	located 1-2 meters below surface; RMS deposit

Table 2: Fired colors of *wadi* clay and refired Iron Age artifacts (Braun 2007; Jacobs 2008).

Fired colors of Wādī Ath Thamad clay & artifacts	Wādī Ath Thamad (Braun 2007, Sidoroff 2011)	Iron Age loom weights, KHirbat Al Mudaynah Jacobs (2008)	Iron Age oven fragments, KHirbat Al Mudaynah (Jacobs (2008)	Total	Comments
white			1 (10YR 8/1)	1	
pink	4 (7.5 YR 7/4)		5 7YR 8/3	9	Frequent fired color of Wādī Ath Thamad, Artisans chose ow iron clay
very pale brown		3 (10YR 7/3)	1 (10YR 8/3)	4	Iron Age artisans chose low iron clay.
light brown	1 (7.5YR 6/4)			1	
red				1	M.Steiner (2006) "red" may be reddish yellow if Munsell coded
reddish yellow	10 (7.5YR 6/6)	4 (5YR 6/6)		14	Frequent fired colors of Wādī Ath Thamad clay and artifacts

M. Steiner identified "red" as the dominant color of Iron Age fired clay bodies in domestic ware excavated at KHirbat Al Mudaynah. Her analysis of the ceramic fabric suggests at least three specialized pottery workshops serving Iron Age markets (Steiner 2006: 107). Based on the fired color of the clay, there are probably functional differences such as red firing clay better for cooking pots. For other objects, fired colors were pink and pale brown with large amounts of micro fossils and less iron.

Results of Quantitative Observations of Thin Sections of Local *Wadi* Clay

Quantitative analysis indicates over 60% of the samples are dominated by fine angular shaped grains and 75% of larger grains range between 1 and 0.5mm (**Table 3).** In thin section slides, large grains were either sub-angular or sub-rounded suggesting transport over a long distance from the source. Rapid flow of clay into the *wadi* during the rainy season creates natural levigation, a process that would retain the very small angular grains, the fine black needle shaped grains (possibly hematite, after Cordova (2005) or basalt, after Braun 2012). Red iron oxides contributed to the strong yellowish red color of the test tiles.

Results of the study of Nabataean cooking pot and unpainted bowls indicated similar technological style of levigated clay, wheel forming, and oxidized atmosphere in firing. Two unpainted bowls were spectrographically different from other fire ware bowls and similar to one cooking pot. Potentially the three were made with *wadi* clay, although overall similarity to the clay samples was low (Sidoroff and Ownby 2016: 211). However, the lack of very common silty quartz in the pottery pastes may suggest an even older deposit of clay or a source on the terrace was exploited as well.

In Nabataean vessels and *wadi* clay with fine black inclusions present in test tiles and artifacts, may signal a signature of Wādī Ath THamad clay. Two unpainted bowls (N74/3.2 and L32/7.4) present fine black inclusions, possibly Biotite in the clay body (Sidoroff and Ownby 2016). In a quantitative thin section analysis of *wadi* clay (see **Table 3**) similar inclusions are also present. Fine black inclusions are also noted as hematite Cordova *et al.* (2005) and Braun (2007) suggested basalt.

Table 3. Quantitative observations of thin sections with binocular microscope, ×25.

Code	Small grains in sample (%)	Shape of small rains	Large grains in sample (%)	Size of large grains (mm)	Shape of large grains	Comments
WaT c 5	50	angular and needle	2	1 ~ 0 .5	subangular	15% fine black/red grains and clasts
WaT c 7	50	angular and needle	< 1	< 0.5	subangular	thin black rims around some large grains and 15% fine black/red grains
WaT c 17	1	angular and rare needle	< 1	< 0.5	subangular	rare fine black/red grains and rare tiny or large grains 2 complex clasts
WaT c 20	50	angular and needle	3	< 0.5	Subangular oval, and unusual	fine 15% black/red grains and clasts
WaT c 21	2	angular and no needle	< 1	< 0.5	subangular ~ subrounded	rare black/red grains and rare tiny or large grains
WaT c 22	50	angular and rare needle	1	< 0.5	subangular ~ subrounded	15% fine black/red grains and clasts
WaTc 24	50	angular and rare needle	< 1	< 0.5 and rocks > 1mm	subangular ~ subrounded	15% fine black/red grains and many clasts
WaT c 25	40	angular and needle	1	> 1	subrounded	new types of grains

Discussion

This study presents thought provoking evidence that the quantities of fine naturally levigated clay in Wādī Ath THamad may have influenced development of ceramic workshops in the region. As Peacock pointed out (1982: 9), workshops are favored when there is availability of raw materials, labor, and markets. Regional surveys and excavations at nearby complex sites, Iron Age KHirbat Al Mudaynah and a Nabataean settlement, revealed great quantities of domestic, industrial, and ritual ceramic wares. However, no pottery workshop has been uncovered in the region to date.

Analysis of 2,830 Iron Age sherds from surface survey identified six fabric types all with small inclusions and fired in oxidized atmospheres (Daviau and Steiner 2000: 15, N.42). Daviau identified the clay as "local" because the great quantity of sherds in the region displayed technological uniformity in fabric types. Fine inclusions in the fabric of regional pottery through time suggest the primary resource procurement zone was the naturally levigated clay from Wādī Ath THamad.

The colors of fired artifacts reveal potter's behavior in choice of certain clay for a particular function. Iron Age potters chose light firing clay for a specific type of vessel such as kraters while iron rich clay from Red Mediterranean Soils was for ovens and red fired cooking pots (Steiner 2006: 1007).

A group of Nabataean sherds was examined petrographically with a focus on the *wadi* as a possible source of the clay (Sidoroff and Ownby 2016). Results indicated similar technological style in the sherds: levigated clay, the potter's wheel for forming, and an oxidized atmosphere in firing. Two unpainted bowls were spectrographically different from other bowls and similar to one cooking pot. Potentially the three vessels were made with *wadi* clay (Sidoroff and Ownby 2016: 211).

Quantitative petrographic data indicate some Nabataean artifacts present a fabric with fine black inclusions, which are also in some *wadi* clay samples. Observations by scholars found similar particles in local pottery and test tiles of *wadi* clay. Once identified, the particles may be a signature mineral of Wādī Ath THamad clay.

Experimental data confirm the workability of recent clay deposits, which flow from the same parent formations as clay during the Iron Age and Nabataean periods.

Conclusion

Preliminary data in this study suggests Wādī Ath THamad qualifies as a potential resource procurement zone for artisans who satisfied demands for ceramic wares at nearby complex archaeological sites.

Maria-Louise Sidoroff, Ph. D.
maria.sidoroff@gmail.com
P.O. Box 967
Hobe Sound, Fl 33475

Bibliography

Ali, N.
2010 Regionalism and Social Landscape as Inferred from an Ethnoarchaeological Study of Pottery Production in Jordan. *Journal of Anthropological Research* 66: 351-373.
Amiran, R. and Shenhav, D.
1984 Experiments with an Ancient Potter's Wheel. Pp. 107-112 in P. Rice (ed.), in *Pots and Potters: Current Approaches in Ceramic Archaeology*. Los Angeles: Institute of Archaeology University of California.
'Amr, K.
1997 The Changing Landscape of the Clay Deposits at 'Ayn at-Tinah, Wadi Musa. *SHAJ* VI:121-126.
Annis, M. B.
1997 Sardinia (Italy): Fieldwork and the Laboratory. *Ceramic Ethnoarchaeology Newsletter of The Department of Pottery Technology* 14/15: 103-120. Leiden University.
Arnold, D.
1985 *Ceramic Theory and Cultural Process*. Cambridge: Cambridge University Press.
Bender, F.
1975 *Geology of the Arabian Peninsula Jordan*. Geological Survey Professional Paper 560. U.S. Department of Interior, Washington DC.
Braun, G.
2007 *Clay Resource Procurement in Wadi ath-Thamad*, Unpublished Paper.
2012 Production and Trade in a Moabite Towm: Petrographic Evidence from an Industrial Complex at Kirbat al-Mudayna, Paper Presented at American Schools of Oriental Research Conference, New Orleans.
Cordova, C.; Foley, C.; Nowell, A. and Bisson, M.
2005 Land Forms, Sediments, Soil Development, and Prehistoric Site Settings on the Madaba-Dhiban Plateau, Jordan. *Geoarchaeology: An International Journal* 20: 29-56.
Daviau, P.M.M.; Chadwick, R.; Weigl, M.; Johnston, E.K.; Gohm, C.J.; Edwards, S.; Ladurner, M.;

Mulder-Hymans, N. and Ferguson, J.
2012 Excavation at Kirbat al-Mudayna and Survey in the Wadi ath-Thamad: Preliminary Report on the 2008, 2010, and 2011 Seasons, *ADAJ* 56: 269-308.

Daviau, P.M.M. and Steiner, M.
2000 A Moabite Sanctuary at Kirbat al-Mudayna. *BASOR* 320:1-21.

Hamer, F. and J. Hamer.
1975 *The Potter's Dictionary of Materials and Techniques*. New York: Watson-Guptil,

Hasaki, E.
2005 The Ethnoarchaeological Project of the Potter's Quarters at Moknine, Tunisia: Seasons 2000, 2002. Africa, *Nouvelle Série Séances Scientifiques* III: 137-810.

Jacobs, L.
2008 *Analysis of Ceramic Artifacts from MT-Mudayna. Ceramic Laboratory of the Faculty of Archaeology, Leiden University*. (unpublished report).

London, G. and Sinclair, M.
1991 An Ethnoarchaeological Survey of Potters in Jordan. Pp. 420-428 in L.G. Herr; L.T. Geraty; O. LaBianca and R. Younker (eds.), in Madaba Plains Project 2: The 1987 Season at Tell el-Umeiri and Vicinity and Subsequent Studies vol 2, 8. Berrien Springs: Andrews University Press.

Matson, F.R.
1966 Power and Fuel Resources in the Ancient Near East. *Advancement of Science* 23: 146-153.
1974 The Archaeological Present: Near Eastern Village Potters at Work. *AJA* 78: 345-347.

Miller, H.M.L.
2009 *Archaeological Approaches to Technology*. Walnut Creek, CA: Left Coast Press.

Nicholson, P. and Patterson, H.
1985 The Ballas Pottery Project Not Use. *Anthropology Today* 1(2): 16-18.

Parker, S.T.
2007 Beyond Frankincense and Myrrh. Pp. 349-357 in T.E.Levy; P.M.M. Daviau and M. Shaer (eds.), in *Crossing Jordan: In North American Contributions to the Archaeology of Jordan*. London: Equinox.

Peacock, D.P.S.
1982 *Pottery in the Roman World: An Ethnoarchaeological Approach*. London: Longman,

Rice, P.M.
1987 *Pottery Analysis*. Chicago, IL: University of Chicago Press.

Sidoroff, M.L.
2013 Unpainted Petra Style Bowls from Wadi ath-Thamad, Jordan: A Technological Focus. Pp. 75-81 in N.I. Khairy and T.M. Weber (eds.), in *Studies on the Nabataean Culture I*. Amman: University of Jordan.
2015 An Ethnoarchaeological Study of the Zizia Pottery Factory in Jizza, Jordan. 7: 86-113.

Sidoroff, M.L. and Ownby, M.
2016 Preliminary Petrographic Study of Nabataean Painted and Unpainted Fine Ware Bowls from Mudayna Thamad, Jordan. Pp. 198-214 in N.I. Khairy and T.M. Weber (eds.), in *Studies on the Nabataean Culture I*. Amman: University of Jordan.

Steiner, M.
2006 The Iron Age Pottery of Khirbet Al-Mudayna and Site WT-13 in Jordan. *Leiden Journal of Pottery Studies* 22:1001-1009.

van As, A. and Jacobs, L.
1995 An Examination of the Clays Probably Used by the Ancient Potters of Lehun, (Jordan). *Newsletter: Department of Pottery Technology, Leiden University* 13: 15-25.

Velde, B.
2012 Clay Minerals. Pp. 1-7 in *Terra Literature Review: An Overview of Research in Earthen Architecture Conservation*. Los Angeles: Getty Institute.

Wentworth, C.K.
1922 A Scale of Grade and Class Terms for Clastic Sediments. *Journal of Geology* 300: 377-392.