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PLASTER FLOOR PRODUCTION AT THE NEOLITHIC SITE OF AIN GHAZAL, JORDAN

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ABSTRACT

Petrographic and petrological techniques have been used to examine Jordanian Neolithic plaster floors from Ain Ghazal, Ain Jamman and plastered walls from Basta. The analyzed plaster samples show that there is a significant difference in the quantities of burnt lime of marl needed in construction of plaster floors. It is more probable to suggest that in order to reduce the amount of burnt lime needed, additive materials such as non-burnt lime or marl, chert, bones, shells, and pottery sherds were used. This suggests that burnt lime was minor in use than the non-burnt lime or marl.

KEYWORDS: Jordan, Plaster, Ain Ghazal, Neolithic

INTRODUCTION

The Pre-Pottery Neolithic B period in the Levant witnesses a dominance of lime plaster and gypsum production. This technological aspect has been identified in several archaeological records during this period and has been employed in several domestic uses. These include: White Ware "Vaisselle Blanche" production (Balfet et al. 1969; Kafafi 1986), architectural uses such as house floors, plastered hearths, plastered walls, and ritual uses such as plastered skulls and statute manufacturing (Aurenche 1981; Rollefson 1983).

Like other handicraft techniques, lime and gypsum plaster production has been investigated by several scholars so as to understand and explain two controversial issues: (a) to explain plaster and gypsum technology and (b) to explain plaster production and its social and economic implications.

Several achaeological litreatures focused on both analytical and use of plaster during the Neolithic period in the Near East. (Frierman 1971; Gourdin and Kingery 1975; Aurench and Marechal 1985; Kingery, Vandiver and Prickett 1988). Other used the technological results so as to explain the segments of this activity and its social implication (Garfinkel 1987). It has been suggested that plaster production is a complex activity which requires organized effort and specialization. This assumption is based on the fact that the out-product of this activity requires a great amount of preparation of the raw material and the fuel (Gourdin and Kingery 1975; Garfinkel 1987; Kingery, Vandiver and Prickett 1988). Others however suggest that plaster production is a secondary activity which did not require firing large amounts of fuel and lime (Goren and Goldberg 1991). Others have proposed a correlation between plaster production and its ecological effects during the Neolithic period. They assumed that plaster production needs firing tons of wood as a fuel to product lime plaster. This process, in turn, would affect the ecological balance of the site catchments during the PPNB (Rollefson and Koheler-Rollefson 1989; Rollefson 1990). This argument could be supported by an observed decrease of lime production in the following Neolithic phases.

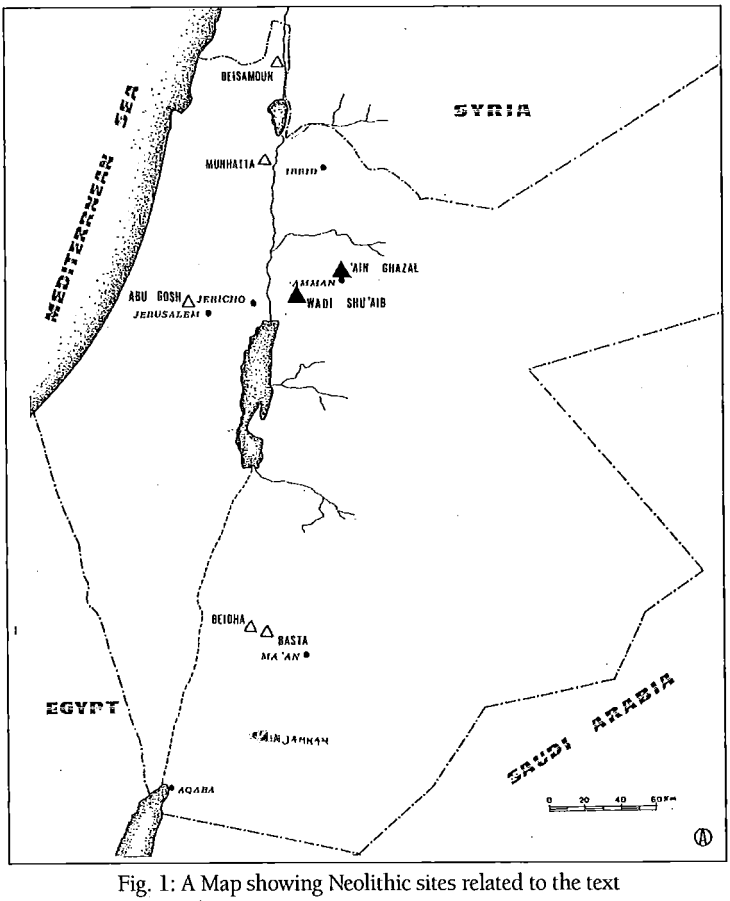

Fig. 1: A Map showing Neolithic sites related to the text

This study aims at nalyzing the plaster raw material used for architecture purposes during the different cultural phases of the Neolithic period in Jordan with main focus on the Neolithic villages of Ain Ghazal, Basta and Ain Jammam. In addition, the research seeks to establish differences in the use of technologies between these cultural phases and thus contributing to extant research on this controversial subject.

SAMPLES AND SITES

The analyzed plaster samples were determined based on available excavated Neolithic sites in Jordan, and geographical distribution of the sites. These are Ain Ghazal, located in central Jordan, near Amman, the Capital (Rollefson et al 1985, Kafafi and Rollefson 1995) while Basta (Nissen et al 1987) and Ain Jammam (Waneeb 1996) both located in southern part of Jordan (Fig. 1). These sites ranged in time period from the 7500-5000? B.C. In total 17 samples have been analyzed. They include 10 plaster samples form Ain Ghazal which represented by the cultural phases of the MPPNB (7250-6500), LPPNB (6500-6000), PPNC (6000-5500) and Yarmoukian (5500-4500?) (Table 1), 4 samples from Basta (PPNB/C) and 3 samples from Ain Jammam (PPNB). These samples represent architecture plasters only including plaster floors from the three sites and plaster wall from Basta.

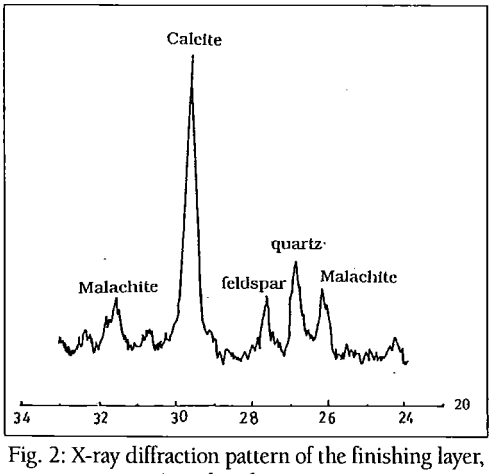

Fig. 2: X-ray diffraction pattern of the finishing layer, Ain Ghazal, MPPNB

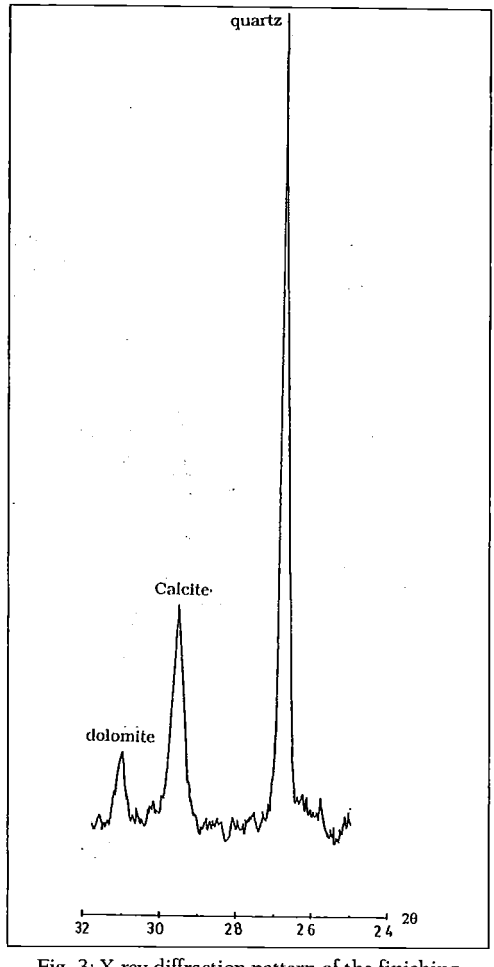

Fig. 3: X-ray diffraction pattern of the finishing

All plaster samples were analyzed mainly by Polarizing microscope, X-ray diffractometer and $CaCO_3$ content was measured by calcimetry. The samples were first examined under a binocular microscope, using magnifications of 6.5x10x to 40x10. Petrographic thin sections were then prepared from samples that were impregnated and hardened by Epoxy Resin. All of the samples were cut perpendicular to their surfaces for the

Table 1: Provenance and analytical description of plaster samples

No	Site	Date	Provenience	Sample Description	Calcium Carbonate	X-ray diffraction	Microscopic description	Material
1	A.Gh	MPPNB	North field: Sq. 5918? Domestic Building	Coarse base layer white (10YR 8/1) Thickness 3 cm	34%	- Calcite - Quartz - Malachite - Feldspar	Uncalcined marl, mixed With crushed shell, bones (2%), quarts (<1%), backed clay (5%), calcite grains (1%). (fig. 6)	Marl plaster
2	A.Gh	MPPNB	Central field taken from the large section along highway	Thickness: 3.5 cm Fine finish layer: 4mm. White, burnished, coarse base layer: 3.1 cm	48%	-Fine layer -Calcite -Quartz	Two distinct layers: 1-Fine finished layer: *a.Calcite & quartz as additive material.* 2-coarse base layer: a.Flint (<2%). b.Elongated shell (<1%). c.Calcite grain. d.Backed clay (2%). e.Quartz (5%). f.Elongated plagioclase (<1%). (fig. 3).	Marl plaster
3	A.Gh	LPPNB	North field Sq. 5317 (cult building)	Thickness: 2cm. Renew? Hard surface with red color	88%	-Calcite -Quartz	-Recarbonated lime -Additives materials: Calcite grain (40%) with some Foraminifera. (fig. 2 & 3)	Lime plaster
4	A.Gh	LPPNB	East field Sq. 11 Temple area	Fine finish layer (5mm): red burnished surface (2.5 YR 4/4).	74%	-Fine layer -Calcite -Quartz	-Recarbonated lime -Additives materials: Calcite grains.	Marl plaster
5		PPNC	South field Sq. 4654 Corridor building	Thickness: 2.5 cm. Fine finish layer: 4mm. -Red burnished surface	91%	-Calcite -Quartz	-Two distinct layers: -Ffine finish layer: -Recarbonated lime -Additives materials: Calcite grains. -Coarse base layer: calcite grains with Foraminifera and quarts.	Lime plaster
6	A.Gh	Yarmoc-ian	Central Field Sq. 3273 Domestic Building	Thickness: 3cm. -Fine finish layer: 4mm. -White surface (10 YR 8/1). Has impression of straw.	60.3%	-Fine layer -Calcite grain -Quartz	Two distinct layers: -Ffine finish layer: -Recarbonated lime, quartz (2%). -Coarse base layer: mixed with flint (10%), quartz (5%), grog (5%), some Foraminifera (fig. 2a & 4).	Marl plaster
7	A.Gh	Yarmoc-ian	Central field Domestic Building	Two distinct layers: 2cm fine finish layer 5mm thickness, white (10 YR 8/1).	70.7%	-Fine layer -Calcite -Quartz	Two distinct layers: -Ffine finish layer: Calcite grains (10%) with some with Foraminifera, quarts (10%), coarse layer: grog (5%) and calcite grains (fig 5).	Marl plaster
8	A. Jam-mam	PPNB PPNB	Area A: Sq. A2 Cult building?	Two distinct layers, 2.5 cm in thickness burnished fine finish layer 1mm light red (10 R 5/4). Coarse layer yellowish color mixed with pebbles and straw.	24%	-Fine layer -Calcite grain -Quartz -Dolomite	-Fine finish layer calcite grains and crystallized quartz, voids (5%), coarse layer: calcite grains (fig. 7).	Marl plaster
9	Basta	PPNB	Wall plaster 37063 Domestic Building	Two layers of renew plaster: 5mm in thickness, burnished dark red (10YR 5/4)	77.6%	-Calcite -Quartz	Two distinct layers: upper layer additive material, quartz, voids, flint (<1%), calcite grains, lower layer as above but with more voids.	Marl plaster

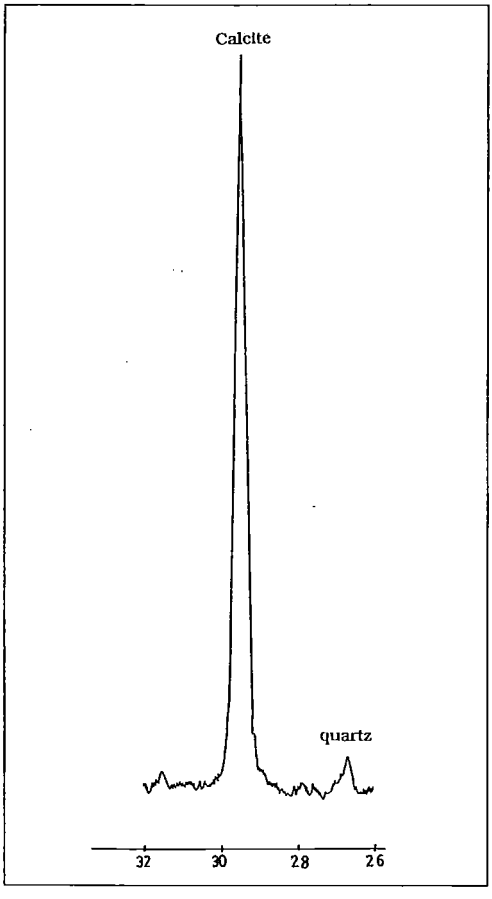

Fig. 4: X-ray diffraction pattern of the finishing layer, Ain Ghzal, PPNC

preparation of large size thin sections (2.5 x 4.5 cm). In addition, the results were supplemented by X-ray diffraction data (Figs. 2,3,4).

Total carbonate content was determined by Calcimetry method. In all samples, subsamples were taken to be analyzed for Calcium Carbonate.

Results of plaster analysis: Ain Ghazal, Basta, and Ain jammam

The results of the plaster analysis reveal that there are two types of plaster utilized by the inhabitants of Ain Ghazal. These are marl plaster and lime plaster. Marl plaster was used in architectural floors during the MPPNB (Table 1, nos. 1.2), LPPNB (Table 1 no.4) and Yarmoukian (Table 1 nos. 6.7) in addition, marl plaster was used in PPNB site of Ain Jammam to produce architectural floors (Table 1 no. 8), while in PPNB site of Basat marl was used in wall plaster (Table 1 no. 9). Lime plaster was revealed in the samples of the LPPNB (Table 1 no. 3) and PPNC (Table 1 no. 5).

The examination of plaster samples from the Neolithic of Ain Ghazal shows that the structure of the plaster floors has two layers. These are fine and course layers. The former ranges in thickness from 2-4mm characterized by a very fine matrix and have a polished surface and is red colored. The analysis of this fine layer shows that it is made of burnt lime or marl but with a frequency ranging from 20-40%. The other content of the sample is made of fine grains of non-burnt lime or marl mixed with quartz as a tempering material. These additive materials represent

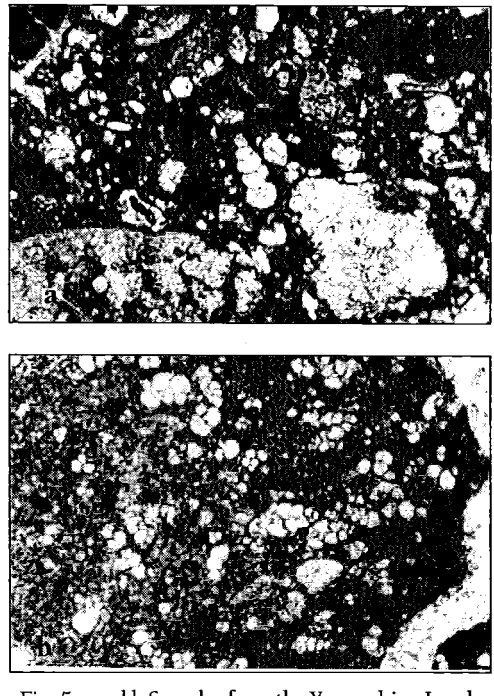

Fig. 5a: and b Samples from the Yarmoukian Levels at Ain Ghazal (PPL)

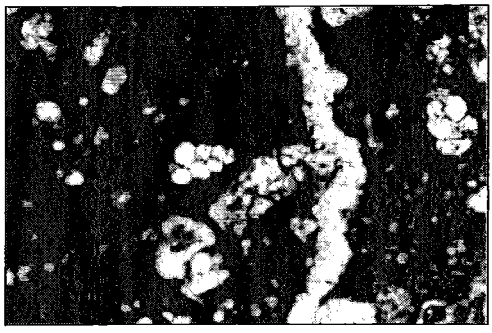

Fig. 5c MPPNB plaster floor sample, Ain Ghazal (PPL)

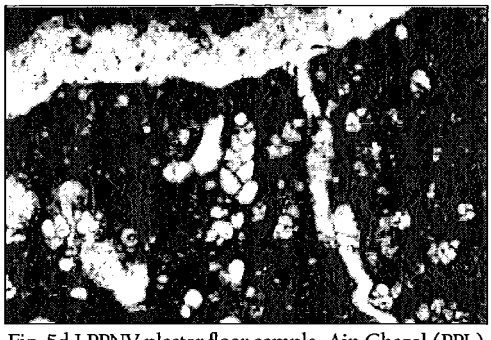

Fig. 5d LPPNV plaster floor sample, Ain Ghazal (PPL)

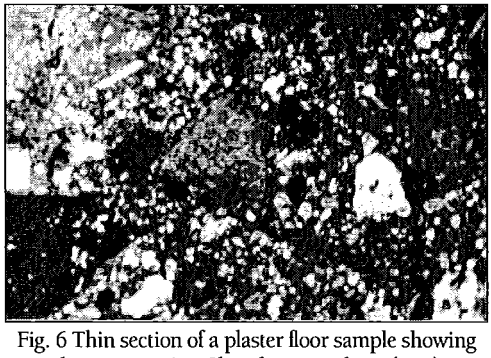

Fig. 6 Thin section of a plaster floor sample showing chert grains, Ain Ghazal, Yarmoukian (PPL)

ca. 60-80% of the total of the samples. This indicates that burnt lime or marl was used in less percent than the non-burnt lime and marl.

The second coarse layer ranges in thickness from 2-6 cm. revealed that non-burnt lime or marl was used alone and mixes with several tempering materials such as shells, flint (Fig. 6), bones (Fig.7) and

Fig. 7 Thin section of a plaster floor sampe showing powdered bone material, Ain Ghazal, LPPNB (PPL)

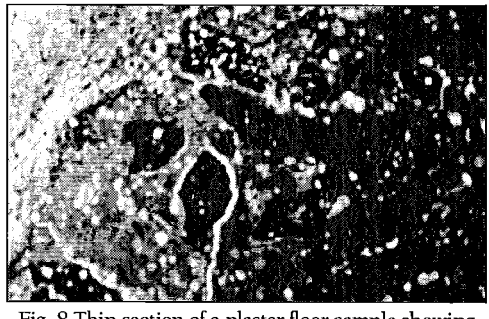

Fig. 8 Thin section of a plaster floor sample showing grog, Ain Ghazal, Yarmoukian (PPL)

pulverized pottery sherds (Fig. 8) or baked clay. In terms of tempering material, the diachronic examination of the samples showed that the pounded pottery sherds were used instead of other material like flint.

The results shows that all samples of either lime or marl plaster were varied in terms of the use of fired raw material. It has been noted that in most cases the use of burnt lime or marl was minimal. This fact was attested by the presence of microfossils like Foraminifer in most of the samples matrices (Fig. 5: a,b,c,d). This is an indication that the raw material was non-burnt. The presence of Foraminifera has been recognized in two subcontexts of the samples. One is referred to as the coarse layer and the second is referred to as the fine layer. In the former, the foraminifera have been revealed in the calcite grain which indicates that burnt lime was

mixed with non-burnt lime to form the fine layer. While in the others these microfossils were identified in the matrix of the non-burnt coarse layer only.

DISCUSSION

The archaeological and technological implications of the Neolithic plaster production, Ain Ghazal as a model.

It has been argued that the PPNB plasters floors were mainly made of burnt lime plaster in the fine or coarse layers. This would suggest that a high percent of wooden fuel was used in manufacturing lime plaster. Such a process would require tons of fuel and lime to produce plaster floors (Garfinkel 1987: 203-204; Kingery, Vandiver and Prickett 1988: 238). This explanatory framework has been used to explain the process of plaster floor production at Ain Ghazal (Rollefson 1990:50; Rollefson and Kohler-Rollefson 1989:8). There scholars argued however that plaster floor production was a limited and casual activity which did not require burning of tons of lime and fuel (Goren and Goldberg 1991: 136-137).

At the Neolithic village of Ain Ghazal, plaster production was explained by Rollefson as an activity which demanded almost 3.3 tons of quick lime to be employed in a single PPNB house construction. These include floor, walls, ceiling and hearth. If one house required this amount of burnt lime, that means at least 13.2 tons of wood were needed as a fuel to produce this quantity of quicklime (Rollefson n.d: 5.6). this assumption is based mainly on the fact that all needed lime was brunt. Furthermore, it has been stated that lime production during the PPNB and in the later phases of occupation might have been a primary factor contributing to the decline of subsistence at Ain Ghazal. Therefore, the gradual deforestation around Ain Ghazal was well formulated during the 6th millennium B.C. That is, at the end of the middle of sixth millennium, the inhabitants of Ain Ghazal used approximately of 57.192 trees for architectural construction purposes. Almost 60% of this amount was used as fuel for lime production. It has been estimated that 3268.2 hectares of tress were planted and that by the Middle PPNC times almost trees of 3km radius of the surrounding landscape from the center of the settlement has been removed (Rollefson 1990: 50-52, n.d.:6; (Rollefson and Kohler-Rolleson 1989:8).

As mentioned above the studied plaster samples which were taken from the different occupational phases at Ain Ghazal showed that the plaster floors consist of two layers. It has been suggested that both layers of the plaster floors were made of burnt lime which consequently meant the use of a large quantity of both fuel and lime to produce the plaster floor (Rollefson and Suleiman 1983; Banning and Byrd 1984). It has been estimated that the thickness average of plaster at Ain Ghazal is 6.6cm. In the contrary, the analyzed samples from different phases at Ain Ghazal showed that only the fine layer was made of burnt lime. This, in turn, would suggest a new interpretation of the relationship between the quantity of burnt lime to non-burnt lime in floors construction. It is very important to distinguish between these amount when estimating the quantity of both burnt lime and fuel. That is, it would be different quantitative data when comparing the employment of burnt lime/or marl in construction of a plaster floor that has an average of 6.6cm in thickness as compared to one of only 2-4mm of the plaster floor. It is more probable to suggest that in order to reduce the amount of burnt lime needed, additive materials such as non-burnt lime or marl, chert, bones, shells and pottery sherds were used.

It is more probably that the addition of non-burnt marl or lime, chert, bones shells and pottery sherds could be explained as an additive material to reduce the amount of burnt lime in the construction of plaster floors.

It has been emphasized that the main fuel used in lime burning was only wood. (Rollefson 1990; Rollefson and kohler-Rollefson 1989) causing a rapid deforestation around the landscape of Ain Ghazal settlement. However, it is feasible to suggest that materials might have been used such as animal dung.

CONCLUSION

The analyzed plaster samples taken from the Neolithic Village of Ain Ghazal show that there are two types of raw material that were used in floor construction. These are marl and lime. Moreover, the sample analysis also revealed that burnt lime or marl were used in minor quantities in floors construction compared with non-burnt lime or marl. Burnt lime and / or marl has been identified in the fine layer of the floor which did not exceed 4mm in thickness. Furthermore, it has been noted that burnt lime and / or marl was mixed with non-burnt lime or marl which comprises about 70-80% of the samples. Meanwhile the foundation or coarse layer was made of only non-burnt limer or/and marl mixed with several additive materials such as chert, flint, bones, pottery and shells. These results shed light on the technology employed in plaster floor production at Ain Ghazal in terms of the rate of burnt marl to non-burnt lime or and marl. This in turn re-enforces the results of analyzed samples taken from different sites at Palestine such as Yiftah'el, Tell Teo Beisamun and Hurbat Galil (Goren and Goldberg 1991). The researchers conclude that estimation of wood and lime quantities used in floor production at Ain Ghazal should be reevaluated.

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