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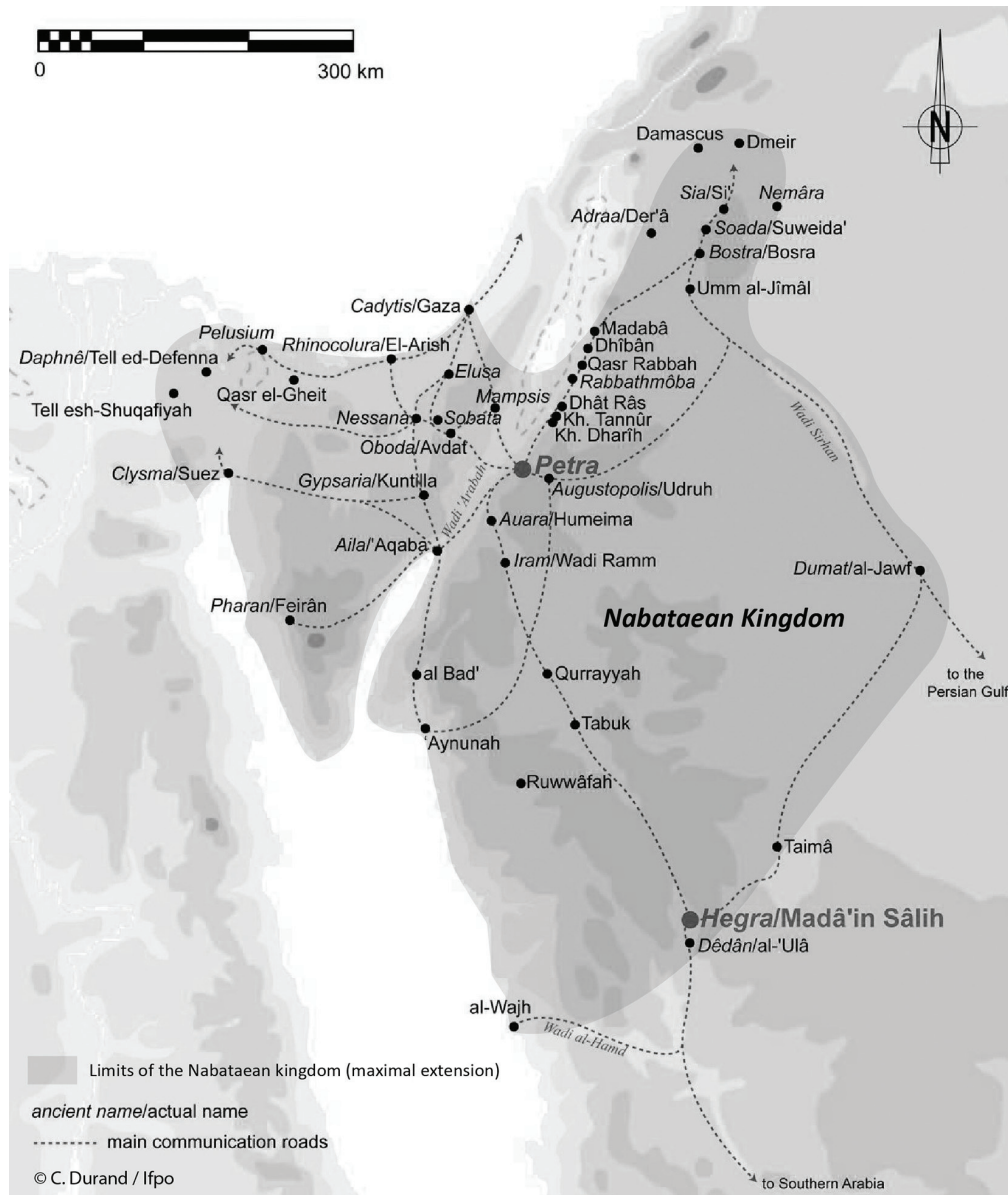
When the Nabataeans Settled in Hejaz: New Data from the Nabataean Painted Fine Ware found in Hegra/Mada'in Salih (Northwest Arabia)

Introduction

Since 2008, a Saudi-French archaeological project has been investigating the major Nabataean site of Hegra/Mada'in Salih, in northwest Saudi Arabia (FIG. 1; see mainly Nehmé 2004; Nehmé *et al.* 2008; Nehmé 2009; 2015; recently Abu Azizeh *et al.* 2020. The complete reports of each campaign are available online).¹ Considered as forming the southern limit of the Nabataean territory, Hegra was one of the main cities of the kingdom after the capital Petra. It is located around 20 km north of Al-Khuraybah, the religious core of ancient Dadan, close to present-day Al-'Ula. The Nabataean settlement of Hegra is surrounded by more than 100 monumental rock-cut

tombs, very similar to those at Petra, that are scattered around a large residential area built primarily of mud bricks, today highly decayed (FIG. 2). However, excavations in the city centre yielded a very deep stratigraphy and a long pottery sequence. After 10 years, we have now obtained a clear idea of the chronology of the site, which was occupied without interruption for approximately one millennium, probably from the 4th c. BC to the early 5th c. AD (see Rohmer and Charloux 2015; Rohmer and Fiema 2016; Durand and Bauzou forthcoming on the earliest occupation phase; Charloux *et al.* 2018 on the latest occupation phase). During its millennium of existence, the city was placed under the rule of successive regional powers such as the Lihyanites, the Nabataeans, and the Romans. Although the proper Nabataean period in Hegra likely lasted less than two centuries, it was nevertheless a time of major development for the city. Besides the above-

¹ The authors wish to thank the Saudi-French Mada'in Salih Archaeological Project directed by Laila Nehmé (CNRS) and Daifallah al-Talhi (University of Hail) for providing the opportunity to publish these results. They are grateful to Laila Nehmé for her reviewing and suggestions.



1. Map of the Nabataean kingdom, showing the localisation of Petra and Hegra (© C. Durand).

mentioned monumental rock-cut tombs, the Nabataean presence is also evidenced by several triclinia, some isolated architectural elements such as typical Nabataean capitals, many Nabataean inscriptions and graffiti, as well as Nabataean coins and pottery scattered on the surface and found in stratigraphy. This article focuses on pottery finds, especially on

the Nabataean painted fine ware bowls found in Hegra. Indeed, these painted vessels are not only the most characteristic Nabataean pottery style, but are also thought to have had specific ritual and social functions (Durand 2017). Therefore, their study can help us understand the settling process of the Nabataeans in Hegra.



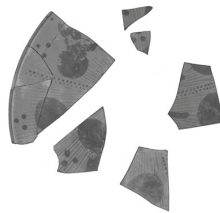
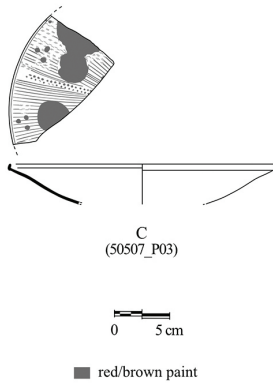
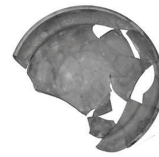
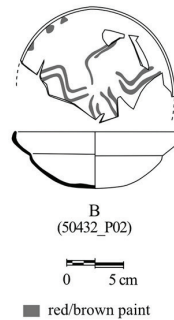
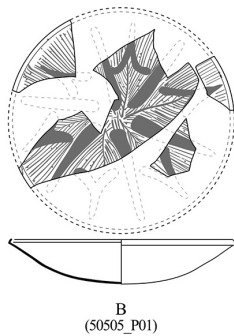
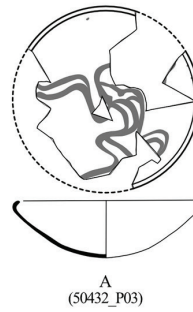
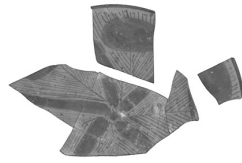
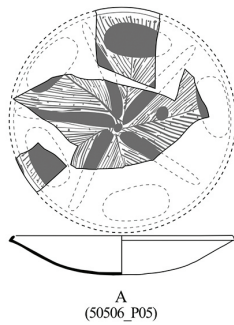
2. View of the site of Hegra (© L. Nehmé).

Nabataean/Petraean Painted Fine Ware in Hegra

The so-called Nabataean painted fine ware corresponds to a specific painted pottery style originating from the Petra region, consisting primarily of footless bowls made of highly levigated clay with extremely thin walls. Their decorative patterns followed a stylistic evolution from the mid-2nd c. BC to the 5th/6th c. AD, as evidenced by stratigraphical studies undertaken at az-Zanṭūr, a domestic area in the city centre of Petra (Schmid 1996; 2000) and by Late Roman/Early Byzantine pottery kilns discovered in the suburbs of the Nabataean capital (ʿAmr 2004).

In Hegra, fragments of Nabataean painted fine ware imported from Petra were found in significant numbers in all the excavated areas (Durand and Gerber 2014: 159–60 fig. 6). This type of pottery, however, was especially represented in

the Jabal Ithlib, which seems to have been occupied exclusively during the Nabataean phase and devoted to ritual meetings (Nehmé 2015: 30–2; Durand 2017: 91–2 fig. 8), as well as in the Nabataean sanctuary called ‘IGN 132’ (Nehmé 2012) and in the monumental tombs, where painted bowls were probably used as funerary offerings during the Nabataean period (see examples from tomb IGN 116.1, FIG. 3). A study of the distribution of the Nabataean painted fine ware according to the phases of production as defined in Schmid’s typo-chronology, shows that it had been imported into Hegra during the whole Nabataean period, from the mid-2nd c. BC to the early 2nd c. AD. Nevertheless, we can observe strong variations within this time-frame. From Schmid’s phase 1 to Schmid’s phases 2b/2c (*i.e.*, from the mid-2nd c. BC to the late 1st c. BC/early 1st c. AD), the quantity remains rather low. Fragments from these phases



Reconstruction proposal without certainty regarding the positioning of the fragments

Drawing/inking: R. Douaud
Layout: C. Durand

4. Examples of Nabataean painted fine ware bowls, '2 red lines' type, from tomb IGN 97 in Hegra (© R. Douaud, C. Durand).

around 76% of the total. The latest phases, from the Late Roman provincial period, are almost absent (only 2% for Schmid's phase 3c corresponding to 2nd c. AD productions) or completely absent (0% for Schmid's phase 4 produced from the 3rd to 5th/6th c. AD).

3. Examples of Nabataean painted fine ware bowls imported from Petra, from tomb IGN 97 in Hegra (© R. Douaud, C. Durand).

The 'Two Red Lines' Group: A New Type of Nabataean Painted Bowls

A previously unknown type of Nabataean painted fine ware bowl, different from the bowls imported from Petra, has been observed in Hegra. It is characterised by a painted pattern made of several groups of two parallel red lines—usually zigzag lines rudimentarily executed—crossing at the bottom of the bowl (see examples from tomb IGN 97, FIG. 4). For this reason, this

represent around 22% of the total of the Nabataean/Petraean painted fine ware sherds from Hegra. Then, the quantity increases considerably during the 1st c. AD, with Schmid's phases 3a and 3b representing

group has been named the ‘two red lines’ type (Durand and Gerber 2014: 159–61 fig. 7). Examples appear in Nabataean contexts and represent the largest group of painted fine ware bowls in Hegra. Their fabric closely resembles the Petraean fine ware bowls; they are similarly thin-walled, scarcely tempered, and well-fired. This explains why they were first thought to have been imported from Petra.

A decorative pattern consisting of two parallel red lines, straight or zig-zag, is known from Petra on deep rounded bowls which belong to Schmid’s decoration phase 1, dated from the *ca.* mid/end-2nd c. to the mid-1st c. BC (Schmid 1996: 200–1 figs. 683–686; 2000: 183 figs. 73–76; Tholbecq and Durand 2013: 213 fig. 9). In Hegra, however, this decoration occurs also on carinated bowls (FIG. 4:B) which, in Petra, would only bear Schmid’s decoration phase 2b, the latter starting around 20 BC (Schmid 1996: 204–5 figs. 693–5; 2000: 183–4 figs. 83–85). The combination of the two red lines decorative pattern and carinated bowl profile is not attested in Petra. Moreover, the fabric of the Hegra ‘two red lines’ bowls is very similar to that of Schmid’s decoration phase 2 products from Petra. The bowls seem ‘technically equivalent’ to those which belong to Schmid’s phases 2b and 2c from Petra. We can therefore assume that they probably started to be produced around the last third of the 1st c. BC.

Having addressed the issue of their date, their provenance remains to be examined. The fabric of these bowls is very fine and is hence quite different from the fabric of the other local products from Hegra. Because of their strong similarity with the Petraean productions, our first thought was that these bowls had been produced in the Petra pottery workshops, with the same raw clay as that used for the locally made Petra bowls, and then exported to Hegra. However, if this hypothesis was correct, it would be difficult to explain why this type of bowl was never

found in Petra. A second hypothesis is that these bowls were produced either elsewhere in southern Jordan or in the Hegra region itself. If this is true, the ‘two red lines’ bowls from Hegra should have a different chemical and mineralogical composition from that of the Petra bowls. In order to answer this question, it was decided to undertake chemical analyses on the clay and to compare the results with Petra fine ware.

Archaeometric Studies

A preliminary selection of Hegra Nabataean fine ware samples, painted and unpainted, were chemically analysed by a portable Energy-dispersive X-ray fluorescence spectrometer by Fisher Scientific.² For comparative purposes, a selection of Nabataean fine and common ware samples from the Swiss-Liechtenstein excavations on az-Zanṭūr in Petra were analysed with the same portable equipment. The Petra samples were produced in the pottery workshops near the ancient city, as shown previously (Gerber 2003; 2005). The production site and the chemical composition of the Petraean fine ware sherds, painted and unpainted, form a reliable reference for the ceramic chemistry of the Petra region.

Technical Notes

As this was the first time we used a portable Energy-dispersive X-ray fluorescence spectrometer rather than the stationary lab equipment we had used in previous studies, we needed to test its performance and stability. Each sample (from Petra and from Hegra) was analysed at least three times. In addition, five Nabataean fine ware sherds were reference-measured over a

² The authors are much obliged to the “Institut für Archäologische Wissenschaften, Prähistorische Archäologie,” of the University of Bern, Switzerland, for granting them the privilege of using its portable XRF: Thermo Scientific Niton XL3t 950 with GOLDD technology. For this specific portable spectrometer, see also Stapfer 2019.

period of five days. A notable fluctuation in some of the crucial elements, usually in the form of partly time-dependent shift or drift, was detected. But the fluctuation patterns diverged. At odds with the usual experience of repeated measurements when compared to reference samples, there appeared to be no way to determine which single value among the several measurements was more accurate, or closer to a true mean. Repeatedly measuring a constant identical surface yielded non-randomly, divergently shifting values. Under such circumstances, taking the mean made no sense, because we have no idea what the true offset is. Taking the mean might just consolidate the error. Therefore, we worked under the provisional assumption that the series of measurements are to be regarded as bundled realisations of independent measurements. They are plotted as such. The five sherds with more than three measurements (≥ 20 measurements) are discernible by the increasing size of the near-overlapping symbols.

For the current statistical evaluations, the major chemical components MgO, Al₂O₃, SiO₂, K₂O, CaO, TiO₂, MnO, Fe₂O₃

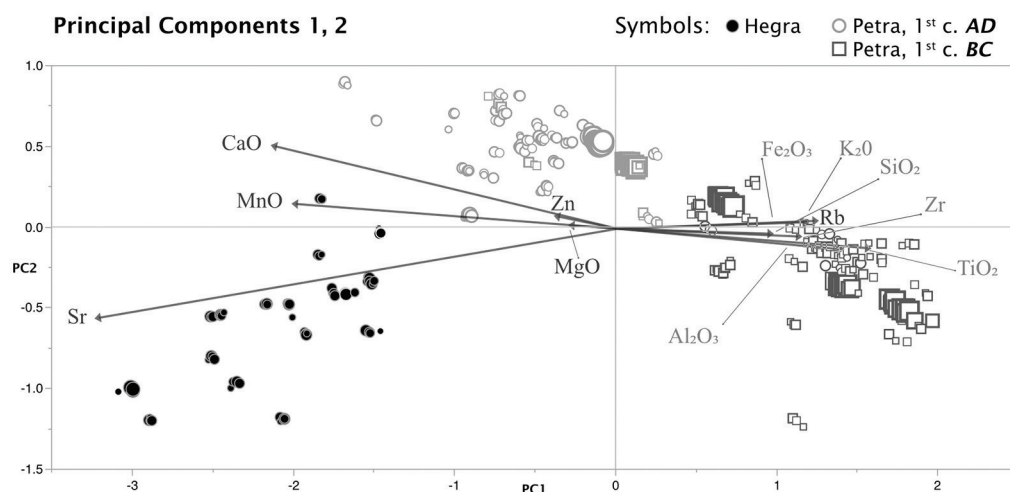
and the trace elements Rb, Sr, Zr, Zn were taken into account.

The chemical results hereafter are treated within the appropriate statistical framework of ‘Compositional Data Analysis’ (Pawlowsky-Glahn *et al.* 2015; Greenacre 2018). The data as presented, and used in further calculations, are *centered logratios*, and explicitly not raw percentages or ppm. Within the scope of the current investigation, the unfettered use of percentages would be inappropriate in statistical terms, and grossly misleading.

Statistical Analyses

Principal Components

All Petraean fine and common ware samples, found and produced in Petra, are shown as open squares and open circles. The samples found in Petra and produced in Petra feature two distinctive clusters along the 1st principal component axis (FIG. 5). While this was not a specific aim of the investigation, the result is a nice confirmation of the previous investigations from 2001, which revealed that the chemical composition of the earlier Nabataean fine and common ware pottery from the 1st c. BC



5. Principal components on centered log-ratios of CaO, MnO and Al₂O₃, SiO₂, K₂O, TiO₂, Fe₂O₃, Rb, Zr (© Y. Gerber).

to the beginning of the early 1st c. AD differs significantly from the chemical composition of the later Nabataean pottery of the 1st c. to early 2nd c. AD (Gerber 2003: 134–9).

The same kind of difference is perceived in the newly analysed data set. The differentiation follows the negatively correlated ratios of CaO, MnO and Al₂O₃, SiO₂, K₂O, TiO₂, Fe₂O₃, Rb, Zr. Nevertheless, all pottery is known to have been produced near Petra. From this we can deduce that the Nabataeans began to alter their clay recipe in the early 1st c. AD (Gerber 2003: 141–4). This alteration is now chemically recognisable. The AD-ware group is not as homogeneous as the BC-group; a few BC-ware samples already show the later recipe-composition. This suggests a rather slow and gradual change.

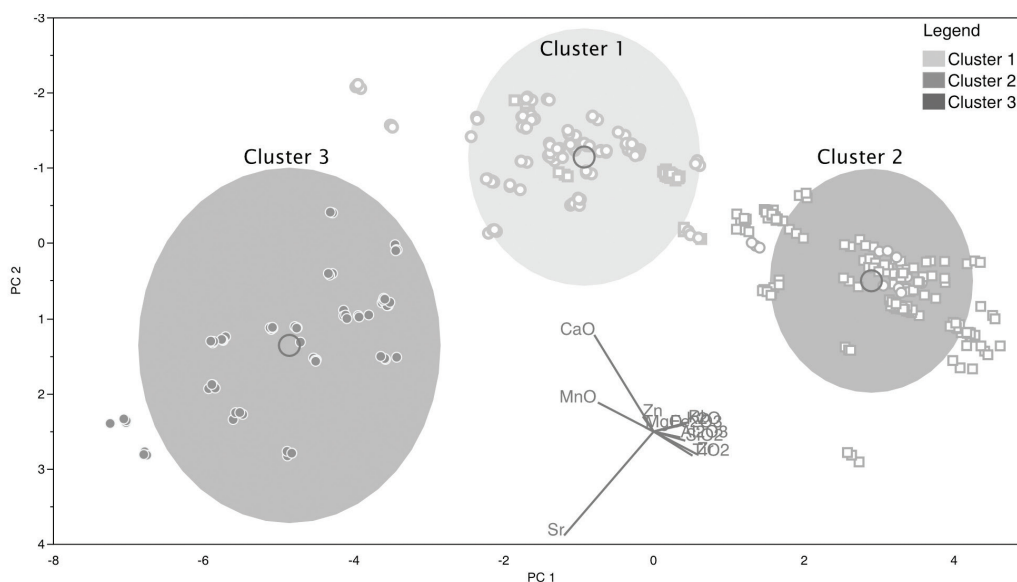
However, the crucial discovery is that all the Hegra fine ware samples which we already ‘earmarked’ visually as probably not produced in Petra (shown as dark closed dots) form a distinctive cluster along the 1st principal component axis. A signal feature of the chemical differentiation between the Petra and Hegra samples is the higher Sr ratio of the Hegra samples.

Kmeans Clusters

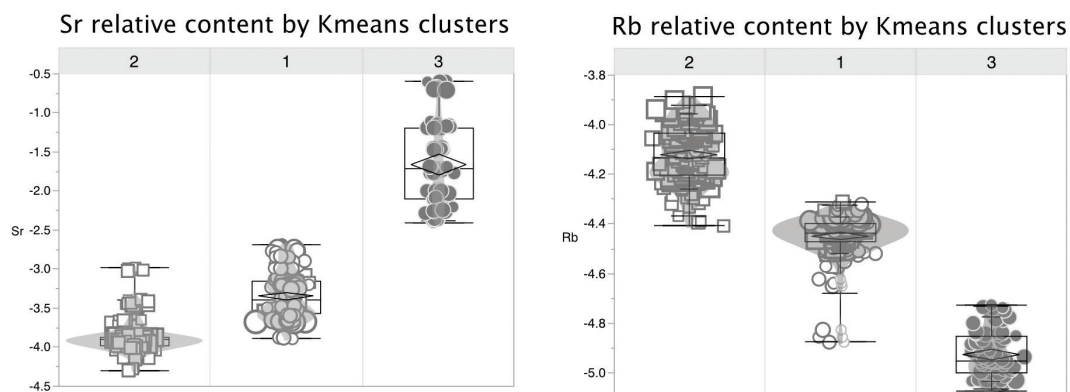
The Kmeans algorithm is an iterative algorithm that aims to partition the dataset into *K* pre-defined, distinct, non-overlapping subgroups (clusters), where each data point belongs to one group only.³

The Kmeans cluster analysis (FIG. 6) is based on data without any extrinsic information, resulting in three distinct, non-overlapping clusters. Inner circles mark the confidence intervals of the cluster centroids. Extrinsic categorical information reveals that Kmeans clusters 2 and 1 correspond to the 1st c. BC and 1st c. AD Petraean fine and common ware samples, while cluster 3 covers the entirety of the Hegra fine ware samples. Higher CaO and MnO ratios are diagnostic indicators for the 1st c. AD group, and higher Sr ratios for the Hegra fine ware samples. Kmeans thus confirms

³ It tries to reduce the intra-cluster distances while maximising the inter-cluster distances. It assigns data points to a cluster such that the sum of the squared distance between the data points and the cluster’s centroid (arithmetic mean of all the data points that belong to that cluster) is at the minimum. The less variation we have within clusters, the more homogeneous (similar) the data points are within the same cluster.



6. Kmeans cluster analysis biplot (for symbols, see FIG. 5) (© Y. Gerber).



7. 'Violin' plots of Sr and Rb ratios; grouped by Kmeans clusters (for symbols, see FIG. 5) (© Y. Gerber).

and reinforces the results of Principal Component Analysis.

'Violin' Plots

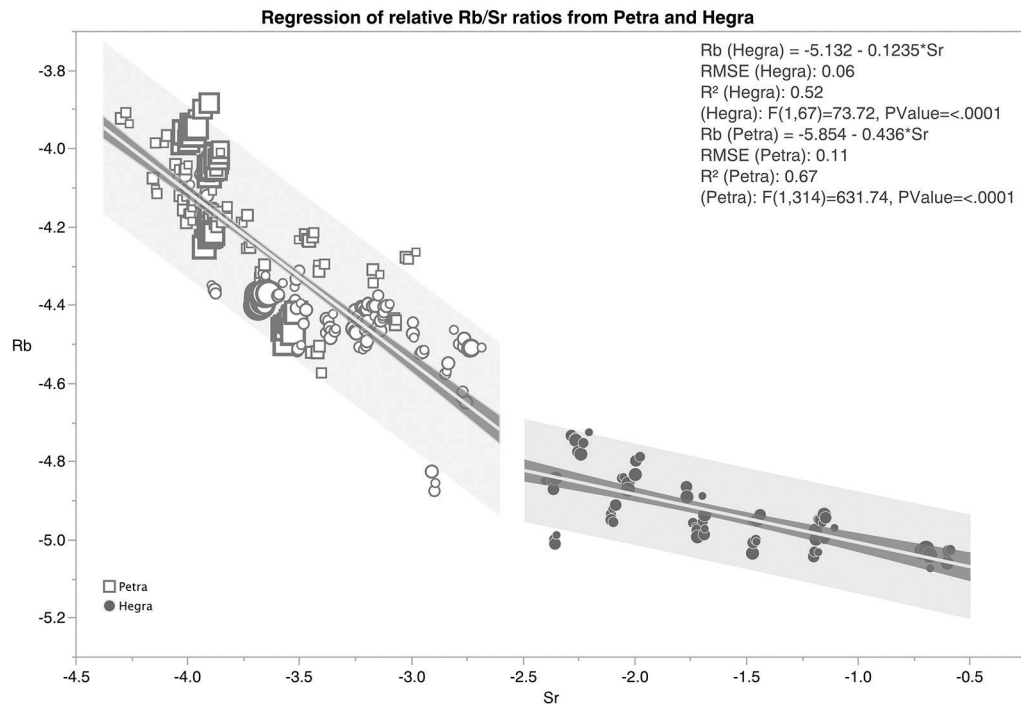
'Violin' plots show the distribution of a variable (or sample distribution), usually across different categories. The shape is given by a rotated kernel density plot.⁴ The Sr and Rb ratios illustrate the relative chemical differences seen in the Kmeans clusters (FIG. 7). These are characteristic for three chemical recipes from Petra and Hegra. While the distribution of the Sr ratios among the 1st c. BC and 1st c. AD Petra samples does not vary significantly, the Sr ratios from the Hegra fine ware samples mark a distinctive chemical cluster. The trace element Rb is an even more striking differentiator. The Rb ratio decreases from 1st c. BC Petra to 1st c. AD Petra to 1st c. AD Hegra, as shown in FIGURE 8, resulting in a 'broken stick' regression of relative Rb/Sr ratios from Petra and Hegra. The graphic features the 95% confidence intervals of the regression lines and the predicted bandwidth of the distribution.

⁴ Typically, a violin plot will include all the data that is in a box plot: a diamond marker for the median of the data; a box indicating the interquartile range; and possibly all sample points, if the number of samples is not too high.

Conclusions

The differentiation of the chemical compositions of the Nabataean Petraean and Hegra ceramic production is explicit. The 'two red lines' fine ware bowls found in Hegra were not produced in the same workshops as the Nabataean/Petraean fine ware, probably not even in the neighbourhood of Petra. But does this prove that these specific Nabataean fine ware sherds found in Hegra were also produced in Hegra? Not yet. Although this hypothesis is highly probable, it remains to be confirmed or rejected by analysing a large reference group of various local wares from Hegra. We have a huge reference group of local Petraean common and fine ware. We are still lacking the chemical analyses of the reference group (at least 40 samples or more) consisting of Hegra sherds of ascertained local production and of local raw clay. This is a research project which should hopefully be performed in the near future. Whether the portable Energy-dispersive X-ray fluorescence spectrometer can be the analytical instrument of choice remains to be seen.

Nevertheless, the strong assumption that the 'two red lines' bowls were produced locally allows us to propose a few conclusions. The study of Nabataean/



8. Regression of relative Rb/Sr ratios from Petra and Hegra (© Y. Gerber).

Petraean painted fine ware found in Hegra reflects the regular contacts between Hegra and Petra throughout the Nabataean period, beginning slowly as early as the end of the Hellenistic period and clearly increasing after the late 1st c. BC/early 1st c. AD. This period is also assumed to be the starting point of the ‘two red lines’ bowls production. This sudden need to produce painted bowls imitating the Petra fine ware vessels may indicate a population change in Hegra, and reflect the installation of a group of people coming from Petra. These may have formed the new political, administrative, religious, and social ‘elite’ of the city. These new inhabitants must have included a few skilled potters, trained in Petra, who had the required know-how to produce the Nabataean fine ware painted bowls. Or—and this does not contradict the first hypothesis—the production of local painted bowls could also reflect the desire of

the local population to join the political and religious practices dictated by the Nabataean capital when Hegra was officially included in the Nabataean kingdom. As noted above, these painted bowls are known to have been used in specific social contexts, in particular during the ritual/political gatherings in triclinia (Durand 2017).

The presence of small quantities of Nabataean/Petraean fine ware from the earlier period (pre-mid-1st c. BC) suggests that the Nabataeans visited Hegra and its region as early as the end of the Hellenistic period. These early contacts are not surprising and have to be related to the Nabataean trading activities with the city of Dadan (Durand and Bauzou forthcoming). By contrast, it is interesting to note that almost no Petraean painted fine ware sherds from the ‘post-Nabataean’/Late Roman phases were found in Hegra. It is even more interesting if one considers

that contacts between Hegra and Petra are attested through imports of common ware during the Late Roman period. Again, we are tempted to interpret this as a reflection of social changes, such as a possible Roman ban of the ritual gatherings of fraternal societies in Hegra after the annexation of the Nabataean kingdom. We can also assume that the Nabataean 'elite' group who used to practise banquets left the city (or were removed) after the Roman takeover.

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