Volume XIV • Issue 1/2023 • 71–77

INTERDISCIPLINARIA ARCHAEOLOGICA
NATURAL SCIENCES IN ARCHAEOLOGY
homepage: http://www.iansa.eu

Locals or Migrants? Strontium Isotope Analysis of Two North-South Oriented Great Moravian Graves

Martina Fojtová[1*], Zdeněk Vytlačil[2,3]

[1]*Anthropos Institute, Moravian Museum, Zelný trh 6, 659 37 Brno, Czech Republic*
[2]*Department of Anthropology, National Museum, Václavské náměstí 68, 115 79 Praha 1, Czech Republic*
[3]*Department of Anthropology and Human Genetics, Faculty of Science, Charles University, Viničná 7, 128 43 Praha 2, Czech Republic*

ARTICLE INFO

Article history:
Received: 3rd June 2022
Accepted: 11th January 2023

DOI: http://dx.doi.org/10.24916/iansa.2023.1.5

Key words:
Early Middle Ages
Slavs
Staré Město – Na Valách
non-standard grave orientation
mobility analysis
$^{87}Sr/^{86}Sr$ ratio

ABSTRACT

Migration has been used as one explanation for graves that deviate from the prevailing orientation and structure. Graves oriented in the north-south direction (*i.e.*, deviating from the customary contemporary west-east orientation) at the Great Moravian and early medieval burial grounds of Přemyslid Bohemia and Moravia have attracted the attention of archaeologists for more than 100 years. These are most often interpreted as the graves of foreigners, based on the assumption that different burial rites indicate immigrants, but this has not been confirmed or refuted with empirical evidence. With this study, we have taken the first step towards testing the validity of this hypothesis. Samples from the dental enamel of the permanent molars of two individuals (H 16/2018 and H 18/2018) from the burial site "Na Valách", located at the Great Moravian central site in Staré Město, were subjected to stable strontium isotope analysis. This analysis can help to assess the likelihood of mobility for these individuals. From the results obtained, it is not possible to confirm the non-local origin of either of the individuals, although in the case of H 16/2018 we may theoretically consider it. However, to definitively reject or confirm the hypothesis of a non-local origin of the people buried along the north-south azimuths, future analysis of a much larger sample size will be necessary.

1. Introduction

Identifying immigrants within various cultural contexts can help us to understand mobility and how people were able to retain their identity while integrating into new communities (the issue is summarised, for example, in overview books by Quast, 2009; Meller *et al.*, 2017 or Ormrod *et al.*, 2020; the problem was also addressed by Storti, 2020). It is not easy to document migration in the archaeological record, as material culture, being more a proof of social communication, cannot be a reliable source of information on the mobility of its bearers (Burmeister, 2017, pp.57–60; Reiter and Frei, 2019, p.1). Perhaps, some elements of the burial rite may give us a clue.

1.1 Early medieval north-south oriented graves and views on their interpretation

From the 9th century onwards, the predominant method of burial in Christian Central Europe was to place the deceased in the grave in an outstretched position on their back with the arms alongside the body and the head facing approximately west and the feet to the east. However, a certain percentage of graves differ from the prevailing burial rite. These include individuals buried in north-south or south-north orientations (with possible slight deviations to the west or east) and are often to be associated with abnormalities in the body position, *e.g.*, a crouched or prone position. The reasons why some members of that society were treated differently after death are still not very clear. Štefan (2009) analysed the phenomenon of non-standard (including unusually oriented) graves at burial sites in Bohemia and Moravia of the 9th–12th centuries, while Nezvalová (2016) summarised and statistically evaluated their occurrence in Moravia and south-western Slovakia in this period. The variations of the burial ritual in the Great Moravian and the post-Great Moravian environment from the territory of Slovakia and their evaluation have been dealt with by Hanuliak (1984; 1994; 2004a; 2004b). Their findings show that there are rarely more than a few such cases per site and that they occur more often in the peripheral parts of burial grounds and the

*Corresponding author. E-mail: mfojtova@mzm.cz

north-south orientation of the grave has no relation to the sex or age of the deceased. In contrast, during the early Middle Ages, the north-south orientation of graves was common in the burial sites of the Huns and Avars (Unger, 2006, p.32), or the Finno-Ugric population of Scandinavia (Niederle, 1911, p.360) and in present day northern Germany (Gerds and Wolf, 2015, vol.1, pp.51–57). However, for the Slavs in the territory of the Great Moravian Empire and Přemyslid Bohemia in the 9th–12th century, the north-south grave orientation is an atypical element. This is also reflected in the approach of archaeologists to its interpretation.

The idea that people of foreign origin or traditions are buried in north-south-oriented graves first appeared in the work of L. Niederle (1911, p.359). This interpretation was then adopted by other researchers (*e.g.*, Hrubý, 1955, p.77; Hochmanová-Vávrová, 1962, p.231; Eisner, 1966, p.382; Krumphanzlová, 1964, p.206; 1966, p.320; *etc.*). M. Hanuliak (2004a, p.112) adds that these may have been deceased people who were not sufficiently integrated into the community, and offers an alternative interpretation, according to which, through a range of north and south azimuths, the bereaved sought to prevent the unfit deceased from travelling to the afterlife, which was intended primarily for upstanding members of society (Hanuliak, 2004b, p.46). The astronomer R. Rajchl (1987, p.173; 2006, p.426) approaches the problem from a completely different angle, suggesting that the placement of the deceased in the N-S direction could be related to the effort to place the dead in such a direction when the Sun is highest above the horizon during the day. Thus, it was not necessarily an effort to single out the deceased socially. Nevertheless, the link between non-local origin and different burial rites is also acknowledged by Croix *et al.* (2020) for the Viking-Age emporium or Jobling and Millard (2020) for medieval England.

Hence, our main research question is: Do different burial rites (in this case, the north-south orientation of the grave) indicate immigrants, or were there other motivations for burying some people this way? It will, therefore, be necessary to focus directly on human remains. Bioarchaeological methods could help to address this research question by providing a different source of data about individual mobility (Price *et al.*, 2002; Bentley, 2006; Montgomery, 2010; Slovak and Paytan 2011; *etc.*). Here we present strontium isotope data from the human teeth of two selected individuals in north-south oriented graves from Staré Město to investigate the possibility of their non-local origin. In recent years, similar research has been made at other sites and periods (Richards *et al.*, 2008; Price *et al.*, 2012; Slater *et al.*, 2014; Krzewińska *et al.*, 2018; Meijer *et al.*, 2019; Vytlačil *et al.*, 2021, *etc.*). The purpose of this paper cannot be – given the size of the sample tested – to confirm or refute this hypothesis, but the results obtained may suggest whether it has sense to pursue further in-depth research in the future.

1.2 Mobility analysis

Strontium isotopes in mobility analysis work on the principle of comparing the ^{87}Sr content of the tissue from the analysed individual, expressed as the $^{87}Sr/^{86}Sr$ ratio, with the so-called locally bioavailable strontium. This term denotes the baseline strontium available in the area of interest that entered the local biosphere. The ratios vary geographically and this inter-regional variability of the $^{87}Sr/^{86}Sr$ ratios stems mainly from the bedrock as minerals differ in their ^{87}Sr content, although various other sources such as water or air can play a role (Bentley, 2006; Budd *et al.*, 2004; Price *et al.*, 2002). As the rocks are eroded, strontium is released and, while it is not a biologically-active element, it can enter biological tissues as a substitute for calcium due to its chemical similarity (Bentley, 2006; Montgomery, 2010). As the $^{87}Sr/^{86}Sr$ ratio is carried throughout the food chain practically unchanged (Blum *et al.*, 2000), the consumption of locally produced foodstuffs by humans will therefore influence their tissue $^{87}Sr/^{86}Sr$ correspondingly (Montgomery, 2010; Price *et al.*, 2002). If an individual spent part of his life, typically early childhood, in a different and isotopically distinct environment, the measured $^{87}Sr/^{86}Sr$ will also differ.

Various samples such as water, plants, or modern animals can be used for establishing a local isotopic baseline. Each has its advantages as well as drawbacks (see, for example, Maurer *et al.*, 2012; Bataille *et al.*, 2020; Holt *et al.*, 2021). For this study, the tooth enamel of archaeological fauna has been used as reference material. Locally kept animals are generally expected to share the feeding range of humans and therefore display the $^{87}Sr/^{86}Sr$ ratio of the studied area (Price *et al.*, 2002; Bentley, 2006). They also usually represent the most readily available sample material at previously excavated sites, are deposited in archaeological or museum collections, for example, and are not at risk of being influenced by modern anthropogenic contaminants such as fertilisers (Bentley, 2006; Maurer *et al.*, 2012), which need to be accounted for in such an agriculturally-exploited area as southern Moravia. However, this type of a sample faces the risk of displaying an inaccurate local $^{87}Sr/^{86}Sr$ ratio. Animals are often subject to trade or exchange, in which case they will not display local strontium values (Holt *et al.*, 2021). Furthermore, the feeding area of animals might differ from humans (Maurer *et al.*, 2012) or cover a notably greater range (Holt *et al.*, 2021), thus leading to a shift in $^{87}Sr/^{86}Sr$ values. This risk can be mitigated to a certain degree by analysing a sufficient number of animals, preferably of such different species that would be expected to share the human feeding range, but it can never be excluded completely.

The tissue of choice for bioarchaeological studies is tooth enamel, as it is often preserved in archaeological contexts and it has shown, unlike bone, greater resistance to diagenetic changes of its $^{87}Sr/^{86}Sr$ ratios (Budd *et al.*, 2000; Hoppe *et al.*, 2003; Trickett *et al.*, 2003). The information in the enamel strontium, however, reflects only early childhood – the time of the tooth crown formation; enamel does not undergo any further remodelling during a lifetime (Budd *et al.*, 2004; Montgomery, 2010).

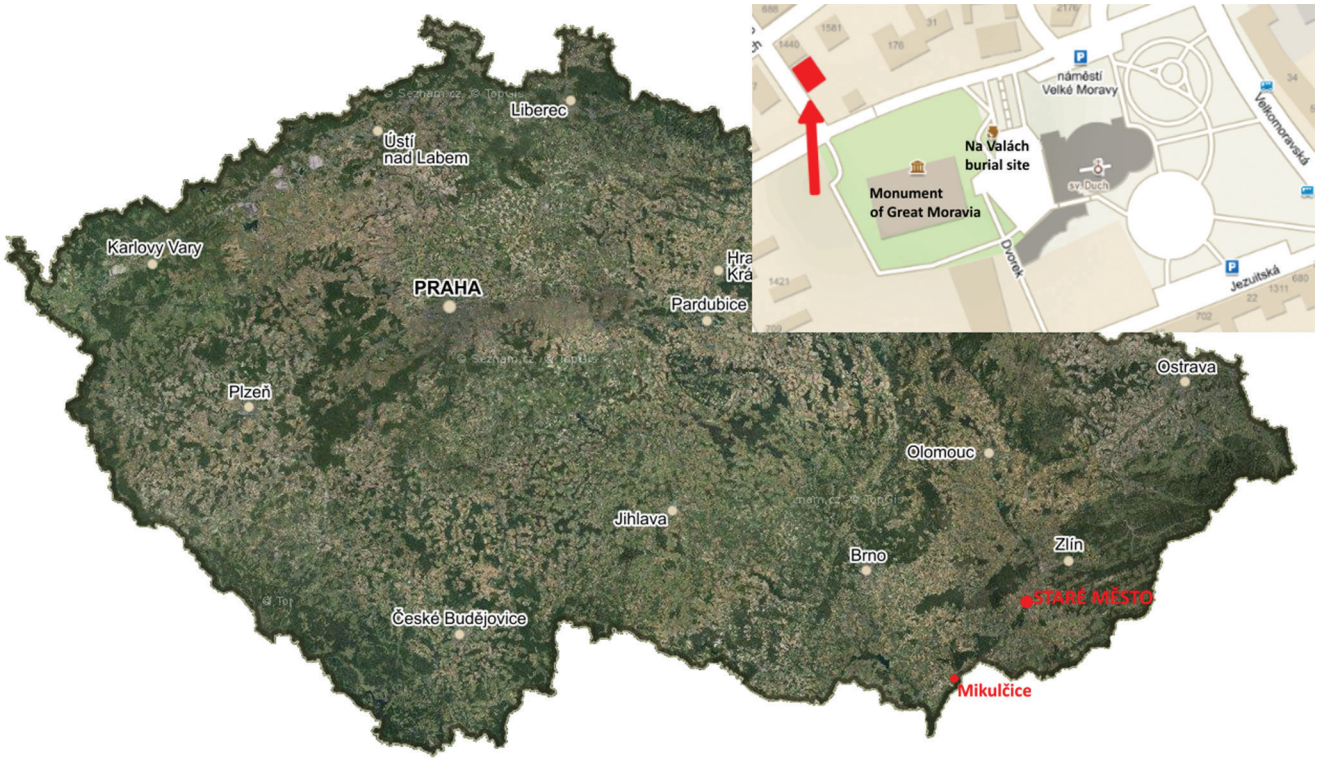

Figure 1. Location of the sites. The cut-out shows the location of the site in Staré Město (map source: www.mapy.cz).

2. Materials

The locality "Na Valách" in Staré Město is among the most important burial sites of the early medieval Great Moravian Empire. More than 2000 graves and settlement features dating back mostly to the 9th and 10th century AD have been found there (Hrubý, 1955; Hochmanová-Vávrová, 1962; Galuška, 2002, 2004; Fojtová and Galuška, 2022; *etc.*). In 1949, the foundations of the first church of proven Great Moravian age were discovered in the area (Hrubý, 1955). However, presently most of the site is built up and therefore it has not yet been explored in its entirety. During one of the most recent rescue excavations conducted in 2018, an area with 26 graves was uncovered on the north-western edge of the burial ground (49.0788817N, 17.4432139E; Figure 1). Most of the graves deviated in some way from the normal burial rite. Three graves (6/2018, 16/2018, and 18/2018) were oriented approximately in a north-south direction (Fojtová and Galuška, 2022).

In grave number 16/2018, the skeleton of a female aged 40–60 years was lying in a supine position with her skull crushed at the right temple and with the mandible dislocated. Both upper limbs were bent at the elbows. The left forearm was positioned below the lumbar spine, and the right was lying on the chest with the hand pointing towards the chin. The position of the upper limbs and the mandible suggests that the body may have originally been wrapped in fabric or leather. The skeleton showed no signs of pathological changes except for a few dental caries and intravital tooth losses.

Grave number 18/2018 contained the skeletal remains of a female aged 30–40 years in an extended supine position. The skull was lying on the occiput and leaning against the sloping wall of the grave-pit and the upper limbs were pointing slightly laterally. The deceased's teeth were in very poor condition (numerous dental caries, intravital losses, and calculus). There were lesions of a "moth-eaten appearance" on the endocranial surface of the parietal bones. These were probably osteolytic metastases of some kind of carcinoma.

Grave number 6/2018 was probably among the north-south oriented graves, but, unfortunately, this was fatally damaged by the digging of younger grave-pits. The find context was therefore unclear and, in addition, no teeth were preserved from the skeleton, so it could not be used for mobility analysis. The human dataset, therefore, includes the upper second right molar of the individual from the grave number 16/2018 and the upper first left molar of the individual from the grave number 18/2018.

The reference sample set consisted of tooth enamel samples from eight domestic pigs (*Sus scrofa f. domestica*), one dog (*Canis lupus familiaris*), and one *Ovis/Capra* specimen. These came from skeletal remains found in graves both during current and past excavations of the "Na Valách" burial site.

3. Methods

Approximately 20 mg of tooth enamel was sampled from the non-abrasive sides of the tooth as described

by Slovak and Paytan (2011). To minimise the risk of diagenetic contamination, the outer layer of the enamel was mechanically abraded and the whole tooth was ultrasonically cleaned in deionised water for at least 30 minutes before sampling. After drying, the enamel powder released by drilling with a diamond-coated drill bit was collected in sealed micro-tubes. Strontium separation from the collected powder followed the modified protocol by Pin *et al.* (2014), using a Sr-specific resin. $^{87}Sr/^{86}Sr$ ratios were measured with a thermal ionization mass spectrometer (Thermo Triton Plus) at the Geological Department of the Czech Academy of Science. The NIST SRM 987 isotopic standard has been used in the study, yielding an $^{87}Sr/^{86}Sr$ of 0.710261 ± 0.000005 (n=5) and a mass fractionation correction was conducted using an $^{88}Sr/^{86}Sr$ of 8.3752.

4. Results and discussion

The results are summarised in Table 1 and Figure 2. For fauna, the measured $^{87}Sr/^{86}Sr$ ratios ranged from 0.70928 to 0.71185, averaging 0.71065 ±0.00072 (1SD). Based on this data, the local range of bioavailable strontium has been estimated to be 0.70921–0.71209 (mean±2SD, Price *et al.*, 2002). If only the domestic pigs are used for the estimation, the range narrows slightly to 0.7091–0.71151.

The measured $^{87}Sr/^{86}Sr$ human enamel ratio for the individual from grave 16/2018 was 0.70929. This value falls within the estimated local range but is located close to its lower cut-off point. The individual from grave 18/2018 had an enamel $^{87}Sr/^{86}Sr$ ratio of 0.71132, *i.e.*, well within the local range. Therefore, according to the available data, a non-local origin of the analysed individuals cannot be proven. The analysed individuals most likely spent their early childhoods in the area of their burial or another isotopically-similar location.

However, a potential non-local origin can be, at least theoretically, considered for the individual 16/2018. The isotope study conducted on the major Great Moravian agglomeration of Mikulčice-Valy (Vytlačil *et al.*, 2021) revealed a significant shift in the human $^{87}Sr/^{86}Sr$ ratios compared to local fauna. Large numbers of analysed individuals in Mikulčice had their strontium values close to the lower end of the estimated local range. One of the possible explanations for this might be found in regional migration – the influx of migrants from relatively close areas with only minor differences in local $^{87}Sr/^{86}Sr$ ratios. This can be supported by the relative geological uniformity and subsequently expected similarity of the $^{87}Sr/^{86}Sr$ ratios in southern Moravia. This similarity would be reflected in the strontium ratios of such regional migrants, who would appear as locals. It is noteworthy that the estimated "pig" interval of biologically available strontium in Staré Město is closely similar to the values measured in the Mikulčice-Valy stronghold (0.70906–0.71134; Vytlačil *et al.*, 2021), located downstream the Morava River, some 40 km away. This could suggest either that strontium ratios are not too variable in the south-eastern part of the Czech Republic, or, as both sites are located on the river's floodplain, that the agricultural production supplying agglomerations in Great Moravia was concentrated on floodplains and areas like Chřiby and the Vizovice Highlands, located on the Carpathian flysch sediment formations surrounding the Staré Město site (Czech Geological Survey, 2019), might not have been exploited to any great extent. In any case, the resemblance of the intervals would agree with the "regional" migration hypothesis mentioned above. However, the strontium data are lacking for these regions and southern Moravia in general and potential areas of origin for such tentative migrants cannot be approximated, especially if the areas would be overlapping with their $^{87}Sr/^{86}Sr$ ratios. Such implications are, therefore, highly speculative. Furthermore, the "isotopic shift" in Mikulčice could, amongst other possibilities, be explained by differential "feeding regimes" of domestic animals and humans, *e.g.*, pastures being located in a slightly differing isotopic background than fields producing grain

Table 1. Analysed samples and their measured $^{87}Sr/^{86}Sr$ ratios.

Sample	$^{87}Sr/^{86}Sr$	2SE	Archaeological designation	Species
UHF-1	0.711241	0.000007	1/18	pig
UHF-2	0.710977	0.000007	7/90	pig
UHF-3	0.710747	0.000007	45/01	pig
UHF-4	0.710225	0.000007	49/90	pig
UHF-5	0.710635	0.000007	50/90	pig
UHF-6	0.709773	0.000007	52/90	pig
UHF-7	0.711280	0.000007	64/90	sheep/goat
UHF-8	0.709280	0.000008	73/90	pig
UHF-9	0.711850	0.000007	1/97	dog
UHF-10	0.710492	0.000008	8/99	pig
UHH-1	0.709294	0.000008	16/18	human
UHH-2	0.711322	0.000007	18/18	human

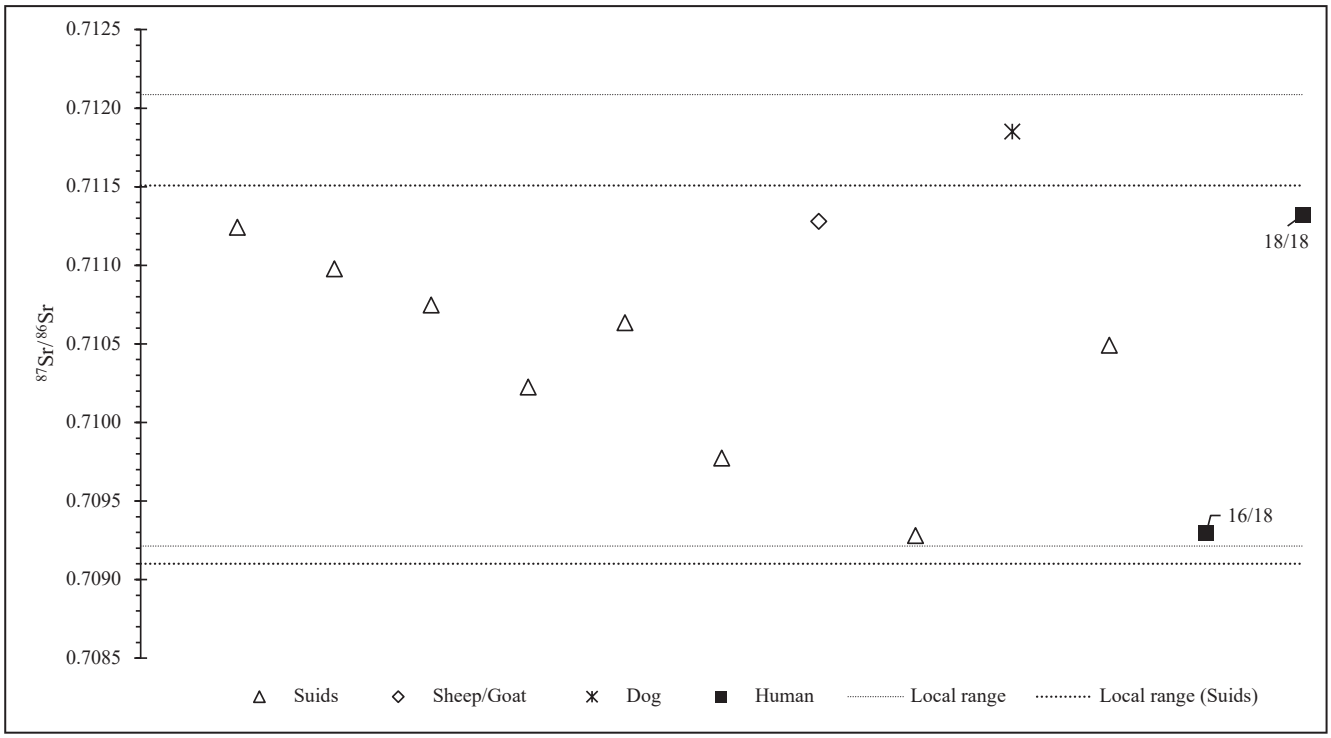

Figure 2. Measured $^{87}Sr/^{86}Sr$ ratios.

for human consumption. Evidencing such situations is, however, pushing the limits of the analytic method and rather challenging using Sr analysis alone, especially with the lack of sufficient reference data and the small sample set, as in the case presented here, in Staré Město. Still, it is noteworthy that the results of this study imply the presence of similar patterns in mobility through the wider area of Great Moravia.

For this study, orientations of the 128 graves from Mikulčice-Valy, subjected to the mobility analysis based on the $^{87}Sr/^{86}Sr$ ratio by Vytlačil *et al.* (2021), were traced in published literary sources dealing with archaeological evaluations of the burial sites (Poulík, 1957; Klanica, 1985; Profantová and Kavánová, 2003; Poláček and Marek, 2005; Klanica *et al.*, 2019). A total of 21 individuals in this set were identified as probably spending their early childhoods in an isotopically different region and can therefore be considered persons of non-local origin (Vytlačil *et al.*, 2021). However, after assigning grave orientations, it emerged that 19 of them were buried in more or less standard orientations, *i.e.*, approximately west-east. The two exceptions were individuals from graves number 420h (oriented SSW-NNE) and 786 (buried in N-S orientation). A north- or south-facing grave orientation was found in the other six individuals (graves number 250, 505, 701, 736, 738 and 1728) sampled by Vytlačil *et al.* (2021), but the $^{87}Sr/^{86}Sr$ ratios of all of them lie well within the estimated bioavailable ranges of the site (summarised in Table 2). Of course, it must be taken into account that the skeletons in the study by Vytlačil *et al.* (2021) were not chosen with regard to their grave orientation. As a result, the dataset may not be generally representative, and

Table 2. Comparison of $^{87}Sr/^{86}Sr$ ratios of individuals buried in north-south azimuths from Staré Město and Mikulčice and their probable origin.

Sample	Grave no.	$^{87}Sr/^{86}Sr$	2SE	Orientation	Origin
UHH-1	16/2018	0.709294	0.000008	NNW-SSE	local
UHH-2	18/2018	0.711322	0.000007	NNW-SSE	local
MH7	505	0.709349	0.000006	NNW-SSE	local
MH66	701	0.709955	0.000005	S-N	local
MH68	736	0.710319	0.000008	S-N	local
MH76	738	0.709713	0.000007	S-N	local
MH102	250	0.709293	0.000007	SSW-NNE	local
MH107	786	0.712568	0.000007	N-S	non-local
MH110	420h	0.708872	0.00001	SSW-NNE	non-local
MH121	1728	0.710614	4.64E-06	NNW-SSE	local

it is possible that some potential non-locals buried in a north-south orientation may not have been recorded. In any case, the association between north-south grave orientation and non-local origin in the case of these burials from Mikulčice-Valy is not obviously clear.

5. Conclusions

We have attempted a preliminary probe into the issue of testing a long-standing archaeological hypothesis about the migratory origin of people who were placed in graves with north-south azimuths, *i.e.*, in a different way from the prevailing contemporary burial ritual in early medieval Moravia and adjacent areas of Bohemia and Slovakia. Based on the results obtained, it is not yet possible to draw any conclusions about the validity or invalidity of this hypothesis; for this, it will be necessary to analyse a much larger dataset in the future. However, in the case of the two females from graves number 16/2018 and 18/2018 from the burial site "Na Valách" in Staré Město, it seems that the individuals did not originate from a foreign environment.

Our results, however, seem to indicate that the hypothesis of a non-local origin of people buried in the north-south azimuths is not based on solid foundations. It will therefore probably be necessary to consider other causes of this phenomenon, such as some types of sociocultural differences that may not necessarily be related to the migratory origin of the bearers. Another possible explanation of inconclusive results is regional migration – "foreigners" originating from geographically (and geologically) close areas where $^{87}Sr/^{86}Sr$ ratios are similar to those at the site we evaluated may also have been buried in different orientations (this could theoretically be applied to individual number 16/2018). In any case, possible cultural influences that may have been reflected in the different treatment of the dead must be taken into account. In the Great Moravian area, historical sources document the presence of, for example, Arab or Frankish traders, Christian missionaries from both Western Europe and the East (Byzantine Empire), and probably slaves (especially from the ranks of prisoners of war), *etc.* Thus, the burial ritual may have involved a combination of various factors which, in their complexity, are not traceable by the methods available today. It is also true that mere chance cannot be ruled out. However, it will only be possible to draw more precise conclusions after more in-depth research into the issue has been undertaken.

Acknowledgements

The article appears through the institutional support of long-term conceptual development of research institutions provided by the Ministry of Culture (ref. MK000094862 and MK000023272).

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