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<b>Autor:</b>	Sankot, Pavel / Havlíková, Alena
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# The application of low-pressure Hydrogen Plasma in the conservation of metal objects at the Museum of Central Bohemia

by PAVEL SANKOT and ALENA HAVLÍNOVÁ

## *Abstract*

Co-operation between conservators and archaeologists of the Swiss National Museum and the Museum of Central Bohemia in Roztoky commenced in 1991. These activities led to the realisation of the project "Preservation of Cultural Heritage in the Czech Republic" and the installation of the plasma apparatus in the Museum of Central Bohemia.

For the first time objects from collections in Czech museums may now be treated by the plasma method. The first to undergo such treatment are dated to the early La Tène period. By such methods it was possible to uncover their form, elements of construction as well as surface treatment and with such information it was possible to fill in some of the gaps in the archaeological assemblage, attribute objects to the early La Tène period, interpret their social context. By using the plasma method on what the conservators considered very difficult cases, it was possible to provide new information on context, communications and movement of Celtic groups between Central Europe and elsewhere and thereby contribute to the understanding of the formation of the La Tène civilisation in Central Europe. The stability of finds treated by the plasma method is also evaluated by comparing the results with other conservation methods.

## Installation of a plasma apparatus in the Museum of Central Bohemia

### *The stability of iron objects conserved by plasma*

As part of an overall project concerned with the "Preservation of cultural heritage in the Czech Republic", the Museum of Central Bohemia in Roztoky, near Prague, was chosen for the installation of a low pressure hydrogen plasma apparatus. Realised by the Swiss National Museum in co-operation with the National Museum in Prague and the Museum of Central Bohemia, two conservators, Dušan Perlík and Alena Havlínová, were given the opportunity to travel to Zurich and undertake a six month training program at the Swiss National Museum. This program included instruction in the use and maintenance of the equipment, the conservation of plasma treated objects, most notably iron objects, and access to the extensive

library facilities. This project was funded by the Swiss Confederation and managed by the Department of Research and Development within the Swiss National Museum.

The principle aim of this project was the co-operation of conservators, scientists and archaeologists in an effort to define optimum conditions for archaeological finds' preservation. Although the project officially commenced at the beginning of 1995, an exchange of both scientific and practical information between conservators and archaeologists of the Swiss National Museum and our museums has taken place since 1991.

The plasma apparatus was installed in the Museum of Central Bohemia in Roztoky between May and July of 1996 by the firm Vacotec SA and was first put into operation under the guidance of Alexander Voûte, physicist, and Katharina Schmidt-Ott, conservator. The arrangement of this apparatus is the same as that installed in the Swiss National Museum. The relative ease with which the installation took place is also due to the kindness of Stanislav Vepřek.

The apparatus installed in Roztoky represents the latest version in the development of such equipment in that its generator is cooled by alcohol/water solution in a closed cycle and the safety system minimises the possibility of human error. Objects treated in our museum will follow the recommended practice for plasma by setting the temperature to 150 °C. This should ensure that no metalographical changes will occur until further research indicates the suitability of using higher temperatures. Following plasma treatment, alkaline sulphite desalination will be used. We first applied this technique in 1986 and all artifacts treated by this method remain in good condition without active corrosion. Alkaline sulphite is rarely used in museums in the Czech Republic, the more common method being electrolysis desalination in water baths.

### *New informations on "La Tène" sites in Bohemia due to the conservation by plasma*

There is a strong mutual interest by both archaeologists and conservators in the conservation of finds. Archaeologists can contribute information about the function, construction and decoration of different parts of an object. By uncovering the original surface of an object the conservator can effectively provide much more information for the

archaeologist. The use of low pressure hydrogen can assist in this process. Our first results as well as how the plasma technique was integrated into new conservation projects for metal objects from the Iron Age "La Tène" sites in Bohemia are presented below.

The history of archaeology as a discipline clearly indicates that like many other humanities studies, it can draw upon very subjective assessments. In many cases this can distort our perceived understanding of prehistoric "reality", particularly when applied to the study of archaeological finds. There is often a lack of proportional representation of objects from a given site due to the researcher's particular bias for certain objects or the absence of a fully conserved assemblage. Often only the finer metal objects such as gold, silver and bronze were examined in greater detail simply because they were more easily preserved. Objects made of iron were therefore often poorly represented in such bodies of work. It is therefore fortunate that within the last few decades the significance of these objects is more readily appreciated. As a result our knowledge of La Tène weapons, for example, is much more comprehensive, thanks to the work of André Rapin and his team at the Laboratory in Compiègne, France<sup>1</sup>.

An issue of great importance to the archaeologists of Central Europe concerns the question of the formation of La Tène culture in this area. Based on Ludwig Pauli's research, it would seem that the production of bronze in the western La Tène area has its counterpart in the production of iron in the eastern La Tène area which includes Bohemia<sup>2</sup>. Thanks to the contribution of the plasma apparatus by the Swiss Confederation, further work in this direction will lead to further new discoveries. Some of the areas of research that previously lacked important information can now be filled in with the assistance of the plasma apparatus and our conservators. Objects well known in western Europe for some time such as early La Tène belt hooks<sup>3</sup> can now be seen in Central Europe and previously unknown types of decoration on "simple" objects such as single blade knives have been discovered<sup>4</sup>. We are also able to define whole workshops in the eastern part of the La Tène culture<sup>5</sup>. Traditional conservation methods are now confined to the most difficult of "patients".

In many cases the traditional methods of conservation are inadequate, especially in such areas as the removal of hard surfaces composed of corroded material and mechanical dirt. We therefore welcome the opportunity to use the plasma apparatus. A good example of this method's value has been its application in the conservation of finds from the La Tène tomb from Bránov, finds that have also been worked on by Jörg Elmer of the Swiss National Museum in Zurich. By using this method we were able to ascertain the exact shape and construction elements of a shield type, previously unknown in Bohemia, as well as identify very fine decoration which appears to be based on Mediterranean motifs. From an archaeological point of view, not only is it a fine example of La Tène art but also a potential source of important informations:

1 Thanks to these results we could lower the date of the first La Tène shield type with metal central parts in Bohemia to the end of the fifth century BC.

2 Given its reassessed date, more could be learned about the social context of the finds of that period. From 1905 until 1985, this material was thought to be dated to the late La Tène or early Roman period. Now that it is attributed to an earlier period it ties in well with a fortified settlement found in the vicinity and the tomb may therefore be attributed to the early La Tène high society of that settlement.

3 The treatment of the metal parts of the shield and the sword scabbard provide some indication of the ritual practices associated with their burial. The central parts as well as the margins of the shield appear to have been ritually destroyed. In this respect the sword from Bránov is also interesting. An old illustration indicated that this sword was unusually long and the placement of the suspension-loop suggested that the sword protruded almost half of its length beyond the scabbard<sup>6</sup>. Following recent restoration it is now clear that the lower part of the scabbard was empty and that the sword is therefore of the more typical length for the early La Tène. It is not a ritually bent sword of exceptional length but one that was partly withdrawn from its scabbard and then ritually deformed. While examining La Tène swords from France to the Carpathian basin, Rapin found similar examples of this kind of sword ritual in a part of Northern Italy that was inhabited by the Celtic tribes of the Senons and Boii<sup>7</sup>. Such conservation methods do not contradict views held about the originality of one part of the La Tène culture in the area of today's Bohemia but rather assist our understanding of communications and movements of Celtic groups between Central Europe and more southern areas such as Austria and northern Italy<sup>8</sup>.

#### *Critical application of the plasma method to objects of fragile construction*

The conservation of other objects using the plasma method have been equally informative. Previously unknown decorative elements have now been found on fine objects such as fibulae of the Marzabotto type as well as on horsebit from the early La Tène cremation burials. Nevertheless, one must critically consider the efficiency and safety of the plasma method when applied to fine objects<sup>9</sup>. The sword scabbard from Modlešovice, southern Bohemia, is a case in point. The fine decoration on the scabbard indicates that it may belong to those with dragon-pair ornaments<sup>10</sup>. Following mechanical cleaning by our department, the plasma technique was applied to this scabbard in 1994 by Miloš Klíma of the Faculty of Natural Sciences in Brno. When it was discovered that the scabbard had very important decoration, the complete removal of chloridions was considered. At that time the plasma method was considered to be

the best way to remove such chloridions. The following steps were applied:

- Step 1 Time of treatment: 2 hours, pressure: 140 Pa, flow of hydrogen ( $H_2$ ) approximately 40 sccm, maximum § temperature: 325 °C.
- Step 2 Time of treatment: 18 hours, pressure 140 Pa, flow of  $H_2$  approximately 30 sccm, temperature: 240–250 °C.

Finally fragile fragments of the scabbard were glued together and set in their original place. Given the fragility of the object, washing with de-ionized water was not undertaken. After the drying process, the object was impregnated with polyacrylate copolymer and the surface was varnished with wax. As yet no active corrosion has been found on the object since restoration. In spite of the attractive result, we must admit that such a technique may not be entirely appropriate for objects of very fine construction.

### Further promotion of the plasma method in the Czech Republic

During our conservation project a larger collection of early La Tène finds has been restored by various methods including the plasma treatment. In spite of the fact that store rooms in museums in the Czech Republic are not optimal, none of the objects exhibit active corrosion. There have been no observable changes in their stability.

Through the exhibition of restored works in the National Museum in Prague in November 1996 and by means of seminars, conservators and archaeologists will be informed about the new technology. As well as offering the more conventional conservation services, the plasma treatment will also be offered to other museums in the Czech Republic. We would like to thank the Swiss National Museum and all the colleagues who have supported the "Preservation of Cultural Heritage in the Czech Republic" project.

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