Environmental Pollution and Archaeological Objects : Effects and Research Perspectives

Abstract

Damage caused by environmental pollution is noticeable on the majority of historical monuments in Estonia. This phenomenon mostly strikes the eye in cities, where the destructive results of acid rain are easily observable. Especially sensitive to acid attack is the limestone used as a building and decorative material in the medieval cities of northern Estonia. Thus, it can be claimed that the major part of the limestone carvings, sculptures and decorative details in old Tallinn have been damaged to a greater or lesser degree. The effect of acid rain on the metal used in the construction of the buildings, such as the roofs, drainpipes and guttering, and forged ornaments, can also be observed.

Because the disintegration of buildings under the influence of environmental pollution can be observed by everyone this has led to a discussion of the problem and the taking of definite measures to improve the situation. Archaeological objects, however, which are not so much in the public eye, have frequently been overlooked. Man-made aerosols, especially sulphuric and nitrogen compounds, occur in the air and subsequently, via precipitation, enter the soil, where they undoubtedly cause the decomposition of archaeological finds present in the cultural layer. The determination of the extent of this damage and its relationship to the various soil types is a problem still to be solved.

A survey of the sulphur content of the sulphur oxides produced by industry in both Estonia and other countries reveals that c. 40 kg of sulphuric compounds are deposited per hectare per year in Estonia. The commonly accepted limit, approved by the Stockholm Convention, is 2.5 kg. The situation concerning nitrogen oxides is somewhat better. The nitrogen oxide content of precipitation has been estimated at close to 10 kg per hectare per year (1987), which is about the same level as in the Scandinavian countries and Finland. It can be seen, therefore, that there is a significant amount of acid available to influence the archaeological finds in a cultural layer. This influence will,

however, differ with the type of soil. It is evident that the amount of damage caused by acid rain is less in northern and western Estonia where the archaeological remains, of which there are many, are situated in alkaline soils rich in carbonate. In such cases the carbonates neutralize the majority of the acids in the soil and thus provide a chemical balance between the archaeological finds and the soil surrounding them. Such a balance is a prerequisite for retarding the decomposition of the finds. Any disturbance of this balance, whether as a result of extracting finds from the cultural layer or from a change in the quality of the soil, would undoubtedly accelerate decomposition. It is possible to stabilize the objects extracted from the cultural layer by using different conservation methods. On the other hand, those objects that remain in the soil are inevitably doomed to destruction because the cultural layer is unstabilized.

The situation is different in southern Estonia where the archaeological remains occur in acid soils. The cultural layer which has developed in such a soil has far less buffering capacity and this results in unstabalization. This has been demonstrated from several archaeological finds. Finds from excavations in northern and western Estonia - metal objects for the most part - are noticeably in a better state than those from southern Estonia. It is clear that metal objects are the most susceptible to destruction but that the influence of acid rain on metal objects differs with the metal in question. A high level of acidity damages the noble patina which accumulates on bronze finds over the centuries and which is composed primarily of carbonates. The removal of this patina accelerates the corrosion of the metal. In the case of iron objects excessively acid precipitation can directly cause chemical decomposition. More important still is the decomposing effect of electrolytic corrosion, where the mineral acids, which have dissolved in water, act as electrolytes. Extreme acidity also destroys organic matter in different ways. The decomposition process is speeded up in the case of vegetable fibre but there is little change in the case of albuminous substances such as wool, keratine (horn) etc.

The salting of soil, as a result of the immoderate use of chlorides to remove snow and ice from the roads in winter, is another aspect of man-made pollution. Some mineral fertilizers used in agriculture are also likely to produce similar results. The fact that chlorides constitute the most active component in electrochemical corrosion is common knowledge. Iron objects are remarkably sensitive to chlorides. The wide range of roadside emergency excavations in recent years has revealed the gravity of the situation. A large number of metal finds have been destroyed by chlorides. That the situation has been considerably aggravated can be seen when a comparison is made with finds from excavations conducted in the same region fifty or more years ago. An analysis of the corrosion products taken from the surface of some of the objects shows that the chloride content has increased twentyfold. Although the chloride content of roadside cultural layers containing archaeological objects has not been studied it can be assumed that the salting of roads has created an emergency situation for those archaeological remains located within 20 m on either side of a road. The number of such archaeological sites reaches hundreds.

What are the possibilities of determining the harmful effects of environmental pollution and their extent and nature of change over the course of time ?

In order to predict possible destruction resulting from chlorides the chloride content of soil samples taken from roadside cultural layers containing archaeological objects should be determined. A comparison between this figure and that of the chloride content of soil samples taken from points at greater distances from the road should provide a good measure for estimating the state of the archaeological objects. It is also possible to place experimental samples at various distances from a road and to study their destruction. Unfortunately, this information would become of use only after a long period of time. In addition the chloride content of numerous archaeological finds composed of different materials should be studied and collated with the chloride content of objects which have been found in the same region fifty or more years ago. We are likely to get interesting data about the increase in soil pollution if we compare samples from the cultural layers which are preserved in the archaeological collections of the Institute of History of the Estonian Academy of Sciences with samples taken from the same historical sites today. In the first instance we would certainly distinguish the most obvious characteristics of the changes in the cultural layer. Good results might be achieved by studying lake deposits and peat samples in order to determine the state of the cultural layer, if those sediments which have accumulated during the last century are considered. At any rate, the danger from environmental pollution is great when unexcavated archaeological objects are considered.

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