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THE ASH-TIGORS' GRANARIES AND PALAEOCLIMATE OF THE 7TH-12TH CENTURIES IN THE NORTH CAUCASUS

The ethnic name Ash-Tigor was first used to designate a tribal unit located in the North Caucasus in »The Armenian Geography« traditionally attributed to Anania Shirakatsi (7th century). Two versions of translations of this Old Armenian written source are most popular: a Russian version was published by K. Patkanov in 1877 (Patkanov 1877), and in 1881 A. Soukry published his French translation. Already in 1887 the Russian specialist in Iranian studies V. F. Miller put forward the conclusion suggesting that the first part of the ethnic name *(Ash)* corresponded to the modern term *(Os)* signifying the modern Ossetians, whilst its second part *(Tigor)* might be applied to the Digorians – the western branch of the modern Ossetians (Miller 1887, 105-106). This opinion was then confirmed by V. I. Abaev (Abaev 1958, 79-80), Yu. S. Gagloiti (Gagloiti 1966, 155-166), A. V. Gadlo (Gadlo 1979, 164-165), A. Aleman' (Aleman' 2003, 367-371) and many other investigators. In 1963 S. T. Eremyan published a new, Modern Armenian translation of »The Armenian Geography«. In this version the Digorians, the Ash-Tigors and the Alans were interpreted as an ethnically united group (Volkova 1973, 110-111); the attribution of the Ash-Tigors to the Ossetian ethnic group has not been seriously questioned ever since. Only some adherents of the Turkic linguistic attribution of the Alans-Ases adopt a different position (Bidschev 1983, 105; Misiev 1985, 200-205), but it should be pointed out that these views have not been accepted in scientific circles (Kuznetsov/Tsetsenov 2000, 34-45; 93-98). As far as the geography of the Ash-Tigors' settling in the North Caucasus against the background of the localization of the Alans, the Digorians and the Agvans-Alans mentioned in the same source is concerned, different positions exist. Thus, in 1962 V. A. Kuznetsov suggested the localization of the Ash-Tigors in the Upper Kuban' basin (Kuznetsov 1962, 72-73) and identified them with the sites of the western variant of the Alanic culture; not long ago, C. Zuckerman proposed the territory situated somewhat farther eastward, on the foothills of the Podkumok and Baksan rivers' interfluve, as being occupied by the Ash-Tigors (Zuckerman 2000). A number of questions arise: which archaeological sites of the 7th century in the discussed region can be attributed to the Ash-Tigors' tribal units? Was their distribution in some way related to the natural landscapes and altitude zones? Is it possible to reveal any historical content from their location and distribution? To answer these questions, the archaeological objects of the Upper Podkumok basin, that is of the Kislovodsk depression, should be considered.

Historic monuments of the Kislovodsk depression attracted the attention of scientists long before this region had officially entered the Russian Empire. Evli Chelebi traveled there in 1666-1667 and wrote a vivid account of the hillfort Burgustan-Rim-gora (Chelebi 1979, 90-91). In 1810, S. M. Bronevsky presented a brief geographic description of Kislovodsk and its neighbourhood, including Zhintemirov settlements inhabited by the Abazines, and mentioned the »Frank« town Burgu-sak (Bronevsky 2004, 145). Among those who explored the region in the 19th century are such known representatives of the historical science as F. D. de Montpereux, A. Firkovich, A. S. Uvarov and P. S. Uvarova, D. Ya. Samokvasov, M. M. Kovalevsky, N. E. Makarenko, and others. In the first part of the 20th century their work was continued by V. R. Apukhtin, A. N. Gren, A. A. Bobrinsky, D. M. Pavlov, N. M. Egorov, A. A. Iessen, S. N. Zamyatnin, V. V. Bobin, in the second part of the century by E. I. Krupnov, V. A. Kuznetsov, V. I. Markovin, V. I. Kozenkova, V. B. Vinogradov, M. P. Abramova, V. B. Kovalevskaya and their pupils and followers. Many of them fruit-

fully investigate this territory at present. We also appreciate the activity of the specialists in local lore A. P. Runich, N. N. Mikhailov and M. I. Rybenko (Afanas'ef/Savenko/Korobov 2004, 9-49) who contributed to the rescue of investigations concerning the archaeological heritage destroyed by the regional development programs. As a result, the archaeological sites of the Kislovodsk depression can be attributed ethnically and culturally. The monuments dating to the Early Middle Ages occupy a specific position in this process.

By the late 80s of the past century, the Early Medieval sites of the Kislovodsk depression had been generally interpreted historically, as far as possible for that time. First, the basic corpus of the sites was identified and their relative and absolute chronology established. It became clear that the ancestors of the Early Medieval population settled in this region as early as in the Sarmatian period. After the Hunnic invasion the discussed groups became the bearers of the so-called Alanic archaeological culture (though not only Alanic tribes were identified with it). This culture got subdivided into three stages: the Early Alanic (5th-7th centuries), the Khazarian (8th-9th centuries) and the Late Alanic (10th-12th centuries). Basic types of Early Medieval burial constructions were established and their ethnic and cultural attribution suggested. There had also been attempts to reveal the key points of the social and economic development of the Early Medieval population, such as their settling in the Kislovodsk depression, the demographic boom of the 6th-7th centuries, basic features of their social system (family types, patronymics) and migrations of the mid-8th century.

At the same time, in the late 80s, parallel to these obvious accomplishments in the field of historical interpretation of the archaeological material, it became clear that the simple mechanical accumulation of archaeological data would not bring about any new knowledge of the historical processes that unfolded in the discussed region during the Early Middle Ages. Thus, absolutely new methodical approaches to the compilation of the archaeological material were needed. It is not a coincidence that the majority of the sites in the Kislovodsk depression have been discovered at localities regarded as the most popular places for organised local lore excursions or montane tourism. Consequently, it might be concluded that the topography of the sites known for this period does not mirror reality, but the »intensity« of one or another locality within the region is surveyed. Thus, it was first of all necessary to investigate the unexplored areas located on the regional map and to establish (with the application of a GPS set) accurate geographical coordinates both of the archaeological sites of the Alanic culture already known and the newly discovered ones. Totally new methodical procedures for the preservation and the study of the archaeological material were needed. But the most important point was that the new methodical pattern must meet the modern demands of the multidisciplinary investigation of archaeological objects in the framework of the landscape archaeology: archaeological site – natural environment – palaeoclimate. Another point to consider was the correctness of the ethnic and cultural interpretations suggested for some archaeological objects, based on analogies or simply on extrapolation from conclusions drawn for other regions of Eastern Europe. First of all, what's being said concerns the elements of the archaeological culture traditionally regarded as the ethnic markers of the proto-Bolgar tribal groups (Afanas'ef/Lopan 1996). Besides, as already mentioned, new interpretations of the written sources have been recently published concerning the localization of the Ash-Tigor tribes in the North Caucasus and reasoning their habitation in the Kislovodsk depression in particular (Zuckerman 2000).

To use methods of a multidisciplinary analysis on the archaeological sites of the Kislovodsk depression, the archaeological-geographical system »Kislovodsk« was created, with the application of GIS (Geographical Information System) and three-dimensional (3D) technologies. For the first time in the science of archaeology, a system has been worked out based on the integration of archaeological and geographical databases and the database on multiscale 3D regional data, the database on basic climatic characteristics (according to the state of the year 2000) with GIS instruments, instruments analyzing 3D information and instruments

for a »perturbed« climate simulation for different spots in the Kislovodsk depression. The archaeological-geographical system »Kislovodsk« consists of three basic blocks.

The first block is the GIS database with data stored in separate layers within the Arcview program. It is based on the topographic map (scale 1:100 000; folios K-38-1 and K-38-2), taken in two projections. Separate layers reflect the hydrographic system, relief contours, modern forestation, springs, modern settlements, roads, data of the territory remote sensing (aerial photography of the territory carried out in the course of two flights and spectrozonal space data). In the final database layer, information on 805 archaeological sites registered in the investigated region is stored.

The second block comprises the complex of numerous and varied investigational instruments and procedures used in spatial, network and remote archaeological analyses based on the program modules Spatial Analyst, Network Analyst, as well as the program ERMapper 5.5.

The third block of the system »Kislovodsk« consists of the complex of programs and a special GIS for the palaeoclimate simulation in the Kislovodsk depression. The above-mentioned traditional GIS layers of the first block were supplemented with the layers designed for the solution of specific problems of palaeoclimatic studies. The territory of the Kislovodsk depression was divided into microcells 0.5 × 0.5 km large. Information on each microcell was stored in separate database GIS layers, containing microclimatic indications for the period of the year 2000, such as the total annual average daily temperatures above 10° C, the total annual radiation balance, the annual moisture budget, the annual number of precipitation days, the annual number of days with an average temperature above 10° C, the hydrothermal coefficient, and the radiation dryness index. Besides, the database contains information on dynamic indications, such as the average monthly precipitation, the average monthly specific air humidity, the total monthly average air temperature over the ground surface, and the average monthly module of wind velocity. Similar information was calculated for the so-called »perturbed« climate highly probable for the first millennium AD.

What new results does this instrumental program system provide for the investigation and understanding of the historical situation and processes that developed in the remote past in the Kislovodsk depression? Let us try to answer this question proceeding from considering the models of responsibility displayed by the strongholds erected by the Alanic tribes and known from the written sources as the Ash-Tigors. Hillforts have been chosen for the analysis, based on the supposition that it had been the patronymic or tribal towers, fortifications and fortresses that were of special significance to the Medieval population of the North Caucasus – as far as the concept of tribal territory is concerned. That is why the investigation of the spatial system of the Early Medieval hillforts in the terrain will provide better perspectives (as compared to dwelling sites) for modelling the system by which different tribal structures exercised their control over certain spots within the Kislovodsk depression.

On the regional level, the analysis of interrelations of sites can be carried out both in synchronistic and diachronic aspects. Considered in a synchronistic aspect, the interactions are studied and interpreted as really existing at a certain moment of time. The diachronic approach aims at the investigation of the sites' interrelations in a certain chronological span. The presented investigation starts from the application of a synchronistic approach to the fortifications of the 5th-9th centuries that are viewed as objects functioning simultaneously. The basic methodical principle of this work consists in comprehending the adaptation strategies worked out by the Early Medieval population of the Kislovodsk depression; it results in a complex network of interactions and mutual dependence and unites the communities that had left the sites under investigation into a functioning system integrity. What's being said is mirrored by the system of fortified dwelling sites determined by the functional role and the pattern of integration of each community in the framework of the general adaptation strategy. In order to suggest a reconstruction of the spatial system of the Early Medieval dwelling sites in the Kislovodsk depression it is necessary to establish and esti-

mate the annual seasonal pattern of occupation in each community and the functional role each community played in the general system of adaptation. This task seems to be very complicated and time-consuming, making long-term, wide-scale excavations and multidisciplinary research necessary. The reconstruction of the model of the hillforts' responsibility for their environs within the Kislovodsk depression is a less complicated task: it consists in establishing the number and the spatial distribution of all sites. Anyway, even this simplified reconstruction puts forward a number of problems, and their solution depends on the quality of the data and the reliability of the historical conclusions.

One of these problems refers to the synchronousness of the analysed sites. The compilation of regional chronologies was for a long time a traditional aspect of archaeological research work, and still, reliable progress can only be reached when analysing burial associations. For the period from the late 4th to the late 9th century, six basic cultural and chronological stages have been singled out, some of them dated as accurately as five decades (Afanas'ef/Runich 2001, 38-43). Concerning material from dwelling sites, it seems to be a far less promising situation. At present there is practically no serious research devoted to the chronological differentiation of the Early Medieval dwelling sites of the Central Caucasus foothills.

Another problem consists in establishing significant regional boundaries which directly refers to the question of what nature the differences revealed in the sites' substantial features are. Do they have a functional, temporal or cultural character? Archaeologists usually just leave this debatable question aside and establish regional boundaries proceeding from conventional geographic features, e.g. rivers and valleys. But the concept of regional boundaries is far more profound. The borders outline the territory occupied by a certain palaeoethnographic unity. Consequently, the problem of establishing significant regional boundaries turns out to be even more complicated, taking into account the practical difficulties in revealing such units as patronymic, clan, tribe or territorial community by archaeological methods, even in their historical or ethnographical meaning. These are the reasons why investigators can only conventionally assume the relations observed in the material culture of two or more communities to point to the linguistic similarity or closeness to other ethnic hallmarks.

Summing up the subject of the Early Medieval strongholds of the 5th-9th centuries in the Kislovodsk depression (**fig. 1**), it first has to be mentioned that the local regional borders have been established on the basis of geographical features such as the Upper Podkumok basin, altitude zones (the sites' location at an altitude 900-1500 m a.s.l.), or three ranges screening the territory (the Kabarda, the Djinal and the Borgustan range). Secondly, we proceeded from the archaeological characteristics: strong territorial links within this group of sites and a long distance separating them from coeval sites situated northward (Pyatigorsk region), westward (Upper Kuban' basin) and eastward (Upper Malka River). Analysis of the data provided by the written sources gives grounds to identify this population with the Ash-Tigors (Zuckerman 2000). Nonetheless, archaeological sources do not allow to suppose that the Early Medieval population of the Kislovodsk depression had been ethnically absolutely homogeneous. This is proven, first of all, by two basic forms of the burial rite practised here in the 5th-12th centuries: catacomb cemeteries and rock graves. Furthermore, ground cemeteries and burials in subterranean and ground chambers are known in this region.

Finally, an even more important problem is the representativeness of the analysed selection. Is the information on 120 hillforts dating from the 5th-9th centuries registered in the Kislovodsk depression exhaustive, or does it only mirror the extent to what some spots of the considered territory have been investigated? The history of investigation of archaeological sites in the region proves that land surveys have covered practically the whole depression with sufficient and equal intensity. From the very beginning, the presented spatial analysis of the Early Medieval hillforts in the Kislovodsk depression is determined by problems like synchronousness of the sites, representativeness of the material and the establishing of significant regional boundaries.

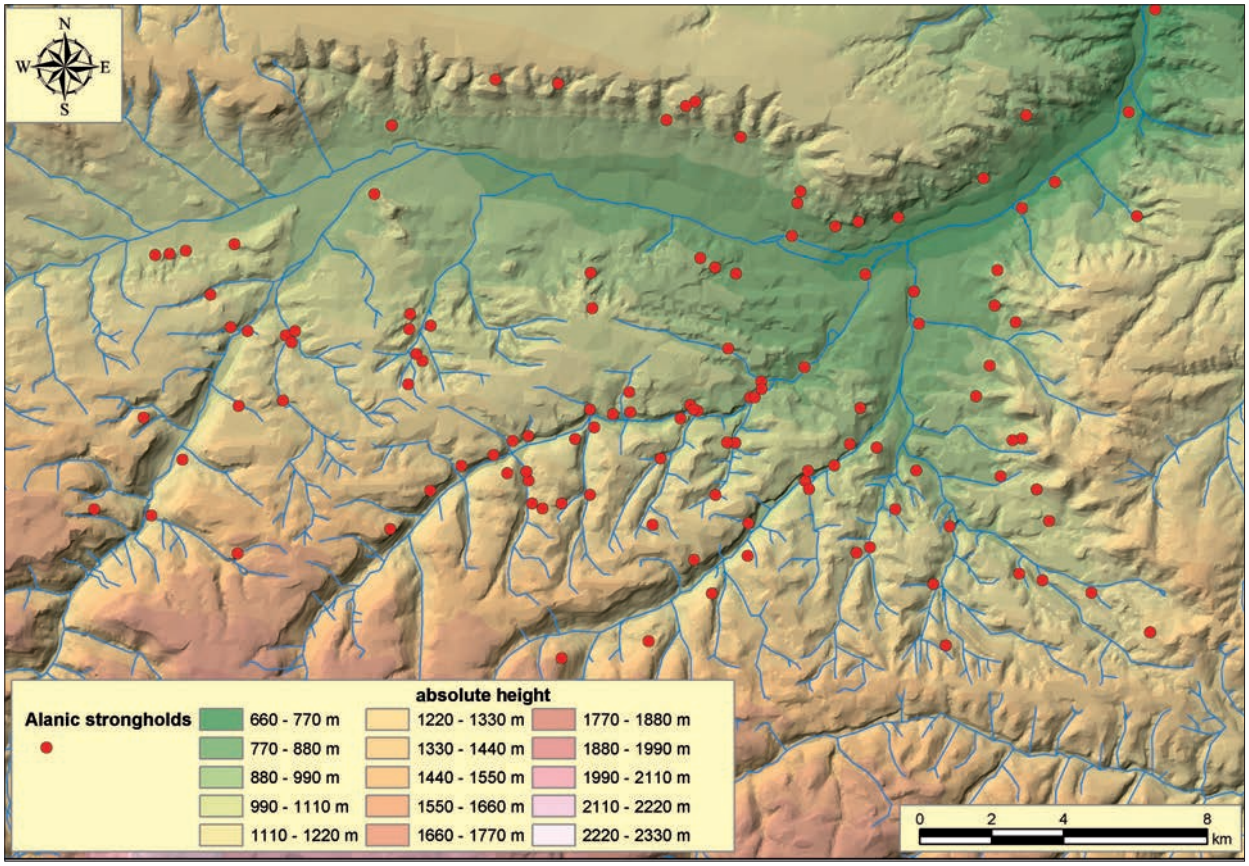

Fig. 1 Map showing the correlation of the Early Alanic fortifications' distribution in the Kislovodsk depression and their altitude above the sea level.

Thus, provided that the Ash-Tigor strongholds of the 5th-9th centuries in the Kislovodsk depression were, taken in their entirety, elements of the general regional system of defence, the problem of the classification of these elements naturally arises. Certainly, systematization of such monuments can be executed in different ways and according to very different indications. In this particular case, we focus on the hillforts' interrelation with the river system and the ranges that encircle the depression as the most influential environmental factors within the organisation of this regional defence system. In the Early Middle Ages, canyons and river valleys probably served as ways for population movements; in this case, the river system played the role of a »network service« with the hillforts (sites) providing a certain kind of facility (namely safety) in a certain »service area« within the territory of the Kislovodsk depression. By applying corresponding procedures of the module Network Analyst, we obtain a clear picture of the territorial interrelation of the hillforts, the river system and the spurs of ranges. It becomes clear that the Alanic fortified sites located in the Kislovodsk depression form two separate groups: their overwhelming majority is related to the river system (**fig. 2**), while the second group shows their connection with the local relief contours, following the Borgustan and the Djinal ranges' spurs.

The situation may be explained in the following way. The hillforts showing their connection to the river system were probably constructed as defensive elements of a certain patronymic or clan (tribal) group to which the adjacent territorial cell belonged – the local polygon that served as farming zone. As a rule, in such cases only one dwelling site is disposed nearby the hillfort. As for the fortified sites located along the

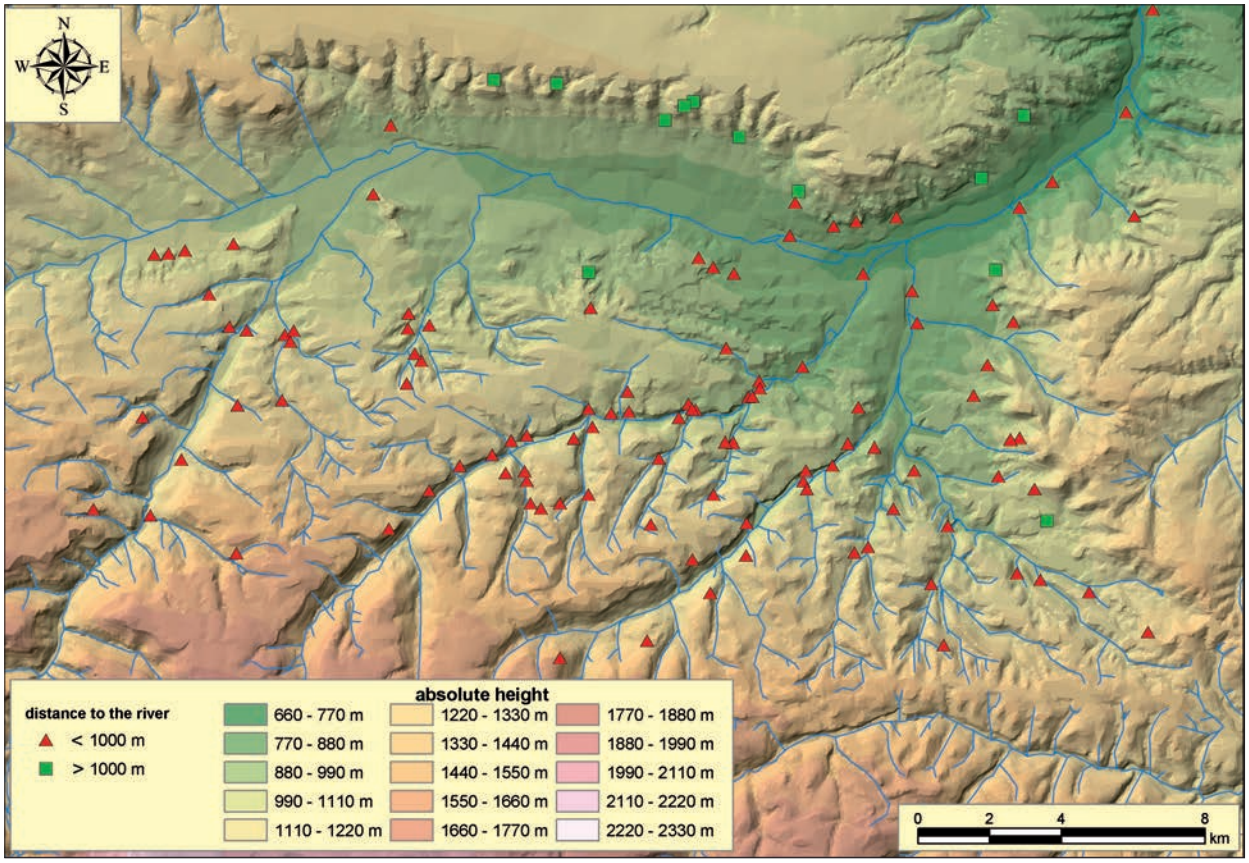

Fig. 2 Map showing the relation of the Alanic fortifications to the river network.

Borgustan and Djinal ranges' spurs, each hillfort can correspond to several dwelling sites. Sometimes the latter are situated not close to the fortification, but far from it, and they do not show any relation to the nearest river. It looks as if these hillforts functioned as patronymic or clan (tribal) refuge places, similar to the fortified sites of the first group, and were also designed to defend the land situated along the valley of the Podkumok, the main river of the region, but also the area opening up towards the Borgustan and Djinal ranges' highlands.

Of interest are the conclusions derived from the analysis of the average distance separating the Early Medieval strongholds of the Kislovodsk depression. The distances between the sites, forming a chain, are in the spurs of the Borgustan range up to 2.9 km on average, in the Eshkakon valley 2.4 km, in the spurs of the Djinal range and further along the Podkumok right bank 1.8 km, and in the Alikonovka valley 0.9 km. The average distance separating the hillforts of the Kislovodsk depression arranged in one line accounts for 1.5 km (**fig. 3**). We may conclude that the conditions the Alikonovka valley granted its local population in the 5th-9th centuries must have been most favourable. The territory of the Djinal range spurs to the Olkhovka valley (on the right bank of the Podkumok) comes in second, while the left bank of the Podkumok is considered to having been the least preferable area.

These observations are confirmed by the investigation of the distribution density of the Early Medieval fortified sites dating to the 5th-9th centuries (**fig. 4**). Using the option »density from« of the module Spatial Analyst, a clear picture reflecting the density of the discussed monuments in the territory in question is shaped. On the Podkumok right bank, three zones with the highest concentration of sites are outlined. The

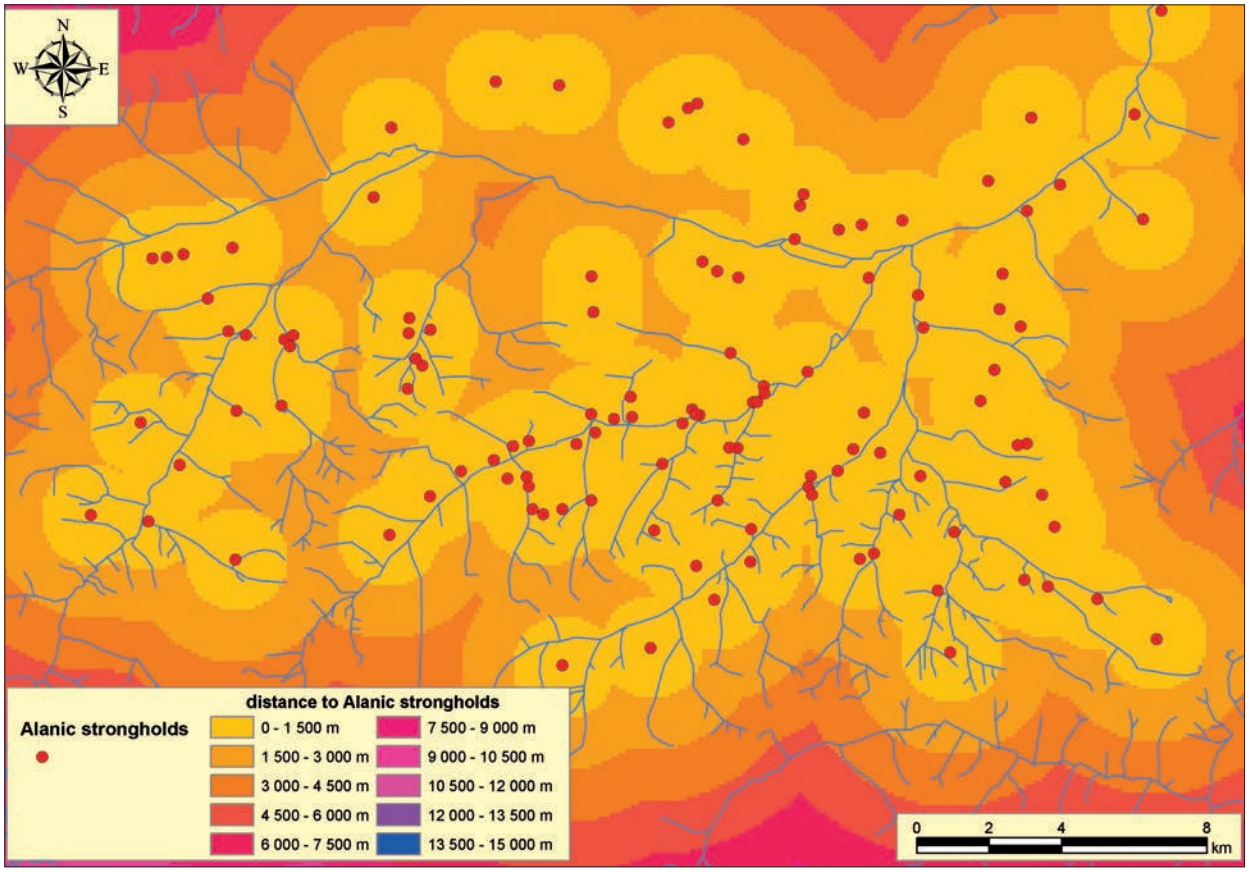

Fig. 3 Map showing the spatial relations between the fortifications disposed within a radius of 1500 m from one another.

first zone is located in the region where the fortified sites Gornoe Ekho (Otstoinik) and Zamok are situated (nos 11 and 23; according to the site list of the Kislovodsk depression[1]). The second zone occupies the Olkhovka-Kabardinka interfluve; it is marked by the known fortified site Lermontovskaya Skala (no. 103). The third zone is disposed between the left bank of the Belaya and the Berezovka-Olkhovka confluence; here the hillforts Krasnoe Solnyshko and Turkmenia are situated (nos 2-3). The existence of three zones with the highest concentration of sites on the right bank of the Podkumok in the 5th-9th centuries territorially correlates well with the topography of the Late Sarmatian sites known from the Kislovodsk depression (fig. 5). The first zone is, to a greater or lesser extent, related to the Late Sarmatian cemeteries Machty, Zamkovy 1, Klin-Yar 3 and Maly Klin-Yar 1 (nos 26, 258, 797 and 802). To the second zone, such Late Sarmatian burials as Budennovskaya Sloboda, Krugozor, Tserkovnaya Gorka, Aeroflot and Teatralny (nos 4-5, 55 and 57-58) are connected. It thus seems possible that the sites playing a central role among the hillforts of the 5th-9th centuries emerged at the spots occupied by the Sarmatian population of the preceding period. The interrelation between the dwelling sites and their ecological microenvironment has recently raised great scientific interest, since it provides the opportunity to extend the informational prospects of the archaeological material by singling out potential economic zones that highlight various aspects of human activity. Having the accurate geographic positions of the Ash-Tigor hillforts of the 5th-9th centuries at our

1 The sites' numbers correspond to those of the site list published in the monograph »Antiquities of the Kislovodsk depression« (Afanas'ef / Savenko / Korobov 2004).

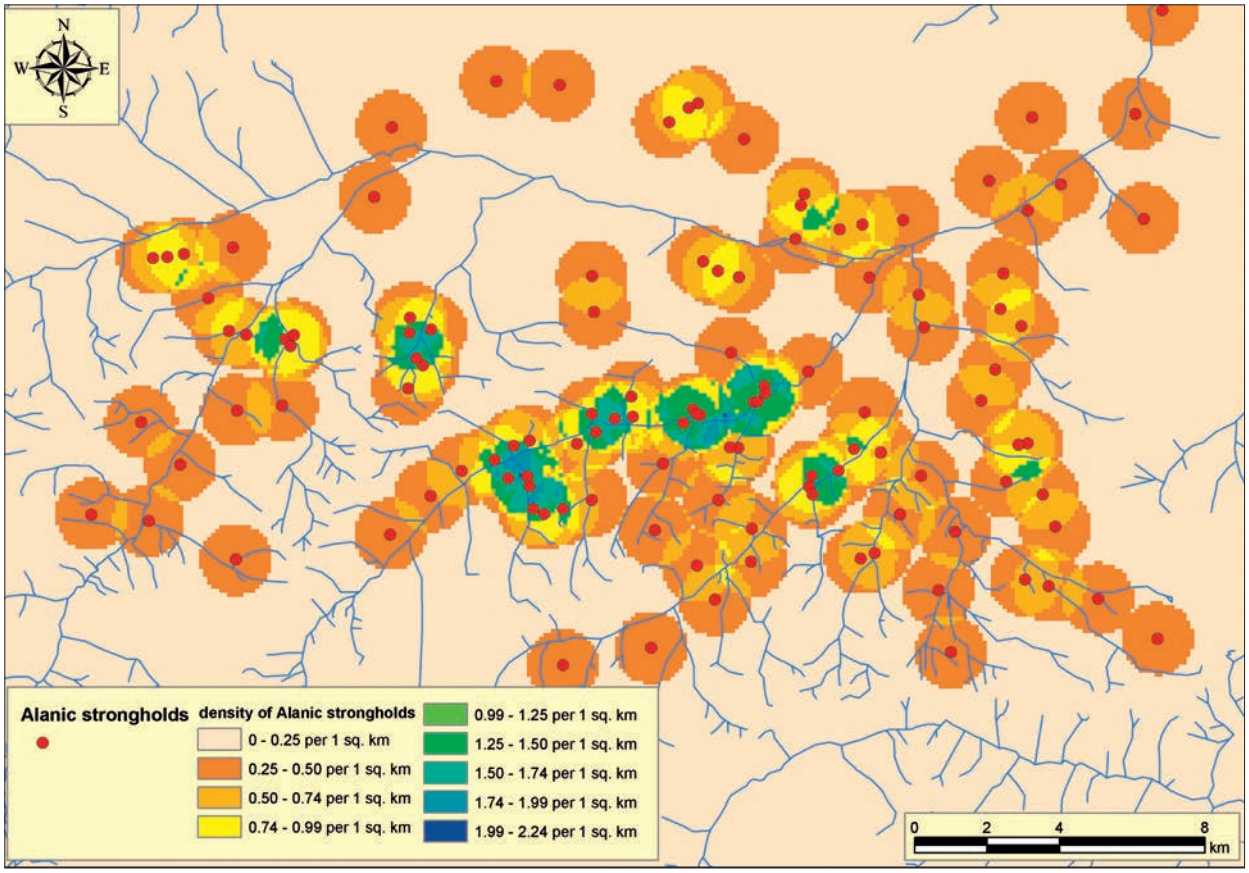

Fig. 4 Map showing the fortification density in the Kislovodsk depression (compiled by applying the method »density from«, simple type).

disposal, we can consider them as waypoint distributions. Consequently, it is possible to characterise and analyse them by applying corresponding procedures of the spatial archaeological analysis, and to suggest and analyse models of potential farming zones adjacent to the fortified sites. To investigate the spatial characteristics of human activity in the past, modern archaeology loaned a whole repertoire of analytical methods from geography and successfully integrated them in the everyday practice. Some analytical methods were also borrowed from the theory of ecological analysis. As a result, many specific works devoted to spatial archaeological analysis with the application of the method of constructing circles or temporal factor were published in the 1970s (see e.g. Jarman/Vita-Finzi/Higgs 1972).

Nonetheless, when the sites' density is high, modelling resource zones or zones of responsibility of one or another hillfort by applying constructing circles or the temporal criterion has only little effect. Actually, the Kislovodsk fortified sites of the 5th-9th centuries are separated by an average distance of only 1.5 km, and in such a case constructing circles does not provide a clear model of the system of each hillfort's responsibility for a certain territory, even over rather smooth relief in some areas. Here, different approaches are necessary. One of them consists in modelling with the application of the Thiessen tesselation (Wheatley/Gillings 2001, 149-151). With the option »slope of distance to« of the module Spatial Analyst, we obtain a picture of the Kislovodsk depression with the Thiessen tesselation constructed for the analysed fortified sites of the 5th-9th centuries (**fig. 6**). One easily notices that in case the hillforts are situated rather close to each other, they form a single polygon. Thus, the fortified sites disposed around Zamok are united within one polygon. The same can be said about the hillforts located around Klin-Yar. A similar picture is registered for the for-

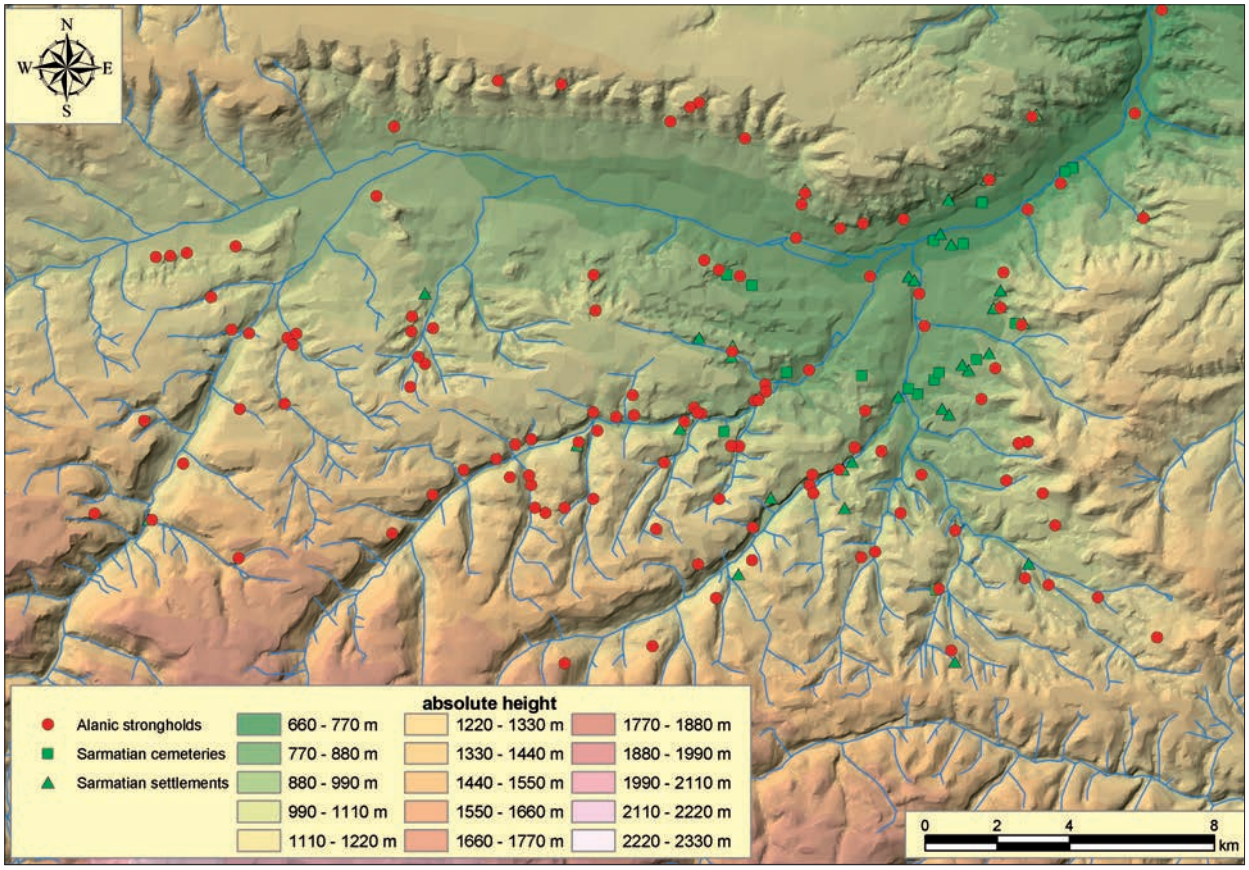

Fig. 5 Map showing the correlation of the Early Alanic fortifications to the Sarmatian fortifications and cemeteries.

tified sites in the Perepryzhka valley and at some other localities. In the outlined boundaries of the polygons, a certain regularity is observed. Thus, if the polygons show a relation with the Podkumok valley, the valley, as a rule, forms a natural boundary dividing the polygons. But if the polygons are related to small rivers, the Podkumok tributaries, they cover both banks of the rivers, and their boundaries run along the watersheds. Comparing the polygons by area per hillfort, one can clearly see that the area is the smaller the closer the site is located to the central part of the depression, the Alikonovka valley. This trend seems to be substantial, since it corresponds well to the above formulated conclusions concerning the location of the central site of the Kislovodsk depression: the hillfort Gornoe Ekho (Otstoinik) in the middle of the Alikonovka valley. The same phenomenon was also registered before, when investigating the central positions dwelling sites of different cultures occupied. Taking in the historical aspect, it means that the economic base of the central dwelling site was not that much focused on the agricultural exploitation of the adjacent territory, but on its population's performing administrative, religious, defensive, producing, commercial, and other functions.

Thus, we have the series of the Thiessen tesselation at our disposal; we can investigate them as potential economic zones related with one or another fortified site by applying the method of site catchment analysis. To draw a comprehensive picture, it is necessary to outline the arable lands and those used as pasture within each polygon. For each polygon, water sources and probable fuel sources must be established. These tasks are difficult to complete, all the more because even now climatic characteristics at different locations of the Kislovodsk depression vary essentially, determining specific economic features developed in each region. It would be incorrect simply to project the present situation with its agricultural tillage on

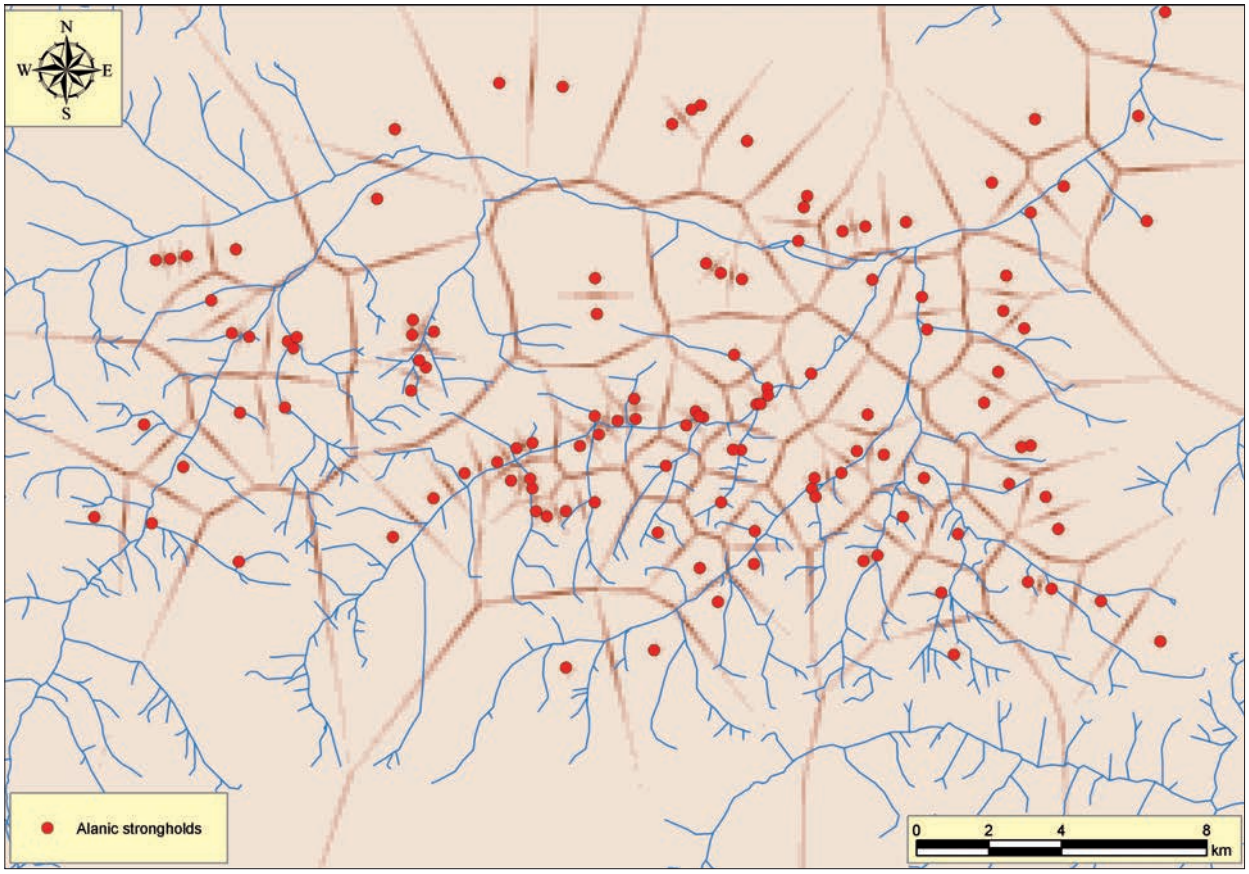

Fig. 6 The Thiessen tessellation around the Early Alanic fortifications.

the Early Middle Ages. Consequently, when revealing and estimating the traces of Early Medieval tillage we must check them with the palaeoclimatic features of the Kislovodsk depression in the 1st millennium AD. Below we will attempt to suggest solutions of some problems involved.

In archaeological publications, one can discover different points of view concerning not only the agricultural models, but also the level of agricultural development among the Early Medieval Alanic population of Eastern Europe. A series of archaeological works prove an extremely high level of farming techniques practiced by the Alans of the North Caucasus (Kuznetsov 1971, 49-73), but nevertheless, some authors still try to prove that the culture of the Alans who in the first part of the 8th century had moved from the North Caucasus to the Middle Don had been typical of nomads in the process of settling. Allegedly, the Alans had even borrowed the construction of their subterranean dwellings from their northern neighbours, the Slavs (Vinnikov 1998, 108-110). To bring some clarity into this discussion, the investigation of potential economic zones of the North Caucasian Alanic dwelling sites, mainly dating from the pre-Migration, pre-Khazarian period, is of special significance. Here, investigations of the Early Medieval terrace agriculture play the key role.

Considering the ethnographically well-known problem of the North Caucasian terrace agriculture (Kaloyev 1981, 62-64), three principal questions arise. First, no archaeological line of arguments exists to establish a chronology of construction of the agricultural terraces in the Central Caucasus foothills. Second, their territorial spread and the scale of this phenomenon remain undetermined, and it is also unclear to what extent the discussed agricultural technique was characteristic of the local population in the Early Middle Ages.

Third, it is difficult to understand why such highly labour-consuming and expensive terraces were constructed for agricultural cultivation, whilst vast open highland areas were left uncultivated – unlike the situation nowadays. We will try to answer these questions, taking into account the analysis of the existing information on the terraces in the Kislovodsk depression. In addition, the region was practically uninhabited for almost 400 years, from the 14th to the 18th century (the minor Zhintemir settlements being populated by the Abazines). This situation provides unique conditions for the investigation in the field of landscape archaeology.

The first traces of terrace agriculture in the discussed region were revealed by A. P. Runich, N. N. Mikhailov and G. E. Afanas'ev in 1958. In the course of the salvage excavations at the Rim-gora necropolis of the 10th-12th centuries, one day, the sunset throwing its light obliquely, the investigators suddenly noticed regular terraces about 10-15 m wide southwest of the cemetery. The constructions displayed a clear contrast to the generally smooth relief gently sloping to the Podkumok's right bank. Such farming technique was not typical of the Abazines, nor of the Cossak population that settled here in the first quarter of the 19th century and founded the village Borgustanskaya, nor of the Karachai who began to settle the territory rather late, in the antebellum times of the 20th century. It was absolutely evident that the discovered terrace fields were territorially related with the hillfort Rim-gora of the 10th-12th centuries and with the large open dwelling site situated nearby. Information on the man-made terraces of the Kislovodsk depression was substantially extended in the 1990s, due to the field surveys conducted by D. S. Korobov. Of special interest are the Early Medieval sites accounted for in the basin of the Perepryzhka rivulet (Korobov 2001, 50): here, the entire complex of the terraces territorially connected with the Early Medieval fortified sites has survived in its original state (**fig. 7**).

The archaeologists' position, as far as the interpretation of the remains of the Early Medieval terrace agriculture as a historical source is concerned, has recently undergone principal changes. The emergence of new trends in the archaeological science, like landscape archaeology (Aston 1998), and the introduction of such methods as the spatial archaeological analysis (Afanas'ef 1989; 2002a, 71-80), remote sensing of archaeological objects with the application of aerial and space data (Afanas'ev 2000; 2002a, 71-80; Afanas'ef/Zotko/Korobov 1999), and the technology of geographical information systems (Afanas'ef 2002b; Afanas'ef/Kislov/Chernyshev 2002) have greatly contributed to this shift. A combined application of the above-mentioned methods permits investigating the interrelations between the dwelling sites and their potential economic zones in a new aspect. The joint multidisciplinary approach to investigating an archaeological source and its natural environment, carried out in collaboration with specialists in geography, has resulted in the discovery of an absolutely new historical phenomenon, unknown so far.

It is known that the humus soil in the considered territory is 1490-1700 years old (Romashkevich 1988, 39), thus its formation took place in the 3rd-5th centuries, which means that by the time the Ash-Tigor tribes settled in the Kislovodsk depression, the humus-containing fertile soils had already been formed.

Land surveys undertaken in order to establish the agricultural terraces' chronology have shown their strong territorial connection with the Ash-Tigor hillforts and dwelling sites (Afanas'ef 2002c, 252-255). This does not only concern the mentioned assemblages of Rim-gora of the 10th-12th centuries, attributed to the epoch of the early feudal Alanic state. The farming terraces of the discussed region display their strong correlation with the Ash-Tigor hillforts and dwelling sites of the preceding period (5th-9th centuries). Besides, the analysis of the correlation between the terraces and the antiquities of different time carried out by D. S. Korobov using the example of the sites located at the Berezovaya and Kabardinka interfluve leads to the following conclusion: practically all the terrace fields mapped by applying aerial photography are disposed in a 1 km wide zone around the fortified sites of the 5th-9th centuries (Korobov 2004).

Thus, independent field and cabinet investigations permit to answer the first question concerning the ter-

Fig. 7 Plots of the ancient terrace agriculture in the Perepryzhka River valley, view from the northeast.

races' chronology. Our observations reliably prove that there are strong grounds to relate the remains of the agricultural terraces with the Early Medieval hillforts (**fig. 8**). Parallel to this, we may formulate an answer to the second question. The number and the density of the terraces registered in the Eshkakon and Alikonovka valleys in the environs of the Early Medieval Ash-Tigor strongholds clearly evidence the extremely wide spread of the discussed agricultural technique among the region's inhabitants. Some of the terraced areas could be found in the previous time of the Late Bronze-Early Iron Age, populated by the »Koban« culture recently determined (Borisov/Korobov 2009).

The answer to the third question is to be found: what were the terraces designed for? At present, the plain territories in the investigated region of the depression undergo an intense agricultural exploitation. The terrace-shaped arrangement of the farming lands and their structure undoubtedly were highly labour-consuming, as far as the aspects of organization and development are concerned. Why have they been constructed? The Early Medieval agricultural lands are disposed close to the zones of relatively plain localities, and, proceeding from modern ideas on practical farming, the latter seem to be most suitable for an economic development, taking into account the morphology of lands (gentle slopes), sufficiency of sunlight, convenient transport access, lower labour intensity of their development, and so forth. We hope that revealing the reasons why the bearers of the Alanic culture disposed their zones of agricultural activity on rather steep slopes might contribute to the elucidation of the regularities within the behaviour of the Early Medieval man so far unknown, and trace their causal relationship with the palaeoenvironment. The data

Fig. 8 Early Medieval fortifications in the Perepryzhka River valley surrounded by plots of terrace agriculture, view from the northeast.

obtained may be interpolated for the evaluation of the economic and recreational comfort of other palaeolandscapes as well as modern environmental and territorial complexes. The concept of arranging agricultural grounds on rather steep slopes and terracing the latter in ancient times could have been caused by a number of factors. Here, we particularly face e.g. the displacement of the landscape zones' boundaries, the phenomenon of a strong forestation of declivities, the population's struggle with erosion and drift of the soil level from the slopes (humid type of microclimate within the investigated territory), or, on the contrary, activities aimed at the preservation of moisture in the soil and the upper layer of the fractured bedrock on the slopes in connection with a dry climate in the open, flat sections (arid type of microclimate).
In order to confirm one or the other concept, G. E. Afanas'ev, A. V. Kislov and A. V. Chernyshev set the task to establish rather reliably the stability of landscapes and their boundaries within the studied territory with regard to possible fluctuations of the climatic parameters, i. e. to carry out a reliable simulation of the microclimate status induced by spatial and temporal shifts within the global climatic process (Afanas'ef/Kislov/Chernyshev 2002, 66-79). Taking into account the spatial aspect of the objects under investigation, it is also necessary to assess the dynamics and the characteristic features of the process of landscape formation by applying adequate cartographic models, i. e. to execute the mathematical-cartographic simulation of the landscapes' statuses depending on changing climatic factors. The solution of the mentioned problem included the following stages: creation of a digital cartographic base proceeding from middle-scale topographic maps of the investigated territory; estimation of the basic morphometric indications for

the elemental territorial objects with a grid square 0.5 × 0.5 km large (slopes' steepness, horizon exposition, the part of the sky above the horizon screened by the mountains); simulation of microclimatic indications for the year 2000 and evaluation of their adequacy to the real data; establishment of landscape types and their boundaries (according to the data of microclimatic simulation) and their mapping; simulation of the hypothetical (perturbed) climate; evaluation and mapping of the corresponding landscape conditions; structuring databases and cartographic models into a special geoinformational system.

Simulation of the local climatic features is carried out in the following way. First, by applying the general circulation model (GCM) of the atmosphere, the global climatic regime is reproduced. Then values of the variables concerning the given region are transformed into regional models connected with the specific forms of its relief. On the final local stage, the adjustment of the meteorological values to the specifics of the vegetation and the top soil is performed. As GCM, the model T21L15 is used (containing 21 harmonics in horizontal resolution of the equations of atmosphere hydro-thermodynamics over sphere, 15 vertical σ-levels), based on the corresponding version of the model of the Federal Centre for Hydrometeorology (Kurbatkin/Dyagterev/Frolov 1994). The temperature on the ocean surface during the simulation is prescribed monthly.

The proving ground under investigation is situated with its borderlines at ca. 44°-50° North latitude and 42°-48° East longitude within the GCM cell. It covers an area of 20-30 km^2, its absolute altitude ranging from 800 to 2400 m. The area had been divided into microcells with a dimension of 0.5 × 0.5 km; within the microcells the topographic, climatic, and landscape characteristics were assumed to be constant. Declivity and the position of the surface relative to the cardinal points, as well as the part of the sky above the horizon screened by the mountains were computed within each microcell. Calculations were carried out for the regular rectangular grid based on the digital relief model, executed by the interpolation of contours from the digital map (scale 1:100 000), applying the module MAGSURF created in the Centre for Geo-Information Research, Faculty of Geography of the Moscow State University. In order to check the correlation of the information reproduced in the GCM cell with the local climate of each microcell, it was necessary to realize »the transmission function«. The regional block was applied, and the equation of the heat and moisture budget permitted to establish the correlation of the GCM data (temperature, humidity, heat flux) with the absolute altitude and the relief of each microcell.

Finally, the distribution of temperature, air humidity and soil moisture in the surface boundary layer and the soil active layer were calculated. These characteristics were established by the solution of equations of the budget of energy and moisture in correspondence with the following variables: air temperature and humidity inside the two-layer vegetation, and soil temperature and moisture represented by the three-layer model (Rozinkina 2001). The present investigation stresses relatively insignificant variations of climate, similar to those of the sub-Atlantic period. Their genesis has not yet been studied comprehensively, however, there are some factors regarded as contributing to their formation, such as stochastic auto-oscillations within the ocean-atmosphere system, and perturbations of the radiation regime caused by fluctuations of the solar activity and intense volcanic eruptions (Kislov 2001, 246-252). It is difficult to realize the simulation of the auto-oscillations, since the integration of a century-long climatic model coupling the atmosphere and the ocean is necessary to obtain a statistically reliable result. This is considered a technically complicated task, and since the discussed models are still imperfect and the calendar of the solar activity remains insufficiently studied, favourable prospects are not to be expected so far.

Another more simplified approach consists in the investigation of the response of one of the media (atmosphere or ocean) to the introduced status of the other. Provided that both the interaction of the atmosphere and the ocean and the variability of the external factors result in a certain anomaly of the temperature on the ocean surface, it should be possible, having created its spatial picture, to determine the global status

of the atmosphere corresponding to it on the basis of simulation. The difference of this status from the modern climate would represent the climatic variation we are interested in. It is difficult to establish the correlation between the abnormality of the kind and certain calendar moment; still, it seems to be typical to some extent. The described approach has been accepted as the base, and the following scenario was worked out, aimed at generating perturbations of global climate within the bounds of GCM. It was held that the abnormality of the temperature on the ocean surface affected only the northern part of the Atlantic Ocean (latitude 30°-60° North). This assumption seems quite reasonable, since it is this region that really represents a key point, as far as the generation of climatic variability of various scales in the northern hemisphere is concerned. The spatial distribution of the temperature abnormality represented a dipole, with positive deviations in the subtropics and negative ones in the moderate latitudinal zones, the total change of temperature accounting for zero. The maximal abnormalities' value was less than 0.8°C (according to the module).

Integration of the global model was performed in accordance with two data sets – one for the modern climate, another for the analysed case of the »perturbed« one. The first model permits to evaluate the degree of reliability of the selected approach proceeding from the comparison of the simulated and actually measured climatic parameters. In the present work, within the coordinates of the total annual precipitation (ΣP) and the total annual of the average daily temperatures above 10° C ($\Sigma t_{>10^\circ C}$), the hydrothermal scheme of vegetation formations was executed (Grebenshchikov 1974). The areas' contours turned out to be disposed not separately from each other, but often superimposed over one another, which meant that different formations could have existed in the same climatic conditions. This conclusion induces problems while trying to establish a simple interpretation of the vegetation's response to climatic variations. To avoid these complications, some areas have been united. The application of the discussed scheme permits to evaluate the trend of the vegetation's variations caused by climatic changes expressed by the corresponding indications.

To provide the preservation of the initial information (relief structure, hydrographic network, landscape types) and the analysis of the model fields in the selected territory of the North Caucasus, a special geographical information system (GIS) was created. It integrates the virtual relief map with the provided possibility to »fly« it over following certain trajectory introduced, the dynamic (animated) cartographic image characterizing spatial and temporal changes in climatic indications with all the parameters taken into account, the electronic map of the locality linked with the database, the latter giving an opportunity to gain pinpoint information on any indication. Finally, a special mechanism was used to generate two-dimensional images (graphics). The system is shaped as a series of multimedia windows.

As a result of the synthesis of the model indications of »real« and »perturbed« climates, landscape maps have been constructed in the GIS system. Their analysis has shown that (coniferous and beech) forest zones, mountain steppes, and a montane sparse growth of trees are typical of the modern conditions, as well as subalpine meadows and rhododendron shrubs. In the perturbed state of climate, subalpine Elfin forests with crooked-stem small trees appear, while subalpine meadows cease. The configuration of the vegetation formations' borderlines changes, and thus, a warmer and more humid climate causes the penetration of steppes into the valleys' upper reaches where they displace forest vegetation. Forests, in their turn, also move upwards. Attention should be paid to the fact that the regions affected by these shifts are located above 1500 m. Vegetation formations in lower situated areas do not display any principal changes. This observation permits to state that in the discussed region mountain steppes and mixed forests are more stable than subalpine vegetation formations.

Thus, the thesis may be put forward that the territory under investigation represents, concerning the climate aspect, a stable arid zone, even in conditions of considerable oscillations of the mesoclimate, while

the terraces once constructed on slopes below 1500m most evidently functioned as moisture accumulating barriers, similar to what is observable now for the terrace agriculture of the mountainous regions of the Crimea. The Kislovodsk depression with an altitude range of 900-1500 m a.s.l. represents a kind of climatic oasis. This conclusion is confirmed by the results of palynological investigations carried out at the Eneolithic dwelling site Zamok and published by S. N. Korenevsky. Analytical investigations by E. A. Spiridonova and Ya. N. Lavrushina show that in the late 5th-early 4th millennium BC the climate of the Kislovodsk depression had been arid and hot. This epoch corresponds with the second part of the Atlantic period in the Holocene. Forest vegetation was insufficiently developed; nevertheless, moisture accumulating oases existed. Pollen columns from the dwelling site Industriya demonstrate that in the second quarter of the 4th-early 3rd millennium BC, the climate was rather mild and favourable to forest vegetation growing in the piedmont valley (Korenevsky 1998, 102-104).

The supposition concerning the reality of the simulated characteristics of the perturbed palaeoclimate of the Kislovodsk depression in the Early Middle Ages has been perfectly confirmed by investigations carried out in the adjacent territory of the Lower Kuban' valley. In this area located on the Taman peninsula, a group of scholars performed palynological research aimed at landscape-climatic reconstructions. As a result, a specific stage of the sub-Atlantic period dating back to the chronological span of the 7th-12th centuries has been singled out. It was characterized by the most arid climate during the whole period of the Holocene for the last 6000 years (Bolihovskaya et al. 2002, 265). The sudden arrival of a hot and dry climate in the 7th-12th centuries in the Taman region had practically caused the disappearance of forest ecotopes and the domination of grass and wormwood-goosefoot steppes. Investigation of palaeosoils underlying the Alanic barrows in North Ossetia proves that since the second part of the 5th century the climate in the region had changed and became very dry (Khokhlova/Golyeva/Khokhlov 2004, 9-10). This thesis of the domination of a strongly arid climate in the North Caucasus foothills in the 7th-12th centuries is also confirmed by investigations of the sea level oscillations of the Caspian Sea. L. N. Gumilev found out that in the 6th century the level of the Caspian Sea was 4-5 m lower than at present (according to some data even 7-8 m lower). This is well proven by the investigation a section of the Derbent defensive wall constructed under Khusrav Anushirvan and now covered by the sea (Gumilev 1966, 88). It is known that the Caspian Sea obtains water from the rivers rising in the northern humid zone.

The low level of the Caspian Sea corresponds with the chronological span characterized by the cyclones' movement northward and southward. In the first case, the climate gets humid in the arctic zone, while it is arid in the taiga and the steppe zones. But in the second case, the climate in the arctic and taiga zones gets arid, while it is humid in the steppe zones (Gumilev 1970, 85-94). An arid climate in the region makes the Caspian Sea level drop. In Gumilev's opinion, the North Caucasian steppe was very dry in the period of the Khazar kaganate (7th-10th centuries; ibid.). R. D. Arsanukaev stated that the very process of the formation and development of the Alanic archaeological culture in the North Caucasus foothills were connected with the climatic change in the North Caucasian steppe towards aridity, accompanied by the lowering of the Caspian Sea level known as the Derbent regression of the 4th-13th centuries (Arsanukaev 2002, 233). This conforms well to the concept of the so-called Arkhyz interval, the minor climatic optimum of the 7th-13th centuries typical of the majority of European territories (Borisenko/Pasetsky 1988). Moreover, palaeoclimatologists suppose the arid climate to be characteristic of the whole northern hemisphere in that period. This idea is confirmed by the glacial columns from Greenland dated back to the 8th century: they show an extremely low ammonium content which points to an insufficient vegetation. The dendrochronological data obtained from the archaeological sites in Germany also prove an extremely arid climate in the mid 3rd-early 5th and in the 8th century (Schmidt/Gruhle 2003). The same concerns Swedish forests (Briffa 1994), bottom sediments in the lakes of Yucatan in Mexico, and many other sources.

Site	Zamok	Katykhinskoe	Konkhutorskoe	Medovoe
altitude a.s.l., *m*	920	990	1240	1250
total annual of an average daily temperature above 10° C	2316.0	2036.6	1918.4	1757.0
total annual of radiation balance, *gJ/sq. m*	1.81	1.8	2.11	2.23
annual moisture budget, *mm*	233	236	318	359
annual number of precipitation days	183	184	174	176
annual number of the days with a daily average temperature above 10° C	256	250	247	242
hydrothermal coefficient, *mm/° C*	0.4	0.6	0.7	0.6
radiation dryness index	3.2	3.7	2.6	2.5

Tab. 1 Characteristics of the »real« climate at the sites of the Alikonovka valley for the year 2000.

In what way can we use these data to interpret the palaeoclimatic characteristics of concrete archaeological monuments? We should consider this question in a practical way, based on the sites of the Kislovodsk depression. Two river valleys have been selected for the analysis, those of Alikonovka and Eshkakon, the Podkumok's longest tributaries. In the Alikonovka valley, four sites have been selected, specific local centres of microregions, situated at a different altitude above the sea level: the hillforts Zamok, Katykhinskoe 1, Konkhutorskoe 1 and Medovoe (nos 23, 313, 332 and 375). Zamok is situated northernmost and lowest above the sea level, Medovoe is the northernmost and highest site. At present, the territory around these sites is cultivated differently, depending on the modern climatic differences at the discussed localities (tab. 1).

The lands of the Zamok's environs have been traditionally cultivated with cereals and vegetables, whilst the land around the hillfort Medovoe is permanently affected by cold winds blowing from the Skalisty range and now only used for pasture and hay-mowing.

In the Eshkakon valley, three sites situated at different altitudes have been selected (tab. 2). The fortified site Pervomaiskoe 1 (no. 757) is the northernmost; vegetables and cereals are actively cultivated on the lands around it. Approximately in the middle of the Eshkakon valley lies the Tsentralnoe Eshkakonskoe hillfort (no. 765). This site is situated somewhat higher above the sea level, the surrounding lands are used for pasture and hay-mowing, and the rate of vegetable cultivating is very low. The third site Levoberezhnoe Eshkakonskoe 3 (no. 762) is located much higher, and its environs are now only used for pasture and hay-mowing. When simulating the »perturbed« climate, the obtained palaeoclimatic characteristics substantially differ from the modern ones (tabs. 3-4).

We will present the analysis of the obtained data carried out with the application of the multidimensional statistics, starting from the cluster analysis. Each site (object) is considered as having two positions: one for the »real« climate (P), another for the »perturbed« one (B).

The obtained dendrogram clearly shows three site clusters (fig. 9). One of them comprises the three sites with the »perturbed« climate: Pervomaiskoe 1, Katykhinskoe and Zamok. All these sites are situated at an altitude of 920-1080 m a.s.l. The group occupies a separate position, as compared with the other sites, because of the palaeoclimatic characteristics typical of a warm climate. Its specifics are determined by the

Site	Pervomaiskoe 1	Tsentralnoe Eshkakonskoe	Levoberezhnoe Eshkakonskoe 3
altitude a.s.l., *m*	1080	1170	1290
total annual of an average daily temperature above 10°C	2178.5	1849.5	1827.7
total annual of radiation balance, *gJ/sq. m*	1.91	2.17	2.36
annual moist budget, *mm*	185	273	356
annual number of precipitation days	158	157	158
annual number of the days with a daily average temperature above 10°C	252	245	244
hydrothermal coefficient, *mm/°C*	0.5	0.8	0.8
radiation dryness index	4.1	3.2	2.7

Tab. 2 Characteristics of the »real« climate at the sites of the Eshkakon valley for the year 2000.

Site	Zamok	Katykhinskoe	Konkhutorskoe	Medovoe
altitude a.s.l., *m*	920	990	1240	1250
total annual of an average daily temperature above 10°C	2775.6	2521.3	2355.1	2216.1
total annual of radiation balance, gJ/sq. m	1.75	1.96	2.06	2.19
annual moist budget, *mm*	247	274	355	391
annual number of precipitation days	168	183	160	162
annual number of the days with a daily average temperature above 10°C	264	257	252	247
hydrothermal coefficient, *mm/°C*	0.5	0.5	0.4	0.3
radiation dryness index	2.9	2.9	2.3	2.2

Tab. 3 Characteristics of the »perturbed« climate at the sites of the Alikonovka valley for the year 2000.

Site	Pervomaiskoe 1	Tsentralnoe Eshkakonskoe	Levoberezhnoe Eshkakonskoe 3
altitude a.s.l., *m*	1080	1170	1290
total annual of an average daily temperature above 10°C	2661.7	2302.7	2062.8
total annual of radiation balance, *gJ/sq. m*	1.85	2.12	2.33
annual moist budget, *mm*	239	329	410
annual number of precipitation days	183	183	183
annual number of the days with a daily average temperature above 10°C	263	249	248
hydrothermal coefficient, *mm/°C*	0.4	0.5	0.4
radiation dryness index	3.1	2.6	2.3

Tab. 4 Characteristics of the »perturbed« climate at the sites of the Eshkakon valley for the year 2000.

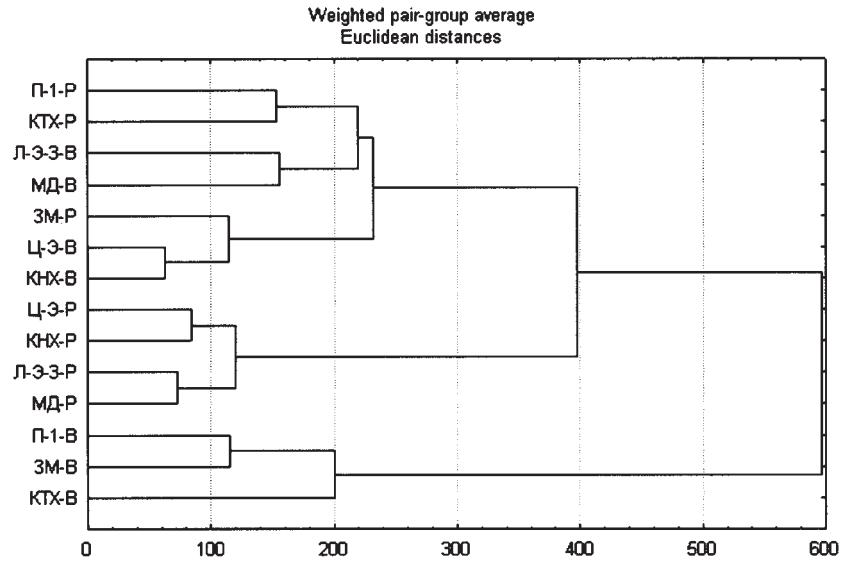

Fig. 9 Cluster analysis of sites in accordance with their climatic and palaeoclimatic characteristics. Notation conventions: П-1 – Pervomaiskoe 1; КТХ – Katykhinskoe; Л-Э-З – Levoberezhnoe Eshkakonskoe 3; МД – Medovy; ЗМ – Zamok; Ц-Э – Tsentralnoe Eshkakonskoe; КНХ – Konkhutorskoe. Р – »real« climate; В – »perturbed« climate.

total annual of the average daily temperature above 10° C ranging from 2521.3 to 2775.6° C and an annual moisture budget ranging from 239 to 274 mm. Provided the simulated characteristics of the »perturbed« climate having been real at the localities in question in the 1st millennium BC, the construction of the terraces playing the role of moisture accumulating barriers should be considered exceptionally expedient.

The second group of hillforts is more closely connected with the third one; it includes four sites with »real« climate: Medovoe, Levoberezhnoe Eshkakonskoe 3, Konkhutorskoe, and Tsentralnoe Eshkakonskoe. All these sites are situated at an altitude of 1170-1290 m. This group mirrors the present state of climate for the objects disposed at the highest points and the corresponding modern tillage (alpine pasture and haymowing). Its specific features are the total annual of the average daily temperature above 10° C ranging from 1757 to 1918.4° C and the annual moisture budget range of 273-356 mm.

The third group comprises three objects with »real« climate (Zamok, Katykhinskoe and Pervomaiskoe 1) as well as four hillforts with »perturbed« climate (Medovoe, Konkhutorskoe, Tsentralnoe Eshkakonskoe and Levoberezhnoe Eshkakonskoe 3) located at an altitude of 920-1290 m a.s.l. Specifics of this group are determined by the total annual of the average daily temperature above 10° C of 2036.6-2355.1° C and the annual moisture budget of 185-410 mm. The most important conclusion to be drawn from the analysis of these sites is that under conditions of a »perturbed« climate, Medovoe, Konkhutorskoe, Tsentralnoe Eshkakonskoe and Levoberezhnoe Eshkakonskoe 3 display the same characteristics as Zamok, Konkhutorskoe and Pervomaiskoe 1 under conditions of a »real« climate. Consequently, taking into account that the environs of the three latter low lying sites are nowadays cultivated with cereals, fruit and vegetables, there are good reasons to suppose that this could have been practiced under conditions of a »perturbed« climate on the lands around the four former, high lying sites, even more because agricultural terraces have been accounted there.

Another question will demand special consideration in the future. It concerns the search for and the investigation of sources of water that could have been used by the Early Medieval population of the Kislovodsk depression. Discussing the low lying fortified sites (e.g. the cluster of the Pervomaiskoe hillforts), it seems

Fig. 10 Aerial photo of the Verkhneteplushkinsky canal (indicated by the digit 1).

to be obvious that the Podkumok and its tributary springs provide a sufficient amount of fresh water. The situation looks more complicated when analyzing the potential economic zones of the strongholds located in the depression's mountainous regions. Considering the altitude, descending for water to the valley of the Podkumok or its major tributaries seems to have been inexpedient. It is quite obvious that the exploitation of the alpine territories in terms of pasture and terrace agriculture, especially under conditions of an arid climate, required another solution to the problem of water supply.

Field research conducted in the Kislovodsk depression in 2001 revealed a number of objects that cardinally change our concept of the system of water supply developed by the Early Medieval people; some time ago, one could only assume it (Kaloyev 1981, 64-65). The simplest mode of irrigation of a terrace field was discovered at the Upper Teplushka. Here, on the slope of the Teplushka right bank, almost at the watershed of the Teplushka and Perepryzhka rivulets, an almost square-shaped farming terrace was surveyed. Into the southern corner of the terrace empties a narrow long ravine; in its upper part a spring once existed. In this case, the natural ravine had been used as an irrigation channel. At the same locality man-made irrigation channels were discovered. Thus, for the first time in Caucasian archaeology, the remains of an alpine irrigation system have been established near the Teplushkinsky agglomeration of dwelling sites of the 5th-9th centuries (**fig. 10**). Another type of water supply constructions looks like a wide-scale vertical clearing of the heights' slopes designed to reveal springs (**fig. 11**). It first was discovered at the watershed of the Upper Teplushka and Upper Alikonovka rivulets. This plot of land has probably been used for alpine pasture in the Early Middle Ages; it is disposed relatively far from both rivers, but at the same time rather abounds in springs.

Fig. 11 The Verkhneteplushkinsky water collector 2.

Having the data concerning the functional differentiation of the Early Medieval farming lands and the instrument of palaeoclimatic simulation in each selected point of the Kislovodsk depression at our disposal, we may undertake the next step: the palaeoclimatic simulation based on the investigation of potential economic zones related to one or another Ash-Tigor hillfort. In this aspect, the method of bio-productivity analysis of the tillage in the Kislovodsk depression during the Early Middle Ages can be of great help. It was developed by G. E. Afanas'ev, A. V. Kislov and A. V. Chernyshev in the framework of the RFBR project 02-06-80047-a and is based on the mathematical-cartographic simulation of bio-climatic parameters in the regime of palaeotime. The goal is to work out reliable methods of spatial assessment of the response of the vegetation's bio-productivity in the territory under investigation to fluctuations of climatic factors simulated for the period of the Alanic culture in the Kislovodsk depression. Bio-productivity is a widely used, complex indicator of landscape status, of vegetation in particular. Mathematically, bio-productivity represents the ratio of the total vegetation mass per area unit (c/ha). The assessment can be based on the dependence of the total bio-productivity on the fluctuation of the set of climatic factors calculated with regard to the regional natural characteristics of the studied territories. Values of the primary bio-productivity may be obtained using a global (regional) climate model. Climate parameters are selected proceeding from the functional correlation of the components of the system soil-vegetation-climate, known or simulated for the accepted time intervals.

The solution of the problem included the following stages: calculation of independent variables by applying the climatic model reduced to the accepted parameters of time and local conditions; determination of the functions of primary bio-productivity of the objects in microcells of 0.5 × 0.5 km within the investigated territory; simulating and mapping bio-productivity fields in modern and palaeo-conditions and their difference. The analysis of the investigation results shows that geographically the bio-productivity clearly correlates with the factors of altitude zonality both for the modern climatic model and that of the palaeoclimatic factors. Thus, the comparison of maps for instance points to the correlation of the bio-productivity intensity with the altitude scale of the relief for both models; in particular, zones with a different intensity in the intervals of an altitude of 500-1300 m and 1300-2100 m are to be observed. At the same time, regions with a low or moderate bio-productivity (up to 8 c/ha), mostly connected with the valleys of big river systems, as well as regions with a substantial rise of bio-productivity. The latter are, as a rule, mountain slopes with an altitude difference significant for the investigated region. In our opinion, of greatest interest is the map showing the difference of values of bio-productivity calculated according to the first and the second model (fig. 12).

The main conclusion which may be derived from the analysis of bio-productivity in the territory of the Kislovodsk depression for modern and »perturbed« climate is that in both cases the maximal bio-productivity is registered on the mountain slopes and on the slopes of diluvial heights, i.e. at localities occupied by the remains of Early Medieval farming terraces. Consequently, it seems highly probable that the Ash-Tigor population was well aware of the much higher bio-productivity of the terrace fields constructed on mountain slopes and on slopes of the diluvial terraces than of those arranged on the plain. Such compre-

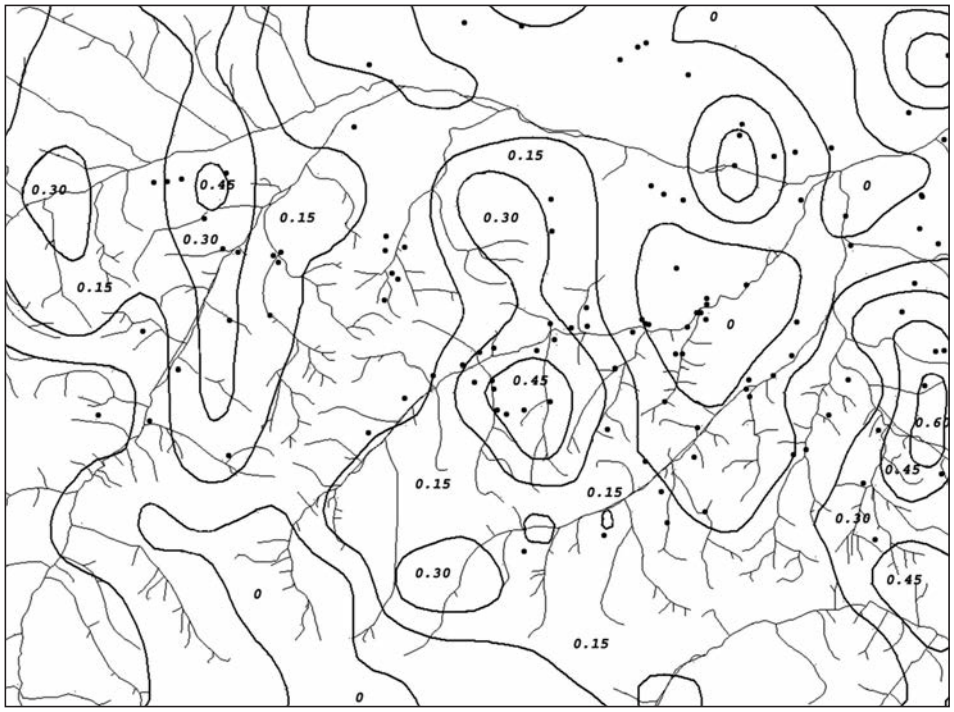

Fig. 12 Analysis of bio-productivity of the Kislovodsk depression in conditions of a »perturbed« climate.

hension could have emerged only due to the experience of practical agricultural development of the region in question for centuries; it reflects the exceptionally high level of agricultural knowledge.

The map of bio-productivity clearly shows several areas with especially high values. The highest difference of bio-productivity (around 60%) is registered at the Djinal range foothills. At this spot, a whole cluster of sites dating to the Early Middle Ages is situated around the famous hillfort Lermontovskaya Skala (no. 103). Besides the lands occupied by terrace fields (**fig. 13, 2**), just nearby the fortified site, a large number of sites attributed to the preceding Sarmatian period are located, the most famous ones being the above-mentioned cemeteries Krugozor, Tserkovnaya Gorka, Teatralny and Aeroflot, and also the dwelling sites Krasnye kamni, Pervomaiskaya polyana and the one near the sanatorium Moskva (nos 4-5, 55, 57, 61, 421 and 423). All these sites are comprised in an area of a high difference of bio-productivity (30-60%). This may be considered as an indirect evidence in favour of the earlier date of the development of this agriculturally profitable region.

Westward lies the territory between the Konkhutorsky and Medovoe ravines with a bio-productivity difference 45% and with numerous fortified sites of the Early Medieval period: the hillfort and the open dwelling site Konkhutorskoe 1, the hillforts Medovoe Pravoberezhnoe 1, 2 and 3, Echkivashskoe and Konkhutorskoe 2 (nos 313-315, 672, 709 and 776-778), with terrace fields all around (**fig. 14**). The region around the hillfort and the open dwelling site Pervomaiskoe 1 (nos 757 and 781) displays the same bio-productivity; the sites are also encircled by numerous plots of terrace agriculture (Afanas'ef/Savenko/Korobov 2004, fig. 26). It seems highly probable that these three microregions constituted the main granary for the Ash-Tigor population of the Kislovodsk depression.

It is undoubtedly of interest that practically no difference of bio-productivity is registered in the microregion around the hillfort Gornoe Ekho (Otstoinik) (no. 11). As already mentioned, the greatest number of fortified sites and cemeteries from the Early Alanic period concentrate in this area. Some scholars have already emphasized the principal position held by Gornoe Ekho (Otstoinik) in the regional system of the Ash-Tigor antiquities. Those who carried out long-term excavations at this site consider it possible to inter-

Fig. 13 Detail of aerial photo of the surroundings of Lermontovskaya Skala: **1** the fortification Lermontovskaya Skala. – **2** Plots of terrace agriculture.

pret it as one of the residences of the Alanic king Sarozius (having reigned from the 50s to the 70s of the 6th century) (Arzhantseva/Savenko/Sychev 2003, 9). Evidently, the high density of cemeteries around the hillfort combined with the reconstructed low level of bio-productivity of the discussed microregion suggest the site's non-agricultural function; it probably played the role of a specific local administrative centre in the Kislovodsk depression.

Taking this into consideration, we may now conclude that the methodical conditions have been worked out and a sufficient database compiled to start a wide-scale scientific research in the field of social and economic history of the Early Medieval population of the Kislovodsk depression based on interdisciplinary investigations. It could comprise the following problems: simulation of responsibility zones of the Early Medieval strongholds revealed in the Kislovodsk depression – Thiessen tesselation; calculations of the bio-productivity of each revealed zone and their comparative analysis; revealing within each polygon the agricultural lands marked by a specific functional differentiation (farming terraces, pastures, water sources, etc.) and subsequent comparative typological analysis of the polygons; palaeoeconomic modelling of each polygon and their subsequent comparative analysis; establishing the chronological and functional relations between the hillforts within each polygon; simulation and comparative analysis of the settlement system of the 5th-9th and the 10th-12th centuries; investigation of the settlement system dynamics of the culture of the catacomb burial rite and the dynamics of the settlement system of the culture of the rock burial rite. The solution of these problems will contribute to a more profound understanding of the historical processes that developed in the territory of the Kislovodsk depression in the 1st millennium AD as well as to a more detailed investigation of the role the Ash-Tigor population of this region played in the Early Medieval history of the North Caucasus and South-Eastern Europe as a whole.

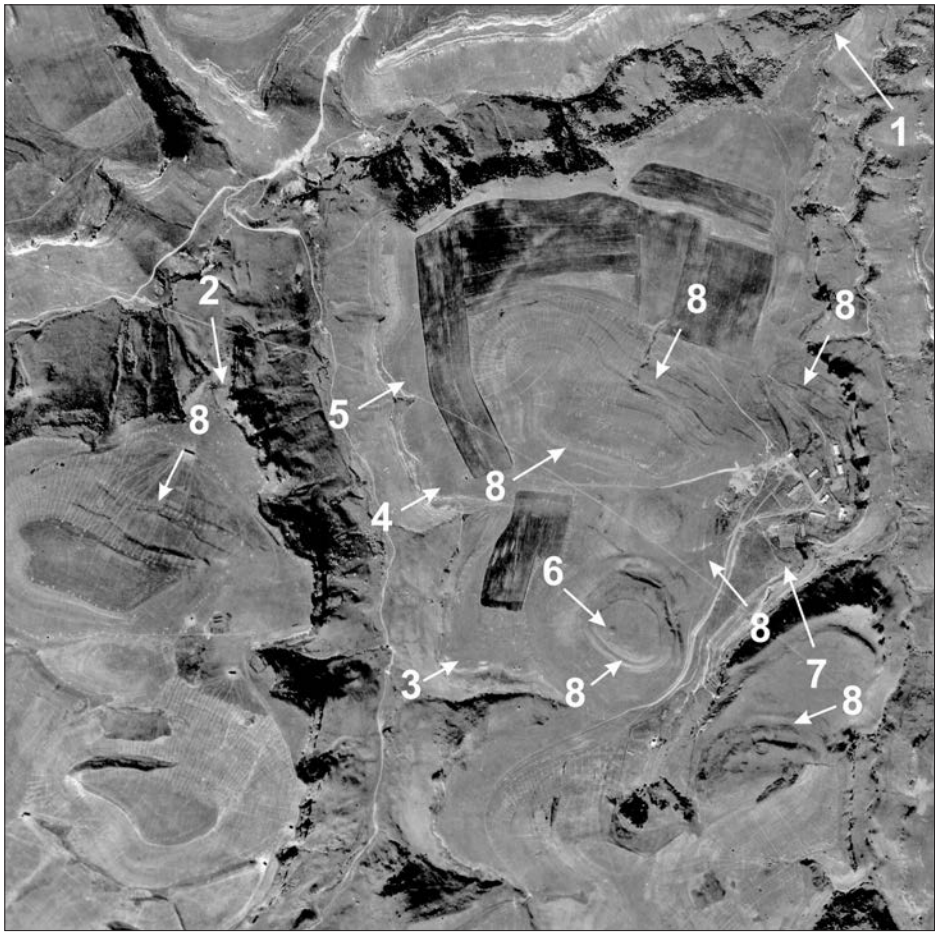

Fig. 14 Detail of aerial photo of the sites situated between the Konkhutorskaya and the Medovaya ravines. Fortifications: **1** Konkhutorskoe 1. – **2** Medovoe. – **3-5** Medovoe Pravoberezhnoe 1, 2 and 3. – **6** Echkivashskoe. – **7** Konkhutorskoe 2. – **8** Plots of terrace agriculture.

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ZUSAMMENFASSUNG

Die Kornkammer der Ash-Tigor und das Paläoklima des 7. bis 12. Jahrhunderts im Nord-Kaukasus

Die historischen Monumente der Kislovodsk-Senke stehen seit dem Ende des 17. Jahrhunderts im Forschungsinteresse. Daher sind die archäologischen Stätten dieser Region ethnisch und kulturell relativ gut zuweisbar. Die Denkmäler des frühen Mittelalters nehmen hier eine spezielle Position ein. Mithilfe einer multidisziplinären Analyse an den archäologischen Fundorten der Kislovodsk-Senke unter Einsatz von GIS-Anwendungen wurde das archäologisch-geographische Informationssystem »Kislovodsk« erarbeitet, mit Mitteln der 3D-Analyse einer »gestörten« Klima-Simulation. Besonders aussagekräftig war die Untersuchung potenzieller Wirtschaftszonen der alanischen Siedlungen und Ackerterrassen. Die Autoren versuchen Fragen zu ihrer Datierung, geographischen Ausbreitung und zu den Gründen ihrer Errichtung zu beantworten. Ihre Beobachtungen zeigen gute Argumente auf, diese Terrassenäcker mit den frühmittelalterlichen befestigten Höhensiedlungen zu verknüpfen. Paläoklimatische Untersuchungen von G.E. Afanas'ev, A.V. Kislov und A.V. Chernyshev beziehen sich auf das Modell von »wirklichem« und »gestörtem« Klima; Landschaftskarten wurden in diesem GIS-System erstellt. Die Hauptaussage der Analyse der Biopro-

duktivität des Untersuchungsgebiet ist, dass die alanische Bevölkerung die Berghänge und die Hänge der diluvialen Hügel als Ackerterrassen nutzte. Diese Interpretation unterstreicht das außergewöhnlich hohe Niveau der agrarischen Kenntnisse der Alanen.

SUMMARY

The Ash-Tigors' granaries and palaeoclimate of the 7th-12th centuries in the North Caucasus

Historic monuments of the Kislovodsk depression attracted the scientists' attention since the end of the 17th century. As a result, the archaeological sites of this region have been attributed ethnically and culturally. The monuments dating to the Early Middle Ages occupy a specific position here. Using methods of a multidisciplinary analysis at the archaeological sites of the Kislovodsk depression with the application of GIS technologies, the archaeological-geographical information system »Kislovodsk« was created with instruments of analysis of three-dimensional information of a »perturbed« climate simulation. Of special significance was the investigation of potential economic zones of the Alanic dwelling sites and the terrace agriculture. The authors try to answer questions concerning their chronology, territorial spread and the reasons for their construction. Their observations reliably prove that there are strong reasons to relate the remains of the agricultural terraces to the Early Medieval hillforts. Paleoclimate research by G. E. Afanas'ev, A. V. Kislov and A. V. Chernyshev is due to the synthesis of the model indications of »real« and »perturbed« climates; landscape maps have been constructed in a GIS system. The main conclusion of the analysis of the bio-productivity of the investigated territory is that the Alanic population used the mountain slopes and the slopes of dealluvial heights for Early Medieval farming terraces. Such comprehension reflects their exceptionally high level of agricultural knowledge.

RÉSUMÉ

Les greniers des Ash-Tigors et le paléoclimat du Caucase septentrional du 7e au 12e siècle

Les monuments historiques de la dépression de Kislovodsk attirèrent l'attention des savants dès le 17e siècle. Ainsi, les sites archéologiques de la région se virent attribués à des ethnies et des cultures bien précises. Les monuments datant du début du Moyen-Age y occupent une position spécifique. Afin de pouvoir appliquer les méthodes d'analyse multidisciplinaire aux sites archéologiques de la dépression de Kislovodsk en intégrant les technologies SIG, on a créé le système d'information archéologique et géographique «Kislovodsk» qui est doté d'instruments capables d'analyser les informations en 3D obtenues en simulant un climat «modifié». Une importance toute spéciale fut réservée à l'investigation des zones économiques potentielles des sites alains et de l'agriculture en terrasse.

Nous constatons qu'il y a de solides raisons d'associer les vestiges de ces terrasses aux sites de hauteur fortifiés du début du Moyen-Age. Les résultats des recherches paléoclimatiques menées par G. E. Afanasiev, A. V. Kislov et A. V. Chernyshev furent obtenus en synthétisant les données provenant de modèles de climat «réel» et de climat «modifié». Des cartes ont été élaborées selon le système SIG.

Le résultat le plus important de l'analyse de la productivité biologique du territoire investigué est que les populations alaines aménageaient leurs terrasses au début du Moyen-Age sur les pentes de montagnes et de hauteurs diluviales. Ce savoir-faire trahit une expérience exceptionnelle de l'agriculture.

Traduction: Y. Gautier

РЕЗЮМЕ

Исторические памятники Кисловодской котловины привлекали внимание ученых с конца 17 в. В итоге длительных исследований была определена культурная и хронологическая атрибуция археологических древностей этого региона. Памятники эпохи раннего средневековья занимают среди них особое место. Для проведения мультидисциплинарного анализа археологических памятников Кисловодской котловины с использованием ГИС-технологий была создана археолого-географическая информационная система «Кисловодск», в которую включены специальные инструменты анализа трехмерных поверхностей для моделирования «возмущенных» климатических условий. Особое внимание уделяется исследованию потенциальных экономических зон вокруг аланских поселенческих памятников, а также изучению террасного земледелия. Авторы пытаются ответить на основные вопросы о датировании подобных следов сельскохозяйственного террасирования, о пространственном распространении данного явления, а также о причинах его появления.

Наши наблюдения позволяют утверждать, что существуют серьезные основания связывать следы сельскохозяйственного террасирования с укреплениями эпохи раннего средневековья. Палеоклиматическое моделирование, проведенное Г. Е. Афанасьевым совместно с А. В. Кисловым и А. В. Чернышевым, привело к синтезированию индикаторов «реального» и «возмущенного» климата; были созданы ландшафтные карты, полученные с помощью ГИС.

Основной вывод, который можно сделать из анализа биопродуктивности изучаемой территории заключается в том, что аланским населением использовались горные и делювиальные склоны для террасирования эпохи раннего средневековья. Подобные представления отражают исключительно высокий уровень сельскохозяйственных знаний.