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ARCHAEOLOGY OF THE KRAS DOLINAS[1]

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ABSTRACT

The authors examine the relationship between the agricultural use of Kras dolinas and demography in the past. Conclusions are based on the results of the archaeological survey of 19 dolinas in August 1995. Archeological and historical data speak for the most intensive use of dolinas in two clearly distinguished periods - later prehistory (1st millenium B.C.) and in 18th-19th centuries.

Key words: dolina, karstic depression, Kras, Karst, Carso, archaeological survey, landscape, land use

1. Definition and the origin of the dolinas

The Kras (italian *il Carso*, german *der Karst*) is an area of some 500 km^2 in SW Slovenia and in hinterland of Trieste, NE Italy, enclosed by the Trieste Bay to the west, the Gorica plain and the Vipava valley to the north and the Brkini hills to the east and southeast[2] (see fig. 1). Geologically, the Kras is a crushed anticlinale with its longer axis following the general Dinaric direction (NW - SE). Lithologically, the Kras is mostly composed of various limestones intersected with belts of dolomites (fig. 2). Geomorphologically, the Kras is a plateau more discretely elevated from the surroundings in its central and western part. Generally, the land is higher in the southern and southeastern part (500-600 m) with some individual peaks reaching more than 1000 m; from there the Kras plateau gradually falls towards the northwest into the Friuli plain.

1 This paper is the completed version of the paper presented at the colloquium *Archéologie et reconstruction environnementale des paysages mediterranéens*, Aix-en-Provence, 14.-15.10.1995 (Novakovič, Simoni, Mušič, 1997).

2 The earliest study on Kras was published by J. V. Valvasor in his monumental synthesis of geographical, topographical, ethnological, historical and archaeological observations on Carniola *(Die Ehre des Herzogthums Krain)* in 1689. He was actually elected to the Royal Geographic Society for his description and explanation of the phenomena of the karstic underground hydrology at Lake Cerknica. Interest in Kras increased from the end of teh 18th century when numerous local and foreign scholars travelled and studied the land and peoples, the best known among them being the naturalists Tobias Gruber *(Briefe hydrographischen und physikalischen Inhalts aus Krain*, Wien 1781) who proposed the 'collapse theory' for karstic geomorphology, and Balthasar Hacquet *(Oryctographia carniolica oder physikalische Erdbeschreibung des Herzogstums Krain*, Leipzig 1778), the proposer of the 'corrosion theory'; both scholars were from Ljubljana. In the second half oh the 19th and in the beginning of the 20th centuries the scholars from Vienna (A. Schmiedl, E. Tietze, A. Penck and others) intensively studied karstic geomorphology in the parental Karst. Another important scholar, J. Cvijić, came from the Vienna geomorphological school (Das Karstphänomen, Wien, 1893; Karst, Beograd, 1895). The development of the Karst studies in Slovenia is associated with the establishment of the University of Ljubljana (1919) and the Institutes of Geology, Geography and Karstic Studies after the second World War.
The study of cultural and historical features of Kras were less developed in the past. It became a part of Karst studies only in the last decades with the further development of approaches in geography and history which integrated natural and cultural phenomena. For studies of 19th and 20th century rural economic and social history of Kras see A. Moritsch *(Das Nahe Triester Hinterland*, 1969).
However, the most complete synthesis of natural, geographical and historical development of Kras was published by Gams, I. *(1979). Kras*. Ljubljana, Slovenska matica.

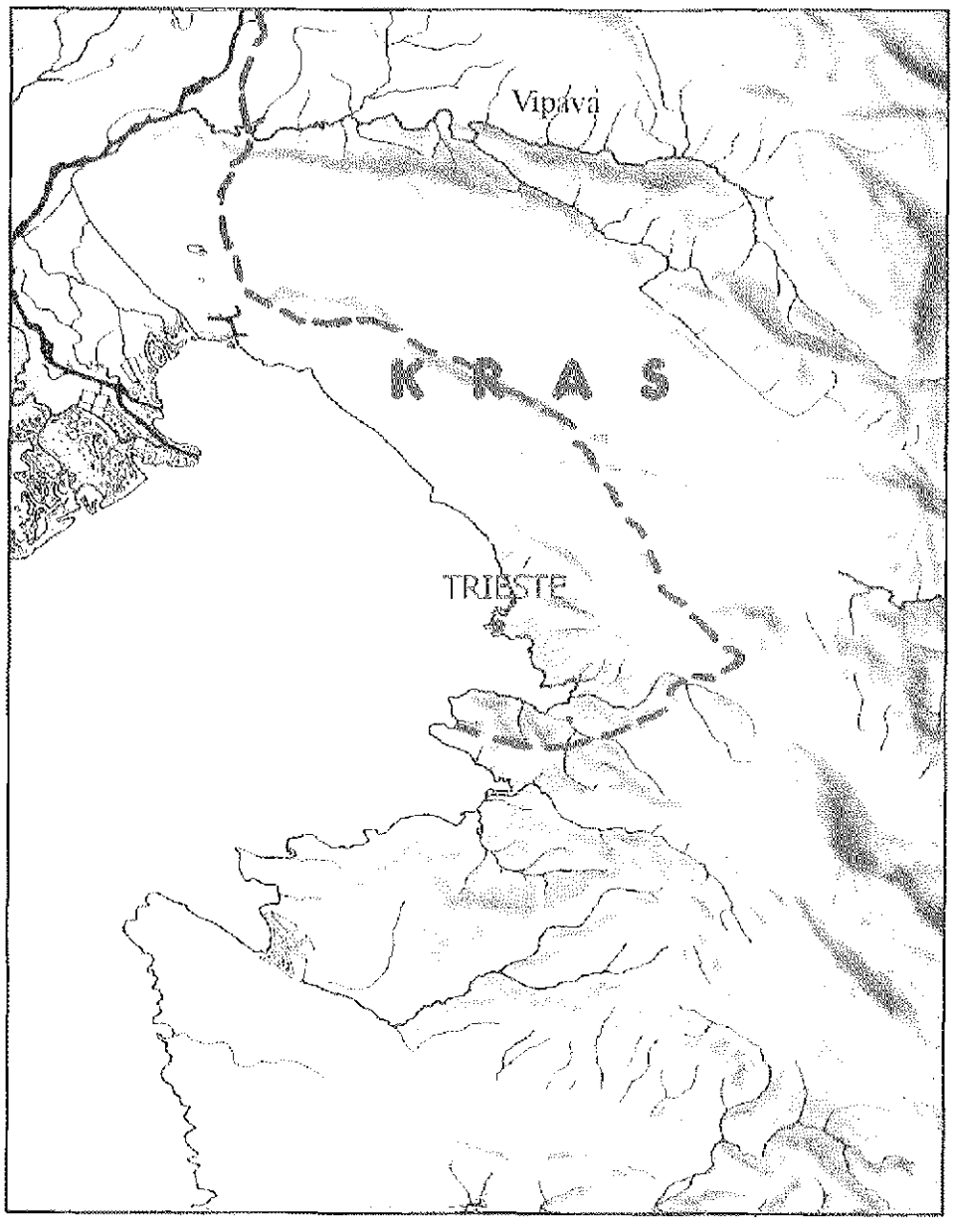

Fig. 1: Location of Kras in SW Slovenia and in Trieste hinterland (Italy).
Sl. 1: Lokacija Krasa v severozahodni Sloveniji in v zaledju Trsta (Italija).

In the 19th century, the Kras with its specific and numerous geological and geomorphological phenomena was such an attractive landscape for the geologists and geographers, that they gradually began to use its name (Kras, il Carso, der Karst) for describing similar limestone landscapes having no superficial waters and poor vegetation coverage.[3] The same goes for the number of karstic geological and geomorphological phenomena primarily observed and researched in the parental Kras and in Dinaric Alps. *Dolinas*, the subject of our study, are among them.

3 To clarify the terminology and avoid confusion, as very similar terms are used for describing different phenomena, we suggest the use of the geographical term Kras when speaking of the actual region in SW Slovenia and in Trieste hinterland. A common synonym for it is also Parental Karst. Dinaric Karst is a term used for the wider karstic region in the western Balkans. However, when referring to general geological and geomorphological phenomena we use the term karst or karstic.

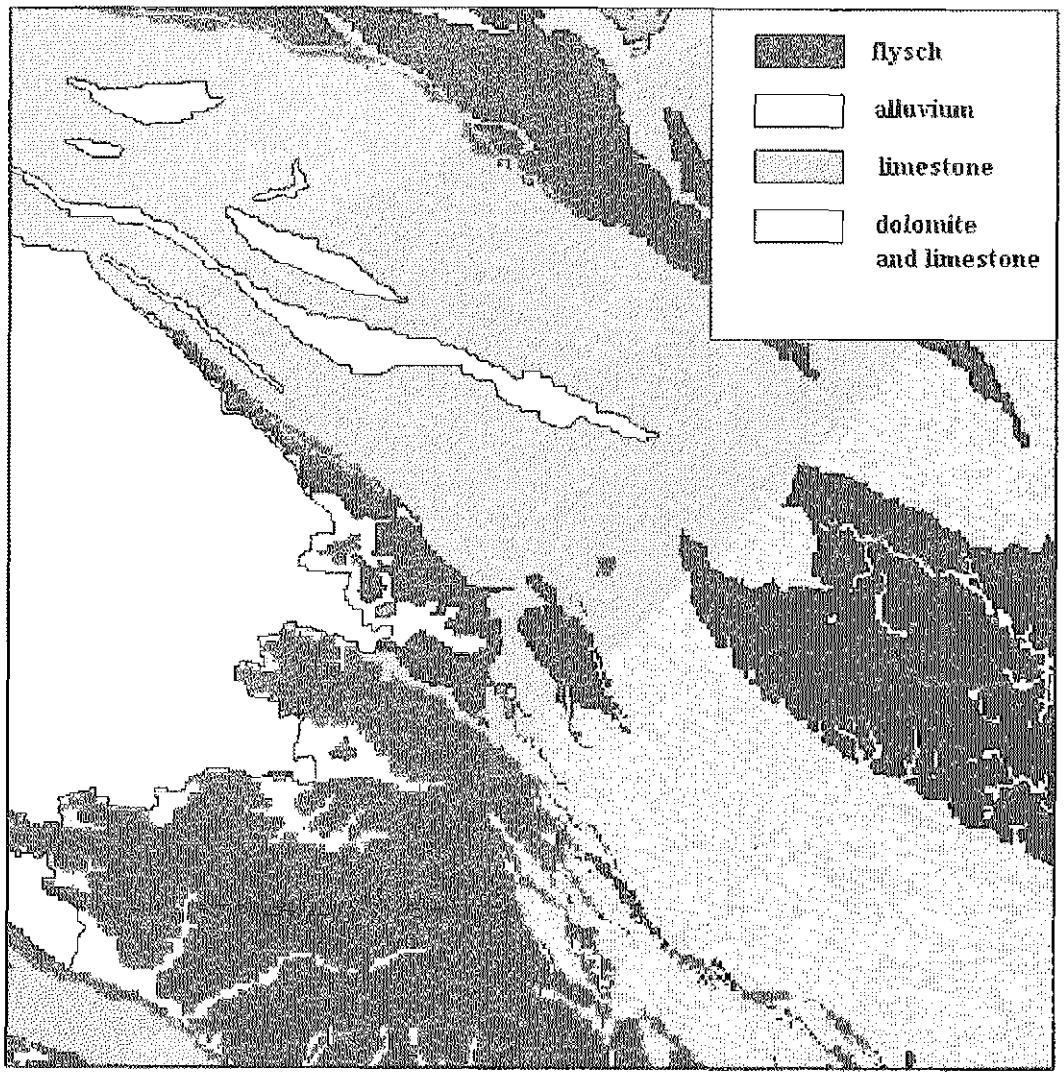

Fig. 2: The parental Kras (Karst). General lithological map of Kras area (after Gams, Habič, 1987, 5).
Sl. 2: Matični kras. Splošni litološki zemljevid kraškega področja (po Gams, Habič, 1987, 5).

Dolinas are among the most universal and typical geomorphological features in the karstic landscapes, and are especially frequent in the Dinaric zone. The term 'dolina' can be found in many South Slavic languages and dialects. It was introduced into international terminology by the first geographers that researched karstic landscapes in the territory of former Yugoslavia. A synonym frequently used for dolinas in many of the South Slavic languages is *'vrtača'*. The latter term derives from the verb *'vrteti'* (to circle), and is associated with the circular or elliptical shape of most of the dolinas. In English a dolina is termed as: *sink hole, swallow, cock pit, hollow* or *cove*. In French, it is *sotch, etonnoir, betoir* or *enselmoir*. In Italian *inbuto, busa, pozzo, lama*; and in German, *Dünloch, Wetterloch* or *Teufelkutte*.

In general, dolinas can be defined as medium sized closed karst depressions (fig. 3). Their size varies from 5 to more than 300 m in diameter, although on average most dolinas have a diameter between 20 and 50 m (Cvijic, 1924, 401). The ratio between the depth and diameter of such depressions is normally between 1:6 and 1:10. Dolinas appear most frequently in half-covered or covered karst landscapes, i.e. in areas with higher precipitation. The density of dolinas tends to be contradictory to their size; the smaller they are the more there are. To a great extent, their density also depends on the underlying geology. Their density is very high on limestones, less dense are on conglomerates, while they are relatively rare on dolomites. Another factor conditioning their density is the relief. They are numerous on flat or levelled and covered limestone terraces and rare on steeper slopes. In some areas of the Parental Kras their density exceeds 150 dolinas per km^2, while on the average there are between 50 to 70 dolinas per km^2.

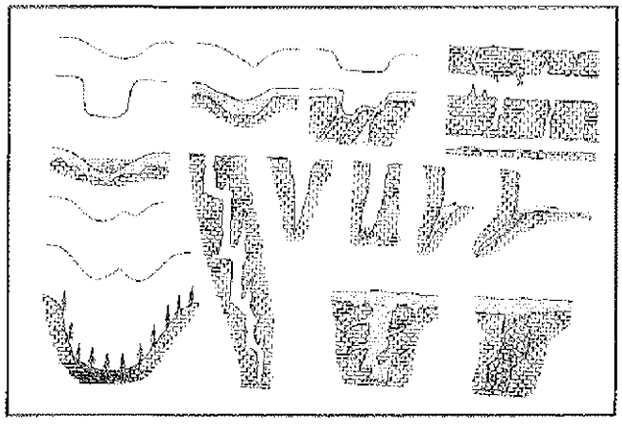

Fig. 3: Sections of the various karstic depressions. Dolinas are on the left and top center (after Gams, 1974, 106).
Sl. 3: Prerez različnih kraških vdrtin. Doline na levem in zgornjem središčU (po Gams, 1974, 106).

Though many researchers studied dolinas very extensively in the last century, their origin and formation processes are yet to be clarified. J. Cvijić, one of the pioneering scholars in karst geomorphology, interpreted dolinas as the result of karst corrosion; as areas that were lowered due to the drainage of rainfall and surface waters into the underground, possibly due to the existence of numerous cracks and breakages in the underlying limestone geology. His explanation was for many decades widely accepted and very influencing in further research in this field. However, there are two other sets of explanations concerning the formation processes of dolinas. The first theory interprets dolinas as an integral part of the karst surface where, due to teh specific local conditions, lowering has been more extensive in some spots; but the processes are absolutely the same in the whole area. The second theory considers dolinas as reproductions of the underground karst voids on the surface, formed by the collapse and denudation processes on the surface which permanently expose the underlying caverns (see Šušteršič, 1994, and Bahun, 1969, for different theories about the origin of dolinas).

However, the present stage of knowledge allows us to rightly assume that the origin of dolinas cannot be explained by merely one general cause and that each dolina has to be considered as an individual problem and ecotopos with its specific pedological, climatic and vegetational manifestations.

2. Ecological conditions for agriculture in Kras

a) Climate

The Kras climate is regarded as submediterranean (Gams, 1987, 95). The annual precipitation is between 1200 and 1500 mm and generally follows the mediterranean pattern of annual distribution of rainfall, with enhanced draughts in the summer (sometimes less than 100mm per month). Mean July temperature is between 19° and 21,5 °C, while mean temperature in January is between 0,2° and 2,1 °C. Microclimatological studies of dolinas and other karst depressions demonstrated a frequent phenomenon of a temperature inversion during the night. Palli (1961, after Gams, 1972) researched numerous dolinas near the villages of Opčine (Villa Opicina), Prosek (Prosecco) and Repentabor (about 300 m above the sea level and 100-200 m in diameter) in the Trieste Karst in the years 1957-1959 and recorded that the mean air temperature of the dolina bottoms in February was by up to 4 °C lower than the temperatures on the rims of the dolinas. In August, the difference is much smaller (0.5 °C on average). These peculiar climatic conditions have a significant effect on vegetation and agriculture. For example, the vineyards are not grown in such depressions in the highest (SE) part of the Kras for this reason.

b) Soils

The most frequent soils in Kras are rendzina, terra rossa, calcocambisols and washed calcocambisols (fig. 4, also Lovrenčak, 1977, 443-449). A major problem regarding the soils in Kras is their very uneven distribution. Open land and steeper slopes normally have very thin layers of soil, sometimes not thick enough to cover the bedrock. There are also differences in soils in dolinas' bottoms and in open karst land. Generally, dolinas' bottoms have soils richer in rubble. Such a soil is more aerated and lighter. It is also warmer in autumn and winter since rubble particles are good heat conductors. Such a soil receives more heat from the deeper warmer layers than clay or loam (Gams, 1977, 60). This factor is very important for vegetation in colder seasons and during the temperature inversions. In addition to some very rare alluvial areas at the fringes of Kras, larger quantities of soils could be found only in the places where it was trapped - in natural or man-made depressions. Soil layers are much thicker there, sometimes reaching more than 4 m deep. Since the underlying geology is highly permeable, there are no permanent superficial streams. The only water containing areas are at the contacts of limestones with other impermeable rocks, like flysch in the Vremska dolina (Vreme valley) and at the Brkini hills. The lack of water is even more enhanced during the summer due to the very low precipitation in July and August.

c) The Bora wind

Among the climatic conditions which also aggrevate

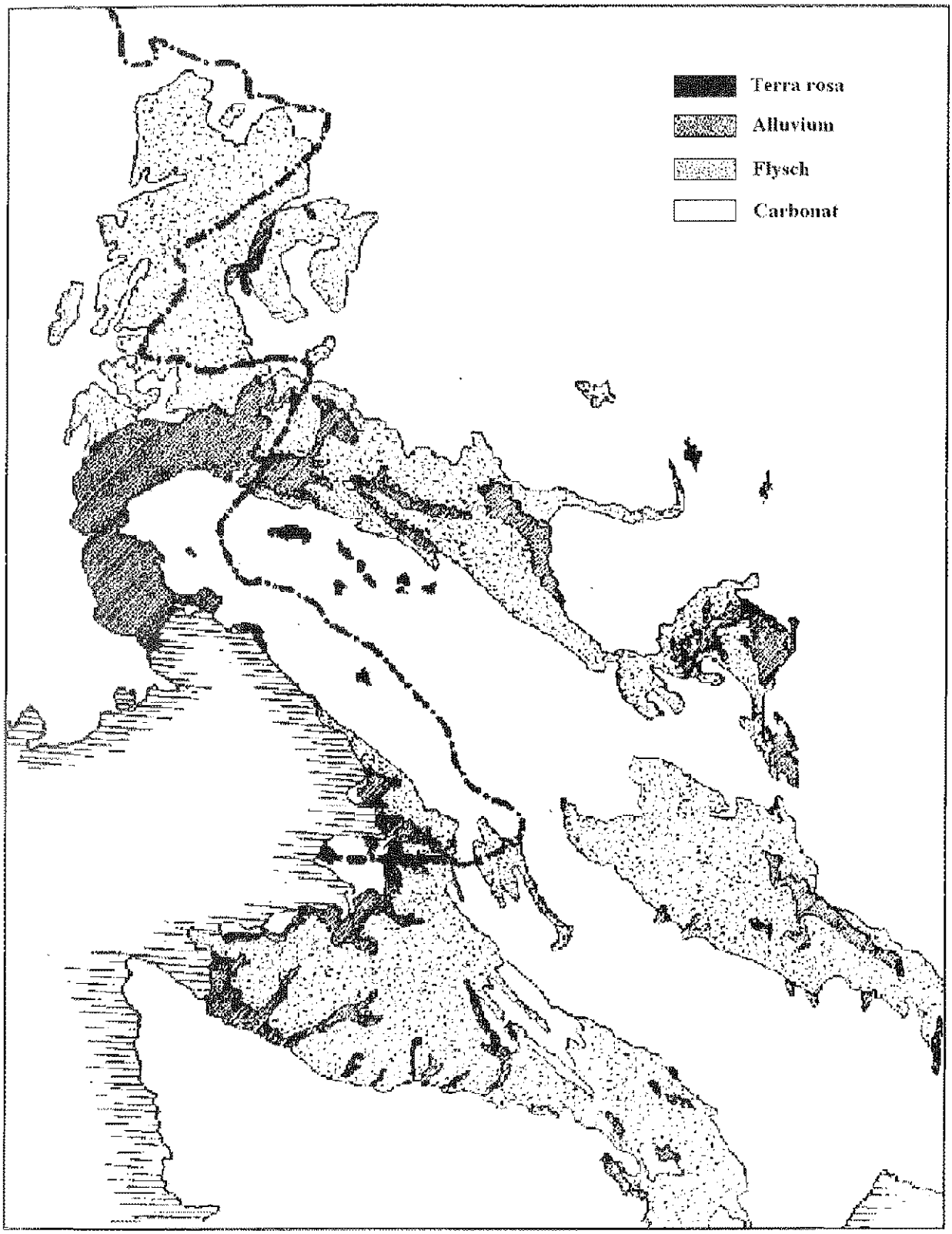

Fig. 4: General soil map of the Kras (after Krš Slovenije, 1957).
Sl. 4: Splošna karta prsti na Krasu (po Krš Slovenije, 1957).

the growth of crops is a very strong northeastern wind, the Bora.[4] It can blow for more than 40 days per year (sometimes for more than 7 days continuously), predominantly in the colder seasons, and can reach velocity of more than 100 km/h. Its effect on agriculture can be disastrous, since it can blow away substantial amounts of soil from openland fields and decrease local air and ground temperatures in the winter period.

d) Forest cover

Among the man-made factors influencing the ecological conditions in the Kras, the deforestation as a result of acquiring new land for agriculture and grazing has been one of the most important. In the Antiquity, Kras contained substantial tree coverage. Natural forest vegetation in Kras was similar to the forests in karstic areas in south-central Slovenia, classified as pre-alpine type of vegetation (Culiberg, 1995, 201). The forests in the past exhibited an important influence on climate in Kras; they were blocking the impacts of (sub)mediterranean climate (Culiberg, 1995, 207). Based on a pollen analysis from the Koper-Škocjanski Inlet Culiberg (1995, 201-204, 208-211, 217) distinguishes three main forest phases in Kras: the beech-fir, oak-hornbeam and hazel phases. The domination of beech and fir associations ceased at arround 1000 B.C. and was replaced by oak and hornbeam associations, which than dominated until approximately the 1st century A.D with their peak around the mid 1st millenium B.C. From this period onwards, and especially after the 1st century B.C., there was a constant increase of NAP (non-arboreal pollen) values indicating more open landscape. The NAP values were the highest after the 11th century A.D., indicating a process of large scale deforestation associated with grazing and transforming the wooded land into the arable one.[5] However, the results of the Culiberg's analysis were obtained from a locations marginal to the Kras core areas[6] and should be considered with some caution.

Nevertheless, archaeological data to a certain extent correspond to the deforestation scheme proposed by Culiberg. In the period after the 2nd millenium B.C. we can trace relatively dense settlement and extensive exploitation of the land in Kras with its peak in the Iron Ages when more than 100 hillfort settlements existed in the area. The larger number of hillforts and the overall density of the settlement in this period certainly had a significant impact on the landscape. The demand for grazing and arable land, fuel and timber put a strong pressure on woodland resources. Undoubtedly, the best evidence for clearing the landscape in the period of the Late Prehistoric hillforts in Kras is provided by the existence of large stone ramparts and barrows containing hundreds of thousands of cubic meters of accumulated stone. However, we are still lacking enough empirical evidence from polen cores to determine the scale of the deforestation in the Iron Ages. For the prehistoric periods, Culiberg is more in favour of interpretations in terms of the fluctuations in forest covers, associated with the climatic changes and changes caused by zooanthropogenic influences, rather than of a deforestation on a scale which would have been caused by intensive agriculture. The most intensive process of exploitation of forests (timber and fuel) and changing woodland in order to gain more pasture and agricultural land reached its peak in the last three centuries and lasted almost until the end of the 20th century, when the Kras landscape reached the peak of its degradation. It is almost needless to say what that meant for agriculture: accelerated aeolic erosion, washdown of soil, lower humidity, changes in microclimate and hydrology (Sauro, 1993).

Similar conditions for agriculture exist in other karst landscapes on the mediterranean and submediterranean plateaus in Central Italy in the Apennines, in Southern France, Spain, Greece, Dalmatia and the Dinaric zone. In these areas we can observe similar strategies and patterns of survival and traditional agriculture: keeping sheep and goats, various transhumant and semi-transhumant strategies, the predominance of early and specialized crops (vine, olives, fruits) in agriculture, land improvements by clearing stones in the fields, meadows and pastures, various strategies of soil conservation (like terracing), construction of protection walls against animals and wind, etc. All these are well known subsistence activities and strategies in the Mediterranean world. However, there are also some distinctive features typical of agricultural life on the mediterranean and submediterranean karst plateaus - extensive agricultural use of plots of land in all sorts of small and medium sized karst depressions, especially the *dolinas, uvale* and *polja*.[7] The French geographer J. Nicod (1987, 98) termed such landscapes as *'paysages agro-karstiques'*.

4 For more detailed study on the Bora wind see Masatoshi M. Yoshino (ed.) (1976): *Local Wind Bora*. University of Tokyo Press.

5 This might be associated with the fact that the town of Trieste issued a law in its municipal status from 1150 prohibiting keeping goats (see Čehovin, 1986, 6).

6 The Koper - Škocjanski inlet is very close to the coast and it is on alluvial plain near the mouth of the Rižana river surrounded by flysch hills. The second location where the pollen samples were taken (Zajezeri - Vodenjak) provided the data only for the last five centuries.

7 *Doline, uvale* and *polja* mainly differ in their size. The largest are *polja*, karstic depressions which frequently have permanent superficial streams and alluvial bottoms. They normally end where the river disappears in the ground when it reaches the permeable rock.

3. Dolinas: the 'agricultural gardens'

Dolinas, though generally relatively small plots of land, acted in the past as a sort of 'agricultural islands' or 'gardens' in degraded landscapes suitable more or less only for pasture. The main reason for this is that they act as natural accumulations and reservoirs of fertile soils. A single medium sized dolina may contain several hundred cubic metres of soil (Radinja, 1987, 131). Dolinas in Kras normally contain calcocambisols (brown soils formed on limestones having residuals of nonsoluble noncarbonate minerals) and washed calcocambisols, the latter are more frequent on the bottoms. The soils at the bottoms also have a lighter texture than the soils in open land and in between the dolinas. A typical village in the Kras in the 19th century normally exploited more than 50 dolinas (Gams, 1987, 118), sometimes even more than 100, and they were categorized as the best land for agriculture.

Though the dolinas are excellent shelters against the wind and as natural reservoirs of soil have more moisture, they are still not ready-made fields. They require further improvements to be used efficiently for agricultural purposes. Local people use the term 'worked dolina' for the improved ones. Although various types of improvements were in force (fig. 5), they all have several things in common: the removal of stones, construction of walls and terraces around the perimeter of the dolina and spreading of the soil on the bottom. Most frequently the farmers dug a hole or trench at the bottom and filled it with stones and rocks collected from the surface of the bottom. The rocks from the dolina slopes were also dug out or hammered out and deposited in the central hole of ditch (fig. 6). The size of the ditches filled with stone debris depended on the size of the dolina; on average they were normally 10-15 m long, 2 m wide and 1,5 m deep and could contain several dozen cubic meters of stone debris with stone fragments ranging from 5-15 cm in length (Radinja, 1987, 134). Then they scraped the soil from the surface and slopes and covered the whole bottom. In this way they also enlarged (raised) the dolina bottom, i.e. the actual field area. There were also other ways to enlarge the field surface, for example, by construction of a scarp made of stones cleared from the slopes and bottom and later filled with soil (Gams, 1974, 178). The research of the collapsed dolina Drčivnik near the Škocjan caves revealed a great amount of rubble, intentionally added to the clayish soil (Gams, 1987, 111). In this way they augmented the fertility of soil by diminishing its acidity and increasing the aeration. Such soil is also warmer since the rock has better heat permeability. This strategy was also important in the dolinas with very low evaporation due to the much diminished windiness. In some cases, the windiness at the bottom could be three times lower than in the open land (Gams, 1987, 112).

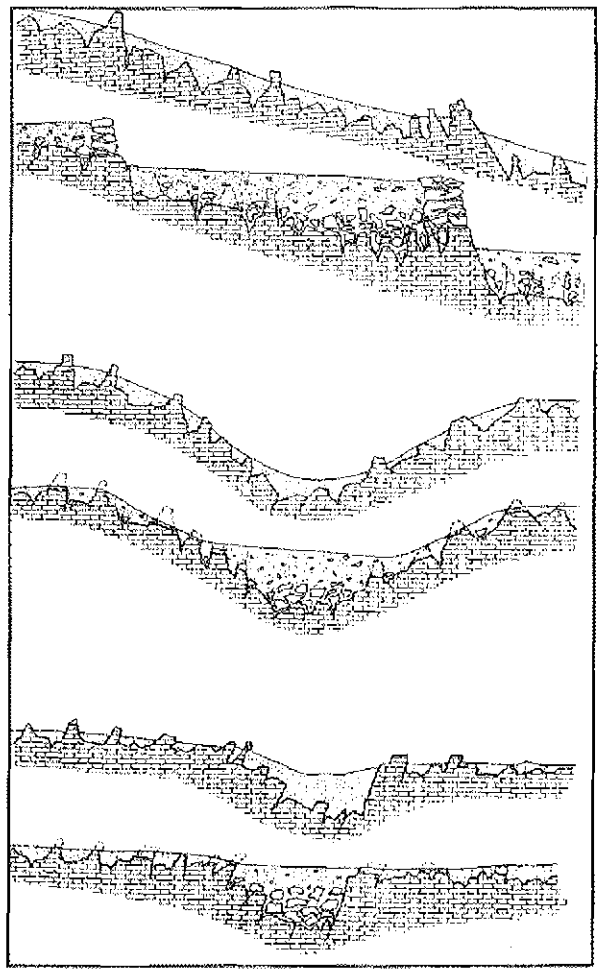

Fig. 5: Various types of ameliorations of the agricultural land in the Kras (after Gams, 1974, 178).
Sl. 5: Različne vrste melioracije kmetijskih površin na Krasu (po Gams, 1974, 178).

Associated with lower evaporation this can result in relatively very humid soils that are not very suitable for agriculture. Added stones also slowed down the aeolic erosion of the superficial soil on the more exposed surfaces in dolinas and in open land. More or less all of teh "worked" dolinas were enclosed by one or two walls. They were the result of a clearance but they served other purposes as well. To a certain extent, they diminished the effect of winds and protected the crops from wild and domesticated animals.

The number of worked dolinas is normally higher closer to a village, and diminishes with distance. In the the village of Krajna vas, almost a half of all the dolinas in the village cadastral district were 'worked'. At the average density of 35 dolinas/100 ha and a total area of 335 ha, this accounts for at least 50 worked dolinas agriculturally exploited by one village (about 20 households before WW I, see Gams et al., 1971). By

taking these figures into account we can easily assume that some two thousand dolinas were "worked" in Kras and though effort in maintaining them, they were the most important agricultural land category.

Agricultural exploitation of Kras reached its peak in the mid 19th century. Since there were almost no other subsistence possibilities than agriculture and stock breeding, the landscape was exploited to its full and even beyond. Population pressure[8] resulted in clearance and the transformation of poor land into the agricultural one. An additional factor that conditioned the increase of small household properties and the dissolution of larger estates in the mid 19th century was the land reform that ended the traditional feudal landownership. Small household properties[9] were probably a reasonable answer to the demands and circumstances of many 'paysages agro-karstiques' since they included various types of mixed agriculture, thus allowing many people to maintain the minimal subsistence. However, as a result of all of these processes, the landscape rapidly degraded due to the accelerated erosion, lack of forests and the effects of sheep and goat grazing.[10] The cadastral maps from the beginning of the 19th century are highly informative in this respect. In the cadastral map from 1822 for the village of Lokev there are more than 100 "islands" of enclosed fields and dolinas (Gams, 1987d, 14). There was practically no potential agricultural land that was not "worked", improved and exploited. The dolinas were exploited to their full potential, even those that were relatively far from the villages as evidenced by the 18th and 19th century pottery found in them. There is another important factor which strongly influenced the economic conjuncture in rural Kras - the rise of the city of Trieste. In 100 years (from 1817 to 1918) the population of the city grew seven times, from 33,000 to nearly 230,000 inhabitants (Moritsch, 1969, 136). The demand for many goods and especially for the mundane ones, like food, fuel, wool etc, and services offered to the city by the rural population in relatively short time transformed the way of life of the latter. The household economy was able, by growing the vines (where possible) and offering services, gain certain surplusess, which in circumstances of the rising demography provided a certain solution to subsistance.[11]

In this century, especially after WW 2, since most of the population aquired jobs in industry and in the tertiary sector, agriculture became economically less important. Another reason for its decline was due to the fact that the establishment of a new border between Italy and Yugoslavia; many villages were cut off from the town of Triest, which had served for a long time as an important market center and attracted the agricultural surpluses. As a result of all these processes, and the introduction of modern machinery which aided farming techniques, most of the dolinas were rapidly abandoned. Their plots of land were too small for efficient farming and most of the dolinas were walled, what prevented easy access for farming machines. However, in the last few decades, many of the dolinas suffered severe changes and processes completely opposite to the processes of their improvements. Aided by the state, the farmers started to improve their fields in the open land. By spreading soil (Habič, 1987a, 115; Radinja, 1987, 134) that was dug out from the dolinas they improved abandoned meadows and vineyards. Several hundred dolinas were emptied by machines for this reason. Radinja (1987, 131) roughly estimated that the surface covered with soil from dolinas is at least ten times greater than the area of the plot from which the soil was extracted. Large quantities of soil were also needed for filling the several kilometers of ditches excavated for the main water supply network.

8 Increase of population is especially evident from the beginning of the second half of the 19th century. One of the main reasons for this increase was reduced mortality of babies and very young children which was very high in the first two decades of the 19th century (Verginella, 1990: 5-6), and the introduction of potato crops (Davies, 1988, 64, footnote 11; Moritsch, 1969, 123). The economy of individual households was very fragile since they had to balance scarce land, crop yields and the number of household members. Even smaller demographic changes could heavily affect individual families and their economies. For example, due to the army service for young males (normally more than 10 years long) many families suffered the lack of the most productive part of the population. On the other hand, however, this could also mean a certain relief for the larger families.

9 The process of fragmentation of households started a century or so earlier due to the continuation of land improvement (clearing, terracing etc.) (see Moritsch, 1969, 123). Also the impact of the bills which at the end of the 18th century secured all the heirs a share of land should not be ignored.

10 This can be best illustrated by the ratios of various land use in the district of Sežana (more or less corresponding to the area of Kras) for the year 1870. 13,1% of the land was fields and fields with vineyards, 45% pastures, 24% meadows, 9,3% pastures and meadows with forest trees, and 7,3% forests (*Gospodarska in družbena zgodovina Slovencev*, 1970, 140-141).

11 In the case of the village of Tomaj in the period from 1840 to 1900 the amount of vineyards was almost doubled (from 15,54 ha to 28 ha), the share of meadows had risen from 129,75 ha to 207 ha, and even the forested land gained some area (from 470,94 to 547 ha). On the other hand the grazing land was more than halved (from 245,97 to 102 ha), while mixed culture and orchards covering 6,12 and 18,75 ha respectively, were not recorded at all for the year 1900. The amount of the arable land remained almost the same (97 to 96 ha). The size of the cadastral unit was equal in 1840 and in 1900 (for details see Moritsch, 1969, 70-85).

4. Archaeology of the dolinas

Intensive settling of Kras falls into the Bronze and Iron Ages. Prior to these periods, the only significant group of sites were in caves frequently used as settlements/shelters for people and animals in the Neolithic and Eneolithic periods. The known settlement pattern from the Bronze and Iron Age consists of numerous hilltops, walled (fortified) settlements also known as *castellieri*, and isolated stone barrows on a dominant locations. The Roman period is mostly characterized by a number of small villages predominantly in the lowlands, settled probably by the indigenous population, a few villa-type settlements on the agriculturally more attractive land and a network of Roman roads, which to a large extent followed the prehistoric routes. The medieval settlement pattern is also marked by numerous smaller villages that can be traced to the 14th century at least; most of them survived into the modern times. In addition to them, there were also some castles that served as local administrative centers.

To a large extent, the natural conditions for agriculture, primarily the scarcity of water and the uneven distribution of soil, profoundly conditioned the settling of Kras throughout the Antiquity. After the period of the *castellieri* in the Bronze and Iron Ages, we can follow more or less the same general pattern: the concentration and clustering of the village type settlements around the naturally distributed small plots of fertile land. Various strategies existed to avoid the lack of water for animals; local and regional transhumance of sheep and goat flocks, numerous pools that can be found throughout the Kras, and by seasonal streams. Some dolinas could serve this purpose, too; the bottom was coated with a layer of kneaded red loam, thus catching the rainfall (Habič, 1987, 8). A very common strategy for the accumulation of water from the Roman period onwards was the construction of cisterns, indeed this was the most common practice in medieval and modern villages prior to the construction of acquaducts after WW 2. Natural conditions for agriculture favoured the continuous occupation of the same locations from the Later Prehistory to the modern times, which in many cases caused the destruction of the archaeological record from the earlier periods.

The abandonment of traditional farming in the 20th century resulted in rapid afforestation (man-made and natural). Today, forests and bushland cover large areas that were previously agriculturally exploited, thus making archaeological survey very difficult. The regular ongoing survey of the Regional Office for the Protection of Natural and Cultural Heritage (Regionalni zavod za varstvo naravne in kulturne dediščine) in Nova Gorica is mainly monitoring larger construction and development works in the area. However, the survey carried out in 1974 by the Department of Archaeology, University of Ljubljana (Slapšak, 1983; Slapšak, 1996) was more ambitious. Numerous interviews with local people and control visits were undertaken with the aim to record the general settlement and economic patterns in different archaeological periods, as well as the factors conditioning the survival of the archaeological record. However, in both surveys large areas of landscape remained unsurveyed. Additionally, the methodology at that time did not include systematic surveying; it was based more on judgemental sampling and was mainly concentrated on existing archaeological sites and modern villages.

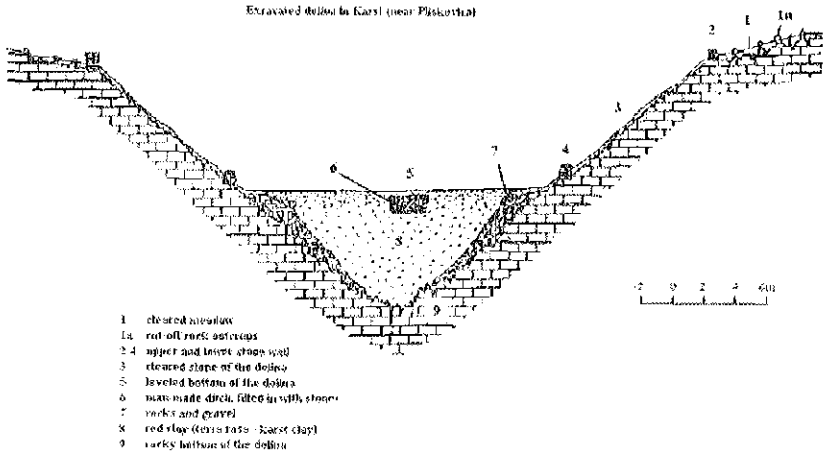

Fig. 6: Section of the typical 'worked' dolina near the village of Pliskovica in NW Kras (after Radinja, 1987, 130).
Sl. 6: Prerez tipične "delane" vrtače pri vasi Pliskovica v severozahodnem Krasu (po Radinja, 1987, 130).

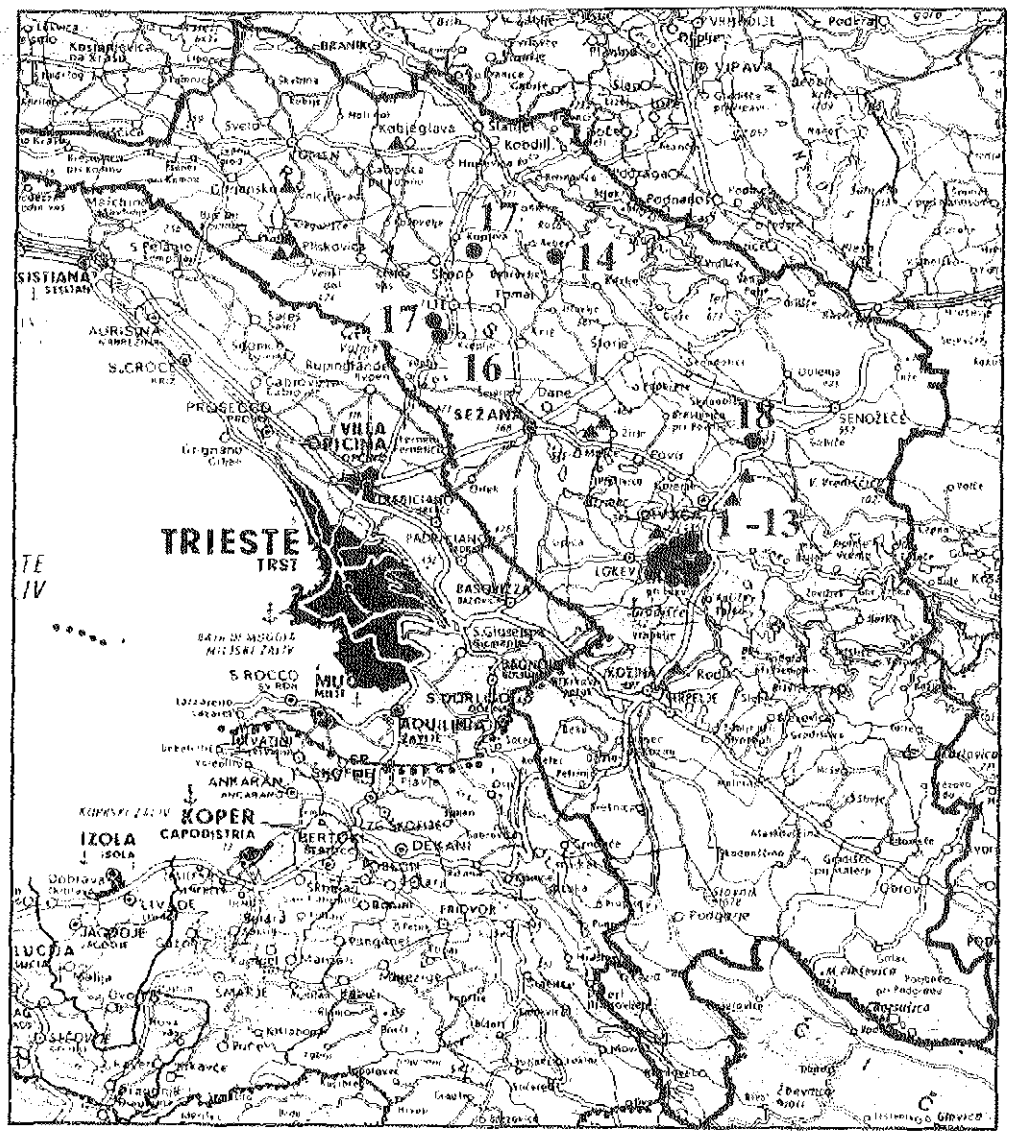

Fig. 7: Distribution of the dolinas with archaeological findings.
Sl. 7: Porazdelitev dolin po arheoloških najdbah.
● Surveyed dolinas of our case study. / Raziskane doline.
▲ Dolinas reported as containing prehistoric and Roman pottery (Osmuk, 1993, 1994). / Doline s prazgodovinsko in rimsko lončenino (Osmuk, 1993, 1994).

The process of agricultural amelioration in the 70s and 80s is credited for the destruction of many traditional agricultural landscape features in Kras (many field boundaries, stone walls and were destroyed, hundreds of dolinas were emptied, new roads were made for the agricultural machinery, etc.). This also affected the archaeological knowledge of this area, since many of the destroyed dolinas are reported to contain remains of prehistoric pottery. However, in spite of the fact that the reports of new finds in recent years were very superficial and non-systematic, their increased number suggested that dolinas probably could have played a much bigger role in the Prehistory than expected. The second reason for choosing dolinas for the investigation purposes is their high density and peculiarity in this particular landscape.

Case study

The first reports on prehistoric finds from the dolinas came from the *Regional Heritage Protection Office* in Nova Gorica (Osmuk, 1993; Osmuk, 1994). Due to the emptying of numerous dolinas, the archaeologists responsible for the archaeological heritage in the area

checked a small number of them and gathered some prehistoric sherds from the surface. However, the evidence was not limited to their fieldwork only. Much of it was derived from accidental discovery of single finds made by the locals during the process of extraction of soil from certain dolinas. A few reconnaisance visits in the region were carried out in the past by the authors of this paper[12] prior to the more systematic archaeological survey.[13]

We surveyed 19 dolinas (fig. 7). Thirteen of them (nos. 1-13), clustered in the area to the east of the Škocjan region in the Upper Kras, were chosen as a sample that could give us an insight into the dolinas' exploitation in the region adjacent to the fertile Vremska dolina (Vreme valley), where a great deal of ancient settlements from the Prehistoric to the Medieval periods are known (see ANSI). Dolinas 1-13 were checked regardless of any previous information or knowledge on their archaeology. The rest of the dolinas (nos. 14-19) are dispersed in the Lower Kras in the north and were known to us from the local archaeological reports.

The picture that evolved in all of them was not an even one. The dolinas were unevenly preserved because of the differentiated exploitation and utilization of each one by their owners. The majority of them (13 out of 19) were not destroyed. Presently left intact, we had the chance to observe what has been described as: *"...a strong artificially modified form of the dolina with a field on the bottom; a rounded bottom, smooth slopes sharp transition of the slope into the bottom level, which is artificially accumulated and therefore larger and higher..."*(Gams et al., 1971, 227) and deduce their prior agrarian use. Some of them (nos. 2, 5-12,13,18,19) were covered with grass, while one (no. 3) has been converted into woodland. Six dolinas (nos. 1, 4, 14-16) have suffered almost complete removal of their soil volume to the level of the limestone bedrock on their bottom and the slopes. Their fully exposed slopes allowed us to acquire a clear, more or less vertical profile and provided us with a geological stratigraphy, measured and illustrated on the spot.

Different states of preservation called for different methods to be employed in each case without escaping from our principal and overall common goal of the case study. Apparently, the long standing use of dolinas in Kras from the Prehistory up to the modern times, though differentiated according to the needs of the communities that utilized them over the centuries, has left its mark on their modern face. First of all, our survey was not meant to be an exhaustive one. Not all the dolinas that we encountered were surveyed. Dolinas with no traces of agrarian use were intentionally omitted.

In all of the 19 dolinas their dimensions were measured, i.e. the length of the long and short axes of the surviving bottom, as well as the depth of the bottom, whenever this could be assumed. A short description of the location accompanied with the orientation of the long axis and a report on its present state were written down. The different features that we particularly took into consideration were signs of elaboration and destruction. Therefore, the existence of an enclosing wall at the upper part and/or the flattening of the bottom bore witness to the former agricultural activities in it. Soil extraction was evidenced by the emptiness and the exposed outcrops of limestone bedrock.

Unfortunately, any remaining constructions such as walls could not offer any chronological indication, as most of them are relatively recent. The mode of construction did not alter our view that it had always served the same purpose and that the same material had always been used: stone accumulated when the dolina was cleared. The volume of the standing wall of dolina 10 was measured in order to assess the volume of stones in such a construction. The wall was some 250 m long and contained approximately 105 m^3 of stone.

Accordingly, different types of survey were applied for the same purpose: to discover archaeological datable material, mainly pottery, whether remaining on the surface or hiding in the subsurface. Wherever profiles of the slopes were visible, sampling points were chosen around the dolina, each one situated 5 m apart, and their surface was scraped to a depth of 5-10 cm all the way from the top to the bottom. The open, uncovered bottom allowed a surface collection and several grab samples were derived in this way. The thickly vegetated dolinas were not suitable for surface collection. A series of small test pits (30x30x30 cm^3) were dug along both axes of these dolinas and ceramics gathered up from the top soil.

It is significant that 14 out of 19 dolinas produced ceramic material either on or under the surface. All material was collected and labelled with reference to its exact position, with the exception of the material recovered as a grab sample. Table I shows the chronological distribution and total number of sherds of all the dolinas surveyed. The table demonstrates that nearly 50% of finds are dated to the Bronze and Iron Ages. Although we cannot ignore that a certain bias was imposed, since we consciously tended to collect more prehistoric sherds whenever we came across with them in dolinas, it is still remarkable that prehistoric pottery, where it was

12 P. Novakovic and P. Turk had separately visited and collected sherds from many of the dolinas in the Škocjan region over the last 5 years. The former returned to that area with B. Mušič and H. Simoni, earlier this summer and went to the Lower Kras as well.

13 The survey was carried out in the first week of August 95. The timing proved to be favourable for our work because, despite the high temperature and fierce sun, we were granted relatively high visibility due to the rainfall on previous days. The team consisted of 3 persons, the authors accompanied by colleague T. Greif.

discovered, outnumbers tiles and pre-modern pottery. This kind of prehistoric pottery is better identified as "castellieri ware", since similar finds have been discovered in the numerous *castellieri* all over the Kras. It consists of reddish-brown to black handmade coarse vases, not uniformly fired, thick and poorly purified, with a rough and porous surface (Karoušková-Soper, 1983, 225-229) which tends to be very fragile.

The Roman period was significantly underrepresented if not absent at all, though there are some reservations for some fragments that might be assigned to this period. Three fragments of Roman pottery belong to one thick-walled vessel (amphora?) and were discovered in dolina 14. Another Roman sherd was found in the same dolina a week later in a fire layer (see Mušič, 1997). In addition to this, three very small and poorly preserved sherds of presumably Roman origin were located in dolina 17. The succeeding periods are better represented, though to a lesser extent than the Prehistory. The medieval pottery belongs to the "gray ware" and consists of sherds with medium thickness, baked in a reduced atmosphere that provided them with a dark color, with smooth and hard surfaces and many limestone and mica inclusions (Tomadin, 1989, 14; Tomadin, 1992, 44-6; Tomadin, 1994, 54). Glazed ware of the post-Medieval (pre-modern) times and other more recent sherds and tiles bore witness to the continuous use of dolinas until very recently.

To strengthen our original hypothesis about the earlier and modern use of the dolinas, a small-scale extensive survey with a surface grab collection was performed in vineyards and meadows adjacent to dolinas 14, 15, 16 and 17. The fields chosen lay in the immediate proximity of the destroyed dolinas, and the locals confirmed the reasonable speculation that some of the soil extracted from the dolinas was spread in these fields and meadows for their improvement and invigoration. In fact, this operation comprises one of the important problems of any potential archaeological survey in Kras. We have found at least 20 cases where archaeological artifacts were moved away from their original location and displaced elsewhere, thus creating a false and misleading pattern to the unsuspected archaeologist.

There was a notable coincidence in the range of dating of sherds from the dolinas and the nearby fields, although the quantity of material discovered differed considerably, which will be interpreted later in the text. For the moment we can say that the amount of material found in the dolinas was greater than that found in the adjacent fields. In dolinas 15, 16 and 17 the Prehistoric whilst in the fields, though again more Prehistoric ware was found, the difference with the post-Roman sherds and tiles was not so sharp. In dolina 14 and in the nearby field Medieval material was to be found, whereas the only Prehistoric sherd was located there (table 2).[14]

dolina	Survey type	total	prehistoric	Roman	medieval	early modern	undatable	tiles
1	G, SS	63	34	0	1	14	0	14
2	TP	6	0	0	0	0	1	5
3	TP	5	0	0	0	0	0	5
4	G	6	0	0	1	1	0	4
5	NS	0	0	0	0	0	0	0
6	TP	4	0	0	0	1	0	3
7	TP	0	0	0	0	0	0	0
8	TP	0	0	0	0	0	0	0
9	TP	2	0	0	0	0	0	2
10	TP	2	0	0	0	0	0	2
11	TP	7	0	0	1	1	0	5
12	G	29	0	0	4	18	0	7
13	TP	0	0	0	0	0	0	0
14	G,SS	10	1	3	2	0	1	3
15	G,SS	18	14	0	0	1	1	2
16	G	6	5	0	0	0	0	1
17	G	59	51	3	2	1	0	2
18	TP	0	0	0	0	0	0	0
19	TP,G	3	0	0	0	1	0	2

Tab. 1: Total amounts and chronological distribution of pottery recovered from dolinas. Key: G - grab collection from the bottom of dolinas; SS - subsurface collection from scraped profiles; TP - test pits; NS - not sampled.

14 The figures referred to in the text and demonstrated in the tables comprise the true figures of the finds discovered during our fieldwork. Any further quantitative analysis was not attempted since it would exceed the goals of this paper. Nevertheless, the generation of more sophisticated statistical formulas for a quantitative manipulation of our numerical data along with the employment of a corresponding survey strategy would be interesting and complementary as an alternative approach to the one presented here.

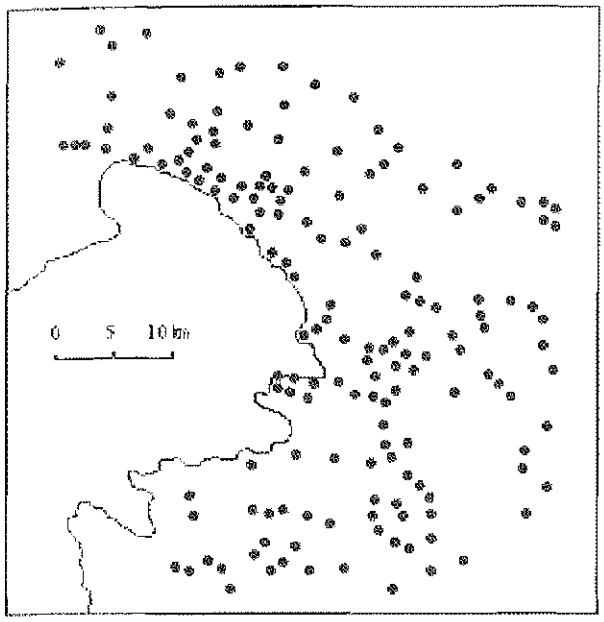

Fig. 8: Distribution of prehistoric hillforts (castellieri) in the Kras.
Sl. 8: Porazdelitev prazgodovinskih gričevnatih utrdb na Krasu.

A mixed survey was performed in dolinas 1, 14 and 15. Material was derived from both surface and subsoil through grab sampling and profile scraping correspondingly. Although the whole slope around each dolina was surveyed through scraping at 5 m intervals, the surface grab sampling proved more fruitful. In dolina 1, out of a total of 63 sherds and tiles, 43 were spotted on the surface of the bottom (7 tiles, 27 prehistoric, 1 medieval, 8 sherds clearly prevailed and the numbers of Mediaeval and pre-Modern sherds and tiles were extremely small; early modern), and only 20 came from the slope's surface (7 tiles, 7 prehistoric, 5 pre-modern, 1 modern) although the total circumference of it was more than 95 m. In dolina 14 the grab sampling revealed 6 sherds (2 tiles, 1 prehistoric, and 3 Roman) while the scraping of one of the exposed profiles brought only 4 sherds (1 tile, 2 medieval, 1 undatable). The slopes of dolina 15 did not reveal anything and all 18 sherds were spotted on the bottom.

Following this archaeological expedition two weeks later, a magnetic susceptibility measurement (methods and results are discussed by Mušič, 1997) took place at a number of dolinas that had already been researched and proven to be the ones with the most abundant pottery (nos. 1, 14, 15, 16, 17). Most of them were characterized by common features. A wall circumscribed their edges and pathways facilitated access to the interior, but no other older human interference could be concluded as everything had been recently emptied of their soil and no marks of agricultural activity remained. Pottery was the sole witness. This method was intended to complete the archaeological investigation of those dolinas where past human activity had been recorded archaeologically with the presence of pottery. A more detailed picture of land use was expected to be detected via geophysical investigation, especially since some layers of the topsoil clearly showed traces of fire (nos. 14, 15, 16). Measurements of magnetic susceptibility were taken from the exposed profiles of the slopes. Where this was not possible (for example in dolina 17) due to the vegetation, small holes on the bottom along the longest axis were dug at a depth of some 15 cm and readings were taken from inside.

In two dolinas (nos. 14 and 16) measurements revealed enhanced magnetic susceptibility caused by fire. Dolina 16 (Mušič, 1997, fig. 8) obtained anomalies more discretely raised above the background values in the northern part of the profile, while in dolina 14 a highly visible layer about 10 cm thick and about 8 m long containing traces of burning limited to the western part of a dolina some 80-60 cm below the present surface was discovered (Mušič, 1997, figs. 3, 4). Since in both cases magnetic susceptibility anomalies are local, we excluded forest fire and presumed man's activities as a cause for them (depositing of ash, burning the waste, clearing etc.). However, in the case of dolina 14 where a burnt layer is highly visible and very discretely delimited, we could not exclude the existence of structures in the dolina. We have checked this layer later for some datable material and found 1 Roman sherd lying directly on the top of the burning layer. It should not be ignored that in the same dolina (no. 3) other Roman sherds were also found at a later instance. In the case of dolina 16 we did not find any datable material that could be associated with the areas of higher magnetic susceptibility.

dolina	Total		prehistoric		Roman		Medieval		early modern		undatable		tiles	
	B	AF	B	AF	B	AF	B	AF	B	AF	B	AF	B	AF
14	10	5	1	0	3	0	2	1	0	2	1	0	3	2
15+16	24	16	19	13	0	0	0	1	1	0	1	0	3	2
17	59	12	51	8	3	0	2	1	1	1	0	0	2	2

Tab. 2: Chronological distribution of quantities of the sherds found in dolinas and in adjacent fields. Key: B - bottom of dolina; AF - adjacent field.

5. Conclusions

The crucial question we have to answer is the occurrence of the prehistoric and Roman pottery and the processes that brought it to the dolinas. Since these dolinas were never studied in more detail the appearance of artifacts in them was commonly explained as a result of the erosion from some nearby lying sites. Though the "erosion" hypothesis has actually not been checked in the past, it remained in use as a rather convenient and accommodating argument. As we were aware of this explanation, we paid special attention to it in our survey. Our conclusions proved to be completely different. All of the dolinas we surveyed are more or less on the flat terrain with no slopes or steeper surfaces. Actually, the only slopes from where we can expect this movement to take place are the slopes of the dolinas themselves. In all cases where we found larger quantities of sherds these seemed to be more or less evenly distributed at the bottoms and not clustered in one place (as the erosion accumulations).

Furthermore, in all cases we surveyed and in the reported cases (they account for more than 20) of the Prehistoric pottery found in dolinas we do not know of any settlement or archaeological site lying in the immediate vicinity from where the finds might have been eroded away. Quite the opposite, the closest known sites are some castellieri that are at least 1 km away. The only case where an archaeological site is adjacent to a dolina is no. 17 where a Roman settlement extended almost to the dolina's rim. Nevertheless, in surveying the dolina we found only 3 fragments out of 59 that are probably Roman; and even they could have been brought there by agricultural exploitation of the dolina and not through erosion. The fact that the Prehistoric pottery was found only in the dolinas where larger amounts of soil were extracted and deeper layers exposed, and only pre-Modern and Modern pottery was found in the upper layers and topsoil of the worked dolinas, speaks for the fact that many of the dolinas' bottoms have been raised several ten centimetres in the last couple of centuries and that layers with Prehistoric pottery were thus buried underneath. The same conclusion goes for the cases of the few Roman sherds.[15]

The other possibilities we can account for are the occupation of the dolinas, cemeterial use, or tillage. The cemeterial use is known from one case. In the beginning of this century a prehistoric cemetery was discovered in the dolina Ponikve near Škocjan (Righi, 1982). There were 92 cremation graves that can be divided into two main phases: the earlier phase (10^{th} - 8^{th} centuries B.C.) and the later phase (4^{th} - 1^{st} centuries B.C.). However, this case is exceptional in many respects - the origin of the dolina itself is to be associated with the collapsed geomorphology of the Škocjan caves; it is in the immediate vicinity of the Škocjan hillfort and in the very center of a wider archaeological complex extremely rich in sites from the Neolithic to the Medieval periods. Therefore, it cannot be used as a typical case for other dolinas. There was no evidence of similar finds in all of the dolinas containing prehistoric pottery (surveyed or reported).[16]

The occupation of dolinas is, at the present stage of our knowledge of the Kras archaeology, still very improbable. There were no settlements of any archaeological periods discovered in any dolinas until now.[17] Nor did we find any stronger evidence of settlement structures in our survey. Aside from relatively numerous fragments of vessels, we did not find any other Bronze and Iron age artifacts, like stone tools, flakes, querns, loam coating, dumb etc., suggesting habitation activities, settlements, or house structures. However, in the similar landscape in Central Dalmatia the remains of Prehistoric houses in some dolinas have recently been found. The excavation (Miloševič, Govedarica, 1986, 53-71) of a destroyed dolina with a diameter of 30 m near the village of Otišić (20 km NW of the town of Sinj) revealed 2 periods of use of the dolina: the Prehistoric period and the period of 15^{th} -16^{th} centuries AD. (The latter dates were attained from the C^{14} analysis. The samples have been taken out of 3 firing places discovered at the bottom of a dolina without any finds). Aside from the numerous, relatively uniform and very decorated pottery that belonged to the so-called Adriatic type of the Ljubljana pottery (Late Eneolithic/Early Bronze Age) and the Early Cetina culture, they also found 5 stone artifacts and the probable remains of houses in the central part of the dolina: 2 areas of beaten/hardened soil (possible floors?) and a posthole. They also checked other dolinas in the vicinity and discovered, in more than 10 of them, similar sherds. The authors are suggesting that many of the dolinas on the plateau of the village of Otišič in the Late Copper/Early Bronze age were used for smaller houses and were part of a larger settlement complex (Miloševic, Govedarica, 1986, 53).

At the moment, we do not have any similar finds from our dolinas. All prehistoric sherds that we found

15 This has also been the case of the dolinas archaeologically surveyed for the motorway construction in 1996. The prehistoric pottery was found only in the dolinas with completely or partly removed soil volume to a depth of more than 2 m (section Senožece - Divača (A. Bavdek pers. comm.), see also the SAAS reports for section Divača-Kozina (P. Novaković, B. Mušič, A. Bavdek).

16 However, we should not completely rule out the cemeterial use of some dolinas. Šlapšak (1974) recorded several cases of stories among local people about "black vessels filled with ash" (probably urns) found in dolinas.

17 The only exceptions are few cases of rock shelters, small abries, caves where the Mesolithic and Neolithic finds were discovered. Nevertheless, the logic and reason of this occupation is of a quite different nature.

are later than in the Dalmatian case, and they mostly belong to the Late Bronze and Early Iron Age periods. The layer containing extensive traces of fire from dolina 14 could be dated to no earlier than the Roman period and it requires a thorough excavation to prove the existence of structures.

At the present stage of research it is reasonable to expect that the majority of the pottery in the dolinas reflects the intensity of their agricultural use. That is certainly the case with the later pottery: Medieval and pre-Modern, brought there by manuring and trash depositing. It is also still possible to see in some places the relatively recent deposits of tiles in fields, where used for improving the soil (for better aeration of the soil, for diminishing the acidity, etc.); although tiles were never widely used in Kras before the 20th century.

Though the dating of the Prehistoric pottery could not be carried out in more detail, the pottery we found generally falls in the period of the castellieri (1st mill. B.C.), and so into the assumed period of the first demographic pressure in the Kras. Prior to the Late Bronze age, the number of castellieri seemed to be smaller (Karoušková-Soper, 1983, 170-175) and they were distributed more evenly regarding the fertile plots of land in Kras. We can reasonably suspect that more intensive use of dolinas in the Prehistory for agricultural purposes began with the Iron age (after 1000 B.C.), when more than 100 castellieri existed and exploited the land (fig. 8). Comparing their number, density and proximity to the neighbouring ones, their catchments rarely exceed more than 15 km^2 in this period (average radius of the sample of 18 castellieri site catchment is between 2-2.5 km according to the calculations of Karoušková-Soper, 1983, 171-2). These calculations also show the figure of an average of only 2% of the agricultural land in their catchments. Since the best soils are in dolinas, it seems reasonable that dolinas were quite intensively used in subsistence strategies. Furthermore, all dolinas containing the Prehistoric pottery are relatively far from the closest known castellieri, halfway or even at the edge of their catchments; we can thus expect that there had to be even more intensive exploitation of the suitable dolinas closer to the settlements. On the other hand, the exploitation of dolinas that are halfway or on the margins of the catchments could implicate the lack of agricultural land and the extensive pressure on the existing resources.

The Roman period is clearly underrepresented by the pottery found in the dolinas. This argues to a certain extent, against the fact that in the Roman period inhabitants tended to settle in the lowland areas and less on the hilltops. From this period some villages and rare villa-type sites are known that agriculturally exploited and cleared larger lowland areas that are close to the later Medieval and Modern villages; for example, Lokev, Sežana, Rodik, Povir, Kopriva, etc. (Slapšak, 1996) comprised the areas with numerous dolinas. The case of dolina 17 features probably the best example of this kind. However, dolinas containing Roman pottery are still very few. The reason for this is still not known. This could be partly answered by the difficulties in recognising some of the local Roman period coarse wares that had been more or less made in the same way as the Prehistoric pottery. It is worth repeating that in all of the emptied dolinas where we found numerous Prehistoric sherds, all other periods, including the pottery from the last couple of centuries, were clearly underrepresented. Nevertheless, the problem is still an open one and requires further investigation. Dolina 14, containing the untouched remains of fire, can be a good case for excavation.

Finally, there is still an open question concerning how the Prehistoric pottery actually came to the dolinas. Erosion could account only for the movement of finds from the slopes or rims of dolinas and only to a minimal extent, as explained above. More substantial evidence for the permanent or temporary occupation of these depressions are also lacking. On the other hand, the agricultural use of dolinas could bring finds in various ways. Manuring is highly improbable, since the flocks of sheep and goat were rather mobile and not kept at home. This argument suits well the pre-Modern times when the farmers turned to cattle grazing and farm enclosures were established to stall the animals. This change meant an additional demand for ameliorations of the dolinas by cutting the outcropping stones so that grass, destined for haymaking, could be mowed with a scythe (Gams, 1987, 66-67; Sauro, 1994, 115). Cattle was not a common livestock in the castellieri period. The faunal remains from the Prehistoric sites in the Trieste Kras depict a clear prevalence of ovicaprids over pigs and bovids, the latter being the least numerous with a few exceptions (Karoušková-Soper, 1983, 201).

It is evident that in pre-Modern times farmers used to improve the quality of soil by adding rubble, tiles and other hard material they discarded as garbage. If similar practices existed in the Prehistory as well, it is difficult to say at the present stage of research; although this interpretation should not be overlooked. It is to be expected that the inhabitants of Kras were well aware of the landscape they lived in. Its strengths and its weakenesses and their long standing habitation there from the earliest Prehistory onwards had allowed them to adapt themselves to the environmental conditions and adjust the environment to their needs when this was possible. It was shown that these karst depressions played an important role in the economy of the people living in Kras and the differences in the intensity and type of their use can serve as indicators of long-term social and economic practices in the past. Since dolinas were among the rare places constantly rich in soils, their symbolic and particular meanings for the people who exploited them

should not be ignored. They had to invest large amount of work, time and man-power to make them suitable for agriculture, and they had to maintain them constantly. Consequently, they had to know the dolinas, their agricultural potential, soil characteristics, micro-climate etc. in a great detail to be able to exploit them fully. Does the pottery brought to the dolinas merely reflects the existence of the agricultural explotation of these karst feature or can we assume some other accompanying meanings associated with these activities? Large investments of experiences, knowledge and physical efforts, and consequentially the expectations from such an important subsistence resource, should have had an impact on the cognition of the landscape and on some practices which could not be explained by the utilitarian meanings only. Although we do not intend to expand our speculations, it is obvious from our case study that the mutual impact between man and the landscape led the former to certain decisions and activities that are not fully understood yet. However, they reflect the human perception of the surrounding nature and a need to appease if not tame it in the material and symbolic ways as well. A further research, including excavation of dolinas as well as a more thorough investigation of the *castellieri*, will hopefully fill the archaeological gap in this region and answer many of the questions raised in this paper.

Epilogue

In the last two years, after our study was completed and presented at the conference in Aix-en-Provence, new cases of archaeological sites in dolinas came to light. Some of them were discovered during the archaeological surveys for motorway constructions and some were chance discoveries reported either by the locals or by the archaeologists. Nevertheless, in all the cases where the prehistoric pottery was discovered the dolinas were emptied of their soil, and all we were able to get were grab samples. However, in two cases (a dolina on the motorway section Divača - Kozina and a dolina near the village of Tupelče) the stratigraphy was preserved clearly, showing the layers containing the prehistoric pottery. These two cases might add an important information to our present perspective. Nevertheless, the number of dolinas containing archaeological finds are at the present stage more than 30 and it is reasonable to assume that we have found only the tip of the iceberg. Undoubtedly, we are dealing with a new type of sites and their high number and density will chalenge our concepts about the prehistoric settlement patterns in Kras. Unfortunately, the process of emptying the dolinas is still going on at a high rate and with no archaeological control. Thus we may easily find ourselves in a situation of losing crucial information before we actually comprehend this type of sites.

ARHEOLOGIJA KRAŠKIH DOLIN

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POVZETEK

Kraške doline oziroma vrtače sodijo med najbolj značilne pojave matičnega Krasa. Definirane so kot srednje velike kraške depresije, katerih premer v povprečju sega od 5 do 300 m in katerih razmerje med daljšo in krajšo osjo je običajno od 1:6 do 1:10. Najpogosteje se pojavljajo na izrazito apnenčastih terenih z veliko precipitacijo, veliko redkeje pa na konglomeratih in dolomitih. Njihova gostota je običajno v obratnem sorazmerju z njihovo velikostjo. Prav tako so precej bolj pogoste na ravnih tleh. Kraške doline so že zelo zgodaj pomenile velik izziv za številne preučevalce kraške geomorfologije. Čeprav so se s problemom kraških vrtač ukvarjali številni strokovnjaki, njihov izvor še vedno ni docela pojasnjen. Na splošno obstajajo tri vrste teorij o njihovem nastanku: korozijska teorija, po kateri naj bi kraške doline nastale na kraških tleh, kjer je bila zaradi razpok in bolj topnega apnenca korozija hitrejša kot v okolici; udorna teorija, po kateri naj bi vrtače nastajale zaradi udorov podzemnih "praznin", ter teorija, ki vidi nastanek vrtač v specifičnih značilnostih posameznih mikrolokacij, na katerih je, kljub sicer uniformnim procesom na celotnem območju, prihajalo do hitrejšega zniževanja površja.

Še vse do tega stoletja so bile kraške vrtače predstavljale zelo pomemben dejavnik v tradicionalnem poljedelstvu. Predvsem zaradi svoje specifične oblike predstavlja kraška vrtača mikro-ekosistemsko enoto s specifično mikro-klimo in prstnimi značilnostmi, ki za kraške okoliščine omogoča dovolj donosno poljedelstvo. Eden najpomembnejših razlogov za intenzivno izrabo vrtač v poljedelske namene je velika količina prsti, akumulirana v njih, prav slednja pa je poleg padavin in površinske vode najbolj kritičen dejavnik za poljedelstvo na Krasu. Podnebje

kraške planote, ki je kombinacija submediteranskih in celinskih podnebnih elementov ter značilnosti geološke osnove in talnega pokrova so dolgoročno zaznamovali oblike subsistenčne ekonomije v preteklosti (pridobivanje poljedelskih površin s krčenjem gozdov in trebljenjem terena, deforestacija, zelo velik pomen drobnice, mešano poljedelstvo...). Način življenja, ki je stoletja zahteval nenehno vzdrževanje kakovosti naravnih virov, je ustvaril specifično kulturno krajino Krasa, ki jo sestavljajo gručasta vaška naselja, poljski zidovi, groblje otrebljenega kamenja, terase, kali in nenazadnje tudi "delane" vrtače.

Poznavanje načina življenja na Krasu in izrabe vrtač je bilo do sedaj v glavnem omejeno na zadnjih nekaj stoletij. Historične in geografske študije so, predvsem zaradi zelo pomanjkljivih virov, zelo redko obravnavale starejšo regionalno ekonomsko in socialno zgodovino tega prostora. Številne novejše arheološke najdbe v vrtačah lahko v marsičem dopolnijo naše poznavanje vrtač in njihove izrabe v preteklosti. Zaradi njihove vse večje pogostnosti smo se odločili za preliminarno arheološko raziskavo z namenom, da bi ugotovili nekatere osnovne značilnosti tega novega tipa arheoloških najdišč.

Odločili smo se za arheološki pregled 19 vrtač (sl. 8). Izbrane vrtače smo razvrstili v dve vzorčni skupini. Vrtače 1-13 so sestavljale vzorčno skupino, o kateri nismo imeli nobenih informacij o arheoloških najdbah. Poleg tega je to zelo strnjena skupina vrtač, različnih velikosti in stopnje ohranjenosti. Druga skupina vrtač (14-19) je sestavljala vzorec vrtač, v katerih so bile odkrite arheološke najdbe. Glavna in, kot se je kasneje izkazalo, zelo pomenljiva razlika med obema skupinama je bila v tem, da so bile v drugi skupini vrtače, ki so bile delno ali pa v celoti izpraznjene. Rezultati arheološkega pregleda so predstavljeni na tabelah I. in II. Pokazalo se je, da sta bili v vrtačah najpogostejši dve kronološki skupini keramičnih najdb - fragmenti posodja iz prazgodovinskega obdobja v petih vrtačah in iz predmodernega obdobja v osmih vrtačah. V vrtačah, kjer je bilo najdeno veliko prazgodovinske keramike smo tudi opravili meritve magnetne susceptibilnosti, ki so potrdile antropogene sledove ognja v njih.

Menimo, da je takšen kronološki klaster najdb pomenljiv kazalec obdobij intenzivnejše poljedelske izrabe na Krasu. Za obe obdobji je značilna gosta poselitev. V pozni bronasti, zlasti pa železni dobi je bilo na Krasu več kot 100 prazgodovinskih gradišč (kašteljirjev), ki so nastajala predvsem okrog površin z večjo količino prsti (npr. gradišča med Senožečami in Dolenjo vasjo, gradišča v okolici Repentabora, gradišča okrog Vremske doline, gradišča med Brestovico in Devinom...). Naselbinski vzorec iz predmodernega obdobja pa izhaja iz srednjeveške poselitve po veliki ekonomski krizi v 14. stoletju. Povečane količine keramičnih najdb iz obeh obdobij povezujemo predvsem z intenzivnejšo izrabo vrtač v poljedelske namene. Pomembno vprašanje, ki smo ga z našo raziskavo pravzaprav samo načeli, je, kako so keramične najdbe dejansko prišle v vrtače. Proti hipotezi, da je erozija zanesla prazgodovinske ostanke z bližnjih najdišč, govori veliko kazalcev: bolj ali manj enakomerna distribucija najdb v posameznih vrtačah, nobenih ostankov prazgodovinske keramike v višjih plasteh vrtač in nenazadnje tudi nobenih prazgodovinskih najdišč v njihovi neposredni bližini. Za predmoderno in moderno obdobje imamo veliko dokazov o tem, da so ljudje odlagali smeti v vrtače (našli smo kupe starega gradbenega materiala in strešnikov) oziroma da so fragmenti keramike prišli v vrtače z gnojenjem (odlaganje črepinj na gnojišča). Za prazgodovinsko obdobje nimamo podobnih dokazov. Gnojenje ni verjetna hipoteza, kajti črede drobnice, ki so jih v prazgodovini vzgajali, so bile precej mobilne. Veliko bolj verjetno se nam zdi, da so bili kosi lončenine namensko dodajani prsti vrtač. Takšen običaj je nedvomno obstajal v zadnjih stoletjih. Z dodajanjem grušča, odlomkov strešnikov in drugega trdega materiala so kmetje povečevali zračnost prsti. Vsekakor še ni dovolj dokazov o podobnih metodah v bronasti in železni dobi, vendar te možnosti ne smemo izključiti. Takšni razlagi v prid govori tudi dejstvo, da smo v vseh primerih prazgodovinskih ostankov našli samo dele lončenine. V vrtačah ni bilo najdenih ostankov hišnega lepa, odbitkov kamnitih orodij oziroma drugih tipov artefaktov, ki bi morebiti kazali na naselbinsko izrabo. Zgodnji prebivalci Krasa so nedvomno morali, če so hoteli uspešno gospodariti s skopimi naravnimi viri, zelo dobro poznati naravne razmere okolja, v katerem so živeli. Nedvomno je, da so že v prazgodovini poznali vrtače kot zelo pomembne lokacije plodne prsti, ki pa so zahtevale stalno vzdrževanje oziroma investiranje velikih količin dela in znanja.

Ključne besede: vrtača, Kras, kras, arheološki pregled, topografija, kultivirana krajina, izraba tal

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