SOIL FORMATION IN THE MEDITERRANEAN TYPE OF CLIMATE, SOUTH COST OF THE CRIMEA

F.N. LISETSKII[1], Å.I. ÅRGINA[2]

[1]Department of Geoecology and Rational Nature Use, University of Belgorod, Belgorod, 308007, Russia; [2]Astonomical Observatory of Crimean Republican Educational-Research Center, Simferopol, Crimea, 333000, Ukraine.

INTRODUCTION

In the region of the mountainous Crimea two districts have been distinguished: the Main mountain-meadow-forest Range and Crimean Southern Coast of the sub-Mediterranean type. Climate here - submediterranean hot arid. Long-term climatic data is as follows: mean annual temperature, 13.0 °Ñ; mean July, 24.0°; mean January, +4.0°; sum of active temperature more 10°, 3940°. Mean annual precipitation reaches 550 mm. The vegetation is dominated by dry juniper-oak forests and shibliaks of the Mediterranean type. Existence of the evergreen plants likens western part of Crimean Southern Coast with communities of maquis in the Mediterranean countries. In western Mediterranean forests and scrubs, primary production can vary largely between 77 and 1500 g $\cdot m^{-2}$ $\cdot year^{-1}$ (Bergkamp, 1996). Under Crimean forests production averaged 370-390 (under pine (*Pinus Pallasiana Lamb.*)) and 520-570 g $\cdot m^{-2}$ $\cdot year^{-1}$ (under oak (*Quercus pubescens Willd*)). Soils - cinnamonic soils are typical for the Southern Coast and particularly south-western part of the mountainous area. Total square of cinnamonic mountainous soils of dry forests and shibliaks comes to 48500 ha, including cinnamonic soils on residual deposits and deluvium of solid rocks - 67 %.

MATERIAL AND METHODS

The pedological investigations at Crimea are based on the identification of soil morphology in conformity with archaeological age of substratum (Table 1).

Table 1 - Principal objects of the study area.

Geographic region	Object of study	Soil	Ah, cm	Humus, %
Cape of Ai-Todor, buttress Monastyr-Burun	Ruins of Fedor Tiron's Church Õ c.	Red-cinnamonic soil on thick limestone of upper Jurassic	0-6 6-15.5	2.2 1.4
Cape of Ai-Todor, altitude 77 m	Upper defence wall of Roman fortress Haraks (I c. B.C. - III c. A.C.)	Cinnamonic soil: - on eluvium carbonat rock; - on platy parting of limestone	0-10 10-27 0-19	7.0 6.0 10.1
Eastern Gursuf, Cape of Plaka (magmatic diapir)	Defence wall Õ c.	Cinnamonic soil on eluvium carbonat and rocks	0-13 13-27	4.6 -
Gursuf Amphitheat-re, butte Krasniy Kamen, altitude 500 m	Defence wall ÕI c.	Cinnamonic soil on rock debris of marble limestone	0-8 8-16	8.0 -
Be west of t.Yalta - butte Krestovaja, altitude 255 m	Defence wall ÕIV-XV cc.	Cinnamonic soil on calcareous debris	0-5.5 5.5-14	8.4 8.4
South foot of Demerdzhi-Jaila, altitude 400 m	Fortress Funa, was destroyed in 1475	Cinnamonic soil on calcareous debris	0-18 ÀÂ, 18-31	6.4 5.4

For the synthesis of the conditions of warm and moisture provision of zone community of soils and vegetations the bioenergetic approach is used (according to Volobuev, 1974), supposing the conduct of counting up of energy outlay on soil formation (Q, $MJ \cdot m^{-2} \cdot yr^{-1}$) by the following formula:

$Q = 41.87[R \cdot \exp(-18.8 \cdot R^{0.73} / P)]$,

where R is the radiation balance, $kcal \cdot cm^{-2} \cdot yr^{-1}$; P - sum of precipitation, mm.

RESULTS AND DISCUSSION

Energy outlay on soil formation (Q), as one of very important parameters of the mathematical model of the soil-forming process (Lisetskiy, 1994), averaged 1270 $MJ \cdot m^{-2} \cdot yr^{-1}$ for conditions of the Crimean Southern Coast. In the Crimean Mountains with raising on every 100 m yearly average temperature decreased on 0.69°, but precipitation increased, the energy outlay on soil formation on height 500 m slightly increased to 1330 $MJ \cdot m^{-2} \cdot yr^{-1}$. These are limits of area cinnamonic soils.

Humus horizon thickness in 20 cm has been formed on thick rocks and 28 cm on calcareous rock debris for 1200 years of soil development. Humus accumulation mainly depended on tipes of parent rock: by 800 yr reorganization of the calcareous residual deposits accumulated 8 %, in following contents increased slightly. The values of humus contents for soils with complete profile (Holocene age) were high, varying between 7 and 9 %, but for agrolandscapes conditions (vineyards, tobacco, essentially-oil-producing crops) contents varied between 2.0 and 3.8 %. Soil formation after 17 centuries restoration of soil properties

(Table 2) describes locations covered with the primary mountainous Crimea's flora (*Quercus pubescens, Pistacia mutica, Juniperus excelsa, Ruscus ponticus*).

Table 2 - Indicators of the cinnamonic soils a 1700-year-old on defence walls of Roman fortress Haraks (Cape of Ai-Todor).

Soil indicators	Upper wall Horizon and depth (cm)			Lower ("tavric") wall Horizon and depth, cm	
	A_0, 0-5	Ah, 5-16	AB, 16-31	Ah, 0-7.5	AB, 7.5-16
Color (by Munsell)					
dry	10YR3/2	10YR3/2.5	10YR4/2	5YR3/2	5YR3/3
moist	7.5YR3/1	7.5YR3/2	7.5YR3/2	7.5YR3/2	5YR3/2
Bulk density, g/cm^3	0.51	0.56	0.73	0.52	0.65
Humus, %	8.5		8.4	8.7	8.3
N_{gross}, %	0.250		0.246	0.908	
C : N	19.7		19.8	5.6	5.3
$CaCO_3$, %	27.07		21.14	0	0

Numerous investigators have depicted the relationship between soil properties and time (soil chronofunctions) as being exponential (Bockheim, 1990). We found that the development of the cinnamonic soils followed an exponential dependence with time. Taking into consideration the dependence of the thickness of humus horizon (H_t, mm) of the main soils in the Eastern European Plain on heat and moisture, the establishment of vegetation, time and composition of the parent rocks, we will get the model (Lisetskiy, 1994)

$$H_t = 10.85\, g\, (F_f / F_z)^{0.37}\, e^{0.0044Q} (1 - ke^{-\lambda t}),$$

where g - coefficient, which reflects granulometric composition (0.72÷1.40); F - annual production of vegetation, $t\ ha^{-1}\ yr^{-1}$: F_f - actual; F_z - zonal; Q - annual outlay of energy on soil formation; t - time, year; k, λ - coefficients, which were received from pedochronological facts.

Generalization of facts for 14 dating surfaces in zone of Mediterranean climate of Crimean Southern Coast gives according to the above-mentioned model estimation of yearly average increase of humus horizon's thickness at first 2000 years of soil formation 0.083 mm/óear or about 1 $t{\cdot}ha^{-1}{\cdot}yr^{-1}$. It is interesting, that little sediment discharge from erosion (in the order of magnitude of 0.05 to 1 $t{\cdot}ha^{-1}\ yr^{-1}$) was generally measured to be produced on slopes covered by natural or semi-natural vegetation within Mediterranean geoecosystems (Bergkamp, 1996). Consequently, below natural vegetation rates of sediment detachment and soil formation regainedbalance.

REFERENCES

BERGKAMP, G., (1996). Mediterranean geoecosystems - hierarchical organisation and degradation. Amsterdam, 238 pp.

BOCKHEIM, J.G., (1990). Soil development rates in the Transantarctic Mountains. Geoderma, vol. 47 : 59-77.

LISETSKIY, F.N., (1994). The place of soil formation values in the problem of rate setting soil loss tolerance. Proc. of an Intern. workshop on soil erosion. Purdue Univ., West Lafayette, IN. : 391-399.

VOLOBUEV, V.R., (1974). Introduction to energetics of soil formation. Nauka, Moscow, 127 pp. (in Russian).